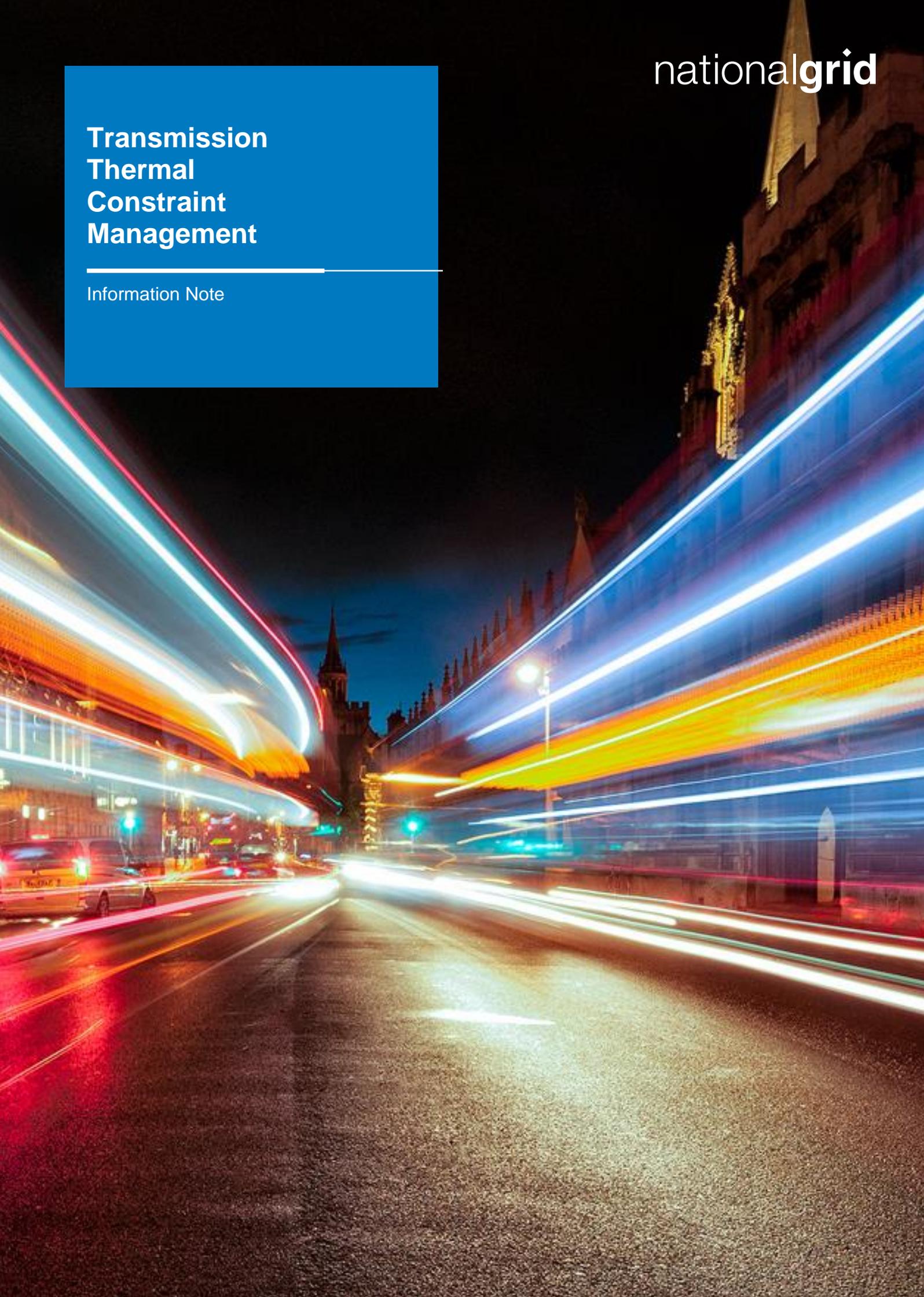


**Transmission
Thermal
Constraint
Management**

Information Note



Introduction

As System Operator our vision is for a more flexible whole electricity system that makes the most economic and effective use of all available resources. The changing generation mix in Great Britain, new forms of generation, connected at different locations and voltage levels are causing flows on networks to change. This has led to a change in the thermal constraints we see on the transmission system and a change in our requirements for managing them. In the past our ability to instruct the output of a large number of transmission connected generators met almost all our constraint management needs. However, the number of transmission connected generators has reduced, and the location of our thermal constraints has changed. As a result, we are seeing more occasions when our options to manage transmission constraints are limited. We also need to work with Distribution Network Operators (DNOs) to take a whole electricity system approach in managing network constraints across transmission and distribution, to ensure efficient outcomes are realised for the end consumer and so that system security is maintained.

