Analyzing Energy Outlooks: Focusing on North America and the United States of America

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Abstract

There are broad ranges of organizations that produce energy forecasts for different purposes. The U.S. Department of Energy produces an International Energy Outlook through their Energy Information Administration (EIA), whose objective is to provide facts for public policy decisions. The International Energy Agency (IEA) produces a World Energy Outlook to ensure their members maintain energy security and have research to achieve clean, cheap and affordable energy sources. Furthermore, various public companies produce outlooks, such as BP and ExxonMobil, which both do so in an effort to promote discussion around energy issues.

Assumptions made about policy, technology, economic development, and demographics strongly affect the different models used in each survey. The objectives of analyzing these outlooks together are to determine how and where they differ, and to explain these differences quantitatively and qualitatively.

The most influencing factor, for all the energy types, was the scenario assumption, namely policy and technology assumptions. Projections that differ the most, or were most similar, can be generally explained by understanding the policy and technology assumptions behind each survey. The EIA provides projections for consumption in production for the status quo, in regards to policy and technology innovation. The IEA used policies that were announced and implements them cautiously. They also take into account foreseeable technology advances. BP and ExxonMobil incorporate the most likely or most practical policy and technology advances in their projections.

Evaluating the differences and the goals of each forecast will allow for a non-biased, well-rounded understanding and discussion of energy projections from these different

organizations. Each organization believes it is important to continue the discussion of energy markets world-wide. Each outlook has differences that impede discussion, thus this study suggests a standardization of energy forecasts in order to not only enable discussion, but also truly expand discussion from not just people in the know, but to the common folk.

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Introduction

The mix of global energy demand is constantly changing. In particular North America and the United States have gone through heavy coal and heavy oil demand cycles. Today with developing countries energy demand growing, the price of fossil fuels rising, and scientific evidence of global climate change are pushing developed nations to reduce fossil fuel usage. Furthermore, due to globalization and resource scarcity, energy security is becoming more of a priority for nations. In order to reduce emissions and secure energy resources, the responsibility not only falls on the government, but also the people and organizations within the country. International organizations, such as the International Energy Organization (IEA), have been developed to promote energy security and provide a medium for an ever more intertwined world to communicate through.

Government agencies, international organizations, and public companies have a significant impact on the energy markets. Each have a certain agenda, but at the end of the day they are operated by people who depend upon energy sources in their lives. These various organizations create energy outlooks, which have extensive variations amongst them. The goal of this study is to take a sample of a wide range of organizations and analyze qualitatively and quantitatively what the differences are amongst them.

Methodology

This analysis compares energy forecasts from governmental agencies, international non-government organization, and public companies. The statistical and analytical branch of the United States Department of Energy is the Energy Information Administration (EIA). The EIA's role is to "collect, analyze, and disseminate independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment".[1] The EIA was created in 1974, which was in the wake of the oil market crisis of 1973. Its Fiscal Year 2011 annual budget was $95 million.[2] This study uses the most recent production of the EIA's annual *International Energy Outlook (2011)*. This is one of four documents under analysis in this study.

The second document under analysis comes from the International Energy Agency (IEA). The organizations mission is to "ensure reliable, affordable, and clean energy for its 28 member countries and beyond".[3] The organization was created in 1974, which was also in response to the early 1970's oil crisis. It was initially intended to co-ordinate amongst countries to respond to supply disruptions by releasing emergency stock piles of oil. Today its role has expanded and serves to promote global discussion on energy through providing "authoritative and unbiased research, statistics, analysis and recommendations".[4] The IEA focuses on energy security, economic development, environmental awareness and engaging non-member countries to

[1] EIA. "Mission and Overview." *About EIA*. EIA, n.d. Web. 21 Mar. 2012. <http://www.eia.gov/about/mission_overview.cfm>.
[2] Ibid.
[3] IEA. "About the IEA." *About IEA*. EIA, 2012. Web. 21 Mar. 2012. <http://www.iea.org/about/index.asp>.
[4] Ibid.

establish relationships.[5] The document under analysis in this study is the IEA's *World Energy Outlook 2011*, which is an annual document.

The last two documents under analysis come from public companies that operate on a global scale. BP is a fully integrated international oil and gas company that operates in over 90 countries.[6] BP's sales and other operating revenues in 2011 were over $375 billion[7] (BP web). Their roles in the energy market are the following: finding, extracting, transporting, and making fuels and products out of oil and gas; they also sell these fuels and products. Furthermore, BP has ventured into developing renewable energy sources and clean technologies; such as wind, solar, biofuels, and carbon capture and storage (CCS).[8] BP has also recently partnered with a company from Abu Dhabi to build a hydrogen power plant.[9] For the past 60 years BP has produced a "*Statistical Review of World Energy*", which purpose has been to provide timely and objective global energy data.[10] The *Statistical Review of World Energy* is the foundation for their energy forecast document, "*Energy Outlook 2030*". BP's goal is for the document to add to the discussion of global energy issues.[11] Furthermore, one of BP's Chief Executives, Bob Dudley, stated that it is part of BP's "responsibility to inform the discussions on energy that are

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[5] Ibid.

[6] BP. "BP Statistical Review of World Energy." N.p., June 2011. Web. 23 Feb. 2012. <http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2011.pdf>.

[7] BP. "BP at a Glance." *About BP*. N.p., 2011. Web. 23 Feb. 2012. <http://www.bp.com/sectiongenericarticle.do?categoryId=3&contentId=2006926>.

[8] BP. "Generating Low Carbon Energy." *About BP*. N.p., 2012. Web. 23 Feb. 2012. <http://www.bp.com/sectiongenericarticle.do?categoryId=3&contentId=2006926>.

[9] BP. "Hydrocarbons with Less Carbon." *Non-renewable Sources*. N.p., 2012. Web. 25 Feb. 2012. <http://www.bp.com/sectiongenericarticle.do?categoryId=9021518&contentId=7040019>.

[10] BP. "Group Chief Executive's Introduction." N.p., June 2011. Web. 3 Mar. 2012. <http://www.bp.com/sectiongenericarticle800.do?categoryId=9037127&contentId=7068552>.

[11] BP. "About Energy Outlook 2030." N.p., Jan. 2012. Web. 5 Mar. 2012. <http://www.bp.com/sectiongenericarticle800.do?categoryId=9037134&contentId=7068677>.

occurring in companies, governments, and over dinner tables worldwide".[12] BP's Energy Outlook is in its second year of public production and is a primary document in this study.

ExxonMobil is also a fully integrated international oil and gas company and is the world's largest publically traded. ExxonMobil is comprised of ten companies that cover upstream, downstream, and chemical businesses. They are the world's largest refiner and marketer of petroleum products.[13] ExxonMobil's sales and other operating revenues in 2010 were over $370 billion dollars.[14] ExxonMobil prides themselves on their ability to develop technologies. Especially, since a significant portion of energy resources are located in challenging environments. Some of these areas include heavy oil/oil sands, Arctic regions, deepwater, and tight gas. They believe their ability to use innovative productive techniques are imperative to keep up with global demand. Some of these techniques include the following: horizontal drilling, hydraulic fracturing, Remote Reservoir Resistivity Mapping (R3M), 3-D seismic, and amongst others.[15] Exxon is also on working on developing algae biofuels, hydrogen fuel cells, and strong plastics to decrease weight of vehicles.[16]

ExxonMobil produces a public energy outlook for two main reasons. First, it acts as a guide to their global investment decisions, which helps investors. Second, they concede that their decisions are not the only ones affecting the energy markets; thus, they provide a document to

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[12] BP. "Energy Outlook 2030." N.p., Jan. 2012. Web. 5 Mar. 2012. <http://www.bp.com/liveassets/bp_internet/globalbp/STAGING/global_assets/downloads/O/2012_2030_energy_outlook_booklet.pdf>.

[13] ExxonMobil. "About Us." *Who We Are*. N.p., n.d. Web. 8 Mar. 2012. <http://www.exxonmobil.com/Corporate/about_who.aspx>.

[14] ExxonMobil. "2010 Summary Annual Report." N.p., 2010. Web. 15 Mar. 2012. <http://thomson.mobular.net/thomson/7/3184/4448/document_0/XOM_SAR2010.pdf>.

[15] ExxonMobil. "Producing Energy." *Energy And Technology*. N.p., n.d. Web. 15 Mar. 2012. <http://www.exxonmobil.com/Corporate/energy_production

[16] ExxonMobil. "Advanced Vehicle and Fuel Technology." *Energy And Technology*. N.p., n.d. Web. 15 Mar. 2012. <http://www.exxonmobil.com/Corporate/energy_vehicle.aspx>.

encourage consumers and policymakers to garner a better understanding of global energy issues.[17]

Knowing the purpose of an organizations existence and their role in the energy market is important because it provides another angle of insight into their energy outlooks. After reviewing all of the energy outlooks, it became quite evident that there is a strong degree of ambiguity around how these major organizations ("survey" will be used to refer to each organizations energy outlook) with international energy projections compare and what exactly are the qualitative and quantitative differences causing the ambiguity.

Prior Studies

My objective is to uncover why and what the major differences are amongst energy outlooks produced by varying types of organizations, namely governmental (EIA), international (IEA), and publically held companies (BP and ExxonMobil). Most prior research conducted using energy outlook documents, focused on one particular issue and not a broad comparison. Below are three examples of prior studies that had narrow research questions.

Published in 2009, "How reasonable are oil production scenarios from public agencies?" by Kristofer Jakobsson, et. al., provides an analysis of the EIA and IEA models used to predict production of conventional oil. The study does not question the quality of the EIA model, but the method in which it is applied.[18] The conclusion states that resource-constrained models are

[17] ExxonMobil. "A View to 2040." *Energy And Technology*. N.p., n.d. Web. 15 Mar. 2012. <http://www.exxonmobil.com/Corporate/energy_outlook_view.aspx>.

[18] Jakobsson, Kristofer, Bengt Soderbergh, Mikael Hook, and Kjell Alekleett. "How Reasonable Are Oil Production Scenarios from Public Agencies." *Energy Policy* 37.11 (2009): 4809-4814. Web. 25 Feb. 2012.

the only current models that reliably production long-term oil production.[19] Furthermore, they found that the EIA used a non-fixed resource base, where a fixed resource base would have promoted an exponentially declining behavior in the model that they believe is more practical given oil supplies are limited.[20] This study provides important insight as well as a critique on how the EIA calculates oil reserves.

Published in 2007, "Understand the three different scales for measuring primary energy and avoid errors" by H. Douglas Lightfoot, offers an analysis of how primary energy is calculated by the International Energy Agency and other organizations.[21] This paper is similar to the objective of this study. In that, the objective of this paper is to highlight that different organizations use different metrics, definitions, and terms when talking about primary energy demand. This causes difficulty in comparing them to one another, which is the central focus of this study. [22]

Published in 2003, "Analysis of US energy scenarios: Meta-scenarios, pathways, and policy implications" by Richard Silberglitt, et. al., compares various energy scenarios quantitatively to United States energy consumption efficiency and carbon content from a policy and planning perspective.[23] The paper covers the EIA's Annual Energy Outlook (used in the parts of their International Energy Outlook), Royal Dutch Shell (similar to BP and ExxonMobil), and other various organizations. The priority of this paper was to examine what policy actions

[19] Ibid, 4817.
[20] Ibid.
[21] Lightfoot, Douglas H. "Understand the Three Different Scales for Measuring Primary Energy and Avoid Errors." *Energy* 32.8 (2007): 1478-1483. Web. 21 Feb. 2012.
[22] Ibid, 1483.
[23] Silberglitt, Richard, Anders Hove, and Peter Shulman. "Analysis of US Energy Scenarios: Meta-scenarios, Pathways, and Policy Implications." *Technological Forecasting and Social Change* 70.4 (2003): 297-315. Web. 10 Feb. 2012. p. 297.

are possible and not to single out the "best policy" or to determine what outlook is the "best outlook".[24] This approach is consistent with the approach of this study, in that it compares and analyzes the differences within the data and content of each of the surveys.

Objective

The goal of this study is to compare each survey for quantitative differences and explain them qualitatively. I will focus on the major points of distinction, which became quite evident after reading through the documents; they included the following: economic outlook, demographic outlook, model type, and baseline scenario (includes technology, policy, and relative price of primary energy fuels). These modes of distinction are where assumptions have to be inputted. They are the driving factors behind the energy projections for consumption and production across various regions.

The scope of this paper focuses on North America and the United States. There is a distinct difference in geographical definitions. The EIA and IEA provide data for the Organization for Economic Co-operation and Development (OECD) within the Americas, as a group. The OECD is an international organization that promotes policies that seek to improve economic and social well-being of the people around the world.[25] Essentially it is a forum for governments around the world to coordinate and share experiences to find solutions to common problems. The focus is on economic, social, and environmental change.[26]

[24] Siberglitt

[25] OECD. "About the Organisation for Economic Co-operation and Development (OECD)." *OECD*. OECD, n.d. Web. 20 Feb. 2012. <http://www.oecd.org/pages/0,3417,en_36734052_36734103_1_1_1_1_1,00.html>.

[26] Ibid.

The EIA and IEA state that the OECD Americas include the United States, Canada, Mexico, and Chile.[27,28] The EIA and IEA also provide data for United States and Canada separately. However they combine the data for Mexico and Chile, which doesn't allow for a strict analysis of North America (United States, Canada, and Mexico) alone. BP provides data for North America an entity, but excludes Puerto Rico.[29] ExxonMobil does not specify what constitutes as their "North America". Furthermore, BP and ExxonMobil do not provide data for individual energy types for United States, only total primary energy of the United States. These varying definitions are partially responsible for inconsistency with data starting points for each surveys projections. Table 1 below serves as a reference to regional definitions.

Table 1: Geographical Distinctions

Survey	Regional Defintion	Separate U.S. Data?
EIA	OECD America's: United States, Canada, Mexico, Chile	**YES**
IEA	OECD America's: United States, Canada, Mexico, Chile	**YES**
BP	North America: United States, Canada, Mexico (*exlcude's* Puerto Rico)	NO
Exxon*	North America: United States, Canada, Mexico	NO

*** Assumed**

There were also differences within defining each specific energy type for consumption and production across the surveys. Additionally, there were different units involved in

[27] Department Of Energy / Energy Information Administration. "International Energy Outlook 2011." 0484(2011): N. pag. Web. 25 Jan. 2012. <http://www.eia.gov/forecasts/ieo/pdf/0484%282011%29.pdf>. p. 291

[28] International Energy Agency. "World Energy Outlook 2011." *OECD Libraries* (2011): N. pag. Web. 25 Jan. 2012. <http://www.oecd-ilibrary.org/energy/world-energy-outlook-2011_weo-2011-en>. p. 639.

[29] BP. "Regional Definitions." BP, 2012. Web. 25 Feb. 2012. <http://www.bp.com/sectiongenericarticle800.do?categoryId=9037195&contentId=7068673>.

measuring energy consumption and production. To normalize the data, I converted all energy units into Quadrillion Btu's, unless otherwise noted (equations are provided in Appendix A).

These are some of the superfluous but important differences between surveys, which cause ambiguity when attempting data analysis of their projections across surveys. Exploring these modes of difference and other assumptions made in their projections will help depict the overall opinion / attitude of each organizations survey. The analyses will also illicit pertinent implications of using individual surveys and the surveys together. The objective is to normalize the data so that one can easily evaluate the differences and goals of each forecast, thus providing a non-biased, well-rounded understanding of the energy projections from different organizations.

Also note that each survey has different time periods. The EIA and IEA projections end in 2035, BP in 2030, and ExxonMobil in 2040.

Results

After analyzing the surveys and the corresponding data, it has become evident that each survey is built upon different assumptions that produce varying degrees of differences in results. The analysis of the surveys will start at the model level to provide insight into the mechanics behind the forecasted energy data points. To further explain the data points, the study will then examine the assumptions made about demographics and economics. Economics and demographics are key indicators of energy consumption.[30] Fuel price is also an important factor, but in many of the models they assume policies and technology will dictate price. Policy and

[30] BP, "Energy Outlook 2030" p. 9

technology factors are determined by each of the surveys' scenario, which for this study is an analysis of their baseline case (more on scenarios below). Following the analyses of these assumptions within the model, the study will than examine the qualitative and quantitative difference between each surveys projections for individual fuel types, as well as the general pattern across each survey.

Overview of Model Characteristics

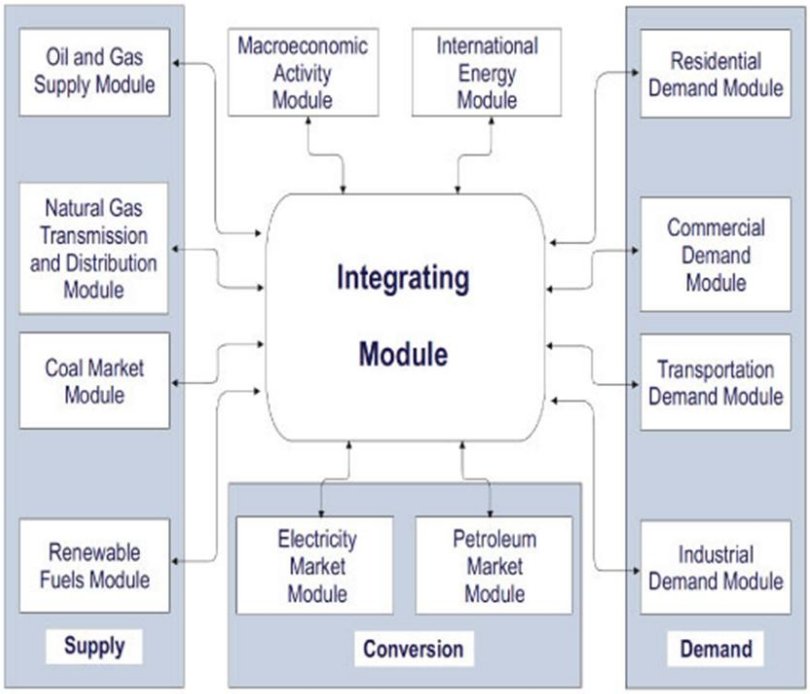
The EIA uses two main models in projecting energy forecasts for their *International Energy Outlook 2011*. The EIA's World Energy Projections plus (WEPS+) is used to project world energy consumption and supply. This model is a bottom-up model that consolidates data from individual sector energy models and integrates consumption and energy prices to reach an equilibrium solution.[31] For example, WEPS+ projects data from 16 regions or countries of the world, where various individual models can interact through a shared database and provide a comprehensive report analysis. Furthermore, in each of the individual models, there are sub-sector levels that include end-use models that project consumption of primary energy sources, i.e. residential, electricity and transportation among others.[32] The WEPS+ model also incorporates data from other complex models, expert judgments, and amassed knowledge.[33] The EIA acknowledges that their consumption models depend not only on retail price of the energy type, but also economic activity and population (demographics).[34] On the production side, WEPS+ incorporates the Generate World Oil Balance (GWOB) model and International

[31] DOE/EIA, "International Energy Outlook 2011" p. 289
[32] Ibid.
[33] Ibid.
[34] Ibid.

Natural Gas Model (INGM) to project world liquid and natural gas, respectively, from a bottom up approach[35].

