How should a stop mechanism for the electricity certificate market be designed?

THEMA Memo 2018-02

About the project

About this memo

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Content

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THEMA Consulting Group is a Norwegian consulting firm focused on Nordic and European energy issues, and specializing in market analysis, market design and business strategy.

Background

Sweden and Norway have had a joint market for electricity certificates (elcertificates) since January 1st, 2012. This common market is based on the Swedish electricity certificate system, which has existed since 2003. The elcertificate market is a marked based support scheme. The target for the scheme has been to increase renewable energy production by a total of 28.4 TWh in the two countries combined from 2012 to the end of 2020, and thus contribute to the countries' targets in relation to the EU Renewable Energy Directive. The common electricity certificate market is an example of a so-called collaboration mechanism under the EU Renewable Energy Directive.

The theory underlying the elcertificate market is that with falling power prices, elcertificate prices should rise to provide sufficient revenues to allow wind to be built, i.e. covering the marginal Levelized Cost of Energy (LCOE) range of wind power. That however, has not happened. Instead, elcertificate prices have been lower and more volatile than expected and have followed the downward movement in the power market. The reasons have been the falling cost of wind power and the large surplus of elcertificates in the market.

In trust of the functioning of this system many invested early in Swedish wind (mainly local utilities, private investors and farmers rather than financial investors like today). These pioneer investors are the ones hit the most by the current low elcertificate prices.

In June 2017 Norway and Sweden signed an agreement allowing Sweden to unilaterally extend the elcertificate market with ten years and increased the investment target by 18 TWh to 46.4 TWh. The agreement between the two countries also states that Sweden must implement a mechanism to end the market, a so-called stop rule. The design of the stop rule must be in place by the end of 2020. To give the elcertificates back their initial purpose of making up the difference between the power price and the cost of wind power and thus to stabilize the cash flows of renewable power projects, it is important that the lawmakers design a stop rule that secures market stability and ensures trust to the market.

The Swedish government has instructed their regulator the Swedish Energy Agency to analyse and propose a stop mechanism. The regulator has been commissioned to analyse diverse options, including a volume based stop mechanism, and its advantages and disadvantages compared to the introduction of a date based deadline. Consequences for the market and the different market participants should be part of the analysis.

Both the Swedish Energy Agency and the Norwegian Water Resources and Energy Directorate has asked the market participants to present their views on the design of a stop mechanism. THEMA Consulting Group has thus initiated a multiclient study to investigate the effects of different stop mechanism. Participants in the study has been OBOS Energi AS, Nord-Trøndelag Elektrisitetsverk AS, TrønderEnergi AS, KGAL Investment Management GmbH & Co. KG and Aquila Capital.

The analysis presented in this memo is based on THEMAs inhouse developed elcertificate model including our wind database with more than 400 wind projects spread across Norway and Sweden modelled bottom up. A description of the framework used can be found in the appendix.

What has been studied?

THEMA has studied three different ways of ending the elcertificate market, and included some comments on the effects of a future market extension with an increased target. The analysed options are presented in Figure 1.

Figure 1 Analysed stop mechanisms

1 VOLUME STOP	▪ The opportunity to invest is closed when facilities with a normal year production of 46.8 TWh are online ▪ The stop rule might take effect any time between 2020 and 2046, but most likely before 2030
2 DATE STOP	▪ Investments must be completed before a certain date (most likely 31/12-2030) to be awarded elcertificates
3 VOLUME + DATE STOP	▪ When a certain volume is met, investor get a pre-specified time to complete investments ▪ Example: When 44 TWh is invested in, investors get 2 years to complete investments in order to be eligible for elcertificates
4 EXTEND MARKET	▪ The market is extended with an increased target

Volume stop

A volume stop can be implemented so that no more projects are awarded elcertificates as soon as projects with a normal year production of 46.4 TWh are online. The stop rule can take effect any time between 2020 and 2046, but with significant volumes already committed or being built and a large volume in the pipeline the target is expected to be met prior to 2030.

Date stop

A date stop can be implemented in the same way as is currently done in Norway, where all projects coming online by the end of 2021 are awarded elcertificates. As the new target for Sweden is to be reached in 2030 we have set the stop date to 31/12-2030 in the analysis.

Combined volume and date stop

A combination of a volume and date stop has been introduced by the regulator as a possible design of the stop mechanism. The combination is designed so that when certain volume is met, investor get a pre-specified time to complete investments. In our analysis we have assumed the volume to be 44 TWh and players investing one or alternatively two years after this volume is met are awarded elcertificates.

