BIOMASS ENERGY TRAINING CURRICULUM

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This curriculum was developed through a Southern SARE grant and collaboration between Tennessee State University, the University of Tennessee, eXtension.org, and USDA-Rural Development. The objective of this curriculum is to provide training on biomass energy to extension agents and local officials so that they may deliver this information to their stakeholders.

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Biomass Energy Training Curriculum

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Cover design: Brett Seybert

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This curriculum and supporting documents can be accessed

online (in full and as separate modules) at

http://articles.extension.org/pages/73919

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Part I: Introduction to Biomass Energy

State of the energy industry

Learning objectives:

- Participants will be able to describe the different energy sources and uses in the U.S. and Tennessee
- Participants will be able to explain the kinds of biofuel production in Tennessee.

Materials:

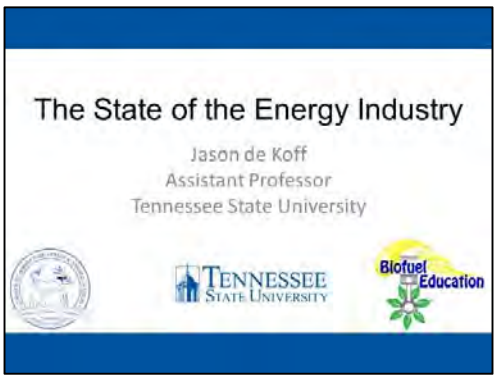
- PowerPoint® slides "State of the Energy Industry"
- Lesson guide: Use the notes in this lesson guide to present information for each presentation slide.
- Factsheet: "State of the Energy Industry"
  http://www.tnstate.edu/extension/documents/EnergyUse.pdf
  A copy can also be found in the Appendix.
- 2 – 3 copies of "Portrait of a Million" This small poster contains 1 million dots to provide a visual for helping build an understanding of what a million of something looks like. Can be ordered from this website for $7 each: http://www.universalworkshop.com/MIL.htm
- Questions found at the end of this lesson guide can be used to test participants' knowledge at the end of the presentation. This can be combined with clickers to improve audience engagement and create discussion.
- An evaluation of the presentation can be found in this lesson guide following the lesson questions.

Topics

U.S. oil production and consumption
Examples of negative effects of fossil fuels
What is renewable energy?
Tennessee energy production

Slide 1

This discussion will provide an overview of energy production and usage in Tennessee and focus on biofuels.

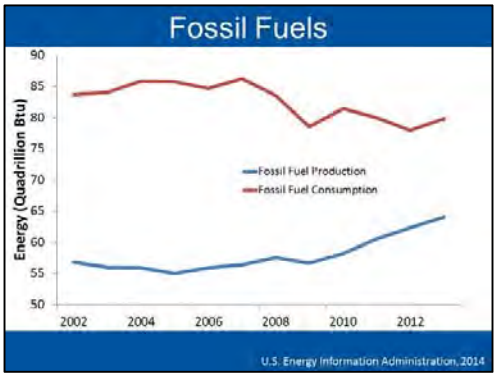


Slide 1

Slide 2

Show this slide and point out that the red line is consumption and blue is production.

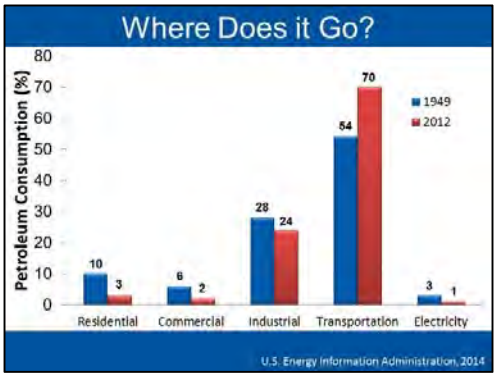
Activity: Distribute "Portrait of a Million". Allow participants to examine the million dots. Ask them to imagine that every dot is a barrel of oil (44 gallons each) and to think about the U.S. using 19 million barrels of oil each day. (source: eia.gov)



Slide 2

Slide 3

Though the other sectors have decreased their proportions of petroleum usage between 1949 and 2012, transportation has increased quite significantly.



