ENERGY RATE IMPACTS ON KENTUCKY INDUSTRY

prepared for
Commonwealth of Kentucky

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EXECUTIVE SUMMARY

The Commonwealth of Kentucky has long enjoyed among the lowest retail electricity rates in the U.S., which has attracted to Kentucky manufacturing industries that are particularly dependent upon electricity. Unfortunately, Kentucky's electricity price advantage, which is due to Kentucky's access to cheap coal-fired electricity generation, seems likely to erode over coming years as its utilities comply with federal standards intended to mitigate the adverse effects of the atmospheric emissions of coal-fired generation. The issues that are raised by this prospective erosion in energy competitiveness include the following:

- Through what measures, if any, should the Commonwealth provide assistance to industrial customers to mitigate the impact of rising electricity costs?
- To what extent, if any, should the Commonwealth provide assistance to heavy industrial electricity customers to preserve the jobs and the economic benefits that those jobs provide?

These questions are particularly acute because of the present circumstances of Kentucky's two aluminum smelters, the Hawesville facility owned by Century Aluminum (Century) and the Sebree facility owned by Alcan Primary Products Corporation (Alcan). According to the smelters, they are under financial pressure because the recent decline of the world price of aluminum makes their operations unprofitable or barely profitable. Because electricity comprises roughly one-third of the cost of producing aluminum, these firms are seeking concessions in the prices that they pay to Big Rivers Electric Corporation (Big Rivers), their electricity supplier.

The purpose of this report is to examine the options open to the Commonwealth for mitigating the adverse impacts of rising electricity costs on heavy industry in the Commonwealth of Kentucky. Consistent with this purpose, this report presents, as a case study, an examination of what other states and utilities have done to assist aluminum smelters and other heavy industrial users of electricity to mitigate rising electricity costs. The policy options and recommendations provided by this report therefore apply both to the Commonwealth's industry in general and to the aluminum smelters in particular.

Methods

This study examines issues and policies associated with retention of Kentucky business in five particular manufacturing industries: aluminum smelting; automobile manufacturing; chemical processing; paper mills; and steel making. To obtain relevant information on the design and success of business retention programs for the five target industries, this study focuses on those states that meet one or more of the following criteria:

- States in which are located aluminum smelting facilities, including facilities that have been closed over the past decade.
- States in which are located automobile manufacturing, chemical processing, paper mills, and/or steel making facilities.
- States that are likely to be Kentucky's direct competitors for manufacturing retention and attraction.

We have gathered information from the Internet, from other states' agencies (e.g., public utility commissions), and from Kentucky parties.

Rationale and Legal Bases for Economic Development Programs

Economic development programs provide net benefits only when their benefits (including those to government, businesses, and residents) exceed their costs. For example, a government subsidy could help retain jobs and businesses, thereby causing the government to end up with more in taxes on profits, wages, and sales than it spent on subsidies or gave up in the way of foregone tax revenues. As another example, electricity price discounts could help retain business customers that make a net contribution to the utility's fixed cost recovery, while the absence of such discounts might lose both the customers and the net contribution.

To create such benefits, all states and many local governments within them have passed legislation promoting economic development through a wide variety of mechanisms. Kentucky's economic development rates (EDRs) go back at least to 1988, when the Kentucky Public Service Commission (Commission) accepted such rates in a case involving the Louisville Gas and Electric Company. The Commission's authority to approve EDRs was tested in the mid-2000s in a case involving Duke Energy Kentucky, wherein the Kentucky Supreme Court found EDRs lawful on the basis of the controlling statutes and longstanding administrative construction of those statutes by the Commission.

Government-Sponsored Economic Development Programs

States and local governments use several general types of programs and mechanisms to promote economic retention and development of large industry. These include:

- *Tax-based incentives* that reduce an industrial firm's taxes when the firm undertakes some type of economic activity that supposedly would not have occurred — or would have occurred to a lesser degree — without the tax reduction.
- *Low interest loans* or *grants* that are provided by government agencies for economic development, energy efficiency, and other public purposes.
- *Industrial Development Bonds (IDBs)* that are basically corporate bonds with the income tax benefits of municipal bonds because they are issued by a governmental entity.
- *Targeted investment programs* that invest state dollars in local industry.

Studies of Kentucky's economic development incentives have differed in their findings of whether Kentucky's programs have significantly created jobs. Such studies have found the following:

- Kentucky compares favorably to its peers in terms of the overall numbers and types of business incentive programs that it offers.
- Kentucky's business incentives are similar to those offered by its competing states. The differences among states lie in the types of credits, training, and financing offered.
- The cost of all incentive programs is small relative to the sizes of Kentucky's economy and taxes, amounting to less than 1% of total state revenues.
- Kentucky incentives during 2001-2010 created jobs that lasted for an average of five years, and had a gross cost to the state averaging $3,330 per job per year. A broad-based tax reduction could have provided between 35% and 71% of the jobs created.
- Relative to its peer states, Kentucky has relatively low shares of knowledge-based employment and research-intensive industries. On the other hand, these shares are growing relatively quickly, and Kentucky's incentive programs are generally available to knowledge-based and high-tech firms.
- Kentucky's business tax and labor cost environment is competitive compared to peer states.
- Kentucky is behind peers in educational attainment and certain types of infrastructure. Kentucky is not using its incentive programs to address weaknesses in these areas.
- Kentucky is in the top half of peer states in its offering of targeted incentives; but other states have unique programs that include funding for infrastructure development and technology transfer assistance.
- Claimed tax incentives are positively correlated with employment and earnings growth: in a county with average employment, a $91,036 increase in tax incentives is predicted to increase employment by 3.40 jobs and earnings by $218,280.
- The Bluegrass State Skills Corporation (BSSC) training program is positively correlated with employment and earnings growth. The long-term (five years) impacts of tax incentives and BSSC training incentives on employment and earnings are as much as four times larger than the short-term impacts.
- Financing programs have no significant correlation with either employment or earnings.

Utility Economic Development Programs

There are three main types of programs that utilities employ to directly and indirectly reduce the impact of electricity costs on business customers and to encourage those customers to remain, expand operations, or locate in the utility's service territory. They are: electricity rate discount programs that reduce the prices that customers pay for electricity; financial support programs that pay for some non-electricity costs that would otherwise be borne by customers;

and information programs that help customers reduce energy costs or otherwise encourage business expansion or retention.

Rate discount programs may attempt to attract large customers to abandoned "brownfield" buildings, to urban areas that are deemed to need revitalization, or to any location within the utility's service territory. Program participation may require that the customer maintain a minimum load factor, add a minimum amount of load, create a minimum number of jobs, or invest a minimum number of dollars in new plant or equipment. Rate discounts are usually given for increases in a customer's peak demand and/or electrical energy consumption, and are almost always set as a percentage of charges. Most discounts are constant for a set period of one to five years, and then end; but some discounts phase out by falling from year to year.

Financial support programs give money or credits to large industrial customers for specified purposes, particularly to improve the efficiency of customers' energy use. Energy efficiency incentive programs may provide incentives either for several standard energy efficient technologies with consistent quantitative benefits, or for energy-saving technologies that are peculiar to particular industries or particular customers. These incentive programs require applicants to provide substantial detail concerning the energy-related characteristics of their technologies, and can also require that the energy savings be verifiable, measurable, and persistent for a minimum period of time such as five years. A few utilities offer construction assistance programs that pay for facilities that are owned by the customer, infrastructure assistance programs pay for facilities that serve a particular customer but are owned by the utility, or loans.

Information programs are of several types. Many of these programs provide customers with information concerning how they can use energy more efficiently. Some programs provide customers with information about the contractors who can help implement energy-savings measures. Other programs seek to facilitate economic development by informing customers about the availability and suitability of industrial sites or about the benefits of doing business in the utility's service area.

Industrial Customers' Energy Efficiency Measures

There are numerous energy efficiency-improving measures that are common among heavy industries. All of the Kentucky industry representatives with whom we spoke indicated that their industry members had adopted many, if not all, of these common and industry-specific measures.

Evaluation of Economic Development Programs in Kentucky

As an economic matter, an economic development program should be undertaken only when its expected benefits exceed its expected costs. As a policy matter, programs should be evaluated as they proceed (or *ex post*) to distinguish the program characteristics that provide net benefits from those that do not.

Evaluation of economic development programs entails measuring both direct and indirect benefits and costs over time. The direct benefits can be measured in terms of the number of jobs retained or created, the wages and benefits paid to those workers, and the incremental capital investments made by the firms receiving the incentives. These direct benefits can be compared to the cost of the incentive program in terms of the direct payments to industry and reduced revenues for state and local governments.

The indirect benefits arise from the businesses that are indirectly supported by the businesses receiving the incentives. This support can be in forms of: a) purchases of products by the incentive recipient; b) purchases of products by employees of the incentive recipient; and c) reduced supply costs for businesses that buy the services of the incentive recipient. The usual approach for measuring the indirect impacts of the economic activity fostered by an incentive program is to apply a "multiplier" to direct benefits: a dollar of incentives might be assumed to create an additional $0.30 of economic activity, for example, so the multiplier would be 1.30. Multipliers are applied to the measured direct outcomes — such as jobs, investment, and income — thereby providing an estimate of total economic activity (hence the benefit) attributable to the incentives.

The literature on business incentives offers the following major implications:

- The impacts of economic development incentives on economic growth are difficult to measure because of the confidentiality of the tax data needed for such evaluation.
- Most states do not regularly evaluate their economic development incentive programs.
- Studies tend to find a positive relationship between development incentives and economic growth, but this finding might partly be due to the studies' general failure to adequately consider variations in jurisdictions' business climates.
- Counties that win the competition for large new industrial plants enjoy dramatically higher economic growth after the plants are built; but it is not clear that the benefits of that higher growth are larger than the incentives paid for that growth.
- The empirical evidence shows no significant impact of enterprise zone programs, tax abatement programs, or tax increment financing programs.
- One study was unable to determine whether Kentucky's Industrial Development Act, Rural Economic Development Act, and Jobs Development Act significantly impacted the state's economy.

State- and utility-sponsored studies of business incentives generally find positive job creation and economic development benefits of such incentives.

Infrastructure Alternatives to Economic Development Programs in Kentucky

Kentucky's infrastructure – particularly its transportation network and educational system (which influences workforce skills) – is a major determinant of businesses' decisions to invest in Kentucky enterprises. Several Kentucky business representatives expressed the views that: a) Kentucky's transportation infrastructure and geographic location are major attractions for

doing business in Kentucky; and b) Kentucky's workforce participants often lack the skills that they need, making it costly for business to attract skilled workers or to provide training to upgrade workers' skills. Workforce quality is a particular concern of business.

In considering how to spend its scarce economic development dollars, the Commonwealth needs to consider whether it is likely to get a better bang for its buck through incentive payments to businesses or by providing businesses with the infrastructure that they need. More accurately, the Commonwealth needs to find the most effective combination of direct and infrastructure support for business.

The World Aluminum Industry

The sales of Kentucky's aluminum smelters and the prices that they are able receive for their sales depend upon the worldwide supply of and demand for aluminum.

The world's production of primary aluminum has been rising at an average annual rate of 3.3% since 1974, and at the faster rate of 5.4% since 2000. Alcoa expects this growth rate to rise to 6.5% per annum during the present decade, roughly doubling global consumption and supply between 2010 and 2020. By contrast, North American primary aluminum production dropped from 5.5 million metric tons in 1974 to 5.0 million metric tons in 2011.

At any point in time, the price of aluminum is fairly uniform all over the world, though it does vary by several percent from place to place depending upon transport costs. The monthly average London Metals Exchange (LME) price for aluminum has exhibited high volatility over the past twenty-five years, reaching a high of $3,578 per metric ton in 1988 and a more recent high of $3,067 in 2008. The simple average monthly price has been $1,773 per metric ton over the past twenty-five years and $2,084 per metric ton over the past decade. Recent LME cash and forward prices indicate that aluminum market participants expect today's price of around $2,068 per metric ton to increase by about 15% to $2,375 per metric ton by the end of 2015.

Electricity accounts for an average of about a third of the cost of primary aluminum production. Consequently, aluminum firms locate their plants where electricity prices are relatively low; and they face the risk that, after building a plant in a low-price location, electricity prices might rise at that location with the passage of time. In 2010, Kentucky's electricity prices, at $43.50 per megawatt-hour (MWh) for its smelters, were high relative to those offered by the utilities that serve smelters elsewhere in the world, which had an average price of $26 and a median price of $30. Just as smelters came to Kentucky decades ago because of Kentucky's relatively low electricity prices, so smelters today are being built where electricity prices are lowest.

The U.S. Aluminum Industry

The North American share of world aluminum production has been falling for decades. It was 41% in 1974 but only 11% in 2011. This near continuous downward trend in North American share in world aluminum output is partly due to the rise in production costs in the U.S. relative to the rest of the world, but is also due to the spectacular industrialization of the developing world, particularly in the Far East. The rising U.S. production costs are due both to increasing

electricity rates and to the aging of U.S. smelting facilities: about 74% of the nameplate capacity of U.S. aluminum smelters resides in facilities built before 1970, though these older facilities have generally been upgraded over the years. By contrast, the new smelters have recently been built in areas of the world that have the cheapest electricity prices, particularly from hydropower and abundant natural gas, and sometimes due to government assistance. These new smelters not only enjoy the advantage of cheap electricity but also often enjoy lower labor costs and greater operational efficiencies based upon the most up-to-date technologies. Some U.S. smelters have closed because of rising electricity prices.

Of the 24 aluminum smelters that were in operation in the U.S. in 2000, only 10 remain in operation today, and one idled smelter awaits possible restart. As plants have closed during these past dozen years, U.S. employment in aluminum smelting declined at a faster rate than U.S. aluminum production. Between 1999 and 2011, production fell by 47% while employment declined by 61%.

The decline of the U.S. primary aluminum smelting industry has occurred partly because of increasing U.S. electricity prices relative to those paid by smelters elsewhere in certain parts of the world. Other input costs, such as labor wages and benefits, have also increased in the U.S. relative to some other regions of the world (e.g., India, Middle East). In addition, the technologies employed by newer smelters in particular parts of the world (e.g., Middle East and Africa) have the advantages of newer and more efficient production technologies.

Of the eight smelter facilities operating in U.S. states other than Kentucky, five receive discounts from their utility, without state assistance. Of these five smelters, four receive discounts subject to employment requirements, two receive discounts based upon LME, and one each receives a discount subject to a production requirement, investment requirements, or power consumption requirements. To support their smelters, two states legislated increases in the discretionary authorities of their utility or regulatory commissions.

Kentucky's Aluminum Smelters

Representatives of Kentucky's aluminum industry have informally requested Commonwealth or utility financial assistance in maintaining their profitability, along with the associated employment and economic benefits. They claim that their rate discount requests amount to $80 million per year, while Big Rivers claims that these requests amount to $110 million per year. Century Aluminum has also requested substantial changes in its electricity service arrangements.

Kentucky's Hawesville and Sebree aluminum smelters have been in operation since the 1970s and are major employers in western Kentucky, with about 1,259 employees and positive local and statewide impacts. Their operations bring dollars to western Kentucky in the form of payments to employees and suppliers, and reduce the input costs for those nearby industries that use aluminum in their production processes.

Alcan says that its Sebree smelter creates 1,834 "total" jobs in Kentucky – 488 "direct" jobs at the Sebree plant plus 1,346 "indirect" and "induced" jobs in Kentucky, for a total value creation

in Kentucky of $198 million per year. We believe that these benefits are substantially overstated, particularly because the indirect impacts are likely to be a fraction of those claimed and because the net impacts that are relevant to policy decisions (particularly Commonwealth support) are a fraction of the gross impacts that are stated by the value creation figure.

A report produced by a consultant for Century states that its Hawesville plant creates 1,241 total jobs for Kentucky – 771 direct and 470 indirect, with total wages and benefits of $95 million per annum. We believe that the indirect impacts are fairly stated, though the net impacts that are relevant to policy decisions will be a fraction of the gross impacts indicated by the wages and benefits figure.

The Kentucky Smelters' Electricity Service

Kentucky's smelters receive their electricity service through the Kenergy Corp., which is a distribution cooperative member of Big Rivers. While the smelters must use the power delivery services provided by Kenergy and Big Rivers because of their physical location within Kenergy's service territory, they have at various times purchased the electric power itself from Big Rivers or from Louisville Gas & Electric (LG&E); and they could, in principle, purchase electric power from other generation-owning entities or from the MISO market.

Big Rivers built most of its generating facilities in the 1970s and 1980s, partly in response to the smelters' needs. It supplied the smelters' electric power until 1998, including a period, beginning in 1987, when the smelters' electricity price was based on the world price of aluminum. It entered bankruptcy in 1996; and when it reorganized in 1998, it leased all of its generating assets to an LG&E subsidiary, which thereupon had operational control of the assets and was responsible for selling electric power to the smelters under pricing agreements that were set to expire in 2010 and 2011. In 2009, a set of agreements among LG&E, Big Rivers, Kenergy, and the smelters, called the "Unwind Transaction", resulted in Big Rivers regaining control of its generating assets and resuming its role as supplier to the smelters. Among the agreements, each smelter has with Kenergy a Retail Electric Service Agreement (backed by a mirror Wholesale Electric Service Agreement between Kenergy and Big Rivers) that provides the smelter with long-term, cost-based power, on a take-or-pay basis, through December 31, 2023, and gives each smelter the right to terminate service on one year's notice "in connection with the termination and cessation of all smelting operations".

Earlier this year, Century proposed that it be allowed to purchase electric power on the open market (e.g., MISO) instead of from Big Rivers. On August 20, 2012, Century gave Big Rivers its one-year notice of service termination for the Hawesville plant. On September 14, 2012, Century made a proposal by which it would continue operations if it could obtain "a new long-term power contract… providing for up to 482 MW of power at a pass-through rate for market purchases by Kenergy."

Alcan, by contrast, has not provided a notice of termination of its Retail Electric Service Agreement for its Sebree facility, nor has it expressed a desire to purchase power on the open market. Alcan has indicated, however, that any increase in the rate paid by the Sebree facility carries a significant probability that Alcan will also provide its one-year notice of termination of

the Sebree facility Retail Electric Service Agreement, and that this is especially likely if aluminum prices remain at or near the levels prevailing in mid-2012.

Big Rivers has indicated that, if one or both smelters went to the open market, one of its options would be to idle some its generation resources and thereby potentially avoid or postpone many millions of dollars of costs of retrofitting its coal-fired generators to meet U.S. Environmental Protection Agency (EPA) environmental requirements. Consequently, Big Rivers is willing, in principle, to allow both smelters to purchase power on the open market; but it insists that both smelters agree to any arrangement that requires amendment of their contracts.

The smelters' electricity rates are determined by the Retail Electric Service Agreements. The smelters pay several charges for their electricity service, the largest of which is an energy charge that is "determined by applying the Large Industrial Rate to a load with a 98% load factor, and adding an additional charge of $0.25 per MWh."

Big Rivers faces two predominant financial risks. The first is that it may lose the smelters' loads or that it may need to renegotiate the terms under which it serves the smelters. The second risk arises from Big Rivers' dependence upon coal-fired generation, which is becoming more expensive over time as environmental regulations tighten.

Century and Alcan have each told Kentucky economic development officials that they need lower electricity rates for their facilities to be sustainable. Century has said that a rate averaging about $34 per MWh through 2015 would make the Hawesville plant competitive, while Alcan has indicated that the Sebree facility is no longer profitable at the low aluminum prices prevailing in the middle of 2012.

Both aluminum prices and market electricity prices have been volatile in recent years; and it is more than a little likely that this volatility will continue in the future. Furthermore, aluminum prices and market electricity prices are correlated, tending to move up and down together with the booms and busts of the general economic cycle. It is clear that market conditions – in the aluminum and electricity markets, singly and in combination – can and will drive smelters back and forth between profits and losses from year to year and, sometimes, from month to month. In parts of the world where electricity costs are always low, it is possible for a smelter to always run a profit; but it is not possible for a smelter to run a profit in every month at the market electricity prices that have been seen in the past several years, and likely will be seen in the next several years, in the Midwestern United States.

Smelter closure would have three sorts of rate impact. First, Big Rivers would lose the smelters' contribution to fixed cost recovery. This contribution equals the difference between the smelters' contract prices and Big Rivers' short-run marginal cost (SRMC) of serving the smelters. Second, Big Rivers would lose some contribution to fixed cost recovery from its sales to those parties (e.g., employees and upstream suppliers) whose income is wholly or partly dependent upon the smelters' business. This indirect revenue loss could be mitigated if some other industrial firms move into the smelters' sites or other available locations. Third, Big Rivers may be able to avoid spending many millions of dollars retrofitting its generators to meet EPA environmental requirements. The net effect of these factors would be a loss to Big Rivers that

would be compensated through increased electricity prices for remaining customers. The rate increase to remaining customers could cause these customers to reduce their electricity purchases, as a result of either price-induced electricity conservation or business curtailments or closure.

To maintain its financial viability, Big Rivers would need to recover lost contributions to fixed cost recovery from its other customers to the extent that it cannot reduce its costs to offset these losses. In other words, Big Rivers cannot provide rate discounts to the smelters without raising the rates of its other customers to make up for the reduced revenue from the smelters, at least in the short run.

Based upon publicly available information, it appears that, for the single year 2013, non-smelter customers would be better off: a) with an $80 million smelter discount than with the smelters buying power directly from the wholesale electricity market; and b) with the smelters buying power directly from the wholesale electricity market than with a $110 million smelter discount. Different forecast market electricity prices could yield a different result, and results could be different for different years. Based upon confidential data for the years 2014 through 2022, the rate impacts on non-smelter customers are worst for the $110 million discount scenario, and best for the scenario in which only one smelter (i.e., Hawesville) closes.

Big Rivers has made plans for and taken specific actions partly in contemplation of losing the smelters' loads. MISO's huge electricity market provides a ready outlet for Big Rivers' sales of excess capacity (if the smelter loads are lost) and of Big Rivers' power purchases (if it retains smelter load but foregoes retrofitting some of its generation). Over time, Big Rivers could enter into long-term power sales arrangements, close excess generating plants, or undertake other mitigation measures.

Recommendations to the Commonwealth

As a first principle, the Commonwealth of Kentucky should try to spend its scarce economic development dollars in a manner that gives it the greatest bang for its buck. Among other things, this principle means that the Commonwealth needs to determine what combination of infrastructure development and direct support to industry best facilitates the state's economic growth in both the short- and long-terms. A reasonable person might wonder, for example, whether the $80 million per year that the smelters seek for the purpose of retaining 1,375 jobs might be better spent on re-training the smelters' displaced workers, who are already skilled.

As a second principle, a short-term fix for any industry only makes sense when there are good long-term prospects for that industry. A key question about the smelters is whether they will be able to stand on their own in the long run. Looking at the prices of electricity around the world, at the long-term cost pressures that are presently facing America's coal and electricity industries, at where new smelters are being built, and at the long-term decline of the smelter industry in the U.S., a reasonable person might wonder whether the U.S. smelter business is a good long-term bet. If short-term support for Kentucky's smelters will see them through short-term problems so that they prosper in the long-run, then the short-term support can make sense. But if the smelters' problems are long-term and the short-term support would merely

postpone their shutdowns by a few years, then the Commonwealth's resources would be better spent on more promising long-term prospects.

The following options have been suggested as means for addressing the aluminum smelters' cost issues.

- *Electricity Price Discounts*. Since a utility's revenue requirement is more or less a fixed number of dollars, a price reduction for one customer usually requires a corresponding price increase for another customer. To minimize the costs borne by a utility's other customers, the utility should endeavor to set the price discounts for participating customers so that, considering electricity price impacts on attraction, retention, or expansion of the participating customer's business, the participating customers make the largest possible contribution to the utility's recovery of its fixed costs. This implies that price discounts should never be so large as to result in participating customers paying prices that are below the utility's SRMC, because prices below the utility's SRMC would result in a loss on every kWh sold to participating customers. For Big Rivers, the SRMC for serving the smelters is the sum of: a) the MISO market prices of the generation services (i.e., energy, regulation, and operating reserves) necessary to serve smelter load; plus b) the costs of administering the smelters' accounts; plus c) any transmission costs that are incremental to the smelters' needs. Any revenue that Big Rivers can derive from the smelters above SRMC would financially benefit Big Rivers' other customers relative to the smelters closing. Price discounts for the smelters should not bring the smelters' electricity prices below SRMC. Instead, the discounts should be set at the minimum level consistent with the smelters remaining in business, but no more than the amount that would bring the smelters' price down to SRMC. Any price discount that brought the smelters' price below SRMC would burden Big Rivers' other customers with not only all of Big Rivers' fixed costs, but also with an additional subsidy to the smelters.
- *Direct Access to Electricity Markets*. It appears that Century is interested in direct access to wholesale electricity markets but that Alcan is not interested. In principle, direct access can promote efficient electricity markets by better connecting consumers with suppliers. In practice, there is a risk that large customers will seek direct access when electricity market prices are relatively low, saddling small customers with the burden of paying for the utility's relatively high costs; and that large customers will seek to return to the utility when market prices are relatively high, taking from small customers part of the benefits of relatively low utility costs. If Kentucky allows the smelters (or any other large customers) to have direct access, it should not allow "heads I win, tails you lose" behavior: **as a matter of fairness to the utility's core customers, the utility should have no obligation to resume providing generation services to those customers who choose direct market access.**
- *Electricity Prices Pegged to World Aluminum Prices*. Pegging the electricity prices paid by aluminum smelters to the world price of aluminum turns the utility into a speculator in world aluminum markets: the utility's revenues and profits go up and down with the LME price. It is reasonable for a firm that is in the aluminum business to face the risks of

aluminum price uncertainty, but it is less reasonable for a utility that is in the electricity business to face such risks. If Big Rivers offered the smelters electricity prices that are pegged to world aluminum prices, the electricity prices should be no lower than Big Rivers' SRMC. Because present MISO electricity prices indicate that this SRMC is well above the average electricity prices of $26 per MWh faced by the world's smelters, it may simply not be possible for Big Rivers to match the electricity prices that are paid by most of the world's other smelters.

- *Forgiveness of Big Rivers' Debt*. At the end of 2010, Big Rivers had total long-term debt of $817 million, of which $675 million was due to the U.S. Department of Agriculture's Rural Utilities Service, and nearly all of the rest were County of Ohio, Kentucky, tax-exempt pollution control bonds. Renegotiation of this debt would occur only under the threat (or actuality) of Big Rivers' bankruptcy, which would only occur if the Commission refused to allow Big Rivers to raise rates sufficiently to avoid bankruptcy. Our understanding is that the Commission would be required to approve such a rate request in view of long-standing legal limits on regulatory discretion in the setting of "just and reasonable rates."

- *Big Rivers' Merger or Acquisition*. Big Rivers combining with another entity would do nothing to solve the smelters' fundamental business problems nor the financial risks to any utility that serves the smelters, both of which arise from conditions in the world market for aluminum. The "advantage" of a merger or acquisition would be that any shifting of electricity costs of service from the smelters to other customers would be shared by a larger number of other customers, which would make such a shift less painful for Big Rivers' other customers but would place a new cost burden on the customers of whatever utility combined with Big Rivers. Even if a combination could be created, the smelter rate discount for the combined entity would be limited by about the same SRMC as for Big Rivers alone.

- *Economic Development Support by the Commonwealth*. The economic development support that existing Kentucky legislation offers is not likely to be sufficient to enable the smelters to remain economically viable in the long-term without significant increases in world aluminum prices. The Commonwealth would therefore have to pass special legislation to enable it to provide sufficient support to the smelters. Such legislation should be conditioned on the belief that such support will enable the smelters to stand on their own in the long run.

- *Mitigating the Adverse Effects of a Smelter Closing*. If a smelter is not financially viable in the long run, then Kentucky is best advised to devote its resources to mitigating the adverse impacts of the smelters' closing rather than sinking its resources in keeping the smelters open for a few more years, after which those adverse impacts will occur anyway. The mitigation can come in several forms, including: a) attraction of other industries with better long-term financial prospects; b) job training of former smelter employees; and c) information services regarding job opportunities elsewhere in Kentucky.

While the smelters' financial problems are most urgent, other large industrial firms in Kentucky also face the challenges of competition in global markets and of rising energy and environmental compliance costs. Any solutions that the Commonwealth or Big Rivers offer to the smelters would be, in principle, applicable to other industries as well. The options for the smelters would have similar strengths and weaknesses if applied to other industries. There are, in addition, a number of other policies that could be pursued that would help strengthen other large industrial firms or help mitigate the impacts of any future plant closings. We recommend serious consideration of the following policies:

- *Continue to rebalance utility rates* to reduce or eliminate any existing cross-subsidies from industrial customers to commercial and residential customers.
- *Devote greater resources to Kentucky's educational system*, including technical training and employee re-training.
- *Provide greater assistance and guidance to business on the use of Industrial Revenue Bonds* to help small to medium sized business invest in energy efficiency projects; and
- *Establish a revolving loan program* to support business investment in energy efficiency projects.

ENERGY RATE IMPACTS ON KENTUCKY INDUSTRY

1. INTRODUCTION

U.S. manufacturers have long competed in worldwide markets for their products; and the U.S. share of world markets in many manufacturing industries has been falling for decades as the dispersion of technology and reductions in transportation costs (among other factors) have improved the competitiveness of foreign firms. In this competitive climate, it is imperative for U.S. industry to improve its operating efficiencies and minimize the costs of its inputs. For manufacturers whose electricity costs are large shares of their total costs – such as aluminum smelters, steel producers, paper and chemical processers – the price of electricity can have large impacts on their market competitiveness and, in turn, on the jobs they provide to their communities, on other commercial enterprise that depends on those jobs, and on the tax revenues of state and local governments.

The Commonwealth of Kentucky has long enjoyed among the lowest retail electricity rates in the U.S., which has attracted to Kentucky manufacturing industries that are particularly dependent upon electricity. Unfortunately, Kentucky's electricity price advantage, which is due to Kentucky's access to cheap coal-fired electricity generation, seems likely to erode over coming years as its utilities comply with federal standards intended to mitigate the adverse effects of the atmospheric emissions of coal-fired generation. The issues that are raised by this prospective erosion in energy competitiveness include the following:

- Through what measures, if any, should the Commonwealth provide assistance to industrial customers to mitigate the impact of rising electricity costs?
- To what extent, if any, should the Commonwealth provide assistance to heavy industrial electricity customers to preserve the jobs and the economic benefits that those jobs provide?

These questions are particularly acute because of the present circumstances of Kentucky's two aluminum smelters, the Hawesville facility owned by Century Aluminum (Century) and the Sebree facility owned by Alcan Primary Products Corporation (Alcan), a wholly-owned subsidiary of Rio Tinto. According to the smelters, they are under financial pressure because the recent decline of the world price of aluminum makes their operations unprofitable or barely profitable. Because electricity comprises roughly one-third of the cost of producing aluminum, these firms are seeking concessions in the prices that they pay to Big Rivers Electric Corporation (Big Rivers), their electricity supplier. Big Rivers, which is a generation and transmission cooperative that is owned by three distribution cooperatives[1], received about 55% of its total

[1] The distribution cooperative members are Jackson Purchase Energy Corporation (headquartered in Paducah), Kenergy Corp. (Henderson), and Meade County Rural Electric Cooperative Corporation (Brandenburg). The smelters are both served by Kenergy.

