

PROSPECTS FOR IMPLEMENTATION OF DEMAND MANAGEMENT PROGRAM IN KAZAKHSTAN



New trends in the electric power industry, the emergence of digital interval electricity meters, development of telecommunications and "Smart Grid" have made it possible to increase the elasticity of consumption by applying the Demand Response concept - an attractive and simple tool for solving energy management problems.





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Demand Response is implemented through the so-called Demand Management Program (DMP), which ensures the interaction of operator of power system with end consumers and implies a reduction in energy consumption at certain economic signals of electricity market with the receipt of revenue for this service.

The DMP concept is relatively new for the electricity markets of Central Asia and its implementation will require significant transformational changes to the existing management model of the energy system. Moreover, it becomes a very time-consuming task to create an infrastructure (metering devices with the possibility of remote data transmission, etc.) that provides the opportunity to participate in demand management programs for a wide range of consumers. Perhaps for this reason, the transition to the aggregated demand model until 2025, included in the action plan for implementation of the draft Concept for development of electric power industry of the Republic of Kazakhstan until 2035¹, was excluded from the approved Concept for development of electric power industry of the Republic of Kazakhstan for 2023-2029².

At the same time, given the large-scale plans for introduction of renewable energy and shortage of maneuverable capacities in Kazakhstan, the DMP, as a tool to maintain and regulate the balance of supply and demand in the wholesale

electricity market, thereby increasing the reliability of the system and reducing prices, should not be ignored.

From the point of view of the power system, the introduction of DMP system provides a number of advantages associated with changing the load curve, filling the gaps in the curve and cutting off the peaks of the load by equalizing the daily electricity consumption and transferring energy consumption to night or to weekends and holidays.

As a result of optimization of energy consumption regime, taking into account the introduction of DMP, the energy system of Kazakhstan receives:

- reduction of peak load of power grid infrastructure, overloads and accidents;
- stabilization of voltage levels and stability of load nodes;
- postponement of investments in development of generating capacities and networks;
- reduction of load losses;
- additional resource for balancing the National Grid of the RK, etc.

Consumers also get a positive effect from the introduction of DMP system:

- reduction of electricity supply costs;
- possibility of obtaining income from participation in DMP;
- improving the reliability of power supply.

¹ Developed by the Ministry of Energy of the Republic of Kazakhstan on the basis of the order of the President of the Republic of Kazakhstan No. 3T-K-17709.1 dated January 26, 2022.

² Approved by Decree of the Government of the Republic of Kazakhstan No. 263 dated March 28, 2023.

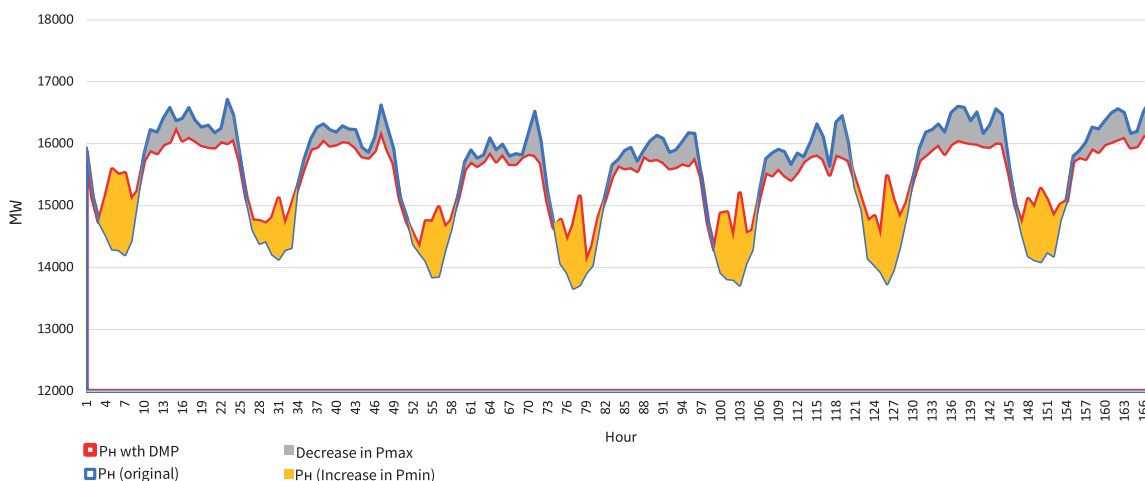


Figure 1 Modeling of impact of DMP on the load profile of the National Grid of the Republic of Kazakhstan at the level of 2030 (summer)

