Socioeconomic Impact Analysis of Proposed Rule 12-16

Regulation 12, Miscellaneous Standards of Performance;

Rule 16, Petroleum Refining Facility-Wide Emissions Limits

Prepared for:
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TABLE OF CONTENTS

1. INTRODUCTION

In response to concerns of harmful pollutants emanating from petroleum refineries operating in the nine-county San Francisco Bay Area region, particularly with respect to greenhouse gases and toxic air contaminants and criteria pollutants, the Board of Directors of the Bay Area Air Quality Management District (Air District) directed staff to bring forward two proposed rules for their consideration. At the request of the Board, District staff has prepared one proposed rule that reflect policies recommended by environmental advocacy organizations, and a second that follows an approach recommended by District staff. Air District staff has developed proposed "Regulation 12, Miscellaneous Standards of Performance; Rule 16, Petroleum Refining Facility-Wide Emissions Limits (Rule 12-16)" based on input from a consortium of environmental groups in the region (CBE). A key provision sought by CBE is a cap on refinery combustion emissions at levels consistent with refineries' recent operations. In addition, proposed Rule 12-16 establishes emissions limits for greenhouse gases (GHG's), nitrogen oxides (NOx), sulfur dioxide (SO2), and particulate matter 10 microns and smaller (PM_{10}) and particulate matter 2.5 microns and smaller ($PM_{2.5}$).

After this introduction, this report discusses in greater detail proposed Rule 12-16 (Section Two). After that discussion, the report describes the socioeconomic impact analysis methodology and data sources (Section Three). The report describes population and economic trends in the nine-county San Francisco Bay Area (Section Four), which serves as a backdrop against which the Air District is contemplating the three sets of rule changes. Finally, the socioeconomic impacts stemming from the proposed rule changes are discussed in Section Five. The report is prepared pursuant to Section 40728.5 of the California Health and Safety Code, which requires an assessment of socioeconomic impacts of proposed air quality rules. The findings in this report can assist Air District staff in understanding the socioeconomic impacts of the proposed requirements, and can assist staff in preparing a refined version of the rule. Figure 1 is a map of the nine-county region that comprises the San Francisco Bay Area Air Basin.