EIA's second model, National Energy Modeling System (NEMS), is the main model of their United States energy projection outlook, "Annual Energy Outlook (AEO) 2011". NEMS is also a bottom-up model that focuses on the regional level aspects of the energy markets to produce national level data.[36] Chart 1 below shows the complexity and bottom-up approach involved with NEMS. WEPS+ uses data from NEMS to provide regional natural gas demand estimates to INGM, the natural gas model within WEPS+, for the United States. This will ensure that the final output of natural gas projections is consistent with the EIA's Annual Energy Outlook.[37]

Chart 1: National Energy Modeling System (NEMS)[38]



[35] Ibid.
[36] Department Of Energy / Energy Information Administration. "Annual Energy Outlook 2011." 0383(2011): N. pag. Web. 20 Feb. 2012. <http://www.eia.gov/oiaf/aeo/overview.html>. p. 3
[37] Ibid.
[38] Ibid, p. 4

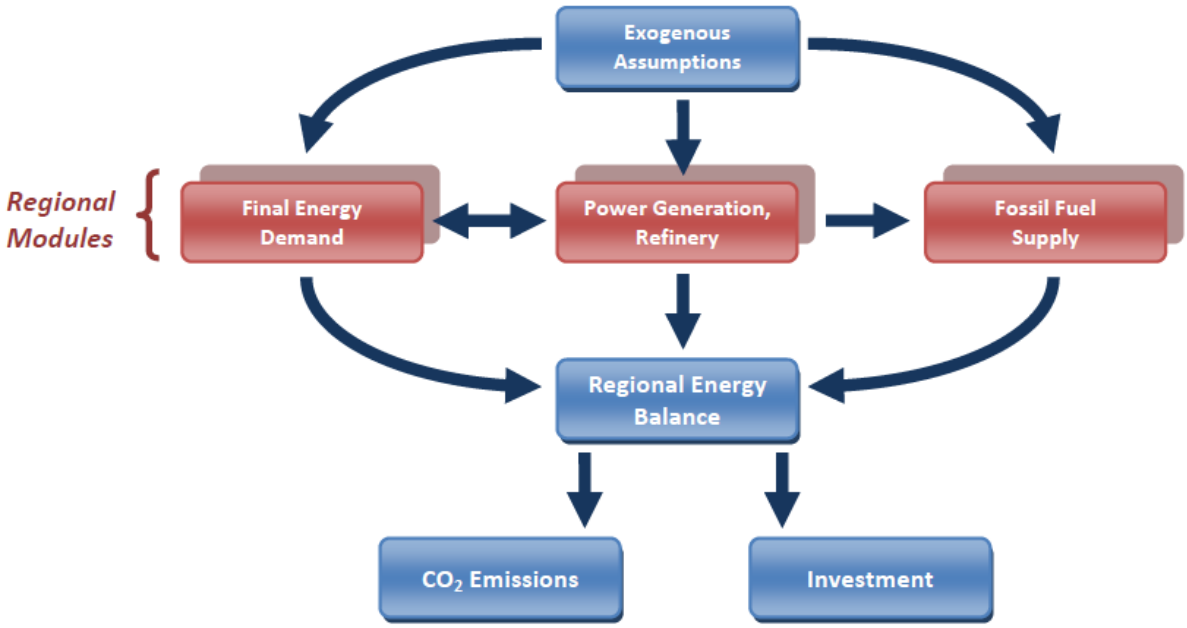
The IEA uses their World Energy Model (WEM), which generates a partial equilibrium designed around duplicating global energy markets function over the long and medium term. [39] The IEA inputs enormous quantities of economic and energy statistics from their historical database and outside sources[40]. There are six main sub-models within WEM, which are the following: end-use demand by sector, power generation and heat, refining and transformation, energy supply by type, CO2 emissions, and investments.[41] WEM is also a bottom-up model that projects energy demand by end-use across 25 regions with sector and multiple sub-sector models.[42] The IEA's WEM states that the "exogenous" assumptions in their model are economic growth, demographics, international fossil fuel prices, and technical development.[43] Economic growth and demographic assumptions will be discussed below, but fuel price and technology advances are assumptions that differ based upon scenario. As previously stated, this study analyzes baseline scenario (more details below).

On the production side, WEM uses a partial bottom-up model for oil supply. The model incorporates historical IEA data on proven and probable reserves in discovered fields, a country-by-country estimate of eventual recoverable resources , and input from numerous databases (internal and external).[44] WEM uses a similar model to project natural gas supply, but

[39] IEA, "World Energy Outlook 2011" p. 60
[40] Ibid.
[41] Ibid.
[42] IEA. "World Energy Model - Methodology and Assumptions." IEA, 2011. Web. 15 Mar. 2012. <http://www.worldenergyoutlook.org/docs/weo2011/other/WEO_methodology/WEM_Methodology_WEO2011.pdf>. p. 2-4
[43] Ibid, p. 4
[44] Ibid, p. 20

assumes that gas is not a globally traded commodity but rather regionally traded.[45] Chart 2 below is a macro view of the IEA's World Energy Model.

Chart 2: World Energy Model (WEM) Overview[46]



BP and ExxonMobil provide very little details on the models they used for their projections. This is another area of difference amongst the surveys. BP and ExxonMobil are publically traded companies that operate for profit, thus it appears practical to keep their models as proprietary information. BP notes they use assumptions on policy, technology, and the economy that are based upon internal and external consultation to incorporate into a range of analytical tools to build an energy model.[47] BP inputs historical data from their 2011 *Statistical Review of World Energy* document.[48]

[45] Ibid, p. 21
[46] Ibid, p. 4
[47] BP, "Energy Outlook 2030" p. 6
[48] Ibid.

ExxonMobil takes a similar approach when explaining how they come to their energy projections. Their projections are developed by a team of experts within ExxonMobil that are assigned the task of producing forecasts using factors that influence global, regional and national level energy supply and demand.[49] The wording in their document suggests that they use a bottom-up model. Similar to the other outlooks, ExxonMobil recognizes that economics, population, price and availability of various energy forms, technology, and policy will dictate their outlook.[50] ExxonMobil's outlook also incorporates publically available information from external sources, such as the IEA.[51]

Overview of Baseline Scenarios

The EIA's baseline scenario is their "Reference case" projections. They do provide four other alternative scenarios with data points: impact of high and low oil prices and demand on global liquids fuel market as well as the impact of high and low non-OECD demand on the world's liquid market.[52] This study focuses on the Reference case, which is a "business-as-usual trend estimate, given known technology and technological and demographic trends".[53] The scenario generally assumes that current laws and regulations are maintained throughout the projection period. [54]

The IEA provides a "New Policy Scenario" as their baseline scenario for their outlook. They do provide data and analysis for two other scenarios, which are a "current policy" scenario

[49] ExxonMobil. "2012 the Outlook for Energy: A View to 2040." ExxonMobil, 2012. Web. 24 Feb. 2012. <http://www.exxonmobil.com/corporate/files/news_pub_eo2012.pdf>. p. 48
[50] Ibid.
[51] Ibid, p. i
[52] DOE/EIA, "International Energy Outlook 2011" p. ii
[53] Ibid.
[54] Ibid.

and a strong approach in reducing greenhouse gas emission in their "450 scenario". The New Policy scenario "takes into account recently announced commitments and plans, even if they are yet to be formally adopted and implemented".[55] These announcements around the world deal with energy insecurity, climate change and local pollution, and other important energy issues.[56]

BP and ExxonMobil take a similar approach in their baseline scenarios for energy forecasts. BP mentions an alternative outlook, but does not provide data. BP's energy outlook is based on their views of the "evolution of the world economy, of policy, and technology".[57] They take into account the developments over the past year as well as incorporating policy, technology, and economic assumptions that are based upon internal and external consultants.[58] The outlook in their eyes is essentially the "most likely" scenario.[59] BP highlights that their scenario outlook lies between the IEA's New Policy Scenario and the Current Policy Scenario (similar to the Reference case of the EIA). They note that they do not cautiously implement policy announcements as the IEA's scenario, but rather they make a judgment on the practicality of implementation and its impact.[60]

ExxonMobil takes a similar approach to BP; in that their outlook is produced to the best of their knowledge and that they only provide data points for that one scenario. The scenario "reflects as best as we can an informed view of what the energy future will actually look like

[55] IEA, "World Energy Outlook 2011" p.49
[56] Ibid, p. 54
[57] BP, "Energy Outlook 2030" p. 4
[58] Ibid, p. 4-6
[59] Ibid.
[60] Ibid, p. 87

through 2040".[61] ExxonMobil also recognizes that game changing or combining types of technology will have a major impact on their projections.[62] ExxonMobil provides the least background information on their scenario approach. Table 2 below is an overview for each scenario.

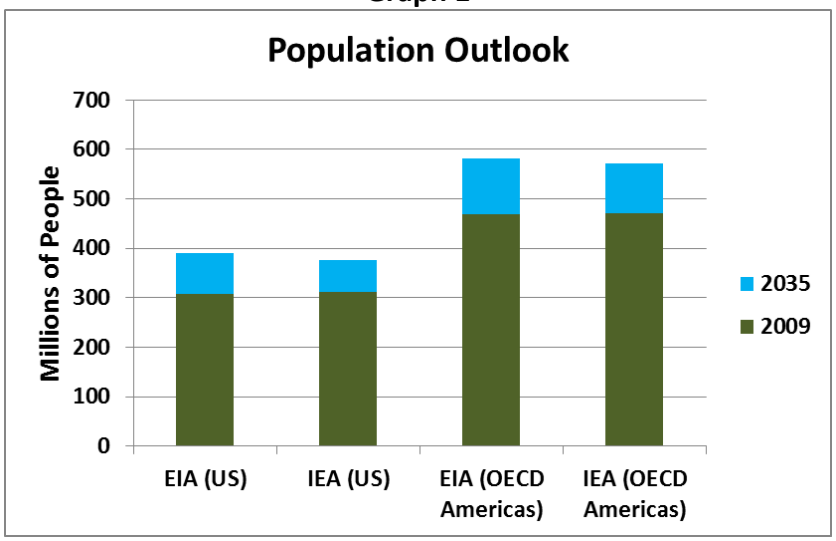
Table 2: Scenario Overview

Forecast	Time Range	Main Case	Overview	Alternative Cases?
EIA	2009/10-2035	Reference	Business-as-usual trend estimate, where current laws and policies are maintained throughout projections	Yes: High / Low Oil Price, Low GDP
IEA	2009/10-2035	New Policy	Existing government policies and declared policy intentions and cautiously implemented	Yes: 450 ppm, Current Policy
BP	2010-2030	"Most Likely"	Accounts for developments of past year and forsees changes in policy in the the future	Yes in prior year: High / Low GDP, and Strong Policy Case
Exxon	2010-2040	Best Judgement	Acknowledges and accepts that public opinion and governement positions will change	Alludes to the fact they do, but provides no details

[61] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 48
[62] Ibid.

Demographic Outlook

Graph 1



The EIA and the IEA provides projections for population growth in the United States and OECD Americas. BP and ExxonMobil provide commentary but no data in their outlook. Graph 1 illustrate that the EIA is projecting moderately higher population grown in both the United States and in the OECD Americas. To be exact, the EIA is projecting the OECD Americas and the United States will both have an average annual population growth rate of 0.9% 2008 to 2035.[63] The IEA is projecting the OECD Americas and the United States will have an average annual population growth rate of 0.8% and 0.7%, respectively, from 2009 to 2035.[64] The starting date is a year after the EIA's forecasts, but Graph 1 clear shows that the EIA estimates are higher than the IEA. This may be an important distinction, in that the EIA may as a result have higher energy consumption numbers than the IEA (there are many other factors involved in consumption, but this is a notable distinction).

[63] DOE/EIA, "International Energy Outlook 2011" p. 171
[64] IEA, "World Energy Outlook 2011" p. 59

The IEA notes that the largest increase in the OECD comes from the OECD Americas.[65] Also, the IEA makes a distinction and discuses urbanization rates and its link to energy demand. Urban areas in non-developed countries tend to have less money and limited access to energy.[66] However, this mostly affects the developing world, which is not the scope of this study.

BP is forecasting global population growth is trending down, but calls for growth to be around 0.9% per year from 2010 until 2030 or to a total of 1.4 billion people.[67] BP forecasts that low population growth, amongst other factors, in the OECD curbs energy demand across sectors.[68] BP does not provide details about North Americas or United States population growth, thus this section focused on what they do cover.

From a macro perspective, since they do not provide data for North America or the United States per say, ExxonMobil is projecting that the world population will grow by 25% from nearly 7 billion to 9 billion, but the rate at which it is increasing slows down.[69] ExxonMobil projects that energy demand will slow as economies mature and population growth slows.[70] From 2010 to 2040 ExxonMobil sees that population growth as one of the main factors to global energy demand growing by 30%. However, growth is projected to remain relatively flat in the OECD.[71] ExxonMobil makes an important distinction when it discusses population, that is, they discuss demographics. ExxonMobil points out that working-age population (people from 15 to 64 years old) are particularly important because they are the engine for economic growth

[65] Ibid.
[66] Ibid, p. 60
[67] BP, “Energy Outlook 2030” p. 8-9
[68] Ibid, p. 9,33
[69] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 1-6
[70] Ibid.
[71] Ibid, p. 6

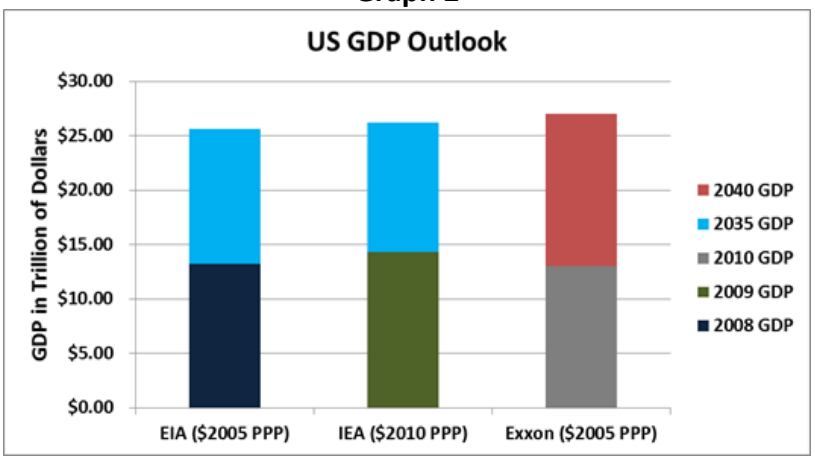
and energy demand.[72] The OECD is projected to have a rising percentage of older citizens because of low birth rate and other factors. This is a little misleading because largely populated countries are grouped in, like China. However, ExxonMobil does note that there is an increasing North America working-age population, which would lead to higher energy demand.[73]

BP and the IEA use the same data source, "United Nations Population Division", when projecting population outlook.[74,75] The EIA uses "IHS Global Insight" for all countries population projections except for the United States.[76] ExxonMobil does not specify where their assumptions come from.

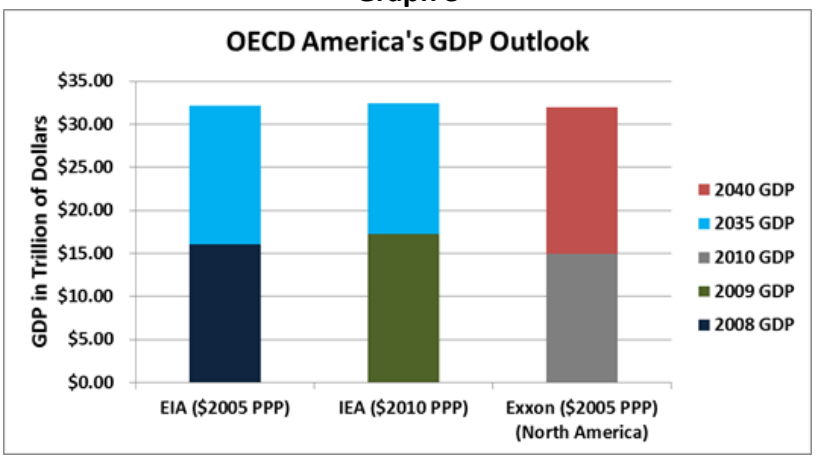
[72] Ibid.
[73] Ibid.
[74] BP, "Energy Outlook 2030" p. 88
[75] IEA, "World Energy Outlook 2011" p.59
[76] DOE/EIA, "International Energy Outlook 2011" p. 171

Economic Outlook

Graph 2



Graph 3



The EIA, IEA, and ExxonMobil provide Gross Domestic Product (GDP) projections. BP provides commentary but does not provide data points in their outlook. Graph 2 and 3 illustrate that the EIA is projecting slightly lower GDP growth than the IEA. However, these two surveys use different units of measure, $2005 Purchasing Power Parity (PPP) and the IEA uses $2010 PPP. PPP adjusts a countries currency in order for an exchange to yield equivalent purchasing

power.[77] Notice that ExxonMobil's outlook is projected out to 2040 and that the EIA and IEA end in 2035 but includes the OECD Americas.

The EIA is projecting average annual GDP rates for OECD Americas and the United States to be 2.6% and 2.5%, respectively, from 2008 to 2035.[78] The IEA is projecting average annual GDP rates for OECD Americas and the United States to be 2.4% and 2.4%, respectively, from 2009 to 2035.[79] ExxonMobil is projecting average annual GDP rates for North America and the United States to be 2.5% and 2.4%, respectively, from 2010 to 2040.[80] It's hard to make sense of these numbers when there are so many different variables. However, it appears that the EIA, IEA, and ExxonMobil are projecting moderate growth in GDP for United States and "North America". BP provides global data for GDP, but that is outside the scope of this study.

The EIA uses IHS Global Insight for their GDP amongst other in house documents.[81] The EIA notes that Chile and Mexico will have significantly higher GDP rates than Canada and the United States. Chile will see robust growth from exports and Mexico will grow as the United States continues to recover from the recent recession.[82]

The IEA believes that GDP, like demographics, is a key driver behind energy consumption.[83] The IEA uses the International Monetary Funds (IMF) GDP projections for the medium-term, with some adjustments to reflect information from the OECD, and other

[77] Investopedia. "Purchasing Power Parity - PPP." *Investopedia*. N.p., 2012. Web. 20 Mar. 2012. <http://www.investopedia.com/terms/p/ppp.asp#axzz1qAHgqf4i>.
[78] DOE/EIA, "International Energy Outlook 2011" p. 160
[79] IEA, "World Energy Outlook 2011" p. 158
[80] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 49
[81] DOE/EIA, "International Energy Outlook 2011" p. 160
[82] Ibid, p. 18
[83] IEA, "World Energy Outlook 2011" p. 49

countries national databases. Longer-term projections are based on historical growth rates and labor supply and productivity.[84]

ExxonMobil is projecting that the OECD's GDP will nearly double from 2010 to 2040, but notes that energy demand will remain flat due to efficiency gains. Without efficiency gains, ExxonMobil projects the OECD energy demand would rise by 90%.[85] They do not comment on North America or the United States GDP or how they formulate their GDP forecast.

As one can tell by all the different colors in Graph 2 and Graph 3, the surveys produce data with different time frames. The overall energy projections will be slightly influenced by starting year, units of measurement, and the year in which the GDP projections concludes. The EIA and Exxon used $2005 Purchasing Power Parity (PPP) and the IEA used $2010 PPP. ExxonMobil produces data to 2040, where the IEA and the EIA produce data until 2035. BP does not include data or details about their outlook on GDP for North America or the United States.

These are a lot of difference amongst the surveys, which adds to the confusion when trying to interpret how they influence their final energy projections. Breaking down the data from above, one could see that there are no clear outliers that show sluggish or robust growth in North America or the United States. This allows for a more direct interpretation of their energy projections.

