



Impatto dello sviluppo dell'elettro-mobilità per la rete elettrica di Edyna in Provincia Autonoma di Bolzano

Ing. Arnold Rofner



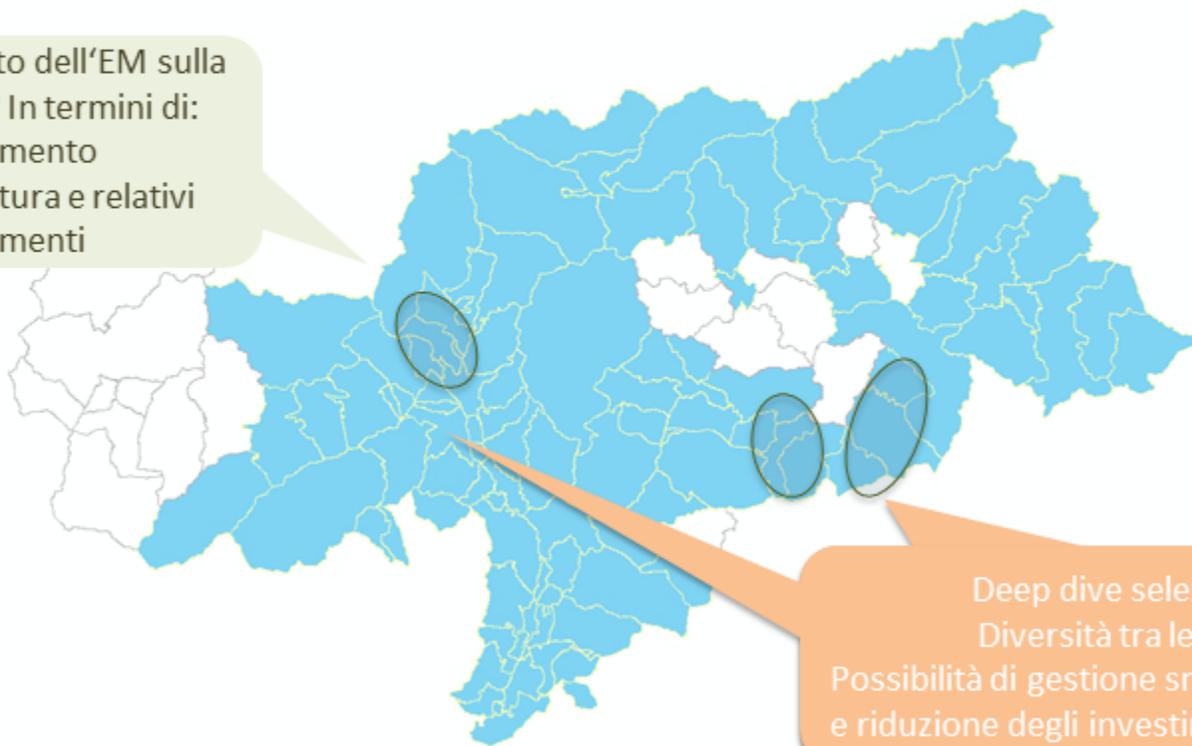
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1 marzo 2019

Obiettivo: individuare le implicazioni dello sviluppo dell'elettro-mobilità per la rete elettrica di Edyna ...

Quale è l'impatto dell'EM sulla rete di Edyna? In termini di: adeguamento dell'infrastruttura e relativi investimenti



... in termini di: potenziamento di rete e investimenti



Il team



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Il nuovo provider energetico
dell'Alto Adige

*wir sind
südtiroler
energie
siamo
l'energia
dell'alto adige*

Business Unit

Sono state definite le seguenti 5 business unit in cui sono state incorporate le varie affiliate Alperia:

Generazione, Reti, Commerciale e trading, calore e servizi nonché, da maggio 2017, Smart Region



Alperia in un colpo d'occhio

In Alto Adige gestiamo

41

centrali idroelettriche



Forniamo calore con

6

centrali di teleriscaldamento



Siamo competenti per

8.778

chilometri di rete elettrica



Forniamo energia a

278.000

clienti



Siamo un team di

1.000

persone



Gestiamo

100

Colonnine di ricarica pubbliche





> 230k POD

8.700 km di rete
AT/MT/BT

84 Impianti primari

118 km rete gas

>4.000 Cabine
Secondarie

39 distributori
sottesi

5.000
produttori

14.800 punti di
illuminazione
pubblica

Investimenti
> 30 Mio. € p.a.

Manutenzione
5 Mio. p.a.



