WRI ANALYTICAL APPROACH DOCUMENT

This document references the report, "How U.S. Federal Climate Policy Could Affect Chemicals' Credit Risk," and describes the World Resources Institute's (WRI) analytical approach in preparing its contributions to the report. The original report, authored by WRI and Standard & Poor's Rating Services, is available at http://www.wri.org/publication/how-us-federal-climate-policy-could-affect-chemicals-credit-risk. S&P's approach and contributions are not referenced in this document.

Data Sources

A. Data Collection

Data used in WRI's analysis was primarily compiled from the following sources:

- All policy-related macroeconomic projections: Energy Information Administration Analysis of the American Power Act
- Data on size and value of shipments of subsectors: 2006 Annual Survey of Manufacturers, and the 2007 U.S. Economic Census
- Data on Energy, including Fuel, Feedstock and Electricity Purchases: 2006 Manufacturing Energy Consumption Survey, Energy Information Administration
- Data on Trade Intensity, Energy Intensity, and Greenhouse Gas Emissions and Intensity: Datafile for "The Effects of H.R. 2454 on International Competitiveness and Emission Leakage in Energy-Intensive Trade-Exposed Industries: An Interagency Report Responding to a Request from Senators Bayh, Specter, Stabenow, McCaskill, and Brown," December 2, 2009. (Interagency Report)
- Subsector characteristics: IBIS World Research Database and Census Bureau, Interviews of Chemical Experts and Financial Analysts covering the industry.
- Data for WRI's company-level analysis: Company sustainability reports, financial statements, Bloomberg, and the data sources listed above.

B. Identification of Policy Impacts

To identify the key sources of policy impacts on the chemicals sector WRI reviewed and/or relied on the following sources:

- The Energy Information Administration's (EIA) data tables on and analysis of the American Power Act and the American Clean Energy and Security Act.
- "The Effects of H.R. 2454 on International Competitiveness and Emission Leakage in Energy-Intensive Trade-Exposed Industries: An Interagency Report Responding to a Request from Senators Bayh, Specter, Stabenow, McCaskill, and Brown," December 2, 2009.
- Bill text of the American Power Act and American Clean Energy and Security Act
- Standard and Poor's publication of Key Credit Drivers for the Commodity and Specialty Chemicals Companies

Approach and Key Assumptions

WRI's analytical results are intended to be illustrative and depend on a number of key assumptions related to policy and data. Below we outline WRI's analytical approach and key assumptions for each section of this

Commentary. As noted in the original report, only policy impacts on energy and compliance costs are considered. Other impacts may be relevant but are out of the scope of this analysis. Generally, for the 13 subsectors analyzed, WRI believes that energy and compliance costs are among the most material considerations for analysts looking at US climate policy.

Section 1: US Climate Policy Scenarios

WRI's analysis of what policy provisions would be relevant for chemicals sectors were based on

- *Cap and Trade Scenarios:* Our review of the American Power Act, EIA's analysis of the American Power Act, Standard and Poor's Key Credit Factors for Commodity Chemicals, and Standard and Poor's Key Credit Factors for Specialty Chemicals.
- *EPA Scenario:* WRI's July 2010 publication , "Reducing Greenhouse Gas Emissions in the United States Using Existing Federal Authorities and State Action" available at http://www.wri.org/publication/reducing-ghg-emissions-using-existing-federal-authorities-and-state-action

