ENERGY EFFICIENCY
Designing Low Energy Buildings Using Energy 10

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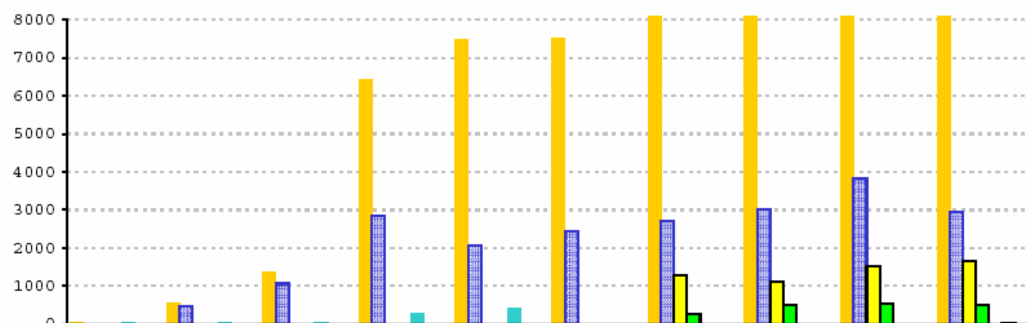
1. OVERVIEW OF ENERGY USE IN MALAYSIA

1.1 Status of Energy Supply & Demand in Malaysia

"The local power sector is currently one of the country's most highly subsidised industries. The price of natural gas has been fixed at RM6.40 per mmbtu since 1997. This represents a 76% discount to average US rates of US$6.39 per mmbtu converted at the prevailing exchange rate. Thus far, the discount has been borne by Petroliam Nasional Bhd (Petronas) in the form of loss of revenue." The Star 3rd July 2004.

The price was up for review in 2000 (following the expiry of the Gas Supply Agreement) when Petronas started pushing hard for an upward revision. In the end, the rate was maintained as any increase would be detrimental to TNB (The utility company has not seen a tariff increase since 1997 when the average rate increased by 9.5% to 23.5 sen per kilowatt-hour). The gas price is scheduled for its next review at end-2005.

NATURAL GAS CONSUMPTION BY SECTORS (ktoe)



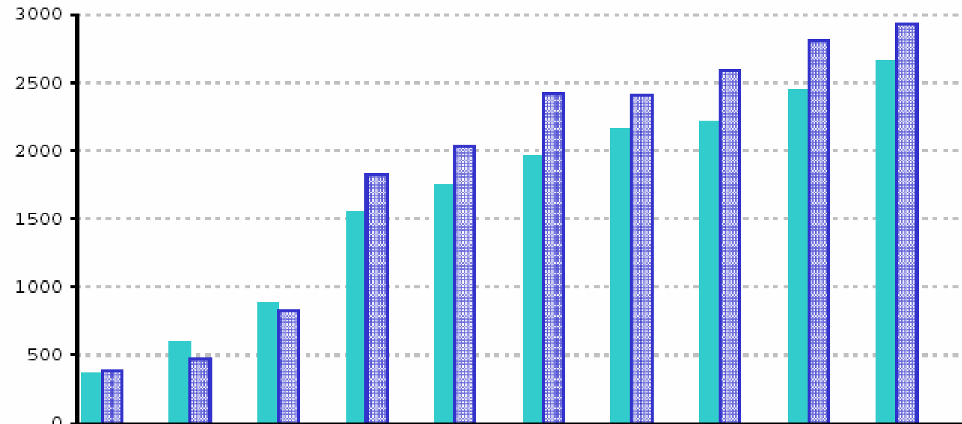
	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001
Power Stations*	33	539	1,361	6,414	7,489	7,531	9,158	10,697	11,580	11,922
Industrial	1	468	1,061	2,853	2,067	2,452	2,712	3,009	3,839	2,937
Non-Energy	na	na	na	na	na	na	1,282	1,118	1,512	1,655
Self-Generation	na	na	na	na	na	na	271	488	530	495
Resid. & Comm.	34	47	32	289	403	8	10	14	16	14.96
Transport	0	0	0	5	4	5	4	0	7	14
Total	68	1,054	2,454	9,556	9,963	9,996	13,437	15,326	17,484	17,037

Note: na = not available

Source: Department of Electricity and Gas Supply Malaysia, power utilities, IPPs and self-generation plants

With about 71% of power stations relying on natural gas as an energy source in 2001, electricity rates can not be expected to remain stagnant if gas prices go up. If the government were to remove the gas subsidy completely and allow Petronas to charge international market rates of around RM24.70 per mmbtu, **TNB would have to raise its average tariff rate by some 25%** in order to maintain its FY05 net profit forecast of RM1.6bil, according to Avenue Securities power analyst Daniel Griffin. Electricity rates have been kept low, to the extent that Malaysia's are now the second lowest in Asia, as a means of attracting foreign direct investment into the country. As a result, the industrial sub-sector is now the most heavily subsidised. "It is highly unlikely that the government will instantly allow Petronas to revise gas prices according to international market rates as that would have an adverse effect on Malaysia's current competitive advantage," the analyst says.

