

ECED 6190: Energy Systems Analysis

Assignment 2: Analysis of large-scale, non-fossil energy sources

Introduction

There are two large-scale,¹ non-fossil energy sources used for the generation of electricity: nuclear and hydroelectricity.² In 2017, these made up about 7.4% of the world's primary energy supply and were responsible for 26.2% of the world's total electricity supply.³ This assignment considers some of the issues associated with nuclear and hydroelectricity.

Questions

1. A nuclear power reactor is essentially a thermal power station with a nuclear reactor producing steam for the turbines for the generation of electricity.
 - a) What are the differences between the main types of nuclear power reactor?
 - b) Explain how small modular reactors work and what is limiting their adoption.
 - c) Why is reprocessing considered essential by some and an anathema by others?
 - d) Identify and explain some of the non-electric uses of nuclear technology.
2. Of the top ten nuclear-electric producing countries, what percentage of each country's electricity is obtained from nuclear power reactors? List five other countries want to adopt nuclear power. What is hindering this growth? How does Rosatom propose to meet this demand?

What is the R/P of the world's uranium supply (one of nuclear-electric's limiting factors)? List the top five countries with the most significant uranium reserves.

3. With respect to hydroelectricity:
 - a) What are the different types of hydroelectric generation?
 - b) List some of the side-effects associated with hydroelectric facilities.
 - c) Is hydroelectricity seen as a more flexible option than nuclear power?
 - d) What is pumped storage?
4. Of the top ten hydroelectric producing countries, what percentage of the country's electricity is obtained from hydro? Which countries appear to have the best potential for growth in hydroelectricity? What will limit the growth in hydroelectricity? Explain your answers.
5. Anthropogenic climate change is caused in part by emissions from the combustion of fossil energy sources. Ironically, this may have an impact on non-emitting sources such as nuclear and hydroelectricity. Explain, with examples, how climate change could affect, or is currently affecting, nuclear and hydroelectricity.

¹ Sometimes referred to as "utility scale".

² In the Soviet Union and now Russia, nuclear reactors are also used as a source of heat for district heating (also referred to as district energy) and to assist nuclear-powered icebreakers in breaking through ice.

³ World total primary energy supply and electricity generation for 2017 from International Energy Agency, *Key World Energy Statistics 2019*. Copies of KWES 2019 (September 2019 publication date) are available, free of charge, from the IEA.

6. According to IPCC SR1.5, if global temperature rise is to be kept to below 1.5°C this century, global emissions must be halved from present values by 2030.⁴ Approximately how many times larger would the world's nuclear reactor fleet have to grow in order to halve global emissions by 2030? Repeat the question for hydroelectricity. In light of questions 2 and 4, how feasible are either, or a combination, of these events?

Your answers to the above questions must be evidence-based and supported by an analysis or discussion of the data, or both. Remember that graphs and charts can simplify the conveying this information; however, every graph must include an explanation. The assignment must be submitted electronically as a PDF.

Dates

Available: 23 October 2019

Due: 17 November 2019 (time-stamped midnight Atlantic)

Suggestions

The BP Statistical Review of World Energy has information on hydroelectric and nuclear electrical generation, as does the IEA's Key World Energy Statistics. The EIA has good sources of data regarding U.S. nuclear generation; while the IAEA (International Atomic Energy Agency) has information on world uranium supplies and generation (look for the IAEA's Red Book). The Institute for Energy and Environmental Research (IEER, ieer.org) offers another view of nuclear power.

As always, if you have any questions or comments regarding this assignment, please contact me.

⁴ <http://www.ipcc.ch/report/sr15/>