2011 revenue from the two smelters, who comprised about 52% of Big Rivers' mega-watt hour sales.

If either of the smelters closed, there is the distinct possibility that resulting rate increases on the remaining industrial customers could cause a domino effect by which other industrial customers (notably including the other smelter) might close as well. The shift of Big Rivers' costs currently borne by the smelters to the remaining residential, commercial, and industrial customers would result in a large increase in the those customers' electricity bills, the exact size of which would depend upon the circumstances of the closing(s) and the extent to which Big Rivers can mitigate the cost shifts through reductions in costs or revenue offsets. Furthermore, the loss of the approximately 1,300 jobs that the two smelters provide would have a large economic impact on some of the communities served by Big Rivers' distribution cooperatives as well as on neighboring communities.

The situation with the aluminum smelters has broad implications for the Commonwealth's policies regarding economic development, energy efficiency, and utility rate setting. Consequently, this report addresses the broad economic development issues while treating the smelter situation as the immediate policy case.

1.1. Purpose

The purpose of this report is to examine the options open to the Commonwealth for mitigating the adverse impacts of rising electricity costs on heavy industry in the Commonwealth of Kentucky. The report accomplishes this objective by:

- Ascertaining the legal basis for the recent provision of state and local assistance programs to energy-intensive industrial and manufacturing companies. The focus is on those programs that are designed to offset high electricity prices or anticipated increases in electricity prices, thereby lowering these companies' production costs and enhancing their market competitiveness.
- Ascertaining the types of economic development programs and mechanisms by which other states support the market competitiveness of their energy-intensive industry and manufacturing facilities.
- Identifying and evaluating the energy efficiency measures (i.e., best practices) that have been implemented by energy-intensive industries and manufacturing companies in other states. Programs in other states may suggest new opportunities in Kentucky to respond to increasing electricity prices by providing loans or other financial assistance to undertake enhanced energy efficiency actions that are newly cost-effective.

Consistent with its purpose, this report presents, as a case study, an examination of what other states and utilities have done (or are currently seeking to do) to assist aluminum smelters and other heavy industrial users of electricity to mitigate rising electricity costs. The policy options and recommendations provided by this report therefore apply both to the Commonwealth's industry in general and to the aluminum smelters in particular.

1.2. Organization of Report

This report is organized as follows. Section 2 describes the methods that are used in this study. Section 3 explains the rationale and legal bases for economic development programs. Sections 4 and 5 survey and describe significant types of government-sponsored and utility-sponsored economic development programs. Section 6 describes energy efficiency measures, with a focus on five major Kentucky industries. Section 7 evaluates the types of economic development programs described in Sections 4 and 5. Section 8 discusses the aluminum industry and its markets. Finally, Section 9 makes recommendations.

The main body of the report is followed by two appendices. The first appendix presents the survey instruments that we used to gather a part of the information that underlies this report. The second appendix lists some of the measures that Kentucky's steel industry has taken to improve its energy efficiency.

2. METHODS

This section describes the scope of this study, the sources of its information, and its evaluation techniques.

2.1. Scope of Study

This study examines issues and policies associated with retention of Kentucky business in five particular manufacturing industries: aluminum smelting; automobile manufacturing; chemical processing; paper mills; and steel making.[2] Each of these industries is represented in Kentucky by multiple facilities and, except for automobile manufacturing, is among the top eight energy-intensive industries in the country. The study focuses in greatest detail on the smelters' situation.

To obtain relevant information on the design and success of business retention programs for the five target industries, this study focuses on those states that meet one or more of the following criteria:

- States in which are located aluminum smelting facilities, including facilities that have been closed over the past decade.
- States in which are located automobile manufacturing, chemical processing, paper mills, and/or steel making facilities.
- States that are likely to be Kentucky's direct competitors for manufacturing retention and attraction.

Table 1 presents the resulting list of states that are covered by this report, and also indicates which of the five industries have a presence in each state.

[2] Much of what is discussed in this report applies to other Kentucky industries as well.

Table 1
Industries and States Covered by This Study

State	Alum.	Auto	Chem.	Paper	Steel
Illinois		Y	Y		Y
Indiana	Y	Y	Y	Y	Y
Kentucky	Y	Y	Y	Y	Y
Missouri	Y	Y	Y		
Montana	Y			Y	
North Carolina	Y		Y	Y	Y
New York	Y		Y	Y	Y
Ohio	Y	Y	Y	Y	Y
South Carolina	Y	Y	Y	Y	Y
Tennessee		Y		Y	Y
Texas	Y	Y	Y	Y	Y
Washington	Y			Y	Y
West Virginia	Y	Y	Y		Y

2.2. Sources of Information

We have gathered information from the Internet, from other states' agencies (e.g., public utility commissions), and from Kentucky parties.

The Internet provides massive information on legislation, regulation, case law, government and utility economic development programs, and the organization and markets of the five target industries.

Kentucky parties provided significant information about circumstances specific to Kentucky. We gathered information from these parties through survey questionnaires[3], memoranda, in-person interviews, and telephone interviews. The Kentucky parties included representatives of the following organizations:

- Alcan Primary Products Corporation
- ALJ Regional Holdings, Inc.
- AK Steel Corporation
- Big Rivers Electric Corporation
- Century Aluminum Company
- Gallatin Steel
- Kenergy

[3] See Appendix A.

- Kentucky Association of Manufacturers
- Kentucky Chamber of Commerce
- Kentucky Industrial Utility Customers
- Kentucky House of Representatives
- Kentucky Legislative Research Commission
- Kentucky Public Service Commission
- Kentucky State Senate
- LG&E and KU Energy LLC
- North American Stainless
- Southwire Company
- United Steelworkers

The interviews, which were mostly in-person, provided information (among other things) on Kentucky's business climate, global and national competition faced by Kentucky manufacturers, Kentucky's economic development programs, and Kentucky's electricity rates and ratemaking policies.

3. RATIONALE AND LEGAL BASES FOR ECONOMIC DEVELOPMENT PROGRAMS[4]

Economic development programs provide net benefits only when their benefits (including those to government, businesses, and residents) exceed their costs. For example, a government subsidy could help retain jobs and businesses, thereby causing the government to end up with more in taxes on profits, wages, and sales than it spent on subsidies or gave up in the way of foregone tax revenues. As another example, electricity price discounts could help retain business customers that make a net contribution to the utility's fixed cost recovery, while the absence of such discounts might lose both the customers and the net contribution.

3.1. Law and Regulation

To create such benefits, all states and many local governments within them have passed legislation promoting economic development through a wide variety of mechanisms. In Kentucky, economic development programs sponsored by state government, particularly those that have a jobs retention component or requirement, are founded on the following key legislation:

- The Kentucky Industrial Revitalization Act (1992) provides income tax credits if 25 jobs are maintained, subject to verification of plant closing endangerment.

[4] For purposes of this report, we define "economic development programs" as those including business retention and expansion.

- The Kentucky Reinvestment Act (2003) provides income tax credits for businesses making investments, subject to each participating firm maintaining 85% of a full employment target.
- The Kentucky Small Business Investment Credit (2009) provides income tax credits for businesses with less than 100 employees who hire at least one additional employee and make an investment of $5,000 or more.
- The Kentucky Business Investment Program (2009) provides corporate tax incentives and wage-related incentives for approved companies for up to 15 years in enhanced incentive counties or up to 10 years in other counties. It combines and replaces the Kentucky Industrial Development Act, the Kentucky Rural Economic Development Act, Kentucky Jobs Development Act, and the Kentucky Economic Opportunity Zone.[5] It requires the creation of at least 10 new full time jobs maintained by businesses making investments of at least $100,000.

Kentucky's economic development rates (EDRs) go back at least to 1988, when the Kentucky Public Service Commission (Commission) accepted such rates in a case involving the Louisville Gas and Electric Company.[6] The Commission thereafter initiated an investigation regarding the implementation of EDRs by gas and electric utilities, focusing particularly on their feasibility, design, and implementation. Based upon the testimony of various parties, the Commission issued an order that outlined the rules for the use of EDRs in Kentucky, and that has served as the foundation for such rates ever since.[7] The order found that EDRs would "provide important incentives to new large commercial and industrial customers to locate facilities in Kentucky and to existing large commercial and industrial customers to expand their operations, thereby bringing much needed jobs and capital investment into Kentucky."[8] Since that time, EDRs have usually been implemented through utility company negotiations with qualifying customers followed by submission of the resulting contracts to the Commission for approval. The reduced rates are subject to the constraint that "No utility shall, as to rates or service, give any unreasonable preference or advantage to any person or subject any person to any unreasonable prejudice or disadvantage, or establish or maintain any unreasonable difference between localities or between classes of service for doing a like and contemporaneous service under the same or substantially the same conditions."[9]

[5] Kentucky Revised Statute (KRS) 154.32-010 – 154.32-100.

[6] See *In the Matter of: Adjustment of Gas and Electric Rates of Louisville Gas and Electric Company*, PSC Case No. 10064 (Ky. PSC July 1, 1988).

[7] See *In the Matter of: An Investigation into the Implementation of Economic Development Rates by Electric and Gas Utilities*, Admin. Case No. 327 (Ky. PSC Sept. 24, 1990).

[8] *Id*., p. 25.

[9] KRS 278.170(1).

3.2. Cases

The Commission's authority to approve EDRs was tested in the mid-2000s. In June 2004, Duke Energy Kentucky initiated a proceeding before the Commission in which it requested implementation of two general EDR rates as "riders" to its general schedule of rates. The Commission eventually approved the riders, thus allowing the utility to make a standing offer to qualifying customers, subject to individual contracting between the utility and the customer, and further subject to Commission approval. The Kentucky Attorney General intervened to challenge the proposed EDR riders as unlawful: a) under KRS 278.170 because the recipients of the reduced rates are not authorized to receive reduced rate service; and b) under KRS 278.030 and 278.170 because the classifications employed and the resulting rates are unjust and unreasonable. On appeal of the Commission's approval of Duke Energy Kentucky's EDR riders, the Franklin Circuit Court determined that the EDR riders are lawful and reasonable under the relevant provisions of KRS Chapter 278. On further appeal, the Court of Appeals reversed, concluding that reduced rates are not available in Kentucky to any class of utility customer not specifically identified in KRS 278.170(2) and (3). On final appeal, the Kentucky Supreme Court reversed the appeals court's decision, finding the EDR riders lawful on the basis of the controlling statutes and longstanding administrative construction of those statutes by the Commission.

4. GOVERNMENT-SPONSORED ECONOMIC DEVELOPMENT PROGRAMS

States and local governments use several general types of programs and mechanisms to promote economic retention and development of large industry. These include the following:

- *Tax-based incentives* reduce an industrial firm's taxes when the firm undertakes some type of economic activity that supposedly would not have occurred — or would have occurred to a lesser degree — without the tax reduction. Such tax reductions are usually implemented as income tax credits or exemptions, sales and use tax refunds or exemptions, or property tax reductions and exemptions (including Tax Increment Financing[10]). Although tax-based incentives directly reduce government tax revenues, they can lead to increased economic activity that indirectly augments government revenues. Tax-based incentives have been widely used as an economic development tool by state and local governments throughout the U.S., particularly for the purposes of inducing or maintaining capital investment, research and development, and job creation.
- *Low interest loans* are sometimes provided by federal, state, and local government agencies for economic development, energy efficiency, and other public purposes.

[10] Tax Increment Financing (TIF) gives a property tax exemption or reduction to investment projects that promise to encourage development or redevelopment in a particular area, thus offering the prospect of property tax revenues from the increased value of the real estate near the TIF investment projects. TIF decisions are based upon property tax expectations, even though TIF projects may also indirectly generate sales tax and income tax revenues.

- *Grants* are sometimes provided by federal, state, and local government agencies for the same public purposes as low-interest loans.
- *Industrial Development Bonds (IDBs)* are tax-exempt securities issued by a governmental entity to provide money to private companies for their acquisition, construction, redevelopment, and/or equipping of manufacturing facilities. IDBs are basically corporate bonds that enjoy the income tax benefits of municipal bonds, thus enabling private enterprise to pay low municipal bond interest rates instead of higher corporate bond interest rates. Legal responsibility for repayment of the bonds rests with the private companies for whom the bonds are issued.
- *Targeted investment programs* are state-sponsored programs that invest state dollars in local industry, often in association with the investment of state pension funds. Such programs provide capital for start-up companies, for expansion of existing businesses that lack sufficient cash flow or credit access to fund future growth, for infrastructure projects, and for joint ventures with business.

The Kentucky Legislative Research Commission recently issued a report (the Incentives Report) that compares and assesses Kentucky's economic development incentives relative to those of thirteen peer states (Alabama, Arkansas, Georgia, Illinois, Indiana, Missouri, North Carolina, Ohio, South Carolina, Tennessee, Texas, Virginia, and West Virginia).[11] The major findings of the Incentives Report are as follows:

- Businesses receiving Kentucky incentives during 2001-2010 claimed creation of 55,173 jobs, resulting in an average of 33,000 retained jobs per year. The report does not "claim that these jobs were directly caused by the provision of the incentive."[12] On the other hand, the report found no systematic over-reporting of jobs created.
- The data indicate that the jobs thus created lasted for an average of five years, though the data appear to be incomplete.
- For 2001-2010, Kentucky's gross cost of tax incentives was $1.29 billion, including $1.01 billion of foregone tax revenues, $0.15 billion in grants and forgivable loans, and $0.13 billion of operating costs for the Cabinet for Economic Development. The average gross cost was thus $3,330 per job per year.
- Even assuming that all jobs claimed for the incentives were in fact due to the incentives, a broad-based tax reduction would have provided between 35% and 71% of the jobs created, depending upon the particular incentive program.[13]

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[11] C.M. Sallee, C. Spencer, J. Horwitz, and A. Rosaen, *Review of Kentucky's Economic Development Incentives*, Anderson Economic Group, prepared for the Kentucky Legislative Research Commission, June 11, 2012. (Incentives Report)

[12] *Id*., p. 79.

[13] A higher percentage (e.g., 71%) indicates that a broad-based tax reduction is relatively more effective and a targeted incentive is relatively less effective. A lower percentage (e.g., 35%) indicates that a broad-based tax reduction is relatively less effective and a targeted incentive is relatively more effective.

- Relative to its peer states, Kentucky has relatively low shares of knowledge-based employment and research-intensive industries, though these shares are growing relatively quickly.
- "Kentucky's business tax and labor cost environment is competitive compared to peer states, but it is behind peers in educational attainment and certain types of infrastructure. Kentucky mostly uses its incentive programs to reinforce good components of its business environment, rather than addressing its weaknesses."[14]
- "Kentucky is not using its incentive programs to address weaknesses in the areas of infrastructure development and a lack of skilled labor."[15] Infrastructure, education, and labor force quality are high on the list of factors that businesses consider important in making decisions about where to locate.[16]
- Kentucky's incentive programs are generally available to knowledge-based and high-tech firms.
- Kentucky is in the top half of peer states in its offering of targeted incentives; but other states have unique programs that include funding for infrastructure development and technology transfer assistance.

Table 2 reproduces (with some rearrangement) a table from the Incentives Report that shows the types and total number of incentive programs offered by each state. The table also shows the number of incentive programs that have a requirement that a participating company must create and/or retain a certain number of jobs in order to receive incentive benefits.

Table 2 shows that Kentucky compares favorably to its peers in terms of the overall numbers and types of business incentive programs that it offers. Kentucky relies more heavily than most of its peers on tax incentives and on job creation or retention requirements. While not shown in the table, Kentucky is unique in that most of its incentive programs pay program participants on the basis of their performance in meeting program requirements, thus avoiding the need to recover ("claw-back") funds from participants who fail to keep their promises.

[14] Incentives Report, p. 13.

[15] *Id.*, p. 44.

[16] *Id*., p. 43 ff.

Table 2
Summary of Incentive Types Offered In Kentucky and Peer States[17]

State	Tax Breaks	Grants	Loans	Bonds	Investment Programs	Total	Job Creation Requirement	Percent with Jobs Requirement	Percent with Tax Breaks
Kentucky[18]	12	1	3	1	0	17	7	41%	71%
Alabama	11	3	1	0	0	15	4	27%	73%
Arkansas	16	4	5	4	3	32	7	22%	50%
Georgia	11	3	4	1	0	16	8	50%	69%
Illinois	4	10	7	1	0	22	3	14%	18%
Indiana	4	4	0	2	1	11	3	27%	36%
Missouri	16	3	4	3	1	27	6	22%	59%
North Carolina	6	2	1	1	1	11	6	55%	55%
Ohio	5	2	7	2	0	16	8	50%	31%
South Carolina	29	1	0	1	0	31	7	23%	94%
Tennessee	15	6	4	1	0	26	10	38%	58%
Texas	4	2	3	1	0	10	3	30%	40%
Virginia	2	6	8	0	0	16	6	38%	13%
West Virginia	17	5	5	2	1	30	6	20%	57%
Totals	152	52	52	20	7	280	84	30%	54%
Average Peer State	11	4	4	1	1	20	6	29%	53%

A University of Kentucky study, published in 2007, reached similar conclusions about Kentucky's use of its incentives programs.[19] The conclusions of that study included the following:

- Kentucky's business incentives are similar to those offered by its competing states. The differences among states lie in the types of credits, training, and financing offered.
- Since 1992, the use of tax incentives has substantially increased while the use of financing programs has substantially fallen.

[17] *Id*., Table 19, p. 39.

[18] Kentucky's total of 17 active incentives does not include the four incentives that were replaced when the Kentucky Business Investment (KBI) program was created in 2009. Businesses still receive incentives under the former programs. The Office of Commercialization and Innovation supports several incentives that could be considered investment programs but are not included in this table.

[19] W. Hoyt, C. Jepsen, and K.R. Troske, An Examination of Incentives to Attract and Retain Businesses in Kentucky, submitted to the Kentucky Cabinet for Economic Development, University of Kentucky Center for Business and Economic Research, January 18, 2007, p. iv.

- The cost of all incentive programs is small relative to the sizes of Kentucky's economy and taxes, amounting to less than 1% of total state revenues.
- Claimed tax incentives are positively correlated with employment and earnings growth: in a county with average employment, a $91,036 increase in tax incentives is predicted to increase employment by 3.40 jobs and earnings by $218,280.
- The Bluegrass State Skills Corporation (BSSC) training program is positively correlated with employment and earnings growth: in a typical county, a $7,004 increase in this program is predicted to increase employment by 2.79 jobs and earnings by $160,146.
- Financing programs have no significant correlation with either employment or earnings.
- The long-term (five years) impacts of tax incentives and BSSC training incentives on employment and earnings are as much as four times larger than the short-term impacts.
- Kentucky's business incentives created an annual average of 4,981 additional jobs, during the period 1996 to 2004, implying that the $925 million that was spent on business incentives during these years increased Kentucky's employment in 2004 by 2%.

Whether state economic development incentives actually spur new economic activity — and whether they do so in a cost-effective manner — are important concerns. This is particularly true in times of fiscal and economic stress, when state policymakers must balance a desire to spark the economy with the need to cope with budget deficits. Unfortunately, determining an incentive program's benefits is inherently difficult, partly because it is impossible to know the level and mix of economic activity that would occur without the credit. Thus, the two reports just cited reach different conclusions: while the recent Incentives Report is agnostic about whether Kentucky's incentives programs have significantly created jobs, the 2007 University of Kentucky study does find a significant job creation benefit.

5. UTILITY ECONOMIC DEVELOPMENT PROGRAMS

This section reviews the main types of programs and services that utilities employ to directly and indirectly reduce the impact of electricity costs on non-residential customers (including energy-intensive industrial customers) and to encourage those customers to remain, expand operations, or locate in the utility's service territory. We divide these programs into three types: electricity rate discount programs that reduce the prices that customers pay for electricity; financial support programs that pay for some non-electricity costs that would otherwise be borne by customers; and information programs that help customers reduce energy costs or otherwise encourage business expansion or retention. This section is organized accordingly.

5.1. Electricity Rate Discount Programs

Many electric utilities offer rate discounts for the purpose of attracting or retaining non-residential customers and the jobs and wealth created by the businesses of those customers. These rate discount programs are generally distinguished by having three different, but related, purposes:

- *Economic development programs* attempt to generally attract or retain large customers;
- *Economic re-development programs* attempt to attract large customers to abandoned "brownfield" buildings; and
- *Economic development zone programs* attempt to attract large customers to urban areas that are deemed to need revitalization.

This section reviews a sample of such discount programs offered by select utilities. Table 3 lists the programs that we examined, indicating the utilities and states that are served by those programs. The table also indicates which of the five target industries are served by the utilities that offer these programs.

For each program, this section describes customer eligibility requirements and the discounts.

5.1.1. Customer Eligibility Requirements

Table 4 summarizes many of the eligibility requirements for customer participation in the programs listed in Table 3. Table 4 indicates that some programs allow variants on these eligibility requirements so that, for example, customers may substitute greater capital investment for fewer jobs (as with Duke Energy Indiana's Rider 58) or customers with different qualifications may be eligible for different discounts (as will be seen in Table 5 for AEP's Indiana Economic Development Rider).

Some rate discount programs have minimum load factor requirements.[20] Of the programs sampled, these minima range from 40% to 65% on a monthly basis.[21]

Nearly all rate discount programs require customers to add minimum amounts of loads. Of the utilities sampled, these minima range from 100 to 1,500 kilowatts (kW) or kilovolt-amperes (kVA).[22]

[20] A customer's "load factor" is defined as the ratio of that customer's average load to its peak load. A customer with the same load in every hour would have a load factor of 100%. Customers with highly variable loads, like residential customers, have load factors below 50%. Load factor is an important determinant of utility costs: the higher a customer's load factor, the lower is the average per-kWh cost of serving that customer. Consequently, utilities can offer lower electricity rates to customers with high load factors than they can offer to customers with low load factors.

[21] In the table, the Ameren load factors are on an annual basis.

[22] Some programs define requirements in terms of the peak load of a new customer or the load that would otherwise be lost. In both cases, these loads can be regarded as "incremental loads" relative to the customer's load in the absence of the rate discount program.

Table 3
Sample of Electricity Rate Discount Programs

Utility[23]	State	Schedule / Rider Number	Schedule/Rider Name	Industries Served				
				Aluminum	Automobile	Chemicals	Paper	Steel
Ameren	MO	EDRR	Economic Development & Retention	X		X		
Ameren	MO	ERR	Economic Re-Development	X		X		
AEP	IN	[ED]	Economic Development					X
Duke Energy	IN	54	Brownfield Redevelopment		X			X
Duke Energy	IN	58	Economic Development		X			X
Duke Energy	IN	59	Urban Redevelopment		X			X
Duke Energy	KY	BR	Brownfield Redevelopment			X		
Duke Energy	KY	DIR	Development Incentive Rider			X		
Duke Energy	NC	EC	Economic Development	X			X	X
Duke Energy	NC	ER	Economic Redevelopment	X			X	X
Duke Energy	SC	EC	Economic Development		X		X	
Duke Energy	SC	ER	Economic Redevelopment				X	
Duke Energy	SC	ER	Economic Redevelopment				X	
LG&E/KU	KY	EDR	Economic Development		X		X	
NIPSCO	IN	677	Economic Development					X
NREMC	IN	EDR 4.2	Economic Development Service					X
NREMC	IN	EDR 5	Economic Development Service					X
Progress Energy	NC	ED-9	Economic Development				X	
Progress Energy	NC	ERD-5	Economic Redevelopment				X	
Progress Energy	SC	ED-10	Economic Development				X	X
Progress Energy	SC	ERD-6	Economic Redevelopment				X	X
Santee Cooper	SC	L-12-ED	Economic Development	X				X
Vectren	IN	AD	Area Development	X				
Vectren	IN	ED	Economic Development	X				

[23] AEP is American Electric Power (Indiana Michigan Power Company). NIPSCO is Northern Indiana Public Service Company. NREMC is Northeastern Rural Electric Membership Corporation.

Table 4
Customer Eligibility Requirements for a Sample of Electricity Rate Discount Programs

Utility	State	Schedule / Rider Number	Variant	Load Factor (monthly)	Load Addition (kW or kVA)	New Jobs (FTE)	New Jobs (FTE/MW)	Capital Investment ($)	Capital Investment ($/kW of new load)	Building Size (sq ft)	Abandoned Facility (months vacant)	Brownfield Development	Economic Development Zone	Government ED Assistance
Ameren	MO	EDRR		55%	500									X
Ameren	MO	ERR		55%	500						6		X	X
AEP	IN	[ED]	1		1,000	10								
AEP	IN	[ED]	2		1,000	10					12			
AEP	IN	[ED]	3		1,000	10					12	X		
Duke Energy	IN	54										X		
Duke Energy	IN	58	1		1,000		25		$1,000					X
Duke Energy	IN	58	2		1,000				$10,000					X
Duke Energy	IN	59			500					25,000	24			
Duke Energy	KY	BR										X		
Duke Energy	KY	DIR	1	40%	1,000		25		$1,000					X
Duke Energy	KY	DIR	2	40%	500					25,000	24			
Duke Energy	NC	EC	1		1,000		75							
Duke Energy	NC	EC	2		1,000				$400					
Duke Energy	NC	ER	1		500		70				6			
Duke Energy	NC	ER	2		500				$400		6			
Duke Energy	SC	EC	1		1,000		75							
Duke Energy	SC	EC	2		1,000				$400					
Duke Energy	SC	ER	1		500		70				6			
Duke Energy	SC	ER	2		500				$400		6			

Table 4 **(continued)**

Utility	State	Schedule / Rider Number	Variant	Load Factor (annual)	Load Addition (kW or kVA)	New Jobs (FTE)	New Jobs (FTE/MW)	Capital Investment ($)	Capital Investment ($/kW of new load)	Building Size (sq ft)	Abandoned Facility (months vacant)	Brownfield Development	Economic Development Zone	Government ED Assistance
LG&E/KU	KY	EDR	1		1,000									
LG&E/KU	KY	EDR	2		500							X		
NIPSCO	IN	677			100	10								
NREMC	IN	EDR 4.2			300									X
NREMC	IN	EDR 5			1,500	10								
Progress Energy	NC	ED-9	1	40%	1,000	75								
Progress Energy	NC	ED-9	2	40%	1,000			$400,000						
Progress Energy	NC	ERD-5	1	40%	500	35					2			
Progress Energy	NC	ERD-5	2	40%	500			$200,000			2			
Progress Energy	SC	ED-10	1	40%	1,000	75								
Progress Energy	SC	ED-10	2	40%	1,000			$400,000						
Progress Energy	SC	ERD-6	1	40%	500	35					2			
Progress Energy	SC	ERD-6	2	40%	500			$200,000			2			
Santee Cooper	SC	L-12-ED	1		1,000		35							
Santee Cooper	SC	L-12-ED	2		1,000				$500					
Vectren	IN	AD	1		300					25,000	24			
Vectren	IN	AD	2		300							X		
Vectren	IN	AD	3		300	15							X	
Vectren	IN	AD	4		300			$500,000					X	
Vectren	IN	ED	1	50%	500	25								
Vectren	IN	ED	2	65%	1,500	100			$1,000					

The sampled rate discount programs are about evenly split on whether they require that the new load be associated with creation of a minimum number of jobs. The programs that do have such minima are divided as to the manner in which the minima are determined. Some programs require that the minimum number of full-time equivalent (FTE) jobs created exceed some specific threshold, where the thresholds in the sample range from 10 to 100. Other programs require that the minimum number of FTE jobs bear some proportion to the amount of new load added, where the proportions in the sample range from 25 to 75 jobs per MW of added load.

About a third of the rate discount programs require that the new load be associated with some minimum level of capital expenditures on new plant or equipment, where these capital expenditures may be in addition to or in lieu of job creation. The programs that require minimum capital expenditures have two ways of determining the minima. Most programs set their minima between $400 and $1,000 of capital expenditure per kW of new load, with a single outlier at $10,000 of capital expenditure per kW. A minority of programs set their minima at specific levels, ranging from $200,000 to $500,000 per customer facility.

Only three of the sampled rate programs required minimum square footages for customers' premises. Two of these programs are Duke Energy's redevelopment programs and the third is Vectren's Indiana urban redevelopment program. All three programs impose a 25,000 square foot minimum.

Many of the redevelopment programs have minimum lengths of time that a building must be vacant before a new occupant can be eligible for a rate discount. Of the sampled programs, these vacancy periods range between 2 and 24 months.

Some of the sampled programs require that a customer be located in a brownfield development or an economic development zone. Such locations may be defined by law, regulation, or the utility offering the program.

Some of the sampled programs require that the customer be eligible for, or actually receiving, economic development assistance from some government entity.

Table 4's listing of eligibility requirements is not exhaustive. For example, utilities always limit eligibility to non-residential customers, usually limit eligibility to particular customer classes or to customers who are already on particular rates, and often limit eligibility to customers who are in certain industrial classifications. For example, some utilities exclude industries that directly serve final consumers.

5.1.2. Rate Discounts

Table 5 lists the rate discounts for the programs listed in Table 3. The "Variant" column of Table 5 indicates that the discounts vary for two of the programs. For AEP in Indiana, the variations give higher discounts to customers moving into abandoned buildings, and give even higher discounts to customers moving into abandoned buildings in brownfield development zones. For Vectren in Indiana, discounts are higher for customers who create more jobs, make larger new capital investments, and add more electric load.

Table 5
Rate Discounts for a Sample of Electricity Rate Discount Programs[24]

Utility	State	Schedule / Rider Number	Variant	Incremental Demand Charge ($/kW)	Incremental Energy Charge ($/kWh)	Term (years)	Early Termination Charge
Ameren	MO	EDRR		≤15%	≤15%	5	X
Ameren	MO	ERR		15%	15%	5	
AEP	IN	[ED]	1	15%		3	X
AEP	IN	[ED]	2	17.5%		3	X
AEP	IN	[ED]	3	20%		3	X
Duke Energy	IN	54		50%→10%			
Duke Energy	IN	58		60%		1	
Duke Energy	IN	59		60%		1	
Duke Energy	KY	BR		50%→10%		5	
Duke Energy	KY	DIR		≤50%	≤50%	1	
Duke Energy	NC	EC		20%→5%	20%→5%	4	X
Duke Energy	NC	ER		50%	50%	1	X
Duke Energy	SC	EC		20%→5%	20%→5%	4	X
Duke Energy	SC	ER		50%	50%	1	X
Duke Energy	SC	ER		50%	50%	1	X
LG&E/KU	KY	EDR		50%→10%		5	
NIPSCO	IN	677		50%→10%		5	
Progress Energy	NC	ED-9		0.70-7.50		5	X
Progress Energy	NC	ERD-5		25%-50%		1	X
Progress Energy	SC	ED-10		0.70-7.50		5	X
Progress Energy	SC	ERD-6		25%-50%		1	X
Santee Cooper	SC	L-12-ED		45%→10%		4	X
Vectren	IN	AD		50%→10%		5	X
Vectren	IN	ED	1	$2.25		2	
Vectren	IN	ED	2	$4.50		2	

[24] Northeastern Rural Electric Membership Corporation is excluded from this table because its Economic Development Service is a rate that is separate from its standard tariff, and is therefore not framed as a discount relative to a standard tariff.

