Building Advanced Ventilation Technological examples to demonstrate materialised energy savings for acceptable indoor air quality and thermal comfort in different European climatic regions.

Advanced Ventilation Technologies

Case Study No 16

ARAS CHILL DARA BUILDING NAAS, IRELAND

Supported by

Intelligent Energy Europe

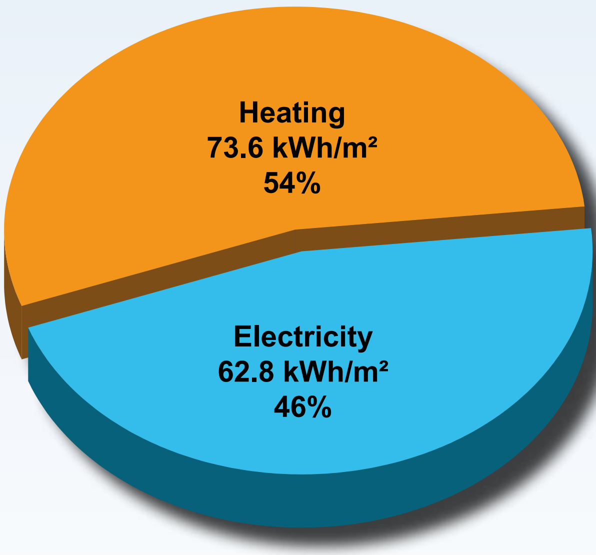
INTRODUCTION

The Aras Chill Dara building consists of two linked blocks and is situated on an exposed site, set away from roads and other buildings.

Summary Table of key design parameters.

Building data	
Building type	Office
Total floor area	12 500 m²
Mean occupant density	30 m²/person (permanent occupants)
Occupied hours	2 500 hrs/year
HVAC data	
Ventilation system type	Principally natural ventilation with some mechanical ventilation and comfort cooling
Heating system	Gas-fired boilers with compensated radiators
Cooling system	Air-cooled chiller (limited locations)
Total ventilation rate	Not applicable
Heat recovery efficiency	Not applicable
Cooling load	Not applicable
Design heating load	988 W/m² (installed capacity)
Building fabric data	
Window U-value	1.8 W/(m² K)
Window g-value	Not available
Exterior wall U-value	0.35 W/(m² K)
Base floor U-value	0.25 W/(m² K)
Roof U-value	0.25 W/(m² K)
Climate data	
Design outdoor temperature for heating	- 4°C
Design outdoor temperature and RH for cooling	Not applicable
Heating degree days (include base temperature)	2 208 days (base 15.5°C)
Cooling degree days (include base temperature)	Not applicable

The building is situated in a climate zone with moderate heating and cooling loads.



Annual energy use.

BUILDING DESCRIPTION

The building provides office accommodation Kildare County Council and also includes meeting rooms and a council chamber. It consists of a pair of tilted glazed four-storey blocks linked by glazed walkways. The blocks are only twelve metres wide to encourage natural ventilation and day-lighting. The building has an overall floor area of around 12 500 m² and is orientated along a north-south axis to maximise east-west exposure. Figure 1 shows a plan view.

Maximum permanent occupancy of the building is approximately 400 with, in addition, an unspecified number of visitors on most days. Hours of operation are between 9:00 – 17:00 with a small amount of start up and shut down occupancy.

DESIGN SOLUTIONS

Space heating is provided by high efficiency gas-fired boilers supplying a compensated radiator circuit. Local zone control is obtained using two-port valves. The boilers also supply domestic hot water, augmented by 60 m² of roof-based solar thermal collectors. The building is predominantly naturally ventilated with some local mechanical ventilation of toilets, food preparation areas and office equipment rooms. The council chamber, meeting rooms subject to in-

