IRISH METEOROLOGICAL SOCIETY

Newsletter

No. 12 January 1988

This Newsletter contains summaries of lectures and talks delivered to the Society by Dr G Lyons (AFT), and Dr P Lynch (Met. Service). Articles of general meteorological interest and announcements regarding forthcoming events are also included.

At a recent meeting of the Committee, it was decided to invite members to submit suggestions for a Society Logo: suggestions should be sent to the Secretary before 1 March 1988.

A letter from a member, Mr Torsney, is published in this issue; letters from members on any aspect of meteorology are welcomed and will be published in the Newsletter.

As we start on a New Year we extend best wishes to all our members - aith bhliain faoi mhaise diobh go leir.

Aodhagan Roddy

Aodhagan Roddy
President

Michael Connaughton

Michael Connaughton
Secretary

NOTICE OF LECTURES

Lecture

"Wave Energy and its Relevance to Ireland"
By Dr Tony Lewis (UCC)
In the Ussher Theatre, Trinity College, Dublin
on Friday 29 January 1988 at 8 p.m.

Guest Lecture

"Meteorological Satellites"
By Mr J Morgan
(Director EUMETSAT)
In St Stephen's Suite, The Shelbourne Hotel, Dublin
on Friday 11 March 1988 at 8 p.m.

Joint Meeting with Solar Energy Society of Ireland

Subject: Energy resources in Ireland
Date, Place: Friday, 8 april 1988, Physics Dept, UCG

Detailed brochure will be sent to members shortly.

Annual Subscription

Annual subscriptions for 1988 are now due. Subscriptions (£8 for Dublin members, £4 for others) should be sent to the Treasurer, Dr J Hamilton, Meteorological Service, Glasnevin Hill, Dublin 9.

Letter from a Member

Local Weather

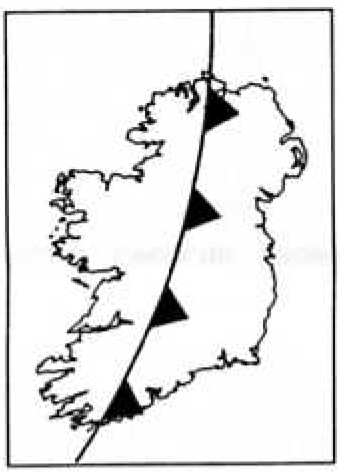
I am interested in local weather in Ireland. It is a small country, and yet its weather can vary greatly from place to place.

I will illustrate this point by referring to the 26th April 1984. An anticyclone was centered in the North Sea and winds were moderate easterly. East and south coasts were affected by on shore winds. An amazing 25·8°C was recorded at Glenties, Co. Donegal. A maximum of only 13°C was recorded at Rosslare on the same day. Dublin Airport recorded 15·7°C. Casement Aerodrome, only a few miles to the south west, recorded a much more respectable 18·8°C.

Considering the time of year, these values are truly amazing. The Glenties maximum of 25·8°C is a national record for April. I would welcome comments on this topic.

Denis Torsney
Lucan, Co.Dublin
30-Nov-1987

IRISH METEOROLOGICAL SOCIETY



LOGO Competition 1988

LOGO Competition

A logo is 'a single piece of type comprising a name and/or address, trademark or design' (Chambers). It is a symbol which represents an organisation and which can be used on letterheads, membership cards *etc.*

The Irish Meteorological Society does not have a logo and the purpose of this competition is to design one.

Suggestions should be sent c/o 'The Secretary' and marked 'LOGO Competition'. If the standard is high enough the best entry will be used by the society.

Entries become the property of the Society and the decision of the committee is final. The closing date for receipt of entries is March 1st 1988.