ACCORDING TO VARIOUS ESTIMATES, THE POTENTIAL FOR REDUCING THE PEAK LOAD IN THE POWER SYSTEM OF KAZAKHSTAN DUE TO THE DMP SYSTEM IS UP TO 10% OF THE PEAK LOAD³, I.E. BY 2025 THE POTENTIAL MAY BE UP TO 1.9 GW.

THE INTRODUCTION OF SINGLE ELECTRICITY BUYER (SEB) AND BALANCING ELECTRICITY MARKET (BEM) IN KAZAKHSTAN FROM JULY 1, 2023 IS A FAVORABLE BASIS FOR THE INTRODUCTION OF DMP.

INTRODUCTION OF DMP IN THE WHOLESALE ELECTRICITY MARKET

The solution that ensures participation in the demand response of end consumers was the creation of specialized organizations – aggregators of demand response.

Demand response aggregators are participants of the wholesale electricity market that sell a set of regulatory abilities of consumers as a single product/service on the wholesale market and/or on the market of system services. The aggregator collects requests for changes in consumption from consumers, distributes the required volume of unloading/loading between consumers and informs them in a convenient format (text message, email, phone call, remote signal directly to the control system of the electrical installation, etc.).

The participation of large consumers of the wholesale market in the DMP is achieved by opening up various market segments, creating the necessary conditions to enable consumers to compete with generating facilities and providing appropriate economic incentives.

⁴Various opportunities for participation have been implemented in foreign demand management mechanisms, for

example:

- direct demand response (implemented in the wholesale electricity and capacity market, balancing market);
- guaranteed load release (for emergency demand response);
- rapid reserve program (to ensure the stability of the system frequency in case of unforeseen increase in load or insufficiency of primary regulation, implemented on system services market).

The introduction of DMP usually begins with the involvement of consumers to reduce electricity consumption, such as through the introduction of tariffs differentiated by time of day.

When implementing the DMP in Kazakhstan, it is necessary to take into account the heterogeneity of the distribution of industrial and household consumers in the context of the National Grid zones. Thus, the consumption of Northern and Western zones is characterized by a fairly dense and uniform profile ($T_{max} \approx 7400$ hours⁵) due to the large share of industrial enterprises (more than 60%). The consumption of the Southern zone has a large share of utility consumption ($\approx 35\%$) and its

³ "Demand Management Program for Kazakhstan: Technical Feasibility", USAID Project "Energy of Central Asia", 2022

⁴ IEA, Demand Response, IEA, Paris <https://www.iea.org/reports/demand-response>, 2022 z.

⁵ The number of hours of use of the maximum load, T_{max} – the time during which the same amount of electricity would be transmitted through the electric grid operating with the maximum load, which is transmitted through it during the year according to the actual load profile.

