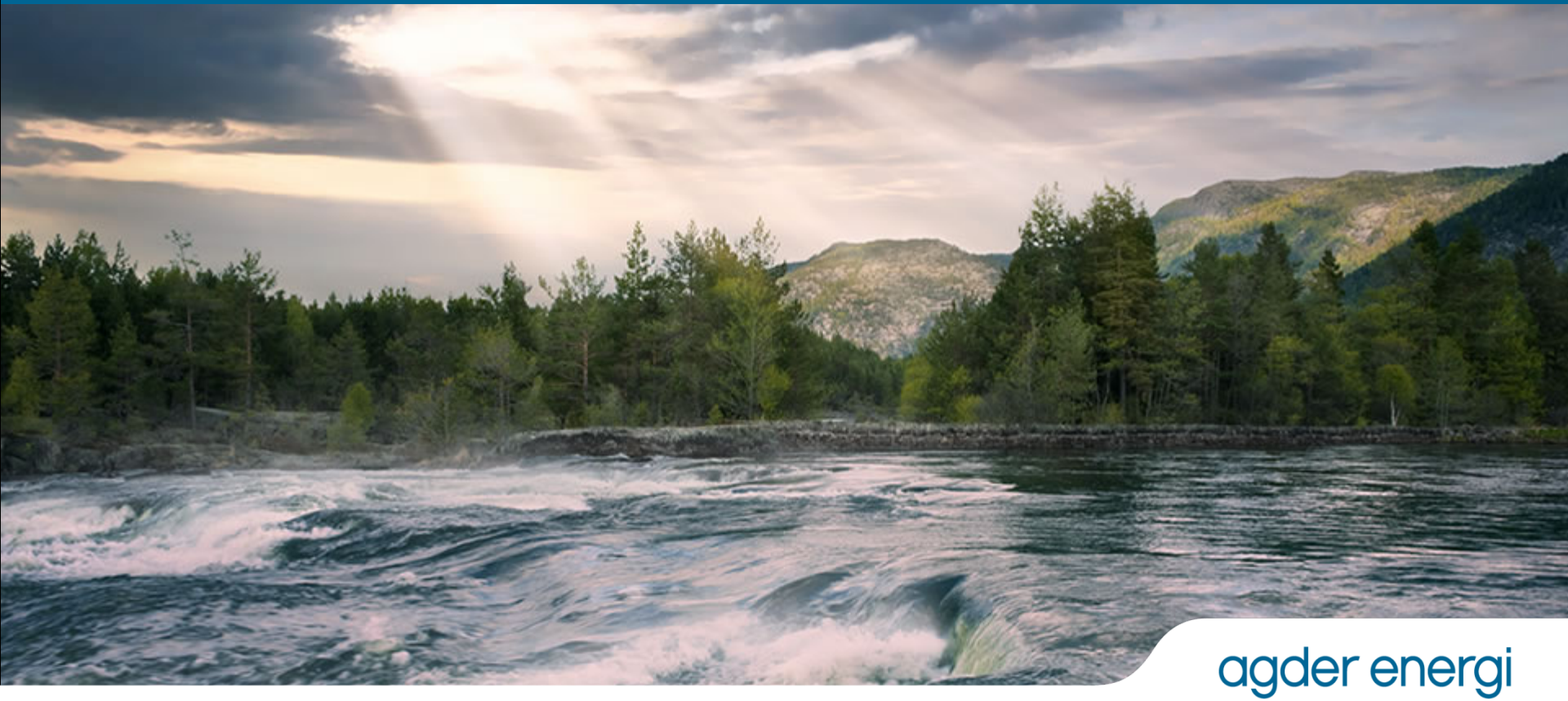
ProdRisk - Agder Energi

21.05.2015 – Olav Einar Rike



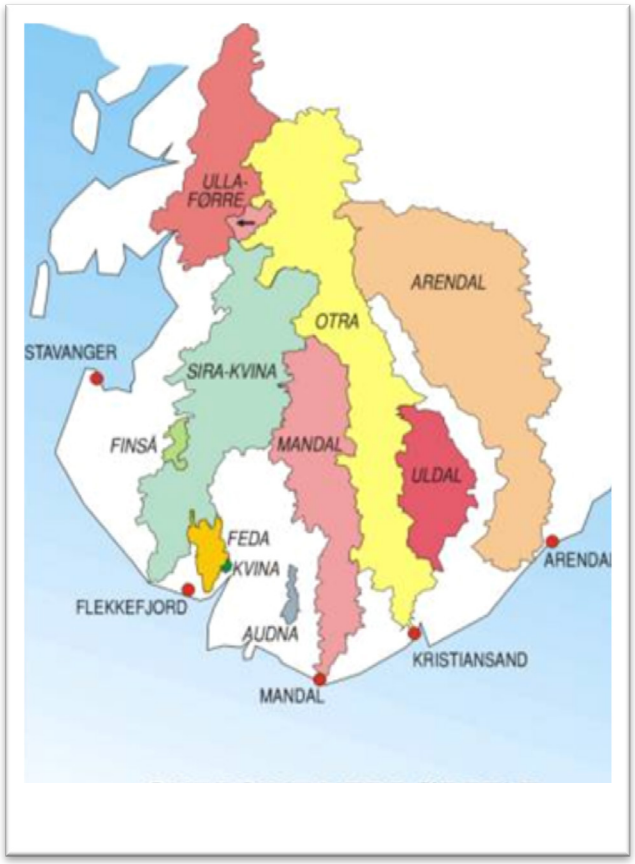
agder energi

Agder Energi

KEY DATA	
Head office	Kristiansand
Annual production	7,8 TWh
Annual production – max (2008)	9,5 TWh
Installed capacity	1750 MW
Regulating capacity	63 %
Power stations - fully owned	32
Power stations - partial owned	17
Owners	
- Statkraft	45,5 %
- 30 Agder municipality	54,5 %
Water courses	10

Agder Energi

KEY DATA	
Head office	Kristiansand
Annual production	7,8 TWh
Annual production – max (2008)	9,5 TWh
Installed capacity	1750 MW
Regulating capacity	63 %
Power stations - fully owned	32
Power stations - partial owned	17
Owners	
- Statkraft	45,5 %
- 30 Agder municipality	54,5 %
Water courses	10



agder energi

Agenda

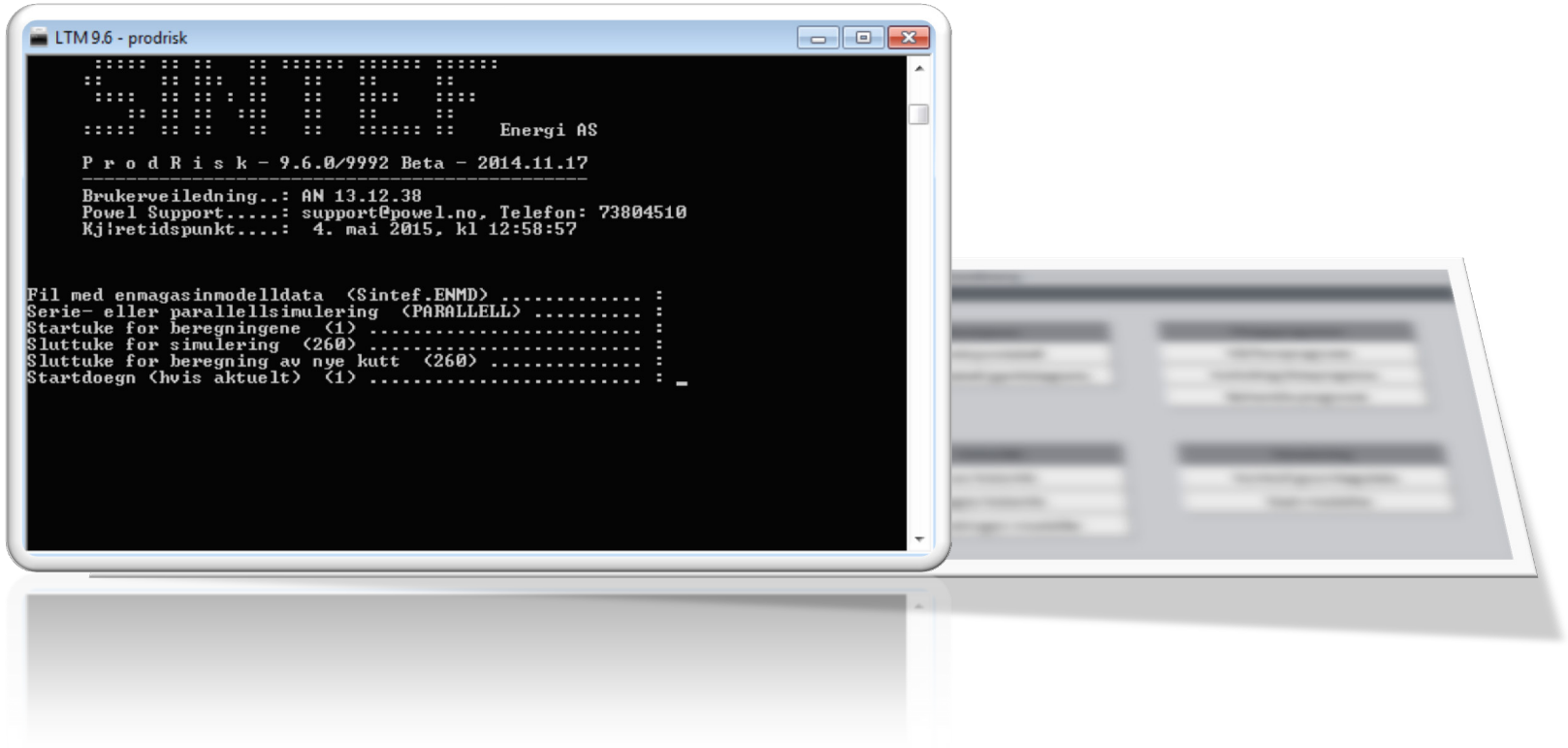
- Daily use of ProdRisk
- Userinterface and program-automation
- Experiences and challenges

Daily use of ProdRisk

- Hydropower optimization on our systems
- Coupled water values for Shop (cuts)
- Scheduling generation and maintenance
- Investment analysis

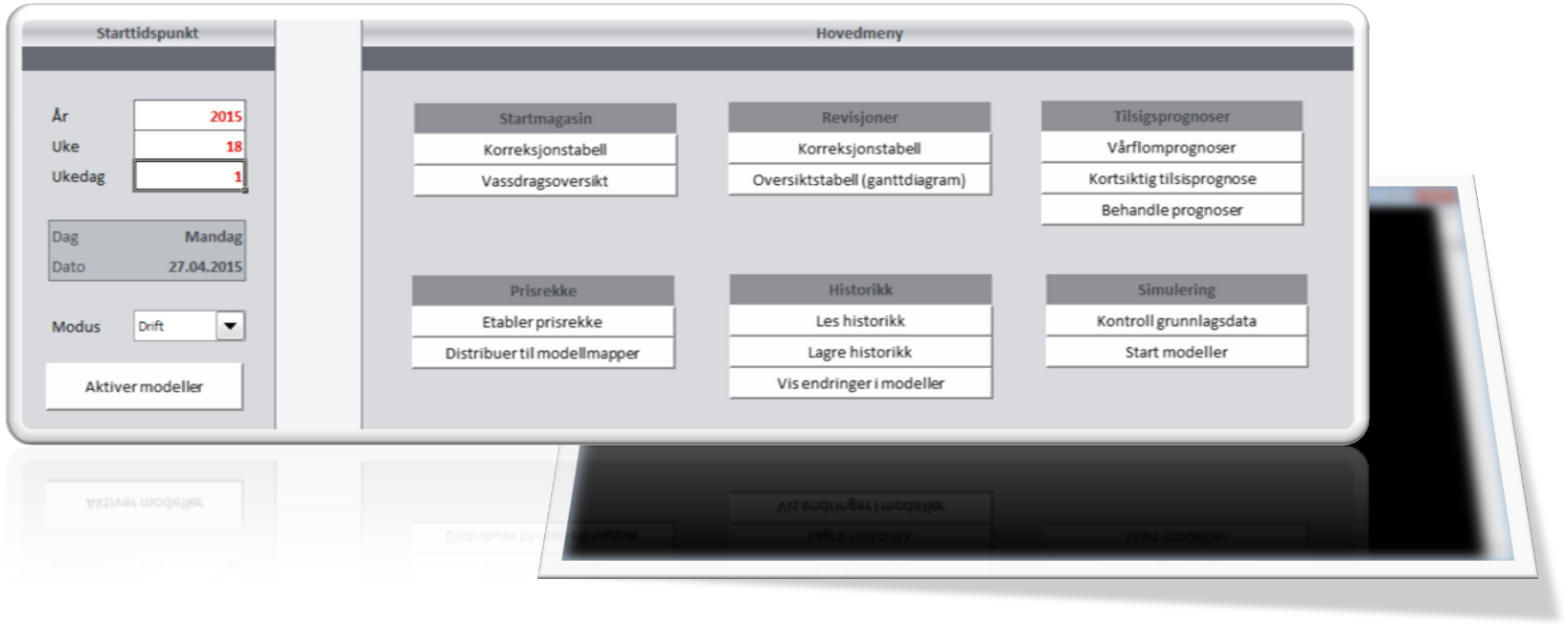
- Currently using ProdRisk 9.3 on a Windows blade server system