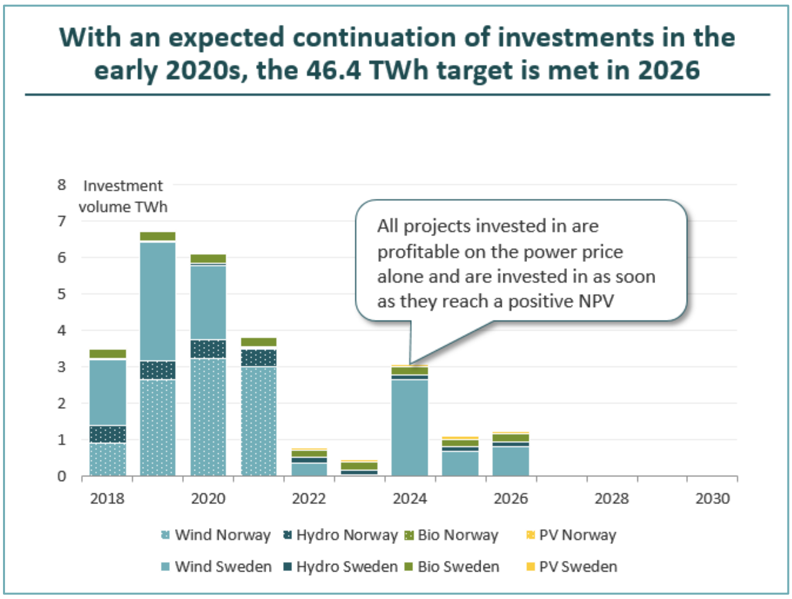
Market extension with increased target

Sweden might opt for extending the elcertificate market and increase the target again. The reasoning for doing so might be that some sort of support system is needed for the country to reach their target of being 100% renewable by 2040. Sweden has a history of extending the elcertificate market and increase the target. We have therefore also briefly discussed a market extension general terms without assuming a specific length of the extension or a specific volume increase.

Volume stop

There are large volumes coming online towards 2021 when the market is closed for investments in Norway. Most of these projects are already in the construction phase or an investment decision has been made. We assume that further projects are invested in as soon as they have a positive NPV valuated on the power price alone. When applying this assumption, the volume target of 46.4 TWh is likely to be met in 2026, 4 years ahead of the target date set by the Swedish government. The expected investment profile can be seen in in Figure 2.

Figure 2 Investment profile with a volume stop



In our modelling approach elcertificate prices will stay positive if there exist a probability of a future scarcity of elcertificates, i.e. that

P (banked elcertificates + produced elcertificates in year x ≤ demand for elcertificate in year x) > 0

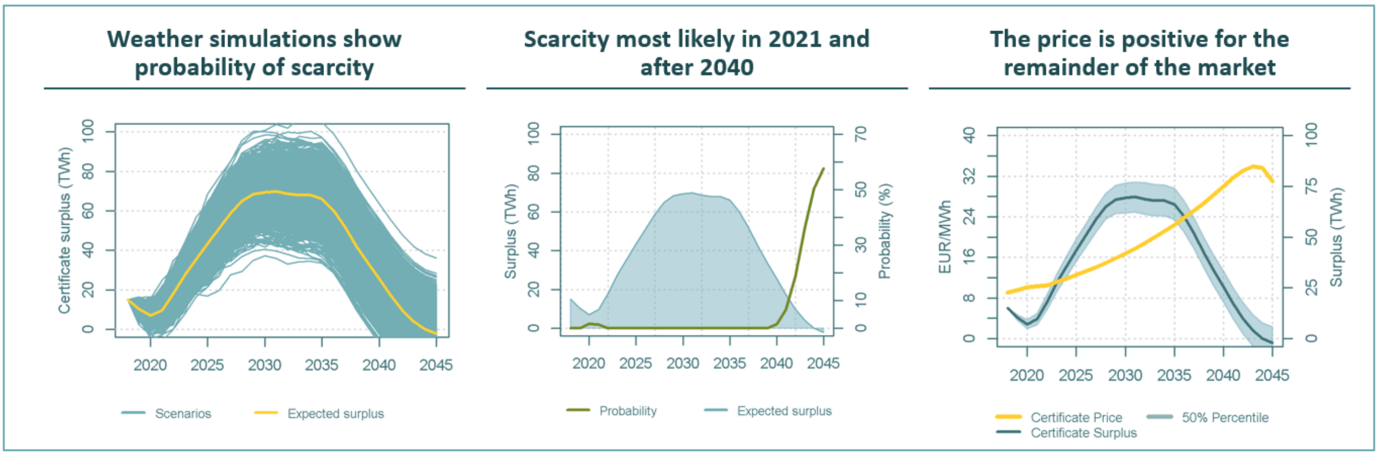
When applying this approach, it is not necessarily a problem that the target is met before 2030 if we apply a volume stop. The reason is that we might have a probability of scarcity in the future even when the target is met, resulting in a positive elcertificate prices.

