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# Constant Terminal Voltage

Working Group 1
29st January 2014

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# Overview

- Objectives of Working Group
- ENTSO-E RfG Implications
- Options
- Summary
- Discussion

# Objectives of Work Group

- National Grid in consultation with industry representatives to:-
  - Provide clarification of GB Grid Code in relation to CC.6.3.4 and CC.6.3.8(a)(i).
  - Consider options based on supplementing tap changer range with terminal voltage adjustments and assess impact in terms of cost and benefits.
  - Ensure any proposal is consistent with the ENTSO-E Requirements for Generators.

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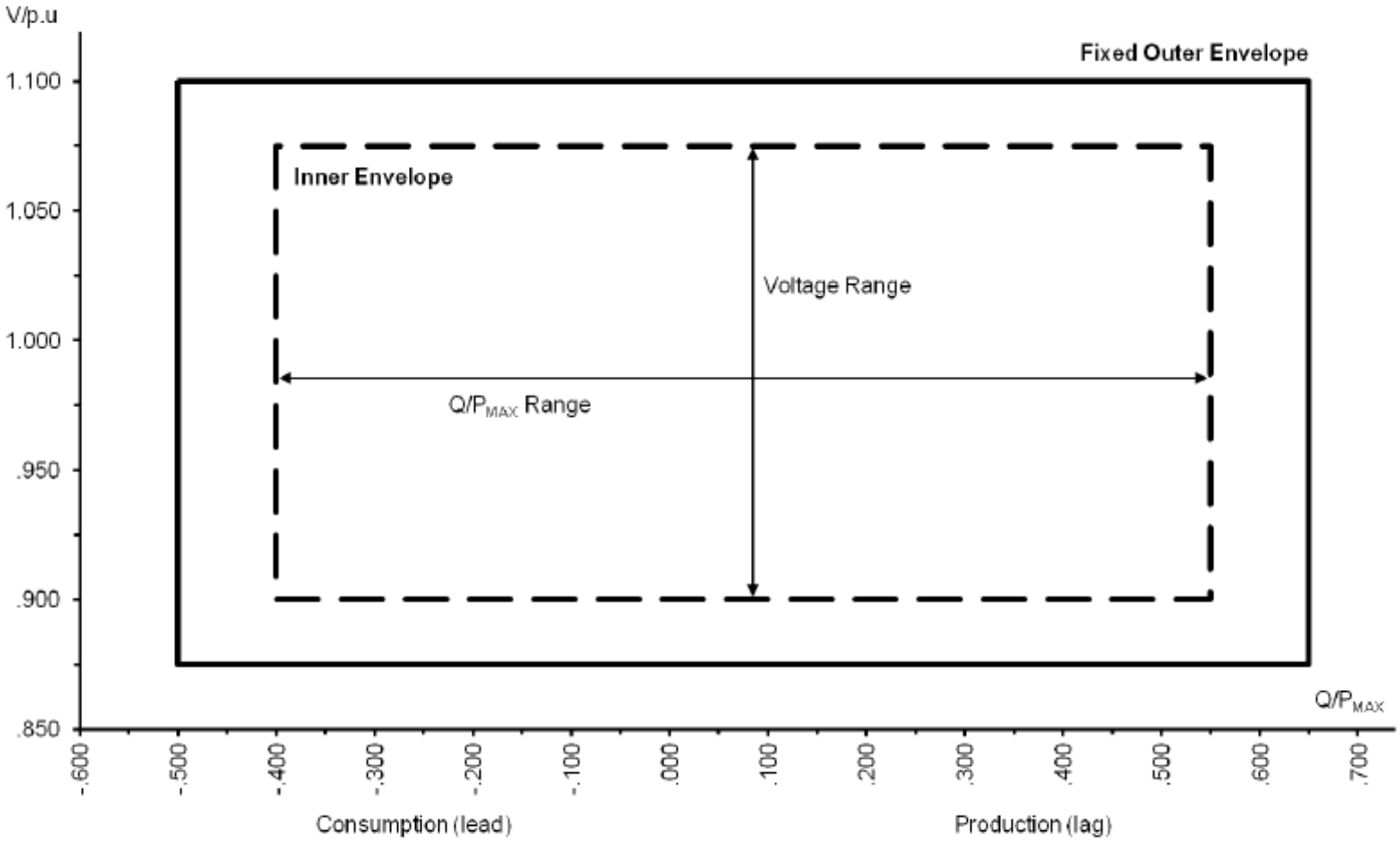
# Figure 7 - ENTSO-E Article 13(b) (1)



