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CONTINUATION:

NAVIGATING GRID CONNECTION INTERPRETATIONS – WITH TARGET TECHNOLOGY, NOT GUESSWORK

In our last article, we examined how vague interpretations of the *5 %-Regel* (5% rule for rapid voltage changes) can destabilize projects – especially when large transformers are switched on. The root cause: if transformers are energized at the wrong moment, it can lead to inrush currents and voltage dips that exceed normative thresholds. The result: project delays, costly retrofits, and uncertainty in planning and operations.

In this issue, we don't stop at the problem – we explore potential solutions and highlight why we consider *Controlled Switching* (also known as Point-on-Wave switching) the most effective and resource-efficient path forward today.

Why uncontrolled energization causes problems

When a transformer is switched on at a random point in the sinusoidal wave, it can cause significant inrush current – depending on the phase angle and the residual magnetism in the transformer core. This so-called *Einschaltstrom* (inrush current) can result in voltage dips well beyond 5%. For grid operators, this threatens network stability. For project developers, it introduces planning uncertainty.

Possible technical approaches

There are different technologies to mitigate inrush currents:

- **Pre-Insertion Resistors (*Vorwiderstände*)**: Inserted briefly during energization to dampen inrush. Effective, but prone to wear and maintenance-intensive.
- **Thermistors (NTC/PTC)**: A simple solution for small transformers, but impractical at scale since they require cooling time.
- **Soft-Starters**: Common in motor applications, but of limited use for transformers because they lack precise control of the energization moment.
- **Design adaptations**: Transformers with reduced residual magnetism can help, but depend on manufacturers and are not a short-term fix.

The most technically convincing approach is *Controlled Switching / Point-on-Wave Schalten*: the breaker operates at a precisely defined point on the sinus wave, so voltage peaks and inrush currents are reliably minimized. The result: voltage fluctuations remain below the 5% threshold – compliant with normative requirements. From our perspective, *Controlled Switching* is currently the best solution. It combines effectiveness with resource efficiency, reduces interpretational disputes, and provides a measurable, reproducible foundation for all stakeholders.

Practical implementation – what is required

To implement Controlled Switching, additional measurement and intelligent control technology are needed. Typically this includes:

- Voltage measurement on the medium-voltage side (*Mittelspannungsseite*, one phase is sufficient for synchronization),
- Current measurement via appropriate sensors (conventional current transformers or high-resolution alternatives),
- If required, voltage measurement on the low-voltage side (*Niederspannungsseite*) across all three phases for improved accuracy,
- A dedicated protection and control unit that calculates the optimal energization moment and triggers the circuit breaker.

The investment costs currently amount to around €35,000 per station (including device, measurement equipment, and commissioning). Compared to total project costs – and the risk of delays or retrofits – this is a manageable sum.

Our industry discussions confirm that more realistic calculation formulas are being developed, which, together with reliable transformer manufacturer data, will allow even more precise forecasts of voltage fluctuations. This reflects a broader trend: away from vague interpretations, towards transparent technical control. Controlled Switching thus provides planning certainty: instead of debating ambiguous formulations in standards, technology delivers objective results.

Outlook & Discussion

Controlled Switching is not a cure-all – but in our view, it is currently the key building block to move grid connection procedures out of the grey zone of interpretation. It delivers measurable results and reliable security – for both grid operators and project developers.

What's your take? Should Controlled Switching become standard in future grid connection guidelines – or remain a project-specific add-on? We look forward to your insights and experiences.

Note: *This article reflects our practical experience and is not a substitute for legal advice.*

Feel free to contact us if you're planning a project—we'll support you with hands-on expertise.

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