Ordine del giorno

- Metodologia e ipotesi di base
- Impatto dello sviluppo dell'elettro-mobilità sulla rete elettrica di Edyna
- Sintesi e prossimi passi

Metodologia e approccio

Definizione degli ipotesi di base



- Sviluppo **numero veicoli** circolanti



- **Potenze** per punti di ricarica, assegnazione ai tipi d'utenza

Per scenario:
simulazione infrastruttura di ricarica

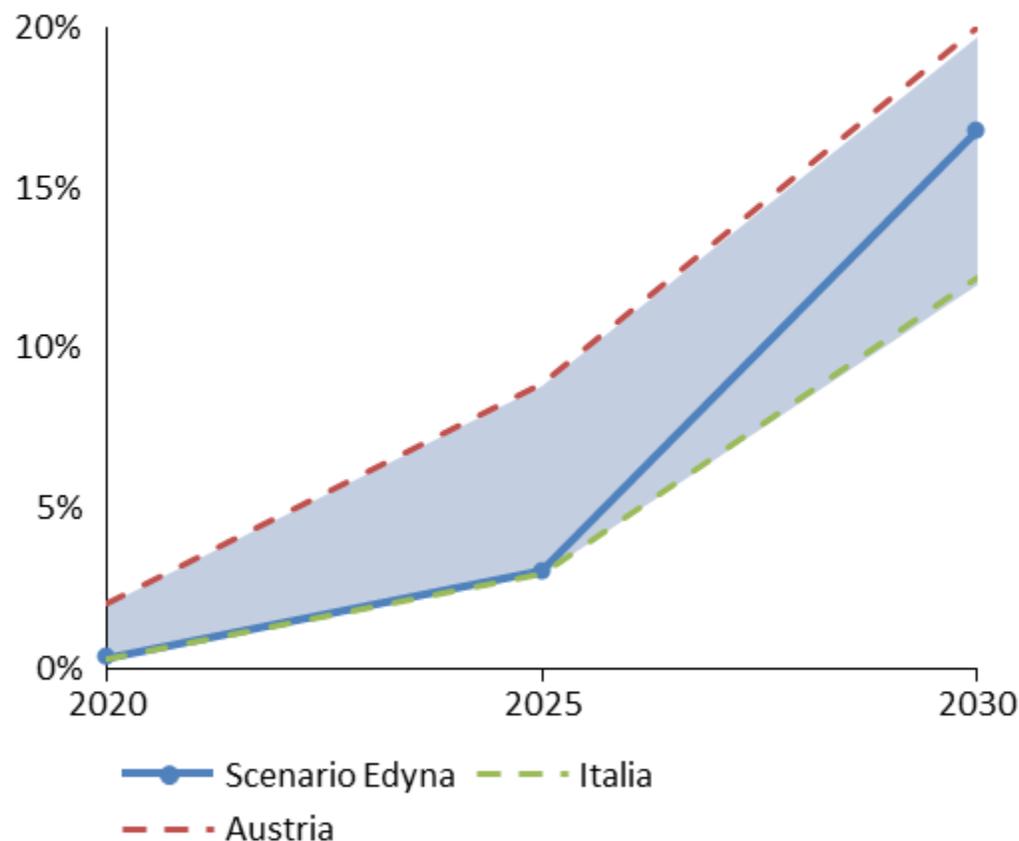


- **Sviluppo:** numero colonnine, potenze, penetrazione per tipo d'utenza
- **5 scenari** (2020, 2025, 2030, «50%», «100%»):

