Voltage Regulators

DSO Briefing

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Magtech AS

27.05.26

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Agenda

- Why voltage regulation? — 10 min
- Magtech introduction — 10 min
- Technology overview — 15 min
- Use cases and best practice — 25 min
- Questions — 30 min

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My Word Cloud

Edit mode

+ New slide

1 According to you, what does voltage...
Word Cloud

2 Where do you think voltage regulators hav...
Poll

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AhaSlides

Where do you think voltage regulators have the biggest impact?

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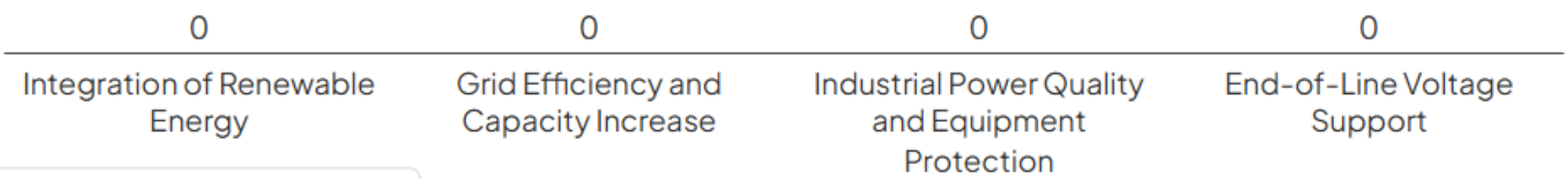
Where do you think voltage regulators have the biggest impact?



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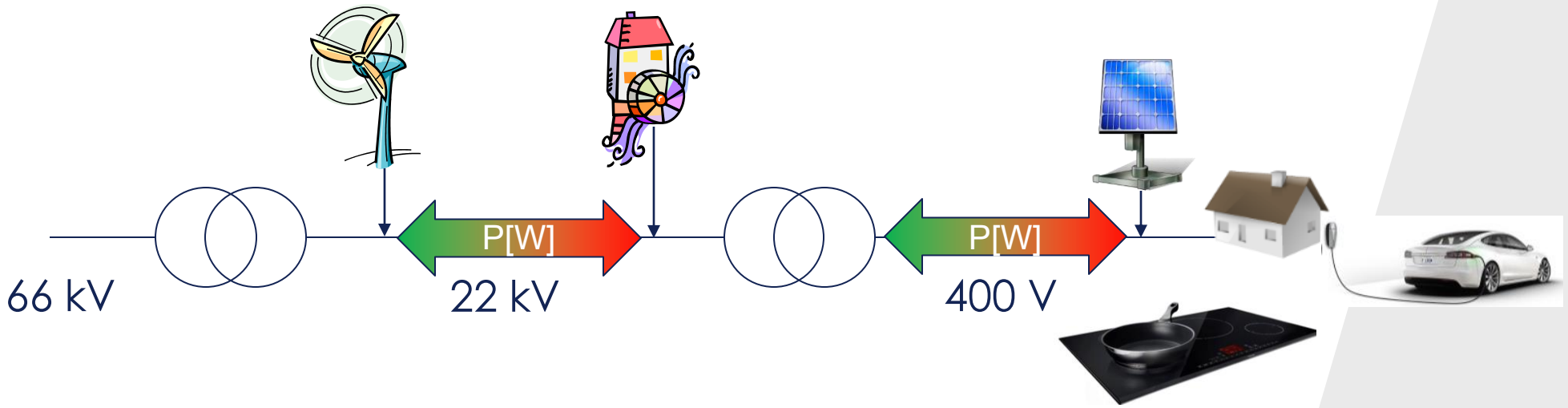
Get Feedback

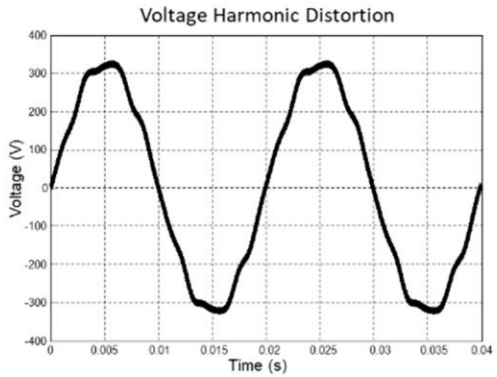
Why voltage regulation?

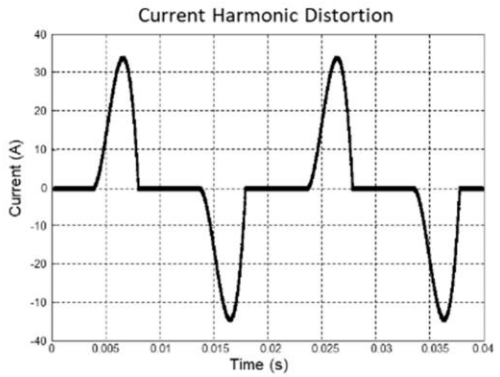
Hint: it's cheaper, faster and more flexible!

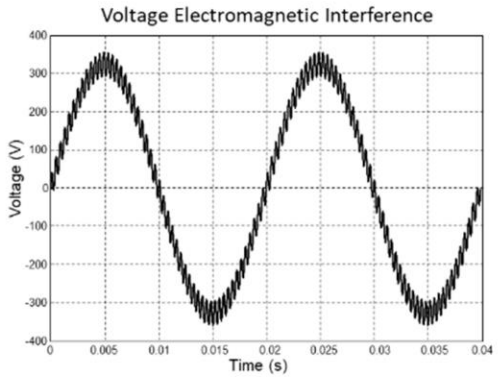
Renewables and demanding loads are stressing an ageing infrastructure…

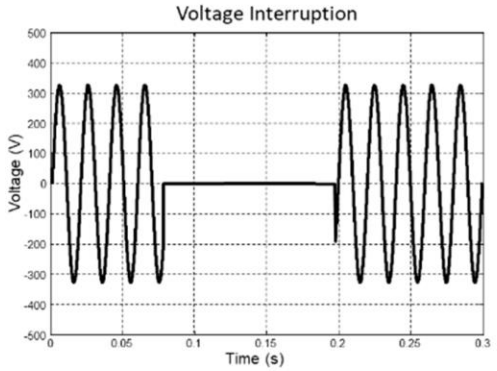


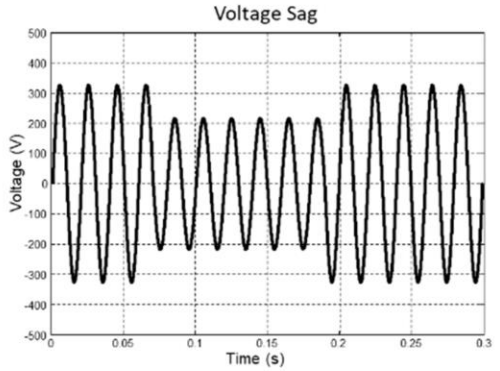
Voltage quality problems

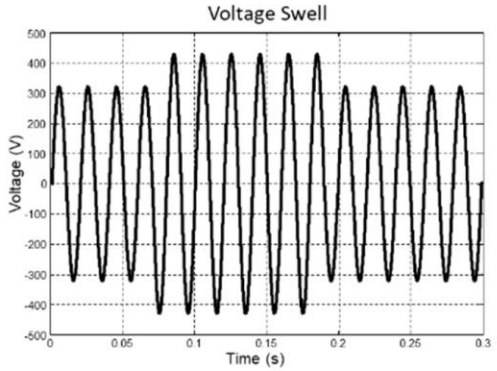


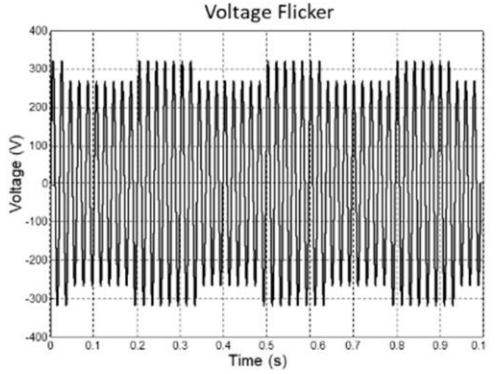


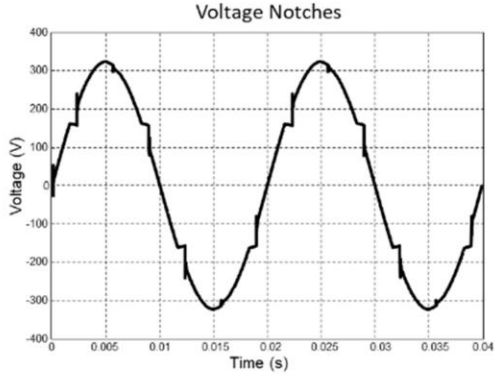


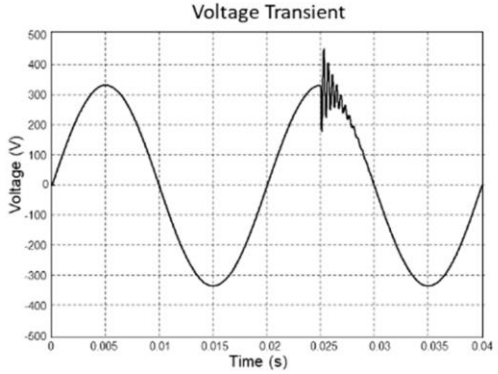












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Traditional solutions vs. voltage regulation

Grid reinforcement

- Replace transformers and cables
- High CAPEX, long lead times
- Permits and civil works
- Stranded asset risk

Voltage regulation

- Targeted, modular deployment
- Lower CAPEX, fast install
- Minimal civil works
- Future-proof and movable

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Typical voltage regulation products

Power electronics

- Capacitor bank
- Volt-VAR control
- Inverters from batteries (and solar)
- STATCOM

Transformer-based

- Distribution transformer with OLTC
- Line voltage regulators

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Cheaper, faster & more flexible

- **Grid impact**: improved capacity using existing infrastructure
- **Speed**: weeks to months vs. years to deploy
- **Cost**: a fraction of reinforcement CAPEX
- **Flexibility**: redeploy as load patterns shift
- **Risk**: avoid stranded assets

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Magtech

Voltage regulation since 2001

Voltage regulation customers

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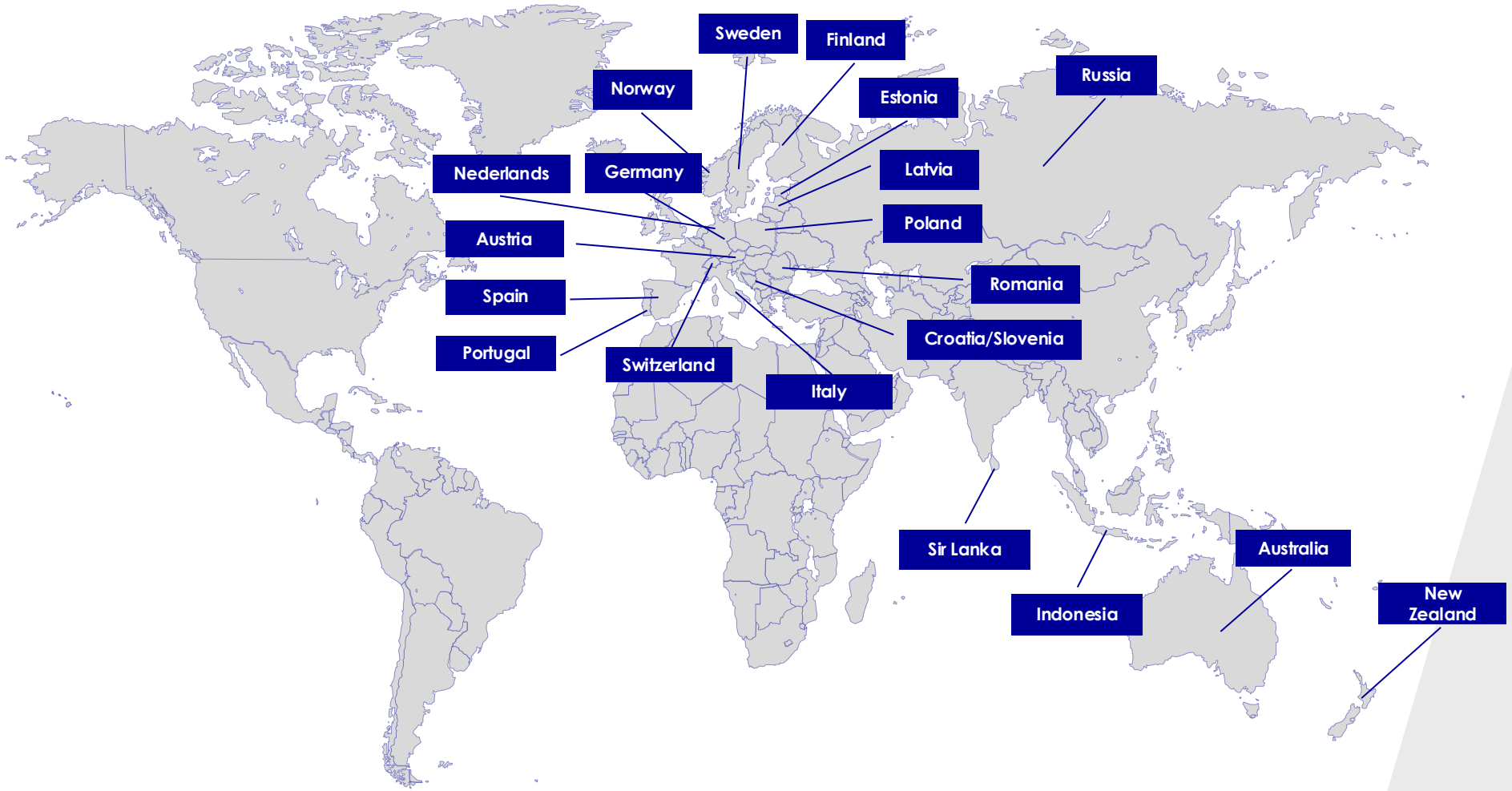
Markets

