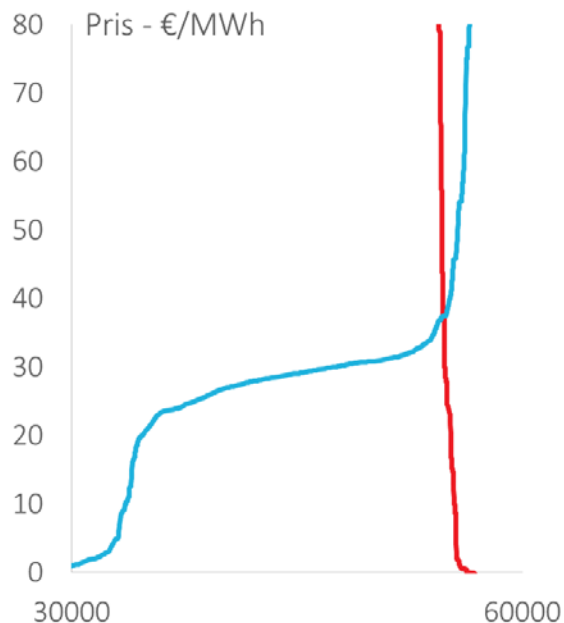




EMPS market curves

Exploring the "Black box" with market curves
User meeting in Production planning, May 10th 2017

We lack short term price variation




System price curve, March 20th 2017 hour 8-9 from Nord Pool

- The world is changing
 - Volatile renewables
 - More exchange with Europe
 - Larger Nordic power deficit
- The models need to keep up
 - Hourly time resolution
 - New models
 - Better data
- But still we haven't got the price right

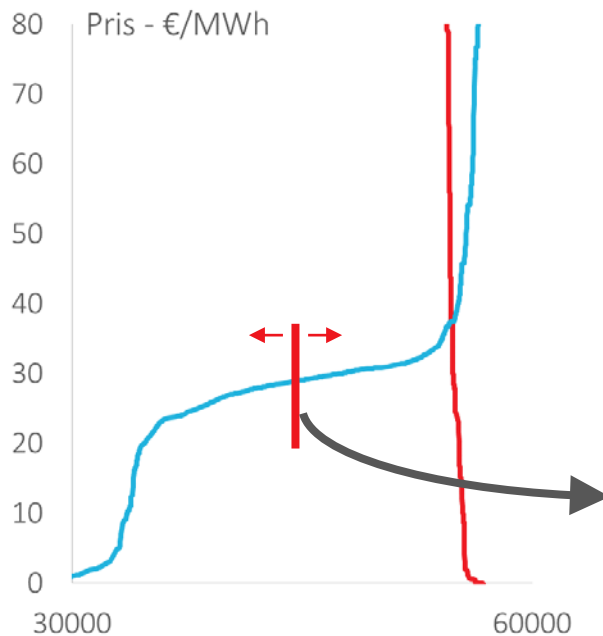
We've tried to improve the data

- CHP flexibility
- Start and stop cost
- Reserves
- Efficiency curves
- Remove power plants
- Increase load variation



