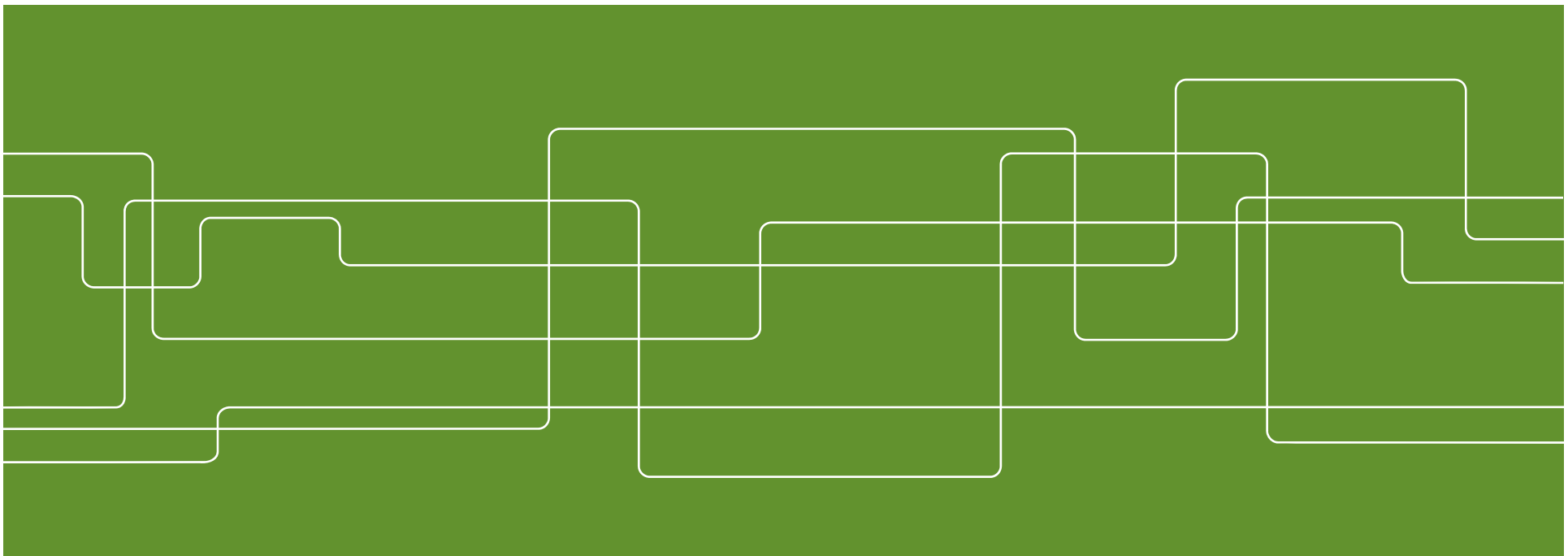




System Planning

Lecture 14 – extra – 2014

Lennart Söder
Electric Power Systems, KTH, Sweden





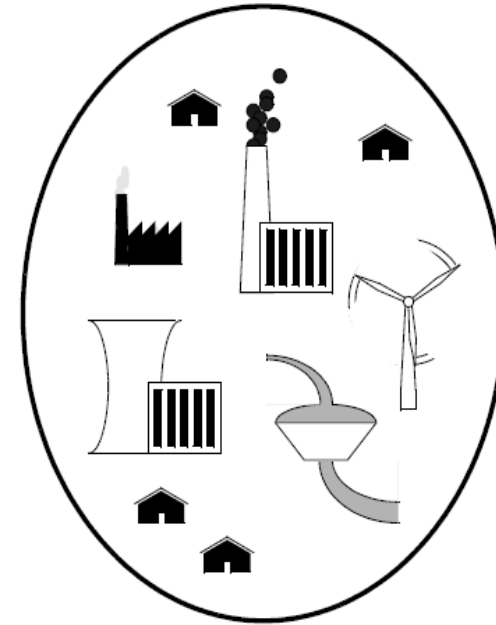
PPC model

Assume

- Perfect competition
- Perfect information
- Load is not price sensitive
- Neglect grid losses and limitations
- All scenario parameters can be treated as independent

Calculate:

- LOLP, EENS and ETOC



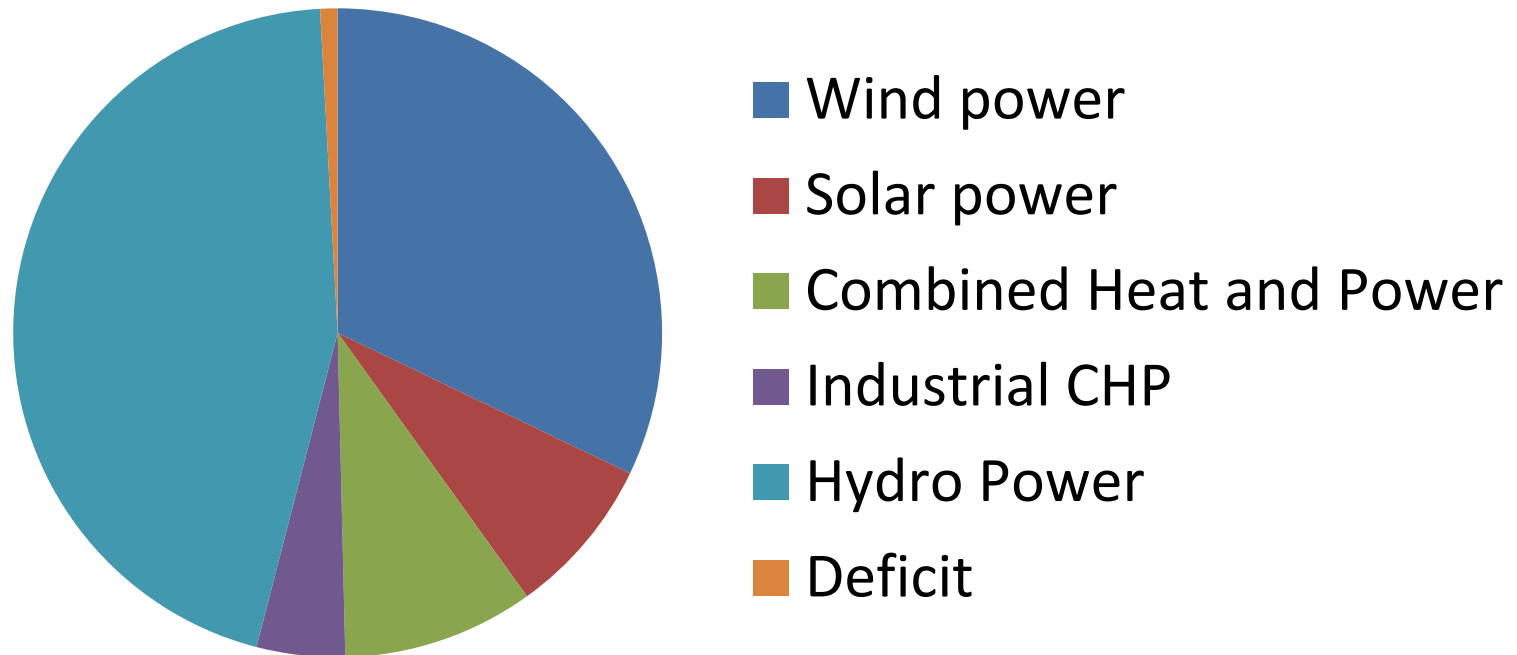
But not so easy:

- Max share of e.g. wind power
- Changes over time
- Minimum levels

Swedish Power production: Total 145,6 TWh

(same as 2011)

Swedish Electric Supply 20XX





Current (2011) Swedish Power System

Source	TWh - 2011	Energy % - 2011	MW-capacity - 2011
Hydro	66,0	44,9	16197
Nuclear	58,0	39,5	9363
Wind	6,1	4,2	2899
Solar	0	0	0
CHP-Ind	6,4	4,4	1240
CHP-distr.	9,4	6,4	3551
Condens	1,01	0,7	3197
Total	146,9	100	36447



Studied Swedish Power System

Source	TWh	Energy %	MW-max
Hydro	65,7	45,1	12951
Nuclear	0	0	0
Wind	46,8	32,1	15633
Solar	11,6	8,0	9148
CHP-Ind	6,4	4,4	1240
CHP-distr.	13,9	9,5	4127
Other	1,3	0,9	5081
Total	139,9	100	48180



New report: Published 21 Oktober 2013



ROYAL INSTITUTE
OF TECHNOLOGY

På väg mot en elförsörjning baserad på enbart förnybar el i Sverige

En studie om kraftsystemets balansering

Version 3.0

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2013-10-21

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Studies:

- Balancing from hour to hour in **"isolated" Sweden!**
- High wind+solar / low consumption
- Low wind+solar / high consumption
- Hydro power regulation
- Can be downloaded from KTH:s home page
- **EXCEL-file for calculat.**



Three challenges in power systems with large amounts of solar + wind:

C1: Keep the **continuous balance**

C2: Handle situations with **large** amounts of variable production

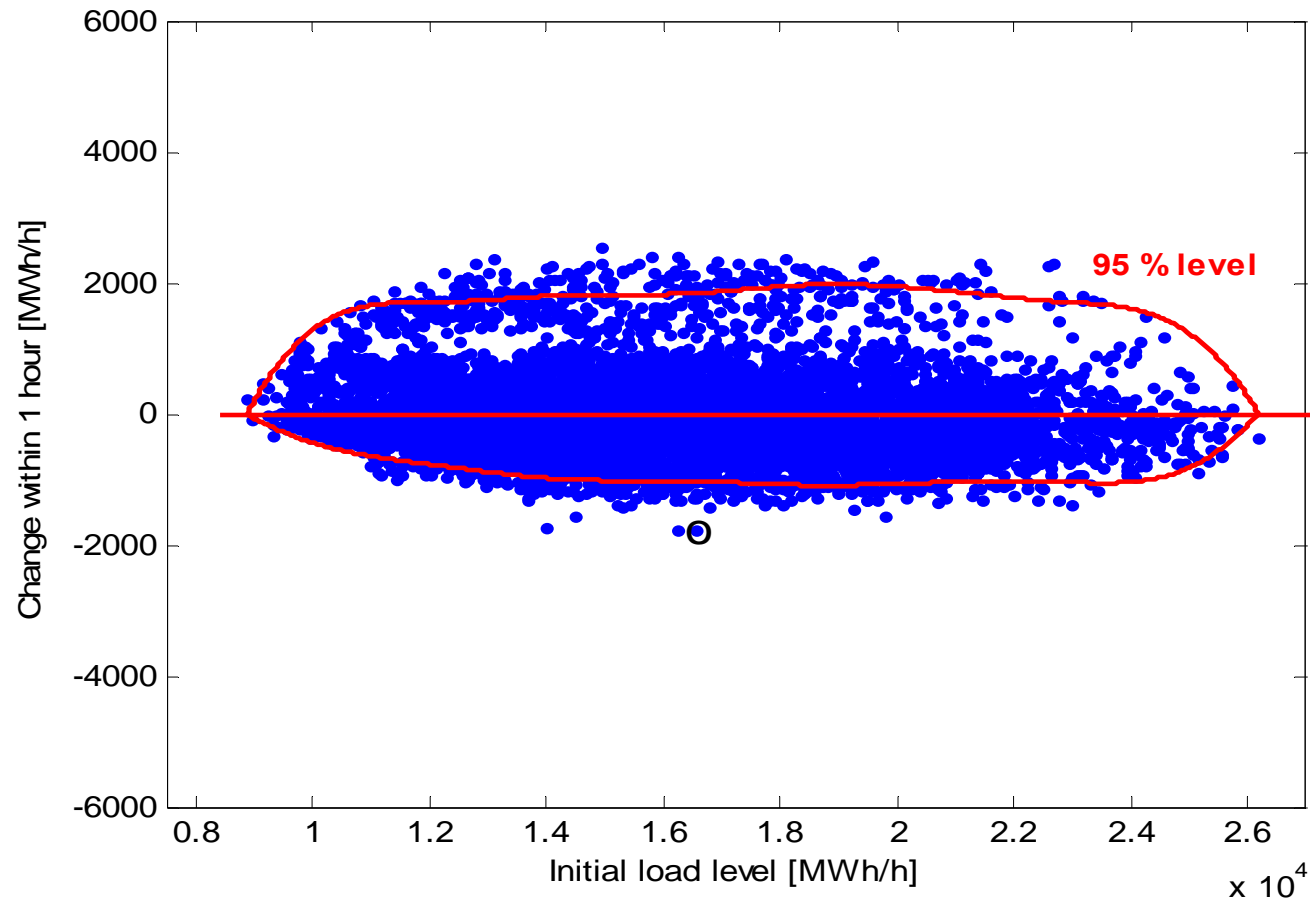
C3: Handle situations with **small** amounts of variable production