20+ years in operation



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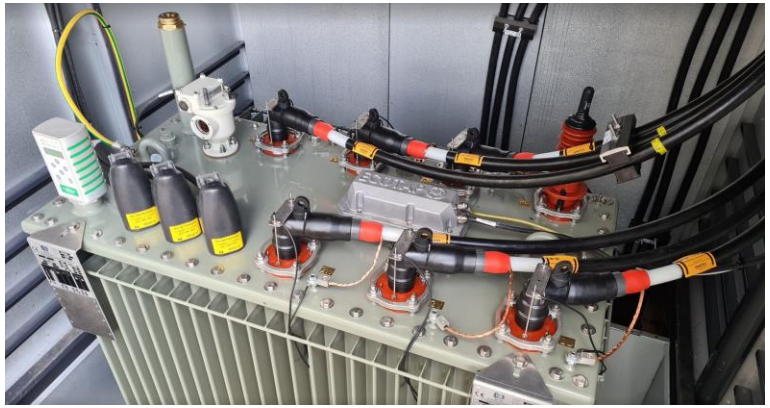
Partnerships

Transformer based voltage regulators

MVR
Medium Voltage Regulator



VRDT
Voltage Regulating Distribution Transformer

LVR
Low Voltage Regulator

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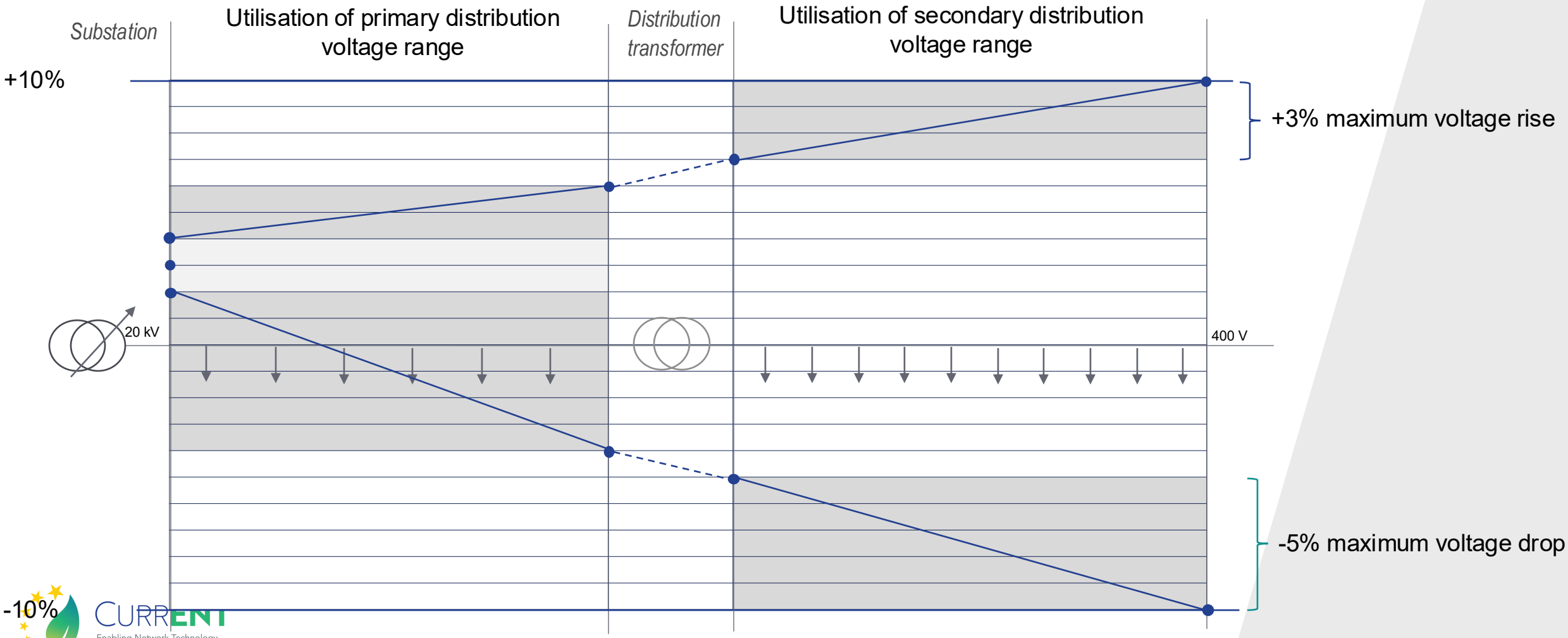
Technology overview

CONVENTIONAL NETWORK PLANNING



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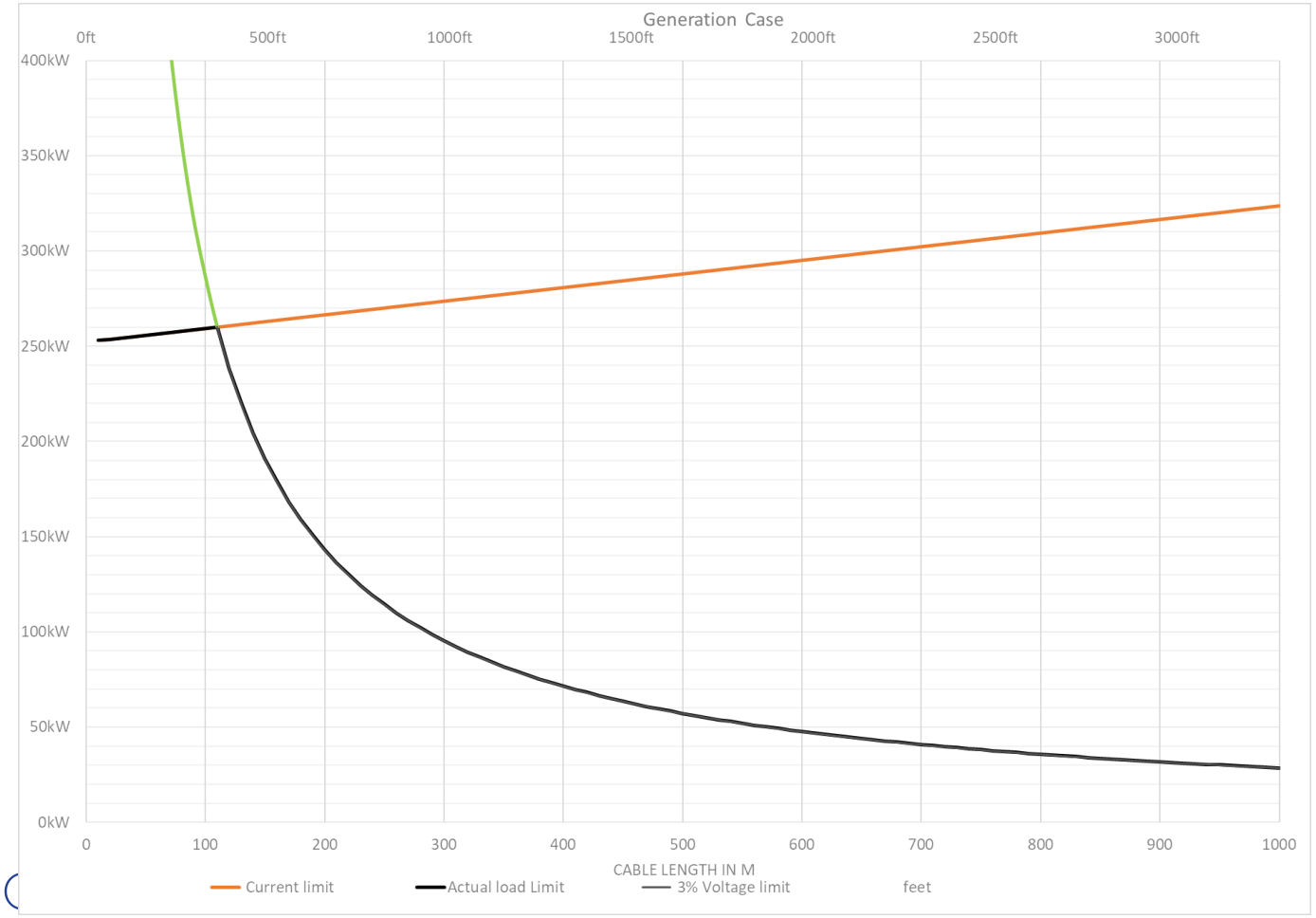
CONVENTIONAL NETWORK PLANNING



← *Thermal limitation*

← *Voltage limitation*

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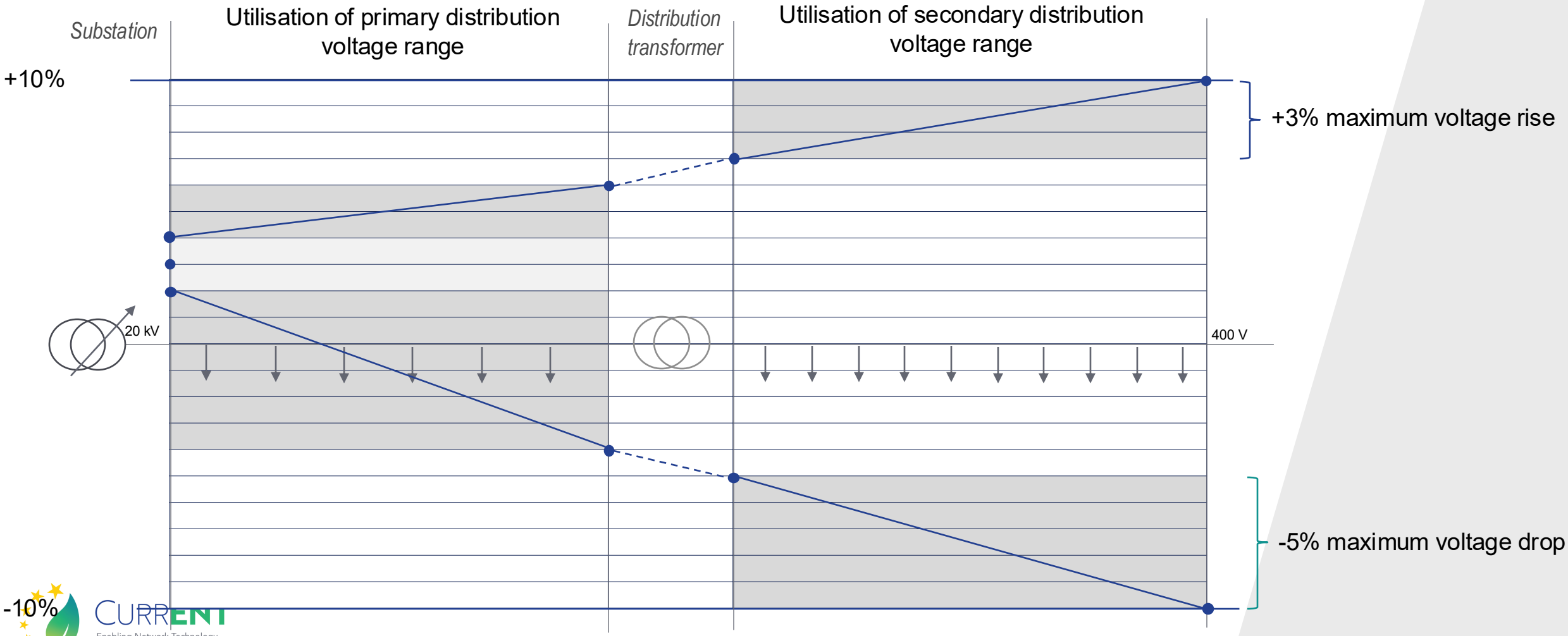
CONVENTIONAL NETWORK PLANNING



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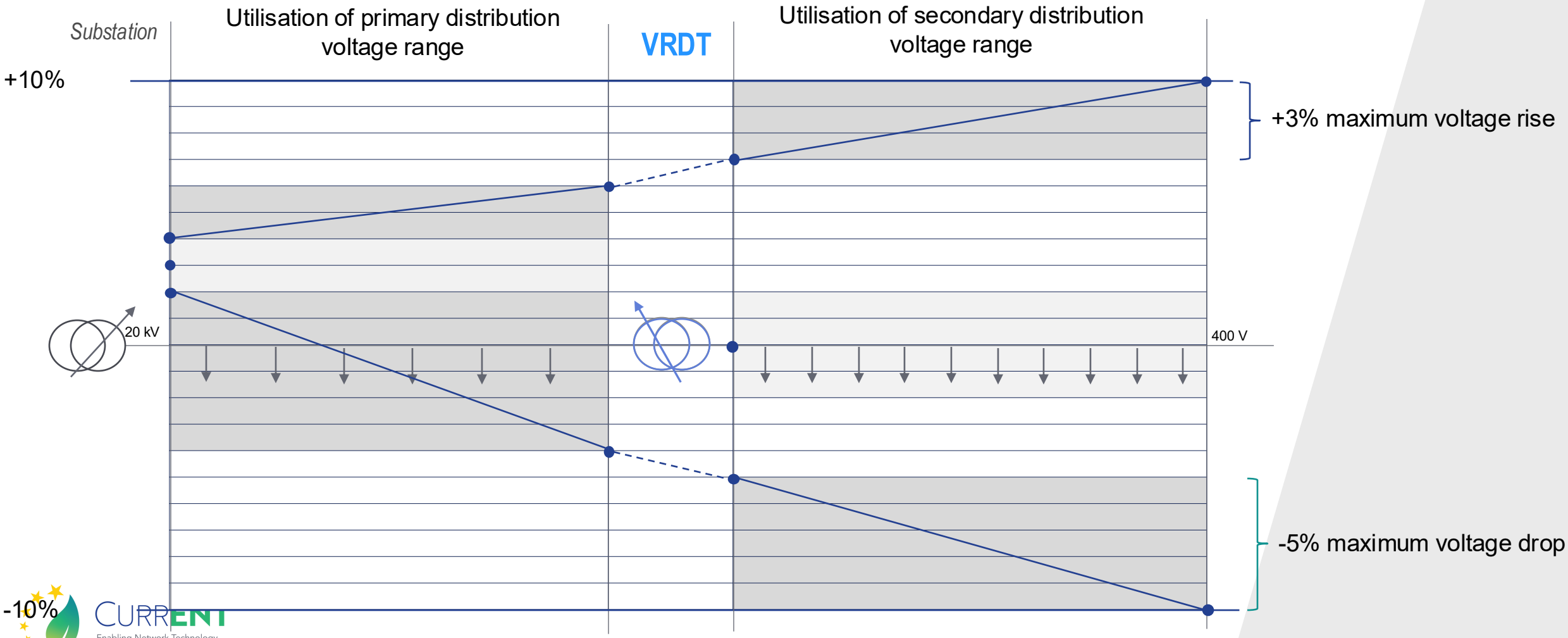
VRDT WITH STATIC SET-POINT