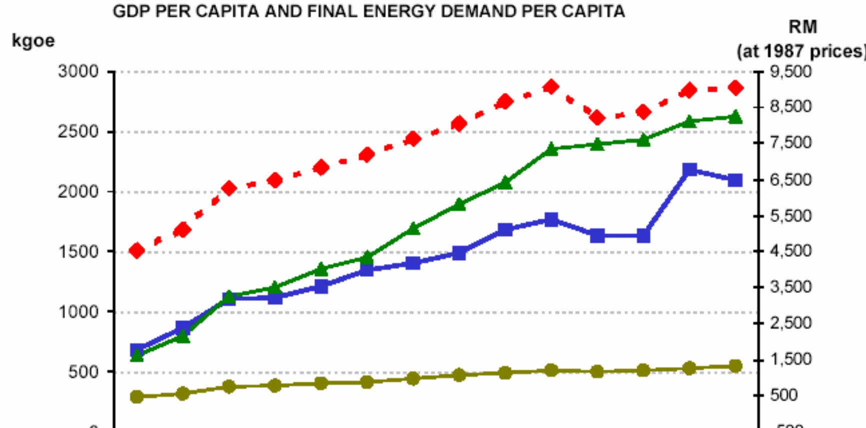
ELECTRICITY CONSUMPTION BY SECTORS (ktoe)



	1980	1985	1990	1995	1996	1997	1998	1999	2000	2001
Resid. & Comm.	363	604	885	1,549	1,747	1,961	2,165	2,220	2,453	2,660
Industrial	384	475	830	1,826	2,029	2,422	2,411	2,591	2,805	2,930
Transport	0	0	0	0	1	1	1	4	4	5.17
Total	747	1,079	1,715	3,375	3,777	4,384	4,577	4,815	5,263	5,594

Source: Department of Electricity and Gas Supply Malaysia, Ketua Merinyu Elektrik Sarawak, TNB, SESCo, SESB, and GDC (M)

TRENDS OF PRIMARY ENERGY SUPPLY PER CAPITA, ELECTRICITY DEMAND PER CAPITA GDP PER CAPITA AND FINAL ENERGY DEMAND PER CAPITA



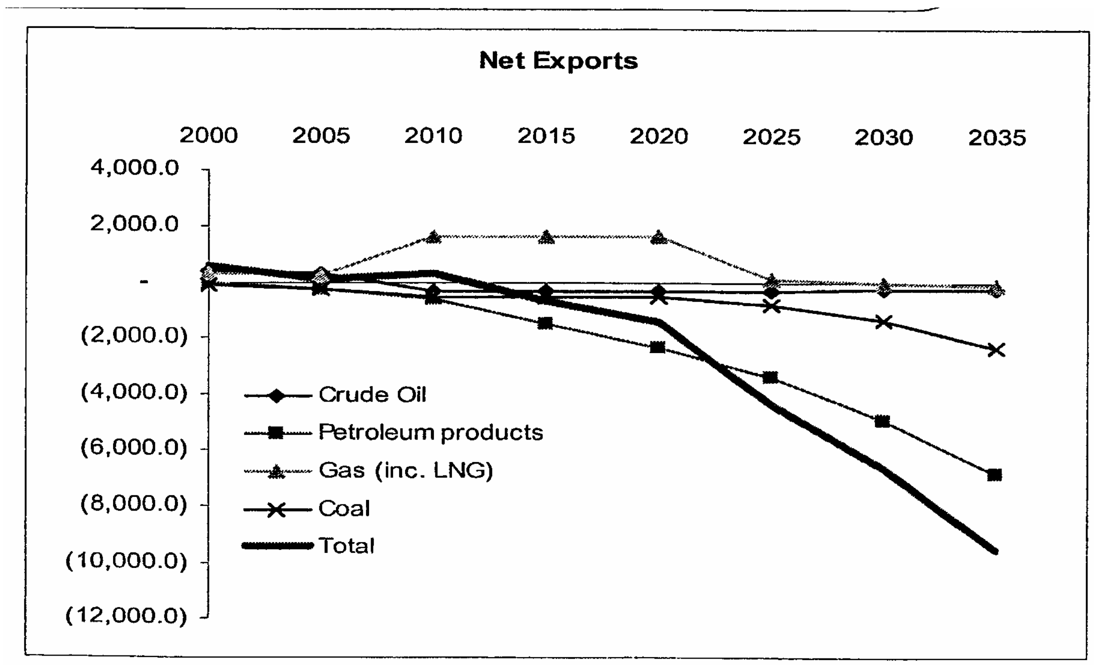
	1980	1985	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Primary Energy Supply per Capita	680	866	1,107	1,111	1,211	1,344	1,404	1,493	1,682	1,765	1,636	1,634	2,179	2,100
Electricity Demand per Capita *	631	800	1,123	1,206	1,354	1,455	1,694	1,896	2,074	2,352	2,398	2,433	2,591	2,625
GDP per Capita	4,528	5,102	6,255	6,503	6,827	7,200	7,651	8,054	8,659	9,098	8,221	8,388	8,995	9,043
Final Energy Demand per Capita	464	556	744	785	850	893	959	1,071	1,142	1,208	1,152	1,184	1,276	1,312