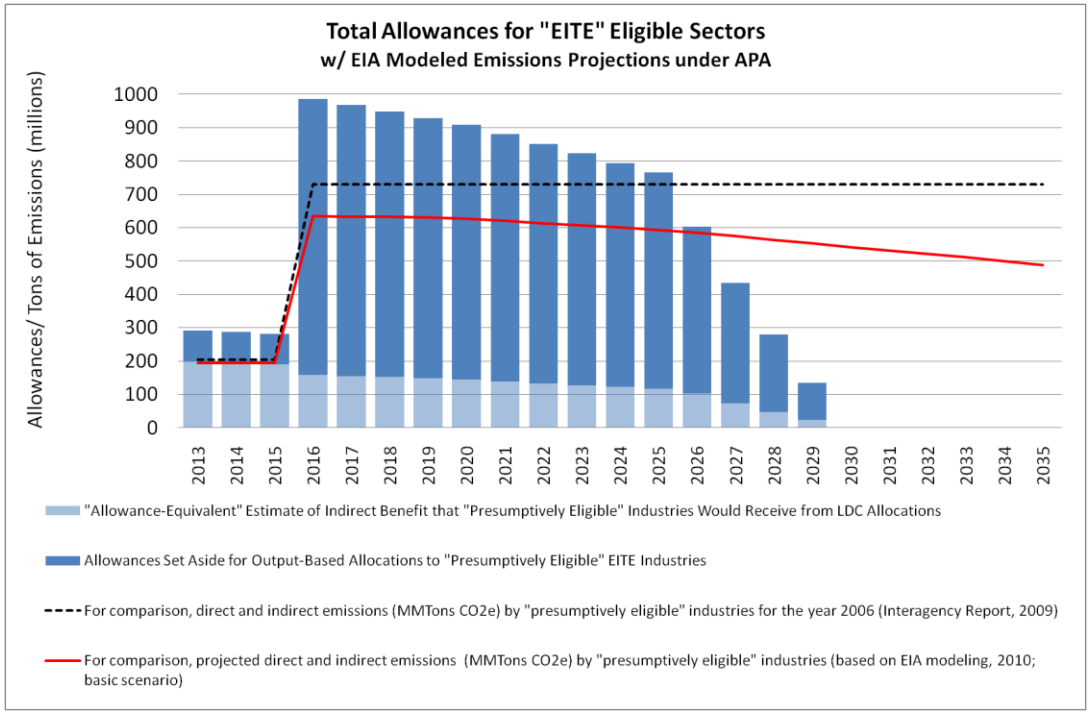
A. Cap and Trade Assumptions

These EIA-based policy scenarios represent varying ease (from a cost, technology-adoption, legal and administrative perspective) of achieving emissions reductions set forth in the American Power Act. Policy scenarios in this section are derived directly from policy scenarios—"Basic Case," "No International Offsets," and "No International Offsets/Limited Alternatives"—modeled by the EIA in their Analysis of the American Power Act. Our "Low Impact" scenario mirrors the "Basic Case"; the "Medium Impact" scenario mirrors the "No International Offsets" scenario; and the "High Impact" scenario mirrors the "No International Offsets/Limited Alternatives" scenario. Complete information on each of these scenarios and underlying assumptions are available here: http://www.eia.doe.gov/oiaf/servicerpt/kgl/index.html

For our cap and trade legislative scenario we assumed that:

- ***Subsectors deemed energy-intensive and trade-exposed (EITE) within the chemicals industry will receive as many direct free allowances as required in 2016.*** We based this assumption on internal WRI analysis of the American Power Act, using the methodology employed by the Interagency Report in their analysis of the American Clean Energy and Security Act. The availability of free allowances in 2016 and even several years beyond is premised on the ability to carry over excess allowances—i.e. allowances beyond what is required for compliance—to future years. See "Chart 1: Total Allowances for "EITE" Eligible Sectors" below:

Chart 1: Total Allowances for Energy-Intensive, Trade-Exposed *Eligible* Subsectors



Notes:

Adapted from figure 15 in the Interagency Report (2009, available at: http://www.epa.gov/climatechange/economics/economicanalyses.html#interagency), the above figure compares direct and indirect emissions from "presumptively eligible" industries in 2006 (dashed line) and projected emissions from energy-intensive sectors (red line, based on EIA modeling of the American Power Act, "basic scenario") with the number of allowances set aside by the American Power Act (APA) for allocation to energy-intensive, trade exposed (EITEs) industrial sectors eligible to receive allowances for direct and indirect compliance costs.

To derive projected emissions from all presumptively eligible sectors based on EIA modeling, some basic assumptions were necessary. Since the EIA does not model all manufacturing sectors individually, projected "energy-related carbon dioxide emissions" from the following manufacturing sectors were used as a proxy index for direct process and combustion-related emissions from the 46 EITE sectors considered presumptively eligible by the Interagency Report: Paper Products, Bulk Chemicals, Glass, Cement Manufacturing, Iron and Steel, Aluminum. The same EIA modeling output is also used to estimate indirect emissions associated with industrial energy use, assuming a uniform national carbon intensity of electricity production. It is also assumed that the proportion of electricity used by EITE industries verses other industrial sources is unchanged over time (based on 2006 data; Interagency Report, 2009).

