# INSIDE OREGON'S FORESTS

## A high school forestry curriculum

# ECONOMIC IMPORTANCE OF OREGON'S FORESTS

1: Oregon's Forest Economy
2: Oregon's Wood Products
3: Biomass Energy from Oregon's Forests
4: Forestry Careers – Find Your Path

Oregon Forest Resources Institute

## Introduction

*Inside Oregon's Forests* is a high school curriculum developed by the Oregon Forest Resources Institute (OFRI) to help students build a deep understanding of Oregon's forests. The seven modules are loosely organized around topics and concepts from the *Oregon Forest Literacy Plan*, a forest-education conceptual framework developed by OFRI and available at learnforests.org.

### Curriculum Goals and Objectives

The overall goal of this curriculum is to provide engaging, standards-based lessons that help high school students understand the environmental, economic and social importance of Oregon's forests, as well as the principles behind forest management. Through the lessons, students will be able to:

- explain basic tree biology
- identify the forest types in Oregon
- describe the environmental, economic and social benefits Oregon's forests provide
- explain scientific and economic principles involved in managing Oregon's forests
- describe current issues facing Oregon's forests
- identify actions they can take to help ensure the sustainability of our forests

### Curriculum Overview

Following is a description, as well as a suggested sequence and time frame, for each of the seven modules in the curriculum.

| Sequence & Time Frame | Module | Description |
|---|---|---|
| Weeks 1-2 | Oregon's Forest Heritage | Students are introduced to Oregon forests and their history, and examine some changes in our state's forestland over time. |
| Week 3 | Forest Basics | Students gain an understanding of both tree biology and the forest types in Oregon, and practice identifying and measuring trees. |
| Weeks 4-5 | Environmental Importance of Oregon's Forests | Students explore the environmental importance of forests: for example, how they protect our water resources, provide habitat and store carbon. |
| Week 6 | Economic Importance of Oregon's Forests | Students examine Oregon's forest economy, including the products, energy and jobs that come from forests. |

| | | |
|---|---|---|
| Weeks 7-9 | Forest Management | Students learn about forest management and practice forest management skills, such as surveying a forest tract, analyzing forest soil and developing a management plan. |
| Weeks 10-11 | Forest Management Issues | Students explore the impacts of fire, forest pests and climate change on Oregon's forests, and conduct an opinion survey related to a forest management issue. |
| Week 12-13 | Our Responsibility to Oregon's Forests | Students learn about certification as a way to achieve forest sustainability, and plan and carry out a service-learning project. |

## How to Use the Curriculum

The curriculum is designed to be flexible. Teachers may select modules or lessons that fit their educational goals, as each lesson can either stand alone or build on prior lessons. This curriculum may be used:

- as the basis for a 13-week or semester-long course on forestry
- to teach a single unit on forestry within other high school courses, such as agricultural science and technology, or environmental science
- to help prepare students for the FFA Career Development Event (CDE) on Forestry, or for Envirothon

## Curriculum Resources

The following Resources (available at learnforests.org) support teaching the curriculum:

- Glossary
- Supplies
- OFRI Publications and Videos
- Student Pages
- Field Investigations
- Oregon Standards Connections
- Oregon Forest Literacy Plan Concepts

## About OFRI

The Oregon Forest Resources Institute supports and enhances Oregon's forest products industry by advancing public understanding of forests, forest management and forest products.

# ECONOMIC IMPORTANCE OF OREGON'S FORESTS

## 1: Oregon's Forest Economy

### Overview

Students read about the economic importance of forests in Oregon (or listen to a lecture about it) and discuss the importance of forests to Oregon's economy. They then analyze county-level economic fact sheets to see how the forest sector impacts each of Oregon's 36 counties.

### Time Considerations

Preparation: 15 minutes

Procedure: One 50-minute class period

### Learning Objectives

Students will be able to:

- Articulate the benefits of and current challenges to the forest sector within Oregon's economy.
- Analyze and interpret county-level information about forest ownership, timber harvest levels and forest sector employment.

### Standards Connections

Oregon Science Standards

- Disciplinary Core Idea – HS.ESS3.A. Natural Resources. All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.
- Science and Engineering Practice – Obtaining, Evaluating, and Communicating Information. Critically read scientific literature adapted for classroom use to determine the central ideas or conclusions and/or to obtain scientific and/or technical information to summarize complex evidence, concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

Oregon English Language Arts Standards

- Reading Science and Technical Subjects — 11-12.RST.1. Analyze what science and technical texts say explicitly as well as inferentially, citing evidence to support the analysis, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

## Oregon Forest Literacy Plan Concepts

- 2.B.2. Oregon's forest sector is one of the state's largest economic sectors. It provides living-wage employment that is important for all communities, particularly in rural areas of Oregon.
- 2.B.3. Forests and forest products are important components of Oregon's green economy, which supports sustainable and efficient resource use. Forests are a renewable resource, and forest products store carbon and are also reusable and recyclable.