[84] Ibid, p. 157
[85] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 7

Oil / Liquids:

Consumption Definitions:

The terms "oil" and "liquids" can include and exclude a variety of products. Each of the surveys in this study had varying definitions. This distinction is important because not only are the starting points affected by the definition, but also the projected data points. The EIA used the term "liquids" when describing oil consumption because they included the following: "petroleum products, natural gas liquids, and biofuels, liquids derived from other hydrocarbons (coal-to-liquids and gas-to-liquids), and petroleum coke".[86] What is not included is also specified: compressed natural gas, liquefied natural gas, and hydrogen.[87] The IEA expresses consumption in terms of "oil" and includes the following in their definition: crude oil (conventional and unconventional), natural gas liquids, and condensates. The IEA excludes biofuels, aviation fuel and marine fuel from their analysis of oil consumptions.[88] BP includes the following in their consumption analysis: "oil, biofuels, gas-to-liquids, and coal-to-liquids".[89] BP also defines their consumption in terms of "liquids". Lastly, ExxonMobil does not explicitly explain what they include. However, extrapolating from graphs and charts, it can be inferred that consumption here includes crude oil (conventional and unconventional), gas-to-liquids, and coal-to-liquids. They exclude biofuels from their analysis and use the term "oil" when defining consumption, which is evident by how they provide their projections.[90] Table 3 below

[86] DOE/EIA, "International Energy Outlook 2011" p. 1

[87] Department Of Energy / Energy Information Administration. "Glossary." *US: EIA*. N.p., 2012. Web. 21 Mar. 2012. <http://www.eia.gov/tools/glossary/index.cfm?id=L>.

[88] IEA, "World Energy Outlook 2011" p. 104, 107, 636

[89] BP. "Energy Outlook 2030 Summary Tables (Excel Document)." *BP*. N.p., 2012. Web. 21 Mar. 2012. <http://www.bp.com/sectiongenericarticle800.do?categoryId=9037134&contentId=7068677>.

[90] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 49-51

is a summary of liquids/ oil consumption definitions, the units that were used in each surveys projections, the term used.

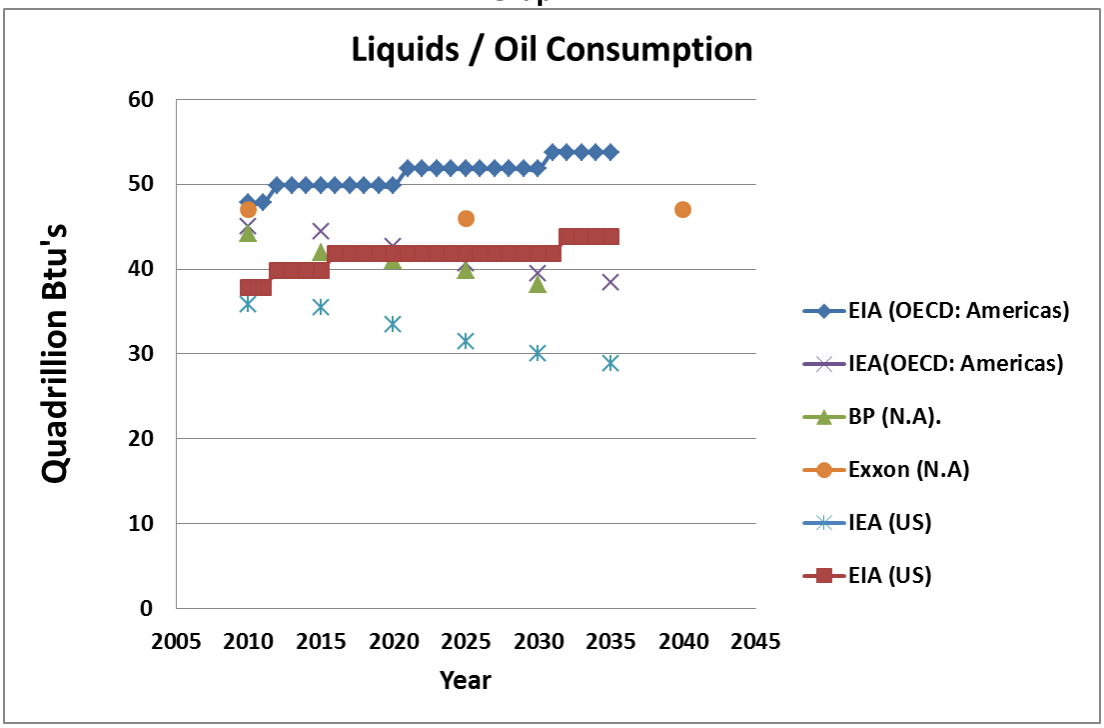
Table 3: Oil / Liquid Consumption Definitions

Consumption	Included	Not Included	Reported Units	Term
EIA	All petroleum products, natural gas liquids, biofuels, liquids derived from other hydrocarbon sources, and Petroleum Coke (solid)	CNG, LNG, and Hydrogen	Millions of Barrels per Day	Liquids
IEA	Crude oil, natural gas liquids, condensates and unconventional oil	Biofuels	Millions of Barrels per Day	Oil
BP	Oil, biofuels, gas-to-liquids, and coal-to-liquids	N/A	Million tonnes oil equivalent	Liquids
Exxon	Conventional and unconventional oil, gas-to-liquids, and coal-to-liquids	Biofuels	Quadrillion Btu's	Oil

Comparing the definitions across each survey will provide greater insight into what is driving the divergence in projections. As Table 3 shows, there are also differences in reported units. It is also important to note that not every barrel of oil is made equally; meaning that each one has a different energy content. When making conversions into Quadrillion Btu's, certain assumptions had to be made about the energy content of a barrel. For this analysis, I used the same Btu content per Mtoe across the surveys (formulas provided in Appendix A). Graph 4 below shows the results of normalizing the data into Quadrillion Btu's.

Oil / Liquids Consumption

Graph 4[91]



Macro

The EIA is projecting, for their baseline scenario, that world oil prices are set to increase to $125 a barrel by 2035.[92] Unconventional sources are technically difficult to produce, thus they require a lot of capital. The sustained high prices will allow for unconventional sources to become competitive / economical.[93] The rising costs of oil will also force many users outside of transportation sector to switch fuel sources when it is realistic.[94]

The IEA is also predicting high oil prices in their baseline scenario, which estimates oil to be at $120 a barrel by 2035.[95] The IEA believes that energy security and climate concerns will

[91] Graph Data from EIA, IEA, BP summary tables, and ExxonMobil outlooks; see work cited
[92] DOE/EIA, "International Energy Outlook 2011" p. 87
[93] Ibid, p. 1-2
[94] Ibid, p. 28
[95] IEA, "World Energy Outlook 2011" p. 103

slightly impede demand.[96] They see the biggest drop in oil consumption (in absolute terms) coming from the United Sates, where demand declines by 3.5 million barrel per day (mb/d) at the end of their projections in 2035.[97] The IEA believes that a high price is a strong enough signal that efficiency measure and fuel substitution will take place across industries.[98] The United States demand declines from 18 mb/d in 2010 to around 14.5 mb/d in 2035, which will be slightly less than 15% of global oil demand.[99] The IEA is also projecting that oil intensity, a measure of oil consumed for every dollar of GDP, is expected to continue to decline in the United States through 2035.[100]

In a similar fashion, BP is projecting that oil prices will remain elevated throughout 2030, but they did not give a hard value. Overall consumption growth is projected to be impeded by high oil prices, technology advances, new policies, and a reduction of non-OECD subsidies.[101]

ExxonMobil is also projecting "high" oil prices as well. They do not outright reference that oil will remain elevated, but they do mention that the economics favor switching fuel sources in power generation away from oil.[102] Although not fully analyzed in this study, it is quite evident that oil dictates consumption levels.

Focusing on North America and the United States oil / liquids consumption will be effected mostly by the scenario of each survey. Scenario's, as outlined in the above section involve assumptions based upon policy and technology amongst other things. Inevitably the price of oil is also tied to the demand of oil; similar to any other good. Across the four surveys,

[96] Ibid, p. 76
[97] Ibid, p. 107
[98] Ibid, p. 108
[99] Ibid, p. 83
[100] Ibid, p. 105-106
[101] BP, "Energy Outlook 2030" p. 25
[102] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 14

it is evident that the biggest impact on oil consumption will come from the transportation sector, power generation, and within industry - in descending magnitude.

Transportation

The EIA baseline scenario projects that the OECD Americas will account for 27% of the total fuel used in transportation world wide by 2035, which is down from 34 % in 2008.[103] This is not due to decreasing demand in the OECD Americas, but because the demand rises slower than emerging economies. The actual energy use in transportation is projected to rise in the OECD Americas from 33 Quadrillion Btu's in 2008 to 38 Quadrillion Btu's in 2035.[104] The United States accounts for 70% of the increase in transportation energy within the OECD Americas. Averaging around 0.5% growth a year, the United States increases from 28 Quadrillion Btu's in 2008 to almost 32 Quadrillion Btu's in 2035.[105] The EIA assumes in their baseline scenario that the Corporate Average Fuel Economy (CAFE) standards for light-duty-vehicle (LDV) for model year 2011, as well as the joint standards with greenhouse gas emissions put forth by the U.S. Environmental Protection Agency (EPA) and National Highway Traffic and Safety Administration (NFTSA) for model years 2012 to 2016 will not be expanded through from 2017 through 2025.[106] However, the Energy Independence Act of 2007 mandates an increase in LDV fuel economy to an average of 35 miles per gallon by model year 2010.[107] As a result of these mandates, the average fuel economy for LDV rises throughout the projections to reach 35.7 miles per gallon in 2020 than slowly grows to reach 37.6 miles per gallon by 2035.[108] LDV

[103] DOE/EIA, "International Energy Outlook 2011" p. 120
[104] Ibid.
[105] Ibid.
[106] Ibid.
[107] Ibid.
[108] Ibid.

consumption in the U.S. grows by nearly 2 Quadrillion Btu', or a 10% increase, from 2008 to 2035.[109] The EIA is projecting growth in LDV energy demand because they are forecasting higher levels of real disposable income despite moderately high fuel prices; the result will be a 17% increase in vehicles miles travel per person.[110] Heavy Duty Vehicles (HDV) also see significant growth due to increases in industrial output and an increase in high value goods being carried by freight trucks. The EIA is projecting a 35% increase, from 5.0 Quadrillion Btu's in 2008 to 6.7 Quadrillion Btu's in 2035; that is partially offset by increased fuel economy.[111] However, there are no standards for fuel economy for HDV in the baseline case of the EIA projections.[112]

The IEA projects that a high price of oil, capacity effects, and policy mandates, will all contribute to an overall decline in oil consumption, especially in the transportation sector. However, improved fuel economy will be the main drivers behind oil demand falling in the transportation sector.[113] Consumption is projected to drop for passenger light-duty vehicles (PLDV) (another definition term that's different), due to high international oil prices, government policies, and fuel efficiency standards.[114] The IEA also cites a recent proposal by the United States government in July 2011 to further increase vehicle fuel efficiency levels from 35.5 miles per gallon by 2016 to an average of 54.5 mpg by 2025.[115] However this was not taken into account in their projections. IEA suggests that if the current CAFE standards are extended until 2025, than oil demand would drop even more and other alternative fuel demand would

[109] Ibid.
[110] Ibid.
[111] Ibid.
[112] Ibid.
[113] IEA, "World Energy Outlook 2011" p. 107
[114] Ibid.
[115] bid, p. 109-110

increase.[116] The United States government also recently proposed mandates on heavy-duty vehicles (road freight) that aim to improve fuel efficiency between 10% and 17%.[117]

Historically, the peoples of the United States are known for buying big cars as signs of status of comfort.[118] This is another factor that could potentially lead to a further decrease of oil consumption in the United States, that is if people started to buy lighter cars or new light weight materialize were developed.[119]

Discussion here for BP will be focused on OECD and the United States because they do not provide facts about North America specifically. BP sees the weakest growth in the OECD coming from the transportation sector. BP expects the transportation sector will diversify the fuel mix away from oil and towards renewables, gas and electricity.[120] This change comes from new policies that cut back on emissions and set efficiency standards, (CAFE in the US[121]), and implementation of technology.[122] BP expects engine efficiency will kick in around 2015 and will drive the decline of oil consumption.[123] Furthermore, higher price of oil and vehicle saturation will contribute to a decline in oil demand.[124] BP believes high oil prices are essential to triggering incentives to increase vehicles efficiency.[125] Efficiency is projected to double over the next 20 years in the internal combustion engine. This improvement will "initially come from engine stop-start technologies, downsizing, and boosting and lower vehicle weight followed by

[116] Ibid, p. 116
[117] Ibid, p. 109
[118] Ibid, p. 117
[119] Ibid.
[120] BP, "Energy Outlook 2030" p. 15
[121] Ibid, p. 67
[122] Ibid, p. 15
[123] Ibid, p. 25
[124] Ibid, p. 67
[125] Ibid.

gradual penetration of the vehicle fleet of hybrid cars".[126] BP is also forecasting that by 2030, global sales of conventional PLDV fall to 33% from nearly 100% today, where hybrids that can switch to oil for longer distance will most likely be the preferred vehicle.[127] HDV are expected to not adopt the hybrid technology, thus by 2030 only 30% of the conventional market will have been replaced with advanced technology. This technology is projected to improve fuel economy by 1.1% per year until 2030.[128] Contrary to what the EIA forecasts, BP is predicting that miles driven by passengers will decrease as disposable income rises. This is due to fuel prices increasing (taxes and removal of subsidies), congestion on roads, and cheaper mass transit options.[129] BP acknowledges that electric vehicles, CNG, and LNG vehicles are growing but there have been difficulties in scaling up the markets.[130] Therefore, BP is forecasting that alternative fuels will not have a big impact by 2030. Global transport fuel mix is expected to be made up of 87% oil, 7% biofuels, and remaining percentage from natural gas and electric vehicles.[131]

ExxonMobil projects consumption in North America to remain flat from 2010 until 2040. ExxonMobil is projecting that United States government will mandate through policy that the fuel economy of personal vehicles will be around 38 mpg by 2040.[132] They are also estimating that the United States average on-road new car fuel efficiency will rise from slightly above 20 mpg in 2010 to approximately 45 mpg in 2040.[133] On a global scale, conventional vehicles will

[126] Ibid, p. 69
[127] Ibid, p. 69
[128] Ibid, p. 69-71
[129] Ibid, p. 71
[130] Ibid.
[131] Ibid, p. 67
[132] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 20
[133] Ibid.

drop from 98% of the global fleet today to about 50% in 2040, and will only comprise 35% of new car sales in 2040.[134] ExxonMobil does not provide a lot of information to back up their data.

The EIA also projects consumption in the United States by the airline industry to increase from 2.7 Quadrillion Btu's in 2008 to 3.1 Quadrillion Btu's in 2035 – roughly 14% increase.[135] As in LDV travel, demand for air travel increases due to an increase in real disposable income and demand for air freight as U.S exports rise. This occurs even in the wake of the price of aviation fuel increasing. However, the EIA projects that efficiency standards will mildly offset the fuel price and increased demand.[136] The IEA notes that if biofuels were built out with substantial infrastructure, than the aviation industry would look into adapting the technology to use biofuels.[137]

In the United States, the EIA is projecting modest consumption gains in marine and rail transportations due to higher industrial output and transportation of bulk commodities.[138] The IEA does not specify details for specific regions on rail or marine consumption levels. BP and ExxonMobil fail to even mention them.

The EIA projects a minute increase of energy used for transportation in Canada, from 2.5 Quadrillion Btu's in 2008 to 2.6 Quadrillion Btu's in 2035.[139] Canada has a similar transportation infrastructure as the United States and a similar mixture of transportation fuel use – mostly gasoline. However, there are several Canadian policies in place that promote alternative fuels, which will erode the market share of petroleum products in the transportation sector – more

[134] Ibid.
[135] DOE/EIA, "International Energy Outlook 2011" p. 121
[136] Ibid, p. 121
[137] IEA, "World Energy Outlook 2011" p. 110-111
[138] DOE/EIA, "International Energy Outlook 2011" p. 121
[139] Ibid

on this in the renewable sector.[140] Canada has also adopted greenhouse gas emission standards for LDV and light trucks that are in line with United States national fuel economy standards.[141] These policies hinder energy demand growth because vehicle fuel economies are rising, thus the net result is a tiny increase in oil demand in Canada. The IEA, BP, and ExxonMobil fail to break down Canada in the way the EIA does so.

The last two countries of the OECD Americas are grouped together in the EIA analysis, Chile and Mexico. Both of these countries transportation infrastructures are far less developed than the U.S. and Canada.[142] However, economic growth is projected to be stronger than the U.S. and Canada, averaging GDP growth of 3.7% per year.[143] Mexico and Chile will see an increase in real income, as a result of increased trade with North and South America, which is projected to increase levels of motorization.[144] Their transportation sector is expected to grow at faster rates than any other OECD countries.[145]

Mexico has developed a plan to meet the rising growth of transportation. The plan is called the National Infrastructure plan (NIP), which foresees around 300 projects across sectors to address transportation over crowdedness. For transport, NIP proposes "100 new highway projects, including the development of an interstate highway system, 2,500 miles of new roads in rural areas, 3 new airports (with further expansion to 31), new intermodal railway corridors, 3 suburban passenger rail lines (to be built in Mexico City area), 5 new seaports, and expansion

[140] Ibid,
[141] Ibid.
[142] Ibid.
[143] Ibid.
[144] Ibid.
[145] Ibid.

of 22 existing ports".[146] The NIP is expected to be complete in 2012, but the Mexican government had some set back in recent years due to rising costs of certain projects.[147] Mexico has also recently been importing used cars from the United States, which may have contributed to slower growth of new car sales in recent years. New car sales were over 820,000 cars in 2010, which was 20% lower than 2008 levels. From 2005 to 2008, Mexico has imported more than 2.5 million cars from the United States.[148]

Chile's transportation infrastructure was crippled by a massive earthquake in 2010 (worlds fifth most powerful ever).[149] The toll of the damage was estimated at $1.2 billion, damaging 965 miles of road, 212 bridges, and 9 airports.[150] Chile's government was set to spend $5 billion on 38 large-scale infrastructure projects before the 2010 earthquake. The projects included construction of a coast road that would cover two-third of the country from North to South, canal projects, shipping improvement, and airport expansion.[151] As of the publication of the EIA document, Chile's government has not commented on whether this plan would still be implemented given they just experienced a devastating earthquake.[152] The IEA, BP, and ExxonMobil fail to break down Mexico / Chile in the way the EIA does so (which is consistent throughout energy type).

[146] Ibid.
[147] Ibid.
[148] Ibid, p. 122
[149] Ibid.
[150] Ibid.
[151] Ibid.
[152] Ibid.

Industry

The EIA notes that the rising costs of oil, encourages many users outside of transportation sector to switch fuel sources when possible.[153] In the OECD, liquids use in industry are projected to remain constant, thus reducing the overall OECD percentage of oils market share from 39% in 2008 to 33% in 2035.[154] In the United States industry, liquids consumption remains flat.[155] The driving reasons behind oil consumption remaining stagnant are the following: increased efficiency, switch to alternatives fuels such as biofuels, waste, and other renewables. Additionally, the OECD in general has been switching from a manufacturing to a service centered economy.[156]

Canada is similar to the United States in that oil consumption within industry remains flat, due to high oil price. Oil demand is displaced by natural gas and renewables.[157] Chile and Mexico continue to use oil and gas for most their industrial energy demand. Chile has a large copper mining industry, which is energy intensive. The Mexican government recently proposed efficiency standards, which may hinder industrial energy growth.[158]

Assuming high oil prices, the IEA see that there is a strong economic incentive, particularly in industry, to reduce oil consumption through fuel substation or efficiency gains. In the United States it can be readily replaces by natural gas and other fuels for heat and steam generation.[159]

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[153] Ibid, p. 28
[154] Ibid, p. 111
[155] Ibid, p. 112
[156] Ibid, p. 111-112
[157] Ibid.
[158] Ibid, p. 112-113
[159] IEA, "World Energy Outlook 2011" p. 108

Similarly, BP points out that the OECD will be able to readily switch oil out of the fuel mix in industry and power generation. This is occurring due to the high price of oil, policies that curb emissions, and technology advances.[160] Exxon is projecting that industry oil demand in North America will be unchanged due to improvements of energy efficiency and shift toward less carbon intensive industries.[161] BP and ExxonMobil see a shift to renewables and gas in industry as well.

