Power Generation Planning (PGP2)

- Problem: select power generators that minimize the total cost of supplying enough electricity to satisfy regional demand.
- Decision:
  - Stage 1: (must decide in advance) how much capacity to acquire for each type of generator. (e.g., gas, coal, nuclear)
  - Stage 2: (can postpone until the demand is seen) how much electricity to generate, once the demand is observed.
- Demand is random for planning purposes.

Load Curve (Demand)

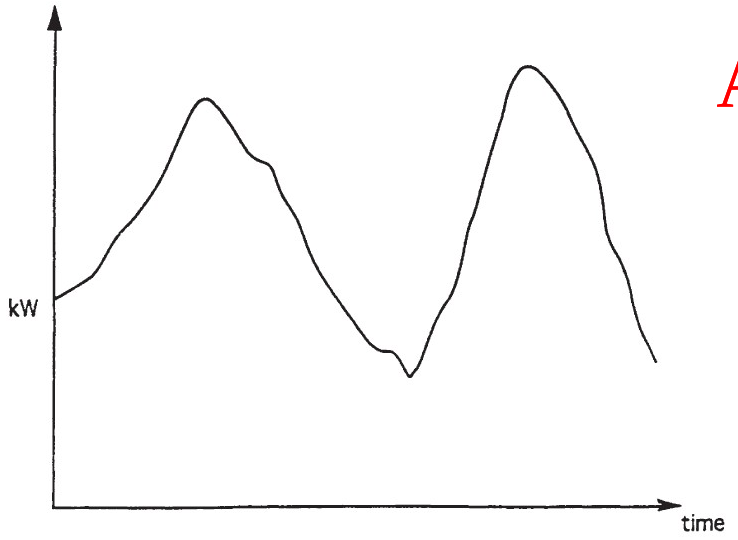

Figure 1.1: Chronological load curve

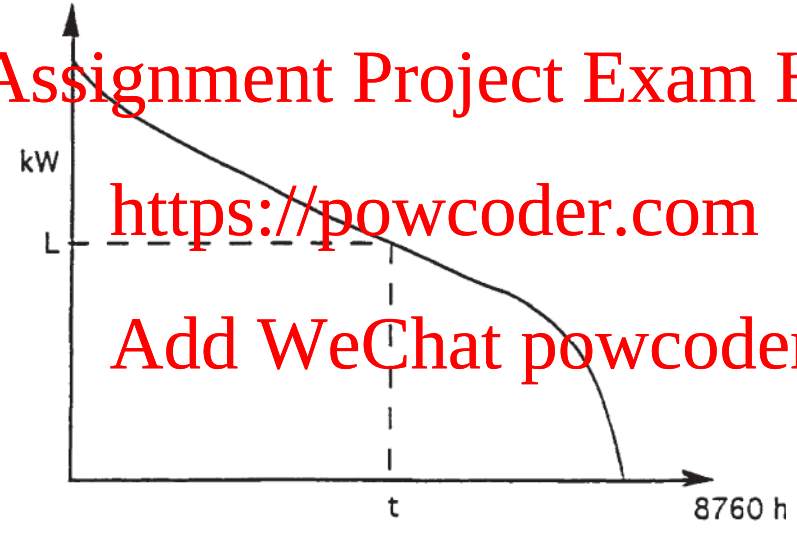

Figure 1.2: Load duration curve

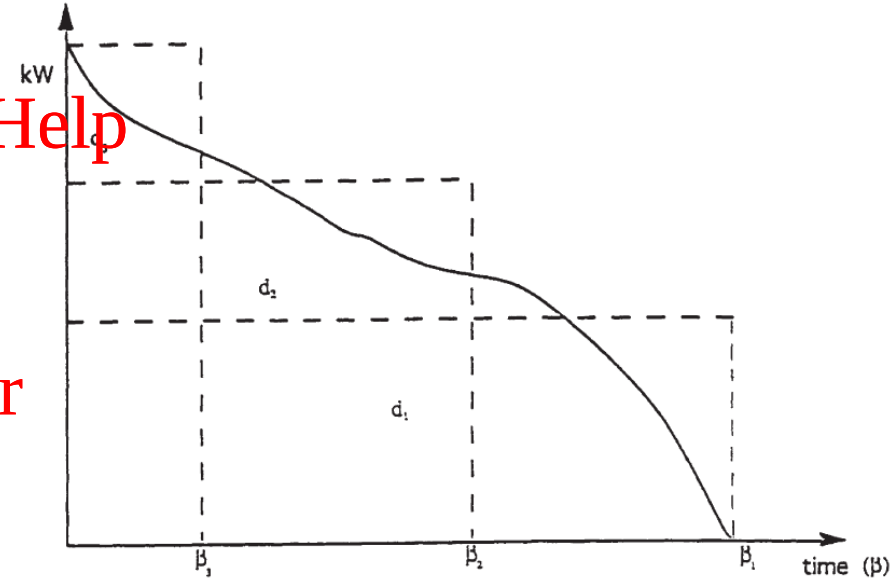

Figure 1.3: Discretized load duration curve

$$\text{Min} \quad \sum_{j \in J} c_j x_j + E[h(x, \tilde{\omega})]$$

$$\text{s.t.} \quad \sum_{j \in J} c_j x_j \leq b \qquad \text{Budget constraint}$$

$$\sum_{j \in J} x_j \geq M \qquad \text{Minimum capacity}$$

$$x_j \geq 0 \qquad \forall j \in J$$

$$h(x, \omega) = \text{Min} \quad \sum_{i \in I} \sum_{j \in J} f_j \beta_i y_{ij} \qquad \text{Operating cost}$$

$$\text{s.t.} \quad -x_j + \sum_{i \in I} y_{ij} \leq 0 \qquad \forall\, j \in J$$

Cannot exceed capacity

$$\sum_{j \in J} y_{ij} = \omega_i \qquad \forall\, i \in I$$

Must meet demand

$$y_{ij} \geq 0 \qquad \forall\, i \in I,\ j \in J$$

Symbol	Meaning