Interface and automation

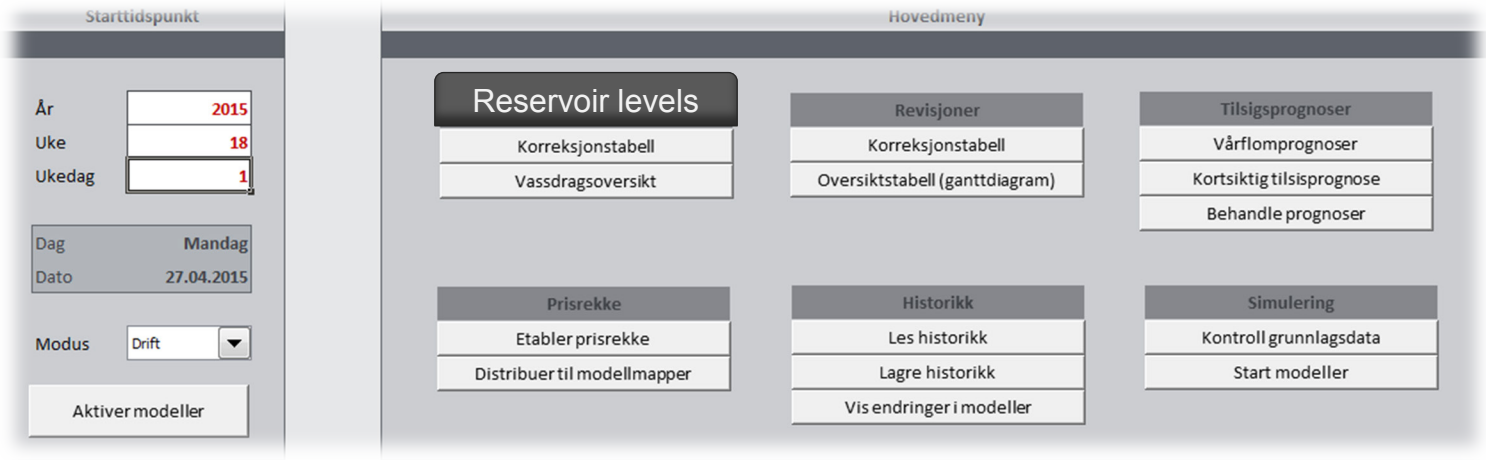


agder energi

Interface and automation



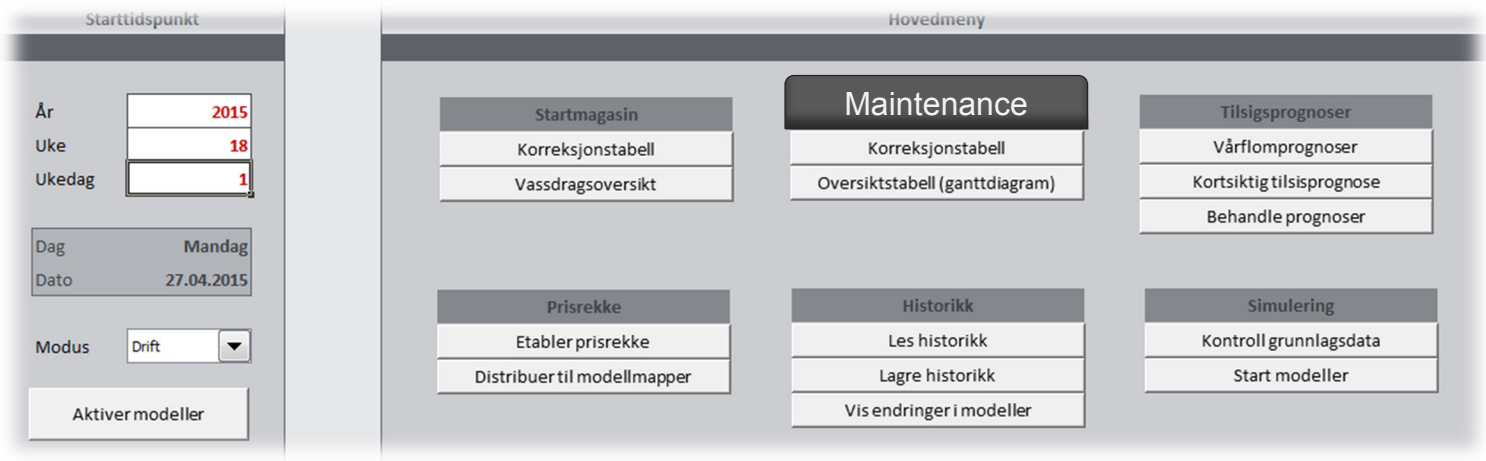
agder energi



#	Modell	Modu	Magasin	Andel	MM3	Eekv		Startmagasin (rediger) MM3	Prosent	GWh	moh	Endring MM3	Prosent	GWh	moh
1	Arendal	10528	NESVATN	100,0 %	256,7	0,928	AE	188,0	73,2 %	174,5	506,07	-9,4	-3,7 %	-8,8	-0,
1	Arendal	10527	GJØV	100,0 %	0,3	0,267	AE	0,3	93,2 %	0,1	-	0,0	-0,1 %	0,0	
1	Arendal	10526	TORSDALEN	0,0 %	105,6	0,789	AE	53,7	50,8 %	42,3	698,14	-7,2	-6,8 %	-5,7	-1,
1	Arendal	10525	ØYSÆ	50,0 %	63,5	0,789	AE	37,4	58,9 %	29,5	674,48	-7,0	-11,1 %	-5,6	-2,
1	Arendal	10522	GAUSVATN	50,0 %	63,1	0,789	AE	54,5	86,3 %	43,0	586,82	-5,1	-8,1 %	-4,0	-1,
1	Arendal	10520	FYRESVATN	100,0 %	218,3	0,421	AE	149,5	68,5 %	62,9	278,25	-9,0	-4,1 %	-3,8	-0,
1	Arendal	10519	HØNETJØNN	100,0 %	2	0,421	AE	1,2	60,1 %	0,5	-	-0,1	-5,8 %	0,0	
1	Arendal	10516	ROLLEIVSTADV	0,0 %	6,5	0,363	AE	4,6	70,2 %	1,7	650,88	-0,6	-9,6 %	-0,2	-0,
1	Arendal	10515	NAPE-LYTINGV	0,0 %	217,2	0,363	AE	141,9	65,3 %	51,5	504,70	-10,6	-4,9 %	-3,9	-1,
1	Arendal	10514	URVATN	0,0 %	32	0,363	AE	24,1	75,3 %	8,7	806,09	-5,0	-15,8 %	-1,8	-1,
1	Arendal	10513	BORSÆ	0,0 %	84,8	0,363	AE	57,9	68,3 %	21,0	752,74	0,3	0,4 %	0,1	0,
1	Arendal	10512	HYLEBUHYLEN	0,0 %	0,6	0,363									
1	Arendal	10511	SKREVATN	0,0 %	19,8	0,363									
1	Arendal	10510	VRÅVATN	100,0 %	21,4	0,363									
1	Arendal	10509	NISSER	100,0 %	222,8	0,363									
1	Arendal	10508	HAUKERHYLEN	100,0 %	2	0,347									
1	Arendal	10507	KJØRULL-SAND	100,0 %	7	0,306									
1	Arendal	10505	NELAUG	100,0 %	25,4	0,136									
2	Arendal AE - Total	10528	NESVATN	100,0 %	256,7	1,095									
2	Arendal AE - Total	10527	GJØV	100,0 %	0,3	0,434									
2	Arendal AE - Total	10526	TORSDALEN	0,0 %	105,6	1,574									
2	Arendal AE - Total	10525	ØYSÆ	50,0 %	63,5	1,324									
2	Arendal AE - Total	10522	GAUSVATN	50,0 %	63,1	1,324									
2	Arendal AE - Total	10520	FYRESVATN	100,0 %	218,3	0,588									
2	Arendal AE - Total	10519	HØNETJØNN	100,0 %	2	0,588									
2	Arendal AE - Total	10516	ROLLEIVSTADV	0,0 %	6,5	1,160									
2	Arendal AE - Total	10515	NAPE-LYTINGV	0,0 %	217,2	1,160									
2	Arendal AE - Total	10514	URVATN	0,0 %	32	1,680									
2	Arendal AE - Total	10513	BORSÆ	0,0 %	84,8	1,680									
2	Arendal AE - Total	10512	HYLEBUHYLEN	0,0 %	0,6	1,464									
2	Arendal AE - Total	10511	SKREVATN	0,0 %	19,8	0,736									
2	Arendal AE - Total	10510	VRÅVATN	100,0 %	21,4	0,530									
2	Arendal AE - Total	10509	NISSER	100,0 %	222,8	0,530									
2	Arendal AE - Total	10508	HAUKERHYLEN	100,0 %	2	0,514									
2	Arendal AE - Total	10507	KJØRULL-SAND	100,0 %	7	0,473									
2	Arendal AE - Total	10505	NELAUG	100,0 %	25,4	0,473									

#	Modell	Antall	Maks MM3	Maks GWh	Magasinfylling MM3	Magasinfylling Prosent	Magasinfylling GWh	Endring MM3	Endring Prosent	Endring GWh
1	Arendal	18	1 349,0	740,0	945,6	69,8 %	516,4	-60,6	-4,8 %	-35,
2	Arendal AE - Total	18	1 349,0	1 357,2	945,6	68,7 %	931,9	-60,6	-4,9 %	-66,
3	Arendal - Fysisk Total	18	1 349,0	1 357,2	938,1	67,9 %	922,1	-55,5	-4,4 %	-59,
4	Mandal	11	384,4	462,1	263,0	68,0 %	314,1	-20,0	-5,7 %	-26,
5	Otra	14	2 157,7	2 730,5	1 872,4	90,4 %	2 467,7	203,1	9,6 %	261,
6	Otra - AE Total	14	2 157,7	3 627,7	1 872,4	90,8 %	3 295,5	203,1	9,8 %	355,
7	Otra - Fysisk Total	14	2 157,7	3 627,7	1 608,7	77,4 %	2 807,5	-60,4	-3,3 %	-119,
8	Audna	4	27,8	11,0	27,4	98,5 %	10,9	0,2	0,7 %	0,
9	Feda	3	13,5	1,6	13,5	100,0 %	1,6	2,5	18,6 %	0,
10	Finså	5	118,4	107,9	107,9	90,0 %	97,1	-2,5	-2,3 %	-2,
11	Kvinesdal	1	2,4	1,4	2,4	100,0 %	1,4	0,0	0,3 %	0,
12	Uldal	5	89,8	21,4	42,1	50,7 %	10,9	-2,1	-2,3 %	-0,
13	Uldal - Total	5	89,8	38,7	42,1	39,8 %	15,4	-2,1	-3,3 %	-1,
14	Sira-Kvina	8	3 005,1	690,4	2 030,1	65,6 %	452,7	-113,0	-3,9 %	-27,
15	Sira-Kvina - Fysisk	8	3 005,1	5 659,3	1 864,5	59,4 %	3 360,4	-78,3	-2,6 %	-149,
16	UF	19	4 275,8	501,2	3 151,1	71,9 %	360,3	-221,8	-6,9 %	-34,