Taking into account the allowance value from which EITEs would benefit per allowance allocations to electricity local distribution companies and a provision of the APA that allows unallocated allowances to be "carried-over" and allocated to eligible EITE industrial sectors during subsequent years, it is estimated that the first year in which there would be an insufficient number of allowances to compensate eligible EITE sectors for all direct and indirect costs would be 2033.

- ***No company requires free indirect allowances***. Under the American Power Act any entity (regardless of whether they are regulated) can apply for *indirect* output based rebates. The formula to calculate the number of *indirect* output based allowance an entity can receive is calculated based on three factors: (1) output, (2) subsector electricity use (kWh) per subsector output, and (3) the emissions per KwH of the utility providing electricity to the entity. Additionally, the number of rebates is adjusted downward to reflect the pass- through of free allowance value (in the form of lower electricity prices) from a utility to an entity. WRI's analysis found that in total, the value of the allowance pass-through (at a given carbon price) from utilities (proportionate to the size of the chemicals industry) would more than cover the value of indirect emissions (at a given carbon price) of the focus subsectors. Thus, we assumed the focus subsectors as a whole would not receive any *indirect* output based rebates. For simplicity we assume that the same conclusion applies at the company/facility level, even though this could in fact vary from company to company.

- ***GHG permit costs are not embedded in natural gas feedstock purchased for the chemicals sectors.*** We assume that natural gas is purchased from the wellhead rather than natural gas LDCs. Since the point of regulation for the American Power Act is at the natural gas LDC rather than the wellhead, the price of carbon does not directly factor into wellhead prices (though the price can still indirectly be impacted by supply/demand dynamics). Even if a chemicals company were to purchase natural gas from an LDC that was eventually used as feedstock, it could apply for free *compensatory allowances*—i.e., free permits used to offset the carbon cost already embedded in the price of natural gas purchased from the LDC. In reality, there could be a mismatch in the number of compensatory allowances received and what is actually required to fully cover the embedded carbon cost. But in our analysis we assume that, in general, any natural gas purchases do not include a carbon cost.

- ***All other impacts fall in line with EIA projections.*** Our policy analysis relied on inputs from EIA's analysis of the American Power Act; key assumptions are provided below in our discussion of Section 3 methodology.

B. EPA Regulatory Scenario Assumptions

Please refer to explanation provided in the Section 2 description below.

Section 2: Climate Policy Impacts on Chemicals Subsectors

A. Cap-and-Trade Analysis

WRI's cap-and-trade analysis was informed by EIA's projected impacts of climate policy on carbon costs, energy costs and GDP growth. Our analysis of risks by subsector did not factor in emissions intensity changes since data was not available to differentiate impacts at the subsector level. This assumption may conflict with some of the assumptions in EIA's modeling.

- The data used to assess the sensitivity of each subsector to changes in energy prices was from the 2006 Annual Survey of Manufacturers, the 2007 US Economic Census and the 2006 Manufacturing Energy Consumption Survey. These data are the most recently available. There are mismatches in the year for various data points, by nature of the survey method (conducted over several years in some cases) and because we had to pull data from different sources. However, most data is from 2006 or 2007.

- To calculate the credit impact on each subsector from compliance related costs we:
    1) Assessed whether a particular subsector was eligible for free allowances. The datafile associated with the Interagency Report on International Competitiveness provided data on which subsectors were likely to be deemed as eligible per policy provisions set forth in the American Clean Energy and Security Act which were also the same requirements in the American Power Act. These bills propose the following requirement to determine eligibility: Trade intensity greater than 25% AND energy intensity greater than 5% or greenhouse gas intensity (calculated at $20/ton of CO2 equivalent emissions) of greater than 1%.
    2) For those subsectors that were ineligible for rebates we calculated the maximum compliance cost by multiplying the subsector's direct (Scope 1) emissions (also based on information from the data source) by the prevailing carbon price at different points projected by the EIA.

3) For those subsectors that were eligible for free rebates we assumed (based on our analysis) that there would be more than adequate direct free allowances available to the subsector to cover its emissions as a whole. Of course, this does not mean there are adequate free allowances for all the companies within a subsector; per policy provisions, by definition, some companies in eligible subsectors will get more allowances than required, and others will less allowances than required.