As can be seen in the middle part of Figure 3 we will, given the investment path show in Figure 2, have a small probability of scarcity around 2020 and a higher probability of scarcity from 2040 onwards. The potential scarcity comes from two factors:

1) Investment profile vs. quota curve
2) Potential deviations from normal year production and consumption due to weather deviations (wind, precipitation and temperature)

Due to this probability of scarcity the elcertificate price stays positive all the way to 2045, as can be seen on the right-hand side of Figure 3.

Figure 3 Elcertificate surplus in different weather scenarios, expected surplus vs probability of scarcity, price vs expected surplus with a volume stop

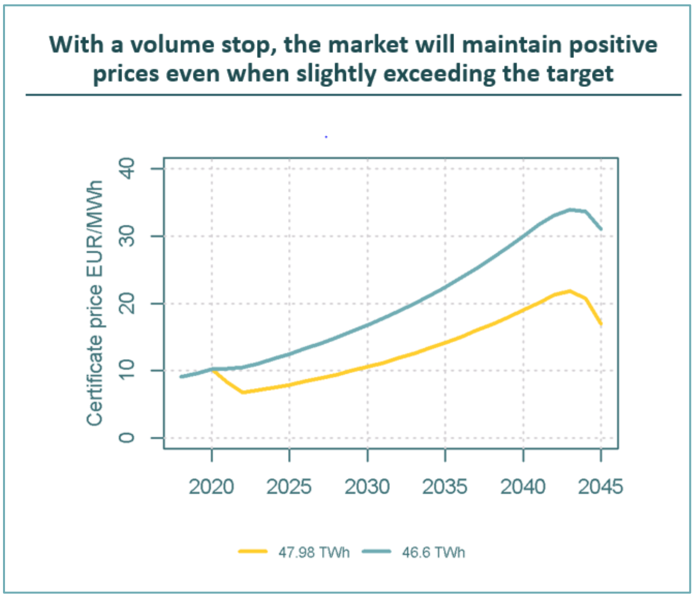


As we have showed, a volume stop is likely to result in positive elcertificate prices. To investigate how robust a volume stop is, we have also tested the volume stop rule with a slight overinvestment of 1 TWh. Reasons for such an overinvestment could be:

1) The last projects getting elcertificates might be large, so that normal year production exceeds 46.4 TWh
2) The government wants a slight overinvestment to be certain to have reached the target

If we overshoot the target by 1 TWh probability of scarcity around 2040 decreases, but stay positive. With a probability of scarcity elcertificate prices stay positive also in this scenario, as can be seen in Figure 4.

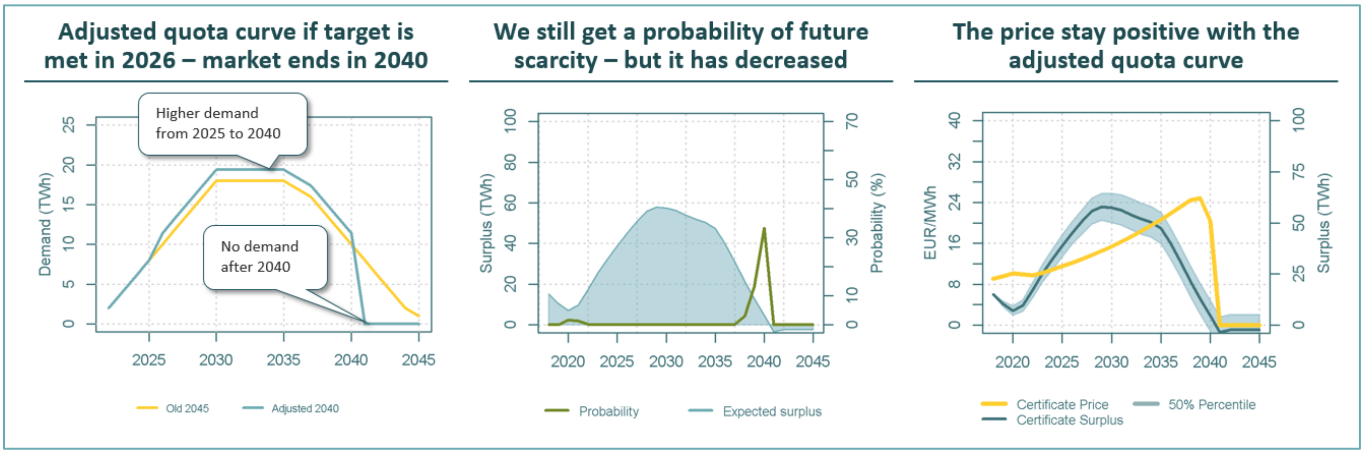
Figure 4 Elcertificate prices with a volume stop and various investment volumes



Adjustment of the quota curve with a volume stop

It can be argued that the market should be closed before 2045, if the volume stop takes effect before 2030, as the investors only get elcertificates for 15 years. As the target is met in 2026 in our analysis and we have also analysed a scenario where we adjust the quota curve so that there is no elcertificate demand beyond 2040. The volumes deducted in the 2040-2045 period is added with equal shares from 2025 to 2040, so that the total elcertificate demand stays unchanged, which is in line with current regulation. As can be seen in Figure 5 this scenario also yields a probability of scarcity around 2040 and positive prices for the systems entire lifetime.

