ELECTRICITY GRIDS IN EUROPE

Study and key findings

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Background

Europe's transition to electric vehicles is accelerating faster than most distribution grids were built to handle.

This study models the impact of Battery Electric Vehicle (BEV) growth on urban electricity grids in 64 cities, across 30 countries (EU-27 + Iceland, Liechtenstein, Norway) through 2030, quantifying where reinforcement is needed, what it will cost, and how smart grid management can reduce this cost significantly.

This study was commissioned by EIT Urban Mobility, ChargeUp Europe, and ACEA, and conducted by Siemens. This document represents key findings from the analysis conducted.



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EV growth needs smarter charging and stronger grids

×3.8 BEV VEHICLE GROWTH BY 2030

EU average ramp-up factor, with a range of x3.4–x4.9

EVERY EU CITY AFFECTED

All 64 cities analysed will require reinforcement

LOW-VOLTAGE GRID TAKES THE HIT

75 - 80% of EV investment burden falls on low-voltage

€24.7bn

Physical grid reinforcement scenario, without EV Load Management

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EV Load management can cut costs by €10.6bn

€14.1bn

TOTAL GRID INVESTMENT NEEDED WITH EV LOAD MANAGEMENT.

Instead of building more grid capacity to handle every peak, EV load management **helps spread electricity demand more intelligently**.

EV load management gives the grid **real time visibility of electricity demand and available capacity**.

This enables smarter EV charging, **avoiding peaks and making better use of existing grid infrastructure**.

43%

EU-WIDE COST REDUCTION BY USING LOAD MANAGEMENT INSTEAD OF ONLY PHYSICAL GRID REINFORCEMENT.

Savings by asset type:

High voltage grid **–46%** | **Medium** voltage grid **–44%**
Low voltage grid **–44%**

EV Load Management is the near real-time control of EV charging power to stay within grid capacity while maintaining charging availability. Costs are modelled only for substations that need digitalisation, which reflects targeted investments.

THE RESULT

€10.6bn SAVING POTENTIAL

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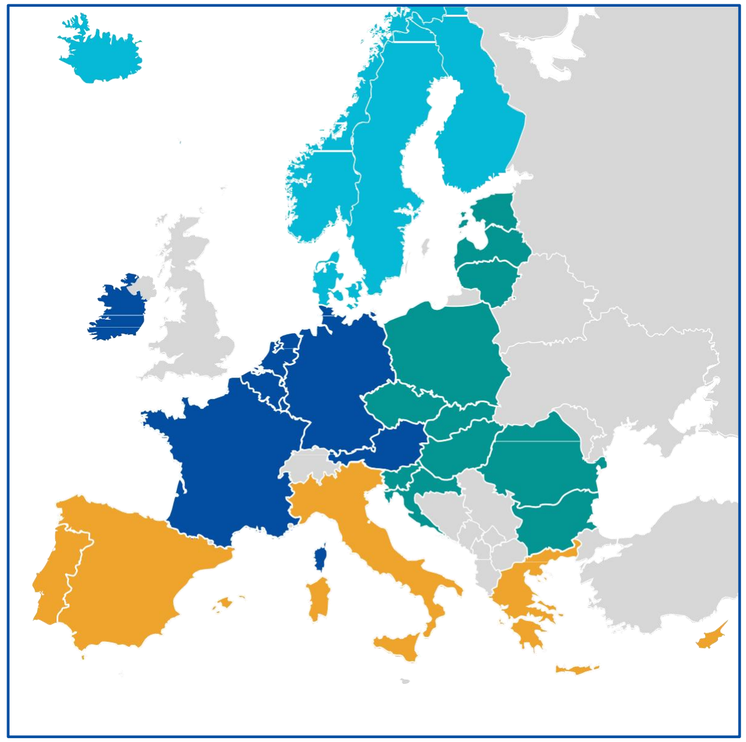
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State of play of Europe's Grids



- **Central Europe** (8 countries)
- **Eastern Europe** (11 countries)
- **Nordic Countries** (5 countries)
- **Southern Europe** (6 countries)

4 clusters capture the structural differences that matter

Grid infrastructure, battery electric vehicle (BEV) adoption rates, and charging behaviour differ significantly across Europe. The study groups the 30 countries studied into 4 structurally similar clusters that support meaningful comparisons and findings that are relevant for policymakers, distribution system operators (DSOs), and charging point operators (CPOs).