C1: Changes within 1 hour

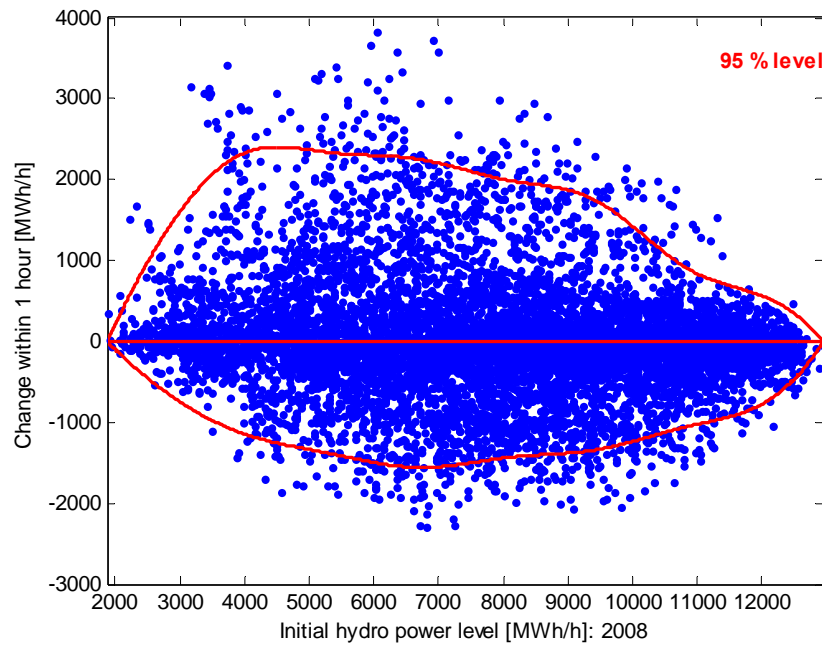
Swedish consumption 2011, (+ 2300 MW)



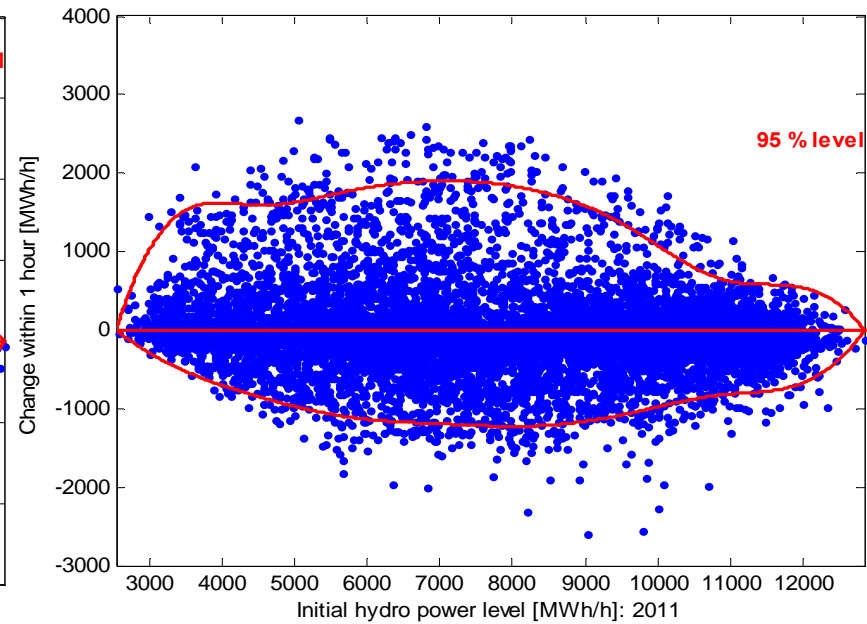


C1: Changes - 1 hour

Today hydro power, (+ 2500-3500 MW)