Figure 5 Demand curve before and after adjustment, expected surplus vs probability of scarcity, price vs expected surplus with a volume stop



Based on the analysis we can conclude the following for a volume stop:

- The RES target will be met
- There will most likely be a probability of scarcity resulting in elcertificate staying positive (but not necessarily high)
- Price development is dependent on weather patterns, but is likely to stay positive given investment volumes close to the target
- The results shown are robust to
    - Changes to investment profiles
    - Small overinvestments
    - Liquidating the market 15 years after the final investment is completed

An additional point to be mentioned is that elcertificate prices might increase significantly in years with scarcity. How high prices can go is difficult to predict and difficult to capture in a model. Prices can skyrocket as buyers increasingly bid higher and higher to get the last elcertificate available. This will hurt consumers who must pay for elcertificates over their electricity bill. If prices go to extreme levels it might call for price stabilising measure to be introduced.

A volume stop can be efficient, but transparency must be improved

A key challenge with a volume stop is the uncertainty it poses for the investor when we are close to the volume target. When an investment decision is made the investor might not know if his project is likely to be among the first 46.4 TWh invested in and thereby be awarded elcertificates. We therefore think it is necessary to improve transparency by starting a prequalification process. With a prequalification process the investors will know before the investment decision is made if the project is awarded elcertificates. Some key questions should be considered when designing a prequalification process:

- Should investors be obligated to build if they are prequalified?
- Can investors decide not to build and let somebody else get the volume?
- Should there be a penalty if the investors withdraw their project after it has been prequalified
    - If so, how high should the penalty be?

It is essential that the rules are set out to minimise the potential for speculation and market abuse.

A summary of the effects of a date stop for different parties can be found in Figure 6.

Figure 6 Effects of a volume stop om different players

Investors

- There will likely be a probability of scarcity in one or more years:
    - Positive prices and investors will cover (some of) their capital costs
    - Some investors might loose money, especially those that invested early in wind power

Consumers

- There will likely be a probability of scarcity in one or more years:
    - Positive prices and consumer will have to pay for new RES
    - Danger of high prices in years with scarcity that will hurt consumers
        - Periods with scarcity likely not long lived

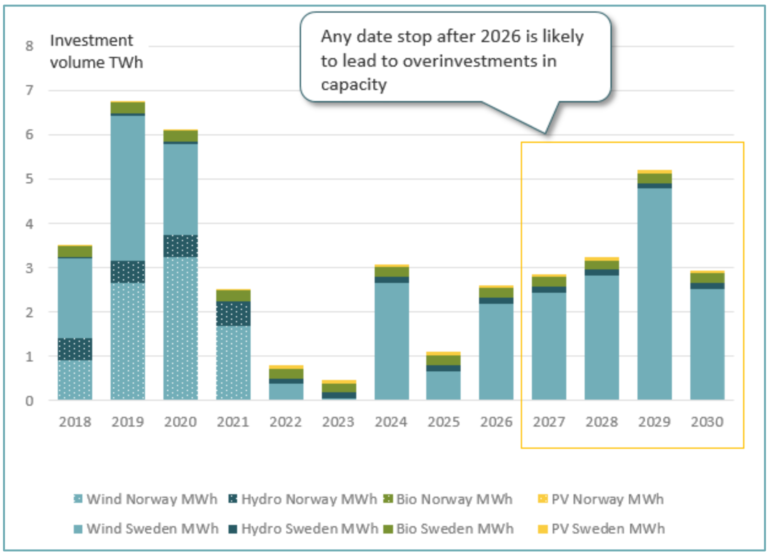
Government

- Target will be met and at a low cost compared to feed-in
- With scarcity prices might skyrocket hurting consumers
    - Government might intervene if prices stay **very high** for a **long time period**

Date stop

With a date stop it is possible to invest until a certain date. With the new target in Sweden being set for 2030 the regulator likely sets the date stop to 31/12-2030. With this date stop the target will likely be overshoot. As was showed under the analysis of a volume stop, the target of 46.4 TWh is expected to be met in 2026. If there exist projects with a positive NPV evaluated on the power price alone, more investments will be realized between 2026 and 2030 leading investments totalling 46.4 TWh, as can be seen in Figure 7.