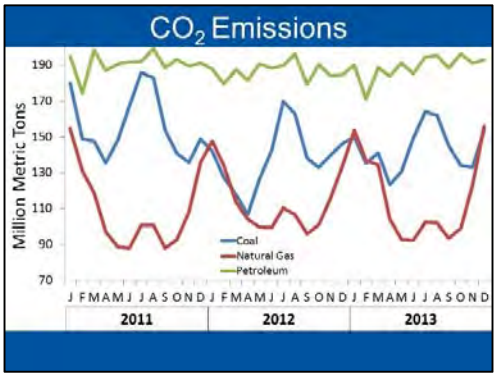
Slide 3

Slide 4

This graph shows the changes in CO_2 emissions for each of the three different types of fossil fuels (coal, petroleum and natural gas).

Q: Examine the graph on Slide #6 "CO_2 Emissions." What do you notice about CO_2 from petroleum vs. CO_2 from coal and natural gas?

A: Emissions from petroleum remain high throughout the year, whereas emissions from coal and natural gas have seasonal highs and lows.

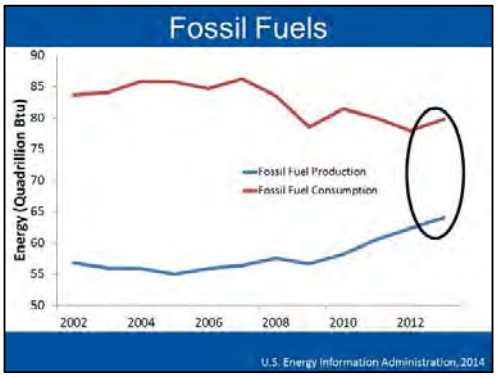


Slide 4

The emissions from petroleum stay relatively similar throughout the year since people are using petroleum for transportation which is relatively constant. The variations in natural gas and coal relate to the use of natural gas for heat in the winter and coal for electricity production for air conditioning in the summer.

Slide 5

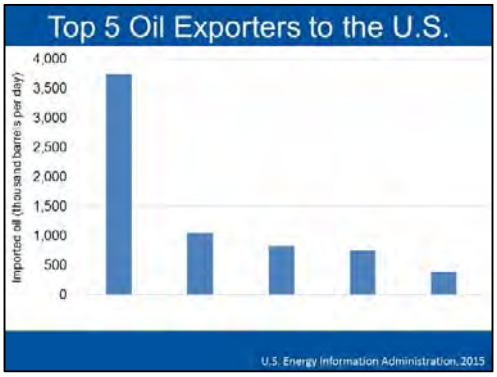
Over the years, in general, we have been increasing our production and decreasing our consumption. From 2012 to 2013 our production continued to increase but our consumption, instead of decreasing actually increased. If consumption continues to increase, which it most likely will without restrictions or incentives, we will continue to have to import our fuels from other countries. Depending upon political and climatic conditions, this may not be best for our economic or energy security.



Slide 5

Slide 6

This slide shows the top 5 countries that export their crude oil to the U.S. Saudi Arabia and Venezuela are both part of OPEC that has given us problems in the past. Recently, Saudi Arabia has worked to depress oil prices so that they are too low for fracking to be economically viable. This directly affects our production capability.



Slide 6

Slide 7

Problems with groups like Russia, OPEC, Nigeria, and the Middle East have caused issues for oil prices in the past and continue to play a role in oil prices today. This is why who we import oil from is an issue. In some ways they can control our foreign policy.

Higher gas prices lead to higher food prices and stifle the economy.

Slide 7

Slide 8

Hurricanes generally cause shortages of gas/reductions in production which lead to increased oil prices. These effects can be an annual event that take place in the summer when most people are doing more driving and vacationing. These storms may also be increasing in occurrence and/or severity due to climate change.

Slide 8

Slide 9

Oil production and transportation have significant effects on the environment as it is toxic and highly flammable. These headlines are all within the last few years.

