ofgem
Making a positive difference
for energy consumers

# Long Term Development Statement (LTDS)
# Capacity Heatmaps Appendix 1: Information Model

**Publication date:** 10 January 2024

This document outlines the Capacity Heatmap information model which describes the structure of data supplied under the Capacity Heatmaps requirement for the LTDS.

## Contents

# 1 Introduction

This document provides detailed information regarding the data structure and format for the capacity heatmaps data. It provides an overview of the information model, and a detailed breakdown of each data element, its properties, relationships, and data types.

The capacity heatmaps data structure is defined in the Unified Modelling Language (UML) and as such is serialisation-agnostic. A Javascript Object Notation (JSON) serialisation format is given for each data type. Network operators are expected to provide this format at a minimum. Alternative formats can be produced.

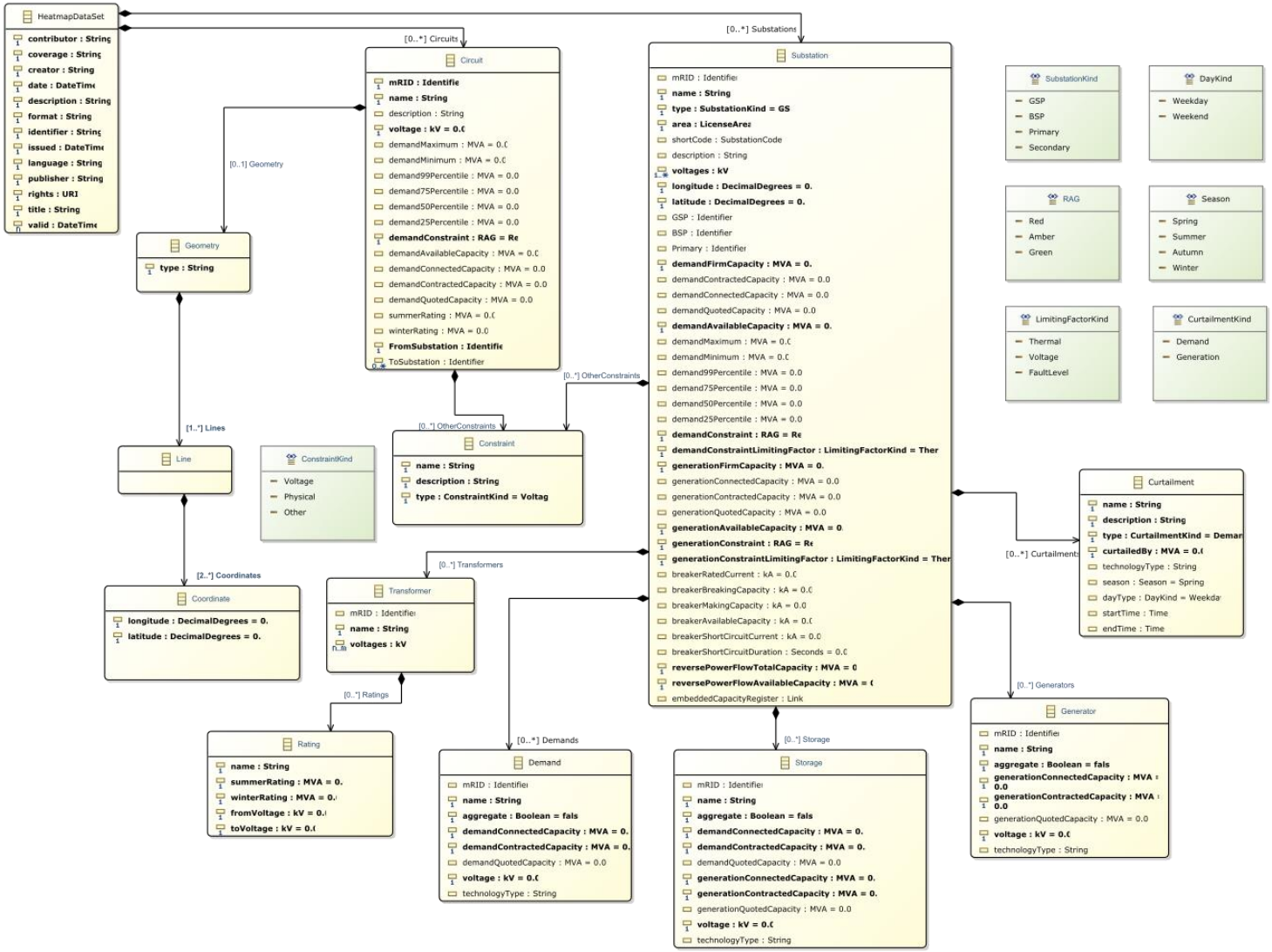
# 2 Capacity Heatmaps Information Model

## 2.1 Background

The capacity heatmaps information model was defined to cover a superset of data exchanged by the GB distribution network operators. A minimum set of data is defined that all operators are expected to conform to, along with a number of optional properties and data types.