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64 / 64

URBAN CENTRES INCLUDED IN THE MODEL REQUIRE SOME GRID REINFORCEMENT BY 2030

- Central Europe
- Eastern Europe
- Nordic Countries
- Southern Europe

From the model analysis, 1 in 10 km of Europe's low-voltage grid is projected to fail under EV load without action by 2030

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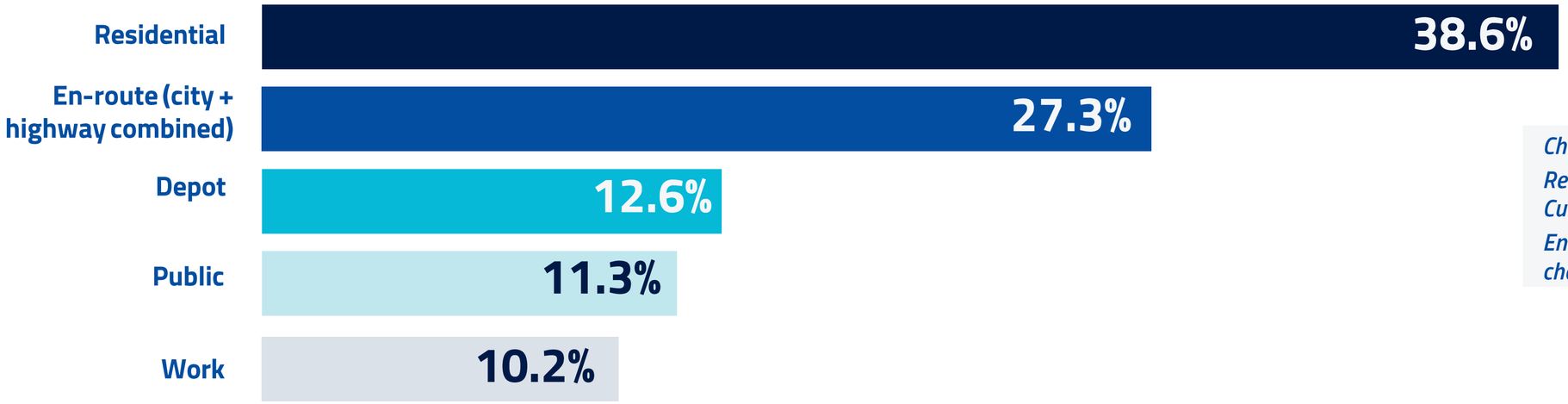
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Residential EV charging creates the greatest pressure on low-voltage grids

EU-WIDE EV CHARGING-DEMAND SPLIT BY LOCATION



Charging speeds:

Residential: Primarily slow/medium Alternating Current charging ("longer" duration).

En-route: Covers fast/super-fast Direct Current charging.

38.6% of all EU-wide EV charging demand happens at home, making it the main category of charging. Without reinforcement or load management, the model projects that around 10% of the low-voltage network could exceed its capacity under peak EV demand by 2030.

Based on the 2030 peak-load simulation (scaled from the 64-city analysis). This represents the "design-case" for grid capacity, the moment of maximum pressure rather than a monthly or yearly energy average.

