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Electrifying Mobility: Integrating Electric Vehicles for Sustainable Tourism and Energy Systems

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Electrifying Mobility: Integrating Electric Vehicles for Sustainable Tourism and Energy Systems

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Introduction

The advent of electric vehicles (EVs) marks a significant milestone in technological innovation, addressing critical environmental concerns and transforming the mobility sector. This shift towards zero-emission vehicles is essential in the fight against climate change, as it reduces greenhouse gas emissions and improves public health by decreasing air pollution. The implications of this innovation extend beyond the automotive industry, influencing the entire energy ecosystem and necessitating the integration of renewable energy sources and the reimagining of charging infrastructure.

In Italy, the need to mitigate the environmental impact of road transport is particularly pressing. Carbon dioxide (CO_2) emissions from traditional vehicles constitute a substantial portion of the nation's total emissions. EVs offer a viable solution, capable of producing zero local emissions and significantly improving urban air quality. However, the widespread adoption of EVs is a complex process, influenced by various interconnected factors that require careful consideration.

This thesis provides a comprehensive analysis of the current state and future prospects of electric vehicle technology and infrastructure. It examines different services for EVs, their charging infrastructure, and the impact of their integration on the electricity grid, aiming to unravel the complexities and innovations within the EV mobility ecosystem. Building on this analysis, the thesis focuses on market services and, through user-centric design and service methodology, explores various paths and behaviors to enhance the charging system for electric vehicles. By embracing electric mobility, the goal is to create vibrant, eco-friendly tourist destinations that attract modern travelers prioritizing sustainability. The transformative impact of these efforts extends beyond environmental benefits, as attracting environmentally conscious tourists and diversifying the tourism landscape can stimulate regional economic growth. Fostering a culture of sustainability aims to inspire a gradual shift towards more eco-friendly travel behaviors, ensuring a brighter, greener future for generations to come.

Following thorough background analysis, market research, and user studies, the thesis applies its findings to the practical case of the Verbano-Cusio-Ossola (VCO) district, particularly focusing on Macugnaga and Santa Maria Maggiore. This service design-based approach aims to integrate EV infrastructure and assess its impact on the region.

In conclusion, this research highlights the transformative potential of electric vehicles in achieving sustainable mobility. By addressing the multifaceted challenges of EV adoption, the study proposes innovative strategies to foster a greener future.

The service design-based model demonstrated in the Verbano-Cusio-Ossola district exemplifies how targeted interventions can enhance both environmental sustainability and economic growth, with the potential for broader application across diverse global contexts.

Background

ANALYSIS

Chapter 1: Electrifying Mobility

1.1 Electric Vehicles

Electric vehicles (EVs) are revolutionizing transportation by offering various power sources and technologies that contribute to sustainability and efficiency. This chapter explores the different categories of EVs, their charging infrastructure, and the impact of their integration on the electricity grid. This examination will aid in understanding the terminology and state-of-the-art developments in EV mobility.

Battery Electric Vehicles (BEVs) rely solely on lithium batteries and electric motors for propulsion, providing an emission-free and quiet driving experience. BEVs can be recharged from external sources like the electricity grid or renewable energy sources such as solar panels, making them environmentally friendly options for transportation.

Plug-in Hybrid Electric Vehicles (PHEVs) combine an electric motor with an internal combustion engine. These vehicles can switch between electric and traditional combustion modes, offering flexibility for different driving needs. PHEVs can be plugged into electrical outlets for charging, allowing for electric-only driving on short trips and utilizing the internal combustion engine for longer journeys, enhancing efficiency and reducing overall emissions.

Hybrid Electric Vehicles (HEVs) also combine an internal combustion engine with one or more electric motors but lack external charging options. They mainly rely on energy recovery during braking to power the electric motors. While HEVs do not offer all-electric driving capability, they improve fuel efficiency and reduce emissions compared to traditional gas-powered vehicles.

An advanced variant of BEVs is the Extended-Range Electric Vehicle (EREV). EREVs use a lithium battery system to power electric motors for propulsion, similar to BEVs. However, they also have an internal combustion engine that acts as a generator to recharge the batteries when needed. This feature significantly extends the vehicle's range, addressing concerns about range anxiety and offering a practical solution for drivers who may not have frequent access to charging stations.

Charging Infrastructure

The charging infrastructure for electric vehicles is structured into three categories based on the type of power used: Level 1, Level 2, and Level 3 (also known as Direct Current Fast Charging, DCFC).

Level 1
Charging utilizes a standard voltage of 110-120 Volts and is commonly found in residences for personal use. These stations offer a power output that allows for a driving range of approximately 5.6-10.5 km per hour of charging. Overnight charging at Level 1 stations can typically provide enough driving range for a full day.

Level 2
Charging operates on 220/240V electrical systems and is suitable for both residential and commercial settings. These stations provide a higher charging power compared to Level 1, allowing for a driving range of approximately 22.5-56.3 km per hour of charging. Level 2 charging stations are particularly beneficial for electric vehicles equipped with larger capacity batteries.

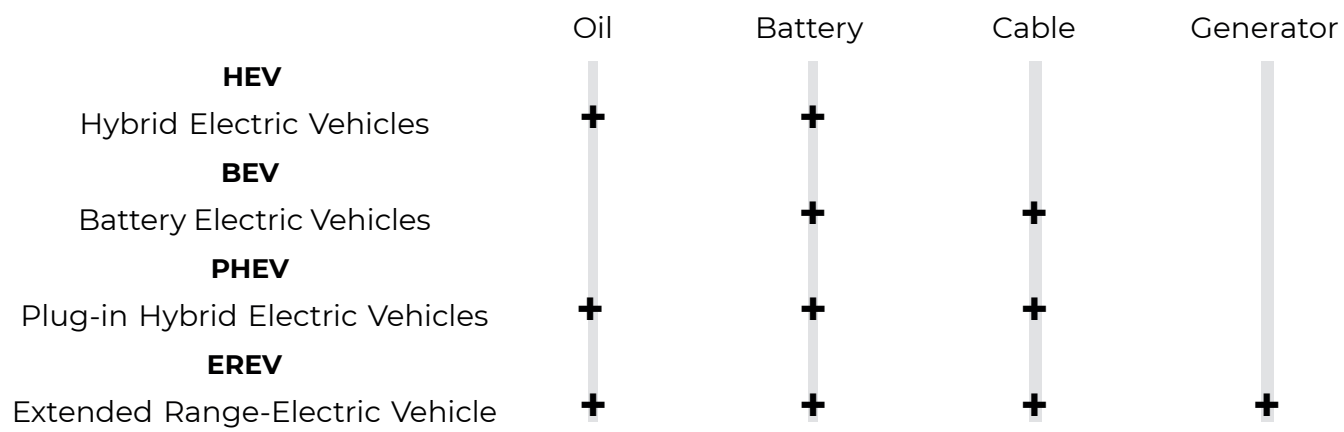
Level 3
Charging, also known as DCFC, is designed to provide high-rate power outputs typically ranging from 25 to 50 kW or more. These stations are commonly placed in public areas such as shopping centers and restaurants to offer fast charging solutions for EV owners. Level 3 charging stations can recharge an electric vehicle battery for a 100-mile drive in just 30 minutes, making them ideal for quick charging needs while on the go.

Charging methods for electric vehicles

The charging methdos for electric vehicles can be categorized based on physical contact and the location of the charging circuitry.

Conductive charging involves using cables to recharge the vehicle, while wireless charging eliminates the need for direct physical connections, offering convenience and flexibility.

Another way to categorize charging methods is based on the location of the charging circuitry: on-board charging integrates the charger into the vehicle itself, while off-board charging places the charging circuit in a separate charging station. Off-board solutions typically offer higher power charging capabilities, making them more suitable for fast charging stations.



	Typology	Voltage	Medium level of power (kW)	Time required to fill a use daily (13.65 kWh)	Time required to fill 160.934 Km (37 kWh)	Distance added for every minute of charge (km)
LEVEL 1 (HOMES)						
	AC	220	1.4 - 2.4	9 h 45 min	26 h 26m	0.097
LEVEL 2 (WORKPLACES)						
standard	AC	220	6.6	2 h 4 min	5 h 34min	0.48
massima	AC	220	19.2	43 min	1h 55min	1.38
LEVEL 3 (PUBLIC PLACES)						
Low	DC	480	50	16 min	44 min	3.62
Medium	DC	480	150	5 min	15 min	10.88
High	DC	480	350	2 min	6 min	25.38

Mahmud, I., Medha, M. B., & Hasanuzzaman, M. (2023). Global challenges of electric vehicle charging systems and its future prospects: A review. Research in Transportation Business & Management, 49, 101011. https://doi.org/10.1016/j.rtbm.2023.101011

The direction of power flow is another important consideration for charging systems. Unidirectional chargers only allow for charging, while bidirectional chargers enable both charging and energy discharge. Bidirectional chargers are crucial for vehicle-to-grid (V2G) applications, allowing vehicles to feed energy back into the grid and support smart grid functionality.

1.2 Charging Coordination

Charging coordination is also a key factor in charging systems. Non-coordinated charging means the vehicle starts charging immediately, leading to increased costs and potential grid overloads during peak consumption. In contrast, coordinated charging involves optimizing power levels and charging times to reduce grid overload and peak consumption. This coordinated approach, often referred to as “smart charging,” is essential for efficient grid

overloads during peak consumption. In contrast, coordinated charging involves optimizing power levels and charging times to reduce grid overload and peak consumption. This coordinated approach, often referred to as “smart charging,” is essential for efficient grid

management and ensuring a stable and reliable power supply.

Impact of Uncoordinated Electric Vehicle Charging on the Electricity Grid

The rapid adoption of electric vehicles poses significant challenges for the electricity grid, particularly when charging is uncoordinated. A case study conducted on a 15 kV medium voltage grid illustrates the substantial impact of EV penetration on the grid. Findings revealed that with a 25% EV integration rate, peak power demand rose by 41%, escalating to 109% with a 50% integration rate. This surge in energy consumption not only challenges voltage stability but also leads to the overloading of various transmission network components, such as distribution transformers.

Excessive loading from EV charging activities has been shown to significantly reduce the operational lifespan of transformers, sometimes by as much as 93%. Additionally, operating the grid close to its capacity limits due

Transmission losses in an electrical grid occur due to the resistance in the wires and components through which electricity flows. When electric vehicles (EVs) are charged, they create a higher demand for electricity, which leads to increased current flowing through the grid. This higher current can exacerbate transmission losses for several reasons:

1. Ohmic Losses (I^2R Losses):

Ohmic losses are directly proportional to the square of the current (I) and the resistance (R) of the transmission lines. As EV charging increases the current demand on the grid, the losses (I^2R) increase exponentially.

2. Increased Line Loading:

Higher current demand due to EV charging can lead to increased loading of transmission lines and transformers. Lines and transformers operating near or at their capacity limits can suffer from higher losses due to increased resistive heating.

3. Voltage Drop:

Increased current demand can cause more significant voltage drops along the transmission lines.
To compensate for these drops, power stations may need to increase the voltage at the supply end, which can increase losses further down the line.

4. Thermal Effects:

Higher currents generate more heat in transmission lines and transformers. Over time, this heating can increase the resistance of these components, leading to further increases in losses.

5. Reactive Power:

Charging EVs involves power conversion processes that can introduce reactive power into the grid.
Reactive power does not do useful work but contributes to the overall current in the system, increasing losses.
Correlation Between High EV Demand and Transmission Losses:

Increased Current Flow: High demand for EV charging translates to higher current flow through the transmission network. As mentioned, losses due to resistance (I^2R) increase with the square of the current.

Capacity Limits: As the grid operates closer to its capacity limits due to the high demand from EVs, components like transformers and lines become less efficient and generate more heat, increasing losses.

Grid Stress: The additional stress on the grid infrastructure from high EV penetration can also lead to increased maintenance and potential failures, indirectly contributing to overall inefficiency and higher losses.

Wirless

Maintenance charge
Wireless charging
Low efficiency
Expensive
High losses

Outside

Offboard charging
Minimal loss
Extremely efficient
Minimum cost

Inside

DC AC public charging
Cable
Highly efficient

Electric Vehicle Grid Integration (EVGI)

Electric Vehicle Grid Integration (EVGI) is a critical strategy designed to address the emerging challenges facing the electrical grid due to the increasing use of renewable energy sources and the rapid adoption of electric vehicles (EVs). As renewable energy becomes more prevalent in the electricity generation mix, its availability becomes heavily dependent on weather conditions, resulting in fluctuating electricity supply.

The introduction of renewable energy brings about new challenges for the electrical grid, as the intermittent nature of renewable sources can lead to imbalances between supply and demand. This can strain the grid, causing issues such as peak overloads, power losses, and disruptions in frequency and voltage stability. Adding to these challenges is the growing number of electric vehicles on the road, which further increases the demand for electricity and can contribute to grid overload issues, particularly during peak charging times.

In response to these challenges, EVGI offers a solution that involves optimizing the interaction between electric vehicles and the electrical grid. By implementing strategies to manage the charging and discharging patterns of EV batteries, EVGI aims to assist in stabilizing the grid and alleviating some of the stress caused by renewable energy integration and EV adoption.

1.3 Evaluation of Different Automated Charging Technologies

Automated charging technologies play a crucial role in the adoption of electric vehicles (EVs). This section evaluates four primary technologies: inductive charging, battery swapping, conductive underbody charging, and conductive side-charging, based on several key factors.

Inductive charging transfers energy wirelessly between a charging pad on the ground and a receiver on the vehicle. This technology requires significant investment in infrastructure and modifications to vehicles. It offers high safety and reliability, with reduced wear and tear due to the absence of physical connectors. However, it is less adaptable to different vehicle designs and has moderate power capability. Inductive charging demonstrates high power transfer efficiency, although it can be influenced by misalignment, and requires minimal maintenance. It is well-established and used in several pilot programs.

Battery swapping involves exchanging a depleted battery for a fully charged one at dedicated stations. This method requires substantial investment in standardized batteries and specialized swapping stations. It has moderate safety and reliability, dependent on the mechanical precision of the swapping process. Battery swapping is highly adaptable to various vehicle types with standardized battery packs and supports rapid charging and discharging with high power capability. The efficiency is moderate, as energy transfer occurs off-vehicle. Maintenance is required for both batteries and swapping mechanisms. Although less common globally, battery swapping is mature and established in certain markets.

Conductive underbody charging uses a physical connection beneath the vehicle to transfer power. This method is less expensive than inductive charging but requires the installation of ground-based connectors. It offers high safety and reliability, although the connectors may be exposed to environmental conditions. Conductive underbody charging is less adaptable to different

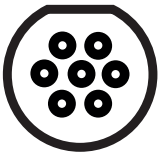
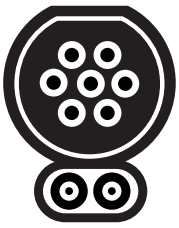
Evaluation of different automated charging technologies

- Negative + Positive	Inductive charging	Battery swapping	Conductive underbody charging	Conductive side-charging
Infrastructure costs	--	--	-	-
Vehicle integration efforts	-	--	-	++
Safety and reliability	++	+	+	+/-
Flexibility for different vehicles	-	-	-	++
AC / DC power capability	-	++	+	++
Power transfer efficiency	-	++	++	++
Operation and maintenance	++	-	+	+
Technology availability & maturity	++	++	-	--

Hirz, M., & Lippitsch, S. (2023). Automated charging of electric cars for improving user experience and charging infrastructure utilization. Usability and User Experience, 110, 171-179. https://doi.org/10.54941/ahfe1003189

vehicle designs and has moderate power capability. This method demonstrates high efficiency due to direct contact charging, with connectors that may require occasional maintenance. It is gaining interest but has fewer deployments compared to other methods.

Conductive side-charging involves connecting a vehicle to a charging station via a side-mounted connector. This technology is simpler and more cost-effective than underbody or inductive charging, with safety and reliability depending on the robustness of the connection mechanism. Conductive side-charging is highly adaptable to various vehicle designs and has moderate power capability. This method demonstrates high efficiency due to the direct connection, with straightforward maintenance. It is less mature and less commonly used compared to other technologies.

	America	EU	China	Japan	Supercharger
AC					
	SAE J1772 /IEC 62196-2	IEC 62196-2	GB/T 20234.1-2011	IEC 62196-2	Tesla
Voltage	120 -240 V	400 V	120 -240 V	230 V	480 V
Capacity	7.68 kW	12.8 kW	7.68 kW	10 kW	615 kW
DC					
	SAE J1772 /IEC 62196-3	IEC 62196-3	GB/T 20234.3-2011	CHAdeMO	Tesla
Voltage	600 V	1000 V	750 - 1000 V	200 - 500 V	480 V
Capacity	50 - 100 kW	200 kW	187.5 kW	12.8 kW	615 kW

Mastoi, M. S., Zhuang, S., Munir, H. M., Haris, M., Hassan, M., Usman, M., Bukhari, S. S. H., & Ro, J.-S. (2022). An in-depth analysis of electric vehicle charging station infrastructure, policy implications, and future trends. Energy Reports, 8, 11504-11529. https://doi.org/10.1016/j.egyr.2022.10.017

1.4 Comparative Analysis of Electric Vehicle Charging Connectors

Electric vehicles (EVs) are designed with various charging connectors to cater to different power sources and standards across regions. It is essential for EV owners and charging infrastructure developers to understand these connectors to ensure compatibility and efficient charging processes.

In North America, the SAE J1772 connector is the most common for AC charging. Developed by the Society of Automotive Engineers (SAE), this connector is equipped with a standard 120-volt AC plug for Level 1 charging and a 240-volt plug for Level 2 charging. It is extensively used in the United States and Canada, both in residential settings and public charging stations.

In the European Union (EU), the Type 2 connector, also known as the Mennekes connector, is widely utilized for AC charging. This connector supports both single-phase and three-phase charging, offering the capability to deliver up to 43 kW of power. Mandated by European regulations, the Type 2 connector is prevalent in residential, commercial, and public charging environments across Europe.

In China, the GB/T connector is the standard AC charging connector, governed by the official designation GB/T 20234.3-2011. While visually similar to the Type 2 connector, the GB/T connector features a different communication protocol and pin configuration. This connector is extensively used in China and is progressively gaining acceptance in other Asian countries.

In Japan, the CHAdeMO connector is commonly associated with DC fast charging but is also utilized for AC charging in certain scenarios. Characterized by a large rectangular plug, the CHAdeMO connector is capable of delivering high-power charging for both AC and DC applications.

Tesla, a prominent electric vehicle manufacturer, employs its proprietary connector for charging purposes, known as the Tesla Supercharger connector. This connector's design and specifications are tailored to Tesla vehicles, providing a specialized charging solution for Tesla owners.

In summary, this chapter has provided a comprehensive overview of the different types of electric vehicles and their charging infrastructure, setting the stage for deeper exploration into the integration of EVs with the electricity grid. Understanding these fundamentals is crucial for appreciating the subsequent discussions on the complexities and innovations within the EV ecosystem.

Chapter 2: Infrastructure: V2G and Communication

This chapter delves into the Vehicle-to-Grid (V2G) systems, highlighting their significance in the EV landscape. We will examine the benefits, challenges, and future trends of V2G systems, alongside the management and communication aspects crucial for effective EV charging.

2.1 V2G Systems

Vehicle-to-Grid (V2G) systems represent an advanced integration of electric vehicles (EVs) with the power grid, enabling bidirectional energy flow between EV batteries and the grid. This technology allows EVs to provide energy storage and supply services, enhancing grid stability and supporting renewable energy integration.

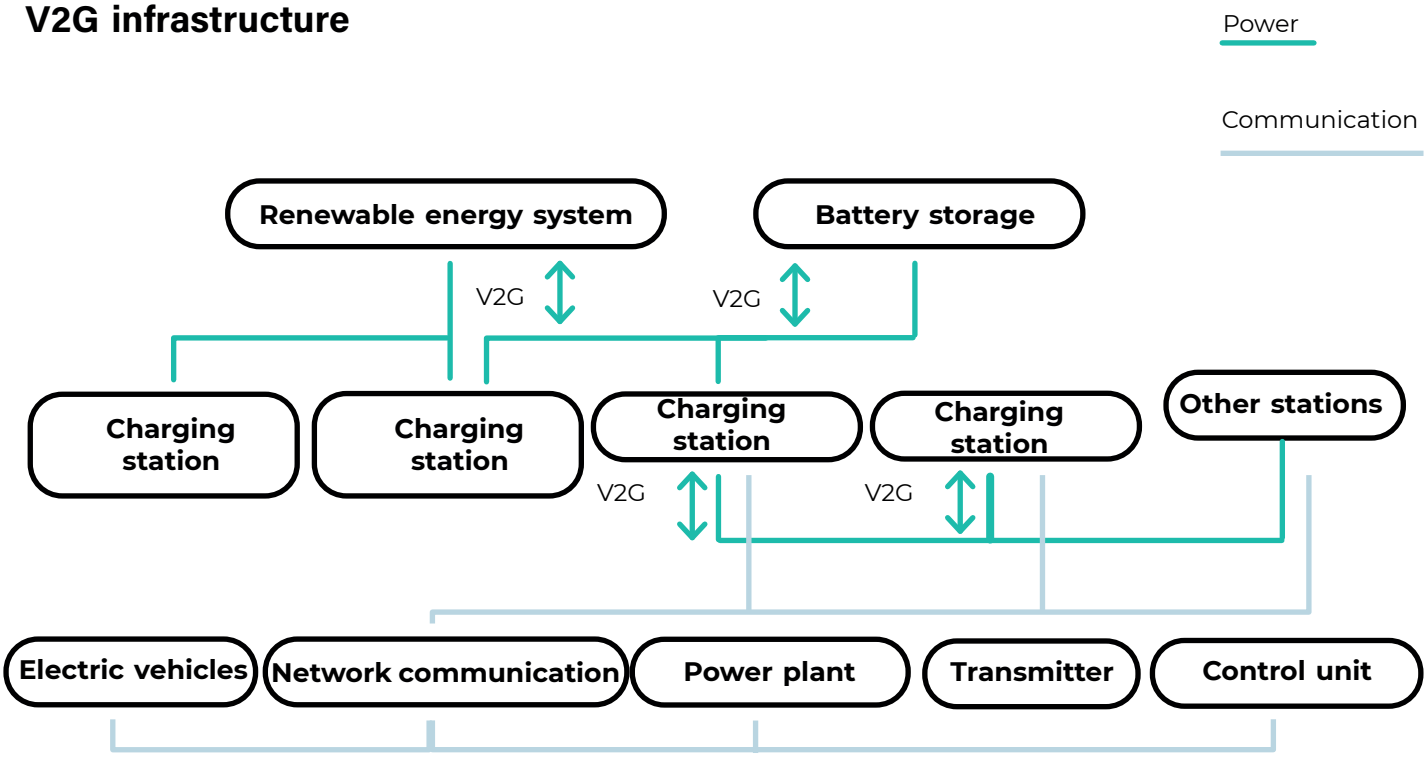
2.2 Benefits of V2G Systems

V2G systems offer numerous benefits across different sectors and stakeholders:

Grid Stability: By providing energy back to the grid during peak demand times, EVs can help stabilize the grid and prevent blackouts. This capability is especially valuable in regions with high penetration of renewable energy sources, which are inherently intermittent.

