MEASURING THE ABILITY OF INDIANA INDUSTRIES TO PASS ON COST INCREASES CAUSED BY CO_2 LEGISLATION

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EXECUTIVE SUMMARY

In the design of most CO_2 legislation, the presumption is that both utilities and industry will be able to pass on to final consumers their process or purchase cost increases caused by CO_2 restrictions. In such a world, all CO_2 allowances should go to final consumers rather than to utilities and industry. To do otherwise invites windfall profits for both, as the utilities and industry sell the allowances and pocket the revenues, passing on their compliance costs to consumers in the form of higher prices. However, the existence of competition from countries without CO_2 limiting legislation will likely limit the amount of the compliance burden trade dependent industries will be able to pass on to their customers. Passing on these costs will result in "carbon leakage" – shifting abroad carbon emissions as competitors in unregulated jurisdictions take market share away from the now higher cost domestic producers, resulting in increases in emissions in these countries which would more than likely offset any decreases in the US. Most global warming legislation has recognized such situations, and included in the legislation provision for reimbursing such companies for their losses to prevent such leakage.

This paper discusses the wisdom of such provisions, as well as providing an estimate of the likely magnitude of the payments necessary to level the playing field for such Indiana trade vulnerable industries.

The paper also discusses a second type of leakage peculiar to states such as Indiana which generate a high percentage of their power from coal. This is the out-migration of electricity intensive industries to neighboring states with less dependence on coal, and hence smaller increases in electricity prices following CO_2 control legislation.

The following conclusions follow from this paper:

1. Partial Grandfathering – the granting of some protection against the negative consequences of retroactive environmental laws on assets – is not vote pandering. It is a continuation of a long tradition of the application of one section of the Fifth Amendment – the government must fairly compensate private parties when such values are taken from them.
2. In most instances, industry can be expected to be able to pass on compliance costs to their customers, and would have no need for Grandfathering, allowing compensating payments to flow to final consumers of electricity and products. Estimates of such payments to Indiana consumers are $4.6 billion, or 2.1% of gross state product.
3. An exception to this principle is the case of trade vulnerable industries which must compete abroad (exports) and domestically (imports) with goods made in countries that have no limits on CO_2 emissions. A solution to the export problem is to exempt the CO_2 associated with the production of exports from the emissions totals of export firms, or simply compensate the export firms for the cost difference. The import problem can be solved by border taxes equivalent to the CO_2 content of domestic goods. To do otherwise invites carbon leakage – moving CO_2 intensive production abroad to pollution havens.
4. If the choice is made to compensate Indiana export firms for their extra costs, the top 10 Indiana emitters would have been entitled to an estimated $107 million in estimated payments, based on the percent of their total emissions associated with their export volume.
5. The out-migration of firms to other states with smaller increases in their electricity costs is a real possibility. Two industries which might shift their production to other states are primary aluminum production and iron and steel mini-mills; both will see substantially large relative cost increases here in Indiana, and both industries are dominated by firms with plants in other states as well as in Indiana.

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I. INTRODUCTION

In the design of most CO_2 legislation, the presumption is that both utilities and industry will be able to pass on to final consumers their process or purchase cost increases caused by CO_2 restrictions. In such a world, all CO_2 allowances should go to final consumers rather than to utilities and industry. To do otherwise invites windfall profits for both, as the utilities and industry sell the allowances and pocket the revenues, passing on their compliance costs to consumers in the form of higher prices. However, the existence of competition from countries without CO_2 limiting legislation will likely limit the amount of the compliance burden trade dependent industries will be able to pass on to their customers.

Passing on these costs will result in "carbon leakage" – shifting abroad carbon emissions as competitors in unregulated jurisdictions take market share away from the now higher cost domestic producers, resulting in increases in emissions in these countries which would more than likely offset any decreases in the US.

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This paper discusses the wisdom of such provisions, as well as providing an estimate of the likely magnitude of the payments necessary to level the playing field for such Indiana trade vulnerable industries.

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II. NATIONAL ISSUES

A. GRANDFATHERING AND ENVIRONMENTAL LEGISLATION

Whether or not one supports or opposes compensation for losses associated with the passage of environmental legislation depends on your point of view regarding the justice, or lack of it, in the original use of public goods such as air and water. If, as Bovenberg, et al (1), has put it, "In effect, these policies (environmental legislation) transfer property rights from firms to the public sector, reclaiming from firms the ownership of environmental resources such as air quality," such legislation simply reclaims ownership and control for assets that were originally the public's. It follows that the property rights values which people suggest need protection can be viewed as simply ill-gotten gains.

If, on the other hand, the private sector's appropriation of these public goods is viewed as an innocent, legal, and desirable part of early uninformed natural resource exploitation, with attendant risks, then the values arising from the use of these public goods seem not so evil, nor the protection through "Grandfathering" so unreasonable.

The basis for the tradition of such "Grandfathering" compensation has a long history in the US, going back to the Constitution. Section 9 of Article 1 of the US Constitution says "no bill of attainder or ex post facto law shall be passed" by Congress; Section 10 says the same thing for the states. The courts have limited the strict application of this ban on retroactive legislation to criminal, not civil cases, and ruled early on that new taxes are not ex post facto laws. Later court decisions say only such retroactive laws must meet the due process requirement – that they were arrived at for "a legitimate legislative purpose furthered by rational means." (2)

Nonetheless, there is a strong tradition which allows long-lived investments (such as those found in the utility and energy intensive heavy industries) made when one set of rules held to be exempted for a limited period of time from the economic consequences of legislation which changes these rules. Such exemptions, known as "Grandfathering," allow such industries to recoup their existing investments before having to comply with the law, even though opponents have characterized them as "loopholes" in the law. Who pays for this recouping – the ratepayers, the stockholders, the public, and a mix of all – has differed, depending on the situation.

Past examples arising in the deregulation of the utility industry include the treatment of electric generating units "stranded" by the deregulation of the electric generation industry, and the treatment of so-called "transition costs" in the deregulation of the natural gas industry. In both of these instances, the argument for compensation was buttressed by the fact that such investments were required by state regulatory commissions under the regulatory compact. Such costs were typically measured by the difference between the book value under regulation and the market value under deregulation, and concluded that owners were entitled to compensation for this amount. (3) More recent examples of its application to utilities and industry are the treatment of existing units exempted from acid rain legislation rules, such provisions in the EU Cap and Trade system, and provisions in the Waxman/Markey CO_2 bill passed by the House that says only units "initially" permitted after January 1, 2009, will be subject to the provisions.

The basic fairness of Grandfathering – "From now on we're going to require…" rules – lies at the heart of the durability of the concept in legislation. Anyone who, in their private lives managing their own long lived assets, has encountered a situation where decisions made in keeping with the law in one time period only to have the rules of the game changed at the expense of their wallet recognizes instantly the justice of such exceptions, at least until they can recoup the remainder of their investment.

Not all such investments should be protected; legal scholars have suggested several tests for justifying asking for such exemptions. First among them is the concept of reliance – if an investor has reasonable reliance on the law remaining unchanged. Weiler (4) negatively put it, "if you have reasonable prior expectations that the law which will affect you will be changed, then you have a weak case for objecting by reason of ex post facto law." Other tests include the extent to which the legislation has tried to moderate the private burden, and equity – weighing the public benefit against the private loss. (4)

The Grandfathering principle allows lawmakers to balance the need to protect investments made under one set of rules with societies need to change these rules to address newly recognized needs. In many ways, it is an extension of the Fifth Amendment clause which allows private property to be appropriated for the public good only if justly compensated.

As might be expected, environmental advocates strongly resist the Grandfathering idea for CO_2 legislation. (5) They argue that it either continues to allow polluters to pollute if they chose to keep the permits (it does), or, if they sell them, fund the compliance costs from the price increases since "the equilibrium price of their output will rise to cover the cost of permits" (it may, or may not), something that would happen without Grandfathering permits, making the revenues from the sale windfall profits for the emitters. Their arguments have been buttressed by the recent experience in the EU, where the sale of such free permits that took place because industry did not need them as a result of the European economic downturn swamped the exchange and drove permit prices down to very low levels.