Electricity

In the midst of high oil prices, the EIA sees nations reducing or eliminating use of oil generation.[162] There will be a change in fuel mix in power generation for OECD countries, specifically the United States and Canada.[163] In Canada, oil-fired generation declines by 1% per year.[164] In Mexico, the government is planning to reduce diesel and oil use in power generation.[165]

On a global scale, the IEA is projecting that electricity produced by oil will drop from 5% in 2009 to 1.5% in 2035; where oil will be replaced by renewables.[166] Similar to industry, the power sector will be heavily influenced by the price of fuels and government policies. The two biggest factors in determining the fuel mix in power generation will come from carbon pricing and subsidies to renewables.[167] Oil Generation in the United States and the OECD Americas is not substantial, due to availability of cheaper fuels.

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[160] BP, “Energy Outlook 2030” p. 25
[161] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 25
[162] DOE/EIA, "International Energy Outlook 2011” p. 86
[163] Ibid, p. 111
[164] Ibid, p. 92
[165] Ibid, p. 93
[166] IEA, "World Energy Outlook 2011" p. 178
[167] Ibid, p. 178

Similar to the EIA, IEA, and BP, ExxonMobil calculates that power generation will continue to shift away from oil and increasingly toward less carbon intensive and cheaper primary energy sources. Biomass will also continue to decrease (specifically in the residential and commercially sector).[168] Table 4 below is a summary of oil / liquids consumption.

Table 4: Oil / Liquid Consumption Summary

Survey	Power Generation	Industry	Transportation	Price?	Conclusion	Time Frame
EIA	Diversify away from oil/liquids to cheaper fuels	Unchanged due to increased consumption in biofuels and other alternative sources	Absence of technology innovation, increase in personal income (increases travel- via LDV and aviation), no HDV standards, CAFÉ standard to 2016. Canada is similar to US, but Mexico and Chile are undergoing enormous infrastructure projects	High ($125)	Increase	2035
IEA	Diversify away from oil/liquids to cheaper and less carbon intensive fuel sources	Diversify away from oil/liquids to cheaper and less carbon intensive fuel sources when possible	Improved fuel economy on heavy duty vehicles (increase efficiency by 10-17%) and LDV (35.5 mpg by 2016)	High ($120)	Slight Decrease	2035
BP	Diversify away from oil/liquids to cheaper and less carbon intensive fuel sources	Replaced by alternative fuels due to high carbon content and price, growth in biofuels and other alternative liquids	Diversify away from oil to other energy sources, due to policy, technology developments, and high oil price. Will see significant growth of biofuel use, but no other alternatives	High	Slight Decrease	2030
Exxon	Diversify away from oil/liquids to cheaper and less carbon intensive fuel sources (specifically in residential and commercial sector)	Unchanged, due to efficiency gains and switch to less carbon intensive fuels	US Government will mandate new personal vehicles on road to reach 38 mpg by 2040, Exxon expect 45 mpg. Conventional vehicles will drop from 98% of fleet to 50%	High	Flat	2040

[168] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 14

Oil / Liquids Production

Production Definitions:

As with oil / liquids consumption, the definition of oil production varies across surveys. Furthermore, it is important to note that ExxonMobil does not supply data for oil production, but they do mention it in their discussion section. Table 5 below breaks down the definitions by what's included, not included, reported units, and the term used in the oil production of each survey. Similarly to oil / liquids consumption, the units had to be converted into Quadrillion Btu's in order to attempt a proper comparison.

Table 5: Oil / Liquid Production Definitions[169]

Production	Included	Not Included	Reported Units	Term
EIA	Crude oil (conventional and unconventional), natural gas liquids, condensates, and *refinery gains*	Biofuels	Millions of Barrels per Day	Oil
IEA	Crude oil (conventional and unconventional), natural gas liquids, condensates	Biofuels	Millions of Barrels per Day	Oil
BP	Crude oil (conventional and unconventional), natural gas liquids, condensates	Biofuels, liquids from coal derivatives	Million tonnes oil equivalent	Oil

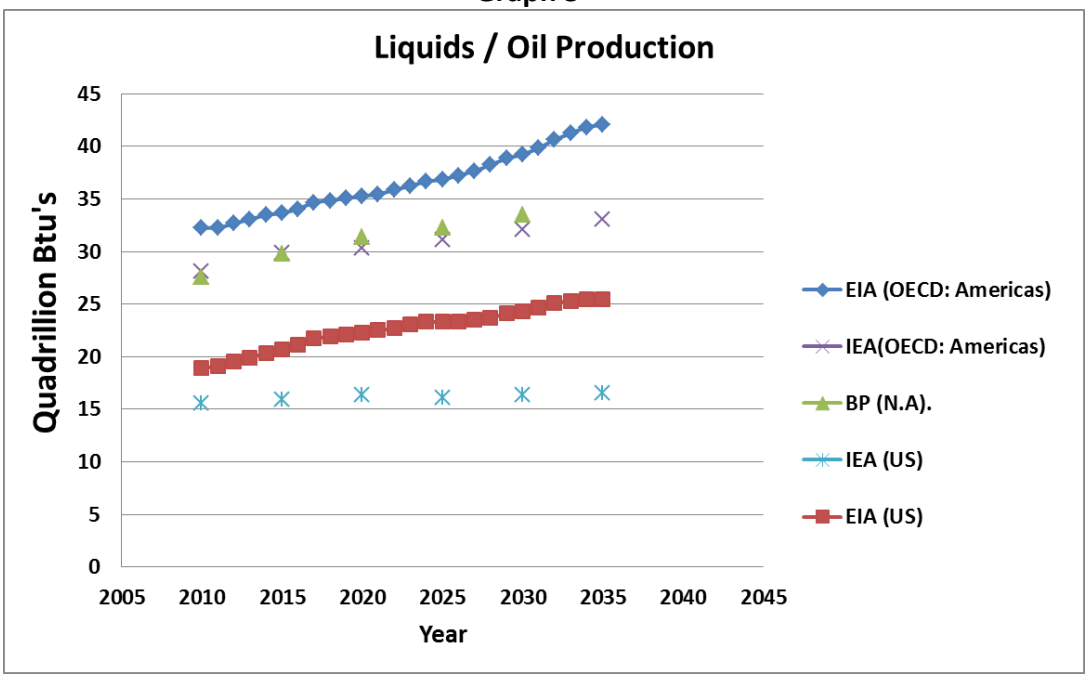
Organization of Petroleum Exporting Countries

The scope of this study focuses on North America and the United Sates, but it would be amiss if the study did not include a brief discussion on the how the surveys view the biggest actor in liquids production, the Organization of Petroleum Exporting Countries (OPEC).

[169] Information from EIA, IEA, and BP outlooks; see work cited

The Organization of Petroleum Exporting Countries is an international government organization created in 1960, by Iraq, Iran, Kuwait, Saudi Arabia and Venezuela. Since then, OPEC has added Qatar, Indonesia (suspended in 2009), Libya, United Arab Emirates, Algeria, Nigeria, Ecuador (suspended in 1992), Angola, and Gabon.[170] OPEC reason for existence is to co-ordinate and coalesce petroleum policy amongst its member countries; thus, attempting to ensure secure fair and stable prices of petroleum producers. They aim to produce at steady rates to consuming nations and allot a fair return on investment in the industry.[171]

Graph 5[172]



Macro

The EIA's baseline case calls for world production of liquids to exceed 2008 levels by 26.6 million barrels per day. This increased production will be met mostly by non-OPEC

[170] OPEC. "Member Countires." OPEC, 2012. Web. 26 Mar. 2012. <http://www.opec.org/opec_web/en/about_us/25.htm>.
[171] Ibid.
[172] Data from EIA, IEA, and BP outlooks; see work cited

countries developing their unconventional liquids.[173] OPEC is set to maintain their 40% - 42% market share of global production, which is estimated to be around 46.9 mb/d in 2035.[174] Contrary to the EIA, the IEA projects OPEC will meet the rising demand. They will produce a little over half (51%) of the world oil by 2035, which is 49 mb/d.[175] Similar to the IEA, BP projects that most of the increased production of liquids will come from OPEC. BP's 2030 outlook projects that OPEC will increase output by 12 mb/d to reach a market share of 45% in 2030.[176] ExxonMobil does not provide any insight into OPECs production in their outlook.

North America / OECD Americas Analysis

As mentioned previously, the EIA foresees world oil prices rising to $125 by 2035.[177] Sustained high prices allows for unconventional sources of oil production to become competitive with conventional because the economics behind exploring, producing and developing the unconventional plays pays off.[178] Furthermore, in non-OPEC countries, the price of oil makes it ideal to continue producing conventional sources and invest in Enhanced Oil Recovery (EOR) projects.[179]

The EIA believes that the United States will become a significant non-OPEC producer. The United States conventional liquids grow by 7.8 mb/d to 9.9 mb/d in 2035, as rising prices encourage both onshore and offshore drilling.[180] In the early years of the projections, the U.S. will see an increase in offshore production in the Gulf of Mexico (GoM) from projects that

[173] DOE/EIA, "International Energy Outlook 2011" p. 30
[174] Ibid, p. 25,30
[175] IEA, "World Energy Outlook 2011" p. 89, 103
[176] BP, "Energy Outlook 2030" p. 23,27
[177] DOE/EIA, "International Energy Outlook 2011" p. 1-2
[178] Ibid, p. 25
[179] Ibid, p. 31
[180] Ibid, p. 33

started within the last 5 years.[181] There has been a moratorium on deepwater drilling in the GoM, which has hindered production: an estimated 82,000 b/d in 2011.[182] Older field production will decline, but yet-to-be discovered and recently discovered fields will more than offset the decline by 2035.[183] On the main land, the lower 48 states of the U.S. will increase production do to EOR techniques, an increase of 37% of onshore production.[184] The EIA acknowledges that oil production is directly linked to the price of oil and improvements of technology. If carbon capture and storage (CCS) was mandatory in the future it would lower the price of EOR, and thus, production on shore would rise.[185]

The United States unconventional liquids production is also projected to increase, partially due to the high projected price of oil. The EIA projects an increase in United States production of biofuels from 0.7 mb/d in 2008 to 2.2 mb/d in 2035.[186] The increase in production of biofuels in the United States is also supported by the Energy Independence Security Act of 2007, which mandates a production increase to 36 billion gallons by 2022.[187] The aim of the mandate is reduce greenhouse gas emissions, promotes energy security, and support domestic economic development.[188] The IEA also acknowledges that biofuels are an important segment of total liquids production in the United Sates; currently the US produces 50% of the world's biofuels.[189] BP forecasts that the United States and Brazil will account for over half the worlds

[181] Ibid
[182] Ibid, p. 33-34
[183] Ibid, p. 34
[184] Ibid.
[185] Ibid.
[186] Ibid.
[187] Ibid, p. 37
[188] Ibid.
[189] IEA, "World Energy Outlook 2011" p. 127

biofuel growth by 2030, increasing production by 3.5 mb/d.[190] ExxonMobil does not provide regional analysis on biofuels, but they forecast that Biofuels will gain a global market share of 5% of total liquid supply by 2040. Furthermore, CTL, GTL, and refinery gains will add another 5% to global supply.[191]

The IEA's baseline scenario foresees the United States mature conventional basins decline, but this is offset by strong growth from light tight oil, natural gas liquids (NGL), and deepwater production of GoM (activity set to pick up after brief moratorium).[192] Natural gas producers will switch to liquid plays (high oil price is more economical) and discoveries in the GoM will be developed (or future Artic discoveries).[193] GoM production came to a standstill in May 2010 after the Macondo blowout, but permits were handed out until February 2011.[194] In June 2011, ExxonMobil found a substantial oil field with an estimated 700 Mboe. Before the blowout there were around 30 rigs active in the GoM and only 7 had left by mid-2011, thus there is still enough capacity to in the GoM to develop the new projects and continue to explore.[195] The projected rising production levels tied with a drop in projected domestic oil demand will cause oil imports to drop by 4mb/d in the United States and in North America by 6mb/d in 2035.[196] It's important to point out that BP reduced biofuel growth from last year's outlook due to "modest penetration levels".[197]

[190] BP, "Energy Outlook 2030" p. 27
[191] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 42
[192] Ibid, p. 127
[193] Ibid.
[194] Ibid, p. 130
[195] Ibid.
[196] Ibid, p. 126
[197] BP, "Energy Outlook 2030" p. 85

Coal liquefaction (CTL) is financially and technically risky in the United Sates, thus there has been very little investments. Although, policy geared at reducing carbon will encourage the development of CTL.[198] The EIA believes that U.S. shale oil production would have to overcome similar environmental, technical and financial hurdles as CTL; commercial production does not start until 2029.[199] According to the IEA outlook, CTL and gas-to-liquids (GTL) will contribute to the growth of oil supply, mainly in the last segment of the projection period within the United States.[200] Recently, the low price of natural gas in North America has already stimulated some growth in GTL, thus increasing liquids production.[201]

ExxonMobil's outlook to 2040 states that oil and other liquid fuels will remain the worlds largest energy source. Advances in technology are key to expanding supplies. ExxonMobil foresees conventional crude oil remaining flat until 2040, thus demand growth will be met by unconventional sources.[202] The largest increase in supply will come from global deepwater, which in 2025 will account for 10% of the world's liquid supply - doubling between 2010 and 2040.[203] The United States has seen large production growth from new technologies and techniques that capture tight-oil and NGLs from challenging rock formation, mainly shale in the United States.[204] New technologies can also revive declining fields, such as EOR. ExxonMobil believes that technology is the answer to meeting global energy demand. They ponder about the breakthrough of algae or non-food corn crops being turned into liquid fuel.[205]

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[198] DOE/EIA, "International Energy Outlook 2011" p. 34
[199] Ibid.
[200] IEA, "World Energy Outlook 2011" p. 127
[201] Ibid, p. 124
[202] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 41
[203] Ibid.
[204] Ibid.
[205] Ibid, p. 42

BP's outlook projects that the Americas will expand production by 8 mb/d. Advances in drilling technology will make additional resources available, such as Canadian oil sands (+2.2 mb/d), Brazilian deepwater (+2 mb/d), and U.S. shale sands (+2.2 mb/d), which will offset declining mature fields for a net gain of 5 mb/d.[206] North America sees substantial growth in biofuels (ethanol) and unconventional oil (shale oil) that is projected to turn todays oil deficit into a small surplus by 2030.[207]

In Canada, the EIA projects conventional oil production to decline slowly, under 20,000 b/d from 2008 to 2035. Unconventional petroleum liquids from oil sands more than offsets conventional declines; production levels increase from 3.4 mb/d in 2008 to 6.6 mb/d in 2035.[208] However, oil sands (bitumen) may face some environmental constraints, but is projected to make up 40% of non-OPEC unconventional liquids production.[209] To promote biofuel production, producers receive payments or operating grants from the Canadian government based upon output.[210] Similar to the EIA, the IEA projects Canada to have rapid growth in oil production through 2035 from oil sands, which could be hindered by environmental concerns and politics. However, provincial and federal governments along with the oil industry have taken steps to reduce environmental footprint. For example, Alberta has committed $2 billion towards CCS.[211] Production is expected to increase from 1.5 mb/d in 2010 to 4.5 mb/d in 2035.[212] ExxonMobil projects "tremendous" growth in oil sands from Canada and Venezuela,

[206] BP, "Energy Outlook 2030" p. 23-27
[207] Ibid, p. 77-79
[208] DOE/EIA, "International Energy Outlook 2011" p. 34
[209] Ibid, p. 25,37
[210] Ibid.
[211] IEA, "World Energy Outlook 2011" p. 125
[212] Ibid.

which are projected to account for 25% of total liquids supply in North and South America by 2040.[213]

EIA's baseline scenario projects Mexico will see a decline of more than 1.5 mb/d from 2008 to 2035. The decline is largely a result of unforeseen large declines in oil production at Cantarell and Chicontepec, and because of a lack of interest in investing (foreign and domestic) in deepwater Golf of Mexico (GoM).[214] Currently, there are laws that restrict foreigners from investing in Mexican hydrocarbons, but it is assumed they will relax the laws after 2015.[215] Post 2025, Mexico is projected to begin to develop deepwater Gulf of Mexico. These projects take years to see oil production.[216] The level of production will be determined by amount of economic access granted to foreign operations that have the technical capability and financial means to develop deepwater projects in GoM.[217]

Comparable to the EIA, the IEA projects that Mexico's production will decline in the first half of the outlook, where older mature fields in the GoM decline. In 2008 the government gave permission to the state owned oil company to hand out small development contracts to incentivize oil production, but these were not awarded until 2011. Larger contracts are thought to be offered in the near future, which will have a meaningful impact on production.[218] Table 6 below is a summary of oil / liquid production.

