

# Policy Statement on Busbar Configuration

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# 1 Introduction

This policy provides a set of practical rules and considerations for **Busbar** configuration design for all new, existing, and planned 110 kV, 220 kV and 400 kV onshore transmission substations. Offshore assets, including the Offshore Compensation Compound are outside the scope of this policy.

This policy supports modular substation development. The standard **Busbar** configuration is the **Enhanced Ring Busbar**, with four HV bays per section for transmission substations. The **C-Type Busbar** configuration is the initial phase for the **Enhanced Ring Busbar** configuration.

The objective is to deliver a consistent approach to the design and operation of transmission substations in Ireland while ensuring a safe, secure, reliable, economical, efficient and co-ordinated electricity transmission system. The policy must assist to ensure the long-term ability of the transmission system to meet reasonable demands for electricity transmission. This is achieved by ensuring an adequate level of transmission substation reliability, and by extension consistent system-wide reliability, while ensuring that investment decisions maintain or improve reliability where required.

Over the life cycle of a transmission substation, the **Enhanced Ring Busbar** configuration is the most effective solution, based on cost, reliability, operational flexibility and capability to meet long-term system needs. The **Enhanced Ring Busbar** offers high levels of reliability and operational flexibility. Furthermore, the ring topology of the **Enhanced Ring Busbar** offers the advantage of increased asset utilisation, better substation through-flow capability and hence better overall system reliability.

## 1.1 Summary of Changes

VERSION	DATE	SUMMARY OF CHANGES/REASONS
V1.0	2009	Original Busbar Policy
V2.1	2013	Updated to, based on legal review, to reflect the EirGrid busbar position paper
V3.0	2015	Updated to address high number of derogations for existing substations
V4.0	2020	Restructuring of document and text edits throughout. Updates to reflect recommendations of joint working group of EirGrid, ESB Networks and ESB International on GIS substations. Changes to switchgear requirements for AIS C-Type Busbar configurations. Changes to text clarifying the minimum standard for C-Type Busbar configurations.
V5.1	2024&2025	<ol style="list-style-type: none"> <li>1. New Transmission Substations</li> </ol> Single Radial: - <ul style="list-style-type: none"> <li>- Introduces minimum Two Bay Substation for radial connections with TSO discretion for single bay non-extendable.</li> <li>- For a single radial station that consists of a minimum number of 4 bays, further expansion shall be designed to an Enhanced Ring Busbar configuration.</li> </ul> Meshed connection with single voltage level: - <ul style="list-style-type: none"> <li>- Option for C-Type operating more than 4 bays is limited to the decision of the TSO.</li> </ul>

2. Existing and Planned Transmission Substations:
  - Any reference to the rules for New Stations to be accounted for automatically.
  - Decision to migrate to C-type or Enhanced ring busbar to be at TSO discretion involving proper assessment.
3. Other changes:
  - The definition of Two Bay Extendable substation is added as an alternative for HV single bays.
  - For clarity, text is added to explain the capital contributions available and used since 2010.

# 2 Busbar Policy

This policy applies to all onshore substation development works. Substation development works are defined as works relating to connection offers executed after the effective policy date and transmission projects receiving capital approval after the effective policy date.

The requirements of this policy vary depending on if the substation development works are carried out at new, existing or planned transmission substations.

New substations are defined as radial or meshed 110 kV, 220 kV or 400 kV substations that are not already constructed and/or connected to the transmission system or do not have a detailed **Busbar** configuration specified in a connection offer executed before the effective date of this policy. Section 2.1 in this policy outlines **Busbar** configuration rules for substation development works at new transmission substations.

Existing substations are defined as radial or meshed 110 kV, 220 kV or 400 kV substations that are already constructed and/or connected to the transmission system.

Planned substations are defined as those having a detailed Busbar configuration specified in a connection offer executed before the effective date of this policy.

Section 2.2 in this policy outlines **Busbar** configuration rules for substation development works at existing and planned transmission substations.