Figure 1 – Map of San Francisco Bay Area Region

SOURCE: Google
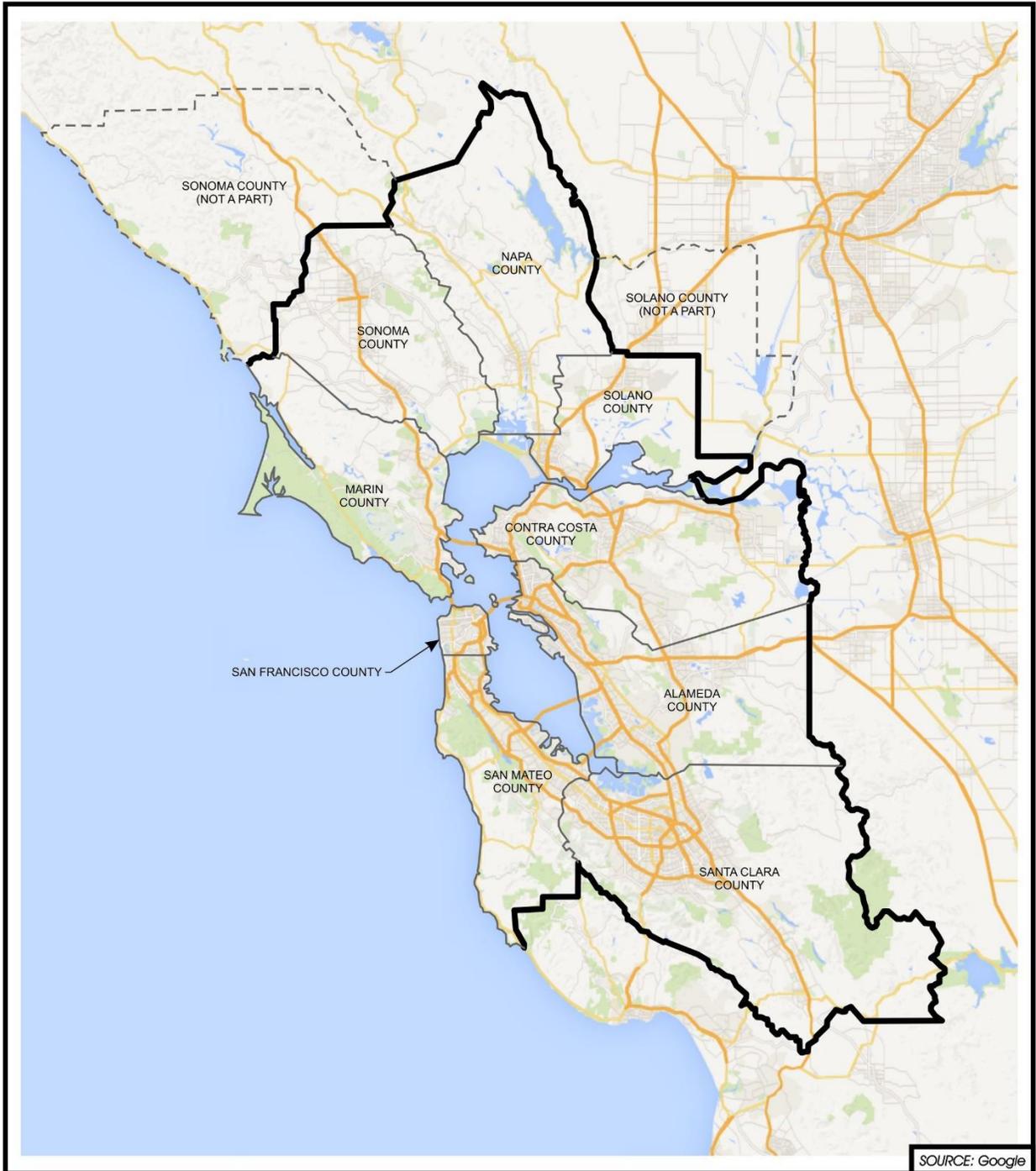
2. BACKGROUND AND OVERVIEW OF PROPOSED RULE 12-16

Proposed Rule 12-16 would apply to the five large refineries operating in the Bay Area. These are Chevron Products Company (BAAQMD Plant #10 in Richmond), Phillips 66 Company Refinery (BAAQMD Plant #21359 in Rodeo), Shell Martinez Refinery (BAAQMD Plant #11 in Martinez), Tesoro Refining and Marketing Company (BAAQMD Plant #14628 in Martinez), and Valero Refining Company (BAAQMD Plant #12626 in Benicia). Three facilities that support a number of these facilities would also be affected. These are Air Products and Chemicals hydrogen plant (BAAQMD Plant #10295), Air Liquide hydrogen plant (BAAQMD Plant #17419), and Martinez Cogen, L.P. (BAAQMD Plant #1820). Proposed Rule 12-16 sets the emission limits for each affected facility. The emissions limits cover greenhouse gases (GHG), sulfur dioxide (SO_2), nitrogen oxides (NOx), particulate matter less than 2.5 microns ($PM_{2.5}$), and particulate matter less 10 microns (PM_{10}).

Each refinery and support facility would report emissions based on the requirements in proposed Rule 12-15, Section 401. The District would review and approve the annual emissions inventory per Rule 12-15, Section 402. District staff would then take the steps needed to exclude flare and cooling tower emissions from the annual emissions inventory, where needed. Refinery and support facility emissions for each pollutant, after exclusions, would be compared to the emissions limits established in Rule 12-16, Section 300. Determination of compliance is described in the staff report prepared for Rule 12-16.

In the case of proposed Rule 12-16, District staff report that there are two general scenarios to consider when evaluating the impact of capping refining emissions. In one general scenario, the refineries decide to make physical improvements in order to reduce emissions to allow for increases in refining capacity while staying below the cap. In this first scenario, a refinery may elect to put in a wet scrubber to reduce PM and SO_2 emissions. In the other general scenario, refineries elect to limit production to a level consistent with the cap.

