Spondon and Heanor BSPs

Network Development Report – East Midlands

May 2024

Electricity Distribution

nationalgrid

Contents

Spondon and Heanor 33 kV

1. Network Overview

Spondon and Heanor Bulk Supply Points (BSPs) are fed from Willington Grid Supply Point (GSP) in National Grid Electricity Distribution's (NGED's) East Midlands licence area. Both BSPs are fed from Willington via Spondon A 132 kV, with Heanor BSP being fed from a dual circuit with a tee off to Stanton BSP which continues on to Annesley BSP and Staythorpe GSP.

Figure 1.1 Spondon and Heanor geographic network coverage

This report discusses all existing and future network constraints over a 0-10 year horizon identified on the 33 kV network fed from Spondon and Heanor BSPs. This uses the methodology outlined in the Network Development Plan Methodology Report with Network Operability Modelling applied as outlined below.

For the purposes of this analysis the NGED Best View Distribution Future Energy Scenario (DFES) has been used to study the years 2022 (baseline), 2028 and 2034, with consideration given to how proposals could change under the other scenarios. Five representative days have been studied across the four seasons: Winter Peak Demand, Intermediate Warm Peak Demand, Intermediate Cool Peak Demand, Summer Peak Demand and Summer Peak Generation.

1.1 Network Topology

Spondon BSP has two 33 kV busbars fed by two 132/33 kV GTs both rated to 60/120/156 MVA. Spondon BSP feeds six primary substations: Belper, Castle Donington, Melbourne T1, Morley T2, Spondon and Trent Lane. Spondon primary is located at the same site as Spondon BSP. All of the primaries fed from Spondon BSP have two 33/11 kV transformers. Spondon BSP is interconnected with Derby South BSP via Melbourne primary, with Heanor BSP via Morley primary and with Coalville BSP via Worthington primary (the interconnection with each of these BSPs is normally run open).

Heanor BSP has two 33 kV busbars fed by two 132/33 kV GTs both rated to 60/90/117 MVA. Heanor BSP feeds seven primary substations: Denby, Heanor, Moorgreen, Morley T1, Ripley, Watnall and Westwood. Heanor primary is located at the same site as Heanor BSP. All of the primaries fed from Heanor BSP have two 33/11 kV transformers. Westwood T2 and Watnall primary are fed from Heanor via Moorgreen primary. Heanor BSP is interconnected with Alfreton and Spondon BSPs via normal open points at Denby and Belper primaries).

