IEc

Models, Methods, and Data for Estimating Small Scale and Small Business Impacts

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prepared for:

South Coast Air Quality Management District

21865 Copley Drive

Diamond Bar, CA 91765-4178

prepared by:

Industrial Economics, Incorporated

2067 Massachusetts Avenue

Cambridge, MA 02140

617/354-0074

INDUSTRIAL ECONOMICS, INCORPORATED

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EXECUTIVE SUMMARY

To inform the development of Air Quality Management Plans (AQMPs) and other air quality regulations, the South Coast Air Quality Management District (SCAQMD or the District) conducts socioeconomic assessments that examine the costs, benefits, and other economic impacts of these initiatives. These assessments apply a customized version of the Regional Economic Models Inc. (REMI) Policy Insight model to generate estimates of economic impacts by industry. Complementing these estimates, SCAQMD's socioeconomic assessments also include qualitative discussions of small business impacts that highlight the small business size standards defined by SCAQMD, the Clean Air Act, and the U.S. Small Business Administration.

While these analyses provide SCAQMD with useful insights, a recent review of SCAQMD's socioeconomic assessments concluded that the model provides a limited view of small scale regulatory impacts (i.e., impacts to industries defined by six-digit NAICS codes) or small business impacts.[1]

To address these limitations, SCAQMD is looking to develop credible approaches for estimating small scale and small business impacts. To that end, this document presents a review of available methods, models, and data for estimating these impacts and recommendations concerning which approaches SCAQMD should apply in its analyses.

REVIEW OF AVAILABLE METHODS, MODELS, AND DATA

This report includes a broad and systematic review of models, analyses, data, and peer-reviewed studies relevant to the estimation of small scale and small business impacts. This review considers not only material that focuses specifically on these impacts but also material that could potentially be adapted to the estimation of these impacts in the context of SCAQMD policies or programs. The findings of this review are as follows:

- ***Academic literature:*** We examined several papers in the peer-reviewed literature that estimate the impact of environmental regulations, air policy, and energy prices on economic metrics of interest to SCAQMD, including employment and industry output. Our review of this literature suggests that it would be difficult to apply it directly in the context of SCAQMD assessments of small scale or small business impacts. Overall, this literature shows conflicting results, with some studies showing a negative relationship between environmental regulation and employment/economic activity and others showing no relationship. These divergent results may reflect differences in the regions or industries examined,

[1] See Abt Associates (2014).

but determining which studies, if any, are transferrable to specific SCAQMD regulations would be a difficult exercise replete with uncertainty.

- ***Existing Guidance:*** Our review also considered the U.S. EPA's *Guidelines for Preparing Economic Analyses* (or *Guidelines*) and the Agency's guidance for rule writers on compliance with the Regulatory Flexibility Act (RFA). While neither document offers specific guidance on methods for estimating small scale or small business impacts, the *Guidelines* document indicates that single-industry models (as opposed to multi-industry models) are appropriate when the effects of a regulation are likely to be confined to a single market. This would suggest that SCAQMD analyses of small scale impacts need not measure indirect economic impacts if the directly affected industry(s) does not have strong connections with other industries in the local economy.

  The *Guidelines* document also highlights that input-output models are most appropriate for estimating short run impacts, while general equilibrium models are better suited for assessing economic impacts in the long run.

- ***Past SCAQMD Case Studies:*** To ensure that the recommendations presented in this document consider SCAQMD's past efforts to enhance its methods for assessing socioeconomic impacts, we reviewed a series of case studies sponsored by SCAQMD between 2000 and 2002. These case studies demonstrate potential approaches for conducting facility-based assessments (FBAs) and post-rule assessments and include many analytic elements that might provide insight into small business and small scale impact assessment. In particular, the case studies highlight the importance of understanding the competitive landscape of directly regulated industries when estimating the incidence of regulatory compliance costs. The case studies also demonstrate different approaches of obtaining baseline financial data for use in small business impact assessment, as well as the variety of financial metrics against which SCAQMD might compare compliance costs incurred by small businesses.

- ***Models:*** We assessed the suitability of several off-the-shelf economic models for the estimation of small scale and small business impacts. These include two input-output models (EMSI and IMPLAN), a small business impact model designed as a pre-processor and post-processor to REMI (the Business Size Impact Module), three linear programming models of the power generation sector (the Integrated Planning Model (IPM), Haiku, and the Regional Energy Deployment System), and a market penetration model (TRUCK). Of these models, we found that EMSI has the greatest potential to improve SCAQMD's ability to assess small scale economic impacts. With industries defined according to six-digit NAICS codes, EMSI was the only off-the-shelf model that we identified that includes the industry detail sufficient to estimate small scale impacts.

  Overall, the models identified are limited in the degree to which they might support SCAQMD efforts to assess small business impacts. Because IPM can generate results for individual electricity generating units, it could support an analysis of small business impacts for regulations affecting the power industry. None of the models that we identified, however, could support the assessment of small business impacts for any other industries.

- ***Policy Analyses:*** We examined several prior economic analyses of environmental and energy policy that may inform SCAQMD's development of small scale and/or small business impact assessment methods. Though many of these analyses use methods, models, or data tailored to a specific industry or analytic question (e.g., estimation of a rule's employment impacts), they include elements that could potentially be adopted for SCAQMD's purposes. In particular, the partial equilibrium approach applied in some of these analyses is suitable for adoption by SCAQMD to assess small scale economic impacts for industries *directly* affected by SCAQMD policies. The small business impact assessments in a number of these analyses could also serve as a model for SCAQMD. These analyses focus on impacts to directly regulated small businesses and typically compare annualized compliance expenditures to annual revenues.

- ***Data:*** Our review also considered potential data sources to parameterize and populate the various models and methods available. These include data related to an industry's level of economic activity under baseline conditions, the revenues or profitability of an industry or a company within that industry, or the elasticity of supply and demand for an industry. Our review suggested that company-specific financial data are available from several sources for publicly traded companies but that less information is available for privately held firms, which includes most small businesses. More aggregate data (by industry, revenue class, and county) from the Economic Census and/or the Risk Management Association, however, could serve as the basis for *pro forma* financials for small businesses across many industries. We also found that U.S. demand elasticity data are available for many goods and services but that data on supply elasticities for U.S. producers are more limited.

RECOMMENDATIONS FOR ASSESSMENT OF SMALL BUSINESS IMPACTS

Based on our review of the available models, methods, and data, we recommend the following approach for SCAQMD assessments of small business impacts:

- ***Scope of small business impacts:*** We recommend that SCAQMD limit the scope of its small business impact analyses to the direct compliance expenditures of regulated facilities. While small businesses may experience changes in output or employment as a result of SCAQMD regulations, the models that estimate these impacts do not distinguish between impacts to small business and impacts to other businesses.

- ***Definition of small business:*** We recommend that SCAQMD choose small business size standards that are regularly updated based on industry-specific data and that can be applied with readily available information. We also recommend that SCAQMD use standards defined for the purposes of impact assessment rather than for procurement purposes. Deciding which specific standard(s) to use for analytic purposes is a policy choice for SCAQMD.

- ***Identification of small businesses:*** Assuming that SCAQMD defines small business based on a business's revenues or number of employees, we recommend a tiered approach for the identification of small businesses. First, we recommend that SCAQMD obtain financial data for regulated companies from Dun & Bradstreet or Hoover's. Using these data, SCAQMD can determine which facilities are owned by companies below the selected small business threshold. Second, in the event that financial data for a company are unavailable from commercially available sources, we would encourage SCAQMD to consult with regulated facilities themselves to inquire if they would be willing to provide sufficient information to make a determination about their small business status. Companies would not necessarily need to provide their exact revenue or employment information. SCAQMD could ask them which revenue or employment categories best describe their operations. The cutoff values between categories could be defined such that the smallest category corresponds to SCAQMD's definition of small business for that industry.

- ***Estimation of compliance costs for small businesses:*** Once the universe of small facilities has been identified, SCAQMD can estimate compliance costs for these facilities based on methods that it already uses in its socioeconomic assessments. Under current practice, SCAQMD typically estimates costs (1) at the facility level or (2) for facility types (*i.e.*, model facilities) that may be mapped to individual facilities.

- ***Comparison of small business compliance costs with baseline revenues and/or profits:*** To provide context for the estimated compliance costs for small business, we recommend that SCAQMD compare these costs to the annual revenues and/or profits of small business. For publicly traded companies, SCAQMD can obtain revenue and profit data from Dun & Bradstreet or Hoover's. For private companies, we recommend that SCAQMD compare costs to the revenues and/or profits of the average small business in an industry. SCAQMD can estimate average revenue and/or profit values for small businesses based on industry-specific revenue data from the Economic Census and industry-specific profit margin data from the Risk Management Association's Annual eStatement Studies series.

RECOMMENDATIONS FOR ASSESSMENT OF SMALL SCALE IMPACTS

Based on the strengths and limitations of the available methods and data and the different dimensions of economic impacts captured under different approaches, we recommend that SCAQMD choose an approach for the estimation of small scale impacts on a case-by-case basis. For each analysis, we suggest that SCAQMD consider both the characteristics of the policy to be analyzed as well as the District's own analytic objectives. An approach chosen based on these factors will help SCAQMD identify an approach that meets its analytic needs and minimize analytic limitations relevant to these needs. As noted above, however, no approach will be without limitations. We urge

SCAQMD to be transparent about the limitations of whatever approach it relies upon in its assessment of small scale impacts.

Our recommendations for specific analytic situations are as follows:

- ***Direct impacts:*** In the event that SCAQMD is interested only in the estimation of direct small scale impacts, we recommend the use of economic modeling tools that are sector-specific. For rules affecting industries other than the electric power sector, we recommend that SCAQMD develop partial equilibrium models on a rule-by-rule basis to assess the direct small scale economic impacts of its policies. To specify these models, we recommend that SCAQMD use baseline data for the appropriate six-digit NAICS from the EMSI input-output model and elasticity estimates from the literature. While the available elasticity values are unlikely to be for specific six-digit NAICS codes, elasticities for a more aggregate industry are likely to be reasonably representative of supply and demand responses for the more narrowly defined sub-sectors within the aggregate industry.

  If SCAQMD develops regulations specific to the electric power sector, we would recommend the estimation of small scale impacts based on the Integrated Planning Model (IPM). The unit-specific results in IPM would support the estimation of revenue, employment, and income impacts for small power producers.

  Direct and indirect impacts: We recommend the estimation of both direct and indirect impacts only when the annualized costs of a policy are economically significant (i.e., at least $5 million); policies with costs below this threshold are unlikely to result in indirect economic impacts larger than model rounding error. For policies with direct compliance costs above this threshold, our recommended approach depends on whether costs are concentrated among a relatively small number of industries or diffuse across several industries. If costs are concentrated, we recommend that the District estimate impacts as a range based on two separate approaches. Under the first approach, SCAQMD would use the EMSI input-output model to allocate REMI results to the various sub-sectors that make up each of the industries reflected in REMI. Under the second approach, SCAQMD would conduct a partial equilibrium analysis for directly regulated industry and use the change in output for this industry as an input in EMSI. The resulting EMSI outputs would reflect the direct and indirect economic impacts of the SCAQMD regulation by six-digit NAICS. When annualized direct costs are diffuse across several industries, we recommend that SCAQMD apply only the first approach described above—using EMSI to allocate REMI results to industries defined in greater detail.

CHAPTER 1 | INTRODUCTION AND APPROACH

INTRODUCTION

To inform the development of Air Quality Management Plans (AQMPs) and other air quality regulations, the South Coast Air Quality Management District (SCAQMD or the District) conducts socioeconomic assessments that examine the costs, benefits, and other economic impacts of these initiatives. These assessments help the District develop AQMPs and rules that achieve its air quality objectives and protect public health. Ensuring the quality of these socioeconomic impact assessments is a formidable task, as SCAQMD has a large, diversified economy with emissions spread across sources in hundreds of inter-dependent industries.

To perform such assessments, SCAQMD currently applies a customized version of the Regional Economic Models Inc. (REMI) Policy Insight model. For any given analysis, the inputs incorporated into the REMI model include engineering costs by sector while the model outputs include the estimated changes in industry output, value added, employment, and income. REMI provides these outputs by sector for each of the 70 industries represented in the model, which correspond roughly to 2- to 4-digit NAICS codes.[2] To complement the economic impact estimates generated by REMI, SCAQMD's socio-economic analyses also include qualitative discussions of small business impacts that highlight the small business size standards defined by SCAQMD, the Clean Air Act, and the U.S. Small Business Administration.

While the REMI model provides SCAQMD with useful insights into the regional socioeconomic impacts of AQMPs and individual rules, a recent review of SCAQMD's socioeconomic assessments concluded that the model provides a limited view of regulatory impacts at a small scale and for small businesses.[3] Within the broad industry definitions specified by REMI, the economic impacts of a given policy may differ significantly across the sub-sectors reflected in the REMI industry definitions. For example, a rule affecting the household and institutional furniture and kitchen cabinet manufacturing industry (NAICS 3371) in REMI could have different effects for wood kitchen cabinet and countertop manufacturing (NAICS 33711) and upholstered household furniture manufacturing (NAICS 337121). Similarly, the REMI results provide no insights into the economic impacts of a policy for small business. While small businesses are reflected in REMI's sector-level results, these results do not show the distribution of impacts between small businesses and other businesses.

[2] REMI also has a 169 sector model, though this version only has up to 3-digit NAICS codes.

[3] See Abt Associates (2014).

To address these limitations in its assessment methods, SCAQMD is looking to develop credible approaches for estimating small scale and small business impacts. As an initial step in this process, SCAQMD has tasked IEc with reviewing various methods, models, and data that the District may use or adapt to estimate these impacts. The District also charged IEc with recommending analytic methods for the assessment of small scale and small business impacts. This document presents the findings of IEc's review as well as our recommendations.

The review and recommendations included in this document will provide insights to SCAQMD, small businesses, regulated industries, and other stakeholders concerning the analytic options for assessing small scale and small business impacts. We highlight the strengths and limitations of different approaches, the data required, and the situations under which different methods are well or poorly suited. The information provided in this report will also shed light on the feasibility of estimating specific types of small scale and small business impacts that may be of interest to different stakeholders.

APPROACH TO THE REVIEW AND DEVELOPMENT OF RECOMMENDATIONS

IEc performed a broad and systematic review of models, analyses, data, and peer-reviewed studies relevant to the estimation of small scale and small business impacts. This review considered not only material that focuses specifically on these impacts but also material that could potentially be adapted to the estimation of these impacts in the context of SCAQMD policies or programs. With this expansive approach, our review considered potential new applications of existing analytic tools and data, as well as ways in which different tools may complement one another in analyses of small scale or small business impacts. Exhibit 1-1 summarizes the material that we examined for this review.

To gauge the extent to which the various models, methods, and data identified in Exhibit 1-1 may help SCAQMD assess the small scale and small business impacts of its policies and programs, IEc reviewed them with a focus on the following considerations:

- ***Conceptual foundations for estimating small scale or small business impacts:*** IEc considered the analytic rigor with which a given model, method, or data source estimates small scale or small business impacts.
- ***Breadth of small scale or small business impacts captured:*** SCAQMD policies and regulations may lead to direct economic impacts for regulated industries as well as indirect impacts for industries that supply inputs to affected industries. Similarly, changes in wage income for workers in directly regulated industries may lead to induced economic impacts as consumption levels for workers in these industries change. IEc's review considered the extent to which a given model, method, or data source could help in capturing the full breadth of these effects.
- ***Assumptions:*** IEc examined the assumptions, both explicit and implicit, in each methodology. Identifying assumptions is important to understanding the potential strengths and limitations of each approach, as well as factors that might influence the results generated by a given method and the weight that should be placed on these results.

EXHIBIT 1-1. SUMMARY OF MODELS, ANALYSES, DATA, AND LITERATURE REVIEWED

CATEGORY	NAME	SUMMARY	STRENGTHS	LIMITATIONS
Past SCAQMD Analyses	Various socioeconomic assessments	SCAQMD uses a customized version of the REMI Policy Insight model to estimate changes in industry output, value added, employment, and income. Qualitative discussion of small business impacts.	Compliance costs can be entered as inputs directly into REMI. Model allows producers to change their input mix in response to price changes.	REMI does not isolate impacts to small businesses. Impacts are only provided at the 2- to 4-digit NAICS level.
	Facility-based assessment case studies	Case studies analyzed the impacts of proposed SCAQMD rulemakings through development of an industry profile, firm profile, regulatory impact model, and impact assessment.	Estimated impacts to specific industries regulated by the proposed rules. Impacts provided separately for small, medium, and large firms.	Detailed estimates of revenues and compliance costs by firm size may be difficult to obtain or produce for all industries.
Models	BSIM/REMI	Pre/post-processor to the REMI Policy Insight model that estimates impacts for firms of various size classes.	Estimates impacts specific to small firms. Works as a supplement to REMI, which SCAQMD already uses.	Proprietary model with no known documentation available.
	EMSI Model	Input-output model that estimates changes in output, value-added, employment, and income by 6-digit NAICS.	Results by 6-digit NAICS, covering over 1,000 industries. Model documentation publicly available. Estimates direct, two categories of indirect, and induced impacts.	Assumes fixed input mix for each industry. Cannot use compliance costs as an input.
	IMPLAN	Input-output model that estimates changes in output, value added, employment, and income by 3- to 5-digit NAICS.	Provides impact estimates at the 3 to 5-digit NAICS level, covering over 500 industries.	Assumes fixed input mix for each industry, but can be changed by the user. Does not use compliance costs as input.
	Integrated Planning Model (IPM)	Dynamic linear programming model of the U.S. electric power sector.	Post-processing computations estimate impacts at the plant level, allowing for the identification of impacts to plants owned by small businesses. Model outputs specific to southern California are available.	Estimates impacts only within the electric power sector.
	Haiku	Dynamic linear programming model of the U.S. electric power sector.	Model outputs specific to southern California are available. Designed to allow for analysis of regulations that change electricity market structure.	Estimates impacts only within the electric power sector. No plant level results available.

CATEGORY	NAME	SUMMARY	STRENGTHS	LIMITATIONS
	ReEDS	Dynamic linear programming model of the U.S. electric power sector.	Model outputs specific to southern California are available. High level of spatial disaggregation allows for detailed analysis of renewable energy policies.	Estimates impacts only within the electric power sector. No plant level results available.
	CA-TIMES	Dynamic linear programming model of the U.S. electric power sector with partial equilibrium components.	Model was designed specifically for use in California. Partial equilibrium component allows energy demand to change in response to prices.	Results are only presented at the state level. No plant level results available.
	TRUCK	Market penetration model that forecasts the future market penetration rate of alternative fuel vehicle technologies.	Model could be used to help assess the impacts of policies that incentivize the use of alternative fuel vehicle technologies.	Model does not estimate compliance costs or other economic impacts.
Policy Analyses	EPA Portland Cement RIA	EPA applied a partial equilibrium model to estimate the economic impacts of the National Emission Standards for Hazardous Air Pollutants (NESHAP) for Portland cement manufacturing.	The methods used to develop the partial equilibrium model could be transferable to certain industries covered by SCAQMD programs. The cost-to-sales ratio that EPA used as a metric of small business impacts is transferable to SCAQMD analyses.	EPA's partial equilibrium approach does not estimate indirect and induced effects.
	EPA Refinery Rule RIA	EPA applied a series of partial equilibrium models to estimate the economic impacts of the NESHAP for petroleum refineries.	The methods used to develop the partial equilibrium models could be transferable to certain industries covered by SCAQMD programs. The cost-to-sales ratio that EPA used as a metric of small business impacts is transferable to SCAQMD analyses.	EPA's approach does not estimate indirect and induced effects.
	EPA Boiler Rule	EPA applied a multi-market partial equilibrium model of the U.S. economy to estimate the economic impacts of the NESHAP for industrial, commercial, and institutional boilers.	Model includes 100 distinct industry groupings. The supply and demand elasticities used in the model could be used in future SCAQMD assessments. The cost-to-sales ratio that EPA used as a metric of small business impacts is transferable to SCAQMD analyses.	Model is designed for the assessment of national rather than regional impacts.

CATEGORY	NAME	SUMMARY	STRENGTHS	LIMITATIONS
	Clean Power Plan RIA	EPA estimated the employment impacts of the Clean Power Plan by integrating the outputs of the IPM electric power sector model with industry cost and productivity data.	Captures impacts to suppliers of directly regulated industries that would not be estimated in a partial equilibrium model.	EPA's approach does not estimate all of the indirect and induced effects associated with the rule.
	DOE RIA for Commercial Refrigeration Energy Efficiency Standards	Estimates the engineering costs, manufacturer impacts, and indirect employment impacts of the rule.	Illustrates how a detailed engineering model can be used with other models to estimate detailed impacts at small scale for directly affected industry and indirect impacts for broader economy.	Model applied by DOE required significant amount of baseline financial data.
	Cost of State Regulations on California Small Business Study	Varshney & Tootelian (2009) conduct a regression analysis to estimate the annual impacts of all regulations in California on gross state product and employment.	Estimates the cost of regulation specifically in California.	Significant methodological flaws, including a failure to control for state population, and an improper use of the IMPLAN model. Methodology would not be easily translatable to the study of a single proposed rulemaking.
	Regulatory Compliance Costs and California Specialty Crop Producers Profitability	Paggi et al. (2009) estimate the costs of agricultural regulations in California using stochastic simulation models of representative farms.	Representative farm methodology could be modified to model the impacts to a representative small business.	The stochastic simulation models require detailed financial and operational data.
Academic Literature	Several papers in the peer-reviewed economics literature.	Papers estimate the various economic impacts of environmental regulations.	Studies are peer-reviewed. Several of the papers estimate the impacts of regulations that have already been enacted.	Studies apply broad measures of stringency (e.g., NAAQS nonattainment) rather than precise measures (e.g., compliance costs).

CATEGORY	NAME	SUMMARY	STRENGTHS	LIMITATIONS
Data	Dun & Bradstreet	Database with firm-level data for public and private companies in many industries.	Firm level data can help identify the number of small businesses in an industry, and the average revenues and employees of small businesses.	Self-reported data may not be complete or current. Data on company ownership and employment may be outdated. Can be difficult to determine the number of firms or establishments in a specific industry due to the way information is stored
	Hoover's	Subsidiary of D&B that maintains a similar database of firm-level data on public and private companies.	Information for individual companies is often more accurate and more complete than in the D&B database. Often contains more data on corporate linkages and other business characteristics.	Same limitations as D&B above.
	Securities and Exchange Commission (SEC) EDGAR Database	Database with information on the financial resources and balance sheets of publicly traded companies.	Provides a more complete picture of firm financial health than D&B or Hoover's.	Information generally limited to publicly-traded firms. Information is provided in lengthy, non-standardized 10-K filings that are difficult to gather and compare.
	LexisNexis	Database that provides information on the ownership hierarchy of firms, as well as financial and other information from reports filed with the SEC.	Information on the ownership hierarchy of firms can be used to determine if a facility is owned by a small business.	Information is generally limited to publicly-traded companies. Information is not easy to export from the database.
	Standard and Poor's (S&P)	Database of SEC filings and other financial information for most publicly traded companies. Multiple years of firm-level data on revenues, earnings, assets, liabilities, cash flow, dividends, and employment.	Generally provides more comprehensive financial information than other sources. Includes multiple years of financial data.	Information is generally limited to publicly-traded companies.

CATEGORY	NAME	SUMMARY	STRENGTHS	LIMITATIONS
	InfoUSA	Database with firm level data for small businesses in many industries.	Firm level data can help identify the number of small businesses in an industry, and the average revenues and employees of small businesses.	Self-reported data may not be complete or current.
	Manta	Database with firm level data for small businesses in many industries.	Firm level data can help identify the number of small businesses in an industry, and the average revenues and employees of small businesses.	Self-reported data may not be complete or current.
	Risk Management Association	Database with information from the financial statements of small and medium-sized businesses.	Provides data on metrics not available from other sources such as profitability cash flow, and financial ratios. Data provided at the 6-digit NAICS level with breakdowns by asset and sales size.	Data are not published for all industries. Records are not disclosed for individual firms, data only reported in aggregate.
	Economic Census	Comprehensive collection of industry statistics, including the number of establishments, firms, and employees, as well as annual payrolls and revenues.	Covers nearly all 6-digit NAICS industries. Aggregate economic data can be broken out by employee and revenue size class. Data is reported at the national, state, and county level.	Economic information is not reported for individual firms or establishments. Economic Census is conducted only every five years.
	County Business Patterns	Similar to the Economic Census, the County Business Patterns dataset provides detailed economic statistics by industry.	Data is released annually. Covers nearly all 6-digit NAICS industries. Data is reported at the national, state, and county level.	Information on the number of firms and annual revenues in an industry is not reported. Data is based on a relatively small sample of firms and thus may be less reliable than the Economic Census.
	Bureau of Labor Statistics (BLS) Productivity Data	Provides annual measures of output per worker at the 4- to 6-digit NAICS level.	Data on output per worker are provided at the 6-digit NAICS level for 124 industries, and at the 4- or 5-digit NAICS level for additional industries.	Data are only available at the national level.
	Manufacturing Industry Database	Database developed by the National Bureau for Economic Research (NBER) and the Census Bureau's Center for Economic Studies (CES) with employment, payroll, and productivity data available for 473 6-digit 1997 NAICS industries.	Data are provided at the 6-digit NAICS level.	Data are only available at the national level. Data may become outdated over time, as NBER and CES currently have no plans to update the dataset.

CATEGORY	NAME	SUMMARY	STRENGTHS	LIMITATIONS
	Broda et al. (2008)	Estimates export supply elasticities for countries other than the U.S. to support analysis of tariff design.	Provides over 1,000 supply elasticities, many corresponding with 5- or 6-digit NAICS codes.	Transferability of non-U.S. elasticities to U.S. firms is uncertain.
	Ho, Morgenstern, and Shih (2008)	Economic analysis examining impact of carbon pricing on U.S. industry	Includes demand elasticities for more than 50 industries derived from a general equilibrium model.	Elasticities derived from a general equilibrium model rather than empirical data.
	Consumer Demand in the United States	Develops models of consumer demand based on BEA personal consumption data to estimate price elasticities of demand for numerous goods and services.	Elasticities and associated data documented in detail.	Derived from national level data rather than data for California.
	Small Business Size Standards	Standards available from several sources, including SCAQMD, the California Department of Health Services, and the Clean Air Act.	Provide clear demarcation between small businesses and other businesses.	Basis for defining small business varies by source.

- ***Transferability:*** The transferability of individual methods to assessment of the District's policy initiatives was an important consideration in IEc's review. While some methods may be unique to just a single industry or require significant modification for application in other industries, others are more transferable across different contexts. IEc's assessment of the transferability of a given approach considered the context in which it was applied, how the methodology was designed to function in that context, and how this setting differs or is similar to the context in which SCAQMD may apply it.

- ***Data requirements:*** The data requirements for a given approach also affect the ease with which it may be applied by SCAQMD. For each model/method reviewed, IEc conducted a detailed accounting of the associated data requirements. Such data may include model parameters, such as elasticity values, and any scenario-specific data that would need to be collected or developed for each analysis.

Drawing from this review, IEc developed recommendations that emphasize the matching of specific approaches with the analytic contexts in which they would be most appropriate. Our goal in building this flexibility into our recommendations was to help SCAQMD identify approaches that meet its analytic needs for a given situation while also minimizing analytic limitations relevant to these needs.

