General Concept for Preventing Energy Crises

L. D. Gitelman, M. V. Kozhevnikov, and T. B. Gavrilova

1 Introduction

Power engineering is a basic infrastructure industry and the backbone of national security. Crises can have detrimental effects on the industry and cause disruption to the security of power supply. Crises can hit the electric power industry in the following ways:

- Demand for electricity (capacity) decreases (one should bear in mind that a decrease in electricity consumption for industrial uses usually occurs later than a drop in output because of continuous power consumption).
- The capacity utilisation factor (CUF) of power plants goes down and production costs go up.
- An uneven loading schedule leads to higher per-unit costs for energy companies because of a drop in consumption by businesses.
- Prices for electricity are subjected to more rigorous regulation in order to curb inflation and provide monetary (government) support to consumers.
- Funding is limited and investment projects have to be abandoned.

As a result, all financial and economic performance results of utilities deteriorate, which might result in a withdrawal of investors from the business, a decline in the quality of equipment operation and maintenance and an outflow of the most qualified personnel.

L. D. Gitelman · M. V. Kozhevnikov (✉) · T. B. Gavrilova
Department of Energy and Industrial Management Systems, Ural Federal University, Yekaterinburg, Russia
e-mail: m.v.kozhevnikov@urfu.ru

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The specific nature of crisis impacts on the electric power industry, and the specific role it plays in the economy determines anti-crisis solutions and ways of addressing the negative effects.

2 Anti-crisis Policy Toolkit

Anti-crisis measures can be grouped into:

- Emergency (aimed at mitigating an ongoing crisis)
- Strategic (preventive) ones

It makes no sense to implement the latter when the crisis peaks as they are aimed at improving the sustainability of the sector amid external economic turbulence.

The following emergency anti-crisis measures could be recommended:

1. Heat and power plants, hydro-electric power stations and nuclear power plants should withdraw from the spot market. They should operate at set standard prices (or marginal prices) that match their effectiveness to consumers. Apart from benefits for consumers, pre-established prices (as opposed to volatile spot markets) will help stabilise generators' financial performance.
2. Spot markets should switch over from marginal to average prices (covering all declared costs of selected generators).
3. Tax concessions should be granted to energy companies for keeping excess capacity in operational mode and to the ones who invest in new equipment (including in the form of accelerated depreciation of fixed assets).
4. Companies should conduct an urgent review of their investment projects considering the outlook for funding and procurement capability (with priority given to Russian-made equipment).
5. Grid companies with a monopoly status should have their transmission tariffs set by the regulator on a progressive basis (using reference prices) with a correction factor applied that takes into account the age and condition of equipment. Profit margins should not be aligned with interest rates in effect during the acute phase of the crisis (an option here is to apply pre-crisis parameters). It is also advisable to reduce the tax burden on companies, offer direct government support for urgent investment projects and, possibly, set maximum prices for transmission.
6. Power plants and grid companies should set up cost reduction efforts (devoid of investment), but they should be cautious when making decisions about operating and maintenance personnel levels and their remuneration. Maintenance and repair costs should also be reduced using a scheme that would minimise the possibility of equipment failure.

The following measures could be listed as strategic (preventive) ones:

1. Development of capital-unintensive small-scale distributed generation with different types of generating units, including mobile ones (placed in the closest proximity to consumption clusters)

2. Adoption of advanced demand-side management policies by grid companies and vertically integrated companies and the drawing-up of standard load shedding agreements (as a separate task)
3. Introduction of cost-effective "smart grid" elements for transmission and distribution infrastructure and installation of smart metres with the two-way communication capability
4. Reinforcement of grid interconnections (including the use of direct current) to validated levels, considering the possibility of merging grid companies and electricity retailers and working on the merger details that cover cost and price reduction as well as combined responsibility for security of the electricity supply in regions
5. Forward-looking innovative development of the machine building and electrical manufacturing industries in order to fully provide new energy facilities and those under refurbishment with locally made equipment; provision of comprehensive after-sales support (including all kinds of repair) by the manufacturer during the entire service life

In today's crisis context, emergency measures are being taken across the board and widely discussed at all levels, generating general approaches and compromise solutions, while strategic measures have been put on the back burner. They are only occasionally mentioned when the current situation is being discussed. Such measures, however, provide for sustainable development of the industry and make it possible to alleviate crisis in the future. One should not, therefore, forget about strategic solutions and supplementary tools when going through deep crisis. Among such always useful tools are:

- Demand-side management
- Development of small-scale power generation
- Cost management
- Asset management

The first two of them will be further considered below. Cost management and asset management will be elaborated on in other chapters of this book.