In opponents' minds, such allowances really reduce to the fact that pollution will not be decreased fast enough as the allowances are phased out. Many view them just as necessary evils to be endured in order to garner enough support for environmental legislation, rather than any recognition of the basic fairness of the provisions. It is somewhat ironic that many of the most vocal supporters of creating property rights for CO_2 pollution by the cap and trade permitting system are also among the most strenuous objectors to recognizing the need for some limited protection of the prior property rights of emitters. One wonders if they will be as harsh a criticizer of the concept of such rights when the rights created by such legislation are challenged in court.

This quote from an article published in 1996 by Steve Selinger (6) is instructive.

"One suitable proposal for handling retroactive legislation is a more flexible approach that would allow retroactive laws so long as individuals harmed by the new laws are compensated. It would make retroactive analysis similar to Fifth Amendment takings analysis. For example, a taking for the public good is permissible if there is compensation to the individuals whose property is taken. Thus, if the state wants to impose new environmental clean-up laws on property owners retroactively, it must pay just compensation to them. "

"Given the close connection between a prohibition on retroactive civil laws and the safeguarding of private property rights, it should not be surprising that enlightened retroactivity analysis mirrors takings analysis. The Fifth Amendment, which allows takings for public use provided compensation is paid, came after the absolute ban on retroactive laws contained in the original Constitution. Therefore, the Fifth Amendment can be viewed as implicitly amending the absolute ban on retroactivity to allow retroactivity if compensation is paid to harmed individuals."

"This proposal makes it possible to respond to one of the chief arguments that proponents of retroactivity have given, namely, that retroactivity should be permitted because the state needs flexibility in running its affairs (e.g., Weiler 1993). Allowing retroactivity if compensation is paid offers the state the flexibility that the Fifth Amendment allows; the state merely needs to pay for it. This flexibility, moreover, is not invented by relying on the vagaries of "substantive due process.'' It flows from the initial wording of the Constitution banning ex post fact laws and an analysis of the subsequently passed Fifth Amendment that allows takings as long as individuals are compensated."

This is not to say that Grandfathering is the perfect solution to CO_2 reductions; it, as a policy, has baggage as well. One major problem is it encourages speedy building of plants that are expensive to retrofit for CO_2 capture in the expectation that once they are fully permitted and construction started, they will be exempted from compliance costs. More socially responsible plants, such as Duke Power's Edwardsport plant which first gasifies coal before combustion, making it less expensive to capture CO_2 emissions, lose out in such a "reward the profligate" legal climate.

B. TRADE VULNERABLE INDUSTRIES

Some free allocations for energy intensive and trade vulnerable industries such as the refinery, iron and steel, cement, and paper industries are generally included in most current and proposed legislation, on the basis of the inability of these industries to pass on compliance costs because of foreign unregulated competition.

Passing on these costs would result in "carbon leakage" – shifting abroad carbon emissions as competitors in unregulated jurisdictions take market share away from the now higher cost domestic producers, resulting in increases in emissions in these countries which would more than likely offset any decreases in the US.

First, note that such industry costs will increase from both the increase in their purchased electricity bill as well as increases in their direct costs of purchased electricity.

How much protection needs to be given to level the playing field for such company's exports and imports?

A simple ex-post calculation for export protection would involve companies furnishing the total quantity of their product sold to unregulated jurisdictions, and the government exempting the CO_2 generated by the production of those exports from the compliance requirement, or reimbursing the companies for the amount. This would end the story as far as making whole the exporters; costs of export production are unchanged, and their production choices are made in a climate as if the tax never existed.

As to imports from unregulated countries, a tariff, or border tax in global warming parlance, equal to the compliance cost differential could be levied on all units imported. This would presumably be passed on to the purchasers of the imported goods, again maintaining domestic competitiveness relative to goods made abroad in unregulated jurisdictions, and hopefully eliminate the migration of CO_2 intensive industries to pollution havens.

Since prices have increased for both the imports and domestically manufactured goods, a whole string of production and consumption substitutions will be set in motion. These involve reductions in the use of CO_2 generating inputs in the production process, and substitution of lower CO_2-using products in the marketplace (in particular, the substitution of gas for electricity), all of which decrease the use of CO_2 intensive processes and products, and thus reduce the impact of such laws below that with no such adjustments. The analysis of such adjustments is the province of more general equilibrium economic models such as those found in Bovenberg, et al (7).

The legality of such a tariff under GATT rules is an open question; one GATT rules section seems to allow such a tariff, as long as the tariff does not overcompensate domestic producers. Another section seems to rule it out on the basis that there is no CO_2 which becomes a physical part of the product. As Sheldon (8) points out, the legality issue likely won't be resolved until GATT specifically addresses the issue of carbon border taxes.

Some free market observers have cautioned against the use of such tariffs, saying their imposition could lead to trade wars as non CO_2 regulated countries eager to protect their new found trade advantage retaliate with tariffs of their own. (9)

Which US industries would seem to most qualify for such allocations? Those industries with (a) higher than average CO_2 emissions per dollar of shipments, the calculation including indirect (purchased electricity) as well as direct CO_2 emissions, and (b) higher than average percent trade dependence, measured by the sum of imports and exports over apparent domestic consumption – domestic production minus exports plus imports.

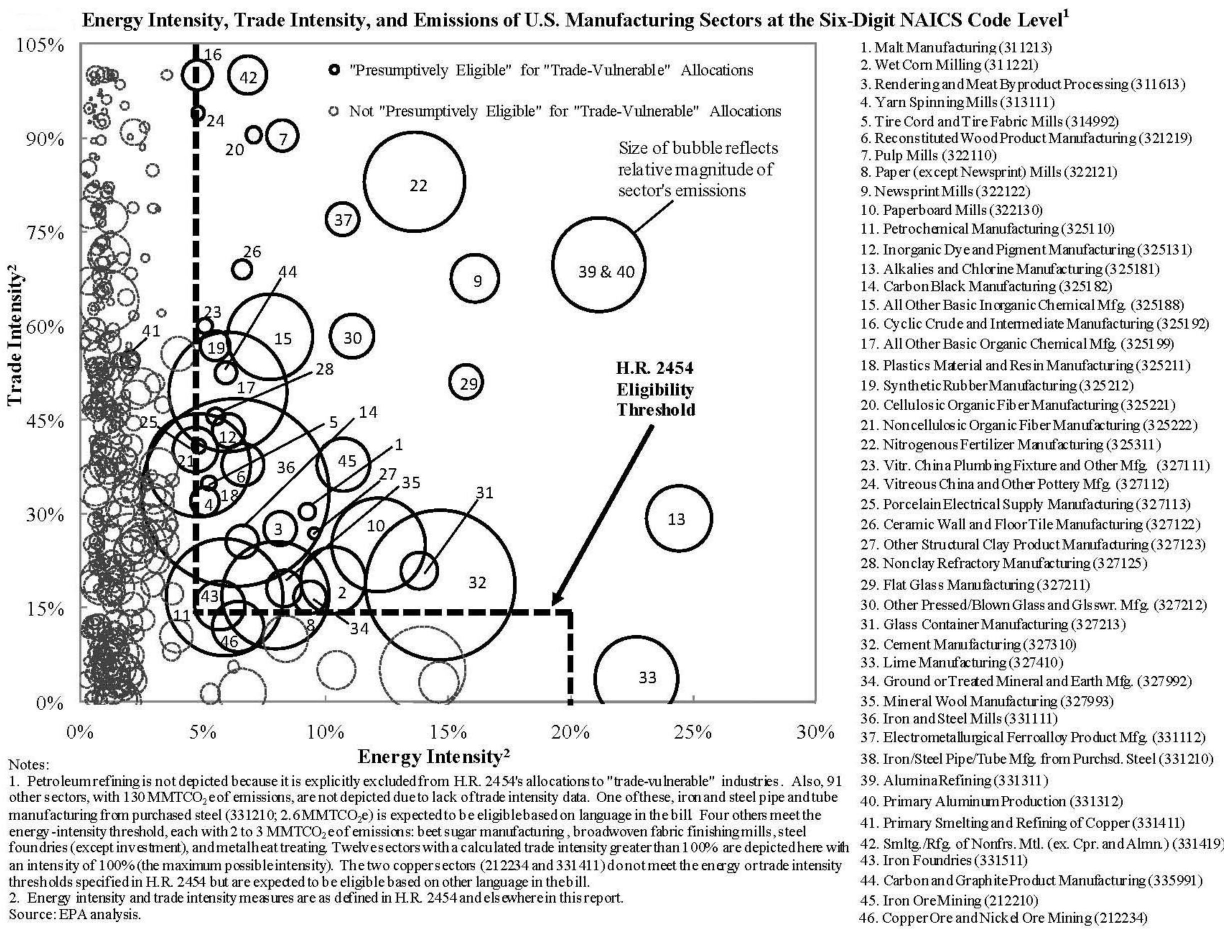
Fortunately, this issue has been studied at length by an interagency task force responding to a request from Senators Bayh, Specter, Stabenow, McCaskill, and Brown entitled "The Effects of H.R. 2454 on International Competitiveness and Emission Leakage in Energy-Intensive Trade Exposed Industries," dated December 2, 2009, and revised February 23, 2010. In it, the task force identifies 44 industries which meet the presumptive guidelines of HR 2454. These guidelines, which qualify industries for allocations, require industries have at least 5% energy intensity (energy expenditures/value of domestic production, or greenhouse gas emissions valued at $20/ton/value of domestic production) and 15% trade intensity (the value of exports plus imports/value of domestic production) or 20% energy or greenhouse gas, regardless of trade intensity.

