Preliminary Draft

CABA White Paper Proposal

Automated Control Systems for Zero Emission Buildings

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Because of out-of-control upstream methane emissions from “fracking”, there is an urgent need to eliminate the use of natural gas for both space heating and peak power production. Particularly in cold climate locations, this a demanding challenge and the purpose of the CABA White Paper is to review how a new generation of automated building controls can play a key role in achieving zero emission (ZE) building performance.

Starting with a review of relevant climate change research, this two-year project will support the development and commercialization of ZE buildings with the White Paper final recommendations being reported prior to the UN Climate Change conference (COP 26) in November 2020. By the November 2020deadline, the dire consequences of out-of-control “fracking” will be more apparent and it will be recognized that there is a need to eliminate the use of “fracked” gas on a global scale.

For cold climate locations, the first step in eliminating natural gas heating is to radically upgrade the thermal performance of the building envelope, including window and door components. The CABA White Paper will specifically focus on a new generation of Smart, High-R windows where both the R-value performance and the solar heat gain coefficient can be dynamically varied both seasonally and diurnally.

The second ZE retrofit step is to replace the natural gas furnace with an electric heat pump that utilizes only clean off-peak power only. The CABA White paper will specially focus on the use of an integrated mechanical system where a single liquid-to-liquid heat pump is used to extract and upgrade heat from a cold-water tank with the heat produced then being stored in a hot water tank. If both the hot and cold water produced can be usefully utilized, there is inherently a 100% improvement in heat pump efficiency. In the summer, heating and cooling loads are roughly balanced but in the winter heating loads dominate and the excess cold water can be usefully utilized to collect low grade heat from various renewable energy sources, including: waste water, geothermal, passive solar and wood stove operation. The hydronic heat pump only operates when clean, off-peak power is available and a key task of the HVAC control systems would be to determine the amount of hot and cold water to be stored.

With existing Smart Home technology, the core component is a programmable thermostat. By lowering room air temperatures during the night or when the building is unoccupied, energy savings can be achieved. The problem is that for well-insulated, electrical heated buildings, the main impact of a night set back is to simply cool down the interior thermal mass which then has to be heated up again in the morning using peak power typically generated by gas power plants. In locations such as Ontario, there is substantial excess clean power available during the night and as a result, conventional programmable thermostats can increase not decrease greenhouse gas (GHG) emissions.

To address the limitations of conventional programmable thermostats, the CABA White paper will specially focus on an alternative strategy where all rooms are kept at a lower temperature with the emphasis on a fast response to achieve comfort conditions. Heating and cooling is delivered by radiant ceiling panels with the hot and cold water being delivered in pulses. Each pulse fills the panels and then there is a delay for a period of time to allow the water temperature to approach room temperature. Operative temperature thermostats are used to initiate the zone valve opening and by focusing on mean radiant temperatures, comfort conditions are realized faster. The fast response controls can be initiated by voice activation, occupancy sensors or manual operation.

With the commercialization of decentralized renewable energy sources such as solar PV and wind, Smart Grids play an increasingly important role. Typically, the

local utility company operates the Smart Grid with excess clean power being thermally or battery stored. A common complaint is that the local utility company pays too little for the excess on-site power sold to the grid or alternatively, the local utility company charges homeowners too much for the excess off-peak power purchased from the grid.

The final component of the CABA White paper will focus on an alternative grid control system that will allow a cloud-based, internet retailer to both purchase and sell excess off-peak power at more competitive rates.

In Ontario, there is an independent grid authority that purchases power from various power producers at pre-agreed prices. The problem is that during the night when excess power is available, Ontario sells this excess power at a loss of about $1 billion per year to neighboring States and Provinces. As a ZE building incentive, an alternative proposed strategy is for a cloud-based internet retailer to purchase this excess power from the grid authority and then resell this off-peak power at discounted prices to home owners. Based on a monitoring system, a key condition of any incentive program would be that ZE performance has to be achieved year-round.