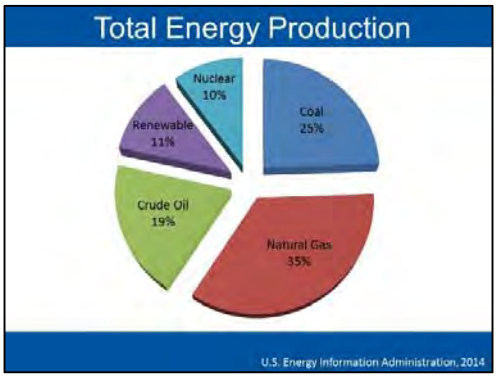
Slide 9

Slide 10

Total energy production in the U.S. is dominated by fossil fuels (79%). With the remainder made up of renewable fuels (11%) and nuclear power (10%)

Q: Why do you think natural gas makes up a larger portion than coal?

A: Natural gas production has increased recently due to lower emissions and the increased use of fracking which extracts natural gas from shale.

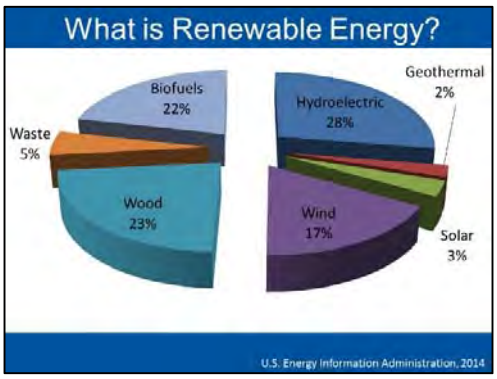


Slide 10

To get a better idea of fracking and the risks/benefits of natural gas, you can choose to show three short video clips from Switch Energy Project at http://www.switchenergyproject.com/education/energy-lab#natural-gas *The three videos recommended are " Benefits of Fracking," Risks of Fracking Water," and "Risks of Fracking Methane."*

Slide 11

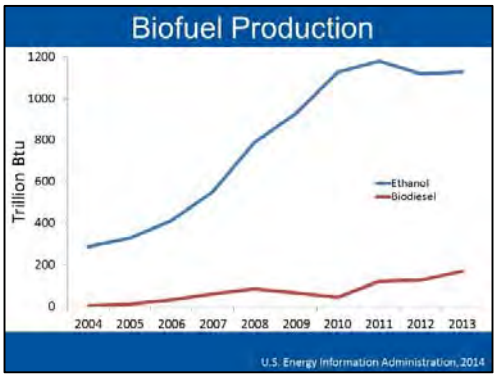
Renewable energy is made up of a number of different sources (hydroelectric, wood, biofuels, wind, waste, solar and geothermal). Currently hydroelectric is the largest source of renewable energy. Most of the biofuels represented here come from corn ethanol.



Slide 11

Slide 12

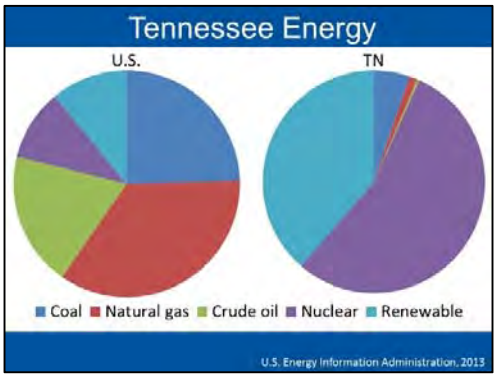
Biodiesel production began in 2001 whereas ethanol production began in the 1981. 12 years after commercial production had begun, ethanol had reached about 98 trillion Btu in production. 12 years after commercial biodiesel production began, biodiesel production has reached 171 trillion Btu. A federal tax credit expired at the end of 2011, potentially curbing the increase in ethanol production.



Slide 12

Slide 13

Data shown is from 2011. Of the renewable energy in TN, about 1/3 is from biofuels.