## Materials

- "Oregon's Forest Economy" student page
- County Economic Fact Sheets, available at oregonforests.org

## Background Information

See the "Oregon's Forest Economy" student page for an overview of Oregon's forest sector. For more specifics on the economic picture of forests in Oregon, see *Oregon Forest Facts* (available at learnforests.org) and *Oregon's Forest Economy* (available at oregonforests.org).

## Key Vocabulary

economic benefit*

**included in Glossary*

## Preparation

- Make copies of the "Oregon's Forest Economy" student page or provide on-screen access to it. (As an alternative, you may choose to prepare a brief lecture based on the material.)
- Review the County Economic Fact Sheets and decide how many and which counties students will analyze. For example, you may choose to have all students analyze just your

county's profile, or give different individuals or groups different county profiles to examine and compare.

## Procedure

1. Introduce the activity and the lesson by reviewing the historical and environmental importance of Oregon forests and asking students why Oregon's forests might be important economically.
2. Provide copies or online access to the "Oregon's Forest Economy" student page and allow time for students to read the material (or, alternatively, present the lecture you have prepared on the material).
3. Discuss the reading:
    a. What economic benefits do Oregon's forests provide?
    b. Who benefits from Oregon's forests?
    c. What challenges are facing Oregon's forest sector today?
    d. What can Oregonians do to get the most economic benefit from our forests?
4. Provide students access to the County Economic Fact Sheets. Invite them to analyze their county using the "Analyzing County Fact Sheets" student page and compare it to the statewide data in the "Forestry & Wood Products in Oregon" fact sheet at the beginning of the collection. They can then compare their county to another county in a different part of the state.
5. Discuss students' findings and the conclusions they can draw from them.

## Assessment

Have students create a T-chart showing the benefits of and current challenges to the forest sector within Oregon's economy. The chart should include specific examples from the reading or county fact sheets.

## Extension Ideas

- Use information in *Oregon Forest Facts* (available at learnforests.org) to graph economic data on Oregon's forests. For example, the 2023-24 edition presents data on timber harvest levels as well as forest sector wages and employment.
- Analyze data on log prices in Oregon (available from Oregon Department of Forestry at https://data.oregon.gov) to look for economic patterns or trends.

# Oregon's Forest Economy[1]

Oregon's forestlands are some of the most productive in the world. The state's mild climate, deep soils and abundant rainfall make it one of the best places to grow trees. A strong social climate helps support our forestlands as well.

As Oregonians, we enjoy:

- Widespread public support for the economic, environmental and social contributions of a stable forest sector.
- Solid educational and research institutions, such as the Oregon State University College of Forestry and the USDA Pacific Northwest Research Station, which keep the sector at the vanguard of best practices.
- Strong forest protection laws under the Oregon Forest Practices Act that ensure landowners employ sound forest management practices.

As a result, by internationally recognized standards of sustainability Oregon is a world leader in timber production, wood product manufacturing and sustainable forestry.

## Jobs and Community

According to 2021 data, forestry products and services employ about 62,000 people in Oregon. These jobs are particularly critical to rural communities, where wood product manufacturing can account for more than 50% of all manufacturing jobs.

Oregon's forest sector provides:

- About 62,000 Oregon jobs.
- 3% of all jobs in Oregon.
- An average yearly wage of $68,200.

## Growing Oregon's Forests

The total acreage of Oregon's forestland has remained mostly unchanged – at about 30 million acres – for nearly 100 years. It's estimated to have been about 30 million acres in the 1600s, as

[1] Sources: *Oregon Forest Facts, 2023-24*, Oregon Forest Resources Institute, oregonforests.org. "Christmas Trees." Oregon Agriculture in the Classroom, oregonaitc.org.

well. Yet since 1953, Oregon has produced more than 450 billion board feet of timber, without a reduction in the size and volume of the state's forestland.

Oregon forests grow about 2.8 billion cubic feet of new wood each year. Overall, about 39% is harvested, 25% is in trees that end up dying from natural causes, and 36% adds to growing trees, which means Oregon grows more wood per year than it harvests.

Today, approximately 76% of Oregon's timber production comes from forestlands owned by companies, families and Native American tribes. On private forestland, the harvest represents about 77% of the new growth being added to the forests each year; on federal forestland, the harvest represents only about 8% of new growth.