With this guidance note we aim to describe how we currently manage thermal constraints on the transmission system and to:

- encourage more potential providers to participate in our services
- discuss our short, medium and long term plans for Thermal Constraint Management on the transmission system
- signpost future developments such as considering distribution level solutions to transmission system needs in the Network Options Assessment (NOA)¹ and the recently published Network Development Roadmap Consultation².

We want to encourage more providers to participate in our existing markets and trials to make the most of current opportunities and to help shape the future of Thermal Constraint Management on the transmission system. More information on this can be found on our Future of Balancing Services website³

We invite everyone to share your views on this document, as well as the type and format of information that would be most useful for your businesses.

You can contact us via email:
box.futureofbalancingservices@nationalgrid.com

Background to transmission thermal constraint management

There is a physical limit to the amount of power which can be transmitted through any piece of equipment on the network and often that limit is set to ensure that equipment does not become overloaded and overheat. Whilst every piece of equipment on the network has this limit, we only have to take action if the generation and demand pattern mean that this limit would otherwise be exceeded.

¹ <https://www.nationalgrid.com/uk/publications/network-options-assessment-noa>

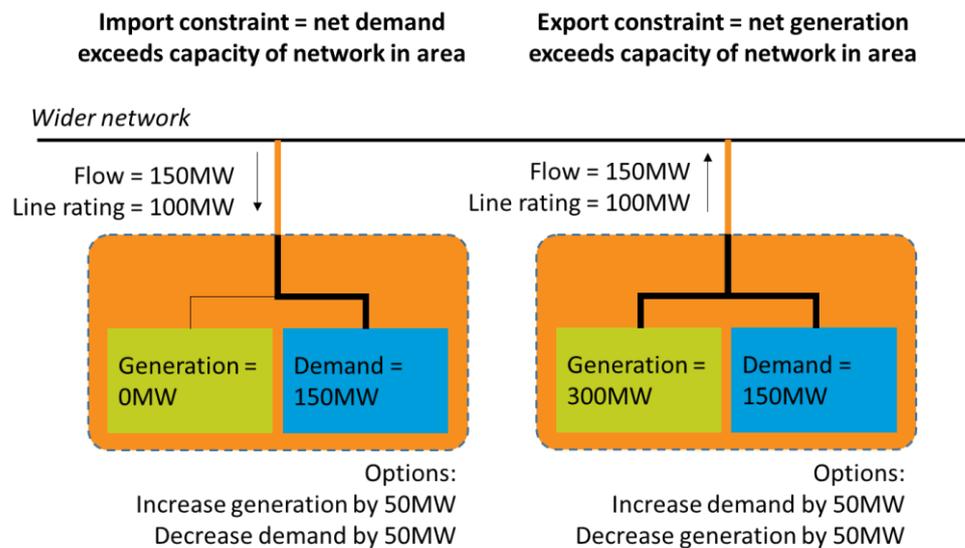
² <https://www.nationalgrid.com/uk/documents/113896-network-development-roadmap-consultation>

³ <https://www.nationalgrid.com/uk/electricity/balancing-services/future-balancing-services>

This is known as a thermal constraint and they can be in the form of either an import or export constraint, as described in Figure 1 below. If the limit were exceeded, parts of the network would need to be temporarily shut down for safety reasons. But this has a knock-on effect: The power which was flowing through those parts of the network will now flow through other parts of the network, potentially overloading them and causing more parts of the network to be shut down.