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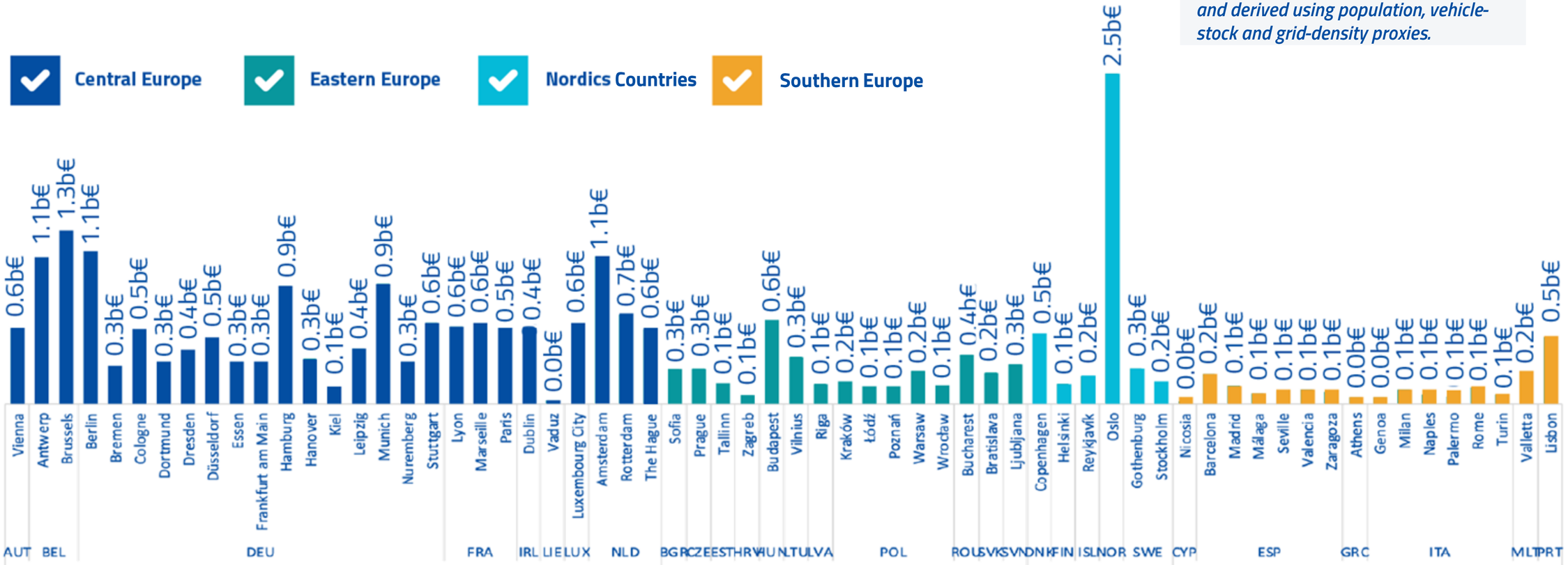
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Modelled investment needs vary considerably between locations

City-level estimates are illustrative and derived using population, vehicle-stock and grid-density proxies.



Estimated distribution-grid investment required by 2030 without EV load management, €bn