Oregon leads the nation in:

- softwood lumber production
- plywood production
- engineered wood product development

## Deck the Halls with Oregon Christmas Trees

In addition to growing timber for wood and paper products, more than 1,000 tree farms around the state have made Oregon the country's leading producer of Christmas trees. Each year, Oregon tree farmers harvest more than 4 million Christmas trees — nearly twice as many as any other state, and about 31% of the country's total. In 2020, Christmas tree farms contributed $107 million to Oregon's economy.

Some 92% of all Oregon Christmas trees are exported out of the region, bringing holiday cheer to California, Hawaii, Alaska and other states, and to foreign markets including Mexico, China, Japan and the Philippines.

## Tourism: Oregon's Natural Attraction

Oregon attracts tourists from around the world, and many of them come to enjoy the natural beauty of our forests and abundant recreational opportunities in the outdoors. A survey by the US Forest Service estimated that more than 11 million recreational tourists visit Oregon's national forests each year, sustaining nearly 15,000 jobs and contributing an estimated $440 million to the economy.

STUDENT PAGE NAME(S): _____

LESSON 1

## Analyzing County Economic Fact Sheets

Using the County Economic Fact Sheets and the "Forestry & Wood Products in Oregon" fact sheet at the beginning of the collection, answer the following questions to assess the economic importance of Oregon's forests. Compare your county to the statewide information, and then compare your county to another county in another part of the state. Provide evidence for your responses from the fact sheets.

Your county: _____

1. How does the forestland ownership in your county compare to Oregon's overall forestland ownership?

2. How does the timber harvest in your county compare to Oregon's overall timber harvest?

3. How significant are forest sector jobs in your county?

4. How many wood processing facilities does your county have? What percentage of the state's overall wood processing facilities does this represent?

Other county analyzed: _____

5. How does this county compare to your county in terms of forestland, timber harvest, forest sector jobs and wood processing facilities?

6. What conclusions can you draw from your findings?

## 2: Oregon's Wood Products

### Overview

Students watch a brief video on Oregon wood products and read how engineered wood products are helping build a more sustainable future for Oregon and beyond. They then research and report on different products made from Oregon trees.

### Time Considerations

Preparation: 30 minutes

Procedure: Two 50-minute class periods, with time between for student research

### Learning Objectives

Students will be able to:

- Articulate the importance of wood products for Oregon's economy.
- Conduct research on several different products made from Oregon trees.
- Summarize their research.

### Standards Connections

Oregon Science Standards

- Disciplinary Core Idea – HS.ESS3.A. Natural Resources. All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Oregon English Language Arts Standards

- Writing History, Science, and Technical Subjects – 9-10.WHST.7 and 11-12.WHST.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- Writing History, Science, and Technical Subjects – 9-10.WHST.9 and 11-12.WHST.9. Draw evidence from informational texts to support analysis, reflection, and research.

## Oregon Forest Literacy Plan Concepts

- 2.B.1. Forests provide multiple economic benefits, including jobs, a source of forest products and business opportunities (e.g., recreation and tourism).
- 2.B.3. Forests and forest products are important components of Oregon's green economy, which supports sustainable and efficient resource use. Forests are a renewable resource, and forest products store carbon and are also reusable and recyclable.

## Materials

- An assortment of items made from trees (for example, a piece of paper, a swatch of rayon fabric, a piece of cellophane, a disposable diaper and a bottle cork)
- *Forest Fact Break: Wood Products* video (1:31 minutes), available at learnforests.org
- Technology for sharing the video
- "Engineered Wood for a More Sustainable Future" in *Forest Essays (Level 7-12)*, available at learnforests.org
- "Wood Products Made from Oregon Trees" student page

## Background Information[2]

Wood products make up 47% of all raw materials used in manufacturing in the United States. Nearly 100% of a harvested log can be used to make wood and other products we use every day — most of which are completely recyclable.

Products from Oregon's forests include:

- Structural lumber – Dimensional lumber, beams, joists, laminated veneer lumber and engineered structural softwood.
- Millwork – Doors, windows, cabinets, furniture, siding, flooring, moldings and fencing.
- Plywood and paneling – Veneer or other composite panels such as particleboard, hardboard and fiberboard.
- Posts, poles and timbers – Utility poles, fence posts, pilings, treated timbers, cross-arms and railroad ties.
- Pulp and paper products – Packaging, printing paper, newsprint, tissue, toweling, absorbents, adhesives, fluff pulp and cellulose products such as rayon, cellophane, food additives and pharmaceuticals.
- Biomass energy – Many Oregon mills burn wood waste to generate heat and electricity for manufacturing.

