APPLICABLE GAIN OF RESILIENCE OF ELECTRICAL GRIDS IN URBAN, SUBURBAN AND RURAL AREAS

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MOTIVATION AND SCIENTIFIC / PRACTICAL QUESTIONS

- The decades-long, sometimes unpredictable increase in energy demand led to a selective and partially suboptimal expansion of the electricity distribution grid in urban, but also suburban and rural areas.
  - The historically grown power grid no longer corresponds to its basic grid structure.
  - Clearly defined service areas are blurred and optimal operation of the power grids is very difficult.

- How far is the concept of **gaining resilience** for distribution system operators applicable in order to ensure an optimized and secure operation of electrical grids?
  - What effects does the implementation towards the target grid have for the switching states and the grid structure?
  - To what extent can the reliability of the grid be improved (ASIDI or SAIDI value)?
  - What costs occur in the course of an optimization, compared to maintaining the current network topology and thus associated troubleshooting or repair?

PLANNING METHOD

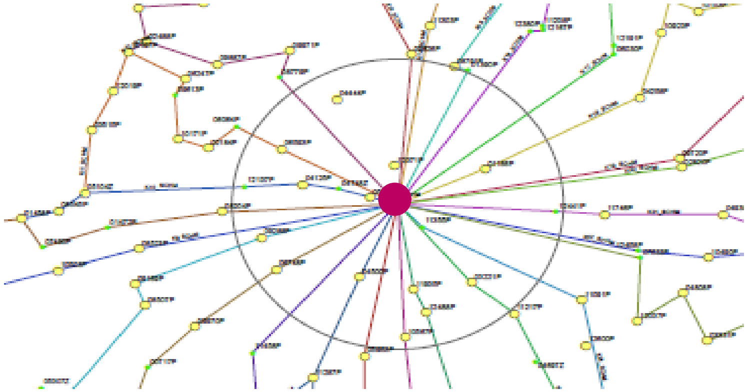
- The methods and application examples show that each grid section must be considered individually. Not every planning method can be used meaningfully and compatibly everywhere.

- The following developed **methods** are used:
  - Destination grid planning / medium voltage system optimization
  - Detour factor (relation of line to airline length)
  - Resilience increase through automation, digitization and application of the developed planning criteria

- The results are **adapted and optimized grid sections**:
  - Shorter cable lengths
  - Even loads
  - Centralized substation supply
  - Uniform structure
  - Intelligent grid nodes

APPLIED METHOD - TARGET GRID PLANNING FOR THE MEDIUM VOLTAGE LEVEL

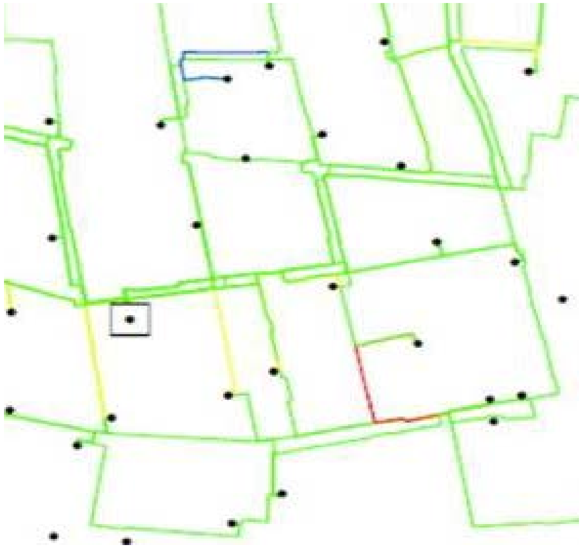
- Within a radius of 300 m around a transformer substation, the **first transformer station** must be "fed" by the medium voltage cable. Within a radius of 1200 m, there must be no “Schutzholz" transformer station.
- A number of approximately ten transformer stations per medium voltage branch should be targeted.
- Every fifth transformer station has a coupling point to a nearest medium voltage line.
- Direct lines to "large" customers must not be changed.
- Reduction of medium-voltage sleeves and distribution line lengths.
- Establishment and strategic positioning of **intelligent substations** and excess current indicators on overhead lines to reduce downtime.
- The load capacity of cables must be taken into account in accordance with the design.