REPORT ORGANIZATION

The remainder of this document describes the models, methods, data, and literature that IEc examined as part of its review. We organize this information as follows:

- ***Chapter 2 - Academic literature:*** Several studies in the peer-reviewed economic literature examine how electricity prices and increased regulatory burden affect employment and firm location. We briefly summarize this literature and discuss the extent to which the conclusions from these studies might be applied in SCAQMD small scale and/or small business impact assessments.

- ***Chapter 3 – Existing Guidance:*** Existing guidance from the U.S. Environmental Protection Agency (EPA) provides potentially valuable insights on the use of different economic analysis tools that could potentially inform SCAQMD assessments of small scale and small business impacts.

- ***Chapter 4 - Past SCAQMD Case Studies:*** Two facility-based case studies previously developed by SCAQMD with the goal of enhancing its socioeconomic impact assessment methods may have bearing on ways in which SCAQMD could improve its methods for assessing small scale and small business impacts. This chapter summarizes these case studies and identifies any data or approaches that might advance SCAQMD's current analytic objectives.

- ***Chapter 5 - Models:*** We identified several models in our review that could potentially inform SCAQMD assessments of small scale or small business impacts. This chapter describes the structure and capabilities of each model and discusses the extent to which each may be used to assess these impacts.

- ***Chapter 6 - Policy analyses:*** Analyses conducted by government agencies and other researchers include a variety of approaches for assessing economic impacts that may inform SCAQMD efforts to assess small scale and/or small business impacts. This chapter highlights these different approaches and identifies elements of each approach that may inform SCAQMD efforts to assess small scale and/or small business impacts.
- ***Chapter 7 - Data:*** IEc's review identified several data sources that may be helpful in the assessment of small scale or small business impacts. This chapter summarizes these data sources and describes how each could potentially be applied.
- ***Chapter 8 – Recommendations:*** Based on the information presented in the other chapters, the report concludes by presenting our recommendations on the data and methods for SCAQMD to use in its assessments of small scale and small business impacts.

CHAPTER 2 | ACADEMIC LITERATURE

As an initial step in this review, IEc examined several papers in the peer-reviewed economics literature that are potentially relevant to the assessment of small scale or small business impacts. IEc specifically examined papers that estimate the impact of environmental regulations, air policy, and energy prices on economic metrics of interest to SCAQMD, including employment and industry output. In addition, IEc attempted to identify studies that assess these impacts in California. While there are many papers in the economic literature that examine the impacts of government regulations that are not related to energy or environmental quality, the above criteria were deemed to be most likely to inform future SCAQMD assessments. Although most of these papers do not focus specifically on small scale or small business impacts, the methods and data that they apply could potentially inform SCAQMD assessments of these impacts. In addition, to the extent that any of these studies focus on industries dominated by small business (e.g., dry cleaning), SCAQMD could use the results of these studies to develop consistency checks of its own small business impact results for these industries.

Several of the studies that we reviewed investigate how electricity prices influence firm location and employment decisions for specific industries. Many of these papers find that higher electricity prices and more stringent environmental regulations are associated with reduced economic activity and employment. For example, Kahn and Mansur (2013) find that energy intensive manufacturing industries in the U.S. are concentrated in low-electricity price counties, and that pollution-intensive industries are concentrated in counties with relatively lax Clean Air Act regulations.[4] Greenstone (2002) finds a similar result when examining the economic impact of the Clean Air Act in particular. Greenstone's results show that in the first 15 years following enactment of the Clean Air Act, nonattainment counties lost approximately 590,000 jobs and $75 billion of output in pollution-intensive industries, relative to attainment counties.[5] Similarly, focusing on the fabricated plastics (SIC 3079), communication transmitting equipment (SIC 3662) and electronic component (SIC 3679) industries, Carlton (1983) finds that energy costs, and in particular electricity prices, are negatively correlated with the creation of new manufacturing plants.

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[4] Kahn and Mansur (2013) examined 21 manufacturing industries and 15 non-manufacturing industries, all defined in terms of 3-digit NAICS codes.

[5] The pollution-intensive industries examined by Greenstone include lumber and wood (SIC 24); pulp and paper (SIC 2611-31); iron and steel (SIC 3312-13, 3321-25); printing (SIC 2711-89); organic chemicals (SIC 2961-69); rubber and plastic (SIC 30); fabricated metals (SIC 34); motor vehicles (SIC 371); inorganic chemicals (SIC 2812-19); petroleum refining (SIC 2911); stone, clay, and glass (SIC 32); and nonferrous metals (SIC 333-34).

Focusing on clusters of industries in aggregate, Garen et al. (2011) and Deschenes (2010) also estimate negative relationships between energy prices and economic activity. Deschenes estimates short-run cross price elasticities between energy prices and employment that range from -0.10 to -0.16. Garen et al. (2011) develop an autoregressive distributed lag model based on the relationship between energy prices, energy consumption, and economic output. The model estimates that a 25 percent increase in electricity prices would reduce the growth rate of gross state product in Kentucky from a baseline of 3.0 percent in the baseline to 2.3 percent growth in the long run, and reduce employment growth from 1.0 percent in the baseline to 0.61 percent.

Our review also identified a number of peer-reviewed studies that found little to no relationship between environmental regulation and employment. Morgenstern et al. (2002) examine the employment impacts of increased pollution abatement costs for four industries: pulp and paper mills, plastic manufacturers, petroleum refiners, and iron and steel mills. Across these industries, they found that the employment impacts of higher abatement costs are statistically insignificant from zero. The authors hypothesize that this is because any negative effects on employment caused by reductions in industry output were mitigated by an increased demand for labor in order to comply with the regulations.

Berman and Bui (2001a) conducted a similar analysis specific to the employment effects of local air quality regulations in Los Angeles in the 1980s.[6] The authors used two sets of panel data made available by special arrangement with the U.S. Census Bureau: the Pollution Abatement Costs and Expenditures Survey (PACE) and the Census of Manufactures. Both of these data sources contain plant-level data, which allowed the authors to identify the specific plants subject to new SCAQMD regulations. The authors found that these regulations induced large compliance costs, but they found no evidence that these costs translated to reduced employment relative to non-regulated plants in other regions of the country. Berman & Bui put forth three possible explanations for their findings:

1. The affected firms are very capital intensive and employ relatively few workers.
2. The affected firms are competing primarily with other local firms, so regulations do not have a large impact on sales.
3. The abatement efforts required to comply with the regulations may increase labor demand.

Given that this study examined air quality regulations in the Los Angeles area, the findings may be particularly relevant to future SCAQMD rulemakings affecting industries similar to those examined in the study. However, this study may have limited applicability to future rulemakings that regulate firms that are relatively labor intensive, or firms that are competing in a regional or national market.

[6] The industries covered by this study include SIC codes 2051-53, 2426, 2431, 2451-52, 2819, 2820-24, 2834, 2843-44, 2851, 2873, 2911, 2952, 2999, 3221, 3229, 3231, 3241, 3271-73, 3315, 3357, 3411, 3452, 3652, 3674, 3711, 3713-16, 3721, 3724, 3728, 3731-32, 3761, 3764, and 3769.

Two other studies that we identified put forth additional explanations for the limited direct impacts of compliance costs on employment. Berman and Bui (2001b) studied the impacts of air quality regulations specifically affecting refineries in the South Coast Air Basin. They find that the productivity of the regulated refineries increased over the study period, while productivity in refineries in non-regulated regions decreased. The authors conclude that abatement costs alone may overstate the impacts of environmental regulation to the extent that abatement can induce increases in productivity. Additionally, Bae (2009) finds that in response to higher electricity prices, heavy users of electricity try to substitute production factors away from electricity instead of relocating. One limitation of this study is that it only examines relocation, and does not appear to assess the potential negative impacts of high electricity prices on new plant creation.

Our review of this literature suggests that it would be difficult to apply it directly in the context of SCAQMD assessments of small scale or small business impacts. Overall, this literature shows conflicting results, with some studies showing a negative relationship between environmental regulation and employment/economic activity and others showing no relationship. These divergent results may reflect differences in the regions or industries examined, but determining which studies, if any, are transferrable to specific SCAQMD regulations would be a difficult exercise replete with uncertainty. In addition, many of the studies use broad indicators of regulatory stringency (e.g., nonattainment with the National Ambient Air Quality Standards) rather than more precise measures such as regulatory compliance costs. Studies that use these broad measures would not be appropriate to use in developing consistency checks for SCAQMD impact estimates.

CHAPTER 3 | EXISTING GUIDANCE

To inform the development of economic analyses of environmental policy, including analyses of small business impacts, the U.S. EPA has developed various guidance documents that outline best practices for performing such analyses. EPA designed these guidelines in large part to aid Agency staff and consultants in the development of economic analyses that are compliant with various statutory and administrative requirements (i.e., Acts of Congress and Executive Orders), but the information contained in these documents would apply to most economic analyses of environmental policy. This chapter summarizes the two EPA guidance documents that are most relevant to SCAQMD's goal of improving its methods for estimating small scale and small business impacts: EPA's *Guidelines for Preparing Economic Analyses* and the Agency document *Final Guidance for EPA Rulewriters: Regulatory Flexibility Act*.[7]

EPA GUIDELINES FOR PREPARING ECONOMIC ANALYSES

EPA's *Guidelines for Preparing Economic Analyses* (or *Guidelines*) provides a broad survey of the methods widely used in economic analyses of environmental regulation. The methods described in the *Guidelines* cover each of the main analytic components of EPA's economic analyses, including specification of the baseline; estimation of costs; analysis of human health, ecological, and other benefits; assessment of distributional impacts; and analysis of various economic impacts as required by statute or Executive Order. For the purposes of informing SCAQMD analyses of small scale and small business impacts, our review of the *Guidelines* focused on Chapters 8 and 9 of the document, which cover various methods for assessing the costs and economic impacts of environmental policy, including compliance cost models, partial equilibrium models, and general equilibrium models.

While the *Guidelines* document does not specifically address the analysis of small scale impacts, its description of the circumstances under which different economic modeling tools are appropriate for the estimation of costs could apply to these impacts. In particular, the *Guidelines* advise EPA analysts that single-industry models, such as partial equilibrium models, are appropriate when the effects of a regulation are likely to be confined to a single market. This would suggest that SCAQMD analyses of small scale impacts need not measure indirect economic impacts if the directly affected industry(s) does not have strong connections with other industries in the local economy. Similarly, the impacts of policy made by SCAQMD or other jurisdictions may be contained to the

[7] See U.S. EPA (2006 and 2010a).

directly affected industry(s) if the direct costs of the policy are small, as affected firms may not deem the costs sufficiently high to alter their pricing or purchasing practices.

Focusing on the time horizon of a policy's impacts, the *Guidelines* also explain that various types of economic models vary in their ability to capture short run versus long run impacts. For example, because input-output models assume a fixed input mix for each industry, they do not account for input substitution that could potentially reduce the cost impacts of a rule for any given industry. In the short run, when input substitution is often not feasible (e.g., due to contractual arrangements for various inputs), an input-output model may provide reasonable estimates of impacts. In the long run, however, firms will change their input mix to minimize costs, in which case an input-output approach is likely to over-estimate impacts. The *Guidelines* also state that computable general equilibrium models are typically more appropriate for estimating impacts in the long run rather than in the short run due to their assumption that the economy is always in equilibrium. Given these differences in the time horizons captured in different types of economic models, SCAQMD's decisions regarding the use of specific methods for estimating small scale impacts will likely need to consider what time horizon is preferable for SCAQMD (short run versus long run) and which time horizons are feasible to capture with the analytic tools that estimate small scale impacts.

The *Guidelines* document provides minimal technical guidance on the development of small business impact analyses. While the document includes a section devoted entirely to small entity impacts, it focuses on the procedural requirements associated with the estimation of these impacts. As described in the document, the Regulatory Flexibility Act requires federal agencies to consider the potential economic effects of proposed regulations on small entities, including small businesses, small not-for-profit organizations, and small governmental jurisdictions. Agencies must use the definition of small business provided by the Small Business Administration. If a screening analysis cannot determine that a proposed rule will not have a "significant impact on a substantial number of small entities," then the economic impacts on small entities must be addressed in detail in the regulatory flexibility analysis. The *Guidelines* document notes that generally this includes a comparison of estimated compliance costs to small business revenues. However, no information is provided on methods for estimating compliance costs specifically for small businesses or sources of data for estimating the revenues and/or profits of small businesses affected by regulation.

EPA GUIDANCE FOR COMPLIANCE WITH THE REGULATORY FLEXIBILITY ACT

Similar to the discussion of small business impacts in EPA's *Guidelines* document, the Agency's guidance for rulewriters on compliance with the Regulatory Flexibility Act (RFA) focuses on the procedures for small entity impact analyses rather than analytic strategies for estimating such impacts. While the document does not provide detailed technical guidance, it outlines four basic steps for small business impact analysis:

1. ***Determine which small entities are subject to the rule's requirements.*** This discussion describes the statutory definition of small business and directs analysts to identify which of the entities affected by the rule are small businesses.

2. ***Select appropriate measures for determining economic impacts for small entities and estimate those impacts***. EPA states that the most appropriate method for estimating small business impacts typically depends on the data available and the methods used in the benefit-cost analysis of the rule. In most cases, the direct compliance cost method is the simplest approach. Under this approach, the compliance costs incurred by small entities (capital, operating maintenance, administrative, and other direct compliance costs) are compared to one or more financial metrics for regulated small entities, such as sales, profits, or operating expenditures. Conceptually, EPA maintains that comparing compliance costs to profits is the most accurate approach for determining whether a regulation will pose a significant economic burden on small businesses. Because of the difficulty in obtaining reliable profit data, however, a comparison of compliance costs and sales is the Agency's preferred approach.

3. ***Determine whether the rule may be certified as not having a significant impact on a substantial number of small entities (SISNOSE).*** EPA does not have firm threshold values for determining whether an impact to small entities is significant, though Agency analysts typically use cost-to-sales ratios of between one and three percent as *de facto* thresholds. EPA similarly has no established thresholds for determining whether the number of small entities facing significant economic impacts is substantial. Instead, the Agency notes that the circumstances of different rules would likely dictate different thresholds.

4. ***Document the analysis and include the appropriate RFA statements in the preamble to the rule.*** EPA notes that documentation of the screening analysis of small business impacts is usually contained within the regulatory impact analysis for the rule.

Overall, the EPA guidance for RFA compliance does not offer any insights into how to estimate impacts to small business or how to estimate their baseline revenues or profits. Nevertheless, the document's emphasis that no hard thresholds exist for what constitutes a significant impact or substantial number of small businesses suggests that a certain degree of flexibility in defining these terms would be appropriate for SCAQMD and other jurisdictions as well.

CHAPTER 4 | PAST SCAQMD CASE STUDIES

Between 2000 and 2002, SCAQMD worked with an external consultant to enhance the District's capabilities for evaluating the socioeconomic impacts of proposed rulemakings.[8] More specifically, the consultant was tasked with developing detailed methodologies for performing facility-based assessments (FBAs) and post-rule assessments. To demonstrate the recommended approach for FBAs, SCAQMD and its consultant produced two case study analyses of proposed SCAQMD rulemakings. The case studies examined Proposed Rule 1137, affecting the lumber and wood products industry in the LA Basin, and Proposed Amended Rule 1421, affecting dry cleaning operations in the region. Each case study includes the following four components:

1. **Industry Profile**, outlining the industries likely to be affected by the proposed rule, and the number and size of firms in each industry;
2. **Firm Profile**, identifying the operational and financial characteristics of average firms within each industry;
3. **Regulatory Impact Model**, estimating the projected compliance costs of the proposed rule based on the operational characteristics developed in the firm profile; and,
4. **Impact Assessment**, combining the regulatory impact model results and the financial characteristics from the firm profile to estimate the impacts of the proposed rule on firm profitability.

This process contains many elements that might provide greater insight into small business and small scale impacts than SCAQMD's standard socioeconomic assessment approach. In particular, the case studies highlight the importance of understanding the competitive landscape of directly regulated industries when estimating the incidence of regulatory compliance costs. The case studies also demonstrate different approaches of obtaining baseline financial data for use in small business impact assessment, as well as the variety of financial metrics against which SCAQMD might compare compliance costs incurred by small businesses.

Below we describe each of the case study components and in greater detail, as well as how they might inform future SCAQMD assessments of small scale and small business impacts.

[8] The discussion in this chapter is based on BBC Research & Consulting (2002).

INDUSTRY PROFILES

To generate profiles of impacted industries, the FBA case studies relied primarily on the U.S. Census Bureau's County Business Patterns dataset. This dataset provides estimates of the number of potentially affected firms within each industry (by county), and divides these firms into four different size classes defined according to the number of employees. Additionally, the case studies qualitatively examined factors and trends relevant to the affected industries that might influence the impact of the proposed rulemakings. Most notably, the case studies qualitatively assess whether affected firms face competition from businesses outside of SCAQMD's jurisdiction. To the extent that competition with firms in other regions is significant, the case studies concluded that regulated firms are not likely to be able to pass on higher costs to consumers. For instance, the lumber and wood products industry in the LA Basin competes in a national market, and thus LA firms are unlikely to be able to raise prices without losing market share to firms in the rest of the country. In contrast, dry cleaning companies typically provide services to a small local market, and thus may be able to raise prices in response to new regulatory compliance costs.

In the context of small scale or small business impact assessments, this understanding of the competitive landscape of an industry will have significant implications for estimating impacts to industry (on a small scale basis) and small businesses. In particular, if SCAQMD is interested in the ultimate incidence of impacts (rather than just resources expended by regulated industries) to small business and industries defined according to 6-digit NAICS codes, understanding whether firms are able to pass costs on to consumers will be important for estimating incidence.

FIRM PROFILES

For both proposed rules, the case studies developed separate firm financial profiles for businesses of varying sizes. To develop the firm profiles for the lumber and wood products rule, SCAQMD identified eight 4-digit SIC codes that are likely to be affected by the proposed rule. The District then developed a profile of the average firm in each of these industries based on national data from the Economic Census and the Risk Management Association (RMA). The profile included average revenues, expenses, and profit before taxes. Separate profiles were developed for the smallest affected firms (10-19 employees) and the largest affected firms (50-99 employees). Both case studies qualitatively discussed possible differences between firms in the LA Basin and the average firm at the national level.

For the dry cleaning rule, SCAQMD relied not only on the Census and RMA data to develop financial profiles, but also information collected directly from the local dry cleaning industry itself. Because dry cleaning is primarily associated with a single 4-digit SIC code, collecting financial data from regulated entities was a tractable proposition. Rather than asking regulated facilities for their own financial information, SCAQMD held a workgroup with dry cleaner facility owners to request input on the typical financial characteristics of dry cleaning operations of various sizes. These data were supplemented with the national data from the Economic Census and RMA described above.

The techniques used by SCAQMD to develop financial profiles based on firm size could be useful in future SCAQMD socioeconomic assessments that seek to analyze impacts on small businesses in greater detail. For some rules, financial data available at the national or regional level may provide a representative estimate of firm characteristics within the LA Basin. However, for rules that affect specific sectors with greater local variability in firm characteristics, such as the dry cleaning rule, direct outreach to business owners may be necessary to develop firm profiles based on varying firm sizes.

REGULATORY IMPACT MODELS

To estimate the compliance costs associated with the two proposed rulemakings, SCAQMD undertook data gathering processes that included strategies such as (1) a mail survey of potentially affected firms to ascertain current equipment and practices, (2) site visits to potentially affected firms, (3) interviews with compliance equipment vendors, (4) review of industry publications and sales brochures, and (5) review of the SCAQMD permit database. This targeted data collection effort allowed SCAQMD to develop separate compliance cost estimates based on firm size. For instance, for the lumber and wood products case study, SCAQMD estimated that the average firm with 10-49 employees would need to install an $800 shroud to comply with the proposed rule, while the average firm with 50-99 employees would need to install a $10,000 enclosure. Identifying potential differences in compliance costs based on firm size, as in the two case studies, could improve SCAQMD's ability to quantify differential impacts to small businesses in future socioeconomic assessments. Doing so would require a strong understanding of how firm (or facility) size affects per-facility compliance costs. With this knowledge, SCAQMD could develop facility-specific compliance costs for small business analyses or costs for representative model facilities. However, in situations where variables other than firm size are the main drivers of compliance costs, developing model facility costs specific to small businesses may not be feasible.

IMPACT ASSESSMENTS

To generate the final impact assessment for each case study, SCAQMD combined the compliance cost data from the regulatory impact model and the financial information from the firm profile. Because compliance costs and financial information were both estimated for small, average, and large size firms, SCAQMD was able to estimate impacts separately for each of these size classes. For each size class, SCAQMD estimated annual costs as a percentage of annual revenue, profits before taxes, and projected cash flow. Exhibits 4-1 and 4-2 below show the estimated impacts of the two proposed rules on small, medium, and large size firms.

EXHIBIT 4-1. PR 1137 POTENTIAL IMPACTS BY FIRM SIZE FOR SIC 2421 (SAWMILLS AND PLANING MILLS)

	SMALL FIRMS (10-19 EMPLOYEES)	AVERAGE FIRMS (20-49 EMPLOYEES)	LARGE FIRMS (50-99 EMPLOYEES)
Total Revenues	$1,877,000	$5,372,000	$13,747,000
# Employees	14	27	70
Depreciation	$46,000	$132,000	$337,000
Profit Before Taxes	$96,000	$177,000	$550,000
Annual Cash Flow	$142,000	$309,000	$887,000
Annual Costs	$2,897 to $3,914	$2,897 to $12,230	$5,162 to $54,535
Costs as a % of Cash Flow	2.0% to 2.8%	0.9% to 4.0%	0.6% to 6.1%
Costs as a % of Profit Before Taxes	3.0% to 4.1%	1.6% to 6.9%	0.9% to 9.9%
Costs as % of Revenues	0.2% to 0.2%	0.1% to 0.2%	0.0% to 0.4%
Note: This exhibit demonstrates the results for SIC 2421 (Sawmills and Planing Mills). BBC separately estimated impacts for 7 other 4-digit SIC code industries. Sources: Results obtained from BBC Research & Consulting (2002).			

EXHIBIT 4-2. PAR 1421 POTENTIAL IMPACTS BY FIRM SIZE (DRY CLEANERS)

	SMALL FIRMS (2 EMPLOYEES)	MEDIUM (7 EMPLOYEES)	LARGE (25 EMPLOYEES)
Average Annual Revenue	$150,000	$450,000	$960,000
Average Annual Pre-Tax Profit	$11,250	$33,750	$48,000
CLEANING			
Estimated Annual Costs	-$4,706 to $4,398	$4,209 to $12,105	$10,725 to $25,758
Costs as % of Revenue	-3.1% to 2.9%	0.9% to 2.7%	1.1% to 2.7%
Costs as % of Pre-Tax Profits	-41.8% to 39.1%	12.5% to 35.9%	22.3% to 53.7%
SOLVENT			
Estimated Annual Costs	$3,212 to $16,350	$2,528 to $16,501	$4,857 to $33,391
Costs as % of Revenue	2.1% to 10.9%	0.6% to 3.7%	0.5% to 3.5%
Costs as % of Pre-Tax Profits	28.5% to 145.3%	7.5% to 48.9%	10.1% to 69.6%
Sources: Results obtained from BBC Research & Consulting (2002).			

Consistent with the EPA guidance summarized in the previous chapter with respect to the assessment of small business impacts, SCAQMD's impact assessments in the two case studies include multiple metrics of impacts. While the SCAQMD case studies do not focus exclusively on small business, their comparison of costs to multiple financial metrics provides policymakers with a broad understanding of the economic context for the compliance costs associated with the two rules.

One potential limitation of SCAQMD's impact assessments in the two case studies is that they refer to 'firms' and 'facilities' interchangeably while developing compliance costs estimates, even though financial characteristics were developed at the firm level in the firm profile. As a result, the impact assessments seem to assume that all firms own a single facility. To the extent that single firms owns multiple facilities, and thus need to install separate abatement technologies at each facility, the impact assessments may underestimate costs at the firm level.

EARLIER SCAQMD SMALL BUSINESS ASSESSMENT METHODOLOGY

In 1988, SCAQMD also worked with an external consultant to develop a methodology for estimating impacts to small businesses resulting from air quality regulations.[9] The consultant also demonstrated how this framework could be applied through six case studies of existing SCAQMD regulations. The framework contained the following steps:

1. ***Determine regulatory requirements:*** Review the applicability of the rule to small businesses and identify which aspects of small business operations would be affected by the proposed rule.
2. ***Definition of a small business and compliance strategies:*** Decide on a definition of small business (the report recommends a cutoff of 10 or fewer employees), and identify how small business operations would need to change to comply with the proposed rule.
3. ***Estimate the potential costs of the regulation on small businesses:*** Develop engineering cost estimates for representative model plants based on the compliance strategies identified in Step 2.
4. ***Assess the degree to which compliance costs vary with the size of firms and/or plants:*** Compare compliance costs as a percentage of output for both small and large model plants.
5. ***Assess the feasibility and extent of small business cost pass-through to consumers***: Examine factors such as the potential for competition from firms outside the region, and the viability of substitutes for the regulated firms' products.
6. ***Determine the timing of small firm compliance cost pass-through:*** Examine factors that would affect the timing of cost pass-through such as the growth in demand for the regulated firms' products, the rate of capital turnover among regulated firms, and the ability of small firms to access external funds during the transition period.

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[9] ICF Consulting Associates, Incorporated. (1988). Small Business Economic Impact Study Final Report.

7. ***Evaluate contraction of industry given full compliance cost pass-through:*** Estimate changes in demand for the regulated firms' products based on elasticity values derived from either a literature review or qualitative discussion with industry experts.

8. ***Summarize economic impacts from all sources:*** Use the information generated in the prior seven steps to develop quantitative and qualitative estimates of potential impacts on small businesses.

Though much of this approach is similar to that outlined in the FBA approach from the 2002 report, this framework does provide some additional insights. In particular, this framework suggests a tiered analysis approach. If step 3 of the analysis framework indicates that the capital costs and non-variable operating and maintenance costs of a regulation are less than 2.5 percent of annual revenues, and variable costs are also low, then the consultant recommended that SCAQMD not continue with the remaining five steps in the analysis. Adopting a similar approach for future regulations would allow SCAQMD to focus greater time and resources on rulemakings that are likely to have comparatively large economic impacts.

CHAPTER 5 | MODELS

To incorporate small scale and/or small business impacts into its socioeconomic impact analyses, SCAQMD may rely upon economic modeling tools similar to REMI, the model that the District currently uses to assess socioeconomic impacts. In this chapter, we discuss six economic models that might help SCAQMD achieve this objective.[10] While some of these models could potentially be used as a replacement for REMI, they are more likely to be useful as complements to the REMI analyses that SCAQMD currently performs on a routine basis. Exhibit 5-1 summarizes the key features of these models. As indicated in the exhibit, the models that we examined include two input-output models (EMSI and IMPLAN), a small business impact model designed as a pre-processor and post-processor to REMI (the Business Size Impact Module), two linear programming models of the power generation sector (the Integrated Planning Model (IPM) and Haiku), and a market penetration model (TRUCK).