[2] Source: "*Oregon's Forest Economy*." Oregon Forest Resources Institute, oregonforests.org.

## Key Vocabulary

biomass energy

dimensional lumber

fiberboard

hardboard

particleboard

reconstituted wood

veneer

## Preparation

- Gather an assortment of items made from trees.
- Make copies of the *Forest Essays* reading and student page, or provide on-screen access to them.

## Procedure

1. Introduce the lesson by showing students the assortment of items you have collected and asking them which are made from trees. After they have had time to consider the items, ask whether they would be surprised to hear that all of them come from trees.
2. Show the 90-second video *Forest Fact Break: Wood Products* and discuss the importance of wood products to Oregon's economy.
3. Provide copies of "Engineered Wood for a More Sustainable Future" or have it available for students to access online. Allow time for students to read the story and answer the questions. Ask students what other wood products might be important in Oregon, and begin a list on the board.
4. Give students copies of the "Wood Products Made from Oregon Trees" student page. Direct students to choose a number of the wood products to research, or you may assign students particular products to explore. (Assign a number of products for each student to research that takes into account your time, learning objectives and the size of your class.)
5. Allow time for students to conduct quick research on each product, focusing on the questions listed in the Task section of the student page. Students should write a brief report (one to two paragraphs) about each product, describing what they learned.

## Assessment

Use students' brief reports to assess what they learned about the wood products and their importance to Oregon's economy.

## Extension Ideas

- Explore two careers associated with wood products in Oregon. Show the 5-minute *Find Your Path: Mill Operator* and *Find Your Path: Procurement Forester* videos, available at learnforests.org, and have students compare the two careers portrayed.
- Learn about Oregon wood products used to frame high-rise buildings. See *Wood Stands Tall*, available at oregonforests.org.
- Visit a mill.
- Explore the production and sale of non-timber forest products, using resources from "*Non-Timber Forest Products*" at knowyourforest.org.

STUDENT PAGE
LESSON 2

NAME(S): _____

# Wood Products Made from Oregon Trees

Lumber
- Dimensional lumber
- Solid beams
- Laminated beams
- Joists
- Laminated veneer lumber
- Finger-jointed lumber

Plywood

Reconstituted Wood
- Particleboard
- Hardboard
- Fiberboard
- Heating pellets

Posts, poles and timbers
- Utility poles
- House logs
- Fence posts
- Pilings
- Treated timbers, cross-arms and railroad ties

Pulp and paper products
- Packaging
- Printing paper
- Newsprint
- Tissue
- Paper towels
- Absorbents
- Adhesives
- Fluff pulp

Cellulose products
- Rayon
- Cellophane
- Food additives
- Pharmaceuticals
- Biomass energy

Millwork

Lumber for products
- Doors
- Windows
- Cabinets
- Furniture
- Siding
- Flooring
- Moldings
- Fencing
- Pallets
- Lath
- Pencils
- Musical instruments

Cross-laminated timber (CLT)

**Task**

As directed by your teacher, select a number of items from the list of wood products. For each product, research and answer the following.

- ☐ Product: _____
- ☐ What is it? How would you define it?
- ☐ What is it used for?
- ☐ How is it made? What raw materials are required to make it?
- ☐ What are the potential environmental, economic and social impacts of this product for Oregon?
- ☐ What sources did you consult?

## 3: Biomass Energy from Oregon's Forests[3]

### Overview

Students explore renewable energy from forests by generating biomass gas and investigating its potential as a fuel.

Note: For non-lab classes, introduce the topic with the suggested video and then explore further using one or more of the Extension Ideas.

### Safety Notes

- The procedures provided in this lesson are intended as suggestions.
- Be sure to follow all lab safety guidelines set out by your school or district.
- Have students wear safety goggles throughout the lab.
- Be mindful of open flames. Use a hood, if possible.

### Time Considerations

Preparation: 30 minutes

Procedure: One to two 50-minute class periods, with the lab (steps 3-4) conducted during one period

### Learning Objectives

Students will be able to:

- Explain the pros and cons of using biomass gasification to produce energy.
- Use proper lab techniques to generate and collect biomass gases.
- Carry out a scientific investigation using the biomass gases.
- Analyze their data and draw conclusions.

[3] The lab was adapted from "*Investigating and Using Biomass Gases*" by Eric Benson and Melissa Highfill. National Renewable Energy Laboratory, U.S. Department of Energy.

## Standards Connections

Oregon Science Standards

- Disciplinary Core Idea – HS.ESS3.A. Natural Resources. All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

## Oregon Forest Literacy Plan Concepts

- 2.B.1. Forests provide multiple economic benefits, including jobs, a source of forest products and business opportunities (e.g., recreation and tourism).

