## ENGLISH SUMMARY OF THE REPORT

There are major changes happening on the power production side. As we all know renewable energy is increasing and replacing traditional energy sources in all of Europe. A considerable part of the new renewable energy is variable, like wind and solar. In addition, smaller-scale, local, distributed energy resources are growing and communities and homes have the opportunity to provide their own electricity. All these variable, unpredictable, renewable power sources influence the power grid and the markets. Some consequences are imbalance between demand and supply, which leads to overload and bottlenecks in the grid, which again lead to imbalance costs and potential big investments in expansion of the grid. To avoid this, the demand side responses with some possible solutions. New players, like aggregators, and new technology establishes itself in the power market to manage customer flexibility and demand response. The theoretical potential for demand side flexibility in the Nordics is estimated to be up to 12.000 MW[1]. In addition to the socio-economic benefit with increased use of renewable energy and demand response, the actors in the power market will individually gain from utilization of demand side flexibility.

Firstly, the end user (household or industry) will be able to reduce their energy cost through energy management and implicit response to electricity prices or grid tariffs. In addition, the end-user can receive some sort of compensation for making their loads available in the power market and an additional compensation for actually dispatching their loads in the markets. The smart service providers and aggregators facilitate and give the end users the opportunity to participate in the market with load flexibility, and will take their profit from this. Both the energy suppliers, which has balancing responsibility, and the producers will reduce their risk for imbalance costs by trading on imbalances close to real time in Intraday or other balancing markets. Intraday and balancing markets will have more reserves available when more demand resources participate in the markets. The DSOs could be able to handle local capacity challenges and bottlenecks in the grid, and in the long term postpone investments in the grid though utilization of demand flexibility. Flexible loads can increase competition in the capacity reserve market, which will force more effective and optimal system operations for the TSO and ensure security of supply.

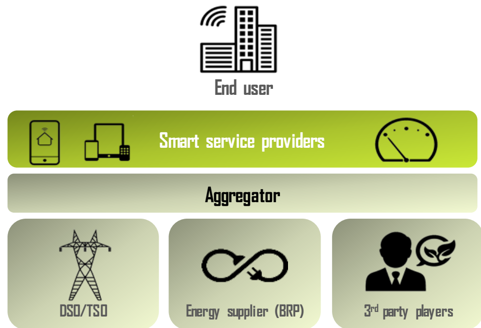
Through smart services and products, and the customer's approval, the aggregator can aggregate flexibility and sell it in the market on behalf of its customers. The aggregators portfolio can consist of loads, production units and storage units. The aggregator will allocate this portfolio in the power markets.

So, who is the aggregator? We have looked in to several scenarios where the aggregator role is taken by either the DSO/TSO, Energy supplier/BRP or a 3rd party player:

- DSO or TSO as an aggregator comes with issues on neutrality and will not provide a competitive market with competitive prices, given their monopoly situation.
- A 3rd party player, on the other hand, will provide competition and facilitate innovation in business models and services, but can be complicating when it comes to balancing settlement. There needs to be an agreement between the balancing responsible energy supplier and the aggregator with regard to the balancing settlement and who is entitled to the profit from flexibility trade.
- The simplest, and what we have concluded with, the best, solution is an aggregator that is integrated with the balancing responsible energy supplier. NordREG[2] also recommends this model in the Nordics and believes that there is enough competition in the Nordic end-user market to only have one balancing responsible per customer, and the model is easier to implement in existing markets.

[1] Nordisk ministerråd/Thema Consulting (2015), Capacity adequacy in the Nordic electricity market

[2] NordREG (2016), Discussion of different arrangements for aggregation of demand response in the Nordic market – February 2016, http://www.nordicenergyregulators.org/wp-content/uploads/2016/02/NordREG-Discussion-of-different-arrangements-for-aggregation-of-demand-response-in-the-Nordic-market.pdf

