one network for Europe

Project execution in practice (Northeast Flow Oy)

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About OneNet

The project OneNet (One Network for Europe) will provide a seamless integration of all the actors in the electricity network across Europe to create the conditions for a synergistic operation that optimizes the overall energy system while creating an open and fair market structure.

OneNet is funded through the EU's eighth Framework Programme Horizon 2020, "TSO – DSO Consumer: Large-scale demonstrations of innovative grid services through demand response, storage and small-scale (RES) generation" and responds to the call "Building a low-carbon, climate resilient future (LC)".

As the electrical grid moves from being a fully centralized to a highly decentralized system, grid operators have to adapt to this changing environment and adjust their current business model to accommodate faster reactions and adaptive flexibility. This is an unprecedented challenge requiring an unprecedented solution. The project brings together a consortium of over 70 partners, including key IT players, leading research institutions and the two most relevant associations for grid operators.

The key elements of the project are:

1. Definition of a common market design for Europe: this means standardized products and key parameters for grid services which aim at the coordination of all actors, from grid operators to customers;
2. Definition of a Common IT Architecture and Common IT Interfaces: this means not trying to create a single IT platform for all the products but enabling an open architecture of interactions among several platforms so that anybody can join any market across Europe; and
3. Large-scale demonstrators to implement and showcase the scalable solutions developed throughout the project. These demonstrators are organized in four clusters coming to include countries in every region of Europe and testing innovative use cases never validated before.

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List of Abbreviations and Acronyms

Acronym	Meaning
NEF	Northeast Flow Oy
kW	Kilowatt
REST	Representational State Transfer
API	Application Programming Interface
MQTT	Message Queuing Telemetry Transport

Executive Summary

Northeast Flow Oy (NEF) retrofits air-cooled computing units with its own water-cooling blocks and uses them to provide its customers heating as a service. This can be seen to halve the energy consumption in the combined sector of heating and computing. Linking these two sectors together also creates an interesting opportunity to bring more heating into the capacities of demand side response. NEF's goal in this OneNet-project is to demonstrate its first-generation digital heating solution's capability in the flexibility markets, so that it is viable technically and financially. The project plan consists of getting familiar with the protocols used for data transferring, programming an operating logic and a weather forecast used for estimating future consumption. If successful, it would become a permanent part of NEF's service offering.

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1 Execution in practice

Northeast Flow has gotten familiar with the different preferred protocols used for transferring data between NEF's computing units and the flexibility aggregator (Enerim). The first priority protocol given from the aggregator side was MQTT with its constant streaming capabilities, but after taking a deeper look into what it needs NEF found out that it would need quite a lot of work and coding to get this type of implementation working with NEF's current system and resources available for this project. This would risk getting to the main objectives in the set deadlines, since the project has a strict time frame of six months and the hands-on iteration & bug-fixing on the practical level is time consuming. Furthermore, the second option given by the aggregator was plain REST-API calls which was seen to be more compatible with NEF's current setup, thus being easier to implement and also more in line with the tight schedule. This is why NEF has decided to go with the REST-API calls, and if there is excess time found during the execution phase or the remaining half of the project, NEF could use it to develop the node needed for MQTT-protocol.

In addition to the data transfer protocols Northeast Flow has of course also familiarized itself with the different points of data that is being exchanged between the flexible resource and the aggregator (*Figure 1.*). The points consist of different parameters and threshold values regarding the flexible resource e.g., maximum power and a few different delays from receiving & handling messages, to full activation of the ordered flexibility. The last section of the transferred data consists of the consumption forecast of the flexible resource and how much of it can be used for providing flexibility each hour. This information then gets polled by the aggregator at least once every hour, to keep them up to date about the current situation. The activation of flexibility happens with a command from the aggregator, which first gets double checked by NEF's software and is then executed (*Figure 3. – operation logic*), given that it has surpassed set threshold values.

Making the consumption forecast is going to be a little more challenging, since NEF is going to use a new site for this demonstration, but NEF has decided to use consumption data gathered from its other sites as a guidance. This should be an accurate enough reference for starters given the similar sizes of the buildings. There is going to be new data coming in continuously from the new site however, and we can expect an improvement in the accuracy of the forecasts during the project.

During the month of October, Northeast Flow installed 24kW of its computing-heating devices *(Figure 2.)* in the new premises located in the Southeastern part of Finland, Kotka, which is going to be the site for demonstration as stated earlier. It was chosen because it provided an opportunity to make a fresh installment of software for new devices, making it an optimal test bench. After getting some user experience from this site, NEF will be able to fix the shortcomings in the first version of software and iterate it to a bug-free condition, which is presumably the most time-consuming part. The next step would be to extend and install this newer

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version with the flexibility-function to NEF's other sites as well, maybe even in the span of this project if all goes well. The goal is to get first tests with activation commands coming from the aggregator during the month of December (2022).

Flex resource basic data
Resource identifier in resource owners system
Flexible active power
Flexible reactive power
Activation preparation delay
Activation ramp up delay
Time to full activation from activation
Deactivation delay
Minimum activation duration
Maximum activation duration
Activity status - if false then activations are not sent
Metering point number from DSO contract
Resource type

Measured consumption
Resource identifier in resource owners system
Frequency of measurement
Load
Time

Flexibility forecast
Resource identifier in resource owners system
Frequency of measurement
Baseline: forecasted load of resource if current control plan is followed
Down flexibility potential
Up flexibility potential
Allocated flexibility
Time that this this prediction concerns

Figure 1. – List of data from the flexibility resource.

