Assessing Biomass Availability with Big Data Analytics
Created by Joe Sagues & SBBP team at NCSU

Overview
During this activity students will use Microsoft Excel or Google Sheets to assess biomass resource availability in the United States for the year 2030. In particular, students will construct a Pivot Table in Excel to quickly and efficiently retrieve data from a large, master data set with nearly 80,000 data points! This assignment is designed to be completed individually. Students are encouraged to navigate the pivot table and learn about biomass resources that are of personal interest.

Objectives
Students will
1. Develop knowledge about biomass resource availability in the United States
2. Develop skills relating to data management in Microsoft Excel or Google Sheets, with an emphasis on the utilization of pivot tables

Content Standards
This lesson is appropriate for high school students interested in sustainability and data management and addresses the following Next Generation Science Standards:

North Carolina Essential Standards

Earth/Environmental	EEn.2.2.1, EEn.2.2.2, EEn.2.6.3, EEn.2.8.1, EEn.2.8.4
Biology	Bio.2.2.2
Physical Science	PSc.3.1.2
Chemistry	Chm.2.2.1

Next Generation Science Standards
Grades 9-12, Disciplinary Core Ideas/Practices/Cross-cutting concepts:

Science and Engineering Practices	Developing and Using Models; Analyzing and Interpreting Data; Using Mathematics and Computational Thinking; Obtaining, Evaluating, and Communicating Information
Cross-Cutting Concepts	Patterns; Systems and System Models

Time Requirements
- Topic overview and computer lab: 50-min
- Assignment complete as homework

Materials

- Computer with Microsoft Excel installed or a Google account with access to Google Sheets

Background Information
The data used for this assignment was obtained from the US Department of Energy's 2016 Billion-Ton Report. Please see link below for more information.

https://www.energy.gov/eere/bioenergy/downloads/us-billion-ton-update-biomass-supply-bioenergy-and-bioproducts-industry

This assignment requires the construction of a pivot table in Excel. See links below for tutorials.

Video tutorials:
- Excel
  - https://www.youtube.com/watch?v=73z3iAdG860&t=6s
- Google Sheets
  - https://www.youtube.com/watch?v=aHNPXaQyjEE&t=150s

Preparation
1. Ensure students have access to a computer with an update-to-date version of Microsoft Excel or a Google account with access to Google Sheets
2. Be ready to show students how to construct and work with pivot tables

<u>Lesson Guide:</u>

Introduction (20-min)
1. Provide an overview of the US Department of Energy's 2016 Billion-Ton Study (link below).
   a. https://www.energy.gov/eere/bioenergy/downloads/us-billion-ton-update-biomass-supply-bioenergy-and-bioproducts-industry
2. Explain how this study is helping to advance the US bioeconomy. Emphasize the need for young professionals skilled in data management and interested in sustainability.
3. Explain how young professionals in North Carolina can utilize their data management skills to identify particular biomass resources that have great potential to stimulate the local bioeconomy.
4. Open the "Biomass Resources" file in Excel or Google Sheets and briefly explain the data.
5. Have students open the "Biomass Resources" file.
6. With students watching your screen, slowly assemble a pivot table and briefly explain how it works.

Independent work (15-min)
7. Let students assemble their own pivot tables and explore the data.

Review (10-min)

8. Make a new pivot table to help students who struggled or are confused with how pivot tables work.
9. Explain in detail how to use the pivot table. In particular, show how to sort data in various ways.

Engage (5-min)

10. Show interesting data for your particular county in North Carolina.
11. Ask students what types of companies or institutions might be interested in using this data, and how might they use it?

Assignment

- Students will use the pivot table to answer questions for three hypothetical scenarios.

<u>Answers to Questions in Assignment:</u>

Scenario 1: Biomass Resource Analyst at a Consulting Firm

1. What is the total production of biomass resources in the US?
    a. *884,595,331 dry tons per year*
2. What is North Carolina's ranking in total biomass resource production?
    a. *18th*
3. What is North Carolina's ranking in forest residue production?
    a. *1st*
4. What is North Carolina's ranking in food waste production?
    a. *10th*

Scenario 2: Data Scientist at a Start-Up Company

1. Start-up company
    a. Top three manure producers: Iowa, California, and North Carolina.
    b. Top three manure + municipal solid waste (MSW) producers: California, Texas, and New York. The difference is due to the large human populations of Texas and New York.

