# MARKET ASSESSMENT OF PASSIVE DOWNDRAUGHT EVAPORATIVE COOLING IN NON-DOMESTIC BUILDINGS IN SOUTHERN EUROPE

B. Ford[1] and K. Cairns[1]

[1] *WSP Environmental, Buchanan House, 24-30 Holborn, London EC1N 2HS, UK*

## ABSTRACT

This paper describes current work to undertake a market assessment of the potential for the application of Passive Downdraft Evaporative Cooling (PDEC) to new and existing buildings in Southern Europe. The work is carried out as part of a European funded ALTENER project focussing on solar and passive ventilation for urban buildings.

PDEC is a technique that may potentially become a substitute for conventional air-conditioning. The technique avoids the need for ductwork, fans and suspended ceilings, and reduces the need for refrigerant based cooling. Hidden benefits include reduction in the overall height required for the building and consequent reduction in cladding costs. More obvious benefits include potential annual savings in energy and maintenance costs.

PDEC is a design approach and it therefore needs to be explained and 'sold' to building designers and building users. The project will include surveys of market barriers to the application of PDEC, and subsequent dissemination of the results to construction industry professionals, developers and facilities managers.

## KEYWORDS

Passive, downdraft, evaporative, cooling, ventilation, Europe

## BACKGROUND

Passive Downdraught Evaporative Cooling (PDEC) is a technique which may well become a substitute (in whole or part) for conventional air-conditioning. The technique has significant architectural and engineering design implications, and involves the configuration of existing products in new ways. The technique avoids the need for ductwork, fans and suspended ceilings and reduces the need for refrigerant based cooling. Less obvious benefits include reduction in the overall height required for the buildings (loss of duct zone on each floor) and consequent reduction of external envelope costs. Detailed analysis of a case study office building in Seville reveals a potential capital construction cost saving of 6% over the equivalent air-conditioned office building and delivered electrical energy savings of 40-50 $kWh/m^2$ per year. Its commercial potential is related to the value of the construction market and the quality and characteristics of the building stock in the countries of Southern Europe.

A previous study, PDEC JOULE II Research & Development Project (1) concentrated on the application of PDEC to Office and Commercial buildings, for which a substantial commercial market has been identified. It is also apparent that PDEC would be applicable to Educational buildings (schools and colleges), Public (cultural and recreational), Industrial and Retail buildings. It may also prove to be particularly appropriate for application to large volume buildings such as Railway Stations, Airports and Stadia. The application of PDEC to Residential Buildings requires further study before its potential can be evaluated but this potential will undoubtedly be exploited in the future.

## THE POTENTIAL FOR PDEC IN EUROPE

The technical and commercial potential for PDEC appears very promising, but as yet a thorough market analysis has not been undertaken. Market evaluations of the potential for passive solar design in the UK have been completed as well as reviews of construction markets in Europe (2), and other countries and are well informed on building stock and investment data in European countries. PDEC will potentially replace conventional air conditioning in buildings but it is not a straightforward substitution since PDEC has as much to do with architectural design as it does with building engineering. The potential market will therefore be related to the size of the construction market and the building stock.

The JOULE research project (1) focuses on potential applications of PDEC to the non-domestic sector. The project demonstrated that there is substantial potential for PDEC to substitute for conventional air-conditioning either as a stand-alone system or in a mixed-mode design. PDEC is not just a clip-on technology (it requires architectural integration); take-up may be relatively slow, since it requires expertise to be developed within the architectural and building service professions. Vigorous promotion and marketing of the financial and environmental benefits of PDEC could, however see the approach applied very widely over the next 10-20 years to both existing buildings and in new construction. However, more detailed market assessment is required to identify where the greatest potential exists, in which building sectors and types, what potential energy savings are achievable; and to initiate a promotional campaign. To this end, a PDEC market assessment study is currently underway and is due to be completed in April 2003.

## MARKET EVALUATION STRUCTURE

Completion of the Market Evaluation Assessment will result in:

1. Establishment of a database on existing and new non-domestic buildings in Italy, Spain, Portugal and Greece
2. Estimation of the proportion of existing buildings and new construction to which PDEC is applicable and the possible cost and energy savings in such buildings by implementing suitable measures over a period of time
3. Determination of those climatic regions in Southern Europe where PDEC is suitable and the overlaying of the location and size (population) of settlements on maps of PDEC applicability
4. Prediction of the likely market penetration over the next 30 years within Italy, Spain, Portugal and Greece
5. Indication of where promotional effort needs to be placed to publish the study findings and disseminate results to key groups within the EU.

## APPROACH

This work has followed an approach developed by D. M. Lush & J. L. Meikle (3), which is based on an examination of building categories and stock characteristics, and the estimation of the building categories where potential for energy savings exist. Potential is gauged against a number of parameters, which affect applicability (e.g. for PDEC, the existence of a transitional space, atrium or courtyard). These parameters are then ranked according to an assessment of their impact, with regard to energy savings and cost-effectiveness.

In order to collect information to feed into the model various processes, each at different stages of completion, are underway in each of the four countries in question.

### Pilot Excersize/ Stock and Investment Assessment

The objective of the pilot exercise is to check the availability of data on building stock and investment, morphology and energy consumption and to compile statistical information on floor area and energy consumption for different building types across the four countries. Most European countries produce new building construction output data in terms of floor area ($m^2$). Both physical and financial measures of the stock are used as a basis for analysis.