Section 2.3 in this policy outlines general **Busbar** configuration rules for substation development works at new, existing, and planned substations.

Modification requests, received after the effective policy date, for connection offers executed before the effective policy date that result in significant and relevant changes to the **Busbar** configuration may result in a planned substation being reclassified as a new substation in the application of this policy, as determined by the Transmission System Operator (TSO).

Requirements outlined in this policy apply to Air Insulated Switchgear (AIS) and Gas Insulated Switchgear (GIS) substations unless otherwise stated.

## 2.1 New Transmission Substations

This section of the policy outlines the minimum requirements for new 110 kV, 220 kV and 400 kV transmission substations.

### 2.1.1 Substation with a single radial connection

A transmission substation with a single radial connection back to transmission system:

1. Shall be designed as a minimum **Two Bay Substation**, expandable to 4 or 8
2. Based on connection requirements or systems needs as determined by EirGrid, as TSO, may require the connection to be designed with a **C-Type Busbar** configuration.
3. With more than four **HV Bays** shall be designed with an **Enhanced Ring Busbar** configuration.
4. Based on connection requirements or systems needs as determined by EirGrid, as TSO, can be designed as **Single Bay Non-Extendable Substation**.

### 2.1.2 Switching station with a meshed connection

A transmission substation with a meshed connection with one voltage level that requires:

1. Up to four **HV Bays** shall be designed with a **C-Type Busbar** configuration.
2. More than four **HV Bays** shall be designed with an **Enhanced Ring Busbar** configuration.

3. Based on connection requirements or systems needs as determined by EirGrid, as TSO, more than four HV Bays can be energised with a **C-Type Busbar** configuration, provided the overall solution is designed to facilitate an **Enhanced Ring Busbar** configuration.

### 2.1.3 Meshed transmission substation

A meshed transmission substation with two or more transmission voltage levels<sup>1</sup> that requires:

1. Four HV Bays or less per transmission voltage level shall be designed with a **C-Type Busbar** or **Enhanced Ring Busbar** configuration at each voltage level with a maximum of two **System Transformers** permitted to connect the transmission voltage levels.
2. More than four HV Bays per voltage level shall be designed with an **Enhanced Ring Busbar** configuration for each voltage level with a maximum of four **System Transformers** split over two bus sections allowing to connect two transmission voltage levels.

### 2.1.4 Radial or meshed transmission substation

A radial or meshed transmission substation with two or more transmission voltage levels may have a combination of **C-Type Busbar** and **Enhanced Ring Busbar** configurations assuming HV Bay requirements in Sections 2.1.1 and 2.1.2 are met.

### 2.1.5 System Operator Preferred Connection Methods

In line with CER1118<sup>2</sup> and with 2010 TSO/DSO Group processing approach charging and rebating principles<sup>3</sup>, if the need for a larger busbar configuration is identified, the TSO, in planning an efficient network, may request new substations to be built larger than initially needed in order to meet the long-term development needs of the transmission system.

In instances where the TSO require a connection method which is over and above the Least Cost Chargeable (LCC), or Customer Preferred Connection Method (CPCM) if requested, then the customer's connection charges will be capped at the LCC or CPCM if applicable.

## 2.2 Existing and Planned Transmission Substations

This section of the policy outlines the rules for the **Busbar** configuration at existing and planned transmission substations.

1. A transmission substation without a **Busbar**, that requires the connection of additional HV Bay(s), shall be designed as a **C-Type Busbar** or **Enhanced Ring Busbar** depending on the rules outlined in Sections 2.1.1 and 2.1.2.
2. An AIS transmission substation with a **C-Type Busbar** configuration with less than four HV Bays, that requires one additional HV Bay, may remain as a **C-Type Busbar** transmission substation.
3. A transmission substation with a **C-Type Busbar** configuration and four HV Bays, which requires an additional HV Bay, may be extended incrementally<sup>4</sup> if a system needs assessment suggests that no additional HV Bays are required, and shall be designed so that the substation ultimately meets the standard **Enhanced Ring Busbar** configuration with four HV Bays per Busbar Section.