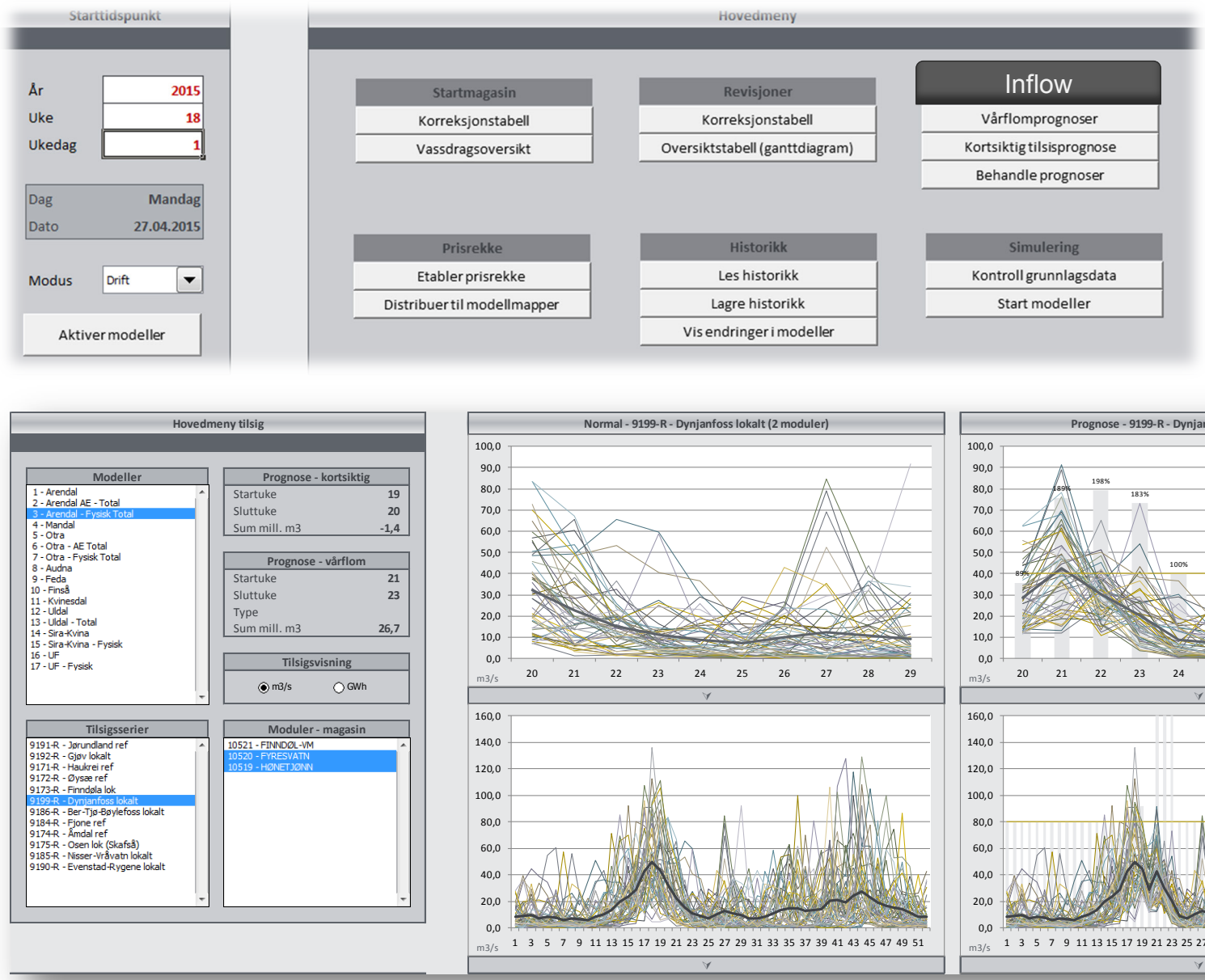
agder energi



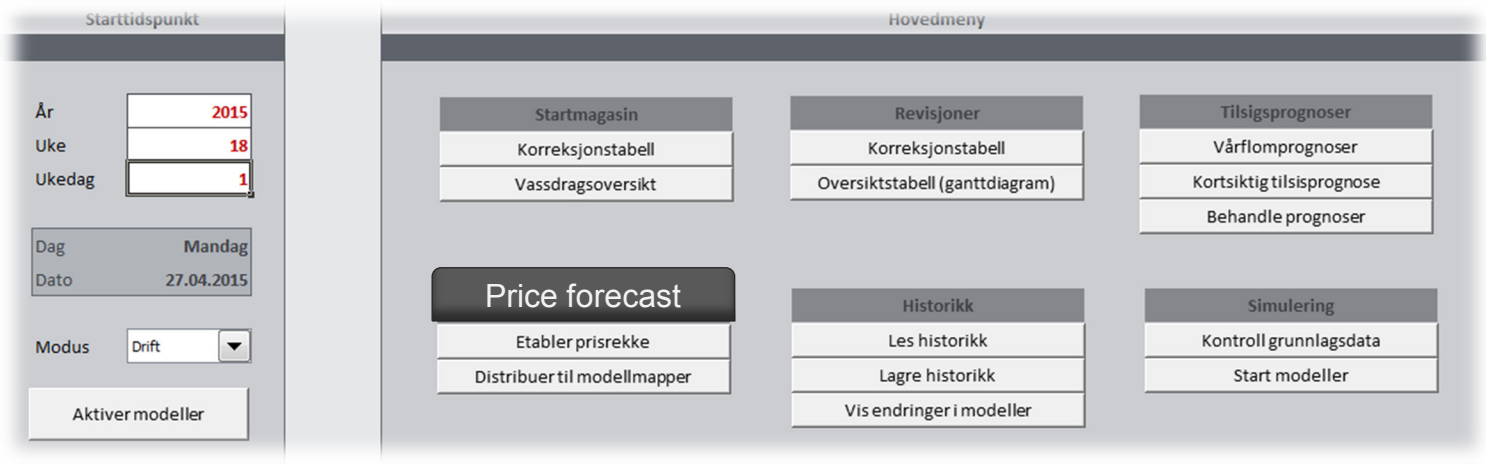
#ID 17730 | Sist endret: 23.03.2015 | Turbinrevisjon, nytt kontrollanlegg, nytt apparatanlegg. Pro.nr. 70044-30. Pro.leder Inge Lines
Start: 15.05.2015 07:00 (fr) | Av: PERSAN
Slutt: 23.10.2015 14:00 (fr) | Godkjent:
* Søknad til Statnett: 09.01.2015 * Ekstern

Uke 18 - 2015

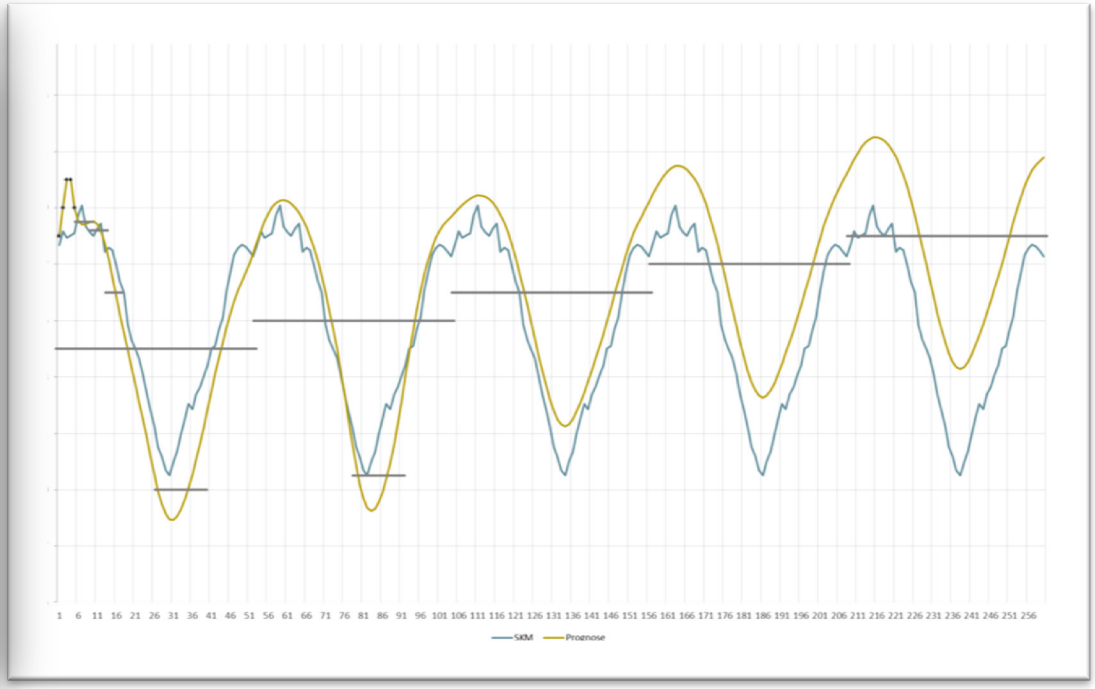
#ID	SYSTEM	Stasjon		Start	Slutt	MW	Endret
23266	SIRAKVINA	KVINEN		27.04.2015 07:00	22.05.2015 14:00	80,0	22.04.2015
13612	MANDAL	SKJERKA		04.05.2015 07:00	04.05.2015 14:00	104,0	21.04.2015
22453	SIRAKVINA	TONSTAD	G3	04.05.2015 07:00	15.05.2015 14:00	160,0	03.02.2015
15750	OTRA	HOLEN-3		04.05.2015 07:00	15.05.2015 14:00	160,0	14.04.2015
21773	ARENDAL	RYGENE		11.05.2015 09:00	11.05.2015 14:00	56,0	20.04.2015
22406	FINSÅ	KULI		11.05.2015 07:00	12.05.2015 14:00	6,2	21.01.2015
17730	ARENDAL	RYGENE		15.05.2015 07:00	23.10.2015 14:00	56,0	23.03.2015
22366	ARENDAL	TJØNNEFOSS		17.05.2015 21:00	23.05.2015 14:00	6,3	21.04.2015
15752	OTRA	HOLEN-12	G1	18.05.2015 07:00	22.05.2015 14:00	120,0	13.01.2015
22507	ARENDAL	HØGEFOSS		18.05.2015 07:00	23.05.2015 14:00	25,7	02.02.2015
16891	ARENDAL	NISSERDAM		18.05.2015 07:00	23.05.2015 14:00	2,2	02.02.2015
17251	FINSÅ	OSEN		18.05.2015 07:00	22.05.2015 14:00	4,4	21.01.2015
15807	OTRA	ULEBERG		18.05.2015 07:00	22.05.2015 14:00	9,4	13.04.2015
23206	ARENDAL	TJØNNEFOSS	G1	21.05.2015 09:00	21.05.2015 14:00	6,3	16.04.2015
23007	SIRAKVINA	KVINEN		25.05.2015 07:00	25.05.2015 14:00	80,0	22.04.2015
22646	SIRAKVINA	SOLHOM	G1	26.05.2015 07:00	04.06.2015 14:00	100,0	10.02.2015
16792	TRYLAND	TRYLAND		26.05.2015 08:00	29.05.2015 14:00	5,5	05.11.2014
21811	TRYLAND	FÆRÅSEN		26.05.2015 08:00	27.05.2015 14:00	1,4	05.11.2014
17238	ARENDAL	EVENSTAD	G4	26.05.2015 07:00	29.05.2015 14:00	11,5	23.10.2014
22647	SIRAKVINA	SOLHOM	G2	26.05.2015 07:00	04.06.2015 14:00	100,0	10.02.2015
16131	OTRA	HOVATN		26.05.2015 07:00	05.06.2015 14:00	45,0	12.01.2015
22552	SIRAKVINA	TONSTAD	G2	29.05.2015 07:00	26.06.2015 14:00	160,0	03.02.2015
22551	SIRAKVINA	TONSTAD	G1	29.05.2015 07:00	26.06.2015 14:00	160,0	03.02.2015
21766	ARENDAL	DYNJANFOSS		01.06.2015 07:00	12.06.2015 14:00	38,0	27.10.2014
15755	OTRA	HOLEN-12	G2	01.06.2015 07:00	05.06.2015 14:00	120,0	12.01.2015
15803	OTRA	NOMELAND	G1	01.06.2015 07:00	04.06.2015 14:00	6,0	08.01.2015