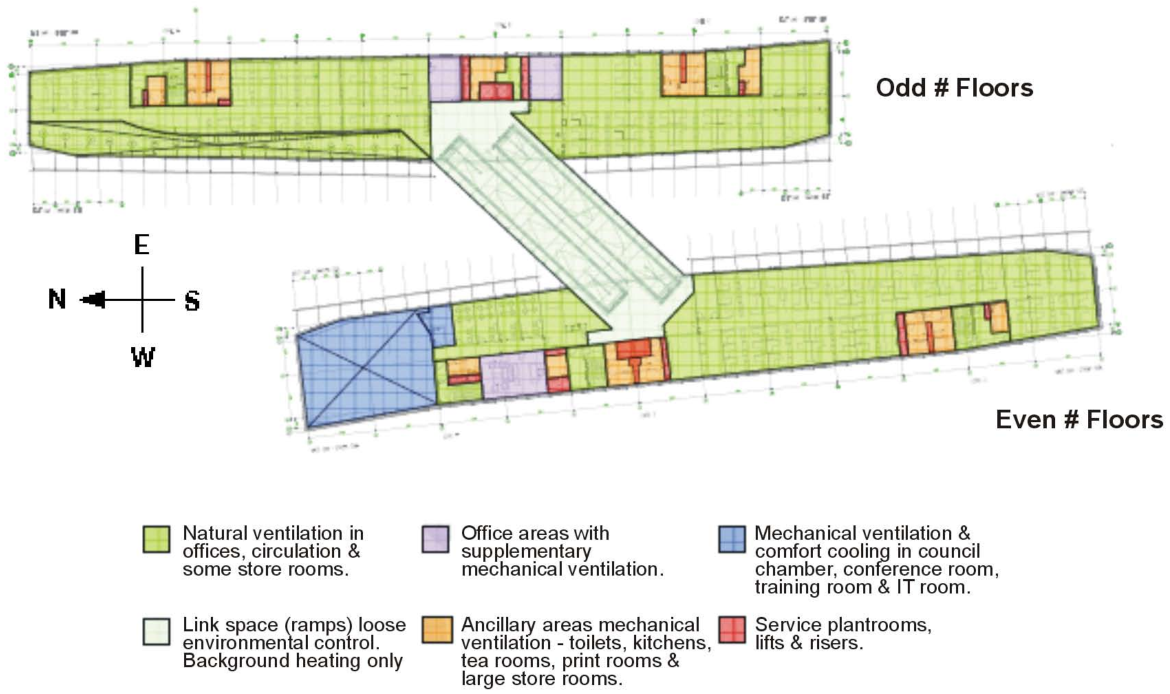


Figure 1. Plan view of the Aras Chill Dara Building.

termittent high occupancy and IT rooms, are provided with mechanical ventilation with comfort cooling supplied by an air-cooled chiller linked to low-level distribution. No spaces are fully air-conditioned.

Control of heating and ventilation is provided by a building management system (BMS). Excessive solar gain is avoided by limiting the glazed areas on the east and west outer façades to 40% and 45% respectively, with controllable shading devices. Solar gain and glare are controlled on the inner façades by incorporating floor to ceiling glazing with a second layer of 'fritted' glass which forms an external screen. The division of the building into two blocks, each with a width of between 12 m and 14 m, provides for the effective use of natural lighting. This is achieved by providing window-mounted luminaires, located at 1.7 m height. The lamps reflect light off polished panels below and above (see Figure 2), and via a perforated reflective veil. Users are provided with 150 W metal halide lamps, located directly opposite to a reflective panel. Corridor lighting is provided by 80 W T5 bulbs recessed into the concrete ceiling. In a typical bay the installed load is high at 16.7 W/m².

VENTILATION

The building is zoned into three areas – natural ventilation, mechanical ventilation and comfort cooling/air-conditioning.

- **Natural ventilation – in areas with low to moderate occupancy and heat gains – offices, and small store rooms.**
- **Mechanical ventilation – in areas with high humidity or odours – toilets, kitchens, large store rooms, tea rooms and print rooms.**
- **Comfort cooling – in areas with high heat gains and/or occupancy – council chamber, large meeting rooms, training room and IT room.**

Natural ventilation is provided by high-level actuator-operated window vents supplemented by

Figure 2. Open plan office showing reflecting surfaces.

low-level manually operated openings. During the day the windows adjust to maintain a maximum CO_2 level within the space, but also sense temperature differences between inside and outside the space, providing cooling when required. The window operation is also linked to wind speeds and rain, with windows closing in poor conditions.