The data is intended to be presented as a hierarchy with a **HeatmapDataSet** at its root, then Substations and Circuits nested inside the HeatmapDataSet. Substations and Ciruits then have their own child elements forming a tree of data with the HeatmapDataSet at the root.

## 2.2 Class Diagram




The class diagram for the Capacity Heatmaps information model is shown here. This diagram shows the classes, properties, relationships, and data types. Properties in **bold** are required, with other optional.

# 3 Capacity Heatmap Data Elements

## 3.1 Overview

The data elements below include a table of properties. This includes attributes (single or multi-value numeric, text, date/time values) and references (other complex types referred to in the document). Multiplicity refers to the upper and lower limit of values expected. For datatypes, the type of data is shown along with the base serialisation type (e.g. MVA is apparent power – Volt Ampere with a Mega multiplier – but this would be serialised as a number).

The Example JSON sections show how this data would be serialised in JSON. The JSON attribute names are taken directly from the UML.[1]

[1] For the purpose of readability for some example JSON code the embedded data elements have been omitted. In the **HeatmapDataSet** the *Substations* and *Circuits* containment references are shown as [], but would contain a list of multiple elements as per the JSON serialisation shown for the Substation and Circuit elements as shown in their Example JSON data.

## 3.2 HeatmapDataSet

A single instance of a published dataset. The descriptions of these fields are taken from the Dublin Core Standard

### 3.2.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| contributor | * | String (string) | 1..1 | An entity responsible for making contributions to the resource. (http://purl.org/dc/terms/contributor) |
| coverage | * | String (string) | 1..1 | The spatial or temporal topic of the resource, spatial applicability of the resource, or jurisdiction under which the resource is relevant. http://purl.org/dc/terms/coverage (http://purl.org/dc/terms/contributor) |
| creator | * | String (string) | 1..1 | An entity responsible for making the resource. (http://purl.org/dc/terms/creator) |
| date | * | DateTime (string) | 1..1 | A point of time associated with an event in the lifecycle of the resource. For this implementation this will represent the date the data set is valid from (http://purl.org/dc/terms/date) |
| description | * | String (string) | 1..1 | An account of the resource. (http://purl.org/dc/terms/description) |
| format | * | String (string) | 1..1 | The file format of the resource (http://purl.org/dc/terms/format) |
| identifier | * | String (string) | 1..1 | An unambiguous reference to the resource within a given context. (http://purl.org/dc/terms/identifier) |
| issued | * | DateTime (string) | 1..1 | Date of formal issuance of the resource. (http://purl.org/dc/terms/issued) |
| language | * | String (string) | 1..1 | A language of the resource. (http://purl.org/dc/terms/language) |

| | | | | |
|---|---|---|---|---|
| publisher | * | String (string) | 1..1 | An entity responsible for making the resource available. (http://purl.org/dc/terms/publisher) |
| rights | * | URI (string) | 1..1 | Information about rights held in and over the resource. (http://purl.org/dc/terms/rights) |
| title | * | String (string) | 1..1 | A name given to the resource. (http://purl.org/dc/terms/title) |
| valid | * | DateTime (string) | 2..2 | A date range for the validity of a resource. This should be two dates to form a range. The first date is inclusive and the second date exclusive (http://purl.org/dc/terms/valid) |
| Substations | | Substation | 0..n | A list of substations with heatmap data |
| Circuits | | Circuit | 0..n | A list of circuits with heatmap data |

### 3.2.2 Example JSON


```
{
    "Circuits": [],
    "Substations": [],
    "contributor": "My Network Operator North, My Network Operator South",
    "coverage": "North of Scotland, South of England",
    "date": "2024-01-01T00:00:00.000+0000",
    "description": "A heatmaps dataset combined for north and south",
    "format": "application/json",
    "identifier": "c91a4b42-4b21-476d-9c6f-5201a1324b2b",
    "issued": "2023-12-22T00:54:52.196+0000",
    "language": "en",
    "publisher": "My Network Operator",
    "rights": "https://www.mynetworkoperators/link/to/license",
    "title": "North South Heatmap Data",
    "valid": [
        "2024-01-01T00:00:00.000+0000",
        "2024-04-01T00:00:00.000+0000"
    ]
}
```

## 3.3 Substation

A Substation with connect demand, generation or storage. A substation can be either a Grid Supply Point (GSP), Bulk Supply Point (BSP), Primary or Secondary station.

