1 operating costs

This section covers all calculations for the operating costs depending on which generator is running.

1.1 only generator 1 running

- 10MW:
  $K = 3750\,NOK + 25\,MW \cdot 350\,NOK/MWh - 15\,MW \cdot 325\,NOK/MWh = 7625\,NOK/h$
- 125MW:
  $K = 3750\,NOK + 50\,MW \cdot 350\,NOK/MWh + 75\,MW \cdot 480\,NOK/MWh = 57250\,NOK/h$
- 210MW:
  $P_{transm} = 210\,MW - P_{1,max} = 160\,MW \geq 130\,MW$
  This is not possible due to transmission line overload.

1.2 only generator 2 running

- 10MW:
  $K = 3000\,NOK + 20\,MW \cdot 450\,NOK/MWh - 10\,MW \cdot 325\,NOK/MWh = 8750\,NOK/h$
- 125MW:
  $K = 3000\,NOK + 100\,MW \cdot 450\,NOK/MWh + 25\,MW \cdot 480\,NOK/MWh = 60000\,NOK/h$
- 210MW:
  $K = 3000\,NOK + 100\,MW \cdot 450\,NOK/MWh + 110\,MW \cdot 480\,NOK/MWh = 100800\,NOK/h$

1.3 both generators running

- 10MW:
  $K = 3000\,NOK + 3750\,NOK + 25\,MW \cdot 350\,NOK/MWh + 20\,MW \cdot 450\,NOK/MWh - 35\,MW \cdot 325\,NOK/MWh = 13125\,NOK/h$
- 125MW:
  $K = 6750\,NOK + 50\,MW \cdot 350\,NOK/MWh + 75\,MW \cdot 450\,NOK/MWh = 58000\,NOK/h$
- 210MW:
  $K = 6750\,NOK + 50\,MW \cdot 350\,NOK/MWh + 100\,MW \cdot 450\,NOK/MWh + 60\,MW \cdot 480\,NOK/MWh = 98050\,NOK/h$

1.4 no generator running

- 10MW:
  $K = 10\,MW \cdot 480\,NOK/MWh = 4800\,NOK/h$
- 125MW:
  $K = 125\,MW \cdot 480\,NOK/MWh = 60000\,NOK/h$
- 210MW:
  not possible, because $210\,MW \geq P_{transm,max}$

stage number	stage	00:00-06:00	06:00-12:00	12:00-18:00	18:00-24:00
1	generator 1	x	x	x	7625 NOK
2	generator 2	x	x	x	8750 NOK
3	transmission line	360000 NOK	604800 NOK	360000 NOK	28800 NOK
4	generator 1 + transmission line	57250 NOK	x	57250 NOK	7625 NOK
5	generator 2 + transmission line	60000 NOK	100800 NOK	60000 NOK	8750 NOK
6	generator 1 + generator 2 + transmission line	58000 NOK	98050 NOK	58000 NOK	13125 NOK

Tabell 1: operating costs

state		to					
		1	2	3	4	5	6
from	1	0 NOK	17000 NOK	7000 NOK	0 NOK	17000 NOK	10000 NOK
	2	17000 NOK	0 NOK	7000 NOK	17000 NOK	0 NOK	10000 NOK
	3	10000 NOK	10000 NOK	0 NOK	10000 NOK	10000 NOK	20000 NOK
	4	0 NOK	17000 NOK	7000 NOK	0 NOK	17000 NOK	10000 NOK
	5	17000 NOK	0 NOK	7000 NOK	17000 NOK	0 NOK	10000 NOK
	6	7000 NOK	7000 NOK	14000 NOK	7000 NOK	7000 NOK	0 NOK

Tabell 2: startup cost

2 minimizing total operating costs

In this section the way of minimizing operating costs done by dynamic programming is listed. In table 1 the operational costs for different power generation combinations is listed. The calculation is done like the following example for stage 3 from 00:00-06:00 shows. $6\,h \cdot 125\,MW \cdot 480\,NOK/MWh = 360000\,NOK$

In table 2 the startup costs for each generator combination is listed. The table 3 show the total costs for each calculation step. The calculation steps are don in table 4 and 5.