EXHIBIT 5-1. SUMMARY OF MODELS REVIWED

MODEL	MODEL TYPE	NAICS LEVEL	NUMBER OF INDUSTRIES	IMPACTS BY FIRM SIZE?
REMI Policy Insight Model[1]	Econometric Input-Output Model	2- to 4-digit NAICS	169	No
Business Size Impact Module	Pre/Post Processor to REMI	2 to 4-digit NAICS	169	Yes
EMSI I-O Model	Input-Output Model	6-digit NAICS	1001	No
IMPLAN	Input-Output Model	3 to 5-digit NAICS	517	No
IPM	Linear Programming Model	N/A	1	No
Haiku	Linear Programming Model	N/A	1	No
ReEDS	Linear Programming Model	N/A	1	No
CA-TIMES	Linear Programming/Partial Equilibrium Model	N/A	1	No
TRUCK	Market Penetration Model	N/A	N/A	No

Notes:
1. SCAQMD currently uses REMI in its socioeconomic impact analyses.

[10] This section focuses on "off the shelf" models that were designed for use in a variety of contexts. Models that were designed for specific analyses are discussed in Chapter 6.

We describe each of these models below, discuss how they might be applied to assessments of small scale and/or small business impacts, and identify their strengths and limitations.

BUSINESS SIZE IMPACT MODULE (BSIM)

The Business Size Impact Module (BSIM) was developed by REMI for the National Federation of Independent Business (NFIB) in the early 2000s. BSIM works in conjunction with the REMI Policy Insight Model to estimate the direct and indirect impacts of regulations by firm size. In communications with IEc, REMI confirmed that BSIM is compatible with newer versions of the REMI model.[11] To our knowledge, detailed documentation describing the module's calculations and assumptions is not available. However, we were able to gather some information about the model from a model user guide and summary level technical documentation provided by REMI, the NFIB's website, previous NFIB analyses, and conversations with NFIB and REMI representatives.[12,13]

To estimate impacts by firm size, BSIM requires users to enter compliance costs into the model separately for firms of different sizes. In multiple previous analyses, the NFIB has estimated impacts for the following size categories defined by number of employees: 1-4, 5-9, 10-19, 20-99, 100-499, and 500+. Communications with a REMI representative confirmed that BSIM is designed to accept inputs for these specific size categories. Compliance costs can be entered into BSIM on either a per-firm or per-employee basis. BSIM transforms these costs, by firm size, into REMI model inputs. These inputs are then run through REMI to generate the standard model outputs. Users must then input the REMI results back into BSIM to generate impact estimates by firm size. Exhibit 5-2 illustrates this sequence.

EXHIBIT 5-2. SCHEMATIC OF PROCESS FOR USING BSIM

While BSIM could potentially be used in conjunction with REMI to assess the small business impacts associated with SCAQMD policies, we are unable to assess the technical merits of BSIM due to the lack of thorough documentation describing the methodological basis for BSIM's calculations. This lack of transparency regarding BSIM's methods and assumptions would jeopardize the credibility of any SCAQMD analyses that rely on BSIM.

[11] Personal communication with Chris Brown, Managing Economic Associate, REMI. April 14, 2016.

[12] Personal communication with Michael Chow, Senior Data Analyst, NFIB Research Foundation. February 2, 2016.

[13] See Chow (2011a, 2011b, and 2012) and Regional Economic Models, Inc (2016a and 2016b).

EMSI INPUT-OUTPUT MODEL

Developed by Economic Modeling Specialists International (EMSI), the EMSI Input-Output Model estimates how changes in demand for one industry cascade across the broader economy. The standard outputs generated by EMSI include changes in employment, output, income, and value added. The model estimates direct, indirect, and induced effects, similar to REMI, though EMSI splits indirect effects into two categories. The first includes impacts to firms immediately upstream of the regulated industry (i.e., their suppliers), while the second category includes all other indirect effects.[14] An important advantage of EMSI in the context of small scale impact analysis is that it calculates economic impacts at the roughly 6-digit NAICS level, encompassing approximately 1,000 industries. This is a considerably greater level of sectoral detail than the 169 industries included in REMI. While not as widely used as the IMPLAN Input-Output model discussed below, EMSI has been used for several large-scale economic impact assessments of special events, major construction projects, and education systems.[15]

The EMSI model is based on the Bureau of Economic Analysis (BEA) U.S. I-O Model, which includes approximately 400 industries. These industries vary in their level of industry detail, ranging from 2-digit NAICS codes to 6-digit NAICS codes. EMSI disaggregates the BEA data to include 1,000 industries, corresponding roughly to the 6-digit NAICS level. To achieve this level of disaggregation, EMSI distributes all inter-industry sales in proportion to each 6-digit NAICS industry's share of the aggregated industry group earnings. This step assumes that the 6-digit NAICS industries within a broad industry group have the same production functions as the more aggregated industry group itself.

As an example of this disaggregation methodology, consider the BEA's input-output data for the "Lime and Gypsum Product Manufacturing" industry. This industry contains two 6-digit NAICS sectors, "Lime Manufacturing (NAICS 327410)" and "Gypsum Product Manufacturing (NAICS 327420)." To disaggregate the input-output matrix for the BEA industry to the two 6-digit NAICS sectors, EMSI distributes all sales and purchases associated with the BEA industry to the 6-digit NAICS sectors based on each sector's share of total aggregate industry earnings. Thus, if Lime Manufacturing were to account for 60 percent of the earnings in the Lime and Gypsum Product Manufacturing industry, then 60 percent of the total sales and purchases in the Lime and Gypsum Product Manufacturing industry would be allocated to Lime Manufacturing.

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14 Because EMSI estimates four categories of impacts, it uses slightly different naming conventions than are used for the three categories estimated by most other input-output models. More specifically, the four impact categories estimated by EMSI include initial, direct, indirect, and induced. Initial impacts are equivalent to direct impacts in other I-O models, and induced impacts are the same as in other I-O models. Direct impacts in EMSI are the first layer of indirect effects in other I-O models (i.e., one transaction upstream from the directly affected industry), while indirect impacts in EMSI correspond to the remaining indirect impacts in other IO models.

15 For example, one recent analysis examined the economic impacts of the Boeing plant closure in Long Beach. See Wright (2014).

It is important to note, however, that EMSI's disaggregation methodology does not produce entirely the same results as disaggregating all of the industry results of a less detailed IO model (*e.g.*,with 2-digit NAICS industry definitions) to the corresponding 6-digit NAICS subsectors in proportion to earnings. Like most IO models, EMSI's interindustry transactions are specified as sales between industries. To estimate the employment and earnings effects that correspond to changes in sales, EMSI uses employment-to-sales and earnings-to-sales ratios unique to each 6-digit NAICS code. Thus, for both indirect and induced effects, the employment and earnings multipliers differ across the 6-digit NAICS industries that fall within the broader industry definitions used in other models. In addition, because of the earnings-to-sales ratios unique to each 6-digit NAICS, the multipliers for induced effects estimated by EMSI also differ across 6-digit NAICS industries. For example, a change in sales for one 6-digitNAICS may correspond to a $1 million change in earnings within that sector while the same increase in sales for another 6-digit NAICS in the same broad industry group may lead to a $1.1 million change in earnings. Because induced effects are driven by the change in earnings for the directly affected industry, the multipliers for induced effects associated with the two industries are different.

An important limitation of EMSI is its assumption of a fixed input mix for each industry. While the REMI model allows producers to change their input mix in response to price changes, EMSI assumes fixed input ratios for all industries. As a result, the EMSI model would provide less reliable impact estimates for rulemakings that result in large price changes. In the short run, the input substitution effects associated with price changes may not be significant, but over time (i.e., in the long run) the substitution of production inputs could significantly affect the changes in output and employment associated with a change in policy. In the long run, these substitution effects may also have significant implications for the distribution of impacts across industries.

As an input-output model, EMSI is also limited in the variables that can be modified in the model to estimate the impacts of a given scenario. Specifically, unlike REMI or an equilibrium model, EMSI does not accept changes in production costs as inputs, but instead requires an exogenous change in demand, employment, or income for an industry. Applying EMSI in the context of a SCAQMD socioeconomic analysis would therefore require a separate analysis to estimate the change in one of these variables.

One potential option for addressing this limitation related to EMSI's use of inputs is to use EMSI in conjunction with REMI. Specifically, it may be possible to use REMI outputs as inputs for the EMSI model. For a given scenario, REMI produces estimates of the direct output and employment for the regulated industry. These estimates could serve as the basis for inputs to the EMSI model. Because REMI estimates impacts at the 2 to 4-digit NAICS level, the REMI projections of direct economic impacts would need to be disaggregated to the 6-digit NAICS level to serve as inputs to the EMSI model. This could be accomplished by distributing the projections of direct impacts for an aggregate industry in REMI to the relevant 6-digit NAICS codes in proportion to each sub-industry's share of output or compliance costs in the broader aggregate industry. This strategy would leverage the ability of the EMSI model to evaluate small scale impacts while maintaining the macroeconomic consistency of the REMI results for the directly affected industry. Furthermore, this strategy would allow SCAQMD to continue using compliance costs as inputs to the REMI model, instead of estimating changes in sales or earnings to input into the EMSI model.

To avoid double counting, the indirect and induced impact results estimated by EMSI for the directly regulated industry would need to be excluded from the EMSI results. Because the indirect and induced effects for the regulated industry are reflected in the REMI outputs used as inputs in EMSI, including the indirect and induced effects estimated by EMSI for the regulated industry would effectively result in double counting. Communication with EMSI confirmed that this approach would be methodologically sound.[16] However, EMSI noted that they are not familiar with any organizations that have used the model this way in the past.

Similar to this approach, SCAQMD could instead develop a partial equilibrium model for the directly affected industry(s) and use the directly estimated change in output for the directly regulated industry(s) as an input into EMSI. The feasibility of this approach would depend in large part on whether SCAQMD could develop a partial equilibrium model for the directly regulated industry.

As an alternative to these approaches, EMSI suggested that the impacts for each broad industry grouping in REMI could be distributed to the sub-sectors within each industry using the baseline distribution of output and employment for these sub-sectors in EMSI. For example, the 70-sector version of the REMI model estimates impacts for the two-digit NAICS code for Construction (23). In contrast, the EMSI model includes 31 six-digit NAICS codes that fall within the construction category, including Industrial Building Construction (236210), Highway, Street, and Bridge Construction (237310), and Electrical Contractors and Other Wiring Installation Contractors (238210). SCAQMD could estimate the impacts to NAICS code 23 using the REMI model, and then allocate these impacts to the 31 six-digit NAICS codes using the baseline distribution of output and employment included in the EMSI model.

The EMSI model is available in EMSI's 'Analyst' software subscription. Based on IEc's communications with EMSI, an annual subscription would cost approximately $10,500 for the counties within the SCAQMD region and $12,500 for the entire state of California.[17] SCAQMD could perform as many model runs as it wanted with either of these subscriptions. The version of the EMSI model available in the Analyst subscription, however, aggregates all results to a single region. Therefore, SCAQMD would not be able to identify differential impacts between the counties under its jurisdiction, and, if SCAQMD were to purchase the California version of the model, it would not be able to separate impacts for SCAQMD counties from the broader impacts for the state.

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[16] Personal communication with Brian Points of EMSI, April 18, 2016.

[17] Personal communication with Brian Points of EMSI, February 8, 2016.

IMPLAN

IMPLAN is an input-output model that shares many similarities with the EMSI model. Like the EMSI model, IMPLAN estimates economic impacts in terms of changes in employment, labor income, value added, and output, and distinguishes between direct, indirect, and induced effects. IMPLAN reports its results at the 3-4 digit NAICS level for the agricultural and service sectors, and at the 4-5 digit NAICS level for manufacturing industries. In the current version of IMPLAN, this amounts to 517 private industry sectors. While this level of sectoral detail is greater than that provided by REMI, it is significantly less detailed than the roughly 1,000 industries included in the EMSI Model. Because IMPLAN is an input-output model, it has the same limitations as the EMSI model (i.e., its assumption of fixed input ratios and its inability to use compliance costs as inputs).

Purchase of any IMPLAN data includes the latest version of the IMPLAN software. Data for the IMPLAN model are available with varying levels of geographic resolution. Data for 2014 cost $800 per county in California, or $4,270 for all counties within the state. Data can also be disaggregated from the county level to the ZIP code level at a cost of $1,130 per county or $10,770 for the entire state. The ability to calculate economic impacts at the county or ZIP code level is an advantage of the IMPLAN model over EMSI, which can only produce results for a single aggregated region.

The approaches described above for using the EMSI model as a means for estimating the small scale impacts of SCAQMD policies would also apply to IMPLAN. The results, however, would not be as detailed as those generated by EMSI because of IMPLAN's lower level of industry detail. In addition, as noted above, results generated by IMPLAN would not distinguish between the two categories of indirect impacts estimated by EMSI (i.e., impacts for suppliers to directly regulated industries and all other indirect impacts).

INTEGRATED PLANNING MODEL (IPM)

The Integrated Planning Model (IPM) is a dynamic linear programming model of the U.S. electric power sector. IPM was developed by the EPA with technical assistance from ICF International, and is used by the EPA to assess the impacts of rulemakings that affect the power sector.[18] For a given scenario, IPM identifies the least-cost approach to serving electricity loads subject to transmission, environmental, and other constraints. IPM disaggregates the U.S. electricity market into 32 model regions to provide a more accurate characterization of local electricity markets. SCAQMD falls within IPM's "California – South" region, as shown in the left panel of Exhibit 5-3.

IPM derives information on existing power generation plants from the EPA's National Electric Energy Data System (NEEDS) database. For computational efficiency, the model collapses power plants with similar characteristics into representative model plants defined according to features such as fuel type, capacity, technology type, model region, and applicable environmental regulations. For many analyses, EPA often translates

[18] The information presented here on IPM is based on IEc's experience with the model and U.S. EPA (2013).

IPM's model plant results to the plant level through a series of post-processing computations that the Agency refers to as "parsing."

EXHIBIT 5-3. ELECTRICITY MARKET REGIONS IN IPM AND HAIKU

IPM Regions

Haiku Regions

Plant level results developed through the parsing of IPM outputs provide a potential avenue for estimating small business impacts. For each plant, the parsed results include projections of capital and O&M costs. Deriving estimates of small business impacts from these data, however, would require targeted research on the ultimate corporate parent of each power plant in the SCAQMD region and the financial characteristics of each of these firms. In addition, because projected changes in plant-level costs in IPM's parsed results reflect changes in plant dispatch patterns (e.g., an increase in costs for a gas fired plant could reflect a shift in generation from coal plants to natural gas plants), analysis of the changes in costs for power plants owned by small firms would ideally consider any cost impacts relative to the generation changes projected for these plants.

The parsed results derived from IPM outputs could also inform assessment of the change in revenues and employment for small business in the electric power sector. In addition to cost projections for each power plant, the IPM parsed data include electric generation projections for each plant and projections of plants that will retire early under a given scenario. Estimates of a policy's revenue impact on small business may be estimated by multiplying the plant-level generation projections in the IPM parsed data by the model's projections of wholesale electricity prices. To estimate the extent to which early plant retirements lead to job losses among small businesses, SCAQMD could apply productivity estimates (employees per million dollars of output) to the baseline fixed O&M costs of plants that are owned by small businesses and projected to retire early. This approach is consistent with EPA's assessment of the Clean Power Plan's employment impacts (see Chapter 6).

As a single industry model, IPM would enable the estimation of small scale impacts only within the electric power sector. Although IPM's results do not specify the 6-digit

NAICS code for each power plant, the plant type indicated in the parsed data would allow SCAQMD to crosswalk plants with 6-digit NAICS codes within the electric power industry. However, similar to potential analyses of small business impacts based on the IPM parsed data, analyses of small scale cost impacts based on these data would ideally account for changes in generation that, in addition to abatement expenditures, might be responsible for some of the projected changes in costs.

HAIKU ELECTRICITY MARKET MODEL

Developed and maintained by Anthony Paul, Dallas Burtraw, and Karen Palmer of Resources for the Future, Haiku is a linear programming model of the electric power sector that estimates the least-cost approach for power producers to meet demand, subject to various physical and policy constraints.[19] Like IPM, the Haiku model is populated with model plants, created by aggregating generators with similar fuel types, capacity, geographic locations, and technological characteristics. Haiku divides the U.S. electricity market into 21 geographic regions. The CALS region includes SCAQMD as well as other counties in southeastern California. As shown in Exhibit 5-3, Haiku and IPM divide southern California into broadly similar electricity market regions.

The Haiku model is designed to provide analysis of numerous types of environmental regulations, including cap-and-trade programs, technology standards, emissions taxes, renewable portfolio standards, and renewable energy production tax credits. Additionally, unlike IPM, the Haiku model is designed to allow for the analysis of regulations that change electricity market structure, such as regulations that introduce retail competition into the electricity market.

Outputs from the Haiku model include electricity prices, generation, demand, and emissions. Haiku does not explicitly forecast impacts to small businesses, and unlike IPM, Haiku does not parse outputs relevant to model units back to individual power plants. As a result, Haiku is not likely to improve SCAQMD's ability to estimate impacts specific to small businesses. Additionally, Haiku is not publically available at present, so SCAQMD is not likely to be able to use the model for future analyses of rulemakings.

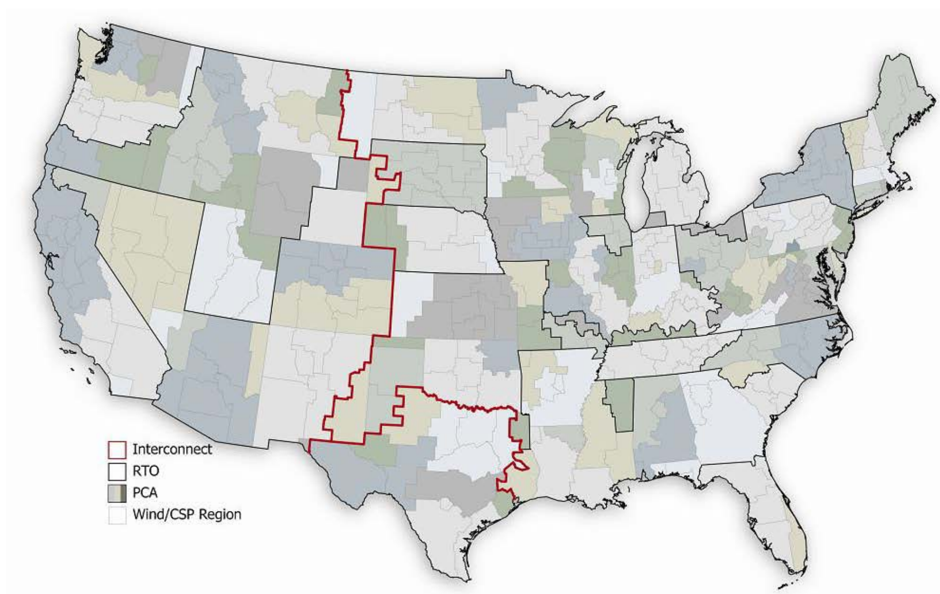
REGIONAL ENERGY DEPLOYMENT SYSTEM (REEDS) MODEL

The Regional Energy Deployment System (ReEDS) is another linear programming model of the electric power sector, developed by the National Renewable Energy Laboratory's (NREL's) Strategic Energy Analysis Center (SEAC). Similar to IPM and Haiku, the ReEDS model calculates the least-cost mix of electric power generation that will satisfy forecasted electricity demand, forecasted transmission constraints, and existing policy constraints. The primary outputs from the model include capacity and annual generation from each source of electricity, transmission and storage capacity, total electric sector costs, electricity and fuel prices, and carbon dioxide emissions. The ReEDS model calculates electric power generation outcomes for 23 two-year periods from 2006 to 2050.

[19] The discussion of Haiku presented here is based upon Paul et al. (2009).

The ReEDS model specializes in the analysis of clean energy policies, such as renewable energy standards and carbon restrictions. ReEDS contains 356 renewable resource regions across the continental United States based on detailed Geographic Information System (GIS) data on wind and solar resources, transmission lines, and existing plants. This high level of spatial disaggregation allows the ReEDS model to estimate the benefits of renewable energy technologies with greater accuracy than many other linear programming models of the electric power sector. The ReEDS model also contains four additional sets of regions based on varying levels of geographic aggregation. These regions include 134 Power Connect Authorities (PCAs), 31 reserve-sharing groups, 13 NERC regions, and three interconnects. This tiered system of geographic detail allows the ReEDS model to satisfy different types of electricity system constraints at differing spatial scales, depending on the spatial resolution of the relevant underlying data. Exhibit 5-4 demonstrates the spatial extent of the various regions reflected in the ReEDS model.

EXHIBIT 5-4. ELECTRICITY MARKET REGIONS IN THE REEDS MODEL



Like the Haiku model, the ReEDS model does not directly estimate impacts to small businesses, and does not provide the ability to view changes in electric power production at the plant level. As a result, the ReEDS model is unlikely to help SCAQMD improve its ability to evaluate impacts to small businesses.

CALIFORNIA TIMES (CA-TIMES) MODEL

Developed by the UC Davis Institute of Transportation Studies for the California Air Resources Board (CARB), the CA-TIMES model is an optimization model of the California energy system. The model was designed to improve CARB's understanding of the policies and technology adoption rates that would be necessary to achieve California's long term goal of an 80 percent reduction in GHG emissions below 1990 levels by 2050. Using a cost minimization approach, CA-TIMES simulates the technology and resource requirements needed to meet projected energy service demands for the commercial, residential, transportation, industrial, and agricultural sectors. Though CA-TIMES uses a similar modeling approach to the three electricity sector models discussed above, it includes a broader representation of energy supply and demand, capturing all segments of the California energy system.

Additionally, the CA-TIMES model incorporates a partial equilibrium approach, allowing demand for energy services to vary in response to changing electricity and fuel prices. The model uses own-price demand elasticities for 17 separate residential and commercial energy service technologies, and 13 transportation sector technologies. These elasticities are presented below in Exhibits 5-5 and 5-6. This approach may allow the CA-TIMES model to produce more accurate estimates of the impacts of various policy scenarios, as compared to the three electricity sector models that exogenously estimate demand for energy services.

EXHIBIT 5-5. TRANSPORT SECTOR ENERGY SERVICE DEMAND ELASTICITIES APPLIED IN CA-TIMES

ENERGY SERVICE DEMAND	LOW (INELASTIC)	HIGH (ELASTIC)	REPRESENTATIVE	SOURCE
Light-duty Passenger Travel	-0.034	-0.213	-0.1	Low from Hughes et al. (2008), High from Barker et al. (2009), Rep. is a mid value that is a little higher than Hughes et al.'s high value.
Motorcycles and Motorscooters Travel	-0.034	-0.213	-0.1	Low from Hughes et al. (2008), High from Barker et al. (2009), Rep. is a mid value that is a little higher than Hughes et al.'s high value. Assume motorcycles are similar to light-duty vehicles.
Light-duty Truck Travel	-0.034	-0.213	-0.1	Low from Hughes et al. (2008), High from Barker et al. (2009), Rep. is a mid value that is a little higher than Hughes et al.'s high value.
Heavy-duty Truck Travel	--	--	-0.213	Only one value found in Barker et al. Road transport category is used.
Medium-duty Travel	--	--	-0.213	
Transit Bus Travel	--	--	-0.213	
School Bus Travel	--	--	-0.213	
Intercity and Other Buses Travel	--	--	-0.213	
Commuter Rail Travel	--	--	-0.311	Only one value found in Barker et al. Rail transport category is used.
Heavy Rail Travel	--	--	-0.311	
Light Rail Travel	--	--	-0.311	
Intercity Rail Travel	--	--	-0.311	
Freight Rail Travel	--	--	-0.311	

EXHIBIT 5-6. RESIDENTIAL AND COMMERCIAL ENERGY SERVICE DEMAND ELASTICITIES APPLIED IN CA-TIMES

ENERGY SERVICE DEMAND	LOW (INELASTIC)	HIGH (ELASTIC)
Commercial-Space Cooling	-0.05	-0.15
Commercial-Cooking	0	-0.05
Commercial-Space Heating	0	-0.1
Commercial-Hot Water Heating	0	-0.1
Commercial-Lighting	0	-0.15
Commercial-Electric Equipment	0	-0.05
Commercial-Refrigeration	0	0
Residential-Space Cooling	-0.05	-0.15
Residential-Clothes Dryers	0	-0.05
Residential-Clothes Washers	0	-0.05
Residential-Dish Washers	-0.03	-0.05
Residential-Electric Appliances	-0.05	-0.2
Residential-Space Heating	0	-0.05
Residential-Hot Water Heating	0	-0.05
Residential-Cooking	0	0
Residential-Lighting	0	-0.1
Residential-Refrigeration	-0.03	-0.05

One limitation of CA-TIMES is that the model appears to generate only one set of outputs for the entire state. As a result, it may be difficult for SCAQMD to isolate the impacts of a proposed rulemaking within the district. Additionally, as with the Haiku and ReEDS models, CA-TIMES does not provide a method to estimate the impacts of regulations specifically to small businesses.

HEAVY VEHICLE MARKET PENETRATION MODEL

The TRUCK5.1 Heavy Vehicle Market Penetration Model was developed by TA Engineering, Inc. to forecast the future market penetration rate of alternative vehicle technologies.[20] The model was originally designed for use in the National Petroleum Council's Future Transportation Fuels Study, but the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy also uses TRUCK as one component of the Heavy Truck Energy Modeling System (HTEMS). Inputs to the model include the fuel type, anticipated maintenance and repair costs, and buyer preferences associated with various alternative vehicle technologies. For each future year, TRUCK calculates the annual fuel and maintenance cost savings associated with alternative technology vehicles relative to a baseline conventional fuels vehicle. These potential savings are compared to the projected purchase and operational costs of a new vehicle to determine the expected payback period associated with adoption of a new technology.

[20] The discussion of TRUCK presented here is based upon TA Engineering (2012).

To determine the rate of technology adoption associated with various payback periods, TRUCK relies on a survey of 224 motor carriers conducted by the American Trucking Association. Truck owners were asked to indicate whether they would consider purchasing an alternative technology vehicle given payback periods of various lengths. The proportion of truck owners willing to buy a new vehicle at payback periods of various lengths determines the annual technology adoption rate in the model.

The structure of TRUCK may be of interest to SCAQMD if the District needs to assess the impacts of policies that incentivize the use of alternative technologies. Because the model does not estimate compliance costs or other economic impacts, it would have limited applicability for assessments of small scale and small business impacts.

CHAPTER 6 | POLICY ANALYSES

In addition to the models described in the previous section, many prior economic analyses of environmental and energy policy may inform SCAQMD's development of methods for estimating small scale and/or small business impacts. Though many of these analyses use methods, models, or data tailored to a specific industry or analytic question (e.g., estimation of a rule's employment impacts), they include elements that could potentially be adopted for SCAQMD's purposes. We discuss several of these analyses below, describe their potential application or adaptation to meet SCAQMD's analytic needs, and identify the challenges that SCAQMD would likely encounter in applying these methods.