2008



2011

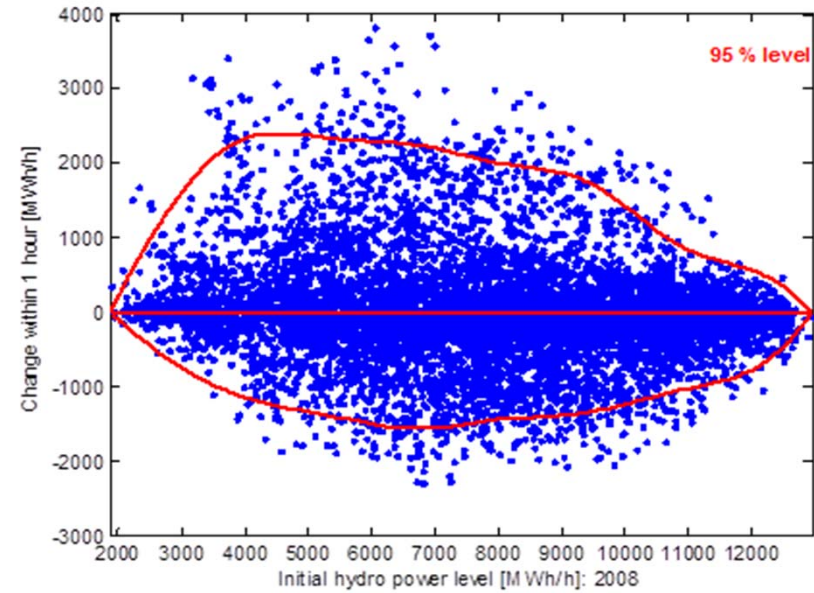
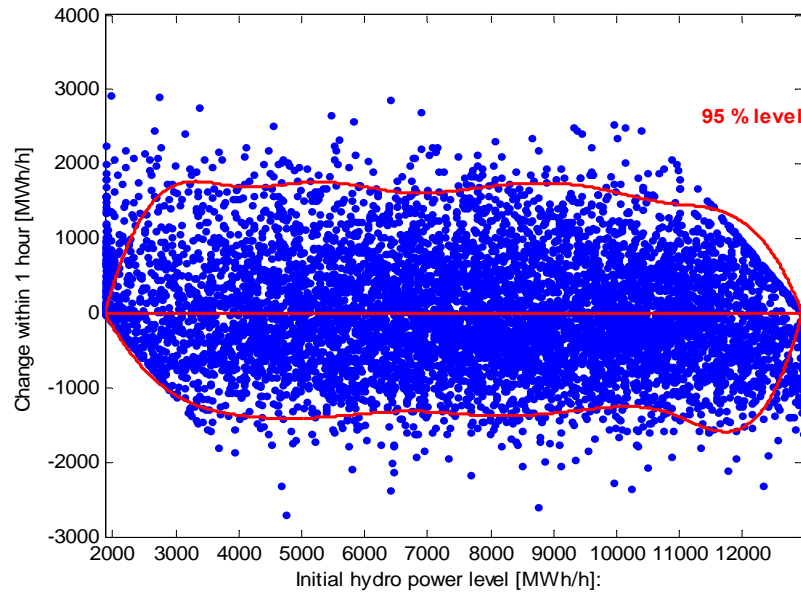