Unfortunately,
none increase
price variation
considerably

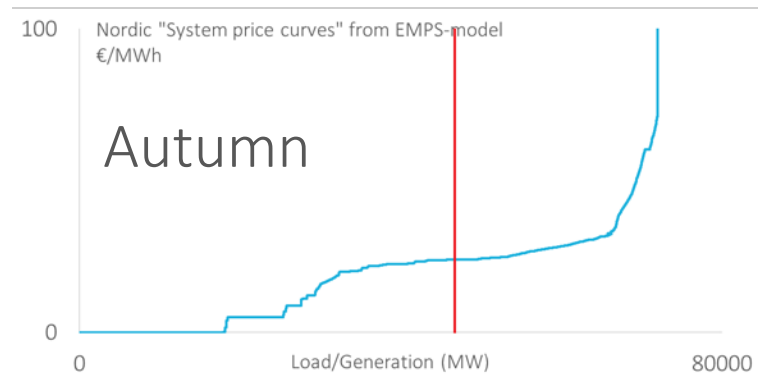
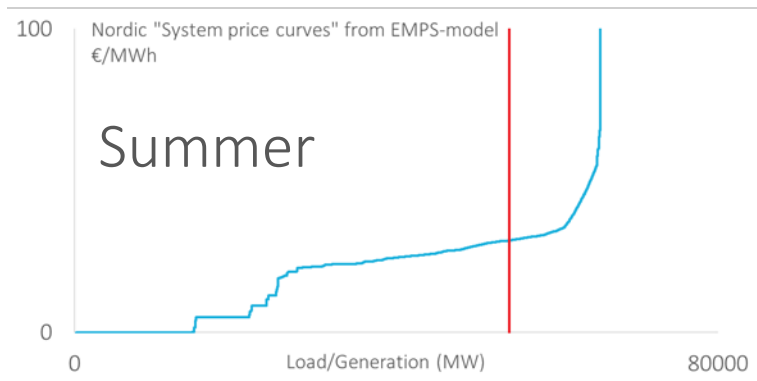
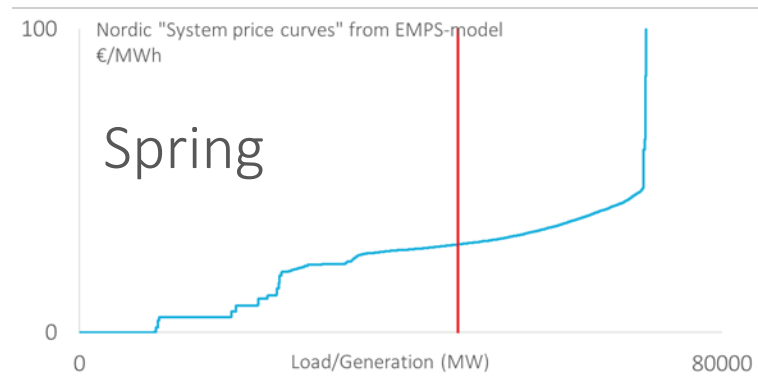
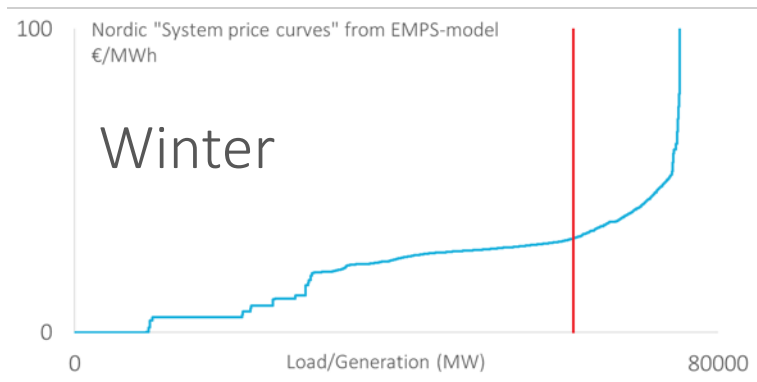
Why doesn't price variation increase?