Figure 7 Investment profile with a date stop shows target to be exceeded

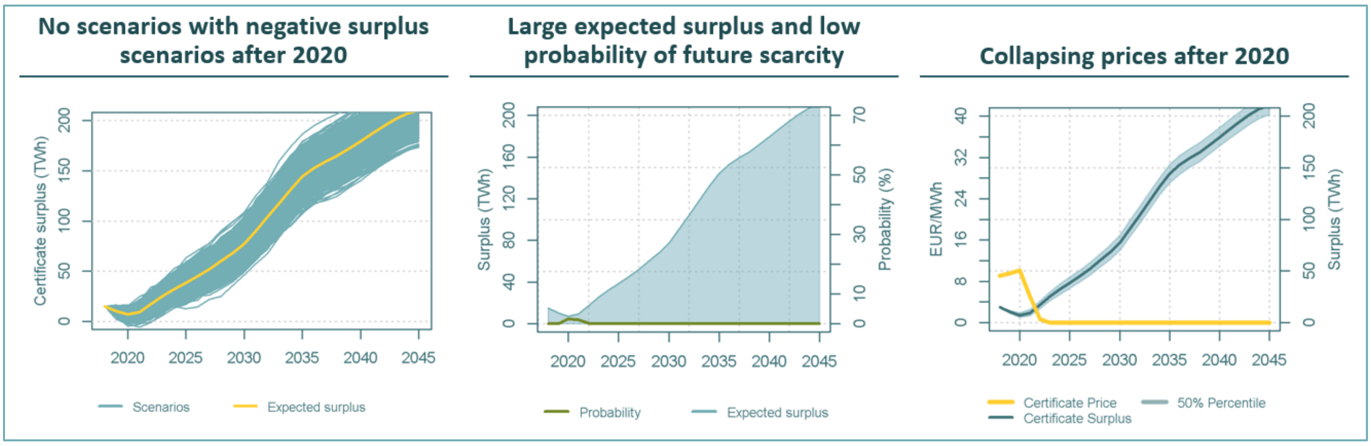


How far above the target we will be in 2030 is dependent on[1]:

1. How fast wind power cost decreases – we have assumed a yearly cost decrease of 0.95% in this analysis
2. How power prices develop in the long term – we have assumed power prices to gradually increase from 2020 onwards, reaching 38 EUR/MWh in 2030 and 41 EUR/MWh in 2040

Based on the assumptions above we do not get any scenarios with a probability of scarcity beyond 2020 if we apply a date stop in 2030. The elcertificate market will therefore collapse shortly after 2020 as the market participants see that the probability of scarcity disappears.

Figure 8 Elcertificate surplus in different weather scenarios, expected surplus vs probability of scarcity, price vs expected surplus with a date stop



[1] Please note that under different assumptions for example:

1. The costs decrease in capex is eaten up by even faster increase of interest rate levels, i.e. an increase in the financing costs
2. Power prices stay low

the target might not be met, leading to scarcity in many years resulting in a lengthy period with potentially very high prices hurting consumers

We can conclude the following for a date stop:

- A date stop will most likely lead to the target being significantly overshoot with no probability of scarcity beyond 2020
  - Under different assumptions we could also end up with investments below the target
- A date stop will lead to elcertificate prices potentially going to zero, or alternatively very high

A summary of the effects of a date stop for different parties can be found in Figure 9.

Figure 9 Effects of a date stop om different players

Investors	**Consumers**	**Government**

▪ With falling cost for RES and potentially higher power prices, overinvestment is very likely
▪ With a significant overinvestment there is no probability of scarcity even in dry years with little wind
  ▪ Prices approach zero
  ▪ Investors relying on positive elcertificate prices will not get their capital cost covered
▪ Under different assumptions, i.e. that cost of RES increases and/or power prices stay low the target might not be reached
  ▪ Prices skyrocket
  ▪ Investors get a very high income
	▪ With an overinvestment with no probability of scarcity consumers are left better off as they do not need to pay for getting more RES into the
	▪ With too low investments and a long period with scarcity, consumers are left worse off as elcertificate prices might be very high increasing the cost for consumers
		▪ Target will most likely be met and at a low cost compared to feed-in
		▪ With no scarcity investors investing in the early years of the market might get into financial problems
		  ▪ Government can blame the investors who did “bad” investments
		▪ Under different assumptions the target might not be reached, prices go very high and consumers are left with a high bill