Renewable Energy Integration: V2G technology can support the integration of intermittent renewable energy sources such as solar and wind by storing excess energy and supplying it when demand exceeds supply. This helps to balance supply and demand on the grid and reduces the need for fossil fuel-based peaking power plants.

V2G infrastructure



Liu, L., Kong, F., Liu, X., Peng, Y., & Wang, Q. (2015). A review on electric vehicles interacting with renewable energy in smart grid. Renewable and Sustainable Energy Reviews, 51, 648-661. https://doi.org/10.1016/j.rser.2015.06.036

Economic Benefits: EV owners can earn additional income by participating in grid services such as frequency regulation, where grid operators pay for the ability to adjust electricity supply to match varying demand. This can offset the cost of EV ownership and charging.

Improved Energy Efficiency: V2G systems can optimize energy usage by enabling EVs to charge during off-peak hours when electricity is cheaper and discharge or sell electricity back to the grid during peak hours when electricity prices are higher. This can lead to overall cost savings and improved grid efficiency.

Environmental Benefits: By supporting renewable energy integration and reducing reliance on fossil fuels for grid stability, V2G systems contribute to lower greenhouse gas emissions and overall environmental sustainability.

2.3 Challenges of V2G Systems

Despite the promising benefits, V2G systems face several challenges that need to be addressed for widespread adoption and effective implementation:

Infrastructure Requirements: Significant investment in charging infrastructure and grid upgrades is necessary to support V2G capabilities. This includes deploying bidirectional chargers that can manage both charging and discharging processes safely and efficiently.

Battery Degradation: Frequent charging and discharging cycles required for V2G operations can accelerate battery degradation, reducing battery lifespan over time. This issue necessitates research into battery technologies that can withstand such cycling without significant degradation.

Regulatory and Policy Issues: Clear and supportive regulations are needed to enable V2G operations and ensure fair compensation for EV owners providing grid services. Policies should address technical standards, liability issues, and revenue models to incentivize participation in V2G programs.

Consumer Acceptance: Encouraging EV owners to participate in V2G programs requires addressing concerns about battery life, reliability, and financial incentives. Education and awareness about the benefits of V2G, along with transparent communication about potential risks, are crucial to gaining consumer trust and acceptance.

2.4 Future Trends in V2G Systems

Future developments in V2G systems are poised to address current challenges and enhance the capabilities of this technology:

Advanced Battery Technologies: Continued research and development in battery technologies, such as solid-state batteries and advanced lithium-ion chemistries, aim to improve battery durability, energy density, and lifespan. These advancements will mitigate concerns over battery degradation in

V2G applications.

Smart Grid Integration: Enhanced communication and coordination between EVs, charging infrastructure, and the grid will enable more dynamic and efficient V2G operations. Artificial intelligence (AI) and machine learning algorithms will play a crucial role in optimizing energy flows and predicting demand patterns.

Standardization: Developing unified technical standards and interoperability protocols for V2G systems will facilitate seamless integration across different vehicle models, charging stations, and grid networks. Standardization efforts will streamline regulatory compliance and promote global adoption of V2G technology.

Economic Models: Innovative business models and financial mechanisms will be developed to maximize the economic benefits of V2G for both EV owners and grid operators. This includes exploring new revenue streams, such as ancillary grid services and energy trading platforms, to optimize the value proposition of V2G participation.

Policy Support: Governments and regulatory bodies will play a crucial role in fostering an enabling environment for V2G deployment through supportive policies, incentives, and pilot programs. This includes incentivizing V2G infrastructure investments, providing regulatory clarity, and establishing frameworks for fair compensation and liability management.

2.5 Management and Communication for Electric Vehicle Charging

Managing the charging of electric vehicles (EVs) involves the electrical system, EV charging stations, and the EVs themselves. Effective management ensures efficient use of resources, cost savings, and network stability. This management can be static or dynamic depending on the mobility of the vehicles, coordination, and control structure.

Vehicle Mobility
Vehicle mobility plays a critical role in determining the charging strategies for EVs. Two primary types of vehicle mobility impact the management of EV charging: static and dynamic.

Static Charging Stations

Static charging stations are fixed installations where EVs can charge while parked. This traditional approach is straightforward and widely implemented in urban and suburban areas. Static charging is ideal for:

Home Charging: Where vehicles are parked overnight.
Workplace Charging: Allowing employees to charge during work hours.
Public Charging: At shopping centers, parking lots, and other public venues.
Static charging is convenient but can lead to congestion during peak hours if not properly managed. It also does not

not account for the variability in vehicle movement throughout the day.

Dynamic Charging Solutions

Dynamic solutions consider the movement of EVs, integrating charging opportunities into the vehicles' travel schedules. This approach is more complex but offers greater flexibility and efficiency. Dynamic planning includes:

On-the-Go Charging: Such as wireless charging embedded in roadways.
Scheduled Charging: Using predictive algorithms to determine optimal charging times and locations based on real-time data and travel patterns.
Mobile Charging Units: Portable chargers that can be deployed to various locations as needed.
Dynamic planning addresses the unplanned arrival and departure of EVs, making the system more adaptable to real-world conditions and reducing waiting times at charging stations.

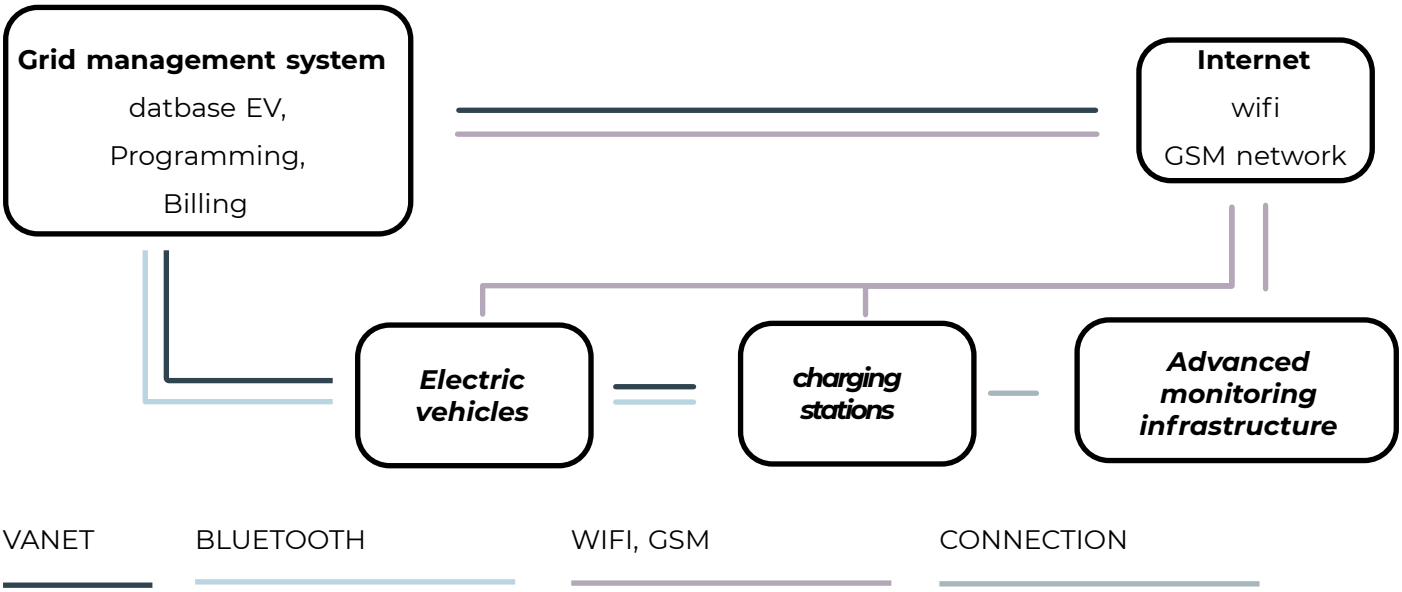
Communication Network for EV Charging
An effective management system for EV charging requires efficient communication between EVs, charging stations, and the electrical grid. Communication networks can be either wired or wireless, each with its advantages.

Wired Communication Networks

Wired networks, such as Power Line Communication (PLC), offer:

Reliability: Less susceptible to interference compared to wireless systems.
Security: More secure against cyber threats.
Consistency: Stable data transfer rates.
However, wired networks can be expensive to install and maintain, especially in widespread or remote

Communication network for electric vehicles



Mastoi, M. S., Zhuang, S., Munir, H. M., Haris, M., Hassan, M., Usman, M., Bukhari, S. S. H., & Ro, J.-S. (2022). An in-depth analysis of electric vehicle charging station infrastructure, policy implications, and future trends. Energy Reports, 8, 11504-11529. https://doi.org/10.1016/j.egyr.2022.10.017

areas.

Wireless Communication Networks

Wireless networks include technologies such as Zigbee, cellular, WiFi, and satellite communication:

Zigbee: Low power consumption, suitable for short-range communication in densely packed areas.
Cellular: Wide coverage area, ideal for urban and rural settings.
WiFi: High data transfer rates, useful for local networks.
Satellite: Provides connectivity in remote or hard-to-reach areas.
Wireless networks offer flexibility and ease of installation but can be vulnerable to interference and require robust security measures.

The insights gained from this chapter underscore the transformative potential of V2G systems in enhancing grid stability and energy management. Addressing the challenges and leveraging the benefits will be pivotal as we move towards a more integrated and sustainable energy infrastructure.

Chapter 3: Barriers to the Adoption of Electric Cars: Evidence from an Italian Survey

The adoption of electric vehicles (EVs) in Italy lags behind other European countries, primarily due to perceived barriers among potential buyers. This chapter investigates these barriers through a survey conducted among a representative sample of Italian adults, aiming to identify key obstacles and propose strategies for enhancing EV adoption.

3.1 Methodology

A survey method was employed, administered to 870 adults in Italy in 2019. Participants were selected from a community managed by SWG s.r.l., ensuring representation across various demographic categories (gender, age, region). The survey comprised 20 statements assessing perceptions related to EV adoption barriers, analyzed through a Likert scale.

Barriers to EV adoption

Usability	Charging infrastructure	Security and technolo-	Environment	Economic uncertainty	Performance
Limited autonomy	Absence of garage	Fire risk	Doubts about the benefits	High purchase price	Poor level of acceleration
Need to Plan Trips	Few charging stations	Lack of trust	Battery disposal	Increase in electricity prices	Less driving pleasure
Autonomy anxiety	Cost for adaptation		Battery degradation	Risk of loss of value	
Long Distance Travel	Increase in costs			Poor maintenance service	
Length of Charging Time					

Survey to Italians

Most relevant barriers	Less relevant barriers
Insufficient density of charging stations	Fire risk
Lack of stations along the highway	Distrust of new technologies
Purchase prices	Poor acceleration and less driving pleasure

Barriers to EV adoption

Solutions
Ecobonus
Incentives on road tax, parking
Cheaper cars
Charging along highways
Reliable information on environmental impact

Source: Giansoldati, M., Monte, A., & Scorrano, M. (2020). Barriers to the adoption of electric cars: Evidence from an Italian survey. Energy Policy, 146, 111812. https://doi.org/10.1016/j.enpol.2020.111812

3.2 Major Barriers to EV Adoption

The survey revealed three primary barriers perceived by participants as most relevant:

Insufficient Density of Charging Stations: A significant number of respondents highlighted the inadequate number of charging stations as a critical barrier. This scarcity affects the convenience and practicality of owning an EV, particularly in urban and rural areas where charging infrastructure is sparse.

Difficulty in Using EVs on Highways: Many participants expressed concerns about the lack of charging stations along highways, which complicates long-distance travel and contributes to range anxiety. This issue underscores the need for a more extensive and reliable network of fast-charging stations on major travel routes.

High Purchase Price: The initial cost of purchasing an EV remains a significant deterrent for many potential buyers. Despite existing incentives, the upfront expense compared to traditional internal combustion engine vehicles is perceived as prohibitive.

3.3 Lesser Perceived Barriers

Four of the 20 hypothesized barriers were not considered significant by more than half of the participants:

Safety Concerns (Risk of Fires): The perceived risk of fires and other safety issues associated with EVs did not rank high among the concerns of most respondents.

Distrust of New Technologies: While some individuals may still be wary of new technologies, this distrust did not emerge as a major barrier in the survey.

Poor Acceleration: Concerns about the acceleration performance of EVs were not widely shared among the participants.

Reduced Driving Pleasure: The absence of an internal combustion engine, and the associated driving experience, was not considered a significant drawback by the majority of respondents.

3.4 Policy Implications

In response to the identified barriers, Italian policymakers have implemented several incentives to promote EV adoption:

National and Local Incentives: The “Ecobonus” purchase bonus significantly reduces the purchase cost of EVs. Additional measures include exemptions from road tax for the first five years, reduced or waived parking fees, and unlimited access to limited traffic zones.

Automaker Initiatives: Automakers are encouraged to produce more affordable EVs in the A and B market segments. The lack of models in these segments currently poses a significant obstacle.

Charging Infrastructure Improvements: Addressing the lack of charging stations along motorways and clarifying regulations around parking costs at charging stations and in apartment buildings are critical steps. Despite European funding, Italy needs to expand both the number and type of charging points available.

Information Dissemination: Providing reliable and comprehensive information about the technological and environmental benefits of EVs is essential. This can be achieved through efforts by academics, traditional media, internet-based media, and car manufacturers.

3.5 Penalties for Overstaying at Charging Stations

The regulation of parking at charging stations includes penalties for overstaying beyond the allowed charging period. For instance, parking is free for up to one hour after charging an electric or plug-in hybrid vehicle. Penalties apply after this period, with specific charges varying by provider:

Plenitude + Be-charge: €0.10 per minute for AC charging.
Enel X Way: €0.10 per minute for AC, €0.20 per minute for DC, and €0.30 per minute for high power charging.
Ionity: €0.50 per minute for exceeding the charging period, with a higher penalty of €1.00 per minute if all stalls are occupied.
Tesla: Similar penalties as Ionity, with €0.50 per minute for exceeding the charging period and €1.00 per minute when all stalls are occupied.
These measures are designed to ensure fair usage and availability of charging stations, promoting efficient turnover and accessibility for all users.

By identifying and understanding the barriers to EV adoption, this chapter provides critical insights that can inform policy-making and strategic initiatives to promote the widespread use of electric vehicles. Overcoming these obstacles is essential for achieving a sustainable and efficient transportation future.

	Price €/kWh ≤22kW	Price €/kWh ≤ 23-50kW	Price €/kWh ≤ 51-99kW	Price €/kWh ≤ 100-149kW	Price €/kWh 150kW	Subscription	Penality
A2A	0.56	0,86	0,86	0,95	0,95	16-90 (0,32-0,53 €/kWh)	-For Digital Islands up to 3 h: 0.00 €/min; from the beginning of the 4th h: 0.166 €/min -For Quick columns up to 2 h: 0.033 €/min; from the beginning of the 3rd h: 0.050 €/min -For Fast columns up to 1h: 0.166 €/min; from the beginning of the 2nd h: 0.250 €/min
Acea	0,69	0,89	/	/	/	/	Reserve column 15 min pirma 0,50 € -Quick 0.09 €/min -Fast 0.18 €/min
Plenitude + Be-charge	0,65	0,85	0.85	0,90	0,95	9,90-19,90 (0,39-0,72 €/kWh)	60 minutes of free parking. -(AC up to 22kW) 0.10 €/min (rate does not apply during 23-7). -Fast (DC ≤ 99) 0.20€/min -Fast+ (DC ≤ 149) 0.30€/min -Ultrafast (DC ≥ 150) 0.30 €/min (H24).
Deferco Energia	0,59-0,79	0,59-0,79	0,79-0,89	0,79-0,89	0,79-0,89	129 (0,64 €/kWh)	/
Enel x way	0,69	0,89	0,89	0,99	0,99	49-129 (0,49-0,61 €/kWh)	Penalty AC: 0,10 €/min Penalty DC: 0,20 €/min Penalty HPC: 0,30 €/min
Ionity	0,49	0,49	0,79	0,79	0,79	11,99 (0,59 €/kWh)	/
Tesla	/	/	/	/	0,46-0,69	12,99 (0,46-0,51 €/kWh)	Charge for stall occupancy beyond charging period (per minute) €0,50 Charge for stall occupancy beyond charging period (per minute) when all stalls are occupied €1,00

DL Semplificazioni (76/2020, articolo 57) In the case of parking following completion of charging, parking is granted free of charge to the electric or plug-in hybrid vehicle for a maximum period of one hour. This time limit does not apply from 11 p.m. to 7 a.m.

The penalty for those who violate this provision by stopping or standing in the stalls of the charging stations despite not having the right to do so is as follows: from 41 to 168 euros if the offense is committed with mopeds and two-wheel motorcycles; and from 87 to 345 euros with passenger cars and other vehicles.

Chapter 4: Challenges and Future Trends in EV Charging Infrastructure

After setting the state of the art and exploring the strengths and drawbacks of EV infrastructure and vehicle technology, this section aims to delve into the challenges and future trends in electric vehicle (EV) charging infrastructure. Understanding these critical factors is essential for developing resilient and efficient charging networks that can support the growing EV market.

4.1 Challenges

Electric vehicles (EVs) are widely regarded as a pivotal trend in transportation, offering solutions to contemporary challenges associated with conventional fuel sources, including fossil fuel depletion, escalating greenhouse gas emissions, and global warming. However, the adoption of electric cars presents certain drawbacks:

Grid Load Capacity: Integrating EVs into existing grids can exacerbate load capacity issues, leading to blackouts and losses due to overload.

Battery Life and Range Anxiety: Limited battery service life and range anxiety

are significant concerns for consumers.

High Costs: The overall higher cost of electric vehicles compared to internal combustion engine vehicles is a major barrier.

As shown in the previous section, several factors hinder the widespread adoption of electric cars, necessitating proactive measures to address these challenges. For instance, the cost of electric vehicles remains higher than that of internal combustion engine vehicles due to charging infrastructure and onboard battery installation costs. Some lithium batteries exhibit reduced lifecycle and low energy density, necessitating the enhancement of battery lifespan and performance using novel materials. Furthermore, the integration of electric cars into transportation systems must be accompanied by the development of suitable charging infrastructures, as we'll see in the next paragraph.

4.2 Future Trends

With the advent of Energy Internet technology, Electric Vehicle Grid Integration (EVGI) can be further empowered. To establish a connected Energy Internet encompassing electric vehicles, energy networks, and transportation networks, various issues need exploration:

Development of a Wireless Power Transfer (WPT) dynamic charging system prototype supporting bidirectional charging.

Future research concentration on creating a bidirectional dynamic WPT system.

Transformation of Existing Networks into Smart Grids
Technological advancements are transforming traditional power grids into smart grids, capable of real-time monitoring, communication, and automated control. Data analytics play a crucial role in optimizing grid operations, enhancing system efficiency, and integrating renewable energy sources more effectively.

Utilization of Vehicle-to-Grid (V2G) Technology
V2G technology enables EV customers to leverage bidirectional energy flow, allowing them to sell excess energy back to the grid. This not only provides financial incentives to EV owners but also supports grid stability and enhances energy security.

Implementation of Battery Swapping Stations
To address range anxiety and make EV charging more convenient, battery swapping stations are being implemented. These stations enable quick battery exchange, similar to refueling at a gas station, thereby reducing charging time and enhancing EV usability.

Importance of Upgrading and Stabilizing Energy Networks
The increasing adoption of electric cars necessitates upgrading and stabilizing

energy networks to meet growing demand. This involves enhancing grid capacity, integrating energy storage solutions, and ensuring reliable electricity supply to support EV charging.

Conclusion Background analysis

The comprehensive analysis conducted in this thesis provides a thorough exploration of Electric Vehicle Grid Integration (EVGI) and its implications for future energy systems. Beginning with an overview of the challenges faced by electric vehicles (EVs), including economic barriers, technical limitations, and infrastructure deficiencies, this study underscores the multifaceted nature of barriers hindering widespread EV adoption. Despite these challenges, technological advancements, such as smart grids and Vehicle-to-Grid (V2G) technology, offer promising solutions to enhance the integration of EVs into energy networks.