3. METHODOLOGY

Applied Development Economics (ADE) began this analysis by preparing a statistical description of the industry groups of which the affected sources are a part, analyzing data on the number of establishments, jobs, and payroll. We also estimated sales generated by impacted industries, as well as net profits for each affected industry.

This report relies heavily on the most current data available from a variety of sources, particularly InfoUSA. In addition, this report relies on data from the US Census County Business Patterns, as well as from the US Internal Revenue Service. ADE also utilized employment data from the California Employment Development Department – Labor Market Information Division (EDD LMID).

With the above information, ADE was able to estimate net after tax profit ratios for sources affected by the proposed rule. ADE calculated ratios of profit per dollar of revenue for affected industries. The result of the socioeconomic analysis shows what proportion of profits the compliance costs represent. Based on assumed thresholds of significance, ADE discusses in the report whether the affected sources are likely to reduce jobs as a means of recouping the cost of rule compliance or as a result of reducing business operations. To the extent that such job losses appear likely, the indirect multiplier effects of the jobs losses are estimated using a regional IMPLAN input-output model. In some instances, particularly where consumers are the ultimately end-users of goods and services provided by the affected sources, we also analyzed whether costs could be passed to households in the region.

When analyzing the socioeconomic impacts of proposed new rules and amendments, ADE attempts to work closely within the parameters of accepted methodologies discussed in a 1995 California Air Resources Board (ARB) report called "Development of a Methodology to Assess the Economic Impact Required by SB513/AB969" (by Peter Berck, PhD, UC Berkeley Department of Agricultural and Resources Economics, Contract No. 93-314, August, 1995). The author of this report reviewed a methodology to assess the impact that California Environmental Protection Agency proposed regulations would have on the ability of California businesses to compete. The ARB has incorporated the methodologies described in this report in its own assessment of socioeconomic impacts of regulations generated by the ARB. One methodology relates to determining a level above or below which a rule and its associated costs is deemed to have significant impacts. When analyzing the degree to which its rules are significant or insignificant, the ARB employs a threshold of significance that ADE follows. Berck reviewed the threshold in his analysis and wrote, "The Air Resources Board's (ARB) use of a 10 percent change in [Return on Equity] ROE (i.e. a change in ROE from 10 percent to a ROE of 9 percent) as a threshold for a finding of no significant, adverse impact on either competitiveness or jobs seems reasonable or even conservative."

4. ECONOMIC AND DEMOGRAPHIC TRENDS

This section of the report discusses the larger context within which the Air District is contemplating proposed Rule 12-16. This section begins with a broad overview of demographic and economic trends, with discussion then narrowing to industries and sources affected by the proposed rule.

REGIONAL POPULATION TRENDS

Table 1 tracks population growth in the nine-county San Francisco Bay Area between 2006 and 2016, including data for the year 2011. Between 2006 and 2017, the region grew by approximately 1.0 percent a year. Between 2011 and 2016, the region grew annually at a somewhat faster rate of 1.2 percent per year. Overall, there are 7,649,565 people in the region. At 1,927,888 Santa Clara County has the most people, while Napa has the least, at 142,028. Santa Clara grew the fastest between 2011 and 2016, at 1.3 percent a year, while Marin grew by the slowest rate (0.6 percent a year) over the same period.

Table 1: Population Trends: Bay Area Counties, Region, and California

JURISDICTION	2006	2011	2016	06-11 CAGR	11-16 CAGR	06-16 CAGR
California	36,116,202	37,536,835	39,255,883	0.8%	0.9%	0.8%
SF Bay Area	6,915,872	7,220,443	7,649,565	0.9%	1.2%	1.0%
Alameda	1,462,371	1,525,695	1,627,865	0.9%	1.3%	1.1%
Contra Costa	1,007,169	1,059,495	1,123,429	1.0%	1.2%	1.1%
Marin	246,969	253,964	262,274	0.6%	0.6%	0.6%
Napa	131,330	136,913	142,028	0.8%	0.7%	0.8%
San Francisco	781,295	815,854	866,583	0.9%	1.2%	1.0%
San Mateo	699,347	726,305	766,041	0.8%	1.1%	0.9%
Santa Clara	1,706,676	1,803,362	1,927,888	1.1%	1.3%	1.2%
Solano	410,964	413,438	431,498	0.1%	0.9%	0.5%
Sonoma	469,751	485,417	501,959	0.7%	0.7%	0.7%

