



# Flex4RES

Flexible Nordic Energy Systems



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Nordic Energy Research

A successful transformation to a carbon neutral energy system, governed by the ambitious Nordic and European climate and energy goals, requires further coupling of energy markets and more flexibility in the energy system in order to minimise the integration cost of variable renewable energy such as wind power and photovoltaic.

There are comparative advantages of combining different energy markets in the Nordic-Baltic region, both with respect to flexibility, but also with respect to synergy and economics.

#### **Higher Flexibility by Better Market Coupling**

So far the Nordic power market is well functioning despite a few technical challenges. With the right coupling to the underlying national and local energy markets for heat, gas, and transportation, the hypothesis is that enough flexibility can be generated in a cost efficient way and so embrace a larger amount of variable renewables.

*“It is very attractive to utilise the high flexibility potential of the region’s thermal-hydro power production mix. There is also a significant po-*

*tential to be realised through better coupling to the district heating systems. For example, during a ‘high-wind’ period, where power-to-heat technologies (heat pumps and electric boilers) can convert electricity to district heating that can be used directly or even stored for later use”, says Klaus Skytte, DTU, project manager of Flex4RES.*

Flex4RES considers all Nordic and Baltic energy systems, as these are linked through the common power market. The inclusive approach creates the basis for efficient competition between flexibility providers in and between all areas.

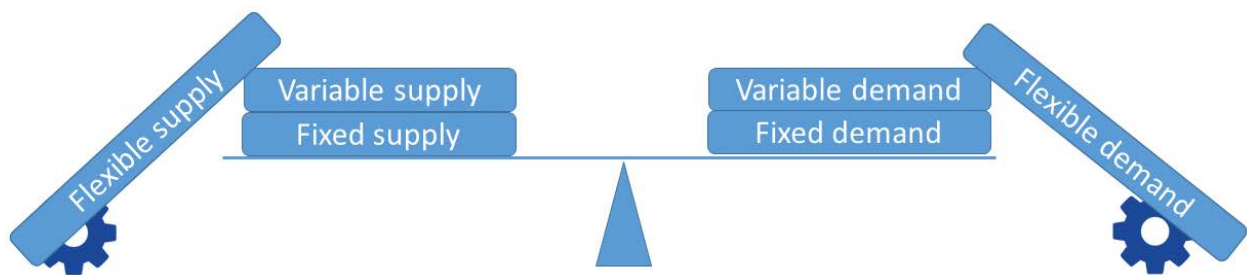
#### **Utilise Regional Synergies**

The Nordic and Baltic countries differ with respect to technology mix, the need for flexibility and the framework conditions at the regional and local level.

Flex4RES uses this heterogeneity to find synergies and best practises, and to identify barriers that hinder efficient interaction between sectors and to develop new regulatory framework, market designs and policy recommendation.

#### **Flexibility definition**

In Flex4RES, flexibility is defined as a measure to keep balance between generation and consumption of electricity, since the variability in generation and in consumption is to be balanced in flexible supply and flexible demand. I.e., electricity supply or demand is considered flexible when it is possible to regulate the increase or the decrease of the generation or the consumption. This can be handled locally as well as it can originate from other regions through the transmission lines to the surrounding countries. Furthermore, the supply and demand of electricity can satisfy final electricity consumption directly, or be coupled to the heat, gas or transport sectors, or even storage facilities. The Flex4RES project focuses on flexibility at an hourly level.



*Flexible supply and demand balance the variability in generation and consumption of electricity*

### **Objective**

The primary objective of Flex4RES is to identify and assess regulatory and technical pathways towards coherent Nordic energy systems.

Furthermore, the project will:

- Estimate the need for flexibility in the future Nordic power market;
- Estimate the potentials and costs of flexibility in the Nordic energy system from the different energy sectors (electricity, heat, gas, and transport);
- Identify regulatory and technological barriers;
- Develop coherent regulatory frameworks and market designs, facilitating energy market couplings that are appropriate for the Nordic conditions in an EU context

The project will adapt the Nordic energy market model Balmorel for quantification of costs and benefits of a coherent energy system framework, and of different regulatory frameworks and market designs.

### **Added Value of Flex4RES**

Flex4RES goes beyond the state of the art by taking an integrative approach.

It combines technology solutions with regulatory framework conditions in order to minimise the costs and maximise the impact from energy system flexibility measures while striving to obtain a high share of variable renewable energy sources in the Nordic energy system.

It addresses three important research gaps:

- Estimation of technical potential, costs, and benefits of increased flexibility from market integration of the electricity, heat, transport, and gas sectors in the Nordic region
- Development of coherent regulatory frameworks for the Nordic region to intensify market interaction and supply of flexibility
- Modelling and analysis of integrated hydro-thermal systems in the Nordic region for cost efficient integration of large shares of variable renewable energy sources

*“Previously, the focus has mainly been on making the renewables market ready. Now it is time to make the markets renewable ready. The market designs and the regulatory frameworks have to be adjusted in order to facilitate the system integration with more flexibility”, Klaus Skytte points out.*



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## A Nordic Energy Research Flagship Project

The Flex4RES project investigates how an intensified interaction between coupled energy markets, supported by coherent regulatory frameworks, can facilitate the integration of high shares of variable renewable energy, in turn ensuring stable, sustainable and cost-efficient Nordic energy systems.

Flex4RES develops and applies a multidisciplinary research strategy that combines technical analysis of flexibility needs and potentials, economic analysis of markets and regulatory frameworks, and energy system modelling that quantifies impacts. The project develops coherent regulatory frameworks and market designs that facilitate market interactions, which are optimal for the Nordic conditions in an EU context, and identify transition pathways to sustainable Nordic energy systems.

Flex4RES is funded by Nordic Energy Research and scheduled to end by March 2019.

## The Flex4RES Partners

DTU, Management Engineering (Denmark)

NMBU, Institutt for Naturforvaltning  
(Norway)

KTH, Electric Power Systems (Sweden)

Aalto University, Applied Physics (Finland)

Riga Technical University, Energy Systems &  
Environment (Latvia)

DTU, Wind Energy (Denmark)

RAM-løse edb, Hans Ravn / Balmorel.com  
(Denmark)

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