EPA REFINERY NESHAP

EPA's regulatory impact analysis (RIA) for the National Emissions Standards for Hazardous Air Pollutants (NESHAP) for petroleum refineries applies a partial equilibrium model to assess the rule's impact on the production and pricing of refined petroleum products.[21] More specifically, the model analyzes these impacts—as well as the corresponding changes in producer and consumer surplus—for five classes of petroleum products: (1) motor gasoline, (2) jet fuel, (3) distillate fuel oil, (4) residual fuel oil, and (5) liquefied petroleum gases. For each of these fuels, EPA specifies a relatively simple partial equilibrium model that assumes perfect competition among producers. Across producers, the model defines the change in quantity supplied as a function of the change in price and an exogenously specified elasticity of supply:

$$\text{(6-1)} \quad \hat{q}_s = \varepsilon_s \hat{p}$$

where $\hat{q}_s$ is the percentage change in quantity supplied, ε_s is the elasticity of supply and $\hat{p}$ is the percentage change in price.

The compliance costs associated with the rule are introduced into the model as a proportional shift in the marginal cost of production ($\widehat{mc}$). Under the assumption of perfect competition, EPA specifies this shift at the initial equilibrium as follows:

$$\text{(6-2)} \quad \widehat{mc} = \frac{c}{mc_0} = \frac{c}{p_0}$$

where c represents the per unit costs of the rule, mc_0 is marginal costs at the initial equilibrium, and p_0 is the initial equilibrium price.

[21] The discussion presented here is based upon information presented in U.S. EPA (2014).

Because the increase in per-unit revenues realized by refineries is the change in price less the increase in costs, the supply equation specified above can be written as follows under the rule:

$$(6\text{-}3) \quad \hat{q}_s = \varepsilon_s(\hat{p} - \widehat{mc})$$

Consistent with model's assumption of equilibrium, the percentage change in supply as specified in Equation 6-3 is assumed to be equal to the percentage change in demand:

$$(6\text{-}4) \quad \hat{q}_s = \hat{q}_d$$

The model specifies the percentage change in demand, $\hat{q}_d$, as follows:

$$(6\text{-}5) \quad \hat{q}_d = \eta_d \hat{p}$$

where $\hat{q}_d$ and $\hat{p}$ are as defined above and η_d is the elasticity of demand.

Taken together, Equations 6-3 through 6-5 represent three equations with three unknown variables ($\hat{q}_s$, $\hat{q}_d$, and $\hat{p}$). Solving this system of equations for each petroleum-based fuel yields the new market equilibrium.

For each of the five fuel classes, EPA's model uses supply and demand elasticities previously estimated by the Agency (U.S. EPA 1995). The demand elasticities reflect a review of the literature available at the time. Because supply elasticity estimates were not available in the literature, EPA econometrically estimated a single supply elasticity for all five petroleum product classes together. Exhibit 6-1 presents these demand and supply elasticities.

EXHIBIT 6-1. DEMAND AND SUPPLY ELASTICITIES APPLIED IN EPA REFINERY NESHAP

	GASOLINE	JET FUEL	DISTILLATE FUEL OIL	RESIDUAL FUEL OIL	LIQUEFIED PETROLEUM GAS
Demand elasticity	-0.69	-0.15	-0.75	-0.68	-0.80
Supply elasticity	1.24	1.24	1.24	1.24	1.24

Source: U.S. EPA (1995).

Overall, the partial equilibrium framework applied by EPA provides an analytically credible method for estimating small scale impacts, but only if elasticity parameters are available for the specific industries of interest. For goods with relatively large markets, such as petroleum products, demand elasticities may be available at the level of detail required to assess small scale impacts. For smaller industries whose goods and services are not as central to the functioning of the economy, however, such data are unlikely to be available, in which case more aggregate elasticity values could potentially be applied in conjunction with output data available for the more narrowly defined sub-sectors. As described further in Chapter 7 below and illustrated in EPA's refinery analysis, supply elasticity data are more limited than demand elasticities, though some values are available for aggregate industry groups. Even when sufficient data are available to apply the partial equilibrium approach, however, this approach does not capture indirect or induced small scale impacts, though such impacts are not likely to be significant for rules where directly affected industries make up a small portion of the economy.

SMALL BUSINESS IMPACTS

While EPA used this partial equilibrium model to estimate the market impacts of the refinery NESHAP, the Agency's assessment of the rule's small business impacts compares the annualized compliance costs of refineries owned by small businesses to the revenues of these firms. Consistent with the Small Business Administration's business size standards at the time, EPA considered a refinery to be small if its parent company employed fewer than 1,500 workers. To obtain information on the employment, sales, and other characteristics of refineries and their parent companies, EPA conducted a survey of refineries through the Federal government's Information Collection Request (ICR) process. Based on the compliance costs estimated for each refinery owned by a small business and the revenues of these refineries' parent companies, EPA determined whether the ratio of annualized compliance costs to annual sales for these companies exceeded 3 percent, which is the threshold that EPA routinely uses for determining whether a regulatory action results in a significant economic impact on a substantial number of small entities (SISNOSE).

Considering potential application to SCAQMD analyses, EPA's survey of affected refineries represents a useful approach for identifying the owner of each regulated facility and obtaining sufficient information to determine whether the facility is owned by a small business. If resources allow, SCAQMD could conduct similar industry surveys to inform the assessment of small business impacts for its rules. While the response rate for such surveys is likely to vary across industries, EPA's survey suggests that the response rate for industries dominated by relatively large facilities is likely to be high. These survey data could also be used to fill gaps in firm-level data obtained from Dun & Bradstreet and some of the other data sources discussed below in the data section of this report.

Regardless of the data collected to apply EPA's approach, an important analytic limitation of this method is that it captures small business impacts only for small businesses affected by the rule. To the extent that SCAQMD is interested in examining indirect impacts to small business, estimates based on EPA's approach would need to be supplemented with additional data.

EPA RIA FOR THE PORTLAND CEMENT RULE

To assess the economic impacts of the portland cement NESHAP, EPA's RIA for the rule applies a partial equilibrium model of the cement industry.[22] Unlike most partial equilibrium models, which assume perfect competition among producers, EPA's cement industry model assumes a regional oligopolistic industry structure due to two important industry characteristics. First, the products sold by different cement producers are nearly

[22] The discussion presented in this section is based upon U.S. EPA (2010b).

identical. Second, because of the high costs of transporting cement, each region has a limited number of cement sellers, each of which has a considerable share of the regional market. In the short and intermediate run, the high regional market share for each producer is maintained due to the high capital costs associated with entry into the portland cement market.

Given the model's assumption of an oligopolistic market structure, its specification of the baseline differs from the baseline that would be realized under perfect competition. Because producers individually represent a large portion of the regional market in the EPA model, the amount of cement that each produces may affect the market price for cement. Thus, when determining how much output to produce, cement makers consider the extent to which producing one more ton of cement may lower the market price and reduce profits on all cement sold. This distortion in the market also raises the price of cement relative to a world with perfect competition, as more limited production makes cement scarcer than it otherwise would be. In contrast, under perfect competition, firms are price takers and do not limit production with the expectation that their actions affect prices.

To estimate the impacts of a regulatory scenario, the model estimates the value of four unknown variables: (1) the change in domestic production, (2) the change in imports, (3) the total change in supply, and (4) market demand. The model's approach for estimating each of these is as follows:

Domestic Production. To estimate the impact of regulatory compliance costs on industry output, the model assumes that the change in marginal revenue must equal the change in marginal costs for each plant. Under the assumption of an oligopolistic market structure, this equality is represented in the model as follows for plant *i*:[23]

$$(6\text{-}6)\quad dprice \times \left(1 + \frac{mkt\ share_i}{\eta}\right) + \frac{dplant\ q}{marketQ} \times \frac{price}{\eta} - \frac{dmarketQ}{(marketQ)^2} \times plantq \times \frac{price}{\eta} = dmarginal\ cost$$

where η is the elasticity of demand. Under a given scenario, the change in plant *i*'s production is set so that the condition above holds.

Imports. EPA's model recognizes that a portion of cement demand in the U.S. is met through imports. The model's approach for estimating the change in imports associated with a given scenario is represented by the following equation:

$$(6\text{-}7)\quad dimports = import\ supply\ elasticity \times \left(\frac{dprice}{baseline\ price}\right) \times baseline\ imports$$

As indicated in the above equation, EPA's estimation of cement imports is dependent on the value of the import supply elasticity. Based on empirical results from Broda et al.

[23] This equation reflects two key assumptions in the Cournot price model: that a plant's own production decisions affect market prices and that a plant's output decisions do not affect those of any other plants.

(2008) for commodities imported into the U.S., the EPA model assumes an import supply elasticity of 2.0 (i.e., a one percent increase in prices results in a two percent increase in the volume of exports).

Total Change in Market Supply. The total change in market supply is estimated as the change in domestic production plus the change in imports.

Change in Market Demand and Pricing. To estimate changes Portland cement pricing and the demand for Portland cement, EPA's model applies the following market demand condition:

(6-8) $$dmarket\ Q = \eta\left(\frac{dprice}{baseline\ price}\right) \times baseline\ consumption$$

where η is the elasticity of demand as specified above. The model assumes a demand elasticity of -0.88, which EPA econometrically estimated for a previous analysis (EPA, 1998). The value of *dprice* is modified in the model until the demand estimate generated from this equation converges with the model's estimate of total supply.

This partial equilibrium model serves as the basis for one of the two approaches that EPA used to estimate the employment impacts of the Portland cement NESHAP. Based on the changes in supply and demand projected by its partial equilibrium model, EPA's first approach assumed that the number of jobs would change in proportion to the estimated change in industry output. This approach effectively assumes constant output per worker across all cement manufacturing facilities.

As an alternative to this approach, EPA also estimated the employment impacts of the rule using the findings of an empirical study by Morgenstern et al. (2002). This study, which focuses on the pulp and paper industry, plastic manufacturers, petroleum refiners, and iron and steel mills, decomposes the impact of increased environmental regulation into three employment effects:

- The demand effect which considers the employment losses due to the reduced quantity of output demanded. *A priori*, the demand effect will have a negative impact on employment because as production costs rise, output prices rise. This causes demand to fall, resulting in a reduction in employment. This is the effect captured in EPA's employment impact estimate derived from the partial equilibrium model.

- The cost effect which considers changes in employment due to the higher costs of production. Economic theory suggests that the cost effect will have a positive impact on employment because as production costs rise, including labor, more inputs are used to produce the same amount of output; and

- The factor-shift effect which considers the labor intensity of environmental activities. Theory suggests that the factor-shift effect will be positive if environmental activities are more labor intensive than conventional production activities.

Applying the findings of the Morgenstern et al. (2002) paper, EPA estimated a net increase in employment, which reflected job gains related to the cost and factor-shift effects and job losses associated with the demand effect. In contrast, the approach derived from the partial equilibrium model suggested a decline in employment approximately equal to the losses associated with the demand effect in Morgenstern et al.

Taken together, EPA's partial equilibrium model of the cement industry and its accompanying assessment of employment impacts include a few elements that might aid SCAQMD in the assessment of small scale impacts under certain circumstances. In particular, the method employed by EPA for estimating changes in production and prices in the context of oligopolistic competition could be transferable to other industries in the area covered by SCAQMD programs. EPA's integration of domestic production with imports could also be important for assessing impacts to industries with significant foreign competition.

Despite these useful elements in EPA's approach, several of its shortcomings might limit its transferability to assessing the small scale impacts of SCAQMD programs. For example, while EPA's model develops robust impact estimates for the cement industry, it does not capture any of the indirect and induced effects associated with air policy. In industries such as cement that have strong connections with other industries (e.g., construction), ignoring spillover effects to other industries risks painting an incomplete picture of a policy's economic impacts. Focusing on direct impacts only would ignore SCAQMD's mandate to consider the impacts of its initiatives on the regional economy. While the employment impacts that EPA estimated based on Morgenstern et al. (2002) capture some indirect effects, the Morgenstern et al. study was specific to just four industries examined at the national level. In most circumstances, the results of this study are unlikely to be transferable to the myriad industries that make up southern California's economy.

SMALL BUSINESS IMPACTS

In addition to the partial equilibrium analysis summarized above, EPA's RIA for the Portland Cement NESHAP includes an assessment of the small business impacts of the rule. This analysis of small business impacts consists of the following three-step process:

1. ***Identify small entities.*** For each cement plant, EPA identified its ultimate corporate parent and determined whether the parent company qualified as a small business according to the Small Business Administration size standards using "industry information and publicly available sales and employment databases." Based on the sources identified in the table presenting parent company information in the RIA, Dun & Bradstreet and LexisNexis are the likely sources of this information.[24] Those facilities whose corporate parents qualified as small businesses under the Small Business Administration definition were considered small for the purposes of EPA's analysis.

2. ***Compiled financial data for small entities.*** To enable comparison of regulatory compliance costs with corporate revenues, EPA compiled data on the revenues of each small company. These data were compiled from the same sources specified

[24] We discuss Dun & Bradstreet and LexisNexis in greater detail in Chapter 7.

above for the identification of small entities. EPA summed across the plants owned by a given small entity to estimate total revenues for each small business.

3. ***Compare compliance costs to revenues.*** As a final step in its small business analysis, EPA calculates the ratio of compliance costs to sales for each small entity to determine whether annualized costs exceed three percent of annual sales for any affected entity. This three percent value is the threshold that EPA routinely uses to determine if regulatory compliance costs are significant for a given small entity.

EPA's analysis found that the rule did not result in annualized costs exceeding 3 percent of sales for any affected small entity.

While EPA's small business analysis did not compare compliance costs to profits, the Agency did estimate the baseline profits of affected companies and the decline in profits implied by the changes in cement prices and cement production estimated by the partial equilibrium model. To estimate baseline profitability, EPA assumed that each plant's profits were equal to the median operating profit margin (16 percent) reported by the Portland Cement Association (2008). This profit margin was also applied to the change in revenues associated with the regulatory scenario to estimate the change in profits. This change totaled less than $1 million across all small entities.

EPA's approach for estimating small business impacts for the Portland cement rule would be transferrable to some but not all SCAQMD assessments of such impacts. For policies affecting a well-defined universe of facilities owned by publicly traded companies for which SCAQMD has estimated compliance costs, most of the effort in applying EPA's approach would go into the identification of small entities and the compilation of their financial data. The data sources used by EPA could serve as the source for this information. For rules affecting privately held facilities, many of which are small, SCAQMD would need to apply a different approach to estimate baseline revenues.

Other limitations associated with EPA's approach relate to the scope of small business impacts estimated. While EPA goes to great lengths to estimate compliance costs for small entities relative to baseline revenues, impacts such as employment dislocations and facility closures among small businesses would also be of interest to policymakers and the public. Similarly, EPA's analysis includes a detailed treatment of direct small business impacts, but does not assess indirect changes in costs, employment, or output for small business.

CLEAN POWER PLAN EMPLOYMENT ANALYSIS

Differing significantly from the partial equilibrium analyses in the refinery, cement kiln, and boiler rule RIAs, EPA's RIA for the final Clean Power Plan integrates the outputs of a detailed industry (power sector) model with industry cost and productivity data to estimate the Clean Power Plan's employment impacts.[25] EPA's analytic strategy of linking model outputs with industry data may provide useful insights that could inform

[25] The discussion presented here on the methods applied in this RIA is based upon U.S. EPA (2015).

SCAQMD's analysis of small scale economic impacts. This section describes EPA's approach in detail and explains how it might be adapted to meet SCAQMD's analytic needs.

EPA's analysis considers two broad categories of employment impacts: supply-side employment impacts and demand-side effects. The former includes the following:

- One-time employment associated with investments in heat rate improvements at coal-fired power plants;
- Construction-related employment for the installation of specific types of generating capacity (i.e., renewables, natural gas combined cycle, and combustion turbines);
- Lost construction-related employment associated with generation investments foregone due to the reduction in electricity demand associated with demand-side energy efficiency measures implemented under the rule;
- Lost operating and maintenance labor due to the early retirement of coal and small oil/gas units, and
- Employment changes (both positive and negative) in the coal and natural gas industries due to changes in the electricity generation mix associated with the rule.

The demand-side employment impacts estimated by EPA include the labor associated with the incremental expenditures on the manufacture and installation of energy efficiency goods (e.g., more efficient air conditioners, insulation, etc.).

EPA's approach for estimating each of these effects is as follows:

Employment associated with heat rate improvements. EPA estimated the employment impacts related to heat rate improvements (HRI) based on the incremental HRI costs incurred under the rule, as projected by EPA's Integrated Planning Model (IPM).[26] Drawing on information for proxy projects assumed to be representative of the activities associated with heat rate improvements, EPA split the incremental HRI costs projected by IPM across four broad categories (see Exhibit 6-2): (1) boilermakers and general construction, (2) engineering and management support labor, (3) equipment, and (4) materials (assumed to be primarily steel). To convert the cost values for each of these categories to employment impact estimates, EPA divided the cost values by the estimated output per worker (i.e., productivity) for each industry, as obtained from BLS data and summarized in Exhibit 6-2. The Agency applied productivity estimates for power sector construction (NAICS 237130) to the boilermaker and general construction costs, engineering services (NAICS 54133) to engineering and management costs, machinery manufacturing (NAICS 333) to equipment costs, and steel manufacturing (NAICS 3312) to material costs. The sum of the resulting four values represents the increase in employment associated with HRI. These employment impacts represent a one-time effect, as HRI is assumed not to require any operating or maintenance labor.

[26] See Chapter 5 for a summary of the model.

EXHIBIT 6-2. LABOR PRODUCTIVITY RELATED TO HEAT RATE IMPROVEMENTS

	SHARE OF TOTAL HRI CAPITAL COSTS	OUTPUT/WORKER (2025)
Boilermaker and General Construction	40%	$78,500
Management/Engineering	20%	$156,000
Equipment	30%	$542,000
Materials	10%	$600,000

Sources: Derived from Andover Technology Partners and BLS, as referenced in U.S. EPA (2015b).

Employment related to building (or avoiding) new generation capacity. EPA estimated the employment impacts associated with changes in new combined cycle, combustion turbine, and renewable generating capacity based on IPM projections of changes in capacity, the corresponding capital costs, and fixed O&M costs. To estimate the change in one-time employment impacts associated with changes in construction, EPA first distributed the incremental change in capital costs for each generating technology across the four broad categories shown in Exhibit 6-3 based on budgets published by the National Energy Technology Laboratory. For example, using the distribution shown in Exhibit 6-3, a combined cycle generation project costing $20 million would include $13 million in equipment costs ($20 million × 0.65), $2 million in material costs, $3.6 million in installation labor costs, and $1.4 million in engineering and construction management. To estimate the employment associated with these costs, EPA multiplied these costs by the productivity values (workers per million dollars of output) shown in Exhibit 6-4.

EXHIBIT 6-3. DISTRIBUTION OF CAPITAL COSTS FOR NEW GENERATING CAPACITY

	EQUIPMENT	MATERIAL	LABOR	ENGINEERING AND CONSTRUCTION MGT.
Renewables	54%	6%	31%	9%
Combined Cycle	65%	10%	18%	7%
Combustion Turbine	65%	10%	18%	7%

Source: Derived from Staudt (2014), as referenced in U.S. EPA (2015b).

In addition to estimating the labor associated with (avoided) power plant construction, EPA also estimated the annual O&M employment associated with changes in generating capacity. To develop these estimates, EPA multiplied IPM's projections of the change in fixed operating and maintenance costs for each model run year by the productivity value for plant operators shown in Exhibit 6-4.

EXHIBIT 6-4. LABOR PRODUCTIVITY RELATED TO NEW GENERATING CAPACITY

CATEGORY[1]	WORKERS PER MILLION $ (2012)
Equipment Use (Machinery)	2.1
Material Use (Steel)	1.9
General Power Plant Construction	5.0
Engineering and Management	4.7
Plant Operators	9.9

Notes:
The Equipment Use, Material Use, General Power Plant Construction and Engineering and Management values are used for the calculation of employment associated with plant construction. The value for Plant Operators is used in estimating employment associated with power plant operations and maintenance.

Source: Derived from BLS, as referenced in U.S. EPA (2015b).

Employment impacts due to coal and oil/gas retirements. EPA's IPM modeling for the Clean Power Plan projects that several MW of coal and oil/gas steam capacity will be retired early as a result of the rule. To estimate the employment losses associated with these early closures, EPA followed a two-step process. First, the Agency estimated the fixed operations and maintenance costs associated with existing coal-fired and oil/gas-fired units in the base case, as projected by IPM and shown in Exhibit 6-5 below. Second, EPA converted these fixed O&M costs to lost employment using output/worker estimates derived from the Economic Census and BLS.

EXHIBIT 6-5. AVERAGE FIXED OPERATIONS AND MAINTENANCE COSTS FOR EXISTING COAL AND OIL/GAS STEAM CAPACITY ($/KW, 2011$)

	2020	2025	2030
Coal	$70	$73	$74
Oil and Gas	$34	$33	$33

Source: Derived from baseline simulation of the Integrated Planning Model (IPM).

Employment impacts due to changes in fossil fuel extraction. The shift from coal-fired capacity to natural gas combined cycle units under the Clean Power Plan will lead to employment losses in the coal mining industry and employment gains in natural gas extraction. To estimate losses in the coal mining industry, EPA applied regional coal mining productivity values (measured in short tons per employee hour) obtained from the Energy Information Administration to IPM projections of changes in regional coal production. For employment related to increased natural gas extraction, EPA followed a similar approach, based on IPM's projected change in power plant natural gas demand. Most data sources related to productivity in the gas sector, however, combine oil and gas into a single industry. To derive a productivity value specific to natural gas, EPA adjusted the labor productivity value for the combined oil and gas sector based on the relative contributions of oil and natural gas to the industry's total output.

EPA's methods for estimating the employment impacts of the Clean Power Plan, as described above, could potentially be adapted for estimating at least a portion of the small scale employment impacts associated with SCAQMD policies and programs. In particular, EPA's approach could be useful for estimating the employment associated with pollution abatement activity. While the partial equilibrium approach described in the previous section might serve as the basis for estimating changes in output and employment in directly regulated industries, it does not capture employment impacts in the pollution abatement sector. To estimate the employment impacts for this sector at a fine level of industry detail, SCAQMD could apply detailed productivity data such as that used by EPA to estimates of abatement expenditures associated with a given policy or program. Following this approach, however, would require SCAQMD to allocate abatement expenditures between equipment vendors inside the region and outside the region and to specific industries, defined by (6-digit) NAICS. SCAQMD could potentially obtain the information necessary for this allocation from regulated entities themselves. For example, SCAQMD could survey 30 or 40 facilities to ask them about the vendors they use for pollution abatement. With these vendors identified, SCAQMD could determine which 6-digit NAICS codes constitute the pollution abatement sector for a given initiative and the extent to which regulated facilities purchase abatement equipment from firms within the region.

EPA's approach may also be useful for assessing the employment impacts associated with major changes in the input mix of directly affected industries (e.g., fuel switching from coal to natural gas). Because these represent employment impacts to the suppliers of directly regulated industries, they would not be captured in a partial equilibrium framework. The estimation of these impacts would require estimates of the reduction in use of one input and the increase in the use of another. In addition, in the context of an analysis focusing on the SCAQMD region, it would be necessary to account for the extent to which the changes in input mix affects firms within the region versus outside the region.

For industries directly regulated by SCAQMD initiatives, EPA's approach of applying productivity estimates, measured as output per worker, to the estimated change in industry output would likely yield similar results as assuming that the change in employment is proportional to the change in industry output. Because the ratio of output to employment is fixed under EPA's approach, it effectively assumes a proportional relationship between output and employment.

Unlike SCAQMD's current REMI-based approach, the EPA method does not fully capture the indirect and induced impacts associated with a policy change. Such impacts may be significant for rules that result in significant compliance costs or that affect industries with close ties to other sectors in the local economy.

EPA BOILER NESHAP REGULATORY IMPACT ANALYSIS

EPA's NESHAP for new and existing industrial, commercial, and institutional boilers and process heaters affects emissions sources across several industries in the U.S. economy, many of which are inter-dependent.[27] To assess the economic impacts of the rule, EPA developed and applied a multi-market partial equilibrium model of the U.S. economy. This model shares many of the same characteristics as the refinery sector model described above, but builds on this model by representing 100 distinct industry groupings. These industries are linked in the model based on their use of energy and other resources, as represented by input-output information obtained from EPA's computable general equilibrium model of the U.S. economy. While supply and final demand within the model respond to changes in price, the input-output relationships for each industry are fixed. Thus, the model's results represent economic impacts in the short run (i.e., transitional impacts) associated with a change in policy.

Within EPA's multi-market model framework, an industry changes production in response to changes in the "net" market clearing price of goods and services under a given policy scenario. As shown in Equation 6-9 below, the net change in price from a producer's perspective reflects the change in the market price, less the additional costs incurred by the producer (both directly and indirectly) as a result of the policy.

(6-9) %Δ "net" price = %Δ market price - %Δ direct costs - %Δ indirect costs

EPA estimates the %Δ direct costs in Equation 6-9 based on its engineering cost analysis for the rule and the baseline value of output in a given industry. The %Δ indirect costs is a function of the percentage change in unit costs for other industries that provide inputs to the industry in question and input use ratios that reflect the extent to which the industry in question relies on other industries for production inputs, as summarized in Equation 6-10. EPA's model assumes that the input ratios for a given industry are fixed and, as such, do not respond to changes in market prices.

(6-10) %Δ indirect costs = input use ratio × %Δ input price

Consistent with the formulations above, EPA's model uses the following general form for the supply function of U.S. industries:

$$(6\text{-}11) \quad Q'_g = b\left(P'_g - t - \sum_{i=1}^{n} \alpha_{gi}(P'_i - P_i)\right)^{\varepsilon_g}$$

where

Q'_g= with-policy domestic supply quantity for industry *g*

b = calibrated scale parameter for the relationship between price and supply

P'_g= with-policy supply price for output from industry *g*

t = direct compliance costs per unit of supply

[27] The discussion presented here on the methods applied in this RIA is based upon U.S. EPA (2011).

α_{gi}= input use ratio (industry g using input i)

P_i'= with-policy input (i) price

P_i= benchmark input (i) price

ε_g= price elasticity of supply for output (g)

In addition to the domestic supply represented in Equation 6-11, EPA's multi-market model also estimates supply from non-U.S. producers, as shown in Equation 6-12.

$$(6\text{-}12)\quad Q_g^{\prime,ROW} = c\left(P_g'\right)^{\varepsilon_g^{ROW}}$$

where

$Q_g^{\prime,ROW}$= with-policy rest-of-world (ROW) supply quantity for industry g

c = calibrated scale parameter for the relationship between price and ROW supply

P_g'= with-policy supply price for output from industry g

ε_g^{ROW}= price elasticity of supply of goods from the ROW to the United States (imports)

As shown in Equations 6-11 and 6-12, the key parameter that influences the supply response to changes in price—both for U.S. and ROW producers—is the elasticity of supply (ε_g and ε_g^{ROW} for U.S. and ROW producers, respectively). EPA's specification of supply elasticities in the multi-market model for both U.S. and ROW supply draws from the ROW inverse supply elasticities derived in Broda et al. (2008). While EPA would have ideally used empirically-derived estimates for U.S. producers, the Agency was aware of no empirical work that examined the short run supply elasticities of all the industry groups included in the model. In the absence of such data, EPA applied the following three-step approach to approximate U.S. supply elasticities from the Broda et al. analyses:

1. ***Identify "low" and "medium" elasticity values.*** Because EPA's model is designed to assess market impacts in the short run, the Agency limited its analysis of elasticities from Broda et al. to those characterized as "low" and "medium" values. These values would be consistent with suppliers having less flexibility in responding to changes in price.