With a single possible exception, the rate discounts are reductions in the price the customer pays for *increases* in their peak demand and/or electrical energy consumption.[25] All programs offer discounts on incremental demand, while only a quarter offer discounts on incremental energy consumption.

Almost all discounts are percentages of particular charges, while a few are in dollars per kW of peak consumption. The initial percentage discounts on demand charges range from 15% to 60%, while those on energy range from 15% to 50%.

Most discounts are constant for a set period of years, and then end; but some discounts phase out by falling from year to year. The discounts that phase out are indicated by arrows. The discounts that are marked "50%→10%" are 50% in the first year, and then decline in 10% decrements in each succeeding year. The discounts that are marked "20%→5%" are 20% in the first year, and then decline in 5% decrements in each succeeding year. The discount that is marked "45%→10%" is 45% in the first year, 30% in the second year, and then declines in 10% decrements in each succeeding year. The Progress Energy Economic Redevelopment rates in the Carolinas, which have a range, "25%-50%", are apparently designed to particularly encourage attraction or retention of the largest customers: they offer a discount of 25% for demands below 1,000 kW, and of 50% for demands above 1,000 kW.

The discounts in dollars per kW of incremental demand have values ranging from $0.70 to $7.50 per kW-month. This whole range is covered by Progress Energy's Economic Development rate discounts in the Carolinas, which are higher for customers with high load factors and which phase out over five years.[26] The $2.25 and $4.50 per kW-month values for Vectren's Indiana Rider ED differ because, as indicated in Table 4, the larger discount requires a greater commitment by the customer to job creation and capital expenditure.

Table 5 indicates that the rate discounts have terms ranging between 1 and 5 years. It also indicates that most of the sampled rate discount programs have "clawbacks" by which, if the customer terminates their electricity service or otherwise violates tariff terms during the course of the discount period, the customer is required to rebate to the utility some or all of the discount received by the customer.

5.2. Financial Support Programs

Utilities offer many programs that give money or credits to large industrial customers for specified purposes, particularly to improve the efficiency of customers' energy use, and to a lesser extent for assistance with construction of customer facilities or of energy-related infrastructure that supports customer facilities. A very few utilities also offer loans. Most of

[25] That exception is Duke Energy's Kentucky Rider DIR, wherein the discount applies to the "customer's total bill for electric service." This arguably means that the discount applies to the customer's total load.

[26] In the first year, the discount is $7.50 for customers with load factors of at least 80%, $5.50 for customers with load factors between 60% and 80%, and $3.50 for customers with load factors between 40% and 60%. Each year that the customer has the discount, the discount per MW-month falls by one-fifth of its original amount.

the programs that offer direct financial assistance are limited to sites within a particular state, hinting that funding of these programs is organized by state governments.

5.2.1. Energy Efficiency Incentives

Utilities have numerous energy efficiency incentive programs, which they typically divide into prescriptive and custom components. *Prescriptive programs* provide incentives for several standard energy efficient technologies with consistent quantitative benefits. Such technologies include those applicable to lighting and heating, ventilation, and air conditioning (HVAC) systems. *Custom programs* provide incentives for energy-saving technologies that are peculiar to particular industries or particular customers. These incentive programs require applicants to provide substantial detail concerning the energy-related characteristics of their technologies, and can also require that the energy savings be verifiable, measurable, and persistent for a minimum period of time such as five years.

For both types of programs, incentive payments (or credits) are generally subject to caps (and sometimes floors), and are determined by one of the following criteria:

- a fixed payment level for each particular technology;
- a payment per kWh of energy saved or per kW of peak demand shaved; or
- a percentage of the capital costs of the improvements that lead to energy savings.

Table 6 lists several examples of the energy efficiency incentive programs that are offered by utilities.

5.2.2. Construction Assistance

Utilities' construction assistance programs pay for facilities that are owned by the customer. We identified only a few such programs, from which we gather that construction assistance is relatively rare.

The National Grid in New York offers the following programs:

- *The Renewable Energy and Economic Development Program* provides matching grants of up to $750,000 for projects that demonstrate alternative generation technologies and promise significant economic development benefits for the region.
- *The Industrial Building Redevelopment Program* provides grants of up to $250,000 to building owners undertaking efforts to retrofit the interior electric and gas infrastructure required to convert these buildings to multi-tenant industrial use.
- *The Power Quality Enhancements Program* offers financial incentives for the installation of power quality mitigation equipment and controls that mitigate production, operational, or quality constraints, including but not limited to downtime and outage costs.

Table 6
Examples of Energy Efficiency Incentive Programs[27]

Utility	State	Program	Details
Ameren	IL	Act On Energy	Offers incentives on: lighting; HVAC; water heaters; specialty equipment; process steam & steam traps; variable frequency drives; retro commissioning; and leak survey and repair.
Ameren	MO	Act On Energy	Provides up to $15,000 in incentives (and no more than 50% of actual project costs) for the purchase and installation of energy efficient: Lighting; HVAC; and refrigeration.
American Electric Power	KY	Commercial Incentive	For existing buildings and new construction, provides incentives, up to the lesser of 50% of incremental equipment costs or $20,000 annually per project, for: lighting; HVAC; and food service and refrigeration.
American Electric Power	OH	Custom	Offers incentives for purchasing high efficiency equipment and implementing industrial process improvements and technologies that reduce energy consumption and peak demand.
American Electric Power	OH	New Construction	Offers financial incentives for implementing energy-efficient improvements and technologies that reduce energy consumption for new construction and major renovation projects.
American Electric Power	OH	Prescriptive	Offers up to $300,000 in financial incentives per project for the implementation of technologies that improve energy efficiency and reduce energy consumption for HVAC; lighting; motors and drives; refrigeration; miscellaneous food preparation & storage equipment.

[27] In the State column, "all" refers to all states served by the named utility.

Table 6 (continued)

Utility	State	Program	Details
American Electric Power	OH	Self-Direct	Offers energy efficiency credits or exemption from certain charges for qualifying project that produce verifiable and persistent energy savings and/or peak demand reductions for at least five years, through an increase in efficiency or through the use of load-shifting technologies.
American Electric Power	OH	T12 Fluorescent Lighting Phase-Out	Provides incentives to eliminate inefficient T12 lighting and upgrade to more energy efficient lighting.
American Electric Power	WV	Commercial and Industrial Prescriptive	Offers incentives for use of high efficiency lighting, HVAC, and motors.
Bonneville Power Administration	WA	Energy Efficiency	Reimburses certain energy efficiency measures according to estimated or verified persistent energy savings.
Bonneville Power Administration	WA	The T8 Lighting Project	Offers incentives to switch to T8 lighting.
Commonwealth Edison	IL	Smart Ideas for your Business	Offers incentives for: custom projects; retro-commissioning; new construction; commercial real estate; load response; HVAC; VSD; transformers; battery chargers; refrigeration; comm. kitchen equipment; lighting; and industrial systems.
Consolidated Edison	NY	Energy Efficiency	Offers cash rebates and incentives for installing energy efficient lighting and lighting controls; led exit signs, chillers, HVAC, furnaces and boilers, motors, variable frequency drives, and other high-efficiency equipment or energy saving solutions. Covers up to lesser of $67,000 or 50% of the costs of energy-efficiency technical studies.

Table 6 (continued)

Utility	State	Program	Details
Duke Energy	NC, SC, KY, IN, OH	Smart Saver Custom Incentive	Offers incentives for certain high-efficiency equipment, such as building automation controls and compressed air systems.
Duke Energy	NC, SC, KY, IN, OH	Smart Saver Prescriptive Incentive	Offers incentives for lighting, variable frequency drives, HVAC, chiller/thermal storage, food service, premium motors, and process equipment.
Flathead Electric Co-Op	MT	Commercial Lighting New Construction	Offers rebates on lighting installations for new construction.
Kansas City Power & Light	MO	Commercial & Industrial Rebates	Provides rebates for high-efficiency equipment for retrofits or new construction.
National Grid	NY	Energy Efficiency in Empire Zones	Provides incentives for installation of energy-efficient lighting, controls, HVAC, motors, electronic speed controls, and other systems that reduce energy use and/or enhance productivity.
NIPSCO	IN	Custom Electric Incentive	Offers rebates, based on energy savings, for cost-effective energy projects involving the installation of new, high-efficiency equipment or systems, including lighting, HVAC, compressed air, refrigeration, food service, motors, and data center and IT systems. Rebates are $.06/kWh for lighting projects and $0.09/kWh for other projects.
NIPSCO	IN	New Construction Electric Incentive	Offers financial incentives, based upon electrical energy savings, for the completion of cost-effective energy projects involving the installation of new, high-efficiency equipment or systems such as lighting, HVAC, compressed air, refrigeration, food service, motors, data center, and IT systems. Incentives are based on electricity reductions in kWh through qualified efficiency improvements at a rate of $.045/kWh.

Table 6 (continued)

Utility	State	Program	Details
NIPSCO	IN	Rebates on Appliances	Offers rebates for Lighting, Variable Frequency Drives (VFDs), HVAC, and commercial kitchen appliances.
Progress Energy	FL	Various	Offers incentives for building envelope Improvements, HVAC equipment and system improvements, indoor lighting improvements, efficient compressed air system, and efficient motors.
Progress Energy	NC, SC	Energy Efficiency for Business	Offers incentives for energy efficiency upgrades and system improvements including lighting, HVAC and refrigeration. Incentives are based upon the quantity, size, and efficiency of the qualified technology or equipment. Offers incentives for custom measures based on electric energy savings. Offers technical assistance with system and building enhancements for new construction and retrofits, including feasibility studies and energy audits.
Seattle City Light	WA	Building Commissioning Assistance	Funds energy conservation measures on new construction projects receiving Energy Smart Services funding.
Seattle City Light	WA	Financial Incentives	Offers incentives, covering up to 70% of cost, for efficient lighting, HVAC, controls, transformers, glazing and insulation, and industrial process improvements.
Tacoma Power	WA	various	Offers incentives for lighting, compressed air efficiency, custom retrofit, energysmart grocer, HVAC, kitchen equipment, drives, multifamily retrofit, smart power strips, new construction, and PC power management.
Tennessee Valley Authority	AL, GA, KY, MS, NC, TN, VA	energyright solutions	Offers rebates for the replacement of Lighting, Motors, HVAC, and Food Service, as well as other custom rebates.

Duke Energy administers a Site Readiness Program that, for qualifying sites within the Carolinas, provides matching grants to customers who implement improvements that are recommended by certain site-specific studies.

5.2.3. Infrastructure Investment Assistance

Utilities' infrastructure assistance programs pay for facilities that are owned by the utility. We identified only a few such programs, from which we gather that such programs are relatively rare.

American Electric Power in Ohio has a Rate Stabilization Plan Grants program that pays part of the cost of the utility infrastructure improvements that may be needed by new or existing industrial customers for the purposes of creating new jobs, retaining existing jobs, and generating new investment. The grant amount for any particular customer depends upon number of jobs created or retained by the customer, the wages associated with those jobs, the level of investment, the customer's location, the purposes for which the grant money will be used, the customer's need for the grant funding, political support for the customer's grant, and overall competition for grant money.

National Grid in New York has three infrastructure investment assistance programs:

- *The Capital Investment Incentive Program* funds electric and natural gas improvements for certain projects that involve major capital investment in plant and equipment and that attract or support expansion of business.
- *The Shovel Ready Incentives Program* grants up to $125,000 for engineering and planning and up to $250,000 for electric and natural gas infrastructure.
- *The Brownfield Redevelopment Program* funds utility-related infrastructure improvements and other costs that are necessary to facilitate the redevelopment of a brownfield site or vacant building.

5.2.4. Loans

We identified only a few loan programs, from which we gather that loans are relatively rare. Tacoma Power (in Washington) has a Zero-Interest Loan program that helps finance the replacement of equipment that has not yet reached the end of its useful life, with the apparent purpose of replacing old equipment with more energy-efficient equipment. The Tennessee Valley Authority has two loan programs – Economic Development Funds and Pathway Lending – both of which appear to be intended to promote economic expansion and encourage job creation in the TVA region.

5.3. Information Programs

Utilities provide many information programs. Many of these programs provide customers with information concerning how they can use energy more efficiently. Some programs provide customers with information about the contractors who can help implement energy-savings measures. Other programs seek to facilitate economic development by informing customers

about the availability and suitability of industrial sites or about the benefits of doing business in the utility's service area. Still other programs provide a variety of other information services.

5.3.1. Energy Efficiency Assistance

Utilities provide a variety of services that help their customers identify energy-saving opportunities at their industrial facilities. The simplest programs merely provide customer energy usage information. Most programs provide energy assessments, basically of three types:

- over the Internet, based upon customer-entered data;
- off-site, through communication with utility energy engineers; and
- on-site, with energy assessments by utility energy engineers who tour the customer's facilities and may interview the customer's staff, often for an extra fee.

Depending upon the utility, the assessments may look only at widely used systems such as lighting, heating, and cooling systems; or the assessments may include detailed assessments of industrial processes for specific industries. Assessments are usually followed by formal reports that identify specific energy-saving opportunities (including both energy and dollar savings), include financial analysis of factors like payback periods, and recommend specific energy-saving measures.

Table 7 provides brief descriptions of several such programs.

Table 7
Examples of Energy Efficiency Assistance Programs

Utility	State	Program	Description
Bonneville Power Administration	WA	Energy Smart Industrial	Provides technical expertise and builds customized solutions that save energy and minimize impacts on production processes.
ComEd	IL	Free Assessment	Helps find energy saving opportunities throughout industrial facilities, including lights, HVAC systems, chillers, and motors. Includes site visits by the utility's energy engineers, followed by recommendations that include estimated energy savings, cost savings, and project cost.
Duke	NC, SC, KY, IN, OH	Energy Assessment	Provides energy usage information, energy efficiency information, and potential energy reduction recommendations, including estimated impacts of implementing energy efficiency measures. Includes off-site assessments and (for a fee) on-site assessments.
East Kentucky Power Cooperative	KY	Energy Audits	Provide on-site assessment of potential energy savings in heating and cooling systems.
LG&E/KU	KY	Commercial Energy Analysis	Provides on-site assessments of the best ways to substantially reduce customers' energy usage and operating costs, particularly those related to lighting, heating, and cooling equipment, followed by recommendations for improvements with potential financial paybacks of no more than seven years.
Santee Cooper	SC	Energy Tracker	Provides a web-based metering service that enables customers to view details of their electrical usage, including downloadable historical data and graphics. Available for $55/month on a one-year contract.
Seattle City Light	WA	Technical Assistance Services	Provides facility assessment, energy analysis, building commissioning assistance, The Lighting Design Lab, LEED Certification assistance, and Climate Wise Greenhouse Gas Reduction assistance

Table 7 (continued)

Utility	State	Program	Description
Seattle City Light	WA	Facility Assessment	Assesses industrial facilities' resource and operation efficiencies and identifies efficiency improvement opportunities. Includes interviews of customers' staffs. Followed by recommendations for specific cost-effective improvements in customer facility efficiency, safety, and productivity.
Seattle City Light	WA	Lighting Design Lab	Promotes energy-efficient lighting technologies via education & training, consultations, technical assistance, and demonstrations.
Tacoma Power	WA	Energy Bill Profile	Quantifies customers' energy uses, including power factors, load factors, and irregularities in consumption patterns.
Tacoma Power	WA	Energy Audit	Finds savings in lighting, motors, and other equipment.

5.3.2. Contractor Referrals and Training

To implement a utility's recommendations for saving energy or to qualify for the energy efficiency incentives that utilities offer, customers need qualified professionals – such as architects, contractors, engineers, and energy service companies – who can implement energy-saving measures and who (for some incentive programs) have been approved by the utility offering the incentives. In many cases, the utilities organize training programs that are available to (and sometimes required of) contractors who wish to participate in the referral program. Table 8 lists some of the utility programs that provide such referrals.

Table 8
Examples of Programs for Referral of Energy-Saving Professionals

Utility	Program
Ameren	Trade Ally Network
American Electric Power	Solution Provider Network
Commonwealth Edison	Trade Allies
Consolidated Edison	Market Power Network
Duke Energy	Smart Saver Trade Ally
National Grid	Supplier & Distributor Networks
NIPSCO	Trade Ally
Santee Cooper	Trade Allies
TVA	Trade Ally Network

Consolidated Edison of New York offers a different sort of referral service. Its website offers referral to local, state, and regional organization programs that provide business information, products, services, and financing.

5.3.3. Site Selection

Utilities offer a wide variety of services to assist customers with site selection. At the simpler end of the spectrum, several utilities provide websites that list available land or buildings suitable for industrial firms, where the listing depends upon the prospective customer's needs as input to the website. Table 9 provides a listing of some utilities offering such website services.

Table 9
Examples of Internet-Based Site Selection Services

Utility	State	Details
Commonwealth Edison	IL	Identifies currently available commercial and industrial buildings as well as vacant land. Provides a customized report.
Consolidated Edison	NY	Offers assistance in locating available commercial and industrial space.
First Energy	OH, MD, NJ, PA, VA	Assists with site selection. Provides: location analysis and community research; site tours; introductions to local, regional and state officials; information on available sites and buildings; demographic, workforce and business establishments data; and information about local and state economic development incentives.
Indiana Michigan Power	IN, MI	Provides an online search tool for site selection.
LGE/KU	KY	Provides an online search tool for site selection.
Progress Energy	NC, SC, FL	Provides a web page that links to separate site search tools depending on whether the site is located in North Carolina, South Carolina, or Florida.
Tennessee Valley Authority	AL, GA, KY, MS, NC, TN, VA	Gives information on communities and on available buildings and sites.

At the more complex end of the spectrum, utilities offer personalized services to prospective industrial customers that include more careful assessment of potential industrial sites than would be available through the Internet. These services may include site visits as well referrals

to professionals who can help develop a site. Table 10 lists some of the utilities that offer such services.

Table 10
Examples of Personalized Site Selection Services

Utility	State	Program	Details
American Electric Power	IN, KY, MI, OH, TN, VA, WV	Location Advisory Services	Provides information on cost-effective facility locations, including specifications, maps and photos; electric service plans and rates; state, regional, and local tax programs and incentives; state-funded employee training and programs; demographics; and labor. Coordinates on-site visits. Provides engineering, procurement, construction, and electrical maintenance services.
Ameren	IL, MO	unnamed	Offers site selection information, workforce surveys that quantifies skills and education level, and information on community attributes.
Duke Energy	IN, NC, SC	Site Readiness Program	Identifies and assesses industrial sites (usually 75 acres or more), including constructability and viability.
National Grid	NY	Site Inspections and Area Tours	Arranges site visits.
Vectren	IN, OH	unnamed	Provides information to site selection consultants and corporate real estate professionals.

5.3.4. Strategic Marketing

Many utilities promote doing business in their service territories through websites and marketing campaigns that trumpet the economic (and sometimes cultural) benefits of their regions or local areas. In some cases, utilities include these promotional materials on their websites. In others, utilities tout their service territories through links to websites produced by promotional organizations such as state government agencies or Chambers of Commerce.

5.3.5. Other

Utilities provide a variety of other information services.

Some utilities provide market research to prospective industrial customers. National Grid in New York provides prospective customers with market research reports, including market trends and economic indicators, based on the customers' Standard Industrial Codes. Northwestern Energy of Montana provides prospective customers with information on utility rates, the availability of utility services, power reliability, energy efficiency programs, and long-range community plans.

Louisville Gas & Electric (LG&E) and Kentucky Utilities provide their customers with information on the most cost-efficient means of dealing with power quality issues (e.g., harmonics, power factors, transfer switches, and uninterruptible power supply) on the customer side of the meter.

National Grid of New York provides its local communities with industry information and detailed company profiles on industrial prospects that might be well suited to the characteristics of each community.

6. INDUSTRIAL CUSTOMERS' ENERGY EFFICIENCY MEASURES[28]

This section discusses the energy efficiency measures that industrial customers can adopt in general and specific measures that can be taken by members of the industries targeted in this report. Most of these measures may have already been adopted by Kentucky industry.

6.1. Description of Efficiency Measures Common to All Industries

Energy efficiency-improving measures that are common among heavy industries include:

- more efficient conversion of energy from one form to another;
- better control of electrical demand (i.e., reducing load during periods with high time-of-use rates and at those times when peak demand is measured for demand charge purposes);
- replacement of standard efficiency motors with higher-performing motors;
- installation of variable speed drives on motors, which allows motors' outputs to adjust to meet the actual demands for output;
- optimization of the operation of compressed air systems;
- optimization of the operation of ventilation systems (e.g., use variable-speed drives on fan motors, optimize static pressure inside ventilation ducts, adopt computerized management of ventilation systems); and

[28] We define "energy efficiency measures" to include demand response. Kentucky enterprises may have already implemented many of these measures, or may have implemented measures in addition to those listed herein.

- installation of insulating material.

All of the Kentucky industry representatives with whom we spoke indicated that their industry members had adopted many, if not all, of the measures listed above in order to reduce energy costs.

6.2. Measures Specific to the Aluminum Smelting Industry

Energy efficiency measures relating to the optimum positioning of burners inside reverberatory furnaces improve furnace air tightness as well as installing heat recovery devices on melting furnace stacks. The steps that smelters can take to improve energy efficiency include:

- Optimizing burner positioning to enhance heat transfer in reverberatory furnaces;
- Proper tuning of burners on the basis of flow regulation, air pressure and excess air;
- Decreasing furnace heat loss through insulation, caulking, reduction in the size of openings, and repair of cracks;
- Repairing or modifying burners;
- Adapting heating power to actual aluminum load though automation or addition of controls to vary heating rate;
- Conducting preheating of aluminum load through a lengthening of furnaces;
- Recovering energy to preheat combustion air fed to the burner;
- Rebuilding or major changes to furnace to increase its efficiency;
- Improving furnace combustion quality;
- Improving air tightness in furnaces;
- Improving heat recovery through installation of devices on exhaust stacks of aluminum melting furnaces and optimizing recovered heat reinjection points, and optimizing use of recovered heat;
- Use of oxygen to enhance furnace efficiency;
- Installation of circulating pumps in melting furnaces; and
- Installation of real-time controls for the cooling of aluminum ingots.

Kentucky's aluminum smelters have taken some steps similar to those listed above.

6.3. Measures Specific to the Automobile Industry

Vehicle assembly plants can reduce energy consumption and maintain or increase the productivity of their plants through implementation of wide range of energy efficiency measures. Table 11 categorizes energy efficiency measures by their systems (general, motors, compressed air, heat and steam distribution, lighting, HVAC, material handling) or by process (painting, welding, stamping).

Table 11
Cross Cutting Energy Efficiency Measures for the Vehicle Assembly Industry[29,]

General Utilities	Motors
Energy management systems	Sizing of motors
Combined heat and power (CHP)	High efficiency motors Switched
CHP combined with absorption cooling	reluctance drives
District heating	Adjustable/variable speed drives
Alternative fuels	Variable voltage controls
Compressed Air Systems	**Heat and Steam Distribution - Boilers**
Maintenance	Improve process control
Monitoring	Reduce flue gas Reduce
Reduce leaks in pipes and equipment	excess air Correct sizing
Turn off unnecessary compressed air	in design
Modify system instead of increasing system pressure	Improve insulation
Use sources other than compressed air	Boiler maintenance
Load management	Recover heat from flue gas
Use air at lowest possible pressure	Return condensate
Minimize distribution system pressure drop	Recover steam from blowdown
Cold air intake	Replace obsolete burners by new optimized boilers
Controls	**Heat and Steam Distribution - distribution**
Correctly sizing pipe diameter	Improve insulation
Properly size regulators	Maintain insulation
Systems improvements	Improve steam traps
Heat recovery for water preheating	Maintain steam
Natural gas engine-driven compressors	traps
Energy efficient chillers	Monitor steam traps automatically
Compressor motors	Repair leaks
Adjustable speed drives	Recover flash steam
High efficiency motors	
Lighting	**HVAC**
Controls	Electronic controls
Setting lighting standards	Weekend setback temperatures
Daylighting	Ventilation and cooling system design improvements
Replace incandescents with fluorescents or CFLs	Recover cooling water
Replace T-12 with T-8 or metal halides	Solar heating (Solarwall)
Replace mercury with metal halide or high pressure sodium	Building shell
Replace metal halide HID with high-intensity fluorescents	Modifying fans
Replace magnetic with electronic ballasts	Other measures
Reflectors	**Materials Handling and Tools**
Light emitting diodes (LEDs) or radium strips	High efficiency belts
System improvements	**Miscellaneous**
	Improvements in electrical harmonic filters
	Energy efficient transformers

[29] Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, *Energy Efficiency Improvement and Cost Saving Opportunities for the Vehicle Assembly Industry: An ENERGY STAR® Guide for Energy and Plant Managers, sponsored* by the U.S. Environmental Protection Agency, March 2008, Table 3, p. 10.

Table 11 lists energy efficiency measures that are general or cross cutting measures,[30] characterized by the system to which they apply. Table 12 similarly lists energy efficiency measures that are process-specific, characterized by the process to which they apply.

Table 12
Process-Related Energy Efficiency Measures for the Vehicle Assembly Industry[31]

Painting Systems	
Maintenance and controls	Wet on wet paint
Minimize stabilization period	New paint—powders
Reduce air flow in paint booths	New paint—powder slurry coats
Insulation	New paint—others
Heat recovery	Ultrafiltration/reverse osmosis for wastewater cleaning
Efficient ventilation system	Carbon filters and other volatile organic carbon (VOC) removers
Oven type	High pressure water jet system
Infrared paint curing	
UV paint curing	
Microwave heating	
Body Weld	**Stamping**
Computer controls	Variable voltage controls
High efficiency welding/inverter technology	Air actuators
Multi-welding units	
Frequency modulated DC-welding machine	
Hydroforming	
Electric robots	

6.4. Measures Specific to the Chemical Processing Industry

The U.S petrochemical industry, which produces organic chemicals and plastics, spends a large share of its costs on fuels and electricity. Most electricity is consumed by machine drives, with substantial shares consumed by lighting systems; HVAC systems; process heating, cooling, and electro-chemical processes (mainly for production of inorganic chemicals). Energy efficiency improvements can help reduce these costs and reduce earnings volatility, particularly when energy prices are volatile.

There may be a variety of cost-effective opportunities for energy savings.[32] These opportunities are in steam generation and distribution, power generation (including cogeneration), compressors, fired heaters, process optimization, heat exchangers, and motor

[30] "Cross-cutting technologies" are defined as equipment that is commonly used in many different sectors, such as boilers, pumps, motors, compressed air systems, and lighting.

[31] Ibid, Table 4, p. 11.

[32] Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, *Energy Efficiency Improvement and Cost Saving Opportunities for the Petrochemical Industry An ENERGY STAR Guide for Energy and Plant Managers*, sponsored by the U.S. Environmental Protection Agency, June 2008, (Chemical Report).

and motor applications. The lowest-cost opportunities for energy savings will vary among chemical processing plants.

Table 13 and Table 14 summarize energy efficiency measures for the chemical industry in terms of energy management programs and systems, and process-specific measures.

Table 13
Energy Management Programs and Systems for the Chemical Industry[33]

Energy Management Programs and Systems	
Energy management programs	Energy teams
Energy monitoring and control systems	
Steam Systems	
Steam Supply	
Boiler feed water preparation	Flue gas heat recovery
Boiler process control	Blow down steam recovery
Reduction of flue gas quantities	Reduce standby losses
Reduction of excess air	Combined Heat and Power (CHP)
Improved boiler insulation	High temperature CHP
Boiler maintenance	Steam expansion turbines
Steam Distribution Systems and Steam End Use	
Improved distribution system insulation	Leak repair
Insulation maintenance	Flash steam recovery
Steam trap improvement	Return condensate
Steam trap maintenance	Improve efficiency at steam end use
Steam trap monitoring	
Furnaces / Process Heaters	
Control air-to-fuel ratio	Improve control
Improve heat transfer	Maintenance
Improve heat containment	Switch electric heaters to fuelled heaters
Heating, Cooling and Process Integration	
Reduce fouling in heat transfer equipment	Process integration
Regular checks of cooling water systems	Pinch analysis
Heat recovery	Total site pinch analysis

[33] Chemical Report, pp. 34-35.

Table 13 (continued)

Electric Motors Systems	
Motor Systems	
Properly sized motors	Reduce voltage unbalance
High efficiency motors	Adjustable-speed drives
Improve power factor	Variable voltage controls
Pumps	
Pump system maintenance	Avoiding throttling valves
Pump system monitoring	Replacement of belt drives
Pump demand reduction	Proper pipe sizing
Controls	Adjustable-speed drives
High-efficiency pumps	Precision castings, surface coatings or polishing
Properly sized pumps	Improve sealings
Multiple pumps for variable loads	Curtailing leakage through clearance reduction
Impeller trimming	Use dry vacuum pumps
Fans and blowers	
Properly sized fans	Improved controls
Adjustable speed drives	High efficiency belts
Compressors and compressed air systems	
System improvements (pressure reduction)	Controls
Maintenance	Properly sized regulators
Monitoring	Properly size piping
Leak reduction	Heat recovery
Reducing the inlet air temperature	Adjustable speed drives
Maximize allowable pressure dew point	High efficiency motors
Improved load management	
Distillation	
Optimization of reflux ratio	Feed conditioning
Check required product purity	Upgrading column internals
Seasonal operating pressure adjustments	Stripper optimization
Reducing reboiler duty	Insulation
Enhanced distillation control	

Table 13 (continued)

Building Energy Efficiency Measures	
HVAC Systems	
Energy efficient system design	Fan modification
Recommissioning	Efficient exhaust fans
Energy monitoring and control systems	Use of ventilation fans
Non-production hours set-back temperatures	Cooling water recovery
Duct leakage repair	Solar air heating
Variable-air-volume systems	Building reflection
Adjustable-speed drives	Low-emittance windows
Heat recovery systems	
Lighting	
Turning off lights in unoccupied areas	Replacement of mercury lights
Lighting controls	High-intensity discharge voltage reduction
Exit signs	High-intensity fluorescent lights
Electronic ballasts	Daylighting
Replacement of T-12 tubes with T-8 tubes	

Table 14
Summary of Process Specific Energy Efficiency Measures for the Chemical Industry[34]

Process	Measures
Ethylene	More selective furnace coils
	Improved transfer line exchangers
	Secondary transfer line exchangers
	Increased efficiency cracking furnaces
	Pre-coupled gas turbine to cracker furnace
	Higher gasoline fractionator bottom temperature
	Improved heat recovery quench water
	Reduced pressure drop in compressor inter-stages
	Additional expander on de-methanizer
	Additional re-boilers (cold recuperation)
	Extended heat exchanger surface
	Optimization steam and power balance
	Improved compressors
Aromatics	Improved product recovery systems
Polymers	Low pressure steam recovery
	Gear pump to replace extruder
	Online compounding extrusion
	Re-use solvents, oils and catalysts
Ethylene Oxide / Ethylene Glycol	Increased selectivity catalyst
	Optimal design EO/EG-sections
	Multi-effect evaporators (Glycol)
	Recovery and sales of by-product CO_2
	Process integration
Ethylene Dichloride / Vinyl Chloride Monomer	Optimize recycle loops
	Gas-phase direct chlorination of ethylene
	Catalytic cracking EDC
Styrene	Condensate recovery and process integration
Toluene diisocyanate	Recover exothermic heat
	Recuperative incinerators

6.5. Measures Specific to the Steel Industry

The iron and steel industry is the fourth largest energy-consuming industry in the U.S. after the petroleum and coal industry, the chemical industry, and the paper industry. A large variety of opportunities exists within the U.S. iron and steel industry to reduce energy consumption while

[34] Chemical Report, p. 36.

maintaining or enhancing the productivity of plants.[35] The International Energy Agency estimates the total primary energy and feedstock savings potential to be 9-18% through the adaptation of best practice commercially available technologies,[36] while Energetics reports that the difference between the industry's average and the practical minimum energy requirements is 31% for ore-based steelmaking and 47% for electric arc furnace steelmaking.[37] Worrell *et al* reported cost-effective energy savings of 18% compared to a 1994 U.S. iron and steel industry's baseline energy use.[38] The benefits of improved energy efficiency include cost savings, reduced exposure to volatile energy prices, and reduced environmental compliance costs.

