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Garage Green WallCharge

A pre-wired backbone and a smart-charging service for electric vehicles in Italian condominium garages

Executive summary

Electrifying private mobility in Italy is no longer a vehicle problem; it is a parking problem. Around 62% of Italian dwellings have no garage or private parking space, and most of those that do sit in shared underground garages whose electrical systems predate any thought of vehicle charging. Residents are left with three poor options: public charging at two to four times the domestic price, a non-compliant domestic socket, or a condominium assembly that will not fund an installation serving three residents out of thirty.

Garage Green WallCharge separates the shared investment from the individual one, in the way fibre-to-the-home networks were built. At day zero the venture installs a single pre-wired backbone along the garage — one certified conduit route, one cable sized on the garage's mature aggregate demand, and a sealed tap-off box waiting at every parking space — at no cost to the condominium. Afterwards, one space at a time, any resident who goes electric has a wallbox connected to the box already waiting at their bay: one working day, no works in the common parts, no new assembly resolution.

What makes a shared connection viable is control. A single controller reads the meter and reallocates the available power across all connected vehicles in real time, scheduling sessions into the cheapest hours. For a fully electrified thirty-space garage this reduces the required connection from 235 kW to 47 kW and delivers 94% of the energy overnight — while the resident sets only one thing: the time the car must be ready.

The concept was validated through thirteen semi-structured interviews and a 62-response survey, a mixed-integer scheduling model solved on quarter-hourly prices, and a full financial model. Two levers, both within the venture's control, decide the case: the cost of building the backbone in an existing garage, and capture of the *bonus colonnine*, which on its own raises the base-case return from 4.3% to 12.4%.

Key Words

Electric vehicle charging, condominium garages, dynamic load management, smart charging, energy transition

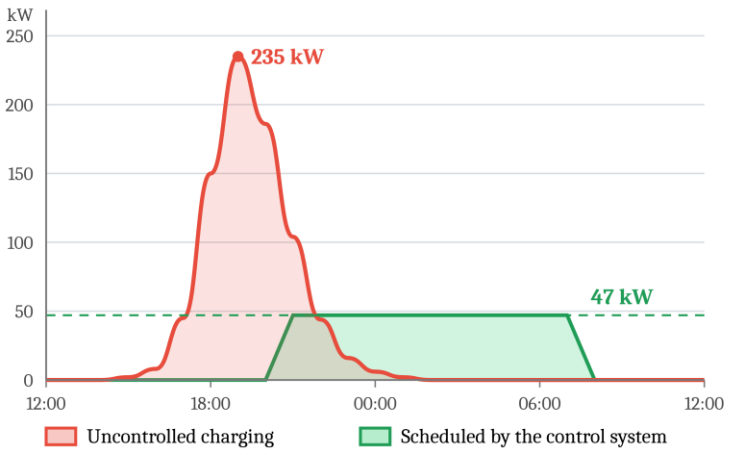


Figure 1. Schematic daily demand of a fully electrified thirty-space garage. Uncontrolled, coincident evening charging peaks at 235 kW; scheduled, the same vehicles are served within 47 kW, when the energy costs less.

HOME CHARGING FOR THE 14 MILLION WHO LIVE IN APARTMENTS

Thirty cars. One connection.

Garage Green WallCharge — a pre-wired backbone and a smart-charging service for Italian condominium garages.

TODAY, THERE IS NO GOOD OPTION

Charge on the street — and pay up to four times more.

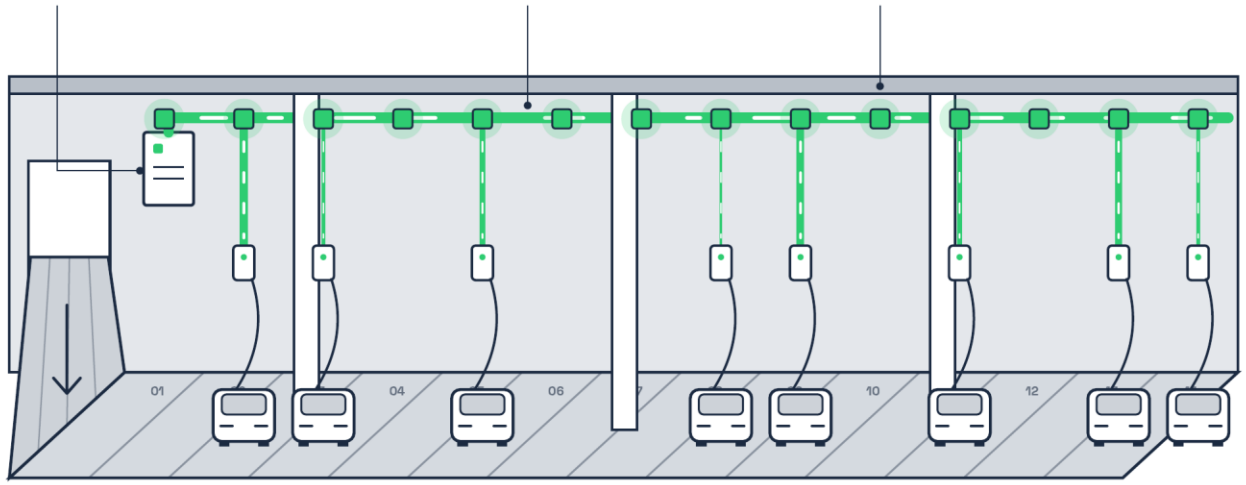
Charge from a household socket — until the building goes dark.