What is not clear is why energy intensity and CO_2 emissions cost intensity are both used for qualification purposes in the bill, not just CO_2 emissions percentages, outside of the fact that if only CO_2 emissions cost percentages were used, only 7 industries – newsprint mills, chlorine manufacturing, carbon black, nitrogenous fertilizers, cement, electromet products, and aluminum refining – would qualify for protection.

Figure 1 below, taken from the interagency report, plots the industries which satisfy the presumptive guidelines, the dashed right angle lines on the diagram; the vertical axis measures %

trade intensity, the horizontal energy intensity. The size of the circles indicates the magnitude of CO_2 emissions for the industries. (Refineries are not included, since they are covered in a separate section of the bill.)

Figure 1. Energy Intensity, Trade Intensity, and Emissions of U.S. Manufacturing Sectors



Source: Interagency Report, Figure 2, p 11
http://www.epa.gov/climatechange/economics/pdfs/InteragencyReport_Competitiveness-EmissionLeakage.pdf

While many of the industries would be expected to be on the list – iron and steel, aluminum, cement, to name a few – other smaller ones also rank high in this accounting – nitrogenous fertilizers, lime, alkalis, pulp and paper mills, and glass appear in the table.

III. INDIANA ISSUES

A. TOTAL DIRECT CO_2 EMISSIONS FROM INDIANA UTILITIES AND INDUSTRY

Set-asides would be particularly important and beneficial for Indiana, given the substantial presence of the refinery, iron and steel, aluminum, cement, and other energy-using industries in our state, and the fact that 96% of the electricity generated in Indiana is generated by coal-fired plants.

In 2009, EPA released estimates of CO_2 emissions by state from 1990-2007 broken down by commercial, industrial, residential, transportation, and electric power sectors. This data showed that Indiana emissions grew from 205 million tons in 1990 to 230 million in 2007, a 12% increase over the 17-year period. During the same period, national CO_2 emissions grew 19%, from 5018 to 5990 million tons. (10) This source indicated that Indiana emitted 230 million tons of CO_2 in 2007, broken down by commercial, 5.1 million; industrial, 53 million; residential, 9 million; transportation, 45 million; and Electric power, 119 million tons of CO_2. An estimated 53 million tons of CO_2 emissions can be attributed to electricity sales to the industrial sector, based on 45% of sales to that sector in 2007. (11)

For 2002, the total was 226 million for the state, and 6, 54, 10, 46, and 112 million tons for the commercial, industrial, residential, transportation, and electric power sectors. This placed our state 7th in CO_2 tonnage production and 8th in tonnage per capita. (12)

Note that the industrial sector totals do not include the CO_2 emitted from the electricity purchased from utilities in the state – it includes only direct energy use. If electricity is generated on site, then the CO_2 produced would be included in the totals.

Valuing the EPA-estimated utility emissions tonnage at \$20/ton, this means \$2.4 billion of allowances would be passed on to local distribution companies in the state to offset the roughly 33% increase in Indiana electricity bills of 7.1 billion caused by the CO_2 limits. (13)

Using another data set, in 2008, Indiana's regulated utilities used 20.8 million tons of western sub-bituminous coal, and 39.8 million tons of Illinois Basin and Eastern Bituminous coal. (14) Using the EIA average of 4931 pounds of CO_2 per ton of bituminous, and 3715 tons per ton of sub-bituminous coal (15), this means Indiana utilities emitted an estimated 137 million tons of CO_2 in 2008.

B. PROTECTION FOR SPECIFIC INDIANA INDUSTRY TRADE LOSSES

What is of interest in this paper are which Indiana industries should qualify for some trade protection from countries without CO_2 laws, and the costs of such protection. Fortunately, the method used in the above referenced paper makes it quite easy to develop measures of trade and cost vulnerability for Indiana industries.

Calculating state specific trade vulnerability measures probably can be done, but would involve much effort; hence, it will be assumed that the national vulnerability estimates hold for Indiana as well.

Such is not the case with CO_2 cost vulnerability. Here, cost vulnerability is defined as compliance cost, measured by multiplying estimated CO_2 emissions by $20, as a percent of industry value of shipments. While process and combustion CO_2 emissions intensities can be expected to vary little across states at the 6-digit disaggregate level used in the analysis, the carbon intensity of electricity generation is highly state specific. Since the data supporting the paper's analysis separates CO_2 emissions into combustion, process, and purchased electricity components, the purchased electricity calculation can easily be adjusted for state CO_2 generation intensities. The interagency paper uses the national average of 1405 pounds of CO_2 per MWh for purchased electricity. Indiana's carbon intensity is much higher due to our dependence on coal to generate electricity; the number is 2050 pounds per MWh, 46% more, which means the CO_2 cost vulnerability ratios need to be re-computed to reflect the combined process, combustion, and purchased electricity CO_2 intensities if the products were made in Indiana.

Once this is done, estimates of CO_2 emission tonnages for Indiana industries in 2007, obtained by multiplying the re-computed CO_2 tonnage intensities for Indiana (tonnage estimates divided by value of shipments) by the value of shipments of Indiana industries (16), can be plotted as a function of the trade and cost vulnerability ratios, as in Figure 1.

This is done in Figure 2 below, where the data for the top 25 Indiana CO_2 emitter industries are plotted as a function of trade intensity (vertical axis) and CO_2 cost intensity (horizontal axis), not energy intensity as in Figure 1.

The magnitude of CO_2 emissions are given in parenthesis beside each point in the graph. Two numbers are given; the first is the tons of direct emissions from on site processes, the second indirect emissions arising from the electricity purchased by each industry. The top 25 shown on the figure account for almost 85% of total (direct plus indirect) Indiana industrial emissions. Of the top 25 total, 35% are from the generation of electricity purchased by industry, the remaining 65% from direct emissions from the industrial processes.

Regarding the emission sizes, first it should be remembered that the numbers on Figure 2 are for direct and indirect emissions, the latter arising from the generation of electricity consumed by the industrial sector. The total of all emissions from all industries – not just the top 25 – is near 80 million tons. If the CO_2 permit prices were to cost $20/ton as is assumed in this paper, this means 1.6 billion dollars in additional costs must be passed on to consumers from Indiana industry alone as a result of the proposed legislation.

The 80 million ton total is substantially less than the 106 million ton direct and indirect estimate based on the EIA state study mentioned earlier, obtained by adding the 53 million ton estimate of direct industrial emissions to the 53 million ton estimate from electricity sold to the industrial sector. Coverage issues possibly could explain a part of this difference – in particular, the possible double counting of electricity generated in the industrial sector. Using the upper estimates of emissions from the iron and steel and refineries industries increases this paper's estimate to 90 million tons (see below) further reduces the difference.