Slide 13

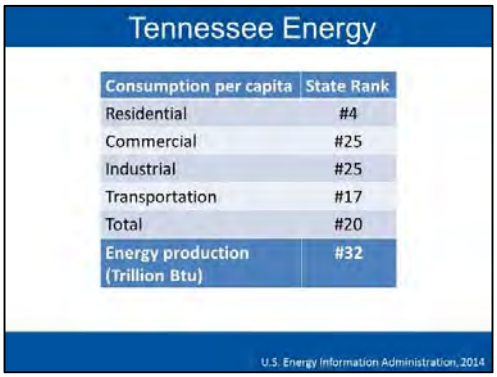
The breakdown is:

U.S.	Tennessee
Coal: 28%	Coal: 8%
Natural Gas: 34%	Natural Gas: 1%
Crude oil: 15%	Crude Oil: 0.003%
Nuclear: 11%	Nuclear: 56%
Renewable: 12%	Renewable: 35%

Of the renewable energy production in TN, __one-third__ of it is from biofuels.

Slide 14

TN energy prices are slightly higher than the national average which may be why some of our consumption is higher than average. Tennessee was #1 in residential electricity usage a few years ago, but the state energy office along with TVA has invested in energy efficiency across the state.



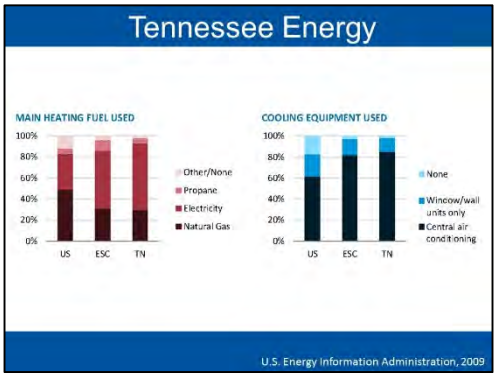
Slide 14

Q: What reasons could you give for TN being ranked #4 in the nation for residential energy usage?

A: Tennessee generally has hot, humid summers and cold winters, building codes are not as strict in TN as in other states, electricity is relatively affordable in TN.

Slide 15

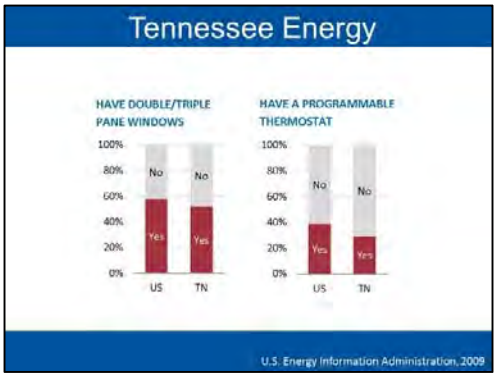
Tennessee uses more electricity than the national average and it also has more central air than the national average.



Slide 15

Slide 16

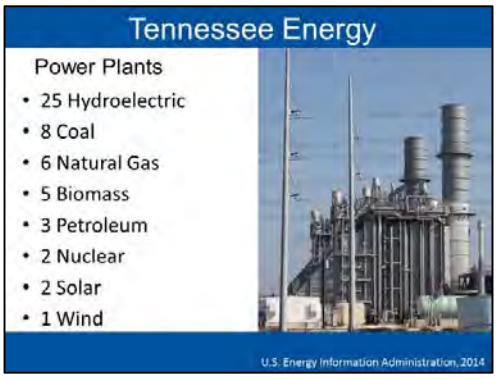
Even though housing in Tennessee is generally newer, they are less likely to contain energy efficient features like double/triple pane windows or programmable thermostats.



Slide 16

Slide 17

The 5 biomass power plants in Tennessee use waste materials as their feedstock. Two are associated with landfills and presumably use the methane produced for power production. The other 3 are associated with manufacturing of paper products and most likely use the waste product (black liquor) for their feedstock.