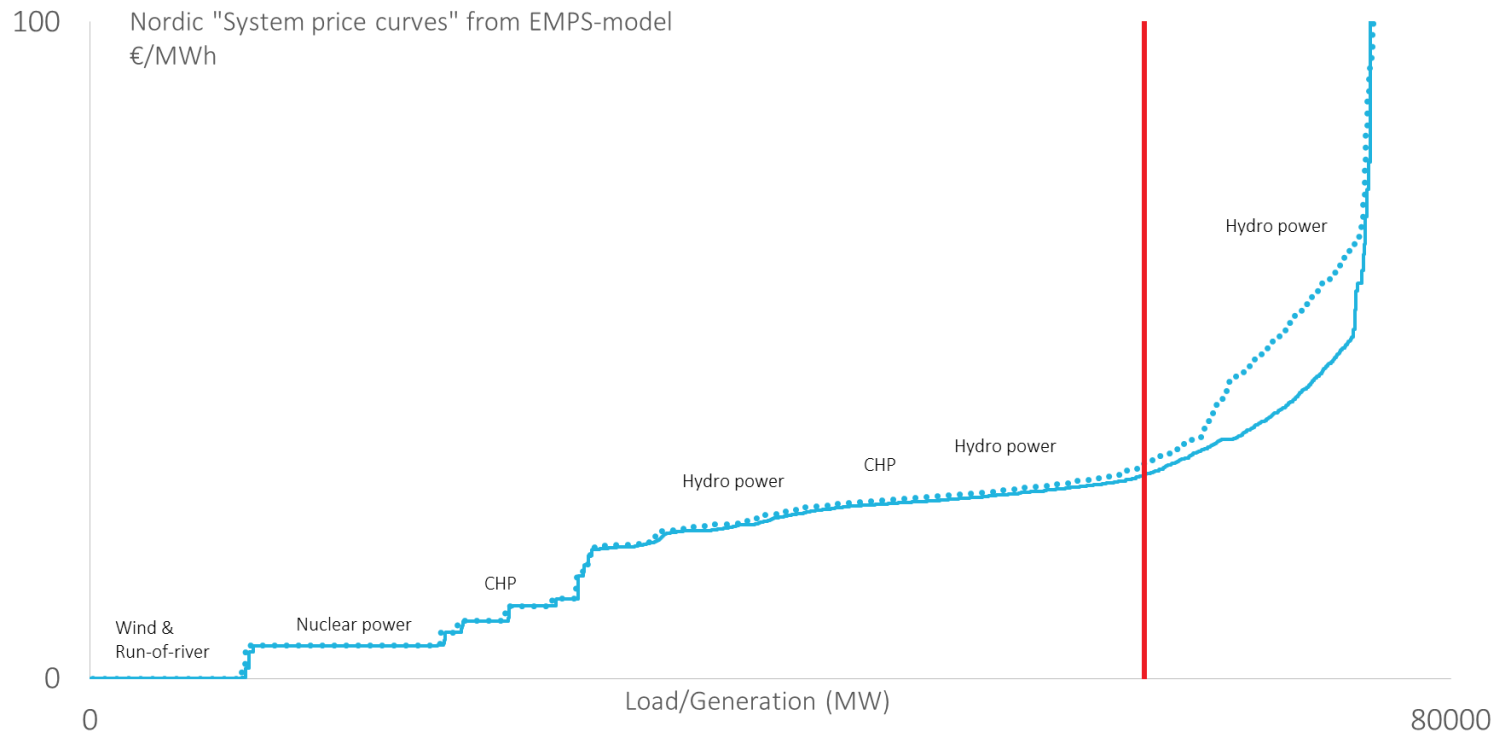
If we start here,
then we won't see
results until all
problems are solved

SINTEF has given us a helpful tool

- We can look at the market curves directly
- Important tool for understanding the model
- Instead of observing change in price and production, we can see change in market
- A change that doesn't affect realized prices can still be a step in the right direction



Result with new efficiency curves



How can we use this insight?

- Identify weaknesses in our data and model
- Find factors that mimic real operation better
- E.g. understand how does the system respond to
 - Implementation of efficiency curves
 - Procurement of reserves
 - Start and stop costs
 - Calibration

Our status and plans

- So far only done small scale tests
- Will use to cast new light on backtesting
- Improve data and model where it counts most
- Evaluate our models – SOVN & MAD vs. EMPS