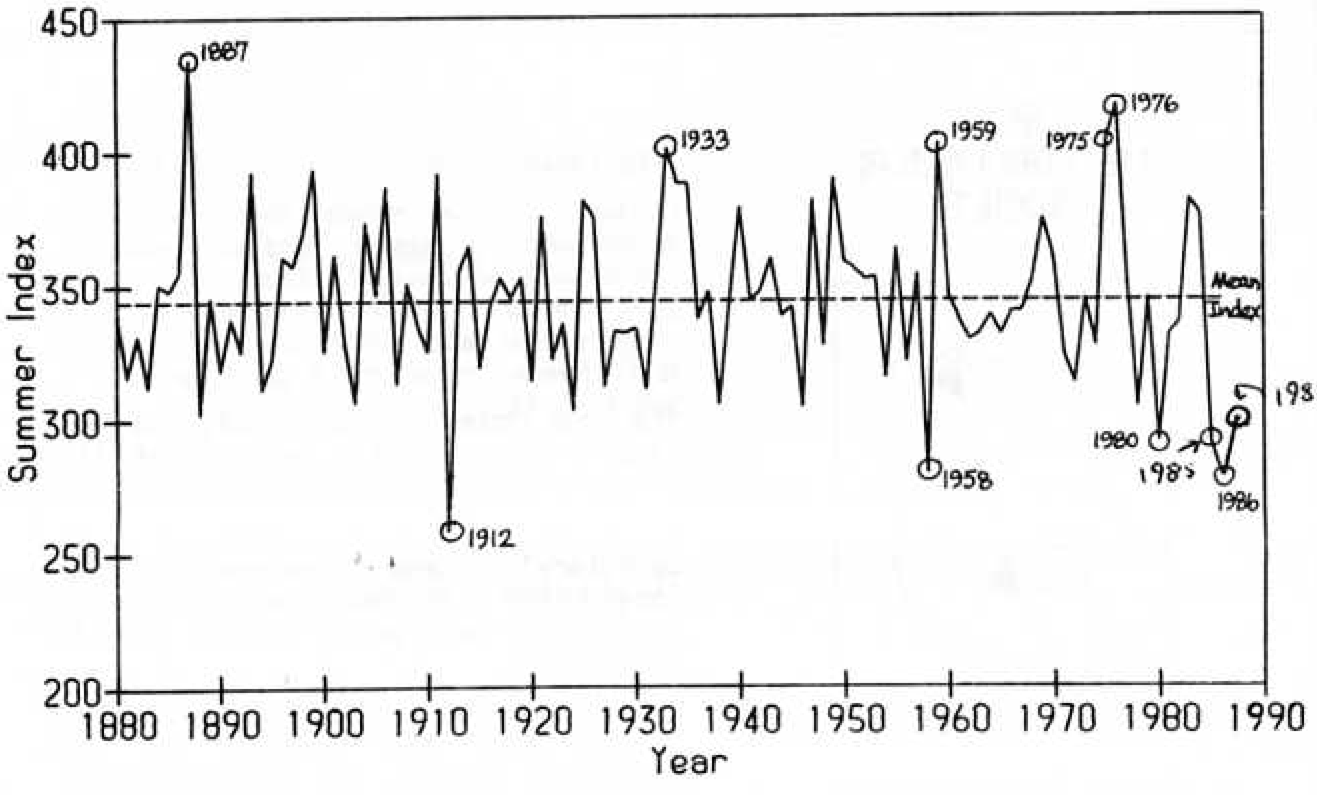
SUMMER INDEX

The weather of a month, season or year is frequently evaluated by comparing certain elements, e.g. precipitation amounts, mean air temperature, sunshine hours, to the normal values for the period. Other criteria often used include accumulated temperature, number of days with maximum temperature exceeding a certain value (e.g. 21°C) and the Poulter Index. The latter is used to express the overall quality of a summer (June to August inclusive) by means of a single figure derived from the sum of weighted values of mean air temperature, total sunshine and total rainfall. High values of the first two elements and low values of rainfall result in a high Index criteria. In a most general way therefore large values of the Summer Index reflect the brighter and drier summer seasons and low values correspond to the cooler, duller and wet seasons. It has been found that the outcome of operations which are very much weather dependent and extend throughout the (summer) season show close association with year-to-year variations in the Index. Milled peat production, for example, has been shown to correlate highly with the Poulter Index for the period May to September inclusive.

The figure below shows the values of the Poulter Summer Index at the Phoenix Park by year since 1880. Considerable year-to-year fluctuation is evident including a number of extreme values (high and low values of the Index). Individual summer seasons can be identified and sequences of seasons. It needs to be stressed, however, that while the number of similar type extreme seasons occurring in sequence are rare, it is not possible to predict upcoming summers by extrapolation of the Index to future years.

T Keane
Meteorological Service

SUMMER WEATHER INDEX* FOR DUBLIN (PHOENIX PARK), 1880-1987



*POULTER INDEX Taken from the Agrometeorological Bulletin of the Meteorological Service.

THE YEAR 1987

Annual rainfall totals were the lowest for more than a decade at more than half our stations and the driest for sixteen years at Shannon Airport and Claremorris. Percentages of normal rainfall ranged from 104% at Roche's Point to 82% at Shannon Airport, but were between 88% and 98% of normal in most places. The most notable daily rainfall occurred in Ulster and parts of north Leinster on October 21st when 50 to 80 millimetres was recorded at lowland stations and over 100 millimetres fell in mountainous areas.

Mean maximum air temperatures were below or about normal while mean minimum temperatures varied from 0·4°C above normal at Shannon Airport to 0·5°C below normal at Belmullet. The resultant mean annual air temperatures were close to normal in most areas and ranged from 0·4°C below normal at Belmullet to 0·2°C above normal at Shannon Airport. In the cold spell of 11th-16th of January, Roche's Point recorded -7·2°C, its lowest air temperature in over a hundred years of record. Highest air temperatures of the year were in August when Dublin Airport recorded 26·6°C on the 16th.

It was a dull year with percentages of average sunshine ranging from 74% at Claremorris to 93% at Malin Head. At Dublin Airport it was the dullest year since records began there in 1942.

There were no notable windstorms and in most areas maximum gusts were between 50 and 65 knots and only at Cahirciveen and Malin Head were gusts in the range 65 to 70 knots recorded.

WIND-CHILL FACTOR

The terms wind chill or wind-chill equivalent temperature are used when conditions are cold and windy. The wind chill refers to the rate of loss of heat of a (human) body to the air whose cooling power is enhanced by increasing windspeeds. In 1945 a formula was devised (by Siple and Passel) for the rate of heat loss from bare skin (assumed to be at a temperature of 33°C). This formula is still widely used and forms the basis of the wind-chill equivalent temperature table given below.

Assuming that a person walking in calm conditions is exposed to a breeze of 1·8 metres per second (4kts), the wind chill equivalent temperature is the temperature which at a wind speed of 1·8 m/s would provide the same sensation of cooling as the existing combination of air temperature and windspeed. One important application of the wind-chill factor is in mountaineering where high winds and low temperatures are always to be contended with.

The table applies to a (human) body which attempts to maintain a temperature higher than the air temperature.

Wind Chill Equivalent Temperature °C

Wind Speed (M/Sec) \ Air Temperature (°C)	6	3	0	-3	-6	-9	-12	-15
24	-10	-15	-20	-25	-30	-35	-39	-44
21	-10	-15	-20	-25	-29	-34	-39	-44
18	-10	-14	-19	-24	-29	-33	-38	-43
15	- 9	-14	-18	-23	-27	-32	-37	-41
12	- 8	-12	-17	-21	-26	-30	-35	-39
9	- 6	-10	-14	-18	-23	-27	-31	-35
6	- 2	- 6	-10	-14	-18	-22	-26	-30
3	3	- 1	- 4	- 7	-11	-14	-18	-21

1m/s = nearly 2kts

TEMPERATURE EXTREMES

Although our weather is quite variable we seldom suffer the extremes in temperature which other countries in these latitudes experience. Temperatures in inland areas fell to -10°C during the cold spell in 1982, and during the exceptional summer of 1976 maximum temperatures in excess of 30°C were recorded. Examination of our climatological data bank reveals that we can expect this temperature to occur about once every fifty years.