	Capacity for generator type (kw) Stage 1 decision
	Annualized capital cost ($/kw)
	Budget ($)
	Minimum capacity requirement (kw)
	Operating cost ($/kw-hr)
	Load duration (hour)
	kw of demand segment served using generator type (kw) Stage 2 decision
	Demand during load (random, kw)

All-in-one

MIN

Symbol	Meaning
	Capacity for generator type (kw) Stage 1 decision
	Annualized capital cost ($/kw)
	Budget ($)
	Minimum capacity requirement (kw)
	Operating cost ($/kw-hr)
	Load duration (hour)
	kw of demand segment served using generator type (kw) Stage 2 decision
	Demand during load (random, kw)

* Index sets:

Data and Scenarios

The random vector is defined by marginal distributions.

Assume independence.

Each possible combination of will become one scenario.

$n = 4,\ m = 3,\ b = 220,\ M = 15,\ p = 1000,$

$c_j = (10, 7, 16, 6),\ f_j = (40, 45, 32, 55)$

$\beta_i = (1, 0.6, 0.1)$

The demand distributions are as follows:

$\widetilde{\omega}_1$		$\widetilde{\omega}_2$		$\widetilde{\omega}_3$	
Value	*Prob.*	*Value*	*Prob.*	*Value*	*Prob.*
0.5	0.00005	0.0	0.0013	0.0	0.0013
1.0	0.00125	1.5	0.0215	0.5	0.0215
2.5	0.0215	2.5	0.2857	1.5	0.2857
3.5	0.2857	4.0	0.3830	3.0	0.3830
5.0	0.3830	5.5	0.2857	4.5	0.2857
6.5	0.2857	6.5	0.0215	5.5	0.0215
7.5	0.0215	8.0	0.00125	7.0	0.00125
9.0	0.00125	8.5	0.00005	7.5	0.00005
9.5	0.00005				