Figure 2. Top 25 Indiana CO_2 Emitter Industries

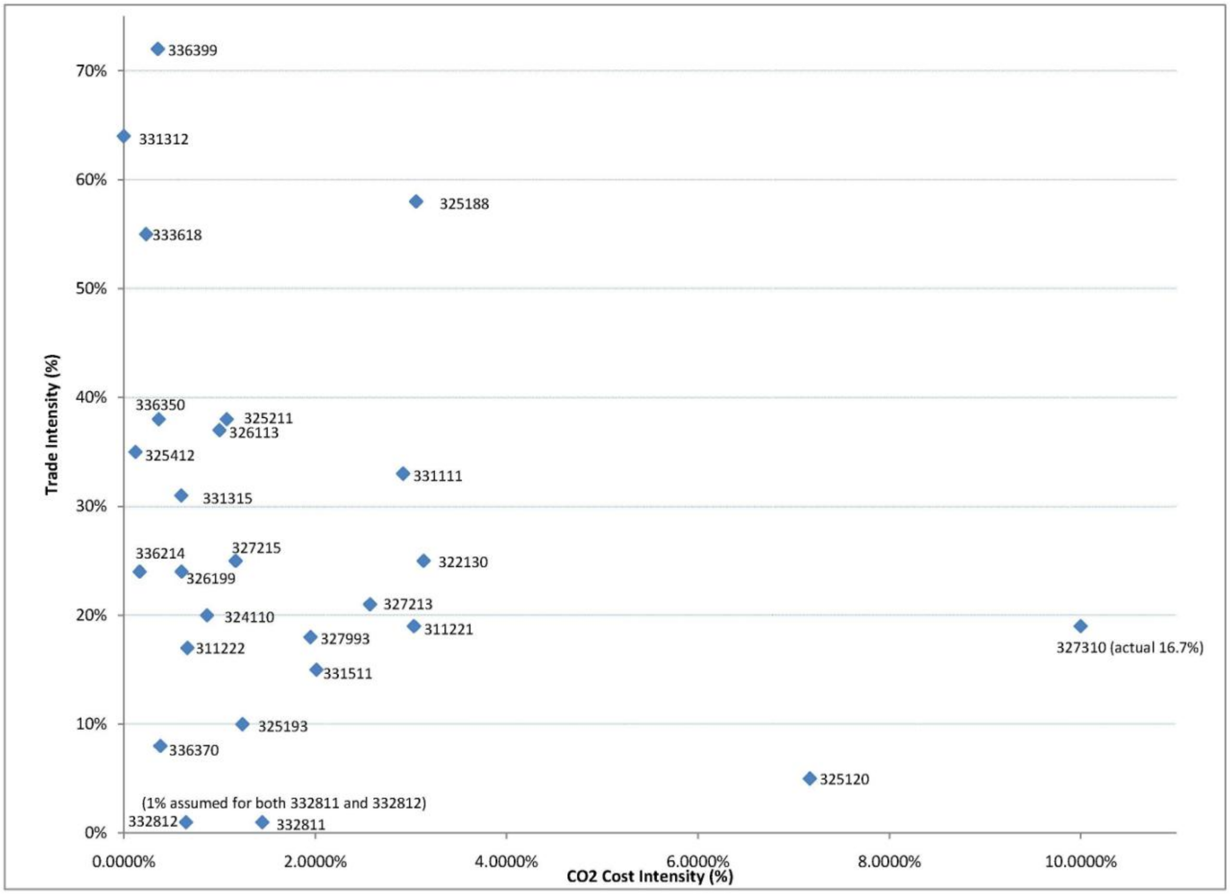


Table 1 presents the NAICS codes with their industry titles given in Figure 2, along with their Indiana direct and indirect emissions (tons CO_2).

Table 1. Indiana Direct and Indirect Emissions (tons CO_2)

2002 NAICS Code	industry Title	Direct Emissions	Indirect Emissions
311221	Wet Corn Milling	2.2	1.0
311222	Soybean Processing	0.4	0.2
322130	Paperboard Mills	0.2	0.2
324110	Petroleum Refineries	3.8	0.6
325120	Industrial Gas Manufacturing	0.8	1.0
325188	All Other Basic Inorganic Chemical Manufacturing	0.2	0.5
325193	Ethyl Alcohol Manufacturing	0.3	0.1
325211	Plastics Material and Resin Manufacturing	0.5	0.5
325412	Pharmaceutical Preparation Manufacturing	0.7	0.3
326113	Unlaminated Plastics Film and Sheet (except Packaging) Manufacturing	0.1	0.3
326199	All Other Plastics Product Manufacturing	0.2	1.1
327213	Glass Container Manufacturing	0.2	0.3
327215	Glass Product Manufacturing Made of Purchased Glass	0.1	0.3
327310	Cement Manufacturing	2.6	0.4
327993	Mineral Wool Manufacturing	0.2	0.3
331111	Iron and steel Mills	20.0	9.0
331312	Primary Aluminum Production	0.4	3.2
331315	Aluminum Sheet, Plate, and Foil Manufacturing	0.2	0.4
331511	Iron Foundries	0.4	0.9
332811	Metal Heat Treating	0.3	0.3
332812	Metal Coating, Engraving (except Jewelry and Silverware), and Allied Services to Manufacturers	0.2	0.3
333618	Other Engine Equipment Manufacturing	0.1	0.4
336214	Travel Trailer and Camper Manufacturing	0.2	0.3
336350	Motor Vehicle Transmission and Power Train Parts Manufacturing	0.3	0.9
336370	Motor Vehicle Metal Stamping	0.1	0.5
336399	All Other Motor Vehicle Parts Manufacturing	0.2	0.4

As might be expected, there are some surprises in Figure 2, particularly the magnitudes of CO_2 emissions and the CO_2 cost intensities.

The dominance of iron and steel mill emissions of 29 million tons – almost 40% of the state industrial total – is somewhat surprising, since nationally, the industry represents a much smaller fraction, until it is realized that Indiana produces more steel than any other state in the Union – usually well over 20% of the total. Second are petroleum refineries, estimated to be 4.3 million tons, due mostly to the presence of at one time the nation's largest refining facility – BP's Whiting complex. Third is aluminum refining, estimated to be 3.3 million tons, due to the presence of Alcoa's Warrick operations in southern Indiana. Wet corn milling is fourth, emitting an estimated 3.2 million tons, and if it's young cousin ethanol plants were added (0.5 million tons), it would be passing aluminum refining for third place. Fifth is cement, 3 million tons; sixth is industrial gas manufacturing, 1.75 million tons, due to the very large electricity requirements for their production. Seventh are iron foundries, 1.3 million tons; eighth, other plastics manufacturing, 1.3

million tons; ninth, motor vehicle transmission and power train parts, 1.2 million tons; and tenth, plastics material and resin, 1.2 million tons.

The CO_2 compliance cost intensity list has some surprises. Among the top 25, the only ones with significant Indiana production are cement (16.7% compliance cost intensity), primary aluminum production (12%), ferroalloy production (7.7% – lumped in with iron and steel in the emissions totals), industrial gas manufacturing (7.2%), paperboard mills (3.1%), other inorganic chemical manufacturing (3%), wet corn milling (3%), iron and steel mills (2.9%), flat glass manufacturing (2.7%), and glass container manufacturing (2.6%).

In those industries where coal-generated electricity and coal compete for process energy with natural gas, CO_2 control legislation will tilt the playing field towards natural gas and its lower CO_2 emissions per million Btu. Major processes where shifts can be expected to take place are process heating, heat treating, drying, curing, melting, and coating and finishing.

Returning to a more general discussion of both the national and state industry vulnerability data shown in Figures 1 and 2, clearly there is a need for a more integrated approach to the allocation of CO_2 emissions allowances among trade vulnerable manufacturers than is evidenced so far in the discussions of proposed legislation. The two suggested volume corrected measures need to be combined to reflect a single measure – the forecast drop in domestic production and profits due to decreasing export volume and increasing import competition due to the increased costs of CO_2 compliance.

A simple method of doing this is to multiply the CO_2 compliance cost increase percentage by the trade vulnerability percentage, arguing that the industry is entitled at most that portion of the cost increase which arises from trade vulnerability. The resultant percentage contours would form rectangular hyperbolas in the first quadrant of Figure 2.