Slide 17

Slide 18

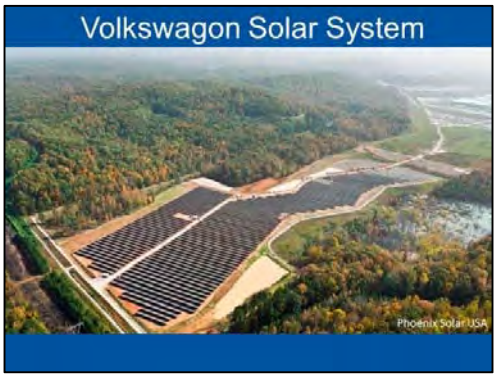
These wind turbines are operated by TVA. There's a total of 18 wind turbines that produce 29 MW of power, which is enough to power 3,780 homes. The turbines are 260 feet tall with 135 foot long blades. Energy is generated once the wind speed reaches 10 mph and are at full capacity at wind speeds of 25 mph. They shut down when winds reach 55 mph.

Slide 18

Slide 19

The Volkswagen solar system is near Chattanooga and contains 33 acres of solar panels which produce 9.5 MW of electricity to meet about 12.5% of the manufacturing plant's needs. It started in February 2014 and is the largest single solar installation at a U.S. automotive facility.

There is also a 5 MW solar farm in West Tennessee near Memphis that generates electricity for a local utility company and TVA.



Slide 19

Slide 20

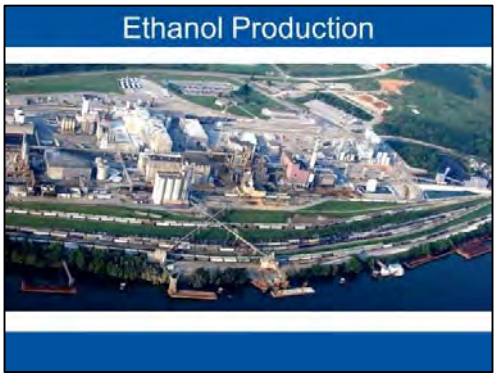
Wampler's Farm Sausage in Lenoir City, TN has a 30 kW solar power system they initially installed which paid for itself in 2.2 years. Then they installed the 500 kW system that you see in the background.

They also have a CHyP system from Aries Energy which creates hydrogen gas from biomass and then burns the hydrogen as a fuel to and creates water, carbon dioxide, carbon monoxide, and biochar. It uses 200 gallons of water for every 1 MWh of electricity in comparison to coal and nuclear power which require much more.

Slide 20

Slide 21

There are two ethanol plants in Tennessee. They are focused on grains like corn to produce ethanol and have a production capacity between 110 and 120 mmgy. There are currently some commercial facilities in Iowa that are producing cellulosic ethanol from corn stover (residue left of field after corn is harvested).



Slide 21

Slide 22

Milagro Biofuels has a facility with a capacity to produce 5 mmg/y from animal fats and soybean oil.

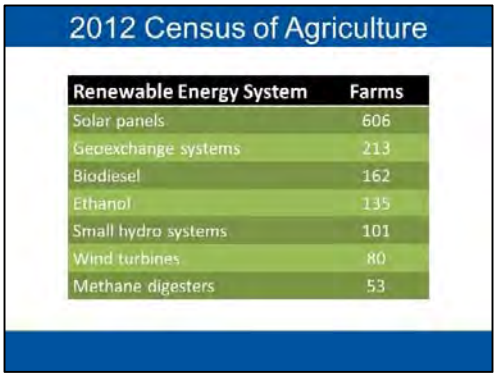
Sullens Biodiesel has a facility with a capacity to produce 2 mmg/y from waste oils.

NuOil, Inc. has a facility with a capacity to produce 1 mmg/y from mixed feedstock.

Slide 22

Slide 23

The number of renewable energy systems on farms in Tennessee is shown in the table based on data from the 2012 Census of Agriculture. There are currently over 350 systems that are producing energy from biomass energy sources (biodiesel, ethanol, methane digesters). Ask participants if any of them have any of these systems on their farms.