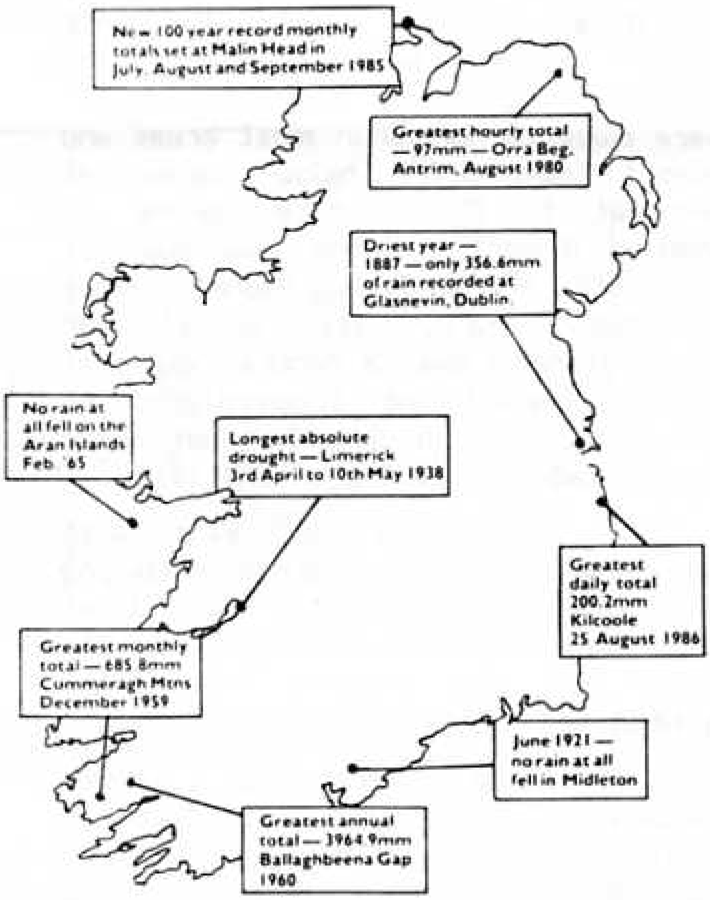
The highest temperature ever recorded here was 33·3°C at Kilkenny Castle on the 26th of June 1887. The lowest temperature was -19.1°C which was recorded on the 16th of January 1881 at Markree Castle, Co. Sligo. The following table gives the return period of temperatures at specified locations. [We expect a temperature with a return period of five years to occur, on average once every five years.]

Station (Inland)	Return period (years) 2		5		10		50		100	
	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.
Birr	26.0	-7.3	27.8	-9.7	28.9	-11.4	30.7	-14.4	31.4	-15.8
Phoenix Pk.	25.5	-7.4	27.2	-9.8	28.3	-11.4	30.5	-14.4	31.3	-15.7
(Coastal)										
Roche's Point	23.0	-1.9	24.3	-2.9	25.0	-3.8	26.8	-5.2	27.4	-5.7
Valentia	24.9	-3.3	26.5	-4.6	27.4	-5.3	29.1	-6.7	29.5	-7.2

Temperatures °C.

RAINFALL RECORDS

The general impression is that it rains quite a lot in Ireland but in fact two out of three hourly observations will not report any measurable rainfall. The average number of wet days (days with over 1mm of rain) ranges from about 150 days a year along the east and south-east coasts, to about 225 days a year in parts of the west. The wettest months, almost everywhere are December and January and the driest month is generally April but in many southern parts, June is the driest.



Weather forecasting by computer

by Peter Lynch

Before the computer era, all operational forecasts were made subjectively. The forecaster began with a synoptic chart showing the weather observations valid at a single time, and analysed the fields of pressure and other elements into weather systems. He then constructed a forecast chart, representing his estimate of the pattern of weather systems (say) one day later, and on this chart he based his forecast of the actual weather, winds, rainfall, etc. His forecasting skill derived from his years of experience in studying weather patterns and his knowledge of how weather systems typically behave.

The physical laws which govern atmospheric motions have been known for a long time: they are the universal principles of conservation of mass, energy and momentum. It was recognized early this century that these laws could, in principle, be used to make objective forecasts — but the amount of calculation required made this approach impracticable. The breakthrough came in the late 1940s with the invention of the electronic computer. The first computer forecasts were made in 1950, and they soon achieved an accuracy comparable to that of a skilled forecaster using subjective techniques. Thus dawned the age of Numerical Weather Prediction (NWP).

NUMERICAL WEATHER PREDICTION

The process of NWP can be broken into several steps. The observations of weather made world-wide are entered on the Global Telecommunications System (GTS) using special numerical codes and are transmitted to the National Meteorological Centres (NMCs). The communications computers at the Irish NMC in Dublin are linked directly to the GTS, and they automatically receive thousands of observations every day from all over the Northern Hemisphere. These are then decoded and checked for errors through a process called Automatic Data Extraction (ADE). The observational data valid at a given time are then used to derive a picture of the state of the atmosphere at that time — this is done by the Objective Analysis (OA) System. The analysis uses several hundred upper-air (radiosonde) observations and some thousands of surface and ship reports, as well as reports from commercial aircraft. Satellite observations are particularly important for us, as conventional observations are scarce over the Atlantic Ocean immediately upstream from Ireland. The objectively analysed fields are plotted on charts for use by the forecasters. They also serve as initial fields for making the computer forecast.

The computer forecasting model is a complex program which solves the mathematical equations corresponding to the physical laws (see box). These equations are solved by the method of finite differences: the initial fields are used to calculate the rate at which variables such as pressure, temperature and wind are changing, and the rates-of-change are used to extrapolate the fields forward in time. To maintain accuracy, the timesteps must be short and so a full forecast is made up of a sequence of many short steps in time. The continuous fields of pressure, temperature and wind are represented by their values at the points of a regular grid superimposed on the area of interest, and at a discrete set of atmospheric levels.

THE IRISH MODEL

Our forecast model has a grid of 2,100 points spaced 150 kilometres apart and covering Europe, the North Atlantic and Eastern North America (see Figure). There are five levels in the vertical. Our original model required about 37 minutes of computations to make a 24-hour forecast. Several innovations, developed within our Research Division, have enabled us to improve the efficiency of the model. The most recent version, introduced into operations on 1 July 1986, makes a 24-hour forecast in only 6 minutes. Many millions of calculations are required for each timestep. Our mainframe computer, a Digital DEC-2050, is capable of executing about one million instructions per second (1 MIPS).