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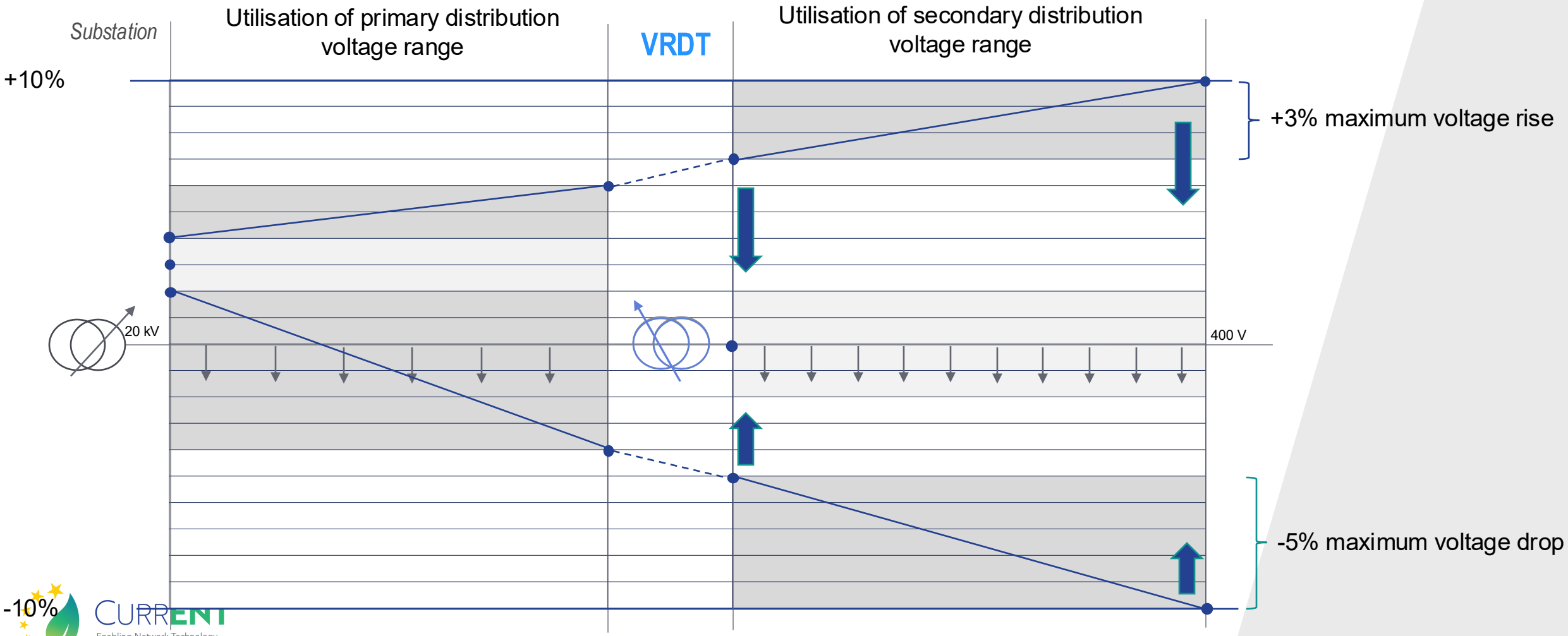
VRDT WITH STATIC SET-POINT



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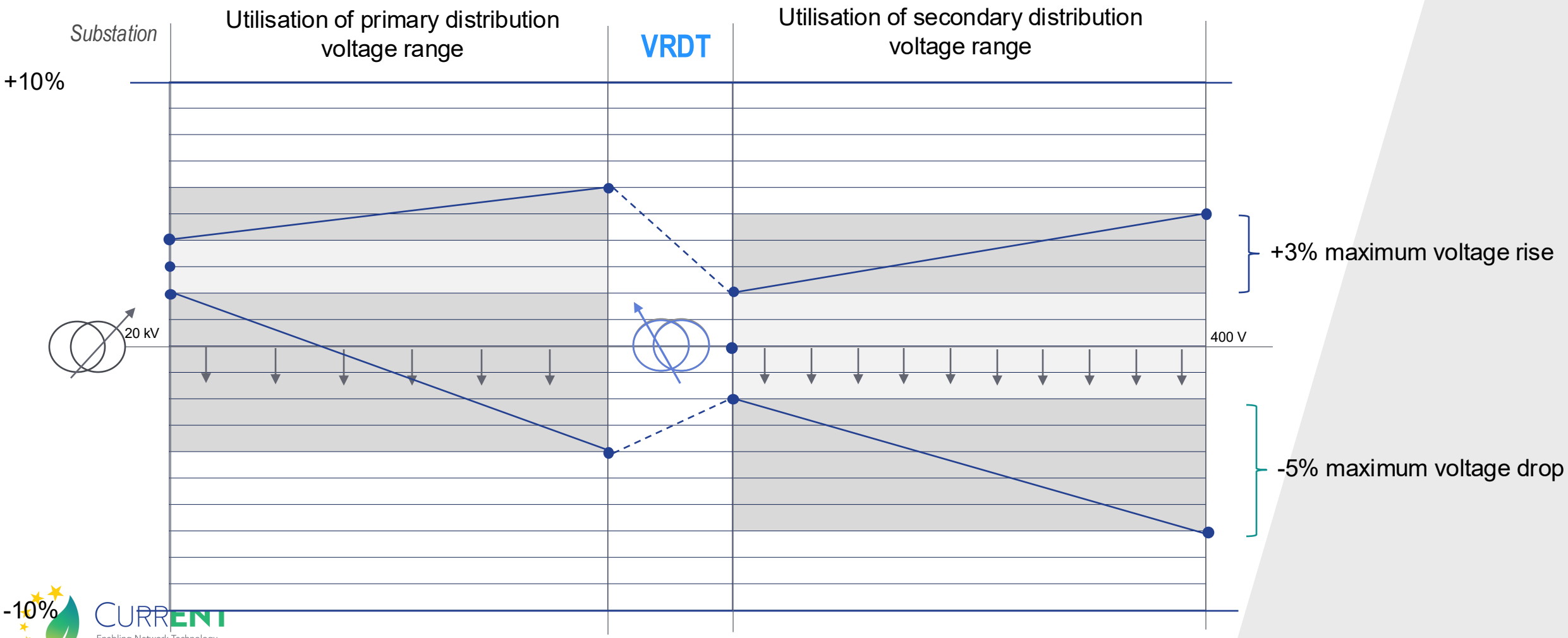
VRDT WITH STATIC SET-POINT



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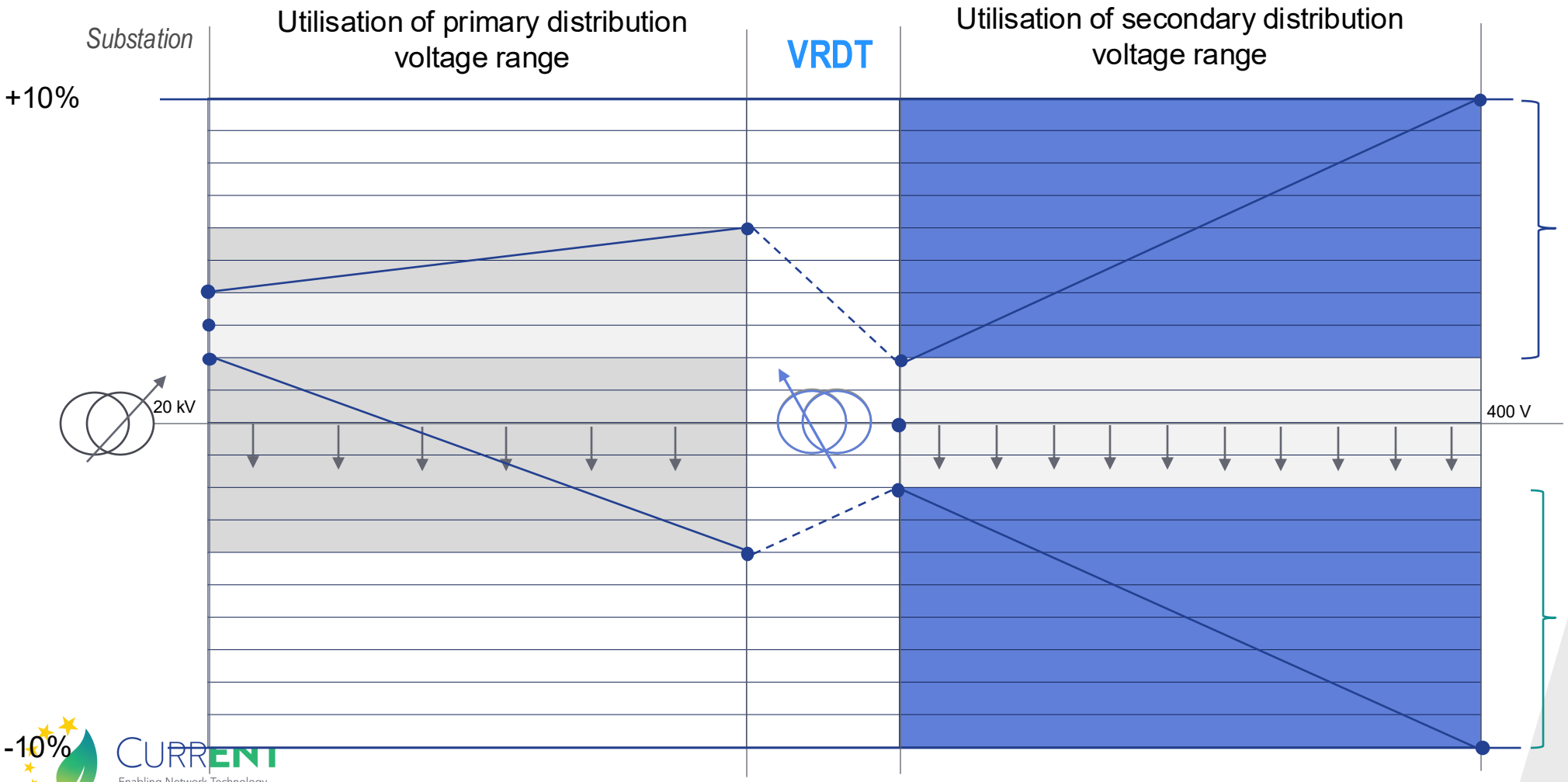
VRDT WITH STATIC SET-POINT



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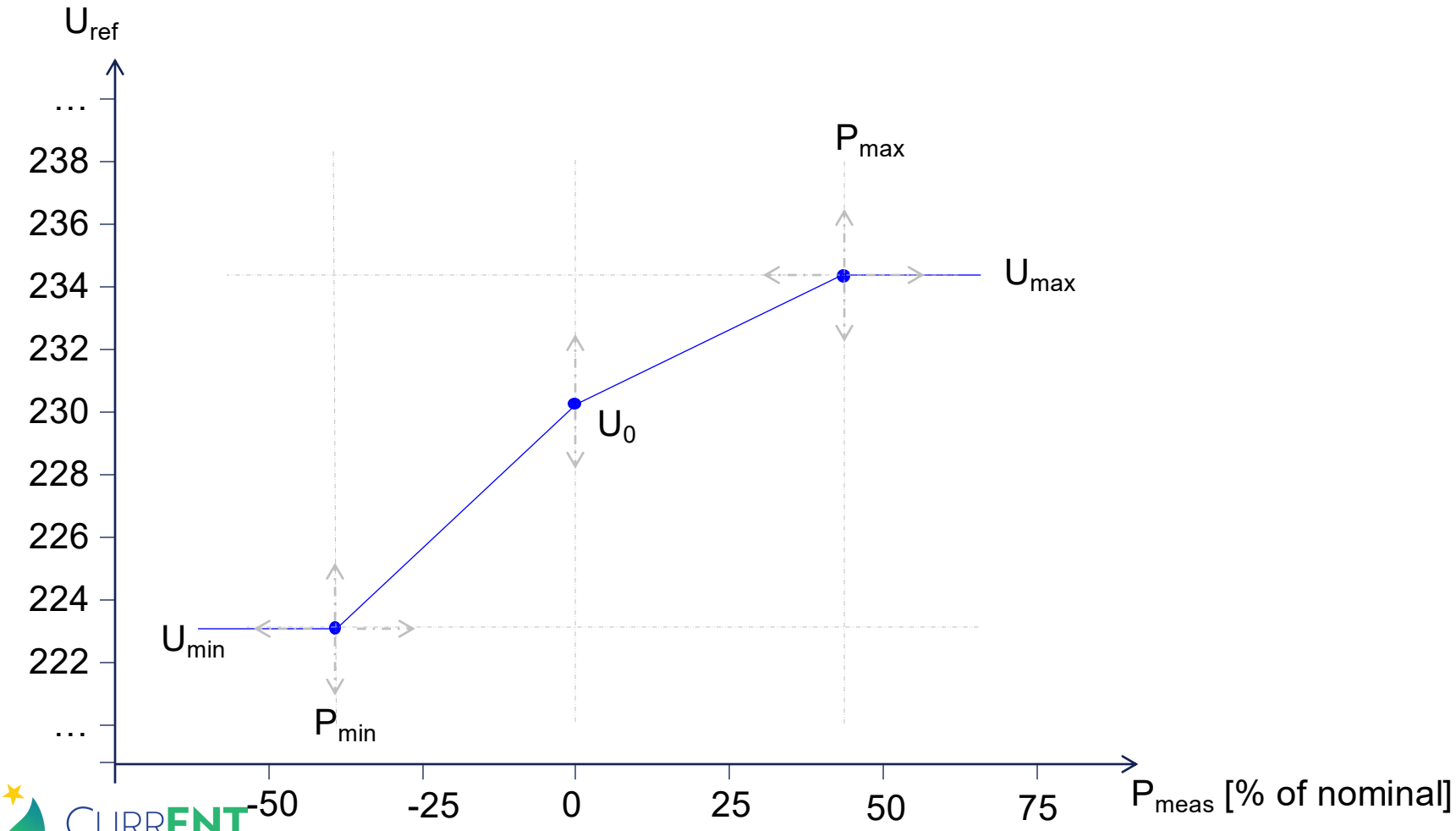
VRDT WITH DYNAMIC SET-POINT