Scenario 3: Science Aid to the Governor of North Carolina

1. Two resource types that can be categorized as household waste: food waste and municipal solid waste (MSW)
2. Top 5 producing counties of food waste and municipal solid waste (MSW) in NC: Mecklenburg, Wake, Guilford, Forsyth, and Cumberland

Name _____ **Student Guide**
Date _____

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Background
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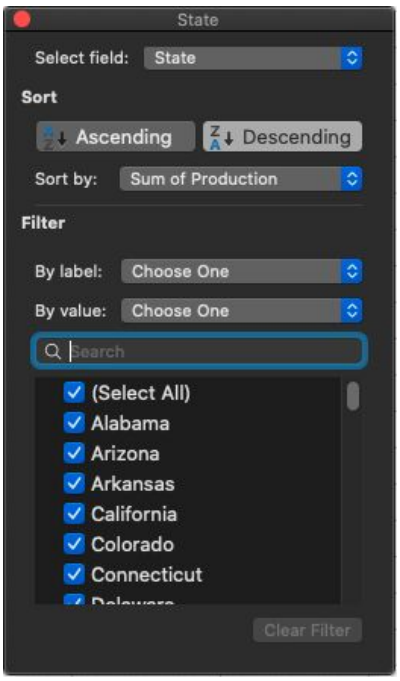
Materials
- Computer with Microsoft Excel installed or a Google account with access to Google Sheets
- Biomass Resource Database

Procedure

Video tutorials:
- Excel
  - https://www.youtube.com/watch?v=73z3iAdG860&t=6s
- Google Sheets
  - https://www.youtube.com/watch?v=aHNPXaQyjEE&t=150s

Written procedure for Excel:
1. Open the Excel file titled "Biomass Resources"
2. Construct a Pivot Table by the following steps:
   a. Click "Insert" on the toolbar, then click "Pivot Table".
   b. Select range of A1:M$78779. This will then open a new worksheet. Rename the new worksheet "Pivot Table".
   c. On the "Pivot Table" worksheet, identify the "Pivot Table Fields" working space (should be on the right of your screen).
   d. In the "Pivot Table Fields", you will see four rectangular areas titled Filters, Columns, Rows, and Values
   e. Drag the following field into the Filters area: Resource Type
   f. Drag the following two fields into the Rows area: State and County
   g. Drag the following field into Values: Production
      i. Once Production is in the Value field, right click on Production, click Field Settings, and select Summarize by Sum
   h. Collapse counties by right clicking on a state (e.g. Alabama) and selecting "Collapse Entire Field"
   i. Sort rows of pivot table by Sum of Production by clicking on the down arrow next to "Row Labels" and selecting "Sum of Production" for both State and County – see figures below.



j. You should now have your pivot table constructed.

Assignment

Scenario 1: Biomass Resource Analyst at a Consulting Firm
A non-profit organization will fund research projects in three states to stimulate the bioeconomy. The non-profit organization is interested in North Carolina, but does not know how it ranks amongst other states. The non-profit organization has hired your consulting firm to assess how the State of North Carolina ranks among other states with regards to biomass resource availability. As a Biomass Resource Analyst in the firm, you must complete the following tasks:

1. Determine the total quantity of biomass resources available in the US.
    a. Include all resource types except conventional. Units are in dry tons per year.
2. North Carolina's ranking in total biomass resource production.
3. North Carolina's ranking in forest residue production.
4. North Carolina's ranking in food waste production.

Scenario 2: Data Scientist at a Start-Up Company
A start-up company has developed a technology to convert manure into biofuel and is looking to construct their first production facility. As a data scientist in the company, you must complete the following tasks:

1. Identify three states that are promising candidates for your technology and explain why.
2. Assume your technology will evolve to convert both manure and municipal solid waste (MSW) to biofuel. As before, identify three states that are promising candidates. Are they different than the original three? If so, why?

Scenario 3: Science Aid to the Governor of North Carolina

The Governor of North Carolina would like to reduce household waste through new educational programs focused on sustainability and recycling. As Science Aid to the Governor, you must complete the following tasks:

1. Define two resource types that can be categorized as household waste.
2. Select 5 counties the Governor should prioritize in implementing new educational programs and explain your decision.