Interventi e investimenti necessari



Numero di veicoli elettrici circolanti

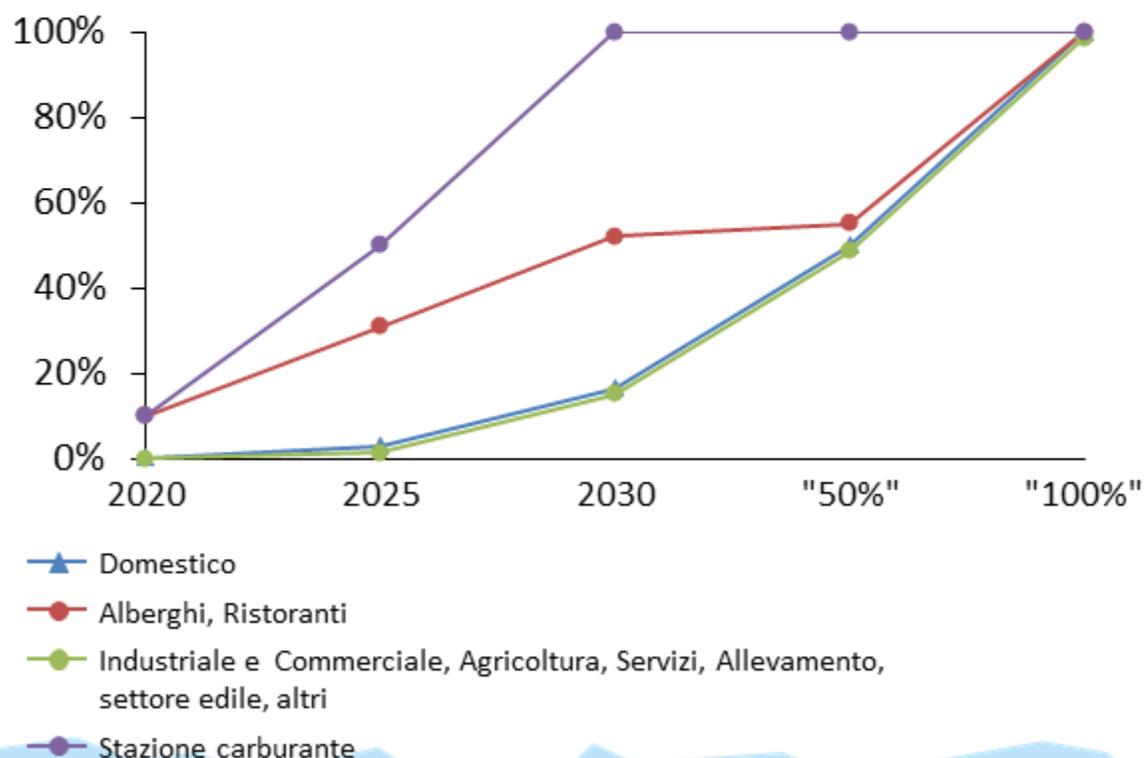


- Numero macchine in totale in Provincia Autonoma di Bolzano³:
 - 680k unità circolanti
 - Di cui 547k autovetture (incl. numero elevato di macchine di noleggio registrate in PAB)
 - Di cui 53% o 290k autovetture private (cioè 0,56 macchine per capita)
- Input per lo studio: macchine private su territorio Edyna (ca. 90% della PAB), in particolare per utenti domestici

1. Scenario Austria: Reinard Nanning (Vorarlberger Energienetze GmbH): E-Mobility Workshop Bregenz 2017 – Results and follow up tasks; 2. Scenario Italia: Politecnico di Milano: "E-Mobility Report 2018 – Le opportunità e le sfide per lo sviluppo della mobilità elettrica in Italia"; 3. Ministero delle infrastrutture e dei trasporti – Parco circolante Trentino Alto Adige 2017

Sviluppo delle colonnine di ricarica (penetrazione in %)

Penetrazione punti di ricarica (in %, relativa ai numeri POD)



- **Utenti domestici, industria e commerciale:** diretta correlazione tra numero di veicoli EM e colonnine di ricarica private
- **Alberghi e Ristoranti:** ruolo di battistrada, in linea con osservazioni sul territorio
- **Stazione carburante:** copertura 100% della prestazione di ricarica in 2030
- I casi di **infrastrutture di ricarica ex novo** sono stati considerati indirettamente (p.es. Parcheggi per centri commerciali etc.)

Input: ipotesi di base per determinare la potenza delle colonnine EM

<i>Tipologia utente</i>	<i>Potenza (kW)</i>	<i>Metodologia per il calcolo la penetrazione delle colonnine</i>
Domestico	3,7	<ul style="list-style-type: none"> • # colonnine ↔ # macchine EM • Ipotesi: 1 x per veicolo EM • Max 1 colonnina elettrica per POD (anche se p.es. 2 EM)
Alberghi	22	• 1 fast charger per ogni 50 kW di potenza attuale
Ristoranti		• 1 fast charger per ogni 20 kW di potenza attuale
Industriale e Commerciale	7,4	• 1 fast charger per ogni 20 kW di potenza attuale
Stazione carburante	45	• 2 colonnina di tipo quick charger per ogni 20 kW di potenza attuale

Sappiamo ora le potenze - come determinare eventuali interventi?

Rete MT

individuazione di eventuali superi di potenza / hosting capacity



- Calcolo del **numero di CS** da potenziare
- **Costi unitari:** ca. 15 k€/CS



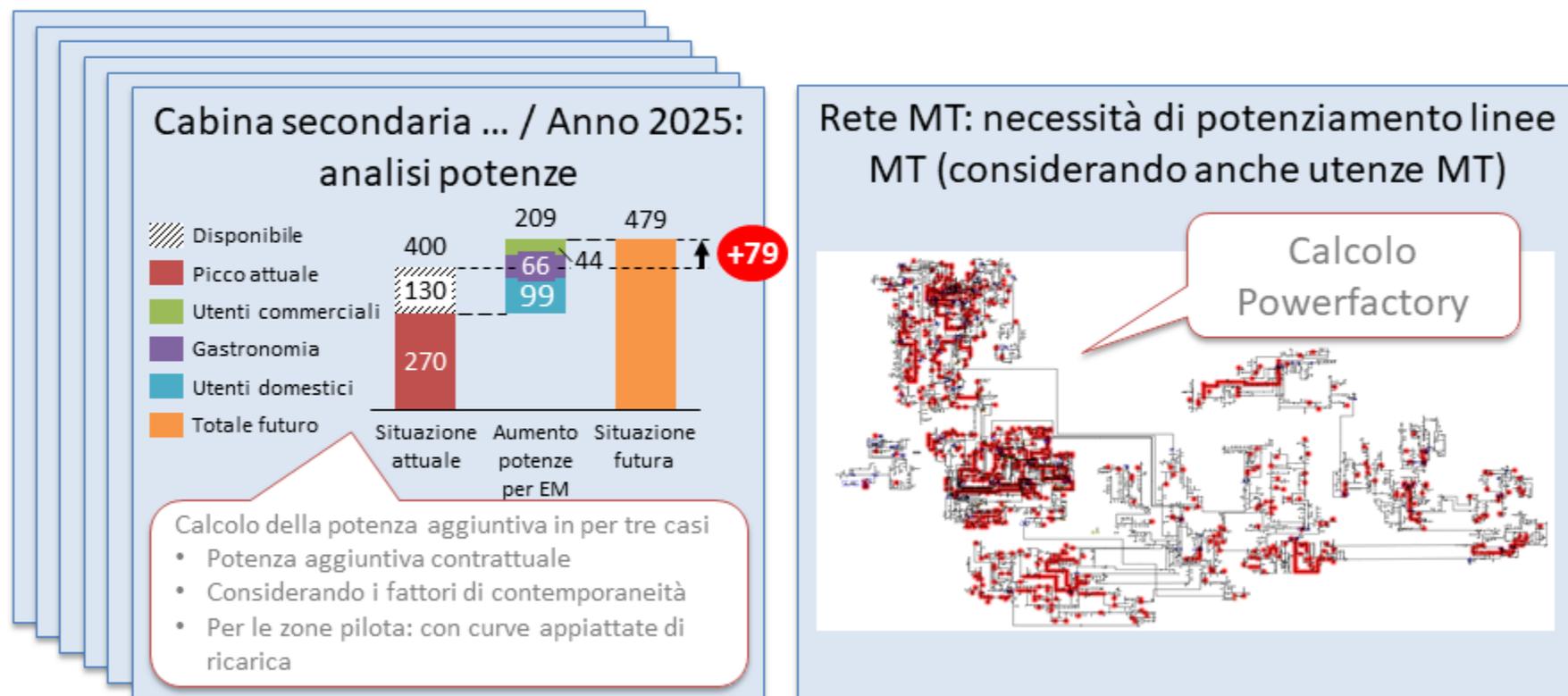
- Individualmente per ogni **linea MT**, identificazione delle lunghezze dei tratti con necessità di potenziamento (Powerfactory)
- **Costi unitari** ca. linee aeree 30 - 130 €/m, linee interrate 50 - 150 €/m