$$U_{ref} = f(P_{meas})$$

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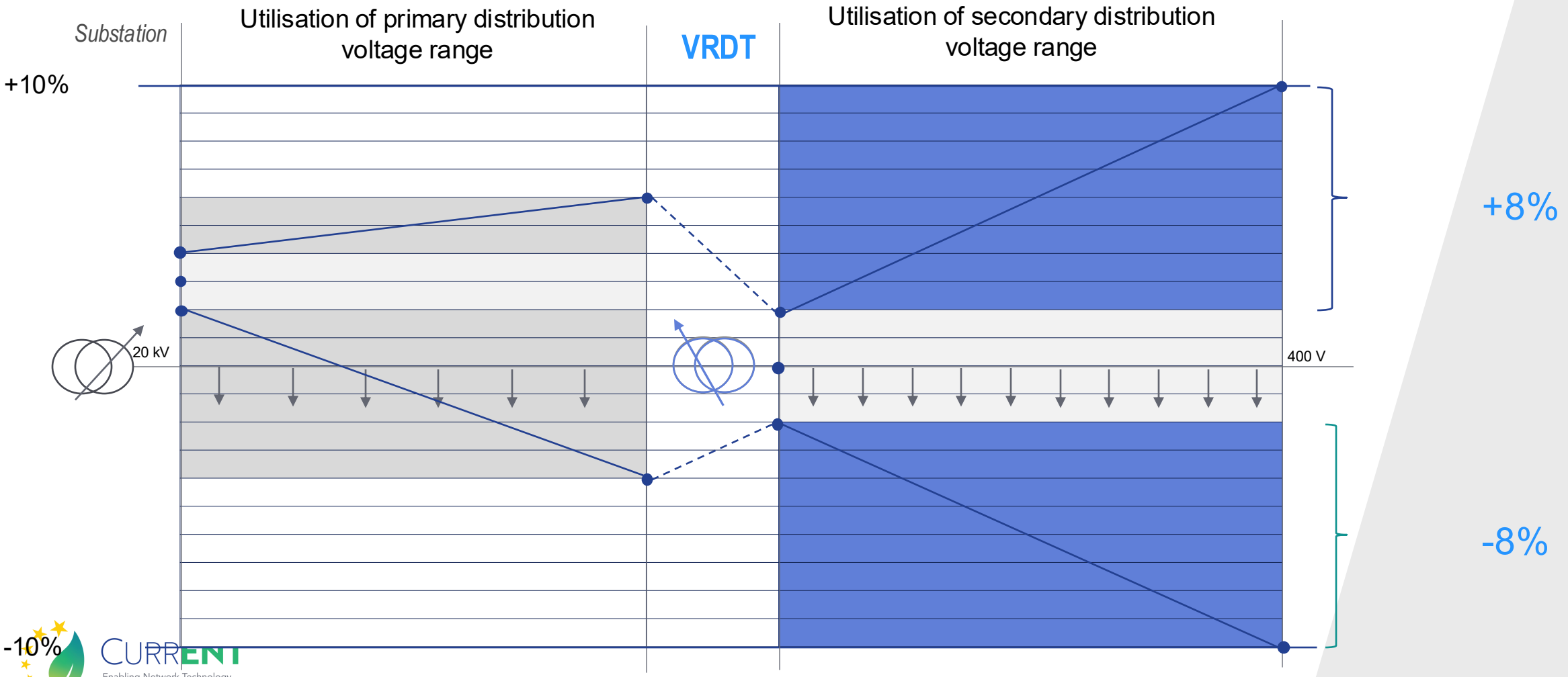
VRDT WITH STATIC SET-POINT



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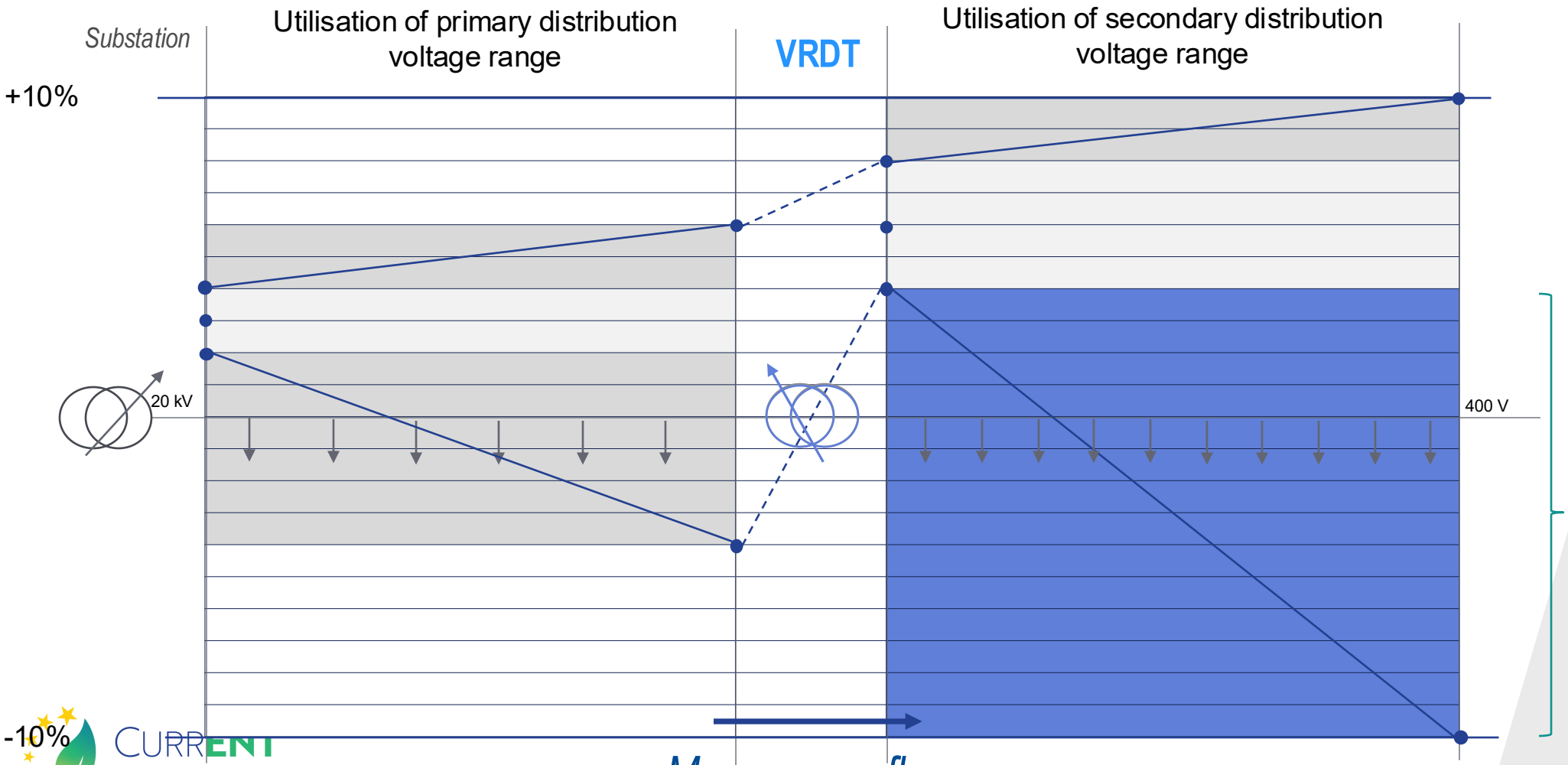
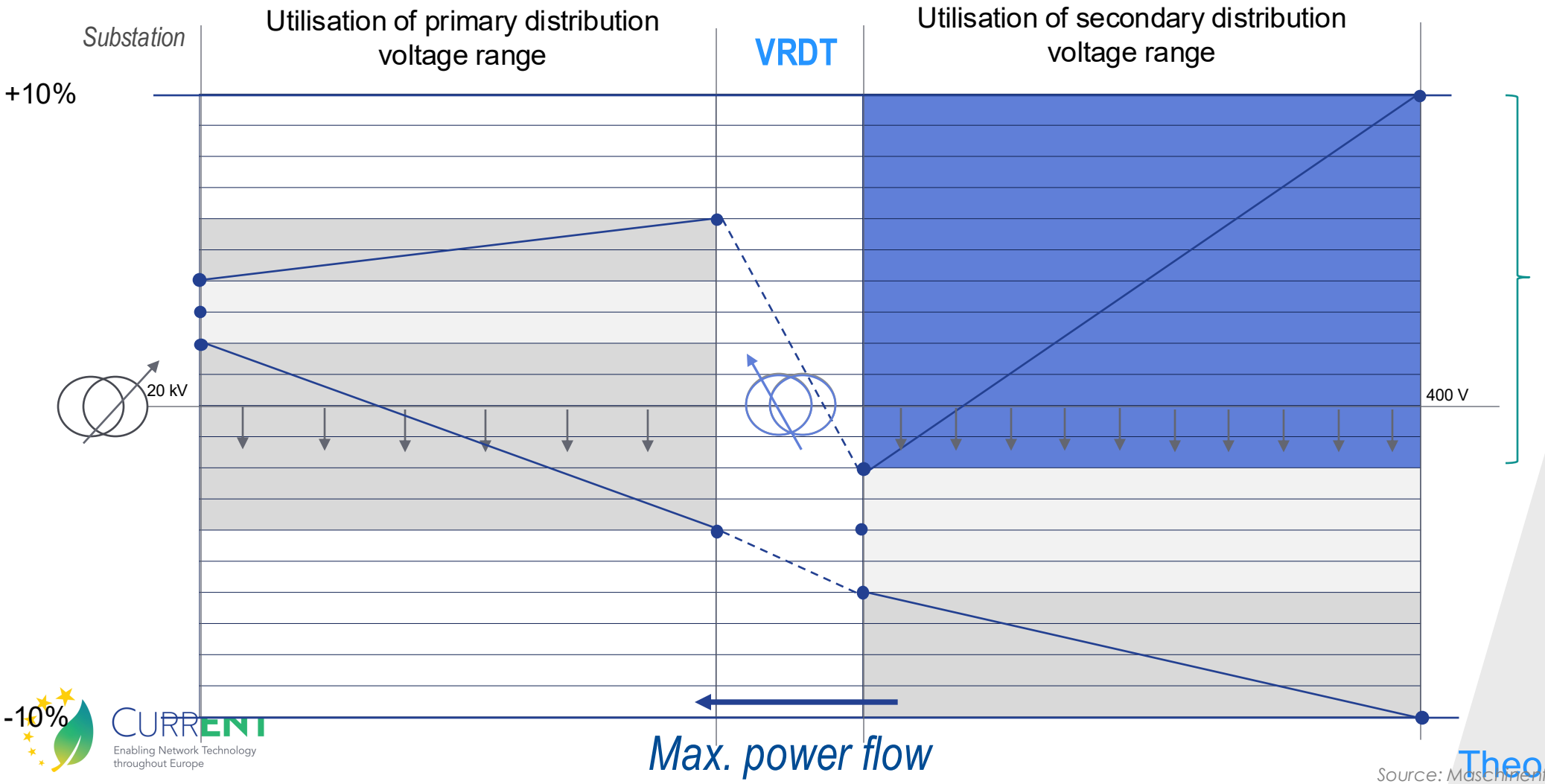
VRDT WITH DYNAMIC SET-POINT



Theoretical max.: -16%

Source: Maschinenfabrik Reinhausen

VRDT WITH DYNAMIC SET-POINT

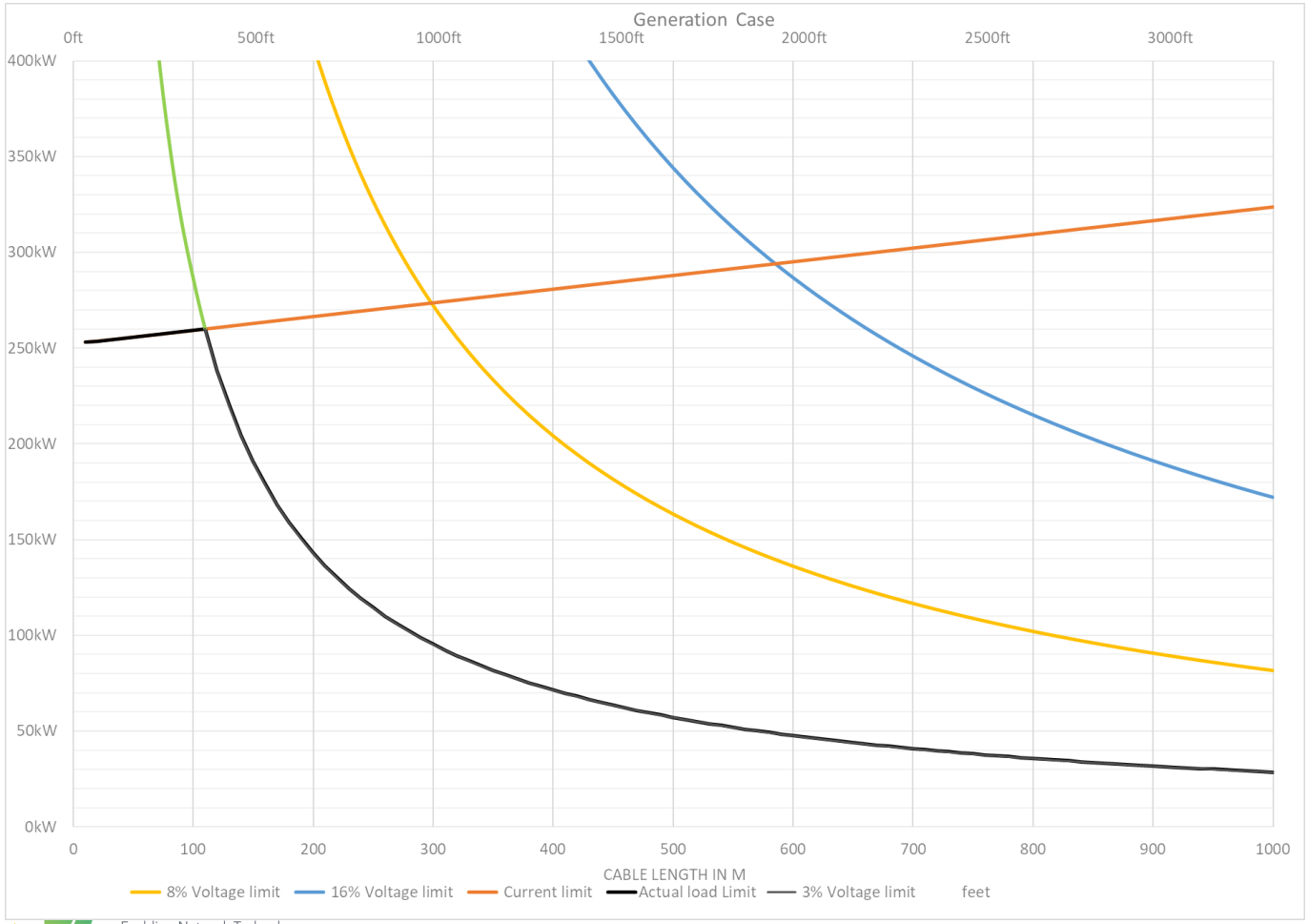


Theoretical max.: +16%

Source: Maschinenfabrik Reinhausen

VRDT INCREASE HOSTING CAPACITY

Generation case: XLPE Al 120 0,4kV



+16% (dynamic set-point)

