Coverage of Petroleum Sector Greenhouse Gas Emissions under Climate Policy

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1 OVERVIEW

The petroleum sector, which includes the production, import, processing, transportation, and distribution of crude oil and refined products such as gasoline, heating oil, diesel, propane, and jet fuel, is a significant source of U.S. greenhouse gas (GHG) emissions. In 2007, GHG emissions from the combustion of petroleum made up 38 percent of total U.S. GHG emissions.[1] Recent federal cap-and-trade proposals regulate emissions from petroleum combustion. Both the Waxman-Markey (H.R. 2454) and Kerry-Boxer (S.1733) bills include petroleum-related emissions under an emissions cap, with the point of regulation at the petroleum refinery or point of import of refined products.

Consumption of most finished petroleum products is already subject to a fuel tax. One alternative to regulating GHG emissions from petroleum at the refiners and importers is to regulate the same entities currently responsible for paying taxes on petroleum products and to apply other measures for regulating emissions from fuels not already subject to a tax. Adopting the same point of regulation for GHG emissions for the petroleum sector as is currently used for fuel taxes poses a number of issues to consider such as how to cover those source categories not already subject to a fuel tax and whether this approach would be more or less feasible to implement. Other alternatives include regulating GHG emissions from this sector upstream at the producer and importer level, regulating emissions at the refiner and importer level, or some hybrid of these approaches.

This paper provides an overview of the petroleum sector, identifying the key entities and associated facilities in the petroleum supply chain. There is also information on GHG emissions from the petroleum sector, a summary of which emission sources are not currently subject to a tax, along with implications of adopting an alternative point of regulation for GHG emissions from petroleum.

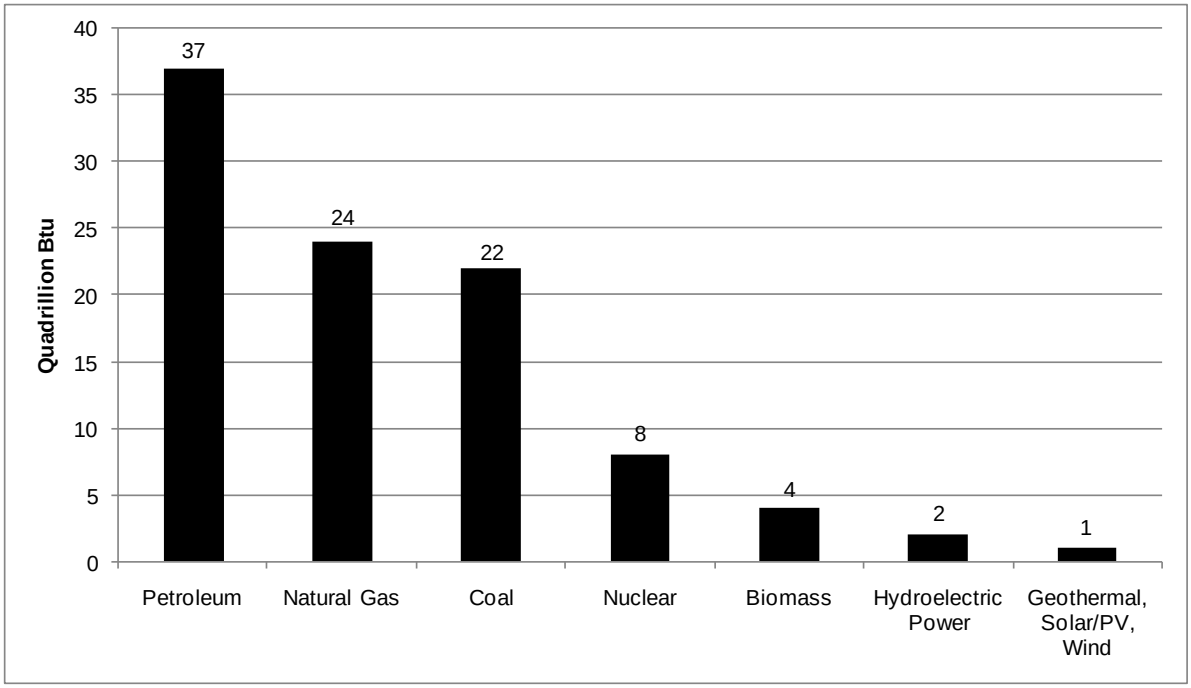
2 OVERVIEW OF THE PETROLEUM SECTOR

2.1 Production and Consumption trends

The petroleum sector consists of: the production of crude oil; the processing of crude oil, natural gas liquids, and other hydrocarbons into a number of refined products such as gasoline, jet fuel, diesel, and other usable fuels; and the delivery of these products to consumers. The United States is currently the third largest producer of crude oil in the world behind Saudi Arabia and Russia. In 2008, the United States produced 7,700 thousand barrels per day (TBD) of total oil (including lease condensate, natural gas liquids, and refinery gain) and 5,000 TBD of crude oil.[2] The United States is also the world's largest consumer of petroleum, consuming 19,400 TBD in 2008. Transportation fuels of various types (gasoline, on-road diesels, marine and locomotive diesels, aviation fuels, and bunkers) constitute over 70 percent of U.S. petroleum consumption.

Petroleum accounts for the largest percentage of U.S. energy consumption at 37.8 percent of U.S. primary energy consumption.[3,4] Figure 2-1 shows the breakdown of U.S. primary energy consumption by energy source.

Figure 2-1: U.S. Primary Energy Consumption by Source, 2008[5]



The United States relies heavily on petroleum imports, including crude oil, refined products, and blending stocks. In 2008, net imports of crude oil and petroleum products (imports minus exports) comprised 57 percent of the country's total petroleum consumption. Net crude oil imports were 10,000 TBD in 2007, and net petroleum product imports were 2,090 TBD in 2007, with daily exports totaling 1,320 TBD.[6] EIA projects that product and crude oil imports will decline over the next few decades, mainly due to increased domestic production resulting from higher prices, but also due to a significant increase in biofuel production and improved vehicle fuel economy.