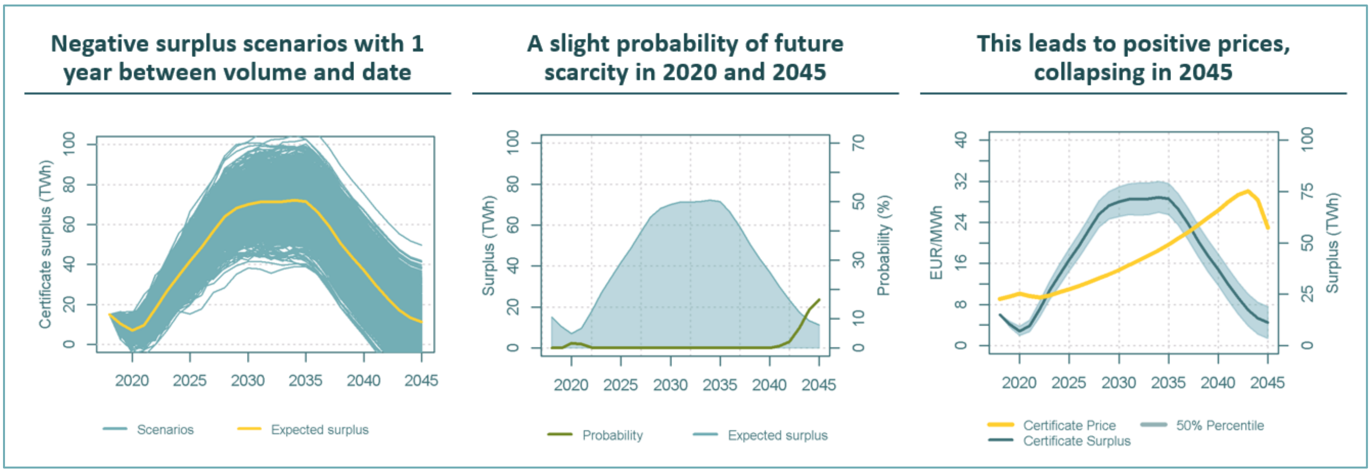
A combined volume and date stop

A combined volume and date stop is assumed to work in the following way:

1. A volume is decided (in our analysis we have assumed 44 TWh)
2. When investments reach the predefined volume, investors get a certain time period to complete further investments (in our analysis 1 or 2 years)

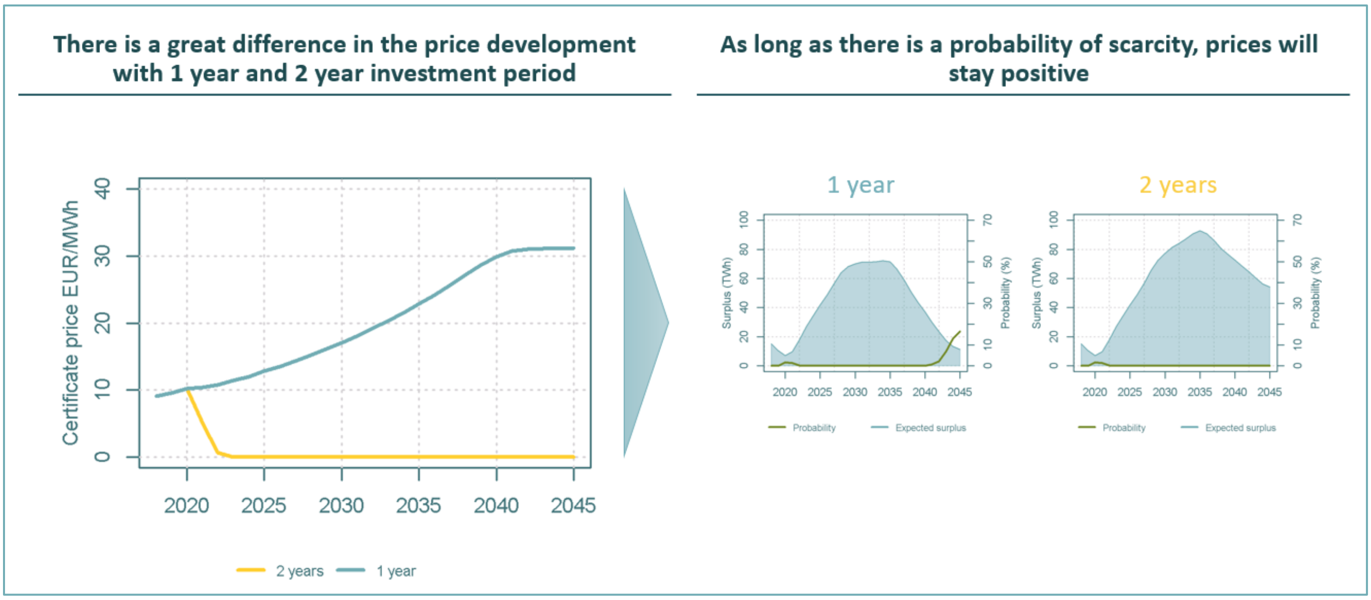
The 44 TWh target will likely be met in 2025. When the predefined volume is met, the key question is how long time period investors get to complete further investments. If the period is too long we would likely see an investment rush with total investments going above the target. In the first example below, we have assumed a 1-year period from the volume stop is met to the market is closed for investments. In this case we get a probability of scarcity in the later years of the system resulting in positive elcertificate prices.

