The applet at http://tcipg.mste.illinois.edu/applet/ws 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.

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.

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\textsubscript{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\textsubscript{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.

Quick Start -- Wind and Storage

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.

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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.

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://tcipg.mste.illinois.edu/applet/ws
Use this applet to explore some issues related to generation, demand and transmission of electricity. How does adding wind power affect the system?

- 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 CO₂ 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?

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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).