Amongst these are a number of market drivers that influence such decisions:

- Low Cost Energy from alternative sources, such as wind and wave power, is increasing
- Greenhouse Gas Emissions to atmosphere need to be reduced to much lower levels
- Elimination of airborne ‘pollutants’ to improve air quality
- Decreasing dependency on Fossil Fuel paralleled with the need to reduce pollution

With our past experience of various fuel types and compositions, Siemens is able to provide a cost-effective solution, with low emissions and an operational capability on fuels outside the normal standard fossil fuel range.

In 2006, in response to the demand for energy, increasing fuel costs and electrical power shortages, the University of New Hampshire (UNH) took delivery of a new Siemens SGT-300 gas turbine package, as part of the Combined Heat & Power (CHP) plant at its Durham Campus.

The CHP plant was required to help provide for the energy needs of the 13,000 person campus, in an efficient and cost effective manner. The plant design centered around one 7.9MW(e) SGT-300 combustion turbine and heat recovery steam generator with auxiliary duct firing. The unit was installed with a standard, dual-fuel, Dry Low Emissions (DLE) combustion system, enabling it to meet stringent regulatory limits on exhaust emissions to atmosphere.

A subsequent phase of the project was to include the use of renewable, carbon neutral, processed landfill gas (PLG) as an alternative to liquid fuel and natural gas. This extension to the turbine application would reduce the University’s dependence on fossil fuels, proving it to be both a fiscal and an environmentally responsible initiative.

Landfill gas is a natural by-product from the decomposition of organic waste, comprised primarily of methane, a potent greenhouse gas (over 20 times* more harmful to the atmosphere than carbon dioxide *source: US Govt. EPA) plus nitrogen and carbon dioxide. It is further ‘contaminated’ by moisture, Sulphur compounds, Siloxane, Volatile Organic Compounds (VOCs) and Oxygen.
Fig. 2: The $49m funded University project commenced with the construction of a gas processing plant at the nearby landfill site in Rochester. The plant purifies and dries the gas before compressing it down a purpose built, 12.7 mile long, underground pipeline to the CHP plant at the Durham campus.

This application provides for the landfill gas to be captured, converted, blended with Natural Gas and used as a renewable energy source, instead of allowing it to escape into the air.

The landfill gas collection system consists of more than 300 extraction wells and miles of collection pipes. The extracted landfill gas is compressed and passed to the processing plant where it is cleaned and enriched (by removing the Carbon Dioxide) thus making it suitable for burning in the SGT-300.

The processed landfill gas (PLG) contains Nitrogen as the dominant inert species, resulting in the gas being some 30 percent weaker than a ‘normal’ pipeline quality natural gas.

UNH are justifiably proud of their investment and as such invite us to view their plant in operation, go to www.energy.unh.edu/ to view their website, an extract of which is shown in Figure 4. It allows the viewer direct access to ‘live’ data on the performance of the unit, showing the unit output power, the fuel composition that it is burning and the level of emissions it is producing.

**UNH /Siemens SGT-300 reported statistics:**
- Student population over 13,000
- Ambient temperature range: -28°C to +32°C
- Unit continuous operation 8,500 hrs/yr
- In commercial operation since 2006
- >3800 hrs Liquid operation from November 2008 to March 2009
- Unit commissioned on PLG, 30 April 2009
- >8500 hrs PLG operation to date
- Up to 7.8 MW(e) electrical power output
- Up to 12MW of heating and cooling
- Overall CHP efficiency of 77%
- >10ppmVd and >25ppmVd at 100% and 59% load, respectively, for NOx, SOx and CO
- Tri-fuel operation: Gas fuel Wobbe index range 32 – 49MJ/m³ (Natural Gas, Processes Land-fill Gas and Liquid)
- Tri-generation (heating, cooling, electrical power)
- Installation of Active Pilot (Dynamic Fuel Schedule management software) in October 2009, modified to support site anomalies. As the PLG, blended with Natural Gas, varies in composition it can lead to high ‘Band 1’ combustion dynamics and “Flame Out”
- UNH runs predominantly at part load, varies load regularly
- Wobbe Index variation and PLG volume, has proven wider and more frequent than expected
- 99.02% average availability for the SGT-300 from November 2009 to March 2010

The SGT-300 gas turbine was designed from the outset to have low emissions combustion (DLE) as a capability and is based on the Lincoln generic DLE solution. This DLE combustion system offers among the widest operability limits in terms of fuel type, load operation and low emissions (it has some of the lowest levels recorded across the SGT product line). The recent addition of ‘Active Pilot’ fuel management software, has allowed for wider variations in PLG composition to be managed, whilst still achieving the required emissions to atmosphere.

