This paper discusses an opportunity to improve energy efficiency of HVAC systems by extending operating hours of Economy Cycle, an energy management control function, via changing its control philosophy, through optimisation of control strategies, control parameters and control limits, which determine its operation.

Key words: BMS, Economy Cycle, Energy Efficiency, Cost Effectiveness, Energy Management

The main proposed modification is to use Economy Cycle, not only as a first stage of cooling when conditions of outside air are suitable (standard practice), but also as a first stage of heating, and for pre-cooling.

It is estimated that the proposed enhanced use of Economy Cycle would prolong its operations by 30-50% (in temperate climate conditions), significantly reducing energy consumption of HVAC systems and significantly improving IAQ of conditioned spaces (Economy Cycle uses 100% outside air in most of the cases).

Emphasis of the paper is to highlight cost effectiveness of the proposed BMS control modifications, as there are no requirements for modification of Economy Cycle’s infrastructure, but programming only.

New control philosophy is demonstrated via control diagrams that show how this enhanced control function can be easily implemented on any BMS.

The paper details various standard practices on how Economy Cycle is operated on BMS, and explain opportunities for enhanced use of this control function. It also details Economy Cycle’s operational and maintenance requirements in order to maximise its energy efficiency.
Dependency between improvement of energy efficiency of Economy Cycle and proper selection of cooling, heating and dead space temperature bands, is also given as a major factor to optimise this BMS control feature.

The Economy Cycle is an energy-conservation measure that utilises outside air for space conditioning, It:

- Reduces energy consumption
- Reduces energy cost
- Improves IAQ (Indoor Air Quality)
- Reduces HVAC maintenance costs

Economy cycle traditionally allows for a 15% - 20% reduction of energy consumption of AC compressors and improved indoor air quality, in temperate climate conditions.

**Background**

Economy Cycle is typically used at centralised HVAC systems with CHW, direct expansion (DX) AHUs (Air Handling Units) and ducted packaged DX systems with motorised O/A dampers connected to a central (BMS) or local HVAC control system. Typically, AHUs facilitate this energy-conservation measure, as they are source of mechanical ventilation for buildings.

When an air conditioning unit operates in cooling mode, it typically cools supply air to 12-13 °C (for chilled water systems) or 8-9 °C (for DX – direct expansion systems). It should be noted that during mild weather conditions cooling requirements can be satisfied with a higher temperature of supply air – even as high as 20 °C

Economy Cycle is typically used for cooling, with or without AC compressors, thereby reducing the energy consumption of associated AC units (DX AC units, chillers and the likes).

The Economy Cycle is normally one of the energy saving strategies of complex HVAC control systems or BMS.

Minimum information required for the Economy Cycle program includes:

- Return air temperature
- Outside air temperature
- Control strategy (Conditions for engagement and disengagement)
- Control parameters (Conditions for engagement and disengagement)
- Time delays for engagement and disengagement
- Override criteria
- Relative humidity (RH) of return air (%) or conditioned spaces
- Absolute Humidity of Outside Air (O/A)

Minimum equipment required for the Economy Cycle program includes:

- Field sensors (O/A and R/A, temperature and RH)
- Controllers and data processors
- Economy Cycle software
- Automated operation of outside and return air dampers
- Optional provision of relief air
- Relief damper
- Outside air cross section inlet to accommodate 100% O/A

*Current Practices*

Economy Cycle, in majority of cases, is underutilised due to an inefficient control strategies and control parameters.

Typical control strategies for engagement of Economy Cycle include:
a) Outside Air (O/A) temperature is lower than the air temperature set point for the Economy Cycle (16°C) – cooler air than space air temperatures is used to reduce load of AC compressors – disadvantage of this method is that it overlooks that warmer air can also be utilised if it has less energy than return air.

b) O/A temperature is similar to Supply Air (S/A) temperature (12-13°C) – this strategy severely disadvantages use of Economy Cycle (minimises its operating hours) as it only operates when outside air temperature is close to the Off-Coil S/A temperature.

c) RH of O/A is lower than 60% or if Economy Cycle is within a given operational temperature limits. This approach overlooks that sometimes even higher RH of O/A (say 70%) does not compromise engagement of Economy Cycle, if outside air temperature is in the lower or mid range – 70%RH and 17 deg C.

d) Total energy (enthalpy) of O/A is less than total energy (enthalpy) of R/A – this is the most efficient control strategy (cooling mode).

Typical O/A operational limits for the Economy Cycle:

a) Temperature (10-20°C)

b) Relative Humidity (RH) – less than 60%

**Opportunity for optimisation**

Use Economy Cycle for:
- pre-cooling,
- cooling and
- heating.

Control Economy Cycle based on:

- enthalpy or temperature differential of O/A and R/A
- wide O/A temperature limits (5-30 deg C – adjustable)
- wide O/A High and Low absolute humidity limits (adjustable)
- wide space air temperature cooling, heating and dead band temperature bands
- time delays for engagement and disengagement (adjustable)
Precooling and Cooling modes of operations of Economy Cycle

Heating Mode of operation of Economy Cycle