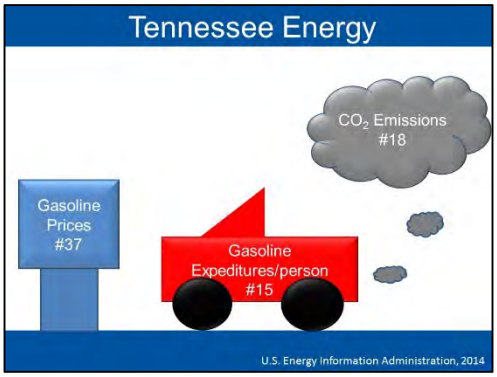


Slide 23

Slide 24

Currently, fuel prices are low compared with the national average but expenditures are high and CO_2 emissions are high. Biofuels can help reduce CO_2 emissions by having a renewable resource that takes up the carbon that it later releases during energy transformation. The fossil fuels release additional carbon that has been stored.

Show the Switch Energy video clip on Biofuels at: http://www.switchenergyproject.com/education/energy-101#biofuels



Slide 24

Slide 25

Let's try to find ways that we can turn Tennessee from a red state into a green one by finding alternatives that reduce dependence on foreign imports, create jobs, improve environmental quality with little increase on fuel prices.

Slide 25

Test their Knowledge - Questions for the audience

The U.S. uses __19 million___barrels of oil each day.

Q: Why do you think consumption dipped around 2008?
A: The economy crashed and not as many people were traveling, production of goods was down, etc.

Oil prices in the U.S. can be affected by relations with _OPEC_ and other oil-producing countries, the __weather__, and __accidents__ during oil production or transportation.

Q: Tennessee use of natural gas for heating is above the national average.
A: False

Q: The most common way to cool homes in Tennessee is the use of a central air conditioner unit.
A: True

The biomass power plants in TN use __waste materials__ as their feedstock.

Biofuels can assist with reducing the environmental impact of fossil fuels because the plants used to produce biofuels __recycle__ the carbon from the atmosphere.

Evaluation

Please give us your feedback regarding this activity. Your feedback will help us improve the activities you attend in the future.

Name of Activity: State of the Energy Industry	Date of Activity:

A. Instruction	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. The specialist was well prepared.	①	②	③	④	⑤	⑥
2. The specialist presented the subject matter clearly.	①	②	③	④	⑤	⑥

B. General Learning and Change	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. I have a deeper understanding of the subject matter as a result of this session.	①	②	③	④	⑤	⑥
2. I have situations in which I can use what I have learned in this session.	①	②	③	④	⑤	⑥
3. I will change my practices based on what I learned from this session.	①	②	③	④	⑤	⑥

C. Specific Learning How much ***did you / do you*** know about these subjects?	***Before this program I knew…***					***Now I know….***				
	Very little	Little	Some	Much	Very Much	Very little	Little	Some	Much	Very Much
1. *Distribution of energy production in U.S. and Tennessee*	①	②	③	④	⑤	①	②	③	④	⑤
2. *Reasons for expanding biomass energy production*	①	②	③	④	⑤	①	②	③	④	⑤
3. *Renewable energy production in Tennessee*	①	②	③	④	⑤	①	②	③	④	⑤

D. Specific Practices To what degree ***did you / will you*** do the following?	***Before this program I did…***					***In the future I will realistically do….***				
	Very little	Little	Some	Much	Very Much	Very little	Little	Some	Much	Very Much
1. *Support activities related to expanding renewable/biomass energy production*	①	②	③	④	⑤	①	②	③	④	⑤
2. *Seek information related to renewable/biomass energy*	①	②	③	④	⑤	①	②	③	④	⑤
3. *Produce renewable/biomass energy*	①	②	③	④	⑤	①	②	③	④	⑤

E. Satisfaction with Activity	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1. *I would recommend this program to others.*	①	②	③	④	⑤	⑥

F. Other comments?

Thank you for completing this survey!

