# EEEN40080: Power System Operation

## Autumn Trimester 2021/2022

## Assignment Question

\*Extract from assignment – this question was the first question in the assignment which neglected reserve requirements and the inclusion of carbon taxes.

Economic dispatch of the system consisting of six generators below. Each unit has minimum and maximum outputs described by *P*min and *P*max and quadratic cost curves described by .

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Unit | *P*min | *P*max | *ai* (€/MWh2) | *bi* (€/MWh) | *ci* (€/h) |
| A | 100 | 185 | 0.134 | 30.4 | 3700 |
| B | 120 | 295 | 0.119 | 23.9 | 3850 |
| C | 85 | 240 | 0.146 | 45.4 | 2750 |
| D | 45 | 140 | 0.111 | 18.9 | 3350 |
| E | 120 | 235 | 0.112 | 33.4 | 2650 |
| F | 135 | 270 | 0.123 | 26.1 | 3550 |

Write GAMS code which will solve the optimisation problem.

## Prompt

I am going to ask you to write code which may be used to solve an optimisation problem in GAMS. The optimisation problem involves the economic dispatch of a simple power system consisting of six generators (A, B, C, D, E and F). Each unit may be assumed to be operational and online.

The cost curves for each of the generators may be described as C\_i = a\_i\*P\_i^2+b\_i\*P\_i+c\_i, where C\_i is the cost associated with running generator i with output P\_i MW. The parameters a\_i, b\_i and c\_i vary for each unit i and are described below. Each unit also has different minimum and maximum outputs, P\_min,i and P\_max,i. These minimum and maximum parameters are also described in the table below.

|Unit|P\_min,i|P\_max,i|a\_i|b\_i|c\_i|

|A|100|185|0.134|30.4|3700|

|B|120|295|0.119|23.9|3850|

|C|85|240|0.146|45.4|2750|

|D|45|140|0.111|18.9|3350|

|E|120|235|0.112|33.4|2650|

|F|135|270|0.123|26.1|3550|

The objective of this optimisation problem is to minimise the cost of running the power system. The constraints acting on the problem are the individual unit minimum and maximum outputs, P\_min,i and P\_max,i. The output of each unit max may not lie outside the bounds [P\_min,i,P\_max,i]. The other constraint is that the sum of outputs from all units must equal demand. The demand in the system is 845 MW.

Now please write the GAMS code which may be used to solve this economic dispatch optimisation problem.

## Response

Sure, here is a simple GAMS code to solve the economic dispatch problem you described. This code defines the generators, their cost functions, and their output constraints. It also includes the total demand constraint.

Sets

i "generators" / A, B, C, D, E, F /

Parameters

a(i) "cost function parameter a" / A 0.134, B 0.119, C 0.146, D 0.111, E 0.112, F 0.123 /

b(i) "cost function parameter b" / A 30.4, B 23.9, C 45.4, D 18.9, E 33.4, F 26.1 /

c(i) "cost function parameter c" / A 3700, B 3850, C 2750, D 3350, E 2650, F 3550 /

Pmin(i) "minimum output" / A 100, B 120, C 85, D 45, E 120, F 135 /

Pmax(i) "maximum output" / A 185, B 295, C 240, D 140, E 235, F 270 /

demand "total demand" / 845 /;

Variables

P(i) "output of generator i"

cost "total cost";

Positive Variable P;

Equations

costDefinition "definition of cost"

powerBalance "balance of power"

lowerBound(i) "lower bound on output"

upperBound(i) "upper bound on output";

costDefinition.. cost =e= sum(i, a(i)\*sqr(P(i)) + b(i)\*P(i) + c(i));

powerBalance.. sum(i, P(i)) =e= demand;

lowerBound(i).. P(i) =g= Pmin(i);

upperBound(i).. P(i) =l= Pmax(i);

Model dispatch /all/;

Solve dispatch using NLP minimizing cost;

This code uses a nonlinear programming (NLP) solver to minimize the total cost subject to the constraints. The solution will give the optimal output for each generator that minimizes the total cost while meeting the demand and respecting the output limits of each generator.