### 3.3.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| mRID | | Identifier (string) | 0..1 | The Master Resource ID of the Substation. Where CIM data is being produced for LTDS this ID should be present, persistent across each release of the data and should be the same as the mRID/rdf:ID of the CIM Substation. If data is produced prior to the CIM LTDS data being published this attribute is optional. |
| name | * | String (string) | 1..1 | The human readable name of the substation. This should be consistent with the naming used in LTDS, either Tables 1-8 of existing Excel format, or CIM Substation names for the CIM LTDS data |
| type | * | SubstationKind (string) | 1..1 | The type of the substation |
| area | * | LicenseArea (string) | 1..1 | The name of the license area. This may be the full text name or an abbreviation that should align with the abbreviations used in the license (e.g. Eastern Power Networks or EPN) |
| shortCode | | SubstationCode (string) | 0..1 | Short code name for substation (alphanumeric, uppercase letters only) |
| description | | String (string) | 0..1 | Free text for any additional descriptive data about the substation |
| voltages | * | kV (number) | 1..n | The voltages at the Substation in Kilovolts (kV) |

| | | | | |
|---|---|---|---|---|
| longitude | * | DecimalDegrees (number) | 1..1 | The longitude value of the substation as a single latitude/longitude point. For a GeoJSON Heatmap format this data will be part of the feature itself allowing for more complex geometry |
| latitude | * | DecimalDegrees (number) | 1..1 | The latitude value of the substation as a single latitude/longitude point. For a GeoJSON Heatmap format this data will be part of the feature itself allowing for more complex geometry |
| GSP | | Identifier (string) | 0..1 | The name or identifier of the GSP this Substation is within. It is assumed the corresponding Substation will be contained within the data. Optional as a GSP Substation will not have this reference |
| BSP | | Identifier (string) | 0..1 | The name or identifier of the BSP this Substation is supplied by. It is assumed the corresponding Substation will be contained within the data. Optional as a GSP or BSP Substation will not have this reference, and the Scottish networks do not have BSPs |
| Primary | | Identifier (string) | 0..1 | The name or identifier of the Primary this Substation is supplied by. It is assumed the corresponding Substation will be contained within the data. Optional as a GSP, BSP or Primary Substation will not have this reference |
| demandFirmCapacity | * | MVA (number) | 1..1 | The firm capacity for demand at the substation. Any constraints that impact this capacity should be listed as individual constraints linked to the substation |
| demandContractedCapacity | | MVA (number) | 0..1 | Sum of all demand currently contracted at the substation which is not yet connected (i.e. do not include any demand that is included in demandConnectedCapacity). This includes individual demands and storage that are explicitly defined and aggregate value of other connect demands and storage. The value for demandContractedCapacity |

| | | | | |
|---|---|---|---|---|
| | | | | must be greater than or equal to the sum of the demandContractedCapacity values in the demand and Storage elements |
| demandConnectedCapacity | | MVA (number) | 0..1 | Sum of all demand currently connected at the substation. This includes individual demands and storage that are explicitly defined and aggregate value of other connect demands and storage. The value for demandConnectedCapacity must be greater than or equal to the sum of the demandConnectedCapacity values in the demand and Storage elements. |
| demandQuotedCapacity | | MVA (number) | 0..1 | Sum of all demand currently quoted at the substation excluding contracted and connected (i.e. does not include demandConnectedCapacity or demandContractedCapacity). This includes individual demands and storage that are explicitly defined and aggregate value of other connect demands and storage. The value for demandQuotedCapacity must be greater than or equal to the sum of the demandQuotedCapacity values in the demand and Storage elements |
| demandAvailableCapacity | * | MVA (number) | 1..1 | The available demand capacity at the substation. This value is calculated based on total firm capacity, maximum demand, connected capacity, quoted capacity, contracted capacity, and any other constraints on the network. The value should reflect the capacity a network operator would make available to a connecting party, which may be calcualted for the most onerous season, or a value based on more detailed analysis and internal policies |
| demandMaximum | | MVA (number) | 0..1 | The maximum demand at the substation. This is a normalised value calculated using historic measured values during normal operating conditions .The data represents net demand corrected for any generation at the substation, demand diversity factors, and any |

| | | | | |
|---|---|---|---|---|
| | | | | other internal processing normally undertaken. All substations at 33kV and above must include demand data; for substations below 33kV, if corrected, net demand data is not available, the value should be omitted. Users wishing to see separate summer/winter peaks can obtain this from the LTDS data |
| demandMinimum | | MVA (number) | 0..1 | The minimum demand at the substation. This is a normalised value calculated using historic measured values during normal operating conditions. The data represents net demand corrected for any generation at the substation, demand diversity factors, and any other internal processing normally undertaken. All substations at 33kV and above must include demand data; for substations below 33kV, if corrected, net demand data is not available, the value should be omitted. Users wishing to see separate summer/winter peaks can obtain this from the LTDS data |
| demand99Percentile | | MVA (number) | 0..1 | The 99th percentile of demanding at the substation. This is a normalised value calculated using historic measured values during normal operating conditions. The data represents net demand corrected for any generation at the substation, demand diversity factors, and any other internal processing normally undertaken. All substations at 33kV and above must include demand data; for substations below 33kV, if corrected, net demand data is not available, the value should be omitted. |
| demand75Percentile | | MVA (number) | 0..1 | The 75th percentile of demanding at the substation. This is a normalised value calculated using historic measured values during normal operating conditions. The data represents net demand corrected for any generation at the substation, demand diversity factors, and any other internal processing normally undertaken. All substations at 33kV and above must |

