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Analysis of industrial electricity consumption flexibility. Assessment of saving potential in Latvia and Kazakhstan

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Abstract

There are several methods to reduce non-renewable resources use and increase share of renewable energy sources. As the main targets are to minimize greenhouse gas emissions till 2020 and 2030, industry and other sectors need to figure out the most suitable solutions for emission reduction. Demand response (DR) application for industry sector can reduce electricity consumption. The aim of this research is to find the positive effect of DR use for food industry and compare demand response potential in Latvia and Kazakhstan. The obtained results enable one to analyse the temporal variability of the overall demand response potential.

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Keywords: demand response; demand side management; energy sector; greenhouse gas emmisions; industry

1. Main text

There are several methods how to achieve long-term goals and results about renewable energy source (RES) integration in electricity production. Demand response has an important role in the electricity market between supply and demand, it is also applied as a solution to improve the reliability of power systems by actively following the supply

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system. Demand side management was known by the 1980s and it included activities such as: energy saving and efficiency, load management, etc. [7, 8]. The term demand response means "changes in electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high whole sale market prices or when system reliability is jeopardized" [9].

Demand response actions are defined as changes in electric use by demand-side resources from their normal consumption patterns in response:

- To changes in the price of electricity;
- To incentive payments designed to induce lower electricity use at times of high wholesale market prices;
- When system reliability is under risk.

In contrast to demand side management, which also comprises energy efficiency measures and permanent and/or regular utility-driven changes in the demand pattern, demand response is focused on load flexibility and short term customer action. In electricity systems primarily relying on fossil and nuclear fuels, interventions in customer load can increase the profitability of power plants and help to avoid investments in additional generation or grid capacities. Most demand side measures are thus designed to either enable load curtailments in times of peak demand or to shift loads to times of low demand.

Industrial companies play an important role in any energy balance, particularly in energy intensive countries. The industrial potential of demand response is not completely comprehended, especially with regard to emerging modern technologies in smart grid. In Latvia and Kazakhstan consumer side flexibility already has not been widely researched, there are only few studies about consumer side flexibility. There are factors that lead to a potential increase of industrial demand response [8, 10].

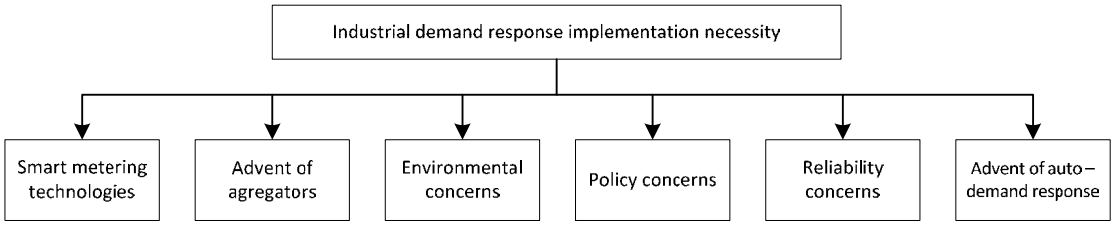

Fig. 1. Necessity for demand response implementation [8].

Fig. 1 illustrates demand response implementation necessity. All factors are necessary for the industrial sector and are also related to and affect one another: advancement in smart meter technology that allows controlling and monitoring responsive loads in near real-time scales, advent of aggregators that can manage smaller loads participating in power markets, environmental concerns related to the increase of fuel consumption, reliability concerns to prevent blackouts, and the Auto-DR promising technology [8].

Nomenclature

E_i	annual electricity demand, MW·h/y
n_{FLH}	number of full load hours, h
$P_{installed}$	installed electrical capacity, MW
$P_{increase}$	potential load increase of process or technological equipment, which uses electricity, MW
$P_{reduction}$	potential load reduction of process or technological equipment, which uses electricity, MW
N_{hours}	total number of hours in year, h/a
$r_{load,i}$	share of hours in the annual electricity demand, h/a
$r_{reduction,i}$	share in current load, which could be reduced, MW
$r_{increase,i}$	share of unused capacity of process or technological equipment, which could be activated, MW