The graduate students in the class summarized the group presentation described briefly below, and made recommendations for how Tompkins County might (hypothetically) replace the AES Cayuga coal electricity generating facility. Their summary can be found at the end of this written summary.

Because of the intense current discussion of natural gas, the group felt in the near term perhaps 25% Tompkins Counties coal-sourced energy could be replaced by wind. Compressed air storage in the Cargill Salt Mine appears to be the best non-hydrocarbon-based way to handle wind variability.

In the medium term, a mix of wind and natural gas is recommended.

In the long term, natural gas would be phased out in favor of Nuclear.

The summary powerpoint presentation is here.

### Natural Gas

The Tompkins County gas resource is the Utica Shale, not the Marcellus, but developing the Marcellus near the Pennsylvania border could develop some of the needed infrastructures. The value of the gas in the Marcellus (and probably the Utica) is high. Wells are proving to be very productive. For initial production rates between 0.2 and 2 million cubic feet per day a landowner with 12.5% royalty on gross gas production could realize $3,150 to $31,000 per month per well (tapping 80 acres). Links are given to a web royalty calculator.

The benefit of natural gas is that it produces half the CO$_2$ per unit combustion heat and none of the other noxious products released by coal or oil. Risks of aquifer contamination from hydrofracing are very low, but surface spills are a risk. Water contamination of all kinds could be almost entirely eliminated by hydrofracing with gelled propane rather than water.

Road usage would double during the drilling period, but this will have low impact on traffic (most traffic is at commuter times). However, large trucks do 1000’s of times more road damage than cars, and road repair costs will need to be recovered somehow by local communities.

Pipeline infrastructure needs to be increased and this is being done. Some of the wildlife issues are reviewed and a brief review is given of environmental legislation.

A combined cycle gas plant (NGCC) costs $400 to $800/kWe and replacing the 350 MWe AES Cayuga coal facility would therefore cost ~$140-280 million. The levelized cost of the electricity would be 3.9 to 4.7¢/kWh and highly sensitive to gas price. For this reason it is not recommended that AES Cayuga be converted to gas until the gas price stabilizes.
Student Conclusions:
“Environmental concerns are relatively minor and trumped by potentially large economic benefits accrued from hydraulic fracturing in the Marcellus Shale.”

“...the use of trucks for hydrofracking in Tompkins County will not significantly increase overall traffic. Nor will it emit enough CO₂ to make natural gas less attractive than burning coal. However, there will be significant road damage, and this is something the gas companies should pay the County for.”

The powerpoint presentation of the group and an extensive list of references and discussion are available at these links.

Wind and Solar

The 2011 Energy and Mineral Resources Renewables Group expanded on last year’s Class recommendation that, in the short term, 25% (or 87.5 MW) of Tompkins County 350 MW electrical energy needs be sought from wind and solar.

Most of the 25% must come from wind. Supplying 87.5 MW would require 175 Vesta V82 turbines (the best for local wind conditions) be placed on 8700 acres between Lakes Cayuga and Seneca (the optimal local location). Temporary use would be made of 280 acres; permanent use of 130 acres. Construction would cost $280 million. Assuming a 25 year life, a 6.5% discount rate, and a sales price of 5¢/kWh, the net present value of the wind farm investment is ~$78 million.

Eighty percent of wind farm insurance claims are for lightening strikes, but lightening protection systems can be installed for <1% additional cost. The risk from ice throws is minimal at downwind distances greater than 230 m from a turbine. Since rows of turbines are spaced 820 m apart, ice throw risk would exist across much of the farm when ice formation conditions existed. Occasionally turbines can self-destruct in high winds (see spectacular you-tube video in powerpoint presentation).

In Tompkins County it is possible to produce ~1kW at an installed cost of ~$3000 from the rooftop installation of 50m² of solar panels. Seven car batteries could store almost 5 days of power output. If 5% of the 2000 houses in Tompkins County installed such panels, rooftop solar could contribute ~1MW to the County.

Because wind and solar power is intermittent, energy storage on a large scale is needed. Of all the options (molten salt, pumped hydro, mechanical flywheels, conventional and flow batteries, and compressed air) the best local option is compressed air either in a portion of the Cargill salt mine or in balloons under Lake Cayuga. Compressed air storage would add 12 to 18% to the cost of the 87.5 MW wind farm.

The powerpoint presentation of the group and an extensive list of references and discussion are available at these links.
Breeder reactors will be needed in the future, and SMR (small modular reactors) may become attractive, but it is best to stick with tried and true, and the Generation III+ Westinghouse AP 1000 1154 MWe a pressurized light water reactor seems the best bet. The III+ rating indicates it represents a very substantial advance over the reactors now running (many simple passive safety features). It was licensed by the Nuclear Regulatory Commission in 2005. One unit is under contract in the US, and there have been 14 licenses applications. Twelve units are scheduled for operation in China in 2015.

Construction is the biggest cost for Nuclear plants. Westinghouse believes that the modular construction of the AP100 will cut construction time to between 30 and 36 months, and make construction costs will similar to coal. Fuel costs are very low and this makes nuclear a competitive baseline source of electricity.

Low and medium level waste from NYS can be disposed of only in Energy Solution’s Clive Operations in Utah. High level waste is stored on site. The Department of Energy has been collecting fees to build a permanent repository, but the Yucca Mt site has now been canceled. A lawsuit has been filed by the attorneys general of NY, Vt, and Conn contending that the health, safety and environmental risks are now not properly assessed. The industry has sued the Energy Department to suspend its (now irrelevant) disposal fee.

All three nuclear accidents (Fukushim, Chernobyl, and Three Mile Island) were caused or exacerbated by human error. Generation III+ reactors learn from these accidents and are safer because of their strong emphasis on simple, passive safety systems with few moving parts and powered by gravity, natural circulation, compressed gas, or batteries.

Greenhouse gas emissions, including mining, transport, and plant operation are very small. Nuclear would be more attractive under cap and trade. Uranium reserves are abundant.

Disposal of heat is a potential issue. Heat from the 830 MW Bell Station reactor proposed for Lake Cayuga before AES Cayuga was built would have added 6 billion Btu more to the Lake rather than the 1.3 billion Btu added by AES Cayuga. The added heat could delay the winter turnover of the lake and have biological consequences.

The US Government supports Nuclear construction through tax credits, loan guarantees, and by covering delays caused by factors outside a company’s control. States also have ways to encourage Nuclear construction. The US is a member of the Global Nuclear Energy Partnership which supports R&D into nuclear energy.

The Nuclear Regulatory Commission regulates construction and operation. The licensing and oversight processes are described in detail. Comments are made on the closing Yucca Mt, and on ways that the public perception of Nuclear might be changed.

The powerpoint presentation of the group and an extensive list of references and discussion are available at these links.