Energy-saving opportunities vary by steel plant, and can involve modest capital investments with short payback periods or large capital investments that are justified by a range benefits that include energy savings. Examples of savings are:

- $100 million saved by installing a combined heat and power system that captures waste heat at a steel mill in East Chicago.
- $17 million annual savings from a new control system that improves plant efficiency and productivity. The project's $16 million cost was recovered in 11 months.
- $3.3 million annual savings from improved efficiency of steam turbine generators at a steel mill in Burns Harbor. The project's cost was recovered in just over one year.

Kentucky's steel industry has taken significant steps over the years to improve the energy efficiency of the steel making process and reduce its energy costs, and its electricity costs in particular, in order to remain competitive in a global steel market. Appendix B presents a listing of steps that members of Kentucky's steel industry have taken to reduce their electricity costs.

6.6. Measures Specific to the Pulp and Paper Industry[39]

The U.S. pulp and paper industry is energy-intensive, with energy costs averaging 16% of production costs[40] and as much as 30% of production costs.[41] About 50% of its primary energy

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[35] Lawrence Berkeley National Laboratory, *Energy Efficiency Improvement and Cost Saving Opportunities for the U.S. Iron and Steel Industry: An ENERGY STAR® Guide for Energy and Plant Managers*, Environmental Energy Technologies Division, sponsored by the U.S. Environmental Protection Agency, October 2010.

[36] International Energy Agency, *Tracking Industrial Energy Efficiency and CO2 Emissions,* 2007.

[37] Energetics, Inc., *Steel industry Marginal Opportunity Study*, prepared for the U.S. Department of Energy, October 2004.

[38] E. Worrell, N. Martin, and L. Price, *Energy Efficiency and Carbon Dioxide Emissions Reduction Opportunities in the U.S. Iron and Steel Sector*, Ernest Orlando Lawrence Berkeley National Laboratory, LBNL-41724, 1999.

[39] Lawrence Berkeley National Laboratory, Energy Analysis Department Environmental Energy Technologies Division, *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Pulp Industry An ENERGY STAR® Guide for Energy and Plant Managers*, October 2009.

[40] European Commission, *JRC-IPTS IPPC Draft Reference Document on Best Available Techniques for the Production of Pulp and Paper.* April 2010.

[41] Confederation of European Paper Industries, *Key Statistics,* 2009.

comes from biomass, partly because of the industry's significant investment in combined heat and power generation. Most of the remainder of the industry's energy comes from fossil fuels. Nonetheless, the industry uses electricity to power motors and machine drives, conveyors, and pumps, as well as for lighting and ventilation.

Table 15 lists energy efficiency measures that are general or cross cutting measures that the industry can use to reduce energy costs, while Table 16 lists energy efficiency measures that are process-specific, characterized by the process to which they apply.

Table 15
Summary of Cross-Cutting Energy Efficiency Measures for Pulp and Paper Industry[42]

Energy Management Programs and Systems	
Energy management programs	Energy teams
Energy monitoring and control systems	
Steam Systems	
Boilers	
Boiler process control	Boiler maintenance
Reduction of flue gas quantities	Minimizing blow down
Reduction of excess air	Blow down steam recovery
Improved boiler insulation	Flue gas heat recovery
Condensate return	Burner replacement
Steam Distribution Systems	
Steam distribution controls	Steam trap maintenance
Improved insulation	Steam trap monitoring
Insulation maintenance	Leak repair
Steam trap improvement	Flash steam recovery
Process Integration	
Combined Heat and Power Systems	
Combined cycle	STIG turbines
Replacement of pressure reducing valves	Operations and maintenance
Motor Systems	
Motor management plan	Adjustable-speed drives (ASDs)
Strategic motor selection	Power factor correction
Maintenance	Minimizing voltage unbalance
Properly sized motors	

[42] Lawrence Berkeley National Laboratory, Environmental Energy Technologies Division, *Energy Efficiency Improvement and Cost Saving Opportunities for the Pulp and Paper Industry An ENERGY STAR® Guide for Energy and Plant Managers,* October 2009, Table 5.1, p. 34.

Table 15 (continued)

Pump Systems	
Pump system maintenance	Avoiding throttling valves
Pump system monitoring	Replacement of belt drives
Pump demand reduction	Proper pipe sizing
Controls	Precision casting, surface coating or polishing
High-efficiency pumps	Sealings
Properly sized pumps	Curtailing leakages through clearance reduction
Multiple pumps for variable loads	Adjustable-speed drives (ASDs)
Impeller trimming	
Fans	
Maintenance	High efficiency belts (cog belts)
Properly sized fans	Duct leakage repair
ASDs and improved control	
Compressed Air Systems	
System improvements	Improved load management
Maintenance	Pressure drop minimization
Monitoring	Inlet air temperature reduction
Leak reduction	Controls
Turning off unnecessary compressed air	Properly sized pipe diameter
Modification of system in lieu of increased pressure	Heat recovery
Replacement by alternative sources	Natural gas engine-driven compressors
Lighting	
Lighting controls	Replacement of mercury lamps
Exit signs	HID voltage reduction
Electronic ballasts	High-intensity fluorescent lights
Replacement of T-12 tubes with T-8 tubes	Daylighting

Table 16
Summary of Process Efficiency Measures for the Pulp and Paper Industry[43]

Raw Material Preparation	
Cradle debarkers	Automatic chip handling and screening
Replace pneumatic chip conveyors with belt conveyors	Bar-type chip screening
Use secondary heat instead of steam in debarking	Chip conditioning
Chemical Pulping	
Pulping	
Use of pulping aids to increase yield	Digester improvement
Optimize the dilution factor control	Digester blow/flash heat recovery
Continuous digester control system	
Bleaching	
Heat recovery from bleach plant effluents	Chlorine dioxide (ClO_2) heat exchange
Improved brownstock washing	
Chemical Recovery	
Lime kiln oxygen enrichment	Improved composite tubes for recovery boiler
Lime kiln modification	Recovery boiler deposition monitoring
Lime kiln electrostatic precipitation	Quaternary air injection
Black liquor solids concentration	
Mechanical Pulping	
Refiner improvements	Increased use of recycle pulp
Refiner optimization for overall energy use	Heat recovery from de-inking plant
Pressurized groundwood	Fractionation of recycled fibers
Continuous repulping	Thermopulping
Efficient repulping rotors	RTS pulping
Drum pulpers	Heat recovery in TMP
Papermaking	
Advanced dryer controls	Waste heat recovery
Control of dew point	Paper machine vacuum system optimization
Optimization of water removal in forming and pressing	Shoe (extended nip) press
Reduction of blowthrough losses	Gap forming
Reduction air requirements	CondeBelt drying
Optimizing pocket ventilation temperature	Air impingement drying

[43] Ibid, Table 5.2, p. 35.

Examples of energy savings in the pulp and paper industry are:[44]

- Proctor & Gamble saved $309,000 annually through an improved compressed air system at a Pennsylvania mill, recovering its capital costs in 21 months.
- The Augusta Newsprint Company saved $175,000 through improved pump system efficiency, recovering in 2 months to 17 months the capital costs of various components of the upgraded system.
- Louisiana Pacific saved $85,000 annually by investing $44,000 in improved ventilation system efficiency.
- Daishowa America saved $42,000 annually through improved the pumping efficiency at a Washington mill, recovering its capital costs in 15 months.

7. EVALUATION OF ECONOMIC DEVELOPMENT PROGRAMS IN KENTUCKY

This section begins with a general discussion of methods for evaluating development programs. It then discusses the fact that Commonwealth support for infrastructure development can and does serve as an alternative and complement to Commonwealth support directed at particular business enterprises. It concludes with a summary of some published studies of the effectiveness of economic development programs.

7.1. Evaluation Methods

As an economic matter, an economic development program should be undertaken only when its expected benefits exceed its expected costs. As a policy matter, programs should be evaluated as they proceed (or *ex post*) to distinguish the program characteristics that provide net benefits from those that do not.

Consequently, evaluation of economic development programs entails measuring both direct and indirect benefits and costs over time. A key difficulty arises, however, from the fact that the benefits of an economic development program are the employment, profits, community, and environmental benefits that occur *with* the program that would *not* have occurred *in the absence* of the program. This latter hypothetical is difficult to deduce because it is not possible to know what economic conditions would have been without the incentive program.

Nonetheless, the direct benefits of an incentive program can be measured in terms of the number of jobs retained or created, the wages and benefits paid to those workers, and the incremental capital investments made by the firms receiving the incentives. These direct benefits can be compared to the cost of the incentive program in terms of the direct payments to industry and reduced revenues for state and local governments.

The indirect benefits of an incentive program arise from the businesses that are indirectly supported by the businesses receiving the incentives. This support can be in forms of: a)

[44] Jacobs Engineering and Georgia institute of Technology, *Pulp and Paper Industry Bandwidth Study,* prepared for the American Institute of Chemical Engineers, August 2006.

purchases of products by the incentive recipient; b) purchases of products by employees of the incentive recipient; and c) reduced supply costs for businesses that buy the services of the incentive recipient. Measurement of the "indirect" impact of economic development programs is by its nature both more difficult and less precise than measuring the direct impacts. It is necessary nonetheless, because these indirect effects provide much of the rationale for governmental actions to encourage economic development in the first place.

The usual approach for measuring the indirect impacts of the economic activity fostered by an incentive program is to apply a "multiplier" to direct benefits: a dollar of incentives might be assumed to create an additional $0.30 of economic activity, for example, so the multiplier would be 1.30. Multipliers are applied to the measured direct outcomes — such as jobs, investment, and income — thereby providing an estimate of total economic activity (hence the benefit) attributable to the incentives.

Estimation of incentive costs is simple in cases where there is some direct payment from the government to a business, such as occurs with a grant. In other cases, however, costs are more uncertain, such as with tax exemptions, reductions, or postponements that change government revenues in ways that may be ambiguous.

The competition among state and local governments for economic development projects has increased over time. Between 1990 and 1998, the average package of economic development incentives offered in the twenty largest manufacturing states grew substantially: while in 1990 it reduced a recipient's average effective state and local tax rate by 10%, in 1998 it reduced the effective tax rate by 30%.[45] This increased competition reflects the finding that a 10% tax reduction tends to raise overall employment, investment, or new business formations by between 1% and 6%.[46]

Despite the complexity of quantifying the benefits and cost of economic development programs, such estimates are vital for assuring the public money is being well spent on increasing or maintaining economic activity, and is not merely lining the pockets of the recipients. Consequently, a state's economic development tools should be evaluated periodically, considering both quantitative and qualitative outcomes. Given the diversity of program features and outcomes, several different measures may be needed to accurately assess a state's range of programs.

7.2. Infrastructure Alternatives

Kentucky's infrastructure – particularly its transportation network and educational system (which influences workforce skills) – is a major determinant of businesses' decisions to invest in Kentucky enterprises. In the course of our interviews, several Kentucky business representatives expressed the views that: a) Kentucky's transportation infrastructure and

[45] Peter Fisher, *The Fiscal Consequences of Competition for Capital*, prepared for the conference "Reining in the Competition for Capital," Humphrey Institute of Public Affairs, University of Minnesota, February, 2004.

[46] Timothy J. Bartik, "The Effects of State and Local Taxes on Economic Development: A Review of Recent Research," *Economic Development Quarterly*, Vol. 26, 1992.

geographic location are major attractions for doing business in Kentucky; and b) Kentucky's workforce participants often lack the skills that they need, making it costly for business to attract skilled workers or to provide training to upgrade workers' skills. Workforce quality is a particular concern of business. The Kentucky Association of Manufacturers is on record as stating the following:[47]

> …workplace remediation remains a costly enterprise which diverts resources employers could potentially utilize to expand their enterprises…
>
> …employers struggle to find workers who are dependable, ethical, willing to learn, can apply math or science, can clearly articulate a problem, solve a problem, think independently and critically, work as a member of a team, or possess other desired employability traits…

Along similar lines, the Kentucky Council on Postsecondary Education notes that Kentucky is behind the rest of the U.S. in its educational attainment:[48]

> …only 22 percent of Kentucky adults… have a bachelor's degree, compared to 27 percent nationally…
>
> …ACT data from the Kentucky Department of Education for the 2008-09 junior class indicate that only 46 percent met the English ACT readiness score of 18, 34 percent met the mathematics ACT readiness standard of 19, and 38 percent met the reading ACT readiness standard of 20…

In considering how to spend its scarce economic development dollars, the Commonwealth needs to consider whether it is likely to get a better bang for its buck through incentive payments to businesses or by providing businesses with the infrastructure that they need. More accurately, the Commonwealth needs to find the most effective combination of direct and infrastructure support for business.

7.3. Published Studies

This section reviews published studies of state economic incentive programs and their main conclusions. It also provides a broad sample of results of the economic incentive programs initiated or provided by utilities, in the target states, as claimed by them.

7.3.1. Studies of State Incentives

The literature on business incentives was thoroughly investigated in a report (the "Hoyt Report") submitted to the Kentucky Cabinet for Economic Development back in 2007.[49] The Hoyt report cites the following main implications of the literature:

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[47] Kentucky Association of Manufacturers, *Remediation Reduction: A Pathway for Postsecondary Readiness*, January 25, 2012, p. 2.

[48] Kentucky Council on Postsecondary Education, Report on College Readiness, August 15, 2010, pp. 1-2.

- The impacts of economic development incentives on economic growth are difficult to measure because of the confidentiality of the tax data that are needed for such evaluation.
- Most states do not regularly evaluate their economic development incentive programs.[50] Such regular evaluations do occur in some states (e.g., Georgia and North Carolina), though few of their incentive programs have sufficient data for evaluation.[51]
- One study found that a modest number of jobs were created by Georgia's jobs tax credit, at a cost of $3,500 per new job (in 2011 dollars).[52]
- Another study was unable to determine whether Kentucky's Industrial Development Act, Rural Economic Development Act, and Jobs Development Act had a significant impact on the state's economy.[53]
- Studies tend to find a positive relationship between development incentives and economic growth, but this finding might partly be due to the studies' general failure to adequately consider variations in jurisdictions' business climates.[54]
- Counties that win the competition for large new industrial plants enjoy dramatically higher economic growth after the plants are built. Due to lack of data, however, it is not clear that the benefits of that higher growth are larger than the incentives paid for that growth.[55]
- As a theoretical matter, economic development incentives seem more likely to have a positive impact in regions with high unemployment than in those with low unemployment.[56] The empirical evidence does not support this theory, however, as

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[49] W. Hoyt, C. Jepsen, and K.R. Troske, An Examination of Incentives to Attract and Retain Businesses in Kentucky, submitted to the Kentucky Cabinet for Economic Development, University of Kentucky Center for Business and Economic Research, January 18, 2007 (Hoyt Report), pp. 2-4.

[50] Hoyt Report, citing T.B. Buss, "The Effect of State Tax Incentives on Economic Growth and Firm Location Decisions: An Overview of the Literature," *Economic Development Quarterly*, 15(1): 90-105, 2001.

[51] Hoyt Report, citing K.R. Ihlanfeldt and D. Sjoquist, "Conducting an Analysis of Georgia's Economic Development Tax Incentive Program," *Economic Development Quarterly*, 15(3): 217-228, 2001.

[52] Hoyt Report, citing D. Faulk, "Do State Economic Development Incentives Create Jobs? An Analysis of State Employment Tax Credits," *National Tax Journal*, 55(2): 263-280 2002.

[53] Hoyt Report, citing K.D. Edmiston, D.L. Sjoquist, and J. Thomas, "An Analysis of Proposed New Economic Development Initiative," Fiscal Research Program Report Number 81, Andrew Young School of Policy Studies, Georgia State University, 2003..

[54] Hoyt Report, citing P.S. Fisher and A.H. Peters, "Tax and Spending Incentives and Enterprise Zones," *New England Economic Review*, March-April, 109-130, 1997.

[55] Hoyt Report, citing M. Greenstone and E. Moretti, "Bidding for Industrial Plants: Does Winning a 'Million Dollar Plant' Increase Welfare," National Bureau of Economic Research Working Paper Number 9844, 2003.

[56] Hoyt Report, citing T. J. Bartik, *Who Benefits from State and Local Economic Development Policies?*, W.E. Upjohn Institute for Employment Research, Kalamazoo, Michigan, 1991.

regions with low unemployment tend to have relatively low manufacturing costs and nonetheless offer competitive economic development incentives.[57]

- The empirical evidence shows no significant impact of enterprise zone programs[58], tax abatement programs, or tax increment financing programs.
- The federal tax credit programs of the 1970s and 1980s appear to have modest positive impacts on employment, though some of the employment gains may have occurred even in the absence of these programs.[59]
- The many articles on taxation and business incentives fail to consider the non-random nature of the incentives (i.e., companies receiving incentives are, or may be, systematically different than those not receiving incentives), and also fail to consider the inevitable time lapse between the enactment of incentives and their economic impacts. These oversights probably cause studies to over-estimate the benefits of incentives.

7.3.2. Reports of Utility Economic Development Initiatives

This section provides a broad sample of the economic impacts of the utility-sponsored economic development programs and services based on claims made by the utilities. There have been no detailed analytical studies of the effectiveness of these programs.

According to Alabama Power, in 2008, it evaluated economic development initiatives of ten communities within its service territory. With the help of the Alabama Development Office, PowerSouth, the Economic Development Partnership of Alabama, and Troy University, the utility launched its 14-county Alabama Existing Industry Initiative to support industrial growth. Alabama Power says that this fostered $2.1 billion in new corporate investment in 2008, creating 4,629 jobs through (among other projects) the expansions of the Austal, EADS CASA North America, Brookwood Pharmaceuticals, Heritage Plastics, Kamtek, and U.S. Steel corporations.[60]

Duke Energy claims to have contributed to the creation of 12,164 new jobs in 2008 as well as an associated $2.9 billion in major expansions by (among others) BMW in South Carolina, Celgard in North Carolina, GE Aviation in Ohio, ZF Steering Systems in Kentucky, and Steel Dynamics in Indiana. A common menu of economic development riders serves business customers in all the five states served by Duke Energy. The utility also claims that its Site Readiness Program in the

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[57] Hoyt Report, citing P.S. Fisher and A.H. Peters, *Industrial Incentives: Competition among American States and Cities*, W.E. Upjohn Institute for Employment Research, Kalamazoo, Michigan, 1998; and J.E. Anderson and R.W. Wassmer, Bidding for Business: The Efficacy of Local Economic Development Incentives in a Metropolitan Area, W.E. Upjohn Institute for Employment Research, Kalamazoo, Michigan, 2001.

[58] Hoyt Report, citing W.H. Hoyt and J.E. Garen, "Fiscal Policy and Economic Development," National Center for Real Estate Research, State and Local Fiscal Research Institute, November 2006.

[59] Hoyt Report, citing J. Bishop and M. Montgomery, "Does the Targeted Tax Credit Create Jobs at Subsidized Firms?", *Industrial Relations*, 32(3): 289-306, 1993; and J.M. Perloff and M.L. Wachter, "The New Jobs Tax Credit: An Evaluation of the 1977-1978 Wage Subsidy Program," *The American Economic Review*, 69(2): 173-179, 1979.

[60] Site Selection Magazine, *Top Utilities in Economic Development*, September 2009, p. 2.

Carolinas assessed 60 potential industrial sites and five potential mega-sites between 2005 and 2009.[61]

In 2008, Entergy Corporation initiated a domestic corporate headquarters visitation program. Entergy's first "Select Site" mega-site, a 2,045 acre parcel located in Saline County Arkansas, was certified in 2008. In Louisiana, Entergy collaborated with other entities in evaluating ten potential business investment sites and worked with Southeastern University on work force training. Entergy has hosted several economic development workshops and conferences. Entergy takes partial credit for stimulating investments by America's Choice, Evergreen Packaging, Stant Manufacturing, and Pine Bluff Poultry in Arkansas; Brown Bottling Group and Denbury Resources in Mississippi; and by the Shaw Group in Louisiana. In 2009, Entergy launched two site selection centers in Arkansas and Louisiana.[62]

In 2008, FirstEnergy claims to have contributed to more than $3.7 billion in corporate facility investment involving more than 10,960 jobs. It has been involved in trade missions to Canada and Mexico that it claims created 48 qualified leads for participating companies. FirstEnergy takes some credit for a 100-job investment by Bookmasters and a 200-job investment by Mustang Dynamometer in Ohio, and investment from pharmaceutical companies Mallinckrodt Baker and Novartis ($25 million) in New Jersey.[63]

According to Georgia Power, its economic development team contributed to attracting to Georgia $1.8 billion of business investment from 84 companies, which could create over 8,400 jobs. Projects included those of Whirlpool and Home Depot.[64]

According to Progress Energy, its efforts contributed to landing over $2.5 billion in corporate investment in 2008, thus creating over 8,340 jobs. The projects include those of the GE-Hitachi Nuclear Energy in North Carolina, International Knife & Saw in South Carolina, and Draper Labs in Florida.[65]

Tennessee Valley Authority claims that its economic development initiatives, including its business location assistance services and its Megasite certification program, contributed to the creation of 41,600 jobs and $5.5 billion in corporate investment in its seven-state territory in 2008.[66] It claims that its fiscal year 2010 activities helped attract or retain more than 41,000 jobs and leverage $4.3 billion in capital investment for the seven-state service territory.[67] It further claims that, between 2005 and 2008, its economic development support contributed to the creation of 264,500 new or retained jobs and $27 billion in business investment, including

[61] *Id*., pp. 3-4.

[62] *Id*., p. 4.

[63] *Id*., p. 4-5.

[64] *Id*., p. 5.

[65] *Id*., p. 6.

[66] *Id*., p. 7.

[67] http://www.redorbit.com/news/business/2605957/
tva_among_top_utilities_for_economic_development_for_sixth_straight/

those of Amazon distribution centers in Tennessee, a new automotive plant in Alabama, and expansion of a drug manufacturing plant in Kentucky. TVA's Valley Investment Initiative program provides incentives to qualifying power customers that make ongoing investments in the region. TVA's data center development program has certified 18 sites as top locations for data centers to house computers, telecommunications, and other systems used by high-tech industries.

Xcel Energy claims that its Process Efficiency program helped Anderson Corporation identify significant opportunities for improving energy efficiency at its door and window manufacturing facilities in Minnesota. Xcel also offers an Energy Design Assistance program.[68]

8. THE ALUMINUM INDUSTRY

Representatives of Kentucky's two aluminum smelters have informally requested Commonwealth or utility financial assistance in maintaining the smelters' profitability, along with the employment and economic benefits that accompany their retention in Kentucky. Because the smelters' financial condition and prospects have served as a key impetus for developing this report, this section focuses on facts related to that industry.

Kentucky's aluminum industry is a part of the world's aluminum industry. In particular, the sales of Kentucky's smelters and the prices that they are able receive for their sales depend upon the worldwide supply of and demand for aluminum. Consequently, this section begins by looking at the world aluminum industry. It then looks at the industry in the U.S. and in Kentucky.

8.1. The World Aluminum Industry and Market

The world's production of primary aluminum has been rising over time. Figure 1 shows that it has been increasing at an average annual rate of 3.3% since 1974, and at the faster rate of 5.4% since 2000. Alcoa expects this growth rate to rise to 6.5% per annum during the present decade, roughly doubling the global consumption and supply between 2010 and 2020. Over this decade, Alcoa forecasts bauxite growth from 214 million metric tons per year to 400 million metric tons per year, alumina growth from 82 million metric tons per year to 156 million metric tons per year, and primary aluminum growth from 39 million metric tons per year to 73 million metric tons per year.[69]

[68] Site Selection Magazine, *Top Utilities in Economic Development*, September 2009, p. 8.

[69] Alcoa, "Global Trends Driving Increased Aluminum Demand," May 6, 2011, http://www.alcoa.com/global/en/news/news_detail.asp?pageID=20110506006117en&newsYear=2011.

Figure 1
Primary Aluminum Production, 1974-2011 (000s of metric tons/year)[70]

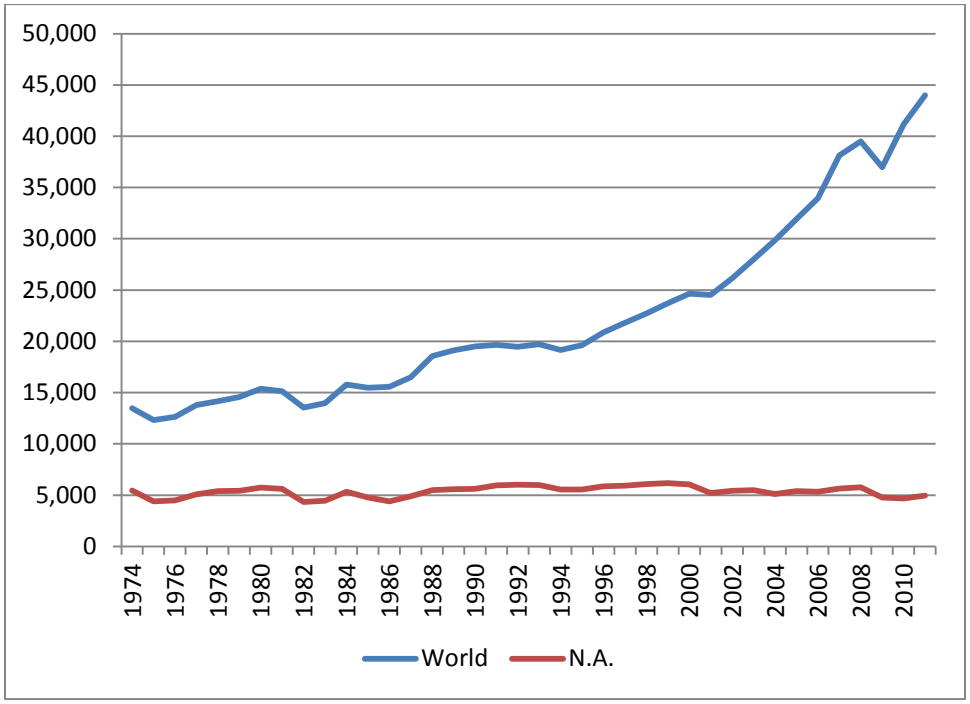

Figure 1 also shows that North American (N.A.) primary aluminum production has been fairly flat over this period, dropping from 5.5 million metric tons in 1974 to 5.0 million metric tons in 2011.

At any point in time, the price of aluminum is fairly uniform all over the world, though it does vary by several percent from place to place depending upon transport costs. A key price index is that of the London Metals Exchange (LME). Figure 2 shows that the monthly average LME price for aluminum has exhibited high volatility over the past twenty-five years, reaching a high of $3,578 per metric ton in 1988 and a more recent high of $3,067 in 2008. The simple average monthly price over the past twenty-five years has been about $1,773 per metric ton, during which time it has trended upward, so that the simple average monthly price over the past decade has been about $2,084 per metric ton.

Table 17 presents LME cash and forward prices as of September 27, 2012, where the latter reflect the expectations of buyers and sellers about the future worldwide price of primary aluminum. These prices indicate that aluminum market participants expect today's price of around $2,068 per metric ton to increase by about 15% to $2,375 per metric ton by the end of 2015. If a particular smelter is not profitable at current prices, a reasonable question is whether it can become profitable at a higher forward price, given expected increases in electricity costs and electricity prices. According to estimates by Bloomberg Industries, 25% of

[70] http://www.world-aluminium.org/statistics/primary-aluminium-production/#data, issued July 20, 2012.

smelters worldwide lose money when the LME price is below $2,350 per metric ton and 50% are unprofitable when the LME price is below $2,000.[71]

Figure 2
Monthly Average LME Prices of Aluminum, 1987- 2012 (nominal $US/metric ton)[72]

Table 17
LME Prices (US$/metric ton) – 27 September 2012[73]

Period	Prompt Date	Bid ($)	Ask ($)
Cash	1/10/2012	2,067.50	2,068.00
3-Month Forward	27/12/2012	2,095.50	2,096.00
1-Year Forward, December	18/12/2013	2,185.00	2,190.00
2-Year Forward, December	17/12/2014	2,280.00	2,285.00
3-Year Forward, December	16/12/2015	2,370.00	2,375.00

[71] http://www.bloomberg.com/news/2011-11-09/aluminum-slump-means-25-of-global-smelters-now-losing-money-commodities.html.

[72] http://www.indexmundi.com/commodities/?commodity=aluminum&months=300. 99.5% minimum purity.

[73] LME Forward prices obtained from http://www.lme.com/aluminium.asp, accessed September 30, 2012.

The price of aluminum is determined by the costs of the resources that are used to create aluminum. Figure 3 shows the cost shares of the inputs to aluminum smelting on an industry-average basis. These cost shares vary by firm.

Figure 3
Average Cost Shares of Inputs to Aluminum Smelting, 2009[74]

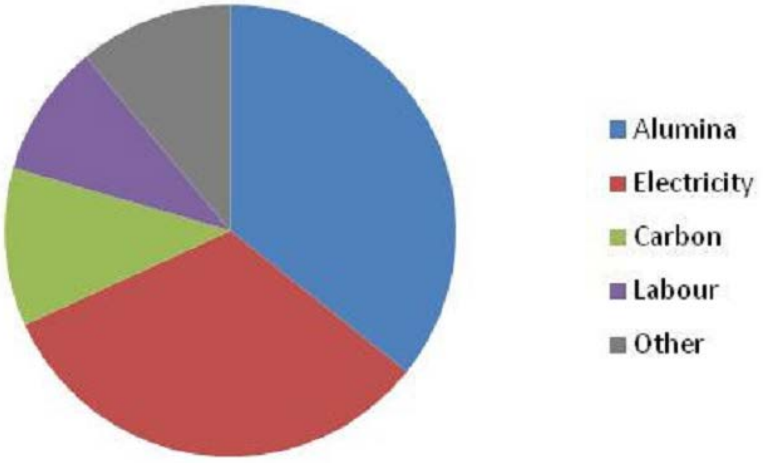

Figure 3 shows that electricity is a major input to aluminum smelting, accounting for an average of about a third of the cost of primary aluminum production. Consequently, aluminum firms locate their plants where electricity prices are relatively low; and they face the risk that, after building a plant in a low-price location, electricity prices might rise at that location with the passage of time.