Figure 10 Elcertificate surplus in different weather scenarios, expected surplus vs probability of scarcity, price vs expected surplus in the case with a combined volume and date stop



If we instead assume two years between the 44 TWh volume is met and date stop we will most likely get an overinvestment and collapsing prices as a result. This is shown in Figure 11. We have in this analysis assumed no lead time on investments and investments coming into the market as soon as they have reached a positive NPV evaluated on the power price alone. Hence, on could conclude that if the time between the predefined volume is met and date stop is too long we will overshoot the target and elcertificate price might collapse.

Figure 11 Price development with 1 and 2 years between 44 TWh is met and market is closed for investments, expected surplus and probability of scarcity in the two scenarios



We can conclude the following for the case with a combined volume and date stop:

- With a combined volume and date stop the time between the volume stop is met and the market is closed for investments will determine if we get to little or too much investments
- If the time period is too long the elcertificate price might collapse irrespective of weather patterns
- If the time period is too short the elcertificate price might skyrocket as the market might be short

A summary of the effects of a date stop for different parties can be found in Figure 12.

Figure 12 Effects of a combined volume and date stop om different players

Investors

- Depending on the length of the time period after the volume is met there might be too little or too much investments
- With a significant overinvestment there is no probability of scarcity even in dry years with little wind
    - Prices approach zero
    - Investors relying on positive elcertificate prices will not get their capital cost covered
- With too little investments there will be scarcity in most years
    - Prices skyrocket
    - Investors get a very high income

Consumers

- With an overinvestment with no probability of scarcity consumers are left better off as they do not need to pay for getting more RES into the
- With too low investments and a long period with scarcity, consumers are left worse off as elcertificate prices might be very high increasing the cost for consumers

Government

- Target might or might not be met
- With no scarcity investors investing in the early years of the market might get into financial problems
    - Government can blame the investors who did “bad” investments
- If the target is not met, there will be scarcity in many years, prices go very high and consumers are left with a high bill

Market extension

Swede has never considered a stop rule as the preferred option has been to increase the RES target and extend the market. With the Swedish government having a RES target of 100% in 2040 one might think that they also this time would extend the market. A further market extension would likely lead to elcertificate prices going to zero. How fast it would happen would depend on how fast the wind power cost fall and if we are to see increasing power price. For new investors with low cost projects the development will likely not mean too much, while for earlier investors the price fall will hit their profitability.

Summing up

We have analysed four different alternatives for the stop rule. Based on the analysis it seems clear that a volume based stop rule is the only option securing stable market conditions and re-establishes trust in the elcertificate market. We do however also recommend that some sort of prequalification process is established so that investors know if the will be awarded elcertificates at the time the investment decision is made.

If a date stop or a combination of a volume and a date stop is chosen we will see an unstable market where prices could collapse or alternatively skyrocket.

Figure 13 Conclusions

Four Alternatives are Analysed and Volume Stop Combined with Transparency Measures is the Preferred Option

	PRO	CON	ADDITIONAL MEASURES NEEDED	CONCLUSIONS
1 VOLUME STOP	▪ Target is met ▪ No overinvestment ▪ Most likely positive prices ▪ Relatively stable price development expected	▪ Difficult for investors to know when target is likely to be met (will I or will I not receive certificates) ▪ Potentially very high prices in single years in case of scarcity	▪ Transparency measure: ▪ Database with prequalified projects	✓
2 DATE STOP	▪ Easier for investors to know if they are eligible for elcertificates	▪ Large probability of overinvestment ▪ Unstable prices most likely going to very low levels at an early point in time ▪ We could also get too low investments with very high prices	▪ Price stabilising measures might be needed ▪ End up with a feed-in tariff	✗
3 VOLUME + DATE STOP	▪ Gives more transparency than a pure date stop	▪ Target might or might not be met ▪ Unstable prices going to very low or very high levels ▪ Complicated mechanism	▪ Price stabilising measures might be needed ▪ End up with a feed-in tariff	✗
4 EXTEND MARKET	▪ A smoother end to the system? ▪ Sweden has an ambitious long term RES target	▪ Wind reaches grid parity – no need for elcerts ▪ Zero prices hurting those investing «early» ▪ Compatible with agreement with Norway?	▪ Price stabilising measures might be needed ▪ End up with a feed-in tariff	–

