3b) Dynamic non-convex LP model for CHP plant

Maximize profit for 6 hour interval with given heat demand and power price

Variables	**Unit**	**Description**
x(j,t)	1	Weights for extreme characteristic operating points, j=1,...9, t=1,...6
y(k,t)	1	Binary variables determining in which sub-area plant operates
Paramete	**Unit**	**Description**
P(j)	MWh/h	Power production at characteristic points
Q(j)	MWh/h	Heat production at characteristic points
F(j)	MWh/h	Fuel consumption at characteristic points, Fj=RPj*Pj+RQj*Qj
Cp(t)	EUR/MWh	Power price for each hour
Q(t)	MWh/h	Heat demand for each hour
CF	EUR/MWh	Fuel price
A(j,k)	1	Matrix telling if characteristic point j belongs to area k

Objective function

max Sum(Sum(Cp(t)*P(j)*x(j,t))
- Sum(CF*F(j)*x(j,t))) Maximize revenue - costs

Constraints

sum(Q(j)*x(j,t) = Q(t)	Heat production each hour t must be Q(t)
sum(x(j,t)) = 1	Sum of weights for each hour t must be 1
x(j,t) >= 0	All weights must be non-negative
x(j,t) <= sum(k,A(j,k)*y(k,t))	Disable points not in current area
y(k,t) binary	

Configuration for Excel Solver

CF #REF! EUR/MWh Fuel price = 20 plus two last digits of student number as cents

Characteristic operating points Convex areas

Point j	**P(j)**	**Q(j)**	**RP(j)**	**RQ(j)**	**F(j)**	**Efficiency**	**A1**	**A2**	**A2**
1	20	20	1,2	1,1	46	87,0%	1	1	0
2	100	90	1,2	1,1	219	86,8%	1	0	1
3	70	40	2	1,1	184	59,8%	1	1	1
4	20	0	3	1,1	60	33,3%	0	1	0
5	50	0	2,6	1,1	130	38,5%	0	1	0
6	70	15	2,7	1,1	205,5	41,4%	0	1	1
7	100	65	2,5	1,1	321,5	51,3%	0	0	1
8	40	100	1,2	1,01	149	94,0%	1	0	0
9	80	100	1,2	1,07	203	88,7%	1	0	0

Hour data	1	2	3	4	5	6
Q	40	60	80	100	60	20
Cp	80	50	20	30	50	100

Variables	1	2	3	4	5	6
x1	0	0	0	0	0	0
x2	0	0	0,6	0	0	0
x3	0	0	0	0	0	0

x4	0	0	0	0	0	0		
x5	0	0	0	0	0	0		
x6	0,5	0,1	0	0	0,1	0,9		
x7	0,5	0,9	0,4	0	0,9	0,1		
x8	0	0	0	0	0	0		
x9	0	0	0	1	0	0		
y1	0,5	0,1	0,6	1	0,1	0,1		
y2	0	0	0	0	0	0		
y3	0,5	0,9	0,4	0	0,9	0,9		
Sum(x)	1	1	1	1	1	1		
Sum(y)	1	1	1	1	1	1		
P	85	97	100	80	97	73		
Q	40	60	80	100	60	20		
F	263,5	309,9	260	203	309,9	217,1		
Efficiency	47,4%	50,7%	69,2%	88,7%	50,7%	42,8%		
Revenue	6800	4850	2000	2400	4850	7300	28200	EUR
Costs	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	#REF!	EUR
						Profit	#REF!	EUR

A(j,k)*y(k)

0,5	0,1	0,6	1	0,1	0,1
1	1	1	1	1	1
1	1	1	1	1	1
0	0	0	0	0	0
0	0	0	0	0	0
0,5	0,9	0,4	0	0,9	0,9
0,5	0,9	0,4	0	0,9	0,9
0,5	0,1	0,6	1	0,1	0,1
0,5	0,1	0,6	1	0,1	0,1

Each x(j,t) must be <= corresponding matrix element

Note: To compute the above elements easily you can
use the Array formula =MMULT($I$37:$K$45;$B$60:$G$62)
To enter an array formula, first select the entire area
for the formula, then enter formula and finally press
Ctrl-Shift-Enter (instead of normal Enter).
Array formula will appear inside curly braces {}

If you do not want to use array formulas, then you can enter
the normal formula =$I37*B$60+$J37*B$61+$K37*B$62
in the first cell and copy it in the entire region.
See how this formula uses absolute column and relative row
references when referring to A(j,k) elements; but relative column
and absolute row references for y(k,t)

Function key F4 cycles between different combinations
of absolute and relative references for selected reference