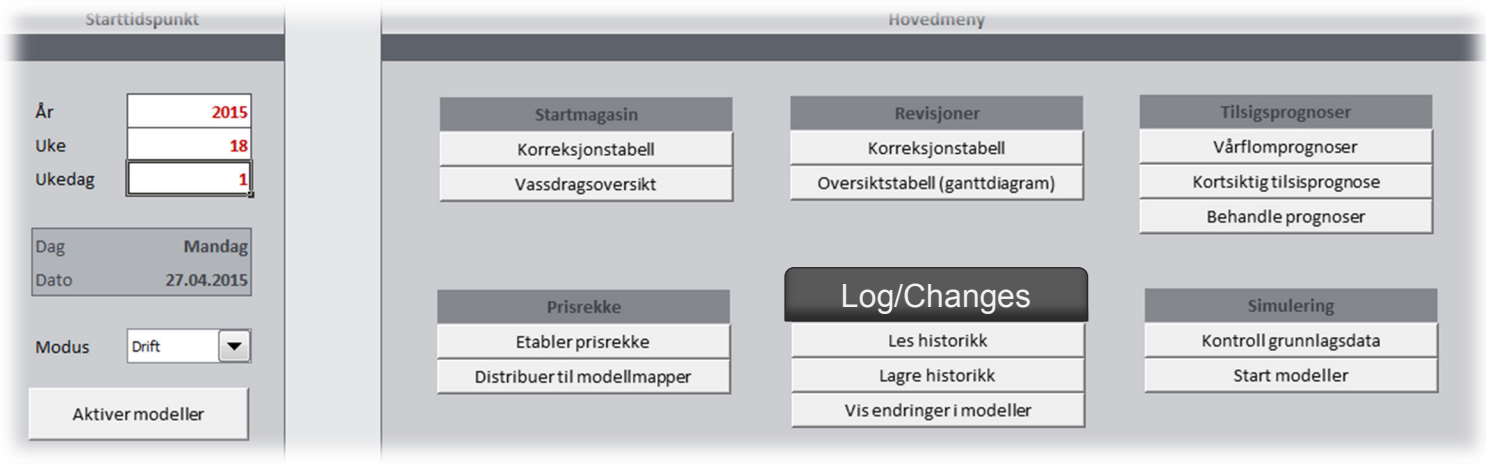
agder energi

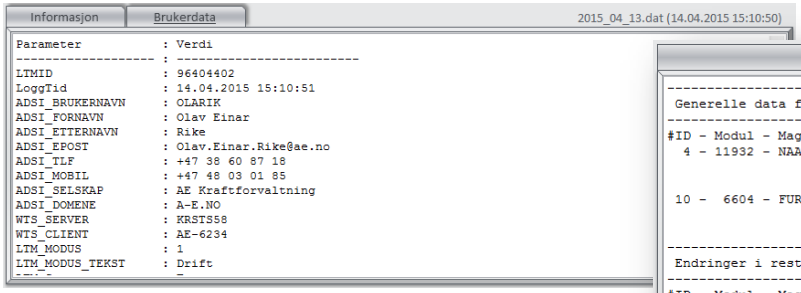


Gjennomsnitt og prosentilpriser fra ukentlige snittpriser						
	Snitt	0	10	50	90	100
1	**28,0**	23,9	26,0	27,6	29,0	33,4
2	**29,0**	23,7	26,3	28,4	30,5	37,7
3	**30,0**	25,3	27,1	29,4	31,3	38,3
4	**30,0**	25,2	26,6	29,4	32,2	39,6
5	**29,0**	24,0	25,8	28,5	30,5	39,8
6	**28,5**	22,7	24,4	27,3	29,9	39,6
jan	**29,3**	24,5	26,4	28,8	30,9	38,1
feb	**28,5**	21,9	24,2	27,5	30,1	38,8
mar	**28,2**	20,5	23,8	26,3	30,6	35,5
apr	**25,9**	17,6	21,5	23,7	28,8	34,1
mai	**23,2**	13,3	20,6	24,0	26,8	30,2
jun	**20,4**	6,6	17,8	23,3	25,4	27,4
Q1-15	**28,7**	22,3	24,8	27,5	30,5	37,4
Q2-15	**23,2**	12,5	19,9	23,7	27,0	30,6
Q3-15	**19,1**	3,3	15,3	21,6	25,0	26,9
Q4-15	**25,2**	16,8	24,1	26,1	27,0	30,3
Q1-16	**28,9**	22,4	25,0	27,7	30,8	37,7
Q2-16	**24,7**	13,0	21,2	25,4	28,9	32,6
Q3-16	**19,7**	3,4	15,9	22,3	25,7	27,6
Q4-16	**27,0**	18,3	25,7	27,9	28,9	32,3
2015	**24,0**	13,7	21,0	24,7	27,4	31,2
2016	**25,0**	14,2	21,9	25,8	28,5	32,5
2017	**26,0**	14,5	22,7	26,9	29,8	33,9
2018	**27,0**	15,0	23,6	27,9	31,0	35,2

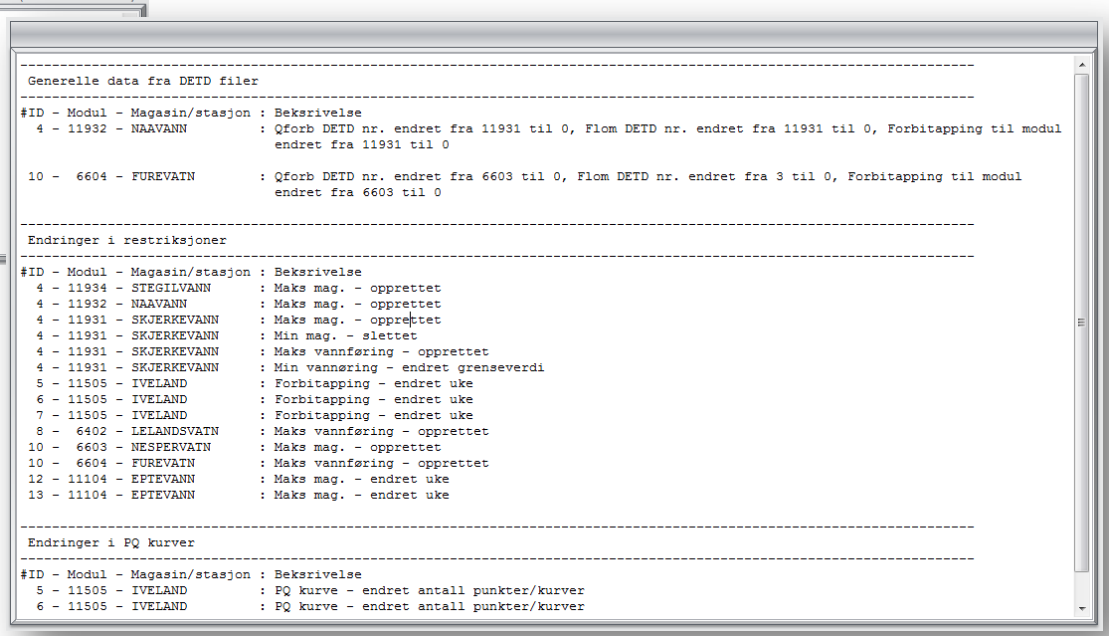


agder energi

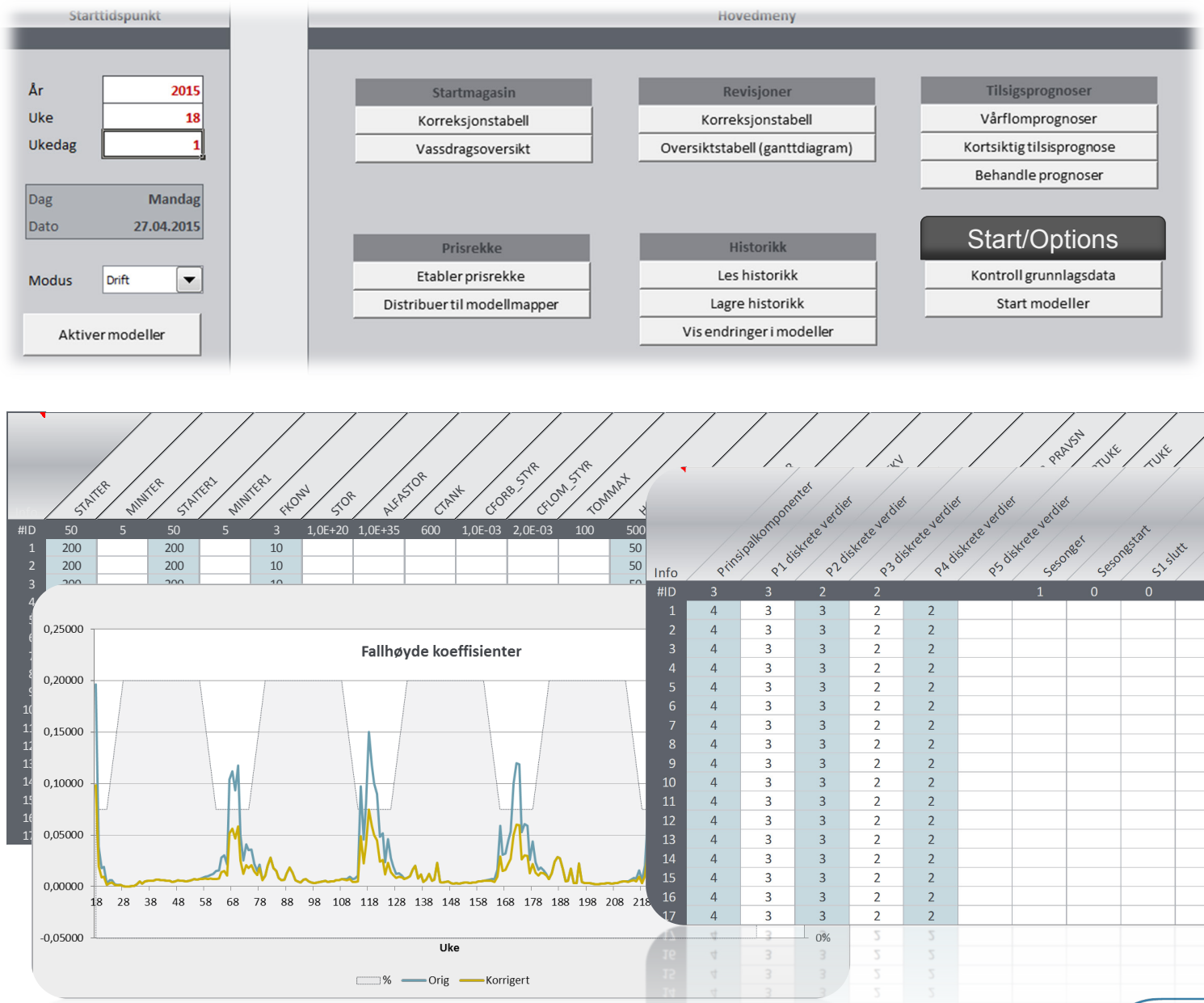




Topology, constraints, reservoir and production curve changes displayed in clear text.



