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Dear Mr. Kaupa,

UCTE as the community of transmission system operators (TSOs) highly welcomes improvements of grid infrastructure which increase the reliability of the synchronously interconnected system and facilitate the well functioning of the free electricity market.

In order to maintain security and stability of the European power system it is of utmost importance to have a strong backbone of 400 kV lines. Up to now this major transmission backbone is still missing in several areas affecting the reliability in critical situations and limiting the transmission capacity for the market.

Especially for the transmission grid situation in Austria we would like to mention the following areas of UCTE concern:

- In the near future strong North to South corridors will be needed for connecting regions of wind energy injection with the locations of powerful pump storage plants.
- The existing single circuit line (220 kV) between Austria and Italy does not meet the requirements of an international tie line as due to overloading it has to be operated in radial operation for long periods of time. If this line were replaced by a 400 kV double circuit line North to South load flows (or vice versa) would increase remarkably.

Concerning infrastructure technology we would like to give some general remarks that may support you to assess various options for current projects.

400 kV overhead power lines have proved to be robust and efficient grid elements of terms of load limits, lifetime, maintenance, and reliability if they are designed and built according to predicted future load flows and adapted to regional meteorological conditions.

Underground cables on the 400 kV level are chosen as an alternative only in very densely populated areas or in environmentally sensible regions or when overhead lines are physically impossible (e.g. near airports). Other applications of 400 kV cables are feeder lines for distribution networks or for connecting power plants to the transmission system. For such applica-

tions load can be defined and the load limits of cables may be chosen in accordance with the load flow that is limited by radial operation or by controllable grid elements like phase shifting transformers.

For the time being 400kV AC cable systems cannot compete with overhead power lines in the transmission grid. Using cables for lines in interconnected operation (400 kV backbone) presents serious technical, financial and environmental drawbacks. In this context the most critical issues of 400 kV underground cables are as follows:

- Dimensioning of new lines should be based on best knowledge of future load increase, commissioning of new power plants, new pump storage facilities, further expansion of renewables, etc. Load limit reserves should be foreseen to last for the lifetime of the planned system. A single cable system has a maximum capacity with forced cooling of about 1.500 MVA whereas a typical capacity of an overhead power line is about 1.800 MVA and more.
- Laying multiple underground cable systems in parallel to achieve the same rating as an overhead power line multiplies investment and increases the required route width.
- Cost factors comparing 400 kV underground cables and overhead lines in the range of 4:1 to 20:1 depending on the capacity and environment do not favor underground cables.
- Due to their low specific impedance cables in interconnected systems "attract" additional loop flows from neighboring branches and are therefore prone to overloading.
- It is true that cables are immune to some causes of disturbances – such as storms, icing, air pollution, etc. – but they are threatened by other causes (floods, landslides, excavation works). Even though faults in cables do not occur very often, every fault in a cable leads to lengthy localization procedures of the fault and long repair times. Repair times for cables range from weeks to months, whereas damages on overhead lines can be either repaired in short time or can be bypassed by erecting provisional towers within a few days.
- Alternating sections of overhead lines and cables cause serious difficulties for the availability of the system. Combined routes of cables and overhead lines combine the drawbacks of both technical systems: due to atmospheric effects, overhead lines have relatively often self healing failures which would lead in a combined cable/overhead line system to a shut down of the system. Before it can be taken back into operation again, lengthy fault localizations procedures are necessary as auto reclosure would damage a cable significantly. Furthermore at every point of change cable/overhead line important installations are necessary with a big impact into the landscape. These installations are additive weak points in the system.
- There is no experience with the life time of new XLPE-400kV cables, estimations range from 25 to 40 years. Compared to 80 years or even more for overhead power lines, much more investment in cables has to be made. Removing worn cables and laying new ones

will keep the system out of operation for long periods or requires parallel systems and routes during the replacement.

- Several electrical phenomena of cables (overcurrents and overvoltages while switching on or off, reactive power compensation) require specially designed components. These problems also restrict the use of cables during island operation or for restoration after blackout.
- Caused by the very high weight of cables and the restricted transportation capacitiy on land the cable parts have to be connected by coupling boxes every 600 to 1000m. These coupling boxes are additive weak points and reduce the security of the system.
- Even though a cable itself is not visible, a cable route is usually very visible as a cable route through a forest requires that all trees are cut down along the route. In addition it is not allowed to plant plants with deep roots over a cable. Consequently the use for farmland is severely restricted. On the other side overhead power lines pose no restrictions on the use of farmland in their vicinity.

UCTE therefore recognizes overhead power lines as the most reliable and most secure technical solution for transmitting electricity over long distances. Furthermore based on different studies within UCTE an overhead line is the more efficient and more economic way for the transportation of electricity compared with underground cables at the 400 kV level.

Taking into account all the experiences reported by TSOs over the last years, the UCTE Working Group "Operations & Security" strongly recommends to avoid using underground cables as part of the 400 kV backbone of the Trans-European Network.

Sincerely yours,

Hans-Peter Aebi
Chairman of the Steering Committee

Marcel Bial
Secretary General

CC: K. Kleinekorte, Chairman of the UCTE WG "Operation and Security"