- To calculate expected impacts of rises in energy prices we
    1) Multiplied EIA's percentage growth projections for each energy type relative to BAU, under different policy scenarios/timeframes, by the energy purchases (in dollars) of each subsector based on data from the 2006 Manufacturing Energy Consumption Survey. This provided us with the isolated dollar impact related to energy costs for the subsector as a whole. *This metric can understate energy-related impacts of policy since many chemicals purchase raw materials which are directly dependent on energy for fuel or feedstock. Users of this Commentary should consider how suppliers may pass through higher energy prices by increasing raw material prices, and how important raw material purchases are in a company's cost structure when evaluating ultimate credit impacts.*
    2) We used energy prices modeled by the EIA *without a carbon fee* attached. Including a carbon fee would have double counted compliance-related costs and energy-related costs. In the case of well-head natural gas, and industrial delivered electricity, prices are the same with or without a carbon fee attached due to policy provisions.
    3) The categorization of energy purchases by source in the 2006 MECS data either did not match up exactly with the categorization of energy prices by source in the EIA analysis of the American Power Act. Here are some of the key changes/assumptions we had to make to adjust for this:
        - Natural gas costs resulting from policy were estimated based on changes in natural gas well-head prices from the lower 48 states; we assumed that all natural gas purchases were from the well-head rather than natural gas LDCs or other sources
        - We used unrefined *industrial* residual and distillate fuel price projections
        - We used industrial liquefied petroleum gas (LPG) prices. We averaged the growth rate of LPG and natural gas well-head prices relative to BAU to calculate LPG/natural gas liquid (NGL) related cost increases. This assumes that LPG and NGL purchases are equal for every subsector—which is not likely to be the case—and further assumes that NGL growth mirrors natural gas growth relative to BAU. But since the 2006 MECS aggregates LPG and NGL purchases, and there is no data on the breakdown between these two categories, we were forced to make this assumption.
        - We used the industrial coal delivered price to estimate both coal and coke and breeze related costs, since no price projections were provided for coke and breeze. The use of coke and breeze by the chemicals subsector is very minimal so this assumption does not have a significant impact on our results.
        - We used *industrial* electricity prices projections
        - **For all energy price projections, we used US-wide projections as state-level information was not available at the subsector level, nor for all energy price projections. It is likely that price changes will vary at state and local levels, though it is not considered in our analysis.**
    4) Some energy purchase data by subsector was missing in the 2006 MECS either because it was withheld or had a value of less than 0.5 for that specific metric. For any data noted as 0.5 or less, we used the value 0.5. The only two subsectors with withheld data were Petrochemicals

and Phosphatic Fertilizer. The 2006 MECS withheld "Residual Fuel" purchases and "All Other Energy Purchases." For these two subsectors, no "All Other Energy Purchases" and that the balance of energy purchases after subtracting data provided for other energy sources, were all "Residual Fuel" purchases. **Thus, for Petrochemical and Phosphatic Fertilizer, this assumption may overestimate "Residual Fuel" purchases and underestimate purchases under "All Other Energy."**

5) Our analysis did not consider any changes in the size of sector and projected emissions reductions other than indirectly through carbon prices and macroeconomic projections due to limited data availability at the subsector level. In line with this, we assume that the relative carbon intensity of the subsectors we analyzed stayed constant through the timeframe of analysis. This assumption contradicts assumptions made in the EIA's analysis of the American Power Act about how the chemicals subsector's emissions and size may change over time. However, there was not enough granularity in the EIA projections for us to be comfortable applying these projections to our subsector analysis. **Our analysis does not account for changes in the market structure of different subsectors and changes in the supplier/purchaser relationships between subsectors.**
6) Detailed calculations by subsector are available upon request.

B. EPA Regulation Analysis

This analysis should not be compared to our cap and trade analysis as it does not look directly at credit impacts, but rather simply evaluates the likelihood of regulation for a given subsector.