## Materials

- "*Powered by Oregon*" video (9:02 minutes), available on the OFRI YouTube channel
- Optional: "*Energy Basics: Biomass*" video (3:22 minutes), available at nrel.gov
- "Syngas Lab" student page
- Lab equipment, per group:
    - Safety goggles
    - Lab coats
    - Latex or nitrile gloves
    - Fume hood (if possible)
    - 35-55 mL test tube with matching one-hole rubber stopper
    - Two ring stands with metal test tube clamp and clamp for Erlenmeyer flask
    - Three pieces stainless steel or glass tubing, each approximately 5 cm long
    - 250 mL Erlenmeyer flask with matching two-hole stopper
    - Three pieces rubber or Tygon tubing, two approximately 60 cm long and one just shorter than the Erlenmeyer flask
    - Bunsen burner and lighter
    - Sink with faucet connection for tubing
    - Wood pellets (enough to fill test tube approximately 3/4 full)
    - Regular-size marshmallow (not mini-size)
    - Skewer for roasting marshmallow
    - One large sealable bag for test tube disposal

- Lab equipment, per class
    - One pair leather gloves
    - Acetone (optional, for cleanup)
    - Additional marshmallows

## Background Information[4]

Oregon produces millions of tons of wood byproducts every year, from logging slash to sawdust to small trees from US Forest Service thinning projects. This material, known as biomass, contains stored solar energy – enough to power hundreds of thousands of homes, businesses and public buildings.

Humans have been using biomass energy since they first discovered fire. Wood fires are, of course, still used for heating and cooking around the world. In addition to wood, people use corn stover (dried leaves and stalks of maize plants), other crop wastes, manure and other once-living materials for fuel.

Woody biomass includes branches, tree tops and other slash left over from logging, as well as bark, sawdust, chips and other residuals from sawmills. Biomass can be used for fuels, to produce power and to manufacture products that would otherwise be made from fossil fuels. It is currently used in Oregon to heat schools and hospitals, and to generate electricity. Entrepreneurs and scientists are also working to develop biomass fuel to power cars, trucks and airplanes, as well as other practical uses for wood byproducts.

There are generally three types of biomass energy technologies:

- **Biofuels** are transportation fuels, such as ethanol and biodiesel, created by converting biomass into liquid fuels.
- **Biopower** includes technologies that convert renewable biofuels into heat and electricity through burning, bacterial decay, or conversion to gas or liquid fuel.
- **Bioproducts** include technologies that convert biomass into chemicals for making plastics and other products typically made from petroleum.

The conversion of woody biomass to energy in Oregon presents a unique opportunity to simultaneously address three challenging needs: restoring forest health, fire resiliency and

[4] Sources: *Biomass Energy and Biofuels from Oregon's Forests*. Oregon Forest Resources Institute. "Biomass Energy Basics." National Renewable Energy Laboratory, nrel.gov.

wildlife habitat; finding renewable energy alternatives; and revitalizing rural economies by providing jobs and a market for wood byproducts.

The use of biomass energy is also an important way to help mitigate climate change. In addition to being renewable, biomass energy can help reduce greenhouse gas emissions. While it's true that burning biomass releases about the same amount of carbon dioxide as burning fossil fuels, there is a key difference between the two energy sources. Fossil fuels release carbon dioxide captured by photosynthesis millions of years ago — adding to greenhouse gas levels with essentially "new" carbon dioxide, while biomass releases carbon dioxide that was recently captured from the atmosphere in its own growth, and so is essentially carbon-neutral.

In this lab, students will synthesize and use syngas, a gaseous fuel made from biomass. If the biomass is heated at high temperatures, gasification occurs, producing syngas. The main components of syngas are hydrogen, methane, carbon monoxide and carbon dioxide. It can be burned directly to power a turbine and generate electricity.

## Key Vocabulary

biomass energy

gasification

syngas

woody biomass

## Preparation

- Before the lab, push two of the pieces of 5-cm long tubing into the two holes of the Erlenmeyer flask stopper, and one into the hole of the test tube stopper.
- Make copies of the student page.

## Procedure

1. Introduce the lesson by asking students what they think biomass is. What are common forms of biomass? How is it used as energy?
2. Show the 9-minute video "Powered by Oregon" and discuss the benefits of woody biomass as a source of fuel. Point out that researchers are working to develop wood-based liquid fuel and other forms of energy from wood. You might also show the video "Energy Basics: Biomass" for more background.