(1) Conservation of momentum (zonal component)

$$\frac{du}{dt} - \left(f + \frac{u\tan\phi}{a}\right)v + \frac{1}{\rho}\frac{\partial p}{\partial x} = 0$$

(2) Conservation of momentum (meridional component)

$$\frac{dv}{dt} + \left(f + \frac{u\tan\phi}{a}\right)u + \frac{1}{\rho}\frac{\partial p}{\partial y} = 0$$

(3) Hydrostatic balance

$$\frac{\partial p}{\partial z} + g\rho = 0$$

(4) Conservation of mass (Continuity equation)

$$\frac{d\rho}{dt} + \rho\nabla\cdot\mathbf{V} = 0$$

(5) Conservation of energy (Thermodynamic equation)

$$\frac{dT}{dt} + (\gamma-1)T\nabla\cdot\mathbf{V} = \dot{Q}/c_v$$

(6) Boyle-Charles law of perfect gases

$$p = R\rho T$$

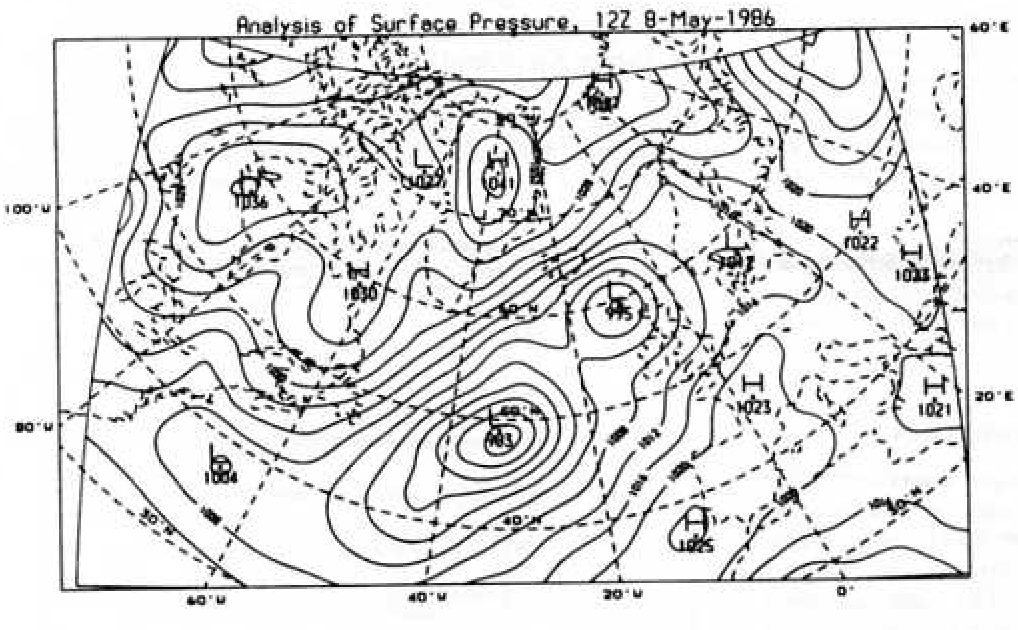
The physical principles governing atmospheric dynamics and their mathematical expression (the equations of motion)

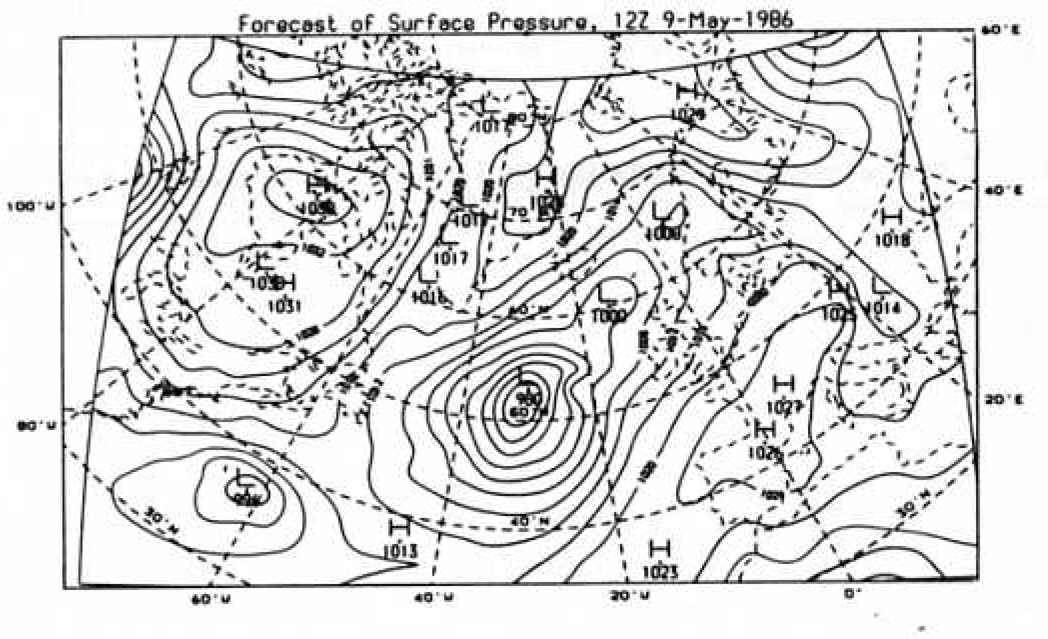
In the Figure we show an example of the objectively analysed surface pressure (above) and of the forecast pressure valid 24 hours later (below). A depression in mid-Atlantic is deepening and moving north-east, while the low-pressure area north of Ireland is filling and moving away. This forecast is the end-product of an intricate sequence of computer operations: The data have been received, decoded, checked and analysed, the numerical forecast made, and the results plotted automatically; and the forecast is ready within a few hours of the time the observations were made.

RESEARCH ACTIVITIES

The quality of computer forecasts depends crucially on the numerical schemes used. To improve this quality, the research team at the Irish Meteorological Service has concentrated upon developing new, accurate and efficient schemes for integrating the equations of motion. The main advance recently has been the introduction of a Lagrangian advection scheme. This scheme forecasts the flow by following the evolution of individual parcels of air, in contrast to the more common Eulerian approach of examining changes at a fixed point. The Lagrangian scheme has allowed us to speed up the numerical forecasts, saving more than one third of the computer time. Thus, the numerical guidance is available to the forecaster earlier than before — with the rapidly changing Irish weather, timeliness is of the essence. Another recent change has been the introduction of a semi-implicit scheme; this numerical method allows us to use a 90-minute timestep, and results in further computational efficiency without loss of accuracy.

At present, computer predictions of pressure patterns are more accurate than those produced by the human forecasters. However, the deduction from these patterns of the actual weather which we experience is still a task for the forecaster; here he can use his experience and knowledge of local conditions, and can take account of factors which are ignored by the numerical models. Thus, the best weather forecasts now available are the result of a man/machine mix, where subjective human experience and sheer number-crunching computational power work in harmony to produce a product which is superior in quality and accuracy to that which might be produced by either man or machine working alone.





ENERGY CONSERVATION ON EXPOSED DOMESTIC SITES

F. O'FARRELL, G. LYONS, G. LYNSKEY.

An Foras Taluntais, Headquarters,
19 Sandymount Avenue, Dublin 4.