Rete BT

applicazione dei risultati ottenuti per i deep dive su tutta la rete Edyna

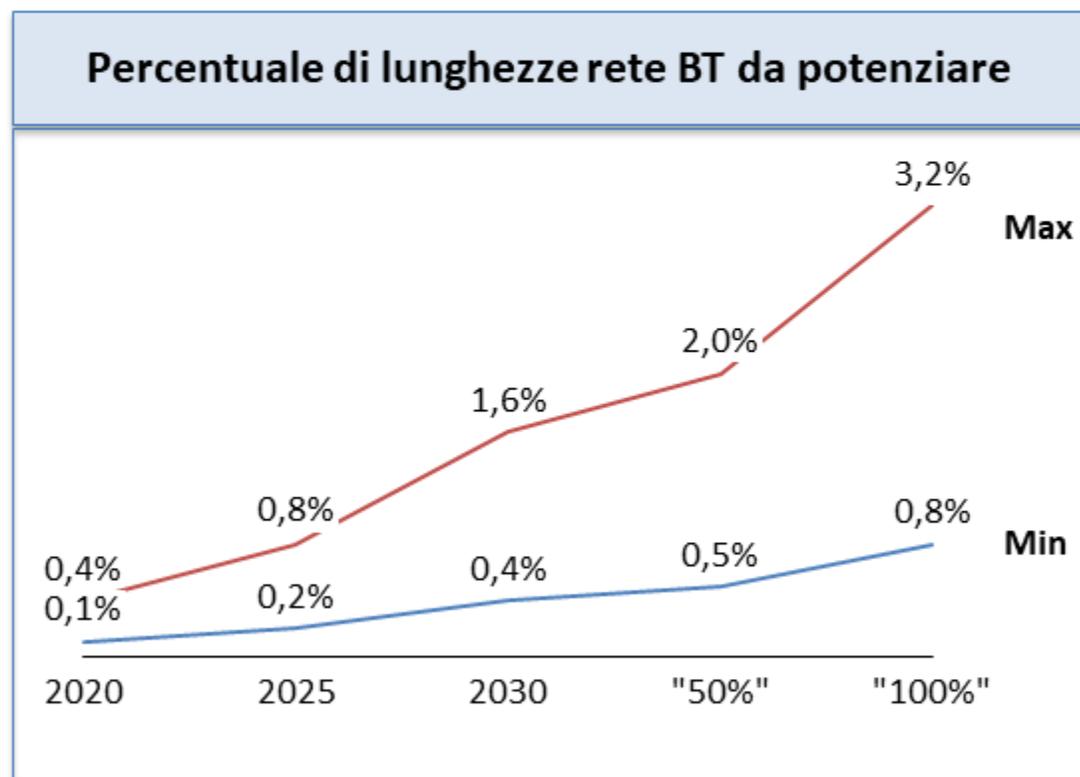


Calcolo dell'impatto sulla rete MT- metodologia



Per ogni singola CS e linea MT: calcolo di un eventuale potenziamento necessario, considerando la hosting capacity del sistema