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<sup>1</sup> E.g. 400/220 kV, 400/110 kV, 220/110 kV or 400/220/110 kV

<sup>2</sup> [Financing of the SO Preferred Connection Method in Contestable Builds](#)

<sup>3</sup> [2025 Standard Transmission Charges | Eirgrid](#)

<sup>4</sup> Incremental expansion may significantly impact the service continuity of the Busbar section being extended.

<sup>5</sup> Changes to GIS standard designs present risks associated with extensions of GIS substations.

4. The Busbar Configuration Guide<sup>6</sup> may be used to determine if an additional **HV Bay**, a replacement **HV Bay**, a **Busbar** uprate, or a substation refurbishment drives the requirement for migration to a **C-Type Busbar** or **Enhanced Ring Busbar** configuration at an existing or planned transmission substation. EirGrid, as the TSO, could make decisions to determine the reason for migration to a C-Type busbar or enhanced ring busbar. Decision taken by the TSO must ensure that existing and planned transmission substation development and operation, and the corresponding decision making, is carried out in a consistent manner, while ensuring a safe, secure and reliable transmission power system is delivered in an economic manner.

## 2.3 General Substation Considerations

This section of the policy outlines additional considerations, irrespective of the substation being classified as new, existing, or planned.

1. The Transmission System Security and Planning Standards<sup>7</sup> (TSSPS) shall be complied with when considering a substation **Busbar** configuration.
2. A **Busbar Section** shall have no more than:
  - Four **HV Bays** for a meshed substation, and
  - Four **HV Bays** for a radial substation.
3. A minimum of three **HV Bays** are required in an initial **C-Type Busbar** configuration, unless the TSO specifies that a **C-Type Busbar** shall be implemented as the initial development for less than three **HV Bays**. Once fully extended each **Busbar Section** in both **C-Type Busbar** and **Enhanced Ring Busbar** configurations shall contain four **HV Bays**.
4. For GIS, four fully equipped **HV Bays** shall be provided as standard in a **C-Type Busbar** configuration<sup>8</sup> where only three **HV Bays** are required in the initial build.
5. The design of a substation with a **C-Type Busbar** configuration shall facilitate expansion, with minimal operational disruption, to an **Enhanced Ring Busbar** configuration:
  - A GIS transmission substation shall be laid out in a manner which includes a full **Sectionaliser Bay** (Figure 3) on each **Busbar**.
6. **GIS Wing Coupler** and **Sectionaliser Bays** shall be installed in their final location<sup>9</sup>. Service continuity implications do not permit relocation of these two bay types.
7. The design of a substation with an **Enhanced Ring Busbar** configuration shall facilitate expansion with minimal operational interruption<sup>10</sup> where extension is foreseeable e.g. extension of 8 bay **Enhanced Ring Busbar** configuration to 12 bay **Enhanced Ring Busbar** configuration. In the case of GIS substations, this may be achieved where practicable by **Busbar**

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<sup>6</sup> [Busbar configuration guide](#)

<sup>7</sup> [EirGrid-Transmission-System-Security-and-Planning-Standards-TSSPS-Final-May-2016-APPROVED.pdf](#)

<sup>8</sup> Provision of four HV Bays as part of initial development ensures that significant service continuity impacts are avoided for GIS substations.

<sup>9</sup> Outcome of joint EirGrid, ESB Networks and ESB International Working Group 2018

<sup>10</sup> Short duration outages of Busbar sections and outages to secondary systems such as Busbar protection and interlocking are anticipated to incorporate new bays.

coupling of two sectionaliser bays, as shown in Figure 5, or by installing a fully functioning coupler bay to join two sectionaliser bays or by some other acceptable means to the TSO.