Source: ADE, Inc., based on California Dept. of Finance E-5 Reports (note: CAGR = compound annual growth rate)

REGIONAL ECONOMIC TRENDS

Data in Table 2 describe the larger economic context within which officials are contemplating the proposed Rule 12-16. Businesses in the region employ almost three and a half million workers, or 3,431,643. The number of private and public sector jobs in the region grew annually by 3.0 percent between 2010 and 2015, after having declined slightly between 2005 and 2010 by 0.6 percent a year. Of the 3,431,643 workers, 168,837, or 4.9 percent, are civil servants in the public sector. This figure does not include public sector education, which was combined with private sector education and placed in the private sector portion of the table, in an effort to present a picture as to the total number

of persons in the education profession in the Bay Area. The most current annual employment data are for the year 2015 as California EDD has not yet posted detailed all-year 2016 employment data.

Table 2 — San Francisco Bay Area Employment Trends By Sector: 2005 - 2015

INDUSTRY SECTOR		2005	2010	2015	2015	2015 CA	SFBA CAGR* 05-10	SFBA CAGR 10-15	CA CAGR 05-10	CA CAGR 10-15
Total		**3,049,802**	**2,963,021**	**3,431,643**	**100.0%**	**100.0%**	**-0.6%**	**3.0%**	**-1.1%**	**2.3%**
Private Sector		2,869,200	2,774,555	3,262,806			-0.7%	-0.7%	3.3%	2.6%
62	Health	300,775	340,492	453,880	13.2%	13.9%	2.5%	5.9%	2.5%	6.5%
54	Prof., Scientific	293,262	322,617	417,902	12.2%	7.4%	1.9%	5.3%	1.2%	3.2%
44-45	Retail	335,744	306,798	340,197	9.9%	10.2%	-1.8%	2.1%	-1.8%	1.8%
31-33	Manufacturing	350,962	305,378	326,362	9.5%	7.9%	-2.7%	1.3%	-3.8%	0.7%
722	Food Srv, Drnkng	214,142	227,750	288,896	8.4%	8.0%	1.2%	4.9%	0.6%	4.2%
561	Admin. Support	170,727	157,319	192,097	5.6%	6.2%	-1.6%	4.1%	-2.4%	4.2%
61	Education	185,310	192,195	180,382	5.3%	8.5%	0.7%	-1.3%	0.1%	0.8%
23	Construction	188,473	129,820	171,403	5.0%	4.4%	-7.2%	5.7%	-9.2%	4.9%
51	Information	112,690	110,725	158,943	4.6%	2.9%	-0.4%	7.5%	-2.1%	2.2%
42	Wholesale	124,390	113,072	125,215	3.6%	4.4%	-1.9%	2.1%	-0.9%	2.1%
81	Other Services	140,159	155,133	121,676	3.5%	3.2%	2.1%	-4.7%	0.9%	-6.6%
52	Finance, Insrnce	151,375	118,163	120,272	3.5%	3.2%	-4.8%	0.4%	-4.4%	0.4%
55	Mgt. of Comp.	54,856	55,605	75,726	2.2%	1.4%	0.3%	6.4%	-2.9%	3.6%
48-49	Trnsprt-Warehsng	51,880	46,721	72,947	2.1%	2.9%	-2.1%	9.3%	-1.0%	3.6%
71	Culture	49,572	52,315	58,669	1.7%	1.8%	1.1%	2.3%	0.6%	3.0%
53	Real Estate	61,402	52,676	57,463	1.7%	1.7%	-3.0%	1.8%	-2.7%	1.6%
721	Accommodation	46,156	44,734	49,490	1.4%	1.3%	-0.6%	2.0%	-0.5%	1.9%
99	Unclassified	338	6,846	18,517	0.5%	0.6%	82.5%	22.0%	-5.5%	12.2%
11	Agriculture	20,082	18,009	14,069	0.4%	2.6%	-2.2%	-4.8%	0.1%	1.9%
562	Waste Mgt.	10,333	11,018	11,866	0.3%	0.3%	1.3%	1.5%	0.7%	3.1%
22	Utilities	4,603	6,367	5,254	0.2%	0.4%	6.7%	-3.8%	0.4%	0.1%
21	Mining	1,969	802	1,584	0.0%	0.2%	-16.4%	14.6%	2.1%	2.1%
Public Sector**		180,602	188,466	168,837	5.0%	6.8%	0.9%	-2.2%	0.4%	-0.8%