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Figure 2. - NEF's digital heating devices installed in Kotka (three units). One unit is approx. 8 kW electric power.

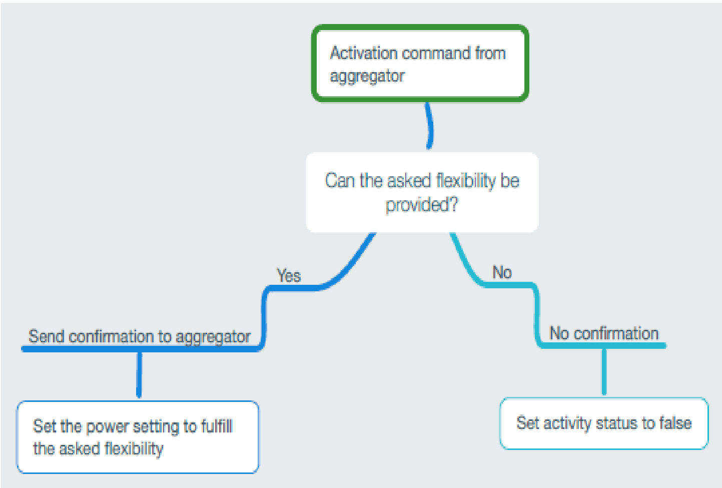

Figure 3. – Operation logic after receiving activation command

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2 Project plan

Electric heating provides an exceptionally flexible load from the grids' point of view. Buildings themselves store heat well, and short pauses in heating with a duration of minutes or even hours have next to no effect on the living conditions, thus being able to go unnoticed.

NEF's digital heating is currently capable of adjusting the units' heat production according to the building's needs and in this project, NEF wants to integrate a capability of adjusting the heat production according to the grid's needs too. This project would also provide solid groundwork for building a tool for smart optimization for heating using weather forecasts.

The impact would be for NEF to be able to use their future sites to provide flexibility to the grid, which could amount to the size of multiple megawatts long-term. NEF also thinks that providing flexibility could increase the competitiveness of digital heating. The measurable indicators should include the amount of flexibility load NEF can provide yearly, and the reduction of CO_2-emissions of heating. The revenue and economic impact from providing flexibility should also be measured.

The service model of NEF is especially well suited for this purpose since it allows easy integration to new buildings (heating customers). Essentially, NEF has solved all investment and installation troubles, and is able to offer to customers an easy to enter heating agreement, where the NEF takes care of the required investment and installation, and the customer will just benefit of reduced costs and reduced emissions. This can be measured by the number of target buildings, the heating power transferred to digital heating, and the achieved cost & emission reductions. The ability to offer flexibility to electricity networks with a growing number of heating targets.

Heating is traditionally seen as a non-flexible energy consumer, being at the same time one of the largest energy consumers. The heterogeneity of heating systems, and lack of abilities to control heating digitally makes it currently non-flexible. With the service model of NEF, non-flexible heating could become the best flexibility provider for electricity networks.

The following table gives an overview of the project plan:

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Task No	Task Title	Start month	End month
T1	Beginning communication	June	June
T2	Data collecting	June	Decembe r
T3	Client workshop	November	November
T4	Summary/Ending analysis	December	December
T5	Familiarization in the data transfer protocols used in flexibility market	June	June
T6	Programming the operation logic for providing capacity in the flexibility market	July	August
T7	Testing in practice	September	December

Figure 2.1 T1 – Done, T2 – Ongoing, T3 – Planned March, T4 – Planned March, T5 – Done, T6 – Done, T7 – Planned February

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3 Impact on OneNet and the general European Energy system

The impact on the European Energy is twofold: Firstly, using computing to produce heat decreases the total energy consumption and secondly, steering this load intelligently can help the grid during peak hours or other situations where flexibility is needed.

There is a major trend in electrification of everything, because of the need to get rid of CO2-emissions, and heating is not an exception in this matter. Heating is a major consumer of energy in the Nordic countries. In Finland space heating was 27% of final energy consumption in year 2021 [1] and is traditionally seen as non-flexible consumer, partly because the heating systems are not controlled digitally and/or intelligently. Buildings also work well as storages for heat and short breaks in heat production of minutes and even hours can easily go unnoticed. Demand for computing power will most likely only keep rising for the decades coming [2] and a new trend in edge computing is also developing. Edge computing is further bringing the computing closer to the source of data, which is beneficial for Northeast Flow's approach of building a distributed data center. Heat is a byproduct of computing, and therefore it only makes sense to combine these two markets by replacing existing and new heating needs with computing power, so that it doesn't increase the total energy consumption.

Electrification of everything with a goal to reduce CO2-emissions means new renewable production connected to grid. New renewable production in the Nordics means mostly wind power, and to keep the grid in balance at 50Hz it helps if there are more flexible resources around. This is where NEF can be of value for OneNet-project as well, providing more flexible resources and finding new innovative ways to introduce flexibility to the consumer side.

4 References

[1] Official Statistics of Finland (OSF): Energy supply and consumption [online publication]. Reference period: 31.12.2021. Helsinki: Statistics Finland [Referenced: 7.12.2022]. Access method: https://www.stat.fi/en/publication/cl1p3puxx03j90cum3pwyy2k5

[2] Andrae, A.S.G.; Edler, T. On Global Electricity Usage of Communication Technology: Trends to 2030. Challenges 2015, 6, 117-157. https://doi.org/10.3390/challe6010117

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