TENNESSEE STATE UNIVERSITY
ANR-B12 2015

College of Agriculture, Human and Natural Sciences
Cooperative Extension

Bioenergy

State of the Energy Industry

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The U.S. energy industry produces our heat, electricity and transportation fuels and is largely dominated by fossil fuel production and consumption. This presents some difficulty in managing risks related to price volatility and uncertainty that these sources are known to encounter (especially for transportation fuels like petroleum). This document identifies current trends in fossil fuels and biofuels in the U.S. and the energy produced in Tennessee.

U.S. Fossil fuels

In general, overall U.S. fossil fuel production has increased since 2005 and consumption has decreased since around 2007. The U.S., however, still relies on other countries for over 3 billion barrels of crude oil each year (Fig. 1). In 2014, the top 5 countries that the U.S. imported oil from included Canada, Saudi Arabia, Mexico, Venezuela and Russia (Fig. 2). These imports can influence U.S. foreign policy because they provide other countries with some leverage over our economic security. Therefore, expanding energy production into other sources can enhance U.S. national security.

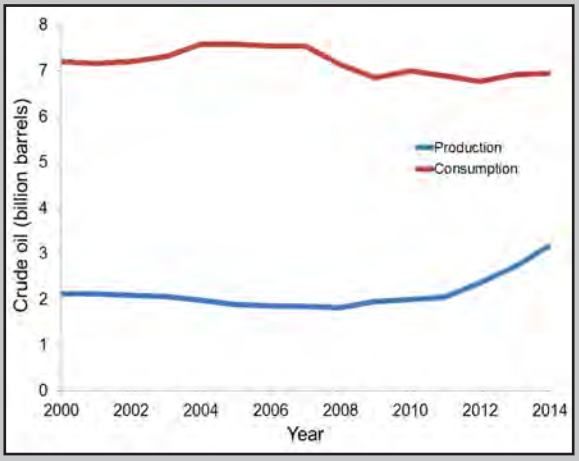

Figure 1. U.S. crude oil production and consumption between 2000 and 2014.

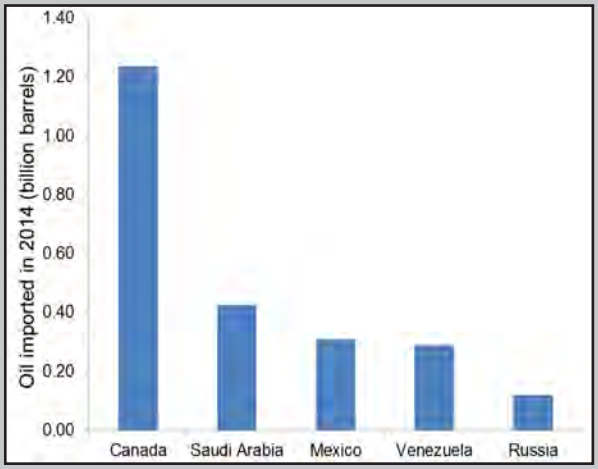

Figure 2. Top 5 countries importing oil to the U.S.

In 2014, the energy consumed in the U.S. largely came from fossil fuels (79%) with smaller portions from nuclear (9.5%) and renewable (11%) energy sources (Fig. 3).

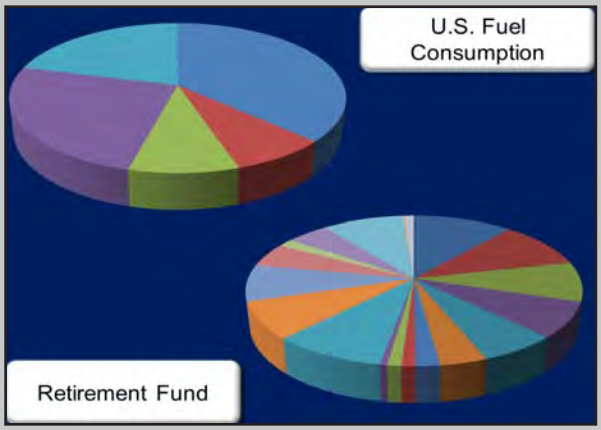

Figure 3. Comparison of U.S. fuel consumption (largest sections represent the fossil fuels) with a retirement fund.

