Course is designed for either a credit course as part of the Carpentry Technology Program at Green River Community College and can readily be adapted for a Continuing Education Course for the General Public

Required Student Materials:

- Text: Towards a Zero Energy Home. Johnson and Gibson
- Supplies: Laptop with Wi-Fi capabilities

Required Instructional Equipment or supplies

- Classroom with seating up to 24 students
- Data Projector and Computer Instructor Work station
- Wi-Fi access for students and instructor or hardwired computer lab
- Solar and Wind lab Equipment
  - Lab-volt system or equivalent 1 per 4-6 students recommended
  - Or Instructor created lab activities. (many are available with a simple Google search and have minimal expense)
- Pre-coordinated field trip locations and/or guest speakers
- Two vacant building lots for Passive Solar Unit and 2 simple plot plans

Unit One: Conventional Energy Resources and Economic and Environmental Impact (2 hours)

Introduction: Since the earliest recorded history of civilizations, the human race has had the need for and used some type of energy. This can be seen in early years in the use of fire, water, sun and even shade for mere survival. Jumping ahead thousands of years to present day energy is need for survival, but also for comfort, transportation, industry, technology, global economy and the list goes one. This unit will study will look at our current Energy Generation and Resources and their impact on the economy and environment

Learning Objective(s)

At the completion of this unit the student will be able to:
1. Explain the current Energy demand and it’s environmental and economic impact
2. Describe typical residential energy load requirements
3. Calculate/estimate their own Energy consumption and Expense

Topics Covered

- Energy Past and Present
- Current and Future Energy Picture
- Energy Sources Compared
- Understanding Home Energy Usage
- Calculating Home Energy Consumption
Major Activities:

Day One

- Instructor Lecture
  - Energy Past and Present
  - The Energy Picture Today
  - Energy Sources Comparisons
  - Environmental Impact
- Group Discussion
  - What are the best choices for Energy Generation?
  - Which is the most efficient both in generation and cost?
- Calculating personal Home Energy Consumption
- Reading and Research Assignments
  - Read Unit 1 (text)
  - Research current Electrical and Gas rates for Puget Power and Seattle City Light
  - Calculate Home energy Usage
    - Use Website: http://c03.apogee.net/calcs/rescalc5x/Profile.aspx
  - If a customer, bring a copy of latest Energy Bill to 2nd class session

Day Two

Instructor and Class

- Review previous days lesson
- Class Discussion: What is Net Zero

Group Activity

- Discuss findings from Homework assignments
  - Compare Energy Consumption
    - Discuss possible solutions to lower cost
  - Present Results to Class

❖ Suggested Assessment for Unit One

- Take Home or in class quick quiz
  - List types of Energy Generation Systems current available
  - List at least two pros and one con per system

Unit Two: Passive Solar Design (PM-D3) (4 hours)

Learning Objective(s)

At the completion of this unit the student will be able to:

1. Explain the principles of Passive Solar Design
Introduction: Passive solar design is not a new building design. In fact Anasazi culture that populated the four corner area of Colorado, Utah, New Mexico and Arizona lived in large open caves that faced South for Winter heat. They recessed these dwellings far enough from the openings that the tall cave roof shaded the homes in the hot summer months. With the exception of modern building materials and equipment these same principles are used today.

**Topics Covered**

- Site Location/Orientation
- Design
- Insulation
- Thermal Mass/Radiant Heat
- Glazing Considerations.
- Shading/cooling

**Major Activities**

**Day One**

- Instructor Lecture
  - History of Passive Solar Design
  - Passive Solar in the 70’s
  - The Nine basic principles of Passive Solar Design
- Group Discussion
  - What are the pros and cons of Passive Solar Design?
- Reading and Research Assignments
  - Read Unit Two (text)
  - Research two different Passive Solar Homes and bring copies to next class

**Day Two**

- Instructor/class review previous days lesson
- Group activity
  - Compare Passive Solar Home designs found via research
  - Discuss pros and cons
  - Make group consensus on best design and present to class
- Instructor Lecture
  - House orientation
  - Window types and locations
  - Thermal Mass
  - Solar Shading
  - Inform students of off-site class project location and have students arrange carpooling if possible
- Suggested Assessment for days one and two
  - Take Home Test on topics covered in day one and two)
Day Three

- Group Activity
  - Using plans provided by instructor, compasses and or GPS units locate homes for best Passive Solar on building lots pre-arranged by instructor (no shading obstacles)
- Instructor
  - Lecture shading calculations
  - Collect and correct test, return next class session
- Group Activity
  - Arrange carpooling for day 4 site

Day Four

- Group Activity
  - Using lot with Passive Solar obstacles considerations, and site and house plans provided by instructor, compasses and or GPS units, locate homes for best Passive Solar on building lots pre-arranged by instructor (no shading obstacles)

  ❖ Suggested Assessment: Collect group calculations, review results, return next class session

Unit Three: Solar Energy Principles and Practices (PM-D3, PM-D8, PM-D6) (6 hours)

Learning Objective(s)

At the completion of this unit the student will be able to:

- Explain the basic Principles of Solar Energy
- Describe basic components of a Solar Energy System

Introduction: The solar energy reaching the surface of the Earth every hour is greater than the total amount of energy the world uses in a year according to the Department of Energy. The trick is capturing it.