1.1 Introduction

This project is concerned with the conservation of energy in isolated dwellings, particularly farm dwellings on exposed sites. While the majority of the population of Europe lives in towns and cities, consequently the greatest amount of energy required for domestic purposes is consumed in these conurbations, a sizable number live in isolated houses scattered throughout the countryside. In Ireland in 1971 there were 225,445 permanent housing units with agricultural land out of a total of 701,180 houses in the State. All those housing units with agricultural land may not be classified as farm dwellings (the number of farmers in the country were approximately 180,000). However the larger number of dwellings all have the similar siting attributes of having land around them, in other words, "open aspect" and therefore similar advantages and disadvantages with regard to energy demands and conservation.

While the complete results of more recent census returns in Ireland are not available estimates would indicate that the proportion of isolated houses has not greatly altered, 287, 883 out of 902, 408, in 1979. This would indicate an annual net energy demand of 39 GJ x 10^6 for such dwellings. If the gross annual energy consumption per farm dwellings was up to the average for the country, 142 GJ., then this figure would be even higher. As it is, it represents well over half the total energy input into Agriculture. This compares with the European scene generally, when it has been estimated that 70% of the conventional energy used in agriculture goes into space heating of rural houses and domestic water heating. Again the figures for farm holdings throughout Europe gives an indication of the amount of dwellings involved, the approximate number of holdings are: Ireland - 260,000, UK - 270,000, Denmark - 127,000, Luxembourg - 5,400, Belgium - 102,000, Netherlands - 141,000, France - 400,000 and Germany - 300,000.

1.01 Extent of energy used

Even among isolated houses and farm dwellings the amount of energy used can vary enormously. Energy usage is very closely related to the standard of household management practiced and the life style of the owners. At the commencement of the 'oil crisis' the mean net energy consumption per house in Ireland was 98 GJ, in Denmark 118 GJ and in America 137 GJ, illustrating the tremendous energy requirement of the dwelling house in Western Society. Consequently it becomes apparent that the way a household lives will be one of the largest determinants on the amount of energy it requires or demands.

Similarly while it has long been acknowledged that the greatest energy savings in the domestic sphere can be realised from adopting conservation measures, the adoption of many of these may require a change of attitude or life style, e.g. in a fairly recent survey in Ireland, it was found that " 14% of the farm households kept the back door open all day even during the heating season ". A first and obvious change of life style is called for if ventilation rates and consequently, heat losses are to be reduced.

1.02 Alternate life style

The large expansive Western way of life has been severely questioned over the last few years, probably spearheaded by Schumacher, but certainly followed by many other individuals and groups, the general tenor being that it cannot, and should not, continue.

However, while much has been written about low energy stretegies, and even acted upon by different small groups, in practice, the general trend is still concerned with large developments and towards large ranch farms and of course, large energy consuming houses. These two approaches, or philosophies perhaps, are poles apart and seen ireconcilable. Yet, some of the implications of the alternate approaches and the philosophies behind them are worth examining and indicate that isolated houses may become more important. Many feel that the balanced use of energy and the development of a meaningful way of life are inextricably bound up with the land question. It is one thing to suppose that all new isolated houses will be large sophisticated and highly mechanised farm dwellings complete with all 'modern services and amenities'. But at the same time to hope that the majority of farmers may live in such houses and that they will be highly energy efficient is frankly contradictory. As Illich (1973) argues 'better housing then can be occupied only be those who are well off or by those on whom the law bestows direct rent subsidies'.

1.03 Household type

Historically and geographically households are in continual change. These range from groups of families, through large extended families, nuclear families, non families to single person households. In Ireland, as elsewhere, it is obvious that the conservative traditional family structure is changing. Yet in 1971, in Ireland, two thirds of the farm households were family households. It is expected that this proportion will increase in the 1981 census. Thus, in Ireland the family remains the basic farm household and it is for this the farm dwelling must be designed and it is this that is worth examining. The energy opportunities and uniqueness of the isolated farm dwelling as a housing unit must be appreciated and exploited.

1.04 Uniqueness of isolated dwellings

The isolated dwelling is unique as a housing form. Because it is in open countryside, it can make optimum use of orientation, siting and shelter with none of the constraints imposed by tight urban situations. Unique by virtue of its demographic structure, it is also unique by virtue of the skills available or by the attitude of the farming community to undertake such skills. Much building at farm level is undertaken by the farmer himself, at least at some stage of their careers. The extent of self build can vary enormously from architect designed houses to houses that received little thought in advance. One of the most successful well designed do-it-yourself vernacular in these parts must be that of Walter Segal, particularly his housing in Lewisham, United Kingdom.

1.05 Appearance in countryside

In addition to the energy conservation aspects of exposed dwellings there is the element of the conservation of the rural countryside. Thus all building in rural areas particularly exposed buildings such as dwellings must be designed so as to be in harmony with the countryside. This applies not only to the building itself, but also to its immediate surroundings including planting, screening or alternations of levels. Thus the objective of this project is to examine the effects of external climatic factors on the heat demand of exposed domestic sites. Also to examine the micro-climate obtainable from different site conditions and thus access the saving that optimum siting and internal retro-fitting can have on the energy consumption and to do this within the context of buildings which compliment the countryside and rest in harmony with it.

2.00 Description

The sites selected for this project are situated at the Oakpark Research Centre of the Agricultural Institute. This is situated about 4 km. almost due North of Carlow town, lat. 52° 15' 12" N., and long. 6° 54' 15" W. This centre is responsible for research on tillage, agricultural engineering and biomass. The estate comprises 292 hectares which include a wild life sanctuary consisting of a 16 hectare artificial lake and several wooded islands.

The sites themselves are exposed to South and South West. The wind being from these directions for 31% of the year.

The mean daily duration of bright sunshine can vary from 2.14 hours in January to 6.62 in May and the annual horizontal global solar radiation is 3,657 Mj/m². The average maximum temperatures in summer is 19.6°C and average minimum in January is 1.3°C. There are an average 2284 degree days below 15°C and the average annual rainfall is 818 mm.

The land generally is flat open land with the odd tree. However as even in exposed buildings some shelter is usually provided it was considered desirable that the houses to be monitored should be protected from the North and East. This decision also meant that monitoring could examine the effect from total exposure on one face and protection from another.

The two sites chosen are within 100 m. of each other. Both sites have the same general characteristics, being exposed to the South and protected from the North. Both houses have been built over three years so that in each case construction has completely dried out and therefore stable thermal performances can be obtained.