Table 2-1: EIA Projected Crude and Product Imports (thousand barrels per day)[7]

	2007	2010	2020	2030
Crude Oil				
Net Imports	10,000	8,830	8,510	8,650
Total Crude Supply	15,170	14,150	14,640	14,850
Other Supply				
Natural Gas Plant Liquids	1,780	1,760	1,800	1,790
Net Product Imports	2,090	1,180	1,160	1,010
Gross Refined Product Imports[1]	1,940	1,190	1,250	1,180
Unfinished Oil Imports	720	750	810	840
Blending Component Imports	750	720	810	830
Exports	1,320	1,490	1,710	1,840
Refinery Processing Gain[2]	1,000	960	1,130	1,160
Other Inputs[4]	670	1,090	1,710	2,550
Total Primary Supply[3]	20,710	19,140	20,440	21,360
Net Import Share of Product Supplied	58.5%	52.4%	47.6%	46.4%

1. Includes other hydrocarbons and alcohols.
2. The volumetric amount by which total output is greater than input due to the processing of crude oil into products which, in total, have a lower specific gravity than the crude oil processed.
3. Total crude supply plus natural gas plant liquids, other inputs, refinery processing gain, and net product imports.
4. "Other Inputs" includes domestic production and imports of ethanol, biodiesel, liquids from coal, liquids from gas, and liquids from biomass.

2.2 Structure of the Petroleum Industry

The structure of the petroleum industry is quite complex. There is a much greater variety of petroleum products compared to that of other major fuel types, and these petroleum products move through a wide variety of different pathways prior to their final end-use in every sector of the economy. The structure of the petroleum industry is important in determining how the GHG emissions from petroleum combustion could be covered. An outline of key segments of this industry is presented in the discussion below.[8]

Producers

Producers are the entities that explore, drill for, and produce petroleum and, in many cases, natural gas in the United States. EIA uses the term operator to track oil and gas production, defining an operator as an entity responsible for day-to-day operation of a well. There were approximately 13,789 operators[9] of around 500,000 oil wells[10] in the United States. in 2007. These operators range from large integrated producers with worldwide operations and interests in all segments of the oil and gas industry, to large independents, to small one- or two-person operations that may only have partial interest in a single well. The ten largest operators in 2007 are shown in Table 2-2. The 10 largest operators accounted for 2,696 thousand barrels per day (TBD) of production in 2007 or 53 percent of total U.S. crude oil production, while the top 50 producers accounted for 74 percent of production.[11] The top 668 producers accounted for 90 percent of total crude oil production, with the remaining 13,121 small operators accounting for the other 10 percent of production.[12]

Table 2-2: Ten Largest Producers of Crude Oil in the United States in 2007[13]

Rank	Company Name	Volume (TBD)
1	BP Plc	654
2	Chevron Corporation	427
3	ConocoPhillips Co	373
4	Shell Oil Co	339
5	Occidental Petroleum Corporation	283
6	Aera Energy LLC	178
7	Anadarko Petroleum Corporation	158
8	ExxonMobil Corporation	115
9	Apache Corporation	107
10	Plains Exploration & Production Co	62
Total		**2,696**
Percentage of U.S. Total		**53%**

The three largest producing states are Texas (21 percent), Alaska (15 percent), and California (12 percent). In addition, 25 percent of U.S. production comes from offshore drilling in the Gulf of Mexico.

Petroleum Imports

The United States imports substantial volumes of petroleum. 57 percent of total petroleum products supplied in the United States come from net imports.[14] There is, however, a difference in both the pattern and participants between crude oil imports and product imports. Most crude oil imports (and unfinished oils) are imported by the oil refiners, with the remainder (about one third) imported by traders. The crude oil comes in either directly to the refiners' marine terminals or to the terminals of the major crude oil pipelines such as Capline. Canadian crude oil enters the northern tier of the United States by pipeline, with Eastern Canadian offshore crude oil moving to the East Coast refiners by tanker.

Crude oil is only used by refiners. Finished products, on the other hand, can come in wherever there is a terminal that meets the offloading and tankage requirements. The make-up of finished product imports can vary considerably from year to year. The marketing arms of the oil companies import products, as do traders, petrochemical/chemical companies, propane distributors, ethanol companies, electric utilities on the East Coast, and even states. The finished products may go directly to consumers but may include blendstocks or feedstocks that are used in production of finished petroleum or petrochemical products.

EIA tracks U.S. companies that import petroleum products, port information, fuel characteristics, and country of origin, along with other details.[15] In 2007, the United States imported 10,000 TBD of crude oil and 3,870 TBD of finished products (this includes natural gas plant liquids and net product imports).[16] Of this total (crude + finished products), 70.4 percent was via ship with the remainder being pipeline imports from Canada and Mexico.[17] Canada is the largest source of U.S. petroleum imports.[18] According to EIA data, crude oil was imported by 44 companies in October 2009 through 48 points of entry, including pipelines. Finished products (including heavy gas, kerosene, naphthas, and residuum) were imported by 191 companies through 103 points of entry. While the exact numbers are likely to vary from year to year, the approximate level is unlikely to vary greatly. Table 2-3 lists the number of companies that import each type of petroleum product.

Table 2-3: Number of U.S. Companies Importing Petroleum Products by Category

Category	Number of U.S. Importers by Individual Company[1]
Finished Motor Gasoline	17
Finished Aviation Gasoline	2
Kerosene-Type Jet Fuel	13
Kerosene	3
Distillate Fuel Oil	35
Residual Fuel Oil	25
Petroleum Coke	9
Special Naphthas	13
Natural Gas Liquids and LRGs	53
Other Liquids	40
Lubricants	31
Waxes	8
Asphalt and Road Oil	21
Miscellaneous Products	1

1. There is double counting of the companies listed above. For example, BP imports propane, residual fuel oil, along with other products and so BP is counted in the residual total, propane total and the natural gas liquids totals.

Gathering Pipelines

The crude oil produced from each individual wellhead is typically collected by gathering pipelines. These pipelines collect petroleum from wellheads in a branch and trunk system and deliver the crude oil into either a refinery or a trunk line that then moves the crude oil to a refinery. There are about 14,911 miles of crude oil gathering pipelines in the United States.[19] They may be owned by the producer or the processing plant, or the affiliate of a trunk line or an independent gathering business.