+8% (static set-point)

+3 % (conventional)

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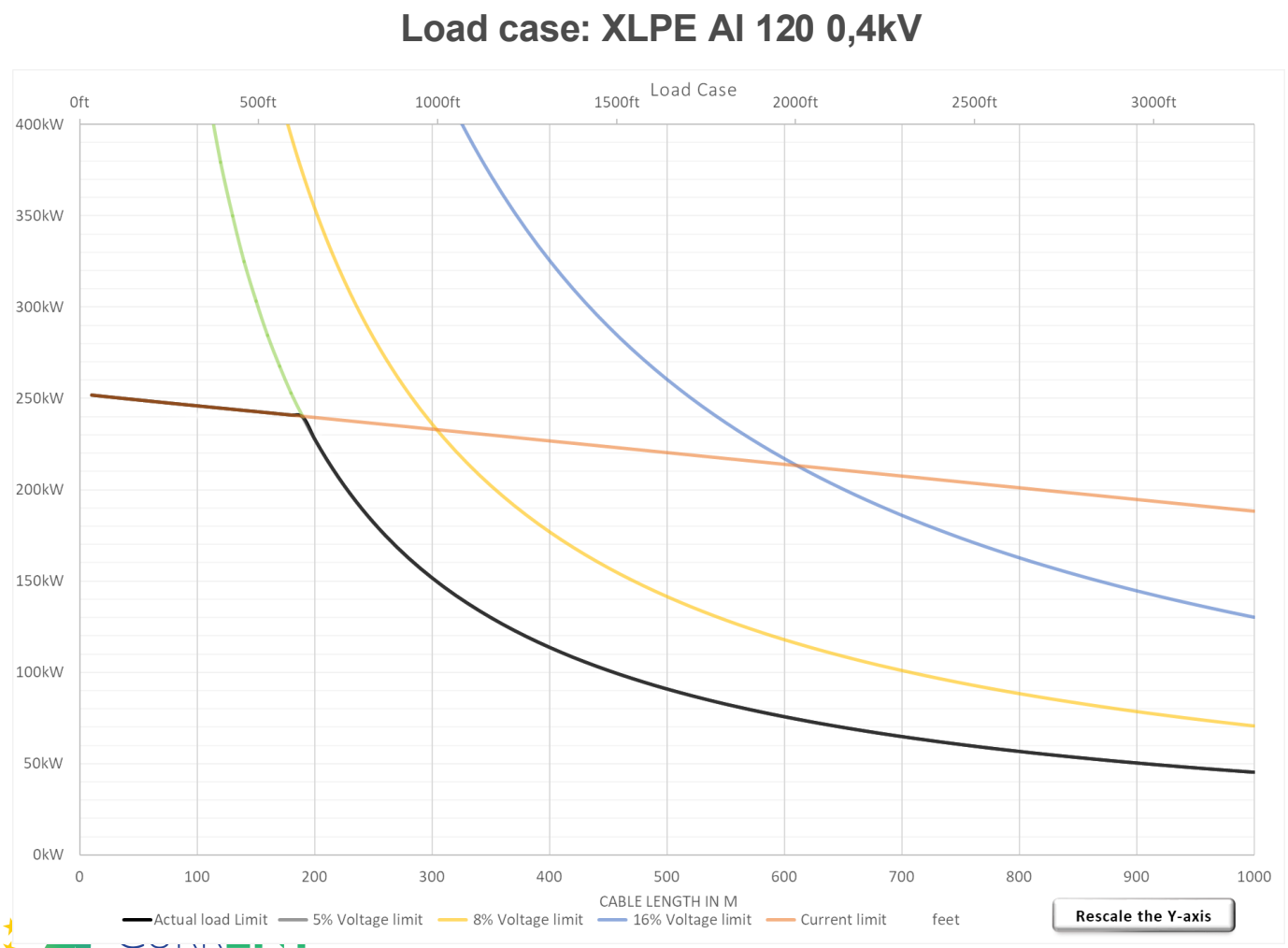
VRDT INCREASE LOAD CAPACITY



← -16% (dynamic set-point)

← -8% (static set-point)

← -5% (conventional)

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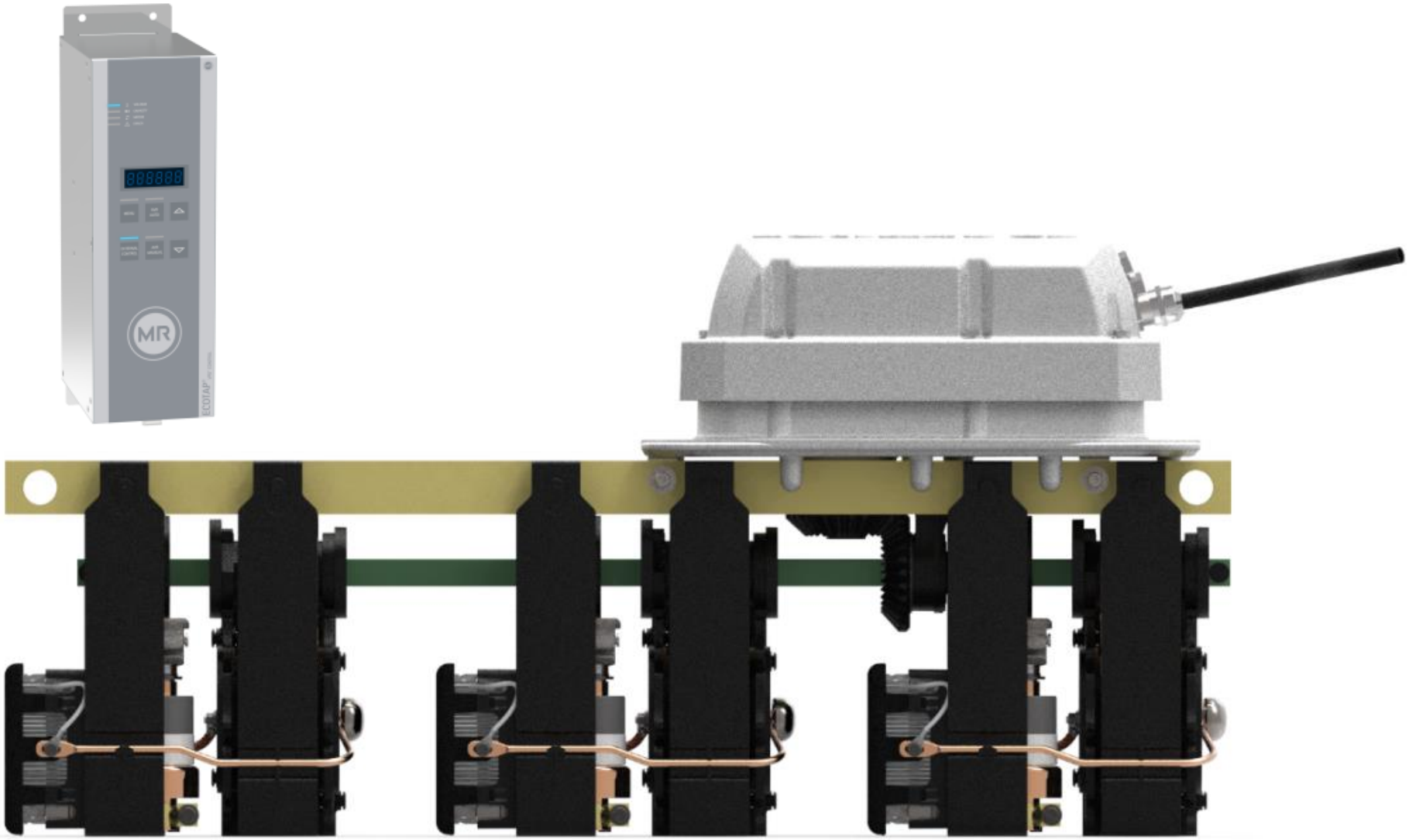
MR OLTC



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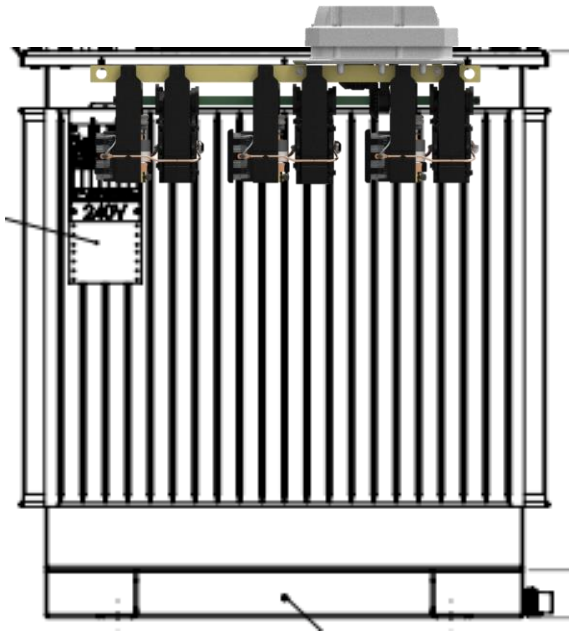

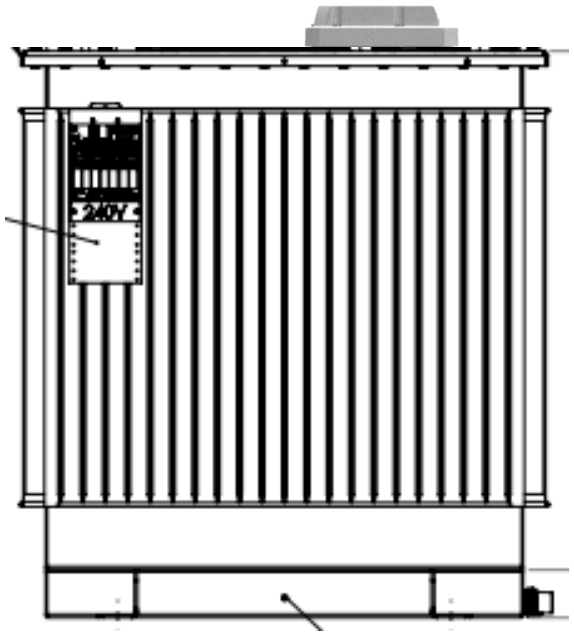

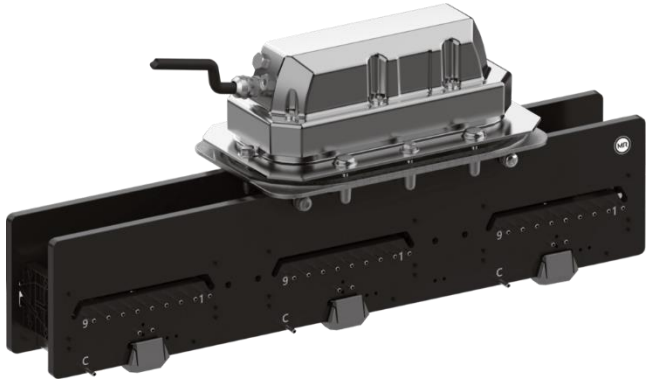

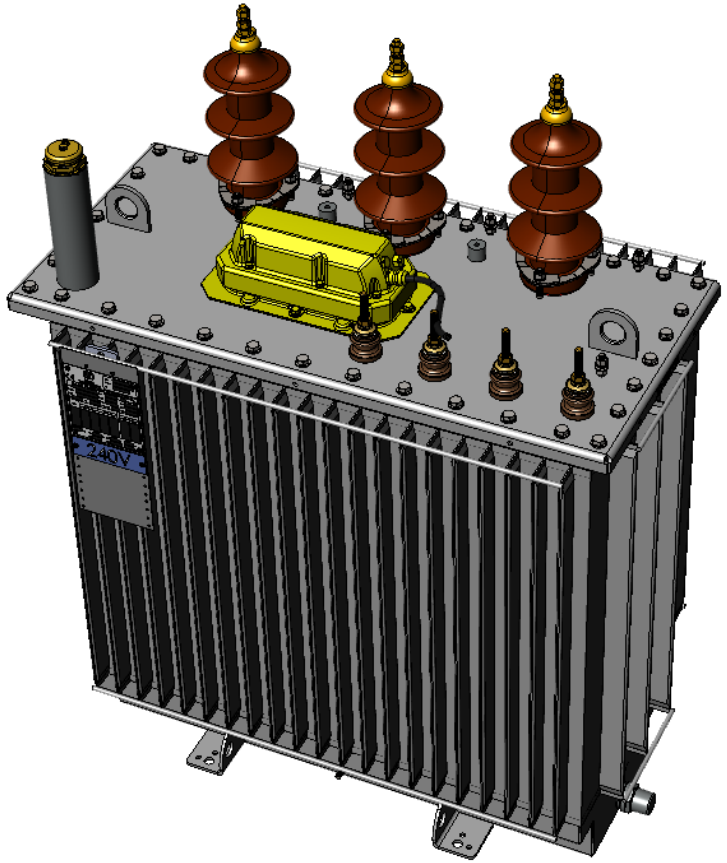

Our 100 kVA has the same footprint as a standard 100 kVA

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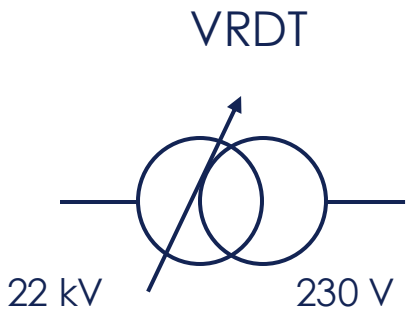
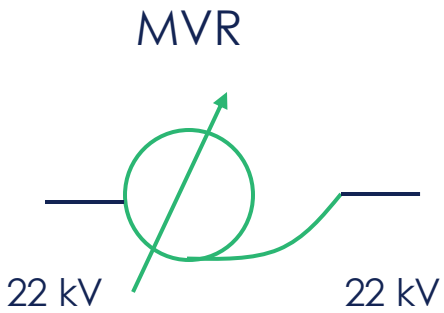
Automatic tap-changer from Maschinenfabrik Reinhausen





- Tried and tested vacuumcell-technology
- No oil pollution
- 👉 Maintenance free under lifetime of the transformer
- No additonal losses
- 9 steps
- …or 2 x 8 + 1 = 17 steps

“Several DSOs are currently ordering around **80-100%** *of their distribution transformers as VRDT’s”*

- F. Pizzutto, Business Development Manager, Machinenfabrik Reinhausen

“We procure one hundred percent of our new transformers as VRDTs since we assume that we need a one hundred percent quota anyway.”