The discussion on future EVGI development outlines key trends and innovations poised to shape the future of electric mobility. From advancements in wireless power transfer (WPT) and autonomous vehicle technologies to the evolution of business models in the sharing economy, the potential synergies between electric vehicles and energy systems are vast. Moreover, the integration of power, transportation, energy, and communication networks through EVs highlights a transformative shift towards a fully functional Energy Internet.

Furthermore, the analysis of barriers to EV adoption delves into economic, technical, infrastructure, consumer perception, and policy-related factors. In conclusion, while challenges persist, the trajectory towards widespread EV adoption appears promising with continued innovation, strategic investments in infrastructure, and supportive regulatory frameworks. By addressing economic, technical, and behavioral barriers through collaborative efforts across sectors, the transition to electric mobility can accelerate, paving the way for sustainable transportation systems and contributing to global climate objectives. Electric vehicles stand at the forefront of a transformative shift in mobility, offering a pathway to cleaner air, reduced greenhouse gas emissions, and enhanced energy security in the decades to come.

Navigating this complexity is a central challenge for this thesis and the services it aims to provide, underscoring the systemic design inherent in the integration of electric vehicles into existing energy grids. To further substantiate these findings, the thesis will now pivot to an examination of case studies from the market, highlighting real-world applications and outcomes.

Market

ANALYSIS

Chapter 5: Case study Tesla

This chapter provides a comprehensive market analysis through case studies of prominent companies like Tesla and an established player like Edison. By examining Tesla, a leader in the EV market, we can understand the advanced technologies and innovative business models driving its success. The inclusion of Edison offers a different perspective, showcasing alternative approaches and solutions within the EV ecosystem, even if they are not as groundbreaking. Additionally, this chapter explores various EV charging apps, different interaction methods, and conducts a technical analysis of both AC and DC charging systems. This combined analysis aims to provide a holistic view of the market, highlighting key trends and innovations that shape the future of electric vehicle infrastructure.

Overview of Tesla's Electric Vehicles and Energy Solutions

Tesla's dedication to sustainable transportation and energy solutions is evident through its diverse lineup of electric vehicles, energy storage systems, and solar products. Central to Tesla's strategy is the creation of high-performance electric vehicles that feature advanced battery technology and autonomous capabilities. These vehicles not only meet consumer demand for environmentally friendly transportation but also contribute to the larger goal of integrating renewable energy sources into the grid.

Tesla's Approach to Vehicle-to-Grid (V2G) Technology

Tesla has been a leader in the exploration of Vehicle-to-Grid (V2G) technology, which allows for bidirectional energy flow between electric vehicles and the grid. This technology enables Tesla owners to not only draw electricity from the grid but also to return excess energy to it during peak demand periods. By utilizing V2G capabilities, Tesla aims to improve grid stability, support the integration of renewable energy, and offer financial incentives to EV owners through energy trading mechanisms.

Deployment of Charging Infrastructure
A key aspect of Tesla's strategy is its extensive Supercharger network, which addresses one of the primary barriers to EV adoption: charging infrastructure. These Supercharger stations are strategically placed along major highways and in urban areas, allowing Tesla owners to travel long distances with ease and convenience. The scalability and accessibility of Tesla's charging infrastructure showcase a proactive approach to overcoming infrastructure-related challenges in the EV market.

1.1 Tesla infrastructure

V1 - 100 kW

Power output is shared and reduced if another vehicle is connected to a paired charger nearby

V2 - 150 kW

Similar to V1, the power output is shared and reduced when another vehicle connects to a nearby paired charger

Urban - 72 kW

Designed for urban areas with a smaller shape and a power output of 72 kW

V3 - 250 kW

Capable of delivering up to 250 kW with a thinner, lighter cable that uses liquid cooling

V4 - 615 kW

Equipped with a longer cable and a credit card reader to accommodate non-Tesla vehicles.
As of March 2023, the maximum power output is limited to 250 kW at 400 V

Mobileconnector

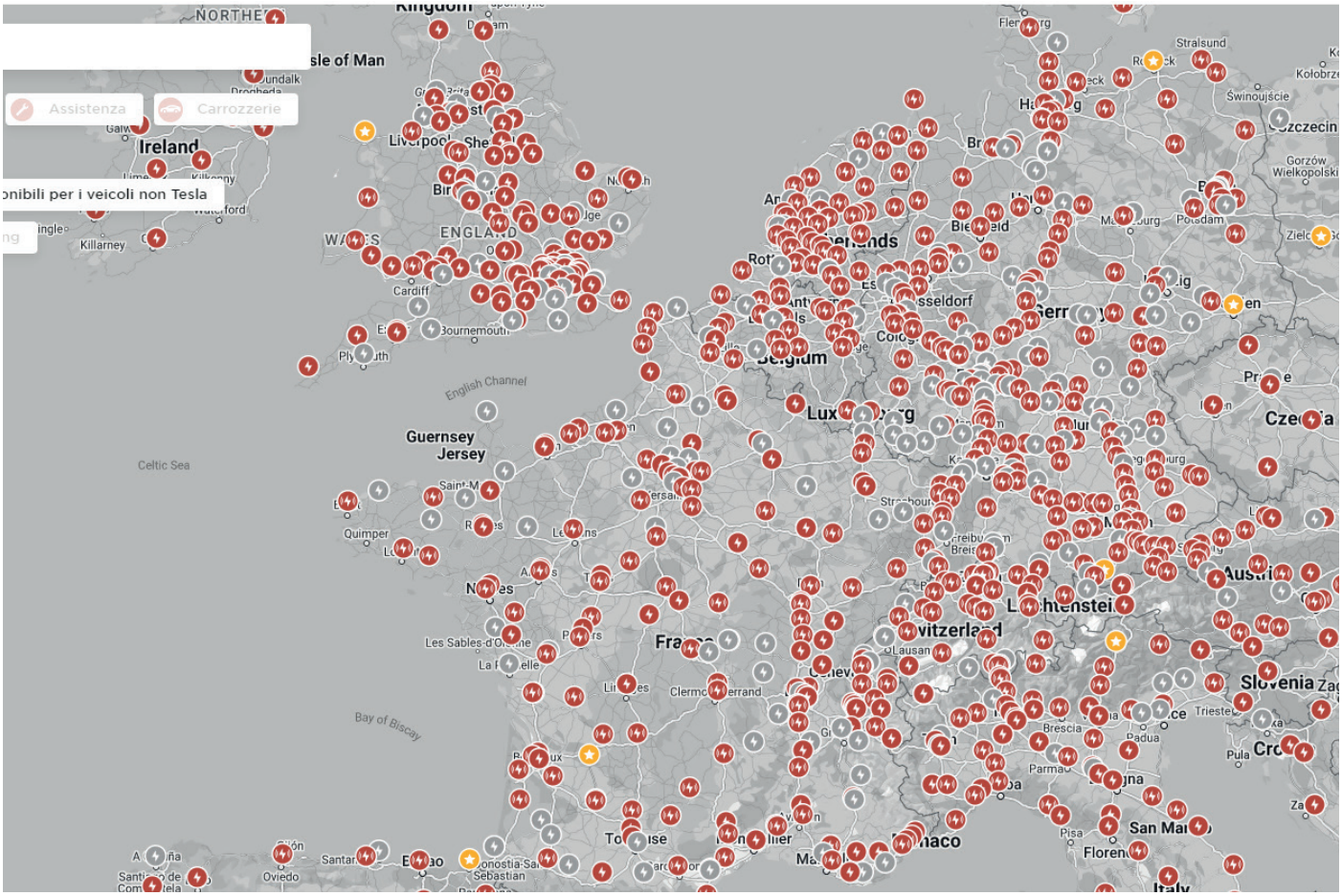
Charging capacity ranges from 4.8 km to 48 km per hour, depending on the adapter used and the vehicle model when connected to a standard outlet

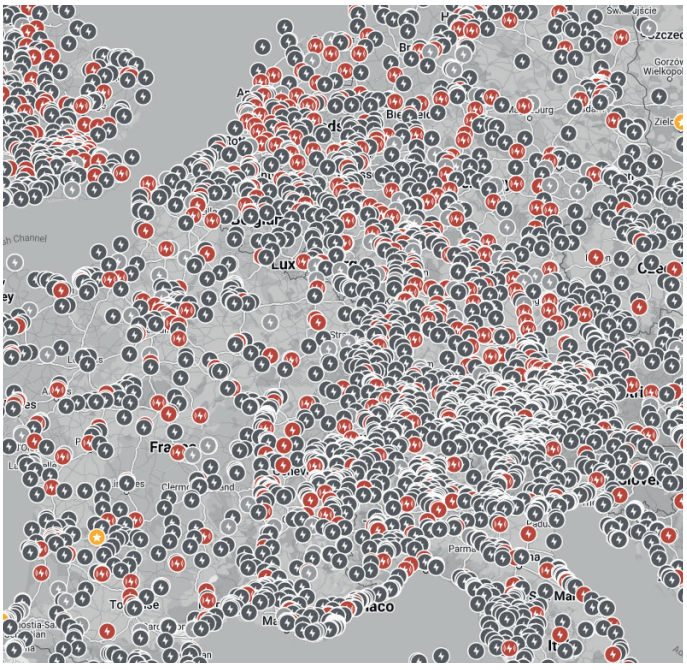
wall connector

Compatible with any electric vehicle and features monitoring of charging and Wi-Fi connection, adjustable amperage settings, a 7.3-meter cable, and a four-year warranty

Pedestal

An aluminum station designed to mount the Gen 3 and Gen 2 Wall Connectors for autonomous charging.
Does not include Wall Connectors or installation services





1075 all the Europe

8 Croatia	76 Italy
1 Luxembourg	115 Norway
43 Holland	7 Romania
13 Poland	20 Belgium
33 Switzerland	179 Germany
60 Spain	159 France

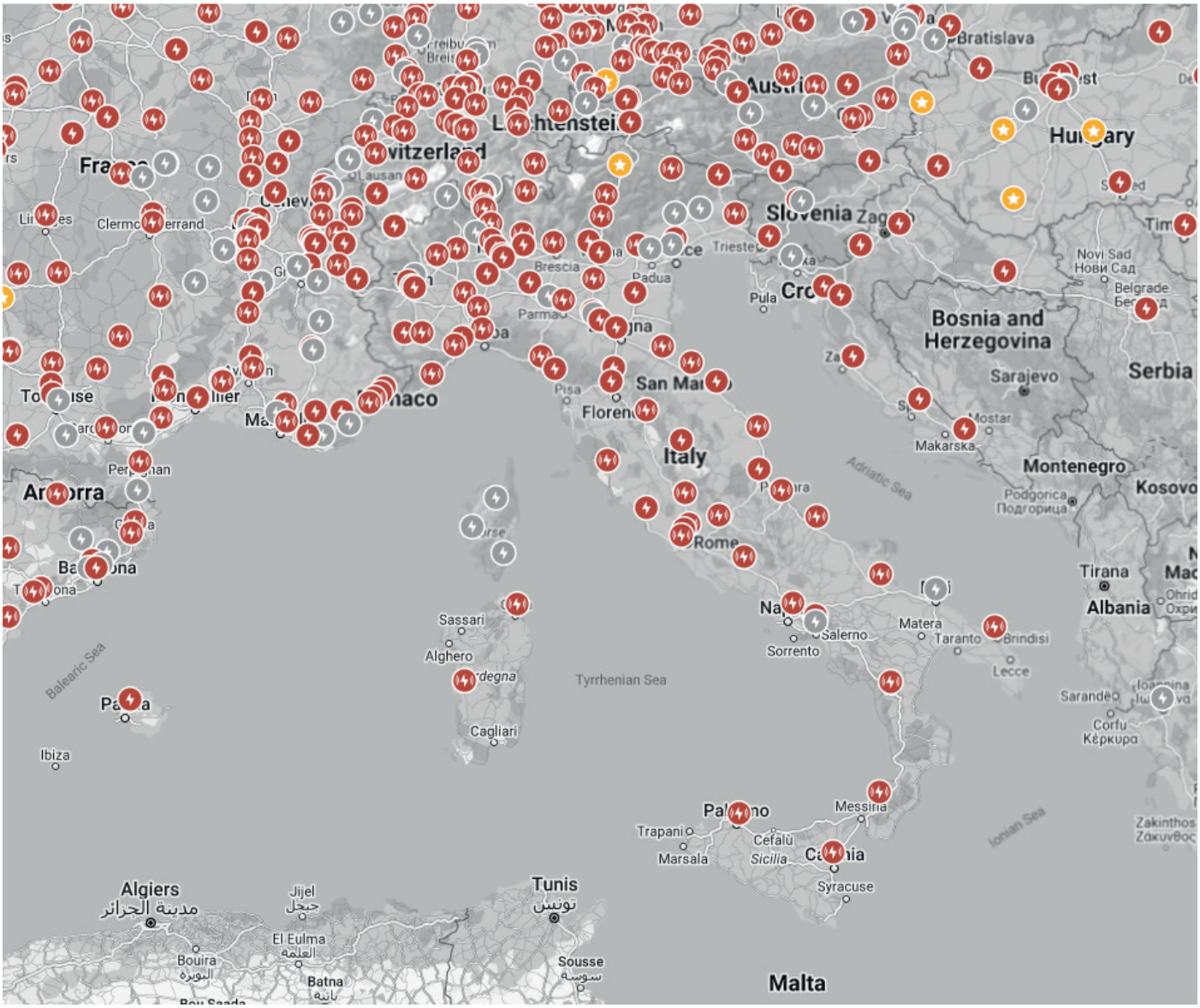
1.2 European Network

Tesla's Impact on Energy Markets and Regulatory Frameworks

The widespread adoption of Tesla's electric vehicles has initiated discussions on energy markets and regulatory frameworks globally. Through the introduction of innovative technologies and business models, Tesla has influenced policy developments aimed at supporting EV adoption, incentivizing renewable energy generation, and promoting grid modernization. The company's advocacy for sustainable energy practices has also spurred collaborations with utilities and other stakeholders.

Challenges and Lessons Learned

Despite its numerous successes, Tesla has faced various challenges in its efforts to integrate electric vehicles into global energy grids. These challenges include technological limitations, regulatory obstacles, and consumer perceptions. By analyzing these obstacles, valuable lessons can be learned regarding the scalability and sustainability of EVGI solutions, providing guidance for future strategies for Tesla and other stakeholders in the EV ecosystem.



1.3 Tesla experience

Trip Planning

Tesla's touch screen interface features a Trip Planner that algorithmically calculates the most efficient route to a destination.
This system considers multiple parameters such as driving behavior, weather conditions, traffic patterns, and the availability of Supercharger stations along the route to ensure an optimal travel plan.

Plug-in Process

The vehicle's charging port door automatically activates when the charging cable cap is selected. Once the cable is inserted, an LED indicator shifts from blue to green, indicating a successful connection and the commencement of charging.

Recharge

Charging progress is displayed on the charging station's interface. During this time, vehicle occupants can utilize the infotainment system for various activities, making the wait more enjoyable.

Monitor

The Tesla mobile app allows users to remotely check the vehicle's current charging status, providing convenience and peace of mind.

1.4 Future of tesla

Supercharger Lounges

Tesla has introduced large cubic lounges at some Supercharger facilities, like the one in Germany. These lounges are equipped with vending machines offering coffee, food, and other amenities. Tesla's collaboration with bk World aims to expand these lounges, especially in areas where traditional amenities are scarce, significantly enhancing the charging experience for users.

Megacharger

Tesla introduced the Megacharger, designed specifically for the Tesla Semi-trailer truck. This high-capacity charger can provide up to 643 kilometers of range in just 30 minutes. The first Megacharger was installed at Gigafactory Nevada in November 2021, with another approved for construction in California. These Megachargers are engineered for high current densities and use liquid cooling to achieve charging speeds of up to 1000 amps at 1000 volts.

Chapter 6: Case study Edison

Edison, a prominent energy provider, has taken a leading role in the development and implementation of sustainable charging infrastructure for electric vehicles (EVs). This chapter delves into Edison's comprehensive approach to designing, installing, and maintaining EV charging systems, highlighting the various services offered, the types of charging infrastructure available, and their practical applications.

Services Provided by Edison

Edison offers a suite of services aimed at promoting the adoption of electric vehicles through robust and efficient charging infrastructure. These services include Needs Analysis and Design, Infrastructure Implementation, Charging System Operation, and Maintenance and Support.

1.1 Services

Needs Analysis and Design

This service focuses on identifying the specific requirements of each client and designing a customized technological setup and charging infrastructure tailored to their needs. Edison assesses various factors such as location, expected usage patterns, and technological requirements to ensure an optimal setup.

Infrastructure Implementation

Edison's Infrastructure Implementation service involves managing the entire process of setting up the charging infrastructure. This includes procurement, installation, and activation of charging systems, all powered by environmentally friendly electricity sources.

Charging System Operation

Edison offers ongoing monitoring and management of the charging infrastructure. This includes efficient utilization, management of access, and handling of payment procedures through a user-friendly digital platform. Continuous monitoring helps maintain the reliability and efficiency of the charging systems.

Maintenance and Support

Edison ensures swift and reliable assistance through a dedicated 24/7 technical support line. This service covers both routine maintenance and emergency repairs, ensuring that the charging infrastructure remains in optimal condition at all times.

*Times depend on the vehicle

1.2 Charging infrastructure

Quick Charging

AC
7 - 22 kW
2 - 4 h*

Quick charging is ideal for parking in residential areas, intermodal hubs, overnight charging, and hybrid cars. This type of charging allows residents to conveniently charge their vehicles at home or at nearby hubs, making it easy to maintain a full charge. Additionally, overnight charging ensures that vehicles are ready for use each morning, while hybrid cars benefit from the faster charging times.

Fast charging

DC
50 - 100 kW
20 - 30 min*

Fast charging is best suited for parking in commercial, recreational, and hospital areas, intermodal hubs, and TPL (Third Party Logistics) night charging. This type of charging infrastructure is designed to accommodate the high demand and quick turnover typical in commercial and recreational zones. It also supports the logistics operations that require vehicles to be quickly recharged and ready for the next delivery.

Ultra-fast charging

DC
150 - 200 kW
10 - 15 min*

Ultra-fast charging is essential for high-traffic roads and LPT (Large Public Transport) logistics vehicles with minimal stopping times. This type of charging infrastructure provides the necessary power to keep high-usage vehicles on the move with minimal downtime, ensuring efficient operation and reducing delays.

1.3 Charging network

Work

Edison specializes in electrifying parking lots used for service or employee vehicles, ensuring that these areas are equipped to handle the charging needs of a fleet efficiently.

Hotels

For hotels, Edison offers charging services and activities designed to boost traffic and visibility, thereby enhancing the guest experience while promoting the use of electric vehicles.

Logistics hubs

At logistics hubs, Edison provides high-power infrastructure that supports the rapid charging and electrification of operational fleets, ensuring minimal downtime and maximizing efficiency.

Parking lots

Edison implements pricing systems in parking lots that are optimized based on the length of stay. These systems feature access management and personalized rates to cater to different user needs and usage patterns.

Administrations

Edison supports administrations in integrating charging infrastructure with electric public transport systems, contributing to the development of Smart Cities by promoting sustainable urban mobility.

Practical Applications

Edison's charging infrastructure is strategically implemented in various settings to maximize accessibility and convenience for EV users. By placing quick charging stations in residential and intermodal hubs, fast charging in commercial and hospital areas, and ultra-fast charging on high-traffic roads, Edison ensures that EV drivers have access to reliable and efficient charging options wherever they are.

Chapter 7: EV apps analysis

The examination of Edison and Tesla within the electric vehicle (EV) market reveals insights into the strategies and technologies employed by a prominent traditional energy player. While Edison may not lead in pioneering advancements like Tesla, its role underscores the significance of established firms in supporting and expanding EV infrastructure. Collaboration between innovative startups and established companies is crucial for fostering a robust and integrated EV charging network, capable of meeting future demands and enhancing overall market resilience.

Transitioning from the exploration of key market players, this section focuses on the analysis of EV charging applications. These digital platforms play a pivotal role in enhancing user experience by offering convenient and efficient solutions for locating, accessing, and managing EV charging stations. Evaluating the strengths and weaknesses of different EV charging apps provides valuable insights into their impact on user adoption and satisfaction. This analysis encompasses aspects such as user interface design, functionality, network coverage, and pricing models, aiming to provide a comprehensive understanding of how these digital tools contribute to the evolving landscape of the EV ecosystem.

Design: Wallbox **Year: 2022**

WALLBOX

The Wallbox application is designed for managing and controlling Wallbox electric vehicle (EV) charging stations. This dedicated app provides users with comprehensive tools for optimizing the charging process and monitoring the performance of their Wallbox systems.

Pros

Dynamic Power Sharing Management (up to 100A)
The app allows for the dynamic management of electrical power, enabling users to control the available power for the charging network at any time.

Cons

Internet Connection Dependency
To fully utilize the app's features, a stable internet connection is necessary, which might be a limitation in areas with poor connectivity.

Brand Limitations
The Wallbox app is specifically designed for Wallbox charging stations, limiting its usability to those particular systems.

Plug share app

PlugShare is a mobile application designed to facilitate the discovery and sharing of electric vehicle (EV) charging stations. It provides a user-friendly platform where EV owners can locate nearby charging points, plan their journeys, and exchange information with fellow users.

Pros

Inclusion of All Car Models
PlugShare accommodates a wide variety of car models, ensuring that the app caters to the diverse preferences of EV owners.

Reviews and Ratings
The app features community feedback, allowing users to make informed decisions based on reviews and ratings from other EV drivers.