**Fig. 3: UNH Plant Schematic.**
Prior to this project, Siemens were already gaining experience on an earlier SGT-300 project, using depleted wellhead gas, containing high levels of Carbon Dioxide. Additional supporting development testing, using a high pressure combustion rig, along with ignition demonstration through an atmospheric facility, enabled the standard combustor to be released for this application.

Fleet experience continues to grow across a wide range of applications, many years after this initial work had been completed. This expanded fuels capability provided the basis for working with UNH, to define a suitable operating window, culminating in achieving tri-fuel operation, i.e. ability to operate with Natural Gas, Processed Landfill Gas, as well as Distillate Fuel.

In summary, the SGT-300 operating at the UNH campus runs on three fuels (PLG, NG and distillate) and achieves NOx guarantee limits throughout the load range, in standard DLE configuration, without hardware changes or additional monitoring.

- Unit is meeting site energy demands (up to 7.8 MW(e) and 77% overall CHP efficiency)
- Unit can tolerate a variable fuel energy content level, Wobbe Index range 32 – 49 MJ/m³
- Unit has maintained emissions level requirements

Acknowledgements:


Our thanks to the University of New Hampshire, for both their support and for allowing us to mention the developments that have come to fruition, through their installation.
Quotes: DURHAM, N.H. May 19 /PRNewswire/ — The University of New Hampshire’s EcoLine™, a landfill gas-to-energy project that uses purified methane gas from a nearby landfill to power the campus, is complete, university officials announced. The five million square-foot campus will receive up to 85 percent of its electricity and heat from purified natural gas, making UNH the first university in the nation to use landfill gas as its primary fuel source.

“This massive project, more than four years in the making, will reduce our dependence on fossil fuels and stabilize our fuel source and costs,” says UNH President Mark W. Huddleston. “EcoLine™ showcases UNH’s fiscal and environmental responsibility and secures our leadership position in sustainability.”

EcoLine™ is a partnership with Waste Management’s Turnkey Recycling and Environmental Enterprise (TREE) in Rochester, N.H. where the naturally occurring by-product of landfill decomposition is collected via a state-of-the-art collection system consisting of more than 300 extraction wells and miles of collection pipes.

After the gas is purified and compressed at a new UNH processing plant at TREE, it travels through a 12.7 mile pipeline from the landfill to UNH’s cogeneration plant, where it will replace commercial natural gas as the primary fuel source. In operation since 2006, UNH’s cogeneration plant captures waste heat normally lost during the production of electricity and uses this energy to heat campus buildings.

Total cost of the project, which included construction of the pipeline and the processing plant at TREE, is $49 million. UNH will sell the renewable energy certificates (RECs) generated by using landfill gas to help finance the overall cost of the project and to invest in additional energy efficiency projects on campus. In addition, UNH will sell power in excess of campus needs back to the electric grid.

“By selling the RECs from EcoLine™, UNH will further fund its aggressive plan toward climate neutrality,” says Tom Kelly, UNH chief sustainability officer and director of the office of sustainability. “With this climate action plan, called WildCAP, UNH has committed to lowering its emissions by 50 percent by 2020 and 80 percent by 2080.”

The University of New Hampshire, founded in 1866, is a world-class public research university with the feel of a New England liberal arts college. A land, sea and space-grant university, UNH is the state’s flagship public institution, enrolling 11,800 undergraduate and 2,400 graduate students.

DURHAM, N.H. – The U.S. Environmental Protection Agency (EPA) has named the University of New Hampshire’s EcoLine™ as a Project of the Year, the agency announced last week. EcoLine™ is a landfill gas-to-energy project that uses purified methane gas from a Waste Management landfill in Rochester to provide up to 85 percent of campus power. When EcoLine™ started in May 2009, UNH became the first university in the nation to use landfill gas as its primary fuel source.

“We are proud to recognize UNH’s EcoLine, a Landfill Methane Outreach Program partner which is turning trash into a clean and profitable source of energy,” said Gina McCarthy, assistant administrator for the EPA’s Office of Air and Radiation. “This project, and others like it, is helping us transition into a clean energy economy and make important greenhouse gas reductions.”