Trunk Pipelines

Trunk pipelines are the large diameter systems that move crude oil from producing regions to refineries or from import terminals to refineries. Not all crude oil moves through these lines as this is dependent on the location of the refinery vis-à-vis the source of crude oil. For example, there are refineries in the coastal regions that receive their imported crude oil directly from tankers that off-load at the refineries' own docks.

Trunk pipelines also include the large diameter product lines that move refinery products to consumers or product imports to final consumers. Crude oil lines and product lines are completely separate. There is one line in the country that occasionally batches crude oil and products but it is the exception. Both the crude and the product lines can be intrastate or interstate. As of 2007 there were 46,658 miles of crude oil trunk lines in the United States and about 85,666 miles of product trunk lines.[20]

Petroleum Refiners

There are currently 150 operating petroleum refineries in the United States with a total capacity of 17,000 TBD. Although no new refinery has been built in the United States for over 30 years, U.S. capacity has been steadily increasing as refiners have expanded existing refineries. This expansion approach is difficult but has proved easier than new construction in terms of permitting of new facilities.

The refining sector is highly concentrated, both geographically and by company. The geographic concentration of refining capacity is a function of the historical pattern of crude oil production in the country, i.e., refineries are clustered near the sources of crude oil production or imports. The economic concentration relates in part to the high capital costs and the economies of scale in refining technology. Table 2-4 shows the geographic concentration of refining – 65 percent of U.S. refining capacity is concentrated in 5 states, all of which constitute the historical production centers of the country.

Table 2-4: Refinery Capacity in the Top 5 States (TBD)[21]

	2003	2004	2005	2006	2007
1. **Texas**	4,329	4,468	4,628	4,241	4,337
2. **Louisiana**	2,719	2,753	2,773	2,534	2,971
3. **California**	1,990	1,984	2,005	2,005	2,022
4. **Illinois**	878	878	896	904	904
5. **Pennsylvania**	760	760	770	770	773
Total	**10,676**	**10,843**	**11,072**	**10,454**	**11,007**
Percentage of U.S. Total	**65%**	**65%**	**65%**	**64%**	**65%**

Table 2-5 shows the concentration by company–the top ten refining companies currently control 72 percent of the refining capacity in the country. For the last two years the list has been topped by the large independent, Valero, which is a refining company only.

Table 2-5: Refinery Capacity of the Top 10 U.S. Refining Companies (TBD)

	2003	2004	2005	2006	2007
1	ExxonMobil 1,808 11%	ConocoPhillips 2,186 13%	ConocoPhillips 2,198 13%	Valero 2,195 13%	Valero 2,219 13%
2	Phillips 1,711 10%	ExxonMobil 1,844 11%	Valero 2,108 12%	ConocoPhillips 1,983 12%	ExxonMobil 1,862 11%
3	BP 1,502 9%	Valero 1,696 10%	ExxonMobil 1,847 11%	ExxonMobil 1,860 11%	ConocoPhillips 1,779 10%
4	Valero 1,317 8%	BP 1,505 9%	BP 1,505 9%	BP 1,039 6%	BP 1,249 7%
5	Chevron 999 6%	Chevron 1,007 6%	Chevron 1,007 6%	Chevron 1,012 6%	Chevron 1012 6%
6	Marathon 935 6%	Marathon 935 6%	Marathon 948 6%	Marathon 974 6%	Marathon 974 6%
7	Motiva 880 5%	Motiva 887 5%	Sunoco 900 5%	Sunoco 900 5%	Sunoco 903 5%
8	Sunoco 730 4%	Sunoco 740 4%	Koch Industries 763 4%	PDV America 785 5%	Koch Industries 777 5%
9	Shell 669 4%	PDV America 640 4%	Motiva 747 4%	Koch Industries 777 5%	Motiva 762 4%
10	Conoco 566 3%	Shell 574 3%	PDV America 640 4%	Motiva 747 5%	PDV America 753 4%

Source: EIA

Marine Transport

A substantial amount of crude oil, unfinished oils, and products is moved by tanker and barge. There is considerable inter-refinery trading of crude oil and unfinished oils, particularly in the Gulf of Mexico region, that moves by barge on the intracoastal waterway. On the East Coast, imports from overseas and Canada and domestic products from the south converge near New York City and are then distributed to New England and the Mid Atlantic by barge along the East Coast inland waterway. During part of the year, substantial volumes of products move up the Mississippi River by barge.

Terminal Operators

Terminals are the main point of distribution between the refinery and the end consumer. They typically receive finished petroleum products from refineries and/or importers and deliver them to retailers and consumers. Some terminals are owned by refineries, and a large number are independent terminals that store both domestic and imported products depending on their location. There are also at least 280 terminals at which additives, blending stock, and biofuels are blended with gasoline.[22]

When petroleum products are taxed, the tax is paid upon the removal of fuel from the terminal.[23] The "position holder," which is the entity that owns the fuel upon removal from the terminal, is responsible for the tax. In some cases, the "position holder" is the terminal owner, but it can also be other fuel wholesalers or bulk sellers. The IRS tracks the movement of fuel into and out of terminals as part of their ExSTARs program.[24] The IRS currently tracks 1,349 fuel terminals[25] as part of the administration of the tax, but there are a larger number of entities who actually pay the tax. The total number of "position holders" (including the terminal operators) filing taxes could be as high as about 6,000.[26] Most states also have fuel taxes, which are also typically collected from the "position holder" (fuel owner). The coverage of these taxes varies by state. An example of which fuel taxes apply in certain western states is shown in Table 2-6.

Table 2-6: Summary of State Fuel Taxes in Western States[27]

	Subject to Fuel Tax				
State	**Diesel**	**Jet Fuel***	**Aviation Fuel****	**Motor Gasoline**	**Gross Gasoline**
Arizona	Yes	Yes	Yes		Yes
Oregon		Yes	Yes	Yes	
Washington	Yes	Yes	Yes	Yes	
California	Yes	Yes		Yes	
Utah			Yes	Yes	
New Mexico			Yes		Yes
Montana	Yes		Yes		Yes

***** Aviation Fuel is gasoline used in aircraft reciprocating engines

**Jet fuel is a kerosene type fuel used in gas turbine jet engines.

Marketers

Petroleum marketers purchase products either directly from refiners or indirectly from terminal operators and resell them to consumers. There are approximately 8,000 independent petroleum marketers in the country. As in all other segments of the industry, the last decade has brought increasing consolidation in this segment.