Note: * Figures in kWh

Source: i) Department of Statistics Malaysia
ii) National Energy Balance 1980 – 2000, Ministry of Energy, Communications and Multimedia

The residential and commercial sector consumed about 48% of total electricity generated. With increasing GDP, electricity demand will increase but in different proportions. Malaysian electricity-GDP elasticity is around 1.5 meaning for every 1% rise in GDP, electricity consumption increases by 1.5%. A comparison of the 1990 energy use per capita output by DANIDA has Malaysia at about 26 GJ/1000USD compared to Thailand at 20

GJ/1000USD and Japan at 7 GJ/1000USD. We are obviously not using our energy very efficiently.



Based on current economic growth rates, PTM or Pusat Tenaga Malaysia have projected that Malaysia would become a **net imported of energy by between 2010 and 2015**. Knowing this, can we as responsible Architects continue to take the "cheap fossil fuel" approach to our built environment?

1.2 National Energy Policy Objectives

Three principal energy objectives are instrumental in guiding the future energy sector development. They are:-

The Supply Objective:

To ensure the provision of adequate, secure, and cost-effective energy supplies through developing indigenous energy resources both non-renewable and renewable energy resources using the least cost options and diversification of supply sources both from within and outside the country;

The Utilization Objective:

To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption; and

The Environmental Objective:

To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

1.3 Malaysian Energy Laws

1. Electricity Supply Act 1990 - Act 447 - coming into operation on 1 September 1990

P.U. (B) 494/90 - Appointment of Date of Coming into Operation

P.U. (A) 272/90 - Suspension of the Operation of the Act (Sarawak) Order 1990

P.U. (A) 384/90 - Licensee Supply (Exemption) Order 1994

P.U. (A) 38/94 - Electricity Regulations 1994
P.U. (A) 156/94 - Electricity Supply (Exemption) Order 1994
P.U. (A) 408/01 - Electricity Supply (Compounding of Offences) Regulations 2001
2. Electricity Supply (Amendment) Act 2001 - Act A1116 - coming into operation on 2 January 2002
P.U. (B) 607/01 - Appointment of Date of Coming into Operation
3. Electricity Supply (Successor Company) Act 1990 - Act 448
P.U. (B) 495/90 - Appointment of Date of Coming into Operation
P.U. (A) 273/90 - Vesting Date Order 1990
4. Lembaga Letrik Sabah Act 1983 - Act 278 - coming into operation on 1 August 1983
P.U. (B) 647/83 - Appointment of Coming of Into Operation
5. Lembaga Letrik Sabah (Amendment) Act 2001 - Act A1127 - coming into operation 1 September 1998
6. Energy Commission Act 2001 - Act 601 - coming into operation on 1 May 2001
P.U. (B) 124/2001 - Appointment of Coming of Into Operation
P.U. (B) 120/2001 - Suspension of the Operation of the Act (Sarawak) Order 2001
P.U. (B) 160/2001 - Appointment of Chairman and Members of Energy Commission

1.4 Energy Commission

The Energy Commission was established as a corporate body under the Energy Commission Act 2001(Act 610), to regulate the energy supply activities in Malaysia and to enforce the energy supply laws, and for matters connected therewith

Energy Commission was set up to enhance the effectiveness of regulatory control over the energy sector (i.e. the electricity supply industry and the gas supply industry at the reticulation stage). It took over the regulatory functions which were formerly performed by the Department of Electricity and Gas Supply, which was dissolved on 2 January 2002.
The principal functions of the Energy Commission are as follows:-
1. To advise the Minister on all matters concerning the national policy objectives for energy supply activities;
2. To advise the Minister on all matters relating to the generation, production, transmission, distribution, supply and use of electricity under the electricity supply laws;
3. To advise the Minister on all matters relating to supply of gas through pipelines (reticulation stage) under the gas supply laws;
4. To implement and enforce the energy supply laws;
5. To regulate on all technical and safety matters relating to the electricity industry and the gas supply industry at the reticulation stage and to protect any person from dangers arising from them, as provided under the electricity and gas supply laws;
6. To regulate in order to protect the interest of consumers by ensuring safe and reliable energy supply at reasonable prices;
7. To promote economic efficiency in the electricity industry and gas supply industry (reticulation stage);
8. **To promote the use of renewable energy and energy efficiency**;
9. To promote research and the development and use of new techniques relating to the generation, production, transmission, distribution, supply and use of electricity and gas at the reticulation level.