C. DIRECT AND INDIRECT CO_2 EMISSIONS COSTS FOR THE TOP 10 INDIANA EMITTING INDUSTRIES, IN ORDER OF THE COST OF CO_2 EMISSIONS

The particular situations each of the top 10 major Indiana emitting industries face will be discussed in turn, distinguishing between direct on-site process and combustion emissions, and emissions from the generation of purchased electricity. Estimates of the dollar value of set-asides necessary to maintain a level playing field for export markets for each of the Indiana industries will also be made.

The top 10 account for about 60 of the 80 million tons of CO_2 emitted from Indiana industry in 2007. Of the top 10 total, 75% is from direct emissions, and 25% from the generation of electricity purchased by the industrial sector.

All 2007 export data for Indiana industries are taken from estimates made by the US Census Bureau. (16) Import market playing fields are assumed to be leveled by a border tax with no financial involvement of the firms potentially hurt by such imports from countries with no CO_2 laws.

INDIANA IRON AND STEEL

EMISSIONS

Estimate – 2007 cost between $580-840 million, based on CO_2 emissions of 29-42 million tons per year; direct emissions 20-28 million tons, emissions from purchased electricity 9-14 million tons. 3% increase in costs of production, trade vulnerability 33%, integrated direct CO_2 intensity, 2.3 tons/ton raw steel, indirect 0.2 tons CO_2/ton; mini-mill direct CO_2 intensity, 0.35 tons CO_2/ton, indirect 0.86 tons CO_2/ton

With emissions permits valued at $20/ton, this means Indiana's iron and steel industry will see costs increase a forecasted $580-840 million, or 3% of Indiana iron and steel's value of shipments. While the bulk of these costs can be expected to be passed on to consumers, the estimated 2007 11% US export value of shipments cannot; firms should be compensated for this to be able to fairly compete with those countries without CO_2 emission legislation. So – assuming Indiana steel export percentages are the same as national percentages, the Indiana iron and steel industry should receive between $64 and 84 million to level the export playing field for the 2007 reference year of this study.

The proper compensation calculation is complicated by the fact that steel's major competitor, aluminum, will see an even bigger increase in its prices as a result of any CO_2 legislation. Primary aluminum production in the state could see an estimated 12% increase in their cost of production, while the iron and steel industry would see about a 3% increase. This is because primary aluminum production is one of the most electricity intensive industries, requiring 14,000 to 15,000 kWh/ton of product, and the price of primary aluminum in competitive markets would be set by aluminum smelted by fossil-fueled electricity, not hydro-generated electricity. The positive impact of such a development on steel profits could offset some of the negative impact of losses due to foreign encroachment on domestic steel markets.

Indiana policymakers should be supportive of industry efforts to include protection for the iron and steel industry in any CO_2 legislation.

Regarding the tonnage and cost estimates themselves, because of confidentiality requirements, only the total of iron and steel and ferroalloy production is reported for Indiana by the Census Bureau. Thus, the emissions of one ferroalloy plant are included in the tonnage estimate.

The data for iron and steel in the interagency report adjusted for Indiana's higher CO_2 emissions per kWh of purchased electricity indicate that an estimated two-thirds of the total – 19 million tons of CO_2 – are emitted from the processes themselves, and one-third – 10 million tons – from the emissions associated with purchased electricity.

It should be emphasized that these figures are for all steel produced in Indiana – from both the integrated mills in the northwestern part of the state, and the mini-mills located in various places around the state. As such, the totals represent a true "adding apples and oranges" cautionary tale, since the two types of mills have vastly differing direct energy and electricity requirements.

An alternative approach is to try to estimate CO_2 emissions separately for the two types of Indiana mills, since the CO_2 production intensities for the two types of mills vary by almost an order of magnitude. If the process converts iron ore into steel – so-called primary or integrated steel production – the direct (not including emissions from purchased electricity) CO_2 intensities can range from 2 to 2.4 tons CO_2/ton of steel, depending on the use of powdered coal injection (PCI) in the blast furnace, the mix of sinter and pellets, and the use of blast furnace gas. (The reference case considered is in a 1999 paper by The Research Institute for French steel. (17)) That report suggests a value of 2.32 tons CO_2/ton of steel produced, assuming 200 kg PCI/ton of steel, a common practice in Indiana integrated mills but at lower rates. The same paper suggests a reference value of 0.35 tons CO_2/ton of steel for the secondary process, assuming 125 kg of pig iron is used per ton of product in addition to the scrap charge. All estimates are through the hot rolling process.

To these totals must be added the emissions from purchased electricity. For the integrated mills, a DOE report (18) estimates that about 200 kWh per ton of steel will be used through the hot rolling mill. The same document estimates that 840 kWh per ton would be used if electric arc furnaces produced the steel – over half – 440 kWh/ton in the electric arc process itself. Using the Indiana tons of CO_2 per MWh figure of 1.025 tons per MWh, 0.2 tons and 0.86 tons of CO_2 need to be added to the direct totals mentioned above, increasing the direct and indirect CO_2 emissions per ton of steel to 2.52 tons per ton of steel produced by the integrated process (thru hot rolling), and 1.21 tons of CO_2 per ton of steel produced by the electric arc process.

In order to separately estimate Indiana CO_2 emissions for integrated and mini-mills, Indiana production of each for 2007 needs to be estimated. This is not an easy task. A reasonable way is to take Indiana shipments of coking coal – 6.14 million tons in 2006 (19), and convert it to tons of coke, using a conversion ratio of 1.38 tons coal/ton coke (20), and then using a ratio of 0.4 tons coke/ton of steel produced by integrated mills, which assumes about 275 lb pc/thm, giving an estimate of 11 million tons of steel from Indiana integrated mills. Since Indiana total steel production was estimated to be 24% of total US production (21) or 23 million tons, this means 12 million tons of steel was produced in Indiana mini-mills in the reference year.

Using the 47/52 production split and the CO_2 intensity numbers referenced above, an estimated 25 million and 4.2 million tons of CO_2 were emitted directly by the integrated and mini mills, an additional 4.2 million and 10.5 million tons of CO_2 indirectly from the generation of electricity, for a total of 29 million tons and 14 million tons of CO_2 from integrated and mini-mills, respectively.

This disaggregated approach yields a substantially higher estimate of CO_2 emissions from Indiana iron and steel mills – a total of 42 million tons of CO_2 emitted, compared to the 29 million ton figure obtained by sharing down national emissions in the interagency reports. By any measure, iron and steel appears to be second only to electric utility industry emissions of 111 million tons in Indiana in 2002 (22). This follows from the fact that the integrated portion of Indiana's steel industry consumes approximately 9 million tons of coal per year (6.5 million for coking), again second only to the Indiana electric utility industry's 60 million tons per year. (23)

ISSUES

Integrated steel production (conversion of iron ore to iron in blast furnaces, and iron to steel in steel furnaces) results in three carbon containing gases; CO and CO_2 from recovery (primarily CO) and non recovery (primarily CO_2) coke ovens, from blast furnaces (lower heat value gas), and from steel furnaces (between coke oven and blast furnace gas heat value), all arising from the carbon contained in the coal used to produce coke which is used in the blast furnace to reduce the iron ore, and from direct injection of coal into the blast furnace. As was mentioned, direct CO_2 intensity (not including the contribution of purchased electricity) for the integrated segment, measured in tons CO_2 per ton of steel, is around 2.3 tons per ton, depending mostly on the blast furnace input mix of sinter, pellets, coke, and coal injection, and around 0.4 tons/ton for scrap based processes. (24)

Various methods of reducing these emissions have been proposed for the integrated portion of the iron and steel industry, such as using the blast furnace gases now flared to reduce energy consumption and thus CO_2 emissions, and suspending CO_2 in transformed slags from the electric arc and blast furnace. (25)

Options for the mini-mill segment of the industry concentrate on reductions in the required kWh/ton, including scrap preheating with waste gas (60 kWh/ton reduction potential), oxy-fuel injection (40kWh/ton), and high power transformers (17 kWh/ton). (26)

INDIANA REFINERIES

EMISSIONS

Estimate – 2007 cost between $86 and 100 million, based on CO_2 emissions of 4.34-4.95 million tons per year; direct emissions, 3.78-4.3 million tons, emissions from purchased electricity, 0.56-0.64 million tons; 1% increase in the cost of production, trade vulnerability 20%

While the bulk of these costs can be expected to be passed on to consumers, the estimated 2007 5% US export value of shipments cannot; firms should be compensated for this to be able to fairly compete with those countries without CO_2 emission legislation. So – assuming Indiana refinery export percentages are the same as national percentages, the Indiana iron and steel industry should receive between $4.3 and 5 million to level the export playing field; for the 2007 reference year of this study, US refinery production capacity has hovered around 17 million barrels per day for the last few years. Indiana's two largest refineries – BP Whiting (405, 000 barrels) and Countrywide (28,000 barrels) – represent about 2.5% of US capacity. (27) Applying this percentage to the US direct CO_2 estimates for the industry in the Schipper paper (255 million tons), an estimated 6.4 million tons of CO_2 were emitted by Indiana's refineries in 2002.