Natural Gas Liquids (NGL)

Natural gas liquids (NGLs) consist of propane and other hydrocarbon liquids including ethane, butane, isobutane, and natural gasoline. Some of these are sometimes referred to as lease condensate and liquefied petroleum gases (LPG). NGLs are found mixed with both crude oil and natural gas and as a result are separated out both at crude oil refineries and at natural gas processing plants. NGL production was 0.8 billion barrels in 2008, a 1.1 percent increase over 2007.[28]

NGLs are used as fuel for direct combustion, as a feedstock for other fuels (gasoline blendstocks), and as a feedstock for non-fuel products such as plastics. The primary NGL used for direct combustion is propane, which is used by residential and commercial consumers for heating and cooking purposes and for small appliances. Propane used by residential and commercial consumers for combustion purposes represents 45 percent of propane demand. About 5 percent of propane is used as a transportation fuel, especially in off-road industrial applications such as forklifts. The remaining propane is primarily used as a feedstock. Other NGLs, such as butane and ethane are used as gasoline blending components, feedstock for the chemical industry, and can be used directly as a fuel gas for domestic uses. Just under 30 percent of NGLs sold are used as fuels directly, with propane being the primary fuel use.[29] Much of the other 70 percent of NGL sales (mainly butane and pentanes-plus but also ethane) is for use as blending components for gasoline. If the GHG point of regulation for gasoline is after blending has already occurred, then the GHG emissions from these blending components would also be covered.

Propane sold to residential, commercial and industrial consumers is odorized to facilitate leak detection. Odorized propane is distributed to retail customers through approximately 3,500 retail distributors. In 2007, sales of propane in the United States totaled 18,860,335 thousand gallons.[30] Overall, propane accounts for less than 2 percent of energy consumed in the United States.[31]

Some uses of NGLs as feedstock are characterized here and in pending legislation as "non-emissive." In these applications the NGL is not combusted but is bound up in secondary products such as plastics, so there is no release of CO_2 at the point of initial use. Most NGLs have non-emissive uses. The petrochemical industry consumes the majority of NGLs, at around 40 percent of propane produced and the vast majority of the other NGLs.[32] The volume of NGL products used as gasoline blending components is around 18 percent.[33] There are a number of other finished petroleum products that have non-emissive uses. For example, CO_2 is embedded in products such as lubricants and waxes, asphalt, and road oil. There are emissions associated with the production of these petroleum products, and these emissions could be covered by GHG regulation in the same way as other direct emissions from industrial facilities. In addition, the products, such as plastic or lubricants, may be combusted later in their life, thereby creating GHG emissions. However, these combustion emissions could also be tracked separately, at the point of combustion. There are no CO_2 emissions from the feedstocks themselves at the point where they are converted into other products such as plastics. Thus, their use at this point is characterized as "non-emissive".

Current federal proposals, such as the Waxman-Markey bill, regulate emissions from all petroleum products (including feedstocks) upstream at the refiner/importer level, but then provide compensation downstream to an entity that consumes such products for non-emissive uses (a more detailed discussion of this is found in section 3.2 below). If the GHG point of regulation for petroleum products were further downstream from the refiners and importers, it might avoid covering non-emissive uses and having to provide compensation to entities that consumed petroleum products as feedstocks for non-emissive products.

End-Use Consumers

Petroleum products are used in every sector of the economy. Consumers receive these products through a variety of channels, depending on the type of fuel and the size of the consumer. It is difficult to identify or quantify all of the possible channels

The transportation sector is by far the largest petroleum-consuming sector, and on-road fuel (motor gasoline and diesel fuel) is the largest component of that sector. These fuels are delivered through retail fueling stations, and, as of 2007, there were 117,908 gas stations in the United States according to the Census Bureau. Fuel is delivered to these stations via petroleum tanker trucks. These trucks also deliver diesel fuel to commercial accounts, including fleet operators, who maintain their own fuel terminals. Farm and other non-road vehicles also receive fuel via trucks from fuel terminals.

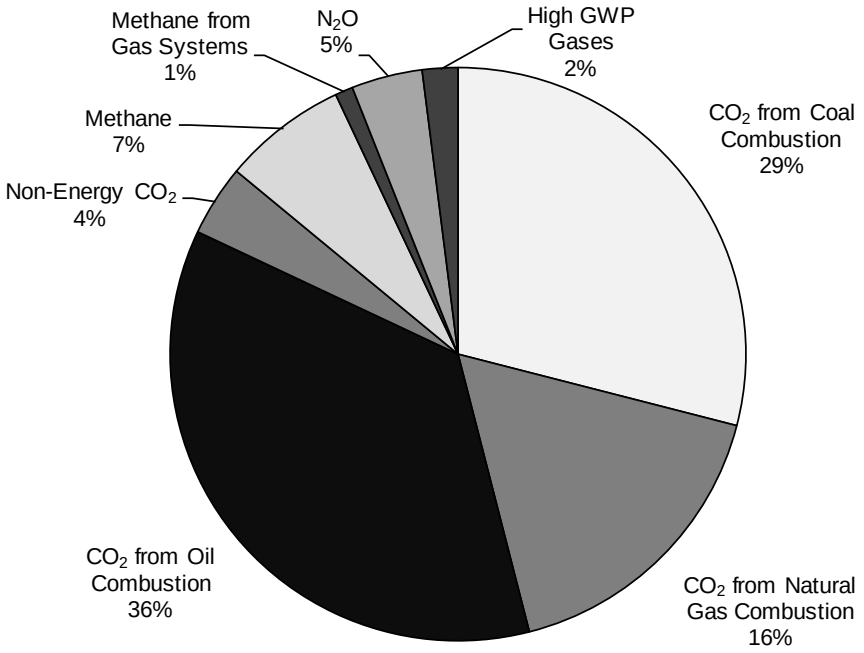
Aircraft receive fuel through common storage and delivery systems at airports. This fuel is delivered to smaller airports primarily from terminals by truck. Larger airports may receive fuel primarily by pipeline from terminals or refineries. Locomotives are also fueled from company facilities supplied by pipeline, rail, or truck. Ships are fueled at ports with either marine distillate delivered by pipeline, ship, or barge or with residual bunker fuel delivered by barge or ship.