agder energi

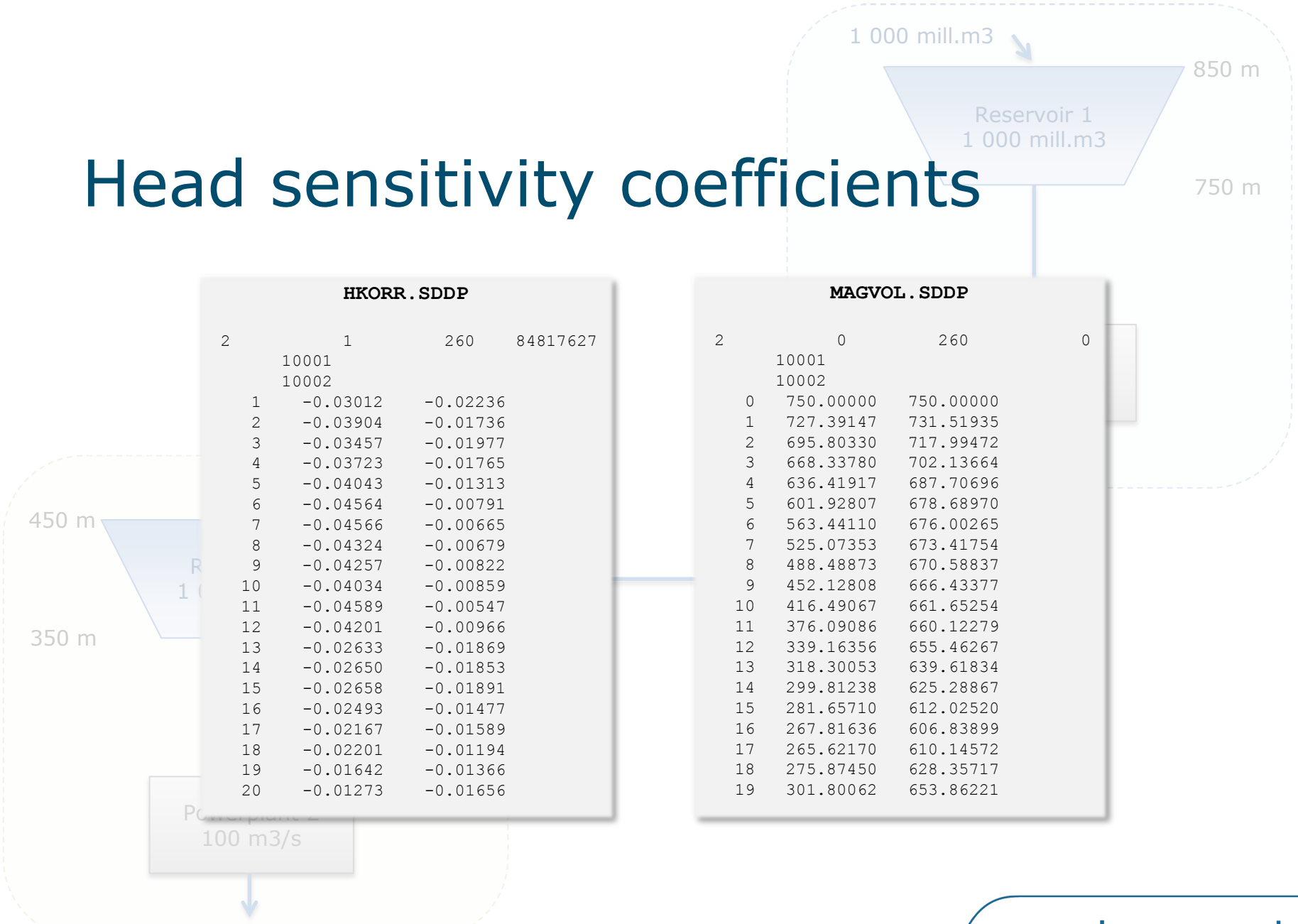


agder energi

Experiences and challenges

- «User-independent» – no calibration
- Higher simulated income than Vansimtap
- Stable software
- Head optimization
  - Works well!
    - Be aware!

Head sensitivity coefficients



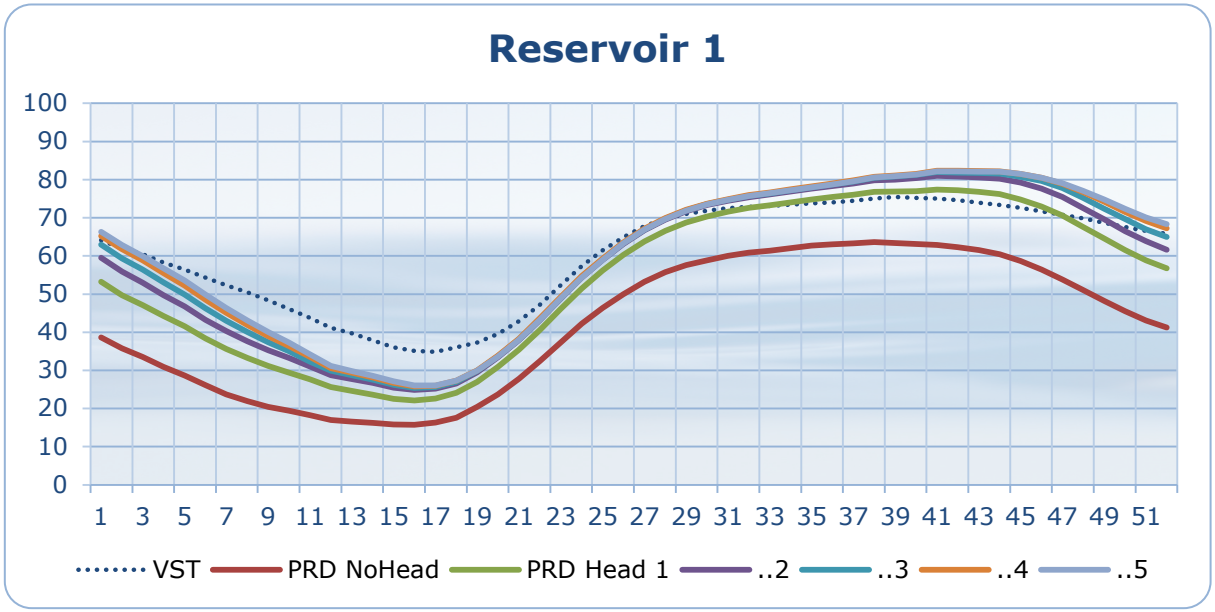
HKORR.SDDP

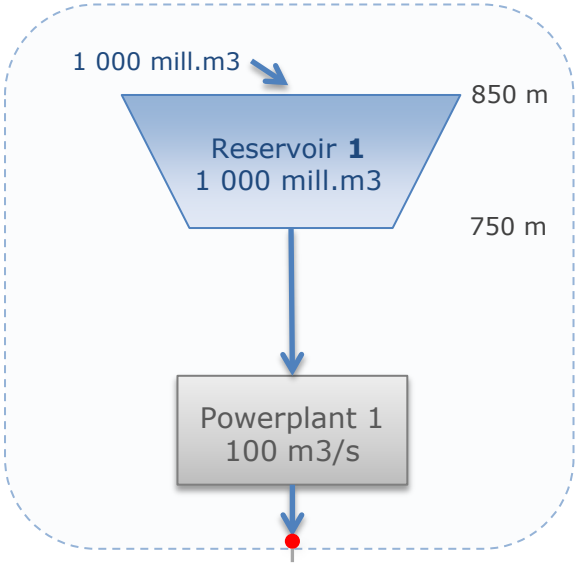
```
2          1         260    84817627
      10001
      10002
    1    -0.03012    -0.02236
    2    -0.03904    -0.01736
    3    -0.03457    -0.01977
    4    -0.03723    -0.01765
    5    -0.04043    -0.01313
    6    -0.04564    -0.00791
    7    -0.04566    -0.00665
    8    -0.04324    -0.00679
    9    -0.04257    -0.00822
   10    -0.04034    -0.00859
   11    -0.04589    -0.00547
   12    -0.04201    -0.00966
   13    -0.02633    -0.01869
   14    -0.02650    -0.01853
   15    -0.02658    -0.01891
   16    -0.02493    -0.01477
   17    -0.02167    -0.01589
   18    -0.02201    -0.01194
   19    -0.01642    -0.01366
   20    -0.01273    -0.01656
```

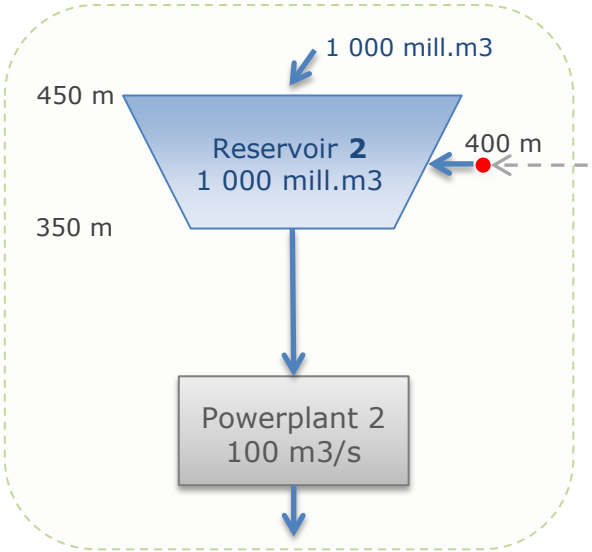
MAGVOL.SDDP

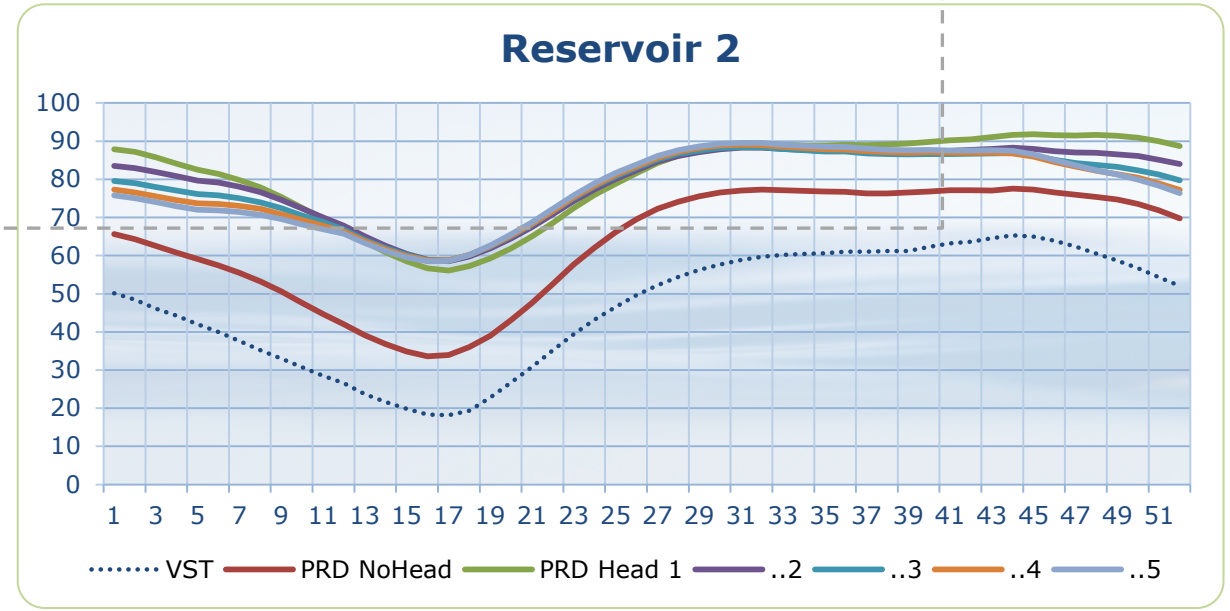
```
2          0         260           0
      10001
      10002
    0   750.00000   750.00000
    1   727.39147   731.51935
    2   695.80330   717.99472
    3   668.33780   702.13664
    4   636.41917   687.70696
    5   601.92807   678.68970
    6   563.44110   676.00265
    7   525.07353   673.41754
    8   488.48873   670.58837
    9   452.12808   666.43377
   10   416.49067   661.65254
   11   376.09086   660.12279
   12   339.16356   655.46267
   13   318.30053   639.61834
   14   299.81238   625.28867
   15   281.65710   612.02520
   16   267.81636   606.83899
   17   265.62170   610.14572
   18   275.87450   628.35717
   19   301.80062   653.86221
```