- To evaluate the likelihood of regulation we
    1) Used the Department of Energy's Chemicals Bandwidth study to determine which subsectors had the greatest potential to reduce energy use. **This study only considered CO_2 reductions**; ability to reduce other GHG reductions may be relevant considerations.
    2) We then ranked this potential on a scale of 1-5 using clusters in data (as the population size of the data was not large enough we could not use typical statistical methods to perform our ranking).
    3) The EPA may not use this methodology to regulate industrial sources; specifically, it is possible that the EPA regulates several chemicals subsectors, or even the sector as a whole on one date.

	% of Total Chemicals Direct Emissions	**Rank (Direct Emissions)**	**% Energy Reduction**	**Rank (Ability to Reduce Emissions)**
Petrochemical	21%	High	24%	High
All Other Basic Organic	17%	High	27%	High
Nitrogenous Fertilizer	16%	High	9%	High*
Plastics Material and Resin	12%	Med/High	2%	Med/Low
Industrial Gas	6%	Medium	9%	Medium
All Other Basic Inorganic	5%	Medium	9%	Medium
Alkalies and Chlorine	5%	Medium	14%	Med/High
Ethyl Alcohol	3%	Med/Low	0%	Low
Noncellulosic Organic Fiber	2%	Med/Low	0%	Low

Carbon Black	2%	Med/Low	3%	Med/Low
Synthetic Rubber	1%	Low	0%	low
Phosphatic Fertilizer	1%	Low	0%	low
Cyclic Crude & Intermediates	1%	Low	3%	Med/Low
Cellulosic Organic Fiber	0%	Low	0%	low

* The rating for Nitrogenous fertilizer was adjusted to reflect N_2O emissions reductions potential.

Section 3: Case Studies on Chemicals Companies

WRI's company analysis focused only on dollar impacts related to compliance and higher energy prices. All other factors were held constant.

To calculate compliance related costs we:

1) Determined whether the product division of focus fell under a subsector that was eligible for rebates. To do this, we cross referenced the products against NAICS subsector definitions provided by the US Census.
2) If the product division was eligible we calculated the *net* compliance cost using the following formula:

[Prevailing Carbon Price] X [Product Division Emissions - Market Share of Subsector Emissions]

Where:
"Product Division Emissions" is estimated at:
[US Emissions] X [Percentage of revenue derived from product division]

Where:
"Market Share of US Emissions" equals:

$$\frac{\text{Company's US Sales X Percentage of in Product Division X Subsector Emissions}}{\text{Subsector Value of Shipments}}$$

Where:
"Prevailing Carbon Price" is the carbon price projected by the EIA (by scenario and year)

The "Product Division Emissions" were calculated using either 2008 or 2009 (whichever was the most recently available) data. The "Market Share of US Emissions" was calculated using 2006 data both at the company and subsector level to ensure that we did not over or understate this metric. All subsector-related data was based on 2006 MECS data.

The formula, based on recent proposals, to calculate the value of a company's net compliance costs (if eligible for rebates) is:

multiplied by

The modifications we made to this formula include:

A. Using sales instead of output since there is no data on subsector or company emissions by output
B. Change in the year of data used (as explained above)

Key Assumptions:

- These formulas assume that the greenhouse gas emissions and intensity of a Product Division stay constant through the timeframes analyzed. **In reality the greenhouse gas emissions are likely to decrease, though it is unclear whether they will increase more or less than the subsector average. For companies ineligible for rebates, our calculations probably overstate compliance costs. For companies eligible for rebates it is hard to say whether our calculations over or understate the actual costs/revenues. Generally, for companies with a more aggressive emissions reduction path relative to peers, our calculations would overstate costs/understate revenues.**
- These formulas assume the greenhouse gas intensity of the total company is equal to the greenhouse gas intensity a specific division; **this may understate the intensity of the company's product division business if other divisions are less intensive, and vice versa.**
- To calculate a company's US product division sales, we multiplied the percentage of US sales by the percentage of product division sales for the company as a whole. **This may under or overstate the actual US sales within a specific product division, and also does not account for US products sold abroad. This assumption was made due to limited public data availability.**
- We did not use 2-year averages for company emissions and sales, thus there is a data mismatch when comparing company emissions intensity to subsector intensity; however, a data lag (though, perhaps shorter) may occur in reality as well.
- We assumed the subsector value of shipments was comparable to company sales. This may not be the case, though value of shipments is the closest comparable to sales in publicly available data.

For more information about WRI's analytical approach used, please contact the authors:

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