— Bianca Renner, Strategy and Innovation Engineer at Avacon Netz GmbH *

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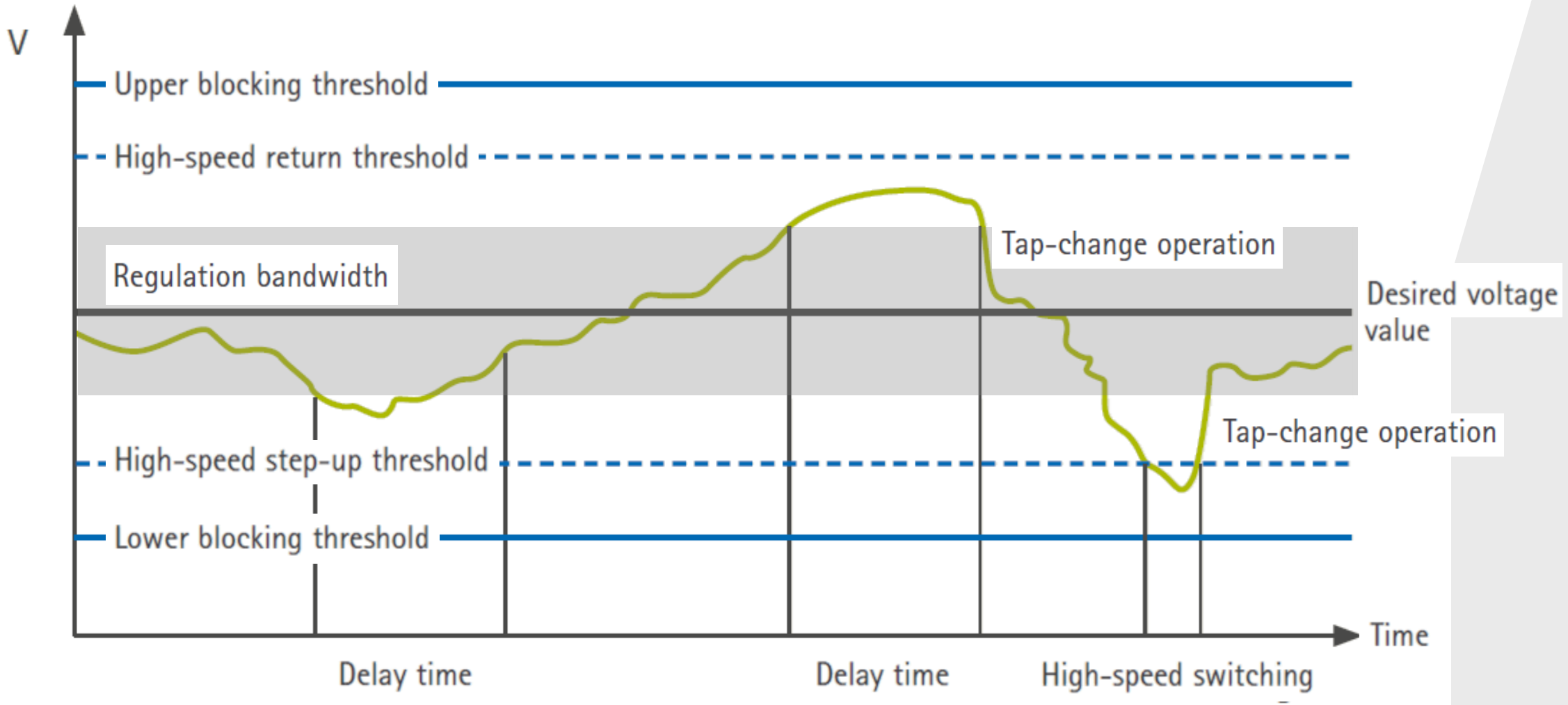
*https://onload.reinhausen.com/en/07-2024/ecotap-voltage-regulating-distribution-transformer/



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VRDT – Voltage Regulating Distribution Transformer

- Distribution transformer with OLTC for:
  - Circuits with high Rooftop PV penetration
  - Upstream voltage variations
- Lifetime: >500.000 switching operations
- Remote control capabilities (IEC104++)
- Max short circuit level: 4,5kA

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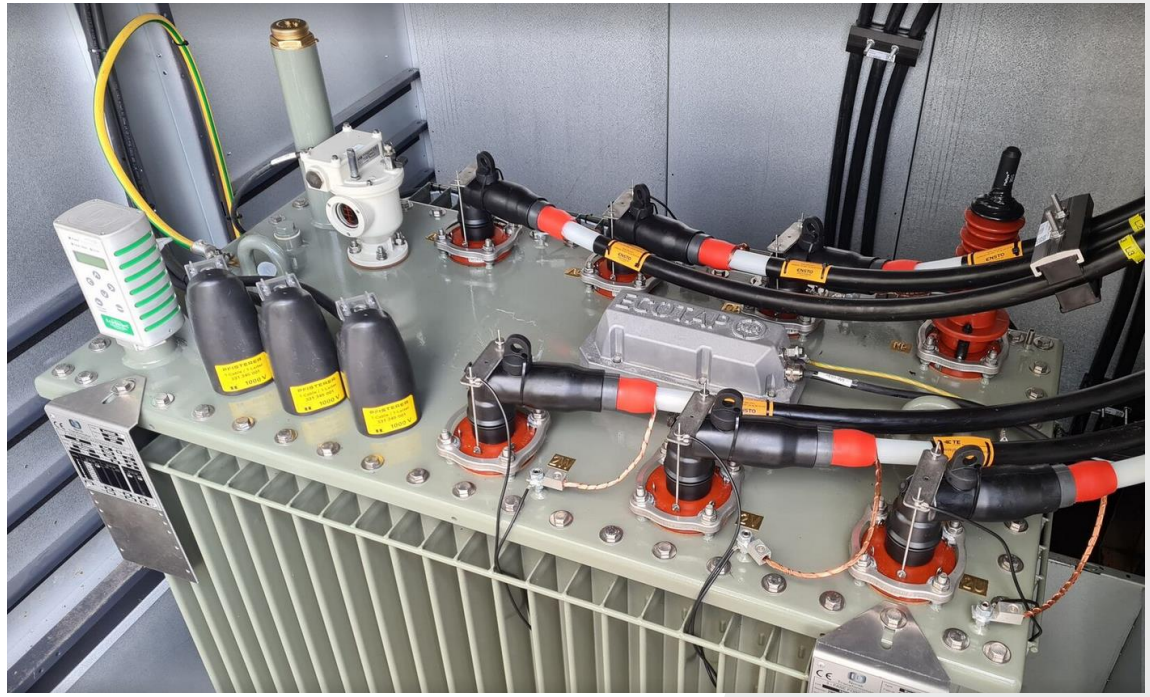
MVR – Medium Voltage Regulator

- Line voltage regulator for MV:
  - Long radials
  - Distributed generation
- Lifetime: >300.000 switching operations
- Remote control capabilities (IEC104++)
- Loadable tertiary delta winding (230V)
- Max short circuit level: 4,5kA



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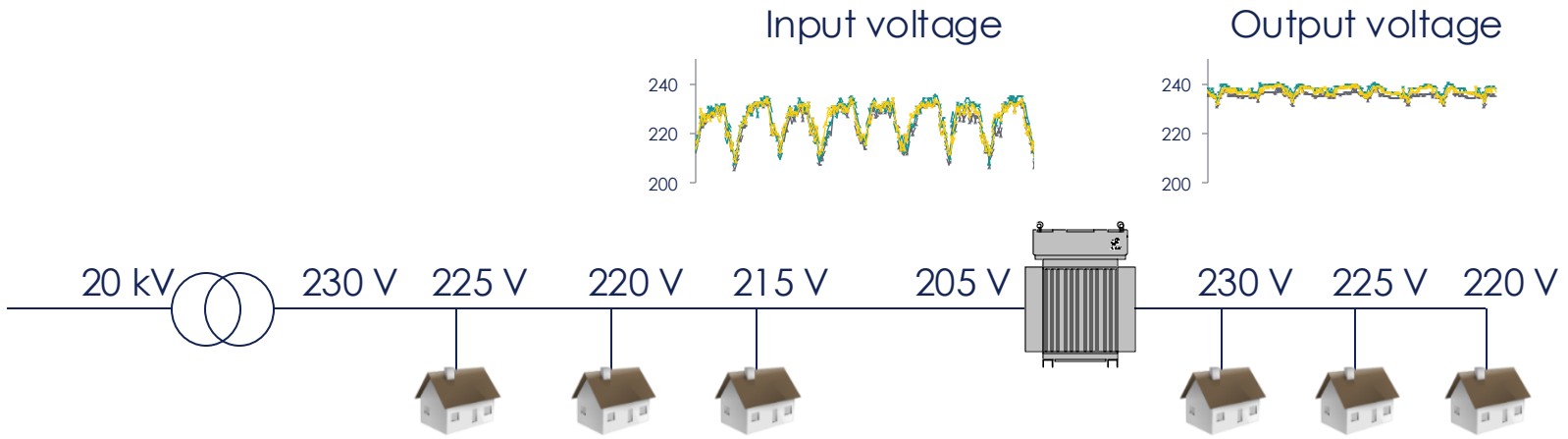
LVR – Low Voltage Regulators

- Improves lifetime of existing LV grid
- Reduces or eliminates grid upgrade cost
- Lifts/lowers and stabilizes the voltage
- Corrects voltage unbalances 3~
- Increases (Isc1) approx. 60%



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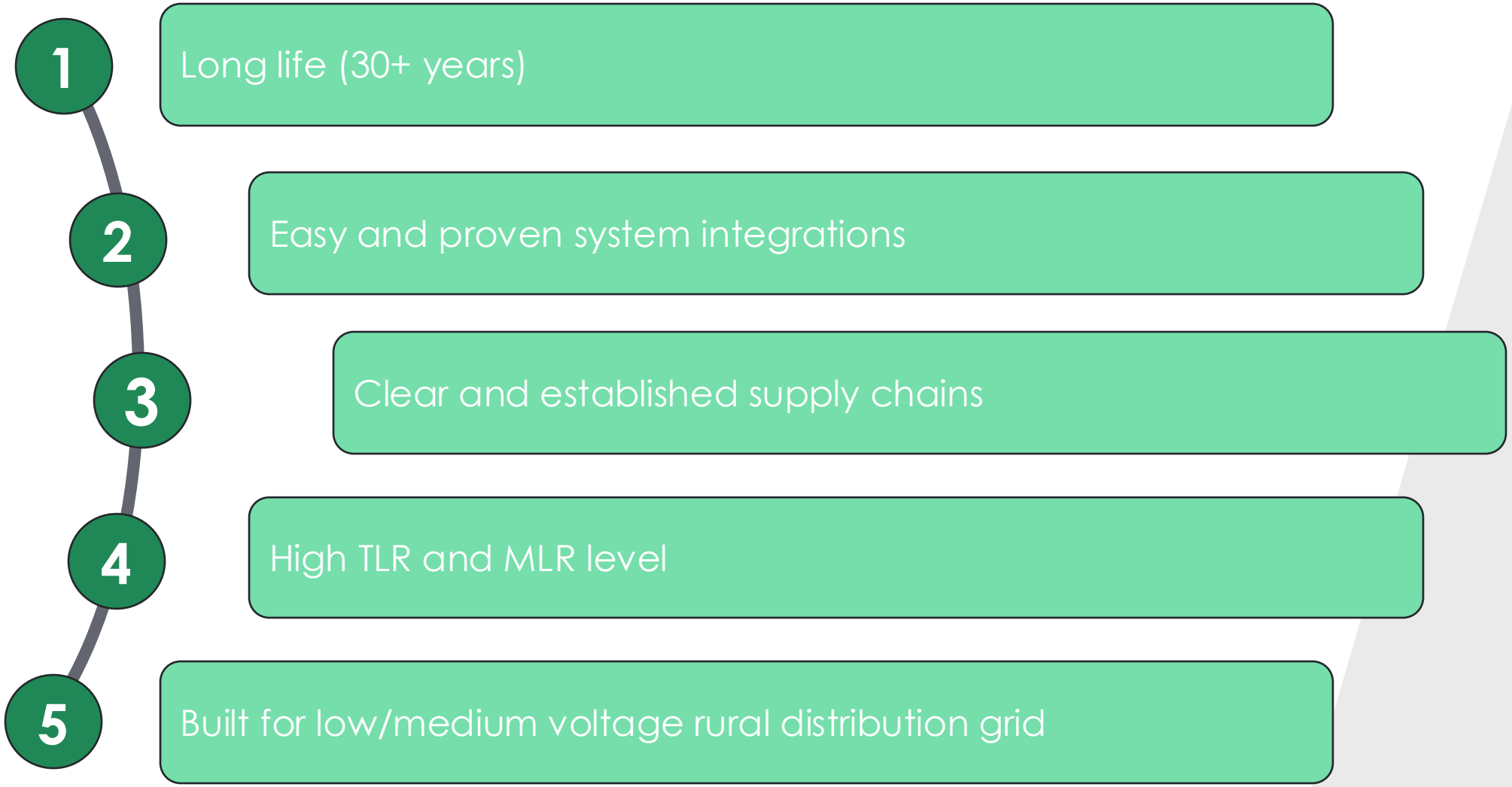
High Level Key takeaways