Calcolo dell'impatto sulla rete BT



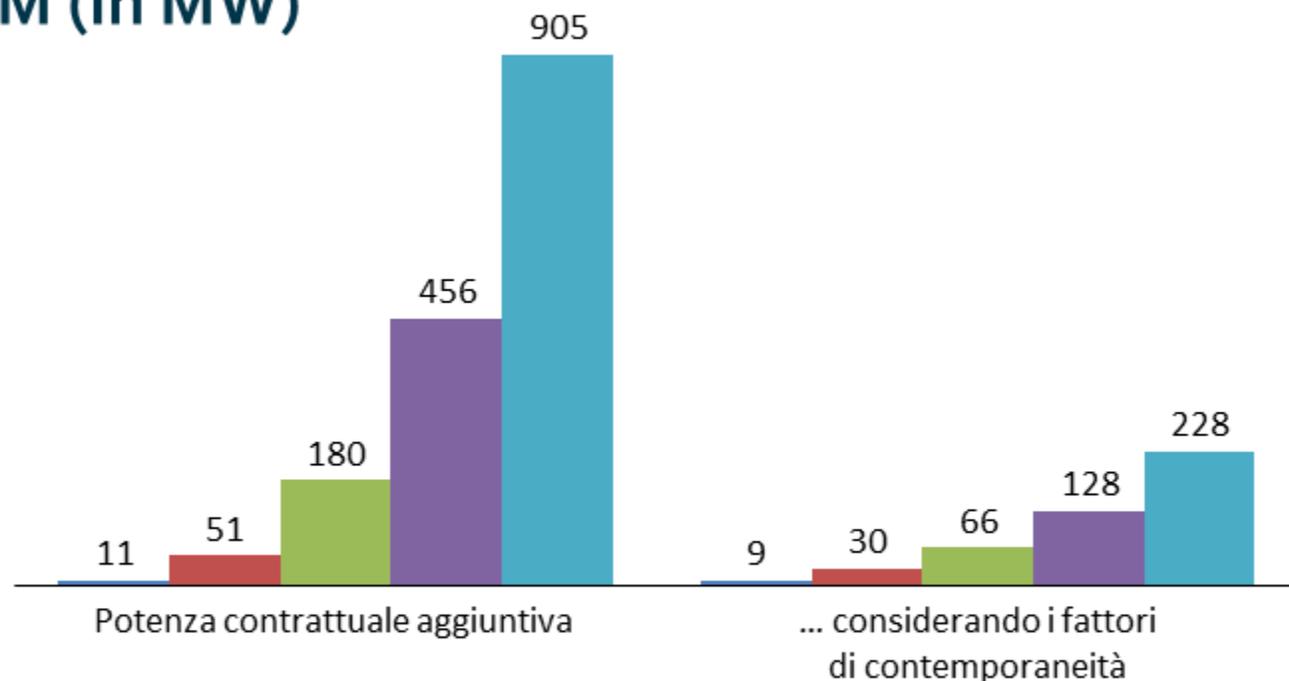
- In base ai valori minimi e massimi di lunghezze di linee BT da potenziare e individuati per le zone selezionate come deep dive, applicazione della percentuale a tutta la rete die Edyna
- Investimenti:
 - Linee aeree: 26 €/m
 - Linee interrate: 80 €/m



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Potenza aggiuntiva nella rete di Edyna a causa di colonnine di ricarica per EM (in MW)



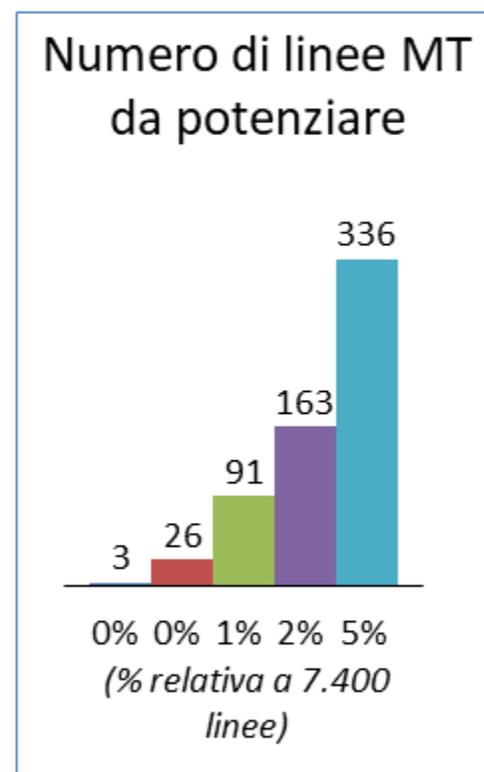
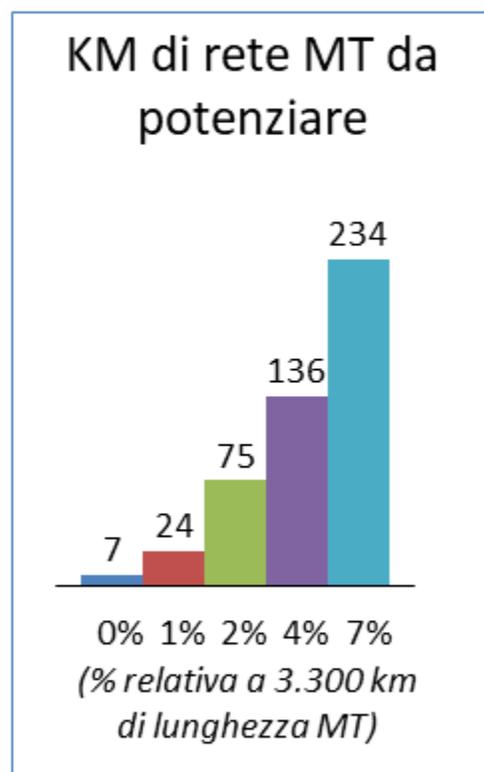
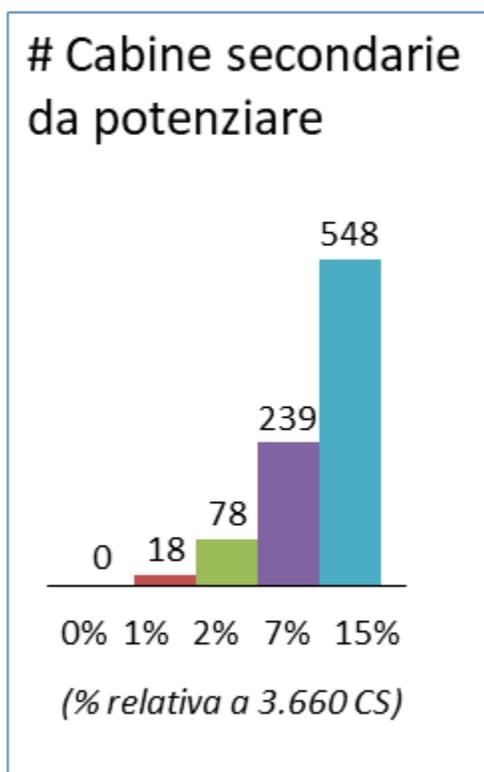
Aumento potenza rispetto a potenza attualmente contrattualizzata di 2.200 MW

