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EV Diffusion Impact Assessment on Distribution Networks of South Tyrol

The research activity aims to explain the expected effects of the future development of eMobility and the related charging infrastructures on Italian distribution networks. South Tyrol one has been chosen as reference case. The activity has been carried out In collaboration with Edyna (South Tyrol regional Distribution System Operator) and Alperia (South Tyrol energy provider). General and detailed analyses, based on locations, penetration rates and power profiles, on networks show that eMobility impact will be quite moderate in the next few years, but it will gain importance approaching 2030 and onwards. To face these challenges, significant investments in the distribution networks have to be planned. Smart solutions (e.g. load modulation, peak shaving etc.) will allow to reduce the required investments. A suitable regulatory framework is needed in order to support technical players in this challenge.

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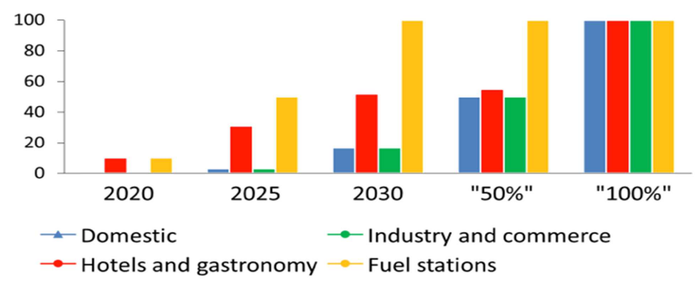
Preliminary aspects

eMobility is fostered with the aim of increasing the sustainability of the energy sector. The limited capacity of distribution networks to sustain a large amount of connections could be anyway a technical barrier. Future scenarios for the deployment of charging infrastructures in South Tyrol, and their impacts, are here shown.

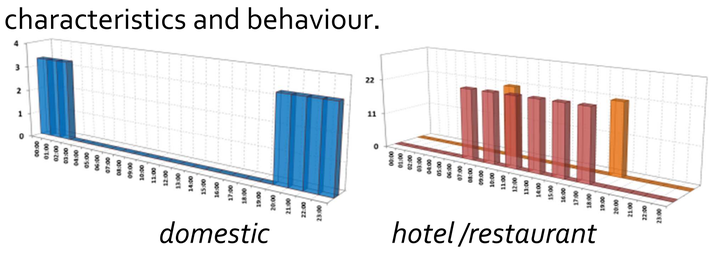
Three main aspects of charging stations to be considered are: location, penetration rate, and power profile. The **location** is defined correlating the charging station type with the point of delivery's destination.

Type user	*Power (kW)*	*Choices*
Domestic	3.3	# charging Points⇔ # EV Max 1 charging infrastructure / point of delivery
Commercial Industrial	7.4	1 fast charger / (20 kW of current contractual power)
Hotels Restaurants	22	1 fast charger / (50 kW of current contractual power) 1 fast charger / (20 kW of current contractual power)

The **penetration rate,** referred to the different charging stations types, is estimated from the literature and the recent trends, considering in particular the South Tyrol area.



A **conventional power profile** is assigned to each type of charging station, according to connected users' characteristics and behaviour.



Network test cases simulation

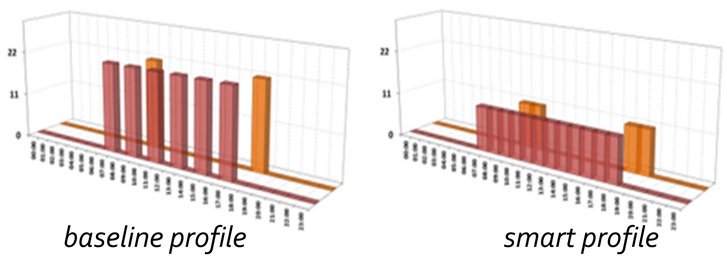
Three MV / LV **test networks** (main characteristic in the following table) are simulated with additional EVs load:

MV + LV	Grid 1	Grid 2	Grid 3
MV Lines [km]	31.8	21.7	26.4
MV / LV transformers	34	44	15
Transformers total power [MW]	11	14.8	4.43
LV lines [km]	58.8	98.2	19.7
Transf. power / kilometre [MW/km]	0.19	0.15	0.22

In the most challenging scenarios, EVs may cause the **violation of the thermal limit** of lines and MV/LV transformers. Only few voltage violations are observed. In the following table, the length of lines exceeding 50% and 100% of thermal limits respectively is reported:

	Grid 1		Grid 2		Grid 3	
[%]	>50	>100	> 50	>100	> 50	>100
	of thermal limit					
2030 [km]	3.4	0.2	5	0.8	3.2	0.2
"100%" [km]	6.7	0.8	11.2	1.7	4.9	0.8

Smart charging profiles allow to nearly halve the issues on the network. The fast charging (22kW) modulation is effective in LV networks, the slow charging (3.3 kW) one for MV networks:

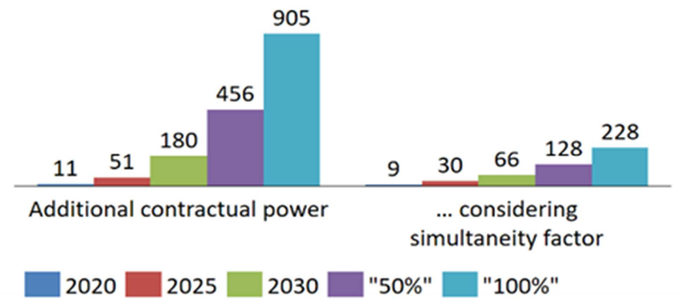


baseline profile *smart profile*

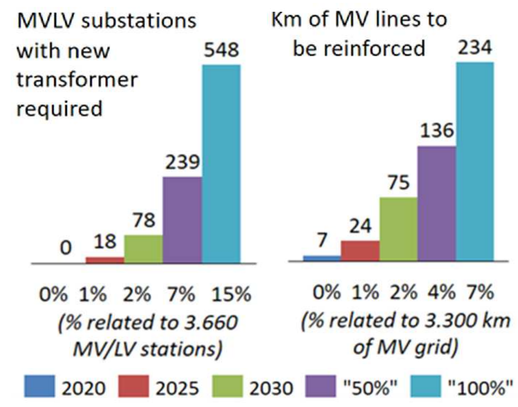
	Lines km mean reduction	
[%]	>50	>100
	of rated current	
2030 [%]	-35	-67
"100%"	-29	-61

Whole network estimation

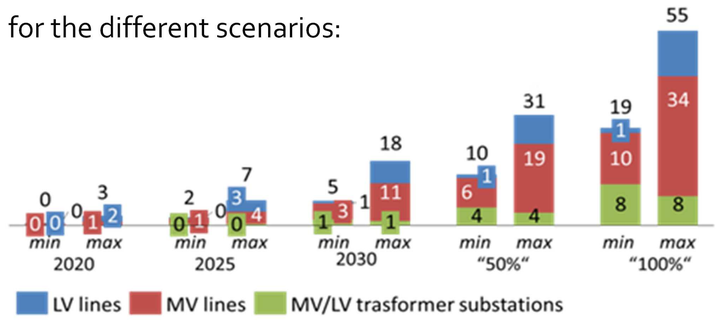
The **Additional power** [MW] from EV charging stations is estimated for the whole distribution network:



Results from test cases analysis allow to extend considerations about additional **reinforcements** needs:



Additional costs for reinforcements are then estimated for the different scenarios:



Expected impact

EVs load impact on distribution networks will be moderate in the next few years, although it would become relevant by 2030. This activity has shown how significant investments have to be planned even if smart solutions could reduce or defer them. A suitable regulatory framework is needed in order to support technical players in this challenge.

References

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Companies

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