EirGrid Policy

Policy on Harmonics	
Issue No.3	**August 2021**
	This policy is being updated following a review of harmonics data and methodology.

Background	The connection conditions (CC.10.13) in the Grid Code set out the requirements for all Users to ensure that their contribution to the Harmonic Voltage Distortion Level at the Point of Connection (POC) does not exceed the limits allocated to them following consultation with the TSO. Traditionally, the Harmonic Voltage Distortion Levels in the Irish Transmission System have been low and well within the IEC standards. With the proliferation of inverter-based devices as well as new cable connections, it is incumbent on the TSO and all Users of the Transmission System to ensure that harmonic distortion continues to remain within limits. This policy defines the applicable criteria and the actions EirGrid implements when planning and developing the Transmission System to ensure that all users are provided with adequate power quality (in terms of harmonics) at their Point of Connection.
Definitions	**Allocated Harmonic Distortion Limit:** The Allocated Harmonic Distortion Limit to a new User's connection is the maximum Incremental Harmonic Voltage Distortion level that the User's facility is allowed to introduce into the Transmission System voltage. The Allocated Harmonic Distortion Limit is assessed at the Point of Connection and it is expressed as a percentage of the RMS value of the fundamental frequency voltage. The Allocated Harmonic Distortion Limit applied to the THD and to each individual harmonic order from the 2^{nd} to the 40^{th} inclusive. **Harmonic Distortion Headroom:** The Harmonic Distortion Headroom at the h^{th} harmonic order is the difference between the Harmonic Planning Level and the Harmonic Voltage Distortion Level (measured or calculated) at the h^{th} order. The harmonic order h is an integer greater than 1 and its frequency is obtained by multiplying h by the fundamental frequency 50Hz. **Harmonic Planning Levels**: The Harmonic Planning Levels are EirGrid's planning limits for Harmonic Voltage Distortion Levels and THD. These limits must be maintained in the planning and development of the Transmission System and must be used for setting Allocated Harmonic Distortion Limits to User's connections. The Harmonic Planning Levels are expressed as a percentage of the RMS value of the fundamental frequency voltage. The Harmonic Planning Levels apply to the THD and to each individual harmonic order from the 2^{nd} up to the 40^{th} inclusive. **Harmonic Voltage Distortion Level:** The Harmonic Voltage Distortion Level of the h^{th} order is the RMS value of the steady-state sinusoidal waveform at a frequency of 50 x h Hz which is present in the voltage waveform in addition to its fundamental frequency component. It is expressed as a percentage of the RMS value of the fundamental frequency voltage. **Incremental Harmonic Voltage Distortion Level:** The Incremental Harmonic Voltage Distortion Level attributed to the User's facility is the incremental change in the magnitude of the Harmonic Voltage Distortion Level measured at the POC which is caused by the connection of the User's facility. The Incremental Harmonic Voltage Distortion Level attributed to the User's facility is a combination of: a) Distortion caused by harmonic voltages or currents generated by the User's facility

b) Amplification (or attenuation) of the existing Harmonic Voltage Distortion Level caused by an interaction between the User's facility and the Transmission System harmonic impedance (due to resonances for example)

Point of Connection (POC): The Point of Connection or Connection Point is the physical point where the User's facility is joined to the Transmission System. This point is typically the HV bushings of the User's Grid Connected Transformer.

Total Harmonic Voltage Distortion (THD): The THD is the RMS value of the sum of all individual Harmonic Voltage Distortion Levels (U_h) up to a specified order h. For this policy, h is defined as 40.

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Harmonic Planning Levels

EirGrid has adopted the Indicative Planning Levels for Harmonic Voltages defined in IEC/TR61000-3-6: 2008 for HV and EHV power systems as internal power quality objectives, and which are defined in this policy as Harmonic Planning Levels. EirGrid shall plan and develop the Transmission System to maintain the Harmonic Voltage Distortion Levels and THD within the adopted Harmonic Planning Levels. In order to do this, Allocated Harmonic Distortion Levels are to be applied at each User's facility, measured at their Connection Point. The relevant limits are shown below in the table excerpt from the IEC standard (HV-EHV columns).

The Harmonic Planning Levels must be maintained under intact network conditions (N) and following a single contingency (N-1).

The Harmonic Planning Levels apply to the THD and to each individual harmonic order from the 2nd to the 40th harmonic inclusive.