Cons

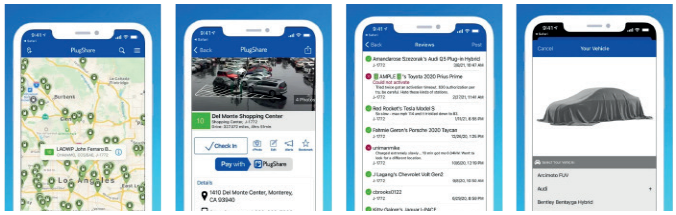
Excessive Advertising
The presence of numerous advertisements can detract from the overall user experience, making the app less enjoyable to use.

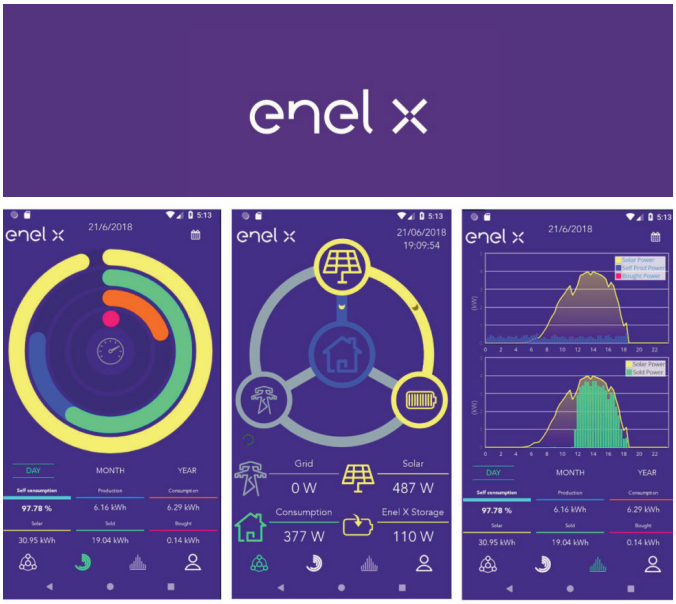
Unattractive Graphics
The app's graphics may be lacking in appeal, which could negatively affect user satisfaction.

Dependence on Community Contributions
The app heavily relies on user content.

Design: Recargo

Year: 2021





Design: ENEL X **Year: 2020**

Enel X

The Enel X electric vehicle charging application stands out as a tool aimed at simplifying the electric vehicle (EV) charging experience.

Pros

Extensive Charging Network: Enel X maintains a widespread network of charging stations across multiple countries, including prominent locations such as Italy and Spain.

Detailed Information: Users benefit from comprehensive and real-time updates on the status of charging stations, ensuring informed decision-making.

Cons

Geographic Availability: The availability and coverage of Enel X charging stations may vary significantly depending on the region.

Exclusive to Enel Wallboxes: The application is primarily designed for use with Enel wallboxes, which may restrict compatibility with other charging infrastructures.

A better route planner

A Better Route Planner (ABRP) caters specifically to electric vehicle (EV) drivers, offering advanced route planning capabilities tailored to their needs.

Pros

Real-Time Updates: ABRP provides up-to-date information on dynamic conditions such as traffic and weather, crucial for optimizing travel routes.

Route Optimization: It excels in planning efficient routes for EVs, considering factors like distance, elevation changes, and the availability of charging stations.

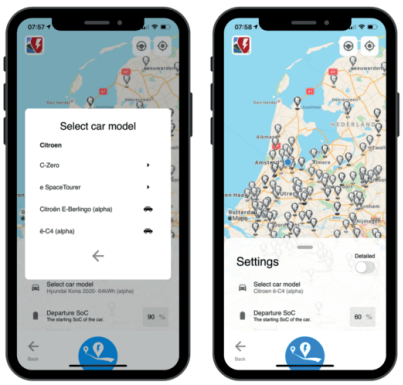
Cons

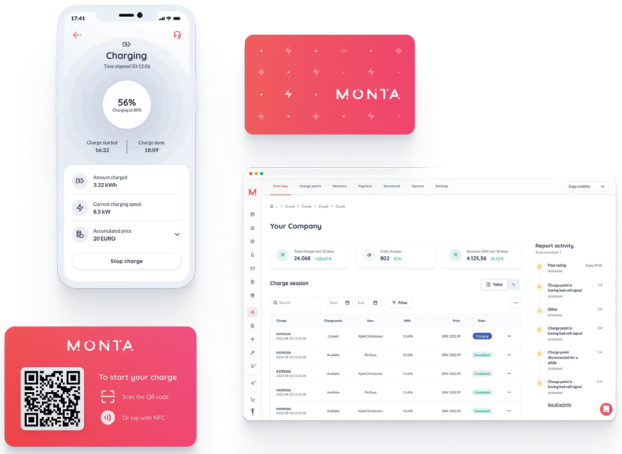
EV Exclusive: Limited to electric vehicles, which narrows its potential user base compared to broader navigation apps.

Data Accuracy Dependency: The reliability of ABRP heavily relies on accurate and current data, especially concerning the availability and status of charging stations, impacting the reliability of trip planning.

Design: Iternio Planning AB

Year: 2020





Design: MONTA **Year: 2020**

MONTA

Monta emerges as a comprehensive software solution designed to streamline the management and utilization of EV charging infrastructure across various stakeholders, including businesses, cities, and utilities.

Pros

Flexible Management: flexible management capabilities tailored for companies and municipalities overseeing charging infrastructure, accommodating diverse operational needs.

Complete Software Solution: It provides an end-to-end software solution covering the entire EV charging ecosystem, from installation to management

Cons

Initial Adoption: Implementing Monta into existing infrastructure may necessitate a period of adaptation for companies and cities, potentially requiring adjustments to workflows and processes.

Possible Technical Problems: As with any software platform, occasional technical issues or interruptions may arise, affecting user experience and operational continuity

SIEMENS

Siemens offers an EV charging management platform that caters to both individual users and fleet operators, emphasizing flexibility and usability.

Pros

Wide Availability: Partnering with major players

Intuitive User Interface: Siemens boasts an intuitive interface that simplifies navigation

Fleet Management: It includes features specifically designed for fleet management, optimizing charging operations for commercial and organizational use.

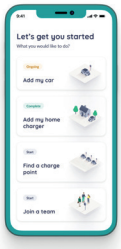
Multiple Payment Options: Users benefit from multiple payment options integrated into the platform.

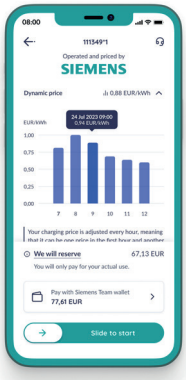
Cons

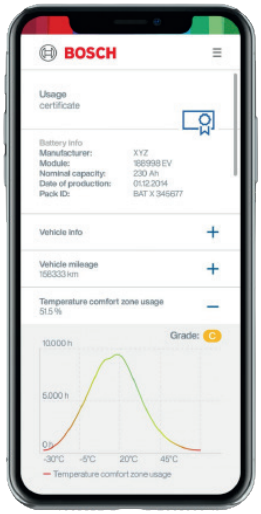
Dependence on Third Parties: The reliance on third-party partnerships for software provision may introduce dependencies that impact service delivery and support consistency.

Design: SIEMENS

Year: 2023







Design: Robert Bosch GmbH

BOSH CLOUD Year: 2021

Bosch Cloud offers the Usage Certificate app, dedicated to providing detailed and transparent information about electric vehicle (EV) battery health.

Pros

Maximum Transparency: The Usage Certificate app addresses the common challenge of understanding EV battery health by offering clear and understandable information.

Multiple Users Benefit: It serves a dual purpose by aiding both sellers, who can showcase the health of the EV's battery, and buyers, who gain assurance about the vehicle's condition.

Cons

Technical Complexity: Interpreting battery health data requires technical expertise, which may pose a challenge for less experienced users, potentially limiting its accessibility.

Possible Limitations: The accuracy and reliability of the data collected are critical; any discrepancies could impact the app's effectiveness in providing trustworthy information.

Drive Green Mobile

Drive Green Mobile is tailored for managing and monitoring Vestel EVCs, enhancing the charging experience through real-time tracking and control features.

Pros

Tracking and Control: Users can monitor and control Vestel EVC chargers remotely via the Drive Green app

Compatibility: Supports Bluetooth and Wi-Fi connectivity options,

Clear Feedback: Provides intuitive feedback on charging statuses through an LED circle that changes color.

Cons

Potential Technical Issues: Reliable operation of the app depends on stable Bluetooth or Wi-Fi connections, which could pose challenges in environments with connectivity issues.

Limitations of Use: Primarily beneficial for users of Vestel EVC chargers, potentially limiting its appeal and utility among a broader audience of EV users.

Design: Vestel UX/UI Design Group **Year: 2022**

ALFEN

Alfen's product line includes a diverse range of wall boxes designed for different applications. The Eve Single S-Line targets residential users, offering power options from 3.7 to 11 kW. The Eve Pro Line, suited for busy public car parks, features double connectors and supports up to 22 kW in AC. This range demonstrates versatility and scalability, catering to both domestic and high-capacity needs.

BTICINO

BTicino's Green'Up system simplifies EV charging with two versions catering to different performance requirements and EV charging modes. This dual-approach enhances flexibility, making it suitable for varied user needs.

BRILA

Brila Srl's ISIEVC wall box is a patented AC solution that is easy to install and operate, available in single-phase and three-phase versions. The inclusion of a release coil, circuit breaker, and an application for charge management showcases its user-centric design, suitable for residential and corporate settings.

AUTEL

Autel provides a wide range of charging solutions, from home wall boxes to ultrafast DC stations, prioritizing battery longevity. Their Maxicharger line supports up to 22 kW for home use, reflecting their commitment to comprehensive and versatile EV charging infrastructure.

CABUR

Cabur's EV Smart Charger series offers flexibility with models ranging from a compact 7 kW base model to advanced versions with internet connectivity and RFID authentication. This range is designed for home, condominium, and business environments, integrating advanced functionalities for efficient charging.

CHINT

Chint Italia provides AC solutions for private and public premises, including portable and wall-mounted options. The WCP-2 wall box, with its smart version, offers remote monitoring and control via a mobile app, enhancing user convenience.

CIRCONTROL

Circontrol designs solutions for various environments, including urban spaces and residential areas. Their product portfolio caters to both AC and DC charging needs, ensuring comprehensive coverage for different charging scenarios.

DAZE

Daze's Dazebox range, including Home, Share, and Pro models, integrates powerful displays and smart energy ecosystem support. The easy installation and app management make these devices versatile for both indoor and outdoor use, promoting sustainable mobility.

DKC

The E.Charger by DKC is designed for multi-user scenarios like condominiums, with options for single-phase and three-phase versions. Features like MID-certified energy meters and RFID card initiation enhance functionality and user management.

ECOLIBRI'

Ecolibrì's EcoCharge line emphasizes Italian-made products, offering single-phase and three-phase AC solutions up to 22 kW, as well as quick charge systems. Their focus on energy efficiency and sustainability aligns with their broader product offerings in renewable energy.

ETREL

Etrel is a leader in electric mobility, offering a comprehensive range of solutions from basic home chargers to sophisticated infrastructure. Their Inch charging stations integrate seamlessly with the advanced Ocean software, providing a complete toolkit for diverse electric mobility services. Etrel's scalable "Tuffati nell'Oceano" software serves as both a charging point and energy management system, ensuring uninterrupted charging experiences and supporting advanced load management for demand response and flexibility.

EVBOX

EvBox's product range spans wall boxes and ultrafast charging stations. The Livo model supports up to 22 kW, while the Troniq High Power stations exceed 400 kW, illustrating their capability to cater to both domestic and high-demand public charging.

FIMER

Fimer's solutions for private, public, and commercial use include a compact wall-mounted device with Plug&Play functionality. Features like Bluetooth connectivity and a dedicated app for local monitoring highlight their focus on ease of use and robust design.

FREEWIRE

FreeWire combines energy storage systems, energy conversion technology, and advanced software in their modular ultra-fast charging infrastructure. This integrated approach reduces costs and offers additional energy services, reflecting innovation and flexibility.

GEWISS

Gewiss' I-CON wall boxes, designed for private and semi-public environments, feature elegant design, anti-vandal sockets, and intelligent load management. These robust and aesthetically pleasing solutions are suitable for various installation contexts.

GROWATT

Growatt's charging stations seamlessly integrate with solar power systems, catering to commercial and residential installations. This integration supports sustainable energy use and efficient EV charging.

HEIDELBERG

Under the Amperfield brand, Heidelberg offers smart stations for home and shared use, with features like energy load balancing and RFID authentication. Public charging stations like ChargeSpot.Connect support up to 22 kW, emphasizing flexibility and user control.

IES SYNERGY

IES Synergy's Keywatt range includes DC charging stations from 24 kW to 100 kW, featuring dual SIM cards and a filterless cooling system. This range supports both light vehicles and larger eBuses and eTrucks, highlighting their versatility.

INGETEAM

Ingeteam's Ingerev range includes AC and DC charging stations for residential and industrial segments. Their continuous charging solutions cater to diverse user needs, from home use to public transportation.

JUICE TECHNOLOGY

Juice Technology offers a broad product range, including mobile, compact, and large fast chargers. Their focus on both AC and DC solutions reflects their commitment to comprehensive charging infrastructure development.

OLIFE

Olife Energy provides a complete range of charging stations, from 3.7 kW AC to 150 kW DC. Their products are developed and manufactured in the EU, emphasizing quality and reliability for various applications.

LYNUS8

Lynus8 develops innovative systems for charging various electric vehicles, aiming to enhance territorial attractiveness and environmental quality. Their approach supports sustainable urban mobility and community benefits.

MENNEKES

Mennekes offers solutions for private and public sectors, including consultancy and maintenance services. Their versatile range supports home use, business environments, and public charging stations.

ORBIS

Orbis' Viaris charging stations are modular AC chargers with power up to 22 kW. Their long-standing market presence and dedicated centers support efficient and reliable charging solutions.

SCAME PARRE

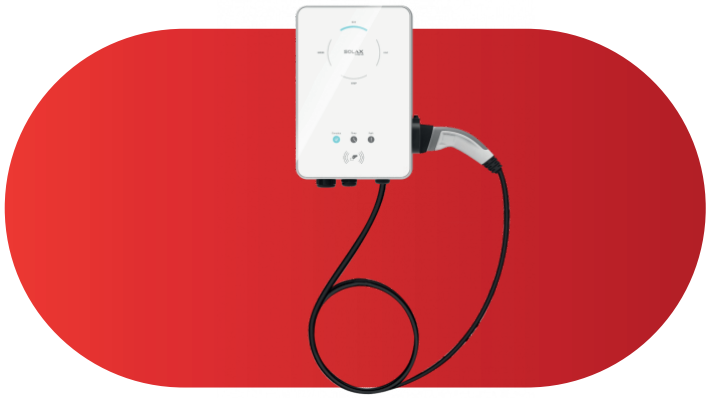
Scame Parre designs and produces charging components in Italy, offering a certified range and additional services like technical assistance. Their New Mobility Team network ensures professional installation for private users.

SENEC

The SENEC.EVcharger, designed in Australia, optimizes solar energy use through three charging modes. Its robust design and Type 2 socket compatibility make it suitable for various weather conditions and vehicle types.

SIEMENS

Siemens' e-mobility division provides a wide range of hardware and software products, from home wall boxes to public DC stations. Their solutions support fleet electrification and public charging services, enhancing the electric transition.

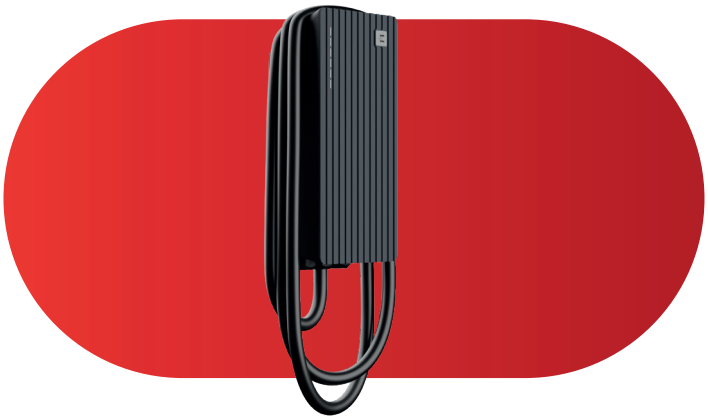


SOLAX

SolaX's Smart EV charger series combines their expertise in photovoltaic and energy storage systems. With single-phase and three-phase options, their chargers support efficient and sustainable energy use.

TELTONIKA

Teltonika's Teltocharge wall box, with customizable wood faceplate and smart functions, supports power ratings up to 22 kW. Integration with photovoltaic systems and app management enhances user experience and sustainability.



VEGACHARGERS

VEGA Chargers specializes in fast DC charging stations, offering models from 30 kW to 150 kW. Their comprehensive software systems and customer training support effective implementation and operation.

VIESSMANN

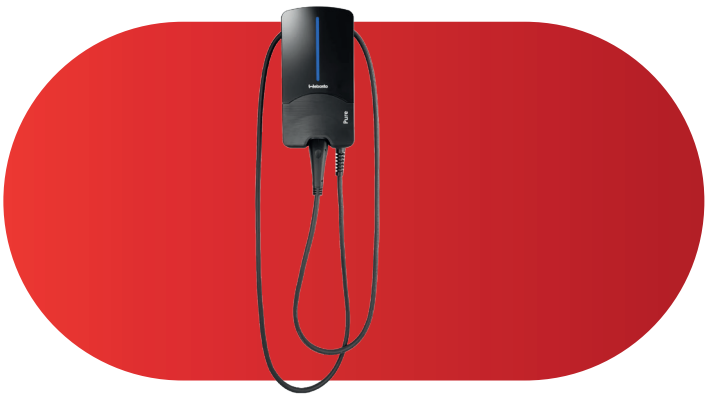
The Eve Mini charging stations complement Viessmann's photovoltaic products, promoting the optimal use of self-produced electricity. This integration supports efficient and sustainable energy use.

WALLBOX

Wallbox offers smart charging solutions with advanced digital platforms for remote management. Their elegant design and customization options cater to both private users and businesses, promoting efficient and connected charging.

WEBASTO

Webasto's charging solutions, including the Webasto Unite and Pure wall boxes, feature integrated cables, LED displays, and load management. Their user-friendly design supports daily EV charging needs.



ENEL X - WAY

Enel X Way, dedicated to electric mobility, operates as a Charge Point Operator (CPO) and Mobility Service Provider (MSP). Their ecosystem of products and services facilitates the transition to renewable energy and accessible electric mobility.

A2A

A2A provides wall boxes with Plug&Charge functionality and smart management via the E-Moving app. Their solutions support residential charging with enhanced convenience and connectivity.

DRIWE

DriWe develops hardware and software services for electric mobility and renewable energy integration. Their role as a system integrator and CPO supports a wide range of EV users and projects.

ALLEGO

Allego offers scalable charging solutions for various vehicle types and environments. Their comprehensive approach supports companies and municipalities in developing efficient and flexible EV charging infrastructure.

CHARGEPOINT

ChargePoint aims to make EV charging simpler and more accessible with a network offering hardware, management platforms, and comprehensive infrastructure packages for home, business, and public use.

BE CHARGE

Be Charge focuses on the diffusion of charging infrastructures, acting as both infrastructure owner and service provider. Their role in managing charging networks enhances the accessibility and convenience of electric mobility.

ENERMIA

EnerMia provides flexible, customized services for companies and individuals, including infrastructure design, installation, and management. Their free app supports efficient use and management of charging systems.

EWIVA

Ewiva, a joint venture between Enel X Way and Volkswagen, aims to create an ultrafast charging network in Italy. Their infrastructure models support high-power charging, promoting widespread EV adoption.

FASTNED

Fastned operates extensively throughout Europe, focusing on establishing fast-charging stations powered by renewable energy sources. Their goal is to improve accessibility and efficiency for electric vehicle drivers, providing convenient charging solutions across strategic locations.

FREETOX

Free To X specializes in developing high-power charging infrastructure along highway networks. Their approach emphasizes innovation, technology integration, and sustainable mobility practices, aiming to significantly reduce charging times and enhance the usability of electric vehicles.

GAS GAS

Gasgas operates as both a charging station network operator and a system integrator catering to external clients. Their services involve managing a network of charging stations, which Gasgas partly owns and operates on behalf of third parties. Gasgas excels in strategically locating charging stations to optimize charging time and ensure reliable service through consistently operational infrastructure.

POWY

Powy offers partnerships to owners of premium parking locations and strategic sites for the implementation of electric vehicle charging services. With three decades of experience in the energy sector and a decade focused on electric mobility, Powy collaborates exclusively with top-tier technology partners while maintaining a strong commitment to environmental stewardship.

CHARGEPOINT

Ressolar offers a wide range of services, spanning from installation to providing IT infrastructure solutions for public use of charging stations (via mobile apps), and extending to managing and owning networks of electric vehicle charging stations on public land.

SAGELIO

Sagelio specializes in providing tailored EV charging solutions designed for hospitality, commercial, and residential environments. Their focus on simplicity, efficiency, and user convenience enhances the accessibility of electric vehicle charging within urban and suburban settings. By prioritizing user experience, Sagelio plays a vital role in integrating electric vehicle infrastructure seamlessly into everyday environments, supporting sustainable mobility practices and enhancing overall customer satisfaction.