8. Regarding unequipped **Future HV Bays**:
  - They are not permitted in GIS substations.
  - They are permitted in AIS substations. Post insulators shall be installed at **Busbars** on all **Future HV Bays** to minimise future outages for equipping bays.
9. The number of **Spare Bays** required should be based on:
  - An assessment of transmission system needs at the substation; or
  - Plans outlined in strategic publications such as the latest national Transmission Development Plan or European Ten-Year Network Development Plan.
10. GIS building sizes shall consider substation extendibility on a project-by-project basis. Service continuity requirements are captured in the latest version of the EirGrid GIS functional specification, XDS-GFS-25-001<sup>11</sup>.
11. 110 kV, 220 kV and 400 kV transmission substation **Busbars** shall not use XLPE cable. Solid tubular **Busbar** or stranded conductor shall be used for AIS **Busbar**. Gas insulated bus duct shall be used for GIS substations.

## 3 Application

This policy applies to all substation development works at new, planned and existing 110 kV, 220 kV and 400 kV transmission substations in Ireland effective from the approval date in the revision history section.

Offshore assets, including the Offshore Compensation Compound are outside the scope of this policy.

## 4 Derogation

Exception from the minimum requirements outlined in this policy can only be achieved by applying the **Derogation Policy**.

## 5 Definitions

**Busbar** Consisting of one or more **Busbar Sections** which are designated with the letters ‘A’ and ‘B’ in **C-Type Busbar** (Figure 2 and 3) and **Enhanced Ring Busbar** substations (Figure 4).

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<sup>11</sup> [XDS-GFS-25-001-R5-110-220-400kV-GIS.pdf](#)

<b>Busbar Section</b>		A <b>Busbar</b> consists of one or more <b>Busbar Sections</b> which are connected together, e.g. with a <b>Sectionalised Bay</b> or <b>Sectionalised Disconnecter</b> . For example a <b>C-Type Busbar</b> configuration consists of two <b>Busbars</b> (A and B) with one <b>Busbar Section</b> (A1 and B1) on each <b>Busbar</b> .
<b>C-Type Busbar</b>		<p>A <b>C-Type Busbar</b> configuration ( Figure 2 and 3) is the initial phase of an <b>Enhanced Ring Busbar</b> configuration which includes:</p> <ul style="list-style-type: none"> <li>• Two <b>Busbars</b>, each with one <b>Busbar Section</b>.</li> <li>• Up to: <ul style="list-style-type: none"> <li>○ Four <b>HV Bays</b> for a meshed and radial substation</li> </ul> </li> <li>• One <b>Wing Coupler</b>.</li> <li>• Two <b>Sectionalised Bays</b> for GIS substations.</li> </ul>
<b>Tail Substation</b>	<b>Fed</b>	A transmission substation with one connection to the transmission system. This is also referred to as Radial Substation.
<b>Single Bay Extendable Substation</b>	<b>Non-</b>	A <b>Tail Fed</b> AIS or GIS substation that is designed for the exclusive purpose of providing a connection to a single HV customer. The substation will not have a <b>Busbar</b> and will not have provision in its design for a <b>Busbar</b> to be installed in the future.
<b>Two Substation</b>	<b>Bay</b>	A <b>Tailed Fed Substation</b> (AIS only) that provides a single HV customer connection and which is designed for a future extension to a <b>C-type Busbar</b> configuration. The design shall consist of two <b>HV bays</b> , one for the HV customer connection and one for the incoming HV feeder bay, along with the associated section of <b>Busbar</b> and the four <b>Busbar Disconnecters</b> . One of the two <b>Busbars</b> shall be designated as ‘spare’. This means that it shall be physically in place but not made part of the transmission system. This is achieved by <u>not</u> installing the connections between the two <b>Busbar Disconnecters</b> and the spare <b>Busbar</b> .
<b>Circuit Breaker</b>		A mechanical switching device capable of making, carrying, and breaking current under intact and contingency operating conditions.
<b>Coupler</b>		A <b>Coupler</b> is used in a substation (typically double <b>Busbar</b> substations) to couple the A and B <b>Busbars</b> . A <b>Coupler</b> consists of a <b>Circuit Breaker</b> and a combination of <b>Busbar Disconnecters</b> and <b>Sectionalised Disconnecters</b> . <b>Couplers</b> can vary in design and can have varying numbers of <b>Busbar</b> and <b>Sectionalised Disconnecters</b> .
<b>Busbar Disconnecter</b>		A switch that connects or disconnects a <b>HV Bay</b> to the A and B <b>Busbars</b> .
<b>Enhanced Busbar</b>	<b>Ring</b>	<p>A <b>Busbar</b> configuration (examples in Figures 4, 5 and 6) that includes:</p> <ul style="list-style-type: none"> <li>• A double <b>Busbar</b> configuration formed as a closed loop with <b>Sectionalised Bays</b> and <b>Wing Couplers</b> in series.</li> <li>• A minimum of four (e.g. A1, B1, A2 and B2) <b>Busbar Sections</b>.</li> <li>• Two <b>Wing Couplers</b>.</li> <li>• A minimum of two <b>Sectionalised Bays</b>.</li> <li>• A maximum of four <b>HV Bays</b> per <b>Busbar Section</b> for a meshed and radial substation.</li> <li>• An even distribution of circuit and transformer bays per <b>Busbar Section</b> where feasible.</li> </ul>
<b>Future HV Bay</b>		An unequipped <b>Future HV Bay</b> , i.e. a <b>Future HV Bay</b> with no switchgear installed that provides space for a <b>Future HV Bay</b> .