The Government had appointed seven members of the Energy Commission, including its Chairman. The members of the Commission were appointed on the basis of their wide experience and expertise in the energy sector. The tenure of office is 3 years for the Chairman and members representing the Government, and 2 years for members who are representatives of the non-Government sector.

In its Inception Workshop PWTC 7th June 2002, the Energy Commission immediately proposed that Energy Efficiency standards be implemented for all Malaysian Buildings by implementation through additions into the Uniform Building By-Law. They proposed that MS 1525 : 2001 be adopted. PAM suggested a more balanced and practical approach by educating practitioners in the construction industry on how to improve and design for Energy Efficiency in buildings first before implementing such laws.

With so many Architects not knowledgeable in the area of incorporating energy saving features let alone estimating the projected energy consumption, this would indeed be a difficult By Law to implement today. Based on current tends however, energy will increasingly become more expensive and when Malaysia becomes a net importer of Energy some time after 2010, energy standards will most definitely become mandatory.

Summary

1. Electricity tariffs are expected to increase by around 25% sometime after 2005
2. Malaysia will become a net imported of energy sometime between 2010 and 2015
3. Energy Efficiency Standards will become mandatory sometime before Malaysia becomes a net energy imported.

2. FACTORS AFFECTING ENERGY USE IN BUILDINGS

2.1 Overview of Factors Affecting Energy Use in Buildings

The factors affecting energy use in buildings can be categorized into two groupings

END –USE : Air Conditioning & Space Heating
Lighting
Power & Process

FACTORS : Occupancy & Management
Environmental Standards
Climate
Building Design & Construction
Mechanical & Electrical Equipment

2.2 Energy Indices

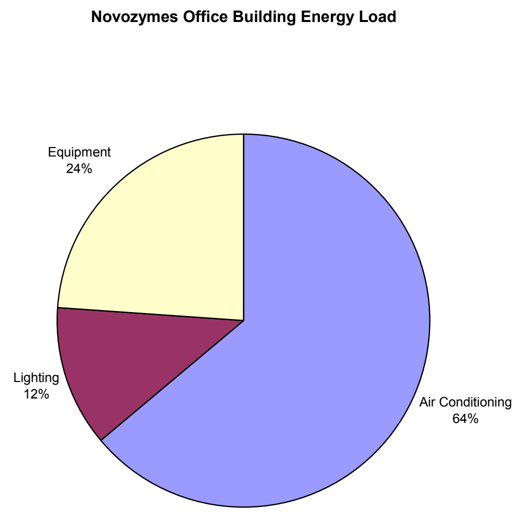
Before going into details of the factors affecting energy use, some method of comparing energy use - the energy use indices – will be explained. The index selected would depend on the intended application of the index and the normalizing factor. Among Architects the normalizing factor for comparing buildings is the gross floor area. The most commonly used index for comparing energy use in buildings is therefore the Annual Area Energy Use Index - AEUI. This is usually expressed as kWh/m2/year which measure the total energy used in a building for one year in kilowatts hours divided by the gross floor area of the building in square meters.

2.3 End Use & Actual Energy Consumption

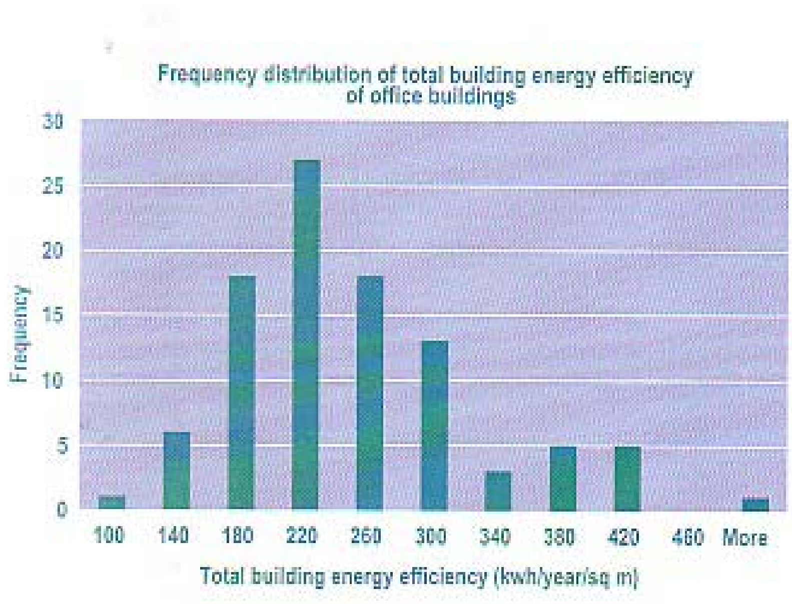
The amount of energy used in buildings depends firstly on WHAT IT IS USED FOR. Thus the initial and most important step in isolating the factors affecting energy use is to determine its end-use. To architects, the category of use or building type will be the first factor to consider. Therefore to compare the energy index of say an office building which operates from 9 am to 5 pm to say a data processing center which operates computers around the clock would not be a reasonable comparison because the operating hours are different and the computers in the data processing centre would consume more electricity and may require a higher environmental standard. Comparing two schools in the same climatic region and similar operating conditions would however give a comparison of the energy performance of the two buildings.