Heating oil for residential and commercial buildings is delivered via petroleum truck from heating oil dealers or petroleum terminals. Distillate is delivered via truck from terminals or rail to industrial facilities or possibly via pipeline to very large industrial facilities or power plants. Residual oil for power plants is delivered primarily by ship or barge from refineries or imports.

2.3 GHG Emissions Associated with Petroleum Usage

Petroleum contributes to U.S. GHG emissions in three ways. Most emissions come from the combustion of petroleum products, which made up 2,480 million metric tons of CO_2-equivalent ($MMTCO_2e$) or 36 percent of total U.S. GHG emissions in 2007. The largest volume of petroleum products is combusted for energy use, either as transportation fuels or as furnace or boiler fuels.

Figure 2-2: U.S. GHG Emissions by Fuel and Gas (MMTCO2e), 2007



Fugitive emissions comprise a second component of GHG emissions associated with petroleum.[34] Most fugitive and vented GHG emissions from petroleum systems are methane (CH_4) emissions, and are associated with crude oil production, transportation, and refining. Fugitive and vented CO_2 emissions are mainly associated with crude oil production. Fugitive CO_2 emissions from transportation and refining are considered negligible.[35] Total fugitive carbon dioxide and methane emissions from petroleum systems totaled 28.8 $MMTCO_2e$ in 2007—equivalent to about 0.4 percent of total U.S. GHG emissions and 5.2 percent of total U.S. methane emissions.[36] Since 1990, methane emissions from the petroleum sector have declined by 15 percent. This can be attributed to both industry efforts to curtail emissions and decreasing domestic production. Fugitive and vented carbon dioxide emissions have also been reduced by 25 percent over this same period due to similar factors.[37]

Some petroleum products are consumed for non-emissive uses as shown in Table 2-7.[38] CO_2 emissions occur from non-emissive uses via several pathways. Emissions may occur when producing plastics or rubber from petroleum-derived feedstocks, for example. Asphalt and petroleum-based solvents, lubricants, and waxes are other examples of non-emissive petroleum use. Since this petroleum is not combusted at its point of use, CO_2 is not accounted for in this stage of the process. However, combustion may take place later in the life of the product and can be accounted for at the point where it occurs. Overall, about 62 percent of the carbon

contained in all of the non-emissive petroleum use is stored in the products with the remaining 38 percent emitted at various stages.[39]

Recent federal proposals such as the Waxman-Markey bill require GHG cap-and-trade allowances to be retired by refineries and importers for all petroleum products, including those for non-emissive use, but provide compensatory allowances for non-emissive use of fuels. Specifically, the Waxman-Markey bill provides compensatory allowances to account for the non-emissive use of petroleum or coal-based liquid or gaseous fuel, petroleum coke, natural gas liquids or natural gas as a feedstock if allowances or offset credits were retired for the GHGs that would have been emitted from their combustion.

Table 2-7: Consumption of Petroleum Products for Non-emissive Uses (TBtu)

	2003	2004	2005	2006
Asphalt & Road Oil	1,219.5	1,303.8	1,323.2	1,225.6
Distillate Fuel Oil	11.7	11.7	11.7	11.7
LPG	1,437.8	1,436.7	1,442.0	1,491.8
Lubricants	159.0	161.0	160.2	130.6
Pentanes Plus	158.3	156.5	146.0	105.1
Naphtha (<401 F)	573.4	687.9	678.6	592.9
Other Oil (>401 F)	501.0	547.8	518.7	573.4
Still Gas	59.0	63.5	67.7	122.3
Petroleum Coke	76.9	161.3	145.0	178.7
Special Naphtha	75.7	47.2	60.9	68.7
Waxes	31.0	30.8	31.4	25.2
Miscellaneous Products	126.0	113.4	112.8	133.2

3 ANALYSIS OF POINT OF REGULATION OF PETROLEUM UNDER CLIMATE POLICY

3.1 Implications of Alternative Points of Regulation

Alternative points of regulation and options for applying a carbon price to GHG emissions from petroleum have different implications in terms of ensuring economy-wide coverage of GHG emissions, limiting the administrative cost and complexity of regulation, and the number and types of entities regulated. As discussed earlier, the petroleum sector contributes significantly to total U.S. GHG emissions. CO_2 from petroleum combustion is about 36 percent of total U.S. GHG emissions, and legislative proposals for economy-wide GHG cap-and-trade programs typically cover about 85 percent of total emissions.

3.2 Regulation of Petroleum in Current Legislative Proposals

Current legislative proposals to create an economy-wide GHG cap-and-trade program, such as the Waxman-Markey and Kerry-Boxer bills, regulate petroleum under the cap at the refinery or point of import. Large stationary sources whose emissions are capped (those that emit 25,000 metric tons CO_2e or more per year) do not have to retire allowances for emissions related to petroleum combustion since they have already been accounted for upstream at the refiner or importer level. Conversely, entities that consume petroleum products for non-emissive uses (e.g., as feedstocks) can receive a compensatory allowance to reimburse them for the cap-and-trade allowance cost that is assumed to be embedded in the feedstock price.

3.3 Alternative Point of Regulation

A large portion of petroleum products–primarily transportation fuels–are already subject to a fuel tax at both the state and federal levels. An alternative point of regulation to the refinery/importer approach adopted in current legislative cap-and-trade proposals would apply a carbon price proportional to the carbon content of petroleum products sold by regulating the same entities that are currently subject to federal fuel taxes. However, this alternative point of regulation raises questions that include:

- What portion of petroleum consumption is not currently subject to a fuel tax?
- What portion of the GHG emissions from petroleum would not be covered were the point of regulation to be established at the existing fuel taxation points?
- How could the GHG emissions from petroleum flows not currently subject to a federal fuel tax be covered?