[213] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 41
[214] DOE/EIA, "International Energy Outlook 2011" p. 32
[215] Ibid, p. 31
[216] Ibid, p. 32
[217] Ibid.
[218] IEA, "World Energy Outlook 2011" p. 129

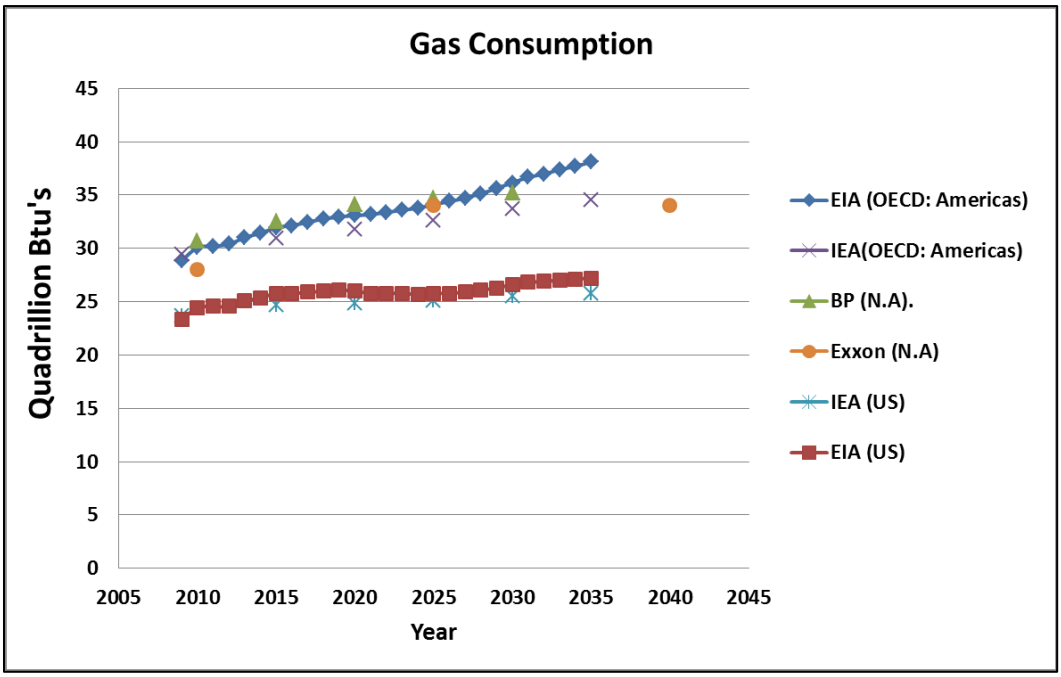
Table 6: Oil / Liquid Production Summary

Survey	Means of Production	Conclusion	OPEC Output	Time Frame
EIA	Growth of unconventional sources as well as use of Enhanced Oil Recovery (EOR) techniques, due to high price of oil. Increase in onshore and offshore drilling, gas-to-liquids, coal-to-liquids, lower-48 increase use of EOR, Canadian sand-oils, and US biofuels (not in prior graph) increase due to US Energy Independence Security Act of 2007. Mexico sees significant growth offshore, post 2015.	Increase	42%	2035
IEA	Low natural gas prices have triggered increase interest in liquefaction, Canadian oil-sands, US conventional declines are offset by "light-tight-oil" (shale oil), NGL, and deep-water production in GoM. Substantial U.S. biofuel growth (not included in graph).Mexico see long term growth in GoM.	OECD Americas: Increase, but only very slightly in US	51%	2035
BP	Increase in Biofuels (not in prior graph), Canadian oil-sands, unconventional sources will offset conventional declines, gains from liquefaction of gas (coal is not included in prior chart)	Increase	46%	2030

Natural Gas

Consumption

Graph 6[219]



Macro

The EIA's Reference case forecasts natural gas demand in the OECD Americas to increase by 0.9% per year, which in volume is a gain from 28.8 trillion cubic feet in 2008 to 37.1 trillion cubic feet in 2035. This represents 60% of the total increase in demand in the OECD and 14% of the global demand.[220] The United States is projected to remain the largest user of natural gas in the OECD Americas.[221] In OECD countries; the IEA is expecting natural gas demand to be strongest in the electricity sector. The reasons behind the rise in demand for natural gas-fired power are the following: lower carbon content, addition of variable renewables (gas is not intermittent), low capital cost, and shorter construction times compared

[219] Data from IEA, EIA, BP and ExxonMobil outlooks; see work cited
[220] DOE/EIA, "International Energy Outlook 2011" p. 44
[221] Ibid.

to other fossil fuels.[222] Furthermore, the abundance of gas in the United States depresses the price. The natural gas market is relatively regionalized, thus there will be price discrepancies between North America, Europe and Asia. LNG exports and imports will only marginally converge the price of natural gas.[223]

The EIA projects that the United States natural gas demand increases by 0.5% per year on average. As a total percentage, it increases 14% from 2008 to 2035.[224] EIA estimates Canadian demand increases by 1.5% per year on average.[225] EIA also foresees Mexican / Chilean demand increasing by 3.4 % per year on average.[226] BP does not break down natural gas demand by region or country per say, but by non-OECD and OECD. ExxonMobil projects that gains in efficiency, through energy-saving practices and new technologies will curb demand and reduce carbon emissions; for example new high-efficiency natural gas plants.[227] ExxonMobil also projects that the United States will shift away from coal to less carbon-intensive fuels such as natural gas.[228]

Transportation

Natural gas benefits from fuel-cost savings and emissions reductions, but is rather limited by refueling infrastructure.[229] On a global level, since the IEA does not mention natural gas's role in North America or the United States, natural gas in transportation is expected to

[222] IEA, "World Energy Outlook 2011" p. 159
[223] Ibid, p. 63
[224] DOE/EIA, "International Energy Outlook 2011" p. 44
[225] Ibid.
[226] Ibid.
[227] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 1
[228] Ibid.
[229] IEA, "World Energy Outlook 2011" p. 160

quadruple by 2035 and make up 3% of the total energy use in road transportation.[230] The EIA does not mention natural gas's role in transportation within OECD Americas or United States. BP also mentions that globally natural gas use in transport will quadruple, but only amounts to 4% by 2030.[231] BP believes this is due to limited policy support and a general lack of infrastructure in several key markets.[232] ExxonMobil projects that plug-in hybrids, electric, and compressed natural gas (CNG), and liquefied natural gas (LNG) vehicles will make up 5% of the global fleet by 2040.[233] ExxonMobil believes the role of natural gas is limited by "cost and functionality considerations".[234]

Industry

The EIA is forecasting an increase in natural gas demand of 1.4 trillion cubic feet within the "price sensitive" industrial sector from 2008 to 2035.[235] Growth in the United States industrial sector is expected to be moderated by policies aimed at curbing energy intensity within the industrial processes. For example, the United States Department of Energy issued the Energy Policy Act of 2005 that aims to cut 25% of energy intensity in the U.S. by 2017.[236] The Energy Independence and Security Act of 2007 (mentioned in Oil / Liquids section) is also geared at improving efficiency. In the near term, the EIA foresees that the low natural gas prices and rejuvenation in industrial production boosts demand for heat and power, but when the price rises at the end of the period and efficiency increases consumption flat lines.[237] BP

[230] Ibid.
[231] BP, "Energy Outlook 2030" p. 67
[232] Ibid.
[233] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 20
[234] Ibid.
[235] DOE/EIA, "International Energy Outlook 2011" p. 44
[236] Ibid, p. 112
[237] Ibid, p. 44

predicts that low population growth and efficiency measures in the OECD will keep the industrial sector depressed at 0.9% energy growth per year.[238]

Similar to BP, ExxonMobil specifies the OECD and not North America's or the United States industrial sector. ExxonMobil includes the following in the industrial sector: energy use towards plastics, steel, agriculture, textiles, and production of fossil fuels. They project that the OECD will see modest gains in natural gas demand, due to efficiency gains and fuel switching (natural gas is less carbon intensive than other fossil fuels).[239]

The EIA, projects Canada will experience 66% growth in natural gas demand for industrial uses (immense amount used to develop Canadian oil sands).[240] The EIA notes that high oil price causes a change in fuel mix in the industrial sector, which leads to an increase of 1.7% per year of natural gas demand.[241] The share of natural gas in industrial fuel mix rises from 38% to 46% from 2008 to 2035.[242] Canada also passed legislation, Canada's Energy Efficiency Act of 1992, and recently in 2007, Regulatory Framework for Industrial Greenhouse Gas Emissions that calls for a 20% reduction in greenhouse gases by 2020.[243] The EIA projects that most of the abatement will come from fuel switching and efficiency, as evidence of EIA's projected increase in natural gas demand for Canada.[244]

Mexico and Chile are also aiming to improve efficiency standards within their industrial sector. For example, in 2005 Chile's National Energy Efficiency Programme was passed and in

[238] BP, "Energy Outlook 2030" p. 33
[239] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 25
[240] DOE/EIA, "International Energy Outlook 2011" p. 45
[241] Ibid, p. 112
[242] Ibid.
[243] Ibid.
[244] Ibid.

affect created plans to boost energy efficiency.[245] Mexico's industrial sector uses oil and natural gas for most of its demand.[246] Mexico's government also recently passed efficiency standards, as mentioned in oil/liquids section above.

Electricity

> *"Natural-gas-fired combined-cycle technology is an attractive choice for new power plants because of its fuel efficiency, operating flexibility (it can be brought online in minutes rather than hours it takes coal-fired and some other generating capacity), relatively short planning and construction times, relatively low emission, and relatively low capital costs" - Energy Information Agency[247]*

The EIA is forecasting an increase in natural gas demand in the United States of 1.2 trillion cubic feet within the "price sensitive" utility sector from 2008 to 2035.[248] However through 2025, the EIA estimates that demand in the United States for natural gas in the electricity sector remains flat (remember this is the scenario with no policy changes), primarily due to increased generating capacity with lower operating costs. For example renewable and nuclear capacity is added during the early part of the projection due to incentive programs.[249] The ladder half of the projection period is where natural gas consumption increases, despite the rise in price, because the economics favor natural gas over other fossil fuels. From 2025 to 2035, the EIA estimates 82% growth rate of capacity additions will come from natural gas in the United States.[250] BP projects that the OECD will see concentrated growth from natural gas demand in power generation, at 1.6% per year.[251]

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[245] Ibid.
[246] Ibid, p. 113
[247] Ibid, p. 87
[248] Ibid, p. 44
[249] Ibid.
[250] Ibid.
[251] BP, "Energy Outlook 2030" p. 33

The IEA acknowledges natural gas's flexibility as a fuel, combined with its environmental and energy security benefits (if produced domestically), makes it an attractive fuel source power generation.[252] In the United States, where natural gas is abundant, demand grows for power generation.[253] Although the absence of a carbon price in the United States provides less of an incentive for utilities to move away from carbon intensive fuels (coal) - the IEA is projecting that a shadow price of carbon in 2015 will affect business decisions.[254] IEA predicts that the increased demand is met by the abundance of natural gas in the United States.

According to ExxonMobil's outlook, electricity generation continues to shift to lower-carbon sources, such as natural gas.[255] Demand for electricity continues to rise in all parts of the world primarily to population and economic growth. Energy demand in power generation would be more robust if ExxonMobil did not believe electricity generation would be drastically more efficient by 2040. They predict it will only take two units of primary energy to produce one unit of electricity as compared with an initial three today.[256] "Natural gas emits up to 60% less CO2 than coal when used for electricity generation," thus promoting natural gas demand.[257] ExxonMobil suggest that either a direct or indirect price of carbon will be in place in their projections, thus increasing the cost of natural gas, but not nearly as much as coal.[258] In North America, "natural gas provides a competitive alternative to coal for electricity generation,

[252] IEA, "World Energy Outlook 2011" p. 78
[253] Ibid.
[254] Ibid, p 52, 83
[255] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 26
[256] Ibid, p 28
[257] Ibid, p 29
[258] Ibid.

especially under policies that impose costs on higher-carbon fuels".[259] The United States will see enormous growth in natural gas power generation because of their domestic abundance.[260]

The EIA, projects Canada will have a 29% increase in natural gas demand for electricity generation.[261] Electricity demand by natural gas increases by 3.8% per year from 2008 to 2035.[262] In Ontario, one of Canada's largest provincial electricity consumers, the government has planned to close down the four remaining coal-fired plants by the beginning of 2015, due to environmental and health concerns.[263] The replacement plants will come from natural gas and other non-carbon intensive fuels.

According to the EIA, Mexico / Chile natural-gas-fired generation increases from 48% of their total generation to 58% from 2008 to 2035.[264] In Mexico, the government has recognized the need to for their countries electricity infrastructure to keep pace with anticipated demand. In July 2007, the government unveiled their National Infrastructure Program (NIP) (as mention in Oil / Liquids section), which includes $25.3 billion to improve and expand electricity infrastructure.[265] Natural-gas-fired generation in Mexico and Chile is expected to double from 147 billion kWh in 2008 to 418 billion kWh in 2035. This is due to Mexico's NIP plan and the government's plan to reduce its use of diesel and fuel oil for power generation. This drastically increases Mexico's demand, so much so that it outpaces electricity production and Mexico turns to LNG imports (various countries) and pipeline imports from the United States.[266] Mexico

[259] Ibid, p 44
[260] Ibid, p 30
[261] DOE/EIA, "International Energy Outlook 2011" p. 45
[262] Ibid, p 92
[263] Ibid.
[264] Ibid.
[265] Ibid, p 93
[266] Ibid.

currently has one LNG import facility on both coasts and a third one is under construction.[267] In Chile, most of their power generation comes from hydropower, 40%, but this leaves them vulnerable to droughts. Recently, the government issued measures to increase imports via their two LNG import facilities. Chile also has natural gas pipelines that connect to Argentina, but it has been unreliable because Argentina can barely meet their own demand.[268]

Not in electricity generation sector per say, but ExxonMobil highlights the residential and commercial use of natural gas. In the wake of global prosperity and increase in number of households, residential and commercial sectors will see demand grow by 25% where the energy will be focused on electricity and natural gas.[269] ExxonMobil highlight the benefits of gas in this sector: "versatility, used for space heating, water heating, commercial cooling, cooking, drying, and combined heat and power in commercial buildings".[270] In North America the number of houses increases from around 180 million to 215 million, which will all need more electricity.[271] However, the energy used per house hold will continue to decline, due to efficiency gains.[272] In the OECD, demand for residential and commercial sector will remain flat due to offsetting population and economic growth by efficiency.[273] Table 7 below is a summary of natural gas demand.

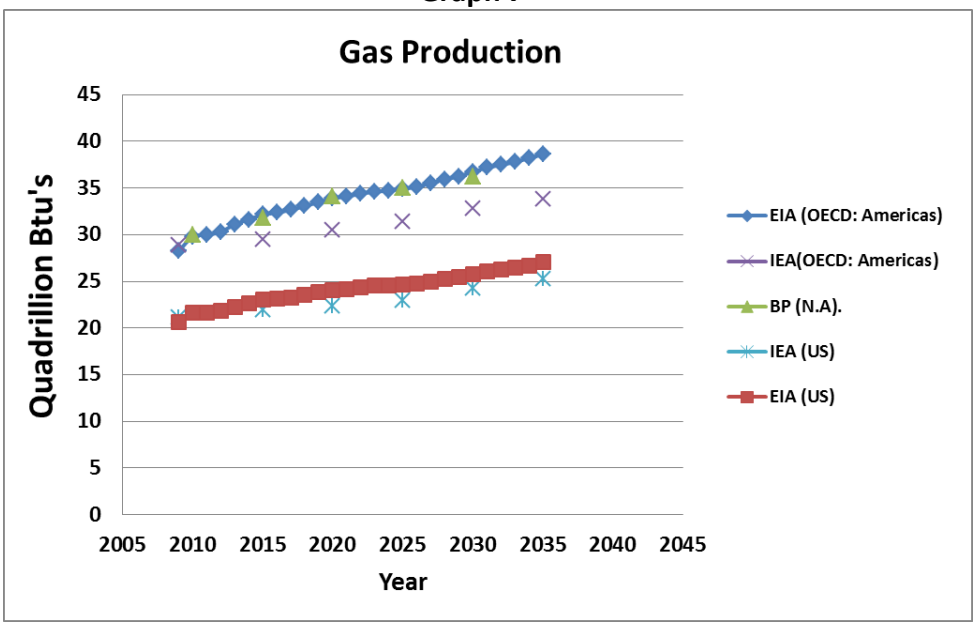
[267] Ibid.
[268] Ibid.
[269] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 10
[270] Ibid.
[271] Ibid, p 12
[272] Ibid.
[273] Ibid, p 13

Table 7: Natural Gas Demand Summary

Survey	Power Generation	Industry	Transportation	Price?	Conclusion	Time Frame
EIA	US remains flat until 2025 due to spare capacity of other energy sources with lower operating costs, such as renewables and nuclear, (supported by incentives). Post 2025, natural gas *has strong* demand in US due to economics, despite rising prices. Canada - natural gas increases due to environmental benefits. Mexico/Chile see strong growth throughout; Chile attempts to diversify energy mix (security)	US: Strong demand as natural gas prices remain low, but demand flattens when price rises at the end of period. Canada: strong demand to develop oil-sands and replaces oil due to its high price. Mexico recently implement efficiency standards - that promote cogeneration	Largely unchanged, but notes that policies and market forces could drive development	Increasing	Increase (US slightly)	2035
IEA	Growth is strongest, due to flexibility to change fuel sources. Energy security and environmental benefits increase demand especially coupled with low natural gas prices. Renewables intermittence adds to growth	"Important Role": increase in industry, where its not as carbon intensive, easily handled, and ability to produce heat to recover materials and commodities . Building sector: needed to source water and space heating)	Minimal Change: due to lack of infrastructure, seen rising to 3% of global fleet	$8.6 Mmbtu ($2010)	Increase (US slightly)	2035
BP	Policy will make it more difficult for carbon intensive energy plants to be built, thus will lead to lower emission fuels; significant increase in natural gas (High price of oil and gas is low). Renewables may hinder growth.	Minimal change: due to increased energy efficiency, low population growth (groups in residential sector)	Minimal change: expects CNG to increase, but only makes up 2% of global fleet	N/A	Increase	2030
Exxon	Gas becomes competitive with coal as policy dictates less carbon intensive fuels and due to an abundant domestic supply	Minimal change: Industrial sector demand will be met be increased efficiency. Residential and Commercial: modest population and economic growth will be offset by gains in energy efficiency	Minimal change: 5% of global fleet (Groups hybrid, electric, LNG, CNG vehicles)	N/A	Increase	2040

Natural Gas Production

Graph 7[274]



North America / OECD Americas Analysis

The EIA notes that tight gas, shale gas, and coalbed methane (CBM) have not yet been fully retrieved in Canada and the United states.[275] EIA projects natural gas production is set to increase by 34% from 2008 to 2035.[276]

Gas production and demand in North America are currently both hovering around 800 billion cubic feet per year.[277] In the IEA's baseline scenario, they project North America's supply and demand to remain mostly imbalance throughout 2035.[278] The recoverable resource base of unconventional natural gas, that being CBM, low-permeability tight-gas, and shale gas have all

[274] Data from IEA, EIA, and BP outlooks; see work cited
[275] DOE/EIA, "International Energy Outlook 2011" p. 3
[276] Ibid.
[277] IEA, "World Energy Outlook 2011" p. 169
[278] Ibid, p. 155

expanded in recent years.[279] In North America, the IEA projects that unconventional gas will increase from 56% in 2009 to 64% in 2035.[280]

BP projects North America's conventional gas supply to decrease, while its unconventional supply outpaces the decline in conventional. Shale gas and CBM will account for roughly 63% of North American production by 2030.[281] The increase is unconventional is so large, BP foresees North America becoming a net exporter by 2030.[282] Exports are estimate to reach 5 billion cubic feet /day by 2030.[283]

United States

According to the EIA, recent estimates of shale gas resources have increased U.S. natural gas reserves by nearly 50% over the past decade and shale gas will become 47% of U.S. production by 2035.[284] The U.S. will see unconventional production increasing from 10.9 trillion cubic feet in 2008 to 19.8 trillion cubic feet in 2035.[285] This increase in shale gas more than offsets the decline in conventional. The total production rises from 20.2 trillion cubic feet in 2008 to 26.4 trillion cubic feet in 2035.[286]

The main areas of production come from shale gas (47%), tight gas (22%), offshore (12%), and the rest come from Alaska and other non-association resources.[287] There is a proposed pipeline from Alaska to the lower 48 states, but it is uneconomical due to the low price of

[279] Ibid, p. 161
[280] Ibid, p. 163
[281] Ibid.
[282] BP, "Energy Outlook 2030" p. 34
[283] Ibid, p. 35
[284] DOE/EIA, "International Energy Outlook 2011" p. 3
[285] Ibid.
[286] Ibid, p. 50
[287] Ibid.

natural gas throughout the outlook.[288] The key to the United States success in producing their abundance of shale gas deposits came from advancements in technology, mainly hydraulic fracturing coupled with horizontal drilling.[289] The United States has several LNG import plants that are currently storing natural gas, while the plants are being retro-fitted to export.[290] Other proposed export LNG plants are currently going through permit process; there is only one export facility in Alaska, which will be mothballed soon.[291]

The United States returns to being the second largest gas producer behind Russia throughout 2035.[292] Similar to the EIA, the IEA acknowledges that recent advancements of drilling techniques, namely hydraulic fracturing, have allowed the US to exploit unconventional resources. However, this has also put the United States in the spotlight for unforeseen consequences, namely environmental impacts.[293] Unconventional resources have allowed the United States to become more responsive to fluctuations in demand, which helps maintain a regional equilibrium (as mentioned in the North America section).[294] IEA throws the idea out there that investment in natural gas vehicles or GTL projects may become competitive due to the depressed price of natural gas in the United States.[295]

[288] Ibid.
[289] Ibid.
[290] Ibid, p. 58
[291] Ibid, p. 51
[292] IEA, "World Energy Outlook 2011" p. 163
[293] Ibid, p. 164
[294] Ibid, p. 169
[295] Ibid.

BP projects the United States to see 11-12% increase in global natural gas growth.[296] BP also projects that the United States will become a net exporter by 2030.[297] They provide very little information on natural gas production.