<b>HV Bay</b>	Any bay (e.g. for a transformer, overhead line, underground cable, capacitor bank etc.) that is directly connected to the substation <b>Busbar</b> . A <b>HV Bay</b> does not include a bay used for equipment that couples <b>Busbars</b> or <b>Busbar Sections</b> such as <b>Couplers</b> , <b>Wing Couplers</b> or <b>Sectionalised Bays</b> .
<b>Largest Credible Generation Infeed</b>	Defined as the single largest generation unit or interconnector connected to Ireland's transmission system as defined in the most recent All-Island Transmission Forecast Statement.
<b>Meshed Substation</b>	A transmission substation with two or more connections to the transmission system.
<b>Non-Standard Configuration</b>	The exception to <b>Standard Configuration</b> is where the <b>Non-Standard Configuration</b> is employed to facilitate the connection and testing of new infrastructure or plant. The <b>Non-Standard Configuration</b> shall only be considered for planned or forced outages permissible under the EirGrid Transmission System Security Planning Standards (TSSPS) to permit maintenance, or following a forced outage, of one item of plant and equipment rather than for unusual generator patterns.
<b>Sectionalised Bay</b>	Consisting of a <b>Circuit Breaker</b> with two <b>Sectionalised Disconnectors</b> connecting two <b>Busbar Sections</b> on the same <b>Busbar</b> (e.g. connecting A1 to A2).
<b>Sectionalised Disconnector</b>	A switch that connects or disconnects two <b>Busbar Sections</b> , e.g. A1 and A2.
<b>Radial Substation</b>	A transmission substation with one connection to the transmission system.
<b>Spare Bay</b>	An equipped <b>HV Bay</b> , i.e. a future <b>HV Bay</b> with switchgear provided.
<b>Standard Configuration</b>	The <b>Standard Configuration</b> of all 110 kV, 220 kV and 400 kV substations shall permit all <b>HV Bays</b> and equipment to be maintained. The <b>Standard Configuration</b> shall have <b>Busbar Sections</b> connected using either <b>Sectionalised Bays</b> or <b>Couplers</b> . <b>Standard Configurations</b> shall be the same for all 110 kV, 220 kV and 400 kV substations to reduce the possibility of operator error.
<b>System Generation</b>	Defined as the generation required to balance the <b>System Load</b> .
<b>System Load</b>	Defined as Ireland's forecasted transmission system peak load corresponding to the final year as detailed in the most recent All-Island Generation Capacity Statement.