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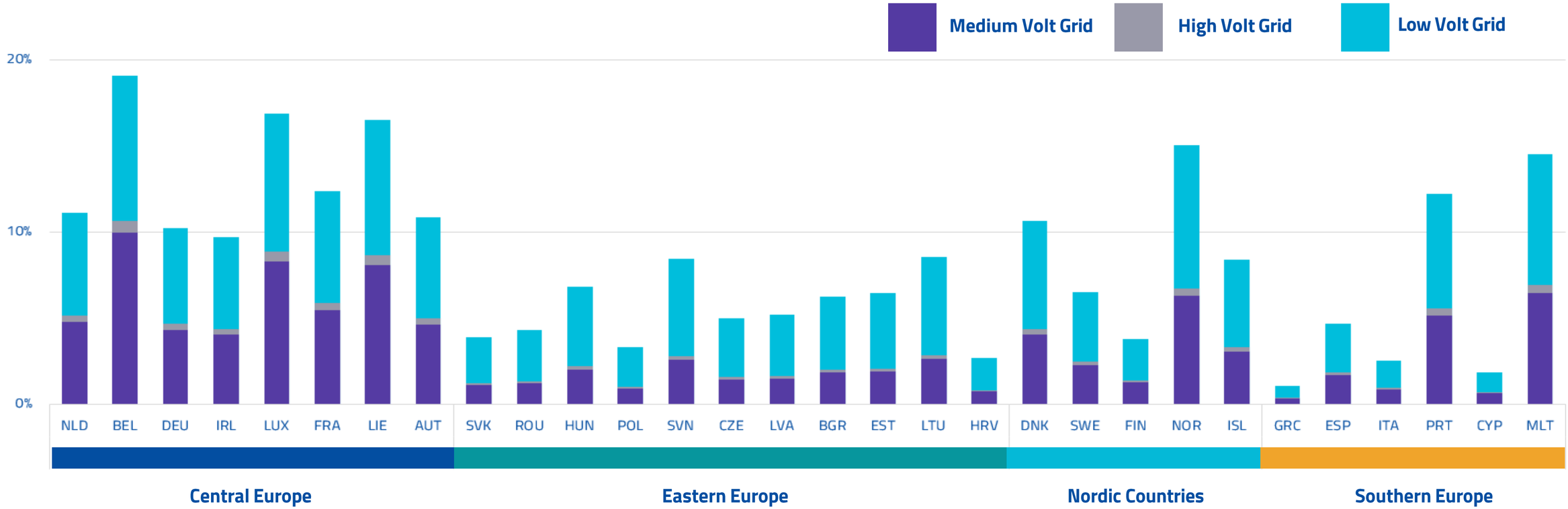
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EV load management reduces modelled peak demand, with effects varying across countries and voltage levels

Additional Hosting Capacity = (Peak Power without EV LM - Peak power with EV LM) / (Peak Power without EV LM)



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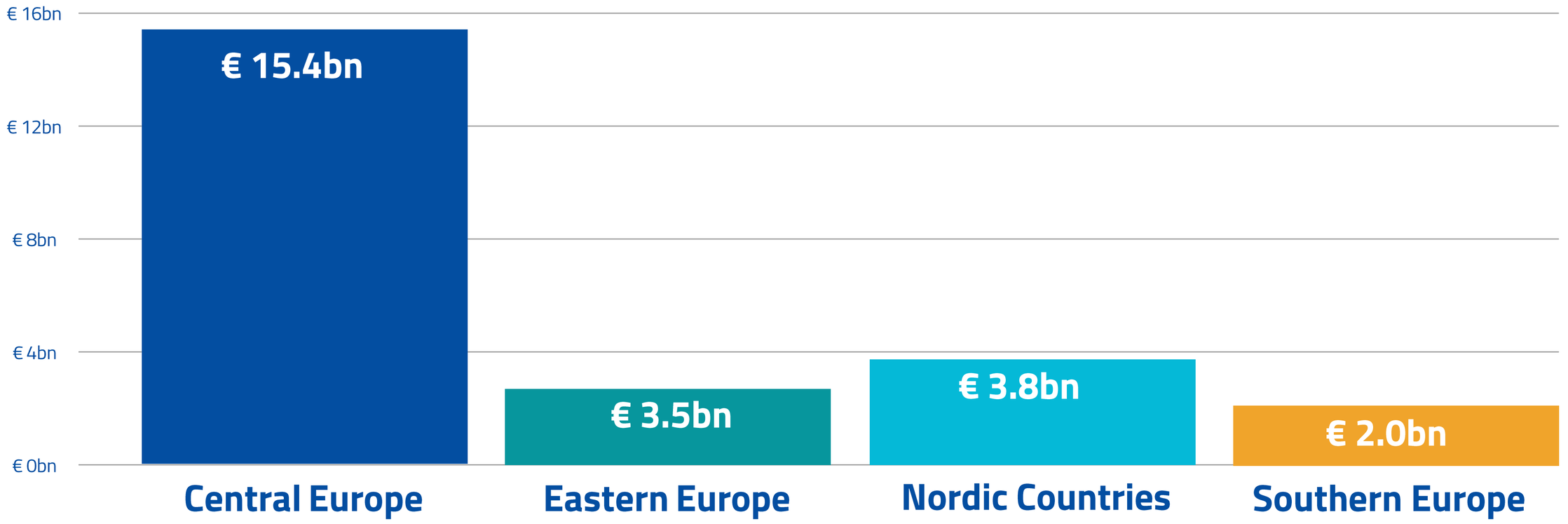
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The required grid investments for BEV Integration by 2030