2.01 House 'A'

House 'A' is a 112 m² bungalow of fairly recent construction, but poor conservation standards. The accommodation consists of five bedrooms, kitchen/living room, sitting room, bathroom and utility room. It is orientated to face S.S.E. The calculated u values are given in Table 1.

TABLE 1: Fabric Conductance - Test house 'A'*

Building Element	Area (m²)	U Value	U x A (W/°C)
Roof	124.965	0.60	74.919
Floor	124.865	0.68	84.908
Ext. Wall (280 cavity)	21.883	1.7	37.201
(225 hol. block)	70.628	2.0	141.256
Windows N.	20.63	4.48	92.422
E. & W.	2.14	4.48	9.587
S.	9.56	5.67	54.205

* Utility has been ignored

This house was considered to have two zones. Zone 1, the southerly one, consisting of the sitting room and two front bedrooms - The back section of the house being zone 2.

2.02 Test House 'B'

This house is also a bungalow, of a similar floor area. The accommodation consists of kitchen/living room, sitting room, four bedrooms, utility room and two bathrooms. This house has three heating zones. The zone 1 consists of kitchen/living room, sitting room, and a bedroom. This southernly zone receives direct insolution through South windows. Zone 2 consists of most of the northern half of the house including three bedrooms and zone 3 consists of the utility room and second bathroom.

The house includes some energy conser.ation and passive solar elements in its construction, thus part of the south wall is a Trombe wall of high density concrete block. The other external walls are of cavity wall construction, the two leaves being 200 mm. hollow concrete block and the 200 mm. cavity containing 150 mm. fibre glass. The calculated u values are given in Table 2.

TABLE 2: Fabric Conductance - Test house 'B'

Building Element	Area (m²)	U-Value (W/°Cm²)	UxA (W/°C)
Roof	121.5	0.11	13.365
Windows N.	2.18	5.00	10.90
Windows S.	11.63	3.97	46.17
Windows E.	0.86	5.00	4.30
Windows W.	3.60	4.48	16.13
Doors N.	1.98	4.00	7.92
Doors E.	1.98	3.50	3.93
Insulated Wall	66.44	0.30	19.07
Trombe Wall	32.11	1.03	33.07
Floor	121.5	0.48	58.32

3.00 Methodology

One of the problems that occur in studying the effect of external macro and micro climate on internal ambient temperatures is the difficulty of obtaining data on which to make comparative analysis. One of the more usual approaches is to take two houses, very often a pair of semi-detached houses, incorporate different energy conservation standards in each house and monitor them for a fixed period. However, this tells very little about the effect of the surrounding site conditions on internal gains and in fact can only examine the effects of different fabric conductance levels. Even in this area one cannot rely on calculated u values as buildings may not achieve such values in practice. Similarly in the case of two semi-detached houses the orientation of each house in practice is not identical and therefore the solar gain must vary to a greater or lesser extent. In other words, it is difficult to achieve identical configurations which would receive identical external climatic data inputs. Not withstanding, this form of monitoring has very obvious advantages and a limited form of such monitoring is incorporated in this project. The two test houses 'A' and 'B' as described are on very similar sites and therefore climatic configurations will both be monitored.

The other analytical approach is to use the same house but with altered fabric conductances and site configurations. This removes all difficulties or discrepancies which would have arisen from identical houses that are not quite identical, but of course, raises its own problems. The obvious one being that if a house is monitored for a fixed period and subsequently altered and remonitored, it will be done under completely different climatic conditions. Nevertheless, from the resultant figures, recorded over a long period of time, predictions could be made for other weather conditions. Thus though different recording times are involved meaningful comparisons may be made. Again the longer the monitoring periods, say even twelve months, the more accurate the predictions.

Passive solar heat gains and the auxiliary heating requirem be evaluated through the application of an hour-by-hour heating l analysis to the different zones of the test houses. A computer pr (SOLHET) is being developed for this analysis using the general heat demand design approach.

3.02 Monitoring Regimes

Several different monitoring regimes will be undertaken. After each regime has been completed, some aspect of the test house or site will be altered and a subsequent regime commenced.

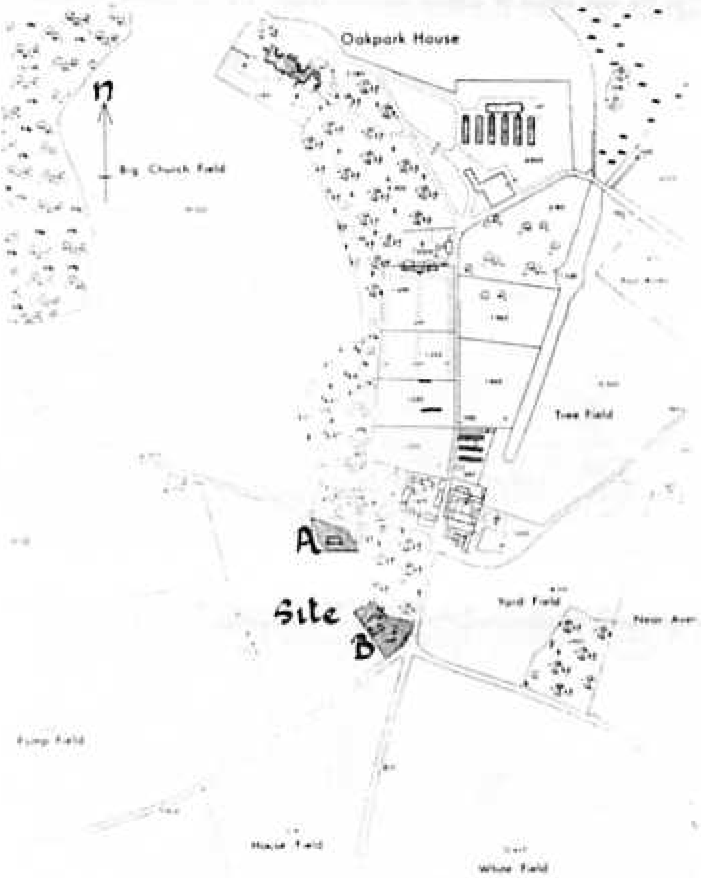
Regime 1. Monitoring internal ambient temperatures in test house 'A' for a five month period.

Regime 2. Altering the ground profile to test house 'B' and monitoring internal ambient temperatures for a four month period.