0,5% 2,3% 8,2% 20,7% 41,1%

Base per investimenti necessari

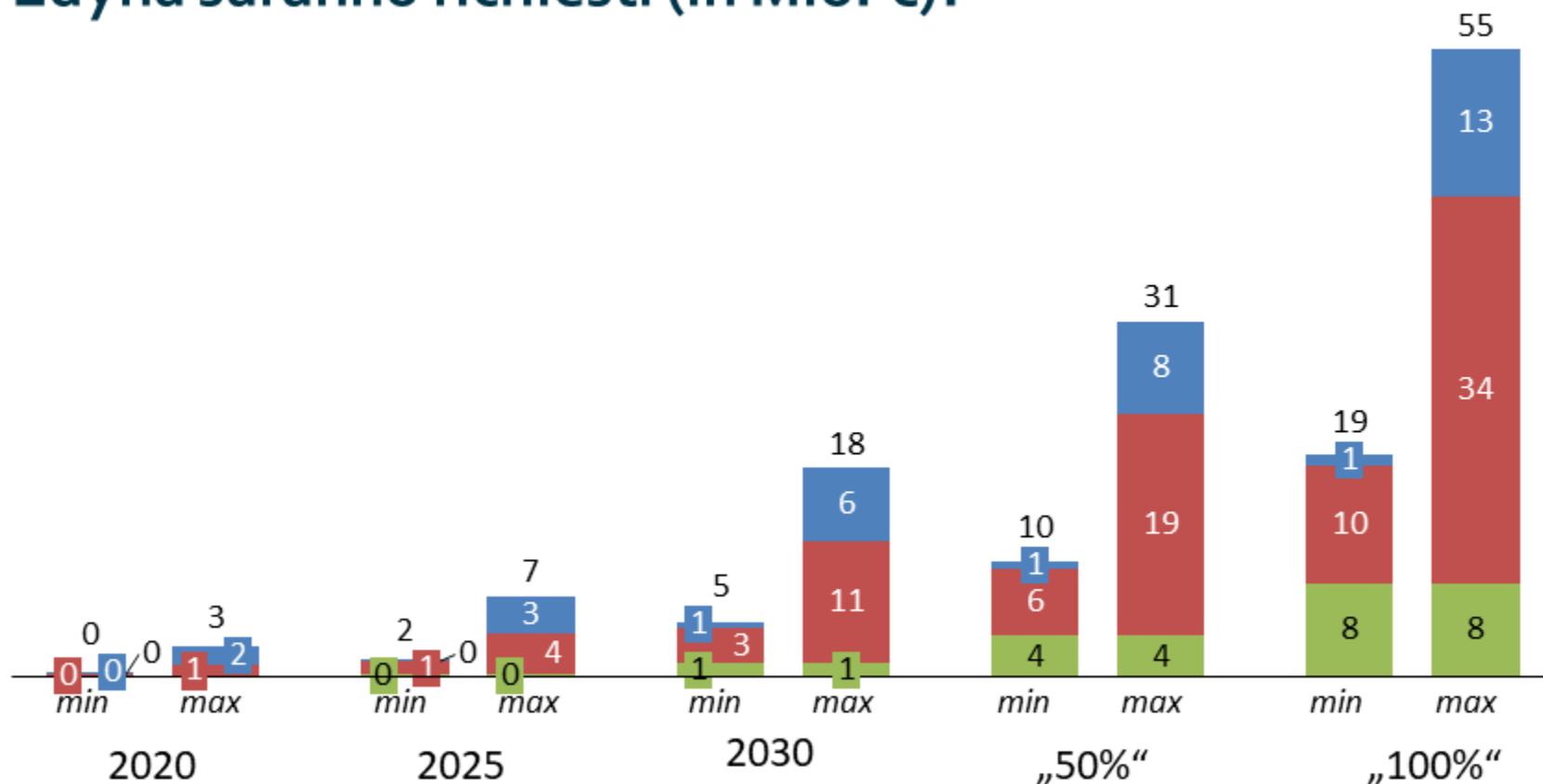
2020 2025 2030 "50%" "100%"

Necessità di potenziamento della rete MT



■ 2020
 ■ 2025
 ■ 2030
 ■ "50%"
 ■ "100%"

Quali investimenti per adeguare l'infrastruttura elettrica di Edyna saranno richiesti (in Mio. €)?