agder energi



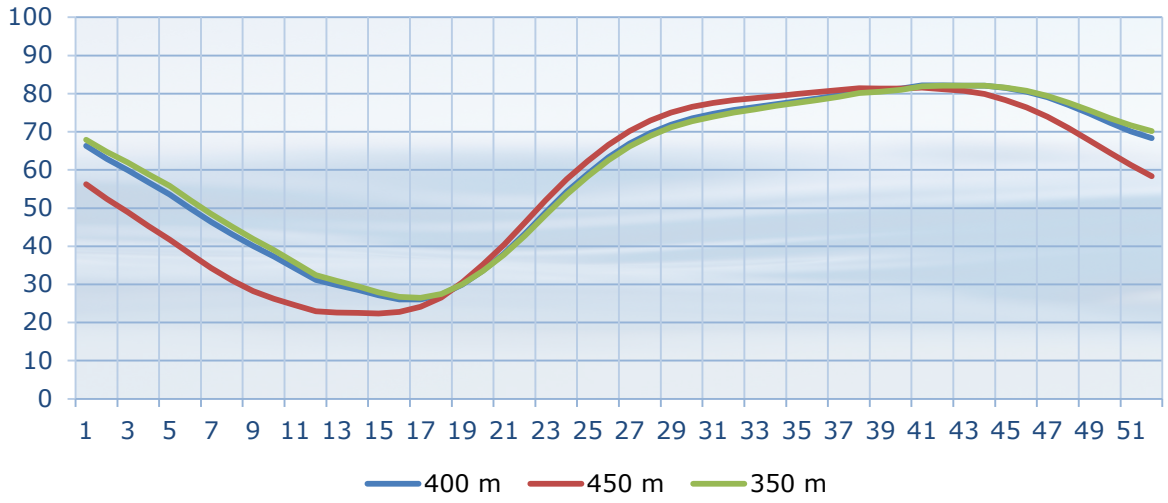


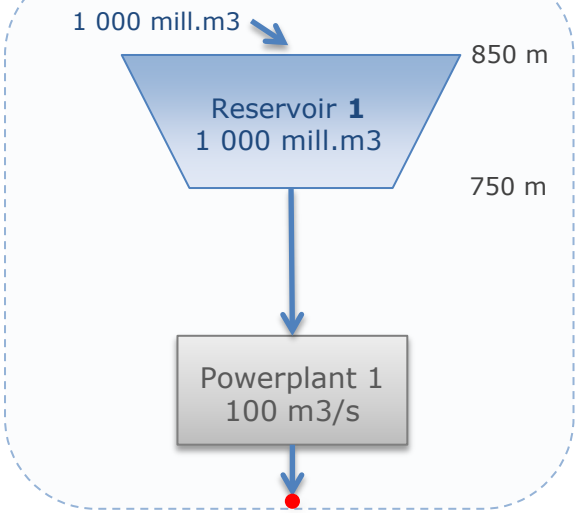


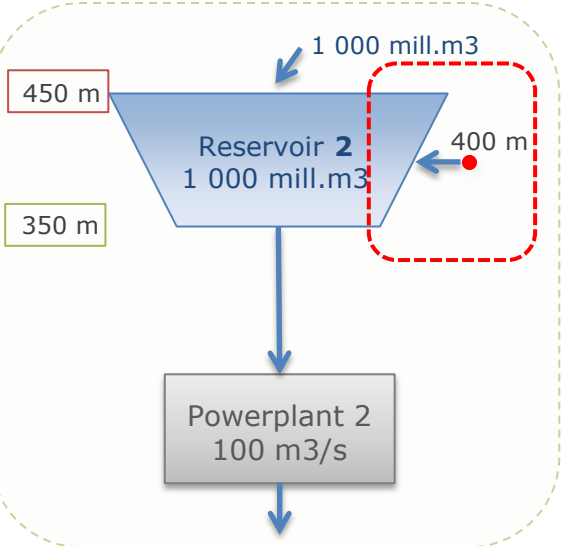


agder energi

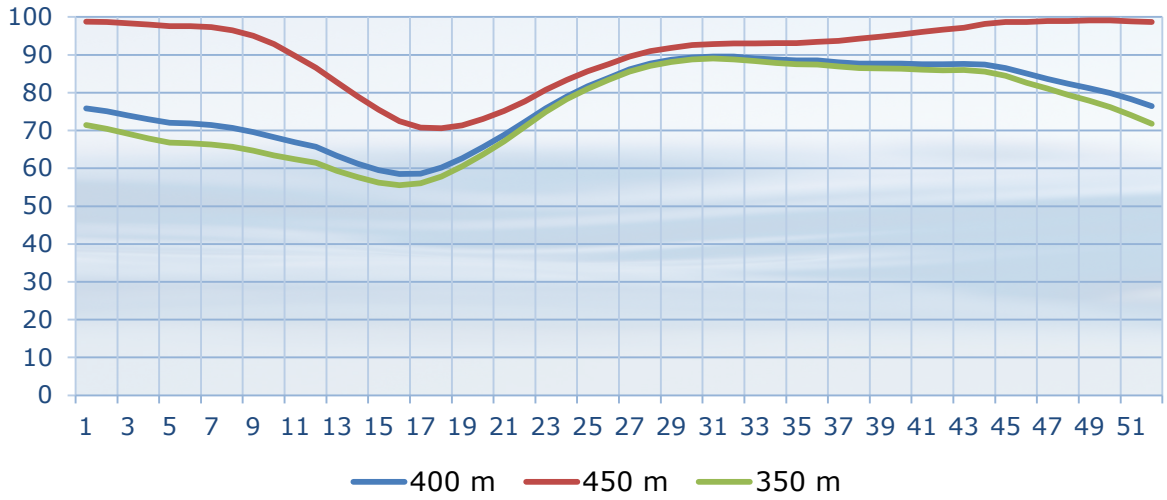
Reservoir 1





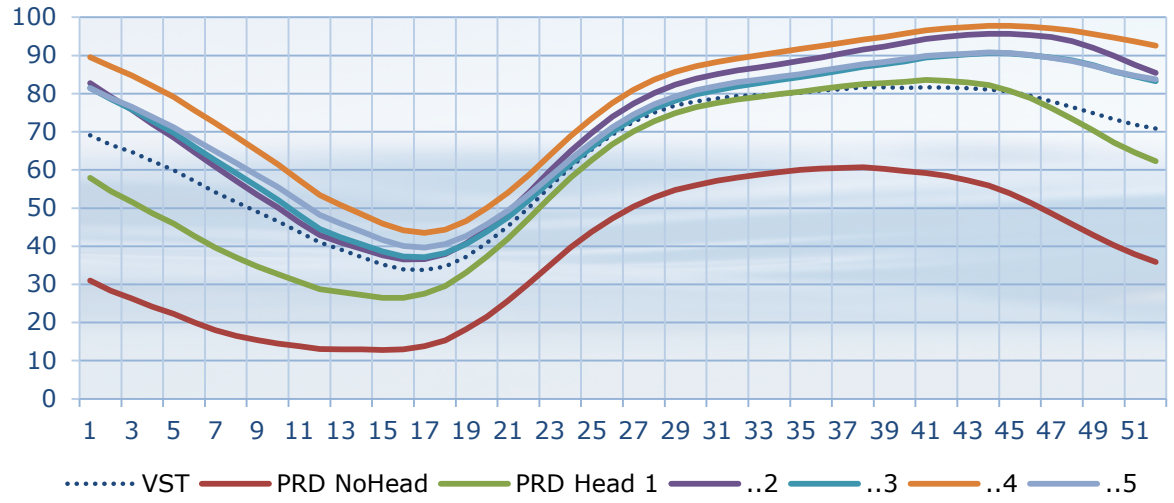


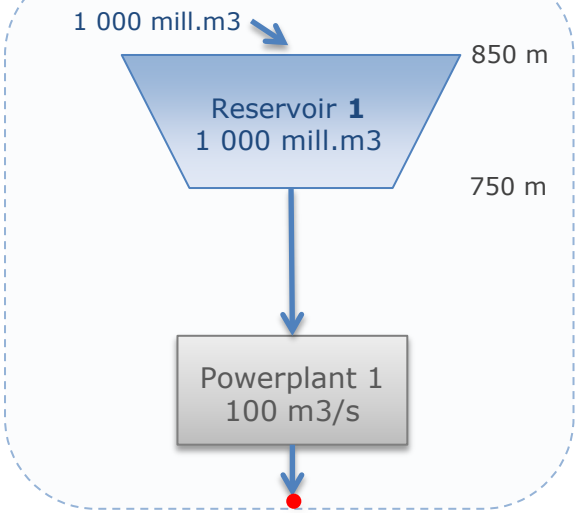
Reservoir 2



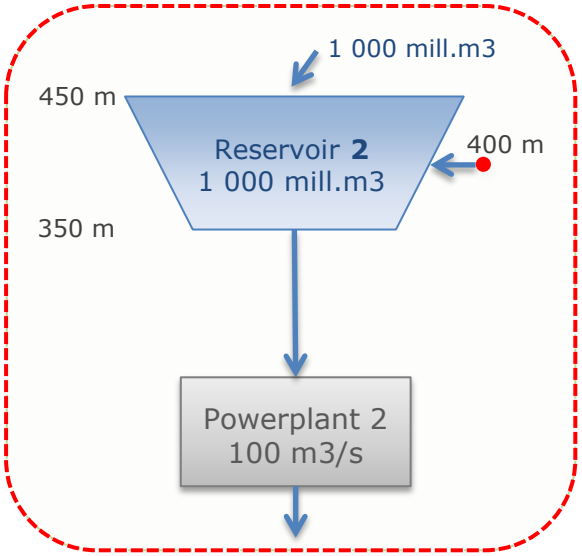
agder energi

Reservoir 1

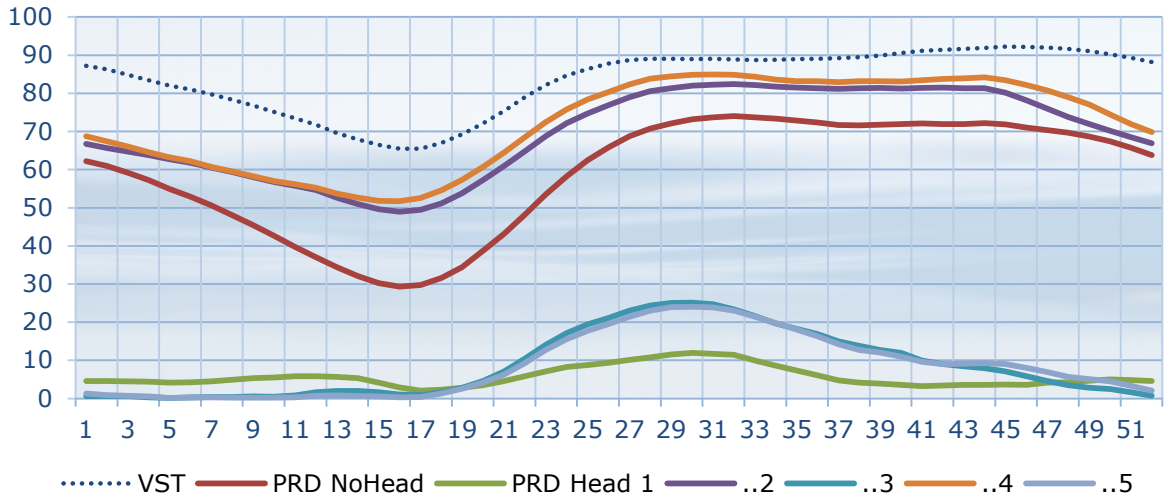




5 % ownership

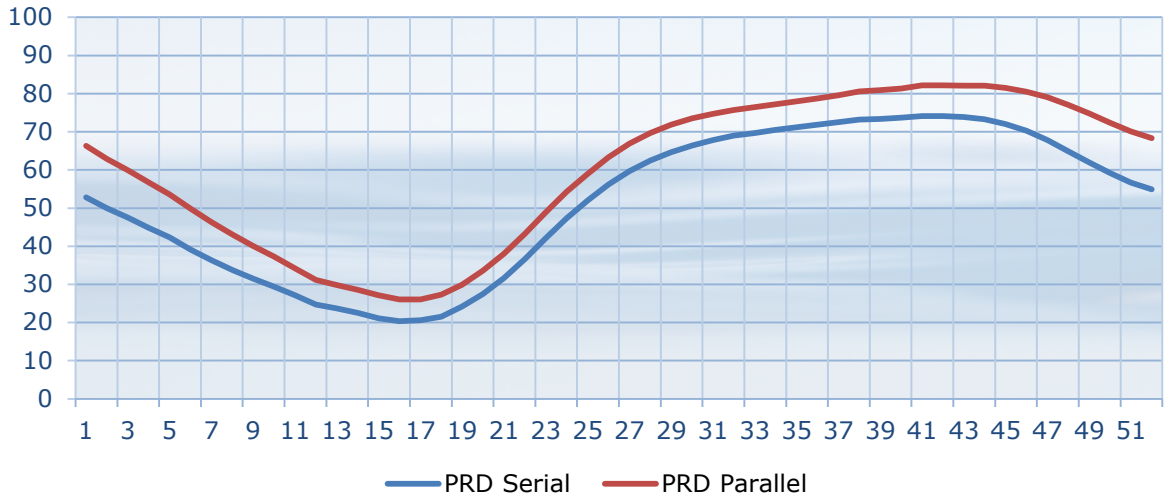


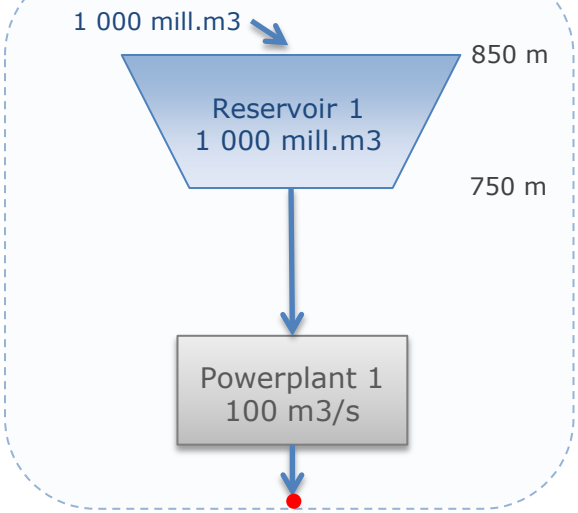
Reservoir 2

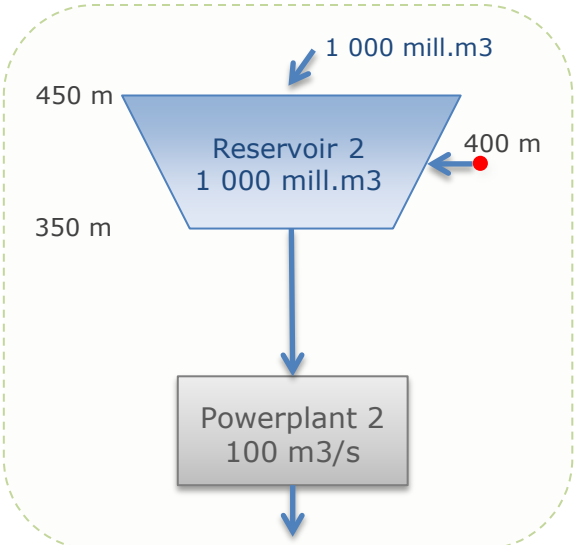


agder energi

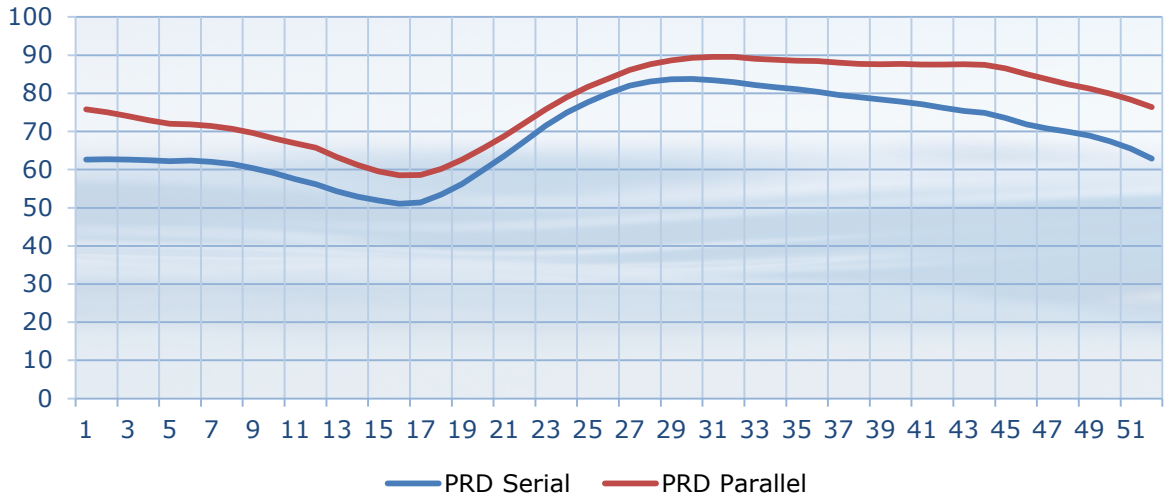
Reservoir 1







Reservoir 2



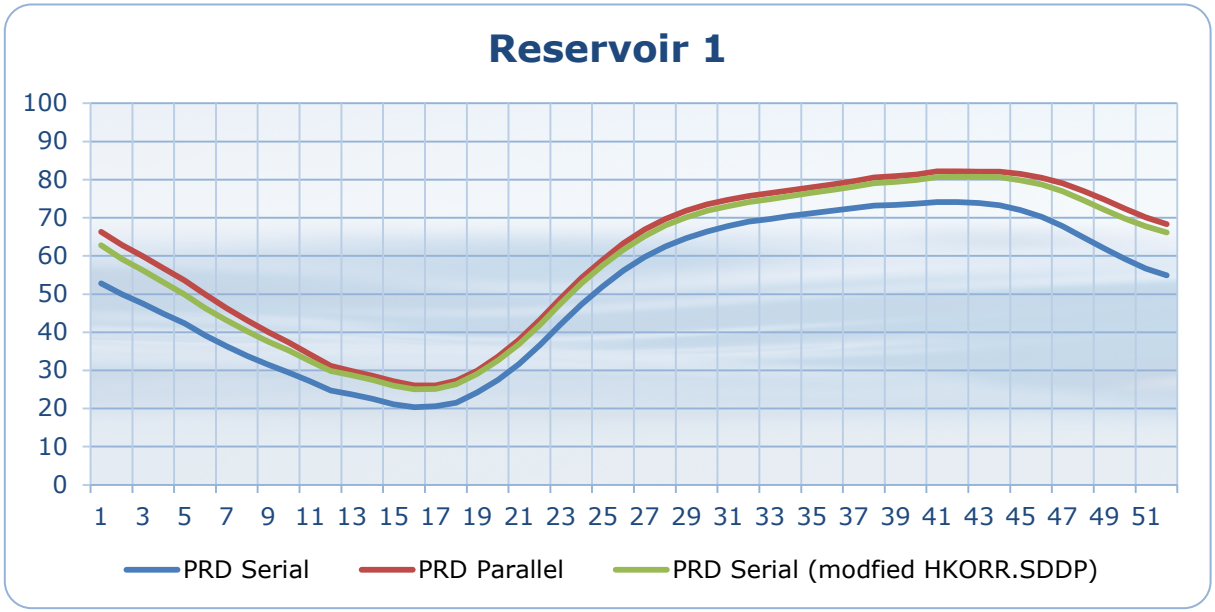
agder energi

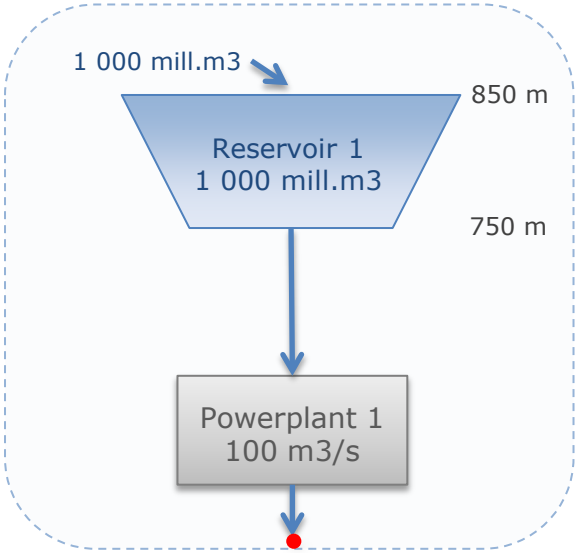
