Introduction to Advanced Combustion

Services provided in modern societies are driven, in large part, by energy liberated during the combustion of carbon-containing fuels. Historically, combustion devices have been inexpensive to build, fuels have been readily available, and the major atmospheric emissions (CO_2, H_2O) have been considered benign. Despite recent oil price increases and ever tightening emissions controls, combustion driven engines remain the most economical source of useful work.

Constraints on CO_2 emissions will change the competitive environment for combustion-driven devices. With today's technology, the thermodynamic efficiency of combustion devices is between 20% and 60%. The systems at the high end of this range are subject to high capital cost (combined cycles) or unacceptable criteria pollutant levels (diesel). Improving efficiency, reducing emissions and decreasing complexity could all have significant impact on total greenhouse gas emissions, possibly with modest capital outlay.

Since its inception, GCEP has conducted research in the area of advanced combustion. Projects in combustion informatics, controlled combustion, combustion sensors and low-irreversibility combustion have all been completed. Information on those projects may be found in GCEP's technical reports from 2006 and 2007.

Currently, Professor Tom Bowman and his colleagues are performing research on the design and optimization of synthetic oxygenated fuels. Such a fuel might be synthesized from a variety of inexpensive and/or low-net-carbon feedstocks, and could enable the market penetration of diesel and hybrid-diesel automobiles. Recently the team has measured, for the first time, key steps in oxygenated fuel combustion kinetics.

Professor Chris Edwards is pursuing engines which reduce exergy loss by conducting combustion at states of extreme energy density. His group has built a test apparatus which should be capable of extracting work at twice the efficiency of today's simple cycle engines.