Topics Covered

- Principles of Photovoltaic Energy
- Photovoltaic Systems
  - On-grid and off-grid designs
- Location and Installation considerations
- Buy back systems
- Solar hot water principles and systems
Major Activities

Day One

- Instructor Lecture
  - History of Solar Energy
  - Basic principles of Solar Energy
- Group Discussion
  - What are the pros and cons of Solar Energy
- Reading and Research Assignments
  - Read Unit 3 (text)
  - Locate at least two local contractors that specialize in Solar Energy installation

Day Two

- Guest Speaker(s)/vendors/contractors
  - Solar Energy equipment
    - Suggested JATC Electrical Workers Solar Trailer exhibit
- Suggested Assessment Collect research assignment, collate information, and return collated information to class.

Day Three

- Instructor Lecture
  - On-Grid, Off-Grid systems
  - Buyback programs
  - Installation considerations
  - Shading considerations
- Research Assignment
  - Visit web site www.solarwa.org
    - List what current jobs are posted

Day Four

- Instructor
  - Collect and previous days assignment
- Instructor
  - Solar lab demonstration
- Group activity
  - Experiment with solar lab equipment (Lab-Volt or similar system)
- Suggested assessment: Day 3 review quiz, open notes, open book
**Day Five**

- Instructor Lecture
  - Solar Hot Water Systems
- Group Activity
  - Solar Lab equipment
- Group activity arrange carpooling for day 6
  - **Suggested assessment: Take home quiz covering days one – five**

**Day Six**

- Tour local solar equipment manufacture and/or supplier or invite as guest speaker

**Unit Four: Wind Energy Principles** (PM-D3, PM-D8, PM-D6)  (3 hours)

**Learning Objective(s)**

At the completion of this unit the student will be able to:

1. Explain the basic Wind Generated Energy
2. Describe basic components of a Wind energy system
3. Describe installation considerations for a wind generating system

Introduction: Harnessing the wind for potential energy is nothing new. Everyone can picture the windmills of Holland still being used today to drive belts for machinery. Way before steam, wind carried goods and people from continent to continent. Even supposedly Ben Franklin and his kite used the wind!! Today examples of modern wind capturing equipment can be seen in just about every region of the U.S that is known for having an abundant supply of natural wind. Just within 75 miles of Seattle is a huge “wind farm” as they are being called. But unlike the sun, is it windy all the time?

**Topics Covered**

a. Principles of Wind Energy
b. Commercial and Residential Wind Turbines
c. Location and Installation considerations
d. Tax Incentive Programs

**Major Activities**

**Day One**

- Instructor Lecture
  - History and example of early wind power
  - Basic Principles of modern Wind Energy Production
• Type of Turbines both Commercial and Residential
• Advantages of wind generated Power

• Group Discussion
  ▪ Disadvantages of wind generated power

• Homework Assignment
  ▪ Research PURPA (it is an acronym). Write a short descriptive paper on what it is and how homeowners could benefit from it.

**Day Two**

• Instructor
  o Review previous class session
  o Lead group discussion on PURPA (Public Utilities Regulatory Policy Act 1978)

• Instructor led Lecture/Class Discussion
  o Economic Impact of Wind Generated Power
  o Comparative cost to other Energy Generating Systems
  o Practicality of Homeowner Wind Generating Systems

• Homework Assignment
  o Research vendor/installers in both Seattle and Portland area.
    ▪ Create list of web addresses and specialties to share with class.

**Day Three**

• Guest Speaker. Keith Hughes West Seattle Natural Energy (or other local wind related contractor)
  o Home Wind Generating Equipment and Installation
    ▪ Either in class or meet at one of their projects.
  ❖ Suggested Assessment:
    • 1-2 page paper on Federal, State or Local Renewable Energy Incentives
      o List Programs, requirements and Incentive amount

**Unit Five: Geothermal Principles and Systems** (PM-D3, PM-D8, PM-D6) (4 hours)

**Learning Objective(s)**

At the completion of this unit the student will be able to:

1. Describe the principles of a Geothermal heating and cooling systems
2. Compare cost and effectiveness of Geothermal heating system to Air Source Heat Pump System

Introduction: Just as passive solar systems use free energy from the sun for heat, a ground-source or geothermal system uses the uniform temperature of the earth to heat and cool. No
matter what it's doing outside, the temperature in the earth is a constant 55 Degrees at some depth below ground. Interesting, but do you always want to be in a 55° home all the time?