3. Divide the class into lab groups to create a biomass gas called syngas. Give each group a copy of the "Syngas Lab" student page. Note that although the gases produced are trapped in the flask, it is advisable to conduct the lab in a fume hood, if possible.
4. As lab groups complete step 10 of the lab procedure, disconnect each group's test tube tubing from their Erlenmeyer flasks and – using leather gloves – move the hot tubing out of the way.
5. After students have completed the lab, discuss the results:
    a. What did you observe during the lab?
    b. What do you think the gas you synthesized is made of? (Explain that the gas is a mixture of methane, hydrogen, carbon monoxide and carbon dioxide. The methane, carbon dioxide and hydrogen are the components of the gas that actually burn.)
    c. What was the purpose of roasting the marshmallow?
    d. How might this experiment compare with actual gasification? (This experiment is at a much lower temperature than commercial gasification and produces more pyrolysis oils than gas.)
    e. What might be the environmental and economic impacts for Oregon – both positive and negative – of biomass gasification or other forms of woody biomass?
6. Lab cleanup: Once the test tubes are cool to the touch (this may be after the class period is over), remove them from the clamps and place the tubes and their contents in the sealable bags. Seal the bags – as the tubes will be very stinky – and dispose in the trash. Wash the dirty tubing and flask in hot soapy water to remove any oils. If oils remain, rinse with acetone.

## Assessment

Have students write a short essay summarizing what they learned from the lab. The essay should include relevant terminology, a summary of gas collection procedures, and the implications of large-scale gasification as a source of renewable energy.

## Extension Ideas

- Using the same procedure as described in the lab, challenge students to compare different biomass materials to determine which is the best energy source. Sources of biomass could include wood pellets or splints, dried grass, nut shells, manure and corn stover (leaves and stalks of maize plants). Students could set their own parameters for what the "best" means, but one possibility is the volume of gas produced by one gram of material.

- Have students calculate their average home energy use over four months and compare it to biomass energy. Electricity usage is stated in terms of kilowatts (KW), while gas usage is in therms (one therm = 100,000 British Thermal Units, or BTUs).[5] In general, one kilogram of dry wood or other biomass can produce about one kilowatt (KW) of electricity, and one liter of syngas contains 13.4 BTUs of energy. How much wood and syngas would students' households need to meet their current energy usage?
- Investigate the possibility of using biomass fuels for your school, like the school featured in the 4-minute video "*Biomass Success in Burns*" (available on the Oregon Department of Forestry YouTube channel). See Oregon's Energy Efficient Schools Program at oregon.gov/energy as a place to start.
- Visit a biomass energy plant, or research bio-energy or co-energy plants in Oregon.

[5] One BTU is the amount of energy needed to raise the temperature of one pound of water one degree Fahrenheit.