Figure 4 shows the electricity prices recently paid by the world's 110 major aluminum smelters in 2010, including those of Kentucky. The figure shows that Kentucky's electricity prices, at $43.50 per megawatt-hour (MWh) for its smelters, were high relative to those offered by the utilities that serve smelters elsewhere in the world, which had an average price of $26 and a median price of $30. Just as smelters came to Kentucky decades ago because of Kentucky's relatively low electricity prices, so smelters today are being built where electricity prices are lowest. Many of today's cheapest electricity sources rely on cheap fuel (e.g., abundant hydropower), while others rely on government subsidies or mispriced resources (e.g., where prices are not determined by market forces).[75]

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[74] CRU, *The Strategic Impact of Changing Energy Markets on the Aluminium Industry*, presentation, Seattle, February 2010, slide 12, citing CRU Aluminium Smelting Cost Service. Current cost shares should be very similar to those of 2009.

[75] For example, in 2009, the average cost of power for Canadian smelters was $192 per metric ton compared to the global average of $463 per metric ton. This translates to a rate of $23.80 per MWh. This cost advantage arises in part from access to lower-cost electricity produced from hydropower, which may be partly due to government subsidies and/or cross-subsidies among customers. Canadian Autoworkers Union, *Production, Profits and Power…behind the success of Rio Tinto Alcan in Canada*, May 2009, p. 8 and p. 13.

Figure 4
Retail Electricity Prices Paid by the World's Major Aluminum Smelters and Kentucky Smelters, 2010 ($/MWh)[76]

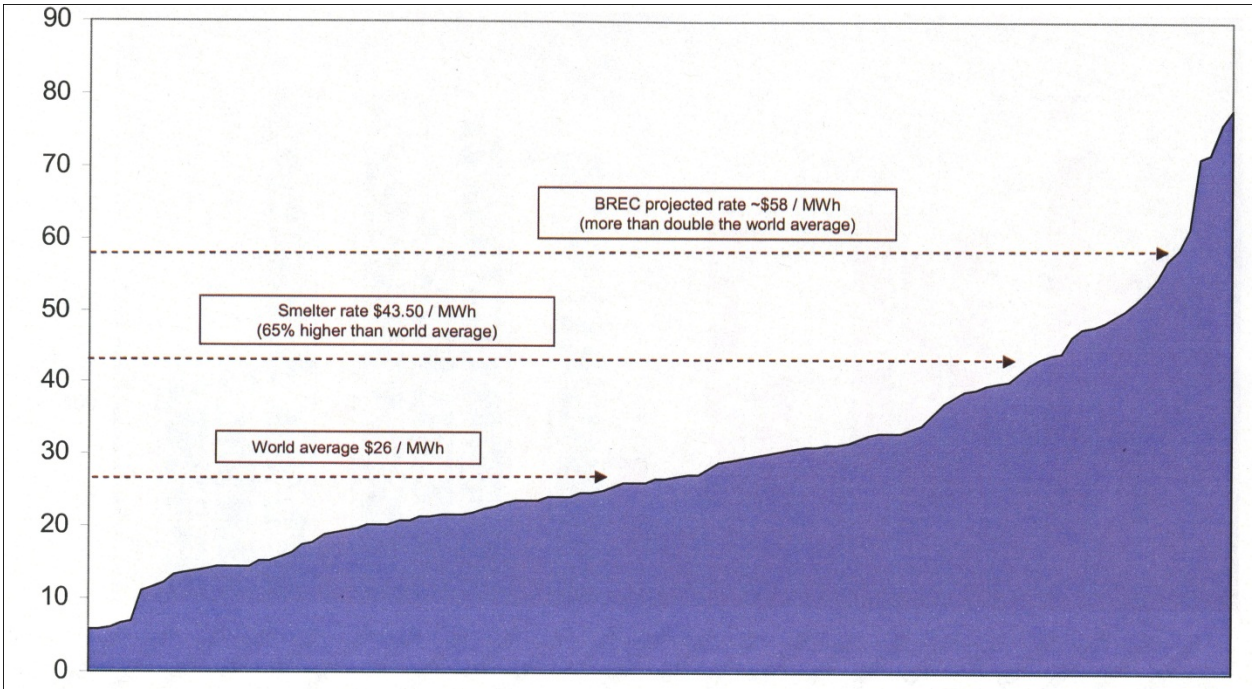
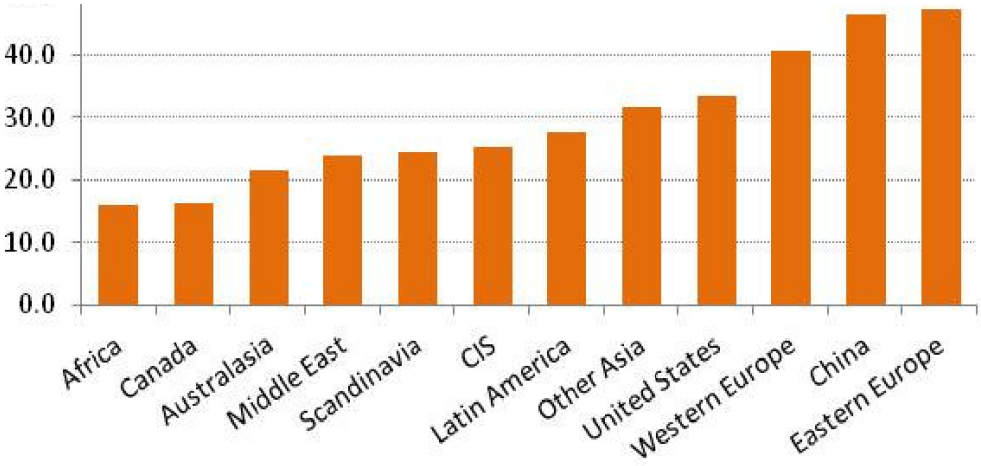


Figure 5 presents a summary of the electricity prices paid by smelters worldwide in 2009. It shows that the average electricity price paid by smelters in the U.S. was just under $35 per MWh, which is higher than that in the many regions of the world that have relatively inexpensive hydropower (e.g., Canada or Scandinavia), natural gas (e.g., Middle East), or coal (e.g., Africa and Australia).

[76] CRU, as cited by Rio Tinto Alcan, *Kentucky's aluminum smelters and the power industry – the future*, presentation, July 12, 2012, slide 3.

Figure 5
Power Prices by World Region, 2009 ($ / MWh)[77]



For a smelter to run a gross profit, its total operating costs must be less than the LME cash price for aluminum plus any regional premiums (e.g., the Midwest Market Premium applicable to Kentucky). Century Aluminum produced such a cost analysis as part of its second quarter 2012 financial conference call presentation. Figure 6 presents some of the key results of that analysis. Century's President and CEO, Michael Bless, in discussing the implications of the analysis stated:

> …we thought we would show you our rendition here of the breakeven global cash cost curve. Just to give you a sense of how we constructed this, we've excluded all the production capacity in China from this chart given the fact that, from a primary production standpoint at least, China is a reasonably closed system, meaning it is balanced over time. We have also excluded just about a million tons of non-economic or social producers as they are sometimes called, small smelters around the world that really produce for social reasons and would be well off at this cost curve to the right hand side, of course.
>
> …we've reduced the cash cost by the current physical premium, so you're seeing really an LME-equivalent cost here. As you can see just eyeballing it, just picking a price like 1,900 even or even a little bit above, you've got a significant portion of the production capacity on this chart that is making cash losses at those kinds of metal prices. Obviously, the problem would be even more pronounced without the current high premiums in the market place. We believe these data obviously support the case that over time we need significantly higher aluminum prices to gain a market equilibrium.[78]

[77] CRU Aluminum Refining Cost Service, *The Strategic Impact of Changing Energy Markets on the Aluminium Industry*, presented to TMS 2010 Seattle, Washington, February 14-18, 2010, slide 13.

[78] http://seekingalpha.com/article/745281-century-aluminum-s-ceo-discusses-q2-2012-results-earnings-call-transcript, accessed July 26, 2012.

Figure 6
Estimated Cumulative Cost Curve for the World's Aluminum Supply (excluding China)[79]

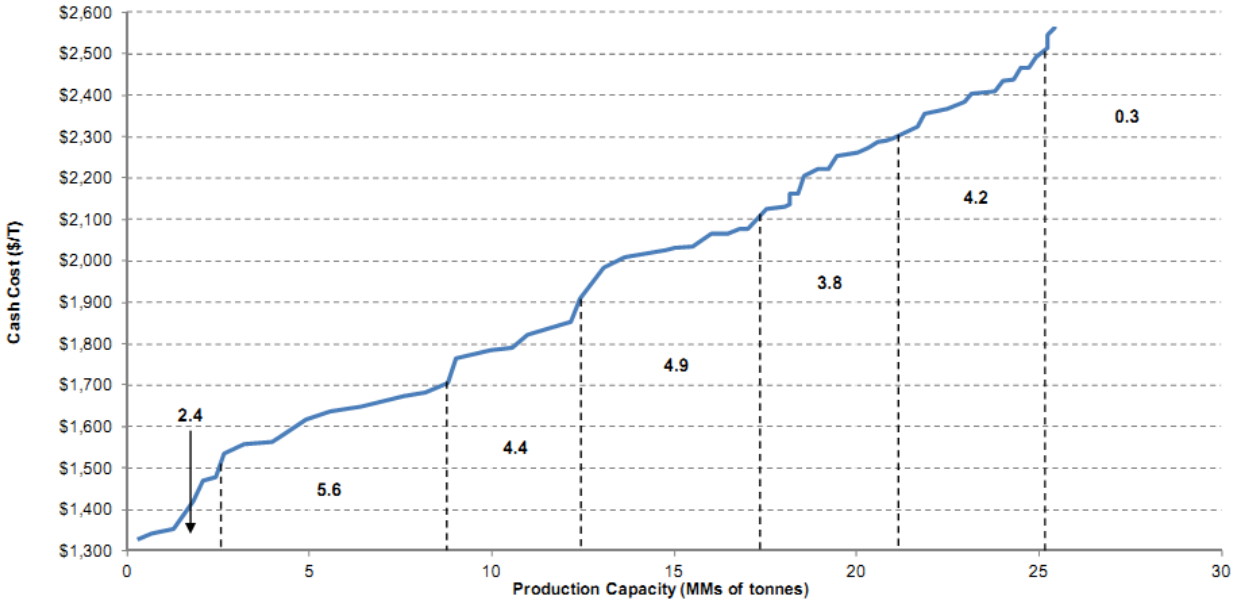


Figure 6 suggests that a large share of the world's aluminum production capacity would operate at a loss at current market prices, and that most of this loss-making capacity is likely to sit idle until the current surplus supply of primary aluminum is worked off and market prices rise.

8.2. The U.S. Aluminum Industry and Market

8.2.1. Recent History

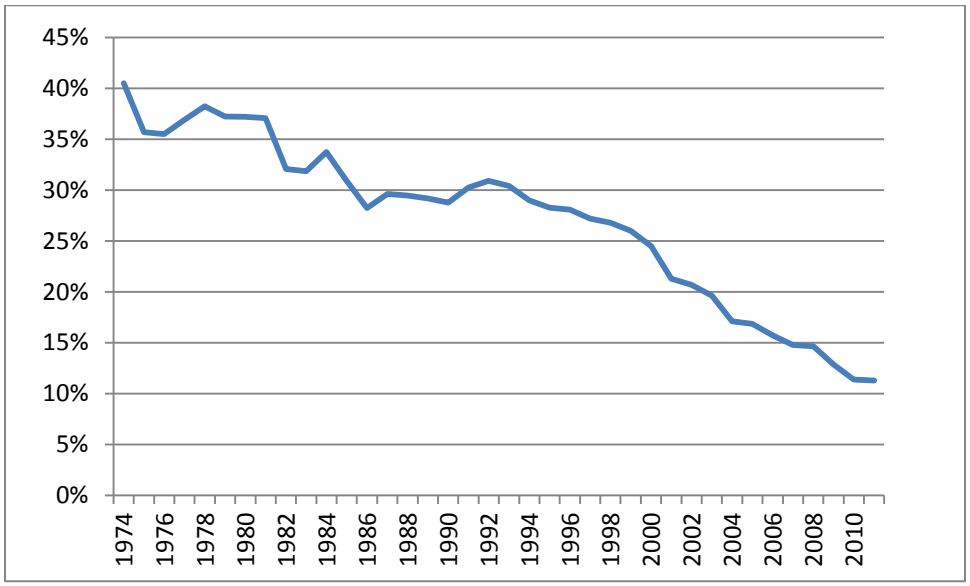
Consistent with the production statistics in Figure 1, Figure 7 shows that the North American (predominantly U.S.) share of world aluminum production has been falling for decades. The North American share of world aluminum production was 41% in 1974, but fell to about 11% in 2011. This near continuous downward trend in North American share in world aluminum output is partly due to the rise in production costs in the U.S. relative to the rest of the world, but is also due to the spectacular industrialization of the developing world, particularly in the Far East. The rising U.S. production costs are due both to increasing electricity rates and to the aging of U.S. smelting facilities: about 74% of the nameplate capacity of U.S. aluminum smelters resides in facilities built before 1970, though these older facilities have been generally upgraded over the years.[80] By contrast, the new smelters have recently been built in areas of the world that have the cheapest electricity prices, particularly from hydropower and abundant natural gas, and sometimes due to government assistance (e.g., in Canada). These new

[79] Century Aluminum, *2nd Quarter 2012 Earnings Conference Call*, presentation, July 24 2012, slide 5.

[80] http://justdigging.wordpress.com/2009/09/23/endangered-specie-us-aluminium-smelters/.

smelters not only enjoy the advantage of cheap electricity but also often enjoy lower labor costs and greater operational efficiencies based upon the most up-to-date technologies.

Figure 7
North American Share of Primary Aluminum Production, 1974 – 2011[81]



Some U.S. smelters have closed because of rising electricity prices. From the history of temporary energy-related shutdowns at the Wenatchee (Alcoa), Goldendale (Glencore), Frederick (Alcoa-Eastalco), and Ferndale (Alcoa-Intalco) smelters, it appears that about a quarter of U.S. nameplate smelter capacity is vulnerable to rising electricity prices. On the other hand, about 30% of U.S. smelter capacity has long-term power agreements and/or independent power arrangements that at least partially insulate them from electricity price uncertainties.[82]

According to Morgan Stanley, the average production cost of aluminum in the U.S. in 2009 was about $1,712 per metric ton, versus $1,389 per metric ton for Canadian smelters.[83] Prospective Environmental Protection Agency regulations promise to increase U.S. electricity prices and, to a lesser extent, the non-electricity costs of U.S. smelting.

Figure 8 shows the relationship between production of primary aluminum and employment at U.S. smelter facilities over the period 1999 to 2011. As plants have closed throughout the past decade, production has fallen by 47% from 3.78 million metric tons in 1999 to 1.99 million

[81] http://www.world-aluminium.org/statistics/primary-aluminium-production/#data, issued July 20, 2012.

[82] http://justdigging.wordpress.com/2009/09/23/endangered-specie-us-aluminium-smelters/.

[83] http://justdigging.wordpress.com/2009/09/23/endangered-specie-us-aluminium-smelters/. A primary reason for the difference is the lower cost of electricity in Canada, which is heavily tied to hydropower, including that owned by smelters.

metric tons in 2011, while employment declined more steeply, by 61% from 76,300 in 1999 to 30,000 in 2011. The silver lining is that the plants are becoming more efficient in terms of increasing output per employee.

Figure 8
Trends in U.S. Smelter Production and Employment, 1999 to 2011[84]

The value of primary aluminum production in the U.S. was $5.27 billion in 2011. Aluminum consumption was centered in the Midwest. Of domestic consumption, about 34% was used in the transportation industry (e.g., automobiles and aircraft), 27% in packaging, 12% in building material, 8% in electrical equipment, 8% in machinery, 7% in consumer durables, and 4% in miscellaneous uses.[85]

Domestic aluminum production has been recovering from the financial crisis of 2008-2009. Several smelters and potlines that were closed during the crisis – Hawesville, Kentucky; Massena, New York; Hannibal, Ohio; Ferndale, Washington; and Wenatchee, Washington – have since reopened or restarted. A modest expansion is underway in New Madrid, Missouri. Nonetheless, U.S. smelters operated at only about 64% of rated capacity in late 2011.

A number of factors have contributed to the decline of the U.S. primary aluminum smelting industry, not the least of which is the increase in electricity prices over the past couple of

[84] CA Energy Consulting analysis based on data obtained from U.S. Geological Survey, Minerals Commodity Summary, various issues, 2002 to 2012.

[85] U.S. Geological Survey, http://minerals.usgs.gov/minerals/pubs/commodity/aluminum, *Minerals Commodity Summary*, 2012, p. 16.

decades relative to those paid by smelters elsewhere in certain parts of the world, with the outcome shown in Figure 5. Other input costs to U.S. production, such as labor wages and benefits, have also increased relative to those faced by smelters in other regions of the world (e.g., India, Middle East). In addition, the technologies employed by newer smelters in particular parts of the world (e.g., Middle East and Africa) have the advantages of newer and more efficient production technologies. The combination of these factors has undermined the competitiveness of U.S. smelters.

Table 18 shows the locations, ownership, and electricity providers of U.S. smelters that were in operation in 2011, and continue to be in operation. Excluding the two idled plants, five companies operated ten plants. Of those ten, six continued operations at or near full capacity, two plants that had been idled were restarted at least in part, and two reduced output by idling potlines.

Table 18
U.S. Aluminum Smelters Presently in Operation - 2011[86]

State	Location	Capacity (000 mtpy)	Company	Owner	Electric Utility Provider	In Operation
IN	Evansville/Warrick	309	Alcoa	Alcoa	Vectren	Yes
KY	Hawesville	244	Century	Century	Big Rivers Electric Corp	Yes
KY	Sebree	196	Alcan	Alcan	Big Rivers Electric Corp	Yes
MO	New Madrid	253	Noranda	Noranda	Ameren	Yes
MT	Columbia Falls	170	CFAC	CFAC	Bonneville Power Administration	Idled
NY	Massena West	130	Alcoa	Alcoa	Massena Electric	Yes
NY	Massena East	125	Alcoa	Alcoa	Massena Electric	Yes, restarted in 2011
OH	Hannibal	267	Ormet	Ormet	AEP Ohio	Yes, but at least 2 potlines idled
SC	Mount Holly	224	Goose Creek	Alcoa / Century	Santee Cooper	Yes
WA	Bellingham/Ferndale	300	Intalco	Alcoa / others	Bonneville Power Administration	Yes, but idled several potlines
WA	Wenatchee	184	Alcoa	Alcoa	Chelan Public Utility District	Yes, restarted idled potlines
WV	Ravenswood	170	Ravenswood	Century	Appalachian Power	Idled

Table 19 shows locations, ownership, and disposition of U.S. smelters that closed permanently over the past dozen years. It indicates that the majority of closed plants were subsequently demolished, with the exceptions of: a) the Columbia Falls plant, which has been idled since 2009 and for which the owner is attempting to work out a power purchase contract that will permit reopening; and b) the Alcoa Tennessee plant, for which the owner is seeking redevelopment. Several of the sites have been sold for industrial redevelopment, although some remain undeveloped as the former owners work on environmental clean-up of their sites.

[86] CA Energy Consulting analysis. Plant capacity figures are in thousands of metric tons per year.

Table 19
U.S. Aluminum Smelter Plants Closed Down, 2000-2011

State	Location	Capacity (000 mtpy)	Owner	Year Closed	Reason	Current Disposition
MD	Frederick	195	Alcoa	2005	Electricity Costs	Demolished
MD	Eastalco	75	Alcoa	2005	Electricity costs	Demolished
MT	Columbia Falls	170	Columbia Falls Aluminum Company	Idled 2009	Low LME & high electricity costs	Idled
NC	Badin	115	Alcoa	2002/2010	Wholesale power more profitable than aluminum	Demolished
OR	The Dalles	82	Northwest Aluminum Company	2000	Low LME & high electricity costs	Demolished
TN	Alcoa Tennessee	215	Alcoa	2009	Low LME & inability to obtain long-term power contract with TVA	Alcoa currently seeking ways to redevelop the site
TX	Rockdale	267	Alcoa	2008	Low LME & high electricity costs	Demolished, Alcoa sold site to Lower Colorado River Authority, 2012
WA	Goldendale	178	Northwest Aluminum Company	2003	Low LME & high electricity costs	Demolished
WA	Vancouver	115	Alcoa	2000	Low LME & high electricity costs	Demolished
WA	Longview	204	Reynolds	2001	Low LME & high electricity costs	Demolished
WA	Tacoma	81	Kaiser Aluminum	2000	Low LME & high electricity costs	Demolished
WA	Spokane	50	Kaiser Aluminum	2000	Low LME & high electricity costs	Demolished, site sold for redevelopment, 2012
WA	Troutdale	121	Reynolds	2002	Low LME & high electricity costs	Demolished

8.2.2. State Actions to Assist Aluminum Smelters

In addition to Century's Hawesville plant and Alcan's Sebree facility, there are eight other smelter facilities located in seven states. Table 20 summarizes the actions that have been taken by state governments and/or utilities to enable these plants to continue to operate, at least for the short term. Excluding the Ravenswood plant in West Virginia, the remaining seven smelters have the following status:

- 5 smelters (in Ohio, Montana, New York, and Washington) receive discounts from the utility, without state assistance; and
- 2 smelters (in Missouri and South Carolina) receive assistance from neither their state nor their utility.

Of the five smelters receiving utility discounts:

- 4 smelters (in Ohio, Montana, New York, and Washington) receive discounts subject to employment requirements;
- 2 smelters (in Ohio and New York) receive discounts based upon LME;
- 1 smelter (in Washington) receives a discount subject to a production requirement;
- 1 smelter (in New York) receives a discount subject to investment requirements; and
- 1 smelter (in Montana) receives a discount subject to power consumption requirements.

Table 20
State Assistance to Mitigate Electricity Costs for Aluminum Smelters

State Smelter (Owner)	Details
OH Hannibal (Ormet)	*Date of Deal*: Power agreement signed and executed September 15, 2009. Filed with state commission on September 19, 2009. Upheld by the state Supreme Court on May 24, 2011 *Effective Electric Rate Discount*: 2010: 0.049*($3,036 - actual LME price/ton) 2011: 0.0377*($3,392 - actual LME price/ton) 2012: 0.05081*($2,846 - actual LME price/ton)[87] *Length of Deal*: Effective until December 31, 2018. *Conditions*: Discount is tied to the LME and changes yearly. For LME prices below the target, the customer gets a discount, while LME prices above the target require the customer to pay a premium. Maximum discount is $60 million in 2010 and 2011, $54 million in 2012, and declines by $10 million each year thereafter. *Required Smelter Action*: Maintain full employment (900 workers) in 2009. Maintain 650 workers every month for entire agreement term. The monthly discount is reduced by $833,000 for every 50 workers not employed relative to 650 in any month.
MO New Madrid (Noranda)	*Date of Deal*: State commission rejected rate increase on May 28, 2010. Other rate increases have been struck down in courts. *Effective Electric Rate*: Rates unchanged in 2010 rate case. However, proposed rates for the smelter may have resulted in a rate decrease, so freezing the rates was not necessarily a deal for them. *Relief Provided by State*: The state commission approved a rate freeze for the smelter, which has the lowest electricity rate of all customers but still higher than cost to serve. *Required Smelter Action*: New legislation in 2011 proposes that the smelter must pay millions in rebates to residential customers if it leaves the state (current status of bill unknown)

[87] Subsequent years see maximum annual discounts to Ormet systematically reduced until 2018.

Table 20 (continued)

State Smelter (Owner)	Details
MT Columbia Falls (Glencore)	*Date of Deal*: To begin on April 1, 2012 *Effective Electric Rate*: The average Industrial Firm Power (IP) annual rate is $36.32/MWh for 2012 and 2013. IP rate is a tariff rate but only offered under special contracts. *Length of Deal*: 4.5 years (until September 30, 2016) *Required Smelter Action*: Between April and December 2012, the smelter must purchase 140 MW to avoid contract termination. After December 2012, CFAC may curtail production but with penalties. CFAC must maintain employment levels tied to average monthly power used.
NY Massena (Alcoa)	*Date of Deal*: January 2009 (Effective July 1, 2013) *Effective Electric Rate*: 2013 Base Rates are $6.23 per kW-month and 1.23 cents per kWh *Length of Deal*: 30 years starting July 1, 2013 (with possible 10-year extension) *Conditions*: Energy and demand charges are subject to annual price index escalation and quarterly adjustments (upward only) based on LME price. *Required Smelter Action*: $600 million investment upgrade of plant, $10 million investment in North Country Economic Development Fund, initial employment of 1,065 allowed to trend to no less than 900.
SC Mount Holly (Alcoa & Century)	*Date of Deal*: June 1, 2012. *Effective Electric Rate:* The Curtailable Supplemental Rate Schedule was amended to allow Mt Holly and Santee Cooper to designate a specific resource to supply all or part of Mt. Holly's Supplemental Power (SP) requirements. The SP energy rate is based on the designated resource's fuel costs rather than Santee Cooper's system average fuel costs. Mt. Holly has also agreed to reduce a defined amount of its load for limited periods during system emergencies in exchange for a reduction in the demand charge. *Effective Electric Rate Discount*: Details are not public. *Required Smelter Action*: Curtail demand upon notification.
WA Intalco (Alcoa)	*Date of Deal*: December 22, 2009 *Effective Electric Rate*: The average Industrial Firm Power (IP) annual rate is $34.60/MWh for 2010 and 2011. IP rate is a tariff rate but only offered under certain contracts. *Length of Deal*: Ends July 31, 2012 *Required Smelter Action*: Must maintain employment levels tied to average monthly power used. May curtail production subject to limitations.

Table 20 (continued)

State Smelter (Owner)	Details
WA Wanatchee (Alcoa)	*Date of Deal*: July 12, 2008 (Effective November 1,2011) *Effective Electric Rate Discount*: The smelter obtains 26% of energy produced by two particular power plants (Rocky Reach and Rock Island Dams) at cost of service, including generation and delivery costs. *Length of Deal*: November 1, 2011 through October 2028. *Required Smelter Action*: The smelter must pay $22.9 million of $89 million capacity reservation charge. The remainder is held in reserve and is forfeited by the smelter only if it shuts down. The utility can terminate the agreement if the smelter operates less than 2 pot lines for 18 months or longer (~390 employees).
WV Ravenswood (Century)	*Date of Deal*: Pending (Public Service Commission (PSC) decision in October 2012, proposed 2013 start date) *Effective Electric Rate or Rate Discount*: Rate tied to LME, adjusted quarterly. The smelter gets a discount below a threshold LME ($2,730 per ton), and otherwise pays a premium. Any loss in revenue is shared between the utility's other customers and taxpayers (through tax credits to coal suppliers who in turn pass on 97% of the credit in effect in the form of lower coal prices). *Length of Deal*: Ends December 31, 2021. *Conditions*: Rate/MWh = (LME per ton – Production Costs per ton w/o Power)/(MWh per ton). Production costs include a margin that when LME is $1800 per ton or less; and there is a rate "floor" at an LME of $1500 per ton. *Relief Provided by State*: In 2010, the legislature authorized the PSC to approve special rates for energy-intensive consumers, where such rates could vary with commodity prices like the LME aluminum price provided such rates do unreasonably burden the utility's other customers. In addition, 2012 Energy Intensive Industrial Consumer Tax Credit (HB 101) provided a $20 million per year tax credit (with maximum carryover of any unused credit of $15 million) granted indirectly to the utility to cover all differences between contract revenues and tariff revenues. *Required Smelter Action*: The smelter must: (1) maintain demand of at least 250 MW; (2) create or retain at least 150 new full-time jobs for a total of at least 300 jobs ; (3) invest at least $500,000 in fixed assets; (4) provide evidence that the smelter plans to operate for an extended period and needs the tax credit to operate.

Of the seven states listed in Table 20, Ohio and West Virginia have legislated solutions beyond those that were already within the authorities of their utility or regulatory commissions. In all other states, efforts to mitigate electricity cost impacts on smelters were taken by utilities under existing authorities, sometimes voluntarily and sometimes under regulatory pressure. In all cases, however, the outcome was either a reduction in smelters' electricity prices or (for Noranda in Missouri) an agreement not to raise such prices.

Because of their unusual circumstances, the following discussion looks at some details of the situations in Ohio and West Virginia. In both cases, the smelters – Ormet Primary Aluminum's plant in Ohio and Century's Ravenswood plant in West Virginia – were idled in 2009 because of

low LME prices and rising electricity prices, similar to the threat facing Kentucky. Prospects for reopening these plants partly depend on substantial reductions in the electricity prices that they will pay over the next several years.

Ormet – Ohio

Ormet Primary Aluminum Corporation (Ormet) is the largest employer in Monroe County, employing around 1,000 people and paying annual wages of over $56 million. At 540 MW, its smelter is Ohio Power's largest customer. Electricity accounts for about 35% of its costs. In the past decade, Ormet has gone through bankruptcy reorganization, shut down, and re-start.

Under R.C. 4905.31, (an act passed by the Ohio legislature in 1993 and amended in 2008), the Public Utilities Commission of Ohio (PUCO) may approve "reasonable arrangements" between utilities and customers. Although the typical customer must take utility service under broadly applicable rates and tariffs, the "reasonable arrangement" statute allows the PUCO to approve rates tailored to a specific customer's situation. As amended, the act states that a reasonable arrangement "may include a device to recover costs incurred in conjunction with any economic development and job retention program of the utility within its certified territory, including recovery of revenue foregone as a result of any such program."[88]

The PUCO approved a "reasonable arrangement" between Ohio Power Company and Ormet that links Ormet's electric rate to the LME price of aluminum. When the LME price falls below a benchmark, Ormet gets a discount relative to Ohio Power's standard tariff; and when the LME price rises above the benchmark, Ormet pays a premium. The benchmark depends upon costs of aluminum production. Nonetheless, the discounts have an upper bound, and the discounts and premia are not symmetric around the benchmark.[89] Given the low aluminum prices that have prevailed since this arrangement began in 2009, this arrangement has had (so far) the effect of giving Ormet a substantial price discount on its electric service. Ohio Power recovers from other customers substantially all of the revenue foregone to the discounts.

On July 13, 2012, the PUCO approved rate increases for Ohio Power. Due to the current LME price for aluminum and that rate increase, Ormet is shutting down one of its six potlines by September, laying off 30 to 50 employees, and is considering closing altogether. Ormet has informed the Ohio Department of Job and Family Services that it may lay off as many as 998 employees by the end of 2012. Thus, the electricity price discounts may not be sufficient to keep Ormet's smelter open in the face of declining aluminum prices.

It is interesting to note that, in 2009, when Ohio commission was considering the rate discounts for Ormet, the Ohio Energy Group (OEG) intervened in the case in *opposition* to the rate discount plan. The OEG, comprised of large industrial energy users throughout the state, has a

[88] See 2008 Am. Sub.S.B. No. 221.

