Statnett

Memo

Subject: Hasle pilot experiences

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Copy to:	Document id.: 16/01787 Date: 2015-12-21

This note summarises the experiences of the Hasle Pilot Project (also called "phase I") and its phase II. The summary builds on the evaluation report of the first phase, adding a description of the second phase, and a brief discussion of an improved simulation of reservation impact on the day-ahead market done by the power exchange, Nord Pool Spot.

Background

The purpose of the "Hasle Pilot" was to test dynamic allocation of cross-zonal transfer capacity (CZC) between the energy spot market and coordinated national markets for automatic reserve capacity of the type "FRR-A", as a means to increase overall socioeconomic benefit.

The CZC allocation for reserves was processed on Thursdays together with the weekly procurement of these reserves in Norway and Sweden, in three weekly blocks of hours on weekdays. The three blocks consisted of the hours 5-8, 17-20 and 20-21, respectively. Reserves were exchanged on the link between the bidding zones NO1 and SE3. The maximum CZC allocation for reserves was 50 MW or 5% of planned CZC, whichever was lower. The alternative value in the spot market of CZC used for reserves was estimated, based on the spot market price differences between NO1 and SE3 during the preceding week, and a margin was added to the observed price difference in order to reduce the risk for reducing CZC in the spot market at a socioeconomic loss. Other measures to

ensure conservative reduction of CZC for the spot market were 1) no CZC allocation to reserves when the spot price was above a predefined level in SE3 or southern Norway, and 2) no CZC allocation to reserves when CZC between NO1 and SE3 was significantly reduced due to grid constraints.

The evaluation report after phase I of the Hasle Pilot concluded that allocation of CZC for cross-border exchange of automatic reserves is possible, and that it can contribute to more efficient use of resources and increased socioeconomic benefit. The report recommended to proceed with a second phase, and to perform a thorough analysis of socioeconomic benefits and distribution impacts. The socioeconomic analysis and the second phase of the Hasle Pilot are now finished, and both are described below.

Hasle Pilot II

The second phase of the Hasle Pilot was performed in the six weeks 20 to 25 of 2015. The aim of phase II was to get a broader base of quantitative results for assessment of the Pilot. Phase I, which covered the 40 weekdays of weeks 44 to 51 of 2014, saw a limited exchange of reserves between Norway and Sweden. The first week of phase I saw exchange of reserves impeded by spot price differences above the threshold for allocating all CZC to the spot market. These spot price differences were due to high reservoir levels and high reservoir inflow in southern Norway.

Phase II saw an even more limited FRR-A exchange. For different technical reasons, the Hasle Pilot could not function during the weeks 21 to 23: Statnett moved the weekly reserve procurement to Wednesday before Ascension Day, and the collection of Swedish FRR-A market bids failed in the other two weeks. In the other three weeks, the exchange of reserves was often impeded by total transfer capacity being reduced. CZC was allocated for reserves only in the morning blocks, i.e. 06:00 AM to 08:00 AM Monday to Friday.