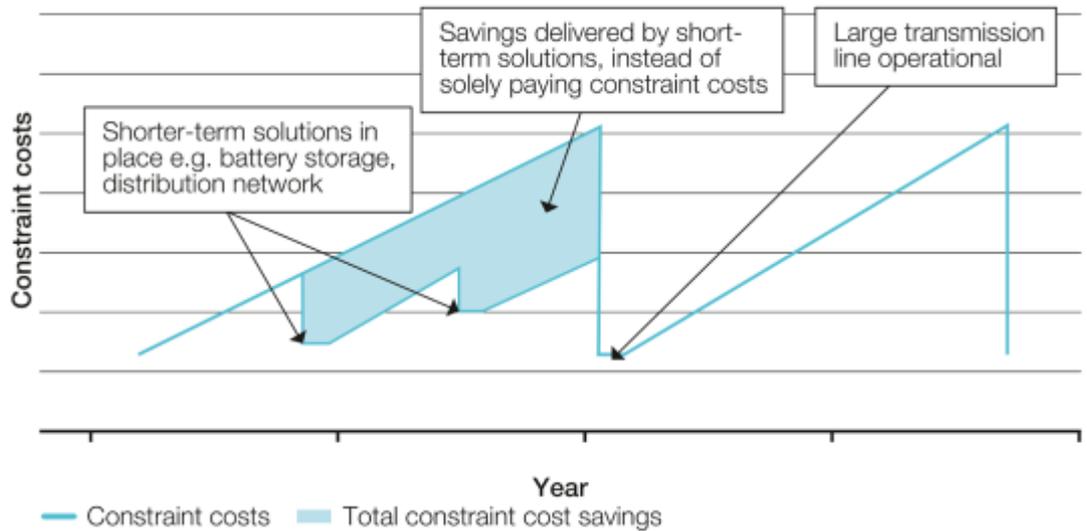
We are able to take a range of actions to vary the output of generation and demand, as well as to reconfigure and optimise the network, to prevent this from happening.

Figure 1: Import and export constraints



capacity. This is illustrated in Figure 2 below, which can also be seen in the Network Development Roadmap Consultation⁴.

Figure 2: Illustrative example of how different solutions may be used to manage constraint costs



How do we currently manage thermal constraints?

Short term

We work with the Transmission Owners (TOs) on network optimisation to:

- manage the number and location of outages on the network at any given time to best optimise the use of the network and minimise constraints
- reconfigure the network through different running arrangements at substations, redirecting flows to parts of the network with capacity
- use short-term circuit enhancements to allow additional power to flow for a predetermined period of time, or under specific weather conditions, temporarily increasing the capacity of the network.

Network optimisation alone will not fix all constraints though, and we also rely on providers to change their output so that we can redirect flows. We do this through the use of Constraint Management Services.

There are three ways providers can offer us Constraint Management Services. These are set out in Figure 3 below.

⁴ <https://www.nationalgrid.com/uk/documents/113896-network-development-roadmap-consultation>

Figure 3: Illustrative example of how different solutions may be used to manage constraint costs

For illustration – overlaps in timing can occur



We use the Balancing Mechanism (BM) for buying flexibility from providers in real time. Balancing Mechanism Units (BMUs) provide us with the information we need to make decisions around adjusting their output, including:

- Current level of output (Physical Notification)
- Availability to import or export power to the transmission system (import and export limits)
- The price they will pay to reduce their output (a Bid)
- The cost to us of increasing their output (an Offer)
- Technical information⁵, such as ramp rates, and the level of minimum stable output.

We use this information to adjust the output of BMUs within a thermal constraint, whilst another BMU, outside of the thermal constraint, will be adjusted in the opposite direction. This repositioning is needed to maintain a balanced system. In the case of multiple BMUs being able to help with the constraint, we will accept the most efficient Bids or Offers. These actions are System Operator (SO) flagged for the purposes of settlement and identified on the BM Reports website⁶. We publish aggregated constraint costs and volumes by geographic region and fuel type in our Monthly Balancing Services Summary (MBSS)⁷, however thermal constraints are currently not reported separately from other constraint types.

We use the BM to manage thermal constraints in a within-day timeframe, as it offers an efficient way of managing the uncertainty these types of constraints present.

Medium term

In slightly longer timeframes, we may need more certainty that a market participant will be available to help us manage the constraint. This happens through placing Forward Energy Trades with the provider, which are generally no longer than four days ahead of delivery and are normally for no more than twenty-four hours.

⁵ Please refer to Grid Code BC1 Appendix 1 for more details.

⁶ <http://www.bmreports.com>

⁷ <https://www.nationalgrid.com/uk/electricity/market-operations-and-data/system-balancing-reports>

For these trades, the provider must sign a Grid Trade Master Agreement (GTMA), which is similar to that used for over-the-counter energy trading. We start a trade with a phone call to market participants, who will choose whether or not to enter into a trade.

Where multiple providers are able to help manage the constraint, we contact all those with a GTMA and agree a deal with the most economic provider. Information on those trades is then published on our website⁸.

Where we need longer-term certainty of a provider's availability, or an adjustment over a longer period that could be costly using the BM or Forward Trades, we may use a Constraint Management Contract.