[89] Public Utility Commission of Ohio, Opinion and Order, *In the Matter of the Application of Ormet Primary Aluminum Corporation for Approval of a Unique Arrangement with Ohio Power Company and Columbus Southern Power Company*, Case No. 09-119-EL-AEC, p. 6, July 15, 2009.

composition quite similar to that of industrial customers that are located in Kentucky. In presenting their opposition to the Ormet proposal, the OEG stated:

> While Ormet's proposed Unique Arrangement caps its power costs at 5% above the otherwise applicable large industrial rate in the event LME aluminum prices more than double from their current level, there is no floor. As proposed by Ormet, the rate that it would pay could go to zero. This means that Ormet proposes that other residential, commercial and industrial customers may be required to pay for the fuel, environmental (emission allowance costs for SO2, NOX and very likely in the near future CO2) and other out of-pocket variable costs to serve its 540 MW load over the period 2010-2018. We are aware of no power contract anywhere in the United States where the consumer did not have to pay at least for the out-of-pocket variable costs to serve its load. In sum, if the aluminum market stays depressed, Ormet wants the opportunity to receive free electricity.[90]

The OEG calculated that, under Ormet's proposal to tie its electricity rate to the LME, application of mid-2010 LME prices to Ormet's electricity rates in 2010 would shift $179 million of electricity costs to other customers. The OEG went on to point out that the direct benefit of the proposed relief would be preservation of 1,996 jobs in Ohio at an average cost of $89,679 per job, which is higher than Ohio's annual average compensation per job of $56,613.[91]

Century Aluminum - West Virginia

Century Aluminum's West Virginia smelter is served by Appalachian Power Company. The plant employed 650 people before it closed in 2009.

This year's Energy Intensive Industrial Consumers Revitalization Tax Credit Act (HB 101)[92] basically gives up to $20 million per year in coal severance tax revenues to industrial electricity customers who employ at least 300 people.

In recent filings and hearings before the West Virginia Public Service Commission,[93] Century has proposed that it pay electricity prices that rise and fall with aluminum prices, leaving other customers to pick up any electricity costs that Century might thus avoid. Century's proposal has four parts:

- use of up to $20 million each year of coal severance tax credits;
- continued absorption by Appalachian Power's other customers of the $17.3 million per year in fixed costs that they have borne since the smelter closed in 2009;

[90] The Ohio Energy Group, *Motion to Intervene of the Ohio Energy Group*, In the Matter Of The Application Of Ormet Primary Aluminum Corporation for Approval of a Unique Arrangement with Ohio Power and Columbus Southern Power Company Case No. 09-119-EL-AEC, March 3, 2009.

[91] *Id.*, p. 6.

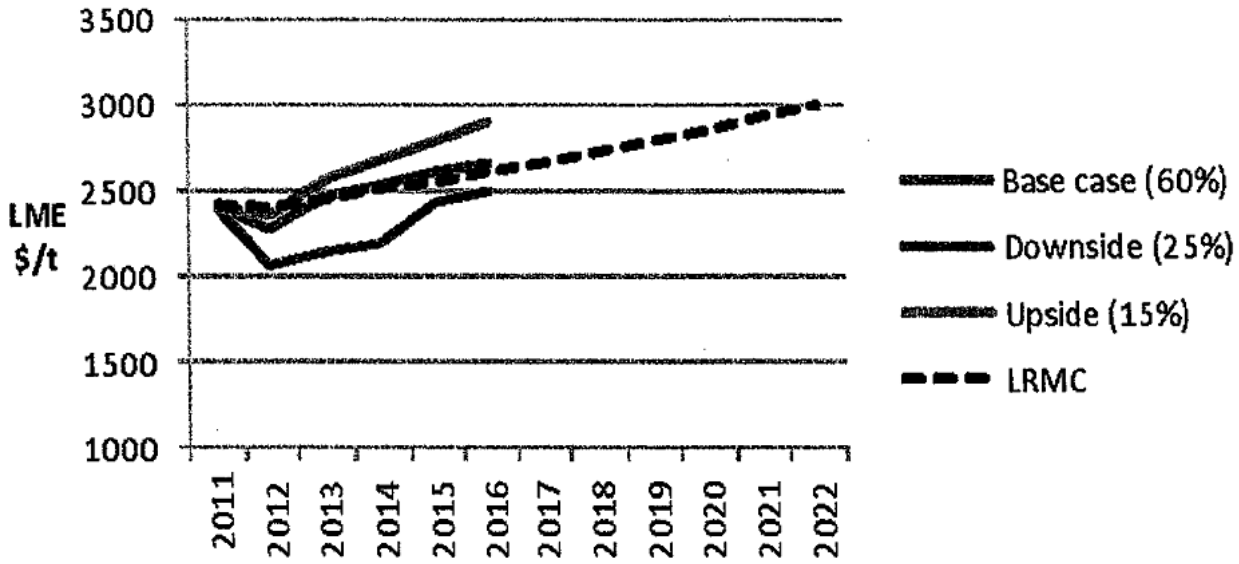
[92] West Virginia Legislature, House Bill (H.B.) 101, March 16, 2012.

[93] Public Service Commission of West Virginia, Case No. 12-0613-E-PC, *Century Aluminum of West Virginia, Inc*.

- Appalachian Power's shareholders' contribution of the $2.7 million per year ; and
- shifting of Appalachian Power's costs to or from other customers depending upon the price of aluminum, with Century projecting a shift to other customers of $20 to $35 million in the first few years if LME prices are around $2,000 per ton.

Century submitted the aluminum price forecast that appears in Figure 9. Based upon this forecast, Century believes that, when applied over the entire term of its proposed special rate, its proposal will lead to no incremental rate increase to other customers.

Figure 9
LME Aluminum Price Forecast and Industry Long-Run Marginal Cost[94]



Other parties, however, are less optimistic about the impacts on other customers:

- Appalachian Power has cautioned that the proposal would harm other customers if aluminum prices dropped further. "The Century proposal has no floor – no minimum price, however greatly discounted, that Century would pay for electricity – thus making the subsidization of Century by APCo's ratepayers virtually unlimited."[95]
- The West Virginia Energy Users Group claims that Century is attempting to shift "the entire risk of its requested special rate to other ratepayers."[96]

[94] Robin G. Adams, *Direct Testimony*, on behalf of Century Aluminum of West Virginia, Inc., before the Public Service Commission of West Virginia, Case No, 12-0613-E-PC, May 11,2012, Exhibit A, p. 7.

[95] Jared Hunt, "Electric Utility Wary of Aluminum Proposal," *Charleston Daily Mail*, June 5, 2012.

[96] Ann Ali, "Reply briefs filed for Century Aluminum rate case," *The State Journal*, August 28, 2012.

- A witness for the Staff of the Public Service Commission of West Virginia likens Century's proposal to asking other customers to "write a blank check."[97]
- Governor Tomblin recently said that he would not support shifting Century's operating costs from Century to West Virginia residents or other state businesses.[98]

The West Virginia Public Service Commission is expected to render a decision in September 2012.

The rate formula that appears in Table 20 increases Century's electricity bill by $1 every time that it cuts its non-electricity costs by $1, thus giving Century poor incentives to reduce its non-electricity costs and shifting to other electricity customers the costs of any of Century's inefficiencies. Nonetheless, to reduce its costs, Century initiated a termination of its retirement medical benefit plan that resulted in a termination of benefits for all former employees who retired prior to November 2010.

8.3. Kentucky's Aluminum Smelters

Representatives of Kentucky's aluminum industry have informally requested Commonwealth or utility financial assistance in maintaining the industry's profitability, along with the employment and economic benefits that accompany retention of Kentucky's two aluminum smelters. The smelters have requested rate discounts that they claim amount to $80 million per year. Big Rivers states that these discounts amount to $110 million per year, based upon a written proposal it received from the smelters on June 24, 2012. Century Aluminum has also requested substantial changes in its electricity service arrangements, as described below.

To help sort through the electricity rate issues related to the smelters, this section describes the smelters, their economic impacts, and the electricity service that they receive.

8.3.1. Description of the Smelters

As indicated by Table 18, Kentucky has two aluminum smelters: the Hawesville plant, which is owned by Century Aluminum; and the Sebree plant, which is owned by Alcan Primary Products Corporation. These plants have been in operation since the 1970s and are major employers in western Kentucky, with about 1,259 employees.

The aluminum prices received by these plants reflect LME world prices of aluminum as adjusted by the U.S. Midwest premium.[99] As noted by Century, the smelters' profitability is sensitive to volatile aluminum prices:

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[97] Marion A. Russell, *Prepared Direct Testimony*, before the Public Service Commission of West Virginia, Case No. 12-0613-E-PC, July 9, 2012, p. 8.

[98] Ann Ali, "Gov. Tomblin opposes passing Century Aluminum's cost to WV residents," *The State Journal*, August 6, 2012, http://www.statejournal.com/story/19205236/gov-tomblin-opposes-passing-century-aluminums-cost-to-wv-residents.

[99] Century Aluminum Company, *Form 10-Q* for the Period Ending 3/31/12, filed May 10, 2012, p. 10.

> Our operating results depend on the market for primary aluminum, which is a highly cyclical commodity with prices that are affected by global demand and supply, political and economic conditions and other related factors… Historically, aluminum prices have been volatile, and we expect such volatility to continue. Declines in primary aluminum prices reduce our earnings and cash flows. If the price we realize for our products falls below our cost of production, we may choose or be forced to curtail operations… Future downturns in aluminum prices may significantly reduce the amount of cash available to meet our obligations and fund our long-term business strategies and could have a material adverse effect on our business, financial conditions, results of operations and liquidity.[100]

The Century Aluminum Hawesville Plant[101]

Century is affiliated with Glencore International, which is a Swiss-based integrated producer and marketer of commodities, including metals, minerals, energy, and agricultural products. Glencore International has an economic interest of 46.4% (41.5% voting interest) in Century Aluminum,[102] which is a NASDAQ–traded company. Hawesville receives its alumina supply from Glencore under a long-term alumina purchase agreement.

The Hawesville plant began operations in 1970. It has five potlines that can annually produce about 244,000 metric tons of primary aluminum, including 195,000 metric tons of high-purity primary aluminum (99.9% pure) that meet the particular needs of its major customer, Southwire Rod and Cable, which produces cable, electric wire, and much more. Aluminum production has been fairly steady over the years, running near capacity for several years through 2008, and running somewhat below capacity since that time. In particular, the 56% drop in world aluminum prices between July 2008 and March 2009 induced Century to temporarily close down one of Hawesville's potlines during 2009 and 2010.

The Hawesville plant employs 771 persons. The United Steel Workers of America (USWA) represents the bargaining unit employees, for whom there is a collective bargaining agreement that expires in March 2015.

The Rio Tinto Alcan Sebree Plant[103]

Rio Tinto is an international mining corporation headquartered in the United Kingdom and Australia. The Sebree plant was acquired by Rio Tinto in 2007. Rio Tinto Alcan is presently

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[100] Century Aluminum Company, *Form 10-K* for the Period Ending 12/31/2011, filed February 29, 2012 p. 13.

[101] Information in this subsection is from several sources, including FitchRatings, *Big Rivers Electric Corporation*, full rating report, www.fitchratings.com, August 31, 2011.

[102] Glencore International web site, http://www.glencore.com/aluminium-alumina.php.

[103] Information in this subsection is from several sources, including FitchRatings, *Big Rivers Electric Corporation*, full rating report, www.fitchratings.com, August 31, 2011; http://www.rtasebree.com/, accessed July 15, 2012; and Rio Tinto Alcan, *Kentucky's aluminum smelters and the power industry – the future*, presentation, July 12, 2012.

investigating "divestment options" for the Sebree plant, which the company characterizes as not being among its "high quality, tier one assets."[104]

The Sebree plant began operations in 1973. It has three potlines that can annually produce about 196,000 metric tons of primary aluminum. Its aluminum production has been fairly steady over recent years. Rio Tinto has recently put substantial sums of money into the Sebree plant, including a completed $50 million bake furnace project. In addition, a $20 million project to increase aluminum production capacity by approximately 5% is close to completion. Consistent with this latter capacity expansion, Sebree (Alcan) has contracted to purchase additional electric power from Big Rivers (through Kenergy) for the twelve months beginning July 1, 2012.[105]

The Sebree plant employs approximately 488 persons at an average compensation level, including benefits, that is well in excess of the Kentucky average.

8.3.2. Economic Impacts of the Smelters

The smelters' operations have positive local and statewide impacts.

First, these operations bring dollars to the western Kentucky in the form of payments to employees and suppliers. Among these suppliers are river barges (that bring in alumina), electricity producers (Big Rivers), coal mines, engineering firms, maintenance contractors, trucking firms, and other vendors. Without the payments from the smelters, employees would spend less money in their present communities and may move elsewhere in search of work; and suppliers would have lower sales and revenues, which could reduce their local expenditures, reduce the number of workers that they employ, and even cause them to reduce or close operations.

Second, the smelter operations reduce the input costs for those nearby industries that use aluminum in their production processes. These nearby firms include rolling and extruding mills, wire plants, auto parts plants, can factories, and other heavy aluminum users. In particular, the closure of the Hawesville smelter would force the Southwire Rod and Cable mill to resort to a more costly source of high-grade aluminum to support its production. Higher costs can adversely impact the nearby industries, possibly causing them to reduce or close operations.

Rio Tinto Alcan Facility

Alcan says that its Sebree smelter creates 1,834 "total" jobs in Kentucky – 488 "direct" jobs at the Sebree plant plus 1,346 "indirect" and "induced" jobs in Kentucky, for a total value creation in Kentucky of $198 million per year. We have not examined the economic models that produced these results; but they apparently overstate the smelter's net benefit to Kentucky in at least three ways.

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[104] Rio Tinto Alcan, "Rio Tinto streamlines Aluminium product group," press release, October 17, 2011, http://www.riotintoalcan.com/ENG/media/media_releases_2131.asp.

[105] Big Rivers Electric Corporation, *Disclosure Statement*, July 12, 2012, p. 40.

First, this relation between "direct" jobs and "indirect" jobs implies an economic impact multiplier for the Sebree plant of 3.7582[106] – in other words, one job at the smelter leads to a total of 3.7582 jobs for Kentucky. This is a much higher multiplier than is ordinarily used in economic impact studies. For example, an analysis of the economic impacts of Century's Hawesville plant used a Direct Effect Employment Multiplier of 1.6091 for Hancock County and a Final Demand Output Multiplier of 1.3637.[107] Using the former multiplier for the Sebree facility would indicate that Sebree's 488 direct jobs support an additional 297 (297 = .6091 x 488) indirect jobs, for a total of 785 jobs, less than half the total jobs claimed by Alcan. If the value created is proportional to the number of jobs created, the total value created by the Sebree plant would be about $85 million per year.

Second, it seems improbable that the total value created by the Sebree plant is as high as the $108,000 per job per year[108] implicitly claimed by Alcan. While the Sebree plant may offer average annual compensation in the neighborhood of $108,000, it seems unlikely that the indirect jobs attributable to that plant would also have such high compensation. Indeed, an analysis of the economic impacts of Century's Hawesville plant used an average wage (excluding benefits) of $56,497 for Hancock County.[109] Use of a lower compensation rate for indirect jobs would further reduce the quantifiable benefits of the Sebree plant.

Third, the claimed value creation is based upon *gross* impacts rather than *net* impacts. In particular, highly compensated workers, such as Sebree's employees, are generally skilled workers, most of whom could presumably find gainful employment elsewhere in the event of the plant's closure. If such gainful employment could be found in Kentucky for average compensation of (say) $75,000 per worker, the net "value creation" would be $33,000 per job (equals $108,000 minus $75,000), a fraction of the gross "value creation" of $108,000 per job. Extending this argument to the rest of Alcan's analysis implies that the *net* "value creation" of the plant is a fraction of the claimed $198 million per year *gross* "value creation".

The difference between net and gross value is not mere semantics, but is central to the determination of how much that the Commonwealth should be willing to pay to keep the smelters running. If the Commonwealth's support was $10,000 per job per year, there would be a net benefit: using the hypothetical numbers just cited, each $10,000 of support per direct job would yield $33,000 of net "value creation" per direct job plus $20,100 of net "value creation" per indirect job[110], for a total net benefit of $53,100 per job. But if the Commonwealth's support was $58,000 per job per year, which is implied by the numbers that

[106] 3.7582 = 1,834 total jobs / 488 direct jobs.

[107] Younger Associates, *Economic Impact Analysis: Economic Impact Analysis of the Operations of Century Aluminum on the Hancock County Economy*, prepared for Century Aluminum, December 2011 (Younger Study), pp. 6-7.

[108] $108,000 per job per year ≈ $198 million per year / 1,834 jobs.

[109] Younger Study, p. 7.

[110] $20,100 ≈ $33,000 * (1.6091 – 1.0000).

the smelters say they are requesting in electricity price relief,[111] looking at the aggregate net "value creation" figure of $53,100 per job per year would give the correct impression that the support would make the Commonwealth worse off by about $4,900 per job per year (equals $58,000 minus $53,100); while looking at the gross "value creation" figure of $108,000 per job would give the very misleading impression that the support would make the Commonwealth much better off by $50,000 per year ($108,000 minus $58,000).

Century Aluminum – Hawesville Plant

Century Aluminum's Hawesville facility has a projected annual operating budget of $613.6 million.[112] Capital spending, based on annual average over the period 2009 through 2011, is estimated at $1.6 million per year.[113] The impact of an industrial plant on a local economy is larger than the plant's direct expenses because the plant's workers and suppliers spend a part of their receipts from the plant on local goods (like groceries and home repairs). To capture these indirect impacts of an industrial firm, a multiplier is typically used to translate the firm's expenditures into total impacts on the local economy. Using a multiplier of 1.3637, the total economic impact of the Hawesville plant has been estimated to be $838.5 million per year.[114]

Table 21 summarizes the economic impact of direct and indirect employment that arises from the Hawesville plant, as per Century's consultant. The total 1,241 direct and indirect jobs associated with the smelter plant are estimated to generate total direct wages and benefits and total indirect wages of $94.7 million annually. The gross benefit of the Hawesville facility in terms of direct wages and benefits is about $68.2 million for 771 jobs, which amounts to a gross benefit per job per year of $88,419.[115] If alternative employment can be obtained for these workers at the Kentucky average annual level of compensation of $48,000 per job per year, the net "value creation" of the Hawesville plant would be about $40,000 per job per year (equals $88,000 minus $48,000). If the Commonwealth were to spend $10,000 per job per year to keep the Hawesville plant open, the state would be better off by roughly $30,000 per job per year. However, if the Commonwealth were to provide support of $58,000 per job per year, which is the average implicit in the smelters' request for relief, the Commonwealth will be worse off by $18,000 per job per year.

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[111] The smelters say they are tentatively seeking $80 million per year in electricity cost reductions for the purpose (among other things) of retaining 1,375 jobs. The $58,000 figure in the text approximates $80 million divided by 1,375. Big Rivers' numbers, by contrast, imply that the Commonwealth's support for the smelters, through $110 million of rate reductions, would be $80,000 per job ($110 million divided by 1,375).

[112] Younger Study, p. 6.

[113] Younger Study, p. 8. The projected capital spending at the Hawesville plant used in the Younger Study appears to substantially underestimate the current planned capital spending, as reported in a confidential document provided to CA Energy Consulting by Century on August 14, 2012. Capital spending during period 2009 to 2011 was lower during the Hawesville plant's output curtailment and thus excluded certain costs, such as pot rebuild costs that have since been included in planned capital spending.

[114] Younger Study, p. 3. $836.5 million = 1.3637 times $613.6 million plus $1.6 million.

[115] $88,419 = $68,171,093 divided by 771.

Table 21
Century Aluminum Hawesville Plant Jobs Impacts[116]

Wages per Job:	
Direct (including benefits)	$88,419
Indirect (excluding benefits)	$56,497
Jobs:	
Direct	771
Indirect	470
Total	1,241
Benefits (millions):	
Total Direct Wages (including benefits)	$ 68.2
Total Indirect Wages (excluding benefits)	$ 26.5
Total Wages and Benefits	$ 94.7

For Hancock County, the Hawesville plant annually generates about $1.0 million in occupational taxes and about $1.3 million in property taxes. For the Commonwealth, the Hawesville plant annually generates about $3.5 million in income taxes in association with both direct and indirect jobs.[117] The foregoing figures are sums of direct and indirect tax impacts, where the indirect impacts are assumed to be about 50% of the direct impacts.

8.3.3. Electricity Service[118]

The Hawesville and Sebree smelters receive their electricity service through the Kenergy Corp. (Kenergy). The smelters are served by transmission lines that supply power at 161 kilovolts (kV), which the smelters step down to 34.5 kV and then convert from alternating current to the direct current required by their potlines. While the smelters must use Kenergy delivery service because of their physical location within Kenergy's service territory, they could, in principle, purchase electric power from other generation-owning entities or from the MISO market; and at various times since 1998, when not limited by contract, they have in fact purchased electric power through Kenergy from sources other than Big Rivers.

[116] Younger Study, p. 7. $88,419 per job ≈ $68.2 million / 771 jobs.

[117] The total Kentucky state income taxes paid was based on an update to the estimates in a study conducted on behalf of Century and Alcan: P.A. Coombes, *The Estimated Economic and Fiscal Impacts of a Shut-down of Kentucky's Two Aluminum Smelters*, January 2008 (Coombes Study). We applied the Coombes Study's estimated "effective income tax rate" for Kentucky, 4.86%, to the direct and indirect wages portion of income as reported in the Younger Study. The direct wages portion of the Century wages plus benefits value in the Younger Study was obtained by assuming that wages held the same 68% share of total wages and benefits as indicated in the Coombes Study. Note that $3.5 million = 0.0486 x ($88,419 x 0.68 x 771 + $56,497 x 470).

[118] Information in this subsection is from several sources, including Big Rivers as well as FitchRatings, *Big Rivers Electric Corporation*, full rating report, www.fitchratings.com, August 31, 2011.

History of the Smelters' Electricity Service

Big Rivers built most of its generating facilities in the 1970s and 1980s, partly in response to the smelters' needs. Big Rivers supplied the smelters' electric power until 1998, including a period, beginning in 1987, when the smelters' electricity price was based on the world price of aluminum. Big Rivers entered bankruptcy in 1996; and when it reorganized in 1998, it leased all of its generating assets to an LG&E subsidiary, which thereupon had operational control of the assets and was responsible for selling the majority of the smelter's electric power needs under pricing agreements that were set to expire in 2010 and 2011. In 2009, a set of agreements among LG&E, Big Rivers, Kenergy, and the smelters, called the "Unwind Transaction", resulted in Big Rivers regaining control of its generating assets and resuming its role as supplier to the smelters. Among the agreements, each smelter has with Kenergy a Retail Electric Service Agreement (backed by a mirror Wholesale Electric Service Agreement between Kenergy and Big Rivers) that provides the smelter with long-term, cost-based power, on a take-or-pay basis, through December 31, 2023, and gives each smelter the right to terminate service on one year's notice "in connection with the termination and cessation of all smelting operations" at the smelter.[119] The Retail Service Agreements also have the following provision:

> Neither Kenergy nor Century will support or seek, directly or indirectly, from any Governmental Authority, including the KPSC, any challenge to or change in the rate formula set forth in this Agreement or other terms and conditions set forth herein, including the relationship of the Large Industrial Rate to amounts payable by Century pursuant hereto, except that any Party may initiate or intervene in a proceeding to (i) clarify, interpret or enforce this Agreement, or (ii) challenge the applicable rate for Transmission Services should those services be unbundled for purposes of calculating the Large Industrial Rate.[120]

These Retail Electric Service Agreements, which are still in effect, gave the smelters a pricing regime and operational flexibility that was agreeable to all parties in 2009.

Earlier this year, Century proposed that it be allowed to purchase electric power on the open market (e.g., MISO) instead of from Big Rivers. On August 20, 2012, Century gave Big Rivers its one-year notice of service termination for the Hawesville plant. During the one-year notice period Century may continue to operate the plant, but is not required to do so. On September 14, 2012, Century made a proposal by which it would continue operations if it could obtain "a new long-term power contract… providing for up to 482 MW of power at a pass-through rate for market purchases by Kenergy."[121]

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[119] *Retail Electric Service Agreement by and between Kenergy Corp. and Century Aluminum of Kentucky General Partnership*, July 1, 2009, Section 7.3.1(a), p. 32. Century believes that notice of termination of the power contract requires it to make a representation that it has made a business judgment in good faith to terminate smelting operations at the plant and that it has no current intention of recommencing smelting operations.

[120] *Id*., Section 13.1.1(b), p. 41.

[121] The proposed terms include: 1) termination of Century's existing contracts with Big Rivers and Kenergy on some date after November 15, 2012; 2) Big Rivers' continued operation of the Coleman plant "until MISO determines that continued operation of the Coleman plant is not necessary"; 3) possible application of reserve

Alcan, by contrast, has not provided a notice of termination of its Retail Electric Service Agreement for its Sebree facility, nor has it expressed a desire to purchase power on the open market instead of continuing to procure power from Big Rivers. Alcan has indicated, however, that any increase in the rate paid by the Sebree facility carries a significant probability that Alcan will also provide its one-year notice of termination of the Sebree facility Retail Electric Service Agreement, and that this is especially likely if aluminum prices remain at or near the levels prevailing in mid-2012. Such a rate increase is likely to occur because Alcan's Retail Electric Service Agreement links the rate paid by the Sebree facility to the Large Industrial Rate, and Big Rivers has notified the Commission that it intends to seek a general rate increase to offset the loss of revenues resulting from termination of the agreement with Century. Alcan has indicated that it will want its current Retail Electric Service Agreement with Big Rivers to be amended to avoid the automatic rate increase that will come about with the approval of the next rate increase that Big Rivers has indicated it will seek.

Big Rivers has indicated that, if one or both smelters went to the open market, one of its options would be to idle some its generation resources and thereby potentially avoid or postpone many millions of dollars of costs of retrofitting its coal-fired generators to meet U.S. Environmental Protection Agency (EPA) environmental requirements. Consequently, Big Rivers was willing, at one point, to explore whether an acceptable plan that allows both smelters to go to the open market could be formulated on terms acceptable to Big Rivers' constituencies.

The Smelters' Electricity Rates

The smelters' electricity rates are determined by the Retail Electric Service Agreements; so they are contract rates that have been approved by the Commission. Thus, any revisions to the smelters' electricity rates need to be made by mutual agreement among the parties to the contracts. The parties' ability to make such an agreement would be subject to various corporate and creditor reviews and approvals, as well as to further Commission approvals and rate adjustments.

The Retail Electric Service Agreements divide the smelters' energy usage into three types: Base Fixed Energy, which is 368 MW for Alcan and 482 MW for Century; Supplemental Energy; and Back-Up Energy.[122] The smelters pay several charges for their electricity service, including variable charges (e.g., fuel adjustment clause, environmental surcharge, purchased power adjustment), surcharges (e.g., fixed annual payment of several million dollars per year, coal cost adjustment), and possible adjustments to meet TIER requirements.[123] The primary charge,

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funds to certain reductions in Big Rivers' revenues due to Century's transition to a new contract; and 4) mitigation of Big Rivers' obligation to serve Century's load if Big Rivers "does not have generation to serve all/part of Century's load in the future."

[122] Big Rivers Electric Corporation, *Disclosure Statement*, July 12, 2012, p. 39.

[123] Big Rivers Electric Corporation, *Financial Statements*, December 31, 2011 and 2010, p. D-5. Per FitchRatings, *Big Rivers Electric Corporation*, full rating report, www.fitchratings.com, August 31, 2011, pp. 4-5, the TIER requirement is "1.24x for each fiscal year. During years in which the cooperative's ratio falls below the 1.24x threshold, additional payments are required by the smelters, subject to limitations. If the cooperative's TIER

however, is an energy charge (in dollars per MWh) that is "determined by applying the Large Industrial Rate to a load with a 98% load factor, and adding an additional charge of $0.25 per MWh."[124]

Big Rivers' Financial Situation[125]

At the end of 2010, Big Rivers had total long-term debt of $817 million, of which $675 million was due to the U.S. Department of Agriculture's Rural Utilities Service (RUS), and nearly all of the rest were County of Ohio, Kentucky, tax-exempt pollution control bonds.[126]

Big Rivers faces two predominant financial risks. The first is that it may lose the smelters' loads or that it may need to renegotiate the terms under which it serves the smelters. Big Rivers' finances are heavily dependent upon sales to the smelters, which account for most of Big Rivers' total sales. If the smelters continue to take service from Big Rivers, this dependence will continue, as Big Rivers expects annual non-smelter load growth of about 1.4% during the present decade, which will barely reduce the smelters' share of Big Rivers' load.[127]

The second financial risk arises from Big Rivers' dependence upon coal-fired generation, which is becoming more expensive over time as environmental regulations tighten. "Although coal-fired capacity accounts for 87% of the cooperative's resource capacity, coal-fired generation accounted for approximately 97% of total power supply in 2010…"[128] While Big Rivers has more than sufficient capacity to meet its load obligations through 2025[129], it will need to expend significant sums of money to retrofit its existing plants to meet new environmental regulations, particularly those promulgated by the EPA. "Big Rivers estimates that full compliance with the regulations could require expenditures of approximately $785 million by 2015, and increase wholesale rates and member retail rates by 39% and 20%, respectively."[130] Due to a recent court ruling halting implementation of EPA's proposed Cross-State Air Pollution Rule[131], Big Rivers now estimates that compliance with remaining environmental regulations

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exceeds 1.24x during any fiscal year, amounts contributing to the excess coverage must be rebated to the smelters and may be rebated to other members, with a *pro rata* portion allocated to the smelters."

[124] Big Rivers Electric Corporation, Financial Statements, December 31, 2011 and 2010, p. 17.

[125] Big Rivers' financial challenges do not seem to be related to operating problems, as its operating performance apparently meets or exceeds power industry norms. Its entire generating system had an equivalent availability factor (EAF) of 93.7% in 2010, and six of its eight generating units had EAFs in the top quartile of their peers during 2007-2010. See FitchRatings, *Big Rivers Electric Corporation*, full rating report, www.fitchratings.com, August 31, 2011, pp. 6-7.

[126] *Id.*, pp. 9-10.

[127] *Id.*, p. 5.

[128] *Id.*, pp. 6-7.

[129] *Id.*

[130] *Id.*

[131] United States Court of Appeals for the District of Columbia Circuit, No. 11-1302, *EME Homer City Generation, L.P., Petitioner V. Environmental Protection Agency, et al., Respondents*, August 21, 2012.

will require expenditures of approximately $60 million by 2015, and increase rural wholesale rates and rural retail rates (gross of tariff reserve accounts) by 3.6% and 2.3% respectively. As an alternative, Big Rivers could theoretically idle some of its generators and procure power on the wholesale market, assuming this action does not create or is limited by any transmission constraints.[132]

Smelter Requests for Rate Relief

Century and Alcan have each told Kentucky economic development officials that they need lower electricity rates for their facilities to be sustainable. Century has said that a rate averaging about $34 per MWh through 2015 would make the Hawesville plant competitive, while Alcan has indicated that the Sebree facility is no longer profitable at the low aluminum prices prevailing in the middle of 2012.