HKORR.SDDP

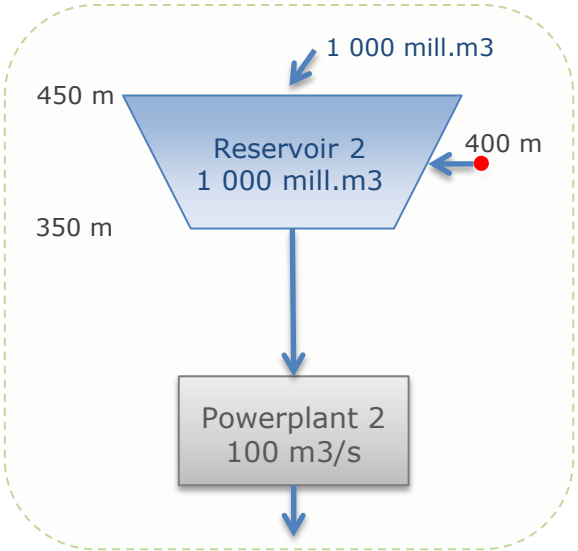
```
2           1         157    85439182
      10001
      10002
   1    -0.02721    -0.01362
   2    -0.03489    -0.01312
   3    -0.02999    -0.01338
   4    -0.03163    -0.01340
   5    -0.03103    -0.01502
   6    -0.03967    -0.01500
   7    -0.03720    -0.01962
   8    -0.03365    -0.01958
   9    -0.02810    -0.02343
  10    -0.02618    -0.02088
  11    -0.02731    -0.02801
  12    -0.02910    -0.02560
----
  50    -0.03410    -0.02725
  51    -0.03009    -0.03148
  52    -0.02411    -0.03668
  53     0.00000     0.00000
  54     0.00000     0.00000
  55     0.00000     0.00000
  56     0.00000     0.00000
  57     0.00000     0.00000
  58     0.00000     0.00000
----
```