The building uses night time ventilation to achieve summertime temperatures by cooling exposed concrete soffits. The BMS controls openable windows to provide the required cross ventilation (Figure 3). The control follows best practice guidance for night cooling. The external and internal temperatures are logged over time. The night cooling strategy is enabled if night time temperatures are lower than the internal temperature, and the daytime internal peak has exceeded 25°C.

PERFORMANCE

(i) Energy performance

Information on energy use was obtained from energy records and data provided by the utility supplier. Adjusting for weather, energy consumed for heating was, in total, 73.6 kWh/m²; of which 62.0 kWh/m² was for space heating and 11.6 kWh/m² was for water heating. Total delivered electrical energy was 62.8 kWh/m² of which 20.8 kWh/m² was for lighting; 26.2 kWh/m² for IT and office equipment; 1.9 kWh/m² for cooling

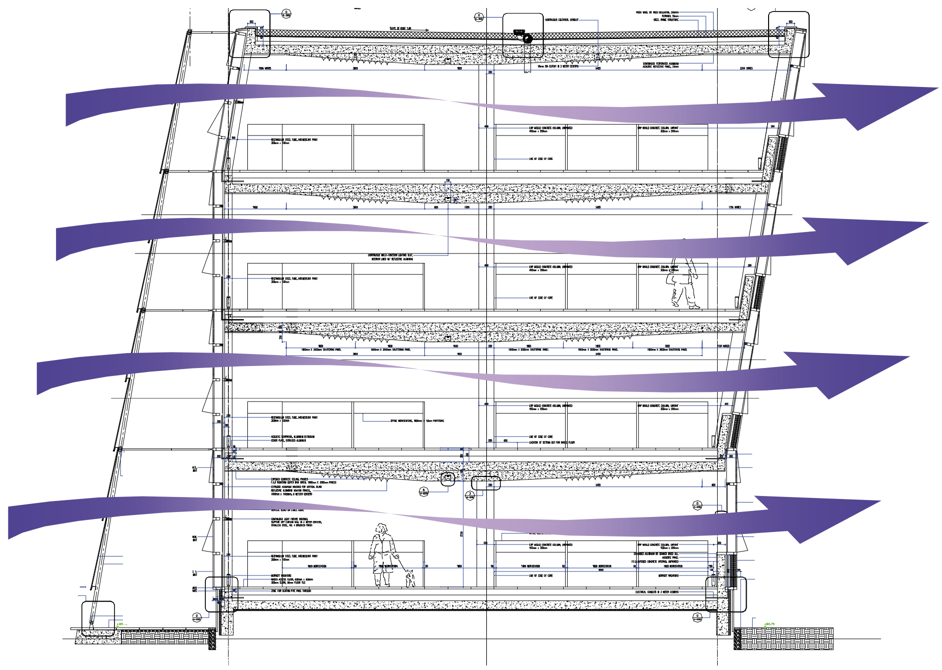


Figure 3. Natural cross ventilation using automatically controlled windows.

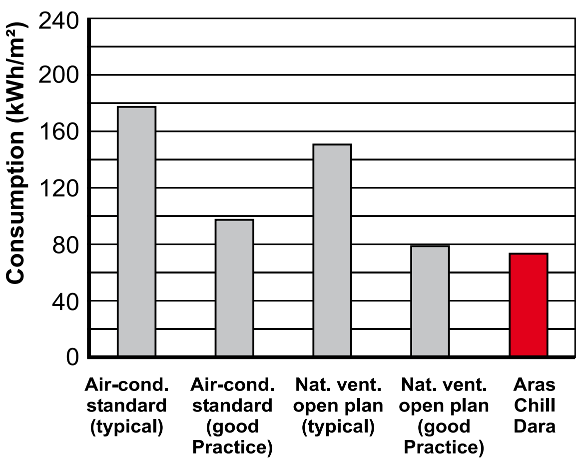


Figure 4(a). Comparison of heating consumption with benchmark values.