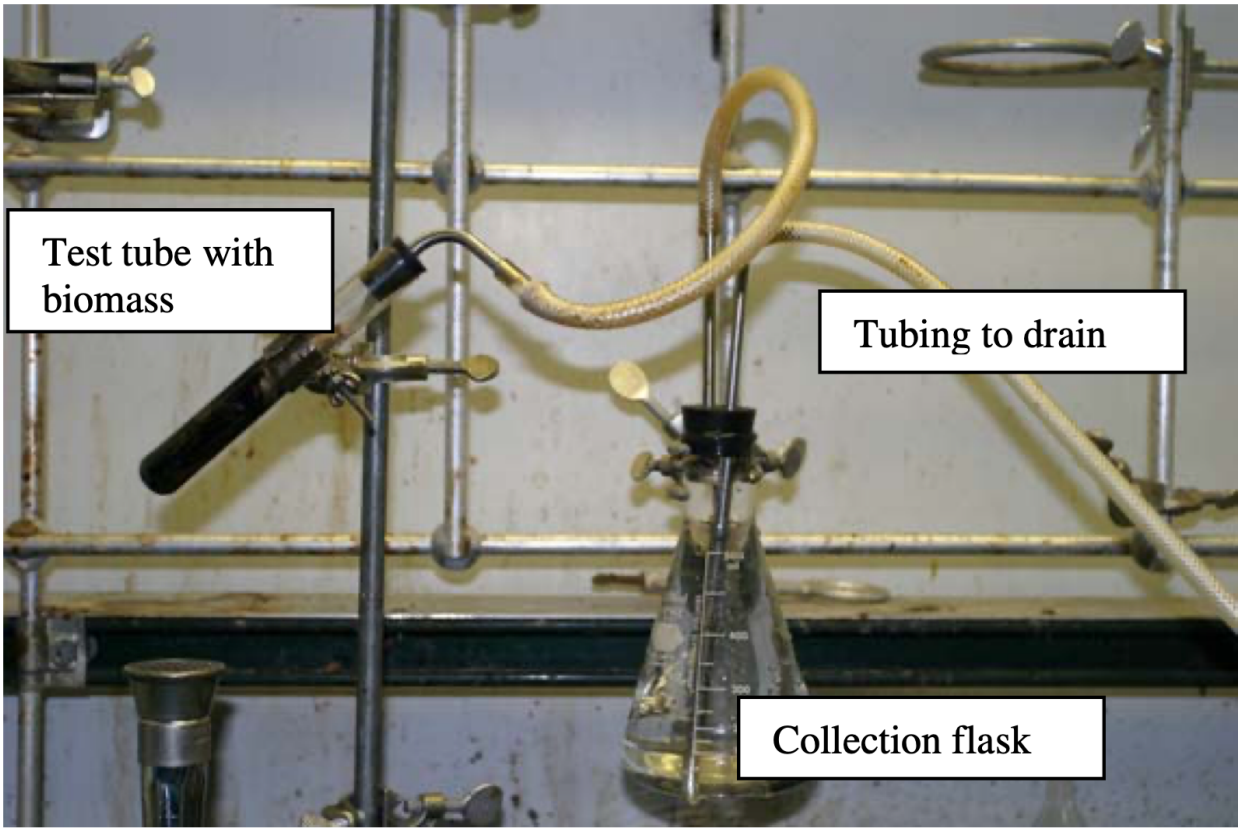
NAME(S): _____

## Syngas Lab[6]

Procedure

1. Fill test tube 3/4 full with wood pellets.
2. Clamp the test tube to the ring stand using the metal clamp. Adjust the height of the tube relative to the Bunsen burner. The bottom of the test tube should be at least 3 centimeters above where the flame will be.
3. Insert the one-hole stopper with tubing into the test tube.
4. Attach the rubber tubing to one of the tubes in the two-hole stopper. The rubber tubing should come from the bottom of the stopper.
5. Fill the Erlenmeyer flask full of water and insert the two-hole stopper with the tubing going into the water. The tube should almost touch the bottom of the flask.
6. Connect the test tube and the Erlenmeyer flask with the piece of rubber tubing from step 3.
7. Connect the last piece of rubber tubing to the top of the two-hole stopper and place the other end into the sink. Check the figure to ensure your setup is correct.
8. Light the Bunsen burner and begin heating the test tube. Make sure the flame is at least 3 centimeters away from the test tube so the tube does not melt.
9. Record observations while the tube is being heated.
10. After a few minutes gas will be evolved and will begin to displace the water in the Erlenmeyer flask. Continue heating until all the water has been displaced.
11. At this point have your teacher disconnect the hot test tube tubing from the Erlenmeyer flask and move the hot test tube out of the way.
12. Connect the drain tubing to the faucet.
13. Slowly turn on the water and light the gas flowing from the end of the glass tubing. Adjust water flow rate to maintain a constant flame.
14. Roast a marshmallow on the flame (but don't eat it, as it may have a little tar on it). Record your observations below.

[6] Source: "Investigating and Using Biomass Gases" by Eric Benson and Melissa Highfill. National Renewable Energy Laboratory, U.S. Department of Energy.




*Equipment setup for syngas lab.*

## Observations

| Lab Step | Time | Observations |
|---|---|---|
| Heating test tube | | |
| Turning on water | | |
| Lighting gas | | |
| Roasting marshmallow | | |

## 4: Forestry Careers: Find Your Path

Students learn about different forest sector careers in Oregon, articulate which careers appeal to them, and identify what education, skills, experience and personal qualities it takes to succeed in a particular career.

### Learning Objectives

Students will be able to:

- Explain that Oregon's forest sector is an important source of jobs in the state.
- Identify what it takes to succeed in different forest sector careers.
- Articulate which forest sector careers appeal to them and why.

### Standards Connections

Oregon Science Standards

- Disciplinary Core Idea – HS.ESS3.A. Natural Resources. All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors.

Oregon English Language Arts Standards

- Writing History, Science, and Technical Subjects – 9-10.WHST.7 and 11-12.WHST.7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

### Oregon Forest Literacy Plan Concepts

- 2.B.1. Forests provide multiple economic benefits, including jobs, a source of forest products and business opportunities (e.g., recreation and tourism).
- 4.B.5. We need a variety of professionals and skilled workers to sustain our forests, including foresters, scientists, engineers, lawyers, information technology professionals, land managers, investors, educators, communications specialists, fire fighters, loggers,

tree planters, truck drivers, mechanics and wood products manufacturers. Resources are available to learn about these valuable and rewarding careers.