In Malaysia not much published data is available yet on the Energy Performance or actual annual energy consumption of buildings. Pusat Tenaga Malaysia - PTM is still in the process of auditing Government Office Buildings and Center for Environment, Technology & Development, Malaysia - CETDEM has just received funding from DANIDA to pilot a study of energy consumption in Malaysian Homes.

In February 2003, Danida and ECO-Energy Systems conducted an energy audit on the office of Novozymes Malaysia Sdn Bhd office building in Technology Park Malaysia. In 2002, the 987 m2 single storey office consumed 232,050 kWh giving it an energy consumption index of 235 kWh/m2/year. The breakdown was 64% for air conditioning, 12% lighting and 24% general equipment. Using Energy-10, DANIDA carried out energy modeling on the building. and came up with 7 energy saving measures. When implemented the energy consumption index was reduced to 181 kWh/m2/year. The 2003 audit confirmed the accuracy of the Energy-10 computer simulation.

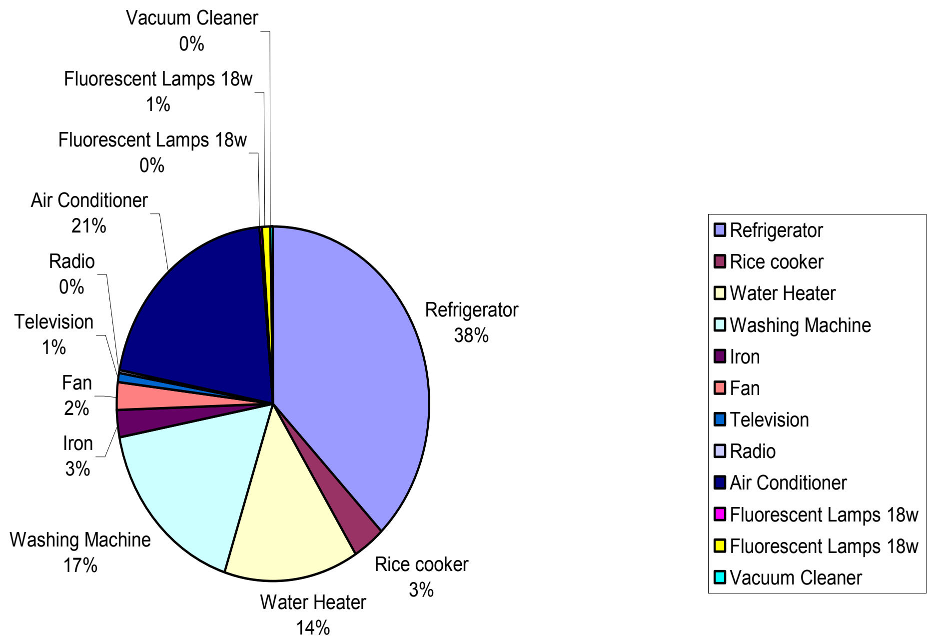


Energy consumption in Singapore average around 220 kWh/m2/yr with only a handful of them below140 kWh/m2/yr. Malaysian Standard MS1525:2001 for non-residential buildings sets an inferred standard of 130 kWh/yr/m2. Most Singapore Office buildings are not able to even meet these standards in spite of Singapore having imposed mandatory OTTV standards from 1978. OTTV stands for overall thermal transmittance value. This is the amount of heat a building fabric can transmit.



Energy Index of Singapore Office Buildings

Home consumption of energy would depend very much on the appliances installed, the hours of use and the efficiency of the equipment. In a typical Malaysian terraced house of about 180 m2, the refrigerator is usually the largest consumer of electricity while the air conditioning will increasingly become more important as living standards rise. The CETDEM survey should reveal clearer results for the future.