Source: Applied Development Economics, based on State of California, Employment Development Department Labor Market Information Division, "Quarterly Census of Employment and Wages" (*Note: CAGR = compound annual growth rate \ **Note: Public sector education placed in Private Sector NAICS 61 -- similarly Public sector health placed into NAICS 62).

Economic sectors in the table above are sorted by the share of total employment. The top-five sectors in the Bay Area in terms of total number of workers are Health and Social Assistance (NAICS 62) (453,880 workers), Professional/Technical Services (NAICS 54) (417,902 workers), Retail (NAICS 44-45) (340,197), Manufacturing (NAICS 31-33) (326,362) and Food Services (288,896). Of the top-ten leading sectors in terms of employment, six exhibited high rates of annual growth from 2010 to 2015, growing annually by more than four percent. These sectors are Health and Social Assistance (5.9 percent per year), Professional/Technical Services (5.3 percent), Food Services (4.9 percent), Administrative Support (NAICS 561) (4.1 percent), Construction (NAICS 23) (5.7 percent per year) and Information (NAICS 51), which grew at a phenomenal annual rate of 7.5 percent. Combined, these five sectors employ 49 percent of total employment, or 1,683,121 out of 3,374,902. Moreover,

of the top-ten leading sectors in the Bay Area, only one (Public Sector) had less workers in 2015 than in 2010, underscoring the resilience of the regional economy in the aftermath of the Great Recession. The table also demonstrates the advanced nature of the regional economy, as 12.2 percent of all workers are in the Professional, Scientific and Technical classification (NAICs 54), whereas in the state, as a whole, 7.4 percent of all workers are in this sector. Interestingly, at 1.3 percent per year, manufacturing employment growth in the Bay Area almost doubled statewide manufacturing growth rates (0.7 percent), underscoring the diversity of the regional economy.

TRENDS FOR INDUSTRIES SUBJECT TO PROPOSED RULE 12-16

Proposed Rule 12-16 would primarily affect refineries (NAICS 324110). However, two support industries (containing three non-refinery firms) would be affected as well. Two of the three non-refineries (Air Liquide and Air Products and Chemicals) operate hydrogen plants, and these are within the industry known as industrial gas manufacturing (NAICS 325120). A third firm is a co-generation plant (Martinez Cogen, L.P), which is classified as "other electric power" (NAICS 221118). The economic data in the table below comes from the US Census County Business Patterns.[1] As indicated in the table below, all industries subject to the proposed rule have yet to recover from the Great Recession, the lowest national point of which occurred in the years 2009 and 2010. In 2009, large refineries employed an estimated 3,976 workers in the Bay Area, which is over 700 more workers than today, or 3,269. Similarly, industrial gas manufacturing (NAICS 325120) has yet to recover from the Great Recession, at 252 workers today versus 413 in 2009.

Table 3: Trends for Industries Subject to Proposed rule 12-16: SF Bay Area: 2009-2014

ESTABLISHMENTS	NAICS	2009	2010	2011	2012	2013	2014	09-14 CHG	09-14 CAGR**
Refineries*	324110	7	8	7	5	17	12	5	11.4%
Large refineries		*5*	*5*	*5*	*5*	*5*	*5*	*0*	*0.0%*
Industrial Gas Manuf.	325120	16	14	14	15	13	12	-4	-5.6%
Other Electric Power	221118	18	23	29	11	7	8	-10	-15.0%
EMPLOYMENT									
Refineries	324110	4,051	3,706	3,704	3,622	3,726	3,574	-477	-2.5%
Large refineries		*3,976*	*3,622*	*3,622*	*3,622*	*3,622*	*3,269*	*-708*	*-3.8%*
Industrial Gas Manuf.	325120	413	295	396	397	210	252	-161	-9.4%
Other Electric Power	221118	146	218	358	139	104	130	-17	-2.4%