Hydro power: Change during 1 hour

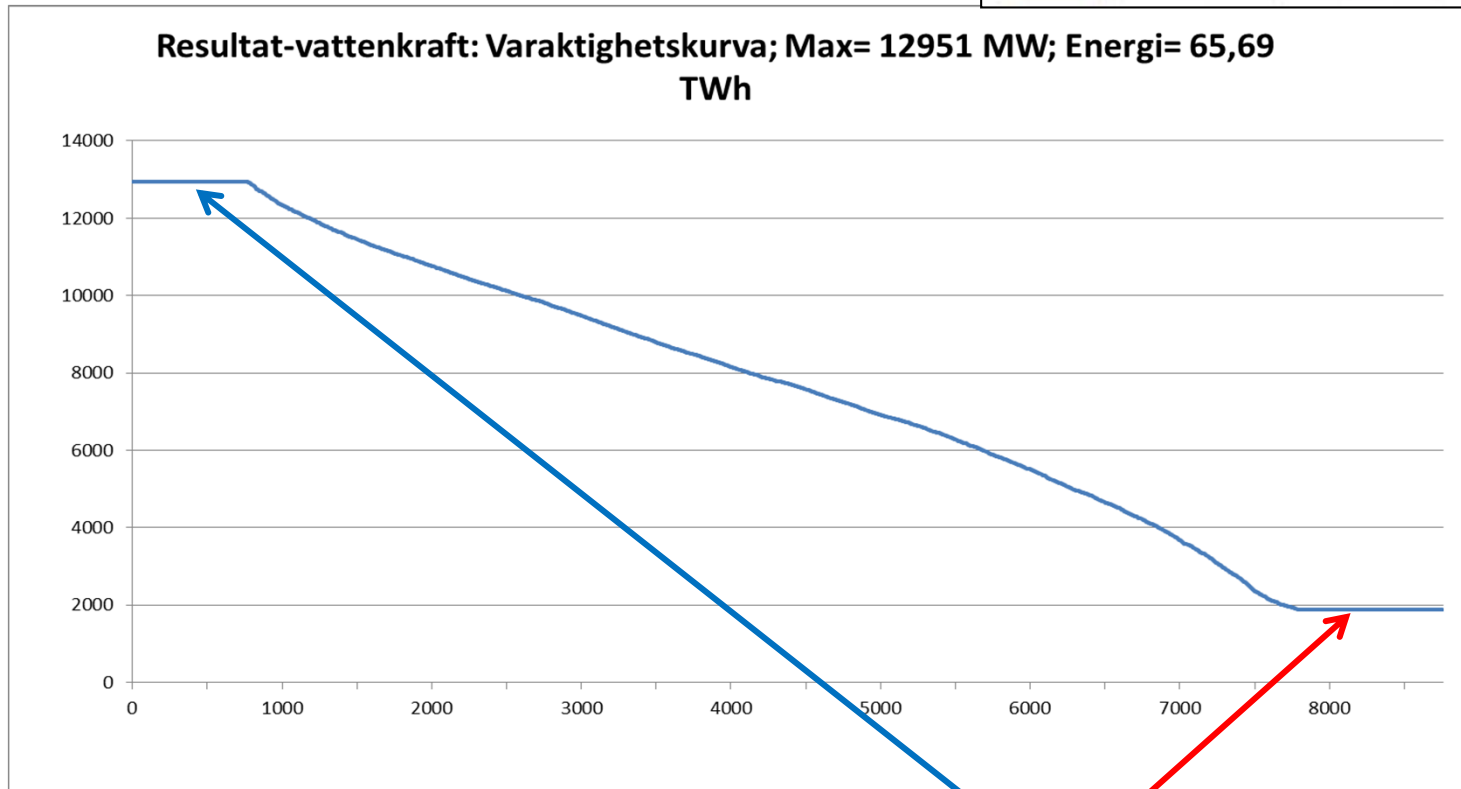
60 TWh wind + solar

2008





Hydro power: Duration curve



Min level: 1875 MW: Needed during **860** hours

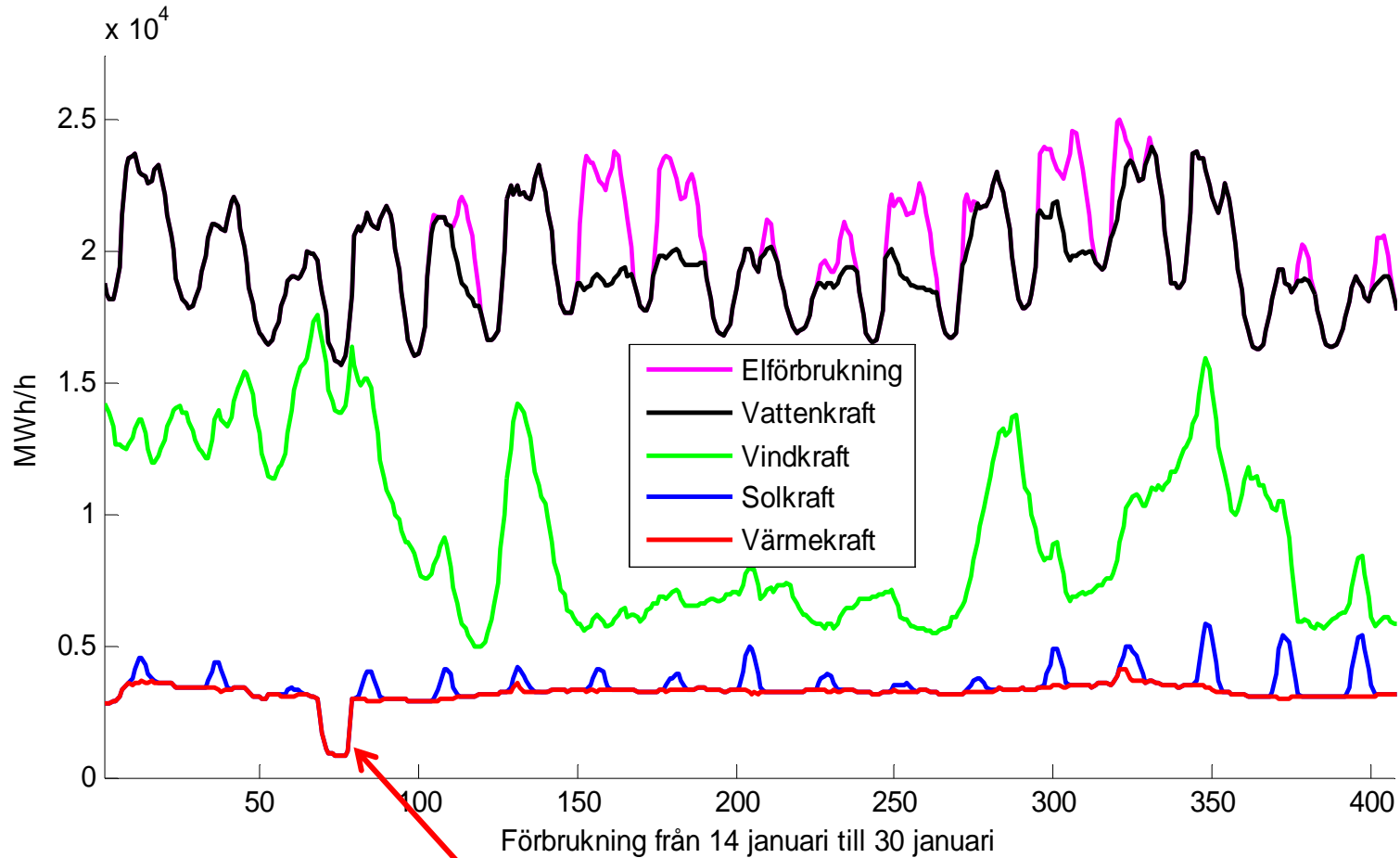
Max level: 12951 MW: Needed during **765** hours