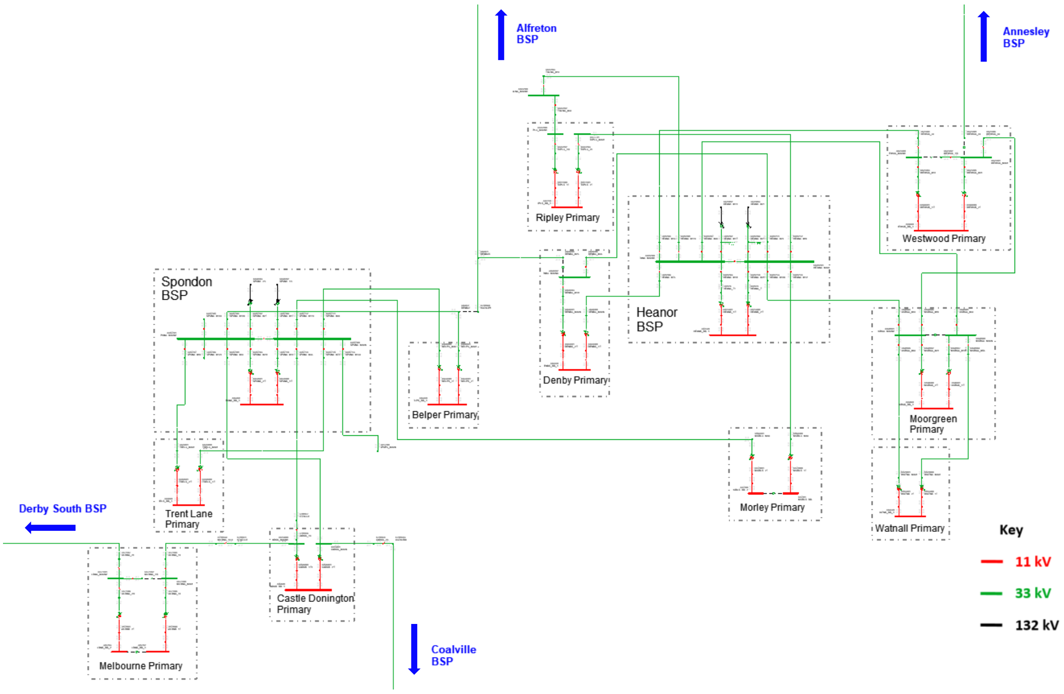

Figure 1.1.1 Spondon and Heanor 33 kV network single line diagram

1.2 Network Operability Modelling

The following network automation and manual switching schemes have been modelled in the analysis of this area, aligning to how the network is currently operated, as well as proposed actions to manage some constraints identified operationally.

- For the loss of an infeed to a transformer at any of the primaries fed from Spondon or Heanor BSPs under arranged outages, the lower voltage side circuit breaker is opened to prevent back-energisation.
- The 33 kV networks downstream of Spondon and Heanor BSPs are split for arranged outages on their respective 33 kV bus section breakers to prevent loose couples. This involves splitting Belper, Castle Donington, Spondon and Trent Lane primaries at 11 kV for Spondon and splitting Denby, Heanor, Moorgreen, Ripley, Watnall and Westwood at 11 kV for Heanor.
- For an outage on the infeed from Spondon or Derby South BSP, Melbourne primary is paralleled at 11 kV and fed fully from the other BSP (i.e. for an outage on the circuit from Spondon BSP the site is fed fully from Derby South BSP and vice versa).
- For an outage on the infeed from Heanor or Spondon BSP, Morley primary is paralleled at 11 kV and fed fully from the other BSP (i.e. for an outage on the circuit from Heanor BSP the site is fed fully from Spondon BSP and vice versa).
- For an outage on either infeed to Moorgreen primary from Heanor BSP the site is paralleled at 33 kV by closing the bus section breaker between the main 1 and main 2 33 kV busbars.
- For an outage on the 33 kV infeed to Melbourne primary from Derby South BSP the possibility of opening the T1 LV circuit breaker at Castle Donington primary has been modelled.

2. Network Constraints and Solution Options

2.1 Summary of Network Constraints

The following constraints were identified for the Best View Scenario, for which mitigation options will be discussed:

- Overloads are seen on the transformers at Trent Lane primary from 2028 for N-1 faults or arranged outages on the other infeed.
- Overloads are seen on the transformers at Spondon primary from 2028 for N-1 faults or arranged outages on the other infeed. N-2 overloads have also been identified but can be managed operationally.
- The transformers at Castle Donington are projected to be overloaded from 2034 for N-1 faults or arranged outages on the other transformer/circuit. The circuit to T1 at Castle Donington is also projected to see overloads for both fault and arranged outages on the circuit to T2 in 2034.

2.2 Trent Lane primary transformer overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.2.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Trent Lane primary transformer overload	Arranged or fault outage on either infeed to Trent Lane primary	None	2028	2028	2028	2028

Uncertainty under other Distribution Future Energy Scenarios: This constraint is present in all seasons by 2028 under Best View, so is only further exacerbated under the higher growth scenarios (Leading the Way and Consumer Transformation). Even under System Transformation and Falling Short this constraint requires intervention by 2028.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.2.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the transformers at Trent Lane primary.
2	Install additional transformers at Trent Lane primary.
Flexibility Services	
3	Procure flexibility under Trent Lane primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the Distribution Network Options Assessment (DNOA) process.