## Materials

- *Forest Essays (Level 7-12)* booklet, available at learnforests.org
- *Find Your Path* videos, available at learnforests.org
- Technology for sharing videos
- "What Does It Take?" student page

## Background Information[7]

Oregon's forest sector – the part of Oregon's economy derived from forests – represents about 61,500 jobs for our state. This sector encompasses forest management, tree harvesting, and converting wood into consumer and construction products such as lumber, plywood, poles, paper and energy. It also includes careers in forestry, science and engineering, trucking and equipment, manufacturing, energy, recreation, government and forest support.

*Find Your Path* is a booklet produced by OFRI that explores a variety of careers in the forestry sector. It includes profiles of 19 different Oregonians working in the following forest-related careers:

- Field Forester
- Forest Manager
- Wildlife Biologist
- Forest Engineer
- Natural Resource Ecologist
- Recreation Unit Manager
- Road and Right-of-Way Specialist
- Research Economist
- Logging Crew
- Harvester Processor Operator
- Log Truck Driver
- Field Technician / Service Mechanic
- Wildland Firefighter / Base Manager
- Nursery Manager
- Mill Operator

[7] Source of information in first paragraph: *Oregon Forest Facts, 2023-24*. Oregon Forest Resources Institute, learnforests.org.

- Shipping and Sales Coordinator
- Vice President of Manufacturing
- Millwright
- Vice President of Timberlands

In addition to the booklet, OFRI has also created a series of short "*Find Your Path*" videos, each highlighting a particular forest career by capturing the voice and perspective of a real person in that career. Currently, the videos profile an Electrician, Field Forester, Fish Biologist, Forest Engineer, Forest Hydrologist, Forest Logging Crew, Forestry Teacher, Maintenance Manager, Mill Operator, Procurement Forester, Recreation Manager, Seedling Nursery Manager, Stewardship Forester, Wildland Firefighter and Wildlife Biologist.

## Preparation

Make copies of the student page.

## Procedure

1. Show one or more of the "*Find Your Path"* videos to begin a discussion about Oregon forest sector careers. Ask students to describe the education, skills, experience and personal attributes necessary to be successful in each career. Discuss: What does or doesn't appeal to you about that career? What might be challenging about that career?
2. Give students copies of the "*Find Your Path"* booklet (or online access to it), and a copy of the "What Does It Take?" student page.
3. Direct students to choose three (or more) careers in the booklet to examine in depth. For each career, they should describe the job involved, as well as the education, skills, experience and personal attributes someone would need to be successful in that career. They should also write a brief paragraph about whether or not that particular job appeals to them, and why.

## Assessment

Use students' responses to the "What Does It Take?" student page to assess their learning.

## Extension Ideas

- Students conduct research on a different forest-related career to find out what education, experience, skills and personal qualities are required (see Forestry Works at

https://www.forestryworks.com for a list of possibilities). Then they create an online poster or other visual to share what they learned.

- Create a "dichotomous key" to forest sector careers that can help others determine which might be best suited to them. The key would be a series of paired questions or attributes users respond to. It might include such attributes as indoor versus outdoor, high school education versus college education, urban setting versus rural setting and so on, to organize the career options.
- Invite someone from the forest sector to come in and talk to students about a range of careers.
- Share the *Find Your Path: Recreation Manager* video, available at learnforests.org, and explore recreation careers related to forests, including opportunities, safety, regulations and OHV (off highway vehicle) use.
- Have students explore their interests and skills related to future careers using various assessment tools available on the Oregon Career Information System website, oregoncis.uoregon.edu.

## Inspiring Career Stories

Inspire students to pursue forest and conservation careers through the stories of Black Americans who have taken this career path and who have advice and resources to share. Project Learning Tree's *Black Faces in Green Spaces: The Journeys of Black Professionals in Green Careers* profiles the career pathways of 22 Black American forestry professionals. It aims to

- make youth and young professionals aware of and excited about the many jobs in the forest and natural resources sector
- advance representation through inspiring stories from historical and current environmental heroes
- highlight the green career opportunities that abound for all

See plt.org for free download or to purchase a hard copy.

NAME: _____

## What Does It Take?

For each forest-related career, identify what education, skills, experience and personal qualities are required. Then, write a paragraph telling whether that career appeals to you and why (or why not).

**Job Title:**

Job description:

Education:

Skills:

Experience:

Personal qualities:

Does this career appeal to you? Explain why or why not.

**Job Title:**

Job description:

Education:

Skills:

Experience:

Personal qualities:

Does this career appeal to you? Explain why or why not.

**Job Title:**

Job description:

Education:

Skills:

Experience:

Personal qualities:

Does this career appeal to you? Explain why or why not.