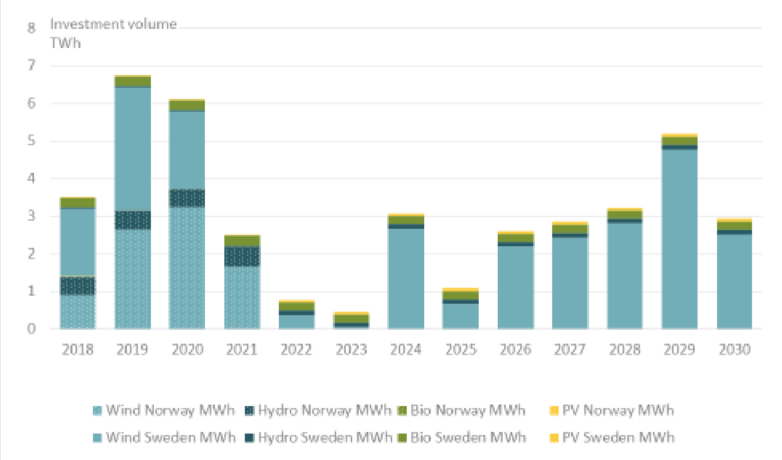
Appendix - methodology

THE METHODOLOGY INCORPORATES FUTURE UNCERTAINTY IN THE CERTIFICATE SUPPLY

Approach	All projects are built as soon as they have a positive NPV based on the power price alone	Scenario generation based on variability of wind, precipitation and temperature	Option pricing
Result	Expected RES buildout	Probability of scarcity	Certificate price

PROJECTS ARE BUILT AS SOON AS THEY HAVE A POSITIVE NPV

EXPECTED INVESTMENTS

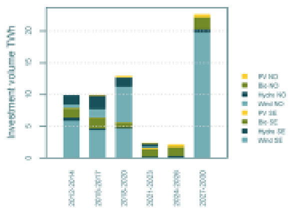


METHODOLOGY

- THEMAs project database containes 400 wind power projects modelled bottom up
- All projects are built as soon as they have a positive NPV based on the power price alone
- Resulting in an expected build out as depicted

MONTE CARLO SIMULATIONS ARE USED TO GENERATE SURPLUS SCENARIOS, CONSIDERING THE UNCERTAINTY OF FUTURE GENERATION AND DEMAND

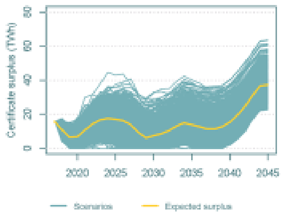
The fundamental model provides the expected RES buildout



Optimal buildout of wind combined with expected capacities of hydro, bio and PV

- Fundamentally sufficient to cover the certificate demand

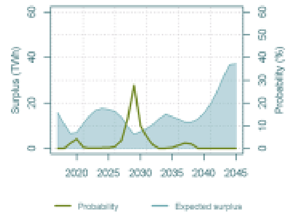
Scenarios with varying generation and demand form different surplus trajectories



Monte Carlo simulations of generation and demand

- The standard deviations of the different production types and electricity demand provide scenarios for different weather years

The scenarios determine the probability of a future scarcity



Probability of a future scarcity

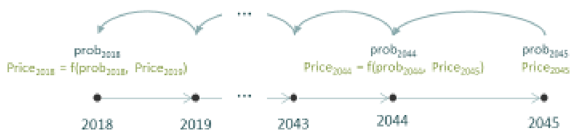
- The probability of a future scarcity in certificates is determined by the share of scenarios that experience a certificate shortage

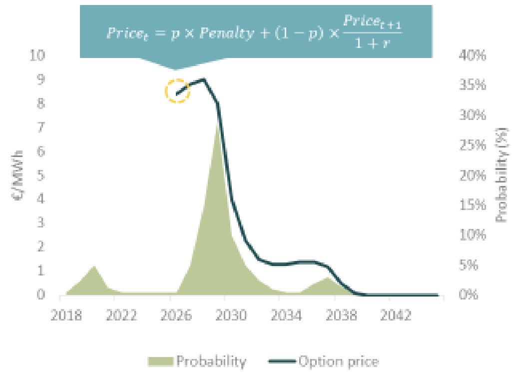
Source: THEMA price forecast fall 2017

THE CERTIFICATE PRICE IS CALCULATED AS THE OPTION VALUE OF BUYING A CERTIFICATE VERSUS PAYING A PENALTY

The price is calculated backwards as the weighted sum of the penalty and discounted price in the next step

- The price in each year is calculated as the sum of
  - The penalty multiplied by the probability of a scarcity in that year
  - The discounted certificate price of the year after, multiplied by the probability of there not being a scarcity in that year





Source: THEMA price forecast fall 2017