ExxonMobil's baseline scenario projects that unconventional natural gas production in the United States will meet demand for the foreseeable future.[298] NGL's production also increases due to recent technology advances in shale drilling.[299] Each survey foresees conventional gas in the United States declining, but the decline is more than offset by unconventional production. ExxonMobil believes economics of unconventional resources is the difference maker.[300]

Canada

In Canada, unconventional natural gas accounts for 50% of total domestic production by 2035.[301] On average, Canada's natural gas production grows at 1.5% per year, from 6.0 trillion cubic feet in 2008 to 9.0 trillion cubic feet in 2035.[302] Similarly to the United States, Canada sees immense growth from shale gas. According to Canada's National Energy Board, Canada produced 4 billion cubic feet in 2008, but has the potential to reach 169 billion cubic feet by 2012.[303] Furthermore there have been three proposed LNG export facilities that would require 1.3 trillion cubic feet to supply them, which is the same volume projected to decrease in

[296] BP, "Energy Outlook 2030" p. 31
[297] Ibid, p. 79
[298] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 44
[299] Ibid, p. 42
[300] Ibid, p. 45
[301] DOE/EIA, "International Energy Outlook 2011" p. 3
[302] Ibid, p. 51
[303] Ibid.

exports being pipelined to the United States.[304] CBM and tight gas are also quite substantial in Canada.[305] Canada has an operating LNG export facility with several others under the review stage. Canada has the potential to have a significant LNG exports to Asian markets.[306]

The IEA acknowledges that Canadian gas production could lead to trans-Pacific LNG trade. Mainly due to the price of natural gas being quite higher abroad, but does not suggest that North America will have a major role in global gas trade.[307]

Mexico

The EIA is projecting flat production of natural gas in Mexico, gaining merely 0.4 trillion cubic feet to a total of 2.1 trillion cubic feet by 2035.[308] As in the oil / liquids section, Mexico faces difficulties in securing investments and lacks the technology needed to increase production. For example, part of a very productive U.S. shale play runs into Mexico, the Eagle Ford shale.[309] Nonetheless, Mexico continues to import natural gas from the United States, currently at 15.7% of total demand.[310] Mexico also imports LNG mainly on its eastern coast. The west coast terminals have been used infrequently.[311]

Chile

The EIA estimates that Chile produced a meek 66 billion cubic feet of natural gas in 2008. Until recently, Chile relied extensively on Argentina for its natural gas demand. In 2004, Argentina had to limit gas supply for export because they couldn't meet domestic demand due

[304] Ibid.
[305] Ibid.
[306] Ibid, p. 58
[307] IEA, "World Energy Outlook 2011" p. 169
[308] DOE/EIA, "International Energy Outlook 2011" p. 51
[309] Ibid.
[310] Ibid, p. 58
[311] Ibid.

to bad policy practice.[312] Chile moved away from dependence on Argentina and built two LNG import facilities and another one is slated to be completed in 2013.[313] These plants have helped Chile reach energy security.

Concerns

According to the IEA, a variety of factors must come together in order for unconventional to have meaning production: "suitable geology, public acceptance, well-adapted regulatory and fiscal regimes, and widespread access to experience and technology".[314] ExxonMobil states that shale drilling via hydraulic fracturing "will depend on industry, government and local communities working together to build a better understanding of the potential benefits from shale gas, as well as proven practices used to protect air and water quality, while minimizing other environmental impact".[315]

Table 8: Natural Gas Production Summary

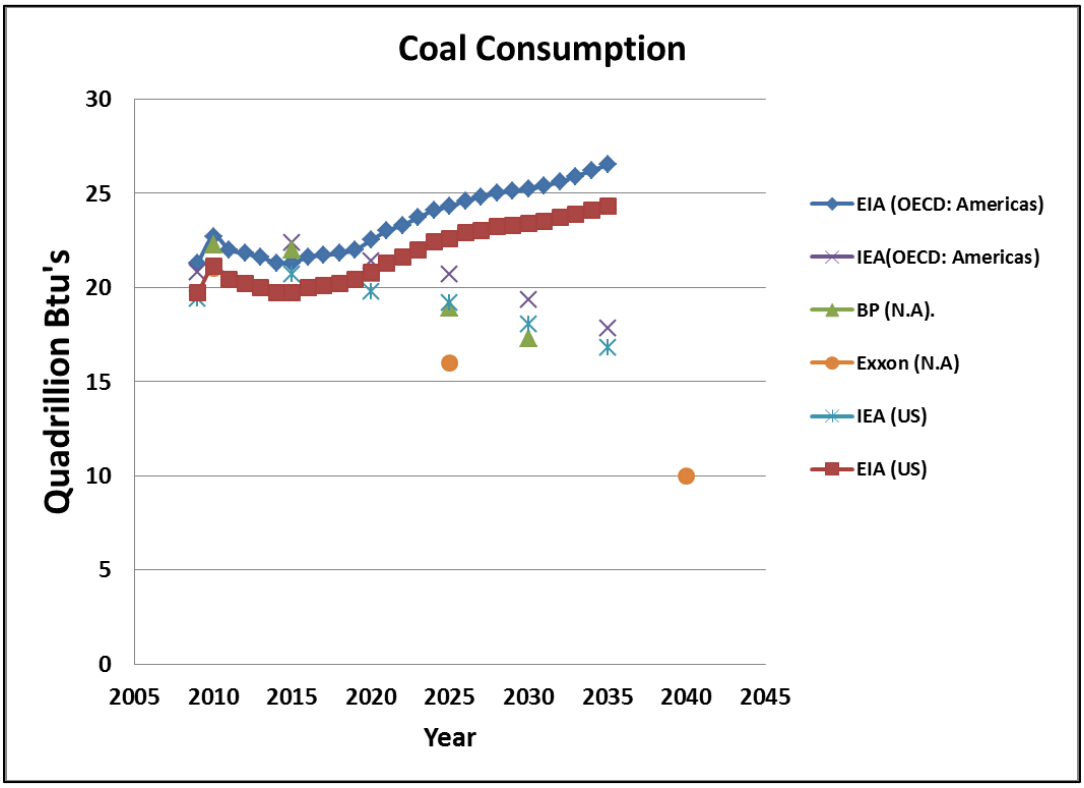
Survey	Means of Production	Conclusion	Time Frame
EIA	US: Substantial production from shale gas coupled with increases in CBM, offshore and tight-gas. Canada and Mexico will predominately see increase in unconventional plays. Together unconventional gas increases fivefold over decling conventional production. Canada will continue to be a net exporter. Mexico has flat production and Chile relies on imports	Increase	2035
IEA	Unconventional expected to increase steadily. Regulations, public acceptance, investment, and environmental impact may hinder growth. US LNG export potential, but will not be significant globally. US production matches consumption	Increase	2035
BP	Increase primarily from shale gas, modest increase in CBM and tight-gas; these gains more than offset the declining conventional plays. Potential for LNG export.	Increase	2030
Exxon	Conventional gas declines in the US, but is offset by unconventional (given that its economical to produce). Provide amble supplies for the forseeable future. Supply will set demand	Increase	2040

[312] Ibid, p. 59
[313] Ibid.
[314] IEA, "World Energy Outlook 2011" p. 163
[315] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 45

Coal

Coal Consumption

Graph 8[316]



Macro

The IEA is projecting that many OECD countries will experience a decline in coal demand due to the progression of policies that reduce carbon-intensive fuels, particularly after 2020. By 2035, OECD countries will consume 22% less coal than in 2009.[317] The IEA is forecasting that thermal efficiency of plants will increase due to increased price of coal. Thermal efficiency is

[316] Data from IEA, EIA, BP, and ExxonMobil outlooks; see work cited
[317] IEA, "World Energy Outlook 2011" p. 83

projected to rise 4%, from 38% in 2009 to 42% by 2035.[318] CCS technology is limited until the end of the period, where it will be deployed in regions with carbon prices.[319]

In the United States the IEA notes that one-fifth of primary energy consumption comes from coal, due to relatively low cost and abundance of source (exports a lot).[320] Coal demand declines, but less than expected than last year's IEA outlook. As stated in the natural gas section, the lack of a carbon price provides no incentive for coal-powered plants to move away from coal-fired generation.[321] However, the prospects of a carbon price cause a shadow price to emerge in 2015, which will stabilize coal demand and cause a 3% decline from 2009 to 2035.[322]

ExxonMobil, similar to the IEA, foresees emerging policies curbing carbon-intensive fuels that will dampen coal demand over the outlook to such an extent that gas becomes the second most widely used fuel.[323] ExxonMobil believes that coal becomes uneconomical with a direct or indirect cost of CO2. Exxon is projecting a price of CO2 by 2030 to be $60 per ton, which according to ExxonMobil would make coal more expensive than natural gas, nuclear, and onshore wind power.[324] ExxonMobil is also projecting a minute increase in coal with CCS technology by 2040.[325]

[318] Ibid, p. 181
[319] Ibid, p. 182
[320] Ibid, p. 190
[321] Ibid, p. 83
[322] Ibid, p. 180
[323] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 1
[324] Ibid, p. 29
[325] Ibid, p. 30

ExxonMobil is predicting that in the OECD residential and commercial sectors, coal use continues to decline through 2040.[326] Coal demand is also projected to decline within the OECD industrial sector due to efficiency gains and a switch to less energy-intensive industries.[327]

BP's outlook to 2030 projects an increase in non-OECD coal demand and OECD to decline.[328] Overall demand begins to decline as coal is replaced by natural gas and non-fossil fuels.[329] BP believes changes in fuel prices, policy (in favor of less carbon-intensive fuels), and technology will shift power generation away from coal and towards renewables.[330] The OECD coal consumption declines at 1.1% per year throughout the projection period, but this is offset by the increase in demand in non-OECD, 2.1% per year increase. BP alludes to the fact that their projected decline in the OECD, could lead to opportunities to export coal to China and India as both countries face difficulties in meeting domestic demand.[331] Note that BP discussion focused on OECD and non-OECD regions, which is because they do not provide discussion on North America or the United States.

Power generation

Coal use in the United States was 22.4 Quadrillion Btu's in 2008, which made up 92% of coal use in the OECD Americas and 48% of the OECD.[332] The EIA projects United States coal demand to increase to 24.3 Quadrillion Btu's by 2035. Consumption increases by 0.3% per year from 2008 to 2035 due to an increase in demand for coal in electricity generation at existing coal-fired power plants, several new plants being built, and at CTL plants that are projected to

[326] Ibid, p. 14
[327] Ibid, p. 25
[328] BP, "Energy Outlook 2030" p. 10-12
[329] Ibid.
[330] Ibid, p. 13
[331] Ibid, p. 37
[332] DOE/EIA, "International Energy Outlook 2011" p. 69

be built at the end of the period.[333] However, coal demand within the United States for power generation (industrial and commercial sectors included) declines in sector share from 48% to 43% by 2035.[334] The increasing costs of coal-fired plants and low natural gas prices in the short term, leads to displacement of coal demand.[335]

In 2009, 90% of coal demand in the United States came from the power generation sector, but environmental concerns locally and greenhouse gas emissions are expected to harshly constrain demand.[336] The IEA believes coal demand in the United States has peaked in 2005. By 2035, the IEA projects coal demand to be down 25% from 2005 levels.[337] New coal-fired plants come on-line for power generations within the decade, mainly due to it being the "cheapest" option, but natural gas is gaining ground.[338] Coal faces tremendous public opposition, due to air quality standards. In the long coal will see competition from renewables and nuclear, that has government support, and natural gas.[339] (The IEA's main scenario, factors in a price of carbon in 2015 at $15 /tonne ($2010) and in 2035 at $35/tonne).[340] Over the outlook natural gas replaces coal because it is cheaper (nuclear and renewables replaces coal as well), which is a result from its abundance and price of carbon. Coal falls from 45% of power generation in 2009 to 35% in 2035, which would be lower without projections of coal plants with CCS.[341]

[333] Ibid, p. 70
[334] Ibid, p. 69
[335] Ibid, p. 70
[336] IEA, "World Energy Outlook 2011" p. 390
[337] Ibid, p. 391
[338] Ibid.
[339] Ibid.
[340] Ibid.
[341] Ibid.

In the OECD, in particular the United States and Europe, coal demand declines within the electricity sector due to efficiency gains and a switch to less carbon-intensive fuels (due to environmental policies), such as natural gas, nuclear and renewables.[342] In the United States, natural gas production becomes competitive with coal, especially in power generation. Coal is projected to decline in the wake of abundance of natural gas and projected policies that impose a carbon cost on fuels.[343] The United States has already begun to shift from coal to less-carbon intensive fuels, such as natural gas.[344]

The EIA projects that Canadian consumption declines by 0.2 Quadrillion Btu's from 2008 to 2035, due to Ontario's government plan to phase out the Province's coal-fired plants by the end of 2014.[345] Coal-fired power generation declines 0.6% per year through the end of the outlook.[346] The total decline in coal-fired generation drops from 104 billion kWh to 88 billion kWh in 2035.[347]

In Mexico and Chile the EIA is estimated that coal demand will rise by 0.5 Quadrillion Btu's from 2008 to 2035, due to increasing demand for electricity. Mexico just installed a 0.7-gigawatt new coal-fired power plant in 2010 and Chile is nearing completion of a 1.7-gigawatt power plant.[348] Chile's seeks to diversify their energy resources away from Argentina, as noted in the "Natural Gas" section above, and increase production of electricity to meet demand.[349]

[342] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 28-30
[343] Ibid, p. 44
[344] Ibid, p. 1
[345] DOE/EIA, "International Energy Outlook 2011" p. 70
[346] Ibid, p. 92
[347] Ibid.
[348] Ibid, p. 70
[349] Ibid.

Industry

The IEA notes that traditional use of coal in industry declines in the United States. That is, coal use for steam generation and coke production for iron and steel fabrication, due to efficiency measures that reduce the need for processed steam, expected declines in smelting, and an increase in electric-arc furnaces that reduces coking needs.[350] Demand within the industrial sector is expected to decrease by 10% from 2009 to 2035.[351]

The EIA projects that the United States demand in industrial use increases from 1.8 Quadrillion Btu's in 2009 to 2.6 Quadrillion Btu's by 2035.[352] As mentioned in the "Natural Gas" section, the Energy Policy Act of 2005 and Energy Independence and Security Act of 2007 seek to boost industrial efficiency by 25% and promote incentives for efficiency.[353] The EIA does not provide clear guidance as to why coal increases.

A decrease in industry and power generation within the United States is partially offset by demand for coal used in CTL plants and a need to blend coal with biomass.[354] Currently, there are ten plant proposals, but due to concerns around oil prices and CO2 emissions none have left the drawing board. The IEA is projecting that CTL plants to produce 185,000 b/d of oil products by 2035, up from 0 in 2009.[355]

ExxonMobil's outlook also calls for CTL, GTL, and refinery gains to increase global liquid fuel supply by 5%. Coal plants take around 5 years to go from approval until completion.

[350] IEA, "World Energy Outlook 2011" p. 391
[351] Ibid.
[352] DOE/EIA, "International Energy Outlook 2011" p. 112
[353] Ibid.
[354] IEA, "World Energy Outlook 2011" p. 391
[355] Ibid.

Although new technology can lower the cost of coal plants, public sentiment matters and can stall coal plant production.[356]

Canada's coal demand decreases in industrial use from 0.4 Quadrillion Btu's in 2009 to 0.3 Quadrillion Btu's by 2035.[357] As mentioned in the "Natural Gas" section, Canada's Energy Efficiency Act of 1992 and subsequent legislation seeks industrial efficiency and curbs greenhouse gas emissions.[358] The reduction in emissions also comes from coal being displaced by natural gas. Table 9 below is a summary of coal demand.

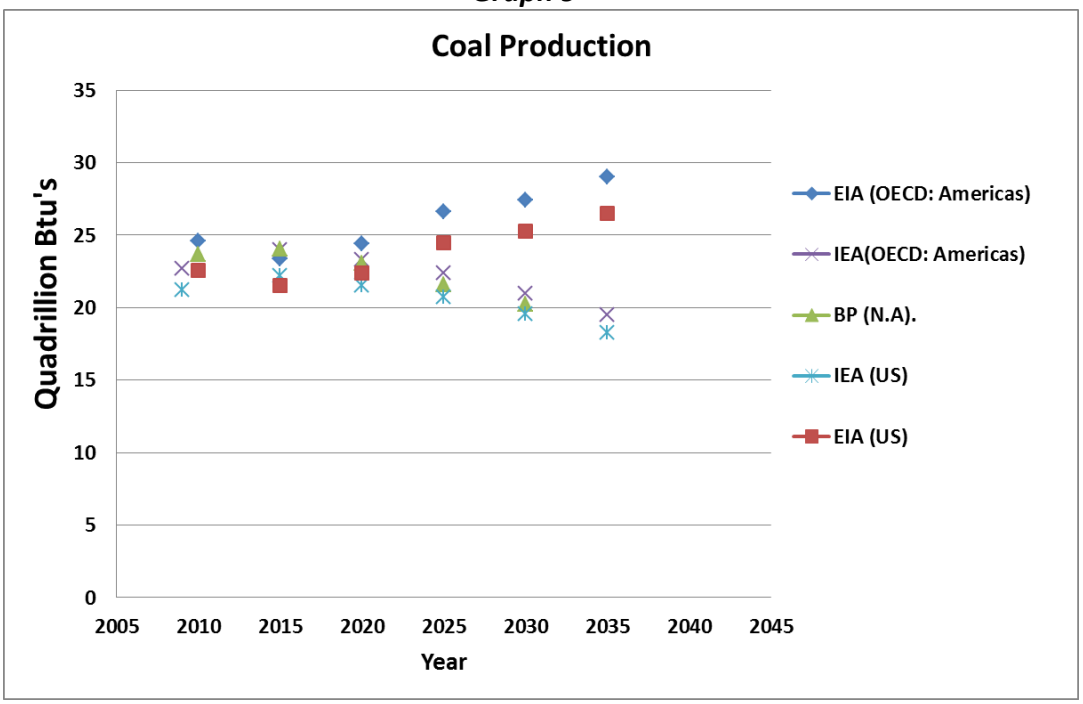
Table 9: Coal Demand Summary

Survey	Power Generation	Industry	Conclusion	Time Frame
EIA	No policy changes: US: coal increases due to current plant construction, although limited by high cost of plants in future. Canada: coal declines because of plants are being shut down in Ontario due to policy measures. Mexico/Chile increase demand due to economic expansion. Chile energy security from Argentina	US: policy curbs emissions, promotes efficiency and security: via the Energy Policy Act of 2005 and Energy Independence and Security Act of 2007. Modest growth in commercial sector, where there is a switch to a service orientation. Growth in CTL at end of projections. Canada: declines due to energy efficiency gains via mandated policies.	Increase	2035
IEA	Coal will decline as policy mandates take effect, which are geared towards environmental benefits and reducing carbon output. US-shadow price of carbon emerges in 2015. There is a switch over to gas, which have lower capital and fuel operating costs. 90% of demand. Renewables and nuclear become viable.	Declines: Coal used for steam and coke production for iron and steel fabrication declines due to energy efficiency gains as well a switch to electric furnaces, demand falls by 10%. CTL: picks up at end of projections due to high price of oil and CO2 penalties: 10 plants have recently been proposed	Decrease	2035
BP	Coal is displaced by gas (as long as it is available at a completive price) and renewables, due to its lower carbon content and local environmental benefits. Policy will dictate the extent of the switch via price of carbon, mandates, installation of low carbon technologies	Declines: did not provide explanation beside lower carbon content	Decrease	2030
Exxon	Coal is displaced by gas: gas is versatile and it has lower carbon emissions, which policy will most likely dictate. The United States also has enormous shale gas reserves. Gas plants are 60% efficient, coal plants are 40%.	Declines overall: increase in demand is met by gains in energy efficiency and switch to lower carbon fuels. Growth in manufacturing, chemicals, and use to make products and materials. Residential and Commercial declines over all	Decrease	2040

[356] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 31
[357] DOE/EIA, "International Energy Outlook 2011" p. 112
[358] Ibid.