1.1 Different interaction with Charging station: Surroundings

Lamp around the column

Street

lamp

Lamp above the column

1.1 Different interaction with Charging station: Charging station

ADV display

Button

RF

FID

Gesture

Electronic payment

1.1 Different interaction with Charging station: Connection with the car

Portable Cable +display

Cable

Spiral cable

Retraction cable

1.1 Different interaction with Charging station: Handle

Handle

Button the

to open tank

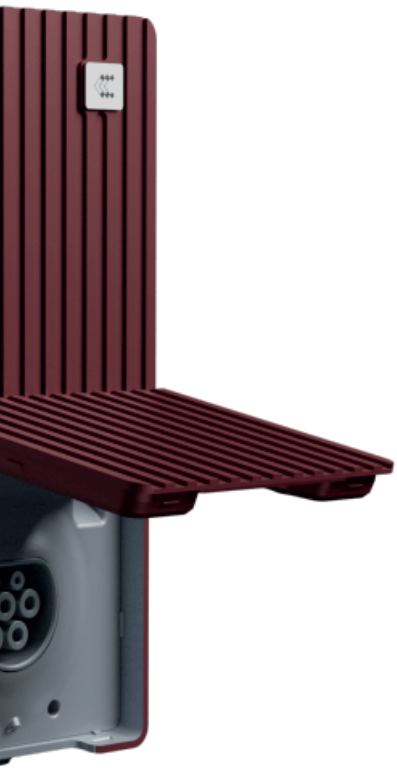
Cover for cable

1.1 Different interaction with Charging station: Connection cable

charging - station

Window open

Windo



w open

Push open

1.2 Technical analysis

	Company	Model	Charging connection			AC phase		Max charging	Monitoring		Ac
			Socket (type 2)	*Cable (type 2)*	*Charg-ing points*	*1*	*3*		*App*	*Display*	*RFI*
	A2A	Wallbox A2A	+	/	1	+	/	7,4 kW	+	/	/
		Wallbox A2A Plus	+	/	1	/	+	22 kW	+	/	+
  	Wall box	Pulsar Plus/ Max	/	+	1	+	+	22 kW	+	/	/
		Copper SB	+	/	1	+	+	22 kW	+	/	+
		Commander 2	/	+	1	+	+	22 kW	+	+	+
	Enel	JuiceBox	+	+	1	+	+	7,4 kW 22 kW	+	/	/
		WayBox/pro/plus	+	+	1	+	+	11 kW 22 kW	+	/	+
	Edison	Plug & go	+	+	1	+	+	11 kW 22 kW	/	/	+
	Repower	Giotto	+	+	1	+	+	11 kW 22 kW	+	/	+
	ETREL	INCH CORE	+	+	1	+	+	7,4 kW 22 kW	/	/	+
		INCH PRO	+	+	1	+	+	7,4 kW 22 kW	/	+	+
	Tesla	Wall connector	+	+	1	+	+	7,4 kW 22 kW	/	/	+
	Volkswagen	ID. Charger Connect/ Pro/Connect	+	+	1	+	+	11 kW	/	+	+
	TELTONIKA	TeltoCharge	+	+	1	+	+	7,4 kW 22 kW	/	/	+

cess control		Electricity metere	OCPP	Net work-ing/slave	Pros	Cons
D	*Key switch*					
	/	/	/	/	*Discounts available for both home and public networks.*	*The inability to wrap the cable around the column, limiting flexibility in installation.*
+	/	+	+	+	*LED indicators provide clear charging status updates.*	*Excessive information overload within the accompanying app, potentially complicating user experience.*
	/	MID	+	+	*Compact design facilitates dynamic load management through Powermeter.*	
+	/	MID	+	+	*Option to permanently connect the charging cable, with a wheelchair-friendly base.*	
+	/	MID	+	+	*Touch screen operation and management via myWallbox business plan, including dynamic load management.*	*Requirement to purchase a separate power meter for accurate load management.*
	/	+	+	+	*Integrated Load Optimization Pro ensures maximum charge without exceeding available power limits.*	*Emphasis on different versions of premium wallboxes could overshadow the availability and support for basic models.*
+	/	+	+	+	*Constructed from 100% recycled materials, in alignment with sustainability goals.* *Winner of the prestigious Compasso d'Oro design award.*	
+	/	+	+	+	*Temperature sensor adjusts power output based on internal temperature changes.*	*Unsuitability for outdoor use due to lack of weatherproofing or durability features.* *Aesthetics that may not align with modern design standards, potentially detracting from visual appeal.*
+	/	+	+	+	*Shell is interchangeable for customization.* *Positive LED interface enhances user interaction.*	
+	/	MID	+	+	*Supports accelerated or optimized charging based on user preference.* *Materials include polycarbonate, fiberglass, and aluminum for durability and aesthetics.*	
+	/	MID	+	+	*PIN code access provides secure identification.* *Stores and predicts user charging habits for optimized usage.Etrel offers battery charger renewal options for sustainability.*	
+	/	MID	+	+	*Includes a 7.3-meter charging cable, suitable for various parking setups.*	*Lack of energy monitoring capabilities, limiting user insight into consumption patterns.* *Need for an adapter to connect non-Tesla electric vehicles, adding to complexity and potential cost.*
+	/	MID	+	+	*Economical operation and maintenance costs.* *App-enabled locking and unlocking functionality.* *Simplified invoicing for company vehicle fleets.*	*Focus on premium versions at the expense of basic models, potentially limiting affordability and accessibility.*
+	/	MID	+	+	*Unique wooden construction option adds aesthetic value.*	*Absence of visible recharge status indicators on the wallbox, requiring users to rely solely on the app or other means for updates.* *Difficulty in inserting the charging cable into the wallbox, which may frustrate users during routine operations.*

	Company	Model	Charging connection		Max charging	Monitoring	
			Cable	*Charging points*		*App*	*Display*
	Blink	DCFC	CCS2 CHAdeMo	*2*	60 kW 120 kW 180 kW	+	/
	LG	EV100J-DEB/DBB	CCS2 CHAdeMo	*2*	100 kW	+	/
	Enel	JuicePump	CCS2 CHAdeMo	*2/3*	75 kW 50 kW 22 kW	+	+
		JuicePump Flexi	CCS2 CHAdeMo	*2/3*	150 kW	+	+
	Flo	FLO ultra	CCS2 CHAdeMo	*2*	160 kW dual chargers 320 kW solo charge	+	+
	Tesla	V3	Tesla	*1*	250 kW	+	/
		V4	Tesla	*1*	315 kW	+	/
	Ionity	Nova	CCS2	*1*	360 kW	+	/
	ABB	Terra HP	CCS2 CHAdeMo	*2*	160 kW with a conver- sion unit 320 kW with two conver- sion unit	+	+
	Charge point	Express	CCS2 CHAdeMo	*2*	125 kW (two)	+	+
		Express Plus	CCS2 CHAdeMo	*2*	500 kW	+	+

Acess control		Electricity metere	OCPP	Net working/slave	Pros	Cons
RFID	*Key switch*					
+	/	MID	+	+	*Integrated retractable cable mechanism* *Accepts credit card payments without the need for an RFID card*	*Lacks LED System: Without LEDs, users cannot easily check the charging status or station availability.* *Design Resembles Petrol Pumps: While familiar, this design may create false expectations about the functionalities available.*
+	/	MID	+	+	*Features a 22-inch touch display* *Utilizes a retractable cable system* *LED indicators to display battery status* *Dual cable system for one station*	*Separate Energy Storage Station: Increases logistical complexity, installation costs, and operational inefficiencies.* *One Screen for Two Cables: Can cause confusion and delays, especially during peak usage times.*
+	/	MID	+	+	*Supports both DC and AC electric currents*	*Unintuitive Interaction: Poor interface design frustrates users, leading to longer charging times and reduced satisfaction.* *No Touch Screen: Limits user interaction options and can make the system less accessible.* *Lack of External LEDs: Reduces visibility of charging status, making it harder for users to assess from a distance.*
+	/	MID	+	+		
+	/	MID	+	+	*Offers flexible parking options* *Colored indicators for charging status* *Dual touch screen interfaces* *Modular design structure*	
+	/	MID	+	+	*Equipped with thinner, lighter cables utilizing liquid cooling technology* *Distinctive and iconic design*	*Lack of External LEDs: Reduces visibility of charging status, making it harder for users to assess from a distance.*
+	/	MID	+	+	*Longer cable length for increased convenience* *Credit card reader compatible with non-Tesla vehicles*	*Only One Cable per Column: Limits the ability to charge multiple vehicles simultaneously, reducing station efficiency.*
+	/	MID	+	+	*Recognized with the 2019 iF World Design Guide Awards*	*Only One Cable per Column: Limits the ability to charge multiple vehicles simultaneously, reducing station efficiency.* *Separate Touch Screen: Can be cumbersome, adding complexity to the user experience*
+	/	MID	+	+	*Cable retraction system with extended cables* *Features galvanic isolation* *External LED lighting*	*No Touch Screen: Limits user interaction options and can make the system less accessible.*
+	/	MID	+	+	*Modular architecture with field-replaceable components* *Compact fast charging unit*	*Lack of External LEDs: Reduces visibility of charging status, making it harder for users to assess from a distance.*
+	/	MID	+	+	*Liquid-cooled cables for enhanced fast charging capabilities* *Modular design enabling incremental power sharing* *Clearly visible battery status indicators*	*Lack of External LEDs: Reduces visibility of charging status, making it harder for users to assess from a distance.*

1.3 Comprehensive Analysis of Wallbox and Charging Point Systems

This section consolidates the extensive evaluation of various wallbox and charging point systems for electric vehicles, focusing on user experience (UX), user interface (UI), systemic design, and sustainability. The analysis draws on detailed comparisons of models from leading manufacturers, as illustrated in the preceding tables, to identify key trends and insights.

1. User Interaction and Interface:

Touch Screens and Displays: Models like the LG EV1003-DE(B) BB and Enel Commander 2 are equipped with large touch screens and displays, enhancing user interaction by providing clear, real-time information. The ability to access detailed charging data, usage history, and status updates via an intuitive interface is crucial for a positive user experience.
LED Indicators: LED indicators are a common feature across many models (e.g., Wallbox Pulsar Plus/Max, Enel JuiceBox), providing immediate visual feedback on the charging status. This simplifies the user experience, allowing for quick and easy status checks without needing to interact with a more complex interface.
App Integration: Many wallboxes, including those from Tesla and Charge Point, offer app-based monitoring and control, enhancing accessibility and convenience. Users can manage their charging sessions remotely, receive notifications, and even schedule charging times to optimize energy costs.

2. Ease of Use:

Cable Management: Effective cable management is a critical aspect of user experience. For instance, Blink's DCFC and ABB's Terra HP models feature retractable cable systems that prevent clutter and reduce the effort required to manage the charging cables.
Plug-and-Play Functionality: Simplicity in connecting and starting a charging session is another vital factor. Models like the Tesla Wall Connector are designed for ease of use, where users can easily plug in and start charging without complex procedures.

3. Dynamic Load Management:

Several models, such as the Wallbox Copper SB and Enel WayBox pro/plus, incorporate dynamic load management systems. These systems optimize the distribution of available power among multiple charging points, ensuring efficient energy use and preventing overloads on the electrical infrastructure.

4. Flexibility and Scalability:

Modular Design: Charge Point's Express Plus and Flo's ultra models exemplify modular design, allowing for scalability and easy upgrades. This systemic design approach ensures that charging infrastructure can grow and adapt to increasing demand without requiring complete overhauls.
Multi-vehicle Compatibility: Systems like the Enel JuicePump Flexi, which support both DC and AC electric currents, demonstrate the importance of flexibility in catering to various electric vehicle types and charging requirements.

5. Sustainable Materials and Construction:

Recycled Materials: Models such as the Enel JuiceBox and Wallbox Commander 2 are constructed from recycled materials, aligning with environmental sustainability goals. Utilizing sustainable materials reduces the carbon footprint and promotes eco-friendly practices in the production of charging infrastructure.
Energy Efficiency: Integrated load optimization, as seen in the Enel JuiceBox, ensures that charging stations operate efficiently, maximizing the use of available power and minimizing waste.

6. Accessibility:

Wheelchair-friendly Design: Accessibility features, such as the wheelchair-friendly base available for Wallbox models, ensure that the charging infrastructure is usable by a broader range of individuals, including those with disabilities.
Inclusive Interaction Options: Models offering various control methods, including RFID, key switches, and mobile apps, cater to diverse user preferences and needs, making the systems more inclusive and user-friendly.

7. Aesthetic and Functional Design:

Interchangeable Shells and Customization: The ability to customize the appearance of charging stations, as seen with Repower's Giotto, adds aesthetic value while allowing users to personalize their installations.
This can improve the integration of charging infrastructure into different environments, enhancing public acceptance and use.
Design Awards and Recognition: Recognized models, such as the Ionity Nova, which won the 2019 IF World Design Guide Awards, exemplify the importance of design excellence in promoting both functional and aesthetic appeal.

User - Centric

DESIGN

BACKGROUND

The current **focus** on **reducing carbon dioxide** (CO2) emissions embraces the European Commission's ambitious plan to achieve a Europe with **zero climate impact by 2050**. Within this initiative, the **transportation sector** has been identified as a significant contributor to CO2 emissions, accounting for 28.3% of total emissions in the European Union. In recognizing the need to address the negative environmental impacts of the transportation sector, the **European Commission** has emphasized the importance of finding new solutions to limit these effects.

Electric mobility has emerged as a potential solution to reduce CO2 emissions from the transportation sector. However, despite increased interest in electric mobility, there are still barriers to its widespread adoption.

A key objective of this thesis is to **promote sustainable tourism**. By embracing **electric mobility**, it seeks to create vibrant, eco-friendly tourist destinations that appeal to **modern travelers** prioritizing sustainability. Through targeted educational initiatives and specialized information tools, we empower both locals and visitors to make sustainable travel choices.

The transformative impact of the efforts extends beyond environmental sustainability. By **attracting environmentally conscious tourists** and diversifying the tourism landscape, we aim to stimulate **economic growth** in the region. Furthermore, by fostering a **culture of sustainability**, we aspire to inspire a gradual shift towards more eco-friendly travel **behaviors**, ensuring a brighter, greener future for generations to come.

CONCEPT

Laura Sergi

age:28 job: Student

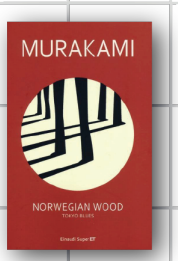
live: Roma status: Single

Bio

Laura Bianchi, a young 28-year-old college student living in Rome, is a crazy dreamer of electric cars. Despite being single and without an electric car, Laura is patiently waiting for an opportunity that is both affordable and environmentally friendly. She is an avid photographer and loves hiking, spending her free time in search of breathtaking views. Her favorite song, "Yellow" by Coldplay, reflects her lively spirit. She uses the BlaBlaCar app on her phone to share trips and save money. When she has her electric car, Laura expects to carefully plan her trips to maximize efficiency. If she's not on the road, you'll find her at work or shopping, but her heart beats for outdoor adventures.

“I'm waiting for the perfect electric car at the right price”

Favourite book



"Norwegian Wood" di Haruki Murakami

Pain point:

limited travel needs

Hobby

Trekking

Photography

Favourite song

Yellow colpdpaly

App

Bla Bla car

Favourite film

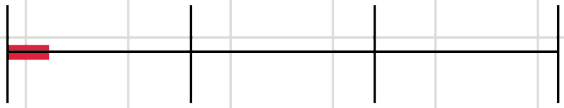
la la land

The lord of rings

Car

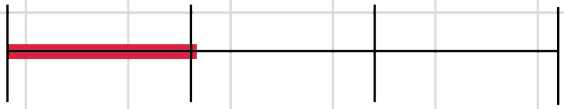
citroen c3 - 2010

Style of driving



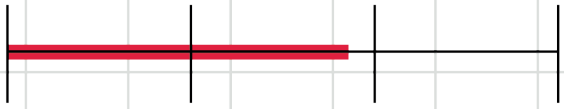
Eco Sport

Interaction with infotainment



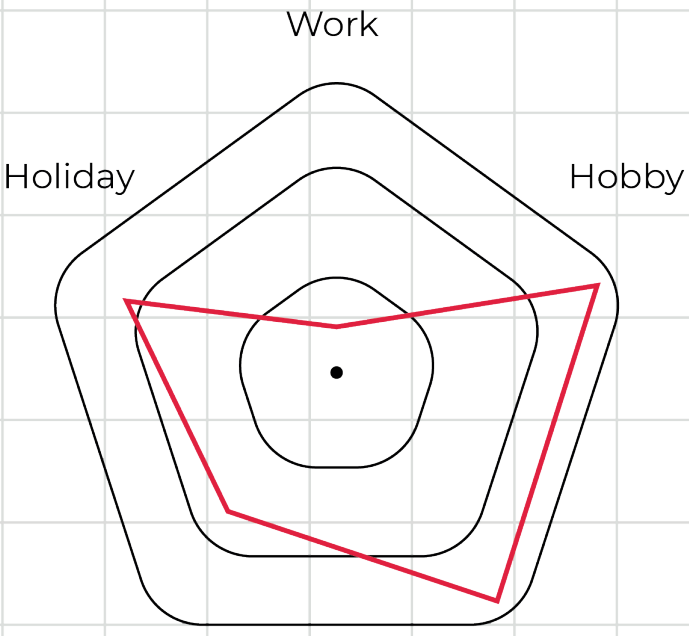
Low High

Type of road



Countryside City

Reason why it moves



Antonio Moretti

age:45

job: Taxi driver

live: Napoli

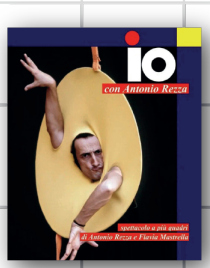
status: Married

Bio

Antonio Moretti is a veteran cab driver with more than two decades of experience in the cab industry in Naples. His reputation is built on reliable service and warm hospitality. Antonio has embraced electric vehicle innovation as a way to reduce operating costs and improve air quality on Naples' crowded streets. His fleet of electric cabs is easily recognizable for its cleanliness and quietness, which offers significantly better ride comfort than traditional internal combustion vehicles. His passion for cards, particularly games such as briscola and scopa, is well known among his fellow taxi drivers. Antonio is a strong advocate for the use of electric vehicles in the transportation sector and is constantly trying to share his enthusiasm and experience with fellow taxi drivers and his passengers.

"Driving is an art, electrically. Silence and savings are my way."

Favourite book



"Io, Antonio" di Antonio Rezza

Car

nissan leaf

Favourite

Gomorr

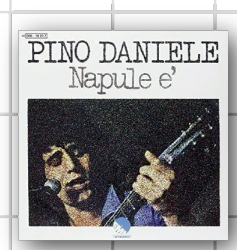
Hobby

Playing card

Pain p

Antonio limited remain ers thro

Favourite song



"Napule è" di Pino Daniele

App

ChargePoint

e film

ra

Benvenuti al sud

oint:

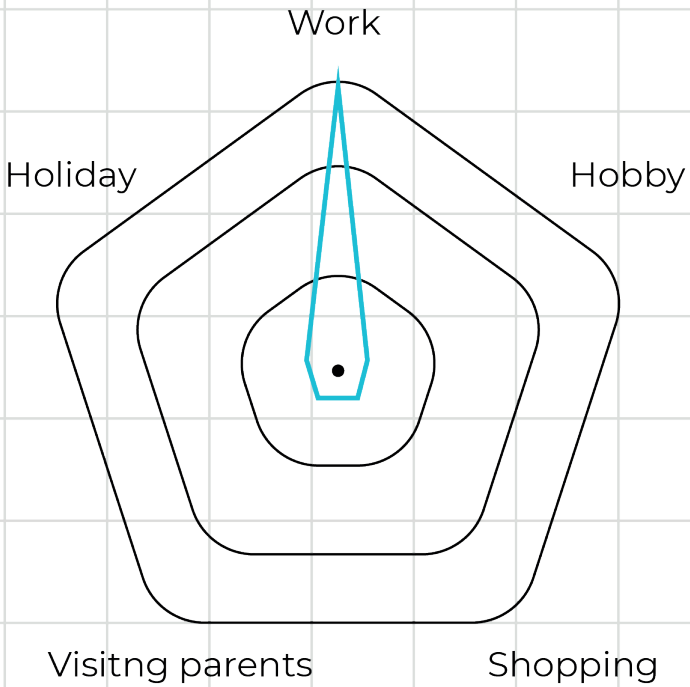
o worries about the battery life, as it must available to custom- oughout the day.

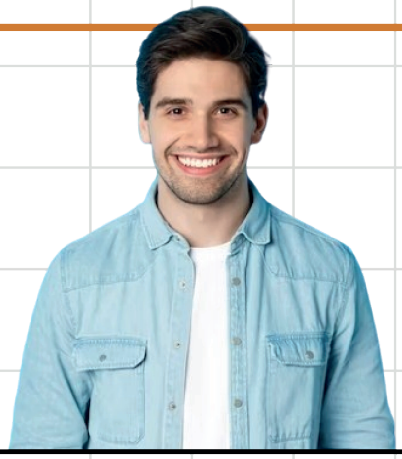
Style of driving

Interaction with infotainment

Type of road

Reason why it moves





Andrea Valli

age:28

job: Aerospace engineer

live: Torino

status: Single

Bio

Andrea is a technology expert with an unbridled passion for Tesla and Elon Musk. Every conversation with him inevitably revolves around technological advances and Elon Musk's latest news. What sets Andrea apart is his passion for taking long trips in his Tesla. He is an avid traveler who has crossed Europe to discover remote charging stations and shares his experiences through his blog and youtube channel dedicated to Tesla adventures. Through his experience, he has become a reference for those seeking advice on how to plan long trips in electric vehicles, proving that electric mobility is more accessible than people think.