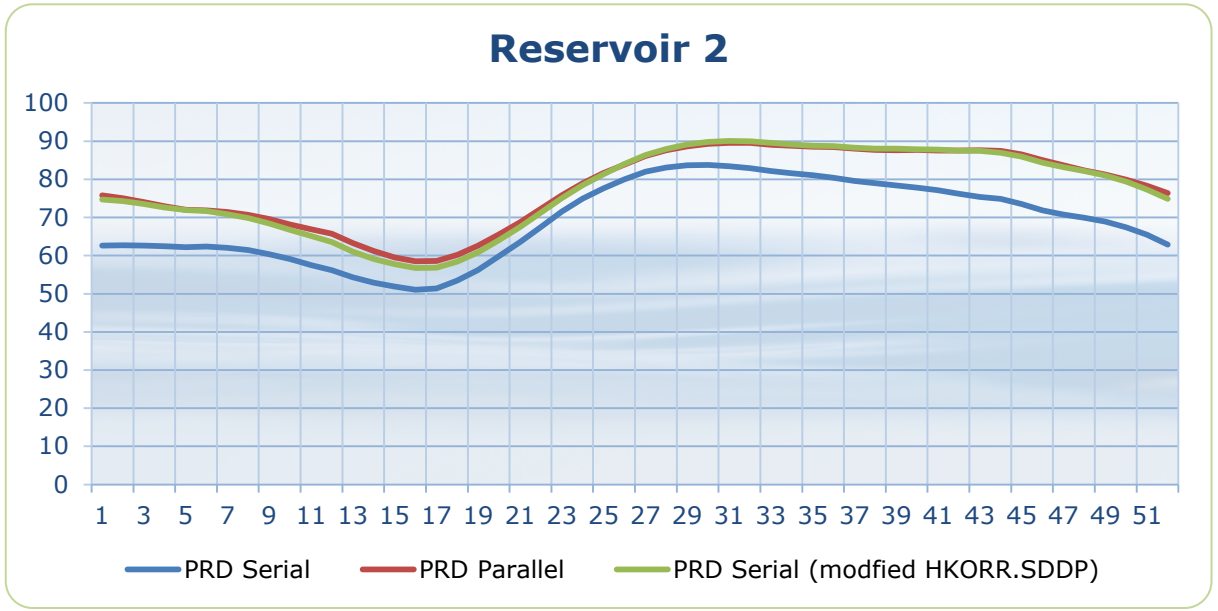
HKORR.SDDP

```
2           1         157    85439182
      10001
      10002
   1    -0.02721    -0.01362
   2    -0.03489    -0.01312
   3    -0.02999    -0.01338
   4    -0.03163    -0.01340
   5    -0.03103    -0.01502
   6    -0.03967    -0.01500
   7    -0.03720    -0.01962
   8    -0.03365    -0.01958
   9    -0.02810    -0.02343
  10    -0.02618    -0.02088
  11    -0.02731    -0.02801
  12    -0.02910    -0.02560
----
  50    -0.03410    -0.02725
  51    -0.03009    -0.03148
  52    -0.02411    -0.03668
  53    -0.02721    -0.01362
  54    -0.03489    -0.01312
  55    -0.02999    -0.01338
  56    -0.03163    -0.01340
  57    -0.03103    -0.01502
  58    -0.03967    -0.01500
----
```



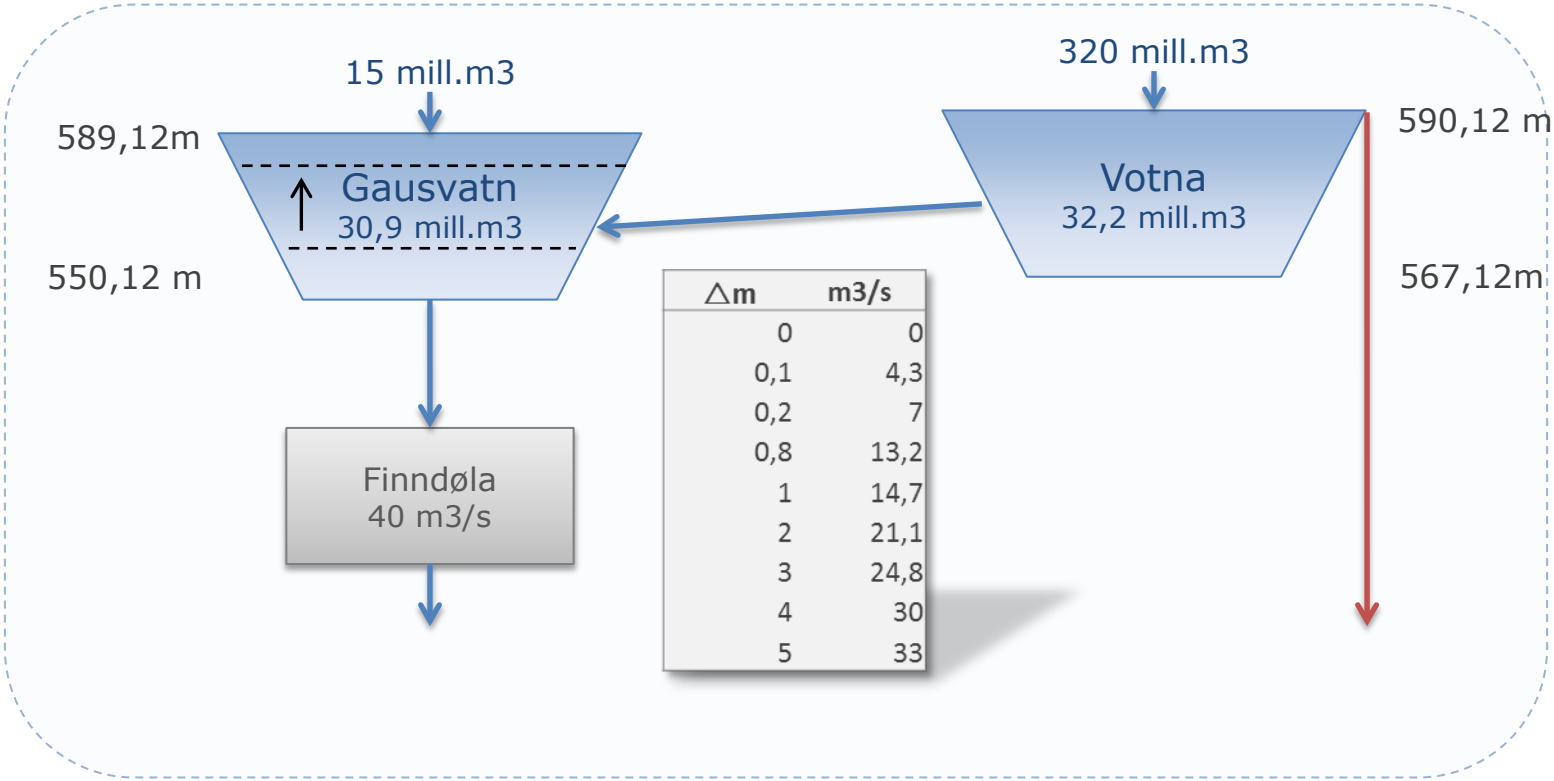






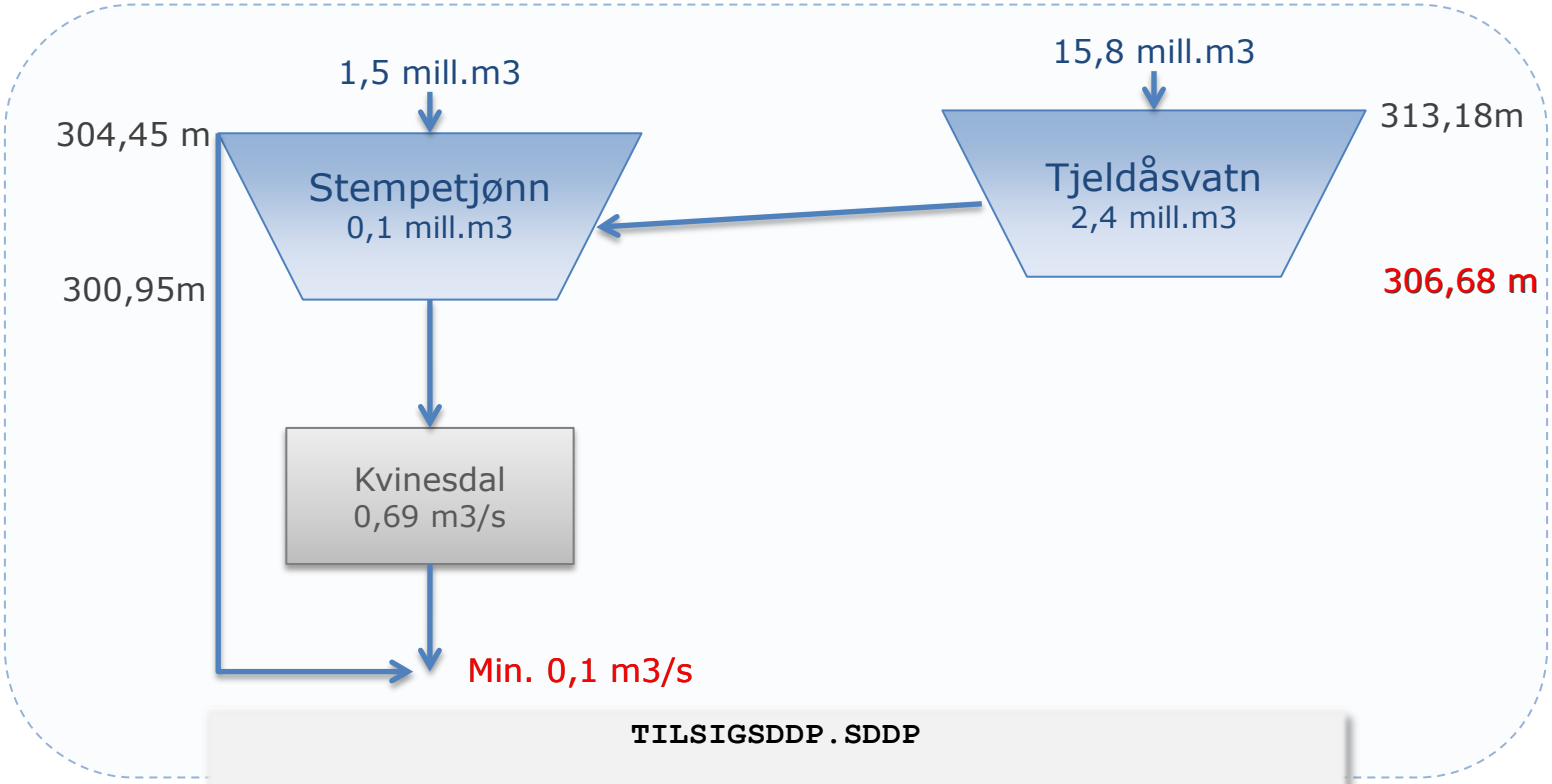
agder energi

Finndøla powerplant



△m	m3/s
0	0
0,1	4,3
0,2	7
0,8	13,2
1	14,7
2	21,1
3	24,8
4	30
5	33

Kvinesdal powerplant



TILSIGSDDP.SDDP

```
1, Antall prinsipalkomponenter ( 1<=NPRBRUK<=NSER )
   xx, Antall diskrete verdier ( NRSTKOM(1:NPRBRUK) 2<=NRSTKOM(I) )
```

agder energi

Summary

- Thumbs up for ProdRisk
- Good dialogue with Sintef
  and their highly qualified employees
- ProdRisk will be important in the future despite
  some challenges

agder energi