E-Stack Low Energy Ventilation

An Introduction

Breathing Buildings
The Courtyard
15 Sturton St.
Cambridge
CB1 2SN

Tel: 01223 450060
Email: info@breathingbuildings.com
Contents

• Company Background
• Natural Ventilation – Issues
• Low-Energy Ventilation Strategies
• E-Stack Systems and Installations
• Summary
Section 1

COMPANY BACKGROUND
• Spin out from Cambridge University BP Institute (Joint Cambridge / MIT Research).

• Research discovered a more efficient scheme of low-energy ventilation.

• Consultancy and product strands to business. Manufacturers of the e-stack products.

• Company aims to “to have as significant an impact on the energy consumption of the built environment as possible”. 
Section 2

NATURAL VENTILATION - ISSUES
Energy Use In Buildings

Differences in energy systems

Natural Vent | Typical
Gravity / Wind | Fans
Insulation / Mass Night Cooling | Chillers
Solar / Occupants Recycling heat | Heaters
Natural Lighting | Electric

Primary Energy Use of Naturally Ventilated and Air-Conditioned Offices in the UK
Ventilation Issues

- Minimum ventilation
- Energy use
- Noise
- Cold draughts
- Maximum temperatures
## Current Ventilation in Schools

### 8 schools, all post-1995 BRE/DfES study


<table>
<thead>
<tr>
<th>School</th>
<th>N</th>
<th>Ventilation rates (L/s per person)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 3 (%)</td>
<td>&lt; 8 (%)</td>
<td>max</td>
</tr>
<tr>
<td>West Grove</td>
<td>10</td>
<td>3 (30)</td>
<td>9 (90)</td>
<td>8.7</td>
</tr>
<tr>
<td>Moorside</td>
<td>10</td>
<td>2 (20)</td>
<td>10 (100)</td>
<td>6.5</td>
</tr>
<tr>
<td>Wavendon Gate</td>
<td>9</td>
<td>4 (44)</td>
<td>9 (100)</td>
<td>7.7</td>
</tr>
<tr>
<td>Bramingham</td>
<td>10</td>
<td>9 (90)</td>
<td>9 (90)</td>
<td>12.1</td>
</tr>
<tr>
<td>Baltonsborough</td>
<td>7</td>
<td>4 (57)</td>
<td>6 (85)</td>
<td>20.9</td>
</tr>
<tr>
<td>Gallions</td>
<td>8</td>
<td>4 (50)</td>
<td>7 (87)</td>
<td>8.6</td>
</tr>
<tr>
<td>Bounds Green</td>
<td>10</td>
<td>3 (30)</td>
<td>10 (100)</td>
<td>7.9</td>
</tr>
<tr>
<td>Victoria</td>
<td>8</td>
<td>7 (87)</td>
<td>8 (100)</td>
<td>3.6</td>
</tr>
<tr>
<td><strong>All results</strong></td>
<td>72</td>
<td>35 (49)</td>
<td>67 (93)</td>
<td>20.9</td>
</tr>
</tbody>
</table>

- Every classroom had periods with less than 3L/s/person
- In total, around 50% of measurements were below 3L/s/person
Section 3

LOW-ENERGY VENTILATION STRATEGIES
“Traditional Approach”

Need to ensure sufficient ventilation rate to avoid overheating

Cold Air In Needs Preheating in Wintertime
e-stack Approach: Winter

Mix incoming cold air with hot classroom air
Air into classroom pre-heated by heat gains in space
Removes requirement for pre-heating with radiators

Patent filed by University of Cambridge
e-stack Approach: Summer

Fan-assisted on hottest days

Cross flow ventilation helps provide fresh air and cooling to all of classroom
e-stack Approach: Night Cooling

Cold fresh air

Hot air

Night cooling cools thermal mass
Night cooling at high level: reduces security risks
Atrium ventilation system

Summer day ventilation when outside T > 18°C is conventional displacement flow

Uses atrium as “super stack”, large head increases buoyancy effect.

Fresh air inlet via windows in rooms off atrium, exhaust through high level openings at top of atrium.
Atrium ventilation system

Winter day ventilation when outside $T < 18\text{C}$

Uses atrium as mixing space

Rooms exchange fresh and spent air with atrium which acts as lung
**Energy Savings: Theoretical**

- Conventional displacement ventilation
- e-stack ventilation

Heating Energy (kW) vs. Ext T
Example Design Criteria

**BB 101 (UK)**
Ventilation of Schools

Need to meet 2 of the following 3 criteria:

a) There should be no more than 120 hours when the air temperature in the classroom rises above 28°C

b) The average internal to external temperature difference should not exceed 5°C (i.e. the internal air temperature should be no more than 5°C above the external air temperature on average)

c) The internal air temperature when the space is occupied should not exceed 32°C

**CIBSE guide A**

1% of occupied year above 28 deg C
Harston project

Before
Prototype e-stack system
Completed September 2006
Monitoring over winter

After
Internal Climate: Comparison

Chart shows internal CO₂ levels in a classroom with and without the e-stack system operating. The system was programmed to run on three out of five weekdays, and was set up to aim to deliver target CO₂ levels of around 1000ppm.

Harston School’s target CO₂ level – 1000ppm

System ON Monday, Wednesday, Friday
System OFF Tuesday, Thursday
Section 4

E-STACK SYSTEMS AND INSTALLATIONS
Queen Alexandra College, Harborne, Birmingham
Section 5

SUMMARY
• Using different ventilation strategies in different seasons can significantly reduce building energy use

• Strategies:
  – Winter: Mixing ventilation
  – Summer: Displacement ventilation

• Intelligent control is key to comfort and energy reduction