| | | | | |
|---|---|---|---|---|
| | | | | include demand data; for substations below 33kV, if corrected, net demand data is not available, the value should be omitted. |
| demand50Percentile | | MVA (number) | 0..1 | The 50th percentile of demanding at the substation. This is a normalised value calculated using historic measured values during normal operating conditions. The data represents net demand corrected for any generation at the substation, demand diversity factors, and any other internal processing normally undertaken. All substations at 33kV and above must include demand data; for substations below 33kV, if corrected, net demand data is not available, the value should be omitted. |
| demand25Percentile | | MVA (number) | 0..1 | The 25th percentile of demanding at the substation. This is a normalised value calculated using historic measured values during normal operating conditions. The data represents net demand corrected for any generation at the substation, demand diversity factors, and any other internal processing normally undertaken. All substations at 33kV and above must include demand data; for substations below 33kV, if corrected, net demand data is not available, the value should be omitted. |
| demandConstraint | * | RAG (string) | 1..1 | A RAG definition of the demand constraints at the substation. A utility should provide details on how this RAG status is calculated as part of the accompanying documentation |
| demandConstraintLimitingFactor | * | LimitingFactorKind (string) | 1..1 | The limiting factor for demand constraints, either thermal, voltage or fault level for the demandConstraint value |
| generationFirmCapacity | * | MVA (number) | 1..1 | The total firm generation capacity of the substation. Any constraints that impact this capacity should be listed as individual constraints linked to the substation |

| | | | | |
|---|---|---|---|---|
| generationConnectedCapacity | | MVA (number) | 0..1 | Sum of all generation currently connected at the substation. This includes individual generation and storage that are explicitly defined and aggregate value of other connect generation and storage. The value forgenerationConnectedCapacity must be greater than or equal to the sum of the generationConnectedCapacity values in the Generator and Storage elements |
| generationContractedCapacity | | MVA (number) | 0..1 | Sum of all generation currently contracted at the substation which is not yet connected (i.e. do not include any generation that is included in generationConnectedCapacity). This includes individual generation and storage that are explicitly defined and aggregate value of other connect generation and storage. The value for generationContractedCapacity must be greater than or equal to the sum of the generationContractedCapacity values in the Generator and Storage elements |
| generationQuotedCapacity | | MVA (number) | 0..1 | Sum of all quoted currently generation at the substation excluding any that are already contracted or connected. This includes individual generation and storage that are explicitly defined and aggregate value of other connect generation and storage. The value for generationQuotedCapacity must be greater than or equal to the sum of the generationQuotedCapacity values in the Generator and Storage elements |
| generationAvailableCapacity | * | MVA (number) | 1..1 | Available generation capacity at the substation.This value is calculated based on total firm generation, capacity, demand, connected capacity, quoted capacity, contracted capacity, and any other constraints on the network |
| generationConstraint | * | RAG (string) | 1..1 | A RAG definition of the demand constraints at the substation. A utility should provide details on how this |

| | | | | |
|---|---|---|---|---|
| | | | | RAG status is calculated as part of the accompanying documentation |
| generationConstraintLimitingFactor | * | LimitingFactorKind (string) | 1..1 | The limiting factor for generation constraints, either thermal or fault level for the generationConstraint value |
| breakerRatedCurrent | | kA (number) | 0..1 | The rated normal current of the circuit breaker is the RMS value of the current with which the circuit breaker shall be able to carry continuously |
| breakerBreakingCapacity | | kA (number) | 0..1 | The short-circuit current that the breakers are capable of breaking. It is expressed in KA RMS at contact separation |
| breakerMakingCapacity | | kA (number) | 0..1 | The making current of the circuit breaker, when closed on a short circuit, is the peak value of the maximum current wave (including dc component) in the first cycle of the current after the circuit is closed by the circuit breaker |
| breakerAvailableCapacity | | kA (number) | 0..1 | The available capacity of the circuit breaker |
| breakerShortCircuitCurrent | | kA (number) | 0..1 | The short circuit current of a circuit breaker is the RMS value of current that a breaker can carry in a fully closed condition without damage, for the specified time interval under prescribed condition. These ratings are based on thermal limitation |
| breakerShortCircuitDuration | | Seconds (number) | 0..1 | Specified time interval the Short Circuit Current can be carried for without damage |
| reversePowerFlowTotalCapacity | * | MVA (number) | 1..1 | The reverse capacity for the substation from lower to higher voltage levels. 0 if there are no reverse powerflow capabilities |
| reversePowerFlowAvailableCapacity | * | MVA (number) | 1..1 | The available reverse capacity for the substation from lower to higher voltage levels. |

| | | | | |
|---|---|---|---|---|
| embeddedCapacityRegister | | Link (string) | 0..1 | A URL to the embedded capacity register entry for this station |
| Demands | | Demand | 0..n | The demands at the station covering connected, contracted and quoted. This data is optional and may aggregated into the substation attributes, but utilities may optionally provide details on individual demands. |
| Generators | | Generator | 0..n | The generators at the station covering connected, contracted and quoted. This data is optional and may aggregated into the substation attributes, but utilities may optionally provide details on individual generators. |
| Storage | | Storage | 0..n | The storage devices at the station covering connected, contracted and quoted. This data is optional and may aggregated into the substation attributes, but utilities may optionally provide details on individual storage devices |
| OtherConstraints | | Constraint | 0..n | An additional constraint on the Substation. |
| Transformers | | Transformer | 0..n | The transformers connected at the substation |
| Curtailments | | Curtailment | 0..n | Curtailments at the Substation |