Calculated socioeconomic surplus of the Hasle Pilot phase I

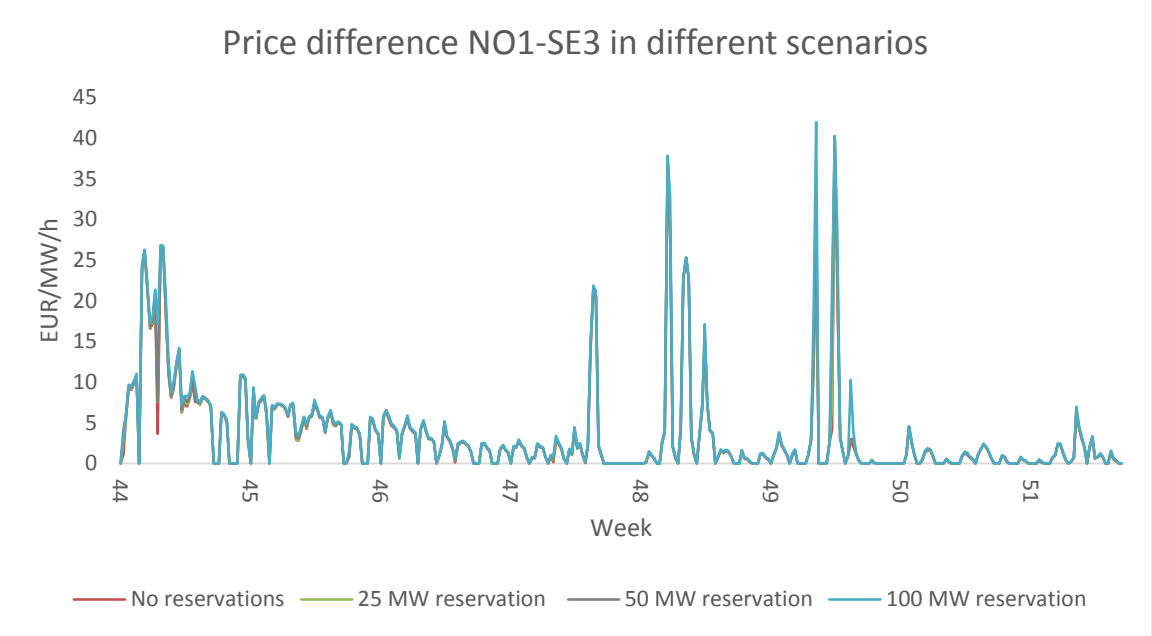
The socioeconomic surplus of the Hasle Pilot phase I was calculated to be 62 kEUR, i.e. an average of 7.7 kEUR per week. If the CZC allocation had been optimal and based on perfect spot price estimates, then the socioeconomic benefit would have been 132 kEUR. The Pilot, though the CZC allocation was designed to be conservative, realized nearly half of the potential for improved efficiency. These figures are calculated as "*the value of exchanged FRR-A (=reduced total reserve procurement costs, and the impact on producer surplus in the reserves market) minus the reduced congestion rent from the spot market*". The impact on spot prices are disregarded. This is a reasonable approximation if the magnitude of the CZC reservation or the slope of supply curves of the spot market is small. The latter assumption is discussed below.

Impacts on spot prices in phase I, spot market simulations

In order to examine the impacts of the CZC allocation on spot market prices, additional calculations were done by Nord Pool Spot (NPS), the Nordic Power Exchange, using the market clearing algorithm of the coupled spot markets of northwestern Europe. This algorithm maximizes an objective function that represents the socioeconomic surplus of the market, defined as the daily sum of producer surplus, consumer surplus and congestion rent (surplus of cross-zonal trade, i.e. gain from buying at a low price and selling it at a higher price).

The calculations consisted in a simulated market clearing for each day of phase I, covering all the coupled areas included in the market algorithm, using the actual spot market bids and different levels of simulated CZC reservation between NO1 and SE3. The CZC levels used were 0 MW, 25 MW, 50 MW, 100 MW, and the actual actual reserved CZC, which varied from 0 MW to 40 MW.

The results showed that the CZC reservation had very little impact on the spot prices in NO1 and SE3, and accordingly on the alternative value of the reserved CZC. The price impact increased predictably but still moderately with greater CZC reservation, particularly when the spot price differences were high. At lower spot price differences, the impact on spot prices from CZC reservation was hard to discern, even for the highest simulated CZC reservation (100 MW).



We emphasize that these results are based on a few days during which the market prices were moderate. The results are not necessarily valid for market situations with higher prices or price volatility.

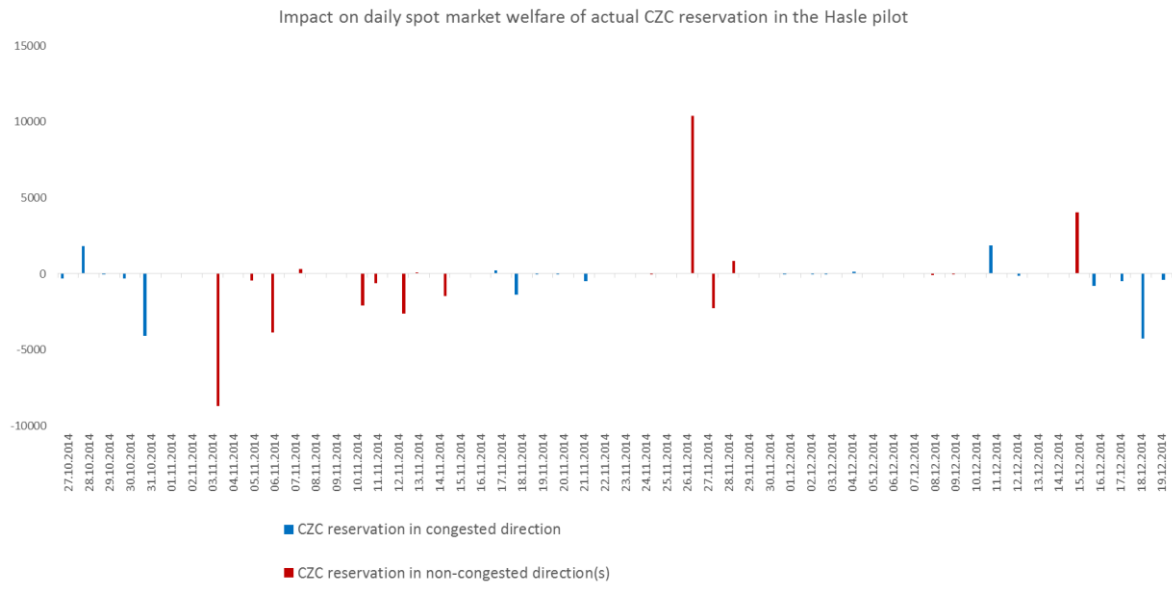
The NPS calculations rendered some counter-intuitive results, such as an increased value of the (daily) objective function despite reduced CZC available for the spot market (for one or more time blocks within the day). The reduction of

