HOW DOES A DNO ANTICIPATE A BLACKOUT?

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ABSTRACT

The European energy market context and the development of intermittent power generation on a massive scale may give rise to an increased risk of black-out phenomena. Although the probability of such an incident is fortunately very low, it would have a major impact on a distribution network operator in both economic and image terms. From the perspective of the network operator, if there is no action that can be taken to prevent the phenomenon occurring, a number of anticipatory measures can still be taken to minimise its operational impact by carrying out a robust analysis of vital infrastructure components and setting up an appropriate organisation that is able to deal effectively with such a situation.

INTRODUCTION

Changes currently taking place in the European context in which the electricity market is developing may create concerns that blackouts will be associated with higher risks. The reasons for these concerns are as follows:

- The low level of investment in power generation and interconnection infrastructures at the European level and specifically in Belgium. Despite significant progress with renewable energy resources in Europe, the development of new thermal generation resources to ensure a balanced supply is currently not being supported by a favourable economic and regulatory context. The development of transmission network infrastructures is incurring major delays due to social resistance (NIMBYism) and burdensome administrative procedures.
- The rapid development of various types of decentralised power generation: wind power and photovoltaics is giving rise to an increase in the variability and a decrease in predictability of the power generation balance. Congestion phenomena are being observed in a number of network portions.
- Decisions to exit from nuclear energy in Germany and Belgium are decreasing the security of supply in the whole CWE region.
- The high dependency of French consumption on temperature, which reduces opportunities for exchanges during periods of severe cold as seen in February 2012.
- The absence of integrated planning and anticipatory policies in relation to power security or securing long-term supplies for the market.

A number of resources have been deployed in an attempt to reduce the impact of these different risk factors, such as increased cooperation between European TNOs. At the national level in Belgium, underlying risk factors such as the non-availability of two major nuclear power stations since the autumn of 2012 have forced the authorities and network operators, for the first time in many years, to put in place a power shortage response plan that will allow them to cope with a generation deficit if one should arise.

In this context, distribution network operators have an interest in developing or reactivating internal contingency plans and preventive measures that will allow them to avoid being taken unprepared if a black-out does occur.

Sibelga, the distribution network operator for Brussels, has decided to develop such a preventive framework.

THE CHALLENGE FOR A DISTRIBUTION NETWORK OPERATOR (DNO)

In operational terms, the DNO has virtually no control over the primary causes of a blackout (BO). These almost always fall within the remit of national transmission network operators. The impact of a BO in terms of both the media and economic damage are so severe that the DNO becomes the focus of pressure, welcome or not, from a number of stakeholders (politicians, customers, institutions etc.) and faces challenges in terms of image and communication. The role of the DNO must therefore be focused on putting a plan in place to restore power to customers within the constraints imposed on it by the transmission network operator (TNO), depending on the type and limitations of the power available. To achieve this, the DNO must have an effective internal organisation that can respond specifically in the event of a BO affecting all or part of the area under its control. This effectiveness is based on preparation and anticipation of the different situations that may arise.

TNO POWER RESTORATION PLAN IN CASE OF A BLACK OUT

The DNO obviously has to work on the basis of the restoration scenarios developed by the TNO that is supplying it. Three scenarios have been analysed in consultation with the national transmission network operator:

Scenario 1: Regional black-out. Part of the transmission network is no longer supplied, while part of it remains in operation. Power generation resources are not affected. Line repairs may be necessary in order to restore supplies.

Scenario 2: National black-out. A restart is possible with help from neighbouring countries.

Scenario 3: "Black-start". National black-out where there is no possibility to receive help with the restart from neighbouring countries. Restart on the basis of black start power stations.

A specific restart plan for each case has been developed in consultation with the national transmission network operator. The two main variables are the extent of prior clearing of substations and the level of available capacity at the time when the restart takes place. The restart sequence does not differ much from one scenario to another. If the restoration process is able to take place with border areas that are sufficiently stable to allow exchange and resynchronisation between national production units, it will not be necessary for the DNO to act at the level of load rationing. If it is necessary to envisage a black start scenario, however, the DNO will probably have to carry out more or less widespread clearing of its substation outputs in order to limit the impact of gradual restoration on the network structure.

PRIORITIES FOR THE DNO

The priorities for the DNO are:
- to have telecommunications and electricity supply resources available that will allow it to take measurements and initiate actions remotely to restore outputs in the various substations supplying its network;
- to have a clearing plan available;
- to have a list and locations accessible for priority customers that need to be restored as quickly as possible; a list of validated criteria should be available for this purpose;
- to put in place an organisation and human resources to manage restoration operations.