Answers to these questions are provided below. As noted above, the petroleum sector is extremely complicated and there may be small components of the total petroleum footprint that require additional analysis. However, the vast majority of petroleum-related emissions are covered by the following discussion.

A number of petroleum products are already subject to a federal and state excise tax at the terminal level (levied on the "position holder," i.e., the entity that owns the fuel when it is removed from the terminal). Thus, there is already a tax structure in place, which could facilitate regulating the carbon content of these fuels by putting the GHG point of regulation on the same entities. Petroleum products subject to a federal excise tax include the following:[40]

- Gasoline, including aviation gasoline and gasoline blendstocks
- Diesel fuel, including dyed diesel fuel
- Diesel-water fuel emulsion
- Kerosene, including dyed kerosene and kerosene used in aviation
- Other fuels (including LPG)
- Compressed natural gas (CNG)
- Fuels used in commercial transportation on inland waterways

Petroleum consumption at large stationary sources and feedstock applications is not currently subject to fuel taxes. One option to address these sources under this alternative approach would be to directly regulate the petroleum-related GHG emissions at the large emitting sources, as is done under most recent federal cap-and-trade proposals for large stationary sources using coal and natural gas, and to exempt the feedstock users from compliance for non-emissive uses.

Under the Waxman-Markey and Kerry-Boxer bills, the GHG emissions from sources that fall below the threshold for directly regulated large sources (i.e., residential, commercial, and institutional sources comprising 8.1 percent of total GHG emissions) are regulated through the upstream coverage of natural gas and petroleum under cap and trade.[41] If the point of regulation for the petroleum sector were altered, then a new mechanism to cover GHG emissions from non-transportation uses of petroleum outside of large sources would be needed.

Based on all of the above, Table 3-1 below summarizes the petroleum consumed for different end uses in 2007 in terms of CO_2 emissions and breaks out:

- The non-emissive uses of petroleum, which could be excluded from GHG regulation
- The CO2 emissions from petroleum use at facilities that could be directly regulated as large sources
- The portion of the remaining emissions that are already subject to federal fuel taxes

Table 3-1 shows that the petroleum products currently subject to fuel tax (transportation fuels) account for the bulk of petroleum-related CO_2 emissions (nearly 80 percent). If large stationary sources are directly regulated for their emissions (about 8 percent of petroleum CO_2 emissions) from petroleum use, then only those non-large sources not subject to a current fuel tax would need to be separately addressed.

Table 3-1: Breakdown of Petroleum by End Use[1]

Petroleum End Use	1000 metric tons CO2	% of Total	Category	% of Total	% of Emissive Uses	% of Emissive Uses Other Than Large Sources
Finished Motor Gasoline	1,254,030	46.3%	Subject to Fuel Tax	72.4%	80.4%	87.9%
On-Highway Diesel	407,502	15.0%				
Aviation	239,059	8.8%				
Railroad and Distillate Bunkering	56,910	2.1%				
Kerosene	4,810	0.2%				
Off-Highway, Military, and Farm	62,232	2.3%	Other Transportation	5.1%	5.6%	6.2%
Resid Bunkering	75,322	2.8%				
Heating Oil	80,476	3.0%	Small Stationary Sources	4.9%	5.4%	5.9%
Odorized Propane	51,242	1.9%				
Distillate	40,051	1.5%	Large Stationary Sources*	7.7%	8.5%	
Still Gas	62,208	2.3%				
Residual Fuel Oil	52,139	1.9%				
Petroleum Coke	54,168	2.0%				
Feedstocks	154,168	5.7%	Non-Emissive	9.9%		
Lubricants and Waxes	24,835	0.9%				
Asphalt and Road Oil	90,193	3.3%				
Total	*2,709,343*	*100.0%*		*100.0%*	*100.0%*	*100.0%*

*Includes some small distillate users

Aside from large stationary sources, there are only a few sources of direct emissions from petroleum that are not already subject to a fuel tax. As shown above in Table 3-1, the largest remaining piece is the small stationary sources, including heating oil and propane (including off-road uses), comprising 5.4 percent of petroleum CO_2 emissions. Non-taxed transportation sector petroleum use (off-highway) comprises 5.6 percent of petroleum CO_2 emissions. The non-highway vehicle portion of the non-taxed component goes through the same distribution channels as the taxed portion, and most is actually taxed and refunded. This is the

[1] There are some emissions associated with feedstocks/"non-emissive" uses such as the blending of NGLs like butane, and pentanes-plus with gasoline. However, gasoline is subject to the fuel tax so emissions associated with feedstocks that are ultimately combusted are still covered under the system.

case, for example, with fuel used for agricultural operations and diesel used in intercity buses.[42] Since these non-highway fuels are handled by the same entities that currently pay federal fuel taxes, these entities could be the point of regulation for the carbon content of both the currently taxed transportation fuels and these non-highway fuels.

The vessel bunkering fuel is delivered directly from refineries, from imports, or through approximately 100 wholesalers.[43] Covering emissions related to bunkering fuel under this alternative point of regulation would require regulating as many as a few hundred additional entities (refineries, wholesalers, importers) for the carbon content of their bunkering fuel sales.

The heating oil users and some small industrial distillate users that are currently lumped in with the large stationary sources would also need to be addressed. There are over 1,000 heating oil distributors, but some portion of heating oil could be covered through petroleum distributors that are already part of the fuel tax network while only adding the larger heating oil dealers that do not receive deliveries from another distributor. In short, covering heating oil and small distillate users will require identifying a group of refineries that make direct deliveries to large customers and retail dealers (e.g., gas stations), some large heating oil dealers, and some fuel distributors who may not distribute currently taxed motor fuel. This will overlap with some entities already identified above. It is difficult to precisely quantify the number of additional entities and sources that would need to be covered but it is estimated to be on the order of several hundred.