3 Demand-Side Management

Evidence on the development of power engineering globally shows that a long-term balance between capacity and load growth can only be secured through rationalisation of electricity consumption that is referred to as "demand-side management (DSM)". DSM programmes could be initiated by consumers, who are challenged by competition to reduce their production costs, as well as by electricity suppliers seeking to cut the growing cost of building new generation and transmission capacity [1].

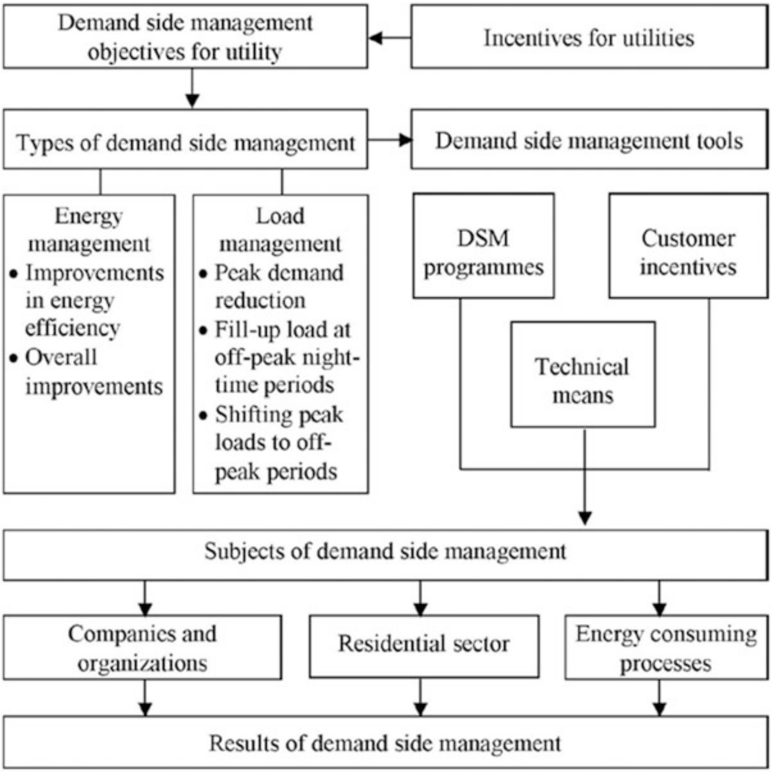

Fig. 1 Demand-side management model in a regional utility

Essentially, demand-side management means that the electricity supplier implements a planned and targeted policy of controlling the quantity, patterns and timing of electricity consumption in its service region. At the same time, the company views a growth in power usage effectiveness and the development of its generating (grid) capacity as complementary ways of ensuring the power supply to its consumers. Pro-active management of demand for electricity and capacity makes it possible to meet emerging energy needs of any local industry at minimal cost, which is particularly important in a time of crisis and during the recovery period.

Apart from the utility as the control agent, demand-side management as a system includes forms, means, tools and control subjects. The effectiveness of demand-side management is determined by the end results that are different for utilities, consumers and the region as a whole (Fig. 1).

The utility benefits by saving on investment and operational costs, expanding its market, increasing the long-term stability of its financial performance and creating a favourable image for itself in the region.

Consumers enjoy increased reliability and quality of the electricity supply as well as lower and stable electricity and heating tariffs and make direct savings by reducing the energy intensity of their products.

From the perspective of long-term societal interests, *the region* benefits from more stable energy supply, both during the crisis and economic recovery, a higher level of energy self-sufficiency and cleaner environment.

A general methodological approach to testing the cost effectiveness of demand-side management programmes is by comparing forecast capacity-related and energy savings (in monetary values) to overall costs of developing and implementing a programme [2]. The monetary value of energy efficiency is established through the prism of avoided costs of building new generation capacity, i.e. as the opportunity cost of electricity production. It is recommended that the most cost-effective installations should be adopted as alternatives for comparison, renewable energy installations and natural gas-fired power plants being the most typical choice. The programme costs should encompass all appropriate capital and operating expenditures, including discounts on prices and tariffs except annual expenditures on servicing earlier investments.