Option 1 – Uprate the transformers at Trent Lane primary

Viable

Capacity released for constraint(s) considered: Up to 15 MVA

New limiting factor for constraint(s) considered: New transformer ratings

Detailed description: Uprating the two 33/11 kV transformers at Trent Lane primary to 20/40 MVA units would alleviate this constraint and provide significant additional capacity for future growth. The 33 kV circuits to Trent Lane are rated high enough that they would not become a limiting factor, so the capacity of these new transformers could be fully utilised.

Option 2 – Install a third transformer at Trent Lane primary

Discounted

Capacity released for constraint(s) considered: Minimal

New limiting factor for constraint(s) considered: As before

Detailed description: Installing a third transformer at Trent Lane would necessitate building a third 33 kV circuit from Spondon BSP, which (subject to detailed route investigation and land rights) would need to be over 10 km long. This makes this solution prohibitively expensive compared with option 1, and would underutilise the existing 33 kV circuit capacity. The only other nearby 33 kV network is the circuits to Castle Donington primary, which would be unsuitable to pick up additional demand as they are projected to be constrained by 2034 (or close to their capacity in the case of the circuit to T2) as discussed in Section 2.4 of this report. Utilising the 33 kV circuit to Castle Donington from Derby South via Melbourne primary is also not an option as that would require paralleling the two BSPs.

Even ignoring the length of 33 kV circuit required to supply a third transformer from Spondon BSP, there are currently only two 33 kV busbars at Spondon. Although installing a third busbar is discussed as an option in Section 2.3 of this report, even if these works were eventually carried out they would not be necessary until significantly later than intervention will be required to resolve the constraint at Trent Lane primary.

Option 3 – Procure flexibility under Trent Lane primary

Viable

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the transformers at Trent Lane primary. Deferral of this constraint may require significant volumes of flexibility as overloads are seen in all four seasons by 2028. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The optimal reinforcement strategy identified for resolving this constraint is to uprate the existing 33/11 kV transformers at Trent Lane primary to 20/40 MVA, which will free up significant capacity as the 33 kV circuits to Trent Lane are already highly rated. No operational mitigations have been identified to manage this constraint and defer this reinforcement, as it is present under N-1 fault outages in 2028 (and overloads are seen in every season).

2.3 Spondon primary transformer overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis. More onerous N-2 overloads were also identified for arranged outages at Allenton primary (which triggered the transfer of demand at 11 kV to Spondon primary) followed by a fault on one of the transformers at Spondon. This operation is discussed in the network operability section of the Derby and Derby South 33 kV report. These overloads have been omitted as they were easily resolvable operationally by not transferring load at 11 kV (and instead splitting Allenton at 11 kV during arranged outages).

Table 2.3.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Spondon primary transformer overload	Arranged or fault outage on either primary transformer or 33 kV busbar at Spondon BSP	None	-	2028	-	-

Uncertainty under other Distribution Future Energy Scenarios: This constraint is present under other seasons under the higher growth scenarios (Leading the Way and Consumer Transformation). Under System Transformation and Falling Short this constraint is still present at intermediate cool peak demand as it is under Best View.

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.3.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the transformers at Spondon primary.
2	Install additional transformers at Spondon primary.
3	Install two 132/11 kV GTs at Spondon BSP.
Operational Mitigation	
4	Review seasonal ratings.
Flexibility Services	
5	Procure flexibility under Spondon primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Uprate the transformers at Spondon primary

Discounted

Capacity released for constraint(s) considered: N/A

New limiting factor for constraint(s) considered: As before

Detailed description: Uprating the two 33/11 kV transformers at Spondon primary would alleviate this constraint. This option is not viable as the transformers are already the highest rating NGED uses on the network as standard. Utilising non-standard equipment creates a number of issues, such as finding replacements if serious faults occur.