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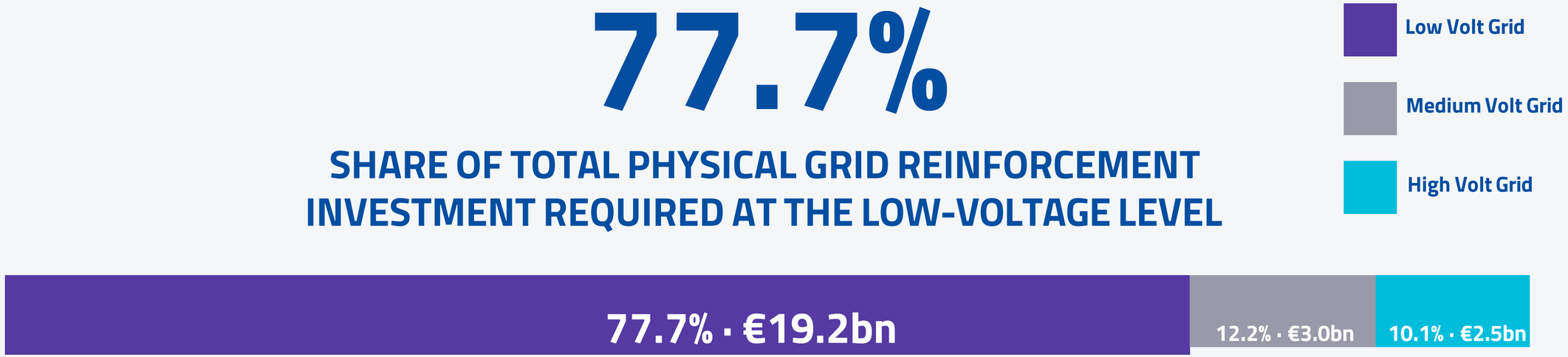
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Home charging is carried out on low-voltage grid, it is the primary stress point of BEV integration

77.7%

SHARE OF TOTAL PHYSICAL GRID REINFORCEMENT INVESTMENT REQUIRED AT THE LOW-VOLTAGE LEVEL



LV investment share varies by cluster: Central Europe 80% | Southern Europe 78% | Nordic Countries 74% | Eastern Europe 72% (EU average 78%). Figures reflect physical grid reinforcement investment share (Conventional scenario), not charging load share.

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Central Europe faces the highest grid investment needs, while Eastern Europe will likely see the fastest EV growth

Central Europe

€15.4bn

HIGHEST ABSOLUTE PHYSICAL GRID-REINFORCEMENT COST OF ANY REGIONAL CLUSTER

Eastern Europe

4.7×

STEEPEST EV FLEET RAMP-UP 2024-2030

At €15bn Central Europe carries the highest grid-reinforcement cost of all clusters, driven by the largest baseline grid infrastructure, highest projected BEV volume, and largest modelled urban population. Nordic Countries €3.8bn | Eastern Europe €3.5bn | Southern Europe €2.0bn. BEV fleet ramp-up 2024–2030: Eastern Europe ×4.7 | Southern Europe ×3.9 | Central Europe ×3.9 | Nordic Countries ×3.8.

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Load Management can make the biggest difference in Eastern Europe

Eastern Europe — Cluster Average

48%

AVERAGE LOAD MANAGEMENT SAVINGS POTENTIAL — THE HIGHEST OF ANY REGIONAL CLUSTER

Croatia — Highest Single Country

53%

THE SINGLE HIGHEST SAVINGS POTENTIAL ACROSS ALL 30 COUNTRIES STUDIED

Load management and smart monitoring cut grid investment needs across every cluster:
Eastern Europe 48% | Southern Europe 43% | Central Europe 42% | Nordic Countries 39% (EU average ~43%).
The modelled scenario includes load management and the monitoring and control infrastructure required to operate it. Physical grid upgrades would still be necessary.