Ask the condominium to invest — for an asset three residents in thirty will use.

One controller sharing the available power in real time.

One backbone. Installed once. €0 to the condominium.

A connection point waiting at every space.



235 kW → 47 kW

What a fully electrified 30-space garage would demand uncontrolled, versus what it actually needs when charging is scheduled.

1 working day

To connect a new resident once the backbone is in. No building works. No new assembly vote.

94%

Of the energy delivered overnight.

~€400 / year

Saved by each resident against public charging.



The resident sets one thing: the time the car must be ready. The system does the rest.

Alta Scuola Politecnica · Multidisciplinary Project with A2A Life Ventures

Giulio Bolognesi · Niko Di Berardino · Andrea Francesco Monari
Filippo Pupo · Roberto Russo · Matteo Scalogna

Academic tutors: Filippo Bovera, Andrea Scrocca, Francesca De Michelis

Project description written by the Principal Academic Tutor

Electrifying private mobility in Italy has ceased to be a vehicle problem and has become a building problem. Around 62% of Italian dwellings have no garage or private parking space, and most of those that do sit in shared underground garages wired long before vehicle charging existed as a use case. The resident who wants to charge at home faces a process that is technically awkward, legally ambiguous and expensive, while the condominium assembly, which must approve any works in the common parts, is asked to invest in an asset that today serves a small minority of its members. Neither party can resolve this alone, and the ceiling it places on private electrification is set by building infrastructure rather than by technology, cost or policy.

GARAGE GREEN WALLCHARGE addressed this bottleneck by designing a charging service for shared residential garages and testing whether it is viable under real Italian constraints. The team proposed a two-stage architecture, borrowed from the way fibre-to-the-home networks were deployed: a pre-wired electrical backbone, sized once for the whole garage and financed by the operator, with a sealed connection point waiting at every space, followed by individual wallboxes connected on demand as residents adopt electric vehicles. The shared connection is made viable by a dynamic load management and scheduling layer that reallocates the available power across connected vehicles in real time. The team quantified what this control is worth, showing that a fully electrified thirty-space garage requires 47 kW rather than the 235 kW of uncontrolled demand, and separated the value of load limiting from that of price-driven scheduling, which the commercial literature routinely bundles.

The project is inherently multidisciplinary. It required electrical engineering to size the backbone and satisfy CEI 64-8 and fire-prevention requirements; operations research to formulate the scheduling problem as a mixed-integer linear program on quarter-hourly prices; regulatory analysis of condominium law, metering and connection rules; and industrial economics to build the business case. The six students, from energy, aerospace and industrial production engineering across the two Politecnici, organised themselves into three pairs, each owning one dimension end to end.

A2A Life Ventures, the group's Corporate Venture Builder, framed the challenge and assessed the concept as a prospective venture rather than as an academic exercise. This shaped the work decisively: the deliverable is not a demonstration that the idea is attractive, but a defensible go / no-go recommendation, which states that the case is marginal at the team's own cost assumptions, identifies the two levers that decide it, and shows that both lie within the venture's control.

A successful outcome would remove a barrier no individual resident can remove alone, for a segment of the market still largely unserved: the fourteen million Italian households living in apartment buildings.

Team description by skill

Six Master of Science students from Politecnico di Milano and Politecnico di Torino, spanning energy, aerospace and industrial production engineering. After the exploratory phase the team divided into three pairs, each owning one dimension of the problem end to end and reconverging at every review.

Technical — Giulio Bolognesi, Andrea Francesco Monari. Electrical architecture, backbone sizing, power and load analysis, regulatory and fire-safety review, integration with photovoltaics and CACER configurations.

Software — Filippo Pupo, Niko Di Berardino. Optimisation model, vehicle and fleet data model, solver implementation, interactive visualisation and code repository.