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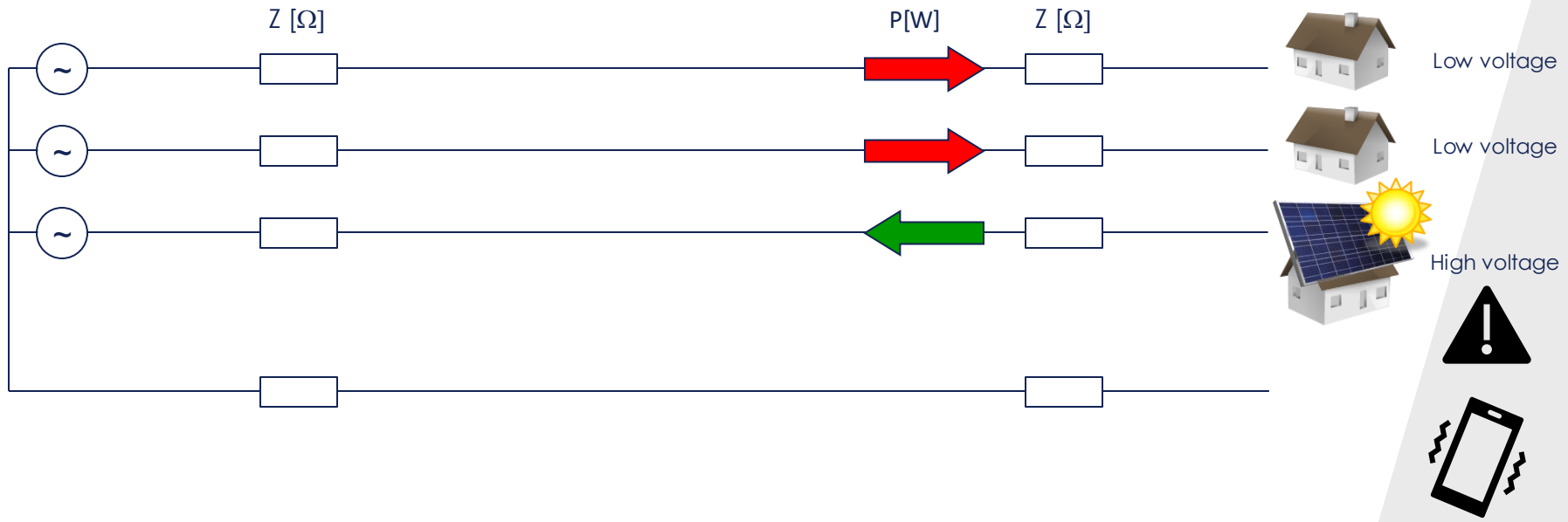
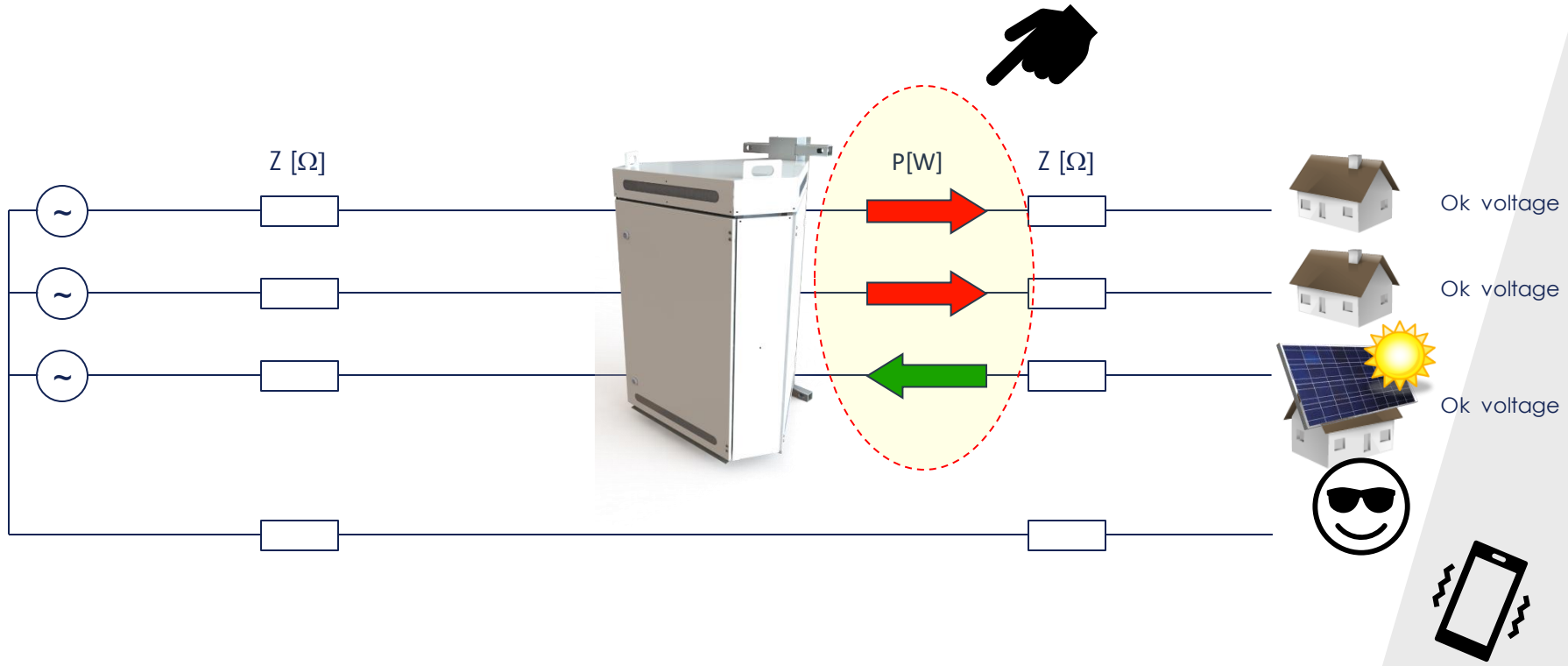
Use cases & best practice

LVR – Low Voltage Regulators

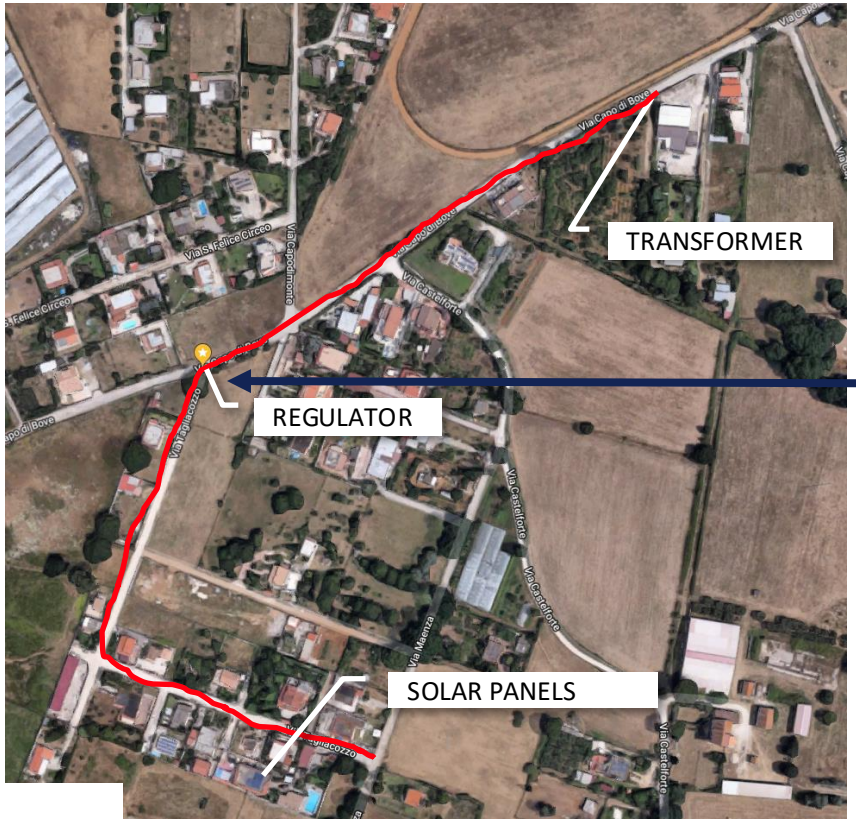
Power flow in both directions

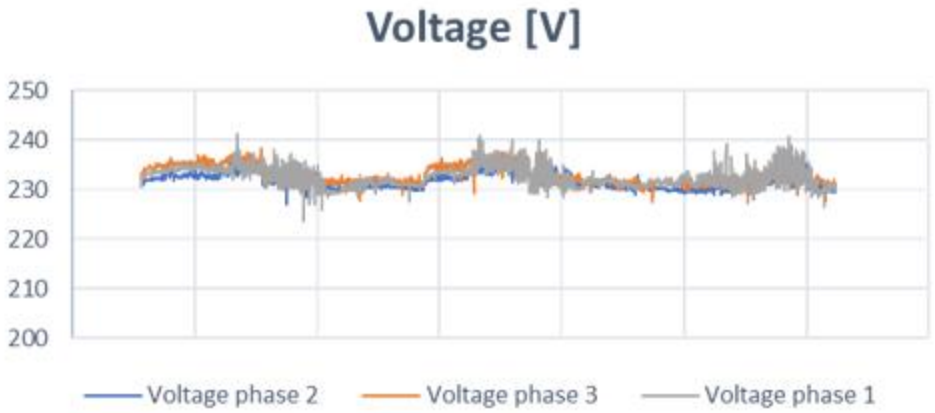


Power flow in both directions



Typical curves after SVB





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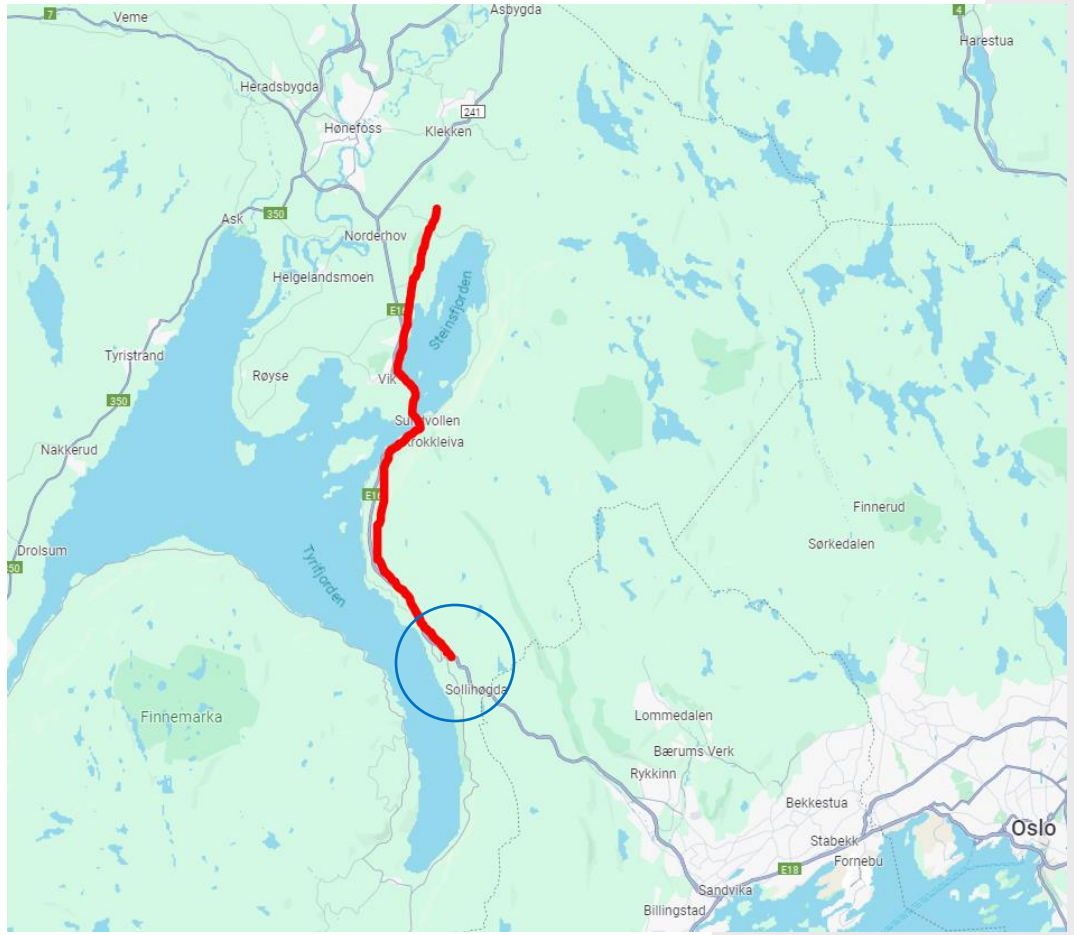
MVR – Medium Voltage Regulator

22 kV MVR Sollihøgda, Norway

- **Need for 2 MW** at the end of a **24 km** radial from substation
- Only 700 kW available
- Alternatives:
  1. Traditional grid reinforcement: approx. **4MEUR** total cost for a temporary demand.
  2. 3 MVA, 22 kV series regulator: **0,4MEUR** including installation and reconfiguration of switches. Can be installed 6-7 months after PO.
- Prototype installed in 2020
- Tunnel is built and the regulator is being prepared to be moved to a new location.



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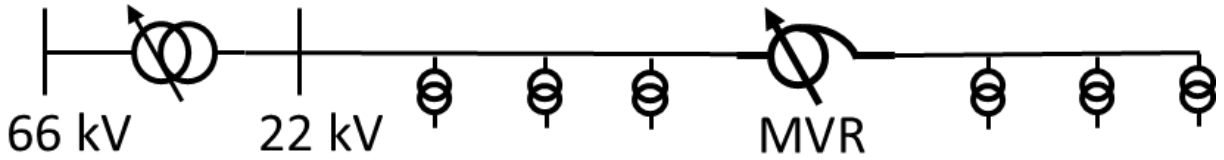