Malaysian Home Energy Use Estimate - 180 m2

180

ITEM	kW	hrs/yr	kWh	kWh/m2/yr	%
Refrigerator	0.3	8760	2628	14.6	38%
Rice cooker	0.65	360	234	1.3	3%
Water Heater	2.7	360	972	5.4	14%
Washing Machine	2.2	540	1188	6.6	17%
Iron	1	180	180	1	3%
Fan	0.045	3600	162	0.9	2%
Television	0.06	1080	64.8	0.36	1%
Radio	0.25	72	18	0.1	0%
Air Conditioner	1	1440	1440	8	21%
Fluorescent Lamps 18w	0.032	288	9.216	0.0512	0%
Fluorescent Lamps 18w	0.192	288	55.296	0.3072	1%
Vacuum Cleaner	0.3	96	28.8	0.16	0%
TOTAL	8.729	17064	6980.112	38.7784	

2.3 Non Design Factors affecting Energy Use in Buildings.

From the results of my own studies on energy use in New Zealand Schools, the following were found to have a significant impact on energy consumption in buildings.

Occupancy and Management - It should be emphasized that people use energy. The building itself does not use much energy. We cool or heat the people in the building, not the building. There are four broad aspects to consider.

1. intensity of building occupancy
2. activity type
3. user attitude and behavior
4. management and organization

First, the amount of energy used will generally be directly proportionate to the intensity of building occupancy. An office building rented out for only half a year will obviously use half the energy of an equivalent building occupied throughout the year. Operating hours will be another normalizing factor energy auditors must keep track of

Second, the level of physical activity, the clothing worn, the duration of occupancy and age, size and background of the occupant will also affect the cooling / heating requirement. These factors will affect cooling requirements by influencing the preferred air temperature. Fanger and Kowakzewski's work show for example that a person wearing light clothes and doing light desk work seated will feel comfortable at 25 degrees centigrade while he will only feel comfortable at 21 degrees centigrade with a light business suit. This 4 degrees difference can mean a 100% difference in the air conditioning energy requirement of a room.

Third, the attitude of the occupants towards energy use has significant consequences. They are influenced by the aims and goals of the uses, the penalties and benefits to the user of conserving energy, expectations of the user and weather the users are aware of the relationship of their actions to the amount of air conditioning of heating energy used

Finally, the organization and management of the building and its air conditioning equipment I terms of operation and maintenance will reflect on its efficiency and thus the energy used.

Environmental Standards – The amount of air conditioning load required and thus air conditioning energy used depends very much on the air temperature maintained in the building. Some office buildings and hotels maintain indoor temperatures as low as 18 to 20 degrees centigrade when the comfortable temperature is about 24 degrees centigrade. There are many office buildings in Malaysia where the indoor temperature is so low that the occupants wear sweaters at the work desk. It is obvious the owners are no aware of the cost implications of their actions. It should also be noted that the average outdoor air temperature in Malaysia is only about 4 degrees above the comfort range.

Climate – The number of publications and studies of the relationship of climate to architecture, people and energy use is very extensive. The purpose here is only to list some of the variables of concern.

Climate affects the energy consumption in a building primarily by influencing the space cooling and heating requirements. The main climatic variables influencing the amount of energy needed for air conditioning are.

1. Solar radiation
2. Outside air temperature
3. Wind and rain
4. Night sky radiation

Geiger has an extensive study of the physical variable influencing the microclimate. This would be useful for those planning large scale developments. The table below lists the major physical factors influencing the climate, some of which may be within the Designers control.

	Solar Gain	Temperature	Wind
MACRO CLIMATE			
Latitude	Major	Major	
Altitude	Minor	Major	Minor
MICRO CLIMATE			
Terrain - Slope	Minor	Minor	Major
Ground Cover - Vegetation		Minor	Major
City / Country – Shading / Shelter	Minor	Minor	Minor
Water Body – Inland / Seaside		Minor	Minor

2.4 Passive Design Factors affecting Energy use in Buildings

The building layout, planning, design, shape, fabric and construction cover a wide number of variables that affect building energy requirements. This the area where the basic decisions of the architect will have the most influence on the building's energy use. How much then does the designer have? The following sets of estimates by Givoni should serve to illustrate a building's influence on its indoor environment and thus air conditioning or heating requirement. Depending on the design

1. the indoor air temperature amplitude – swing from lowest to highest – can vary from 10% to 150% of outdoor amplitude
2. the indoor maximum air temperature can vary by -10 to +10 deg.C from outdoor maximum
3. indoor minimum air temperature can vary by 0 to +7 deg.C from outdoor minimum
4. indoor surface temperature can vary by +8 to +30 deg.C from outdoor maximum and minimum.

The building related factors influencing energy requirements are numerous and complex. They can be classified under the following headings.