*Source: Applied Development Economics, based on US Census County Business Patterns 2009-2014. *Note: The proposed rule changes affects five refineries. Both County Business Patterns and the EDD LMID report more than five refineries in the nine-county region, which is because both apply a broader definition for refinery operations. **CAGR= compound annual growth rate.*

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[1]When analyzing industry employment trends, we typically use California EDD LMID data. However, while the EDD LMID indicate the presence of a number of establishments in any of the three industries above in Bay Area counties, for a number of Bay Area counties, the EDD LMID data set did not precisely identify the number of establishments or number of workers, replacing numbers with an asterisk mark, thus making difficult any analysis of EDD LMID data. As a result, we used US Census County Business Patterns, which provides enough county-level data to allow us to track trends. However, the most current County Business Pattern data is for the year 2014.

5. SOCIOECONOMIC IMPACT ANALYSIS OF PROPOSED RULE 12-16

This section of the report analyzes socioeconomic impacts stemming from proposed Rule 12-16. The analysis is divided into two sections, with the first covering impacts based on the first scenario contemplated by District staff, in which affected sources implement scrubbers to achieve the aims of proposed Rule 12-16. In the second part, we present our determination of possible impacts resulting from a production limit.

SECTION ONE: NON-REGENERATIVE AND REGENERATIVE SCRUBBERS

The discussion begins first with a summary of costs associated with the rule. Then, we present our findings with regard to estimated revenues and profits generated by the five affected refineries and three non-refineries, comparing the cost of proposed rule against estimated net profits, in an effort to determine if the rule would significantly impact the affected industry.

Cost of Compliance

In the event affected sources adopt physical improvements to comply with proposed Rule 12-16, District staff has indicated that affected sources will adopt one of two scrubbers, i.e. a FCCU non-regenerative scrubber or a FCCU regenerative scrubber. According to District staff, one FCCU non-regenerative scrubber with a flow rate of 275,000 dscfm annually costs $6,336,978. Of this amount, $5,170,880 is the annual capital cost associated with a non-regenerative scrubber, with the balance at $1,166,098 the annual operating cost associated with maintaining this scrubber. District staff places the annual cost of one FCCU regenerative scrubber with a flow rate of 275,000 dscfm at $12,818,246. Of this amount, $10,999,872 is the cost of the equipment, and $1,818,374 is the annual operating cost.

Of the five large refineries in the Bay Area, three could adopt scrubbers, with each implementing one, i.e. either a non-regenerative scrubber or a regenerative scrubber. It is important to note that these three refineries could choose to adopt scrubbers to comply with the proposed measure because they operate units that are subject to Rule 12-16. Furthermore, three non-refineries subject to the proposed measure do not need to consider installing scrubbers as they do not operate what are called FCC units.

In the table below we estimate the annual cost of compliance associated with proposed Rule 12-16, should affected sources achieve the aims of the proposed rule by adopting new equipment to stay below the emission cap. If the three refineries in need of implementing a scrubber did so, they would face a combined annual cost ranging from $19.0 million to $38.4 million.

Table 4: Aggregate Annual Capital and Operating Cost By Affected Industry: Low Scenario and High Scenario

INDUSTRY	NAICS	NOS OF. EQUIPMENT	LOW SCENARIO (NON-REGENERATIVE SCRUBBER)	HIGH SCENARIO (REGENERATIVE SCRUBBER)
Refineries	324111	3	$19,010,934	$38,454,739
Others				
Industrial Gas Manufacturing	325120	na	na	na
Other Electric Power	221118	na	na	na

Profile of Affected Sources

Based on information from a variety of sources, such as InfoUSA, California Energy Commission, the US Energy Information Administration, US Internal Revenue Service, and the Economic Census, ADE has prepared an economic profile of sources affected by the proposed rule. The three affected refineries (NAICS 324111) generate an estimated $26.6 billion in combined annual revenues and $1.0 billion in net profits. The two industrial gas manufacturers (NAICS 325120) generate anywhere between $200 million and $500 million in combined revenues, and between $15 million and $25 million in annual profits. Martinez CoGen (NAICS 221118) generates between $5 million and $15 million in annual revenues, and $225,000 to $500,000 in net profits.