### Typological Evaluation

Studies of the building stock and its morphology have been undertaken in a few European countries. A classification of buildings according to type and form is being used and each category ranked according to the potential for PDEC application (0 – no potential, 10 – high potential). This data is used to identify those building types for which PDEC is most appropriate and to estimate the percentage floor area to which PDEC could be applicable for both new build construction and existing buildings.

### Mapping

Mapping of the potential for PDEC in Southern Europe as part of the PDEC JOULE project (1), is used as a starting point and focuses on Spain, Italy, Greece and Portugal. Information on location and size of population is overlaid on the maps already produced. The maps also include information on the existing stock of buildings as it becomes available.

### Market Barriers to PDEC

Potential barriers to the uptake of PDEC are evaluated by surveys of developers, clients and design professionals (architects/ engineers). Senior (property, design, construction and other) professionals in each country are asked a limited number of key questions. A few in-depth interviews in each country help to develop understanding of these issues.

## Cost Benefit Evaluation

A cost benefit evaluation is achieved by undertaking a cost benefit assessment based on performance indicators derived from the design studies which were undertaken in the PDEC JOULE project (1), and evaluating performance of the design study buildings transferred to the four countries within Southern Europe. Potential benefits include energy savings; capital and running cost savings as well as environmental benefits (e.g. reduction in $CO_2$ emissions).

## Market Penetration

Determination of the likely market penetration is estimated using a model incorporating construction output, urban and non-urban population and the building stock for particular countries in Europe. Some information is available for most European countries. 'Low' and 'high' scenarios can be developed, containing likely new building and refurb rates with technical potential and likely take-up rates.

For example in 1996 new office and commercial buildings represented a construction cost of 3.3 billion EURO in Italy, 3.23 billion EURO in Spain, 1.06 billion EURO in Portugal and 1.57 billion EURO in Greece. Results from the PDEC project indicate that capital construction cost savings of 6% can be achieved in new office/ commercial buildings, representing a total potential capital saving in these countries of around 549 million EURO based on 1996 data and assuming a 100% take up. If a 10% take up rate is assumed the potential savings would be around 55 million EURO/ yr. in these four countries.

If such savings can be achieved in all new non-residential building work, the potential savings in Spain could represent 480 million EURO/ yr., and in Italy 880 million EURO/ yr. These scenarios assume an implausible 100% take up rate but if a low rate of 10% and a high of 35% are taken this represents potential savings in Spain and in Italy in the non-domestic sector of 136 to 476 million EURO/ yr.

The potential capital savings identified above do not include the annual savings in energy and maintenance costs. In the office and commercial sector in Spain and Italy, assuming the lower 10% take up rate, energy savings alone could represent 12.5 million kWh equivalent to 1.6 million EURO/ year, and at the higher 35% take up rate would represent 5.6 million EURO/ yr. (assuming average energy savings of approx. 25 $kWh/m^2$ and average construction costs for new offices of EURO 1300/m2). These savings will of course accumulate over successive years.

## Review and Dissemination

On completion of this work a final report presents the results and conclusions on the market potential for PDEC in the four countries. This information will be available on a Website.

## THE WIDER APPLICATION

The work carried out in this project constitutes part of an EU funded ‘cluster’ group investigating Solar Passive Heating and Cooling, comprising two other project groups carrying out similar studies.

The first study proposes a legislative and marketing framework to facilitate the use of solar assisted and natural ventilation in buildings in existing urban communities. The project is Phase 2 of an on-going study, which is combining and adapting existing technical knowledge with best practice engineering and current architectural practice to facilitate the uptake of the technology.

The second study is the dissemination of information on the application of techniques employing the roof to provide some or all of the cooling requirements of buildings. The proposed dissemination measures include the publication of a European Handbook on Roof Solutions for Natural Cooling covering experimental results, building case studies, roof design principles, and guidelines; the publication of an electronic Atlas encompassing maps of applicability, design data and energy saving potential throughout the European Union.

The three studies achieve mutual advantage by sharing information related to the common themes of Investigation of Market Potential, Applicability Mapping, Evaluation of Market Barriers and Dissemination.

## CONCLUSIONS

Passive Downdraught Evaporative Cooling (PDEC) is a technique which may well become a substitute for conventional air-conditioning. The technique is not simply an ‘add-on’ but has significant architectural and engineering design implications.

Benefits of the application of PDEC are the avoidance of ductwork, fans and suspended ceilings and a reduced need for refrigerant based cooling. Other benefits include reduction in the overall height required for the buildings and consequent reduction of external envelope costs.

The commercial potential of PDEC is related to the value of the construction market and the quality and characteristics of the building stock in the countries of Southern Europe.

The completion of this Market Assessment will allow effective promotion of the technique in areas where climatic conditions, type of building stock, and construction activity facilitate most efficient and cost effective operation in Spain, Greece, Italy and Portugal.

By carrying out this project as part of a cluster it is anticipated that a synergy will arise from the three projects producing a much more integrated and rich result.

The final report is due in April 2003.

## References


(1) Contract No. JOR3-CT-950078 1996-1999 (Unpublished)

(2) Davis Langdon Consultancy (April 1998) *Review of Construction Markets in Europe* Spon

(3) D.M. Lush & J.L. Meikle (1998) *Passive Solar Energy in Buildings*, published on behalf of the Watt Committee on Energy by Elsevier Applied Science Publishers pp 36-45