“Dream big and never stop believing in your dreams.” - Elon Musk

Favourite book

"Il libro completo delle aperture" di Claudio Pantaleoni

Car

tesla model s

Favourite

Gomor

Hobby

Lego tech

Pain p

Excessi
as a co
Musk's

Favourite song

"Space Oddity" di David Bowie

App

Tesla

e film

ra

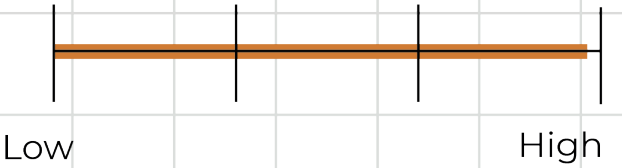
Star wars revenge of the sith

oint:

ve confidence in Tesla
mpany and in Elon
vision

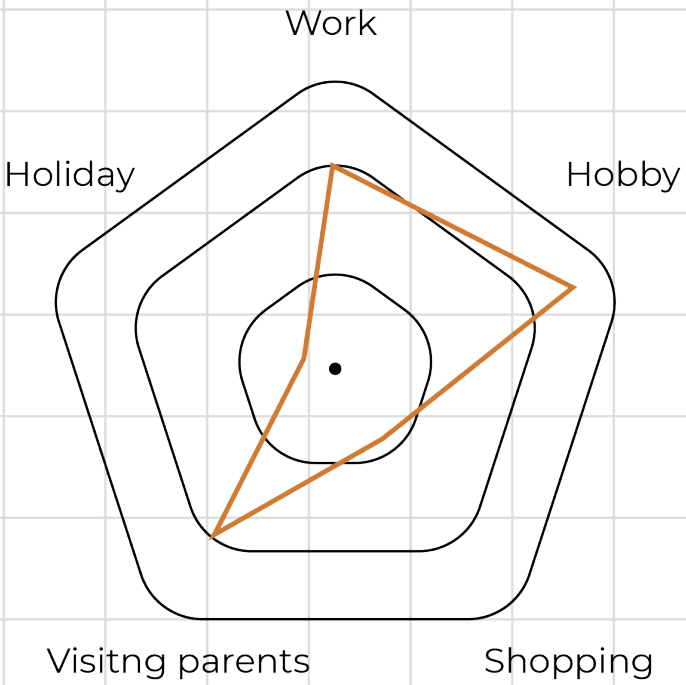
Style of driving

Interaction with infotainment



Type of road

Reason why it moves



"Saving today is investing in the future."

Carla Fois

age:55

job: Financial advisor

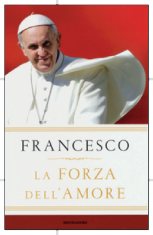
live: Varese

status: Married

Bio

Carla is a 55-year-old woman with a strong inclination toward savings and efficiency. She works as a financial consultant and is always looking for opportunities to reduce expenses. She is married and has two teenage children with whom she shares a car. Carla made the decision to purchase a hybrid car to take advantage of incentives and save on fuel costs. Her choice is motivated mainly by her financial aptitude and her desire to reduce family expenses. Considering the rising price of fuel, she sees the hybrid as a practical solution to contain her mobility expenses without having to give up the comfort and versatility of a car.

Favourite book



"La forza dell'amore" di Francesco

Car

toyota hybrid

Favourite

The pur
happyn

Hobby

Yoga

Pain p

Concer

Favourite song

"A modo tuo" di Elisa

App

Fuelio

e film

rsuit of
ess

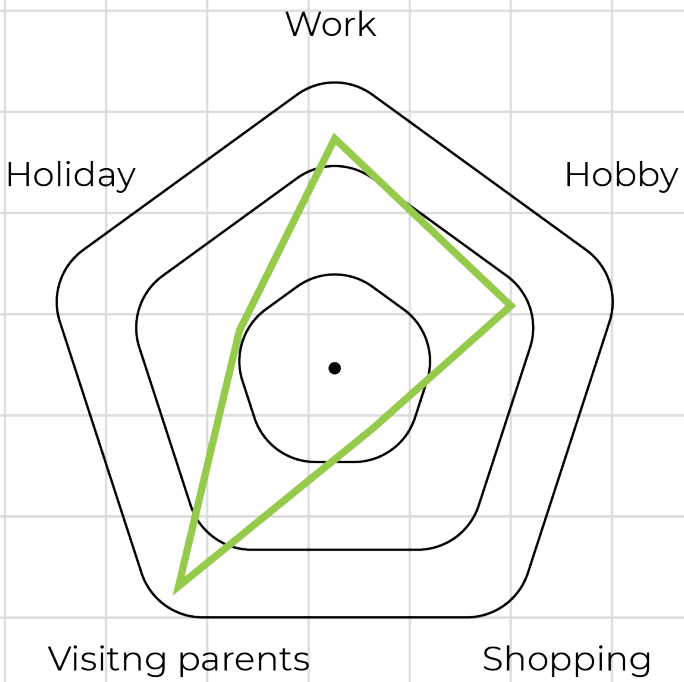
Che bella giornata

Style of driving

Interaction with infotainment

Type of road

Reason why it moves

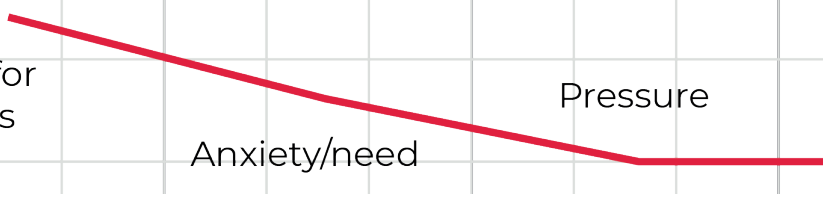


oint:

n about fuel costs

User Journey Laura Current situation

	Planning	*Enter*	*Connect*
Actions	Laura notices that the fuel level is low and plans to refuel	Drive to the gas station	He gets out of the car and interacts with the ATM, selects the pump and and inserts the pump by open-ing the tank
Touch point	uses his phone to check gas prices and the most convenient stations	Arrival at the gas station	ATM, selects amount and pump, opens tank, takes pump
Content and interaction	search the internet for the gas sta-tion with the lowest price	looks for the appropriate vending ma-chine, waits his turn, and inserts his credit card	The user should look for the ATM, insert it, follow the instructions, select the pump, remove the cap from the tank, and isert the pump
Weakness	Is concerned about rising gasoline prices.	May have to wait in line if the gas station is crowd-ed	Confusion with ATM, may create queue, error in selecting pump
Emotion	Hope for savings	Anxiety/need	Pressure



Engage		*Exit*	*Extend*
Dead time	*Disconnect*		
Wait with the pump in hand until he sees the desired amount on the display	Removes the pump backs it up, closes the tank	Finish refueling and resume driving	After refueling, normal routine resumes
Gasoline pump and light display	Gasoline pump	Machine and petrol mark display	He reflects on his Citroën C3's efficiency and fuel expenditure
Visual interac-tion of the dis-play showing price and gal-lons of gasoline and with the snap handle	Inserting the pump into the column making sure to insert it correctly	Turning on the car and viewing the diaplay. And exited the binzi-naio paying attention to the cars	Assesses whether a future invest-ment in a more efficient or electric car is needed
Amount not accurate	Drops out of the tank	Real under-standing of the autonomy of the car	reflect on the envi-ronmental impact and costs associat-ed with using a gasoline car

User Journey Antonio Fast charge

	Planning	*Enter*	*Connect*
Actions	Planning of energy supply for the cab	Arrival at the charging station	He gets out of the car and interacts with the column, identifies him-self with the card and selects the pump
Touch point	Cab fleet manage-ment app to see vacant cab stands	Parking lot entrance	App, Column, pump, tank
Content and interaction	Checking availability of charging stations and route plan-ning	Identification of charging station and parking lot	Charging cable connection, communication with charging infrastructure and charge level monitor-ing
Weakness	Concern over availability of charging sta-tions	searching for the column and finding free space	Need for down-time during charging, concern about delays
Emotion	Distrust	Anxiety/need	Pressure

Engage		*Exit*	*Extend*
Dead time	*Disconnect*		
Wait for the machine to finish recharg-ing until the next call	Removes the pump, sets it down, and closes the tank	Resumption of cab service following a call	Reflection on the continued use of electric vehicles
Charging hubs and colleagues	Charging column	Charging app and cab sta-tion	Charging app with statistics
Playing phone or card games with colleagues	Notification of end of charging and disconnec-tion via app.	Clear summary of costs and kW consumed	Reflection on efficiency and the environ-ment, graphs and machine status
Charging hub without services	Recharge close signal	Delays or incor-rect end time of uploading	Possible cus-tomers lost to recharge times
Relaxation	Satisfaction	Satisfaction	Satisfaction

User Journey Carla plug-in

	Planning	*Enter*	*Connect*
Actions	Charging level exhausted during the trip	Go inside the garage	Connection to charging cable
Touch point	Car display	Garage and wallbox	Wall-box and charging cable
Content and interaction	-	Garage opening with remote con-trol and car aparcheggio	The user opens the car tank and inserts the charging cable and through light feedback understands that charging is started
Weakness	Wrong electric motor autono-my	Wallbox occu-pied by another electric vehicle	Pounding the wallbox cable with the wheels
Emotion	Happiness	Neutral	Happiness

Engage		*Exit*	*Extend*
Dead time	*Disconnect*		
Wait until the charge is over	Current disconnection	Disconnect charging cable	Reflection on his hybrid car efficiency and savings
Home	App	Wall box and cable	Evaluation of driving experience and cost
Fun activities or household chores	via app is decided to disconnect the power	Cable coiling and garage usicta	Gratitude for savings and convenience of hybrid, eventual anxiety about remaining range
Power failure	Disconnection failed, need notification to remember	Range anxiety	reflect on the environmental impact and costs associated with using a gasoline car
Happiness	Happiness	Anxiety	Satisfaction

User Journey Andrea slow chargin

	Planning	*Enter*	
			Connect
Actions	Andrea parks the car in the company courtyard at the gas sta-tion	Drive to the slow charge column	He plugs the charging cable into his Tesla Model S
Touch point	Corporate park-ing	Arrival at the slow charge column	Column and cable
Content and interaction	Interaction with the bar and surveil-lance persoanle	It searches for the slow charge column and positions itself to con-nect the cable	Andrea inserts the cable taken from the car trunk and makes sure the charging has started
Weakness	Possible con-cern about availability of the column	Occupied column	Twisted cable or out of parking lot limit
Emotion	Hurry	Happy	Pressure

ng range anxiety

Engage		*Exit*	*Extend*
Dead time	*Disconnect*		
The charging process begins	Removes the charging cable	Usicta from the office	After charging, Andrea can share her expe-rience on social media or her blog
Jobs and apps	Column, cable and trunk	bar, security personnel display	After charging, Andrea can share her experi-ence on social media or her blog
Monitor via app the progress of charging and in the meantime work	Unplug the cable, put it in the car	100% autonomy level	Reflects on the benefits of the electric car and shares with the online commu-nity
Need to move the car for end of charging	Heavy cable and difficult to plug into machina	Anxiety about not being able to do all the errands before getting home	-
Happy	Fatigue	Satisfaction	Satisfaction

Chapter 10: Personas and User journey

Introduction

The purpose of this chapter is to present and justify the selection of personas used in the study, focusing on their roles in understanding user experiences and designing a service for electric vehicles (EVs) aimed at sustainable tourism. The personas were chosen to represent a diverse range of users, each with unique needs and pain points. This diversity helps in creating a comprehensive service that caters to various scenarios.

Methodology

The methodology for selecting personas involved analyzing different types of users based on their current vehicle usage, driving habits, and attitudes towards electric mobility. The personas were created to reflect real-life scenarios and provide insights into the challenges and expectations of different users. This approach is grounded in user experience (UX) and service design principles, ensuring that the service is user-centric and addresses the specific needs of its target audience.

Selected Personas

The four personas chosen for this study are Laura, Antonio, Andrea, and Carla. Each persona was selected based on their distinct characteristics and relevance to the study's objectives.

Laura Sergi

Current Situation: Laura drives a diesel Citroën C3 and is keen on switching to an electric vehicle. She is waiting for financial assistance or incentives to make the transition affordable.
User Journey Focus: Laura's user journey illustrates the challenges faced by potential EV buyers, including range anxiety and the need for reliable charging infrastructure.
Rationale: Laura represents a significant segment of the population that is environmentally conscious but constrained by economic factors. Understanding her journey helps in designing services that can ease the transition to electric mobility.

Antonio Moretti

Profile: Antonio is a veteran taxi driver in Naples with over two decades of experience. He has adopted electric vehicles to reduce operational costs and improve air quality.
User Journey Focus: Antonio's journey emphasizes the practical use of EVs in a professional context, particularly focusing on fast charging and maintaining efficiency in a work environment.
Rationale: Antonio's persona highlights the benefits of electric vehicles in commercial use, demonstrating their potential for cost savings and environmental benefits. This insight is crucial for promoting EV adoption among professionals in the transportation industry.

Andrea

Profile: Andrea is a tech enthusiast and a passionate Tesla user. He frequently embarks on long journeys and documents his experiences to educate others about electric mobility.
User Journey Focus: Andrea's journey focuses on long-distance travel, exploring the availability and reliability of charging stations, and managing range anxiety.
Rationale: Andrea represents the tech-savvy user who is already invested in electric mobility. His experiences provide valuable insights into the needs of long-distance travelers and the importance of a robust charging network.

Carla

Profile: Carla is a 55-year-old financial consultant who prioritizes cost efficiency. She owns a hybrid vehicle and shares it with her teenage children.
User Journey Focus: Carla's journey addresses the practical aspects of owning a hybrid vehicle, including fuel savings and the convenience of a dual powertrain.
Rationale: Carla's persona underscores the financial motivations behind choosing hybrid vehicles.
Her perspective is essential for understanding the economic considerations that influence the adoption of electric and hybrid cars.

Analysis and Insights

The personas were analyzed to uncover their specific needs, pain points, and preferences. This analysis informed the design of the service, ensuring it addresses the key issues faced by each type of user. The personas also helped identify opportunities for improving the user experience, such as:

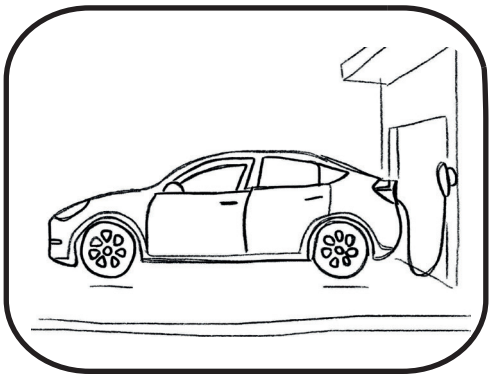
Financial Incentives and Support: For users like Laura, providing information on available incentives and financial support can ease the transition to electric vehicles.
Efficient Charging Solutions: For professional users like Antonio, the availability of fast and reliable charging stations is critical to maintaining productivity and reducing downtime.
Long-Distance Travel Support: For tech enthusiasts like Andrea, ensuring a seamless and stress-free long-distance travel experience is essential. This includes a well-distributed network of charging stations and real-time information on their availability.
Cost Efficiency: For financially motivated users like Carla, highlighting the long-term cost savings and environmental benefits of hybrid and electric vehicles can encourage adoption.

The selection of these four personas was driven by the need to cover a wide spectrum of user experiences and expectations. By focusing on these diverse profiles, the study aims to design a comprehensive service that addresses the unique challenges of each user type. This user-centric approach is fundamental to creating a service that not only promotes sustainable tourism but also enhances the overall user experience, encouraging more people to embrace electric mobility.

Storyboard
Torino - Zoagli

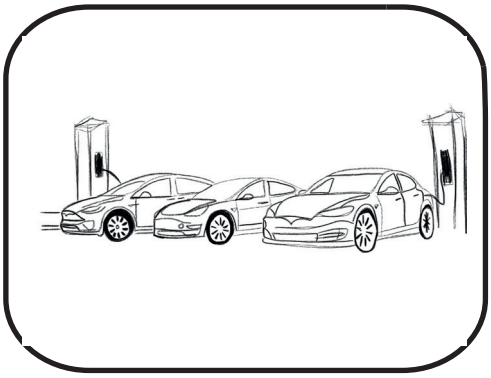
19°C - 29°C

533 km (WLTP)
450 km (city - suburban)
330 km (highway)



Torino hours : 8:00 **100%**

context: The user plans with the tesla “Go anyware planner” to depart from the garage in Turin, with a fully charged battery. He decided to use the navigation of tesla
service: cable reel, monitoring app
pain point: preheating



Charging in Acqui Terme hours: 9:30 ~75%

context: After 120km on the road, the car arrives at the charging station in the city of Acqui Terme.
service: slot reservation, remote visible columns, surveillance cameras, tourist info

Arrival at the spa hours: 9:45 **~ 100%**

context: The column delivers 150kW and charges the car immediately. Meanwhile, the user enters the spa.
service: Monitoraggio della carica
pain point: Interrupted recharge or disconnection

Lunch break hours: 13:00 **100%**

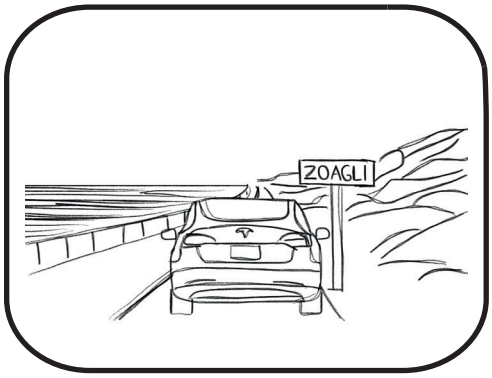
context: After leaving the spa the user goes in search of a place to eat
service: Agreed or car-booked lunch services
pain point: Payment of penalties for column occupancy exceeding 1h

19°C - 29°C

533 km (WLTP)
450 km (city - suburban)
330 km (highway)

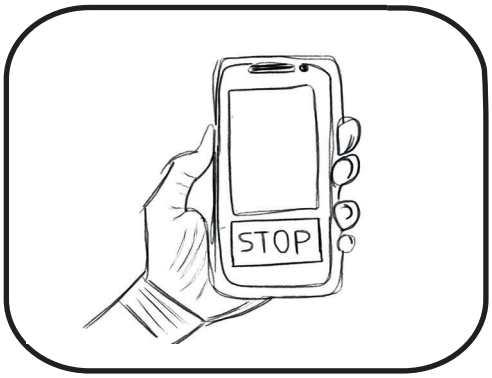
Disconnection and travel hours: 14:30 **100%**

context: The user returns to the column and disconnects the machine
service: instant billing, customer loyalty
pain point: Fine payable, Extra cost



Arrival at B&B Zoagli hours: 17:00 **~ 73%**

context: The user after about 100km arrives in Zoagli
service: facility reservation and car parking, bike and water sports services, technical assistance



Zoagli hours: 20:00 **100%**

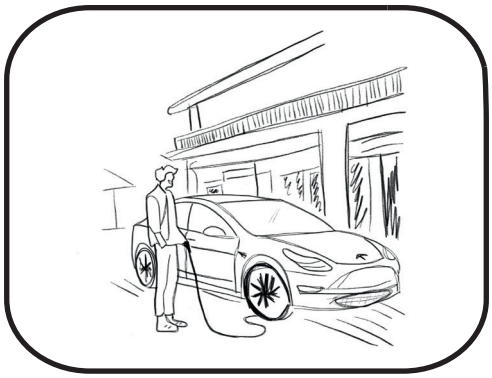
context: The user attaches and detaches the column from the B&B but he is not using the tesla charging. After getting ready, he goes outside to go to the restaurant
service: Dedicated parking space, tourist info, agreement with the restaurant.
pain point: risk of losing parking space

Restaurant in camogli ore: 21:30 **~ 92%**

context: The user eats out and goes to the risotrante in Camogli but has no need to charge. After dinner he takes a walk downtown
service: Tourist info, restaurant reservation.
pain point: tourist environment difficult to find place

19°C - 29°C

533 km (WLTP)
450 km (city - suburban)
330 km (highway)

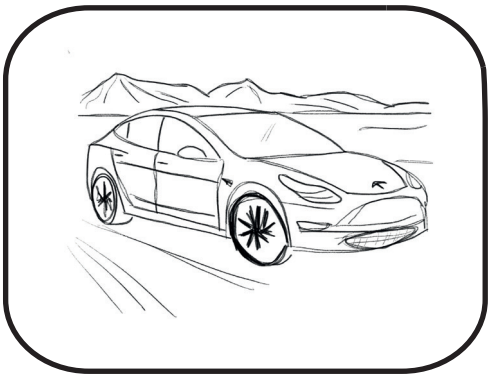


Return to the B&B hours: 24:45 ~84%

context: The machine is put on charge outside the B&B.
service: Charge monitoring
pain point: Interrupted recharge or disconnection

Wake up and rent bikes at: 9:00 100%

context: Go for breakfast and rent an ebike to go hiking in the area
service: bike rental
pain point: lack of bike routes



Lunch and departure time: 14:30 100%

context: Lunch at the B&B and back to Turin
service: single billing for recharge and accommodation
pain point: Extra or unreported costs

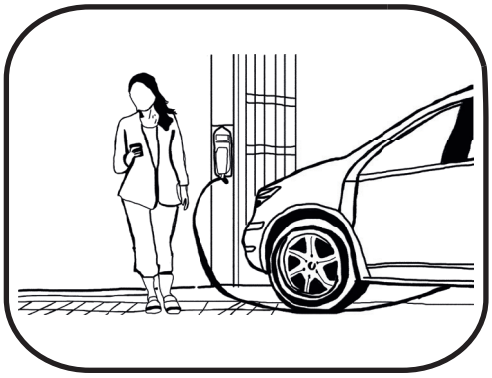
Arrival in Turin hours: 16:30 ~ 50%

context: After 203 km, the user returns to Turin and loads his car in the garage at home
service: integration of home and public charging

Storyboard
Torino - Macugnaga

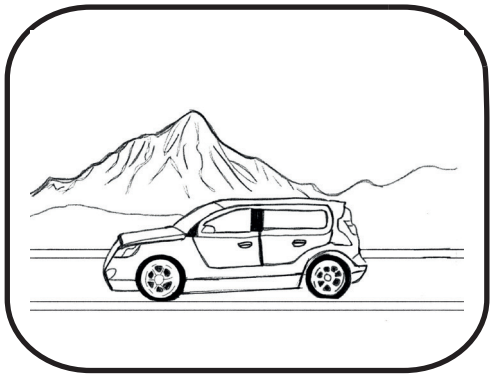
-4°C - 6°C

280 km (city-extraurban)
150 km (highway)



Turin time: 6:30 **100%**

context: Laura exits her apartment to retrieve her undercharged car
service: preheating, monitoring app
pain point: Tarnished glass, battery percentage not allowing you to get to your destination.