THE PHASES OF THE RESTORATION PROCESS

The management of a black-out has been subdivided into seven phases, and the checks required have been described for the actions that take place in each phase. The phases are as follows:

Identification:
The DNO has to receive from the TNO the confirmation and area of the BO.

Setting up the crisis organisation (see below: Internal organisation)

Defining the scenario. The DNO will adapt to the situation resulting from the diagnostic phase after the black-out as communicated to it by the TNO.

Clearing the necessary substations depending on the scenario to guarantee restoration of power to the grid in a way compatible with restarting of power stations or interconnections. A clearing plan that has been put in place beforehand for each substation, pre-programmed into the local controllers if necessary, makes it possible to ensure that switchgear substations and customers supplied directly from the substation can be restored as a priority. The DNO must identify which customers supplied by its network have the highest priority. In the absence of any legal framework that applies to the DNO in the event of a blackout, the DNO will identify the feeders that supply the relevant customers beforehand, and will not clear these outputs.

Start-up. Restoring power to substation transformers and restoring power to priority customers.

Restoring power everywhere, following the priority sequence and in accordance with the agreed power capacities.

Checking. Checking that power has been fully restored. From this phase onwards it will be necessary to deploy personnel in the field, particularly to deal with shutdowns caused by overload, including low voltage**.**

CRITICAL DNO INFRASTRUCTURE

A blackout preparation plan also includes producing an inventory of the various "end-to-end" elements in the remote control system to ensure that it is "blackout resistant".
- The telecommunications network used by Sibelga is currently largely leased or uses dedicated infrastructures. These currently offer sufficient guarantees of blackout resistance, but changes in the technologies used by the operators will no doubt alter this situation, forcing DNOs to look for other solutions.
- In the substations themselves, systematic verification and upgrading of battery capacity has taken place in order to guarantee that they are able to operate for 12 hours without power from the grid. Measures have been taken to increase battery autonomy periods. These measures show that the backup voltage is still sufficient for operations until point B, which is 12 hours 20 mins after interruption of the power supply.

- At the company headquarters, an emergency infrastructure upgrade has been carried out which allows control room and essential services, particularly communications, to run on emergency generators. A new 400 kVA generator will be installed in 2013. It has been necessary to pay particular attention to the voice telephony aspect: due to technical developments in this area, voice telephony is no longer provided by traditional PABX systems but makes extensive use of both information technologies (VOIP) and the IT infrastructure of the company. The crisis "contact center" intended specifically for BO situations should be set up on a flexible footing using a dedicated, secured infrastructure.

IMPACT ON THE GAS NETWORK

Sibelga supplies approximately 420,000 customers via a low-pressure network (25 mbar) and about 1800 clients with medium pressure (1.7-2.5 bar).
In the event of a BO affecting the power grid and particularly in situations of severe cold, the power cut will cause instant shutdown of all gas boilers or other appliances regulated by electronic control systems. During periods of severe cold, the pressure regulators of the gas reducing station are fully opened to provide enough gas to the network at the desired pressure. Unfortunately the time taken for these regulators to close is not instantaneous. The result could be a slight overpressure and some older installations (weight regulators) may shut down by closing the safety valve. When power is restored, the network could therefore fall below the permitted pressure threshold. This situation must be avoided at all costs because it would result in the risk of maintaining a flow of gas to appliances that are switched off, the oldest of which are not fitted with flame safety detector.
To safeguard against this risk, in case of a BO the plan allows for eight teams of two technicians to be called in to inspect the most critical grid gasstations before restoring electrical power.
Plans also exist to install small mobile power generators in key backup substations to maintain gas heating boilers and allow continued operation of pressure regulators.

LEVEL OF PRIORITY OF FEEDERS

All feeders in the network have been classified according to two parameters: the level of priority of the consumers supplied from these feeders and the dominant direction of the flow of energy. Priority levels 1 to 10 are based on a Ministerial Decree concerning the shedding plan, but these have been refined and harmonised for the whole of Belgium on the basis of the following definitions:

1. **Auxiliary**: auxiliary supplies to substations or power stations.
2. **Essential services**: feeders that **directly** supply a customer in one of the following categories: public transport, audiovisual telecommunications media, hospitals.
3. Essential services in the loop
4. **Seveso industries**: feeders that directly supply an industry in the SEVESO category.
5. Seveso industries supplied in a loop
6. **Urban**+: feeders supplying urban areas in which a sensitive customer is connected in a loop
7. **Urban**: other feeders supplying urban areas.
8. **Industry**: feeders directly supplying industries.
9. **Rural +**: feeders supplying rural areas to which a sensitive customer is connected in a loop.
10. **Rural**: other feeders supplying rural areas.