2. ***Group and average elasticity values from Broda et al.*** As described in Chapter 7, Broda et al. estimate more than 1,000 inverse supply elasticities, defined according to Harmonized Trade System (HTS) codes, many of which correspond roughly to 5- and 6-digit NAICS codes. To develop elasticity values for the more aggregated industries (3- or 4-digit NAICS codes) in EPA's multi-market model, the Agency grouped the inverse supply elasticities from Broda et al. that correspond to the more aggregated industry sectors and calculated the average.

3. ***Adjust for domestic producers.*** EPA assumes that the domestic supply elasticity for a good would be less than the export supply elasticity for non-U.S. producers.

To account for this difference, EPA calculated the standard deviation for each 3- and 4-digit NAICS sample specified in Step 2 and added these values to the averages estimated for each sample group. The inverse of the resulting value represents the supply elasticity that EPA included in the multi-market model for domestic supply.

To estimate the supply elasticity for non-U.S. supply, EPA followed the same approach as outlined above, but without adding the standard deviation for each 3- and4-digit NAICS sample.

EPA's multi-market model includes three categories of demand for each industry's goods/services: investment/government use, domestic intermediate uses (i.e., as inputs used by other industries), and final use (domestic and exports). Because EPA's model assumes a short run time horizon, investment/government use is assumed to remain unchanged relative to the baseline. In addition, the model estimates intermediate use based on the fixed input use ratios included in the model and the estimated output decisions of each industry, as represented by the following equation.

(6-13) $$Q_i' = \alpha_{gi} Q_g'$$

where

Q_i'= with-policy input intermediate use demand quantity from industry *i*

α_{gi}= input use ratio (industry g using input i)

Q_g'= with-policy output quantity for industry g.

To estimate demand associated with final use, EPA's model applies the following function:

(6-14) $$Q_g' = a\left(P_g'\right)^{\eta_g}$$

where

Q_g'= with-policy demand for output from industry g

a = calibrated scale parameter for the relationship between price and the demand for output from industry g

P_g'= with-policy price for output from industry g

η_g= price elasticity of demand for output from industry g

As suggested by Equation 6-14, the key parameter that influences demand is the price elasticity of demand (η_g). The EPA model uses demand elasticity estimates that were simulated by the general equilibrium model in Ho et al. (2008).

Overall, the multi-market partial equilibrium model that EPA developed may not be easily transferable to analyses of the small scale impacts of SCAQMD policies and programs. The industry definitions used in the model are less detailed than those in the model that SCAQMD currently uses (REMI). In addition, EPA designed the model for assessments of national rather than regional impacts. Adapting the model to a region such as southern California would require additional calculations and data to isolate impacts specific to the region. Despite these limitations, EPA's use of the model highlighted sources of supply and demand elasticity values that could be of use to SCAQMD. The analysis also demonstrated strategies for aggregating the (non-U.S) supply elasticity values and scaling them to better reflect elasticities for U.S. industries.

SMALL BUSINESS IMPACTS

EPA's analysis of the small business impacts associated with the Boiler NESHAP applied two distinct approaches for estimating these impacts. Under the first approach, EPA estimated the ratio of compliance costs to sales (i.e., the sales test) for representative establishments by 3-digit NAICS code. For each NAICS, EPA estimated the ratio as a range, with the low and high ends of the range reflecting the minimum and maximum small entity facility-level compliance costs estimated by EPA for each 3-digit NAICS code. The sales estimates for each NAICS were obtained from the U.S. Census Bureau's Statistics of U.S. Business (SUSB), which includes national information on the distribution of economic variables by industry and enterprise size. For the purposes of computing the cost-to-sales ratio, EPA used the sales estimates for the size category(s) considered small for each NAICS, according to the SBA regulations. As noted above, EPA estimated the cost-to-sales ratio at the establishment (facility) level. While it would be more appropriate to perform the analysis for representative enterprises (which may operate multiple establishments) rather than for representative establishments, the data from the Census did not support analysis at the enterprise level.

Under EPA's second approach, the Agency performed a more detailed assessment of small business impacts for a sample of 50 facilities identified as being owned by a small entity in the survey of boiler operators that EPA conducted in support of the rule. For these 50 facilities, EPA identified the ultimate parent company and collected the most recent sales data. Using these data in conjunction with the compliance costs of affected facilities, EPA estimated the ratio of compliance costs to sales for the companies that own the 50 sampled facilities. The average cost-to-sales ratios under this approach were lower than those estimated under the first approach.

The methods applied by EPA demonstrate the data required for a precise analysis of small business impacts for rules affecting many facilities (illustrated by EPA's second approach) and strategies for approximating potential small business impacts when the data required for a precise analysis are unavailable (illustrated by EPA's first approach). In situations where SCAQMD is able to identify each facility affected by a policy and obtain information on its ultimate corporate parent, the second approach applied by EPA would be appropriate. It is unclear, however, that SCAQMD would be able to identify the corporate parent of each facility under all circumstances. Absent such information, the first approach described above would likely yield a conservative estimate of the cost-to-sales ratio for small businesses relative to the second approach, because it would rely on establishment level revenue estimates rather than enterprise-wide revenues.

In the context of potential SCAQMD applications, it is also important to acknowledge two important limitations of EPA's methods. First, neither captures the indirect or induced economic impacts of a policy on small businesses. For rules with relatively small impacts to industries not closely linked with other sectors of the local economy, this limitation is unlikely to be significant. However, for policies that result in more significant impacts for industries closely linked to the local economy, not capturing indirect or induced effects may have implications for the conclusions drawn from the small business analysis. The second limitation of EPA's methods is that costs are compared to sales rather than profits. While the cost-to-sales approach is standard practice in EPA small business analyses, SCAQMD prefers to assess costs relative to the profits of affected firms.[28]

COMMERCIAL REFRIGERATION EQUIPMENT ENERGY EFFICIENCY STANDARDS

In 2014, the U.S. Department of Energy (DOE) conducted an analysis of the impacts of proposed energy efficiency standards for commercial refrigeration equipment.[29] The analysis involved numerous components including:

- An engineering analysis to estimate cost increases for commercial refrigeration equipment manufacturers, retail price increases for commercial refrigeration equipment, and life-cycle costs of refrigeration equipment complying with the revised standards;
- A Manufacturer Impact Analysis to identify the direct impact of the proposed energy efficiency standards on commercial refrigeration manufacturers, including impacts to cash flows and employment; and,
- An Employment Impact Analysis to identify the indirect impacts of the proposed rulemaking on job creation or elimination in all other sectors of the economy.

DOE has used this assessment approach in multiple other energy efficiency standard RIAs. While the DOE methodology is likely more detailed than would be feasible for routine SCAQMD assessments, aspects of the DOE analysis may provide valuable insights to SCAQMD. We outline DOE's approach to each component of its analysis below.

ENGINEERING AND COST ANALYSIS

DOE estimated the incremental manufacturing costs associated with higher efficiency refrigeration equipment through a detailed engineering analysis. The analysis involved equipment dismantling and accounting of component parts, review of trade publications, interviews, and plant visits with equipment manufacturers. Following the estimation of incremental manufacturing costs, DOE conducted a markup analysis to determine the average increase in retail price associated with the energy efficiency improvements. This was calculated through a weighted average of the markups in each distribution channel

[28] Based on IEc communications with SCAQMD staff.

[29] The discussion presented here on the methods applied in this RIA is based upon U.S. DOE (2014).

for commercial refrigeration equipment, and a weighted average of sales taxes in commercial refrigeration markets. Finally, DOE estimated the lifecycle cost of new refrigeration equipment, taking into account the higher estimated purchase price but lower incremental operating cost associated with the higher efficiency products.

MANUFACTURING IMPACT ANALYSIS

In the Manufacturing Impact Analysis, DOE estimated the impact of incremental increases in manufacturing costs on the commercial refrigeration equipment manufacturing industry. DOE adapted its Government Regulatory Impact Model (GRIM) to estimate the impact of the rulemaking on industry cash flow. DOE input baseline manufacturing prices, costs, shipments, and other industry financial characteristics into the GRIM, along with the estimated changes in manufacturing costs developed in the engineering cost analysis. Industry financial characteristics were obtained from both publically available sources and confidential information provided in manufacturer interviews.

The GRIM estimated the impact on the commercial refrigeration equipment manufacturing industry as the difference between the discounted annual cash flows under the baseline and the regulatory scenario. Under the regulatory scenario, cash flows decrease in the years leading up to the regulation, as companies increase capital expenditures to prepare for the amended efficiency standards. In the year the rule goes into effect, cash flows may either increase or decrease, depending on the relative size of increased cash flows resulting from write-downs of any stranded assets created by the rulemaking, and the increased production costs associated with ensuring that products are in compliance with the efficiency standard. In addition, the GRIM estimated a range of direct employment impacts for the equipment manufacturing industry. The lower bound, however, assumes that all jobs in the equipment manufacturing sector are shifted outside the U.S., which produces a range of employment impacts so broad that it provides only minimal insight.

While the GRIM is appealing in its ability to examine the effects of a rulemaking on a very specific industry, the data requirements may be prohibitive for SCAQMD to use a similar strategy in regular socioeconomic assessments. In particular, the detailed data that it requires on baseline costs for regulated industries (e.g., overhead, depreciation, stranded assets) is likely to be beyond the scope of costs estimated by SCAQMD on a regular basis.

DOE also included a discussion of small business impacts in the Manufacturing Impact Analysis. DOE extensively researched public and proprietary data sources to identify the number of commercial refrigeration equipment manufacturers that are small businesses. DOE found that 32 out of the 45 manufacturers identified would qualify as small businesses under the SBA definition for NAICS 333415, “Air-conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing.” While DOE provided a qualitative discussion of potential differential impacts to small businesses, no impacts were quantitatively analyzed.

EMPLOYMENT IMPACT ANALYSIS

DOE's employment impact analysis considers the rule's indirect employment impacts of the proposed rulemaking on sectors other than the commercial refrigeration equipment manufacturing industry. To conduct this analysis, DOE uses the ImSET model, a specialized version of the IMPLAN Input-Output model developed by the Pacific Northwest National Laboratory. Representing 187 sectors, ImSET was specifically designed to evaluate the impacts of energy efficiency technologies on the national economy. ImSET accepts as inputs estimates of initial energy efficiency investments and projected energy savings. The model then estimates impacts on output and employment in all other sectors of the economy. Changes to output and employment occur in ImSET through two primary pathways:

- Higher retail prices for energy efficient equipment may lower employment and output in downstream industries, and
- Energy savings may cause businesses to spend less on electricity and more on other inputs, lowering output and employment in the electricity industry and raising output and employment in other industries.

ImSET may not be appropriate for use in SCAQMD socioeconomic assessments due to its national scope and focus on energy efficiency, but a two-model approach such as DOE's (i.e., use of GRIM for the directly regulated industry and ImSET for other sectors) would allow for the development of detailed impact estimates on a small scale for the directly regulated industry, while still considering broader effects on the rest of the economy.

COST OF STATE REGULATIONS ON CALIFORNIA SMALL BUSINESSES STUDY

In 2009, Varshney & Tootelian produced a report estimating the total cost of regulation to small businesses in the state of California. The authors conducted a regression analysis to estimate the relationship between gross state product and relative state rankings across the six categories that make up the Forbes "Best States for Business" rankings. These categories include business costs, labor supply, economic climate, regulatory environment, quality of life, and growth prospects. The regression analysis suggested that an increase in a state's regulatory environment ranking by one point is associated with a $4.4 billion decrease in gross state product. Because California ranks 40th on regulatory environment, Varshney & Tootelian multiply $4.4 billion by 40 to estimate that California loses $177 billion in gross state product each year as a result of regulations. The $177 billion impact is then fed into the IMPLAN model, producing a total annual cost of regulation of $493 billion, equaling nearly one-third of California's gross state product. The IMPLAN results also predict that this lost output is associated with 3.8 million fewer jobs each year, equivalent to roughly 10 percent of California's population.

Both the California Legislative Analyst's Office (LAO) and Dr. Frank Ackerman of Tufts University have identified major methodological flaws in the Varshney & Tootelian study.[30] The most significant flaw is that Varshney & Tootelian failed to control for state population. In effect, their regression analysis attempts to explain the differences between the total economic outputs of the states with the largest and smallest populations, while only taking into account differences in regulatory environment and business costs. Ackerman (2010) reproduced the same regression analysis, and found that the Varshney & Tootelian results were no longer significant after controlling for state population.

The LAO also points out that Varshney & Tootelian use the IMPLAN model incorrectly. Because Varshney & Tootelian are estimating the relationship of regulations on gross state product itself, any indirect or induced effects of state regulations will already be implicitly reflected in the regression results. As a result, Varshney & Tootelian double count the indirect and induced effects of regulation by using the regression coefficient as an input to IMPLAN. As a result of these two major methodological flaws, among several others identified by LAO and Ackerman, this study is not likely to provide SCAQMD with any insights into small business impact analysis.

REGULATORY COMPLIANCE COSTS AND CALIFORNIA SPECIALTY CROP PRODUCERS PROFITABILITY

Agricultural producers in California are subject to numerous regulations, including rules related to water quality, air quality, chemical use, and timber harvest. Paggi et al. (2009) examined the impacts of these agricultural regulations on California specialty crop producers. Specifically, the authors examined the cumulative impact of all regulations on California orange producers, as well as the potential impacts of a proposed regulation that would impact peach processers. To estimate the burden of these regulations, Paggi et al developed stochastic simulation models of representative farms for each specialty crop. The stochastic simulation models rely on estimates of operational and compliance costs for each representative farm, and allow Paggi et al. to estimate the profitability of representative farms with and without regulatory compliance costs included in the cost of production. The data used to develop the representative farm models were obtained through studies and statistics produced by various state agencies and universities, as well as communication with regional food processing firms.

Through their analysis of orange producers, Paggi et al. found that average representative farm income would be 74 percent higher in the absence of all regulatory compliance costs. The authors also noted that cumulative regulatory compliance costs are associated with a 17 percentage point increase in the probability of a farm sustaining a financial loss over a five year period. In an additional analysis of a proposed processing waste disposal rule, Paggi et al. estimated that average net returns to peach processing firms would fall by 12 to 17 percent if the rule were to go into effect. Additionally, Paggi et al. conduct an IMPLAN analysis to estimate the potential impacts to Stanislaus County in California if increased compliance costs resulted in an exit of the processing industry from the county. The authors estimate a loss of 2,248 jobs and $183 million in value added.

[30] See Ackerman (2009) and Taylor (2010).

Though Paggi et al. did not estimate impacts specific to small businesses, SCAQMD may be able to adapt some of the methods from their analysis to future socioeconomic assessments. If SCAQMD was able to obtain financial and operational information on firms within the regulated industry, the agency could develop a representative small business. Compliance cost estimates could then be compared to this representative small firm. SCAQMD may also be able to incorporate stochastic simulations into future socioeconomic assessments. However, the data requirements for such simulations would likely be prohibitive for most rulemakings. For instance, Paggi et al. state that key operating variables in the stochastic simulation models include "yearly net income, cash flow position, financial ratios such as return on assets, debt to equity or liquidity, and net present values of net income." For small scale industries in particular, SCAQMD is unlikely to be able to obtain financial data with this level of detail without targeted stakeholder outreach.

CHAPTER 7 | DATA

Assessment of the small scale and small business impacts of SCAQMD policies may often require detailed information on affected industries. Such information may include data characterizing an industry's level of economic activity under baseline conditions, data on the revenues or profitability of an industry or a company within that industry, or elasticity data depicting how producers or consumers in an industry respond to changes in prices.

This chapter examines several data sources identified by IEc within each of these broad categories. IEc's review of each data source considers its potential to be combined with other data and/or models to shed light on small scale and/or small business impacts. For each data source, we provide a detailed accounting of the information available and assess its reliability, accessibility, and applicability to SCAQMD's analyses. In addition to outlining the relative strengths and weaknesses of each data source, we also describe the circumstances under which each might be preferred over the available alternatives.

SUMMARY OF DATA SOURCES

Exhibit 7-1 summarizes each of the data sources that IEc examined in its review. A more detailed discussion of each data source follows in the sections below.

DUN & BRADSTREET

Dun & Bradstreet (D&B), a leading private source of commercial information, maintains a database containing more than 220 million business records. Updated on a monthly basis, the database captures a wide range of industries. It is an extensive source of business data for both public and private companies, including information on annual revenues and employment. It also provides information on the corporate linkages among business establishments. Firm-level data can be queried by company name or by industry.

EXHIBIT 7-1. SUMMARY OF DATA SOURCES REVIEWED

DATA SOURCE	MOST RECENT DATA YEAR	FREQUENCY OF UPDATES	FIRM-LEVEL OR INDUSTRY-WIDE DATA	SPATIAL RESOLUTION	DATA ELEMENTS						
					REVENUES	EMPLOYMENT	PAYROLL/WAGES	PRODUCTIVITY	ELASTICITIES	CORPORATE STRUCTURE	CREDITWORTHINESS/ PROBABILITY OF DEFAULT
Dun & Bradstreet	Current	Monthly	Firm	Not applicable	✓	✓				✓	✓
Hoover's	Current	Weekly	Firm	Not applicable	✓	✓				✓	✓
EDGAR (SEC filings)	Current	Quarterly	Firm	Not applicable	✓	✓				✓	
LexisNexis	Current	Daily	Firm	Not applicable	✓	✓				✓	
Standard &Poor's	Current	Daily	Firm	Not applicable	✓	✓					✓
Manta	Current	Irregular	Firm	Not applicable	✓	✓					
infoUSA	Current	Daily	Firm	Not applicable	✓	✓					✓
Risk Management Association	2014	Annual	Industry	Region	✓						✓
Economic Census	2012	Every 5 Years	Industry	County	✓	✓	✓				
County Business Patterns	2013	Annual	Industry	County		✓	✓				
Bureau of Labor Statistics Productivity Data	2014	Annual	Industry	National		✓	✓	✓			
NBER-CES Manufacturing Industry Database	2009	None	Industry	National		✓	✓	✓			
Supply elasticities from Broda et al. (2008)	2008	None	Industry	International					✓		
Consumer Demand in the United States	2005	None	Industry	National					✓		
Ho et al. (2008)	Not specified	None	Industry	National					✓		

D&B may be useful to policymakers assessing small business impacts because the firm-level data can help identify small businesses within an industry and characterize the average annual revenues and number of employees of small businesses. However, there are several limitations of the D&B database. First, self-reported company information may not be complete or current. Financial data are not available for many small businesses, in particular. D&B's information on company ownership and employment may also be considerably out-of-date. Additionally, while the data include a wide range of industries, it is difficult to determine the number of firms or establishments within an industry. Specifically, D&B contains records pertaining to (1) different departments within a single establishment; (2) different business names and/or street addresses for the same establishment, resulting in multiple records; and (3) all corporate, subsidiary, and affiliated entities for a given establishment even if they are not in the same industry (i.e., they have a different NAICS code). For these reasons, a query of the D&B data for a particular NAICS code may overstate the actual number of establishments in that industry. For example, as part of an analysis that IEc performed for EPA, the D&B database yielded more than 24,000 results for a query of U.S. hospitals (NAICS 622) compared to 6,475 establishments reported in the 2012 U.S. Economic Census.

HOOVER'S

Hoover's is a subsidiary of D&B that maintains a database of more than 85 million companies. Similar to the D&B database, it contains information on both public and private companies, including information on annual revenues and employment. The seeming advantage of the Hoover's database is that information for individual companies is more accurate and more complete than the D&B database. IEc has conducted a number of company queries in which the Hoover's database had annual revenue data that was not available in the D&B database. Furthermore, the Hoover's database includes more detail about corporate linkages and other business information, such as key personnel. We note, however, that Hoover's has some of the same limitations as D&B in that information may be limited for many small businesses and it does not provide an accurate estimate of the total number of firms or establishments within an industry.

SECURITIES AND EXCHANGE COMMISSION (SEC) EDGAR DATABASE

The SEC's EDGAR database provides information on the financial resources and balance sheet information of publicly traded companies that may be affected by proposed regulations. While this information is limited to publicly-traded companies, it provides a more complete picture of the financial health of individual firms than D&B and Hoover's. The limitations of this database are that data are generally not available for privately-held companies and 10-K filings are lengthy, non-standardized documents that are not easy to gather and compare for a large number of companies at a time.

LEXISNEXIS

Similar to the D&B and Hoovers' databases described above, LexisNexis provides information on the ownership hierarchy of firms, including parent companies and subsidiaries. Thus, it would be useful in determining whether a facility is owned by a small business. LexisNexis also has financial and other information from reports filed with the SEC. This database may be used to fill in missing financial data from the other sources outlined above, but is subject to similar limitations in that information is generally only available for publicly-traded companies. Furthermore, information is not easy to export so it is difficult to query and access financial records for a large number of companies at a time.

STANDARD AND POOR'S (S&P)

S&P maintains a database of SEC filings and other financial information for most publicly-traded companies. Specifically, S&P provides multiple years of data on revenues, debt, earnings, assets, liabilities, cash flow, dividends, number of employees, and bankruptcies. It is one of the most comprehensive databases in terms of providing a complete financial picture of a company and has the benefit of multiple years of data. NAICS information is also included, which may help in developing industry profiles from firm-level data. However, S&P is still limited in that information is not available for most privately-held companies.

INFOUSA

InfoUSA maintains a database of businesses with over 16 million verified records. Information on each business includes industry, NAICS code, number of employees, sales volume, and credit rating. Similar to the D&B database, the InfoUSA database could be used to query firm level data on small businesses. However, the InfoUSA database likely suffers from the same shortcomings of the D&B database, including incomplete or out-of-date information for some businesses.

MANTA

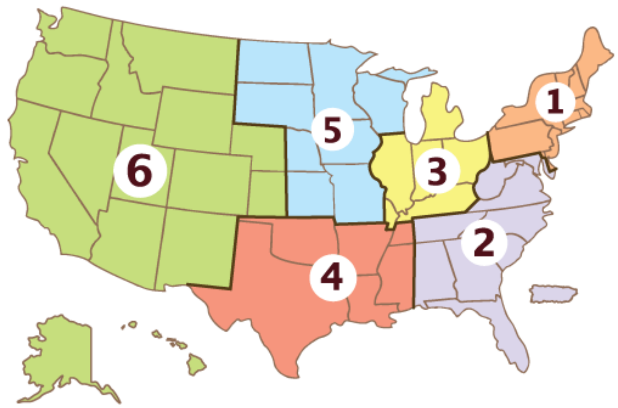
Manta maintains a searchable directory of small businesses, similar to the D&B and InfoUSA databases. Information on each small business in the Manta directory may include estimated annual revenues, number of employees, SIC code, year of establishment, and a description of the businesses services each company provides. Similar to the D&B and InfoUSA databases, information on individual businesses is often incomplete or potentially out-of-date.

RISK MANAGEMENT ASSOCIATION (RMA)

RMA conducts Annual Statement Studies for industries (as opposed to individual firms) at the 6-digit NAICS level, with breakdowns by asset and sales size. This information is available at the regional level through RMA's online eStatement Studies (see Exhibit 7-2 for the regions). The organization collects data directly from financial statements of small and medium-sized businesses that are RMA members—information that is not available from other sources. This includes detailed information such as financial ratios, profitability, cash flow, and the rate of industry default. Therefore, the industry-specific RMA data can supplement company data from other sources, such as D&B, Hoover's, and S&P, with more comprehensive information for small and medium-sized companies. The primary limitations of RMA studies are that data are not published for all industries (if there are an insufficient number of RMA members within an industry) and do not disclose records for individual companies, but only report the data at the industry level.

EXHIBIT 7-2. RMA eSTATEMENT STUDIES AVAILABILITY BY REGION

Regional Data



eStatement Studies includes regional data as follows:

Region 1—Connecticut, Delaware, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont

Region 2—Alabama, Florida, Georgia, Maryland, North Carolina, Puerto Rico, South Carolina, Tennessee,* Virginia, Washington, D.C., West Virginia

Region 3—Illinois, Indiana, Kentucky, Michigan,* Missouri,* Ohio

Region 4—Arkansas, Louisiana, Mississippi, Oklahoma, Tennessee,* Texas

Region 5—Iowa, Kansas,* Michigan,* Minnesota, Missouri,* Nebraska,* North Dakota, South Dakota, Wisconsin

Region 6—Alaska, Arizona, California, Colorado, Hawaii, Idaho, Kansas,* Montana, Nebraska,* Nevada, New Mexico, Oregon, Utah, Washington, Wyoming

*State spans two regions.

ECONOMIC CENSUS

The Economic Census, conducted by the U.S. Census Bureau, provides a nearly comprehensive collection of statistics at the industry level, including: the number of establishments, firms, and employees, as well as annual payrolls and revenues. Conducted every five years, the Economic Census covers nearly all industries identified by 6-digit NAICS codes, with the exception of agriculture, forestry, government, rail transportation, and employment by private households.[31, 32] It therefore provides some of the most detailed economy-wide data available on the number of employees, and revenues in an industry—including data on the number of firms and establishments by employee and revenue size. The data available from the Economic Census are reported at varying levels of geographic detail, including at the national, state, and county level. Due to privacy concerns, economic information is not reported for individual establishments or firms. The data are reported in aggregate by industry and location, with additional detail broken out by employment or revenue size class.

[31] The 1997 Economic Census was the first major statistical report to use the North American Industry Classification System (NAICS). U.S. Department of Commerce, U.S. Census Bureau, *History of the Economic Census: In Business Since 1810*, accessed at www.census.gov/econ/census/about/history.html on March 1, 2016.

[32] Additional employment and revenue data for the agriculture sector and government are available from the U.S. Department of Agriculture's Census of Agriculture and the U.S. Census Bureau's Census of Government, respectively.

COUNTY BUSINESS PATTERNS

Similar in many ways to the Economic Census, the Census Bureau's County Business Patterns dataset provides detailed industry statistics by industry, with geographic and sectoral detail similar to that of the Economic Census. Unlike the Economic Census data, which are released every five years (2012 is the most recent year available), County Business Patterns are released annually and therefore may be more useful for identifying recent industry trends. The most recent edition of County Business Patterns contains industry data for 2013.[33] An important limitation of the County Business Patterns data though is that they do not include information on the number of firms in an industry or annual revenues. Similar to other U.S. Census Bureau data, County Business Pattern data collected on an annual basis rely on a relatively small sample size and may be less statistically reliable than the full Economic Census.

SMALL BUSINESS SIZE STANDARDS

Assessments of the small business impacts of SCAQMD policies require a definition of what constitutes a small business. As documented in many of SCAQMD's recent socioeconomic assessments, SCAQMD itself defines a small business, under Rule 102, as a business that employs 10 or fewer persons and that earns less than $500,000 in gross annual receipts. Also, the California Department of Health Services defines small business based on an annual gross receipt criterion (ranging from $1 million to $9.5 million, depending on industry type) for non-manufacturing industries and an employment criterion of fewer than 250 employees for manufacturers.

At the Federal level, the U.S. Small Business Administration (SBA) periodically publishes a table of small business size standards for individual industries matched to 2012 NAICS codes. Businesses that meet the size standards for a small business may qualify for certain government programs, such as SBA loans and contracting opportunities. The most recent SBA small business size standards were updated on February 26, 2016.[34] In addition to the Federal SBA standards, the Clean Air Act Amendments classify a facility as a "small business stationary source" if it: (1) employs 100 or fewer employees, (2) does not emit more than 10 tons per year of either VOC or NO_x, and (3) is a small business as defined by SBA.

