

ECED 6190: Energy Systems Analysis

Assignment 1: Analysis of hydrocarbon energy supplies

Introduction

In 2016, the world consumed an estimated 13.76 billion tonnes of oil equivalent (or almost 101 billion barrels of oil equivalent at 7.33 barrels per tonne), over 80% of which was supplied from three sources: oil (31.9%), coal (27.1%), and natural gas (22.1%).¹ Relying so heavily on only three hydrocarbon energy sources has a number of implications, including security of supply and long-term environmental impacts.²

This assignment is to examine the past, present, and possible futures of each of these energy sources by considering both production, consumption, and reserves. It introduces different data sources and some basic energy analysis techniques and shows where the majority of the world's hydrocarbon energy sources are located, their vulnerabilities, and where they may come from in the future.

Questions

1. The following questions refer to crude oil:

- a) How is conventional crude oil formed?
- b) List the top fifteen oil-producing countries for the years 1965 and 2018.³
- c) What percentage of world production did each country represent in 1965? In 2018?
- d) Has the membership of the list changed during this time?
- e) Have countries changed position?
- f) Examine the production and reserves for the top five countries listed in 2018. Has production peaked? What happens to reserves over time? What should happen? Does this make sense? (For some insight with respect to oil, see questions 1.k through 1.m.)
- g) How is oil transported?
- h) What percentage of the world's oil is transported between countries? When answering this question for "oil", please consider questions 1.i through 1.o.

Questions 'i' through 'o' are specific to "oil" only:

- i) What is difference, if any, between *conventional* and *unconventional* crude oil? Give examples of each and explain how they are extracted and transported.
- j) How "deep" is *deep* and *ultra-deep* in offshore environments? Give examples of locations where deep and ultra-deep production is occurring.
- k) What is R/P or the reserve-to-production ratio? What factors influence R/P? Use Canadian and Russian Federation production since 1985 as examples.
- l) What are 1P, 2P, and 3P reserves? How do they change over time?
- m) What is *primary*, *secondary*, and *tertiary* recovery? Give examples.
- n) In a refinery, what is *cracking*? What are *processing gains* and how do they occur?
- o) What is a *refined petroleum product*? How are refined products classified? Give three examples.

¹ *Key World Energy Statistics 2018*. Paris : International Energy Agency, 2018

² Although the term "hydrocarbon" usually refers to crude oil and its products and natural gas, it can also refer to coal (as it does in this assignment).

³ If using BP data, *Other Europe and Eurasia* refers to most of the member countries of the former Soviet Union (FSU), consisting of the *Russian Federation*, *Turkmenistan*, and *Uzbekistan*. This starts in 1985.

2. Repeat questions 1a through 1h for coal, starting in 1981 rather than 1965.
3. Repeat questions 1a through 1h for natural gas, starting in 1970 rather than 1965.
4. What is meant by *tonnes of oil-equivalent*? How are tonnes of coal and billions of cubic-feet (Bcf) of natural gas can equal a specific number of Mtoe?
5. To ensure that global mean temperature does not exceed 1.5°C this century, what, according to the IPCC, must happen to global CO₂ emissions? Looking at the IEA's different policy scenarios in WEO 2018, is this likely to occur? What are some of the risks if this target is not met? Explain and justify your answer.⁴

Requirements

Please answer the questions raised in the previous section. Your answers should be supported by an analysis or discussion of the data and citations to relevant material. When answering the questions, please try to organize them in a coherent and systematic fashion. Remember that graphs and charts can simplify conveying this information. All material *must* be properly cited and a bibliography *is* required.

Your assignment must be submitted electronically as a PDF. Non-PDF submissions will *not* be marked.

Dates

Available: 30 September 2019

Due: 25 October 2019 (midnight AST timestamp)

Suggestions

Most of the questions on production and reserves can be answered by obtaining a copy of the most recent BP Statistical Review of World Energy, while future projections of world energy supply and demand supply is available from the Energy Information Administration (EIA) and the International Energy Agency (IEA).

Much of the available data pertains to crude oil (given its importance, this should not be too surprising) and to a lesser extent, natural gas; coal data can be harder to find (why this is should become apparent as you answer the questions).

Finally, if you have any questions or comments regarding the assignment or its requirements, please feel free to contact me.

⁴ The Paris Agreement and the 2017 Emissions Gap Report are potentially useful references. Both are available on line.