CZC means a tighter constraint or boundary condition, and in principle, such a limitation on the optimisation cannot increase the value of the objective function. There were also changes in the value of the objective function in response to CZC reservation that should not have any impact, i.e. when the CZC was not a binding constraint. This is the case when the reservation is done in the direction opposed to the actual flow or in the direction of the flow when there is spare CZC. In order to examine these counter-intuitive results, the calculations were rerun in a test environment that ensured the same performance and consistency as the spot market clearing. The repeated calculations also gave counter-intuitive results, to a lesser degree but spanning 40% of the days of Phase I.

It is evident from the simulation results that the market clearing is not always optimal. The market algorithm has 10 minutes to find a solution to a big and complex optimization problem, and it delivers the best solution that can be found within the time limit. Changes to input data that should not affect the optimal market solution such as reduced transmission capacity against the flow direction can lead the algorithm to a different solution. This implies that to a certain extent the variation in results cannot be explained by economic reasoning as it is caused by properties of the algorithm, the effect of which is impossible to predict.

As a sensitivity test, the calculations were rerun with more time for completion – 20 minutes instead of 10. The value of the objective function was equal or slightly higher for all days. The higher values for some days are attributable to better market solutions that cannot be calculated in just 10 minutes for these days.

The figure below shows the impact of the actual CZC reservations in the Hasle pilot on the value of the objective function of the day-ahead market optimization.If the algorithm found the optimal solution every time we would only see negative blue bars (negative impact of reservations in congested direction). The positive blue bars (positive impact of reservation in congested direction) together with the red bars (impact of reservation in non-congested direction) would not occur in the diagram. The figure indicates that the variation in impacts of the relatively small CZC reservations in the Hasle pilot is dominated by the unexplainable variation in the results caused by the shortcoming of the optimization algorithm. Although the unexplainable variation is relatively small compared to the value of the objective function, it may still be large in absolute value since the value reflects the social welfare of a large share of Europe's countries. As a comcequence it is more suitable to focus on the impact on market prices than the change in spot market welfare when assessing the impact CZC reservations in the Hasle pilot have on the elspot market.



Our conclusion is that the energy market prices and schedules are imperfect yet robust in the aggregate, and that it is beneficial to use CZC for automatic reserves at the expense of the spot market, when the CZC value is expected to be higher in the reserves market. However, the simulations indicate that when the price difference is high we can expect the impact of CZC reservation to have a larger impact on prices and this should be taken into account in the methodology for determing the CZC value of the spot market.

Summary of experiences from the Hasle Pilot

The two phases of CZC allocation for exchange of automatic reserves have shown the following:

- Coordinated procurement of reserves and allocation of transfer capacity is possible.
- Exchange of reserves based on an assessment of the alternative value of transfer capacity has a positive socioeconomic benefit; therefore, it is efficient use of transfer capacity.
- The conservative allocation of transfer capacity for automatic reserves realized half the potential efficiency gain. A better price forecast and a less conservative allocation of transfer capacity could increase the benefit further.
- The reserved transfer capacity had very little impact on spot prices in the studied period. However, the impact was bigger when the spot price difference was bigger.

References:

- The Hasle-pilot project: Market based transmission capacity reservation 27th of October 2014 to 19th of December 2014 (Evaluation after Phase I)

- Methodology and parameters for determining capacity reservation