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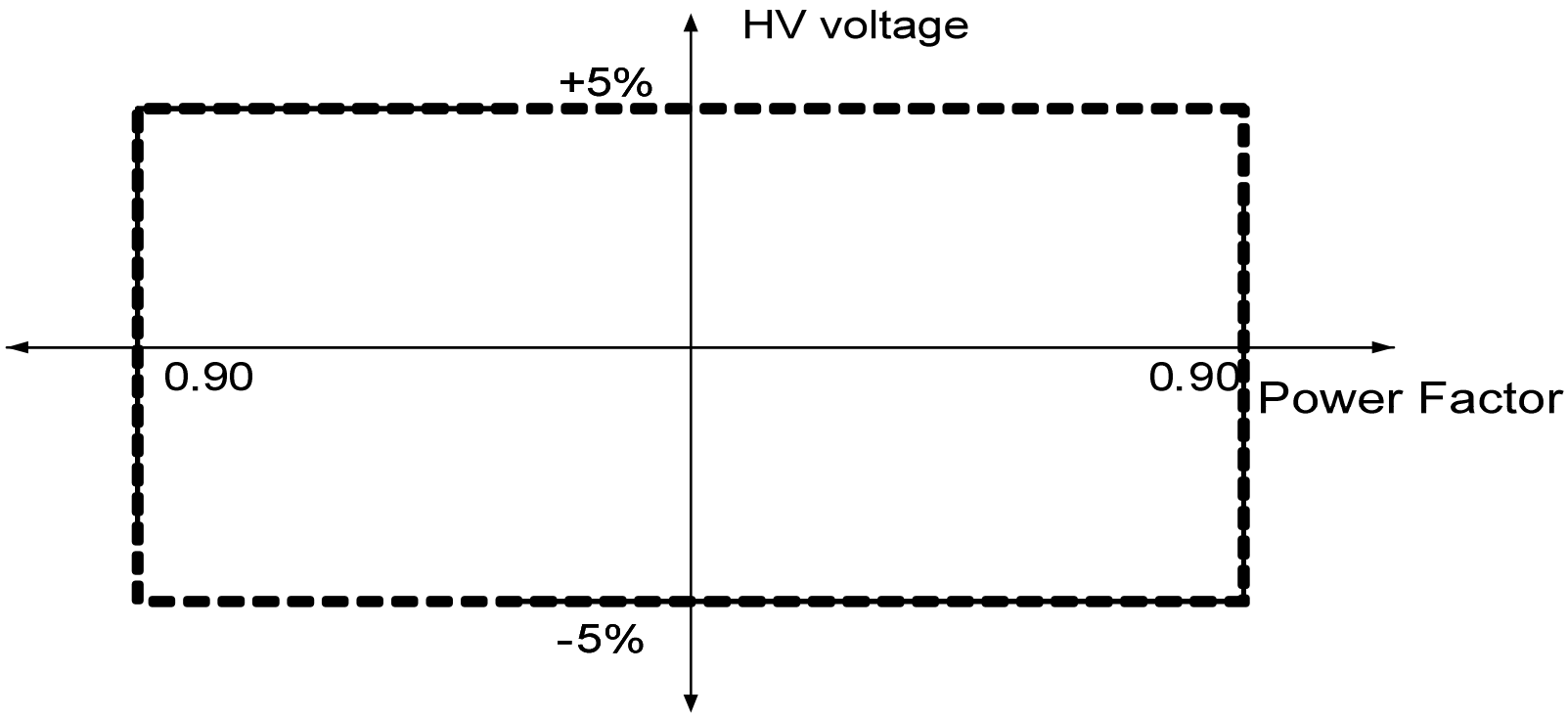
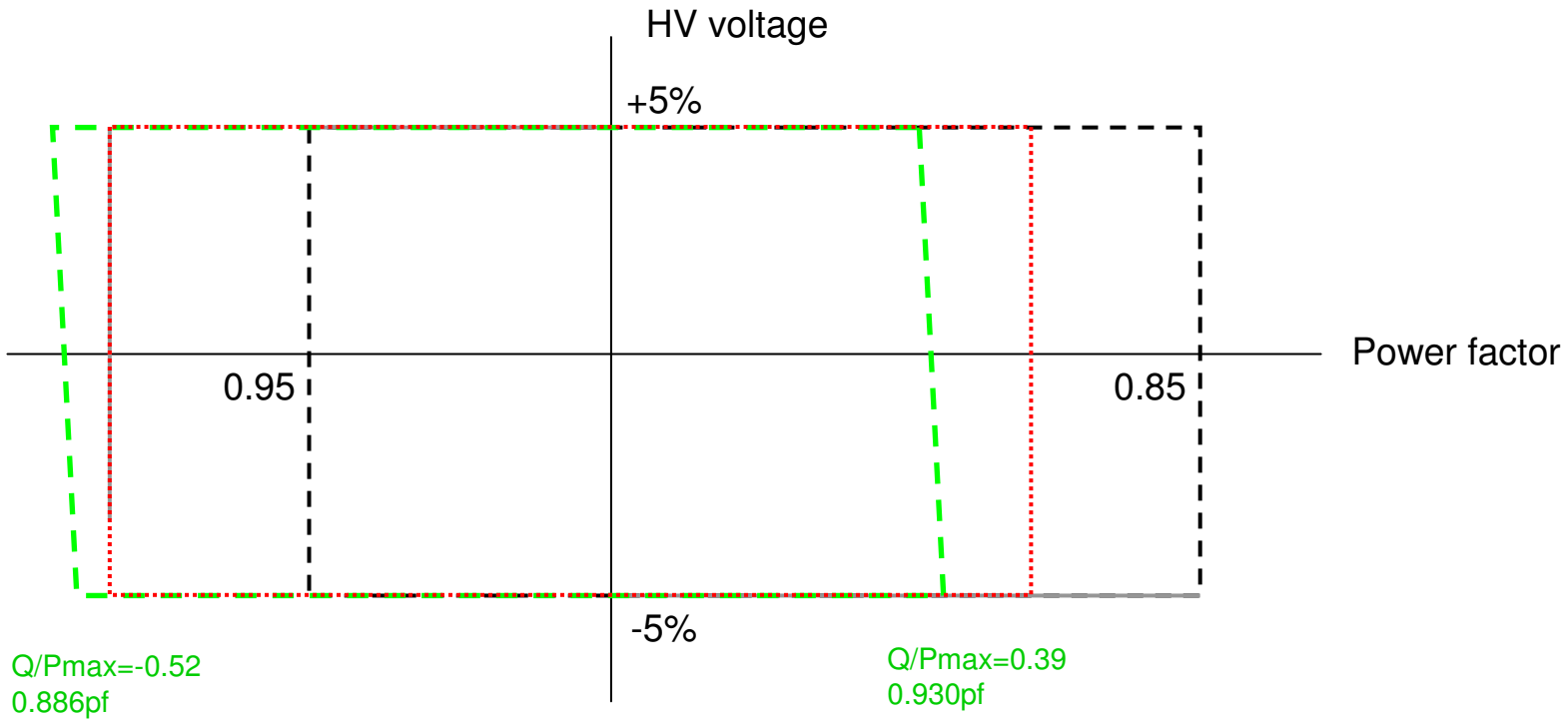
# Figure 7 - Article 13.2(b) for GB