An estimate for 2007 could be obtained by using the 11.44 tons of CO_2/bbl/day estimate for PAD District II (which includes Indiana) refineries contained in a 2007 publication. (28) Use of this estimate yields 433,000*11.44, or 4.95 million tons of CO_2 emitted by refineries in Indiana.

A third method, and the one used in preparing this paper's estimates, is to assume the state's share of national pollution is proportional to the state's share of national value of shipments. The problem is that because of confidentiality requirements, state value of shipment totals are available only at the 4-digit level – NAICS 3241, petroleum and coal products. Using this method, Indiana's share of NACIS 3241 value of shipments is 1.7%, and this percent applied to the 248 million ton total CO_2 emissions for NACIS 3241 results in an estimate of 4.34 million tons of CO_2 emitted by Indiana refineries and other petroleum and coal products.

No matter which of these estimates are used, Indiana refineries are major emitters, exceeded only by electric generation and iron and steel, and equal to that for aluminum.

ISSUES

Energy use in the industry is primarily still gas, a byproduct of refining operations, and natural gas. Factors that will tend to increase CO_2 emissions are the switch to feedstocks which require more energy such as heavy/sour crudes and unconventional sources of oil such as tar sands, oil shales, and coal. All such switches will increase industry CO_2 emissions (29).Other CO_2 increasing developments include government encouraged switches to producing more gas that can be blended with Biofuels, and more low sulfur diesel fuels.

Opportunities for CO_2 emission reductions include more Combined Heat and Power units (CHP), retrofitting existing equipment with heat exchangers and the like, and improving the process efficiency of the energy intensive processes such as distillation, hydro treating, alkylation, and reforming. (30)

PRIMARY ALUMINUM PRODUCTION

EMISSIONS

Estimate – 2007 cost $72 million, based on CO_2 emissions of 3.6 million tons per year; direct emissions, 0.36 million tons, emissions from electricity generation, 3.24 million tons; 12% increase in the cost of production, trade vulnerability 64%

Indiana primary aluminum producers are forecast to see a $72 million increase in their cost of production associated with the passage of the CO_2 control legislation, representing a 12% increase in their cost of production. While a good portion of this can be passed on to the consumer, the cost increases for exports cannot. Since 16% of shipments in 2007 were exports, and assuming Indiana export share is the same as the national share, the Indiana aluminum industry should receive $12 million in compensation to level the playing field for exports.

Regarding the CO_2 estimates themselves, according to a recent Canadian study (31), center-worked prebaked anode processes generate 3080 pounds of CO_2 per ton of aluminum, or 1.54 tons/ton, mostly from anode consumption. To this must be added the emissions from the electricity used in the process, which can range from 12-16,000 kWh/ton. An average of 14,500 kWh/ton is frequently used, which, if generated by sub-critical coal units similar to Alcoa's Warrick units, would emit about 1 ton of CO_2 per MWh. Thus, total emissions are estimated at 16 tons of CO_2 per ton of primary aluminum produced in Indiana. The capacity of Alcoa's Warrick potlines is estimated at 309 thousand metric tons (32) or 340 thousand short tons. Assuming the operations are running at 2/3 of their capacity, this means in 2007, 3.6 million tons of CO_2 were emitted in Indiana in association with primary aluminum production. This estimate is used in this study.

A later study (33) provides a timely and detailed summary of the CO_2 emissions for both the primary (reduction of alumina to aluminum) and secondary (aluminum can and scrap melting and refining) segments of the European industry.

According to the study, primary aluminum production, including anode production, primary smelting (not including the CO_2 generated by the used to generate electricity), and primary casting, generates from 2 to 3.7 tons of CO_2/ton of primary aluminum, and electricity consumption for the process ranges from 13 to 16,000 kWh/ton, higher than the Canadian estimate just presented.

The secondary process which remelts and refines aluminum from aluminum scrap, including remelting and refining, emits from 0.34 to 0.60 tons of CO_2/ton of secondary aluminum, according to the study.

In the US in 2007, production of secondary aluminum dropped to 3.6 million metric tons, split 60 post industrial, and 40% post consumer scrap. (34) The publication "Light Metal Age" lists about one million tons a year of Indiana secondary melting capacity in 2009. Again assuming the secondary operations in 2007 were running at 2/3 of capacity, this means the melting of secondary aluminum in Indiana emitted an estimated 225 to 400 thousand tons of CO_2 during 2007.

ISSUES

Opportunities lie in the closure of the less efficient Soderberg process potlines, decreasing anode use, and better controls of the potlines and scrap melting processes.

WET CORN MILLING

EMISSIONS

Estimate – 2007 cost $63 million, based on CO_2 emissions of 3.17 million tons/year; direct emissions 2.17 million tons, emissions from purchased electricity, 1 million tons; 3% increase in the cost of production, trade vulnerability 19%

Using the $20/ton estimate of the cost of permits, this means the Indiana industry would have seen costs increase by $63 million in 2007, a 3% increase in the value of shipments. Exports are estimated to be 15% of 2007 value of shipments. Thus, Indiana's wet corn milling industry in 2007 would have received $9.5 million to level the playing field for Indiana wet corn exports.

Because of confidentiality requirements, value of shipments data for NAICS 311221, Wet Corn Mills, was not reported in the 2007 Census. What was reported was the total payroll of $89.899 million.

Nationally, the ratio of value of shipments to payroll was 23 to 1 for wet corn mills, which implies Indiana value of shipments was $2090.515 million, if the 23 to 1 ratio held for Indiana plants. Using the Indiana CO_2 tons per thousand dollars of value of shipments estimate of 1.52 based on the interagency report, the $2090 million estimate translates into an estimate of 3.17 million tons of CO_2 emitted by the industry in 2007.

Ethanol plants are just wet corn milling plants designed for the special purpose of producing ethanol, rather than the broader range of products typically produced by wet corn mills, which include, in addition to ethanol, corn sweeteners, starches, and corn oils. Thus, although the data report wet corn mills (Indiana CO_2 emissions estimate 3.17 million tons in 2007) and ethanol plants (0.47 million tons) separately, they can be easily combined to get a better picture of the industry processes.

WET CORN MILLS

Since energy use depends on the mix of products produced, energy use by wet corn mills is usually reported as Btus per bushel of corn entering the plant. A recent EPA study estimated that an average of 115,777 Btus per bushel of corn were required for a typical 100,000 bushel a year plant in the United States. (35)

ETHANOL PLANTS

The United States Department of Agriculture estimated that in 2001, an average of 30,500 Btus per gallon of product in the form of gas were used in the production of ethanol. (36) Since the combustion of natural gas emits 117 pounds of CO_2 per million Btu, this means 0.030500*117=3.57 pounds of CO_2 are emitted per gallon of ethanol produced. The latest Indiana ethanol operating productive capacity was estimated to be 706 million gallons, and the nameplate capacity of current plants and those under construction was slightly over 1100 million gallons by the Renewable Fuels Association. (37) Using these numbers, 1.26 to 2 million tons of CO_2 could be emitted from the plants in Indiana, if all were operating at their productive capacity. Current capacity utilization is near 66% in the industry (38), so these figures should be reduced to between 0.8 to 1.3 million tons per year. This is to be compared with the 0.47 million ton estimate obtained by converting Indiana value of shipments in 2007 to tons of CO_2, using the CO_2 intensities based on the interagency report, adjusted for the higher CO_2 emissions from Indiana coal-fired generators.

ISSUES

Since ethanol production will substitute for gas produced from more conventional fuels, proper CO_2 emissions analysis of the substitution of ethanol for conventional fuels must include the decrease in CO_2 emissions from conventional refineries, as well as the increase in ethanol production related CO_2 emissions.