Coal Production

Graph 9[359]



United States

The IEA estimates that hard and brown coal reserves in US are estimated to last 265 years, at 2009 production levels.[360] The United States has around a quarter of the world's reserves.[361] The IEA defines coal reserves as coal that is known in detail and can be recovered economically, using modern technology.[362] Within the United States, environmental policies will be key to the projections of coal production. These policies will dictate access to resources, air pollution standards, carbon emission levels, and the cost of complying with regulations aimed at minimizing damages and risks associated with mining.[363] These regulations will severly damped coal demand across various sectors within the United States. However, coal producers

[359] Data from IEA, EIA, and BP outlooks; see work cited
[360] IEA, "World Energy Outlook 2011" p. 430
[361] Ibid.
[362] Ibid, p. 403
[363] Ibid, p. 430

will increasingly look to increase sales by exporting coal to make up for domestic loss in sales.[364] Several projects are currently being designed that would boost export capacity, for example the Asia-focuses Gateway Pacific Terminal in Washington.[365] Due to a strong global demand of coal, the IEA projects coal exports are expected to grow from 32 Million tons coal equivalent (Mtce) in 2009 to 53 Mtce by 2035.[366]

Nonetheless, the IEA expects coal production to decline in the United States by 0.6% per year until 2035.[367] The fall is production is attributed to weak domestic coal demand, which is due to the fact that a shadow price of carbon attracts non-carbon intensive fuels such as renewables and low-cost natural-gas in power generation.[368] Furthermore, the United States does have an abundance of coal, but it is rather costly to extract, transport to market, especially along the east coast. The Appalachian coal is rather costly to extract because it requires large underground mines or mountaintop removal, which permits for have recently been frozen.[369] Western United States production is cheaper and the IEA projects that CTL plants may be built to take advantage of the high price of oil.[370]

The EIA estimates that the United States reserves to production ratio of 222.3 years, measured by 2008 consumption level.[371] Regardless of reserves, the EIA projects that the United States coal imports will rise through 2035, which is contrary to the other three

[364] Ibid.
[365] Ibid.
[366] Ibid, p. 431
[367] Ibid, p. 430
[368] Ibid.
[369] Ibid, p. 431
[370] Ibid.
[371] DOE/EIA, "International Energy Outlook 2011" p. 80

surveys.[372] The East Coast of the United States is projected to have production declines, but contrary to other surveys, the EIA is anticipating that imports are needed to meet demand.[373] On the West Coast, coal exports have the potential to rise, due to increased Asian demand. West Coast terminals have seen environmental protests and permitting issues have caused delays in those projects.[374] Furthermore, the expansion of the Panama Canal could improve the United States position in coal export market, but it opens the door for competitors as well. Therefore the EIA projects the United States as only a marginal player in the global coal market.[375]

Canada

Most of Canada's imported coal comes from the United States. However the imports are off of historical high and will continue to decline.[376] The EIA notes that Canada will maintain their 10% of international seaborne trade in coking coal through 2035. This is due to the fact that producers in Western Canada have improved productivity.[377] Table 10 below is a summary of coal production.

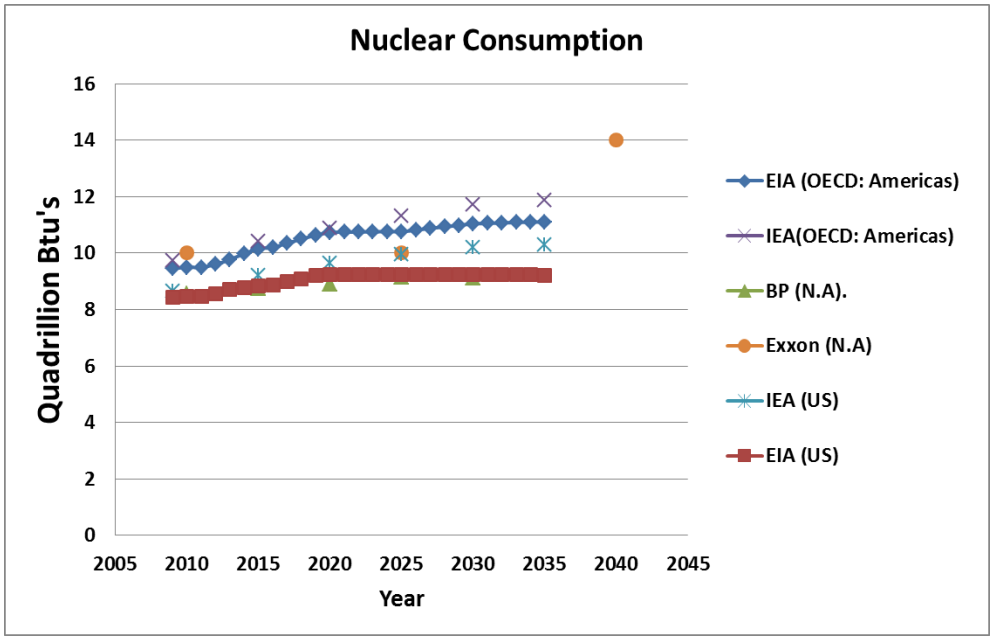
[372] Ibid, p. 77
[373] Ibid.
[374] Ibid, p. 78-79
[375] Ibid.
[376] Ibid, p. 77
[377] Ibid, p. 79

Table 10: Coal Production Summary

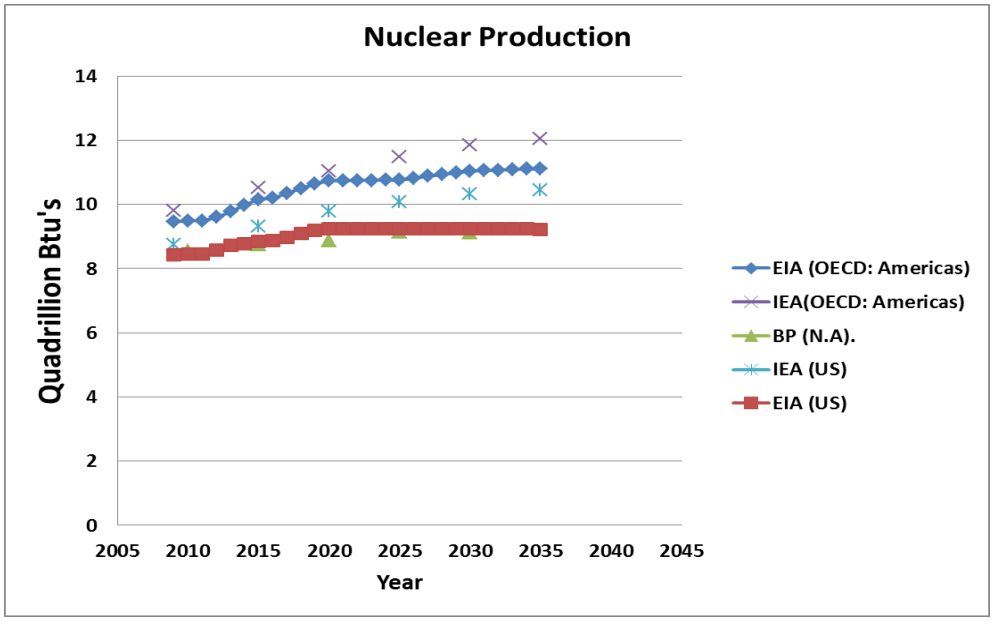
Survey	Means of Production	Conclusion	Time Frame
EIA	US: estimated to have 27% of world reserves, or 222 years at 2008 consumption level. Coal imports will increase due to high costs associated with extracting coal, specifically along the east coast. Exports will rise as well due to increased Non-OECD demand, but US is at disadvantage (exports facilities are on East coast, West coast would be more direct access to China). Ports have been proposed, but environmental protests and permit process have caused delays. Canada: imports from US will drop due to government mandates. West coast ports will continue to export, mainly coking coal, making up 10% of world market through 2035. Mexico / Chile: insignificant	Increase	2035
IEA	US: estimated to have 25% (or 269 years at 2009 consumption levels) of world reserves (which is based of economic of recovering coal). Policy will inhibit growth by adding costs associated with environmental damage and stricter regulations. Extraction in the US is costly, but high prices have made it economical. The recent decline domestically, due to high price and carbon restriction, are given mining companies the opportunity to export, where they is demand, especially in Asia and India. Canadian exports are expected to increase until 2020 than stabilize. Freeze in permits in the Appalachian region, where mountain top removal was taking place. Western US, has opencast coal mines, which are easier to extract. CTL plants are expected to built there later in the projections. CCS technology development may reverse the declining trend	Decrease	2035
BP	N/A	Decrease	2030
Exxon	N/A	Decrease	2040

Nuclear

Graph 10[378]



Graph 11[379]



Note difference: IEA provides slightly higher numbers for production than consumption and ExxonMobil does not provide production data.

[378] Data from IEA, EIA, BP, and ExxonMobil outlooks; see work cited
[379] Data from IEA, EIA, and BP outlooks; see work cited

March 11, 20011 a devastating earthquake and tsunami had struck the northeastern region of Japan. The natural disaster had severely damaged Japans infrastructure, especially several nuclear reactors at Fukushima Daiichi.[380] The effects were not contained to the island of Japan; the disaster at the nuclear reactors had global implications for the nuclear industry.

Macro

The IEA projects that in the OECD nuclear power is expected to increase by 53-gigawatts, reaching 380-gigawatts by 2035.[381] From 2009 to 2035, nuclear power is projected to increase 23%.[382] In the OECD, 60% of the added capacity comes at the expense of retiring nuclear plants and capacity only increase 16%.[383] Globally, at current consumption rates the reserves of uranium (nuclear fuel source) are proven to last well beyond 2035.[384] A price of carbon would encourage investment in renewables or nuclear.[385] By 2020 the IEA suggests that the levelised cost of nuclear power electricity will be the cheapest amongst fossil fueled fired generation and wind power if there were a CO2 price of $50 per tonne.[386] The levelised cost is defined as "the cost per unit of electricity generation taking into account all the costs over the lifetime of the asset, including construction, operation and maintenance, fuel inputs and the cost of capital".[387] However, due to increased uncertainty, financing may become more difficult to secure; capital costs for nuclear projects are up 5-10% from last year's projections.[388] Nonetheless, nuclear power still plays a major role in providing baseload capacity.[389]

[380] DOE/EIA, "International Energy Outlook 2011" p. 1
[381] IEA, "World Energy Outlook 2011" p. 79
[382] Ibid, p. 83
[383] Ibid, p. 183
[384] Ibid, p. 191
[385] Ibid, p. 179
[386] Ibid, p. 180
[387] Ibid, p.
[388] Ibid, p. 183
[389] Ibid.

In the OECD Americas the EIA projects nuclear generating capacity to increase by approximately 20-gigawatts.[390] Globally, the nuclear power industry still faces uncertainty around plant safety, radioactive waste disposal, and proliferation of nuclear materials that raise public concern.[391] Nuclear power also has high capital and maintenance costs as well as a need for highly skilled labor.[392]

BP, similar to the IEA and EIA, provides a macro view on nuclear. BP notes that nuclear, hydro, and other renewables together account for the same percentage of coal in global electricity demand.[393] In the OECD nuclear power remains relatively flat.[394] BP believes nuclear power was set back by the disaster at Fukushima. BP projects that nuclear will reach its pre-Fukushima levels by 2020 and with only moderate growth to 2030.[395] Nuclear consumption has been considerably marked down compared to their last outlook, but they point out that it's mainly to due EU Europe and Japan.[396]

Similar to BP, ExxonMobil provides a mostly macro analysis of nuclear role in the future. On a global level, coal declines in part due to emerging policies that seek to curb carbon-intensive fuel and the use of renewables and nuclear power grows significantly.[397] Nuclear grows at a slower pace globally than in their previous projections that were before the incident at Fukushima.[398] To be exact, ExxonMobil cut the growth rate by 0.5% year over year

[390] DOE/EIA, "International Energy Outlook 2011" p. 5
[391] Ibid, p. 4
[392] Ibid.
[393] BP, "Energy Outlook 2030" p. 17
[394] Ibid, p. 38
[395] Ibid, p. 39
[396] Ibid, p. 84
[397] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 1
[398] Ibid, p. 8

globally.[399] Coal and nuclear power plants are only 40% efficient at most, where new natural gas plants are 60%. Electricity generation sees a fuel switch to less-carbon intensive energy, such as natural gas, renewables, and nuclear.[400] However due to the intermittence of renewables, nuclear will be able to provide baseload capacity.[401] According to ExxonMobil, if there was a direct cost of CO2 in the United States of $60 per ton in 2030, nuclear power would have the second lowest cost of electricity, behind onshore wind.[402]

United States

According to the EIA's outlook, "the United States Title XVII of the Energy Policy Act of 2005 authorizes the United States Department of Energy to issue loan guarantees for innovative technologies that [avoid, reduce, or sequester greenhouse gases]. In addition, subsequent legislation provisions in the Consolidated Appropriation Act of 2008 allocated $18.5 billion in guarantees for Nuclear power plants".[403] The EIA estimates that it is equivalent to 10-gigawatts of power capacity.[404] In the EIA's baseline scenario, all U.S. nuclear units operate through 2035.[405]

The IEA's outlook for the United States has declined since the previous year's outlook, due to a lack of availability of policy support and the Fukushima effect.[406、407]

ExxonMobil provides a chart that shows nuclear power grows in the United States toward the end of the outlook, 2040.[408] This is driven by the fact that they are assuming a direct

[399] Ibid, p. 29
[400] Ibid, p. 26
[401] Ibid, p. 15
[402] Ibid, p. 29
[403] DOE/EIA, "International Energy Outlook 2011" p. 13
[404] Ibid.
[405] Ibid.
[406] IEA, "World Energy Outlook 2011" p. 83
[407] Ibid, p. 86

or indirect cost of CO2 at $80 per ton, where governments will set policies that indirectly or directly due this. However, ExxonMobil highlights that consumer sentiment and technology may hold back development of nuclear power.[409] They barely cover nuclear in their outlook.

Canada

Nuclear power generation is expected to increase at 2.2% per year according to the EIA. As mentioned in previous sectors, several coal-plants are being retired, thus they are planning to partially replace them with less-carbon intensive nuclear power.[410]

Other

The EIA states that their nuclear power projections are based on short term and long term analysis. In the short term (2010-2020) projections are based off of current activities of the nuclear industry and the government; thus it is relatively easy to establish what plants will come online in short term, due to long the permitting process.[411] The long term (2020-2035) projections are based off of announced plans, goals of each country and regional level, and other issues such as economics, geopolitics, technology advances, environmental policy, supply chain issues and uranium availability.[412]

The EIA's projections "do not reflect the possible ramifications of Fuskushima for the long-term global development of nuclear power or the policies that some countries have already adopted in its aftermath with respect to the continued operations of existing nuclear plants".[413] Table 11 provides a summary of nuclear energy demand.

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[408] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 30
[409] Ibid, p. 31
[410] DOE/EIA, "International Energy Outlook 2011" p. 92
[411] Ibid, p. 88
[412] Ibid.
[413] Ibid, p. 1

Table 11: Nuclear Demand Summary

Survey	Power Generation	Conclusion	Time Frame
EIA	US: appears to remain flat, did not give reasons. Canada: government plans to retire coal plants and replace them partially with nuclear plants; nuclear output projected to increase 2.2% /yr (Canada).	Increase	2035
IEA	OECD is expected to see a 60% increase - did not provide detailed information on North America. By 2020, the levelised cost per unit of electricity generation will be cheaper than coal, gas, and renewables if there is a $30/tonne price on CO2. Critical in providing baseload power.	Increase	2035
BP	No North America explanation. Globally: Increases marginally, reverts back to 1990 levels. 10% of global energy mix.	Slight Increase	2030
Exxon	Will grow sharply, due to cut back in coal. US shifts away from coal to less carbon intensive fuels. Provides diversity amongst fuel generation, increasing energy security.	Large Increase	2040

Renewables

Macro

The EIA states that renewables have "positive environment and energy security attributes, but most renewable technologies other than hydroelectricity are not able to compete economically with fossil fuels through 2035, except in a few niche markets".[414] For example, solar can be "economical where electricity prices are high, peak load pricing occurs, or where government incentives are available".[415] That being said, the EIA recognizes that government policies and incentives generally allow renewables be economical to produce.[416] The downsides to renewables are their intermittency and storage concerns.[417] The EIA does not include off-grid solar PV and non-commercial bio-mass are not included in projections.[418]

[414] Ibid, p. 88
[415] Ibid.
[416] Ibid.
[417] Ibid, p. 90
[418] Ibid, p. 89

Globally, the IEA is projecting that modern renewables will have the most growth, but in terms of total demand they still do not equal the demand of one fossil fuel. Modern renewables include: wind, solar, geothermal, marina, modern biomass, and hydro.[419] The percentage of total global energy demand from renewables led by solar and wind increases from 7% in 2009 to 14% in 2030.[420] Non-hydro renewables are bolstered by annual subsidies, which are projected to rise fivefold globally.[421] Furthermore, the decrease in oil and coal-fired electricity leads to increase market share for renewables. Non-hydro renewable generation increases from 3% in 2009 to 15% in 2035, with the majority of gains coming from wind, biomass, and solar PV.[422]

BP's outlook suggests that renewables will be the fastest growing fuel sources (they include biofuels) which are expected to grow at 8.2% per year from 2010 to 2030.[423] Renewables consumption increases in both the OECD and non-OECD. Globally, renewables, nuclear and hydro consumption together for the first time will be larger than any single fossil fuel consumption.[424] Hydro power continues to grow in the OECD, but is limited by suitable sites.[425] Renewables displace oil in transport and coal in power generation due to policy, price of fuels, and technology innovation.[426] Renewables have been projected to increase at a higher rate than last year's outlook, due to improved predictions for cost structure.[427] BP identifies that renewables are for the most part more costly than other energy sources, although in

[419] IEA, "World Energy Outlook 2011" p. 79
[420] Ibid, p. 42,79
[421] Ibid, p. 42
[422] Ibid, p. 178
[423] BP, "Energy Outlook 2030" p. 11
[424] Ibid, p. 13
[425] Ibid, p. 39
[426] Ibid, p. 13
[427] Ibid, p. 85

certain niche area they have become competitive already. For example, the United States onshore wind is competitive in suitable locations.[428] Furthermore, policy is expected to remain in place and help the industry drive down costs and create new technology. An important constraint on market penetration is the rather large costs associated with policy support of scaling up renewables.[429] Post 2020, the United States and China are expected to be the largest sources of growth within renewables. BP does not mention wind power or geothermal.