Combined with information on firm-level revenues and employment from D&B, Hoover's, or S&P, the size standards outlined above could help SCAQMD identify firms that meet the federal definition of a small business. Furthermore, combined with aggregate industry data from the Economic Census, County Business Patterns, or RMA, the size standards can also be used to estimate the total number of small businesses, average annual revenues for small businesses, and small business employment for an industry (at the 6-digit NAICS level) in a particular geographic area.

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[33] The 2014 County Business Patterns is scheduled for release in April 2016.

[34] U.S. Small Business Administration, Table of Small Business Size Standards, accessed at https://www.sba.gov/content/small-business-size-standards on March 1, 2016.

BUREAU OF LABOR STATISTICS (BLS) PRODUCTIVITY DATA

In addition to drawing upon the economic data outlined above, SCAQMD assessments of small scale impacts could potentially rely upon productivity data to estimate employment impacts. As described above in the summary of EPA's employment analysis of the Clean Power Plan, productivity data could be used in conjunction with estimates of abatement expenditures to generate estimates of the employment impacts associated with abatement investments.

One potential source of productivity data is the BLS Industry Productivity program, which publishes annual measures of output per worker at the 6-digit NAICS level for 124 industries, and at the 4- or 5-digit NAICS level for additional industries (BLS, 2016). Although productivity may vary regionally, the NAICS level data from BLS are available only at the national level. Thus, in applying these data, SCAQMD would need to assume that industry productivity in California is consistent with the national average.

MANUFACUTURING INDUSTRY DATABASE

As an alternative to BLS productivity data, SCAQMD could apply productivity data from the Manufacturing Industry Database jointly developed by the National Bureau for Economic Research (NBER) and the Census Bureau's Center for Economic Studies (CES).[35] NBER and CES developed the manufacturing industry database using annual industry-level data from 1958-2009 on output, employment, payroll and other input costs, investment, capital stocks, and various industry-specific price indices. Employment, payroll, and productivity data are available for 473 6-digit 1997 NAICS industries. National level productivity data include worker-hours, production costs, and total factor productivity. A potential limitation of the database is that the data may get outdated over time, as the NBER and CES currently have no plans to update this dataset. In addition, similar to the BLS productivity data, information is available only at the national level.

SUPPLY ELASTICITIES

Application of partial equilibrium methods such as those described in Chapter 6 requires estimates of the elasticity of supply and elasticity of demand for directly regulated industries. Because supply elasticities typically reflect confidential cost information for regulated firms, the available information on supply elasticities is fairly limited. One potentially useful source for supply elasticities that we identified, however, is Broda et al. (2008), which EPA applied in the multi-market partial equilibrium model described in Chapter 6. While this study focuses on tariff policy and market power, the methods developed by the authors required export supply elasticities for a broad set of (non-U.S.) countries and goods. Based on industry data from the United Nations, Broda et al. estimated inverse supply elasticities for goods defined according to their 4-digit HTS codes, which correspond roughly to 5- or 6-digit NAICS codes.

The transferability of the supply elasticities estimated by Broda et al. to California, or even the U.S., is an open question, given their non-U.S. origins. As described in Chapter 6, the U.S. EPA's economic analysis of the Boiler NESHAP assumed that U.S.

[35] NBER-CES Manufacturing Industry Database accessed at http://www.nber.org/nberces/ on March 1, 2016.

elasticities would be more elastic than the export supply elasticities estimated by Broda et al. EPA therefore added one standard deviation to the average of the industry-specific inverse supply elasticities estimated by Broda et al. before applying them to the U.S.

DEMAND ELASTICITIES

Relative to supply elasticities, more information is available on demand elasticities for a variety of goods and services produced by U.S. industries. A comprehensive review of the empirical literature examining demand elasticities is beyond the scope of this effort, but we summarize two sources in this section that present or derive demand elasticities for multiple goods and services.

Taylor and Houthakker's *Consumer Demand in the United States: Prices, Income, and Consumption Behavior* constructs several models of consumer demand based on aggregate time-series data on personal consumption expenditures (PCE) from the BEA's U.S. National Income and Product Accounts (NIPA).The authors used these models to estimate own-price and total expenditure elasticities for 20 quarterly PCE categories and 107 annual PCE categories. Exhibit 7-3 lists the annual PCE categories. One potential limitation of Taylor and Houthakker's demand elasticities is that they were derived from national level data. To the extent that consumer preferences in southern California differ from the national average, the national data may not be representative of consumers in the SCAQMD region.

In an assessment examining the impact of carbon pricing on U.S. industry, Ho et al. (2008) applied industry demand elasticities simulated with the Adkins-Garbaccio computable general equilibrium (CGE) model described in Adkins and Garbaccio (2007) and Adkins (2006). Detailed documentation of how the values presented in Ho et al. were derived by the CGE model was not readily available.

EXHIBIT 7-3. ANNUAL PCE MODEL CATEGORIES FOR ESTIMATION OF DEMAND ELASTICITIES

GROUP	CATEGORY
Food, Tobacco and Alcohol	Food Purchased for Off-Premise Consumption
	Purchased Food and Beverages
	Tobacco
	Alcoholic Beverages
Clothing, Accessories and Jewelry	Shoes
	Clothing excluding Shoes - Women's and children's
	Clothing excluding Shoes - Men's and boys'
	Cleaning, Storage and Repair of Clothing and Shoes
	Jewelry and Watches
	Other clothing
Personal Care	Toilet Articles and Preparations
	Barbershops. Beauty Salons and Health Clubs

GROUP	CATEGORY
Housing	Owner-Occupied Housing
	Rental Housing
	Rental Value of Farm Housing
	Other Housing
Housing Operation	Furniture, including Mattresses and Bedsprings
	Household Appliances
	China, Glassware, Tableware and Utensils
	Other Durable House Furnishing
	Semi-Durable House Furnishings
	Cleaning and Polishing Preparations and Miscellaneous Household, Supplies and Paper Products
	Stationary and Writing Supplies
	Household Utilities - Electricity
	Household Utilities – Gas
	Household Utilities – Water and other sanitary services
	Household Utilities – Fuel oil and coal
	Household Utilities – Telephone and telegraph
	Domestic Services
	Other Household Operations
Medical Care	Drug Preparation and Sundries
	Ophthalmic Products and Orthopedic Appliances
	Physicians
	Dentists
	Other Professional Services
	Hospitals – Nonprofit
	Hospitals – Proprietary
	Hospitals – Government
	Nursing homes
	Health Insurance – Medical care and hospitalization
	Health Insurance – Income loss
	Health Insurance – Workers' compensation
Personal Business	Brokerage Services
	Bank Service Charges, Trust Services and Safe Deposit Box Rental
	Services Furnished Without Payment by Financial Intermediaries, Except Life Insurance Carriers
	Expense of Handling Life Insurance and Pension Plans
	Legal Services
	Funeral and Burial Expenses
	Other Personal Business Services
Transportation	User-Operated Transportation
	New Autos
	Net Purchases of Used Autos
	Other Motor Vehicles

GROUP	CATEGORY
	Tires, Tubes, Accessories and Other Parts
	Repair, Greasing, Washing, Parking, Storage, Rental and Leasing
	Gasoline and Oil
	Bridge, Tunnel, Ferry and Road Tolls
	Transportation Insurance
	Purchased Local Transportation – Mass transit systems
	Purchased Local Transportation – Taxicab
	Intercity Transportation - Railway
	Intercity Transportation – Bus
	Intercity Transportation - Airline
	Intercity Transportation – Other
Recreation	Books and Maps
	Magazines, Newspapers and Sheet Music
	Non-Durable Toys and Sports Supplies
	Wheel Goods, Sports and Photographic Equipment, Boats and Pleasure Aircraft
	Video and Audio Goods, including Musical Instruments
	Computers, peripherals, and software
	Radio and Television Repair
	Flowers, Seeds and Potted Plants
	Admissions to Specified Spectator Amusements – Motion picture theaters
	Admissions to Specified Spectator Amusements – Legitimate theaters and opera, and entertainments of nonprofit institutions (except athletics)
	Admissions to Specified Spectator Amusements – Spectator sports
	Clubs and Fraternal Organizations
	Commercial Participant Amusements
	Pari-Mutuel Net Receipts
	Other Recreation
Education	Higher Education
	Nursery, Elementary and Secondary Education
	Other Education
Religious and Welfare Activities	Religious and Welfare Activities
Foreign Travel and Other, Net	U.S. Foreign Travel
	Expenditures Abroad by U.S. Residents

POTENTIAL APPLICATIONS OF DATA

The data sources described above can potentially be used in a variety of contexts to help SCAQMD assess small scale and/or small business impacts. With respect to the estimation of small scale impacts, SCAQMD could use the county- and industry-specific output and employment data from the Economic Census or County Business Patterns in conjunction with elasticity values to construct partial equilibrium models for regulated industries. Such models would provide the estimated change in output by 6-digit NAICS industry group. Alternatively, SCAQMD could use the 6-digit NAICS industry data from the Economic Census or County Business Patterns to distribute the more aggregated industry-level REMI results. In addition, the productivity data identified above could provide a basis for estimating the employment impacts associated with pollution controls. Specifically, these data could be applied to expenditures on locally provided abatement capital to estimate the amount of local labor associated with abatement investments. Chapter 8 includes additional detail on these options.

To isolate small business impacts, SCAQMD could use corporate ownership and financial data from D&B, Hoover's, the SEC's EDGAR database, LexisNexis, S&P, Manta, and InfoUSA to determine whether many regulated facilities are owned by small businesses. These databases include baseline financial data for many of these firms as well, which SCAQMD could compare to policy-specific compliance costs. Alternatively, because these sources lack data on many private and small firms, SCAQMD could rely on more aggregate data from RMA, the Economic Census, or County Business Patterns for more comprehensive information on the number and characteristics of small businesses, though these sources provide no firm- or facility-level data.

Exhibit 7-4 demonstrates how SCAQMD could use small business size standards from the SBA (or another source) in conjunction with Economic Census data to obtain average annual revenues and employment size for small businesses.[36] The exhibit shows the relevant SBA small business size standard for one industry with small business status defined according to employment (NAICS 441110) and one industry with small business status defined based on revenue (NAICS 447110). While the SBA thresholds do not always perfectly align with the Economic Census firm-size categories, they can provide a reasonable approximation. In both cases, the SBA size standard falls somewhere within the largest Economic Census category. The remaining rows are highlighted to illustrate that they fall within the SBA definition of a small business. Conservatively assuming that the largest category only includes large businesses, the data suggest that the average new car dealer (NAICS 441110) that is a small business has 35 employees and $24 million in annual revenues compared with 147 employees and $103 million in annual revenues for a large business.[37] For gasoline stations with convenience stores (NAICS 447110), the average establishment that is a small business has 7 employees and $3.5 million in annual revenues compared with 230 employees and $32 million in revenues for a large business. These estimates are conservative in that not distributing the final category for each industry into small and large businesses would tend to underestimate average annual revenues, and thus would make compliance costs a larger portion of annual revenues.

[36] SCAQMD currently uses small business size standards for qualitative assessments of small business impacts in its socioeconomic impact analyses.

[37] We calculate the average employment and revenues by summing the shaded rows and unshaded rows (separately) and then dividing total employment and revenues by the number of establishments.

For small business impact analyses comparing compliance costs to profits, financial information from RMA may be particularly useful to SCAQMD. Although RMA does not include firm-specific data, its exclusive focus on small and medium entities combined with the data it provides on their average profitability provide a means for SCAQMD to compare small business compliance costs with typical profits for the industry.

EXHIBIT 7-4. EXAMPLE OF 2012 U.S. ECONOMIC CENSUS DATA AND SBA SMALL BUSINESS SIZE STANDARDS

NAICS	INDUSTRY	SBA SMALL BUSINESS SIZE STANDARD	EMPLOYMENT/REVENUE SIZE OF ESTABLISHMENTS	NUMBER OF ESTABLISHMENTS	REVENUES ($1,000)	ANNUAL PAYROLL ($1,000)	NUMBER OF EMPLOYEES
441110	New car dealers	200 employees	Less than 5 employees	2,220	5,148,168	156,919	4,717
			5 or 6 employees	655	2,140,231	130,612	3,574
			7 to 9 employees	741	3,352,709	218,321	5,906
			10 to 14 employees	1,157	8,507,159	547,385	13,845
			15 to 19 employees	1,183	12,824,660	808,395	20,065
			20 to 49 employees	6,752	154,359,744	10,107,882	226,288
			50 to 99 employees	5,024	244,624,935	17,372,529	350,483
			100 employees or more	2,295	235,642,971	17,771,834	337,879
447110	Gasoline stations with convenience stores	$29.5 million	Sales/receipts/revenue less than $10,000	3	25	20	4
			Sales/receipts/revenue of $10,000 to $24,999	46	794	378	71
			Sales/receipts/revenue of $25,000 to $49,999	138	5,069	2,198	236
			Sales/receipts/revenue of $50,000 to $99,999	286	21,715	6,900	683
			Sales/receipts/revenue of $100,000 to $249,999	1,362	241,679	51,886	3,913
			Sales/receipts/revenue of $250,000 to $499,999	3,240	1,217,934	147,791	10,231
			Sales/receipts/revenue of $500,000 to $999,999	7,009	5,240,884	389,454	26,157
			Sales/receipts/revenue of $1,000,000 to $2,499,999	20,187	34,996,498	1,713,489	111,137
			Sales/receipts/revenue of $2,500,000 to $4,999,999	25,502	92,697,501	3,197,834	193,617
			Sales/receipts/revenue of $5,000,000 to $9,999,999	20,664	143,543,321	3,771,040	207,625
			Sales/receipts/revenue of $25,000,000 or more	517	16,688,965	332,984	119,146

Source:
1. U.S. Census Bureau, 2012 Economic Census, accessed through American Factfinder at http://factfinder.census.gov/ on March 2, 2016.
2. U.S. Small Business Administration, Table of Small Business Size Standards, accessed at https://www.sba.gov/content/small-business-size-standards on March 2, 2016.

CHAPTER 8 | RECOMMENDATIONS

The previous chapters of this report include a detailed review of various methods, models, and data that SCAQMD may use or adapt to estimate the small scale and small business impacts of its AQMPs and other regulations. Drawing from this review, this chapter presents IEc's recommended methods for SCAQMD analyses of small business and small scale impacts. These recommendations reflect the rigor of the analytic tools available, the transferability of these tools to the SCAQMD policy context, the ability of these tools to isolate impacts in the SCAQMD region, and the availability of data necessary to apply each tool.

SMALL BUSINESS IMPACTS

The development of credible estimates of small business impacts requires (1) distinguishing between small businesses and other businesses within an industry and (2) determining whether the cost impacts of a policy fundamentally differ between small business and other businesses. The review presented in previous chapters of this report identifies a number of analyses that include both of these elements. By necessity, most of these analyses are data-intensive, relying on data related to facilities' operating characteristics and the finances of the company that owns each facility. The approach that we recommend to SCAQMD for the assessment of small business impacts is similar to the methods applied in these analyses, as described in the sections below.

RECOMMENDED SCOPE OF SMALL BUSINESS IMPACTS

The first element of our proposed approach relates to the scope of small business impacts analyzed. Policies implemented by SCAQMD may result in direct impacts to small businesses (*e.g.*, impacts to small businesses in directly regulated industries) and indirect impacts to small business (*e.g.*, spillover effects to small businesses that are suppliers to directly regulated industries). While both of these categories of effects are important, we recommend that SCAQMD focus on direct small business impacts only. The analyses that we examined in our literature review provide analytic precedent for developing credible estimates of direct small business impacts, but none of the models, methods, or data in our review provide a credible means for assessing indirect effects to small business.

Also with respect to the scope of small business impacts examined, we recommend analysis of expenditure impacts (*i.e.*, compliance costs) only. Because these impacts are often estimated at the facility level, it is typically feasible to distinguish between compliance expenditures incurred by small businesses and compliance expenditures for all other businesses. While it may be possible to allocate policy-related output and employment impacts (e.g., as estimated in a partial equilibrium analysis) between small businesses and other businesses, such an allocation would likely assume that the distribution of output and employment impacts is proportional to baseline output or employment. In reality, however, small businesses could realize a larger or smaller effect in proportionate terms.

DEFINITION OF SMALL BUSINESS

Under current practice, SCAQMD's socioeconomic impact assessments qualitatively describe the small business impacts of a new regulation and present various small business size standards defined by SCAQMD, the Clean Air Act, and the U.S. Small Business Administration. In addition, AB 1033, which went into effect as of 1 January 2017, defines small business as a business that (1) is independently owned and operated, (2) is not dominant in its field of operation, and (3) has fewer than 100 employees.[38]

For the purpose of estimating small business impacts, we recommend that SCAQMD choose standards that are regularly updated based on industry-specific data and that can be applied with readily available information. We also recommend that SCAQMD use standards defined for the purposes of impact assessment rather than for procurement purposes. Deciding which specific standard(s) to use for analytic purposes is a policy choice for SCAQMD. Whichever set of standards SCAQMD chooses can be incorporated into the recommended approach that we present here.

IDENTIFICATION OF SMALL BUSINESSES

Based on the small business definition chosen, SCAQMD must then identify facilities owned by small businesses in the regulated universe. If the small business definition is based on revenues or employees, we recommend a tiered approach. First, we recommend that SCAQMD use the Dun & Bradstreet or Hoover's databases to obtain financial data for regulated companies. Both databases contain information on most publicly traded companies in the U.S. and many private companies, including information on annual revenues and employment. Using these data, SCAQMD can determine which facilities are owned by companies below the selected small business threshold. To obtain financial information for companies not in Dun & Bradstreet or Hoover's, we recommend that SCAQMD consult alternatives such as InfoUSA or other databases identified Chapter 7. We would also encourage SCAQMD to consult with regulated facilities themselves to inquire if they would be willing to provide sufficient information to make a determination about their small business status. Companies would not necessarily need to provide their exact revenue or employment information. SCAQMD could ask them which revenue or employment categories best describe their operations. The cutoff values between categories could be defined such that the smallest category corresponds to SCAQMD's definition of small business for that industry.

After identifying specific facilities as small or not small, we also recommend that SCAQMD perform a comparison of its small business tally to data in the Economic Census as a quality control check. The Economic Census includes county-level data on the number of establishments by employment and revenue size for each industry, using

38 California Assembly Bill No. 1033, Approved by Governor September 14, 2016.

broad employment and revenue size categories. The cutoff values between categories may not correspond to the selected small business size standards for most industries, but the data may nonetheless provide a basis for approximating the number of small businesses in the SCAQMD region and for assessing whether SCAQMD's estimates of the number of small businesses within an industry are reasonable. If SCAQMD's estimates differ significantly from the number of small businesses implied by the Economic Census, we would recommend that SCAQMD re-visit the financial data described above and try to reconcile any differences between these data and the Economic Census data.

ESTIMATION OF COMPLIANCE COSTS FOR SMALL BUSINESSES

Once the universe of small facilities has been identified, we recommend that SCAQMD estimate the compliance costs incurred by each of these facilities. Based on IEc's discussions with SCAQMD, the District typically estimates costs (1) at the facility level or (2) for facility types (*i.e.*, model facilities) that may be mapped to individual facilities. For facilities identified as small businesses by SCAQMD, the District will need to determine which of these two approaches it used in its cost analysis. For facilities for which SCAQMD used the first approach, a facility-specific estimate of compliance costs will already be available. For facilities where SCQAMD used the second approach, the District will need to apply the model facility cost most appropriate to each facility. From these values, SCAQMD can then tally costs to small businesses.

COMPARE TO BASELINE REVENUES AND PROFITS

To provide context for estimates of small business compliance expenditures, we recommend that SCAQMD compare these values, on a per company basis, to the baseline revenues and/or profits of each company. Baseline revenues and profits for many affected companies may be available from Dun & Bradstreet (D&B), Hoover's, filings with the Securities & Exchange Commission, or InfoUSA. All of these data sources are summarized in IEc's literature review. When comparing compliance costs to firm level revenues and profits, SCAQMD will need to aggregate facility-level costs to the company level. For example, if SCAQMD implements a policy affecting dry cleaners, SCAQMD will need to sum the costs for all facilities owned by the same dry cleaning chain and compare those costs to the revenue and profit information from D&B or related sources for that company.

Financial information for *private* companies may not appear in D&B or other available databases. For these companies, SCAQMD could use the Economic Census to estimate the average annual revenues of companies below the chosen size standard. For example, if the small business size standard for an industry is $15 million in annual revenues per company, SCAQMD could calculate the average per company revenues across all of the Economic Census revenue categories below this threshold. While this would not provide a precise estimate of revenues for each individual company, it would provide the best estimates possible with the available information.

We also recommend that SCAQMD use the Economic Census data in conjunction with the Risk Management Association's (RMA's) Annual eStatement Studies series to estimate average baseline profits per company for private companies that are not in D&B

or other widely available financial databases. The Annual eStatement Studies series includes information on baseline profit margins by NAICS and region for small- and medium-sized companies. Using this information in conjunction with average firm-level revenues derived from the Economic Census, SCAQMD could develop average estimates of baseline profits for directly affected small business in a given industry. For example, if, for a given industry, the Economic Census data indicate that the per firm revenues for small businesses is $4 million and the RMA data indicate that average profitability for small- and medium-sized businesses within that industry in the region is 20 percent, SCAQMD would estimate the average baseline profits per firm as $666,667.[39]

SMALL SCALE IMPACTS

The estimation of small scale economic impacts poses several challenges that complicate the development of clear recommendations. In particular, the estimation of such impacts is often an inherently data-intensive task, particularly with more sophisticated approaches and methods. For example, such analyses often require detailed baseline data for affected industries (*e.g.*, baseline output and employment), data on industry-level labor requirements per unit of output, supply and demand elasticities, and/or input-output data for individual industries. As the number of sectors included in an analysis grows, these data requirements grow proportionately. In addition, as described earlier in this report, few models exist that estimate economic impacts at the sectoral scale sought by SCAQMD. Those models that do include such detail suffer from several important limitations. For example, while input-output models may include significant sectoral detail, they do not capture substitution in the use of production inputs as relative prices change. Similarly, partial equilibrium models may account for sensitivity to price changes in the assessment of small scale impacts for a particular industry, but they do not capture indirect spillover impacts to other industries. Given the limitations of the available economic modeling tools, any approach that we recommend will also be limited in some way. In developing our recommendations, we have attempted to steer SCAQMD toward methods that minimize these limitations.

FACTORS INFLUENCING THE CHOICE OF METHODS

Considering the limitations of the methodological tools reviewed earlier in this report, the most appropriate approach for estimating small scale impacts is likely to differ depending on the analytic needs and circumstances of a given analysis. Specific factors that may determine which approach is most appropriate include the following:

- ***Direct or indirect effects:*** The analytic tools available for the assessment of small scale economic impacts may focus exclusively on impacts to directly regulated industries or may capture indirect spillover impacts to other sectors of the economy. SCAQMD's choice of model or approach for estimating small scale impacts may therefore depend on whether the District is more interested in capturing direct economic impacts or indirect effects.

[39] Value calculated as $\$4\ million - \frac{\$4 million}{1+0.2} = 0.667\ million$.

- ***Magnitude of direct effects:*** Related to the consideration of direct versus indirect economic impacts, the magnitude of policy-related cost impacts to directly regulated industries provides an indication of potential indirect impacts. All else equal, as compliance costs become more significant, the indirect economic impacts resulting from a policy are also likely to be more significant as costs get passed on to consumers and other industries as increased prices. Conversely, if cost impacts are likely to be minimal, indirect impacts will also not be as significant.

- ***Concentrated or diffuse effects:*** Whether the direct impacts of a SCAQMD policy are concentrated within a limited number of industries or diffuse across several industries may affect the resource requirements and feasibility of potential approaches. All else equal, analysis of policies with more diffuse impacts are likely to be more data- and resource-intensive than analyses of policies with relatively concentrated impacts.

- ***Focus of regulation:*** Whether SCAQMD policies regulate specific industries, production technologies, or products may also be important in determining which approach is most appropriate. For example, a regulation affecting a specific product (*e.g.*, paint) will affect all sellers of that product in the District, whereas a SCAQMD regulation affecting an industry will affect only those producers located within the District. These differences will likely have implications for assumptions made in the analysis of small scale economic impacts.

- ***Competitive landscape:*** Whether a regulation affects producers of local goods or producers of traded goods may also influence SCAQMD's analysis of small scale impacts. Because producers of traded goods face competition from outside the region, their ability to increase prices in response to regulation is limited.

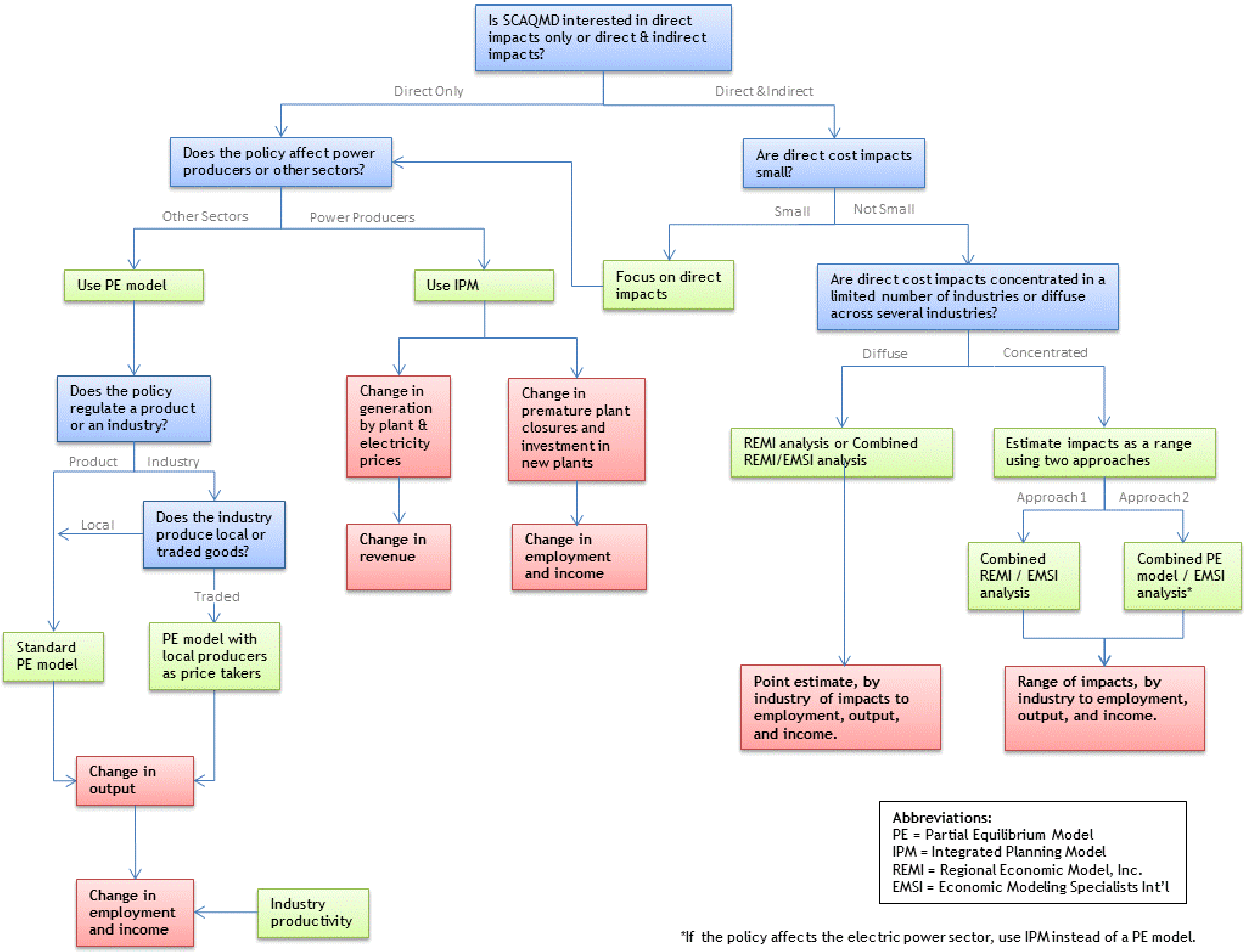
The recommendations that we present below account for each of these considerations.