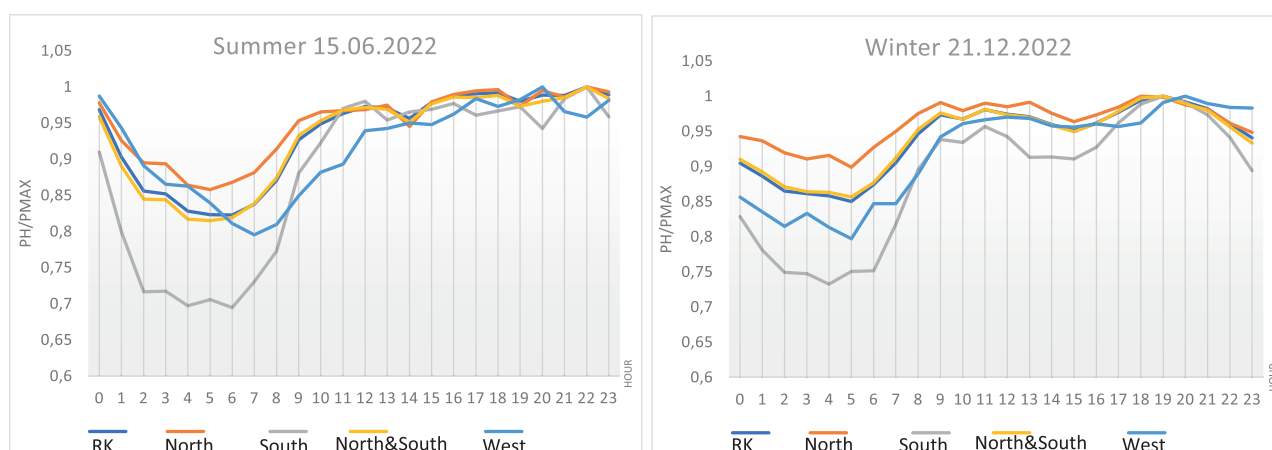


Figure 2. Daily profiles of summer and winter day loads of control measurements

consumption profile is less uniform and dense ($T_{max} \approx 6600$ hours). Thus, taking into account the uneven load profile, the current deficit and limited capacity of North-South transit, the use of demand response is primarily relevant in the Southern Zone.

On the other hand, the key category of electricity consumers in Kazakhstan are large enterprises of the industrial sector, which can also act as separate entities of the wholesale electricity market. Thus, it makes sense to start implementing the DMP with large enterprises in the wholesale electricity market that have the ability to effectively manage their own

load profiles. Pilot projects at the Bukhtarma Cement Plant and the branch of K.Satpayev Channel showed that in the presence of incentive payments, the ability to manage the demand of enterprises can be up to 20-30%⁶.

Taking into account the planned development of renewable energy in Kazakhstan, including in the Southern zone, in accordance with the Projected Energy Balance until 2035⁷ (PB 2035) and the prospective development of the National Electric Grid (NG)⁸, it is advisable to connect primarily industrial consumers of the Southern zone to the DMP, and at later stages industrial consumers of the Northern and Western zones.

IT IS ADVISABLE TO START THE IMPLEMENTATION OF DEMAND RESPONSE IN THE WHOLESALE ELECTRICITY MARKET WITH THE INDUSTRIAL ENTERPRISES OF THE SOUTHERN ZONE.

AT LATER STAGES, IT IS ADVISABLE TO CONNECT INDUSTRIAL CONSUMERS OF THE NORTHERN AND WESTERN ZONES, AS WELL AS CONSUMERS OF THE RETAIL ELECTRICITY MARKET, TO THE DMP.

REALIZATION OF THE POTENTIAL OF MANAGEMENT OF DEMAND OF NET CONSUMERS

Significant demand management potential is concentrated among consumers of retail market (medium and small businesses, household consumption). At the same time, if large industrial enterprises can participate in the DMP by changing

the planned daily consumption profile in the wholesale market, then for retail consumers to participate in the balancing market and receive a premium from response to short-term unbalances might be of interest.

Considering that a legislative and regulatory environment has been formed in Kazakhstan to support the renewable

⁶ "Demand Management Program for Kazakhstan: Technical Feasibility", USAID Project "Energy of Central Asia", 2022

⁷ The forecast energy balance approved by Order No. 104 of the Minister of Energy of the Republic of Kazakhstan dated 24.03.2022 (in the version valid until 30.01.2023).

⁸ KEGOC JSC is currently implementing the pre-FS "Vision of the development of the National Grid".

energy sector, the introduction of low-power renewable energy with storage in distribution networks of voltage class 35-10-0.4 kV can be considered an alternative option for implementation of DMP by retail consumers⁹.