### 3.3.2 Example JSON


```
{
    "BSP": "c7698a80b40ab978da9a03e053d82d42b9f907a4",
    "Curtailments": [],
    "Demands": [],
    "GSP": "4293c7249942d7c91a951b9bbc5d0519ec8ea18d",
    "Generators": [],
    "OtherConstraints": [],
    "Storage": [],
    "Transformers": [],
```

```
    "area": "Southern England",
    "demandAvailableCapacity": 0.6,
    "demandConstraint": "Amber",
    "demandConstraintLimitingFactor": "FaultLevel",
    "demandContractedCapacity": 0,
    "demandFirmCapacity": 30,
    "demandMaximum": 23.604368,
    "demandMinimum": 5.986012,
    "demandQuotedCapacity": 0,
    "generationAvailableCapacity": 0.2,
    "generationConstraint": "Green",
    "generationConstraintLimitingFactor": "Thermal",
    "generationContractedCapacity": 0.504,
    "generationFirmCapacity": 1.504,
    "generationQuotedCapacity": 0,
    "latitude": 51.749565,
    "longitude": -1.275823,
    "mRID": "248ff818f157022515afc2b8e3c65894449ab903",
    "name": "OSPREY",
    "reversePowerFlowAvailableCapacity": 0,
    "reversePowerFlowTotalCapacity": 0,
    "shortCode": "OSPE",
    "type": "Primary",
    "voltages": [
        33,
        11
    ]
}
```


## 3.4 Circuit

A circuit representing a connection between substations. This could be an HV circuit between stations or a circuit feeding multiple secondary stations from a primary. This data element is provided to support utilities that wish to share specfic or all circuits.

### 3.4.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| mRID | * | Identifier (string) | 1..1 | The Master Resource ID of the Circuit. Where CIM data is being produced for LTDS this ID should be present, persistent across each release of the data and should be the same as the mRID/rdf:ID of the CIM elements. If data is produced prior to the CIM LTDS data being published this attribute is optional. |
| name | * | String (string) | 1..1 | The human readable name of the circuit |
| description | | String (string) | 0..1 | Free text for any additional descriptive data about the circuit |
| voltage | * | kV (number) | 1..1 | Voltage of the circuit |
| demandMaximum | | MVA (number) | 0..1 | The maximum load on the circuit. This is a value calculated using historic measured values and would not necessarily be corrected for generation on the circuit and normal operating conditions. All circuits at 33kV and above must include demand data |
| demandMinimum | | MVA (number) | 0..1 | The minimum demand on the circuit. This is a value calculated using historic measured values and would not necessarily be corrected for generation on the circuit and normal operating conditions. All circuits at 33kV and above must include demand data. |
| demand99Percentile | | MVA (number) | 0..1 | The 99th percentile of demand on the circuit. This is a value calculated using historic measured values and would not necessarily be corrected for generation on the circuit and normal operating conditions. All circuits at 33kV and above must include demand data |
| demand75Percentile | | MVA (number) | 0..1 | The 75th percentile of demand on the circuit. This is a value calculated using historic measured values and would not necessarily be corrected |

| | | | | |
|---|---|---|---|---|
| | | | | for generation on the circuit and normal operating conditions. All circuits at 33kV and above must include demand data |
| demand50Percentile | | MVA (number) | 0..1 | The 50th percentile of demand on the circuit. This is a value calculated using historic measured values and would not necessarily be corrected for generation on the circuit and normal operating conditions. All circuits at 33kV and above must include demand data |
| demand25Percentile | | MVA (number) | 0..1 | The 25th percentile of demand on the circuit. This is a value calculated using historic measured values and would not necessarily be corrected for generation on the circuit and normal operating conditions. All circuits at 33kV and above must include demand data |
| demandConstraint | * | RAG (string) | 1..1 | A RAG definition of the demand constraints on the circuit. A utility should provide details on how this RAG status is calculated |
| demandAvailableCapacity | | MVA (number) | 0..1 | The available demand capacity on the circuit. This value is calculated based on the circuit rating, maximum demand, contracted capacity, and any other constraints on the network |
| demandConnectedCapacity | | MVA (number) | 0..1 | Sum of all demand currently connected on the circuit |
| demandContractedCapacity | | MVA (number) | 0..1 | Sum of all demand currently contracted on the circuit which are not yet connected (i.e. do not include any demand that is included in demandConnectedCapacity). |
| demandQuotedCapacity | | MVA (number) | 0..1 | Sum of all demand currently quoted on the circuit excluding contracted and connected (i.e. does not include demandConnectedCapacity or demandContractedCapacity). |
| summerRating | | MVA (number) | 0..1 | Summer rating for minimum rated section in the circuit (i.e. limiting series element) |
| winterRating | | MVA (number) | 0..1 | Winter rating for minimum rated section in the circuit (i.e. limiting series element) |
| FromSubstation | * | Identifier (string) | 1..1 | mRID of the Substation the Circuit is from (used where CIM data is being produced and the mRID attributes are populated for |