Economics — Matteo Scalogna, Roberto Russo. Market sizing, competitive benchmarking, pricing, business model, financial model and sensitivity analysis. Matteo Scalogna also acted as Team Controller.

The division was by dimension rather than by deliverable, so each pair carried a piece of every deliverable and none could finish without the others. Interfaces were explicit: the technical pair specified the constraint set the optimiser had to respect, software returned the coincidence factor and the cost saving, economics turned those into contracted-power cost and energy spread. The most valuable moment of the project was when those three chains closed on each other and failed to agree, which forced a correction to the way the saving had been attributed.

Goal

Working back from the challenge and from what we learned in the field, the team set itself five objectives:

- To validate that a scalable charging service for shared residential garages is technically feasible under the real constraints of the Italian building stock — available power, ageing wiring, fire safety and the CEI 64-8 series — and to quantify how much power such a system actually needs.
- To design and implement the control logic that makes the shared connection work, and to measure what it is worth in reduced connection size and reduced energy cost.
- To define a business model that removes the investment decision from the condominium assembly, and to test whether it is financially sustainable for an operator with A2A's cost of capital.
- To establish the regulatory and authorisation path — condominium law, fire prevention, connection and metering — and to identify which public incentives the model can capture.
- To reach a defensible go / no-go recommendation, stating explicitly the conditions under which the venture creates value and the conditions under which it does not.

Understanding the problem

Electrifying private mobility in Italy is not primarily a vehicle problem any more. Battery electric vehicles have become competitive on total cost of ownership for a widening set of use profiles, and the market has begun to move: 78,819 battery electric vehicles were registered in the first half of 2026, 76.3% more than in the same period of 2025 [1]. Yet the circulating fleet stood at 435,237 units at 30 June 2026, barely above one percent of the total car park, while Belgium and the Netherlands were registering more than a third of their new cars electric [1].

The gap is not explained by prices or by product. It is explained, to a large degree, by where Italians park. Around 62% of Italian dwellings have no garage or private parking space [2]; of the households that do, a large share holds a box in a shared underground garage whose electrical system predates any thought of vehicle charging. The first Italian law setting requirements for domestic electrical installations dates from 1990, and buildings constructed before it have very often received only partial upgrades. A condominium administrator managing some 7,000 units across Milan and Genoa told us plainly that not one of the garages in his portfolio, absent a complete new installation, is ready to support electric vehicle charging.

This produces a self-reinforcing failure. Residents who want to charge at home face a process that is technically awkward, legally ambiguous and expensive: a long cable run from a distant meter, conduits that are full or unsuitable, a fire-prevention certificate to update, an assembly that may or may not cooperate. Some give up and use public charging at two to four times the price. Some proceed anyway with a domestic socket, which is neither compliant nor safe in a garage subject to fire-prevention control [10][11]. And prospective buyers, seeing all this, do not buy the car — closing the loop. In our survey, 38.1% of those not interested in an electric vehicle cited lack of access to home charging, and a further 22.2% that their building was not equipped.

Two asymmetries drove the design. The party that must approve the works — the assembly, collectively — is not the party that benefits, and in Italy today that beneficiary group is very small. And the administrator carries liability for what happens in the garage but has no power to inspect a private box: he can ask, he cannot verify. Any solution that leaves compliance to individual residents leaves him exposed, and he knows it.

Exploring the opportunities

Four classes of solution exist today, best distinguished by two questions: who owns the infrastructure, and who decides.

Do it yourself, one box at a time. The resident pulls a cable from their own meter and installs a wallbox or, more often, an industrial socket — what most interviewees actually did. Fast where the building permits it and impossible where it does not; it consumes shared conduit capacity irreversibly, coordinates users not at all, and in fire-controlled garages is frequently non-compliant.

The condominium buys and owns a shared system. Technically sound and asset-retaining, but it requires the assembly to invest in an asset serving a minority — exactly what our interviews say does not happen at today's penetration.

Charging as a service, operator-owned. A third party installs the shared infrastructure at its own expense, retains ownership, and monetises through a subscription and an energy tariff paid by participating residents, at zero cost to the condominium. This is the Zeplug and ChargeGuru model in France and Italy [24], EverCharge in the United States [28], and the model this project adopts.

Rely on public charging. Not a solution to the same problem, but the default for those excluded from the first three. Italy had 84,564 public points at 30 June 2026 [3] against roughly 560,000 private ones at the end of 2024 [5]; around 75% are accelerated points designed for short stops, not the overnight replenishment a resident needs.