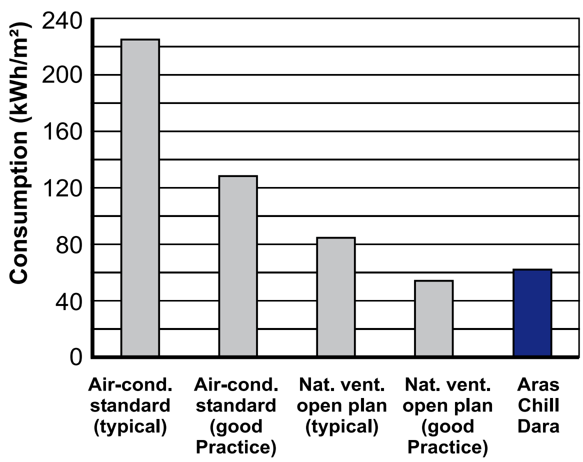


Figure 4(b). Comparison of electricity consumption with benchmark values.

and 13.9 kWh/m² for other uses including, pumps, fans and lifts. Total energy consumption amounted to 136.4 kWh/m².

Figures 4(a) and 4(b) compare the annual heating and electrical energy consumption by the building with the benchmarks currently used for office buildings in the UK and show that consumption is considerably better than for air-conditioned buildings and comparable with good practice naturally-ventilated open-plan buildings.

(ii) Indoor environment performance

(a) Thermal

Air temperature, resultant temperature, air speed and relative humidity were measured at selected positions on the second and third floors of each of the blocks composing the building for one week in each location during July/August 2006. During these periods internal temperature remained below 26°C and generally varied between 21°C and 24°C during occupied hours. Relative humidity generally remained within the range 40% to 60%. Limited measurements to estimate potential dissatisfaction over two working days indicated that the percentage of people dissatisfied (PPD) was less than 10%. Air speed was measured at a number of locations and was found to be low with average speed of 0.06 m/s and a maximum of 0.2 m/s.

(b) Ventilation

Figure 5 shows the results of carbon dioxide measurements made at a central location of the open plan area of the second floor. Carbon dioxide concentration did not exceed 750 ppm, well below the level suggested by ASHRAE of 1000 ppm. Similar results were obtained on the third floor.

(iii) Occupant assessment of performance

A questionnaire survey of occupants was undertaken over the period March to April 2008. While satisfaction with both natural and artificial lighting is high, the level of satisfaction with other aspects of the indoor environment is less positive. In general, occupants are marginally more satisfied with summer than winter conditions.

DESIGN LESSONS

The use of controls that default to 'off' worked well. The commissioning of automatic window and lighting systems was time-consuming but ultimately beneficial. Daylight modelling was used to show that light shelves and reflectors can balance the distribution of natural light. This assisted in reducing the use of shading, therefore increasing the efficiency of lighting controls while helping to maintain excellent comfort conditions.

GENERAL

Key points concerning the design

- **Elimination of the need for mechanical ventilation or air-conditioning for the office zones by use of controlled natural ventilation.**
- **Limited building depth to optimise use of natural day-lighting and to assist natural ventilation.**
- **Design of location and control of artificial lighting using daylight dimming and timers to reduce unnecessary use.**
- **Use of exposed concrete soffits to provide internal thermal mass for use with natural ventilation to provide night-cooling.**