# Case: LV / HV Reactive Capability




Current GB Grid Code requirement (LV)

Translated GB Grid Code HV capability

+/-0.9pf position (ENTSO-E – GB )

# Case: LV / HV Reactive Capability with adjustable Terminal Voltage

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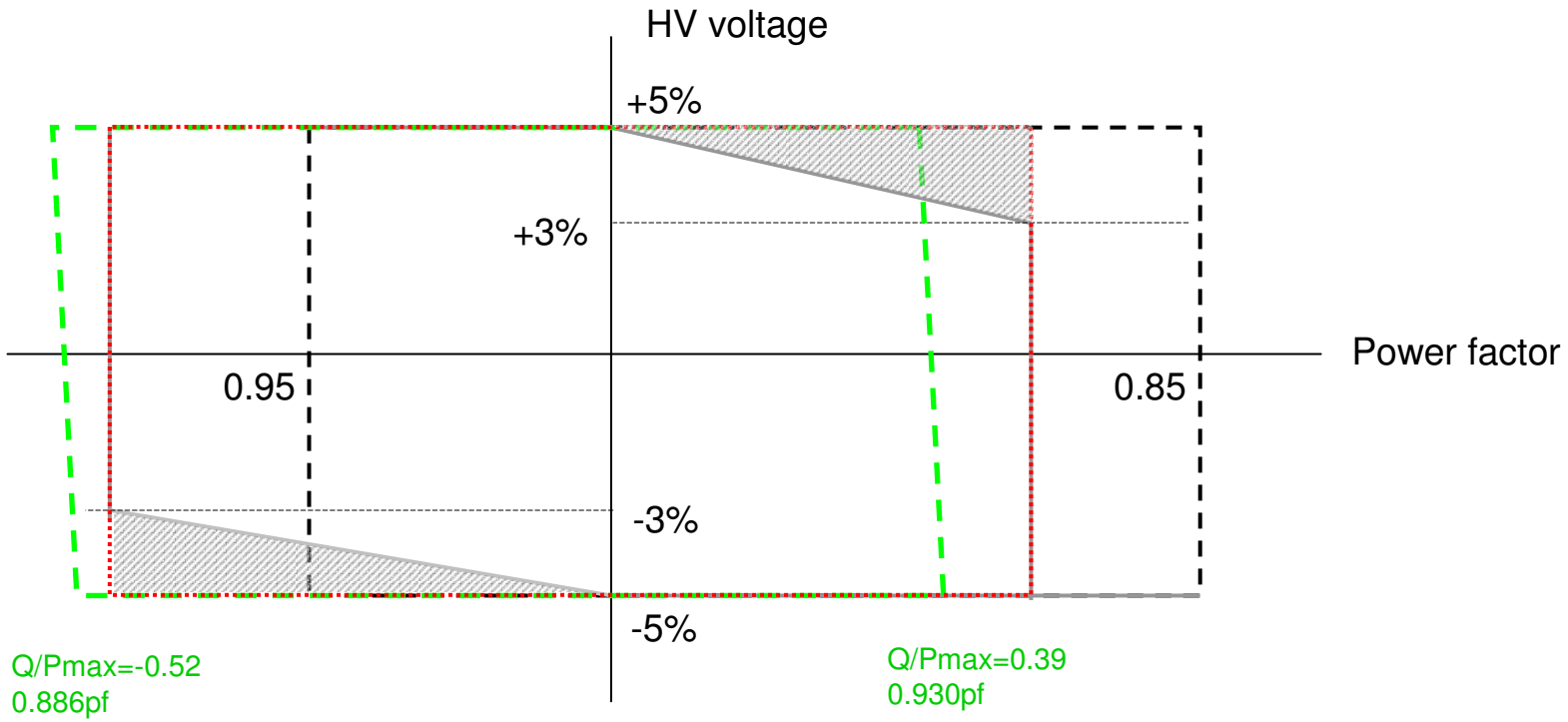