4 Distributed Generation

As a rule, small-scale power plants service consumers who cannot be connected to electrical grids for technical reasons. In the majority of cases, the capacity of such installations varies between several kilowatts (a detached house) and a few dozen megawatts (a village with a population of several thousand, or a small company). However, consumers with access to centralised grid-connected power express an interest in such generators, too. They are attracted by the reliability of stand-alone power systems, cost-related and environmental benefits and the possibility of increasing their energy security by using locally available energy sources [3].

A short and cost-effective investment cycle (including design, construction, installation and setup), low maintenance costs and ease of operation make small-scale power generation a highly attractive area of power engineering (provided there is no discrimination as regards access to markets and guaranteed sales of electricity and heat).

Technological flexibility is a noteworthy feature of distributed generation. Generation units are compact, easy to deliver and install in almost any location and are fully automated, which makes it possible to promptly put them into service in places with a shortage of generation or where access to the grid is limited. Being essentially a type of local electricity generation, small-scale generation options provide an opportunity to overcome technological and economic inertia that big energy systems are known for. This makes distributed generation a universal tool for preventing electricity supply crises in regions.

The owners of small-scale installations come to appreciate their technological flexibility in the course of operation. For example, small generators can be switched on during peak hours and put on standby when prices are low. The ease of installation makes it possible to quickly increase capacity in response to favourable market conditions. Some distributed generation installations are so mobile that they can virtually “follow the market”.

The development of small-scale power generation reduces transit flows, takes load off the grids and increases the transfer capacity of transmission lines. Additionally, spending on main and distribution electricity networks and substations go down, as do the costs of refurbishing overloaded transmission lines and grid losses.

The growth in small-scale generation as private business encourages competition, especially in local retail markets. Independent power producers will be a source of growing pressure for regional utilities, encroaching on their cash flow.

At the same time, small-scale power generation is confronted with a number of problems, the prime one being a relatively high cost of some environmentally friendly installations. This calls for scientific and technological advances in small-scale generation.

It has to be pointed out that some installations (e.g. windmills, solar farms and some heat and power plants) are unable to operate in a load dispatch control mode. This imposes restrictions on utilising their reserve capacity and raises the issue of reliability of the electricity system. A possible solution could be to create powerful electric energy storage devices.

Small generation units are installed in distribution networks in close proximity to specific consumers. This changes the technical characteristics of the distribution network and can affect its stability. To avoid such effects, energy systems need to be modified to be able to incorporate such installations.

The government should provide legal, technical and economic conditions for promoting small-scale power generation. It is particularly important to introduce uniform rules for a small-scale power generation market that would:

- Govern access for independent power producers to the grid.
- Introduce regulation procedures for electricity and heat prices.
- Establish power supply arrangements (govern relations between independent producers, their consumers, grid companies and electricity retailers).
- Establish dispatch control procedures.
- Introduce a mechanism for encouraging investment in small-scale power generation.

Economic regulation should primarily aim to support temporarily uncompetitive power plants such as heat and power plants during periods of an unfavourable ratio of natural gas prices to electricity (heat) prices, some renewable energy installations and microgeneration units powered by natural gas and liquid fuel. Incentives should be provided at all cost-intensive stages from construction and grid connection to operation. The mix of possible incentives is well known and includes interest rate subsidies, tax concessions, accelerated depreciation, operating cost subsidies and sales guarantees.

For example, the European Union has been implementing renewable energy support programmes (primarily to reduce CO_2 emissions). The programmes might differ in specific countries, but generally they combine a system of emission allowances with pricing instruments.

5 Conclusion

The implementation of the above-described measures will eventually make it possible to:

- Mitigate the effects of an economic crisis on the electric power sector (thanks to "emergency" measures).
- Avoid the impact of crisis occurrences by taking "organisational and technical" (strategic) measures.
- Find a solution to the "compromise" price issue in extraordinary circumstances.
- Ensure required stability of the electricity supply to business consumers and households (the issue of acceptable prices for electricity is to be addressed by the regulator at government level and at government expense).
- Preserve and boost workforce potential of the industry, retain investors and carry out refurbishment projects even in unfavourable circumstances.
- Ensure national energy security through import substitution for refurbishment and construction purposes.

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