The High Efficiency Combustion Laboratory develops advanced concepts and technologies for energy-efficient and low polluting gas and oil-fired heating systems for residential and commercial applications.

An area of concentration is integrated systems, where multiple functions are provided from one energy source. Significant effort is being expended on ultra-high-efficiency present and next-generation (ēKocomfort-type) systems combining space heating, water heating and ventilation. The laboratory can determine the performance of up to 6 prototype integrated systems. One such unit under development is a high efficiency condensing fireplace. Another is a highly-modulating integrated space-water-ventilating system with advanced learning-based controls.

The facility is designed to meet the needs of equipment manufacturers, energy suppliers, end-users, policy and program developers and standards organizations in assuring rapid development and implementation of the most suitable energy-efficient equipment for the Canadian market.

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CETC CANMET ENERGY TECHNOLOGY CENTRE

INTEGRATED ENERGY SYSTEMS

CLEAN ENERGY TECHNOLOGIES

RESIDENTIAL COMMERCIAL COMBUSTION

The Residential/Commercial Combustion Laboratory is part of CETC-Ottawa's Sustainable Buildings and Communities Group (SBC). The Group has a research staff of some forty scientists, engineers and technologists, with world-wide networks in the fields of combustion technology. The laboratory is one of North America's leaders in the characterization and development of efficient, low-polluting, combustion-based home and industrial heating systems.

CETC-Ottawa's scientists and engineers work closely with industry to develop cost-effective, combustion-based techniques and technologies for the North American market-place. In addition, the Group can assess the suitability of a wide range of fuels including natural gas, No. 2 fuel oil, propane, heavier fuel oils, waste oils and biomass-based fuels, in order to help reduce costs and emissions and increase appliance operating efficiencies.

High Efficiency Combustion Laboratory

Facilities Supporting this Research Include:

- a high efficiency laboratory for the development and performance determination of up to six Integrated systems;
- a controlled environment (temperature, pressure) test cell for combustion system performance trials of combustion systems;
- a source-emission sampling system for gas-phase and particulate matter emissions;
- mathematical models and simulation software using fuzzy logic, neural networks and thermo-hydraulic models for advanced design and control of integrated systems;
- natural gas, oil and wood testing cells for furnaces, woodstoves, fireplaces, heaters, boilers and service hot water systems; and
- pilot-scale gas and oil-fired steam and hot water commercial boilers.

Canada

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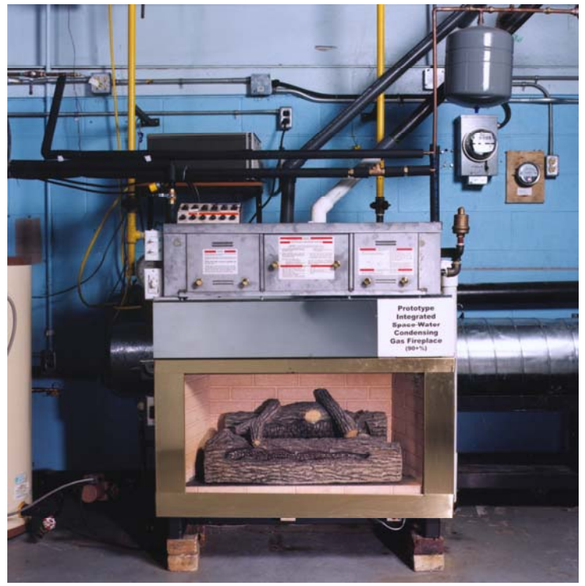

Prototype Integrated Space-WaterCondensing Gas Fireplace

CETC-Ottawa's laboratory facilities are designed to meet the needs of:

- manufacturers of residential/ commercial combustion equipment: furnaces, boilers, fireplaces, water heaters, integrated systems, burners, controls, rooftop heaters, space heaters, venting systems, heat ex- changers, fresh air ventilators and distribution systems;
- energy suppliers, including gas utilities, oil companies and electric utilities;
- end-users such as home builders, architects, engineers and the public-at-large; and
- developers and adopters of codes, standards and regulations governing the efficiency, safety and environmental aspects of combustion systems.