Deficit situation

low solar+wind: January

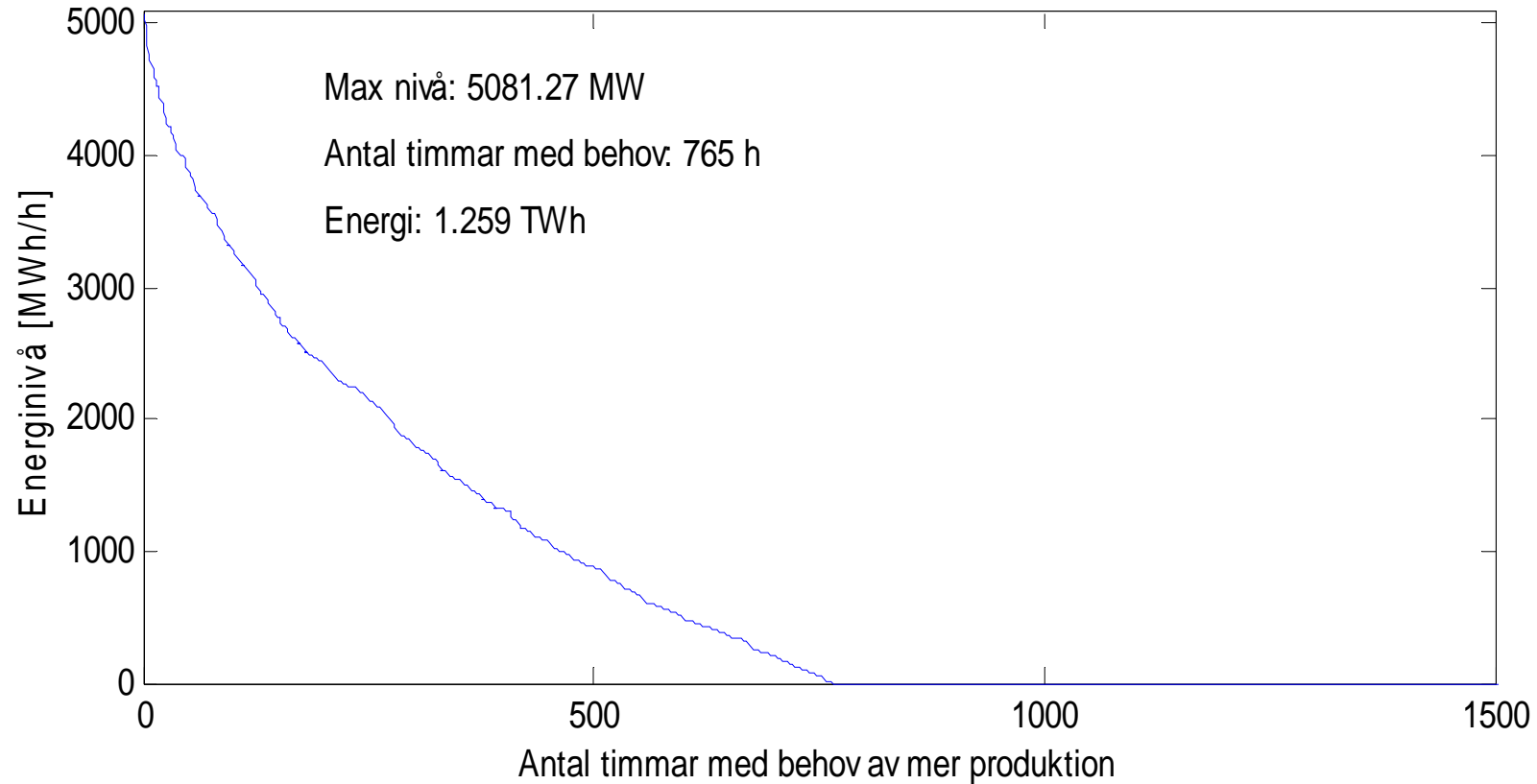


High wind → decrease CHP





Deficit situation (yearly basis)