Reviewing these classes and the players offering them, three gaps remain that this project addresses directly. **The sizing question is asserted, not answered:** every operator claims that dynamic load management avoids costly electrical upgrades, but none states how much power a condominium garage actually needs as a function of how many vehicles it serves — the single most important number in the business case. **The value of load limiting is not separated from the value of scheduling:** keeping an installation inside its connection and choosing when to charge are different functions with different worth, and operators bundle them. **The economics are presented as a foregone conclusion:** the French precedent is used as evidence that the Italian case works, whereas our analysis suggests it is far more marginal, for a specific and identifiable reason.

Generating a solution

The concept rests on a single structural idea, borrowed from the way fibre-to-the-home networks were built: **separate the shared, expensive, disruptive investment from the individual, cheap, fast one, and make only the first of them unconditional.**

Stage one, at day zero. A single certified conduit route runs the length of the garage from a new main switchboard, carrying a cable sized once on the garage's mature aggregate demand, with a sealed tap-off box at every parking space. This is the part that requires scaffolding, drilling, fire-stopping, coordination with the administrator and a connection request to the distribution system operator. It is done once, it is done properly, and it is paid for by the venture. Each drop is sized and protected for 32 A three-phase whether or not the point installed today draws that much, because it is the only part of the installation that cannot be revisited without reopening the garage.

Stage two, on demand and one space at a time. A resident who switches to an electric car signs a contract and a technician connects a wallbox to the tap-off box already waiting at their space. No works in the common parts, no new assembly resolution, no disruption to neighbours. Building thirty charging points into a garage where three residents own electric cars is an investment in idle assets; building the backbone for thirty and the points for three is an investment in optionality.

The control system. A single controller reads the second-generation meter through its Chain 2 interface and reallocates the available power across all connected vehicles in real time, modulating each point between 6 and 32 A, while a scheduling layer places sessions in the cheapest quarter-hours. Compliance is built in rather than left to residents: each point carries its own residual-current protection per CEI 64-8 Section 722, and a single emergency disconnect on the garage ramp de-energises every point at once, as Circular 2 of 5 November 2018 requires in fire-controlled premises [11][13].

What it is worth. A fully electrified thirty-space garage would demand 235 kW uncontrolled; scheduled, it needs 47 kW — a conductor of the order of 25 mm^2 rather than a busway, and a fifth of the contracted power on which the annual network tariff is billed. Ninety-four percent of the energy is delivered at night. The resident's only mandatory input is the time the car must be ready.

The business case. Two offers were modelled: a Purchase Model with a higher upfront contribution and a lower monthly fee, and a Rental Model with a low activation cost and a higher

fee. At the team's own assumptions — 18,000 € of backbone cost and 50% take-up — the case is marginal. A backbone at 12,000 € already reaches the 9% cost of capital at the same take-up, and the *bonus colonnine*, which covers 80% of the condominium common-parts works up to 8,000 € and is funded to 31 March 2030, raises the base-case return from 4.3% to 12.4% on its own [9]. Building selection and the incentive are therefore the two levers that decide the case, and both are within the venture's control.

Main bibliographic references

[1] Motus-E, *Analisi di mercato — Auto elettriche in Italia, quota di mercato oltre il 10%*, Rome, 2026.

[2] Idealista, *Studio sulla disponibilità di box e posti auto nelle abitazioni italiane*, Idealista Research, Milan, 2025.

[3] Motus-E, *Quante colonnine di ricarica a uso pubblico ci sono in Italia — monitoraggio trimestrale*, Rome, 2026.

[5] Energy & Strategy Group, *Smart Mobility Report 2025*, School of Management, Politecnico di Milano, Milan, 2025.

[9] Presidenza del Consiglio dei Ministri, *DPCM 10 giugno 2026 — Misure per il settore automotive, art. 6*, Gazzetta Ufficiale, Rome, 2026.

[10] Ministero dell'Interno, *Decreto 15 maggio 2020 — Regola tecnica di prevenzione incendi per le attività di autorimessa*, Gazzetta Ufficiale n. 132, Rome, 2020.

[11] Ministero dell'Interno, Corpo Nazionale dei Vigili del Fuoco, *Circolare n. 2 del 5 novembre 2018 — Installazione di infrastrutture di ricarica di veicoli elettrici in attività soggette a controllo di prevenzione incendi*, Rome, 2018.

[13] Comitato Elettrotecnico Italiano, *CEI 64-8/7, Sezione 722 — Alimentazione dei veicoli elettrici*, CEI, Milan.

[24] ChargeGuru / Zeplug, company technical and commercial documentation, 2024–2026.

[28] EverCharge (SK E&S), *Dynamic load management for multi-family buildings*, company documentation, United States.

The full bibliography, comprising 30 numbered references, is given in the project Final Report.