Option 2 – Install additional transformers at Spondon primary

Viable

Capacity released for constraint(s) considered: 38 MVA

New limiting factor for constraint(s) considered: As before

Detailed description: Installing a third primary transformer at Spondon alone would not create any additional capacity for the 11 kV network, as the transformers would still be fed from only two 33 kV busbars (so for the loss of a busbar two primary transformers could be lost). To create additional primary transformer capacity at Spondon BSP either a third 33 kV busbar or four primary transformers are required. If four primary transformers (two existing and two new) were installed then two Spondon primaries could be created, doubling the capacity for Spondon 11 kV.

If a third 33 kV busbar were installed this would facilitate the future connection of a third GT at Spondon BSP. Although no constraints have been identified on the GTs at Spondon in the Willington 132 kV report, it should be noted that the existing transformers are non-standard 60/120/156 MVA units. If these GTs needed replacing (either due to fault levels, their condition or following a serious fault) they would be replaced by standard 60/90/117 MVA units. This would reduce the capacity of the site, bringing forward any possible constraints (forecasts indicate that by 2034 demand at Spondon BSP will be close to this reduced capacity). If Chaddesden primary were transferred into Spondon BSP (which is discussed as an option to reduce demand at Derby BSP in the Willington 132 kV report) this would further reduce headroom at Spondon and bring forward the need for a third GT and associated 33 kV busbar.

Additional benefits of adding a third 33 kV busbar at Spondon include creating space for more 33 kV feeders and facilitating a third 33 kV circuit to Belper primary. A third 33 kV circuit to and transformer at Belper primary has not been identified as a requirement by 2034 but load growth beyond that point could necessitate it, and it could be achieved at a relatively low cost as the existing 33 kV circuits to Belper are on a triple circuit tower construction.

Creating a three transformer primary at Spondon would carry disadvantages in terms of operability (such as having to split the 11 kV network for an arranged outage on any primary transformer to prepare for a possible subsequent fault). Installing additional primary transformers would also require additional 33 kV feeders at Spondon BSP (this would not be an issue if a new 33 kV busbar were being installed).

Option 3 – Install two 132/11 kV GTs at Spondon BSP

Discounted

Capacity released for constraint(s) considered: 38 MVA

New limiting factor for constraint(s) considered: New 132/11 kV GT capacity

Detailed description: Replacing the existing 33/11 kV primary transformers at Spondon with two 30/60/78 MVA 132/11 kV GTs would alleviate this constraint and provide enough capacity on the 11 kV network at Spondon for long term future growth. This option would also free up capacity on the 132/33 kV GTs at Spondon (which may not be required initially but could be beneficial in the long term as discussed in option 2 above). These 132/11 kV GTs could be fed from two of the 132 kV busbars at Spondon A (as there are four 132 kV busbars at Spondon A they could be fed from separate busbars to the existing 132/33 kV GTs).

While this option is technically feasible (and the projected load growth a Spondon primary is high) it may not be as economic as option 2. This is because high load growth is also projected on the other primaries supplied from Spondon BSP (namely Belper, Trent Lane and Castle Donington primaries) which could not be as easily accommodated if this option were progressed in favour of option 2. Transferring load to Spondon at 11 kV to further utilise the 132/11 kV GTs would likely be prohibitively expensive given how far the primaries listed above are from Spondon BSP (with the 33 kV circuits to each being over 10 km in length).

Option 4 – Review seasonal ratings

Viable

Capacity released for constraint(s) considered: Dependent on review

New limiting factor for constraint(s) considered: As before

Detailed description: Overloads are only seen in 2028 and 2034 for intermediate cool. It is therefore possible that this constraint could be delayed slightly by reviewing NGED's internal policy regarding transformer ratings, which does not currently distinguish between summer and intermediate cool ratings (which may be overly pessimistic). This solution is dependent on an internal review and would not be a long term solution.

Option 5 – Procure flexibility under Spondon primary

Viable

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the transformers at Spondon primary. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

The most efficient and strategic long term reinforcement strategy identified is to install additional primary transformers at Spondon BSP. In the short to medium term this constraint could possibly be deferred by a review of the seasonal transformer ratings, the procurement of flexibility services, or both. This deferral if achieved would create additional option value as it would create the opportunity to develop Spondon primary in tandem with Spondon BSP as a whole (the demand at both the primary and the BSP will be continually reassessed in future NDP reports based on subsequent DFES forecasts to ensure an optimal overall reinforcement strategy is progressed).