In 2020, the company ESR LLP carried out a feasibility study to determine the potential of distributed generation of renewable energy in the grids of Ontustik Zharyk Transit LLP (OZhT LLP) according to the following criteria:

- Criterion 1 – availability of wind and solar resources near consumption nodes and power grid infrastructure;
- Criterion 2 – availability of suitable land;
- Criterion 3 – potential of consumers in terms of placement of small RES;
- Criterion 4 – loading of electric grids of "OZhT" LLP;
- Criterion 5 – configuration of daily load profile of consumers of OZhT LLP.

The research results showed the following:

- high solar potential throughout the Turkestan region will mainly contribute to the development of SES;
- total potential of distributed generation in the Turkestan region is estimated at 450 MW (185 MW – individual housing, 120 MW – SMEs, 45 – farming, 100 – the growth of electricity consumption);
- the maximum required volume of distributed generation under the condition of reducing the load of transformers at substations to acceptable values is estimated at 110 MW.

However, the demand response resource of an individual retail consumer is relatively small, with significant costs for interaction with the System Operator and operator of the wholesale market. Therefore, the use of this potential requires the development of mechanisms for transmitting the economic effect of reducing the load on the wholesale market to the retail consumer, as well as special regulatory, organizational and technical solutions.

FOR RETAIL CONSUMERS TO PARTICIPATE IN THE BALANCING MARKET AND RECEIVE A PREMIUM FROM RESPONSE TO SHORT-TERM UNBALANCES MIGHT BE OF INTEREST. USING THE POTENTIAL OF RETAIL CONSUMERS REQUIRES SPECIAL REGULATORY, ORGANIZATIONAL AND TECHNICAL SOLUTIONS

PRELIMINARY ASSESSMENT OF THE IMPACT OF THE INTRODUCTION OF DMP IN KAZAKHSTAN

The development of renewable energy, envisaged under the PB 2035, will lead to an increase in the variability of "net load" profile¹⁰ and will require the introduction of significant amounts of maneuverable capacity. Preliminary assessment of the prospective generation structure in accordance with the forecast balance showed the need to introduce renewable energy curtailments in minimum summer and winter modes due to insufficient reserve for reduction. The introduction of DMP will reduce the frequency and size of these restrictions.

In order to demonstrate the effect, an assessment of possible coverage of the load profile for 2030 on the day of the summer minimum ± 3 days before and after was made. The volume of RES was adopted according to PB 2035, and profile of RES generation was calculated using specialized software (WindPRO and PVSyst). When dispatching existing and planned traditional power plants according to PB 2035, the type, maneuverability capabilities and technological limits of operation were taken into account.

The analysis showed that during the minimum load hours, the introduction of the DMP helps to reduce excess power and, consequently, to reduce the under-supply of electricity from RES by reducing the frequency and size of RES curtailments.



⁹ The Law "On Support for Use of Renewable Energy Sources" defines the net consumer (Article 1) and measures of support for sale of electric energy produced by renewable energy facilities (Article 9). The Rules for electricity sale-purchase from net consumers (Order of the Minister of Energy of the Republic of Kazakhstan dated July 8, 2016 No. 309) were approved. These Rules define the procedure for purchase and sale of electricity from net consumers and procedure for mutual settlements, and according to which the "net consumer" can consume electricity from its own installation up to 100 kW, and give the surplus to the grid.

¹⁰ "Net Load" is the load minus the generation of renewable energy sources covered by traditional generation sources.