RECOMMENDATIONS FOR THE ESTIMATION OF SMALL SCALE IMPACTS

Based on the strengths and limitations of the available methods and data and the different dimensions of economic impacts captured under different approaches, we recommend that SCAQMD decide upon an approach for the estimation of small scale impacts on a case-by-case basis. For each analysis, we suggest that SCAQMD consider both the characteristics of the policy to be analyzed as well as the District's own analytic objectives. An approach chosen based on these factors will help SCAQMD identify an approach that meets its analytic needs and minimize analytic limitations relevant to these needs. As noted above, however, no approach will be without limitations. We urge SCAQMD to be transparent about the limitations of whatever approach it relies upon in its assessment of small scale impacts.

To provide structure for the choice of approach and promote consistency in the decision-making process across analyses, we recommend that SCAQMD use a series of structured decision rules as a guide for selecting an analytic approach. Exhibit 8-1 presents the specific series of decision-rules that we recommend. As indicated in the exhibit, the selection of an approach and assumptions to apply under a given approach are dependent

EXHIBIT 8-1. SCHEMATIC FOR SELECTION OF METHODS FOR ASSESSING SMALL SCALE ECONOMIC IMPACTS



*If the policy affects the electric power sector, use IPM instead of a PE model.

on many of the factors identified above, including the estimation of direct versus indirect impacts, magnitude of likely direct cost impacts, and the focus of regulation on producers of local goods versus traded goods. The most important of these variables, in terms of its influence on the choice of approach, is whether SCAQMD seeks to estimate direct impacts at a small scale or both direct and indirect impacts. Below we describe our recommendations for each of these two main branches of Exhibit 8-1.

Direct Impacts

In the event that SCAQMD is interested only in the estimation of *direct* small scale impacts, we recommend the use of economic modeling tools that are sector-specific. As outlined below, we recommend one set of approaches for estimating small scale impacts for policies affecting the power sector and another set of approaches for policies focusing on other sectors. In both cases, we recommend these approaches for policies with annualized costs of at least $5 million. When costs are below this threshold, the economic impact estimates derived from the approaches outlined below are more likely to be uncertain and/or minimal. Factors affecting this uncertainty include the size of the affected industry(s) (both in terms of output and the number of affected entities), whether the affected industry is competing in a national or local market, and whether compliance costs are concentrated in a limited number of industries or diffuse across several industries. In light of these uncertainties, we recommend that SCAQMD decide on a case-by-case basis whether to apply the methods outlined below to policies with annualized costs of less than $5 million.

Estimation of Direct Economic Impacts for Industries Other than Electric Generation

For most sectors of the economy, pre-existing models that capture producer and consumer behavior are not available. In the absence of such models, we recommend that SCAQMD develop partial equilibrium models on a rule-by-rule basis to assess the direct small scale economic impacts of its policies.[40] Under this framework, SCAQMD will estimate the change in price in the affected market such that the proportional change in demand is equal to the proportional change in supply, as represented in Equation 8.1.

$$(8.1)\quad \hat{q}_{s,i} = \hat{q}_{d,i}$$

where $\hat{q}_{d,i}$ is the proportional change in demand for industry i and $\hat{q}_{s,i}$ is the proportional change in supply for i.

In the context of SCAQMD policy changes, both prices and production costs are likely to increase. Because the increase in per-unit revenues realized by producers is the change in price less the increase in costs, the supply response of regulated firms can be written as follows[41]:

40 The partial equilibrium approach described here would also provide insights into the welfare effects (i.e., changes in producer surplus and consumer surplus) associated with SCAQMD regulations. Because the focus of this report is methods for the estimation of economic impacts, we do not provide details on how the partial equilibrium methods presented here may be used to estimate welfare effects.

41 The percentage proportional change in price and proportional change in costs per unit are based on the same baseline value where price is equal to marginal cost.

(8.2) $\hat{q}_{s,i} = \varepsilon_s(\hat{p}_i - \widehat{mc}_i)$

where $\hat{q}_{s,i}$ is as defined above,

ε_s is the price elasticity of supply,

$\widehat{p}_i$ is the proportional change in price for industry i,

$\widehat{mc}_i$ is the proportional change in the per-unit costs of production for industry i resulting from the policy.

Within Equation 8.2, the expression $(\hat{p}_i - \widehat{mc}_i)$ represents the proportional change in revenue from the perspective of suppliers.

We recommend a similar specification for demand, as shown in Equation 8.3.

(8.3) $\hat{q}_{d,i} = \eta_d \widehat{p}_i$

where $\hat{q}_{d,i}$ and $\widehat{p}_i$ are as defined above and η_d is the elasticity of demand.

Collectively, Equations 8.1 through 8.3 represent three equations with three known variables (ε_s, $\widehat{mc}_i$, and η_d) and three unknown variables ($\hat{q}_{d.i}$, $\hat{q}_{s,i}$, and $\widehat{p}_i$). Solving this system yields the values for each of the three unknowns.

The data necessary to solve this system of equations include the proportional change in per-unit production costs ($\widehat{mc}_i$), elasticity of supply (ε_s), and elasticity of demand (η_d). Our recommended approach for estimating the proportional change in per-unit costs is based upon the relationships shown in Equation 8.4. As indicated in the equation, the proportional change in costs is equal to the ratio of the per-unit costs of a policy to the initial equilibrium price. Multiplying both of these values by the baseline production volume yields the same result. The resulting numerator, however, represents the total compliance costs of the rule (assuming compliance cost estimates reflect an assumption of constant production levels), while the denominator represents baseline revenues. To estimate the proportional change in per-unit production costs ($\widehat{mc}$), we therefore recommend that SCAQMD calculate the ratio of an industry's compliance costs to its baseline revenues. SCAQMD already develops estimates of compliance costs at a small scale. Baseline revenue (gross output) estimates by six-digit NAICS code for the counties that make up the SCAQMD area can be obtained from EMSI for a recent historical year.[42]

(8.4) $$\widehat{mc}_i = \frac{c_i}{mc_{i,0}} = \frac{c_i}{p_{i,0}} = \frac{c_i \times Q_{i,0}}{p_{i,0} \times Q_{i,0}}$$

where c_i represents the per unit costs of the rule for industry i, $mc_{i,0}$ is marginal costs at the initial equilibrium for the industry, $p_{i,0}$ is the initial equilibrium price for industry i, and $Q_{i,0}$ is the baseline production volume.

[42] We assume that SCAQMD gains access to EMSI to estimate indirect impacts, per the recommendations later in this document.

For the elasticity of supply (ε_s) and elasticity of demand (η_d), we recommend that SCAQMD obtain values from the regulated industry or the literature. If SCAQMD needs to rely on the literature, we would recommend demand elasticity values from Taylor and Houthakker's *Consumer Demand in the United States: Prices, Income, and Consumption Behavior* and the supply elasticities from Broda et al. (2008). As described in Chapter 7, Taylor and Houthakker construct models of consumer demand for 107 personal consumption expenditures (PCE) categories at the national level. While these categories may be broader than the small scale industry categories for which SCAQMD would like to estimate economic impacts, the elasticity values for these broad categories provide a reasonable representation of the demand elasticity for the various sub-sectors that comprise them.

The data review in Chapter 7 also indicates that the available information on supply elasticities is quite limited. If values cannot be obtained from industry or other sources, we would recommend that SCAQMD adapt the values from Broda et al. (2008), similar to EPA's use of the Broda et al. data in the Agency's multi-market partial equilibrium model, as documented in U.S. EPA (2011). Based on industry data from the United Nations, Broda et al. presents inverse supply elasticities for goods exported to the U.S. defined according to their 4-digit harmonized tariff system (HTS) codes, which correspond roughly to 5- or 6-digit NAICS codes. For most industries, Broda et al. present low, medium, and high elasticity values.

In its use of the Broda et al. data, the U.S. EPA assumes that elasticities for U.S. suppliers would be more elastic than the export supply elasticities estimated by Broda et al. EPA therefore added one standard deviation to the average of the industry-specific inverse supply elasticities estimated by Broda et al. and calculated the inverse of each resulting value before applying it to the U.S. Because non-U.S. suppliers may have more rigid contractual arrangements that obligate them to supply goods to the U.S., we agree that U.S. suppliers may have a more elastic response to changes in price. The magnitude of the difference between U.S. and non-U.S. suppliers, however, is unclear. Given this uncertainty, we recommend that SCAQMD specify two partial equilibrium models for a given analysis: one using the average inverse supply elasticity from Broda et al., with no adjustment, and a second in which one standard deviation is added to the Broda et al. inverse supply elasticity.

EPA also uses the low and medium elasticity values from Broda et al. for each industry, as these most closely represent price sensitivity in the short run. To the degree that SCAQMD is more interested in medium- or long-run effects, however, we would recommend use of the medium or high elasticity values. Over longer time horizons, an industry is likely to have greater sensitivity to changes in price, which would make the medium and high values from Broda et al. more appropriate.

Note that the time horizon reflected in the short run or long run may vary between analyses, depending on rigidities in the markets under analysis. In general, the short run represents the period of time before which producers and consumers have fully responded to changes in economic conditions. The amount of time before such responses occur depends on factors such as contractual arrangements and company budget cycles.

The partial equilibrium framework described above will provide SCAQMD with the percentage change in quantity and percentage change in price resulting from a policy change. SCAQMD may use this information as the basis for estimating the change in output (in absolute rather than relative terms) associated with a policy, the change in employment, and the change in income. To estimate the *absolute* change in output, SCAQMD can apply the percentage change in output, as derived from Equations 8.1 through 8.3, to baseline output data for the affected industry, as represented in Equation 8.5.

$$(8.5) \qquad \Delta Q_{S,i} = \hat{q}_{s,i} \times Q_{i,0}$$

where $\Delta Q_{S,i}$ is the absolute change in production for industry *i* in the SCAQMD region ,

$\hat{q}_{s,i}$ is as defined above,

$Q_{i,0}$ represents baseline output for industry *i* in the SCAQMD region.

To apply Equation 8.5, SCQAMD can use baseline output data for a recent historical year, by industry, for the counties that make up the SCAQMD region from EMSI.

We recommend that SCAQMD use the change in output estimated in Equation 8.5 as the basis for the estimated changes in employment and income for a given industry. As shown in Equations 8.6 and 8.7, EMSI includes employment-to-output and income-to-output ratios that SCAQMD can use in conjunction with the estimated change in output to estimate changes in employment and income, respectively.

$$(8.6) \qquad \Delta E_i = \Delta Q_{S,i} \times e_i$$

where ΔE_i is the change in employment for industry *i*,

$\Delta Q_{S,i}$ is as defined above,

e_i is the employment-to-output ratio for industry *i* in the SCAQMD region as obtained from EMSI.

$$(8.7) \qquad \Delta Y_i = \Delta Q_{S,i} \times y_i$$

where ΔY_i is the change in income for workers in industry *i*,

$\Delta Q_{S,i}$ is as defined above,

y_i is the income-to-output ratio for industry *i* in the SCAQMD region as obtained from EMSI.

The approach outlined above does not consider the impacts of competition from outside the SCAQMD region. For industries that produce goods that are consumed locally and face little to no competition from outside the region, this approach is appropriate. However, for industries that produce traded goods and must compete with firms outside the region, we would recommend one important refinement to the approach outlined above: assume that suppliers are price takers and that there would be no change in price resulting from the policy. Under these circumstances, SCAQMD would simply insert the proportional change in costs ($\widehat{mc_i}$) into Equation 8.2 and solve for the proportional change in supply ($\hat{q}_{s,i}$). The resulting value could then be used in conjunction with Equations 8.5 through 8.7 to estimate the changes in output, employment, and income.

In determining whether to treat an industry as a producer of a local good or traded good, it is necessary to clarify what constitutes a local good and what would be considered a traded good. Unfortunately, no universally accepted guideline exists. The carbon leakage literature, however, typically considers a good to be a local good if less than 15 percent is sourced externally.[43] We recommend that SCAQMD adopt this convention.

Another consideration for application of the approach outlined here is the type of policy that SCAQMD is analyzing. While many policies target the production processes within a particular sector, other policies focus on the characteristics of goods sold in the SCAQMD region (*e.g.*, low-VOC paint). Analysis of the small scale economic impacts of these policies is complicated by the fact that producers within the region as well as producers in other regions may supply affected goods within the SCAQMD region. SCAQMD may estimate the percentage change in the quantity sold and the percentage change in price using the same framework as presented in Equations 8.1 through 8.3. Equation 8.5, however, would need to be modified as follows to estimate the change in local sales of the regulated good:

$$(8.8) \qquad \Delta Q_G = \hat{q}_{s,i} \times Q_{G,0}$$

where ΔQ_G is the change in sales for good G in the SCAQMD region,

$\hat{q}_{s,g}$ is the percentage change in supply of good G in the SCAQMD region,

$Q_{G,0}$ represents baseline sales in the SCAQMD region of good G.

Data for $Q_{G,0}$ would not be available from the EMSI model because it includes output estimates for broad industries, many of which produce multiple goods. If SCAQMD would not already collect data on the baseline sales of affected goods in the region, we recommend that SCAQMD reach out to vendors in the area for this information.

While Equation 8.8 provides the change in the quantity of affected goods sold in the SCAQMD region, it does not provide the change in the quantity *produced* in the region, as some of the reduction in sales may reflect changes in production from outside the area. To estimate the change in local production, we recommend that SCAQMD assume that local producers' share of the overall change in sales is proportional to their share of the local market for the affected good in the baseline. For example, if local producers account for 20 percent of the sales of good G in the SCAQMD region in the baseline, we recommend that SCAQMD assume that local producers account for 20 percent of the change in local sales. Equation 8.9 summarizes this approach.

[43] For example, see California Air Resources Board (2010).

$$(8.9) \qquad \Delta Q_{GL} = M_{GL} \times \Delta Q_G$$

Where ΔQ_{GL} is the change in local producer sales of good *G* in the SCAQMD region,

M_{GL} is local producers' share of the local market for good *G* in the baseline,

ΔQ_G is as defined above.

As indicated in the equation, application of this approach requires data on local producers' share of the local market for goods affected by SCAQMD regulation. We would recommend that SCAQMD survey local vendors of good *G* (or wholesalers who supply local vendors) and ask them what percentage of good *G* supplied in the SCAQMD region is from local suppliers. Data from the Economic Census or County Business Patterns might also provide some insights on the size of the local industry producing good *G* relative to the rest of the industry across the U.S. These data, however, do not capture domestic or international trade flows that would be important in calculating the share of good *G* supplied locally within the SCAQMD region.

Based on the value for ΔQ_{GL} derived from Equation 8.9, SCAQMD could then estimate the corresponding changes in local employment and income using the same approach outlined above in Equations 8.6 and 8.7.

In applying the partial equilibrium approach presented in this section, we would urge SCAQMD to consider the analytic timeframe of its analyses. Because the costs of SCAQMD policies are likely to change over time (e.g., as the requirements of a program phase in), policymakers are likely to be interested in the trajectory of small scale economic impacts over time as well. We therefore recommend that SCAQMD forecast impacts over time rather than estimate impacts for a single year.

To develop such a forecast within the framework presented above, SCAQMD will need a time series of annualized compliance costs and a baseline output forecast for each small scale industry. SCAQMD already develops the former as part of its cost analyses. These year-specific costs can be applied in Equation 8.4 above. Developing an output forecast for narrowly defined industries (i.e., 6-digit NAICS) will be more challenging, as the REMI forecast currently used by SCAQMD is based on more aggregate industry definitions. We recommend that SCAQMD develop detailed output forecasts based on two approaches: (1) consulting with local industry representatives for their input on the industry growth rate and (2) assuming that the growth rate for the broader industry classification in REMI also applies to the more narrowly defined industry in EMSI. Based on the results generated by these options, SCAQMD will have a range of growth rates to apply to the historical output estimates available from EMSI. We recommend that SCAQMD use the midpoint of this range.

Estimation of Direct Economic Impacts for the Electric Power Sector

In the event that a SCAQMD regulation focuses on air pollutant emissions from the electric power sector, we would recommend a different approach than specified above for other industries. As described in Chapter 5, a number of economic models specific to the electric power sector are readily available. Based on our review of these models, we would recommend use of the Integrated Planning Model (IPM), paired with other economic data, to assess the small scale impacts of regulations affecting the power sector. As described previously in this report, IPM is a linear programming model of the electric power sector that identifies the sector's least-cost approach to serving electricity loads subject to transmission, environmental, and other constraints. The model disaggregates the U.S. electricity market into 32 model regions (including a region for Southern California). In addition, when IPM outputs are parsed (*i.e.*, disaggregated from broad model units to individual units), the model provides unit-level results. As reference, an example of IPM's parsed outputs is provided as an attachment to this report.

Using parsed model outputs, SCAQMD can estimate economic impacts for individual units or for specific portions of the industry (*e.g.*, natural gas combined cycle power plants). The specific metrics that SCAQMD could estimate at this level of detail based on IPM data include changes in revenue (monetized output), employment, and labor income. Identifying units in the IPM parse results that are located within the SCAQMD area would be relatively straightforward because the parse files include the county where each unit is located.

To estimate employment and income impacts based on IPM data, we recommend that SCAQMD focus on impacts related to early power plant retirement and changes in power plant construction (or avoided construction). With respect to the former, if SCAQMD regulation results in the premature retirement of power plants in the region, workers at these plants will presumably lose their jobs, which will reduce their incomes. Because IPM identifies early retirement as a compliance strategy, the IPM parse files for the baseline and policy cases can be used to identify individual units projected to retire under the policy case that are not projected to retire under the baseline. These would represent early retirements. SCAQMD can estimate the employment and income losses associated with these units based on their fixed operations and maintenance (O&M) costs in the baseline and average productivity estimates for the industry. Under this approach, the fixed O&M costs estimated by IPM are assumed to be labor income.

To estimate the economic impacts associated with changes in capacity investments, we recommend the SCAQMD separately estimate impacts associated with construction and impacts associated with the operations and maintenance of new plants. The analysis of construction-related impacts requires (1) estimating the change in capacity investment by year based on IPM outputs, (2) allocating investment expenditures to different items (e.g., equipment, material, installation labor), and (3) estimating the amount of labor associated with each of these items. For impacts related to the ongoing operations and maintenance of new capacity, we recommend that SCAQMD follow the same approach as described above for employment impacts related to early retirements.

The appendix to this document includes additional details on the use of IPM to estimate small scale economic impacts for regulations affecting the electric power sector.

INDIRECT AND DIRECT IMPACTS

For some policies, SCAQMD may be interested in assessing both direct and indirect small scale economic impacts. Before embarking on an analysis of these impacts, however, we would recommend that SCAQMD consider the magnitude of the policy's direct economic impacts, in particular compliance costs to directly regulated entities. Policies with minimal direct compliance costs are unlikely to result in significant spillover effects to other industries. While it may be possible to assess these effects using input-output models or other economic modeling tools, the results would likely be insignificant and in the model's rounding error. At the national level, policies that are smaller in scale than $100 million in annual compliance expenditures do not typically result in effects larger than rounding errors (Berck and Hoffman, 2002). Given that the Los Angeles Metropolitan Area accounts for approximately 5 percent of the U.S. economy, the corresponding threshold for the SCAQMD area would be approximately $5 million in annual costs.[44] For policies with annual costs below this threshold, we would recommend that SCAQMD focus its analysis on direct impacts only and apply the methods outlined above. In other words, we recommend that SCAQMD assess indirect economic impacts only for those policies with annualized costs of at least $5 million. This recommendation applies to indirect small-scale impacts as well as indirect impacts more broadly.

The other consideration in choosing an approach for the assessment of both direct and indirect small scale impacts is whether the direct compliance costs of the policy are diffuse across several industries or concentrated in a limited number of industries. When these costs are diffuse, the data required for the assessment of indirect impacts may be significant. In contrast, when compliance costs are more concentrated, the data requirements for the assessment of indirect impacts are likely to be less onerous. We present separate recommendations for each of these cases below.

Estimation of Direct and Indirect Small Scale Impacts When Costs Are Concentrated

Once determinations have been made that (1) a policy's direct effects are of large enough magnitude to warrant estimation of both direct and indirect small scale impacts and (2) these impacts are concentrated across a limited number of industries, we recommend that SCAQMD estimate small scale impacts as a range, using two approaches if sufficient data are available.

The first of these two approaches builds on SCAQMD's current use of REMI. As described in Chapter 1, REMI alone is not suitable for the estimation of small scale impacts because it lacks the industry detail necessary to assess impacts to narrowly defined industries. To address this limitation of the model, we recommend that SCAQMD use REMI in conjunction with the EMSI input-output model, the latter of which defines industries according to six-digit NAICS codes. Under this approach, results from REMI would serve as inputs to the EMSI model. The steps in this process are as follows:

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[44] The 2015 GDP for the Los Angeles Metropolitan Area was approximately $930 billion according to Bureau of Economic Analysis (BEA) data. BEA also estimates that U.S. GDP in 2015 was approximately $18 trillion.

- ***Perform REMI analysis:*** As an initial step, SCAQMD would apply REMI just as it currently does, generating estimates of output, employment, and income impacts for each sector included in the model.
- ***Map REMI sectors to EMSI sectors:*** To develop a link between REMI and EMSI, SCAMD will need to create a crosswalk between the broadly defined industries in REMI and the more detailed sectors in the EMSI input-output model.
- ***Distribute REMI results to EMSI sectors:*** Using the crosswalk developed under the previous step, we recommend that SCAQMD distribute the sector-specific output impacts estimated by REMI proportionately to the various EMSI sectors that correspond to each REMI sector. For example, assume hypothetically that REMI includes a sector for paint and adhesives manufacturing that corresponds to two sectors in EMSI: paint manufacturing and adhesives manufacturing. If, according to the benchmark data in EMSI, annual output for the paint manufacturing industry in the SCAQMD region is $70 million and the corresponding figure for the region's adhesive industry is $30 million, 70 percent of the change in output estimated by REMI for the paint and adhesives industry would be allocated to the paint industry and 30 percent would be allocated to the adhesives industry.
- ***Perform EMSI simulation:*** Using the changes in output allocated to each EMSI sector in the previous step as data inputs, the next step in the process is for SCAQMD to perform an EMSI model run. Prior to conducting the run, SCAQMD will need to convert the REMI results to the same dollar years as the EMSI data. For example, if the REMI results are in year 2014 dollars and the EMSI data are in year 2015 dollars, the REMI results will need to be inflated one year to account for inflation. After making the inflationary adjustment, the allocated outputs from REMI can be incorporated into EMSI as inputs and the EMSI model run can proceed.
- ***Report the direct impact estimates generated by EMSI:*** The direct economic impact estimates generated by EMSI will serve as SCAQMD's estimates of the indirect impacts resulting from the policy in question. Although the direct *output* effects from EMSI will simply be the REMI results distributed in proportion to the baseline EMSI data, the direct employment and income effects reported by EMSI will not, because the more detailed industry classifications in EMSI use sales-to-employment and sales-to-earnings ratios unique to each of the sub-sectors that make up the REMI sectors, as described in Chapter 5. In addition, we do not recommend that SCAQMD use the estimates of indirect and induced impacts produced by EMSI under this approach because the REMI results used as inputs in the EMSI model run already reflect indirect and induced impacts. Thus, using the indirect and induced impact estimates from EMSI would result in double counting of impacts.

In effect, this approach uses the industry detail in EMSI to allocate REMI results to more detailed industry definitions.

Although the data in EMSI represent a snapshot of the economy for a recent historical year, this approach is suitable for estimating impacts over time. Consistent with SCAQMD's current practice, the REMI analysis conducted as part of this approach will estimate impacts by year relative to REMI's baseline forecast. The EMSI model runs for each year projected by REMI would simply distribute the impact projections from REMI to the more detailed industries in EMSI, under the assumption that each industry's input structure remains constant over time.

Under our second recommended approach for estimating direct and indirect economic impacts, SCAQMD will combine EMSI with partial equilibrium models for the directly affected sectors. Unlike the first approach, this approach does not involve the use of REMI. The details of this approach are as follows:

- ***Develop partial equilibrium models:*** The first step under this approach is the development of a partial equilibrium model for each directly affected industry, using the approach outlined above for the assessment of direct impacts. Based on the model for each directly affected sector, SCAQMD will estimate changes in price and quantity associated with the policy change in question. The estimated changes in output will serve as the basis for inputs in EMSI in a later step.
- ***Estimate impacts to downstream industry(s):*** Because EMSI is an input-output model, incorporating only the change in production estimated in the previous step would not capture how increased prices for the directly affected industry affect local industries that use outputs from the directly affected industry as an input (*i.e.*, input-output models capture upstream effects from purchasing more inputs but not downstream effects due to price changes). We therefore propose estimation of the change in production for the most significant downstream customer(s) of the directly affected industry. To estimate this change, we recommend that SCAQMD adapt the framework presented above in Equations 8.1 through 8.3. As indicated in these equations, estimation of the change in quantity for a given industry requires an estimate of the proportional change in per unit production costs. Equation 8.10 illustrates how SCAQMD could estimate this proportional change in costs for the customers of a directly regulated industry.

$$(8.10) \quad \widehat{mc}_j = \alpha_{j,i} \times \hat{p}_i$$

where $\widehat{mc}_j$ is the percentage change in costs for industry *j*, which is a downstream customer of industry *i*,

$\alpha_{j,i}$ is the proportional representation of directly affected industry *i* in the production function of downstream industry *j*, as provided by EMSI,

$\hat{p}_i$ is the proportional change in price for directly affected industry *i*.

After estimating $\widehat{mc}_j$, SCAQMD can then apply a system of equations similar to Equations 8.1 through 8.3 to estimate the proportional changes in production and pricing for the downstream industry. Supply and demand elasticities for the downstream industry(s) would be obtained from the same sources as outlined above for directly affected industries. The absolute change in output for the downstream industry can then be estimated by multiplying the proportional change in output by the baseline value, as obtained from the EMSI model.

- ***Modify the change in demand for the directly regulated industry:*** If the full change in demand for the directly regulated industry and the change in demand for downstream industries were entered into EMSI, this would lead to the double-counting of impacts. Within EMSI's input-output framework, the reduction in demand for the downstream industry would lead to reduced demand for the directly regulated (upstream) industry. This reduction in demand for the directly regulated industry, however, will have already been estimated using a partial equilibrium model for the industry. To avoid double-counting, we recommend that SCAQMD, for the purposes of performing the EMSI simulation in the next step, adjust the change in demand for the directly regulated industry to exclude demand associated with reduced demand from downstream industries.