How the function works

```
SDInput.dat x
1 Område, prisavsnitt, tilsigsår, uke
2 1,3,1,4
3 1,3,1,18
4 1,3,1,29
5 1,3,1,37
6 2,3,1,4
7 2,3,1,18
8 2,3,1,29
9 2,3,1,37
10 3,3,1,4
11 3,3,1,18
12 3,3,1,29
13 3,3,1,37
14 4,3,1,4
15 4,3,1,18
16 4,3,1,29
17 4,3,1,37
18 5,3,1,4
19 5,3,1,18
```

```
SDRes adv [3]
1 Supply and demand information
2 IVERK; IPEIN; YEAR; WEEK; TYPE: ;UReg Hydro ;Wind ;VADSO
3 1: 3: 1: 4:S Volume: 0.000000; 0.072595; 0.411960; 0.418860;
4 1: 3: 1: 4:S Price ; 0.000000; 0.000000; 0.000000; 0.010000;
5 IVERK; IPEIN; YEAR; WEEK; TYPE: ;Firm demand ;FTR_SNOHVIT ;FTR_GOLIAT
6 1: 3: 1: 4:D Volume: 0.000000; 1.072225; 1.656016; 1.795379;
7 1: 3: 1: 4:D Price ; 900.000000; 900.000000; 37.500000; 37.500000;
8 IVERK; IPEIN; YEAR; WEEK; TYPE: ;UReg Hydro ;Wind ;FINNFJORD
9 2: 3: 1: 4:S Volume: 0.000000; 0.050881; 0.239172; 0.328457;
10 2: 3: 1: 4:S Price ; 0.000000; 0.000000; 0.000000; 0.010000;
11 IVERK; IPEIN; YEAR; WEEK; TYPE: ;Firm demand ;KII_FINNFJORD ;KII_SALTEN
12 2: 3: 1: 4:D Volume: 0.000000; 3.101293; 3.310771; 3.647309;
13 2: 3: 1: 4:D Price ; 900.000000; 900.000000; 37.500000; 37.500000;
14 IVERK; IPEIN; YEAR; WEEK; TYPE: ;UReg Hydro ;Exchange ;Pa. Kjøp BELLAST ;
15 3: 3: 1: 4:S Volume: 0.000000; 0.002832; 0.110040; 0.111940;
16 3: 3: 1: 4:S Price ; 0.000000; 0.000000; 3.105356; 6.023868;
17 IVERK; IPEIN; YEAR; WEEK; TYPE: ;Firm demand ;FLOMGRAFT ;
18 3: 3: 1: 4:D Volume: 0.000000; 0.108690; 1.989630;
19 3: 3: 1: 4:D Price ; 900.000000; 900.000000; 0.002000;
20 IVERK; IPEIN; YEAR; WEEK; TYPE: ;UReg Hydro ;Reg Hydro ;Reg Hydro
21 4: 3: 1: 4:S Volume: 0.000000; 0.108677; 0.509383; 0.910089;
22 4: 3: 1: 4:S Price ; 0.000000; 0.000000; 2.710862; 2.725618;
23 IVERK; IPEIN; YEAR; WEEK; TYPE: ;Firm demand ;KII_MOSJOEN_ALU ;KII_RIODOCE_MANGAN
24 4: 3: 1: 4:D Volume: 0.000000; 1.330966; 2.347449; 2.519153;
25 4: 3: 1: 4:D Price ; 900.000000; 900.000000; 37.500000; 37.500000;
26 IVERK; IPEIN; YEAR; WEEK; TYPE: ;UReg Hydro ;Wind ;THAMSHAVN
27 5: 3: 1: 4:S Volume: 0.000000; 0.343223; 0.862055; 0.901055;
28 5: 3: 1: 4:S Price ; 0.000000; 0.000000; 0.000000; 0.010000;
29 IVERK; IPEIN; YEAR; WEEK; TYPE: ;Firm demand ;KII_ORKLA_EXOLON ;TRF_STRINDA
30 5: 3: 1: 4:D Volume: 0.000000; 3.386454; 3.400190; 3.418734;
31 5: 3: 1: 4:D Price ; 900.000000; 900.000000; 37.500000; 37.500000;
32 IVERK; IPEIN; YEAR; WEEK; TYPE: ;UReg Hydro ;Wind ;Exchange
33 6: 3: 1: 4:S Volume: 0.000000; 0.359890; 0.759052; 5.558200;
34 6: 3: 1: 4:S Price ; 0.000000; 0.000000; 0.000000; 3.278240;
```

Input

Specify which areas,
years, weeks and price
segments to analyze

Run simulation

Output

Aggregated bid volumes
and prices are given as
output from the simulation