INDIANA CEMENT

Estimate – 2007 cost $60 million, based on CO_2 emissions of 3.02 million tons/year; direct emissions 2.6 million tons, emissions from purchased electricity 0.4 million tons; 17% increase in the cost of production, trade vulnerability 19%

Using the $20/ton estimate of the cost of permits, this means the Indiana industry would have seen costs increase by $60 million in 2007, a 17% increase in the value of shipments. Cement exports in 2007 were estimated to be about 1% of shipments in 2007. Thus, Indiana's cement industry in 2007 would have received only $600,000 to level the playing field for Indiana cement exports.

EMISSIONS

The estimate of 3.02 million tons of CO_2 was arrived at by multiplying Indiana cement value of shipments in 2007 of $360.9 million by the adjusted interagency report intensity of 8.36 tons of CO_2 per thousand dollars of value of shipments intensity factor. For comparison purposes, as reported in a study done a few years ago, national combustion and process CO_2 emissions were estimated to be 76 million tons, 3.1 million tons from Indiana (4% of the total), making it rank as the 9th largest cement emitter among the states. Indiana cement CO_2 intensity was calculated to be 1.07 tons of CO_2/ton of cement, close to the national average of 0.97 tons/ton (for comparison purposes, Texas, the number one CO_2 emitter, emitted over 11 million tons in 2001). (39)

The 76 million ton CO_2 US total is much larger than Schipper's 39 million ton estimate for 2002 shown in his table 1, as is the state estimate of 1.6 million tons using a 4% share of the 39 million US total. No explanation can be found for the almost 100% difference in the estimates; the Schipper paper includes CO_2 emissions from purchased electricity, so that can't be the explanation. Combustion generated CO_2 is associated with the use of coal as a heat source for the production of clinker, the major material for the production of cement. CO_2 emissions from the cement-making process itself are approximately equal to the emissions arising from combustion.

ISSUES

Variations in CO_2 cement plant CO_2 emissions intensities are governed primarily by the mix of wet and dry processes, and the presence of clinker or just grinding activities. Facilities with wet and clinker processes have higher CO_2/ton emissions than those with dry processes, and those with only grinding.

CO_2 reducing technologies proposed for the industry include blended cements (fly ash, slag); carbon neutral (biomass) fuels rather than coal, increased process energy efficiency, and hybrid cement plants that utilize the waste heat from clinker production. (40)

Since US cement production competes in global markets (imports represent 12% of domestic use), unilateral adoption of CO_2 reducing rules will hurt domestic producers competing with non-CO_2 limiting countries. Thus, industry representatives have successfully lobbied to have cement included in the industries which should receive some protection to offset export and import losses caused by the legislation.

Given Indiana's substantial presence in the industry, Indiana policymakers should support their efforts to obtain allowances as compensation.

INDUSTRIAL GASES

Estimate – 2007 cost $35 million, based on CO_2 emissions of 1.75 million tons; direct emissions 0.79 million tons, emissions from purchased electricity 0.96 million tons; 7% increase in the cost of production, trade vulnerability 5%

Industrial gas exports were estimated at 3% of the value of shipments in 2007, so the Indiana industry should receive $1 million to level the playing field for exports in 2007.

The 1.75 million ton estimate for Indiana is arrived at by multiplying the $488 million 2007 Census Bureau estimate of value of shipments from Indiana by the interagency report estimate of CO_2 intensity for NAICS 325120 of 3.6 tons of CO_2 per thousand dollars of value added.

Indiana is the third largest producer of industrial gases, behind only Texas and California. 2002 value of shipments from Indiana include nitrogen, $87 million; argon/hydrogen, 78 million; and CO_2 (!) 19 million. Almost 60% of the CO_2 emissions are caused by the use of purchased electricity associated with liquefying air by compression and separating out nitrogen, argon, and oxygen for steel production and other uses, and the separation of hydrogen from water by electrolysis.

IRON FOUNDRIES

Estimate – 2007 cost $25 million dollars, based on CO2 emissions of 1.32 million tons; direct emissions 0.45 million tons, emissions from purchased electricity.87 million tons; 2% increase in cost, 15% trade vulnerability

Using the $20/ton estimate of the cost of permits, this means the Indiana industry would have seen costs increase by $26 million in 2007, a 2% increase in the value of shipments. Iron foundry exports in 2007 were estimated to be 8% of the value of shipments. Thus, Indiana's iron foundry industry in 2007 would have received $2 million to level the playing field for Indiana iron foundry exports.

The 1.32 million ton estimate for Indiana is arrived at by Indiana by multiplying the $1,315 million Census Bureau estimate of 2007 value of shipments from Indiana by the interagency report estimate of CO_2 intensity for NACIS 325120 of 1 ton of CO_2 per thousand dollars of value of shipments. Iron foundry value of shipments in 2002 was $1.179 billion, fifth in US value of shipments behind Ohio, Michigan, Alabama, and Wisconsin. Production was divided between ductile iron (27% of value of shipments) and gray iron (73% of shipments). Indiana's ductile iron foundries produced 11% of the nation's ductile foundry products, and 18% of the gray iron output.

55% of the energy use in the processes was in the melt step, while the balance was in the mold and core making processes. Melting is carried out in cupolas, electric arcs, or induction furnaces. Materials include scrap iron and some pig iron, the mix depending on the type of iron – gray, or ductile. Fuel use was 59% gas, 27% electricity, and the balance coke of coal breeze for the melting process.

CO_2 reduction is keyed to reductions in energy use and fuel switching. Energy reduction options included ladle preheating, scrap preheating, foundry sand reclamation, and decreased heat leakage from the melting furnaces. CO_2 reducing fuel switching measures include gas and oxygen injection into the cupola to replace coal, oxygen injection into electric arcs. Off peak melting saves costs, but increases energy use because of the cost of maintaining the melt temperature overnight. (41)

ALL OTHER PLASTICS MANUFACTURING

Estimate – 2007 cost $25 million, based on emissions of 1.27 million tons; direct emissions 0.17 million tons, emissions from purchased electricity 1.1 million tons; 1.08% increase in cost, 0.61% trade vulnerability, 0.66% product

Exports were estimated to be 12% of the value of shipments in 2007. Thus, the industry should receive $3 million to level the playing field for their exports.

The 1.27 million ton estimate for Indiana is arrived at by Indiana by multiplying the $4219 million Census Bureau estimate of 2007 value of shipments from Indiana by the interagency report estimate of CO_2 intensity for NACIS 325120 of 0.305 tons of CO_2 per thousand dollars of value of shipments. Indiana shipments represent about 5% of national production; shipments are 95% thermoplastic (can be remelted) materials, and 5% thermosetting (can't) plastics. Almost 90% of the CO_2 comes from the electricity used in the process; combustion makes up the other 10%.

Major users of Indiana plastics are building and construction, 25%; plastics packaging, 10%; reinforced and fiberglass, 9%; and plastics for the transportation industry, 7%.

Major production steps for thermoplastic products are resin drying, injection (13%), extrusion (55%), blow (9%) or other (13%) molding (energy use around 1900 Btu/lb), cooling, trim/tumble, and packaging. Average energy use is around 6000 Btu/lb. (42) This is one of the few industries where electricity provides more process heat than gas – electricity accounts for almost 60% of total energy use. Platen heating, resin drying, sheet product curing, coating, and sealing are all processes where electricity competes with gas for market share; CO_2 compliance costs will tilt the playing field towards gas.

MOTOR VEHICLE TRANSMISSION AND POWER TRAIN PARTS MANUFACTURING

Estimate – 2007 cost $24 million dollars, based on CO2 emissions of 1.21 million tons; direct emissions 0.35 million tons, emissions from purchased electricity 0.86 million tons; 0.37% increase in cost, trade vulnerability 0.4%

Exports were estimated to be 17%. Thus, the industry should receive $4 million to level the playing field for their exports.

70% of the CO_2 emitted comes from the generation of electricity purchased by the industry; the balance is direct combustion.