This classification is an essential but delicate task of working out a plan, since it makes it possible to determine an objective restoration sequence.

COMMUNICATION PLAN

Preventive

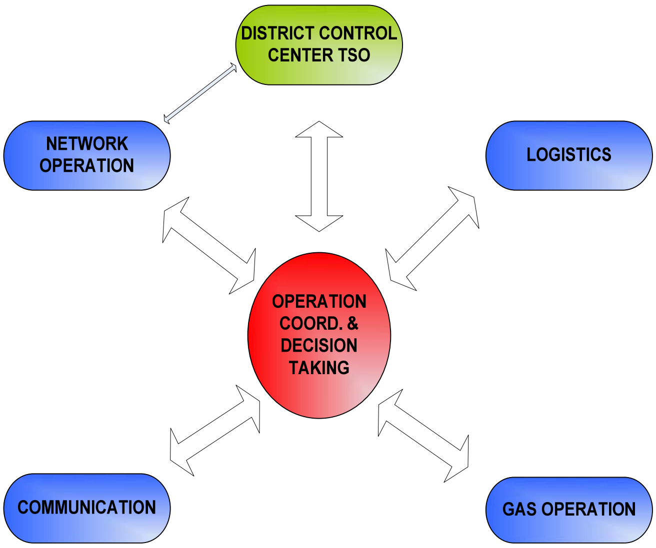
A preventive communication plan for priority customers has been put in place. The aim of these contacts is both to raise awareness among these customers of the problem of a long period of BO type power cut and make them aware of the need to carry out internal "business continuity" studies associated with their power supply. Actions have also been carried out aimed at raising awareness and clarifying roles and responsibilities between network operators and public authorities.

During the BO

An external communication cell is set up once a BO is confirmed. The cell is responsible for communication with local authorities, local emergency services and the press to pass on specific messages and keep them informed of specific local situations and the evolution of the situation. This cell is situated at a defined location, with a secure power supply and equipped with adequate communications infrastructure.
One of the first tasks of the cell is to redirect telephone lines to the cell and set up pre-recorded response messages. These messages are updated as the power restoration situation evolves.
During this phase it is important to continue to identify urgent calls in relation to emergency situations such as gas leaks.

INTERNAL ORGANISATION

An internal organisation plan has been put in place to define both roles and players both operationally (teams responsible for network restoration activities) and in terms of internal and external communication. Exercises and simulations will be scheduled to take place during the next few months.



The roles of the various sections are described in brief below.

Coordination of operations:

- Regularly updating the transmission network operator on the development of the situation.
- Coordinating operations and making key decisions.
- Ensuring that the organisation that has been set up is respected.
- Keeping the other locations informed of the situation and informing them about decisions that affect them.

Carrying out operations:

- Carrying out activities according to the plan and the start-up scenario: clearing, restoration, on-site activities.
- Producing reports on the progress of operations in terms of customer numbers and capacity.

Communication:

- Keeping the management and public authorities in Brussels informed, including Mayors. The communication towards the federal/European authorities is the responsibility of the TNO with the national crisis center
- Informing the media about the situation in Brussels and answering their questions.
- Ensuring a permanent telephone presence until the end of the restoration phase and regularly updating the pre-recorded messages.

Logistics:

- Monitoring staff personnel entering and leaving the site.
- Managing catering for the service staff personnel (in case of a long period of BO).
- If the staff are required to remain at the site, organising catering and/or transport to and from home according to circumstances: can they travel or not?
- Organising a "help desk" to try to resolve logistical problems encountered by the other teams.
- Monitoring the operations of on-site emergency groups.

Gas operations

- Checking and monitoring the situation in the gas network during the BO and the start-up phase.
- Checking the status of regulators and resetting overpressure valves if necessary.
- Providing feedback to the operations coordinators to coordinate the pace of the restart.
- Ensure a temporary emergency supply in the DNO main gas reducing station.

CONCLUSION

The risk of blackout for a DNO should be taken into account and anticipated by verifying the specific network infrastructures and preparing action plans that are coherent with the blackout scenarios anticipated by the TNO. The internal DNO procedures and external awareness-raising activities should also be conducted preventively to limit the impact and effects of a possible blackout.

Finally, the process of setting up the specific organisation in the case of a black-out must be meticulously prepared, the actors involved must be well aware of their roles and simulation exercises should be carried out to ensure that the system is operational.