The final piece would be emissive uses of NGLs. The primary direct emissions component is odorized propane used in stationary combustion and vehicle applications. Odorized propane is subject to the Propane Education and Research Council's (PERC) assessment fee or tax, so it would be possible to make the same entities already paying the PERC fee the GHG point of regulation. PERC and the associated tax funding this organization were authorized by Congress in 1996 with the passage of the Propane Education and Research Act (PERA). The odorized propane assessment fee is administered by PERC and not the federal government. The tax applies to "the owner of odorized propane at the time of odorization, or the time of import of odorized propane."[44] This could apply to propane suppliers, terminal operators, end-users or marketers/distributors. As of December 2009, 161 companies were subject to the PERC assessment fee.[45] There is also a very small share of ethane and butane that is directly combusted. While further analysis would be required to quantify this component, it is a very small share of the total GHG emissions from petroleum.

The emissions from NGLs used as gasoline feedstocks will be covered because these feedstocks are blended into motor fuels prior to fuels being subject to current federal and state excise taxes, so using the entities currently subject to federal and state fuel taxes as the GHG point of regulation for gasoline would cover emissions from these NGLs. Additionally, propane that is sold directly as a vehicle fuel is odorized first, so making the same entities subject to the PERC assessment the GHG point of regulation would cover emissions associated with propane-fueled vehicles. The NGLs used as feedstocks for non-emissive uses would also need to be covered downstream, and a later time, if, and when, the CO_2 from those secondary products is released.

It is important to note that NGLs are also produced at natural gas processing plants. These sources are discussed in the Pew report entitled, *Coverage of Natural Gas Emissions and Flows Under a Greenhouse Gas Cap-and-Trade Program*. The approach to addressing GHG emissions from NGLs from the petroleum and natural gas sectors should be coordinated in order to avoid creating distortions in the NGL market.

4 CONCLUSIONS

This report reviews three alternative points of regulation for CO_2 emissions associated with combustion of petroleum-derived fuels. The analysis shows that all three approaches could provide coverage of essentially 100 percent of these emissions, albeit with differing structures and numbers of regulated entities. Table 4-1 shows the number of facilities and entities that would be affected under each option.

Option A would apply coverage purely upstream at the producer/importer level, which would cover 100 percent of CO_2 combustion emissions from the petroleum sector in the United States. The downside to using this approach is that a large number of entities and facilities would be covered, raising administrative costs and complexity. A smaller number of the largest producers (fewer than 1,000) would cover almost 90 percent of the emissions.

Option B would regulate GHG emissions at the refiner/importer level. This option would also cover 100 percent of CO_2 combustion emissions from the petroleum sector but would require regulating far fewer entities and facilities.

Table 4-1: Petroleum Sector Coverage Summary

Point-of-Regulation Option	Entities	Facilities
Option A — Producers & Importers	13,774 domestic well operators + 314 importers of crude + finished products	497,403 oil wells, 120 ports
Option B — Refineries & Importers of Finished Products	271 importers of finished products, about 67 refinery owners	150 refineries, 120 ports
Option C — Fuel Terminals and “Position Holders,” Dealers, Odorizers, Large Stationary Sources	N/A	1,349 petroleum terminals (the number of “position holders,” including terminal operators, may be as high as 6,000), over 100 bunkering terminals, 4,672 heating oil dealers, <200 propane odorizers, large stationary sources regulated directly

Option C, the approach detailed in this paper, would cover roughly 80 percent of GHG emissions from petroleum use by making the entities that are currently subject to federal fuel taxes the GHG point of regulation. To cover the other 20 percent of GHG emissions from petroleum use, Option C would define multiple supplemental points of regulation for GHGs (as explained above in Section 3.1.3)—mainly the following:

- Applying the GHG point of regulation to transportation fuels that are not currently subject to a federal fuels tax (e.g., non-highway and bunkering fuel). In many cases, the entities that would be regulated under this measure are the same entities already subject to federal taxes on other fuels.
- Regulating entities that distribute petroleum products to small stationary sources (e.g., residential, commercial and industrial users). In many cases, this would mean regulating entities that are already subject to the federal fuels tax for some of their other products.
- Making large stationary sources the point of regulation for their use of petroleum products as fuel.
- Making entities currently subject to the PERC fee for odorized propane the GHG point of regulation for that fuel as well.

CO_2 emissions from petroleum fuels already subject to a fuel tax and CO_2 emissions from petroleum use by large stationary sources that could be directly regulated together account for about 87 percent of all CO_2 emissions from petroleum use. Covering the remainder of CO_2 emissions from petroleum use, including points of delivery for bunkering fuel, propane odorization, and petroleum deliveries to small consumers, would add between 500 and 5,000 points of regulation to a GHG emission reduction program. Additional analysis would be required to refine this estimate.

Endnotes

[1] U.S. EPA. 2009. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007*. See http://www.epa.gov/climatechange/emissions/downloads09/GHG2007entire_report-508.pdf. The percentage of U.S. GHG emissions associated with petroleum was determined by taking the total in table 3-1 (2717.75 Tg), which comes from 2007 EIA data, compared to total U.S. GHG emissions in 2007 estimated by the EPA (7,150.1 Tg).

[2] The difference between the two numbers represents production of lease condensate and natural gas liquids as well as refinery gain, where refinery gain in the U.S. ranges between six and seven percent on average. Refinery gain refers to the increase in volume that occurs when heavy molecules in crude oil are broken up during the refining process into lighter molecules, which take up more space, in refined products. Production and consumption data comes from EIA. 2008. *Annual Energy Review*. See http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf.

[3] Primary energy is defined by EIA as energy in the form that it is first accounted for in a statistical energy balance, before any transformation to secondary or tertiary forms of energy. For EIA definitions of "primary energy" and "primary energy consumption," See http://www.eia.doe.gov/glossary/glossary_p.htm.

[4] U.S. EPA. 2009. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007*. See http://www.epa.gov/climatechange/emissions/downloads09/GHG2007entire_report-508.pdf. The percentage of U.S. GHG emissions associated with petroleum was determined by taking the total in table 3-1 (2717.75 Tg), which comes from 2007 EIA data, compared to total U.S. GHG emissions in 2007 estimated by the EPA (7,150.1 Tg).

[5] EIA. 2008. Annual Energy Review. See, http://www.eia.doe.gov/emeu/aer/pdf/aer.pdf.

[6] EIA. 2009. A*nnual Energy Outlook (AEO)*. See http://www.eia.doe.gov/oiaf/servicerpt/stimulus/excel/aeostimtab_11.xls

[7] EIA. 2009. A*nnual Energy Outlook (AEO) 2010 Early Release*. See Table 11.