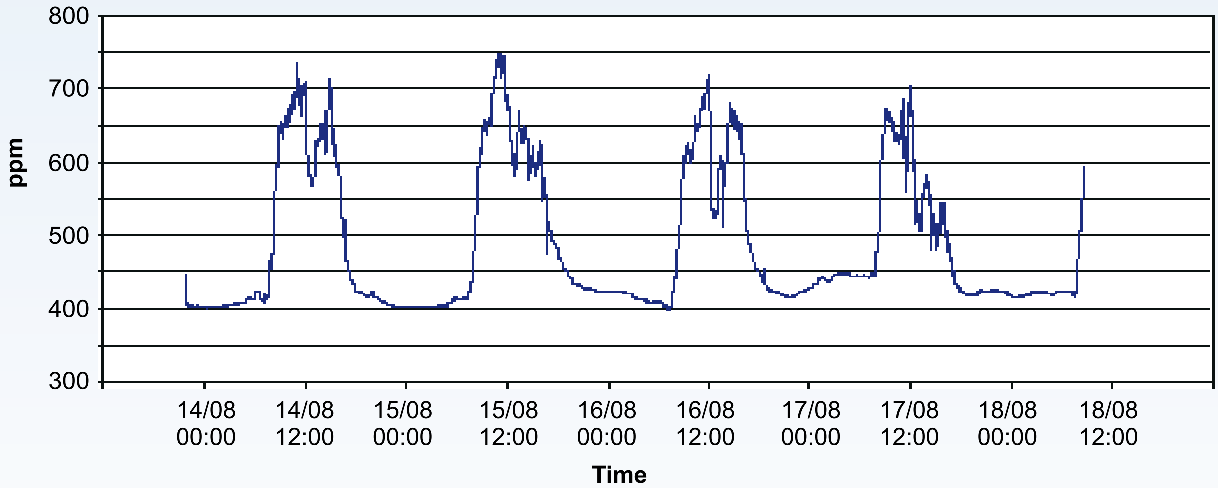


Figure 5. Variation of carbon dioxide concentration on the second floor (2006).

Table 1.
Summary of occupant assessment of the indoor environment.

	Summer %	Winter %
People finding the **overall indoor environment** acceptable	61	65
People finding the **thermal environment** acceptable	56	61
People finding the **indoor air quality** acceptable	57	66
People finding the **acoustic environment** acceptable	56	53
People finding the **lighting** acceptable	85	84

Design team information
Designers and contractors

Client	Kildare County Council
Architects	Heneghan Peng Architects Arthur Gibney & Partners
Engineering Consultant	Buro Happold

REFERENCES

Civic Pride: Balancing Sustainability and Stunning Design at Aras Chill Dara. Construct Ireland, Issue 16. [available at: http://www.constructireland.ie/articles/0215araschilldara.php].

Brochure authors: A Cripps, Z Gill, I Pegg and G Susman, Buro Happold.

Building Advanced Ventilation Technological examples to demonstrate materialised energy savings for acceptable indoor air quality and thermal comfort in different European climatic regions.

BUILDING ADVENT

Full title of the project: Building Advanced Ventilation Technological examples to demonstrate materialised energy savings for acceptable indoor air quality and thermal comfort in different European climatic regions. Building AdVent is funded by the European Commission, Directorate-General for Energy and Transport as part of the Intelligent Energy - Europe Programme.

It is estimated that energy consumption due to ventilation losses and the operation of fans and conditioning equipment is almost 10% of total energy use in the European Union and that about one third of this could be saved by implementing improved ventilation methods. A number of projects have been undertaken under the auspices of the European Union (under the SAVE and ALTENER programmes) and the International Energy Agency (Energy Conservation in Buildings and Community Systems Annexes 26 and 35) to identify and develop improvements in ventilation technology.
The AdVent programme is intended to build on these and has three principal objectives:

- Classification of existing building ventilation technologies as applied in built examples and collection of information on building performance.
- Identification of barriers for future application.
- Preparation of case-studies in a common format, together with training material

BUILDING ADVENT PARTICIPANTS

Coordinator

Buro Happold Consulting Engineers .... UK

Participating Organisations

Brunel University .... UK
National and Kapodistrian University of Athens .... Greece
Helsinki University of Technology .... Finland
Aalborg University .... Denmark
Faculdade de Engenharia da Universidade do Porto .... Portugal
International Network for Information on Ventilation and Energy Performance (INIVE) .... Belgium

Major Sub-Contractors

Federation of European Heating and Air-Conditioning Associations (REHVA) .... The Netherlands
International Union of Architects .... France/Greece
—Architectural and Renewable Energy Sources Work Programme (UIA - ARESWP)

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