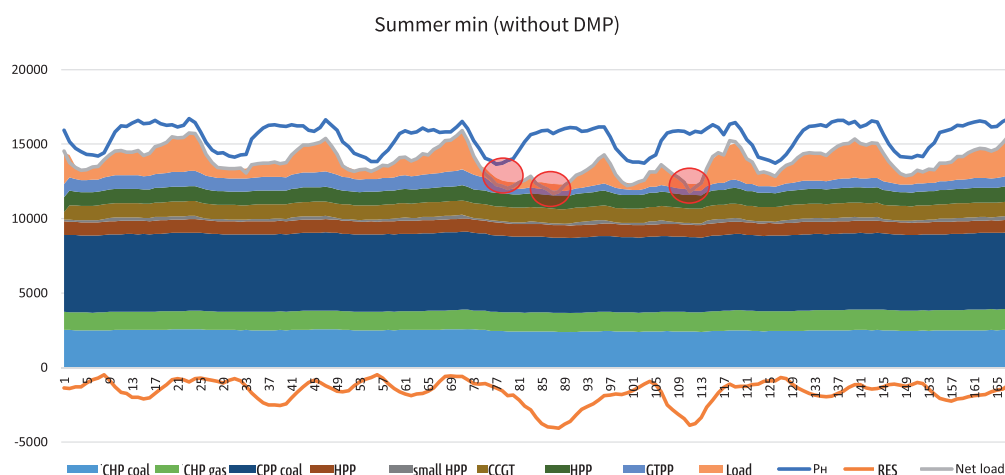


Figure 3. Coverage of summer daily profiles in 2030 (modeling)

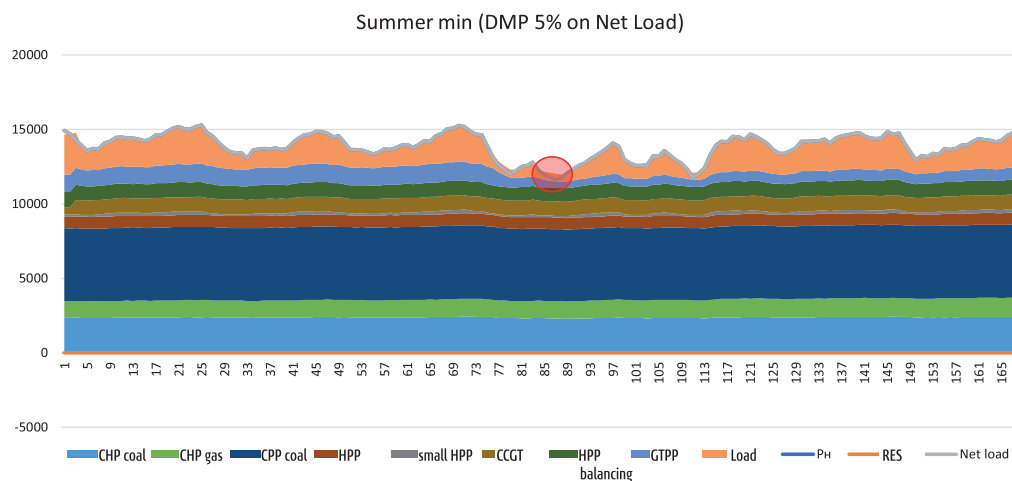


Figure 4. Coverage of summer daily profiles in 2030 with the use of DMP 5% on the "net load" profile (modeling)

In general, the overall assessment of the implementation of DMP in Kazakhstan in the amount of 10% of the load compared to the PB 2035 will lead to

- significant reduction in the need to curtail RES and an

increase in the share of RES in electricity consumption by $\approx 3\%$ (PB 2035 $\approx 20\%$),

- reduction of CUF of gas/coal CPP and emissions by more than 15% (PB 2035 $\approx 53\%$ and 90 million tons CO_2).

THE INTRODUCTION OF DMP IN KAZAKHSTAN WILL LEAD TO REDUCTION IN RENEWABLE ENERGY CURTAILMENTS, AN INCREASE IN THE SHARE OF RENEWABLE ENERGY, A REDUCTION IN CF OF GAS/COAL CPP AND EMISSIONS.

In addition to creation of infrastructure and registration of demand aggregators, in order to implement the DMP, it is also necessary to make appropriate changes to regulatory legal acts in the field of electric power industry (the law "On Electric Power Industry", "Rules for Organization and Functioning of Wholesale Electricity Market", "Rules for functioning of balancing electricity market", etc.)

To determine the possibility of implementing the DMP system, a large wholesale consumers of the Republic of Kazakhstan – the main suppliers of this service should conduct a detailed analysis of this issue. Consumers often do not know the real flexibility potential of their consumption and therefore need expert support.