■ Per linee BT ■ Per linee MT ■ Per cabine secondarie

NB: valori annui sono valori complessivi; # CS riguarda solo utenze BT (considerando aumento potenza fino a 200 kW), km di linea da potenziare per utenze BT e MT



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Riassunto: necessità di importanti investimenti per soddisfare le potenze richieste per le colonnine elettriche

- Lo studio ha come obiettivo l'analisi dell'impatto dello sviluppo del EM sulla rete di Edyna con **focus sulla rete MT e BT**; non è stata considerata la rete AT, dato l'impatto limitato
- Nel focus era lo studio dell'impatto sulle potenze e quindi il dimensionamento delle infrastrutture elettriche; dal punto di vista **dell'energia consumata** l'effetto è ritenuto **abbastanza contenuto** (come anche confermato dagli analisi «deep dive» nelle zone di Ponte Gardena e Val Badia, e altri studi)
- L'installazione di colonnine di ricarica per EM comporterà un **forte aumento della potenza contrattuale**
- Tenendo conto delle curve di ricarica / fattori di contemporaneità e della potenza residua disponibile si può constatare che la nostra rete ha una **hosting capacity sufficiente** per accogliere una gran parte degli aumenti richiesti fino l'anno 2025, con **investimenti** in poi soprattutto per le linee MT
- In termini di investimenti, questo si traduce in **5 a 18 mio. € fino 2030**, quindi tra 0,4 a 1,5 Mio. € investimenti annui aggiuntivi da affrontare, che rappresenta un aumento di 1,2 – 4,4% rispetto an un volume d'investimenti attuale annuo di ca. 35 Mio. € (Edyna)
- **Non sono stati considerati** innovativi modi di gestione delle potenze da considerare (**Peak shaving** – solo per zone deep dive, impiego di **storage locale**, autoproduzione etc.)

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Paper n° 1726

EV DIFFUSION IN SOUTH TYROL: DEVELOPMENT OF THE CHARGING INFRASTRUCTURE AND ASSESSMENT OF ITS IMPACT ON THE DISTRIBUTION NETWORK

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ABSTRACT
Strategies outlined at national and European level, aimed at increasing the sustainability of the energy sector, are fostering alternative drive systems for public and private transport. In particular, e-mobility market share is expected to increase significantly in the years ahead. The paper summarizes the results of activities on assessing the effect of the future development of electric mobility and related charging infrastructure on the Edyna network (South Tyrol).

INTRODUCTION
Strategies outlined at national and European level, aimed at increasing the sustainability of the energy sector, are fostering alternative drive systems for public and private transport. In particular, e-mobility market share is expected to increase significantly in the years ahead. This development prospectively will lead to major challenges for Distribution System Operators (DSOs). The purpose of the activity described in the paper is to anticipate the effect of the future development of electric mobility and related charging infrastructure on the Edyna network (main DSO of South Tyrol and no. 5 in Italy Figure 1), also in terms of investments.

Figure 1: Distribution grid areas served by Edyna in the Province of South Tyrol and position of the "daisy drive" pilot area

The province is characterized by a remarkable environmental awareness, and it presents a significant tourism attraction both in winter and summer. For these reasons, it is expected that Electric Vehicles (EVs)

Once defined the type of charging stations it is necessary to determine the impact of EV on the distribution network. In order to derive input data for the present study, focus has been put on the car fleet only, with 472,000 units in 2017. Among these, 53% are private cars, leading to 0.56 private car per person, this figure is confirmed by [2], as the territory of Tyrol has very similar characteristics compared to South Tyrol. From 2010 onwards, registrations of hybrid and electricity powered vehicles have grown exponentially. In order to forecast the future trend of EVs penetration, other than past registrations, also current impact factors (economic conditions, political ambition levels, weak charging infrastructures, single anxiety, etc.) and other studies [3], [4], have been considered. The results are shown in Figure 2. In terms of percentage of the car fleet by 2030, approximately 17% of all cars in South Tyrol will be electrically powered.

DEFINITION OF DEVELOPMENT SCENARIOS FOR EV AND CHARGING INFRASTRUCTURES
Starting from the current situation, a forecast of EV penetration is estimated. The general penetration is decided for the various types of recharging stations which are then assigned to corresponding customer segments. Finally, the scenarios for the development of the charging infrastructure, serving as input for the analysis, are presented.

According to Italian Ministry of Infrastructures and Transport [1], the total vehicle fleet in the Province of Bozen accounts for 680,000 circulating units by the end of 2017. This figure seems to be high (as considering around 525,000 inhabitants, this leads to about 1.3 vehicles per person, but is justified by the high number of cars registrations by car rental companies, due to South Tyrol's low taxation compared to the rest of Italy. In order to derive input data for the present study, focus has been put on the car fleet only, with 472,000 units in 2017. Among these, 53% are private cars, leading to 0.56 private car per person, this figure is confirmed by [2], as the territory of Tyrol has very similar characteristics compared to South Tyrol. From 2010 onwards, registrations of hybrid and electricity powered vehicles have grown exponentially. In order to forecast the future trend of EVs penetration, other than past registrations, also current impact factors (economic conditions, political ambition levels, weak charging infrastructures, single anxiety, etc.) and other studies [3], [4], have been considered. The results are shown in Figure 2. In terms of percentage of the car fleet by 2030, approximately 17% of all cars in South Tyrol will be electrically powered.