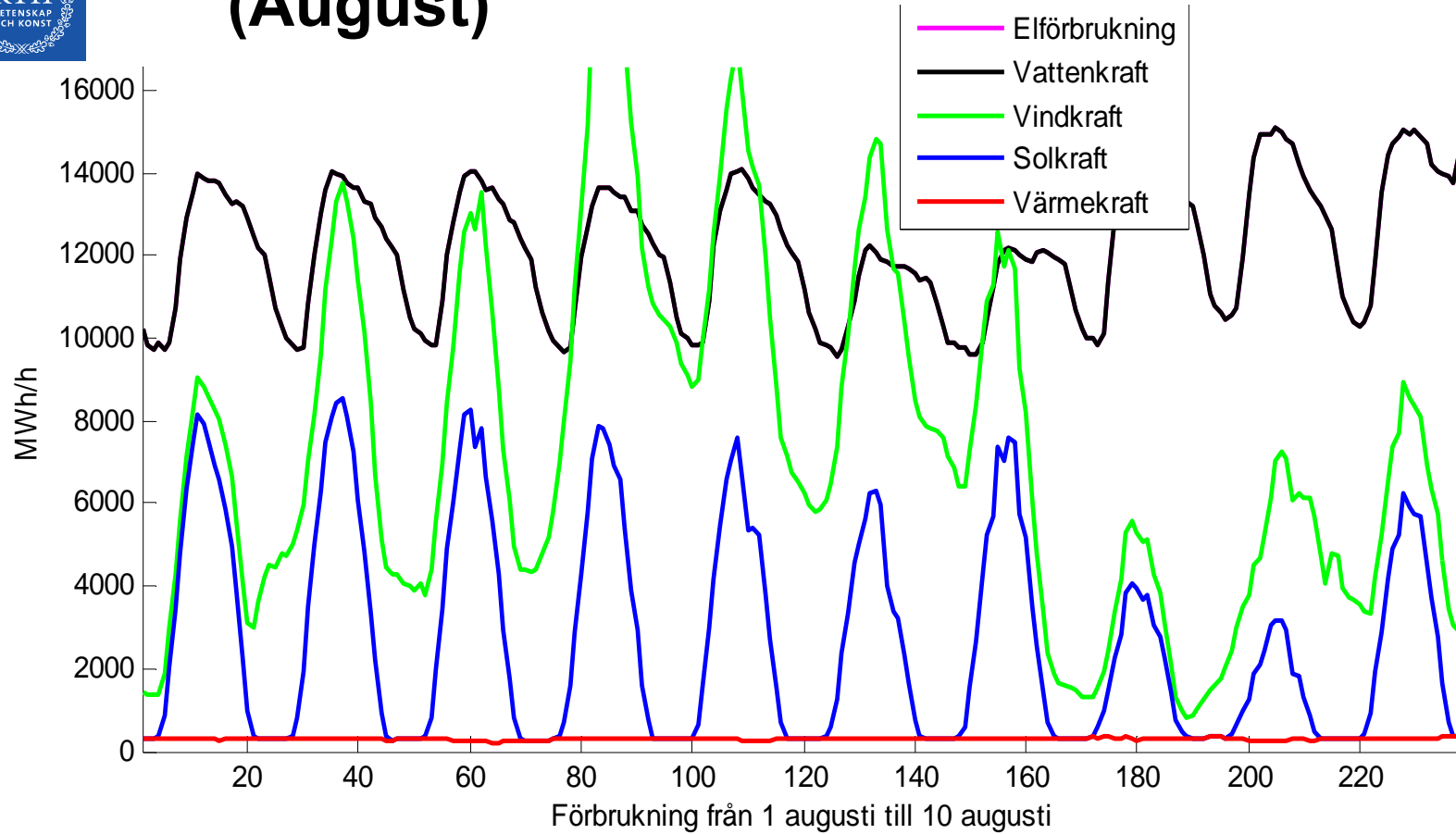


Cost for this: 1,5 öre/kWh





Surplus situation (August)

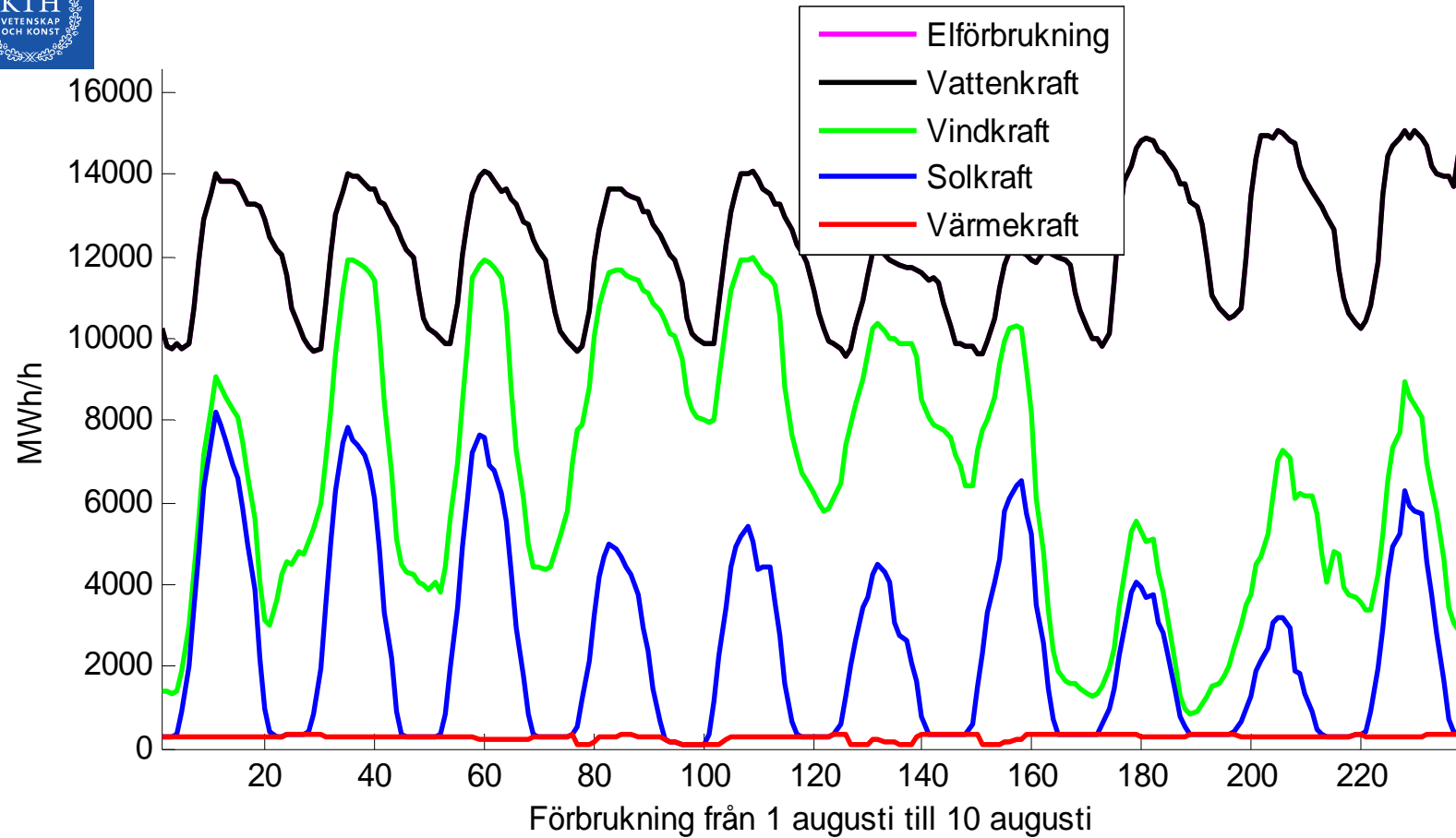


Not OK: 83% limit, min-hydro, min-CHP





Surplus situation (August)