Similar to BP, ExxonMobil forecasts growth of renewables in the wake of increased demand for non-carbon intensive fuels.[430] Specifically, renewables increase in electricity generation, but are constrained to their intermittence nature. For example, wind and solar can only operate when the wind is blowing or when the sun is shining.[431]) Global wind, solar and biofuels will account for 4% of global energy demand by 2040, where accelerates the fastest.[432] In the OECD residential and commercial sector, renewables gain a small fraction of total demand due to their ability to improve air quality.[433]

United States

The EIA points out that renewable electricity generation increases in response to requirement in more than half the 50 states for minimum renewable share of electricity or capacity.[434] However, compared to last years' forecast, renewables are 17% lower. This huge drop is due to electricity prices being driven down by the abundance of shale gas and revised

[428] Ibid, p. 41
[429] Ibid.
[430] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 8

[431] Ibid, p. 14-15
[432] Ibid, p. 8
[433] Ibid, p. 14
[434] DOE/EIA, "International Energy Outlook 2011" p. 92

policy and technology assumptions.[435] The total market share of power generation is expected to be 14.3% in 2035, up from 9.7% in 2008.[436] Renewables subsidies are expected to expire in the EIA outlook, thus there is room for renewables to have a larger market share.[437]

Given that oil prices maintain their relatively high price, the EIA projects liquids growth to deteriorate in the industrial sector of the OECD. Oil is displaced by natural gas, electricity, and especially renewables. Renewables grow from 7% to 10% from 2008 to 2035.[438]

The IEA projects that over 75% of wind capacity and 70% of solar PV growth is installed in the United States, Chine, European Union and the India by 2035.[439] The United States is projected to increase onshore wind fivefold to 390 TWh by 2035. Offshore wind becomes economical towards the end the projections period.[440] Solar PV and hydropower are projected to increase from around 3-gigawatts and 40-gigawatts, in 2010 to about 66-gigawatts and 175-gigawatts, respectively, by 2035.[441] Renewables gain a total market share in of 16% in the United States by 2035.[442] The United States will be ripe with policies geared towards promoting renewables: state level support, enhanced CAFE standards, tax credits, and the IEA adds a shadow price of carbon in 2015.[443]

The IEA believes the main divers behind the change in fuel mix are the relative costs influenced by governmental policy and the subsidies provided to renewables. The IEA projects governments will attempt to reduce greenhouse gas emissions and local energy-related

[435] Ibid.
[436] Ibid.
[437] Ibid.
[438] Ibid, p. 108
[439] IEA, "World Energy Outlook 2011" p. 184
[440] Ibid, p. 185
[441] Ibid.
[442] Ibid, p. 179
[443] Ibid, p. 52

pollutants.[444] As mentioned previously, the IEA introduces a shadow carbon price in 2015 for the United States. However, carbon pricing alone will not effect the growth of renewable electricity generation. There are costs associated with linking renewables to the existing infrastructure and adding additional capacity to the grid that have to be realized.[445]

ExxonMobil is projecting that there will be strong growth in renewable power generation, due to a shift away from coal and toward lower carbon –intensive fuels.[446]

In the United States, wind-power will lead in renewable power generation, although it is limited by its intermittency and high cost to install offshore. By 2040, wind power in the US and Europe combined, are estimated to be around 550-gigawatts, which will be around 50% of the world's capacity.[447] ExxonMobil is projecting that the cost of onshore wind-powered electricity by 2030, given there is a $60 / ton on CO2 through either a direct or indirect tax, will be cheaper than any other energy source.[448] Offshore wind is as much as 50% more expensive to produce.[449] (Note: ExxonMobil did not factor in additional transformers or backup capacity into their calculations, which would raise the cost.[450]) If there is no CO2 market, then gas and coal-fired power remains cheaper than onshore wind power.[451] Nonetheless, ExxonMobil is projecting that the quantity of electricity generated by wind power globally will grow more than tenfold by 2040.[452] In the United States, solar photovoltaic and solar thermal are the most expensive regardless of CO2 prices. However, ExxonMobil notes that this generally varies with

[444] Ibid, p. 178
[445] Ibid, p. 179-180
[446] ExxonMobil, "2012 the Outlook for Energy: A View to 2040" p. 28
[447] Ibid.
[448] Ibid, p. 29
[449] Ibid.
[450] Ibid.
[451] Ibid.
[452] Ibid.

size of project; the larger the project, the cheaper the costs involved on the margin.[453] Geothermal is expensive as well, especially if there is not a price for CO2.[454] Technology developments in battery storage for electricity will improve the outlook for wind and solar, in power generation. Battery development could also have a large impact on electric car market.[455]

Biofuels

The EIA plans that in the United States, the price of liquids causes consumption to remain flat and renewable fuels, such as waste and biomass, will meet demand. The EIA is projecting that United States will triple biofuel output by 2035, as the price of oil increases.[456] In 2010, the Canadian government mandated that gasoline require 5% renewable fuel.[457] BP points out that the United States has taken dominate role in the OECD in terms of incentivizing biofuels, from 4% in 2010 to 155 in 2030.[458]

Canada

In Canada, the EIA articulates that in 2008 hydro-electricity made up 60% of total electricity production.[459] They project this percentage to fall to 54% in 2035, but still increases by 0.9% per year.[460] The EIA acknowledges that Canada has plenty of opportunities to build large and small-scale hydro-plants. This is exactly what Ontario's Provincial government plans

[453] Ibid.
[454] Ibid.
[455] Ibid, p. 48
[456] Ibid, p. 34
[457] Ibid, p. 121
[458] BP, "Energy Outlook 2030" p. 41
[459] DOE/EIA, "International Energy Outlook 2011" p. 91
[460] Ibid, p. 93

to do when they shut down their coal plant.[461] Wind power is the fastest growing renewable in Canada, reaching 5% market share of electricity production by 2035. In terms of capacity, wind power increase from 4-gigawatts to 16.6-gagawatts.[462] This is mainly due to federal Canadian support through various programs, such as "ecoENERGY for Renewable Power".[463] There are also several provincial governments that instituted their own incentive programs for wind, such as feed-in-tariffs.[464] The EIA projects continued government support and high fossil fuel prices will keep wind capacity growing in Canada.[465]

Mexico/ Chile

In Mexico and Chile most power generation comes from hydroelectric dams, in total it comes to 85% of the regions renewable energy power generation mix; there are also plans to expand. The second source of power comes from geothermal, at 9%.[466] Mexico currently has two major hydro-plants being built, but one is delayed to 2018. Chile plans to construct several smaller hydro-plants.[467] In terms of wind and solar power, Mexico and Chile have very little capacity. Mexico's government plans to build out wind and solar because they want to cut their emission levels of 2002 in half by 2050.[468]

[461] Ibid.
[462] Ibid.
[463] Ibid.
[464] Ibid.
[465] Ibid.
[466] Ibid.
[467] Ibid.
[468] Ibid.

Discussion & Implications

The models across the four surveys, EIA, IEA, BP, and ExxonMobil, have similarities and distinct differences. The factors at play that cause these similarities and differences are the following: energy projection model, baseline scenario (policy, technology, and energy prices), demographic outlook, economic outlook, energy specific definitions, outlook period, and units used in energy measurement. Initially projections for consumption and production mainly varied due to energy specific definitions, geographic inclusivity, and conversions used to normalize the data into Quadrillion Btu's. However, the most influencing factor across all energy types is scenario assumption, namely policy and technology assumptions. Projections that differ the most, or were most similar, can be generally explained by understanding the policy and technology assumptions behind each survey.

The EIA assumes minimum policy changes and technology innovation. Thus, they are assuming the status quo. The EIA projects consistently higher levels of consumption and production compared to the other surveys in North America and the United States. The implications of not assuming policy changes allows for increasing consumption due to increasing demand from a growing population and an expanding economy. Production was more closely tied to fuel price, which is tied to policy. Policies that curb carbon intensive fuels will increase the price of those fuels either directly or indirectly. The EIA does not recognize a future price of carbon, causing their consumption and production projections of fossil fuels remain elevated compared to the IEA, BP, and ExxonMobil.

The IEA assumes that recently announces policies will be implemented cautiously. Policies will formulate a price of carbon, which is projected to have a profound impact on the

energy markets. These policy changes will cause a change in fuel mix across industries, towards less carbon-intensive fuels. The strength of these policies will dictate consumption level of carbon intensive fuels. The IEA uses a moderate price of carbon compared to the other surveys. The IEA's scenario foresees that technology advances will increase the efficiency levels throughout various industries. The implications of efficiency gains will cause levels of energy demand to flatten, if not decrease (industry specific). In terms of production, the IEA projects levels to be tied to the economics of each energy type. For example, the EIA and the IEA have diverging notions of coal production. This can be explained by the emergence of a direct or indirect cost of carbon. The EIA projects no additional costs, thus production increases, but the IEA foresees a real cost of carbon, thus production decreases in their outlook.

BP and ExxonMobil take a more aggressive approach than the IEA when implementing policy and technology changes in their outlooks. BP and ExxonMobil make assumptions that they see as being most practical throughout their outlook. Similar to the IEA, BP and ExxonMobil foresee a price of carbon emerging in their outlooks. Again, this causes their projections in carbon-intensive fuels to diverge from the EIA's projections. ExxonMobil projections suggest that the price of carbon will severely impact levels of carbon-intensive fuels. For example, ExxonMobil is projecting coal demand in North America to drop at a faster rate than any other survey.

Each energy type, liquids/oil, gas, coal, nuclear, and renewables, has its own story in regards to policy and technology outlook. Liquids/oil consumption will be at the mercy of efficiency gains (technology) and the actual price, which across the board is seen as been elevated due to supply constraints and/or possible price of carbon. The gas market projections

for all four surveys are strikingly similar. In North America and the United States it is clear that the technology exists to tap the large reserves of natural gas in shale formations. Furthermore, gas is not only more efficient, but also dramatically less-carbon intensive than crude oil and coal. The EIA is the only survey that is projecting coal to increase in both production and consumption, which is mainly due to their lack of a carbon price. The nuclear projections are also strikingly similar across surveys. In the wake of Fukushima, nuclear projections have been curtailed from previous outlooks. Public opinion will drive policy in the nuclear industry, as well as technology that enable safe storage or usage of nuclear fuel. Renewable growth will be directly tied to subsidy availability. The EIA projections have subsidies expiring, thus their projections flat line. The IEA's projections foresee the subsidies being reenacted, thus there is abundant growth in renewables.

Policy and technology changes are two main drivers behind the energy markets. Needless to say, markets can be severely impacted by externalities, such as wars or natural disasters. The surveys each have their own strengths and weaknesses. It is important to recognize the main drivers behind each survey and how they differ in terms of starting points.

Conclusion

Through comparing the outlooks qualitatively and quantitatively it is evident that there are tremendous variations in how each organization goes about portraying their projections. The EIA, IEA, BP and ExxonMobil all assume different GDP and demographic outlooks for the United States and North America. Furthermore, these numbers get inputted into their models to turn out data based upon varying scenarios. Each organization has a baseline scenario that they highlight throughout their outlook document. The scenarios vary in scope and detail due to the goals of each organizations outlook. It's important to recognize all of the differences between the surveys before comparing them. To name a few, there are difference in outlook time line, energy definitions, geographical distinctions, energy units, policy/technology assumptions, and many more. In order to compare the surveys, it is crucial to normalize the data and explain how each organization operates and defines the variables in their survey.

Whether it's the EIA, IEA, BP, or ExxonMobil, one thing is for certain. That is, according to their mission statements for their outlook, they all want to promote the discussion of global energy usage. Since all of these outlooks vary tremendously in dozens of ways, there is room to create a standardized outlook for energy forecasts. This would not only increase clarity of what the documents are portraying, but would allow for better discussion and understanding of energy consumption and production. If discussion and policymaking are truly the goal of these documents, then coordinating to make a standard template with set units and metric would do justice to their goal. This could be done externally as well, which hopefully this study can aid you along the way.

Appendix A

Conversions Used

$$\frac{Millon\ barrels}{day} \times \frac{365\ days}{1\ year} \times \frac{1\ Millon\ tonnes\ oil\ equivalent}{7.33\ per\ million\ barrel\ s} \times \frac{40{,}000{,}000\ Mbtu}{1\ Mtoe} \times \frac{1\ Quadrillion\ \ Btu}{10^9 Mbtu}$$

- 40,000,000 Mbtu per Mtoe is an estimate. Some outlooks were precise and others were not, thus I used 40,000,000 for all outlooks.

$$\frac{Billions\ \ of\ Cubic\ \ Meters}{1} \times \frac{1{,}000{,}000{,}000\ Cubic\ \ Meters}{1\ Bcm} \times \frac{36267.9662\ Btu}{1\ Cubic\ \ meter} \times \frac{1\ Mbtu}{10^6 Btu} \times \frac{1\ Quadrillion\ \ Btu}{10^9 Mbtu}$$

- 1027 Btu's per Cubic Foot; used to estimated natural gas energy

$$\frac{Million\ \ Short\ \ Tons}{1} \times \frac{1{,}000{,}000\ Short\ \ Ton}{1\ Million\ \ Short\ \ Ton} \times \frac{19{,}953{,}000\ Btu}{1\ Short\ \ Ton} \times \frac{1\ Mbtu}{10^6 Btu} \times \frac{1\ Quadrillion\ \ Btu}{10^9 Mbtu}$$

$$\frac{Million\ \ Tonnes\ \ Coal\ \ Equivalent}{1} \times \frac{0.7\ Million\ \ Tonnes\ \ Oil\ \ Equivalent}{1\ Million\ \ Tonnes\ \ Coal\ \ Equivalent} \times \frac{40{,}000{,}000\ Mbtu}{1\ Mtoe} \times \frac{1\ Quadrillion\ \ Btu}{10^9 Mbtu}$$

- Coal varies in energy content, thus this is a rough estimate

$$\frac{Billion\ \ Kilowatt\ hours}{1} \times \frac{1{,}000{,}000{,}000\ Kilowatt\ hours}{1\ Billion\ \ Kilowatt\ hours} \times \frac{10{,}542\ Btu}{1\ Kwh} \times \frac{1\ Mbtu}{10^6 Btu} \times \frac{1\ Quadrillion\ \ Btu}{10^9 Mbtu}$$

- Btu's per Kwh was taken from EIA website, which states it was 2010's average heat rate
- Terawatt-hour is equivalent to a Billion Kwh's

Work Cited

BP. "About Energy Outlook 2030." N.p., Jan. 2012. Web. 5 Mar. 2012. <http://www.bp.com/sectiongenericarticle800.do?categoryId=9037134&contentId=7068677>.

BP. "BP at a Glance." *About BP*. N.p., 2011. Web. 23 Feb. 2012. <http://www.bp.com/sectiongenericarticle.do?categoryId=3&contentId=2006926>.

BP. "BP Statistical Review of World Energy." N.p., June 2011. Web. 23 Feb. 2012. <http://www.bp.com/liveassets/bp_internet/globalbp/globalbp_uk_english/reports_and_publications/statistical_energy_review_2011/STAGING/local_assets/pdf/statistical_review_of_world_energy_full_report_2011.pdf>.

BP. "Energy Outlook 2030." N.p., Jan. 2012. Web. 5 Mar. 2012. <http://www.bp.com/liveassets/bp_internet/globalbp/STAGING/global_assets/downloads/O/2012_2030_energy_outlook_booklet.pdf>.

BP. "Energy Outlook 2030 Summary Tables (Excel Document)." *BP*. N.p., 2012. Web. 21 Mar. 2012.<http://www.bp.com/sectiongenericarticle800.do?categoryId=9037134&contentId=7068677>.

BP. "Generating Low Carbon Energy." *About BP*. N.p., 2012. Web. 23 Feb. 2012. <http://www.bp.com/sectiongenericarticle.do?categoryId=3&contentId=2006926>.

BP. "Group Chief Executive's Introduction." N.p., June 2011. Web. 3 Mar. 2012. <http://www.bp.com/sectiongenericarticle800.do?categoryId=9037127&contentId=7068552>.

BP. "Hydrocarbons with Less Carbon." *Non-renewable Sources*. N.p., 2012. Web. 25 Feb. 2012. <http://www.bp.com/sectiongenericarticle.do?categoryId=9021518&contentId=7040019>.

BP. "Regional Definitions." BP, 2012. Web. 25 Feb. 2012. <http://www.bp.com/sectiongenericarticle800.do?categoryId=9037195&contentId=7068673>.

Department Of Energy / Energy Information Administration. "Annual Energy Outlook 2011." 0383(2011): N. pag. Web. 20 Feb. 2012. <http://www.eia.gov/oiaf/aeo/overview.html>.

Department Of Energy / Energy Information Administration. "International Energy Outlook 2011." 0484(2011): N. pag. Web. 25 Jan. 2012. <http://www.eia.gov/forecasts/ieo/pdf/0484%282011%29.pdf>.

Department Of Energy / Energy Information Administration. "Glossary." *US: EIA*. N.p., 2012. Web. 21 Mar. 2012. <http://www.eia.gov/tools/glossary/index.cfm?id=L>.

EIA. "Mission and Overview." *About EIA*. EIA, n.d. Web. 21 Mar. 2012. <http://www.eia.gov/about/mission_overview.cfm>.

ExxonMobil. "2010 Summary Annual Report." N.p., 2010. Web. 15 Mar. 2012. <http://thomson.mobular.net/thomson/7/3184/4448/document_0/XOM_SAR2010.pdf>.

ExxonMobil. "2012 the Outlook for Energy: a View to 2040." ExxonMobil, 2012. Web. 24 Feb. 2012. <http://www.exxonmobil.com/corporate/files/news_pub_eo2012.pdf>.

ExxonMobil. "About Us." *Who We Are*. N.p., n.d. Web. 8 Mar. 2012. <http://www.exxonmobil.com/Corporate/about_who.aspx>.

ExxonMobil. "Advanced Vehicle and Fuel Technology." *Energy And Technology*. N.p., n.d. Web. 15 Mar. 2012. <http://www.exxonmobil.com/Corporate/energy_vehicle.aspx>.

ExxonMobil. "A View to 2040." *Energy And Technology*. N.p., n.d. Web. 15 Mar. 2012. <http://www.exxonmobil.com/Corporate/energy_outlook_view.aspx>.

ExxonMobil. "Producing Energy." *Energy And Technology*. N.p., n.d. Web. 15 Mar. 2012. <http://www.exxonmobil.com/Corporate/energy_production.aspx>.

IEA. "About the IEA." *About IEA*. EIA, 2012. Web. 21 Mar. 2012. <http://www.iea.org/about/index.asp>.

IEA. "World Energy Model - Methodology and Assumptions." IEA, 2011. Web. 15 Mar. 2012. <http://www.worldenergyoutlook.org/docs/weo2011/other/WEO_methodology/WEM_Methodology_WEO2011.pdf>.

International Energy Agency. "World Energy Outlook 2011." *OECD Libraries* (2011): N. pag. Web. 25 Jan. 2012. <http://www.oecd-ilibrary.org/energy/world-energy-outlook-2011_weo-2011-en>.

Investopedia. "Purchasing Power Parity - PPP." *Investopedia*. N.p., 2012. Web. 20 Mar. 2012. <http://www.investopedia.com/terms/p/ppp.asp#axzz1qAHgqf4i>.

Jakobsson, Kristofer, Bengt Soderbergh, Mikael Hook, and Kjell Alekleett. "How Reasonable Are Oil Production Scenarios from Public Agencies." *Energy Policy* 37.11 (2009): 4809-4814. Web. 25 Feb. 2012.

Lightfoot, Douglas H. "Understand the Three Different Scales for Measuring Primary Energy and Avoid Errors." *Energy* 32.8 (2007): 1478-1483. Web. 21 Feb. 2012.

OECD. "About the Organisation for Economic Co-operation and Development (OECD)." *OECD*. OECD, n.d. Web. 20 Feb. 2012. <http://www.oecd.org/pages/0,3417,en_36734052_36734103_1_1_1_1_1,00.html>.

OPEC. "Member Countires." OPEC, 2012. Web. 26 Mar. 2012. <http://www.opec.org/opec_web/en/about_us/25.htm>.

Silberglitt, Richard, Anders Hove, and Peter Shulman. "Analysis of US Energy Scenarios: Meta-scenarios, Pathways, and Policy Implications." *Technological Forecasting and Social Change* 70.4 (2003): 297-315. Web. 10 Feb. 2012.