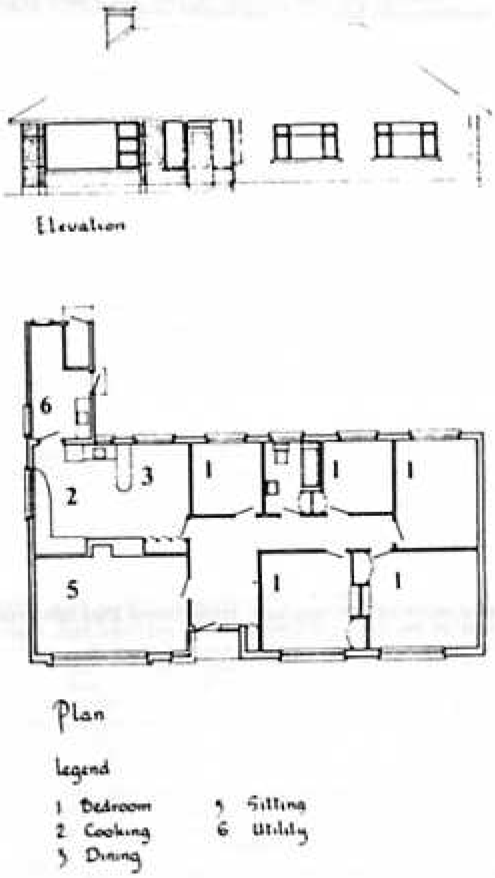
Regime 3. Altering the fabric conductance of test house 'B' by double glazing and monitoring for three months period.

Regime 4. Erecting shelter belt to the South of test house 'B' and monitoring for three monts period.

Regime 5. Altering the shelter belt and monitoring to continue for further three months.



Oak Park Research Centre
Carlow



Test House A

However, time is not always available on such a generous scale, ner indeed are facilities. The present project seeks to investigate the relationships of external climatic to internal heat gain in considerable detail but over fairly long periods of time. Thus one of the main trusts of the project will involve the development of the methodology. This will involve the establishment of formulae of a steady-state nature by which internal ambient temperature may be generated from external meteorological data. This will be set up by the application of multiple regression techniques to internal and external data recorded over a period of months. From this a theoretical computer simulation model for predicting internal ambient temperatures on an hourly basis will be constructed. By the application of these techniques, the potential for conservation for exposed dwellings will be examined.

3.01 Heat Gains

Casual heat gains in any building originate from three main sources:

1. Human emission.
2. Activity of domestic appliance.
3. External factors.

By examining unoccupied and unheated buildings, the first two factors can be eliminated. It is also hoped to keep monitoring as simple as possible. No matter how many sensors or how complicated a regime may be, it is still the internal ambient temperatures which will reflect any and all gains due to climatic factors. Thus the analysis will follow the general pattern of internal temperatures without heating being dependant on external temperatures without heating on the previous day. Hourly based regression models will be developed so that the steady state assumption applies only between estimated hourly values. In this way the continuously varying climatic and solar radiation influences are accurately reflected by internal temperatures.

At present the Irish Meteorological Service are preparing, along with their European partners, a standard meteorological year. By adopting such a base for the predictions from the different monitoring regimes, it should be possible to provide an even more meaningful and useful study.

3.01 Sub regimes

One of the constraints of this project is the time factor. The longer the period of time for each regime that is monitored, the more accurate will be the regression analysis equation. Obviously the length of time available for the overall project places considerable restrictions on the alterations and variations that can be incorporated into it. Not withstanding there are many additional variations that are worth examining. So in addition to the main regimes, it is hoped to examine several sub regimes. These will be examined with a view to improving the methodology for such detailed alterations and also to procuring results which while maybe not statistically accurate, would never the less be obviously sound. The sub-regimes would run for days rather than months and would include the following alterations:-

Regime 5. The addition of triple glazing and the sealing of airleaks.

Regime 6. The addition of thermal shutters to windows which would be opened by day and closed by night.

Regime 7. The performance of the house resulting from snow cover conditions not usual in Ireland but relevant to Continental conditions.

3.03 External micro-climate

In addition to monitoring the general external climatic conditions, more detailed monitoring of the micro-climate will also be undertaken. Wind direction, wind speed and ambient temperature will be monitored in different positions.

3.04 Final assessment

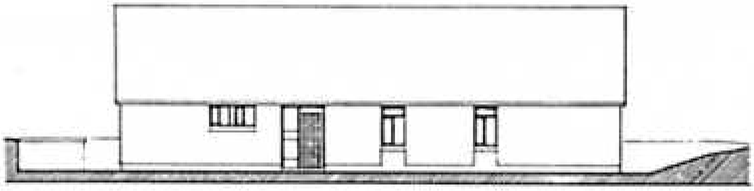
Study of the different monitoring regimes and their predicted casual heat gains will be used to generate an economic assessment of the measures. All monitoring, site alterations and house alterations will be made available to the technical University of Lyngby, Copenhagen for subsequent wind tunnel studies. Finally recommendations will be made for further research and study.

...ess

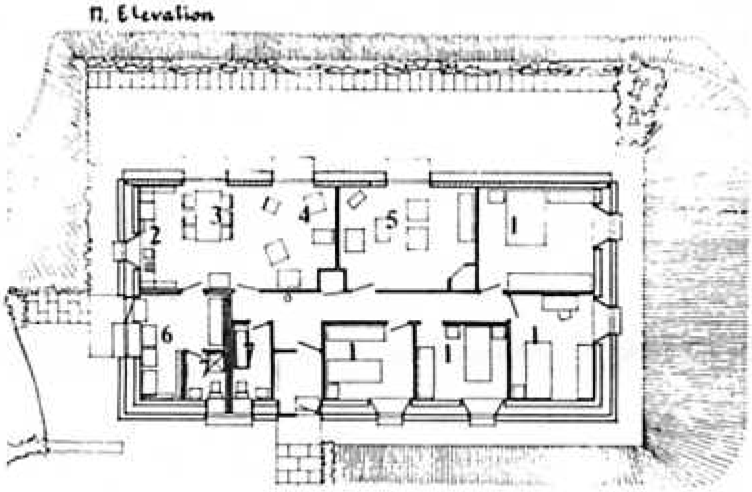
...of the monitoring regimes have been completed and part of the ...of regime 1.

Regime 1. As it was considered essential that every effort should ...de that the project could be completed in time set for it, it was ...ded to commence monitoring as early as possible rather than to wait ...ound for every item of equipment, provided that that would not interfere ...ith the monitoring itself. Internal ambient air temperature was adopted as the main thermal indicator within the dwelling and measured in both zones of the house. The data thus collected consisted of hourly internal ambient temperatures, hourly external ambient temperatures, hourly wind-speed and hourly global solar radiation.