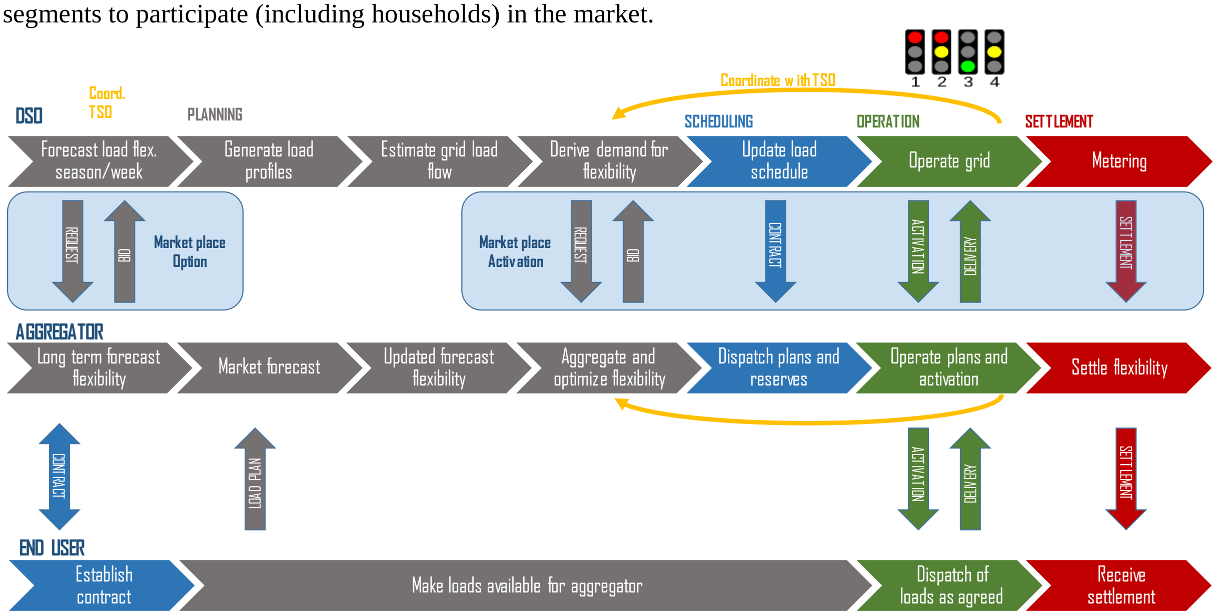



We have looked in to different compensation models between the end user and the aggregator. The compensation model will depend on the customer and the customers marginal cost for dispatching the load and we have proposed profit-sharing model for large consumers and fixed fee contracts for households.

The aggregator will then allocate the flexibility from the end-users to the most profitable market. Today we have spot, intraday and the reserve market:

- The aggregator could place price-dependent bids in the spot market. These bids will only be activated for the price the aggregator or the customer finds it optimal to activate the flexibility.
- In the Intraday market the participants can trade flexibility to optimize their balance close to real time. The aggregator can place bids with their customer's flexibility close to real time here. The Intraday market is not designed for the DSO to participate because the pricing areas are not fit to the grid areas. If the DSO is to buy reserves in the Intraday market, the bids must contain geographic information regarding which grid area the reserve is in, and preferably even more detailed information about the resource to handle local bottlenecks.
- In the reserve markets the TSO buys reserves to regulate imbalances in the grid. Today, this market is a single-buyer market, where the TSO is the only buyer and most of the activated reserves are from the production side. If the aggregator and the DSO wants to trade flexibility on the reserve market, there are still some barriers that makes it difficult for the aggregator and the DSO.
    - There is a minimum bid size of 10 MW in today's reserve market, and this presents a barrier for the aggregator; both in attaining such a big customer portfolio and being able to deliver that large bids.
    - Todays reserve market also has difficulties with aggregated bids, because they have to split them up and identify each load, which is a time consuming process, and could lead to not choosing these bids.
    - Activation of tertiary reserve is still done by telephone from the TSO, and is a manual process, which gives the TSO incentive to choose larger bids, that are not aggregated, and preferably call directly to the customer, to ensure the delivery.
    - The same geographical issue for the DSO appears in the reserve market, the DSO needs more detailed geographic information regarding the reserve to buy it.
    - Baseline calculations of the settlement to the end user is difficult, because we don't know what that specific customer was supposed to consume
    - Some of the markets require symmetrical bids. This makes it difficult for the consumption side to participate unless you have energy storage to rely on.
    - Duration of different products is also an important parameter that should be taken into consideration. Shorter products like 15 minutes will open access to far more reserves when many industrial loads represent much flexibility in a shorter horizon than 1 hour.
    - Smart meters and documentation of activations for each load is necessary, and will be possible with smart meters.
    - Lack of prequalification procedures is one of the biggest barriers for the consumption side in the reserve market. With a prequalification scheme the TSO must set requirements for technical solutions both through verification and validation of solutions and business processes before a player is prequalified.
    - The customer is not sufficiently exposed for price signals or variations today

Given these barriers, we have recommended to establish local DSO flexibility markets to handle trade of more local flexibility reserves[3]. It is mainly the need for a capacity option market for the DSO that makes local DSO flexibility markets a preferable model. This model will also make it possible to design products that allow all customer segments to participate (including households) in the market.




With local DSO flexibility markets, the DSO can buy flexibility from an aggregator, that manages the flexibility for its customers. Our recommendation is that this is a centralized market place with local market places for each DSO.

- The idea in this model is that the end-user and the aggregator establish a contract where the aggregator is allowed to dispatch their loads for a compensation. The aggregator forecast flexibility available and places bids in an option market place, like todays reserve option market. The buyer of this option-bid is the DSO in the given grid area. The DSO will, at the same time, generate load profiles and estimate needed flexibility.
- If the bid is activated by the DSO, the aggregator will activate the load dispatch from its customers as agreed. This model requires coordination between the TSO and the DSO. Eurelectric[4] has proposed a traffic light coordination between the TSO and the DSO, where for instance the DSO can block planned activations from the TSO, if this creates problems for the DSO. And vice versa.
- The DSO compensates the aggregator and the aggregator compensate the end-user.

Given the small degree of competition on the one-buyer market, the price on the bids could be connected/linked to the existing reserve market or a centralized DSO market place.

There are still some unanswered questions regarding this model, and our recommendation is to try this out in a pilot.

[3] iPower (2013), FLECH: Flexibility Clearing House Specifications, part of iPower project, http://www.google.no/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwiQ8eaS0dnKAhUKWCwKHZutDjQQFggIMAA&url=http%3A%2F%2Fwww.danskenergi.dk%2F~%2Fmedia%2FAnalyse%2FProjekter%2FiPower%2FFLECH_Technical_Requirement_Specifications.ashx&usg=AFQjCNHAG8XQYsU6-4hQ8faDkiTPBl7yPw&sig2=P-S0Ih9mOYsMOq21CiDVSQ

[4] Eurelectric (2013), Active Distribution System Management, http://www.eurelectric.org/media/74356/asm_full_report_discussion_paper_final-2013-030-0117-01-e.pdf