2.4 Castle Donington transformer and circuit overloads

Constraint Overview

Generation | **Demand**

The table below outlines the nature of the network constraints identified in the network analysis.

Table 2.4.1 constraint(s) and conditions under which constraint(s) occur

Constraint	N-1 Condition	Subsequent N-2 Condition	First studied year constraint is observed in each season under Best View			
			Winter	Int Cool	Int Warm	Summer
Castle Donington primary transformer overload	Arranged or fault outage on either infeed to Castle Donington primary	None	-	2034	2034	-
Spondon BSP – Castle Donington 1L9 circuit overload	Arranged or fault outage on the Spondon – Castle Donington T2 circuit	None	2034	2034	2034	-
Castle Donington 1L9 – Castle Donington circuit overload	Arranged or fault outage on the Spondon – Castle Donington T2 circuit	None	-	2034	-	-
Spondon BSP – Castle Donington 1L9 circuit overload	Arranged outage on the infeed to Melbourne from Derby South BSP	Fault on the Spondon – Castle Donington T2 circuit	2034	2034	2034	2034
Castle Donington 1L9 – Castle Donington circuit overload	Arranged outage on the infeed to Melbourne from Derby South BSP	Fault on the Spondon – Castle Donington T2 circuit	2034	2034	2034	-

Uncertainty under other Distribution Future Energy Scenarios: Under the higher growth scenarios (Leading the Way and Consumer Transformation) overloads are observed in 2034 as under Best View (no overloads are seen in 2028 under any scenario). Under System Transformation and Falling Short intervention is not triggered by 2034 (overloads are not seen in any season).

Solution Options

A list of each of the options considered for this constraint is given below.

Table 2.4.2 solution options to solve constraint(s)

Option	Description
Reinforcement	
1	Uprate the transformers and circuits to Castle Donington primary.
2	Install a third transformer at Castle Donington primary.
Operational Mitigation	
3	Alternative running arrangements.
Flexibility Services	
4	Procure flexibility under Castle Donington primary.

Solution Development

These options have been assessed on their technical viability and their likely cost-effectiveness pending a full CBA. This CBA will be subsequently carried out by the DNO to determine the optimal reinforcement solution, which will then be tested against market provided flexibility by the DSO as part of the DNOA process.

Option 1 – Uprate the transformers and circuits to Castle Donington primary

Viable

Capacity released for constraint(s) considered: Dependent on circuit works

New limiting factor for constraint(s) considered: 33 kV circuit ratings

Detailed description: Uprating the transformers at Castle Donington would resolve the thermal constraint seen on them, and would also benefit the condition of the assets as the current units are over 60 years old. The new units could be 12/24 MVA or 20/40 MVA units, with the size to be determined as forecasts evolve in future DFES publications and NDP reports.

If the primary transformers at Castle Donington were uprated the next limiting factor would be the 33 kV circuits to the primary (in particular the circuit to T1 as it also picks up half of the load from Melbourne primary). The alternative running arrangements discussed in option 3 below could provide a short term solution but in the long term reinforcement of the 33 kV infeeds may be necessary. This could be achieved in two ways: by uprating the circuits themselves or by building new 33 kV circuits from Trent Lane primary.

On the existing circuits, 3 MVA of capacity could be added by uprating relatively short sections of underground cable on each circuit (less than 400 m in total). Uprating the circuits further would require much more extensive circuit works. If new circuits were built from Trent Lane primary (which is only around 1.5 km away) the circuit capacity to Castle Donington would be increased significantly (assuming the existing circuits were retained), because as noted in Section 2.2 of this report the 33 kV circuits to Trent Lane are highly rated. Given the proximity of the primaries there could be potential to transfer load at 11 kV to Trent Lane. The viability and magnitude of these transfers (and the associated costs if new 11 kV network needed building) would need to be assessed as part of a full 11 kV study.