The external parameters were monitored at the Oakpark weather station (approx. 300 m. from house 'A' and 200 m. from house 'B'). However, as this station provided only daily averages it was necessary to use the more detailed hourly records from Kilkenny meteorological station situated 35km. distance. To determine if this data accurately represented climatic conditions in the neighbourhood of the test house, a series of statistical comaprisons were applied to daily average meteorological records from both the Oakpark and Kilkenny stations. This was conducted by applying statistical F - test to the mean daily values from both locations to establish



N. Elevation



Plan

Legend

1. Bedroom 4. Living
2. Cooking 5. Sitting
3. Dining 6. Utility

Test House B

the significance of the difference between the two records. The results of these tests showed a non significant difference for external air temperature, wind speed or global solar radiation.

Internal air temperatures were measured by means of copper-constantan thermocouples and recorded on a Phillips PM 8235 Multipoint chart recorder which incorporated antomatic cold-junction temperature compensation. Supplementary measurements were taken on bi-metallic strip thermograph pen recorders, to maintain continuity of data during equipment calibration or failure. All probes were checked weekly against a standard thermocouple temperature meter.

4.02 Regime 2. Before monitoring was commenced, the erection of wind deflecting mounds around house 'B' were designed. Models of the house were made and these mounds were examined in a water table to simulate wind flow across the house. In the three dimensional model flow from six directions were examined, E. and S.E., were omitted as the cover from surrounding trees provided considerable protection from this direction. In the two dimensional model flow was examined only from North or South.

The final design and formation of the mound as shown on the drawings also sought to incorporate aspects of design suitable for the countryside. Thus on the south side it is kept fairly near the face of the house, but such that the trust of any flow from the south would be deflected to the eaves level of the house. (The mound could not be higher than 1 m. above f.f.l. of the house itself to allow the occupants a clear view over the mound while seated). The mound was not continued around the house as this would be visually depressing. The planting was also selected to enhance the environs of the house and to assist wind protection.

The house itself, as mentioned, contained several passive solar elements and ventilation louvres and grills. However, it was decided that if all ventilation louvres were continually adjusted to gain optimum solar benefit, it would yield very biased results. Consequently, the position of all louvres were kept open during the monitoring and will remain the same for all subsequent regimes. The data monitoring in house 'B' has been undertaken by means of a Microdata logger M 1600 L and p.r.t. probes over a four month period. This data logger has given considerable trouble. It was in operation being tested before the starting date and so far three of the cards have been faulty and have had to be returned for repair. The latest fault which occurred was a malfunction of the integrated circuit on the C 1139 buffer and scan control card. This caused several errors on the recorded data for the first recording regime on house 'B'. However the extent will not be statistically relevant and a programme has been prepared to clean up the tape. At present, some difficulty has arisen with interfacing the tape from the data logger with the PDP 11 computer at Oakpark, this should be solved shortly. The data will then be transferred to floppy disc and moved to the Vax computer in H.Q. for further analysis.

4.03 Regime 3. The fabric conductance of experimental house 'B' has now been altered by means of additional glazing and a new monitoring regime, similar to regime 2, is at present on going.

5.00 Analysis

The data generated from regime 1 are now being used to develop analogue functional relationships to equate mean zonal internal temperatures with the selected variables. The range of variables included in the analysis are:

1. Internal temperature at time i ($t_{int._i}$), the dependent variable. (°C)
2. Internal temperature at time i - 1 ($t_{int._{i-1}}$) (°C)
3. External air temperature at time i ($t_{ext._i}$) (°C)
4. Wind speed at time i (W_i). (knots)
5. Global solar radiation received at a horizontal surface, at time i (R_i). (J/cm²).

The two main hourly based regression models are presented in Tables 3 and 4.

TABLE 3 : Regime 1 - Zone 1 - hourly based multiple regression model

	Constant Term	Variables				
		$t_{int.1_{i-1}}$	$t_{ext._i}$	W_i	R_i	R^2
Regression Coefficient	0.656	0.909	0.042	-0.025	0.003	0.962
T-value		161.100	8.520	-8.355	15.745	
β Coefficient		0.909	0.049	0.029	0.058	

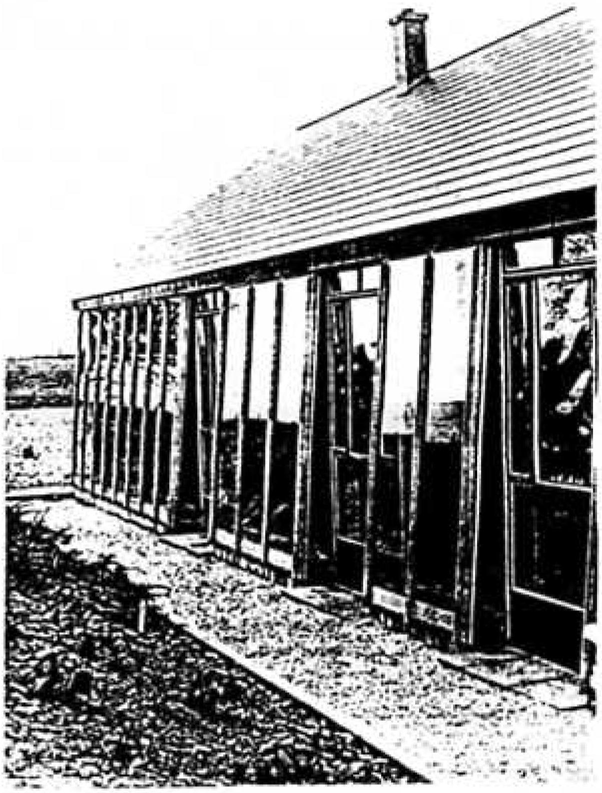
TABLE 4: Regime 1 - Zone 2-hourly based multiple regression model

	Constant Term	Variables				
		$t_{int.2_{i-1}}$	$t_{ext._i}$	W_i	R_i	R^2
Regression Coefficient	0.022	0.960	0.039	-0.005	0.008	0.996
T-value		509.571	20.739	-4.473	11.215	
β Coefficient		0.960	0.044	0.006	0.015	

Further analysis has yet to be undertaken including analysis of data from subsequent regimes.

6.00 Conclusions

There are no firm conclusions at this stage of the project, save perhaps that things often take longer than one thinks.



Test House 'B' - South Aspect