Currently, biomass energy (mostly from wood and corn ethanol) makes up about 4.7% of total energy production. Having multiple investments in a retirement plan is a

good example of a way to mitigate risk from financial crisis and can be a goal for the U.S. energy sector (Fig. 3). In a well-structured retirement plan, a decrease in market prices will have less effect because it is balanced out by more stable investments. Having more sources of energy will provide greater stability in energy prices because if the cost of one source increases, another can be used in its place.

Tennessee Energy

Tennessee has few fossil fuel reserves and produces a lot of its electricity from nuclear and renewable (primarily hydropower) fuel (Fig. 4).

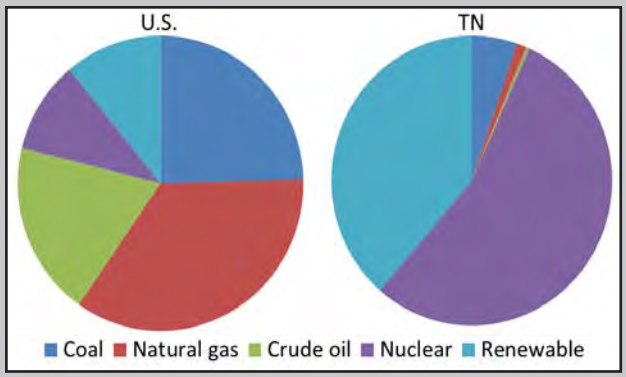

Figure 4. Comparison of U.S. and Tennessee energy production sources.

Tennessee currently has 52 power plants producing electricity and the fuel sources range from hydropower to fossil fuels to nuclear, wind, solar, and biomass energy (Fig. 5).

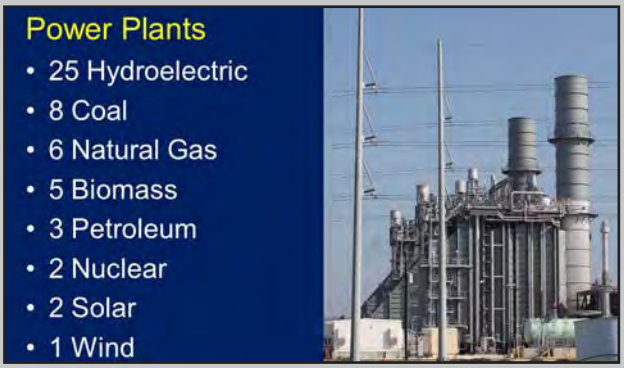

Figure 5. Sources of Tennessee electricity generation

Of the 5 biomass plants in Tennessee, two are associated with landfills where they presumably use the methane produced in these areas to produce electricity. The remaining three are located with paper product manufacturing plants which burn their waste product to produce electricity.

In addition to electricity production, there are two ethanol production plants in Tennessee that produce about 110-120 million gallons of corn ethanol each year. There are also some small commercial biodiesel production plants that produce 2-5 million gallons per year, primarily from waste cooking oils.

According to the 2012 Census of Agriculture, there are a number of different renewable energy systems employed on Tennessee farms (Fig. 6).

Renewable Energy System	Farms
Solar panels	606
Geoexchange systems	213
Biodiesel	162
Ethanol	135
Small hydro systems	101
Wind turbines	80
Methane digesters	53

Figure 6. Renewable energy on Tennessee farms (Census of Agriculture, 2012)

Tennessee is working toward increasing renewable energy production, particularly biomass energy, through different ventures in cellulosic ethanol and biodiesel production and education. This will provide benefits like job growth and economic development to the state since there are few fossil fuel reserves and the use of these sources will enhance environmental quality.

References and Resources

U.S. Energy Information Administration
www.eia.gov/state

U.S. Census of Agriculture
http://www.agcensus.usda.gov/Publications/2012/

TSU Extension Publications
http://www.tnstate.edu/extension/publication_index.aspx

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