Based on publicly available information, Table 22 summarizes the Hawesville plant's revenues and costs over the period 2013 to 2015 under three electricity pricing scenarios: at Big Rivers contract rates; at MISO wholesale prices, including a $1.99 per MWh adder for transmission charges from the MISO market to Hawesville[133]; and at electricity prices that allow the Hawesville plant to earn a zero profit. The top part of the table shows assumptions common to all three scenarios. In all years, plant output is assumed to equal the plant's capacity, and electricity consumption is assumed to exactly meet contractual demand and load factor requirements.[134] LME forward prices are rounded figures from Table 17. The product premium is an assumed value for the Midwest Market Premium for primary aluminum plus a premium for Hawesville's high-purity product. Revenues equal plant output times total primary aluminum prices. Non-electricity operating costs are based on the Younger Study operating budget net of the Younger Study capital expenditures net of power costs at Big Rivers' contract

[132] On August 21, 2012, the U.S. Court of Appeals for the D.C. Circuit issued a decision on the EPA's Cross-State Air Pollution Rule in which the Court sent the rule back to EPA for revision and told it to administer its existing Clean Air Interstate Rule in the interim. As a consequence of this development, Big Rivers has revised downward its estimates of the costs of environmental regulation compliance. Nonetheless, it is not yet known whether the Court's ruling will be sustained on appeal.

[133] $1.99 per MWh = Big Rivers' Open Access Transmission Tariff rate of $17,082.07 per MW-year / (8,760 hours per year x 0.98 load factor). The charges to deliver power to Century from the MISO wholesale market across Big Rivers' transmission system would include, but not necessarily be limited to, MISO Open Access Transmission Tariff charges (including those for reactive and voltage support, network integration service, FERC charges, and MISO transmission expansion costs), MISO market charges (including ancillary service costs, market administration fees, local balancing authority administration fees, FTR administration fees, revenue sufficiency guarantee charges, revenue neutrality uplift charges, costs for planning reserve credits, and basis differentials), and third-party account administration charges.

[134] 4,138 GWh per year = 482 MW of contract demand x 0.98 load factor x 8760 hours per year / 1,000 MWh per GWh.

rates.[135] Capital expenditures are based on the Younger Study.[136] Income before electricity and taxes equals revenue minus total non-electricity costs.

The effective average Big Rivers rates are the average of confidential forecasts provided by Alcan, Big Rivers, and Century, rounded to the nearest dollar to further mask the underlying forecasts. The average MISO prices are annual averages of Cinergy Hub On Peak Strip prices[137], with $1.99 per MWh added to cover Big Rivers' open access transmission charges to deliver power to Hawesville from the MISO wholesale market. Zero-profit electricity prices are calculated to give Hawesville a zero profit or loss. Electricity costs are calculated by multiplying electricity consumption by the relevant price. Income before taxes equals revenues minus total non-electricity costs minus electricity costs.

Table 22 shows that the Hawesville plant loses money at the contract rates with Big Rivers. Although the table also shows that the plant also loses money at market electricity prices, this is partly an artifact of the underlying assumptions: slightly different assumptions lead to Hawesville running small profits in 2014 and 2015. For 2013, the table confirms Century assertion that it needs a rate of about $34 per MWh to avoid losses on the Hawesville plant. To achieve a zero profit, Hawesville would need electricity prices that are below market levels in 2012 and near market levels – somewhat below market levels under the assumptions shown in Table 22, somewhat above market levels under alternative plausible assumptions – at which levels Hawesville would contribute little or nothing to Big Rivers' recovery of its generation capital costs or of its transmission costs, and might also require millions of dollars of additional support from either other Big Rivers' customers or the Commonwealth.

If the Hawesville zero-profit prices are below market prices, the direct revenue loss to Big Rivers – and the consequent cost shift to non-smelter customers – would be less if the discount were limited to market electricity prices than if it were large enough to reach Hawesville's zero-profit level. Because discounting the smelter rate down to market electricity prices is essentially equivalent to the smelters buying their power directly from the market, the direct revenue loss to Big Rivers would also be less if the smelters bought power from the market than if Big Rivers offered a discount down to a Hawesville's zero-profit level that is below market prices.

[135] For 2013, the value of $401.0 million equals $613.6 million operating budget from the Younger Study, p. 6, less $1.6 million of capital expenditures from the Younger Study, p. 3, less $211.0 million of electricity costs per the Big Rivers contract rate scenario. Values for 2014 and 2015 are escalated at the rate of 5% per year.

[136] For 2013, the value is from Younger Study, p. 3. Values for 2014 and 2015 are escalated at the rate of 5% per year.

[137] http://www.profitquotes.com/commodities-quotes.mpl?c=EM&n=Cinergy%20Hub%20Peak, accessed August 29, 2012.

Table 22
Hawesville Revenue & Costs, 2013–2015, by Electricity Price Scenario

	2013	2014	2015
Plant Output (tons per year)	250,000	250,000	250,000
Electricity Consumption (GWh per year)[138]	4,138	4,138	4,138
Primary Aluminum Prices ($/ton):			
London Metals Exchange	2,000	2,100	2,200
Product premium	160	160	160
Total	2,160	2,260	2,360
Revenue (millions of $)	540.0	565.0	590.0
Non-Electricity Costs (millions of $)			
Non-Electricity Operating Costs	401.0	421.0	442.1
Capital Expenditures	1.6	1.7	1.8
Total	402.6	422.7	443.8
Income Before Electricity and Taxes	137.4	142.3	146.2
Outcomes at Big Rivers Contract Rates:			
Effective average Big Rivers rate ($/MWh)	51.00	54.00	58.00
Electricity costs (millions of dollars)	211.0	223.4	240.0
Income before taxes (millions of $)	(73.6)	(81.1)	(93.8)
Outcomes at Market Electricity Prices:			
Average MISO price ($/MWh)	36.43	35.43	37.88
Electricity costs (millions of dollars)	150.7	146.6	156.7
Income before taxes (millions of $)	(13.3)	(4.3)	(10.6)
Outcomes at Zero-Profit Electricity Prices:			
Zero-profit electricity price ($/MWh)	33.21	34.39	35.32
Electricity costs (millions of dollars)	137.4	142.3	146.2
Income before taxes (millions of $)	-	-	-

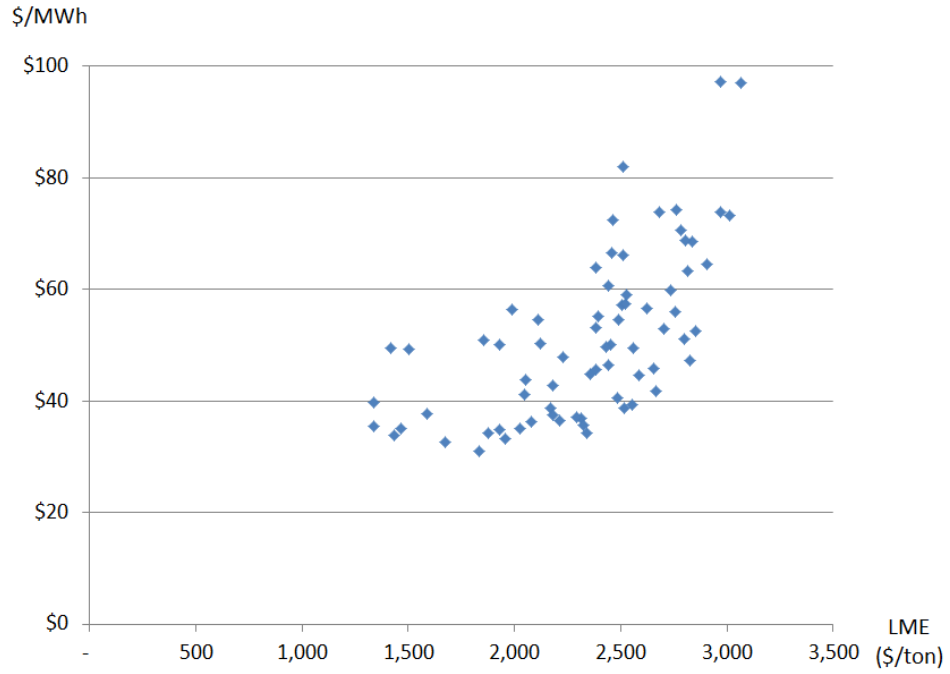
To understand the relationship between smelters profits, aluminum prices, and electricity prices, it would be helpful to know the relationship between aluminum prices and electricity prices. Figure 10 presents a recent history of that relationship: each blue diamond shows the

[138] "GWh" denotes gigawatt-hours. 1 GWh = 1,000 megawatt-hours (MWh) = 1,000,000 kilowatt-hours (kWh).

combination of LME aluminum prices and MISO electricity prices that actually occurred during each of the months of the years 2006 through 2011.[139]

Figure 10 illustrates two key points. First, both aluminum prices and market electricity prices have been volatile in recent years; and it is more than a little likely that this volatility will continue in the future. Second, aluminum prices and market electricity prices are correlated, tending to move up and down together with the booms and busts of the general economic cycle. [140]

Figure 10
Monthly Historical Aluminum and Market Electricity Prices for 2006-2011



Based upon figures provided by the smelters and considering the correlation between LME aluminum prices and the price of alumina, it appears that each dollar per MWh of electricity price discount has an effect on the smelters' bottom line profits equivalent to an LME price increase of roughly $25 per ton, keeping all non-alumina costs constant. From the perspective of the smelters' profits, a $15 to $20 per MWh rate reduction such as the smelters are requesting would therefore be approximately equivalent to a $375 to $500 per ton increase in the world price of aluminum. Or, to put it the other way, a $375 to $500 per ton increase in the

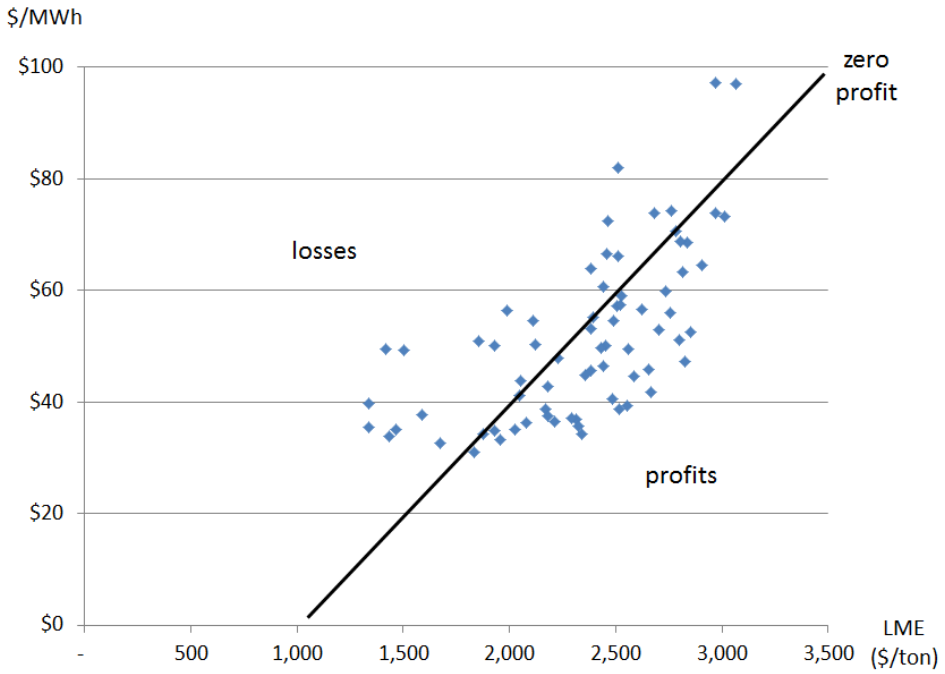
[139] The electricity prices are the MISO Indiana hub prices plus $1.99 per MWh to cover Big Rivers' transmission costs.

[140] The correlation coefficient is 0.646, where 1.000 would indicate variables that move in perfect lockstep with each other while 0.000 would indicate variables that are completely unrelated.

world price of aluminum would give the smelters about the same net benefit as a $15 to $20 per MWh rate reduction.

For each smelter – in Kentucky or anywhere else – it is possible to place into a diagram, like Figure 10, a zero-profit line that shows the combinations of aluminum and electricity prices at which the smelter runs a zero profit. Such a line must be upward sloping because, as the price of aluminum gets higher, the smelter can afford to pay more for electricity. For the purpose of illustration, Figure 11 shows such a line placed among the historical aluminum and electricity prices relevant to Kentucky. For purposes of illustration, the line has the slope of $25 per ton of aluminum for each $1 per MWh of electricity as just mentioned, and is placed so that the hypothetical smelter runs a zero profit when the price of aluminum is $3,500 and the price of electricity is $100.[141]

Figure 11
Zero-Profit Combinations of Aluminum Prices and Electricity Prices for a Hypothetical Smelter with Monthly Historical Aluminum and Market Electricity Prices for 2006-2011



In Figure 11, the smelter runs a profit when the combination of aluminum and electricity prices falls to the right of the line (aluminum prices are high, electricity prices are low); and the

[141] The slope of the line depends upon: a) the relationship between the price of alumina and price of primary aluminum; and b) the efficiency with which the smelter converts alumina into primary aluminum. The leftward or rightward placement of the line depends upon the smelter's non-alumina and non-electricity costs: when these other costs are lower, the line is more to the left and the profit area is greater; and when these other costs are higher, the line is more to the right and the profit area is smaller.

smelter runs a loss when the combination of aluminum and electricity prices falls to the left of the line (aluminum prices are low, electricity prices are high). The implication is that market conditions – in the aluminum and electricity markets, singly and in combination – can and will drive smelters back and forth between profits and losses from year to year and, sometimes, from month to month. In parts of the world where electricity costs are always low, it is possible for a smelter to always run a profit; but it is not possible for a smelter to run a profit in every month at the market electricity prices that have been seen, and likely will be seen, in the Midwestern United States.

Electricity Rate Impacts of Smelter Closure

Smelter closure would have three sorts of rate impact. First, Big Rivers would lose the smelters' contribution to fixed cost recovery. This contribution equals the difference between the smelters' contract prices and Big Rivers' SRMC of serving the smelters. This lost contribution is the *direct* revenue loss discussed in conjunction with Table 22. Second, Big Rivers would lose some contribution to fixed cost recovery from its sales to those parties (e.g., employees and upstream suppliers) whose income is wholly or partly dependent upon the smelters' business. In other words, the smelters' employees and suppliers would experience a drop in income that, for some of them, would reduce their purchases of electricity from Big Rivers. This *indirect* revenue loss could be mitigated if some other industrial firms move into Big Rivers' members' service territories. Third, Big Rivers may be able to avoid spending many millions of dollars retrofitting its generators to meet future EPA environmental requirements. Because the reduced fixed cost recovery will exceed the avoided environmental compliance costs, the net effect would be a loss to Big Rivers that would be compensated through increased electricity prices for remaining customers. The rate increase to remaining customers could cause customers to reduce their electricity purchases, as a result of either price-induced electricity conservation or business curtailments or closure.

The loss of the smelters' contribution to fixed cost recovery equals the amount of any rate reduction times the smelters' load. If Big Rivers offered the smelters rates that would allow the Hawesville plant to run a zero profit, Big Rivers would experience the revenue losses (i.e., the lost contributions to fixed cost recovery) shown in Table 23. The rate discounts that would be required to bring Big Rivers' smelter rates low enough that Hawesville would avoid losses are equal to the amounts by which the effective average Big Rivers' rate to the smelters under the *status quo* exceeds Hawesville's zero-profit electricity prices presented in Table 22. Table 23 shows that this discount averages $17.79 per MWh in 2013 and rises to $22.68 per MWh in 2015. Presuming that a discount that is offered to one smelter must be offered to both smelters[142], the revenue loss rises from $129.8 million in 2013 to $165.5 million in 2015.

[142] According to Marty Littrel, Big Rivers' communications and community relations manager "…we can't, by law, offer anything to Century without offering it to (Rio Tinto) Alcan." See Joy Campbell, "Sides in rate battle aren't talking," *Owensboro Messenger-Inquirer*, August 28, 2012.

Table 23
Loss in Big Rivers' Revenue from the Smelters at Hawesville's Zero-Profit Rates

	2013	2014	2015
Effective Average Big Rivers Rate ($/MWh)	51.00	54.00	58.00
Zero-Profit Electricity Price ($/MWh)	33.21	34.39	35.32
Rate Discount ($/MWh)	17.79	19.61	22.68
Electricity Consumption (GWh per year)	7,297	7,297	7,297
Revenue Loss (millions of $)	129.8	143.1	165.5

As a matter of financial viability, Big Rivers cannot sustain losses if it is to continue to provide electric power service.[143] To maintain such viability, Big Rivers would need to recover lost contributions to fixed cost recovery from its other customers to the extent that it cannot reduce its costs to offset these losses. In other words, Big Rivers cannot provide rate discounts to the smelters without raising the rates of its other customers to make up for the reduced revenue from the smelters, at least in the short run.

Table 24 shows how discounts offered to the smelters would interact with the rates of other customer classes under six scenarios.[144] The scenarios are ordered so that revenue losses to Big Rivers increase as the table moves from left to right. All figures apply to year 2013.

The *status quo* scenario shows loads, revenues, and rates for four classes of customers (smelters, other industrial, rural, and off-system sales) assuming that both smelters continue to take electricity as per contract and that smelter rates continue to be set in the future as in the past. Total load is 12,249 GWh and total revenue is $571.2 million.

[143] Big Rivers has bond covenants under its debt arrangements with the RUS that require it to maintain a Margin for Interest Ratio (MFIR) of at least 1.1, and this target likely could not be met in the short term without a shift to other customers. If Big Rivers failed to meet these covenants, it would be required to implement a plan that would correct this deficiency, and would be prohibited from securing debt under its indenture until it had maintained the minimum MFIR for a prescribed period. If Big Rivers failed in its efforts and defaulted under its credit agreements, that could trigger bankruptcy proceedings.

[144] To make the calculations feasible with our limited information, we assumed that rates for Other Industrial Customers and Rural Customers would increase by identical percentages to make up for losses of smelter revenues. According to Big Rivers, this assumption is not accurate. Marty Littrel, Big Rivers' communications and community relations manager, has said that, "If Century shuts down, residential rates [i.e., Rural rates] would increase temporarily by 19 to 20 percent and industrial rates would go up temporarily by 21 percent. If Century remains open with Big Rivers paying both smelters a combined $110 million, then residential rates will go up by 37 percent permanently with industrial rates rising 56 percent permanently." See Joy Campbell, "Sides in rate battle aren't talking," *Owensboro Messenger-Inquirer*, August 28, 2012. Big Rivers thus finds the percentages equal in some circumstances and unequal in other circumstances. Figure 11 shows rate increases for the Century-only case that closely match the 19% to 21% figures just cited. For the $110 million case, the figure shows an average increase of 59%, somewhat higher than indicated by Big Rivers, likely due to reasonable differences in assumptions.

Table 24
Impacts of Smelter Discounts on Other Customers in 2013

Variable	Units	Scenario					
		Status Quo	$80 Million Discount	Market Prices	$110 Million Discount	Smelter Closure	Hawesville Zero-Profit
Smelters:							
Load	GWh	7,297	7,297	7,297	7,297	0	7,297
Revenue	million $	372.2	292.2	265.8	262.2	0	242.4
Rate	$/MWh	51.00	40.04	36.43	35.93		33.21
Other Industrial:							
Load	GWh	962	962	962	962	962	962
Revenue	million $	36.5	56.9	63.6	64.5	67.3	69.6
Rate	$/MWh	38.00	59.18	66.15	67.12	69.99	72.36
Rural Customers:							
Load	GWh	2,378	2,378	2,378	2,378	2,378	2,378
Revenue	million $	107.0	166.6	186.3	189.0	197.1	203.8
Rate	$/MWh	45.00	70.08	78.33	79.48	82.89	85.69
Off-System Sales:							
Load	GWh	1,612	1,612	1,612	1,612	8,910	1,612
Revenue	million $	55.5	55.5	55.5	55.5	306.8	55.5
Rate	$/MWh	34.44	34.44	34.44	34.44	34.44	34.44
Totals							
Load	GWh	12,249	12,249	12,249	12,249	12,249	12,249
Revenue	million $	571.2	571.2	571.2	571.2	571.2	571.2

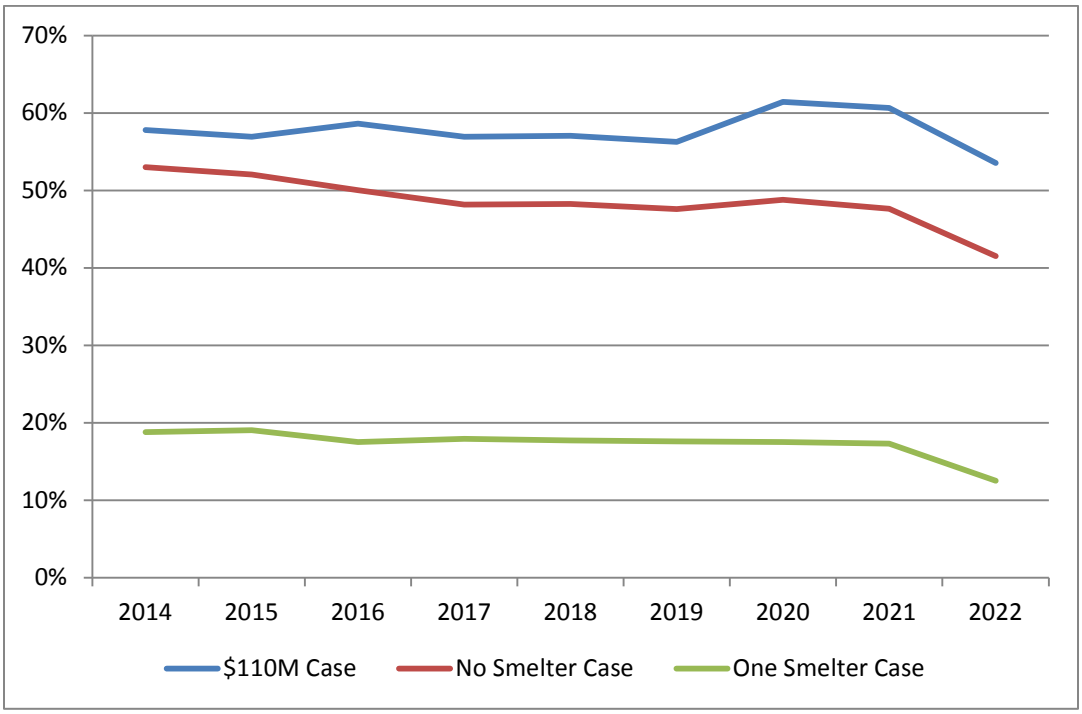
The other five scenarios assume that load does not respond to price – an unrealistic assumption that will slightly under-estimate the rate increases for the Other Industrial and Rural classes. Rates for the other five scenarios are set to maintain total revenue of $571.2 million. Rates for the Other Industrial and Rural classes are increased by equal percentages to make up for lost smelter revenues. The rates for Off-System Sales are the same for all scenarios because they are determined by the market. As indicated by their names, the $80 Million Discount and $110 Million Discount scenarios shift $80.0 million and $110.0 million of cost responsibility, respectively, from the smelters to the Other Industrial and Rural classes. For the Market Prices, Smelter Closure, and Hawesville Zero-Profit scenarios, the respective shifts are $106.3 million, $120.9 million, and $129.9 million.[145]

[145] It may seem odd that the Smelter Closure scenario assumes that Big Rivers would shift all smelter sales to off-system sales. This is a mathematical approach to getting the right rate increase numbers even though we do not expect such a shift in sales to actually occur. The mathematics are reasonable because, in the absence of the smelters, Big Rivers could always sell excess power to the MISO market if that is the most profitable course of action. If Big Rivers found a more profitable course of action – like closing some generating units, for example –

Table 24 indicates that, for the single year 2013, given forecast market prices of electricity, non-smelter customers would be better off: a) with an $80 million smelter discount than with the smelters buying power directly from the wholesale electricity market; and b) with the smelters buying power directly from the wholesale electricity market than with a $110 million smelter discount. Different forecast market electricity prices could yield a different result, and results could be different for different years.

Based upon confidential data that differs from that underlying Table 24, Figure 12 shows how Rural class wholesale rates are affected in each year of the next decade by smelter closures and by the $110 million discount, all relative to the *status quo* wholesale rates for each year. The wholesale rate impacts are largest for the $110 million discount scenario, and least for the scenario in which only one smelter (i.e., the Hawesville plant) closes. Retail rate impacts will be less than the wholesale rate impacts.

Figure 12
Percent Changes in Rural Class Wholesale Revenue Relative to the Status Quo, 2014-2022



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the rate impacts on the Other Industrial and Rural classes would be less adverse than shown in the table. Thus, the results for the Smelter Closure scenario presented in Table 24 should be regarded as a worst-case outcome for that scenario.

By the way, note that the results for the Market Prices and Smelter Closure scenarios differ solely by the amount that the smelters would pay to Big Rivers for use of Big Rivers' transmission system. If the smelters get electricity directly from the market, Big Rivers makes no money on the sale of electricity, but it still collects money from the smelters for providing transmission. If the smelters close, Big Rivers needs to recover the lost transmission revenue either from the Other Industrial and Rural classes or through the sale of transmission service to others.

Other Industrial (non-smelter) wholesale rates have average wholesale price increases that are similar to the increases shown in Figure 12.

Big Rivers' Preparation for Smelter Closures

Big Rivers has made plans for and taken specific actions partly in contemplation of losing the smelters' loads.

Because Big Rivers transferred functional control of its transmission system to MISO in December 2010, MISO's huge electricity market provides a ready outlet for Big Rivers' sales of excess capacity (if the smelter loads are lost) and of Big Rivers' power purchases (if it retains smelter load but foregoes retrofitting some of its generation). Big Rivers has sufficient transmission capability to export generation capacity equal to the smelters' total load if that load is lost. Furthermore, the prospective completion of certain TVA construction projects should increase Big Rivers' export capability in 2016 to 1,263 MW to TVA and 1,210 MW to MISO.[146]

Big Rivers has said that, immediately upon a smelter giving notice of contract termination, it will request an increase in the rates of remaining customers. Big Rivers will sell excess generating capability in wholesale markets, to the extent that the sales are at prices in excess of its marginal production costs. Sales may be both long-term and short-term. If sufficient sales do not materialize, Big Rivers may be forced to idle some of its capacity.

Over time, Big Rivers would be expected to undertake some combination of the following courses of action:

- Entering into long-term power sales arrangements;
- Idling excess generating plants, particularly those exposed to EPA compliance costs;
- Sales of physical generating capacity;
- Attracting new business load to its service territory;
- Adding distribution cooperatives to its membership; and
- Merger with another cooperative.

Some of these options would take significant time to bring to fruition. In all cases, the immediate consequence would be increases in rates for Rural and Other Industrial customers similar to those shown in Table 24. Over time, the rates may be reduced as Big Rivers is able to work out strategies for lowering its costs and increasing revenues from other sources.

[146] Big Rivers Electric Corporation, *Disclosure Statement*, July 12, 2012, p. 45.

9. RECOMMENDATIONS TO THE COMMONWEALTH

This section begins with general observations about Commonwealth support for industry. It then looks at several options for addressing the smelters' cost issues, and closes with an overview of options that might be applied to other Kentucky industries.

9.1. General Observations

As a first principle, the Commonwealth of Kentucky should try to spend its scarce economic development dollars in a manner that gives it the greatest bang for its buck. This principle applies not only to the tax incentives, loans, and grants that the Commonwealth dispenses from its own fiscal resources, but also to any subsidies imposed on some electricity customers to support other customers. What this principle means, among other things, is that the Commonwealth needs to determine what combination of infrastructure development and direct support to industry best facilitates the state's economic growth in both the short- and long-terms.

In particular, the business representatives with whom we met expressed strong concern about the quality of Kentucky's workforce. This present report cites several other reports, both by business groups and by entities working for the Commonwealth, that express similar concerns about the workforce and about the Commonwealth's educational system. If the smelters obtain the $80 million per year that they seek for the purpose (among other things) of retaining 1,375 jobs, the support that the smelters obtain will cost over $58,000 per job per year. A reasonable person might wonder whether that magnitude of money would be more than sufficient to re-train the smelters' displaced workers, who are already skilled. A reasonable person, looking at the economic successes of the Far Eastern economies and at their relatively educated societies, might suspect that future economic success will go to those regions that have the best educational systems, and that Kentucky's long-term economic success urgently depends upon its lifting up its educational system.

As a second principle, a short-term fix only makes sense when there are good long-term prospects. Kentuckians are proud of their success with Toyota and Ford, whereby incentives given to the automobile manufacturers to locate and expand in Kentucky resulted in substantial investments in and jobs from firms that serve as their suppliers. That is a success story that the Commonwealth rightly hopes to repeat. A crucial element of the success story is that, after seed money from the Commonwealth, the automobile manufacturers and their suppliers were able to stand on their own in the long run. A key question about the smelters, which we are not able to answer definitively, is whether they will be able to stand on their own in the long run. Looking at the prices of electricity around the world, at the long-term cost pressures that are presently facing America's coal and electricity industries, at where new smelters are being built, and at the long-term decline of the smelter industry in the U.S., a reasonable person might wonder whether the U.S. smelter business is a good long-term bet. If short-term support for Kentucky's smelters will see them through short-term problems so that they prosper in the long-run, then the short-term support can make sense. But if the smelters' problems are long-term and the short-term support would merely postpone their shutdowns by a few years, then the Commonwealth's resources would be better spent on more promising long-term prospects.

Another basic principle is that state and local economic development programs are economically justified only when their benefits to the state (including government, businesses, and residents) exceed their costs. This is a standard that should be imposed prior to any commitment to a particular program participant; and such commitments should be re-evaluated at appropriate time intervals.

9.2. Options for Addressing the Aluminum Smelters' Cost Issues

Representatives of Kentucky's aluminum smelters have informally requested Commonwealth or utility financial assistance in maintaining their financial viability (i.e., profitability), along with the employment and economic benefits that accompany retention of their businesses. In this section, we identify solutions that have been identified by Kentucky parties, as well as those that we think may be plausible. We identify the advantages, disadvantages, and challenges of each option; and as best we can, we lay out the risks and expected costs of each solution.

9.2.1. Electricity Price Discounts

Electric utilities generally charge prices based upon their accounting costs ("cost of service"), which reflect the actual costs of investments, fuel, labor, and so on. To remain financially viable, utilities need to have revenues approximating their costs of service. Since a utility's revenue requirement is more or less a fixed number of dollars, a price reduction for one customer usually requires a corresponding price increase for another customer. While the price reduction for the first customer can stimulate the economy by enabling that customer to remain in business or increase output, the price increase for the other customer can harm the economy by depressing that customer's demand for goods and services, including electricity. The total impact of a price discount program should therefore consider both its stimulating and depressing effects.