  For example, assume that a SCAQMD regulation of cement facilities reduces regional demand for cement by $20 million and that increased cement costs lead to a $5 million reduction in demand for construction services. If, according to EMSI's input-output data, cement accounts for 10 percent of the inputs used in the construction industry, the reduced demand for construction would reduce cement demand by $0.5 million (10 percent of $5 million). To avoid double-counting of impacts, this $0.5 million demand reduction should be deducted from the original $20 million estimate. Thus, the input-output analysis would be based on a $19.5 million reduction in cement demand and a $5 million reduction in construction demand.

- ***Perform EMSI simulation:*** After estimating the changes in output for the directly affected industry and the downstream industry(s) likely to realize significant impacts (including the adjustment described above for the directly regulated industry), we recommend that SCAQMD conduct an EMSI simulation, using these estimated changes as inputs. The full results from EMSI (direct, indirect, and induced) would then represent SCAQMD's estimates of indirect economic impacts.

In applying this approach, SCAQMD will need to decide what constitutes a "significant" downstream customer of a directed regulated industry. SCAQMD may decide on this definition a case-by-case basis, but we would recommend that an impact to a downstream customer is considered significant if the upstream price change would lead to a 5 percent change in costs for the downstream industry (i.e., if $\widehat{mc}_j$ is at least 5 percent). This threshold would keep the analysis focused on downstream industries for which impacts are likely to be most significant.

Note that for SCAQMD policies affecting industries selling traded goods (as opposed to local goods), the estimated impacts to downstream industries will be zero because prices would be unchanged. Local producers in the directly affected industry would be price takers, which would imply no change in price and no spillover effect to the directly affected industry's customers.

Similar to our recommendations related to the approaches presented above, we recommend that SCAQMD use this approach to develop a forecast of small scale economic impacts. Generating such an impact forecast would require a baseline output projection for the directly regulated industry(s) and the significant downstream industry(s). To develop these baseline forecasts, we recommend that SCAQMD follow the same approach as specified in the above discussion of direct impacts. Changes in output derived from these baseline forecasts will then serve as inputs in EMSI, providing a forecast of indirect and induced economic impacts.[45]

As indicated above, the two methods presented here would provide a range of estimates for the combined direct and indirect economic impacts associated with SCAQMD policies. *A priori*, it is unclear which approach would yield higher impact estimates. For some analyses, impact estimates derived from the first approach might be higher, but for other analyses the first approach might generate lower impact estimates. Repeated applications of the two approaches could reveal that one typically provides a low-end estimate while the other typically yields higher estimates of economic impacts.

Estimation of Direct and Indirect Small Scale Impacts When Costs Are Diffuse

When the compliance costs of SCAQMD policy are diffuse across several industries, implementation of the second approach outlined above (i.e., estimating impacts based on partial equilibrium models and the EMSI input-output model) could require a significant resource commitment. Such a commitment may render this approach cost-prohibitive and practically infeasible. Therefore, for policies under which direct compliance costs are diffuse across a large number of industries, we recommend that SCAQMD either (1) limit its assessment of direct and indirect impacts to the first approach outlined above (i.e., using EMSI to allocate REMI results to more detailed industry definitions) or (2) perform a REMI analysis only, similar to current practice. Using EMSI in conjunction with REMI will provide SCAQMD with impact estimates at a finer level of sectoral detail than using REMI alone. However, if the REMI results are widely distributed across many industries, further disaggregating those results to additional industries may not provide actionable insights. Due to this uncertainty, we recommend that SCAQMD decide on a case-by-case basis whether to use REMI alone or to use it in conjunction with EMSI.

CONSISTENCY CHECKS WITH THE PEER-REVIEWED LITERATURE

To assess the reasonableness of the small scale impact estimates derived from the methods above, we recommend that SCAQMD compare these results to select studies from the peer-reviewed literature. The review of this literature presented in Chapter 2 indicates that it would be difficult to use this literature as the basis for assessing small

45 Although EMSI itself does not include a baseline output forecast, the results generated by EMSI would, in effect, be an impact forecast because they would be based on a forecast of direct impacts derived from the partial equilibrium models for the directly affected industry and significant downstream industries.

scale impacts because most studies use broad indicators of regulatory stringency (*e.g.*, nonattainment with the National Ambient Air Quality Standards) rather than more precise measures. Some of these studies, however, may provide an approximation of the scale of impacts that SCAQMD might expect or the percentage change in metrics such as employment. For example, SCAQMD could compare its findings with those from Greenstone (2002), who found that in the first 15 years following enactment of the Clean Air Act, nonattainment counties lost approximately 590,000 jobs and $75 billion of output in pollution-intensive industries, relative to attainment counties. SCAQMD could convert these values to percentage changes and compare the results of its analyses to these estimates. If SCAQMD's percentage values for a relatively narrow policy are significantly higher than the Greenstone (2002) estimate, this might suggest that SCAQMD is overestimating impacts. Similarly, based on Deschenes' (2010) finding that short-run cross price elasticities between energy prices and employment range from -0.10 to -0.16, SCAQMD could compare its impact estimates for actions affecting energy prices to these results. We would also encourage SCAQMD to look to other studies for similar comparisons.

DATA SOURCES FOR IMPLEMENTATION OF RECOMMENDATIONS

Implementation of the recommendations presented above will require data from several sources. Most of these data are specific to individual industries or to the SCAQMD region. We have identified these data sources throughout this document in our presentation of recommendations. To provide SCAQMD with a single reference that it can consult for this information, this section identifies the specific data sources required or recommended for each of our recommendations. Exhibits 8-2 and 8-3 identify each of these sources for our recommendations concerning small business impacts and small scale impacts, respectively.

EXHIBIT 8-2. SUMMARY OF DATA SOURCES FOR ESTIMATION OF SMALL BUSINESS IMPACTS

DATA NEED	DATA SOURCE
Definition of small business	Policy decision for SCAQMD.
Annual revenues of regulated firms	Initially consult Dun & Bradstreet, followed by Hoover's, SEC filings, and InfoUSA if not available from D&B. If these sources contain no data, develop estimates of average revenue per firm for companies below the small business size threshold using data from the Economic Census.
Annual employment of regulated firms	Initially consult Dun & Bradstreet, followed by Hoover's, SEC filings, and InfoUSA if not available from Dun & Bradstreet. If these sources contain no data, develop estimates of average employment per company for companies below the small business size threshold using data from the Economic Census.
Annual profits of regulated firms	Initially consult Dun & Bradstreet, followed by Hoover's, SEC filings, and InfoUSA if not available from D&B. If these sources contain no data, estimate average profitability using average per-company revenue for small businesses, by NAICS, as derived from the Economic Census. Average per-firm profits may then be estimated by applying average profit margin estimates from RMA. RMA provides profitability data for small and medium sized businesses by industry and region.
Compliance costs for small businesses	Facility-specific costs or model facility costs, as estimated by SCAQMD.

EXHIBIT 8-3. SUMMARY OF DATA SOURCES FOR ESTIMATION OF SMALL SCALE IMPACTS

DIRECT OR INDIRECT IMPACTS	DATA NEED	DATA SOURCE
Direct	Own price elasticity of demand	Taylor and Houthakker (2010)
	Elasticity of supply	Obtain values from industry or the literature if possible. If not possible, adapt elasticity values from Broda et al. (2008).
	Total annual costs of SCAQMD policy, by 6-digit NAICS	To be estimated by SCAQMD.
	Baseline annual revenues by six-digit NAICS within the SCAQMD region.	Obtain from EMSI input-output model.
	Employment-to-output ratio for individual industries, defined by six-digit NAICS, in the SCAQMD region.	Obtain from EMSI input-output model.
	Income-to-output ratio for individual industries, defined by six-digit NAICS, in the SCAQMD region.	Obtain from EMSI input-output model.
	Baseline sales in the SCAQMD region of a given good regulated by SCAQMD policy.	If SCAQMD would not already collect data on the baseline sales of affected goods in the region, we recommend that SCAQMD reach out to vendors in the area for this information.
	Local producers' share of the market for a given good in the SCAQMD region (*i.e.*, the percentage of local sales of a given good supplied by local firms).	We would recommend that SCAQMD survey local vendors of a given good (or wholesalers who supply local vendors) and inquire what percentage of the good supplied in the SCAQMD region is from local suppliers.
Indirect and Direct	Data for assessment of direct impacts.	See listings above.
	REMI industry definitions	Assume that SCAQMD already has or that REMI would provide.
	EMSI industry definitions	Assume that EMSI would provide.
	The proportional representation of directly affected industry *i* in the production function of downstream industry *j*.	Derive from EMSI input-output data for the SCAQMD region.

RESOURCES REQUIRED TO IMPLEMENT RECOMMENDATIONS

To assist SCAQMD with planning for analyses based on the recommendations presented in this chapter, Exhibits 8-4 and 8-5 include information on the resources required to implement these recommendations. As indicated in the exhibit, the resources required will depend

EXHIBIT 8-4. RESOURCES NECESSARY FOR SMALL BUSINESS IMPACT ANALYSIS

CATEGORY	ITEM/ACTIVITY	COST
Data Purchases	Dun & Bradstreet or Hoover's (annual subscription)	$5,000 to $9,000
	RMA, eStatement Studies (1 user, annual subscription)	$625
Personnel Time	Analyst time to perform small business impact analysis (incremental to time already spent analyzing regulatory costs)	For relatively narrow regulations, approximately 100 – 200 labor hours For relatively broad regulations, approximately 200-300 hours

EXHIBIT 8-5. RESOURCES NECESSARY FOR ANALYSIS OF SMALL SCALE IMPACTS

SCOPE OF ANALYSIS	ITEM/ACTIVITY	COST
Direct Impacts	EMSI Model, for obtaining baseline data for regulated industry (annual subscription for the counties that make up the SCAQMD region)	Approximately $10,500
	Analyst time for the following (incremental to time already spent analyzing compliance costs): • Collection of baseline economic data. • Specification of partial equilibrium model for regulated industry(s) • Interpretation of results	For relatively narrow regulations: approximately 200 to 300 labor hours. For relatively broad regulations, approximately 500 to 600 labor hours.
Direct and Indirect Impacts	REMI Model	No incremental cost. SCAQMD already has the model.
	EMSI Model (annual subscription for the counties that make up the SCAQMD region)	Approximately $10,500
	Analyst time for the following (incremental to time already spent analyzing regulatory costs): • Data collection • Data preparation • Specification of partial equilibrium model(s) for downstream industry • Perform REMI and/or EMSI model runs • Interpret results of analyses	For relatively narrow regulations: approximately 400 to 600 labor hours. For relatively broad regulations, approximately 800 to 1,000 labor hours.

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APPENDIX A

ESTIMATION OF DIRECT SMALL SCALE IMPACTS FOR ELECTRICITY GENERATORS

As described in the main body of this document, if SCAQMD is developing a policy that would affect the electric power sector and the District is interested in direct impacts only, we would recommend use of the Integrated Planning Model (IPM), paired with other economic data, to assess small scale impacts. The purpose of this appendix is to provide additional detail on the implementation of this recommendation. We present these details separately for the specific types of impacts that we recommend SCAQMD estimate based on the IPM data.

As background for these recommendations, IPM is a linear programming model of the electric power sector that identifies the sector's least-cost approach to serving electricity loads subject to transmission, environmental, and other constraints. The model disaggregates the U.S. electricity market into 32 model regions (including a region for Southern California). In addition, when IPM outputs are parsed (*i.e.*, disaggregated from broad model units to individual units), the model provides unit-level results. As reference, an example of IPM's parsed outputs is provided as an attachment to this report.

Using parsed model outputs, SCAQMD can estimate economic impacts for individual units or for specific portions of the industry (e.g., natural gas combined cycle power plants). The specific metrics that SCAQMD could estimate at this level of detail with the IPM data include changes in revenue (monetized output) and employment. We do not recommend estimation of employment impacts associated with changes in generation at plants that operate in the baseline and continue to operate in the policy case. While the demand for labor at a given plant may change as the plant's generation fluctuates, we would not expect such changes to be significant, as many operational activities that require labor do not change significantly with generation (*e.g.*, boiler operators, switchboard operators, etc.).

CHANGE IN REVENUES

To estimate changes in power sector revenue, we recommend that SCAQMD integrate IPM's unit level generation estimates for the baseline and policy scenarios with its wholesale electricity pricing projections for both scenarios, as summarized by Equation A.1.

$$\text{(A.1)} \qquad \Delta R_{U,t} = \sum_{u} \left[\left(G_{u,p,t} \times P_{r,p,t} \right) - \left(G_{u,b,t} \times P_{r,b,t} \right) \right]$$

Where $\Delta R_{U,t}$ represents the change in revenue for segment U of the SCAQMD's area's power sector at time t,

$G_{u,p,t}$ is the amount of electricity generated by unit u within segment U of the area's power sector under the policy case at time t,

$P_{r,p,t}$ is the wholesale price of electricity in the region under the policy case at time t[46],

$G_{u,b,t}$ is the amount of electricity generated by unit u within segment U of the area's power sector in the baseline at time t,

$P_{r,b,t}$ is the wholesale price of electricity in the region in the baseline at time t,

Because IPM's parse files provide generation projections at the unit level, SCAQMD would have the flexibility to group power producers according to any of the industry segments (U) represented in IPM. For example, these industry segments include combined cycle natural gas plants and natural gas steam plants. In addition, identifying units in the IPM parse results within the SCAQMD area would be relatively straightforward because the parse files include the county where each unit is located.

EMPLOYMENT AND INCOME IMPACTS

For the estimation of employment and income impacts, we recommend that SCAQMD focus on impacts related to early retirements of power plants and impacts related to changes in power plant construction (or avoided construction). With respect to the former, if SCAQMD regulation results in the premature retirement of power plants in the region, workers at these plants will presumably lose their jobs, which will reduce their incomes. Because IPM identifies early retirement as a compliance strategy, the IPM parse files for the baseline and policy cases can be used to identify individual units projected to retire under the policy case that are not projected to retire under the baseline. These would represent early retirements. The employment and income losses associated with these units may be estimated based on their fixed operations and maintenance costs in the baseline and average productivity estimates for the industry. Equations A.2a and A.2b specify this approach more formally.

$$\text{(A.2a)} \quad Y_{er,t} = \sum_{U} K_{er,U,t} \times FOM_{b,U,t}$$

where $Y_{er,t}$ is the income impact of early retirements for the SCAQMD's area's power sector at time t,

$K_{er,U,t}$ is the change in retirement in kW of capacity projected by IPM for segment U of the SCAQMD area's power sector at time t,

$FOM_{b,U,t}$ is fixed O&M costs per kW of capacity in the baseline for segment U of the SCAQMD area power industry at time t, as derived from IPM outputs.

$$\text{(A.2b)} \quad E_{er,t} = \sum_{U} \frac{K_{er,U,t} \times FOM_{b,U,t}}{D}$$

[46] For a given scenario, IPM's wholesale electricity price projections are reported in the SSR file generated as part of IPM's results. We provide an example of one of these files as an attachment to this document.

where $E_{er,t}$ is the employment impact of early retirements for the SCAQMD's area's power sector at time t,

$K_{er,U,t}$ is as defined above

$FOM_{b,U,t}$ is as defined above,

D represents productivity (labor costs per full time equivalent employee) within the power generation and supply industry (NAICS 2211), as derived from Bureau of Labor Statistics (BLS)[47] data.

Under this approach, the fixed O&M costs estimated by IPM are assumed to be labor income. This is consistent with the U.S. EPA's estimation of employment impacts in recent regulatory impact analyses.[48] To the extent that fixed O&M costs include other items, SCAQMD may note the reliance on fixed O&M costs as a limitation of this approach. Similarly, while it is possible that some of the labor income reflected in a power plant's fixed O&M costs reflect payments to factors of production outside the SCAQMD region (*e.g.*, technicians called in for annual maintenance), insufficient information is readily available to assess the magnitude of this leakage of labor income outside the region.

The average fixed O&M costs per kW of capacity for each segment U of the SCAQMD area's power sector can be estimated directly from the IPM parse file data, which include the fixed O&M costs by generation unit. We recommend that SCAQMD combine the data for each segment of the electric power industry into an average cost-per-kW value rather than using unit-specific estimates, as the uncertainty in the unit-specific values is likely to be significant. Exhibit A-1 shows the fixed O&M costs per kW estimated from IPM data for EPA's analysis of the employment impacts of the final Clean Power Plan. We present these values for illustrative purposes. For analyses specific to the SCAQMD area, we recommend that SCAQMD develop values based on generation units located in the SCAQMD area.

EXHIBIT A-1. AVERAGE FOM COSTS FOR EXISTING COAL AND OIL & GAS STEAM CAPACITY NATIONALLY ($/KW, 2011$)

GENERATION TECHNOLOGY	2020	2025	2030
Coal	$70	$73	$74
Oil and Gas	$34	$33	$33

Source: *Source: U.S. EPA, Regulatory Impact Analysis for the Final Clean Power Plan, Table 6A-5, October 23, 2015.*

[47] See BLS, Division of Industry Productivity Studies, U.S. Labor Productivity, available online at http://www.bls.gov/lpc/ and BLS, National Occupational Employment and Wage Estimates, http://www.bls.gov/oes/current/oes_nat.htm.

[48] For example, see U.S. EPA, Regulatory Impact Analysis for the Final Clean Power Plan, October 23, 2015.

Equation A.2 also shows that productivity estimates, expressed as labor costs per full time equivalent employee, are necessary to convert estimates of labor costs into employment estimates. These productivity values may be derived from BLS data as follows:

$$\text{(A.3)} \quad D = \frac{L}{H/a} \times \frac{w_s}{w_{US}}$$

Where *L* represents annual labor compensation costs for NAICS 2211 reported by BLS at the national level,

H is the number of labor hours for NAICS 2211 reported by BLS,

a is the assumed number of labor hours per year per full time equivalent worker (2080).

W_s is the average annual wage rate in the Los Angeles-Long Beach-Anaheim Metropolitan Statistical Area (MSA), as reported by BLS[49],

W_{US} is the average annual waste rate for the U.S., as reported by BLS.

Within Equation A.3, the term *L/(H/a)* represents the average cost per worker nationally. To adjust for regional differences and derive a value specific to the SCAQMD region, this term is multiplied by the ratio of the average wage rate in the Los Angeles MSA to the average wage rate nationally.

As noted above, policies affecting the power sector may also affect employment and income through their impact on investments in new generating capacity. For example, a given policy may discourage the construction of coal-fired power plants relative to the baseline and encourage the construction of combined cycle natural gas capacity. These changes in investment patterns may lead to two types of employment and income impacts: (1) short-term impacts associated with changes in construction activity and (2) longer-term impacts associated with the operation and maintenance of the plants constructed or not constructed because of the policy.

To estimate short-term construction-related employment and income impacts for individual segments of the power industry, we recommend that SCAQMD estimate these impacts based on the capital costs estimated by IPM for new units. The steps involved in this process are as follows:

1. ***Estimate upfront capital investment associated with changes in new capacity.*** The IPM parse files include estimates of annualized capital costs for each unit in the model, including new units. To convert these annualized values to estimates of upfront capital investment, they must be divided by the capital charge rate that IPM uses to annualize capital investments, as illustrated in Equation A.4.[50]

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[49] See BLS, Metropolitan and Nonmetropolitan Area Occupational Employment and Wage Estimates, http://www.bls.gov/oes/current/oes_31080.htm.

[50] The capital charge rate is an annualization factor that converts upfront capital costs to annualized values, based on the assumed interest rate and the tax treatment of debt financing.

These capital charge rates vary by technology type. Exhibit A-2 presents the capital charge rates used in IPM for EPA's analysis of the final Clean Power Plan.

$$\text{(A.4)} \quad C_{I,N,U,t} = \frac{C_{a,N,U,t}}{CCR_U}$$

where $C_{I,N,U,t}$ is the total upfront capital investment for new capacity in segment *U* of the SCAQMD area's power sector at time *t*,

$C_{a,N,U,t}$ is the annualized investment cost for new capacity in segment *U* of the SCAQMD area's power sector in time *t*,

CCR_U represents the capital charge rate for segment *U* of the SCAQMD area's power sector.

EXHIBIT A-2. CAPITAL CHARGE RATE AND CONSTRUCTION DURATION ASSUMPTIONS FROM EPA CLEAN POWER PLAN ANALYSIS

NEW INVESTMENT TECHNOLOGY	CAPITAL CHARGE RATE	CONSTRUCTION DURATION (YEARS)
Advanced Combined Cycle	10.3%	3
Advanced Combustion Turbine	10.6%	2
Renewables		
Dedicated Biomass	9.5%	3
Wind (Onshore)	10.9%	3
Landfill Gas	10.9%	3
Solar	10.9%	3
Geothermal	10.9%	3

Source: U.S. EPA, Regulatory Impact Analysis for the Final Clean Power Plan, Table 6A-2, October 23, 2015.

2. ***For each IPM model year, isolate incremental investment.*** IPM's capital cost values for a given model run year, as described in Step 1 above, represent snapshots that reflect investments made that year and in prior model run years. Therefore, when estimating the change in investment occurring in a given model run year, one must net out the changes estimated for prior years. For example, assume that, after implementing the first step above, the IPM baseline shows $20 million of new capacity investment in 2020 and $25 million of new investment in 2025 and that the policy case shows $22 million of new capacity investment in 2020 and $28 million in new investment in 2025. Based on these trajectories, the policy results in $2 million of additional investment in 2020 ($22 million minus $20 million is $2 million) and $1 million in 2025 ($28 million minus $25 million, less the $2 million previously invested in 2020).

3. ***Convert total incremental capital investments to annual values.*** The values generated by Steps 1 and 2 represent the total capital investments associated with new capacity installed in a given year. The construction of a new electricity generation unit, however, takes place over a period of years. To convert the total investment estimated in Steps 1 and 2 to annual values by generation type (segment), the totals from Step 2 must be divided by the duration of construction by generation type, as summarized in the right-hand column of Exhibit A-2. For example, if the IPM results for 2025 show $30 million in upfront investment costs for new combined cycle capacity, this $30 million investment would be spread over three years (e.g., 2023, 2024, and 2025).

4. ***Distribute construction costs to different construction activities***. The investment costs generated by Steps 1 through 3 reflect a combination of equipment, material, installation labor, and support labor in engineering and management. To isolate costs specific to each of these items, we recommend that SCAQMD apply the expenditure breakdown presented in Exhibit A-3 that EPA applied in its analysis of the employment impacts of the final Clean Power Plan.

EXHIBIT A-3. EXPENDITURE BREAKDOWN DUE TO NEW GENERATING CAPACITY

	EQUIPMENT	MATERIAL	LABOR	ENG. AND CONST. MGT.
Renewables	54%	6%	31%	9%
Combined Cycle	65%	10%	18%	7%
Combustion Turbine	65%	10%	18%	7%

Source: U.S. EPA, Regulatory Impact Analysis for the Final Clean Power Plan, Table 6A-3, October 23, 2015.

5. ***Estimate employment and income for each construction-related activity.*** After isolating costs specific to each of the items shown in Exhibit A-3, SCAQMD can apply income-to-output and employment-to-output ratios from BLS for each activity likely to occur in the SCAQMD region to convert activity-specific costs to estimates of construction-related jobs and income in the region.[51] We recommend that SCAQMD perform this calculation only for the labor and engineering and construction management categories in Exhibit A-3. For engineering and construction management, we recommend use of BLS data for the engineering services sector (NAICS 54133). For general installation labor, we recommend that SCAQMD use BLS data for the power industry construction sector (NAICS 2371). While labor is required for the manufacturing of

[51] See BLS, Division of Industry Productivity Studies, U.S. Labor Productivity, available online at http://www.bls.gov/lpc/.

equipment (*e.g.*, industrial machinery) and material (*e.g.*, steel), this labor is likely to be employed outside of the SCQAMD region.

To estimate long-term O&M-related employment and income impacts associated with an increase or decrease in new generating capacity, we recommend that SCAQMD use a similar approach as described above for employment and income losses from early retirement (see Equation A.2). As indicated in the above discussion of employment and income impacts related to early retirements, we assume that fixed O&M costs for power plants are labor costs, consistent with EPA practice. IPM's parse files include estimates of fixed O&M costs for new capacity in the baseline and under the policy case. These data can form the basis of estimates of average fixed O&M (labor income) costs per kW for new capacity, by generation technology type. Applying these average values to the change in new capacity yields the change in fixed O&M costs (labor income) associated with changes in capacity. To estimate O&M-related employment impacts, SCAQMD can divide these fixed O&M (labor) costs by average productivity in the power sector, as estimated according to Equation A.3 above.

As described above, our recommend approach for the power sector focuses on (1) revenue impacts from reduced generation, (2) employment impacts associated with early retirements, and (3) employment impacts resulting from changes in new capacity. We do not recommend estimation of employment impacts associated with changes in generation at plants that operate in the baseline and continue to operate in the policy case. While the demand for labor at a given plant may change as the plant's generation fluctuates, we would not expect such changes to be significant, as many operational activities that require labor do not change significantly with generation (*e.g.*, boiler operators, switchboard operators, etc.).

DATA SOURCES

The detailed approach presented in this appendix would require data for several key variables. Exhibit A-4 summarizes potential data sources for this information.

EXHIBIT A-4. SUMMARY OF DATA SOURCES FOR ESTIMATION OF SMALL SCALE IMPACTS FOR ELECTRICITY PRODUCERS

INDUSTRY	DATA NEED	DATA SOURCE
Electricity production	Change in electricity prices	The SSR file of the Integrated Planning Model (IPM) results includes wholesale electricity prices by region.
	Change in electricity generation, by power plant type	IPM parse files include baseline and policy case generation by unit.
	Number and capacity of units that retire prematurely in the baseline and under the policy case	IPM parse files.
	Fixed O&M cost per kW of capacity, by generation technology	Can be derived from unit-specific fixed O&M costs and capacity as obtained from the IPM parse files. We recommend average fixed O&M per kW, by technology type.
	Productivity (labor costs per full time equivalent employee) within the power generation and supply industry	BLS, Division of Industry Productivity Studies, U.S. Labor Productivity, available online at http://www.bls.gov/lpc/.
	New generation capacity constructed (MW), by generation technology, under the baseline and policy case.	IPM parse files provide at the unit level. SCAQMD can aggregate these data to the counties that make up the SCAQMD region.
	Annualized investment cost for new capacity, by generating technology	IPM parse files provide by unit. SCAQMD can aggregate across units for a given technology type.
	Capital charge factor (to de-annualize annualized investment cost for new capacity)	IPM documentation for version of the model applied.
	Time required to construct new power plant, by technology type	U.S. EPA, Regulatory Impact Analysis for the Final Clean Power Plan, Table 6A-2, October 23, 2015.
	Distribution of expenditures on new power plant across different activities (e.g., equipment, material, labor, etc.)	U.S. EPA, Regulatory Impact Analysis for the Final Clean Power Plan, Table 6A-3, October 23, 2015.
	Fixed O&M costs per kW of new capacity, by generation technology.	Can be derived from unit-specific fixed O&M costs and capacity as obtained from the IPM parse files. We recommend average fixed O&M per kW, by technology type.