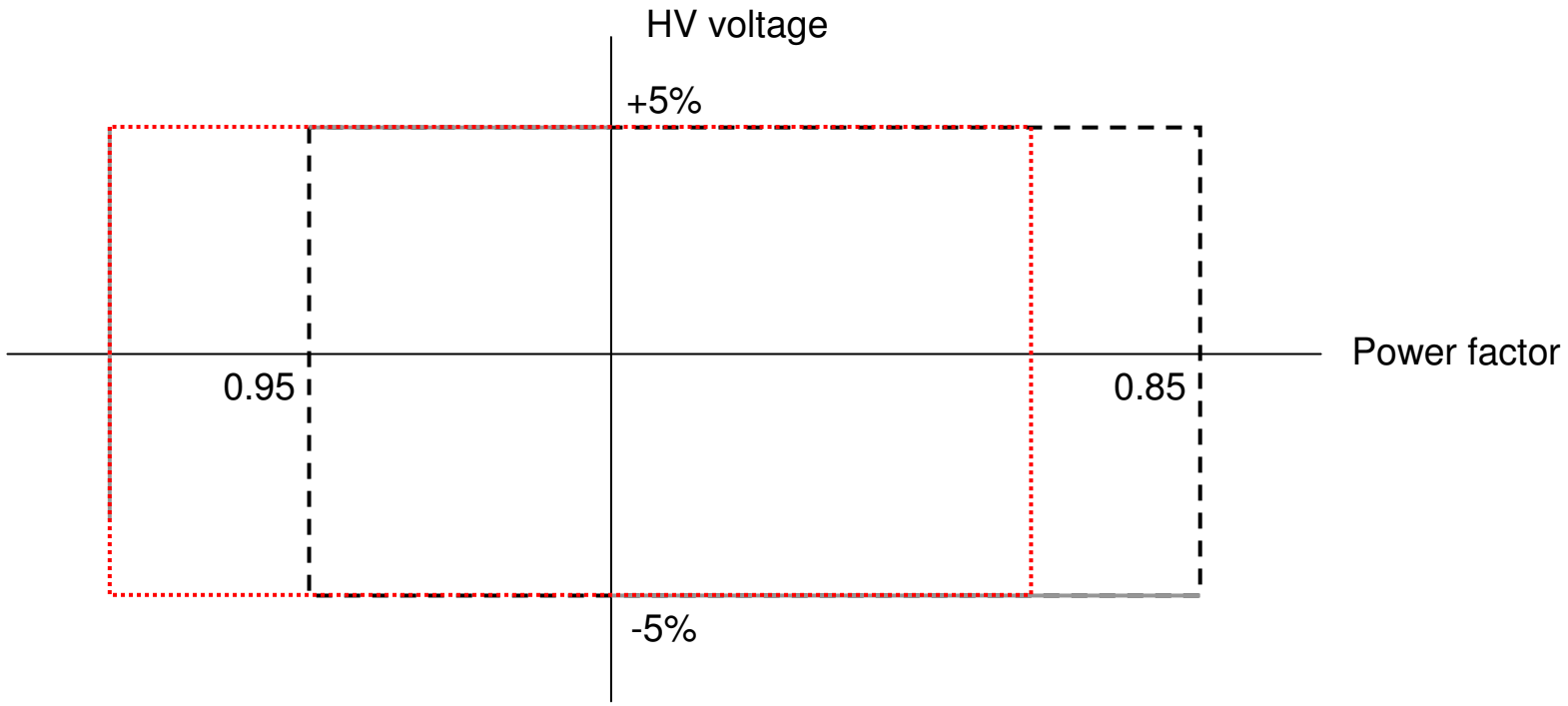

Current Grid Code requirement (LV)

Translated HV capability

+/-0.9pf position

Line for discussion

# Option 1 – Constant Terminal Voltage Controlled to 1 p.u with full Transformer Tapping Range



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# Option 1 Legal Drafting - Example

- CC.6.3.8(a)(i) - A continuously-acting automatic excitation control system is required to provide constant terminal voltage control of the **Onshore Synchronous Generating Unit** without instability over the entire operating range of the **Onshore Generating Unit**. In addition to the requirements of CC.6.3.4, **Generators** with a **Completion Date** on or after 1 January 2017 shall ensure that each **Onshore Synchronous Generating Unit** shall be capable of continually controlling the terminal voltage of the **Onshore Synchronous Generating Unit** to its **Rated Terminal Voltage** unless otherwise specified in the **Bilateral Agreement**. For **Generators** with a **Completion Date** before the 1 January 2017, each **Onshore Synchronous Generating Unit** shall be capable of controlling its terminal voltage to a value specified in the **Bilateral Agreement**
- **Rated Terminal Voltage** - The terminal voltage of a **Synchronous Generating Unit** at its **Rated MW** output is defined