1. Size and Shape
2. Orientation
3. Planning and Organization
4. Thermo physical properties – thermal resistance & thermal capacity

5. Window systems
6. Construction detailing.

Size and Shape – Generally, a larger building will require more energy to cool than a smaller building because of the larger of space to be cooled. This is widely accepted. The question of whether a building needs less energy per unit volume or floor area is however a more complex one and still not completely resolved. Many theoretical researchers take the view that larger buildings need less energy per unit size because of their smaller surface area per unit size and thus lower heat gain per unit size. Based on this theory they say " The larger a building, and the nearer to spherical in shape, the less are its energy needs because of the simple reduction in the ration of surface area to volume". They conclude that "The architectural fad for angular protrusions of buildings is an energy wasting form".

The Building Research Unit however found from field data that compact buildings cost more to erect and had higher energy running costs than sprawling ones. These empirical findings were contrary to the Unit's theoretical predictions. They concluded that the quality of "compactness" in layout is one which cannot, on present evidence, be shown to be of paramount importance. Stein reach conclusions similar to the BPRU " …the maximum volume, minimum perimeter building will not be the most energy conservative and because of the mechanical systems required to provide interior comfort conditions at all times, may not even be the least expensive."

Building Orientation – Building orientation affects the air conditioning / heating energy requirements in two respects by its regulation of then influence of two distinct climatic factors.

1. Solar radiation and its heating effects on walls and rooms facing different directions
2. Ventilation effects associated with the relation between the direction of the prevailing winds and the orientation of the building.

Of the two, solar influence on energy is the most significant in the tropics and is extensively covered by many others.

Planning & Layout – It is not possible to generalize or quantify the complex implications that planning and layout of spaces will have on air conditioning and lighting requirements. Some areas where the layout will influence are listed below.

1. Grouping of spaces
2. Interaction of spaces
3. Ceiling height and space volume
4. Buffer zones

Thermo Physical Properties – The properties of materials which affect the rate of heat transfer in and out of a building, and consequently the air conditioning or heating energy requirements are.

1. Thermal Resistance
2. Surface Convective coefficient
3. Absorptivity, Reflectivity and Emissivity
4. Heat Capacity

Window Systems – The size, location, shape and orientation of glazed areas in a building will have a critical effect on both the heat gains and solar gains of a building because glazed areas have the highest hat gain per unit area and the major proportion of solar gains are also

through windows. The importance of this factor is indicated by Stein's finds that the school with the highest energy use per square foot in New York City was a completely sealed building with windowless classrooms.
The amount of heat gains will also be influenced by
1. Type and design of shading system employed
2. Composition and type of glass
3. Obstruction and shading by surrounding buildings, structures and trees

Construction Detailing – This will influence air conditioning loads in the following areas.
1. Infiltration cold air losses at junctions of different materials especially between roof joist and exterior walls, similar to the effect of leaving the door open in an air conditioned room
2. Conduction bridges – These are paths through which heat gain will be greatest, for example through a metal deck roof on a steel roof truss directly into the top floor of air conditioned spaces.

Summary

1. The amount of energy used in buildings depends on WHAT IT IS USED FOR
2. A typical Malaysia Office Building consumes about 250 kWh/m2/year of energy of which about 64% is for air conditioning, 12% lighting and 24% general equipment
3. The major non design factors influencing energy use in buildings are 1. Occupancy & Management, 2. Environmental Standards, 3. Climate
4. Major building related factors influencing energy requirements can be classified under the following headings.
    - Size and Shape
    - Orientation
    - Planning and Organization
    - Thermo physical properties – thermal resistance & thermal capacity
    - Window systems
    - Construction detailing.

3. DESIGNING LOW ENERGY BUILDINGS USING ENERGY 10

3.1 What is Energy 10

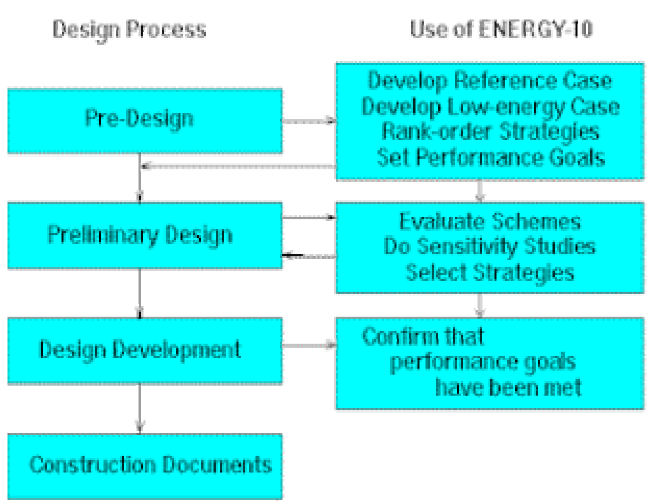
The ENERGY-10 computer program was introduced to Malaysia by its inventor Dr J D Balcomb on 15th January 2004 at the E-10 Train the Trainer Seminar held at Colma Tropical , Bukit Tinggi, Pahang between 15 to 17 January 2004. It takes about two days of training for an architect with reasonable computer literacy to learn the basics of how to use this program and so this half day seminar is not intended to train an architect on the use of the program but only to give him or her sufficient information on whether he should attend further training on this program which PAM will be offering in the next few months.