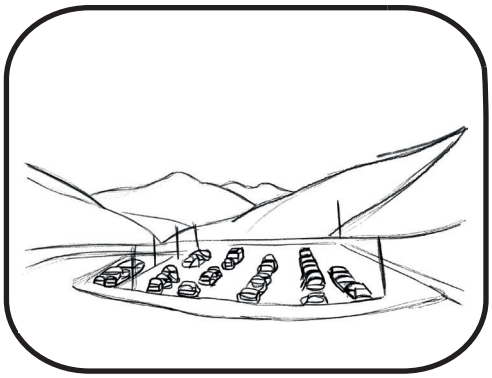


Arrival at the ski resort hours: 9:00 **~10%**

context: After a 200km drive, the car arrives at the macugnaga ski resort.
service: slot reservation, columns visible from a remote, surveillance cameras, tourist info
pain point: Busy station, inability to get to destination

Arrival at the plant at: 9:35 **~ 10%**

context: The column delivers 50kW and charges the car immediately. Meanwhile, the user rents skis and starts skiing.
service: Charge Monitoring, Rental
pain point: Interrupted charging or disconnection distant ski establishment



Issue with the charging hours: 13:00 **100%**

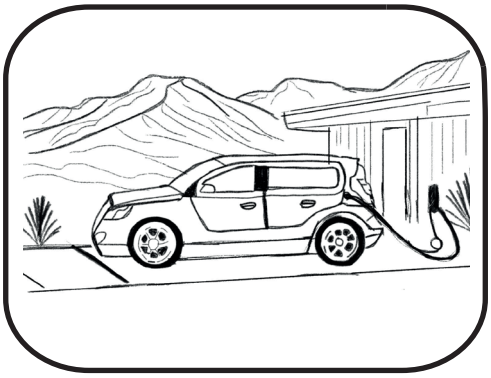
context: The car has run out of charge and Laura goes to move the car.
service: Valet, V2G, remote disconnect, remote move
pain point: leave the ski experience, car full of snow

-4°C - 6°C

280 km (city-extraurban)
150 km (highway)

Lunch and snow shoeing hours: 14:30 100%

context: Laura and her friends go to the facility's restaurant for lunch, and in the afternoon they take a snowshoe walk
service: Reservation service, lunch service, virtual tour guides
pain point: not knowing what to do in the afternoon pain point: car ricochet, car full of snow

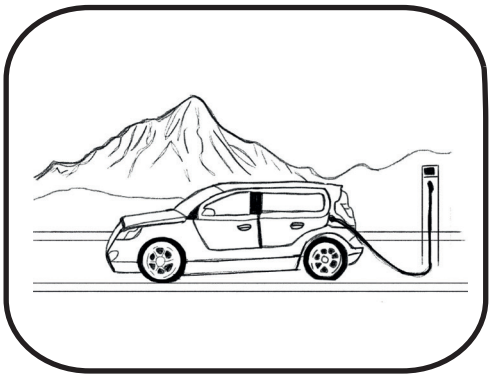


Arrival at the B&B hours: 17:00 ~ 90%

context: Laura and her friends arrive at the B&B in Macugnaga
service: Facility reservation and car parking, bike and water sports services, technical assistance
pain point: Check-in to be coordinated with outgoing user

Dinner hours: 20:00 100%

context: Laura attaches and detaches the column from the B&B, and goes to the facility for dinner. She spends the evening around the fire looking at the stars
service: place booked, app managment
pain point: risk of losing parking space

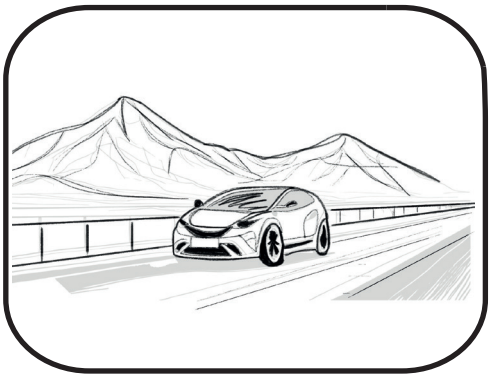


Morning hours: 8:00 ~ 90%

context: Laura charges the car at the plant and stands by to have 100% charge for the return to Turin in the afternoon
service: Internet connection, Heated lounge
pain point: Fast dead time, need to move the machine

-4°C - 6°C

280 km (city-extraurban)
150 km (highway)

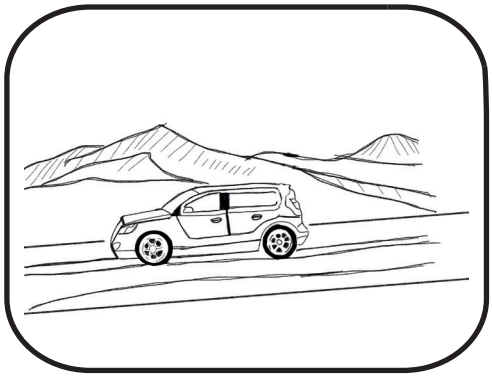


Return to the car hours: 13:00 **~ 100%**

context: Laura and her friends pack a lunch and head back to turin
service: Billing and recharge data
pain point: Difficulty getting out of the parking lot

Stop in Candelo hours: 15:00 **~ 40%**

context: Laura exits the highway and heads to the charming medieval village of Ricetto di Candelo. To load the car.
service: bike rental, tour guide, shopping center in the area
pain point: lack of activities to do



Disconnect and depart for Turin 16:30 **100%**

context: Once the activity is over, the car is loaded and Laura can safely return to Turin
service: Billing and service data, reviews of the place
pain point: Extra or unreported costs

Arrival in Turin at: 17:30 **~ 66%**

context: After the trip, Laura is happy to be able to look for parking in Turin for the electric car without the anxiety of recharging

1.1 Analysing User Journeys for Electric Vehicle Tourism Services

In this section, we delve into the user journeys of two personas, Laura and Andrea, to understand the challenges and opportunities associated with electric vehicle (EV) usage in the context of sustainable tourism. This analysis is pivotal for designing a service that addresses range anxiety and enhances the overall travel experience by integrating activities around charging stations.

Research Design and Approach

The research adopts a qualitative approach, employing personas and storyboards to visualize and analyze user journeys. This method allows for capturing the nuances of user experiences and identifying specific pain points and service opportunities.

Persona Development

Two key personas were identified:

- Laura Sergi A diesel car user keen on transitioning to an EV, representing environmentally conscious individuals constrained by economic factors in one of the first experience with an EV car.
- Andrea: A tech-savvy Tesla user who frequently embarks on long journeys, representing experienced EV users with insights into long-distance travel needs.

User Journey Mapping

The user journeys were mapped using storyboards that outline the key steps and interactions in the travel experiences of Laura and Andrea. Each storyboard highlights specific contexts, services, and pain points. These storyboards serve as a visual representation to better understand user behaviour and service needs.

1.2 Key Components of the Analysis

- Service Design: Focused on identifying and designing services that enhance the EV travel experience. This includes preheating options, charge monitoring apps, slot reservation systems, and integrated billing solutions.
- Pain Points: Detailed analysis of user pain points such as range anxiety, interrupted charging sessions, parking space availability, and the need for reliable charging infrastructure.
- Opportunities for Improvement: Identifying opportunities to improve the EV travel experience through better infrastructure, seamless integration of services, and enhanced user support.

Scenario Analysis

To provide a comprehensive analysis, I have considered two different car models and trips, each under varying temperature conditions to examine the impact on battery performance and range anxiety:

Impact of Temperature

Temperature significantly affects battery efficiency in electric vehicles, with cold temperatures reducing range due to increased energy consumption for heating. This factor was incorporated into our analysis to provide realistic scenarios:

- Laura’s Trip (Cold Weather): The journey from Torino to Macugnaga occurs during winter, with temperatures

ranging from -4°C to 6°C. Cold weather impacts battery performance, increasing range anxiety and necessitating more frequent charging stops.

-Andrea's Trip (Moderate Weather): The trip from Torino to Zoagli takes place in warmer weather, with temperatures ranging from 19°C to 29°C. These conditions are more favorable for battery performance, reducing range anxiety and allowing for longer travel distances between charges.

1.3 Charging Infrastructure Interaction

The interaction with charging infrastructure is a critical component of the EV user journey. This study examines how Laura and Andrea manage charging stops, including the services available at charging stations and the challenges faced:

- Laura's Interaction: Laura's budget-friendly EV has a limited range, requiring more frequent stops. She interacts with charging stations that offer services such as slot reservations, charge monitoring, and visible columns from remote locations. However, she faces challenges such as interrupted charging sessions, potential wait times at busy stations, and managing range anxiety exacerbated by cold temperatures.
- Andrea's Interaction: Andrea benefits from the extensive range of his Tesla and the availability of Superchargers, which are faster and more efficient. His interaction with charging stations is generally smoother, with fewer stops required. The Tesla's advanced features, such as navigation systems that optimize charging stops and provide real-time availability, significantly reduce range anxiety. However, Andrea still needs to ensure optimal battery levels and manage his travel time effectively.

Pre-Trip Planning and Preparation

Pre-trip planning is crucial for EV users to ensure a smooth journey. Both personas engage in detailed preparation to mitigate range anxiety and optimize their travel experience:

- Laura: Preheats her car and uses a monitoring app to ensure the battery is sufficiently charged before departure. She plans her route to include charging stations at regular intervals and makes reservations where possible to avoid wait times.
- Andre: Relies on the Tesla's advanced navigation system "Go anywhere planner", which plans charging stops efficiently based on real-time data.

En Route Charging Experiences

The charging experiences of Laura and Andrea vary significantly due to their different vehicle models and travel conditions:

- Laura: During her journey, Laura frequently stops at charging stations. She faces range anxiety, especially in cold weather, and must manage interrupted charging sessions and potential delays. The services at charging stations, such as slot reservations and visible columns, help alleviate some stress, but the overall experience is still challenging.

- Andrea: Andrea's Tesla, with its longer range and access to Superchargers, provides a more relaxed travel experience. He stops less frequently and benefits from faster charging times. The Tesla's navigation system guides him to the nearest available Supercharger, reducing the need for manual planning and significantly easing range anxiety.

Destination and Activity Integration

Integrating EV charging with tourist activities enhances the travel experience by making efficient use of waiting times during charging sessions:

- Laura: At the ski resort in Macugnaga, Laura faces challenges with interrupted charging sessions and potential issues with parking space availability. The resort offers services such as facility reservations and car parking, but the cold weather and busy station conditions can still pose problems.
- Andrea: At Zoagli, Andrea enjoys seamless integration of EV services with tourist activities. The town provides dedicated parking spaces for EVs, bike and water sports services, and technical assistance. These integrated services significantly reduce range anxiety and enhance the overall travel experience.

Return Trip Considerations

The return journey also poses unique challenges, particularly in ensuring the car is sufficiently charged for the trip back:

- Laura: Faces challenges related to ensuring the car is adequately charged, especially under cold conditions. She plans her return route carefully, considering charging station availability and potential delays.
- Andrea: Benefits from Tesla's extensive charging network, allowing for a stress-free return journey with minimal range anxiety. He utilizes the Tesla navigation system to plan his route and ensure optimal battery levels throughout the trip.

The chapter outlines a systematic approach to analyzing user journeys for EV tourism services. By focusing on detailed personas and user journeys, the research provides valuable insights into the challenges and opportunities of promoting sustainable tourism through enhanced EV services.

This approach not only addresses the immediate needs of EV users but also contributes to the broader goal of sustainable tourism by reducing carbon footprints and promoting eco-friendly travel options. By addressing range anxiety and optimizing interactions with charging infrastructure, the study aims to enhance the overall travel experience and encourage greater adoption of electric vehicles in tourism.

This comprehensive analysis highlights the importance of considering various factors such as temperature, vehicle model, and charging infrastructure in designing services for EV users. The findings provide a foundation for developing robust, user-centered solutions that facilitate sustainable tourism and support the transition to electric mobility.

Territory

ANALYSIS

Chapter 12: Territorial Analysis for Sustainable Electric Vehicle Tourism

This chapter aims to provide a detailed territorial analysis for the development of sustainable electric vehicle (EV) tourism services, focusing specifically on the journey of Laura from Torino to Macugnaga. The choice of Macugnaga is motivated by its high potential for sustainable tourism despite the current lack of adequate charging infrastructure. Additionally, the analysis will compare Macugnaga with Santa Maria Maggiore, a more advanced territory in terms of EV services within the same province of Verbano-Cusio-Ossola (VCO). This chapter will also explore the cultural, adventurous, and culinary offerings of the region to emphasize the holistic value of integrating sustainable mobility with tourism.

1.1 Rationale for Choosing Verbano-Cusio-Ossola (VCO)

The National Strategy for Inner Areas (SNAI) is an Italian government initiative aimed at promoting sustainable development and improving the quality of life in Italy's remote and marginal areas. Launched in 2012, SNAI seeks to address the economic, social, and demographic challenges faced by these regions by implementing integrated policies and projects. The strategy focuses on enhancing public services, promoting economic diversification, and fostering social inclusion to reverse the decline in population and stimulate local economies.

This section provides an explanation of the SNAI initiative, particularly its relevance and application to the Province of Verbano-Cusio-Ossola (VCO). This region, where the project under study is situated, serves as a prime example of an inner area that can benefit from the SNAI's strategic interventions. By exploring the principles and objectives of SNAI, this section aims to contextualize the project's goals within broader national policies and highlight the potential synergies between local and national efforts to promote sustainable tourism and electric mobility.

1.2 National strategy SNAI Objectives and Principles

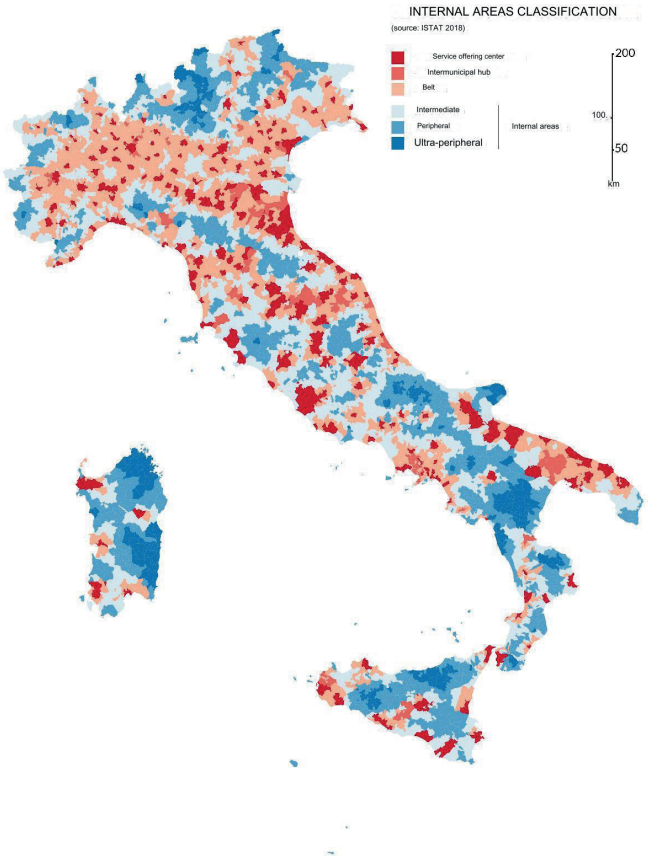
The primary objective of SNAI is to tackle the multifaceted challenges faced by inner areas, which include depopulation, economic stagnation, and limited access to essential services such as healthcare, education, and transportation. SNAI operates on several key principles:

1. Integrated Approach: SNAI promotes a comprehensive approach to development, combining economic, social, and environmental dimensions to create sustainable growth models.
2. Participatory Planning: The strategy emphasizes the involvement of local

communities in planning and decision-making processes, ensuring that interventions are tailored to the specific needs and potentials of each area.

3. Multilevel Governance: SNAI advocates for collaboration between different levels of government—national, regional, and local—to ensure coherent and effective implementation of policies.

4.Innovation and Diversification: The strategy encourages innovative solutions and economic diversification to build resilient local economies and reduce dependency on traditional sectors.



Strategic Areas and Interventions

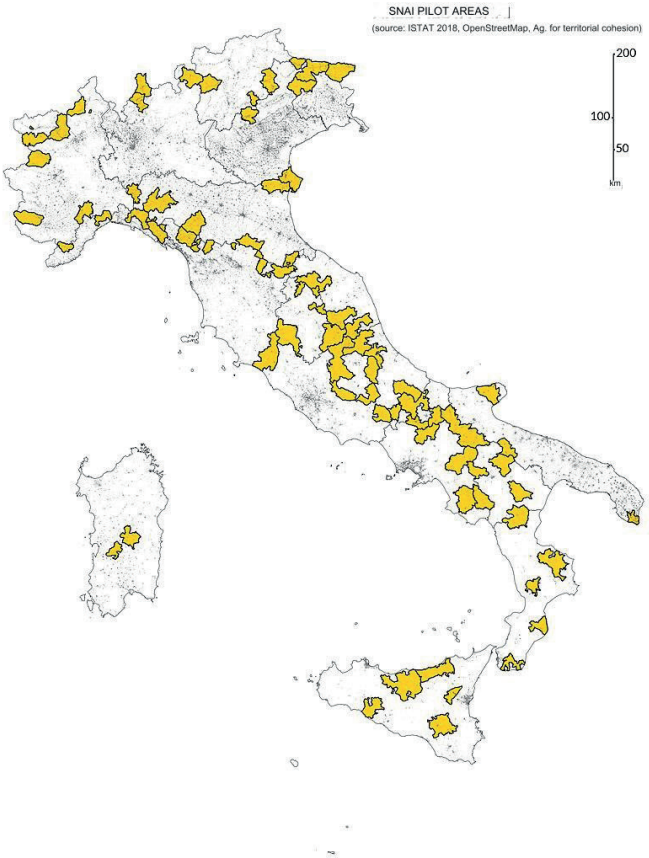
SNAI targets several strategic areas to achieve its objectives:

1. Service Provision: Improving access to healthcare, education, and social services to enhance the quality of life and retain populations in inner areas.

2. Economic Development: Supporting local businesses, promoting entrepreneurship, and fostering new economic activities, including tourism and sustainable agriculture.

3. Infrastructure and Connectivity: Upgrading physical and digital infrastructure to enhance connectivity and reduce isolation.

4. Environmental Sustainability: Promoting the sustainable use of natural resources and protecting the environment to ensure long-term ecological balance.



Relevance to the Province of Verbano-Cusio-Ossola

The Province of Verbano-Cusio-Ossola (VCO) is characterized by its mountainous terrain, rich natural resources, and significant tourism potential. However, like many inner areas, it faces challenges such as population decline, limited infrastructure, and economic vulnerability. The application of SNAI principles in VCO can address these issues by leveraging the region's strengths and addressing its weaknesses.

Demographic and Economic Context

VCO has experienced a gradual decline in population, particularly in its more remote areas, leading to a shrinking labor force and reduced economic activity. The region's economy has traditionally relied on tourism, agriculture, and small-scale manufacturing, sectors that have faced significant challenges in recent years. By promoting economic diversification and enhancing service provision, SNAI can help stabilize the population and stimulate economic growth in VCO.

Strategic Interventions in VCO

The implementation of SNAI in VCO involves several strategic interventions:

1. Enhancing Tourism Infrastructure: Developing sustainable tourism infrastructure, including electric vehicle (EV) charging stations, to attract environmentally conscious tourists and extend the tourist season.
2. Improving Connectivity: Upgrading transportation networks and digital infrastructure to improve accessibility and support economic activities.
3. Promoting Sustainable Practices: Encouraging the adoption of sustainable practices in tourism, agriculture, and other sectors to protect the region's natural environment and promote long-term resilience.
4. Fostering Community Engagement: Involving local communities in planning and decision-making processes to ensure that interventions meet local needs and harness local knowledge and resources.

Rationale for SNAI in VCO

The rationale behind implementing SNAI in VCO lies in the strategy's potential to create a multiplier effect by addressing multiple challenges simultaneously. By improving public services, enhancing infrastructure, and promoting sustainable economic activities, SNAI can foster a virtuous cycle of development that benefits both local communities and the broader region.

Enhancing Economic Resilience

Economic diversification and innovation are critical to building resilience in VCO's economy. By supporting new sectors such as sustainable tourism and renewable energy, SNAI can reduce the region's dependence on traditional industries and create new opportunities

industries and create new opportunities for growth and employment.

Addressing Environmental Challenges

VCO's natural environment is both a valuable asset and a vulnerable resource. SNAI's focus on environmental sustainability can help protect the region's ecosystems while leveraging them for sustainable economic activities. For example, promoting EV tourism not only reduces carbon emissions but also enhances the region's appeal to eco-conscious travelers.