# Option 2 – Adjustable Terminal Voltage with a limited Transformer Tapping Range

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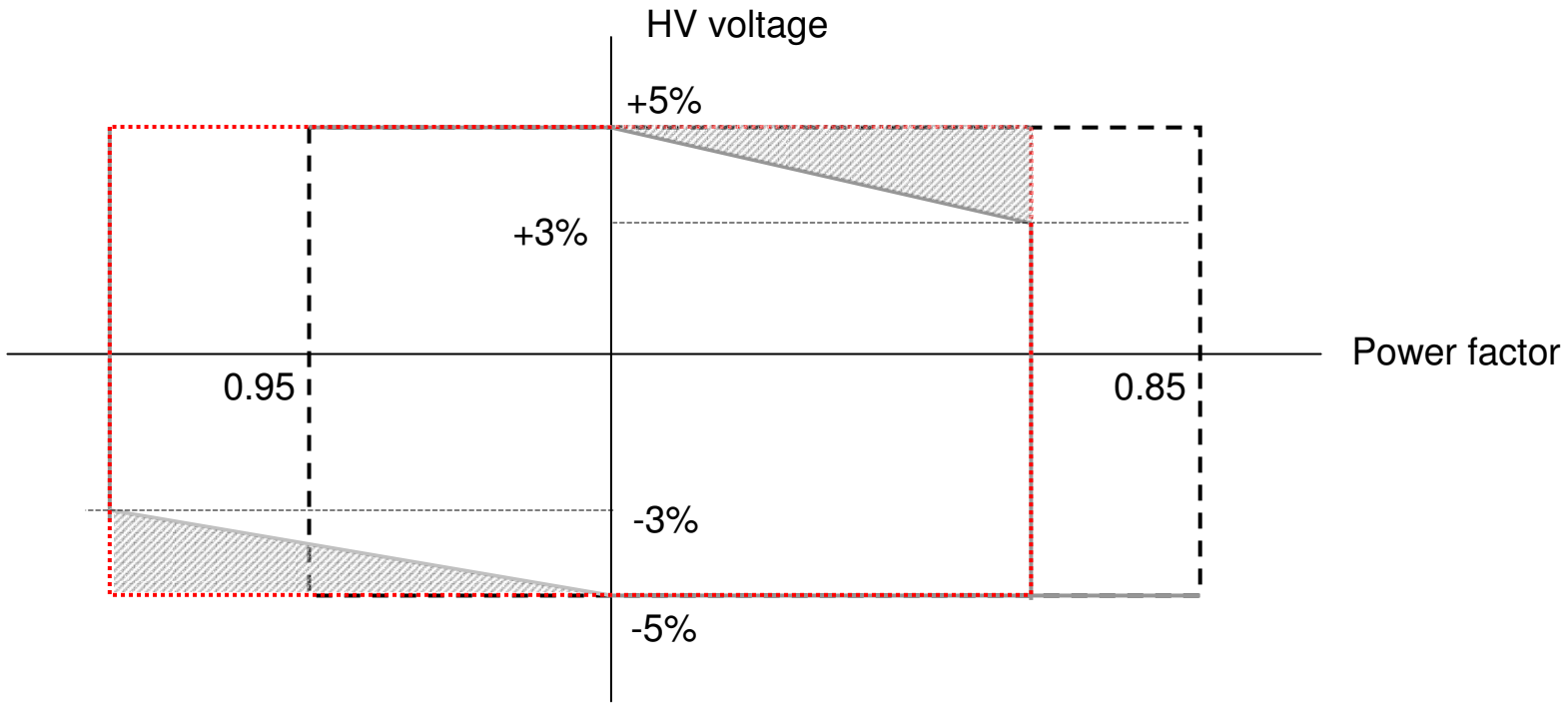
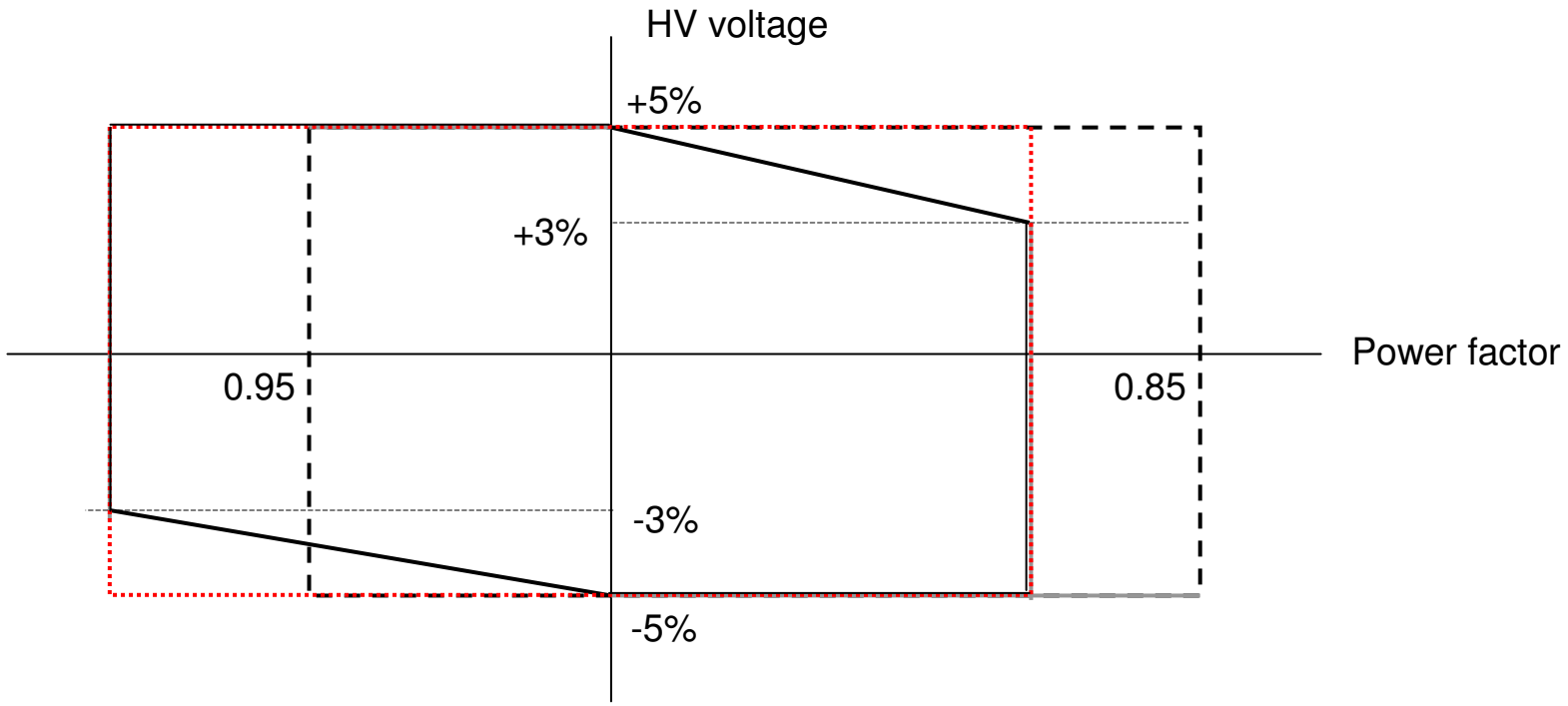