Table 5: Economic Profile of Sources Affected By Proposed Rule 12-16

INDUSTRY	NAICS	ESTABLISHMENTS	EST. ANNUAL REVENUES	EST. ANNUAL NET PROFITS
Refineries	324111	3	$26,574,614,058	$1,064,599,599
Others				
Industrial Gas Manufacturing	325120	2	$200M - $500M	$15M - $25M
Other Electric Power	221118	1	$5M - $15M	$225K - $500K

Source: Applied Development Economics, based on InfoUSA, California Energy Commission, the US Energy Information Administration, US Internal Revenue Service, and the Economic Census

Socioeconomic Impact Analysis of Proposed Rule 12-16

In both the low or high cost scenarios, the three affected refineries are not significantly impacted by proposed Rule 12-16, should they choose to achieve the emissions-limitation aims of the measure by adopting new scrubbers.

Table 6: Socioeconomic Impact of Proposed Rule 12-16 on Affected Industries

Industry	NAICS	Establishments	Low Scenario: FCCU Non-Regenerative Scrubber Cost Effectiveness	High Scenario: FCCU Regenerative Scrubber Cost Effectiveness	Low Scenario: FCCU Non-Regenerative Scrubber Cost Effectiveness: Cost to Net Profit	High Scenario: FCCU Regenerative Scrubber Cost Effectiveness: Cost to Net Profit
Refineries	324111	3	$19,010,934	$38,454,739	1.8%	3.6%
Others						
Industrial Gas Manufacturing	325120	2	na	na	na	na
Other Electric Power	221118	1	na	na	na	na

Source: Applied Development Economics

Small Business Disproportionate Impacts

According to the State of California, among other things, small businesses generate annual sales of less than $10 million.[2] Of the three sources affected by the proposed rule, none are small businesses. As a result, small businesses are not disproportionately impacted by proposed Rule 12-16.

SECTION TWO: LIMITING REFINERY PRODUCTION

In this second part of the socioeconomic analysis, we present our determination of possible impacts resulting from a limit on production at refineries. In its staff report for the proposed measure, District staff analyzed a variety of data sources on refinery capacity and utilization, and observed that emissions limits contemplated in proposed Rule 12-16 do not appear to inhibit refining capacity, as the caps in the proposed rule appear to be consistent with the current maximum production capability of area refineries.

One caveat expressed by District staff is that they do not expect the cap in Rule 12-16 to have significant impacts on the market for refined fuels so long as fuel consumption does not significantly increase. Consumption for fuel can increase in absolute and relative terms for a variety of reasons, with a corresponding increase in price of fuel at the retail level. For example, population growth and an increase in the number of persons commuting into the area would result in greater demand for fuel whose supply could be limited by proposed Rule 12-16, resulting in a bidding-up of the price of fuel.

While the impact of a limited supply of refined product relative to demand on the retail price of fuel is observable in that prices tend to go up, how much prices increase can vary widely. Price spikes tend to be an inherent, if latent, feature of the oil refining-gasoline consuming activity, due to the combined facts that people tend to keep buying gas to drive their cars to work and other places even as the price of gas rises, and that California refineries tend to operate very close to capacity, meaning that refineries are unable to boost supply significantly when they need to. As Boorstein notes, "The market can easily become out of balance if there is an unexpected jump in demand, or more commonly, if a refinery experiences a supply disruption or outage and output is reduced."[3]   Thus, in the case of the

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[2] http://www.leginfo.ca.gov/cgi-bin/displaycode?section=gov&group=14001-15000&file=14835-14843