Indiana is second only to Michigan in industry value of shipments; Indiana shipments are 20% of US shipments. (43) The industry is primarily an assembly operation, with almost two-thirds of the value of shipments accounted for by purchases of iron and steel and aluminum castings, shapes and forms, ball bearings, and electronic parts. (44)

PLASTICS MATERIAL AND RESIN MANUFACTURING

Estimate – 2007 cost $24 million, based on CO2 emissions of 1.2 million tons; direct emissions 0.53 million tons, emissions from purchased electricity 0.47 million tons; 1.08% increase in cost, trade vulnerability 1%

Exports were estimated to be 30% of the value of shipments in 2007. Thus, the industry should receive $7.2 million to level the playing field for their exports.

Almost 60% of estimated CO_2 emissions come from direct combustion; the remaining 40% come from the generation of electricity purchased by the industry in Indiana. The industry is dominated by firms in Texas and Louisiana, not surprising given the raw materials for the processes are mostly refinery products such as ethylene, propylene other cyclic crudes. As is the case in other plastics product manufacturing, there is intensive competition between gas and electricity for process heat in this industry. 80% of national production is thermoplastic resins, 20% thermosetting resins. Processes manufacture, compound, and extrude resins and sheet products. Indiana production appears to be concentrated in the production of polyvinyl chloride (PVC) for pipes and bottles.

SUMMARY OF DIRECT AND INDIRECT CO_2 EMISSIONS ESTIMATE FOR TOP 10 INDUSTRIES

Table 2 shows direct, indirect, and CO_2 emissions for the top 10 Indiana emitters, total costs of a $20/ton emissions charge, along with estimates of the dollar magnitude of protection each needs from foreign competition whose production costs are not hampered by CO_2 legislation.

Table 2. Impact on Top 10 Emitters of CO_2 Legislation @ $20/ton price

NAICS	Name	CO_2 Emissions (x 10^6 tons)			Total Cost Increase @ $20/ton (e6$)	Cost increase as % Value of Shipments	Exports as % of Value of Shipments	Export Trade Protection Needed (x e6$)
		Direct	Indirect	Total				
351111	Iron & Steel	20-26	9-12	29-38	580-760	3-4%	11%	64-84
324110	Petroleum Refiners	3.78-4.3	0.56-0.64	4.3-4.95	86-100	1%	5%	4.3-5
331312	Primary Aluminum	0.36	3.24	3.60	72	12%	16%	12
311221	Wet Corn Milling	2.17	1	3.17	63	3%	15%	9.5
327310	Cement	2.6	0.4	3.02	60	17%	1%	0.60
325120	Industrial Gases	0.79	0.96	1.75	35	7%	3%	1.0
331511	Iron Foundries	0.45	0.87	1.32	25	2%	8%	2.0
326199	Other Plastics Manufacture	0.17	1.1	1.27	25	1%	12%	3.0
336350	Motor Vehicle Transmissions	0.35	0.86	1.21	24	0.4%	17%	4.0
325211	Plastic Material & Resin	0.53	0.47	1.20	24	1%	30%	7.2
	TOTALS	31.2 to 37.7 (64%)	18.46 to 21.54 (36%)	49.8 to 59.4 (75% of state total)	994 to 1188	-	-	107 to 110

OUT-MIGRATION TO OTHER STATES WITH SMALLER INCREASES IN ELECTRICITY COSTS CAUSED BY CO_2 LEGISLATION

A problem peculiar to states such as Indiana and Kentucky is the possibility that companies that use large amounts of currently cheap electricity generated from coal will move to jurisdictions which will see smaller increases in electricity prices as a result of CO_2 limiting legislation. Industries likely to consider such moves are those with (a) high CO_2 cost intensity, measured by the likely percent increase in their costs associated with CO_2 legislation, and (b) a high share of these costs caused by increases in the costs of purchased electricity. A single measure of the likelihood of industry movement would be the percent increase in costs associated with the increase in purchased electricity alone, measured by the product of measure (a) and (b) above.

Using this single mix as a measure, six industries stand out as possibilities.

One industry stands out as the most susceptible to out-migration of this type by this measure – primary aluminum production. Production costs are expected to increase 11% in Indiana due to increases in the cost of electricity because of the passage of CO_2 legislation, compared to the national average of 7.5%, based on the 46% higher emissions per kWh for Indiana mentioned earlier. Since the Indiana operations are owned by Alcoa, the shift, if it were to occur, would take place by shifts in primary aluminum output from Alcoa's Indiana plants to plants located in regions which generate less electricity from coal. Obvious candidates are the potlines in the Pacific Northwest and elsewhere which use hydropower to generate much of the region's electricity.

Next highest on the list is industrial gas manufacturing – their costs of manufacturing are forecast to increase 3.7% because of the increase in costs of purchased electricity, compared to a national increase of 2.5%, probably not enough of a difference to trigger a stampede across the state border to Illinois, even though a substantial industrial gas manufacturing industry exists in the state.

Iron and steel mills, with their costs forecast to increase by 2.9% because of electricity cost increases, are next in size of impact. But this statistic is misleading, since it is an average cost increase over two types of plants – integrated mills, which use relatively minor amounts of electricity, and mini-mills, who purchase about 650 kWh/ton for scrap preparation, melting (525kWh/ton), continuous casting, and hot rolling processes. (41) Assuming an Indiana average industrial rate of 5.5 cents/kWh (42), a 33% increase in those costs, and an average cost (not price) of $380/ton, this means an average increase in the Indiana cost of production of almost 10% caused by CO_2 legislation, as compared to 6.5% nationwide. Since the Indiana industry is dominated by firms which have plants outside Indiana – Nucor and Steel Dynamics come to mind – shifts would likely take place by shifting output from Indiana plants to plants in states with smaller increases in electricity prices.

Iron foundries are next, with costs estimated to increase by 1.4% because of increases in electricity costs. As is the case in iron and steel mills, this increase is misleading, since this percent increase is a percent averaged over cupola melting foundries which use no electricity for melting, and foundries with melting taking place in electric arc or coreless/channel induction furnaces. For electric arc/coreless induction iron melting facilities, melting energy is less than melting steel, since the melting point of gray iron is 20% less than for steel. Total electricity use/ton in such melting facilities is about 480kWh/ton, including ladle preheat, mold/core making, melting, shakeout/cleaning, and environmental control (41), or about $27/ton at 5.5 cents/kWh. Assuming a 33% increase in these costs in Indiana, compared to a 22% increase nationally due to CO_2 legislation, means Indiana gray iron foundries could save $4/ton transferring their output to plants outside Indiana. However, since the industry is dominated by small privately-owned firms, or captive foundries, it is unlikely that much out-migration will take place in this industry because of higher relative electricity costs in Indiana.

Other industries in the top 25 listed that warrant attention include other inorganic chemicals, glass containers, and paperboard manufacture, but none are of sufficient magnitude to cause concern.

IV. SUMMARY AND CONCLUSIONS

The following conclusions follow from this paper:

6. Partial Grandfathering – the granting of some protection against the negative consequences of retroactive environmental laws on assets – is not vote pandering. It is a continuation of a long tradition of the application of one section of the Fifth Amendment – the government must fairly compensate private parties when such values are taken from them.

7. In most instances, industry can be expected to be able to pass on compliance costs to their customers, and would have no need for Grandfathering, allowing compensating payments to flow to final consumers of electricity and products. Estimates of such payments to Indiana consumers are $4.6 billion, or 2.1% of gross state product.

8. An exception to this principle is the case of trade vulnerable industries which must compete abroad (exports) and domestically (imports) with goods made in countries that have no limits on CO_2 emissions. A solution to the export problem is to exempt the CO_2 associated with the production of exports from the emissions totals of export firms, or simply compensate the export firms for the cost difference. The import problem can be solved by border taxes equivalent to the CO_2 content of domestic goods. To do otherwise invites carbon leakage – moving CO_2 intensive production abroad to pollution havens.

9. If the choice is made to compensate Indiana export firms for their extra costs, the top 10 Indiana emitters would have been entitled to an estimated $107 million in estimated payments, based on the percent of their total emissions associated with their export volume.

10. The out-migration of firms to other states with smaller increases in their electricity costs is a real possibility. Two industries which might shift their production to other states are primary aluminum production and iron and steel mini-mills; both will see substantially large relative cost increases here in Indiana, and both industries are dominated by firms with plants in other states as well as in Indiana.

V. ENDNOTES

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