| | | | | |
|---|---|---|---|---|
| | | | | Substations). Where no CIM mRID is yet being produced, the name of the Substation should be used |
| ToSubstation | | Identifier (string) | 0..n | mRID of the Substations the Circuit is to (optional if LV circuits are shown but no LV/Secondary substations). Where CIM data is being produced the identifiers attributes reflect the mRID of the Substations . Where no CIM mRID is yet being produced, the names of the Substations should be used |
| OtherConstraints | | Constraint | 0..n | An additional constraint on the Circuit. |
| Geometry | | Geometry | 0..1 | The geometry of the circuit |

### 3.4.2 Example JSON


```
{
   "FromSubstation": "b3d5cdd9e3033cf61ec1e5c783a4aedeed93ae55",
   "Geometry": {
      "Lines": [{"Coordinates": [
         {
            "latitude": 56.397694,
            "longitude": -3.437605
         },
         {
            "latitude": 56.397602,
            "longitude": -3.4373312
         },
         {
            "latitude": 56.397587,
            "longitude": -3.4371276
         },
         {
            "latitude": 56.39722,
            "longitude": -3.4372349
         },
         {
            "latitude": 56.397186,
```

```
                "longitude": -3.436972
            },
            {
                "latitude": 56.39692,
                "longitude": -3.4370577
            },
            {
                "latitude": 56.396824,
                "longitude": -3.4359794
            },
            {
                "latitude": 56.39622,
                "longitude": -3.4361565
            },
            {
                "latitude": 56.395767,
                "longitude": -3.4361725
            }
        ]}],
        "type": "LineString"
    },
    "demandConstraint": "Amber",
    "mRID": "109cb050-a158-4df7-bd8e-a1e8b0469346",
    "name": "My Example Circuit",
    "voltage": 11
}
```


## 3.5 Demand

Represents an individual or aggregated demand at the substation. This may represent the aggregation of all generation at a voltage level or individual connected/contracted/quoted generators.

### 3.5.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| mRID | | Identifier (string) | 0..1 | The Master Resource ID of the demand. Where CIM data is being produced for LTDS this ID should be present, persistent across each release of the data and should be the same as the mRID/rdf:ID of the CIM elements. If data is produced prior to the CIM LTDS data being published this attribute is optional. |
| name | * | String (string) | 1..1 | The human readable name of the demand |
| aggregate | * | Boolean (boolean) | 1..1 | True if the demand represents an aggregation of multiple demands all connected at a single voltage level |
| demandConnectedCapacity | * | MVA (number) | 1..1 | The currently connected demand capacity |
| demandContractedCapacity | * | MVA (number) | 1..1 | The currently contracted demand capacity which is not yet connected (i.e. do not include any demand that is included in demandConnectedCapacity) |
| demandQuotedCapacity | | MVA (number) | 0..1 | The currently active quoted demand capacity excluding contracted and connected (this is optional as connected/contracted generation may not have records of quotes and after a value is contracted this value is no longer relevant) |
| voltage | * | kV (number) | 1..1 | The voltage the demand is connected at |
| technologyType | | String (string) | 0..1 | The technology the connected demand |

### 3.5.2 Example JSON

```
{
   "aggregate": false,
   "demandConnectedCapacity": 157.58,
   "name": "New Demand Project",
   "voltage": 132
```

```
}
```

## 3.6 Generator

Represents an individual or aggregated generator at the substation. This may represent the aggregation of all generation at a voltage level or individual connected/contracted/quoted generators.

### 3.6.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| mRID | | Identifier (string) | 0..1 | The Master Resource ID of the Generator. Where CIM data is being produced for LTDS this ID should be present, persistent across each release of the data and should be the same as the mRID/rdf:ID of the CIM elements. If data is produced prior to the CIM LTDS data being published this attribute is optional. |
| name | * | String (string) | 1..1 | The human readable name of the generator |
| aggregate | * | Boolean (boolean) | 1..1 | True if the generator represents an aggregation of multiple generators all connected at a single voltage level. If technologyType is left blank it is assumed that the Generator aggregates all generation types. If technologyType is populated and aggregate is true the Generator reflects the aggregate of that type of generation |
| generationConnectedCapacity | * | MVA (number) | 1..1 | The currently connected generation capacity |
| generationContractedCapacity | * | MVA (number) | 1..1 | The currently contracted generation capacity excluding any that are already contracted or connected (i.e. do not include any generation that is included in generationConnectedCapacity) |
| generationQuotedCapacity | | MVA (number) | 0..1 | The currently active quoted generation capacity above contracted (this is optional as connected/contracted generation may not have records of quotes and after a value is contracted this value is no longer relevant) |

| | | | | |
|---|---|---|---|---|
| voltage | * | kV (number) | 1..1 | The voltage the generator is connected at |
| technologyType | | String (string) | 0..1 | The technology the connected generation e.g. CHP, Wind, PV, Battery |

