Module 1: A Context for Building Energy Audits

Learning Objectives

After completing this module, you will be able to
- Understand DME's Building Audit Program
- Understand the use of energy indices
- Develop buildings operation and system benchmarks
- Develop good practices in building operation.

1.1 The Context for Building Audits

1.1.1 DME's Building Audit Program

The White Paper on Energy Policy published in 1998 gave a mandate for the formulation of an Energy Efficiency Strategy. In April 2004 the Draft Energy Efficiency Strategy for the Republic of South Africa was put out for comments. The Energy Efficiency Strategy a bearing to the DME's Building Energy Audit Training Programme. The strategy has set national and sectorial energy demand targets to be achieved by 2014. The overall national target for energy savings is 12%. The commercial and public building sector target is 15%.

It is envisaged that these energy efficiency improvements will be achieved through enabling instruments and interventions including economic and legislative means, information activities, energy labels, energy performance standards, energy audits, energy management and by the promotion of efficient technologies.

The salient support mechanisms, relevant to the building energy audit training, that are highlighted by the strategy are as follows:

- Establishment of Efficiency standards;
- The development of an Accreditation procedure and the awarding of certification for competency to undertake auditing functions;
- Energy Audits will be promoted as means of improving efficiency;
- Eskom DSM Programme and the support link for Energy Service Companies.

The core objectives for the commercial and public sector programme are as follows:

- To demonstrate the government's commitment to sustainable energy development within its own building stock;
- To progressively upgrade the energy performance of existing public and commercial building stock; and
- To achieve best practice energy performance in new public and commercial building stock.

The approach in achieving these objectives is:

- The government will lead by example through raising energy efficiency awareness and by implementing specific measures within its own estate;
- Energy efficiency standards for buildings will be introduced and made mandatory, together with a building Energy Audit programme;
- Emphasis will be placed on incorporating energy efficiency into building design and energy efficiency technologies will be introduced in existing buildings;

- Energy management systems for buildings will be tested, demonstrated and promoted;
- In conjunction with the implementation of SANS 204 (SAEDES), energy labels will be developed to assist with compliance rating; and
- The standards for commercial buildings (SANS 204) will be made mandatory by its incorporation into the Building Code.

1.1.2 Characteristics of Government and Institutional Buildings

Buildings owned or operated by the government sector range from older refurbished buildings to purpose-built developments. The variety of building types range from university estates, prisons, courts, military facilities, hospitals, specialist laboratories, and office blocks.

Table 1.1 below shows the generic space types and occupancy characteristics.

Table 1.1: Generic Spare Types and Occupancy Characteristics

Generic Spaces	Areas Covered	Occupancy and System Characteristics
Teaching	Classroom / Lecture halls	Variable occupancy patterns, some transient periods but generally medium-to-long use.
	Tutorial rooms	Dense occupancy for mid-to-short term. Large room volumes with mechanical ventilation and additional specialist electrical loads.
	Seminar rooms	
	Halls	Long term occupancy. Increasing use of computer terminals.
	Resource Centres	
Research	Laboratories	Variable occupancy pattern. Potential for high process loads
	Workshops	
Offices	Administration	Mainly cellular spaces with single occupancy. Mechanical HVAC systems range from natural ventilation to modular chilled water fan coil units. Local control
	Department offices	
Catering	Kitchens	Staff areas tend to be long-term, low-density occupancy whilst public spaces are subject to transit use which can be high density
	Canteens	
Recreation	Sports Halls	Large volumes of spaces with occasional short-term high density occupancy
	Swimming Pools	
Residential	Study Rooms	Domestic usage patterns
	Catering facilities	
	Shared Bathrooms	
	En-suite Bathrooms	

1.2 Good Practice in Building Operations

1.2.1 Energy Indicators

Benchmarking is critical in understanding the absolute and relative performance of buildings, institutions, and their management of energy. Energy use in offices has risen in recent years because of the growth in information technology and air-conditioning. As a result there has been a strong increase in cooling in warm & cold countries and in electricity consumption. However, this trend is offset by considerable improvements in insulation, lighting and controls.

30% of all European buildings are tertiary sector buildings and most industry buildings include also an office. Energy efficiency in tertiary sector buildings and especially in office buildings is therefore an important factor for a sustainable future. The energy consumption is typically split in the following way: 52% space heating, 9% water heating, 14% lighting, 4% cooling, 16% other.

Analyses of energy consumption in office buildings showed that, on the average, energy consumption was split equally between heating and electricity. Electricity, however, can be responsible for up to 88 % of total energy costs (the average was 75%).

Best Practice also show how the proper selection and efficient use of office appliances (computers, printers, fax machines, etc.) and systems (ventilation and air-conditioning, lighting, lifts, etc.) can all help to reduce electricity consumption.

The following questions need to be asked for one to develop energy benchmarks;

- How does the level of energy consumption compare to other similar facilities and sites?
- What level of consumption is achievable with the best operating practices and performance benchmarks?
- How does energy consumption this year compare to last year?
- How does site A compare to site B on an energy performance basis?

Controlling costs in today’s public sector environment has become a critical priority that requires clear strategies for managing the variety of expenses incurred on a daily basis. Improving the energy efficiency of your organization offers many cost reduction opportunities.

