D. ECONOMICS OF CANDU

ENABLING OBJECTIVES:

1.13 Match the following terms with their definition:

a) Base load;
b) Peak load.
c) Fixed cost;
d) Fuelling cost;
e) Capacity factor;

1.14 Using the terms defined in 1.13, explain how adjusting the generation mix and using Nuclear Stations as base load generation minimises the Total Unit Energy Cost (TUEC).

This section introduces some of the basic concepts associated with the economics of electrical power production so that you will understand the role CANDU plays in the overall electrical generation mix in Ontario Hydro.

TOTAL UNIT ENERGY COST

The electrical load[13] demanded from Ontario Hydro varies with time of day, day of week, and season, among other factors. Loads peak in the daytime, on business days, when factories are busy and society active. The loads are high during the summer because of the air conditioning load but even higher during the winter cold weather because of heating requirements. Load is composed of two basic elements: **base load** which is the minimum load demand over a 24 hour period, and **peak load** which is the amount in addition to base load to accomodate the daily peaks (refer to Figure 1.6).

[13] The amount of electrical power demanded by consumers of electricity at any point in time.

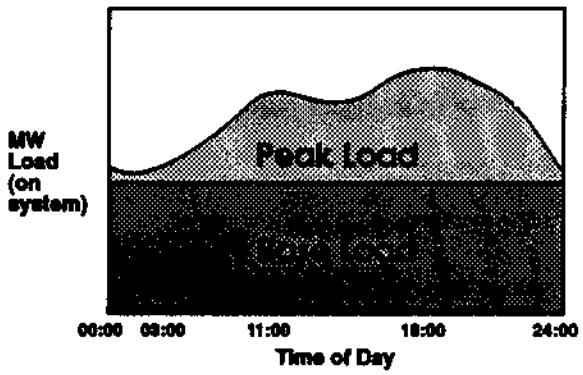


Figure 1.6
Typical Daily Electrical Load (Base and Peak)

There are currently a number of large scale sources of electrical generation: nuclear, fossil-fuel, hydraulic, purchased power. Economic generation of electricity requires matching the appropriate source of generation with the two types of load. Before we examine how this is done, we need to define a number of terms.

- **Fixed cost** includes the capital cost of the plant, the cost of servicing the debt, an allowance for decommissioning, and operation, maintenance and administration (OM&A) including salaries. The fixed cost is incurred regardless of whether the station is generating power or not.
- **Fuelling cost** is the cost of the fuel whether it is uranium, coal, gas or water. This cost varies with the fuel source and is directly dependent on whether the station is generating power.
- **Heavy water upkeep** is a unique cost of nuclear generation that is also dependent on the station actually generating.
- **Capacity factor** is the percentage of actual generation versus the amount of generation possible at full rated power.

The trick is to adjust our generation mix for each type of load so as to minimise the **Total Unit Energy Cost (TUEC)**. The TUEC equals the

total annual cost of generation divided by the total annual energy produced and is expressed in dollars per megawatt hour $\frac{\$}{MWh}$.

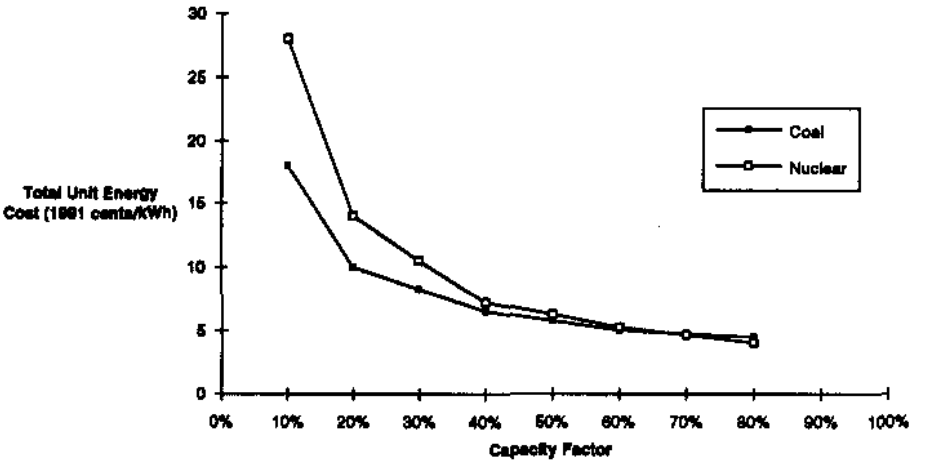
Figure 1.7 lists some of the advantages and disadvantages of each form of electrical generation.