### 3.6.2 Example JSON

```
{
    "aggregate": false,
    "generationConnectedCapacity": 2.8,
    "generationContractedCapacity": 0,
    "name": "New Generator Project",
    "voltage": 11
}
```

## 3.7 Storage

Represents an individual or aggregated storage at the substation. This may represent the aggregation of all storage at a voltage level or individual connected/contracted/quoted storage.

### 3.7.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| mRID | | Identifier (string) | 0..1 | The Master Resource ID of the Storage device. Where CIM data is being produced for LTDS this ID should be present, persistent across each release of the data and should be the same as the mRID/rdf:ID of the CIM elements. If data is produced prior to the CIM LTDS data being published this attribute is optional. |
| name | * | String (string) | 1..1 | The human readable name of the storage device |

| | | | | |
|---|---|---|---|---|
| aggregate | * | Boolean (boolean) | 1..1 | True if the generator represents an aggregation of multiple storage devices all connected at a single voltage level. If technologyType is left blank it is assumed that the Storage aggregates all storage types. If technologyType is populated and aggregate is true the Storage reflects the aggregate of that type of storage |
| demandConnectedCapacity | * | MVA (number) | 1..1 | The currently connected demand capacity |
| demandContractedCapacity | * | MVA (number) | 1..1 | The currently contracted demand capacity which is not yet connected (i.e. do not include any demand that is included in demandConnectedCapacity) |
| demandQuotedCapacity | | MVA (number) | 0..1 | The currently active quoted demand capacity excluding contracted and connected (this is optional as connected/contracted generation may not have records of quotes and after a value is contracted this value is no longer relevant) |
| generationConnectedCapacity | * | MVA (number) | 1..1 | The currently connected generation capacity |
| generationContractedCapacity | * | MVA (number) | 1..1 | The currently contracted generation capacity excluding any that are already contracted or connected (i.e. do not include any generation that is included in generationConnectedCapacity) |
| generationQuotedCapacity | | MVA (number) | 0..1 | The currently active quoted generation capacity above contracted (this is optional as connected/contracted generation may not have records of quotes and after a value is contracted this value is no longer relevant) |
| voltage | * | kV (number) | 1..1 | The voltage the storage is connected at |
| technologyType | | String (string) | 0..1 | The technology the connected generation e.g. PumpStorage, Battery |

### 3.7.2 Example JSON

```
{
```

```
    "aggregate": false,
    "demandConnectedCapacity": 21.3,
    "demandContractedCapacity": 0,
    "generationConnectedCapacity": 1.8,
    "generationContractedCapacity": 0,
    "name": "New Storage Project",
    "voltage": 11
}
```


## 3.8 Transformer

A transformer at a substation. Optional but can be useful if ratings and capacity are required on a per-transformer level.

### 3.8.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| mRID | | Identifier (string) | 0..1 | The Master Resource ID of the Traansformer. Where CIM data is being produced for LTDS this ID should be present, persistent across each release of the data and should be the same as the mRID/rdf:ID of the CIM PowerTransformer. If data is produced prior to the CIM LTDS data being published this attribute is optional. |
| name | * | String (string) | 1..1 | The human readable name of the storage device |
| voltages | * | kV (number) | 2..3 | The primary, secondary (and optional tertiary) voltages of the transformer |
| Ratings | | Rating | 0..n | The ratings of the transformer as defined by the Ratings element |

### 3.8.2 Example JSON


```
{
    "Ratings": [{
        "fromVoltage": 33,
        "name": "Operational",
        "summerRating": 100,
```

```
        "toVoltage": 11,
        "winterRating": 120
    }],
    "name": "Transformer",
    "voltages": [
        11,
        33
    ]
}
```


## 3.9 Rating

A rating assigned to a transformer. This would allow multiple ratings to be defined for a single transformer e.g. OFAF ONAN and different ratings for different voltages (e.g. 11->33 is different from 33->11 for reverse powerflow).

### 3.9.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| name | * | String (string) | 1..1 | Human readble name of the rating |
| summerRating | * | MVA (number) | 1..1 | Summer Rating in MVA |
| winterRating | * | MVA (number) | 1..1 | Winter Rating in MVA |
| fromVoltage | * | kV (number) | 1..1 | From voltage for the rating |
| toVoltage | * | kV (number) | 1..1 | To voltage for the rating |

### 3.9.2 Example JSON


```
{
    "fromVoltage": 33,
    "name": "Operational",
    "summerRating": 100,
    "toVoltage": 11,
```

```
    "winterRating": 120
}
```

## 3.10 Constraint

An additional constraint/restriction on the Substation or Circuit. This is intended for non-numeric constraints e.g. to denote physical restrictions on reinforcement.