To minimize the costs borne by a utility's other customers, the utility should endeavor to set the price discounts for participating customers so that, considering electricity price impacts on attraction, retention, or expansion of the participating customer's business, the participating customers make the largest possible contribution to the utility's recovery of its costs of service. This implies that price discounts should never be so large as to result in participating customers paying prices that are below the utility's short-run marginal cost (SRMC), because prices below the utility's SRMC would result in a loss on every kWh sold to participating customers.

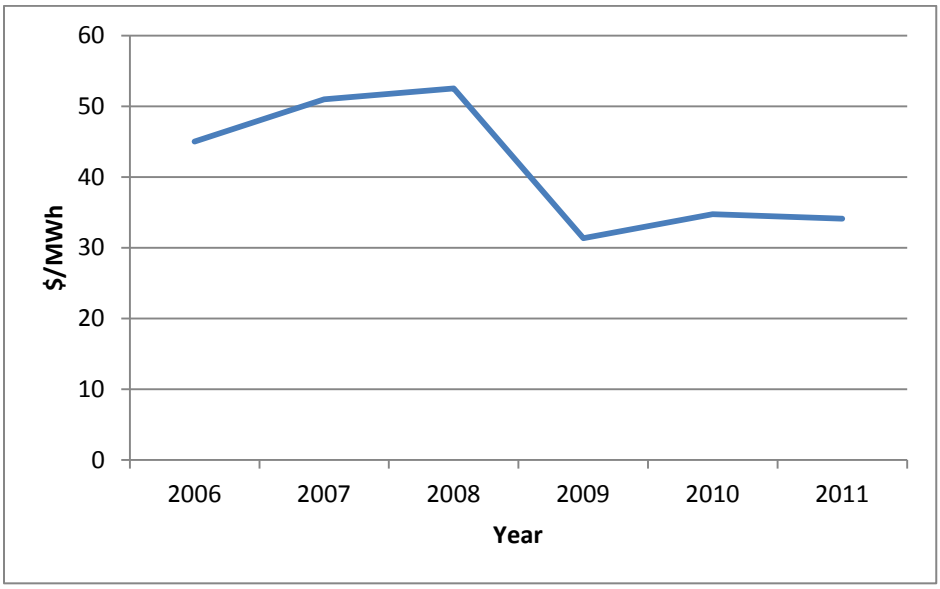
For Big Rivers, the SRMC for serving the smelters is the sum of: a) the MISO market prices of the generation services (i.e., energy, regulation, and operating reserves) necessary to serve smelter load; plus b) the costs of administering the smelters' accounts; plus c) any transmission service costs (e.g., transmission maintenance, reactive and voltage support, FERC charges, MISO market administration fees, MISO Revenue Sufficiency Guarantee Charges, MISO Revenue Neutrality Uplift, MISO transmission expansion costs) that are incremental to the smelters' needs.[147] Any revenue that Big Rivers can derive from the smelters above SRMC

[147] The cost to a third party of serving the smelters with market-priced power would be all the costs listed in the text, plus certain average costs that exceed SRMC.

would financially benefit Big Rivers' other customers relative to the smelters closing. Price discounts for the smelters should not bring the smelters' electricity prices below SRMC. Instead, the discounts should be set at the minimum level consistent with the smelters remaining in business, but no more than the amount that would bring the smelters' price down to SRMC. Any price discount that brought the smelters' price below SRMC would burden Big Rivers' other customers with not only all of Big Rivers' fixed costs, but also with an additional subsidy to the smelters.

Figure 13 and Figure 14 indicate what Big Rivers' SRMC may be. Figure 13 shows average annual MISO prices for electrical energy for the past decade, while Figure 14 shows average annual MISO prices for the next dozen years. To cover Big Rivers' costs of operating reserves, transmission service, administration, and the other aforementioned cost factors, SRMC would be a few dollars per MWh higher than shown in these figures.[148]

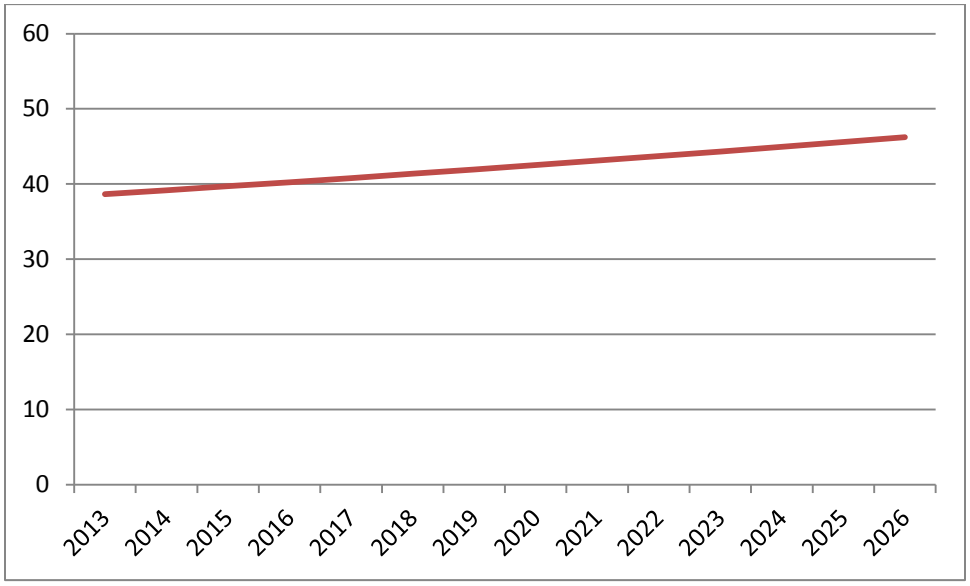
Figure 13
Historical Annual Average MISO Energy Prices, 2002-2011 ($/MWh)[149]



[148] Not only does SRMC change over years, as shown in the figures, but it can change dramatically from hour to hour. For customers with the smelters' high load factors, however, hourly price differentiation is of little practical importance; so it may be sufficient to have contract prices that reflect average SRMCs for large sets of hours (like for a year).

[149] Potomac Economics, *2011 State of the Market Report for the MISO Electricity Markets*, June 2012, p. 2; 2010 State of the Market Report for the MISO Electricity Markets, June 2010, p. v; *2009 State of the Market Report for the Midwest ISO*, August 2010, p. v; *2008 State of the Market Report for the Midwest ISO*, July 2009, p. v; *2007 State of the Market Report for the Midwest ISO*, July 2008, p. iii, http://www.potomaceconomics.com/documents/C7&C10.

Figure 14
Forecast Annual Average MISO Energy Prices, 2012-2026 ($/MWh)[150]



The SRMC is a floor, not a target. Any discount given to the smelters – that is, any reduction from the smelters' contract electricity prices to a lower discounted price – must be made up through increased electricity prices to other customers. Without compensating price increases to other customers, Big Rivers would violate the terms of its loans and go into default, with consequences described further in Section 9.2.4. To minimize the price increases to other customers, it is therefore necessary to minimize the smelters' price discounts, consistent with their remaining in business. This requires detailed knowledge of the smelters' finances and of their parent companies' production alternatives.[151]

Further complicating matters is the dependence of the minimum price discount on fluctuating aluminum prices. As implied by the discussion in Section 8.3.3, the minimum electricity price discount would change by roughly $1 per MWh in the opposite direction of every $25 per ton change in world aluminum price. Over the past ten years, the month-to-month absolute

[150] This forecast is based upon a regression of annual average MISO Illinois Hub prices on Electric Generation Delivered Natural Gas prices and MISO Peak Load for the years 2006 to 2012. The forward values of Electric Generation Natural Gas prices were obtained from U.S. Energy Information Administration, http://www.eia.gov/forecasts/archive/aeo11/source_natural_gas.cfm, Table 13. Forward values for MISO Peak Load were obtained by assuming that MISO Peak Load grows at 3% per year. Historical Electric Generation Delivered Natural Gas prices were obtained from the Energy Information Administration, http://www.eia.gov/dnav/ng/hist/n3045us3m.htm. Historical MISO Peak Load values were obtained from Potomac Economics, *State of the Market Reports* for the Midwest ISO, for the years 2006 through 2011.

[151] The smelters have each provided us with information on their current and prospective finances from which we could calculate the necessary discounts. We cannot present the figures for those necessary discounts in this report without breaching confidentiality; but even more important, we would not want to present such figures without conducting detailed audits of the smelters' numbers, such audits being well outside of the scope of this report.

changes in the LME price of aluminum have averaged $92 per ton, with the largest month-to-month change being $402 per ton. To offset any windfall losses or gains (to the smelters or to other customers) arising from changing aluminum prices, the electricity price discount could reasonably be expected to bounce around by an average of almost $4 per MWh from one month to the next, and by a maximum of $16 per MWh from one month to the next![152] As an alternative, Kentucky could use the banking approach that West Virginia has used, accumulating these windfall losses or gains so that they partially offset each other over time; but as the West Virginia Public Service Commission Staff has noted, this approach can have serious problems in practice.[153]

The minimum price discounts consistent with the smelters remaining in business not only depends upon world aluminum prices, but also depends upon measures of the smelters' profitability that are subject to accounting ambiguities. A further complication arises from the fact that the Hawesville and Sebree plants have different cost structures and so would require different discounts, which may reasonably be regarded as unduly discriminatory.

9.2.2. Direct Access to Electricity Markets

It appears that Century is interested in direct access to wholesale electricity markets but that Alcan is not interested. According to Big Rivers' CEO Mark Bailey:

> Big Rivers "floated" the market idea earlier this year to Century and "initially they were warm about it," he added. But Big Rivers also insisted that both Century and Rio Tinto Alcan… would have to agree on a market approach. Century, he said, "was unable to convince Alcan to do that."[154]

Big Rivers' insists that both smelters go to the market because it requires that both smelters agree to any arrangement that requires amendment of their contracts.

For any utility, the effects of direct access are almost identical to the effects of the utility selling power to participating customers at its SRMC: participating customers buy generation services at market prices which, depending upon the particular terms of these customers' power purchase contracts, may be somewhat better or worse than the terms that the utility would arrange; and the participating customers buy transmission (and possibly distribution) services, as well as administrative services, from the local utility at prices that would probably reflect some combination of SRMC and cost of service.

Market prices of electricity bear a relationship to utility cost of service that depends upon the business cycle. If utility investments in generation facilities are efficient[155], the market prices of

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[152] $92 per ton / ($25 per ton / $1 per MWh) = $3.68 per MWh ≈ $4 per MWh. $402 per ton / ($25 per ton / $1 per MWh) = $16.08 per MWh ≈ $16 per MWh.

[153] See Section 9.2.3 for a description of the banking approach and the problems encountered in West Virginia.

[154] "Century to end power deal but keep Hawesville open for now," *Metals Week*, August 27, 2012.

[155] A utility investment in generation is efficient only if, over the course of the decades of the generator's life, the market values of its outputs are reasonably expected to exceed its accounting costs of capital and operations.

generation services will exceed costs of service in years when the regional economy is booming or when general price inflation (particularly fossil fuel prices) is high; and the market prices of generation services will be less than costs of service in years when the regional economy is stagnant or in recession or when general price inflation is low. Not surprisingly, when market prices of generation services are low relative to cost of service, large industry seeks market access and lobbies for laws (like the Energy Policy Act of 1992) that improve direct access to electricity markets; while when market prices are high relative to costs of service (as in the Western power crisis of 2000-2001), large industry is less enthusiastic about direct access.

In principle, direct access can promote efficient electricity markets by better connecting consumers with suppliers. In practice, there is a risk that large customers will seek direct access when electricity market prices are relatively low, saddling small customers with the burden of paying for the utility's relatively high costs; and that large customers will seek to return to the utility when market prices are relatively high, taking from small customers part of the benefits of relatively low utility costs. If Kentucky allows the smelters (or any other large customers) to have direct access, it should not allow "heads I win, tails you lose" behavior: **as a matter of fairness to the utility's core customers, the utility should have no obligation to resume providing generation services to those customers who choose direct market access.**

9.2.3. Electricity Prices Pegged to World Aluminum Prices

Throughout the U.S., there has been a long history of pegging the electricity prices paid by aluminum smelters to the world price of aluminum. Kentucky's smelters were on such an electricity tariff in the late 1980s and early 1990s; and Table 20 shows that one smelter (Ormet in Ohio) is presently on such a tariff, and that a second smelter (Ravenswood in West Virginia) has requested to be on such a tariff.

A major difficulty with such a tariff is that it turns the utility into a speculator in world aluminum markets: the utility's revenues and profits go up and down with the LME price. It is reasonable for a firm that is in the aluminum business to face the risks of aluminum price uncertainty because, in addition to having detailed knowledge of aluminum markets, it can mitigate the associated financial risks through a variety of actions, including long-term bauxite purchase contracting, long-term aluminum product sales contracts, variations in its plant production and employment levels, and the use of financial instruments (e.g., metals futures) as hedging tools. It is less reasonable for a utility that is in the electricity business to face the risks of aluminum price uncertainty because it has fewer means of mitigating the associated financial risks and a weaker understanding of aluminum markets.

If Big Rivers offered the smelters electricity prices that are pegged to world aluminum prices, the electricity prices should be no lower than Big Rivers' SRMC described in Section 9.2.1. Because present MISO electricity prices indicate that this SRMC is well above the average electricity prices of $26 per MWh faced by the world's smelters as shown in Figure 4, it may simply not be possible for Big Rivers to match the electricity prices that are paid by most of the world's other smelters or, for that matter, the electricity prices that are paid by most other U.S. smelters.

Further practical difficulties of pegging electricity prices to world aluminum prices are highlighted by the recent history of Century's Ravenswood smelter in West Virginia. According to the recent testimony of the Staff of the Public Service Commission of West Virginia, Century agreed, on September 11, 2006, that it would pay Appalachian Power Company (APCo) an electricity rate based upon the LME world aluminum price, and that deficits or surpluses, relative to a "cost base charge" would accumulate in a "Century Bank." The idea was that, when aluminum prices were low, Century would pay a low electricity rate; and when aluminum prices were high, Century would pay a high electricity rate; and over the course of years, the resulting deficits and surpluses would balance each other out (at least partly) in the Century Bank. According to the West Virginia Staff testimony:

> …the accumulated Century Bank ended the month of January 2009 with a surplus of $7,512,867 but… spiral[ed] downward to an accumulated total deficit of $13,926,641 as of December 31, 2011… Century has stated that if the 2006 special rate was terminated, APCo could seek recovery of the deficit from its other ratepayers.[156]

It thus appears that Century got the deal it wanted back in 2006; but now that the deal has resulted in a multi-million dollar liability, Century wants to terminate its special rate so that the utility's other ratepayers absorb that liability. The West Virginia Staff witness notes that the $13.9 million accumulated deficit will increase further – perhaps by tens of millions of dollars – if the LME price continues to be below $2,400 per metric ton.[157] Pegging electricity prices to world aluminum prices can thus lead to another "heads I win, tails you lose" situation which, in the case of West Virginia, already has a price tag of $13.9 million and climbing.

9.2.4. Forgiveness of Big Rivers' Debt

As a means of financing price reductions for the smelters, it has been suggested that Big Rivers renegotiate its roughly $640 million debt with the Rural Utilities Service. We believe that this suggestion is infeasible. Such renegotiation would occur only under the threat (or actuality) of Big Rivers' bankruptcy, which would only occur if the Kentucky Public Service Commission refused to allow Big Rivers to raise rates sufficiently to avoid bankruptcy. Our understanding is that the Commission would be required to approve such a rate request in view of long-standing legal limits on regulatory discretion in the setting of "just and reasonable rates."

Since 1886, the U.S. Supreme Court has consistently held that, in view of the unique obligation of utilities to furnish adequate service on demand, the price-fixing authority of the state in the public utility field is subject to the requirement that individual utility companies' rates must be "just and reasonable." Furthermore, the constitutionality of rates must be tested by the application of eminent domain principles. Chief Justice Rehnquist reaffirmed this century-old rule in the *Duquesne Light* case:

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[156] Marion A. Russell, *Prepared Direct Testimony*, before the Public Service Commission of West Virginia, Case No. 12-0613-E-PC, July 9, 2012, pp. 4-5.

[157] *Id*., p. 10.

> The Constitution protects the utility from the net effect of the rate order on its property. The Constitution protects utilities from being limited to a charge for their property serving the public which is so 'unjust' as to be confiscatory… If the rate does not afford sufficient compensation, the State has taken the use of utility property without paying just compensation and so violated the Fifth and Fourteenth Amendments.[158]

Earlier decisions in the *Bluefield Waterworks* and *Hope Natural Gas* cases[159] provide ample additional precedent on the Constitutional limits of the Commission's discretionary power to deny Big Rivers an opportunity to recover prudently incurred costs. Thus, precedent in utility regulatory practice and utility case law suggests that the Commission would not be able to deny Big Rivers request to raise rates to avoid bankruptcy. The Rural Utilities Service, for its part, would take a dim view of any brinksmanship by Kentucky, and might respond by imposing more stringent conditions on any future financing of Kentucky's cooperative utilities.

9.2.5. Big Rivers' Merger or Acquisition

To deal with the problem of the smelters having such a large share of Big Rivers load, it has been suggested that Big Rivers merge with another utility or be acquired by another utility. We believe that this suggestion would do nothing to solve the smelters' fundamental business problems nor the financial risks to any utility that serves the smelters, both of which arise from conditions in the world market for aluminum. The "advantage" of a merger or acquisition would be that any shifting of electricity costs of service from the smelters to other customers would be shared by a larger number of other customers, which would make such a shift less painful for Big Rivers' other customers but would place a new cost burden on the customers of whatever utility merged with or acquired Big Rivers. Even if a merger or acquisition could be accomplished, the limit on a smelter rate discount would be the SRMC for the merged utility, which likely would be little different than the SRMC for Big Rivers alone.

It seems very unlikely that another utility would want to accept such a burden without due compensation, which Big Rivers is unable to provide. To put it a different way, while Big Rivers' generating plants and non-smelter load may be attractive to other utilities, its debt and its smelter load pose challenges that would likely dissuade other utilities from seeking merger or acquisition at this time.

We are not aware of any utilities that are considering merging with or acquiring Big Rivers.

9.2.6. Economic Development Support by the Commonwealth

In view of Big Rivers extreme financial dependence upon the smelters, which has prevailed for most of the last four decades, it has been suggested that the Commonwealth consider providing some form of financial support over and above what Big Rivers is capable of offering

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[158] U.S. Supreme Court, *Duquesne Light Co. V. Barasch*, 488 U.S. 299 (1989) at 314, 307, and 308.

[159] U.S. Supreme Court, *Bluefield Water Works v. Public Service Commission*, 262 U.S. 679 (1923); U.S. Supreme Court, *Federal Power Commission v. Hope Natural Gas Co*., 320 U. S. 591 (1944).

the smelters. The West Virginia government's decision to pass legislation to provide additional aid up to $20 million per year Century's Ravenswood smelter is an example of the options the Commonwealth may consider, keeping foremost in mind the several principles outlined in Section 9.1 that should inform any decision of this magnitude.

The economic development support that existing Kentucky legislation offers is not likely to be sufficient to enable the smelters to remain economically viable in the long-term without significant increases in world aluminum prices. The magnitude of the economic support that the Commonwealth may have to provide the smelters along with the uncertain length of time such support may be required renders all of the Commonwealth's existing economic development programs inadequate to the task, if the Commonwealth believes that the benefit of economic aid exceeds the cost.

To put the magnitude of the problem for the Commonwealth into perspective, if, for the sake of argument, assume that Big Rivers is willing to provide a $25 million per year discount to the smelters, which would require a corresponding increase in rates for its other customers. If the smelters are seeking $80 million (to pick a number), then a full package of financial aid would require the Commonwealth to provide tax relief or direct (or indirect) funding support of $55 million per year. The Commonwealth does not have any existing program that would support that magnitude of economic assistance to industrial electricity users. The Commonwealth would have to pass special legislation to enable it to provide that kind of support targeted specifically to the smelters. Before doing that, the Commonwealth must decide whether it believes that, by providing such support, the smelters will be enabled to stand on their own, without further support, in the long run, and whether that support establishes a business incentive policy that the Commonwealth can reasonably apply to other energy-intensive industries.

9.2.7. Mitigating the Adverse Effects of a Smelter Closing

In considering the Commonwealth's options for addressing the smelters' financial challenges, a guiding principle is that the expected benefits to the Commonwealth of an option should be less than the costs of that option. Given the decline of the U.S. aluminum industry over the past few decades, including the past decade in particular, the implementation of this guiding principle rests on the key question of whether Kentucky's aluminum smelters are financially viable in the long-run. If a smelter is not financially viable in the long run, then Kentucky is best advised to devote its resources to mitigating the adverse impacts of the smelters' closing rather than sinking its resources in keeping the smelters open for a few more years, after which those adverse impacts will occur anyway. The mitigation can come in several forms, including: a) attraction of other industries with better long-term financial prospects; b) job training of former smelter employees; and c) information services regarding job opportunities elsewhere in Kentucky.

9.3. Options for Other Industries

While the smelters' financial problems are most urgent, other large industrial firms in Kentucky also face the challenges of competition in global markets and of rising energy and

environmental compliance costs. Any solutions that the Commonwealth or Big Rivers offer to the smelters would be, in principle, applicable to other industries as well. The Commonwealth and Big Rivers needs to be cognizant of the precedents set by policy toward the smelters: Commonwealth aid for the smelters and Big Rivers discounts to the smelters might be claimed by other industries as well.

Consequently, the options for the smelters described in Section 9.2 would have similar strengths and weaknesses if applied to other industries. There are, in addition, a number of other policies that could be pursued that would help strengthen other large industrial firms or help mitigate the impacts of any future plant closings. We recommend the following policies:

- *Continue to rebalance utility rates* to reduce or eliminate any existing cross-subsidies from industrial customers to commercial and residential customers. Such a policy would support job retention and expansion, and is particularly important because large industrial customers, having global perspectives on their competition and their production opportunities, are more likely to choose their locations on the basis of electricity prices than are other types of customer.
- *Devote greater resources to Kentucky's educational system*, including technical training and employee re-training. In the long run, Kentucky's educational system will be a key determinant of the state's prosperity. In the mid-term, improved technical training will get better jobs for Kentuckians who are entering or already in the work force, and will get Kentucky businesses the skilled workers that they need. In the short-term, workers who lose their jobs need a hand in moving into the jobs that remain or are being created in Kentucky.

In keeping with the general concern that Kentucky industrial electricity users have expressed during interviews that, for the Commonwealth's industrial base to remain competitive, the Commonwealth should broaden the economic incentives it offers to businesses to invest in energy efficiency, we also recommend the Commonwealth consider advancing policies that:

- Provide greater assistance and guidance to business on the use of Industrial Revenue Bonds (IRBs) to help small to medium sized business invest in energy efficiency projects; and
- Establish a revolving loan program, which could be an IRB program, to support business investment in energy efficiency projects.[160]

[160] For example, there currently is about $500 million allocated to support IRBs that is not being fully utilized. This could become a financial base for a revolving loan program.

APPENDIX A.
SURVEY INSTRUMENTS

Survey on Behalf of the Commonwealth of Kentucky
Concerning Electric Costs to Heavy Industry

Questions for State Legislative and Energy Office Staff

1. Please provide electronic copies of (or url links to) your state's statutes, court rulings, and case law that provide the legal basis for:
    a. your state providing assistance to energy-intensive industrial and manufacturing companies in offsetting high electricity prices or anticipated increases in electricity prices;
    b. your state providing similar assistance to attract new industrial facilities or promote the expansion of existing facilities and employment;
    c. state and local bond or tax authority targeted to assisting energy-intensive industrial and manufacturing companies by offsetting either high electricity prices or anticipated increases in electricity prices; and
    d. state and local bond or tax authority targeted to attracting energy-intensive industrial and manufacturing companies to your state or encouraging expansion of existing facilities by offsetting either high electricity prices or anticipated increases in electricity prices.
2. Please provide electronic copies of (or url links to) your state's current programs and mechanisms that provide incentives for economic retention, expansion, or attraction of energy-intensive industrial and manufacturing companies. Such programs and mechanisms may include, but are not limited to: low-interest loans; bonding schemes to limit costs or provide financing; grants; tax incentives; workforce training; and provision of physical facilities, infrastructure, or access to industrial sites.

Survey on Behalf of the Commonwealth of Kentucky
Concerning Electric Costs to Heavy Industry

Questions for State Regulatory Commission Staff

1. Please provide electronic copies of (or url links to) your state's statutes, court rulings, regulations, and regulatory case law that provide the legal basis for your utility regulatory commission and utilities:
    a. providing assistance to energy-intensive industrial and manufacturing companies in offsetting high electricity prices or anticipated increases in electricity prices; and
    b. providing similar assistance to attract new industrial facilities or expand operations of existing facilities and increase employment.
2. Please provide electronic copies of (or url links to) your state's regulations that are intended to mitigate rising electric costs to heavy industrial and manufacturing companies.
3. Please provide electronic copies of (or url links to) your state utilities' rate and rate rider schedules for energy-intensive industrial and manufacturing companies. If available and not subject to confidentiality provisions, please also provide copies of any special contracts between utilities and energy-intensive industrial and manufacturing companies. For the special contracts that are subject to confidentiality, CA Energy Consulting would be willing to sign an appropriate non-disclosure agreement.

Survey on Behalf of the Commonwealth of Kentucky
Concerning Electric Costs to Heavy Industry

Questions for Utilities

1. Please provide electronic copies of (or url links to) your utility's rate and rate rider schedules for energy-intensive industrial and manufacturing companies. If available and not subject to confidentiality provisions, please also provide copies of any special contracts between your utility and energy-intensive industrial and manufacturing companies. For special contracts that are subject to confidentiality, CA Energy Consulting would be willing to sign an appropriate non-disclosure agreement.
2. Please provide electronic copies of (or url links) to descriptions of any non-rate programs by which your utility supports efficient use of energy by your energy-intensive industrial and manufacturing customers. Such support may include, for example, assistance with: selection of customer facility sites, infrastructure, strategic marketing, energy efficiency improvements, and productivity improvements.

Survey on Behalf of the Commonwealth of Kentucky
Concerning Electric Costs to Heavy Industry

Questions for Manufacturers

1. What has your company done to improve the energy efficiency and reduce energy costs within the past five years?
2. If you have invested in energy efficiency improvements:
    a. When was the investment made?
    b. Was the investment made in response to an energy audit?
    c. What was the up-front capital cost of the investment?
    d. What are the annual costs, if any, associated with operating or maintaining the investment?
    e. What are the benefits of the investment, in terms of lower energy bills, reduced kWh or kW electricity consumption, or other measures of success?
    f. Has there been any benefit/cost analysis of the investment? If so, what were the findings of that analysis?
3. Has your company ever received any state or local incentives to retain the facility in the state, to promote the expansion of the facility, and/or to increase employment at the facility? If so, please
    a. describe these incentives, indicating whether any of the incentives were specifically intended to reduce energy costs or to reduce other costs as an indirect means of offsetting energy costs;
    b. provide documents that describe the details of the incentives; or
    c. provide a contact person or state agency that can be contacted to obtain information about the incentives.

APPENDIX B.
KENTUCKY STEEL INDUSTRY ENERGY EFFICIENCY IMPROVEMENTS

This appendix presents information provided by Kentucky steel firms, most of it in their own words.

AK Steel has provided the following description of its efforts:

> In order to reduce costs and remain competitive, AK Steel's Ashland Works has made substantial improvements to its energy efficiency over the past several years. As an integrated mill, many of the improvements at Ashland Works have been related to coal and natural gas consumption, although significant improvement has also been made with regard to reducing electricity consumption.
>
> By focusing on operational efficiencies, scheduling management and process improvements, Ashland Works has reduced its kwh/ton measure for producing carbon steel slabs by approximately 20% over the past few years. In addition, AK Steel is a member of the U.S. Government's Energy Star Steel program which promotes energy efficiency, and has implemented the program at Ashland.

Gallatin Steel describes its efforts as follows:

> Over the years, Gallatin Steel has made reducing electrical consumption a priority due to the significant portion that electricity represents of our controllable conversion costs. The specific actions implemented must remain confidential, but thanks to these activities and the efforts of our operators to diligently apply our processes and identify new and ever more creative ways to address this issue, we continue to reduce the consumption of electricity which … is critical to our competitiveness.

Kentucky Electric Steel says that nearly every steel production process improvement effort it undertakes is designed toward lowering electricity consumption. This is because electricity is, after raw materials, its single largest cost to make steel. That said, the following is an incomplete list of efforts that KES has expended in pursuit of a more competitive liquid steel cost:

- The furnace transformer and its condition is key to the efficient utilization of the electricity. We have spent much to improve the transformer, enhance its maintainability, and protect it from damage (both electrically and from the environment).

- The electrodes that deliver the electrical current to the furnace to melt the scrap play a keen role in the electrical efficiency of the process. We have experimented with many electrode sources as the proper graphite raw materials for the electrodes and the electrode manufacturing process is critical to obtaining the lowest electrical usage. The protection of the electrodes (with water sprays) and the regulation of the balance of current between the three electrode utilized is also critical. We have installed improved systems for all of this.
- The control of the actual electrical arc and its flaring is a critical component to minimizing power consumption. We have, and do, expend significant effort and money to purchase scrap that supports proper arcing and slag practices that minimize arc flare. This includes installation of auxiliary burners which replace electricity with chemical energy. This has required determination of properly-sized carbon for injection as well as development of proper oxygen and carbon injection practices. This also requires exact tailoring of slag chemistry to promote slag foaming to protect electrodes and promote efficiency of arcing.
- Minimization of electricity consumption also requires minimization of heat losses. To this end, we have expended efforts to design and implement refractory linings into our furnace that are ever more advanced to protect the furnace shell from excess heat loss. We also continue to improve our gunning practices to extend furnace lining life.

Kentucky Electric Steel spends a lot of time and money trying to control our electric bill, over $2 million spread over the past eight years. This has reduced energy intensity from 743 kWh per billet ton in 2002 to 480 kWh per billet ton today. That represents an annual savings of over $600k with just our night-time operations; the savings would be even more if we ran during on-peak hours, except that the higher power cost would eat them up!

North American Stainless has implemented the following programs:

- Natural Gas/Oxygen Burners in Ladle Preheaters reduce energy demand.
- Power reduction goals by mill set and reviewed monthly by president and managers.
- Senior energy management group established and reviews projects to reduce electrical consumption and demand.
- Shutdown procedures established for each mill, so equipment is shut off when mills are not running production and are then rated on performance.
- Meters added throughout NAS showing trends over time to understand power usage.
- Energy management software purchased being learned and established.
- Production planning to cycle equipment shut-off times for efficient power usage.
- Automation established in rolling mills reducing demand during peak power periods.

- Air leak identification program reducing air consumption and in turn electrical consumption.
- Power usage is communicated in daily mill group meetings.
- All new lighting projects and retrofits are with LED lighting.
- Standardizing on variable frequency drive (VFD) technology for any new motor applications.
- All replacement motors are high efficiency duty.
- Electric Arc Furnaces (EAFs) are automatically cycled during peak power demand periods to reduce usage to 75MW.
- Arc profile changes in the EAFs have been adjusted to reduce kWh's/ton, decreasing electrical consumption by 7% over last year's average for most product grades.