Odd harmonics non-multiple of 3			Odd harmonics multiple of 3			Even harmonics		
Harmonic order h	Harmonic voltage %		Harmonic order h	Harmonic voltage %		Harmonic order h	Harmonic voltage %	
	MV	HV-EHV		MV	HV-EHV		MV	HV-EHV
5	5	2	3	4	2	2	1,8	1,4
7	4	2	9	1,2	1	4	1	0,8
11	3	1,5	15	0,3	0,3	6	0,5	0,4
13	2,5	1,5	21	0,2	0,2	8	0,5	0,4
$17 \le h \le 49$	$1{,}9 \cdot \frac{17}{h} - 0{,}2$	$1{,}2 \cdot \frac{17}{h}$	$21 < h \le 45$	0,2	0,2	$10 \le h \le 50$	$0{,}25 \cdot \frac{10}{h} + 0{,}22$	$0{,}19 \cdot \frac{10}{h} + 0{,}16$

The indicative planning levels for the total harmonic distortion are THD_{MV} = 6,5% and $THD_{HV\text{-}EHV}$ = 3 %

Transmission System Development in Compliance with Harmonic Planning Levels

EirGrid shall endeavour to ensure that the introduction of new transmission circuits, reactive compensation devices, or any other equipment, will not result in the Harmonic Planning Levels being exceeded at any location on the Transmission System. When in breach, mitigation solutions shall be implemented at appropriate locations to reduce the Harmonic Voltage Distortion Levels and THD below the Harmonic Planning Levels.

Allocated Harmonic Distortion Limits to Users

In order to ensure that the Harmonic Voltage Distortion Levels and THD are kept below the Harmonic Planning Levels at all Transmission Nodes, EirGrid must assess the impact of the connection of new Users. As a result of this assessment, specified Allocated Harmonic Distortion Limits can be imposed on User's connections.

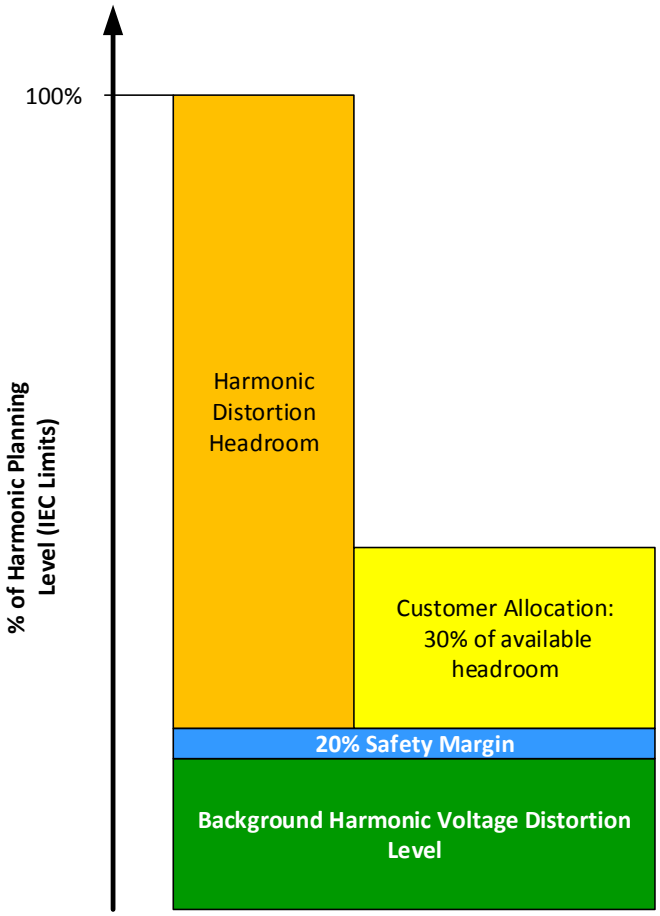
The method adopted by EirGrid for calculating the Allocated Harmonic Distortion Limits for each new User's connection has been revised following a review of harmonic distortion trends across the system. The main principles in the allocation method are described below:

(i) Carry out measurements of existing background Harmonic Voltage Distortion Levels and THD at nearest Transmission nodes.
(ii) Increase background by 20% to allow for uncertainties / measurement error.
(iii) Allocate 30% of the resultant Harmonic Distortion Headroom to the User, taking into account relevant N-1 contingencies and nearby Transmission nodes.
(iv) Round any zero allocations up by 0.05 - 0.1% in recognition of the uncertainties around measurement of high frequency harmonics (unless there are existing breaches at that harmonic number).
(v) Issue harmonic allocations and impedance loci in order for the User to assess their compliance (c. 18 months prior to energisation).

Measurements of Harmonic Voltage Distortion following Connection

Following energisation, the harmonic distortion at the User's facility is to be monitored for a period of three months of normal operation to ensure that any resultant harmonic distortion is within the allocated limits and aligns with the simulated harmonic distortion and the User's own compliance report. Following this period, a report will issue determining whether the User is in compliance, or whether further engagement is required with EirGrid in terms of mitigating harmonic limit breaches, as noted under Grid Code CC.10.13.1.

Illustration



Sign Off	**Prepared by:** Daphne Schwanz, Future Networks Alan Rogers, Future Networks **Checked/Reviewed by:** Robbie Aherne Manager, Future Networks Ray Doyle, Manager, System Integrity **16th August, 2021.**