**System Transformers** Transformers used to connect transmission voltage levels (e.g. 400/220 kV, 400/110 kV, 220/110 kV or 220/275 kV).

**Wing Coupler** Consisting of a **Circuit Breaker** with two **Sectionaliser Disconnectors** connecting two **Busbars Sections** on different **Busbars** (e.g. connecting A1 to B1 in Figures 2, 3 and 4 or A2 to B2 in Figure 4).

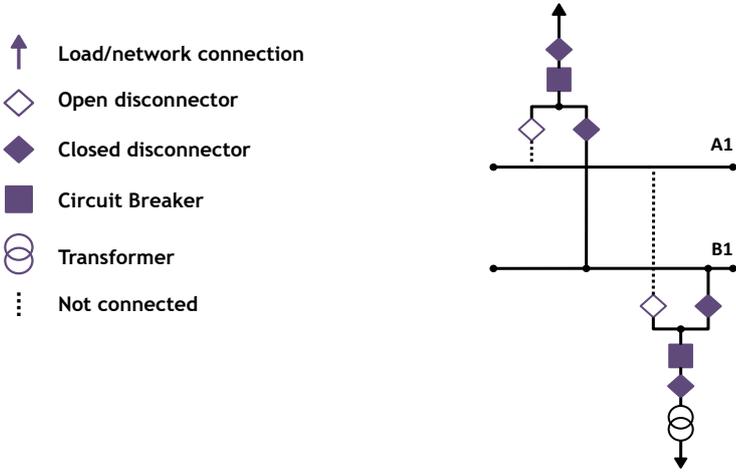


Figure 1: Two Bay Configuration

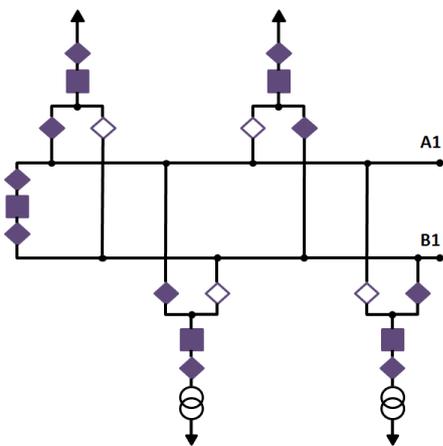