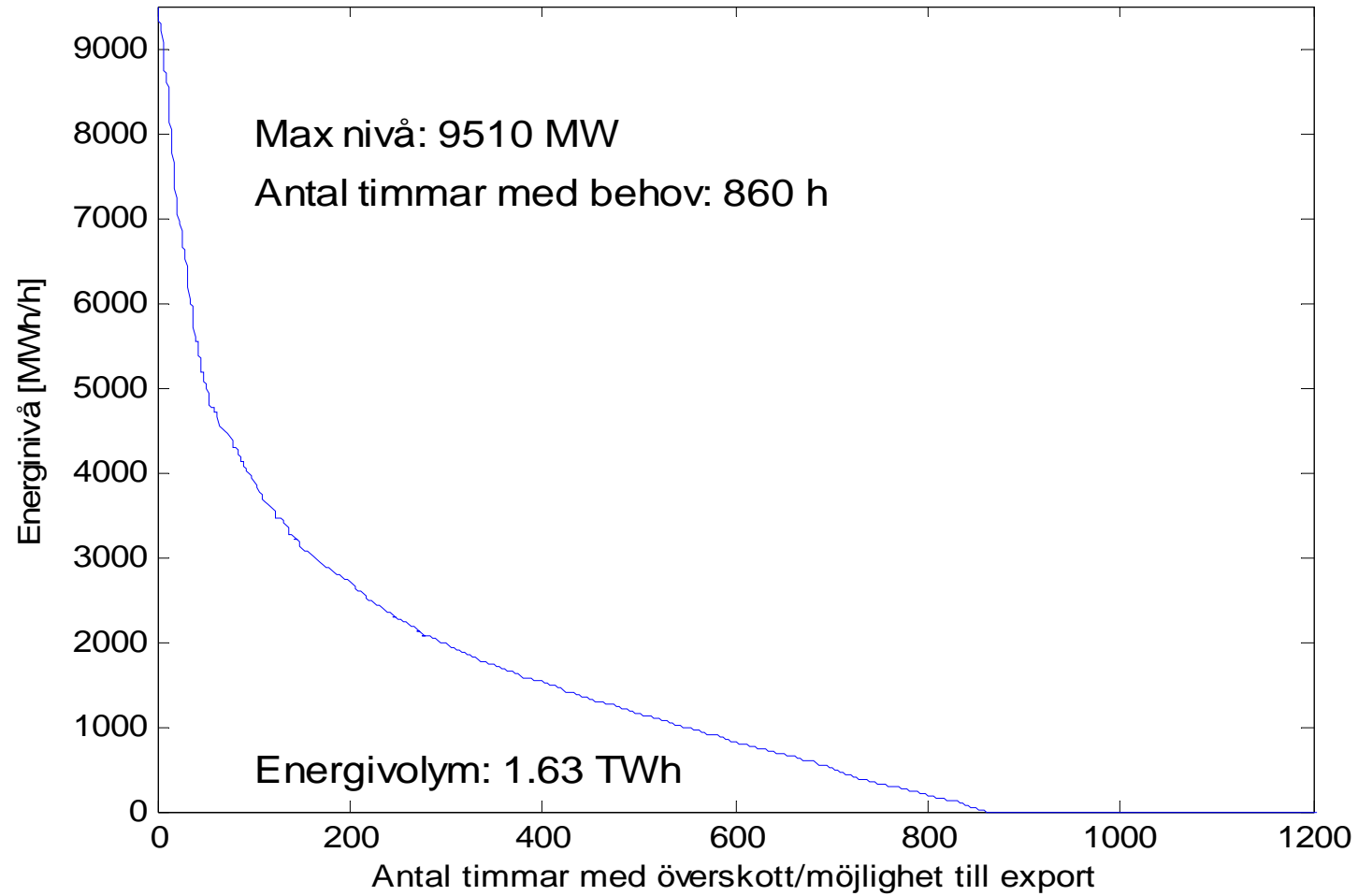


Now OK: 83% limit, min-hydro, min-CHP





Surplus during a year





Some recent (2014) articles (in Swedish)

We can do better than Germany

<http://www.di.se/artiklar/2014/1/30/debatt-vi-kan-bättre-antyskland/>

The ones who pollute do not pay

http://www.svd.se/opinion/brannpunkt/de-som-smutsar-ned-betalar-inte_8946120.svd

Misunderstandings about "base power"

<http://www.second-opinion.se/energi/view/2807>

Continuous misunderstandings about "base power"

<http://www.second-opinion.se/energi/view/2812>



About new nuclear power



- The government in UK has agreed with EDF group”about an offer to construct new nuclear power in UK.
- The key terms include a “Strike Price” of £89.50 /MWh (96-99 öre/kWh)
- A contract difference payment duration of 35 years, from the earlier of the point at which each reactor at Hinkley Point C becomes commercially operational.
- <https://www.gov.uk/government/news/initial-agreement-reached-on-new-nuclear-power-station-at-hinkley>



Identified wind power projects in Sweden:

Identified wind power projects:

- **45000 MW** (\approx 100 TWh/year)

Today capacities:

- **Hydro Power: 16000 MW** (\approx 65 TWh)
- **Nuclear power: 9000 MW** (\approx 65 TWh)
- **→ total of 25000 MW**