**Topics Covered**

- Principles of Geothermal Energy
- Types of Geothermal Heat Pump systems
- Air Source Heat Pump systems
- Location and Installation considerations

**Major Activities**

**Day One**

- Instructor Lecture
  - Principles of Geothermal Heat Pump Systems
  - Types of Closed Loop systems
- Group Discussion
  - Advantages/disadvantages geothermal systems
- Reading Assignment Unit 4
  - List 4 types of heating systems and list advantages and disadvantages of each
  - List 2 types of cooling systems and again, list advantages and disadvantages of each
  - list advantages and disadvantages of each

**Day Two**

- Instructor Lecture
  - Air Source Heat Pump Systems
  - High Efficient Gas/Propane Furnace
  - Common Air Conditioning Units
  - Efficient Zonal Heating/Cooling Systems

**Day Three**

- Guest Speaker or field trip
  - Geothermal Heating/Cooling System equipment and installation
  - **Suggested Assessment:** Research and compare cost and operation of Geothermal Heating/Cooling, Air source Heat Pump and Zonal Heating/Cooling Heat pump systems

**Day Four**

- Group Discussion
  - Compare Research results from previous class written assignment
- Instructor
  - Review all 5 Units
Unit Six: Net Zero Home Principles and Systems (PM-D3) (4 hours)

Learning Objective(s)

At the completion of this unit the student will be able to:

- Define what defines a Net Zero Home
- List various components and practices of a Net Zero Home
- Locate two actual examples of a Net Zero home with 50 miles of class and list systems used to save and or generate Energy

Introduction: Imagine living in a home where the air is always clean and fresh, total power bills are $50 or less a month or better yet, you receive a significant check at the end of the year from the power company for the energy you generated for them, the comfort level within the home is always constant and most of the building materials had no or little impact on the environment. How long till this actually is common place? Well the future is here.

Topics Covered

- Principles of Net Zero Homes
- Building Envelope
- Energy Star or similar principles
- Design Considerations
- Types of Net Zero Homes

Major Activities

Day One

- Instructor
  - Collect Test from previous class
  - Lecture
    - The Building Envelope
    - Air movement
    - Air Sealing
    - Water and Water Vapor Control
  - Reading Assignment Unit One and Five
    - Select one of the Case Study homes and methods/systems used to make it a Net Zero Home.
    - Would your case study home be a Net Zero home if placed where you currently live? Why or why not?

Suggested Assessment: Collect written assignment and critique
Day Two

- Instructor
  - Lecture
    - Incorporating Passive/Solar, Photovoltaic, Wind energy, geothermal/air source
    - Water Conservation Equipment
    - Energy Saving appliances, fixtures
    - Testing for Net Zero
- Group
  - Arrange carpooling details for field trips

Day Three

- Class
  - Meet at Issaquah Highlands Net Zero Town House Project for Tour
  - Alternate site if not available

Day Four

- Class
  - Meet at Todd Sakai Net Zero Home in Kent (or other local Net Zero Home)

  Suggested Assignment: Written Assignment
  - Write up comparison of Town Home Project and Sakai Home
  - 5 pros and 5 cons for both projects
  - What features impressed you the most? Which the least
  - What features could be easily incorporated in a typical new Spec Home today?

Unit Seven : Career Opportunities in Residential Alternative Energy

(PM-D3) (1 hour)

Learning Objective(s)

At the completion of this unit the student will be able to:

- List at least 3 careers in Residential Alternative Energy and training required

Introduction: Now that you have a fair understanding of Alternative Energy practices, you should also have a understanding that each of the areas you've studied need technicians, designers, engineers and contractors to make all of this work effectively and efficiently as possible. What some of those opportunities will be or are is the purpose of this unit.

Topics Covered

- Careers in Alternative Energy
- Recommended training/education
**Major Activities**

**Day One**

- Instructor
  - Collect assignment from previous class
- Lecture
  - Careers in Alternative Energy and Training
  - Recommended web Career sites to visit handout
- Written Assignment
  - Research one Energy career that is of interested and list training or education required and how many job openings are listed either locally or nationally. Assignment must be e-mailed as an attachment to instructor with one week of last day of class.

- Suggested Assessment: Collect written assignment, critique, compile results and return to student and return compilations to class