Figure 2: Four Bay C-Type AIS Busbar Configuration

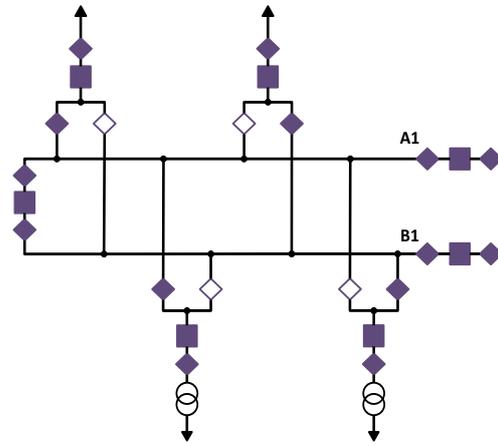


Figure 3: Four Bay C-Type GIS Busbar Configuration

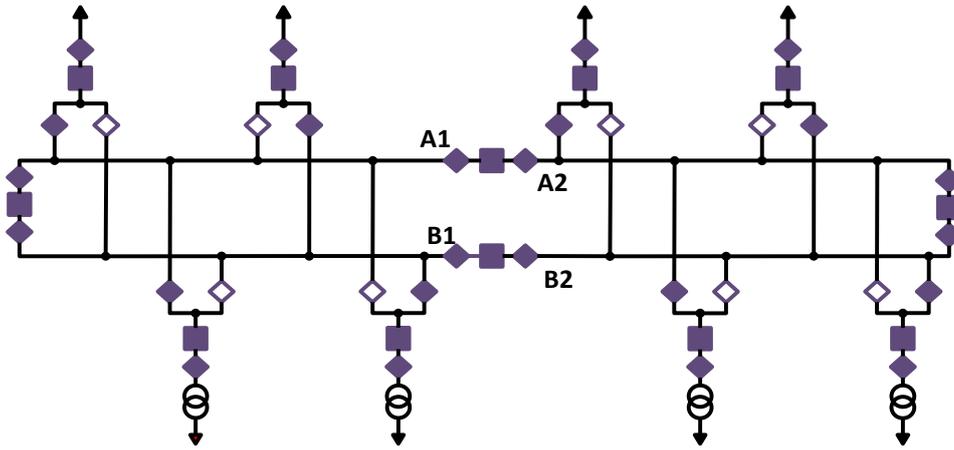


Figure 4: Eight Bay Enhanced Ring Busbar Configuration

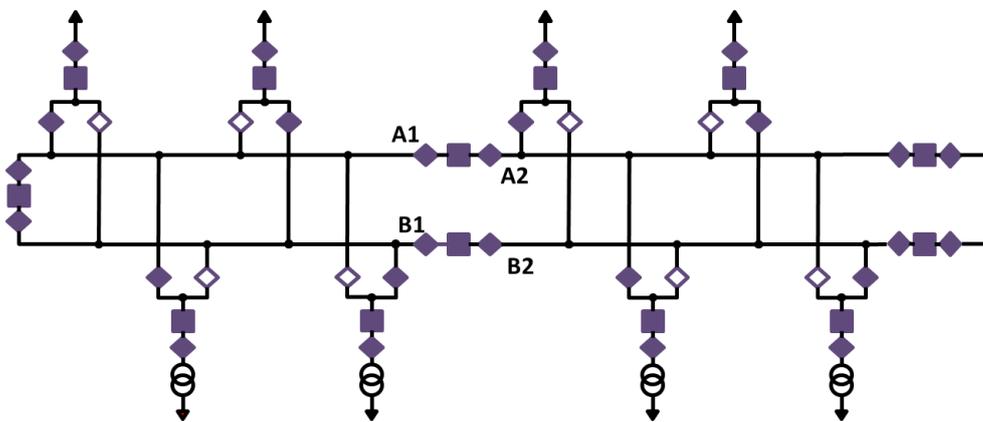


Figure 5: Eight Bay Enhanced Ring Busbar Configuration with Busbar coupling of two sectionaliser bays.

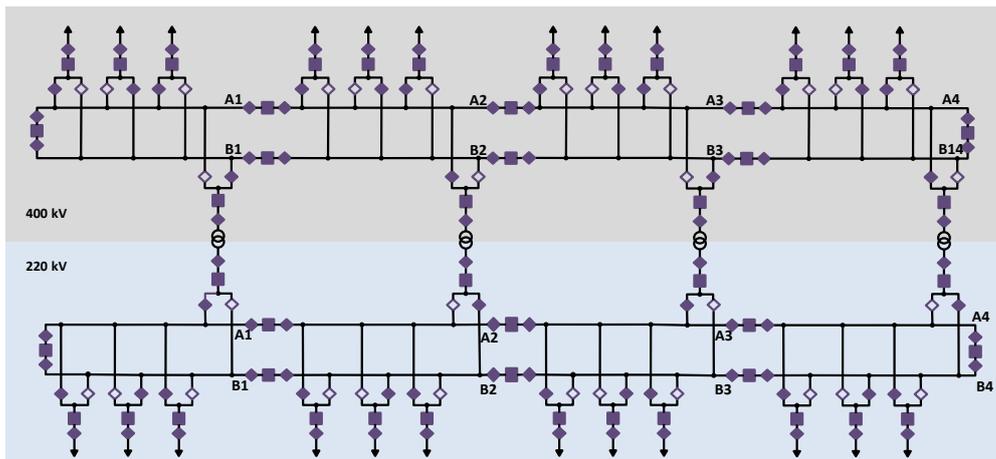


Figure 6: Sixteen Bay Enhanced Ring Busbar Configuration