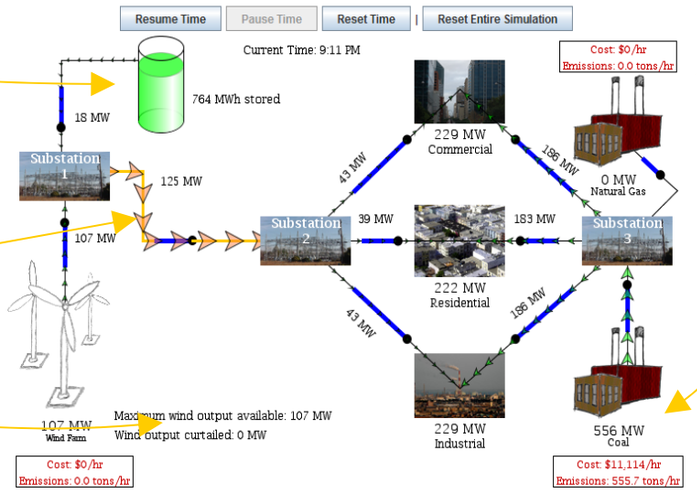
Quick Start -- Wind and Storage

The applet at http://tcip.mste.illinois.edu/applet4.php allows the user to explore effects on the transmission system as communities demand more power, and wind generation is added or increased. When the applet opens, a coal powered generator and a natural gas generator are available to deliver electricity to three communities, but only the coal generator is producing. The wind farm is not yet connected to the system. The demand from the communities (power professionals call the users of electricity "loads") varies throughout the day. Every time a person turns an appliance off or on the demand changes, but the total for the whole community follows a predictable pattern. The applet uses data from the Energy Information Administration to create a profile for an average day for each type of community.

Connecting substation 1 to the storage device allows you to consider how the future availability of **storage** technology might allow the system to use output from the wind farm that would otherwise be curtailed.

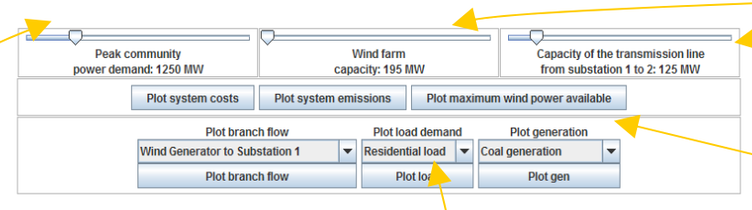
This line is yellow because it is at its 125 MW limit.

The **Maximum wind output available** depends on the wind resource and the number and size of the turbines. If the wind farm is producing more power than the transmission line between substations 1 and 2 can carry and there is no available storage, some of the wind output is curtailed.



When the applet opens a coal powered generator and a natural gas generator are available to deliver electricity to three communities, but only the coal generator is producing. As the demand from the communities changes you can see the generators adjust their power production. You can also see fuel costs and carbon dioxide (CO_2) emissions per hour for each of the generators. The only generation costs shown in this applet are fuel costs. Power utilities incur other costs that are not shown in this applet. Also, only CO_2 emissions are shown.

Change the "size" of the wind farm using the **Wind farm capacity slider.** Use the **Capacity of the transmission line between substations 1 and 2** slider to change the transmission capacity.



Power utilities must generate electricity just when the users need it. The applet shows the generators adjusting to the demand. Utilities and power professionals study when people typically use electricity and how much they use. System operators monitor demand and communicate with generation sites to be sure users of electricity get the power they need when they need it.

The **Peak community power demand slider** allows you to change the total peak demand. Peak demand occurs around 4:00 PM.

Clicking the **Plot load** button shows a graph of the power demanded by the **Residential load.** The graph shows Residenceburg using the most energy between about 5:00 and 8:00 PM. The drop down arrow on the right allows you to choose to plot the load for Commerceton or Industryville.

Click on the **Plot generation** button for a graph of coal generation. It is possible to plot graphs for all of the generators, all of the loads, all of the branch flows, system costs, emissions and available wind power.

The applet used in this exercise is available at http://tcip.mste.illinois.edu/applet4.php

Use this applet to explore some issues related to generation, demand and transmission of electricity. How does adding wind power affect the system?

http://tcip.mste.illinois.edu/applet4.php

- Watch the clock and notice how the demand from the communities changes throughout the day. What do you see?

  At what times is the power demand from the residential load lowest? When is it highest?

  At what times are the power demands from the commercial load and industrial load lowest and highest?

- The power utility wants to provide electricity to its customers at the lowest cost. It is also concerned about climate change and wants to keep its CO_2 emissions as low as possible, so it wants to add wind power generation. The site with good wind resources is some distance from the communities so the utility needs transmission lines to connect to it. Click on the switch to close the line between substation 1 and substation 2.

  How much power does the wind farm contribute to the communities?

  How does this affect the costs and emissions?

- Notice the slider for **Wind farm capacity**. The wind farm's capacity is 195 MW when the applet opens. This slider sets the maximum power the wind farm can produce under perfect wind conditions. The power utility could increase the wind farm capacity by building more turbines.

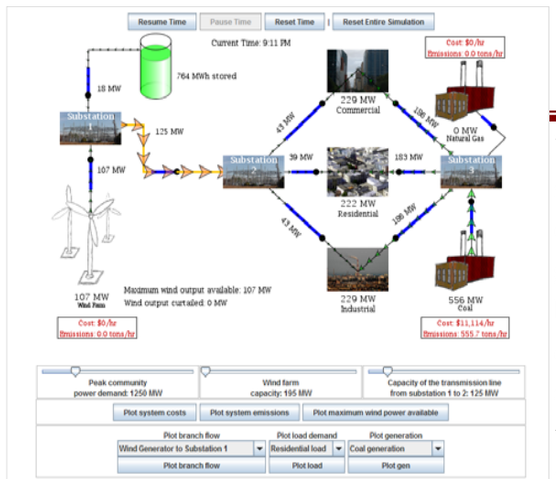
  What changes when you move this slider?

  How does the plot showing **system costs** change when wind is added to the system?

CONTACT:
Jana Sebestik
Office for Mathematics, Science, and Technology Education
Phone: 217-244-7486
Email: sebestik@illinois.edu

Wind and Storage Quick Start Guide

for the applet at http://tcip.mste.illinois.edu/applet4.php



The **Wind and Storage** applet simulates a utility that owns one coal generator and one natural gas generator. Each of these generators has the ability to supply 1500 MW of power. The utility plans to add a wind farm. The applet opens with the coal generator supplying all the power to the communities. If the coal generator is disconnected from the system or if the communities demand more than 1500 MW of power, the natural gas generator supplies power. Electricity generated from coal is relatively inexpensive, but burning coal generates significant CO_2 emissions. Natural gas generators produce less CO_2, but they are more expensive to operate. Scientists and engineers are working to find alternative sources that compete with the cost of coal and yet have low or no emissions. Adding wind powered generation is one possibility.

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TCIP Education is a joint project of the Office for Mathematics, Science, and Technology Education (MSTE) and Information Trust Institute (ITI).