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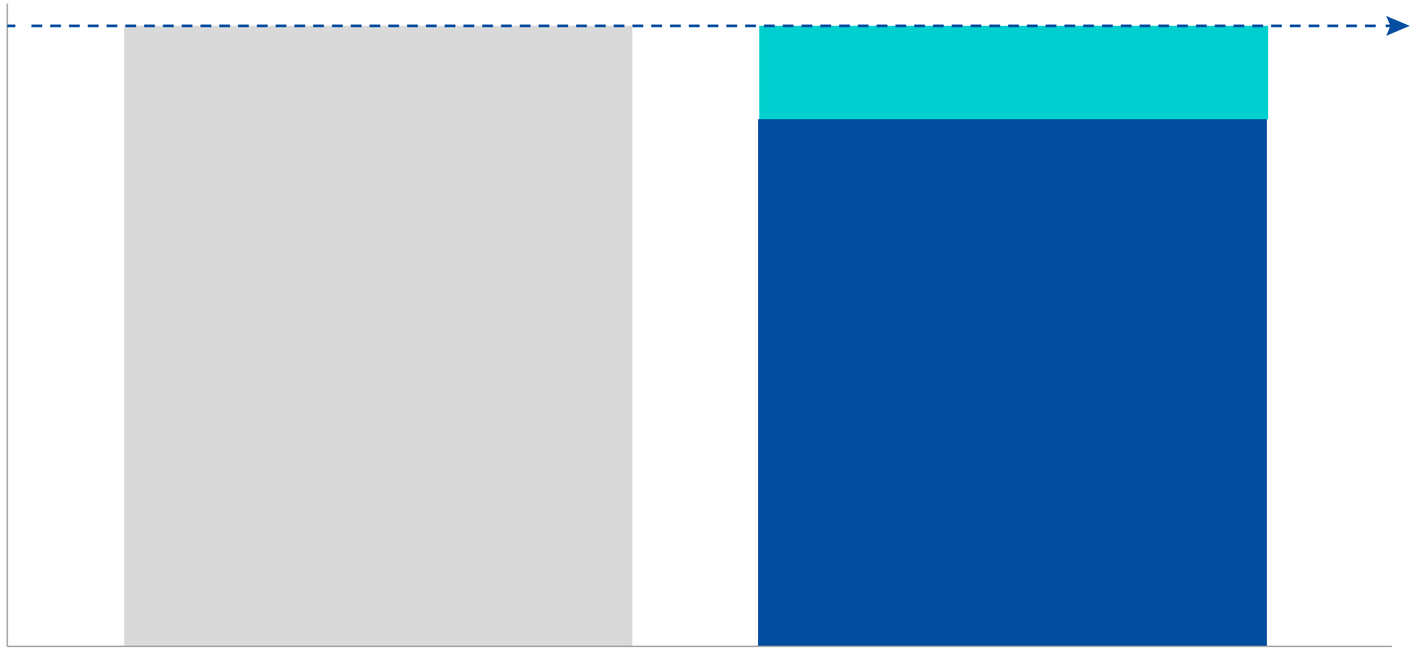
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Load management can help low-voltage grids capacity



Standard Charging

Load reaches the grid's operating limit — no room for additional EVs

With Load Management

Frees up ~20% additional capacity for more EVs before the limit is reached

GRID CAPACITY LIMIT

Grid planners call this 'hosting capacity': the additional load a network segment can carry before reaching its operating limit.

LV hosting capacity is the additional demand a network can accommodate before reaching its operating limit. This capacity gain is only realised where measurement and control infrastructure is deployed — without grid digitalisation, EV Load Management delivers 0% benefit.

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