[8] Most of the discussion involving the structure of the petroleum industry comes from the EPA's Technical Support Document (TSD) for the Mandatory Reporting Rule for GHGs. EPA. 2009. *Technical Support Document, Industry Overview and Current Reporting Requirements for Petroleum Refining and Petroleum Imports, Proposed Rule for Mandatory Reporting of Greenhouse Gases*.

[9] EIA. 2007. *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserve Report*. Appendix A. See http://www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/crude_oil_natural_gas_reserves/historical/2007/cr2007.html.

[10] EIA. *Crude Oil Production and Crude Oil Well Productivity, 1954-2008*. See http://www.eia.doe.gov/emeu/aer/txt/ptb0502.html.

[11] EIA. 2007.

[12] EIA. 2007. *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserve Report*. Appendix A. See http://www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/crude_oil_natural_gas_reserves/historical/2007/cr2007.html.

[13] EIA. 2007. *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserve Report*. Appendix A. See http://www.eia.doe.gov/pub/oil_gas/natural_gas/data_publications/crude_oil_natural_gas_reserves/historical/2007/cr2007.html.

[14] U.S. EIA. 2009. *Oil: Crude and Petroleum Products Explained, Oil Imports and Exports*. See http://tonto.eia.doe.gov/energyexplained/index.cfm?page=oil_imports.

[15] EIA. 2009. Company Level Imports. See http://www.eia.doe.gov/oil_gas/petroleum/data_publications/company_level_imports/cli.html.

[16] EIA. 2009. *Annual Energy Outlook*. See http://www.eia.doe.gov/oiaf/servicerpt/stimulus/excel/aeostimtab_11.xls

[17] EIA. 2007. *U.S. Imports by Country of Origin*. See http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbblpd_a.htm.

[18] EIA. 2007. U.S. Imports by Country of Origin. See http://tonto.eia.doe.gov/dnav/pet/pet_move_impcus_a2_nus_ep00_im0_mbbl_a.htm.

[19] Oil & Gas Journal. 2008. Volume 10633.

[20] *Ibid.*

[21] EIA.

[22] Motor gasoline blending components or blendstocks are defined by EIA as naphthas (e.g., straight-run gasoline, alkylate, reformate, benzene, toluene, xylene) used for blending or compounding into finished motor gasoline.

[23] IRS. 2009. *Publication 510 (04/2009), Excise Taxes – Fuel Taxes*. See http://www.irs.gov/publications/p510/ch01.html.

[24] IRS. 2010. *Excise Summary Terminal Activity Reporting Systems (ExSTARS)*. See http://www.irs.gov/businesses/small/article/0,,id=177193,00.html.

[25] IRS. 2010. *Active Fuel Terminal*s. See http://www.irs.gov/pub/irs-utl/tcn_db.xls.

[26] Hoovers. *Petroleum Wholesale Distribution*. http://www.hoovers.com/petroleum-wholesale-distribution/--ID__62--/free-ind-fr-profile-basic.xhtml.

[27] ICF International. *Summary of State Fuel Taxes*.

[28] EIA. 2009. *U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Reserves*. See http://www.eia.doe.gov/oil_gas/natural_gas/data_publications/crude_oil_natural_gas_reserves/cr.html.

[29] U.S. EPA. 2009. *Technical Support Document, The Natural Gas Distribution and Natural Gas Processing Sectors, Proposed Rule for Mandatory Reporting of Greenhouse Gases*. http://www.epa.gov/climatechange/emissions/downloads/tsd/TSD%20Natural%20Gas%20NGL%20suppliers_%201-30-09.pdf.

[30] American Petroleum Institute (API). 2008. *2007 Sales of Natural Gas Liquids and Liquefied Refinery Gases*.

[31] EIA. 2009. *Propane Explained, Use of Propane*. See http://tonto.eia.doe.gov/energyexplained/index.cfm?page=propane_use.

[32] American Petroleum Institute (API). 2008. *Propane Supply and Demand*. See http://www.api.org/aboutoilgas/otherfuels/propane-supply-deman.cfm.

[33] U.S. EPA. Technical Support Document. 2009. The Natural Gas Distribution and Natural Gas Processing Sectors, Proposed Rule for Mandatory Reporting of Greenhouse Gases.

[34] Fugitive emissions generally come from fugitive equipment leaks, process venting, disposal of waste gas streams (e.g., by venting or flaring), and accidents and equipment failures.

[35] U.S. EPA. 2009. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007*. See http://www.epa.gov/climatechange/emissions/downloads09/GHG2007entire_report-508.pdf.

[36] U.S. EPA. 2009. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007*. See http://www.epa.gov/climatechange/emissions/downloads09/GHG2007entire_report-508.pdf.

[37] U.S. EPA. 2009. *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2007*. See http://www.epa.gov/climatechange/emissions/downloads09/GHG2007entire_report-508.pdf.

[38] ICF has conducted an intensive study for non-emissive uses for EPA's *Inventory of Greenhouse Gases and Sinks*.[38]

[39] EPA. 2009. *Technical Support Document, Industry Overview and Current Reporting Requirements for Petroleum Refining and Petroleum Imports, Proposed Rule for Mandatory Reporting of Greenhouse Gases*.

[40] IRS. 2009. *Fuel Taxes*. See, http://www.irs.gov/publications/p510/ch01.html.

[41] Note that emissions from coal combustion in the commercial/industrial sector (universities, district heating, etc) are not covered under the current bills.

[42] IRS. 2009. *Credit for Federal Tax Paid on Fuels*. See, http://www.irs.gov/pub/irs-pdf/f4136.pdf.

[43] Bunker fuel is fuel supplied to ships consisting primarily of residual and distillate fuel oil.

[44] Propane Education & Research Council (PERC). 2007. *Guidelines for PERC Odorized Propane Assessments*. http://www.propanecouncil.org/uploadedFiles/Assessment_Audit_Guidelines.pdf.

[45] Propane Education & Research Council (PERC). December 31, 2009. *PERC Remitters List*. http://www.propanecouncil.org/abouttemplate.aspx?id=3434.

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