### 3.10.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| name | * | String (string) | 1..1 | Human readable name of the constraint |
| description | * | String (string) | 1..1 | Free text for any additional descriptive data about the constraint |
| type | * | ConstraintKind (string) | 1..1 | The type of constraint (enumerated field to allow for easier processing/identification) |

### 3.10.2 Example JSON

```
{
    "description": "No room for upgrades",
    "name": "Station Constraint",
    "type": "Physical"
}
```

## 3.11 Curtailment

Curtailment of demand or generation capacity at the substation with optional day/time and season parameters.

### 3.11.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| name | * | String (string) | 1..1 | Human readable name of the curtailment |
| description | * | String (string) | 1..1 | Free text for any additional descriptive data about the curtailment |
| type | * | CurtailmentKind (string) | 1..1 | The type of curtailment (enumerated field to allow for easier processing/identification) |
| curtailedBy | * | MVA (number) | 1..1 | The amount the demand/generation capacity is curtailed by |
| technologyType | | String (string) | 0..1 | The technology the curtailment applies to e.g for generation CHP, Wind, PV, Battery |
| season | | Season (string) | 0..1 | The season this curtailment applies during |
| dayType | | DayKind (string) | 0..1 | The type of day the curtailment applies during (weekday or weekend) |
| startTime | | Time (string) | 0..1 | The start time of a curtailment (inclusive) |
| endTime | | Time (string) | 0..1 | The end time of a curtailment (exclusive) |

### 3.11.2 Example JSON

```
{
    "curtailedBy": 50,
    "dayType": "Weekday",
    "description": "Reduced generation capacity in the afternoon",
    "endTime": "16:00",
    "name": "Low load curtailment",
    "startTime": "11:00",
    "type": "Generation"
}
```

## 3.12 Geometry

The geometry of the line, this will be one or more Lines i.e. series of ordered coordinates. Multiple Lines allowed to allow for radial geometries. It is likely that this will be rendered as a GeoJSON geometry in that format.

### 3.12.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| type | * | String (string) | 1..1 | The geometry type (LineString or MultiLineString) |
| Lines | * | Line | 1..n | The Line elements |

### 3.12.2 Example JSON


```
{
   "Lines": [{"Coordinates": [
      {
         "latitude": 56.397694,
         "longitude": -3.437605
      },
      {
         "latitude": 56.397602,
         "longitude": -3.4373312
      },
      {
         "latitude": 56.397587,
         "longitude": -3.4371276
      },
      {
         "latitude": 56.39722,
         "longitude": -3.4372349
      },
      {
         "latitude": 56.397186,
         "longitude": -3.436972
      },
      {
         "latitude": 56.39692,
         "longitude": -3.4370577
      },
      {
```

```
            "latitude": 56.396824,
            "longitude": -3.4359794
        },
        {
            "latitude": 56.39622,
            "longitude": -3.4361565
        },
        {
            "latitude": 56.395767,
            "longitude": -3.4361725
        }
    ]}],
    "type": "LineString"
}
```


## 3.13 Line

A series of coordinates.

### 3.13.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| Coordinates | * | Coordinate | 2..n | 2 or more coordinates for a line |

### 3.13.2 Example JSON


```
{"Coordinates": [
    {
        "latitude": 56.397694,
        "longitude": -3.437605
    },
    {
        "latitude": 56.397602,
        "longitude": -3.4373312
```

```
   },
   {
      "latitude": 56.397587,
      "longitude": -3.4371276
   },
   {
      "latitude": 56.39722,
      "longitude": -3.4372349
   },
   {
      "latitude": 56.397186,
      "longitude": -3.436972
   },
   {
      "latitude": 56.39692,
      "longitude": -3.4370577
   },
   {
      "latitude": 56.396824,
      "longitude": -3.4359794
   },
   {
      "latitude": 56.39622,
      "longitude": -3.4361565
   },
   {
      "latitude": 56.395767,
      "longitude": -3.4361725
   }
]}
```


## 3.14 Coordinate

A coordinate of latitude/longitude.

### 3.14.1 Properties

| Name | Required | Type | Multiplicity | Description |
|---|---|---|---|---|
| longitude | * | DecimalDegrees (number) | 1..1 | The longitude value of the coordinate as a single latitude/longitude point. For a GeoJSON Heatmap format this data will be part of the LineString geometry |
| latitude | * | DecimalDegrees (number) | 1..1 | The latitude value of the coordinate as a single latitude/longitude point. For a GeoJSON Heatmap format this data will be part of the LineString geometry |

### 3.14.2 Example JSON

```
{
    "latitude": 56.397694,
    "longitude": -3.437605
}
```