[3] Borenstein, Bushnell, and Lewis, "Market Power in California's Gasoline Market" (May 2004), page 8

temporary shut-down of the southern Californian refinery in Torrance in 2015, BAAQMD staff quoted a California Energy Commission report that found that the 10 percent reduction in supply led to 27.6 cents increase in the cost of gasoline.[4] ADE estimates that between February 12, 2015 and March 13, 2015 the average price of gasoline in the City of Los Angeles increased by 32 percent as a result of the Torrance shutdown, which occurred on February 18, going from $2.65 a gallon to $3.51 a gallon.[5] The peculiarities of the California market also explain the magnitude of price increases in California when supply shocks occur. By way of example, Phoenix, Arizona in 2003 experienced a 30 percent drop in volume resulting from a pipeline failure, which then led to a 37 percent increase in price of gas in Phoenix.[6] The FTC observed that prices in Phoenix in 2003 did not rise even faster largely because West Coast refineries were able to ship more gasoline into Arizona to hold down prices. The unique blend required in California makes it difficult (but not impossible) to ameliorate the effects of supply shocks along the lines of Phoenix in 2003, which perhaps explains why in one instance a ten percent drop in supply in southern California leads to almost 32 percent increase in price while a steeper 30 percent supply drop in Phoenix at another instance led to 37 percent price increase there.[7]

While the Torrance and the Phoenix examples demonstrate prices could rise by 32 to 37 percent in a short-time due to supply cuts, projecting changes to price following supply shocks is still not an exact science. One could apply the Torrance and Phoenix examples to roughly estimate price impacts. Thus, if production at refineries is capped per the limits contemplated in proposed Rule 12-16, then a percentage increase in population over some time period would be equivalent to a reduction in supply of gasoline by a similar percentage over the same period. Since ABAG projects the nine-county San Francisco Bay Area region to grow by 9.2 percent over the ten-year 2015-2025 period, when we apply the Torrance example, we arrive at an estimated 29.4 percent increase in price over the same ten-year period.[8] This price increase would average less than three percent a year, which would have a cumulative effect but would be much less than a short-term price shock such as occurred in the Torrance incident, or other price fluctuations that occur due to market conditions. For example, in January 2015, regular gasoline in California cost $2.68 per gallon, of which $1.29 was attributable to the price of crude oil purchased by the refinery. Six months later, a gallon of regular gas was $3.45, of which

[4] Bay Area Air Quality Management District, Draft 12-16 and Draft 11-18 (Draft Staff Report: October 2016) page 23 (citing California Energy Commission)

[5] GasBuddy California http://archive.is/tlKBy

[6] Federal Trade Commission, Gasoline Price Changes: The Dynamic of Supply, Demand, and Competition (2005), page 29

[7] While it is true that California's market for refined product is almost a closed market due to the special blends generated only for Californians, there are some refiners outside of California who produce to California's standard, although delivery of their products takes 2 to 5 weeks and entails prohibitive transport costs. See Borenstein, Bushnell, and Lewis, "Market Power in California's Gasoline Market" (May 2004), page 20 ; see also US EIA, "California's gasoline imports increase 10-fold after major refinery outage" (October 2015) http://archive.is/oRGoI

[8] See http://archive.is/qGomH: The nine-county San Francisco Bay Area region is projected to grow over the ten-year 2015-2025 period by 672,600 persons, from 7,461,400 to 8,134,000. Including estimated number of non-residents commuting daily into the Bay Area for jobs, the total number of persons in the Bay Area will go from 7,938,800 in 2015 to 8,668,700 in 2025, for a 9.2 percent increase over the ten-year 2015-2025 period.

$1.45 was attributable to crude oil, for a 12 percent increase over a six-month period in the cost of a gallon of gas attributable to crude oil.[9] The overall price of gas in this six month-period increased by 29 percent, from $2.68 to $3.45 a gallon. In short, proposed Rule 12-16 would introduce a regime to limit the production of refined petroleum products, but for various reasons, the price of these refined products can go up and down, consequently lessening the effect in modelling the socioeconomic impacts of a limit on the production of refined petroleum products supply on the wider economy.

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[9] See http://bit.ly/2mkDgLW