CETC-Ottawa's R&D Facilities

CETC-Ottawa has state-of-the-art facilities to determine the performance of residential and commercial combustion systems, both within the laboratory itself and at in-situ-installations. These facilities enable staff to determine transient and seasonal performance relating to both efficiency and pollutant emissions.

In addition, other aspects of combustion performance can be assessed, including the potential for corrosion or degradation, and the correctness of approach used in venting combustion products. The laboratory has strong skills in advanced control technology and expert systems capable of learning and based on fuzzy logic and neural networks. Additional skills lie in computer modelling of combustion and heat distribution systems, and in the determination and minimization of indoor air quality problems due to combustion appliances.

Analytical Capabilities

Flue gas measurement capabilities include the continuous measurement of CO_2, O_2, CO, NO_x, SO_x, particulates and gas-phase polycyclic aromatic hydro-carbons (PAHs), their temperatures and flow rates. The laboratory also has the capability to determine total emissions of N_2O, condensate, particulates, trace metals and heavy organic compounds, as well as species differentiation.

Test Equipment

The laboratory uses continuous data logging systems tied to data-reducing advanced computers in order to carry out performance trials for space and/or hot water heating, either naturally aspirating or power vented. Control systems have been set up to carry out standard and non-standard cyclic performance trials.

Residential Heating Systems

There is a major opportunity to increase the efficiency of residential combustion systems by integrating two or more energy uses with one energy generator. At the same time, overall pollutant emissions can be reduced, including global warming gases while enhancing user satisfaction and desirability can be enhanced.

CETC-Ottawa researchers work with utilities, fuel suppliers, manufacturers and policy makers in a number of residential areas such as:

- developing standards for the seasonal efficiency of furnaces, water heaters, integrated systems and fireplaces;
- developing guidelines for optimizing the design and performance of gas-fired combined space/water systems and for integrated space/water/ventilating systems,
- developing oil-fired integrated systems for low-energy housing;
- developing retrofit condensing gas furnaces;
- developing learning-based fuzzy logic controls for residential combustion systems;
- developing guidelines for the safe operation and venting of combustion systems;
- carrying out field trials on fireplaces, furnaces and integrated systems to determine real-life performance and opportunities for improvement;
- developing technology for high efficiency, hot water generation;
- determining how best to integrate fossil fuel and biomass-fired systems for combination systems; and
- developing design characteristics for next generation, high efficiency, natural gas and wood fireplaces.

Commercial and Industrial System

Most commercial combustion systems are designed for and operate at much less than optimal efficiency. This wastes energy and money.

There is an opportunity to develop systems with real-use efficiency improvements of 15-40%, particularly for Canadian conditions and usage patterns.

CETC-Ottawa is working with utilities, manufacturers and policy makers to realize this potential by:

- developing seasonal efficiency and emissions standards for commercial heaters and boilers;
- conducting field trials on advanced rooftop units and on commercial water heaters;
- developing optimization models for hydronic heat distribution in large buildings;
- developing advanced learning-based expert system controls for space and water heating; and
- developing design guidelines for advanced commercial boilers and heaters.

Advanced Concepts Integrated Laboratory

The Advanced Concepts Integrated Laboratory concentrates on next generation systems for residential and commercial applications, where electricity, generated from non-conventional technologies, becomes an important component for the integrated heating system, for residential and commercial co-generation-like applications. Prototype thermophotovoltaic (TPV) and thermoelectric (TE) cascaded systems are under development. Here electricity is generated with no moving parts and the heat is recovered for space/water applications. Gas lighting, whereby light is generated by a highly luminous flame and then transported to applications through light pipes, while the heat is recovered for space/water applications, offers 10-fold GHG reductions. Alternative fuels, such as alcohols, bio-fuels, and hydrogen are being examined for high-efficiency combustion applications for buildings.

Advanced Concepts Integrated Laboratory