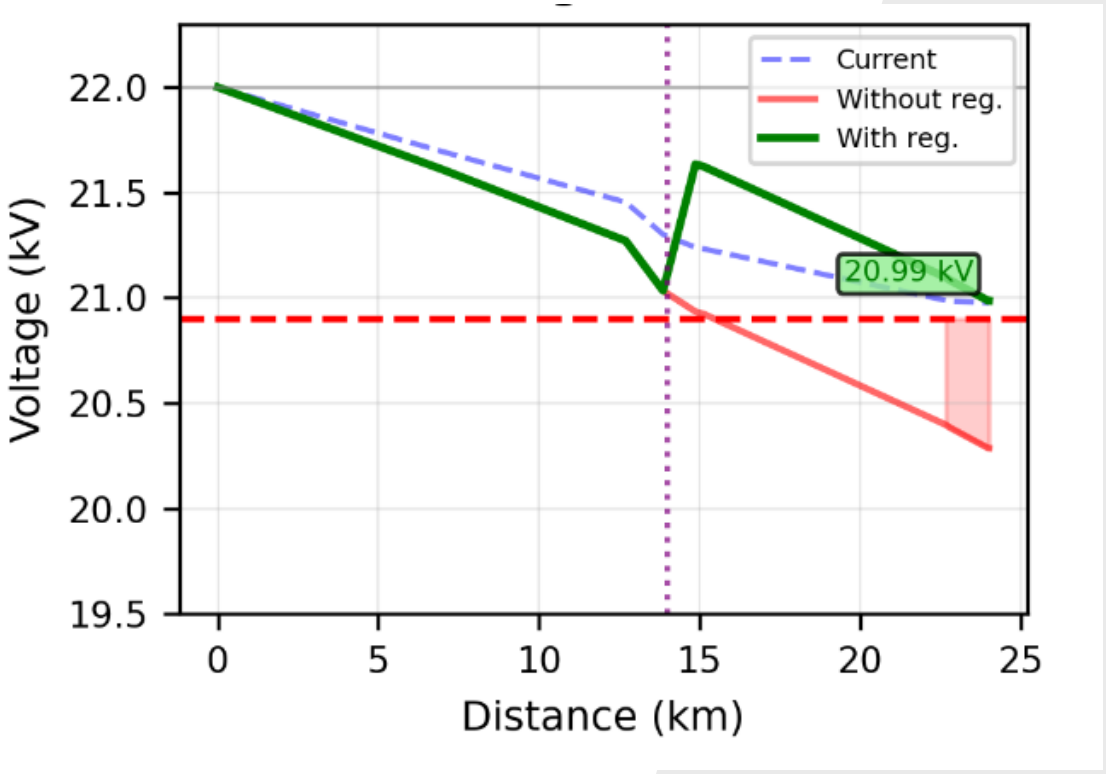

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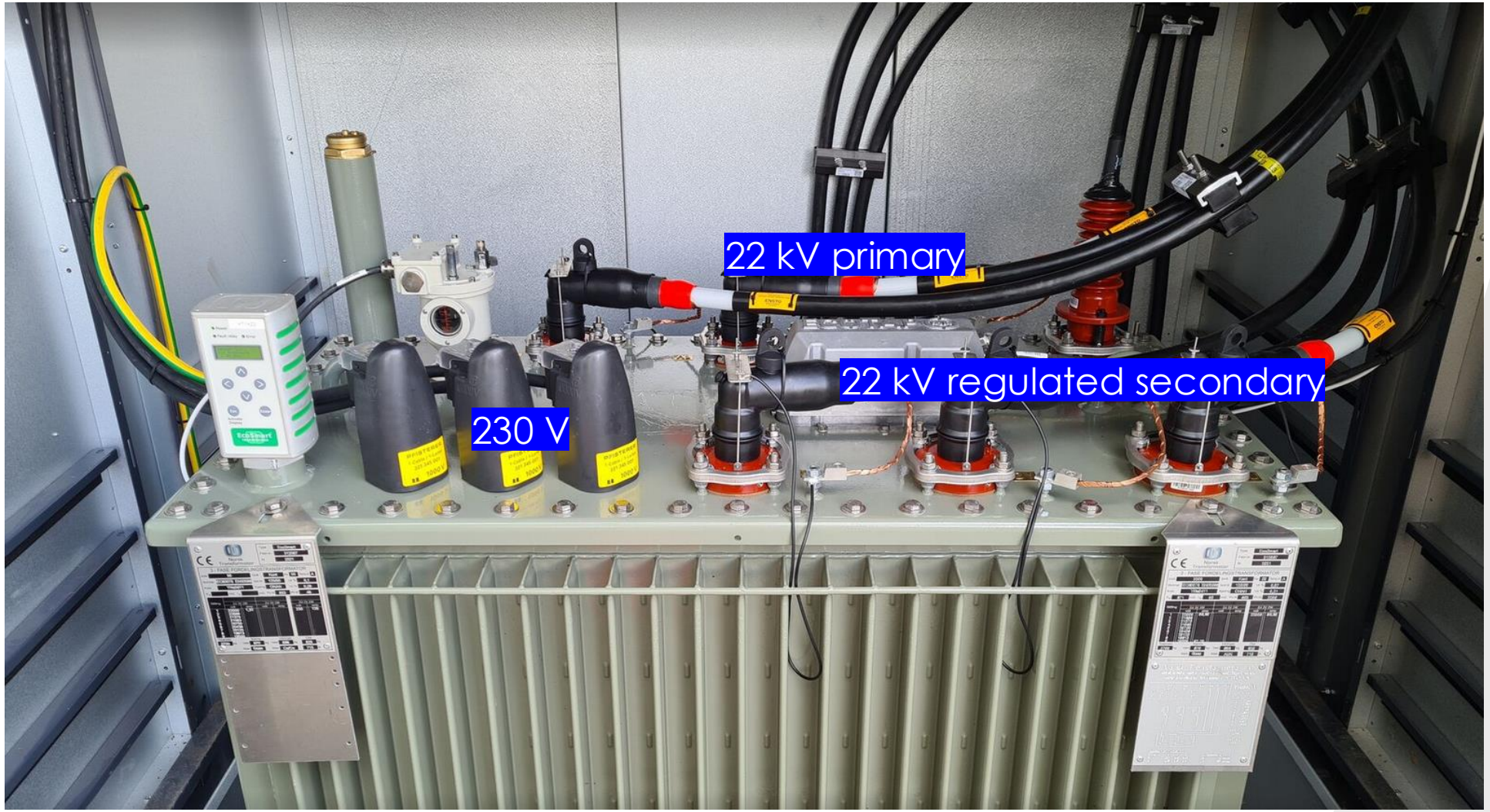

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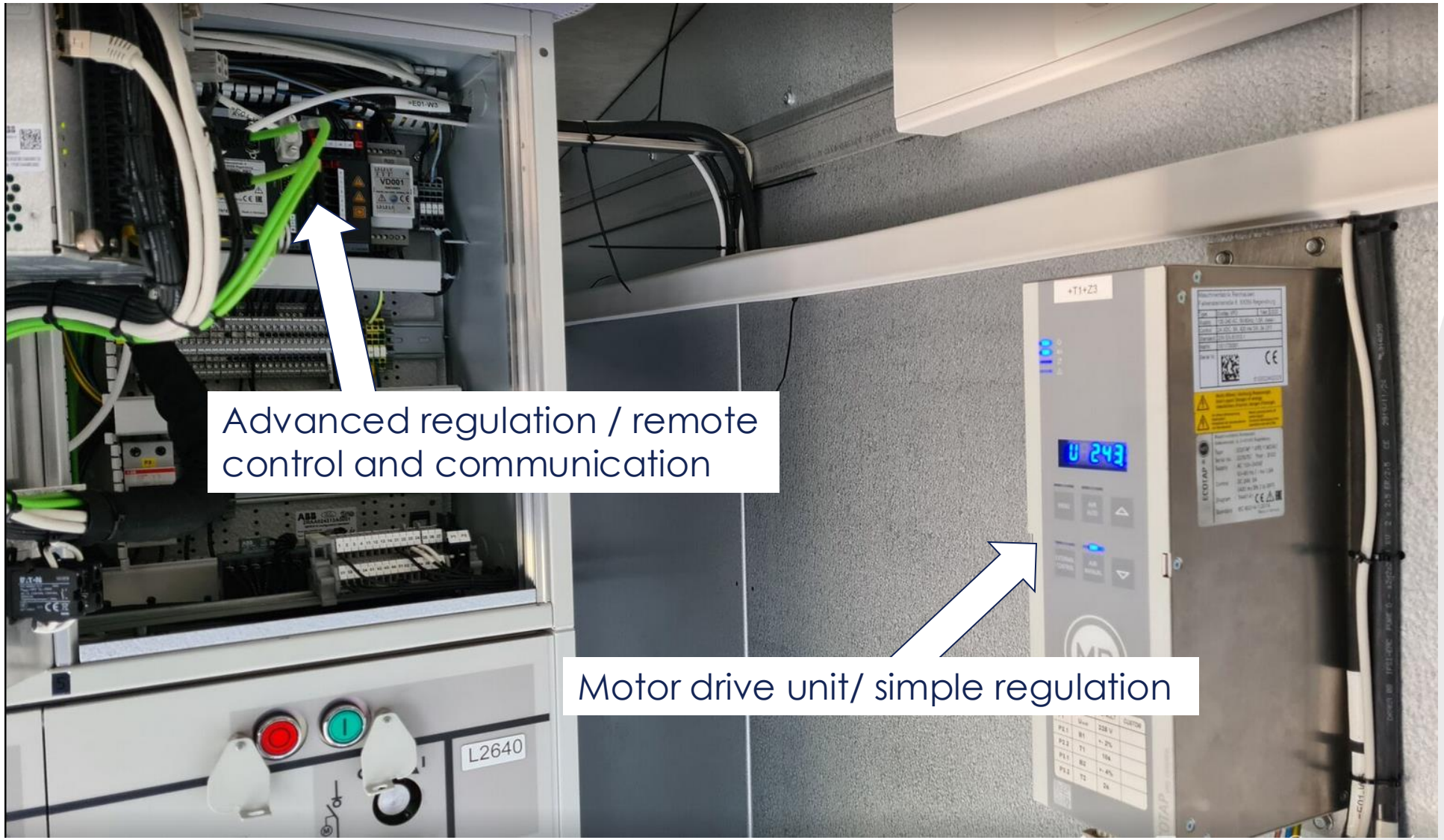

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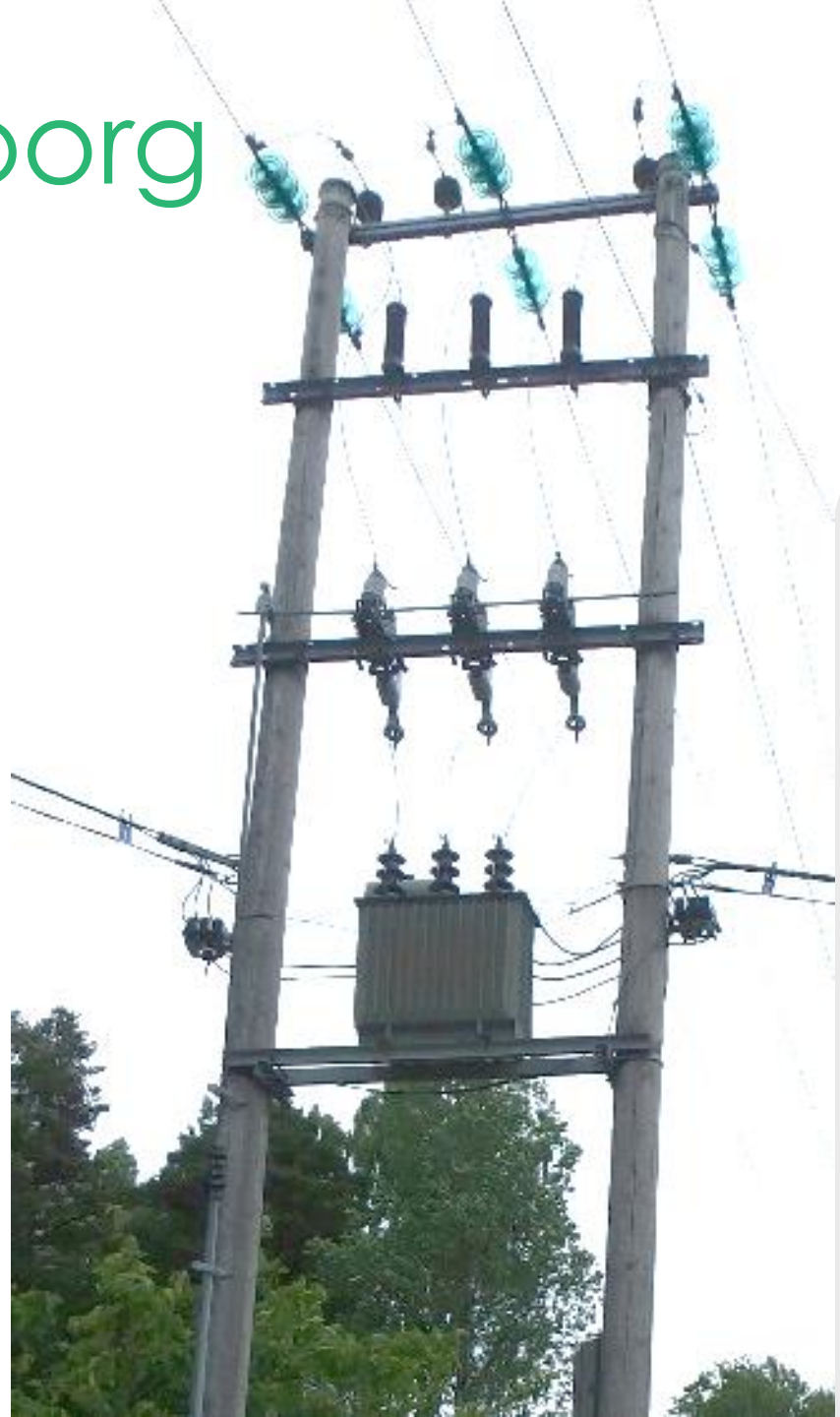
VRDT – Voltage Regulating Distribution Transformer

Project – VRDT Sarpsborg

Rooftop solar creates voltage variations in the transformer circuit.

- Increasing the allowed voltage rise from DG from 2.5% to 5% would double the available capacity.
- The problem was solved with VRDT, and the OLTC switches roughly once per day.
- With a guaranteed 500,000 switching operations, the tap changer will outlast the transformer by a wide margin.



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Helgeland Kraft AS

Kilde: Eivind Parelius, Helgeland Kraft

energiteknikk

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OM OSS TIPS

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Sivilingeniør Eivind Parelius i Helgeland Kraft foran nettstasjonen med ny teknologi for automatisk avlesning av spenningskvalitet. (Foto: Helgeland Kraft)

Regulerer spenning automatisk

Helgeland Kraft har i samarbeid med Sintef Energi testet ut Nordens første automatiske spenningsregulator. Den står plassert bak en snødunge i Snefjellåga, men overvåkes nøye.

MANDAG, 27 MARS, 2017 - 09:52

Kilde: Helgeland Kraft

Transformatoren er produsert av Norsk Transformator på Steinkjer og hadde en investeringskostnad på 250.000 kroner. I samarbeid med Sintef Energi følger de nøye med på hvordan nyinvesteringen kan regulere spenningen i nettet.

Høy produksjon på Snefjellå kraftverk i kombinasjon med lavt forbruk kan føre til for høye spenninger. Dette har man prøvd å begrense med å forsterke nettkabelen, men resultatet ble ikke godt nok.

– Spenningen varierte mer enn hva vi hadde tenkt. Dette er uheldig og kan for eksempel føre til økt forbruk av lyspærer i perioder der spenningen er høy, forteller sivilingeniør Eivind Parelius i Helgeland Kraft.

Best practice & key takeaways

- Plan voltage regulation alongside reinforcement, not after
- Measure first: voltage logs guide sizing
- Coordinate MV and LV regulation with PV inverter control

Key takeaway: regulation is cheaper, faster and more flexible

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Questions?

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