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Table 2: Type of charging stations per customer segment

Type of charging station	Charging Power (kW)	Charging segments
Home charger	3.7	Residential
Fast charger	7.4	Industrial and commercial customers (incl. agriculture, farming activities)
Fast charger	22	Workplaces and restaurants
Ultra-fast charger	43	Fast stations

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Figure 2: Development of charging stations (penetration in terms of current grid connections, in %)

In order to derive the effectively installed power to be considered in the electrical grid, types and number of charging stations previously determined have been assigned to existing POEs (Point Of Delivery). Two different approaches have been considered, distinguishing between residential and non-residential customers. For the former, the additional power to be assigned to each substation was derived multiplying the penetration level with the number of domestic customers connected to it. For the non-residential customers, the scenarios have been generated with a Monte Carlo procedure, assigning the number of recharging stations to the individual connection points across the entire grid in a random

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to be reinforced. This becomes even clearer when peaking results are related with actual grid dimensions.

Figure 3: Reinforcement needs in the MV grid
In order to derive the financial impact, reinforcement needs in MV substations are quantified by 17M€ (combination with one new 670 kW transformer). For the MV lines, different ranges are being applied for overhead power lines and cables, ranging from 50M€ to 150M€. Contrary to the MV grid, in the LV network the specific characteristics such as dimensions of conductors are often not available in detail. In order to assess investment needs for the LV grid, a daisy drive approach (described later) had to be followed. Instead of performing calculations individually for each single line, results (grid length to be reinforced) obtained for the "daisy drive" areas presented in the next sections, have been generalized to the entire grid, with average costs of 25.80 €/km of grid length. Resulting investment needs are summarized in Figure 4.

Figure 4: Investment needs in the MV grid
The MV networks are more robust and even in the scenario "100%", only few branches reach their thermal limits. However, while the LV grids are more subject to the effects of fast charging stations, the MV networks are exposed to the effects of domestic charging stations. In fact, while the contribution for each LV network is low, they sum up in the MV network. This can determine some issues in particular when this contribution is added to the pre-existing peak determining also an increase of the maximum current of about 10 % of nominal rating in the scenario 2030.

Smart recharging
Even if the networks are quite robust, in the most extreme scenarios, some violations may occur in particular if the installation of charging stations is less uniform along the networks. In order to reduce the current in LV lines, peak sharing by 50% for fast

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violations. The violation of current limits is more important, but even in the most extreme scenario only about 1 % of the branches exceed their thermal limit. Also, the impact on the MV/LV transformers is limited only in the scenario "100%", (fast electrification) two transformers need to be replaced.

Table 3: List of branches that exceed the max current thresholds (50% and 100% of the rated value)

Scenario	50%		100%	
	Number	Length (km)	Number	Length (km)
2010	1	0.04	1	0.20
2020	1	0.13	1	0.21
2030	1	0.13	1	0.21
100%	2	0.27	1	0.40
100%	1	0.13	1	0.21

Although the grid is quite robust, this does not mean that no violations may occur. For the LV networks the main issues are due to the local effects of fast charging stations. In Figure 7 it is shown the maximum and average current in a LV network in the 2030 scenario. The maximum current reaches the upper limit due to the fast charging stations, however the effect is quite local since the average current remains rather low (there are many branches connected to small users). So in this case it is enough to replace the few branches affected by high currents.

Figure 7: Current of network

Figure 8: Current of network

The MV networks are more robust and even in the scenario "100%", only few branches reach their thermal limits. However, while the LV grids are more subject to the effects of fast charging stations, the MV networks are exposed to the effects of domestic charging stations. In fact, while the contribution for each LV network is low, they sum up in the MV network. This can determine some issues in particular when this contribution is added to the pre-existing peak determining also an increase of the maximum current of about 10 % of nominal rating in the scenario 2030.

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detailed analysis on the Edyna network have reported show that the impact will be quite limited in the next few years and gain importance approaching the year's 2030 and onwards.

In order to meet these challenges, important investments in the grid have to be made. Considering alternative solutions (peak sharing) will eventually allow to reduce investments required, as shown for the daisy drive studies carried out in two pilot areas.

As mentioned previously, the present study considered the additional load caused by an increase of charging devices for EV only. In order to get an even more detailed picture on developments and resulting challenges to be faced in the years ahead, a more detailed grid simulation would have to integrate also the effects of distributed generation, local storage and load increase other than for E-mobility. Respective activities are being planned in the near future.

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E quindi?

- ✓ Lo studio rappresenta un contributo alla **discussione pubblica**
- ✓ Aiuta ad **anticipare** eventuali investimenti
- ✓ È un **primo passo** per affrontare il tema
- ✓ **Eventuali approfondimenti** dovranno considerare p.es. la generazione distribuita, storage locale, peak shaving, altri carichi EM per hypercharger, Pullmann, altri carichi non-EM, ...



Grazie per la Vostra attenzione!