The foundational elements of energy indices that should be continuously considered and assessed are detailed in the following country energy indices comparison table 2:

Table 1.2: Country Energy Indices Comparison

Country Energy Indices Comparison		
Austria	UK	South Africa
Office space in m² per staff member	Energy use indices (EUIs): annual kWh/m² of treated floor area	Net Rent area (m^2)
Specific energy consumption (kWh/m²,a)	Energy cost indices (ECIs): annual Pounds/m² of treated floor area	Yearly electricity consumption rate (kWh/year)
Specific energy costs (€/m²,a)	Carbon dioxide emission indices (CEIs): annual kg CO2 / m² of treated floor area	Monthly electricity consumption rate (kWh/month)
Specific annual electricity consumption (kWh/m²,a)	Energy use indices for hot water: kWh/m² of treated floor area	Monthly average maximum demand rate (KVA/month)
Specific annual electricity costs (€/m²,a)	Lighting benchmarks: W/m², hrs/year, percentage utilisation, energy use indices in kWh/m²,a	Monthly maximum demand rate (KVA/month)
Specific energy consumption for heating & hot water (kWh/m²,a)	Air handling benchmarks: litre/second per m², specific fan power in Watts per litre/second, hours/year, fan energy use indices in kWh/m²,a, fan/pumps and control energy use indices in kWh/m²,a	
Specific energy costs for heating & hot water (kWh/m²,a)	office equipment benchmarks: W/m², hours/year, percentage of treated floor area, energy use indices in kWh/m²,a	

1.2.2 International Good Practice and Case Studies

Design Stage Conceptualisation:

Key features:

- The standards to which the building and its services are designed
- The presence of air-conditioning.
- The proportion of open-planned offices; these tend to use more energy, particularly for lighting.

Building quality:

- Design which maximises the use of form and fabric to control the internal environment.
- Design which minimises the provision, capacity and use of building services.
- The efficient design and effective, usable control of these services.
- The quality of construction, installation and commissioning.

Occupancy and management:

- Occupancy hours and, to a lesser extent, densities.
- The amount of office and other equipment installed and its intensity of use.
- Matching standards and operating hours of services and equipment to usage.
- Effective maintenance.
- Unoccupied space.

Energy-intensive areas:

- Mainframe computer rooms, communications rooms and extensive dealing rooms, and their air-conditioning.
- Catering kitchens and sports and leisure facilities.
- Investigations clearly demonstrated that it is possible to combine high standard (meaning reduced energy consumption) with low construction costs. Taking into account running costs, such buildings can be even more economic than conventional office buildings.
- A crucial factor is the planning phase. The main objective should be to reduce energy consumption as much as possible and cover the remaining needs in an environmentally friendly way. Thermal and lighting simulation models are very helpful in the planning phase.
- After finalisation of the building, it has to be ensured that the planning concepts are put into practice (e.g. maintenance, control devices) and energy accounting can help to maintain a good standard.

Case Studies

Energy Saving Partnership Dr.-Horst-Schmidt-Hospitals

Aim of the project: Energy Performance Contracting and modernisation of the energy supply facilities with the aim to reduce the energy costs

Name and data of the building concerned: 8 buildings of the hospital with 972 beds (planned), energy reference area 59,270 m2

Measures: To realise the guaranteed savings, the bidding consortium has installed the following energy saving measures in the buildings, among others:

- CHP with thermal output of 661 kW and electrical power of 495 kW
- Modernisation of the air-conditioning and ventilation systems including demand-optimised regulation and control, use of frequency converters, replacement of ventilators and drives
- Modernisation of the automatic control systems of the heating installations, use of electronically controlled circulating pumps
- Speed controlled drives for circulating pumps and ventilators
- Heat recovery from laundry exhaust air for service water preheating
- Optimisation of steam supply
- Installation of a wattless current compensation system
- Use of energy-saving lighting systems (replacement of 1,500 recessed luminaries)
- Installation of a building management system with peak load programme

Sports Centre University Bremen

Aim of the project: Combined model energy performance contracting /own financing investment by the client with the main aim to reduce energy costs by 17% with a guaranteed saving of energy costs and therefore a relevant reduction of the investment risks for the federal government of Bremen.

Name and data of the building concerned: Building for administration and events, sports hall, swimming centre (year of building 1977)

Measures: Technical measures (optimization lighting, ventilation, heating), energy management and controlling

- Kind of EPC technology/model: “Easy EPC technology” without financing the energy saving measures by contractor
- guaranteed saving of energy costs for a large multifunctional sports centre (financing of the investment by client; share of the additional saving energy costs between client and contractor)
- combination of energy saving, reconstruction and a continual improvement of management with the help of modern energy system management technologies
- ***soft impacts“:*** Training program for technical staff of client, motivation as a result of the quarterly energy consumption reports (the client keep 50% of the additional saving energy costs)
- ***repeatability of the project:*** The project is repeatable due to the fact, that the contractor has the know-how and that a lot of other sports centre, which were built during the 70ies and early 80ies, are constructed without considering the real energy demand.
- ***key elements of success:*** 100% of the investment were financed by the client; the amortization is realized due to the guaranteed savings of energy costs (duration 4,5 years)
- ***main sources of problems:*** lack of data at the beginning of the project