stage number	00:00-06:00	06:00-12:00	12:00-18:00	18:00-24:00
	t1	t2	t3	t4
1	x	x	x	237.175k NOK
2	x	x	x	239.05k NOK
3	367k NOK	669.05k NOK	539.3k NOK	265.1k NOK
4	57.25 NOK	x	229.55k NOK	237.575k NOK
5	77 NOK	175.05k NOK	232.3k NOK	239.05k NOK
6	68 NOK	165.3k NOK	223.3k NOK	236.425k NOK

Tabell 3: total costs

With this calculations the production process 1-4-6-6-6 would be the cheapest one.

current state	time	previous state	costs			
			previous	startup	operation	sum
3	t1	1	0 NOK	7k NOK	360k NOK	367k NOK
4	t1	1	0 NOK	0 NOK	57.25k NOK	57.25k NOK
5	t1	1	0 NOK	17k NOK	60k NOK	77k NOK
6	t1	1	0 NOK	10k NOK	58k NOK	68k NOK
3	t2	3	367k NOK	0 NOK	604.8k NOK	971.8k NOK
		4	57.25k NOK	7k NOK		***669.05k NOK***
		5	77k NOK	7k NOK		688.8k NOK
		6	68k NOK	14k NOK		686.8k NOK
5	t2	3	367k NOK	10 NOK	100.8k NOK	477.8k NOK
		4	57.25k NOK	17k NOK		***175.05k NOK***
		5	77k NOK	0k NOK		177.8k NOK
		6	68k NOK	7k NOK		175.8k NOK
6	t2	3	367k NOK	20 NOK	98.05k NOK	485.05k NOK
		4	57.25k NOK	10k NOK		***165.3k NOK***
		5	77k NOK	10k NOK		185.05k NOK
		6	68k NOK	0k NOK		166.05k NOK
3	t3	3	669.05k NOK	0 NOK	360k NOK	1029.05k NOK
		5	175.05k NOK	7k NOK		542.05k NOK
		6	165.3k NOK	14k NOK		***539.3k NOK***
4	t3	3	669.05k NOK	10 NOK	57.25k NOK	736.3k NOK
		5	175.05k NOK	17k NOK		249.3k NOK
		6	165.3k NOK	7k NOK		***229.55k NOK***
5	t3	3	669.05k NOK	10 NOK	60k NOK	739.05k NOK
		5	175.05k NOK	0k NOK		235.05k NOK
		6	165.3k NOK	7k NOK		***232.3k NOK***
6	t3	3	669.05k NOK	20 NOK	58k NOK	747.05k NOK
		5	175.05k NOK	10k NOK		243.05k NOK
		6	165.3k NOK	0k NOK		***223.3k NOK***

Tabell 4: calculations t1-t3

current state	time	previous state	costs			
			previous	startup	operation	sum
1	t4	3	539.3k NOK	10 NOK	7.625k NOK	556.925k NOK
		4	229.55k NOK	7k NOK		***237.175k NOK***
		5	232.3k NOK	17k NOK		256.925k NOK
		6	223.3k NOK	7k NOK		237.925k NOK
2	t4	3	539.3k NOK	10 NOK	8.75k NOK	558.05k NOK
		4	229.55k NOK	17k NOK		255.3k NOK
		5	232.3k NOK	0k NOK		241.05k NOK
		6	223.3k NOK	7k NOK		***239.05k NOK***
3	t4	3	539.3k NOK	0 NOK	28.8k NOK	568.1k NOK
		4	229.55k NOK	7k NOK		***265.75k NOK***
		5	232.3k NOK	7k NOK		268.1k NOK
		6	223.3k NOK	14k NOK		266.1k NOK
4	t4	3	539.3k NOK	10 NOK	7.625k NOK	556.925k NOK
		4	229.55k NOK	0k NOK		***237.575k NOK***
		5	232.3k NOK	17k NOK		256.925k NOK
		6	223.3k NOK	7k NOK		237.925k NOK
5	t4	3	539.3k NOK	10 NOK	8.75k NOK	558.05k NOK
		4	229.55k NOK	17k NOK		255.7k NOK
		5	232.3k NOK	0k NOK		241.05k NOK
		6	223.3k NOK	7k NOK		***239.05k NOK***
6	t4	3	539.3k NOK	20 NOK	13.125k NOK	572.425k NOK
		4	229.55k NOK	10k NOK		253.075k NOK
		5	232.3k NOK	10k NOK		255.425k NOK
		6	223.3k NOK	0k NOK		***236.425k NOK***

Tabell 5: calculations t4