EXAMPLES, RESULTS

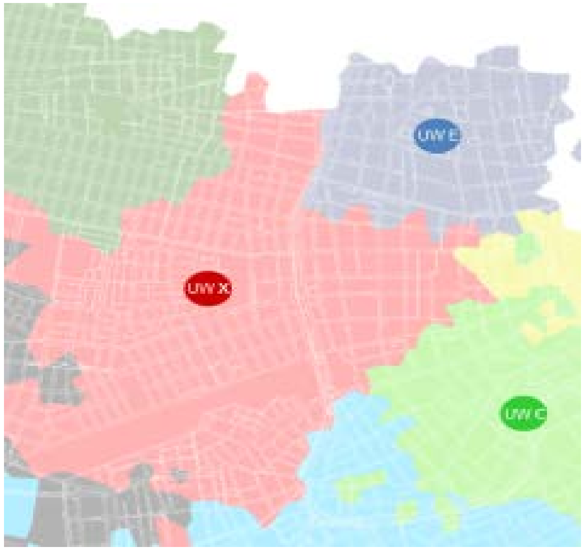
URBAN

- Compact spatial boundary of the area
- Depending on the application of the criteria and framework conditions of the medium-voltage system optimization, the number of branches per substation can be reduced from 22 to 14.



SUBURBAN

- Wider areas
- Depending on the application of the criteria and framework conditions of the medium-voltage system optimization, the number of branches per substation can be reduced from 57 to 42.

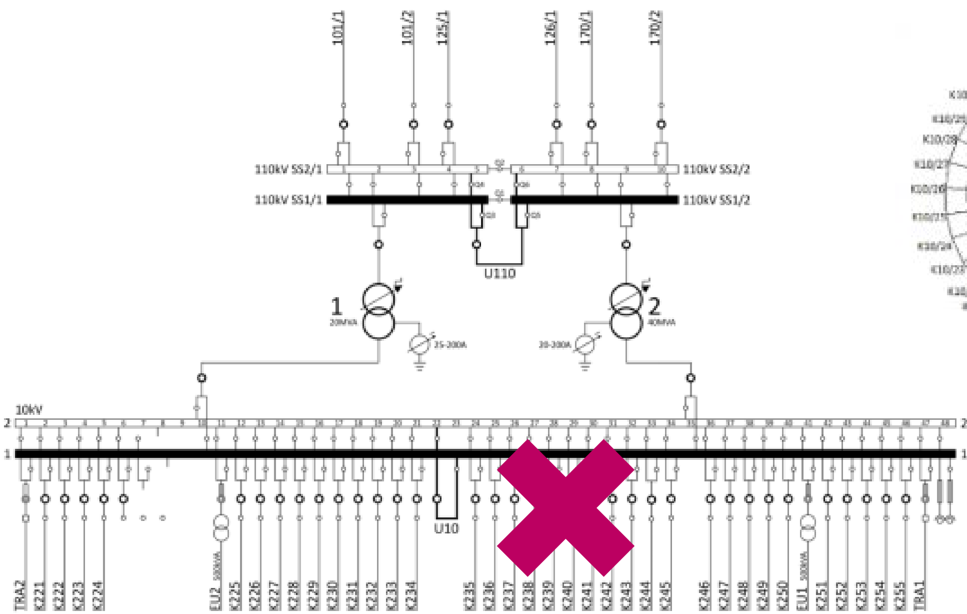


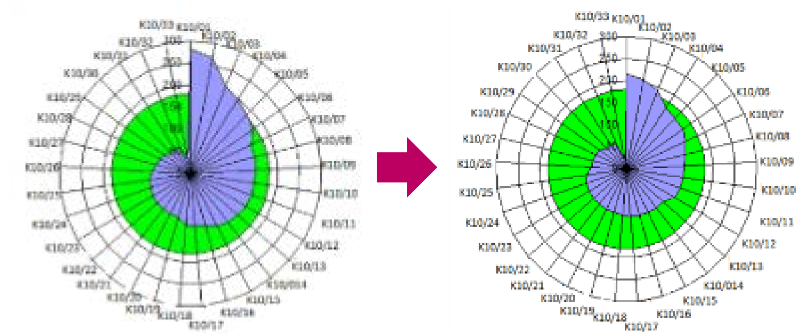
RURAL

- Few, spacious cables with long lengths. Large number of transformer stations per line.
- Target grid planning recommends eight instead of seven medium-voltage branches per substation for better load distribution and fast fault clearance.

CONCLUSION

- The increase in resilience of the medium-voltage level is characterized by extensive adaptation possibilities for different service areas toward the target grid (independent of the medium voltage level: 10, 20 or 30 kV).
- The increase in resilience is efficient and expedient, as it can be used area-wide, but also occasionally selectively. An event-related possibility of implementation (eg interruptions, expanding-related new investments, dismantling and decommissioning) is applicable at any time.





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