

ECED 6190: Energy Systems Analysis

Assignment 3: Biomass and other renewable energy sources

Introduction

As assignment 2 showed, the expansion of non-fossil energy sources such as nuclear and hydroelectricity may be limited in the future because of a variety of availability, affordability, and acceptability reasons. There are however other non-fossil energy sources, some of which have been used for millennia by humans, principally biomass (both traditional and modern), wind (for mechanical and electrical applications), and solar (for heating and electricity).

The importance of biomass cannot be underemphasized. According to the IEA's New Policies Scenario, in 2017, biomass supplied an estimated 1,384 Mtoe of the world's primary energy demand and will increase to 1,851 Mtoe in 2040. In both years, more than nuclear and hydroelectricity combined. Over the same period, other renewables, principally wind and solar, are projected to increase from about 254 Mtoe to 1,223 Mtoe in the New Policies Scenario.¹

Questions

1. Broadly speaking, biomass for bioenergy can be divided into waste (municipal, post-consumer, and industrial), agricultural, and woody (or simply forest bioenergy).

Give examples of waste for bioenergy and its use. Is the energy content uniform? What are the limits to future supplies of waste?

Give examples of agricultural and woody biomass, the typical yields per hectare (or acre), and the associated bioenergy products produced from each from various locations around the world. What factors (if any) will limit the expansion of the different sources of bioenergy production? Consider all the world's arable land and forest.

What is meant by "modern" biomass and how does it differ from traditional biomass?

Of the top 10 countries using biofuels, what is the fuel used for? Where do they get the biomass from?

2. Of the top ten wind-electric producing countries, what percentage of electricity is obtained from wind?
3. Rank Canada's provincial capitals in terms of their mean daily global insolation (MJ/m^2 or kWh/m^2).² In these cities, how much influence does latitude have on the November-February insolation? Why is this? Why does tilting help increase output?
4. Given that the earth is mostly ocean, why aren't tidal and wave energy more widely used?
5. Explain how wind and biomass could be affected by climate change.

¹ See International Energy Agency *New Policies Scenario* in *IEA World Energy Outlook 2018 Annex A Tables for Scenario Projections*.

² For example, see <http://www.nrcan.gc.ca/18366>. Note that it is necessary to do a *Municipality Search* for different cities. The ratio kWh/kW refers to the number of kilowatt-hours that could be produced per installed kilowatt.

Dates

Available: 15 November 2019

Due: 6 December 2019 (time-stamped midnight Atlantic)

Suggestions

The BP Statistical Review of World Energy has information on biomass and other renewables, 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). There are a number of wind energy associations, including the European Wind Energy Association, British Wind Energy Association, American Wind Energy Association, and CanWEA.

The World Energy Council has research available on biomass and bioenergy, as does the World Bioenergy Association.³ The IEA's WEO 2019 has information on other generation sources.⁴

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

³ <http://www.worldbioenergy.org/>

⁴ WEO 2019 has been ordered. Its arrival will be announced!