Current Grid Code requirement (LV)

+/-0.9pf position

Adjustable terminal voltage setpoint

# Option 3 – Limited Transformer Tapping Range only




Current Grid Code requirement (LV)

+/-0.9pf position

Operating Envelope

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# Advantages / Disadvantages

| Option | Advantages | Disadvantages |
|---|---|---|
| 1 | i) Generator Terminal voltage continuously controlled to 1p.u<br>ii) Maintains current Dynamic Reserve provision post fault.<br>iii) Maintains Stability margin | i) Potentially more expensive than other options (eg Transformer required with wider tapping range).<br>ii) References to BCA – Loss of Transparency<br>iii) Does not fully address Derogation issue |
| 2 | i) Potentially cheaper Generator Transformer with lower tapping range.<br>ii) Preserves the total reactive capability (ie operating envelope still maintained) | i) Less dynamic MVAr reserve provision post fault.<br>ii) Lower Stability Margin<br>iii) More complex to define minimum requirements of Generator transformer tapping range and Generating Unit target voltage range.<br>iv) Wider System implications would need to be understood eg would more reactive compensation equipment be required on the System or would enhanced excitation performance requirements be necessary. |
| 3 | i) Potentially cheaper Transformer with lower tapping range | i) As per option 2 in particular iv) which is likely to result in potentially greater costs to both NGET and Generators |

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# Summary of Options

- Option 1
  - Amend the Grid Code requiring all Synchronous Generators with a Completion Date after 1 January 2017 to be capable of operating to a constant terminal voltage of 1p.u (unless otherwise agreed) and satisfying the requirements of CC.6.3.4.
  - Defining the requirements for Synchronous Generating Units with a Completion Date before 1 January 2017 to be specified in the Bilateral Agreement.
- Option 2 and Option 3
  - The impact of a variable terminal voltage and limited transformer tapping range (option 2) or a solely limited transformer tapping range (option 3) would need to be understood in the context of the wider Transmission System, particularly in respect of reduced stability margins.
  - This would need to be considered against the material cost of purchasing Generator Transformers which are capable of meeting the requirement when correctly specified.
  - Reactive Power and Voltage Margins (both pre-fault and post fault) would need to be identified.
  - Transparency issues need to be addressed if requirements are specified Bilaterally
  - Derogation issues need further examination

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# Discussion