ENERGY-10 is a software tool for designing low-energy buildings. ENERGY-10 integrates day lighting, passive solar heating, and low-energy cooling strategies with energy-efficient shell design and mechanical equipment. It enables architects to make good decisions about energy efficiency early in the design process. ENERGY-10 was developed with a building industry task force that included architects, engineers, builders, and utility representatives. The program is geared toward buildings of 10,000 square feet or less—in fact, that's where the "10" in ENERGY-10 comes from.

ENERGY-10's accuracy has been demonstrated using the BESTEST procedure developed by NREL's Center for Buildings and Thermal Systems within the International Energy Agency Solar Heating and Cooling Program Task 12. BESTEST has been adopted by the U.S. Department of Energy and the international community as the accepted basis for verifying the credibility of computer simulation programs.

3.2 Designing for Energy Efficiency in the Overall Design Process

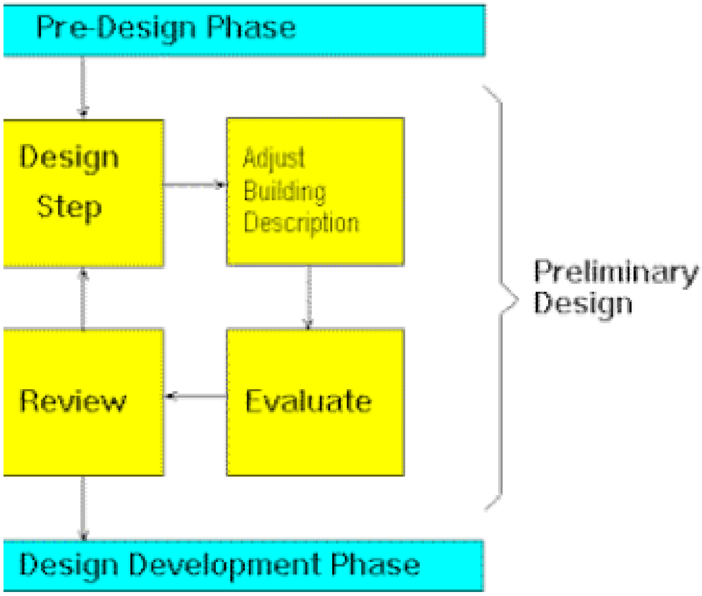
ENERGY-10 is designed to complement the normal architectural design process, as shown in the diagram.



Predesign - In the predesign phase (sometimes called the programming phase), both reference case and low-energy case building descriptions are generated using AutoBuild, the automatic building-generation wizard. The wizard creates a basic shoe-box reference building with general characteristics required to satisfy the architectural program. (The user can modify this building description, if desired.) The low-energy case is also automatically generated at the same time by using the Apply feature. This applies a set of user-defined solar and energy-efficient strategies (EESs) to the reference case to create the low-energy case. These two buildings are then simulated and evaluated to identify (1) the energy issues of greatest importance and (2) the effectiveness of the selected EESs.

Next, the **Rank** feature is used to set priorities among the selected EESs. The designer is now well equipped to begin the building design, knowing which strategies should be incorporated. The designer presents these results to the client, and the two parties agree on energy-performance goals for the building.

Preliminary Design - In the preliminary design phase (sometimes called the schematic design phase), the user adjusts the original low-energy case building description to be consistent with the first building scheme proposed, simulates that building, and compares the results with the original two shoe-box designs and with the performance goals. This requires manually computing the wall surface and other areas of the building and entering the values in appropriate places in the building-description dialog boxes. New walls, roofs, and floors can be created to describe multiple orientations or tilts. The evolving building description can be called the current design. This is a repetitive process (as shown in the diagram)—design, adjust the model, review, design, adjust the building description, evaluate, design, adjust the building description, review, etc. Each step represents a different design scheme. The **Apply** feature can be used to speed up the process of adjusting the model. The preliminary design is complete when the process has produced a design that satisfies the client.



3.3 How the Energy 10 Program Works

Details about how the ENERGY-10 computer program can be obtained from the article by Dr Balcomb J. Douglas "Using ENERGY-10 to Design Low-Energy Buildings" National Renewable Energy Laboratory. September 1999. Further data can be obtained from the website www.nrel.gov/buildings/energy10/.

Summary

1. ENERGY-10 is a computer program specifically for designing low-energy buildings
2. ENERGY-10 integrates day lighting, passive low-energy cooling strategies with energy-efficient shell design and mechanical equipment.
3. ENERGY-10 is a preliminary design tool. It enables architects to make good decisions about energy efficiency early in the design process.
4. ENERGY-10 is geared towards air conditioned buildings of 10,000 square feet or less

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