These can take different forms, though the most common is to agree a minimum and maximum output of the provider. We publish these on our website⁹.

Longer term

In the longer term, we may recommend changing the configuration of the network permanently, to completely remove, or bypass the constraint.

To do this, we use the Network Options Assessment, (NOA). This makes recommendations on the types of network investments network owners could use, and the most efficient timing to make these investments. More information about the NOA is available at:

<https://www.nationalgrid.com/uk/publications/network-options-assessment-noa>.

This includes our Network Development Roadmap Consultation¹⁰ which proposes a number of changes to our network planning tools.

How do we plan to manage thermal constraints in the future?

New forms of generation, at different locations on the network, are causing flows on the network to change. We also do not always have the same level of visibility of, or commercial agreements with, these new forms of generation.

As a result, we are seeing more occasions when our options to manage transmission constraints are limited. We also need to work with DNOs to take a whole electricity system approach to managing network constraints

We want to encourage more potential providers to participate in our services.

Large volumes of lower-carbon generation and flexible technologies are now connected to the system, both at transmission and distribution voltage levels.

As long as we can see their output and vary it as required, they have the potential to provide Constraint Management Services.

⁸ <https://trades.nationalgrid.co.uk>

⁹ <https://www.nationalgrid.com/uk/electricity/balancing-services/system-security-services/transmission-constraint-management?market-information>

¹⁰ <https://www.nationalgrid.com/uk/documents/113896-network-development-roadmap-consultation>

across transmission and distribution, to ensure efficient outcomes are realised for the end consumer and so that system security is maintained. For example understanding how automatic systems on the distribution networks may release capacity, created on the network by System Operator actions and required for constraint management, back to providers.

Short term developments: increasing access to our Constraint Management Services

We want to encourage more potential providers to participate in our services. Large volumes of lower-carbon generation, and flexible technologies (such as Demand Side Response (DSR), batteries, and engines) are now connected to the system, both at transmission and distribution voltage levels. As long as we can see their output and vary it as required, they have the potential to provide Constraint Management Services. So we are broadening the scope of our thermal transmission constraint services to allow distributed energy resources (DER) to take part. One example is our work with UK Power Networks and Western Power Distribution, outlined in Box 1.

Box 1: DER participation in thermal constraint management

We have been working with UK Power Networks to enable DER to provide thermal constraint management on the South Coast of England, and with Western Power Distribution in the South West. This involved changing the connection agreements in these areas to require visibility and controllability of DER output.

A key enabler will be the provision of a 'back-stop' price as part of the connection process, so DER can receive compensation for curtailment, without having to regularly monitor and take part in our commercial processes. For providers with the appetite to become more actively involved, we can offer more frequent price submissions.

These actions will provide us with a greater number of alternative providers for constraint management, as well as unlocking additional network capacity for new connections in those areas.

You can monitor our progress on our Future of Balancing Services webpage³.

Medium term plans: increasing transparency

We recognise our service needs to be as accessible as possible to attract the broadest range of participants. This requires a greater level of transparency on our spending. We want to improve the regional details of what we publish and are working to deliver more granular data on both our spending and our requirements in this area.

Longer term: whole system solutions in NOA

We will use the NOA to allow the comparison of network and non-network solutions across the transmission and distribution network. This competition between solutions should drive greater value for consumers. More information can be found in the Network Development Roadmap Consultation¹⁰ and on the NOA page of our website¹.

We want as many market participants as possible to take part in all these initiatives to shape the future of Thermal Constraint Management and also consider the current opportunities to participate in our existing markets and trials by:

- Signing up to a Grid Trade Master Agreement (GTMA), which allow us to call on a provider to increase or decrease output for an agreed price and time
- Participating in the BM if you are currently eligible, and
- Speaking to your account manager about other opportunities (e.g. upcoming tenders) in your area or if you believe you can provide other balancing services.

We encourage all market participants to monitor our progress with DNOs in revising distribution connection agreements, and in finalising the back-stop terms which will give DERs access to thermal constraint management. We're starting in UK Power Networks and Western Power Distribution regions covered by Regional Development Programmes, but we expect successful initiatives to be rolled out more widely at a later date. Outside of the changes to connection agreements, we will also be exploring market-based solutions to providing reactive power through the Power Potential Network Innovation Competition trials planned for 2019.

We invite everyone to share your views on this document, as well as the type and format of information that would be most useful for your businesses, via email: **box.futureofbalancingservices@nationalgrid.com**