Type of Production	Fixed Cost	Fuelling Cost (and heavy water upkeep)
Nuclear	Very high	Low
Fossil	Low	Very high
Hydraulic	High	Lowest

Figure 1.7
Relative Costs of Generation

Overall, the TUEC is lowest for hydraulic, but hydraulic suffers from its dependency on water which is most available in the spring and fall rather than winter and summer when it is most needed. Of the other two sources, nuclear's TUEC is lower than that of fossil-fuelled, provided that we operate the stations at high capacity factors. To keep the overall TUEC as low as possible, therefore, Ontario Hydro attempts to produce the bulk of its base load through nuclear generation and hydraulic generation. Fossil-fuelled stations are saved for peak load generation. The lower fixed costs make them more economical for peak load despite their higher fuel cost. Purchased power usually only plays a significant role when peak loads surpass the generating capability of the system.

Of course the relative advantage for nuclear units is based on meeting a reasonable capacity factor. The cost advantage of using nuclear is based on a capacity factor of 80%. In the recent past, nuclear's capacity factors have slipped to the point that we may no longer have a cost advantage over fossil generation for base load. Efforts are, however, underway to bring our nuclear capacity factors back up to target. The charts in figure 1.8 shows the relationship between a Darlington unit and a similar sized coal-fired unit equipped with a flue gas de-sulphurization plant and a selective catalytic reduction plant for pollution control. In this diagram the crossover point occurs at ~65%. This is the capacity factor that our newest nuclear units have to exceed over their lifetime to gain a cost advantage over a modern coal-fired unit. The crossover point for previous generations of nuclear stations is actually much lower.



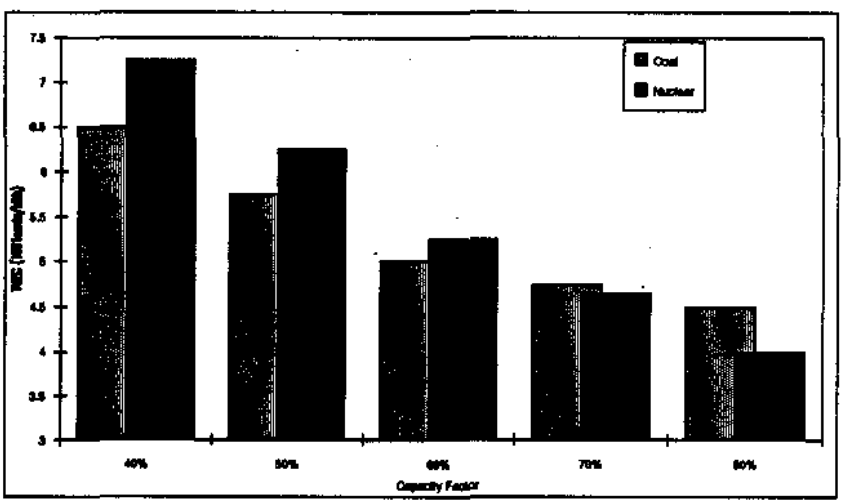


Figure 1.8
COAL vs. NUCLEAR - TUEC at Various Capacity Factors

ASSIGNMENT

1. What is base load and what types of generation does Ontario Hydro employ to meet the need?

2. What factors offset Nuclear's very high fixed costs to enable it to compete with fossil-fuelled generation for base load power production?

3. How does Ontario Hydro employ its three basic sources of electrical generation to minimise its overall Total Unit Energy Cost?