Creating additional 33 kV circuit capacity to Castle Donington primary could create other opportunities such as the ability to transfer Worthington primary into Spondon BSP (the implications of which are discussed in the Coalville 33 kV report).

Option 2 – Install a third transformer at Castle Donington primary

Discounted

Capacity released for constraint(s) considered: Minimal

New limiting factor for constraint(s) considered: As before

Detailed description: Installing a third transformer at Castle Donington would necessitate building a new 33 kV circuit to the substation as the 33 kV circuits to Melbourne and Worthington primaries are both unsuitable for the purpose of supplying a transformer at Castle Donington. This is due to the fact that both would create loose couples with other BSPs, and in the case of the circuit to Worthington would loose couple Willington and Enderby GSPs (the circuits to Mantle Lane primary which supply Worthington are also projected to be constrained already as discussed in the Coalville 33 kV report). A third circuit could be built from Trent Lane primary, but this would leave two transformers at Castle Donington supplied by one busbar at Spondon BSP (so minimal capacity would be added).

Although a third 33 kV busbar could at some point be added to Spondon BSP (as discussed in Section 2.3 of this report), this option has still been discounted as it would not benefit the condition of the existing transformers as option 1 described above would (so the existing transformers would likely need replacing based on their condition soon regardless).

Option 3 – Alternative running arrangements

Viable

Capacity released for constraint(s) considered: Resolves circuit constraints

New limiting factor for constraint(s) considered: Transformer ratings

Detailed description: For arranged outages on the infeed to Melbourne primary from Derby South BSP the T1 LV circuit breaker could be opened at Castle Donington primary. This would leave Castle Donington fully supplied by the circuit to T2, and Melbourne fully supplied by the circuit to T1, preventing any overloads for subsequent faults. This could be effective in managing the N-2 constraints seen on the circuit to Castle Donington T1.

Another option would be to feed Melbourne fully from Derby South under normal running arrangements which could help alleviate the projected N-1 circuit constraints. However, Melbourne would still need to be fed from Spondon BSP for arranged or fault outages on its infeed from Derby South. Neither of these alternative running arrangements would help alleviate the constraints seen on the transformers at Castle Donington (so this solution alone is not sufficient to fully manage this constraint) and both would reduce security of supply for Castle Donington primary (but would still allow the network to remain compliant with the demand security requirements outlined in Engineering Recommendation P2).

Option 4 – Procure flexibility under Castle Donington primary

Viable

Flexibility service type: Generation turn up/demand turn down.

Detailed description: Flexibility services could be procured to alleviate the projected overloads seen on the transformers at Castle Donington primary and the circuit to T1. Flexibility procured at Melbourne primary could also be used to help prevent overloads on the circuit to T1, but would not provide any benefit for the transformers at Castle Donington. The procurement of flexibility would also provide no benefit for the condition of the transformers at Castle Donington. The viability of utilising flexibility will be further investigated as part of the DNOA process.

Solution Recommendation

Uprating the transformers at Castle Donington primary has been identified as the optimal reinforcement strategy, providing additional demand capacity at the substation and benefiting the condition of the transformers. The running arrangements discussed in option 3 could help defer the need for reinforcement of the 33 kV infeeds to Castle Donington, but in the long term intervention will likely still be required (either uprating the existing circuits or building new circuits from Trent Lane primary).

Some of the demand growth forecast at Castle Donington primary is due to hydrogen electrolysis (with very high growth in the technology in the area forecast beyond 2034 as well). If this hydrogen electrolysis were to connect directly to Spondon BSP (or have a dedicated 132 kV connection as the level of hydrogen electrolysis forecast by 2050 would necessitate) then some of the strategies discussed above for Castle Donington would not be required (at least in the short and medium term) as growth at the primary is projected to be relatively slow without the addition of hydrogen electrolysis. The uprating of the transformers would however likely be triggered regardless due to the additional condition based driver for investment which will provide an economic opportunity to add capacity.

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