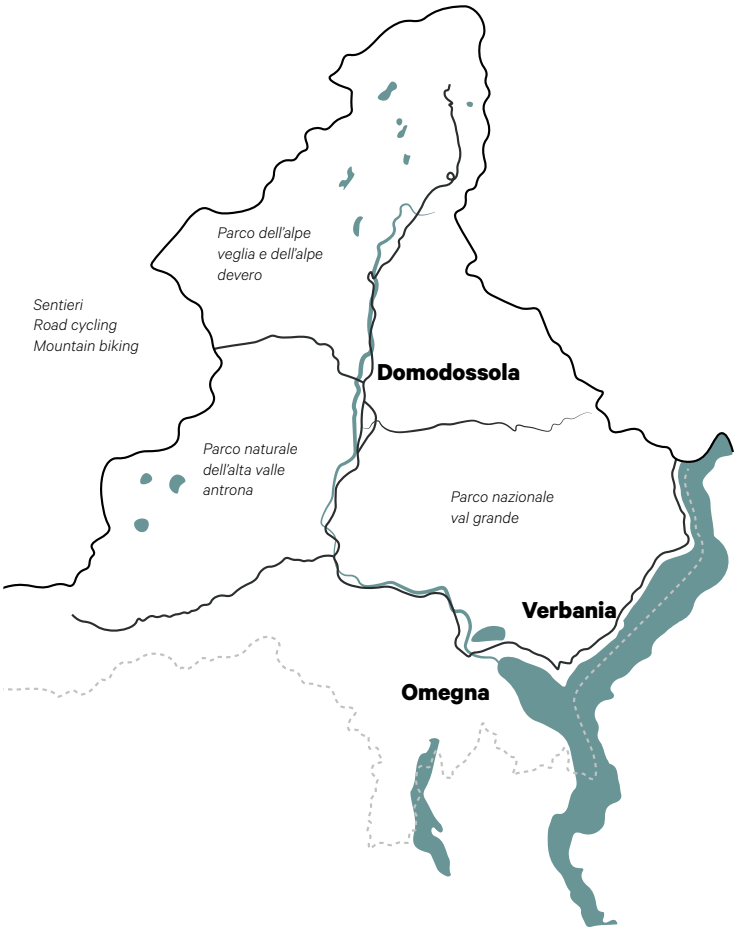
Social Inclusion and Quality of Life

Improving access to essential services is crucial for retaining and attracting residents in VCO. By enhancing healthcare, education, and social services, SNAI can improve the quality of life for local communities, making the region more attractive for living and working.

The second rationale for focusing on VCO and Macugnaga is the MOBSTER (Mobility and Sustainable Tourism in Cross-Border Regions) project. This initiative is a collaborative effort between the provinces of South Tyrol, Verbano-Cusio-Ossola, and Canton of Ticino, aimed at advancing electric mobility and sustainable tourism.

1.3 MOBSTER Project: Promoting Sustainable Mobility and Tourism

The MOBSTER (Mobility Strategy for Alpine Region) project is a collaborative effort involving stakeholders from South



Tyrol, Verbano-Cusio-Ossola (VCO), and Canton Ticino. It aims to enhance electric mobility and sustainable tourism in the Alpine border areas of Italy and Switzerland. By leveraging existing e-mobility tools and strategies, the project seeks to mitigate environmental impacts associated with traditional transportation methods while enhancing tourism infrastructure and visitor experiences.

Methodologies and Approaches The MOBSTER project employs a multifaceted approach to achieve its objectives:

-Comprehensive Assessment:
A thorough assessment of the current state of electric mobility across the participating regions. This includes analyzing existing infrastructure, policies, and initiatives related to electric vehicles (EVs) and sustainable transportation within the tourism sector.

-Best Practices Identification:
Identification and documentation of 26 best practices in electric mobility and sustainable tourism. These practices encompass successful case studies and strategies from South Tyrol, Canton Ticino, and VCO, serving as valuable insights for implementing similar projects in other Alpine regions.

-Knowledge Sharing and Collaboration:
Facilitation of knowledge sharing and collaboration among project partners and stakeholders. This involves workshops, forums, and exchanges aimed at sharing experiences, challenges, and innovations to foster a unified approach towards promoting electric mobility.

-Technological Innovations:
Implementation of innovative technologies tailored to the unique environmental and geographic characteristics of the Alpine region. Examples include solar-powered charging stations, electric boats for eco-tours in nature reserves, and mobile apps to facilitate seamless EV charging experiences for tourists.

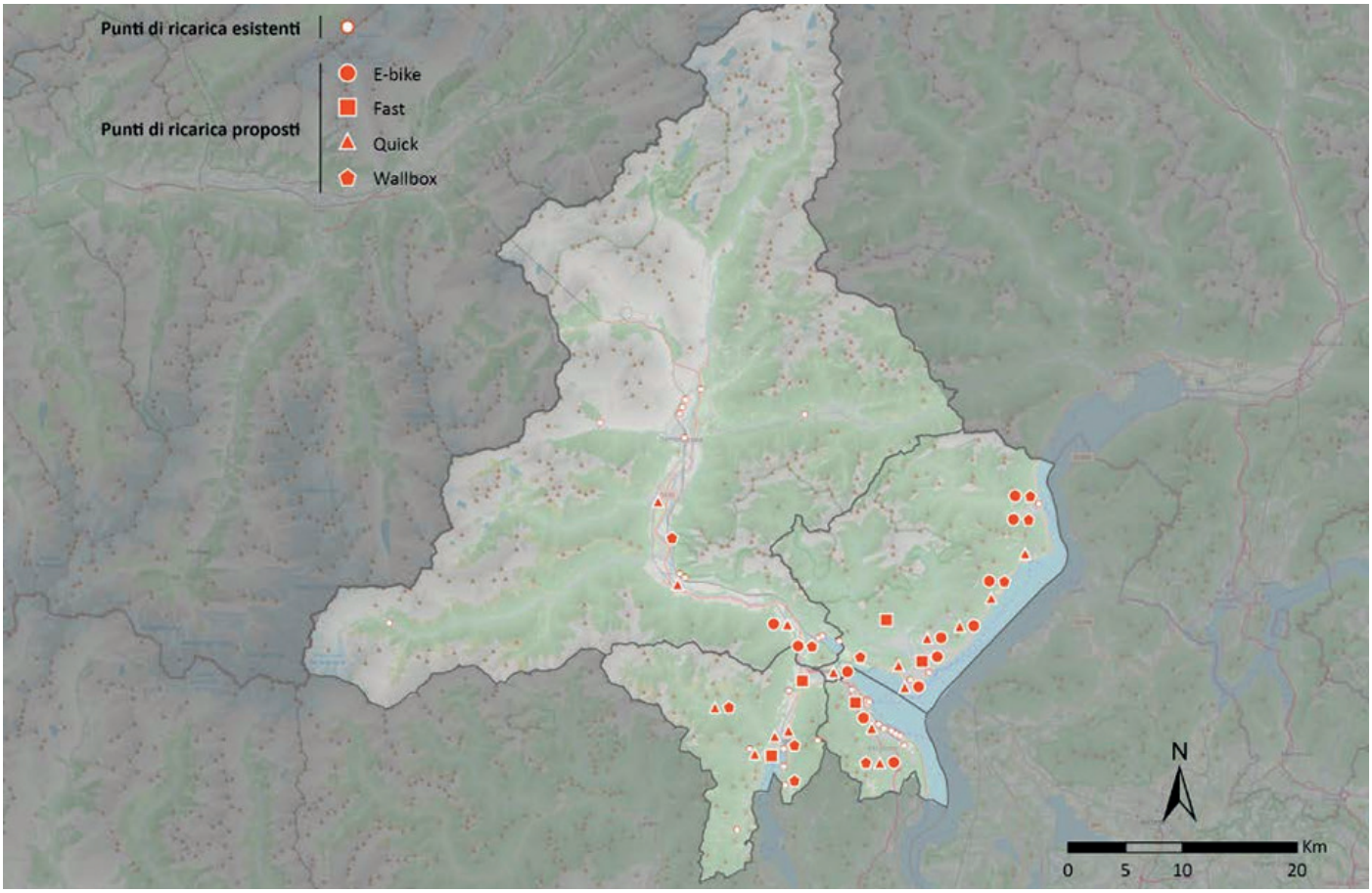
-Policy Development:
Formulation of policy recommendations and guidelines to support the adoption of electric vehicles and sustainable tourism practices at regional and national levels. These recommendations aim to create an enabling environment for stakeholders, policymakers, and businesses to invest in and promote electric mobility.

Research by Eurac and Stakeholder Engagement

Eurac Research, a key partner in the MOBSTER project, conducted extensive research on tourists' mobility preferences and awareness of sustainable transportation options in the Alpine region, focusing on Alto Adige, Verbano-Cusio-Ossola, and Canton Ticino.

Methodology

The research employed an online questionnaire distributed via various communication channels, including the project website, social media platforms,



Project partner

eurac research

Protoscar

NEOGY

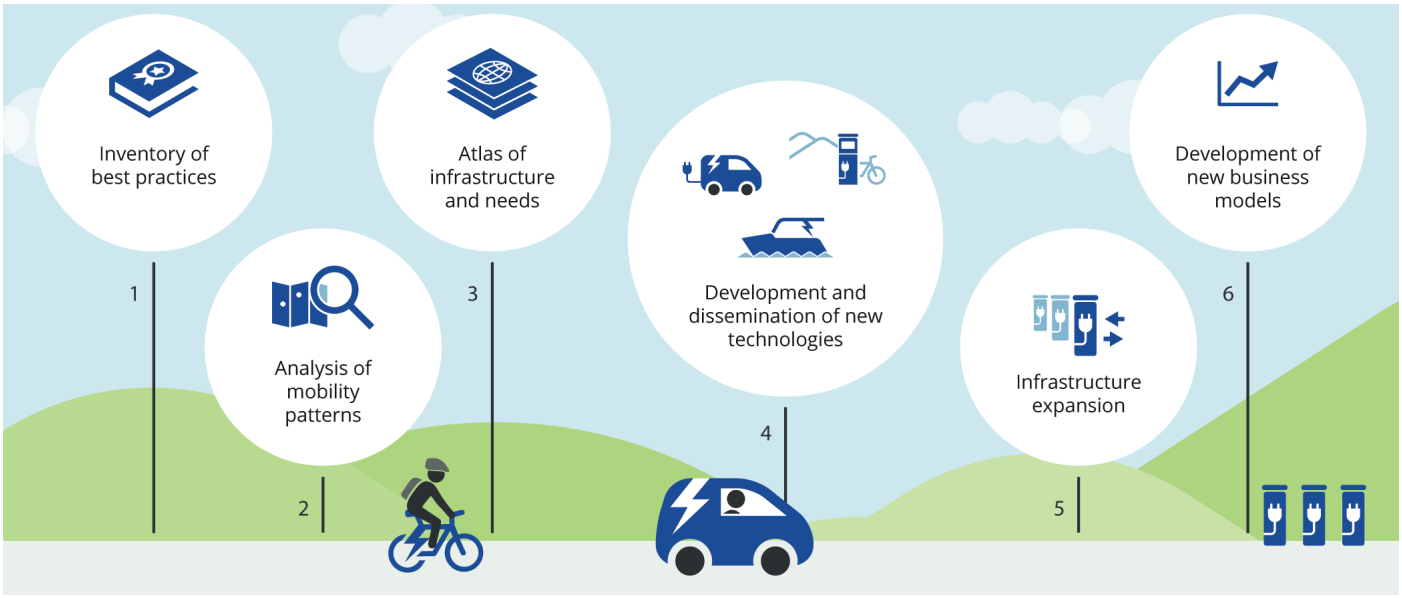
vcotrasporti

Città di Verbania

Interreg

Italia - Svizzera | Italie - Suisse | Italien - Schweiz

Cofinanziato dall'Unione Europea



and newsletters. Data were collected from 542 respondents, with 348 providing complete responses. Respondents were queried about their transportation preferences during vacations, awareness of sustainable transportation services, and preferences for infrastructure placement. Data analysis was carried out using statistical software.

Results

The findings indicate that the majority of respondents rely on private cars as their primary mode of transportation during vacations, followed by walking. While awareness of electric vehicle rental services remains low, respondents demonstrate greater familiarity with electric bicycle rental options. Additionally, respondents emphasize the importance of visible charging infrastructure for electric vehicles, favoring placement in public areas and along main roads. The study also reveals a growing interest in electric vehicles among tourists, with a significant proportion expressing intentions to purchase such vehicles in the future.

The research highlights the significance of promoting sustainable transportation options among tourists visiting the Alpine region. Efforts to enhance infrastructure for electric vehicles and bicycles, coupled with increased awareness of available services, can contribute to reducing reliance on private cars and mitigating environmental impact. Understanding tourists' preferences for infrastructure placement can inform strategies to improve the overall visitor experience and promote sustainable tourism practices.

Interviews with Stakeholders

Eurac has conducted also six interviews with various stakeholders, including the Consortium of Accommodation Facilities along Lake Maggiore, the Local Tourist Agency, the Public Line Service for navigation on Lake Orta, several accommodation facilities, a tourist and cycling guide, and the local section of the hoteliers' association.

In the VCO area, infrastructure for electric vehicle charging is predominantly found within private accommodation facilities. There is significant appreciation for e-bike charging stations, especially considering the Nordic origin of many tourists, who have a strong cycling culture.

In addition to charging facilities, the region offers other services for e-bikes, including rental services and promotion of dedicated cycling routes, as well as regular maintenance services provided by affiliated mechanics. The introduction of electric boats and electric mini-car rentals to explore the region is seen as potentially increasing tourist flows. Respondents also proposed vacation packages that include itineraries for exploring the region, incorporating fast charging facilities for electric vehicles.

Furthermore, there is a call for increased dissemination of e-bike charging points, both through sensitization of private accommodation providers and the expansion of public infrastructure in strategic locations, such as along cycling routes.

Another suggested service alongside charging facilities is the provision of secure storage for personal belongings while bikes are being charged. Improvements and expansions to cycling paths and their promotion alongside charging points are also recommended. Finally, there's a need for improved intermodality to make less-known areas of the region, such as mountainous areas, more accessible.

The Current Situation of Electric Mobility in the VCO Region

The current state of electric mobility in the Province of Verbano-Cusio-Ossola (VCO) presents a mix of challenges and opportunities that require comprehensive analysis. A significant issue is the lack of a unified strategic vision and effective collaboration among the various stakeholders involved in promoting electric mobility. This disjointed approach has led to issues such as stakeholders being unaware of existing electric charging stations, highlighting communication gaps within the region.

Additionally, the VCO region faces infrastructure and service deficiencies related to electric mobility. Key issues include a lack of continuous cycle paths and a low density of charging stations, which hinder the widespread adoption of electric vehicles. For instance, the insufficient connectivity of cycling routes of varying difficulty levels limits the creation of a diverse cycling tourism offering that caters to both experienced cyclists and families.

The limited uptake of electric vehicles in the region can be attributed to the high costs associated with them, as well as the prioritization of investments in enhancing road infrastructure over electric mobility initiatives. The absence of incentives and a notable political commitment further contribute to the slow adoption of electric vehicles in the area.

Opportunities and Strategies for Improvement

Despite these challenges, there are opportunities to improve the electric mobility landscape in the VCO province. Strategies such as establishing family-friendly cycling routes, introducing electric car-sharing services, and fostering collaboration between public and private stakeholders can advance electric mobility in the region.

To effectively address the challenges and capitalize on the opportunities present, it is essential to develop an integrated strategic vision for e-mobility in the VCO region. This requires ongoing dialogues and active participation from all stakeholders to ensure a holistic and coordinated approach to promoting electric mobility within the province.

Proposed Strategies and Initiatives

In the VCO region, a series of interviews with key stakeholders, including the Consortium of accommodation facilities and the Local Tourist Agency, revealed that while the electric charging infrastructure is primarily private, there is notable interest in charging stations for e-bikes, particularly among Nordic tourists. This presents an opportunity to enhance the promotion of e-bikes

in the region, aligning with the preferences of the tourist demographic. One proposed strategy is to install multiple charging points for e-bikes, coupled with additional services such as rental services and the promotion of cycling routes. This would not only enhance the experience for electric cyclists but also attract a broader clientele interested in cycle tourism. Moreover, offering maintenance services through affiliated mechanics can further enhance the overall cyclist experience, ensuring a seamless and enjoyable visit.

In addition to e-bikes, the introduction of electric boats and the rental of minicars are suggested as services that could generate interest and boost tourist traffic in the area.

To improve accessibility in mountain areas and enhance the overall tourist experience, several strategies are proposed, including the enhancement of intermodal transportation and the strengthening of cycling infrastructure. By developing an integrated network of public transport and cycling facilities, access to less explored areas can be facilitated, thereby promoting sustainable tourism practices.

Interventions by Public Administration

Key interventions identified by public authorities include increasing territorial marketing efforts, expanding the network of charging infrastructures, and enhancing connectivity across the region. These steps are vital for driving the adoption of electric mobility and making the area more accessible for tourists, which in turn contributes to a more sustainable and enjoyable tourism experience.

To maximize the impact of electric mobility on tourism, it is essential to create an integrated strategy that engages all relevant stakeholders. This includes government agencies, tourism boards, transportation companies, and operators of charging stations. Regular discussions and collaborative efforts among these stakeholders are necessary to ensure the effective implementation and maintenance of the required infrastructure.

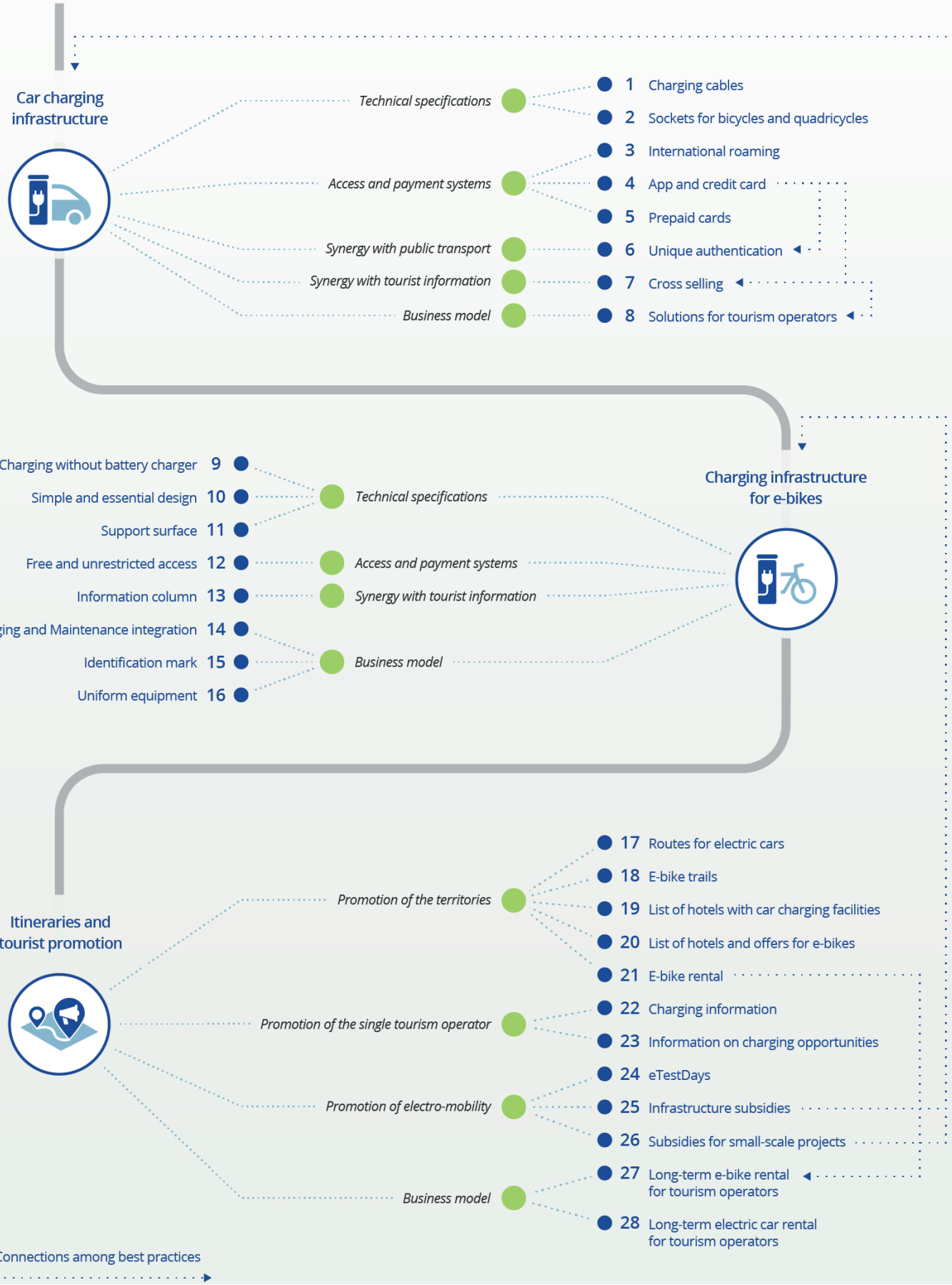
A critical component of sustainable mobility strategies is the ongoing monitoring and evaluation of their effectiveness. This involves tracking the usage of charging stations, collecting feedback from tourists, and making any necessary adjustments to enhance the overall experience. By continuously refining these strategies, destinations can better meet the needs of tourists who opt for electric vehicles as their mode of transportation.

Best Practices and Current Situation of Electric Charging Stations in VCO

The Province of Verbano-Cusio-Ossola (VCO) has undertaken various policies and initiatives to promote electro-mobility, derived from both national and regional levels. The Piedmont Region, for instance, provides incentives such as car tax exemptions for hybrid vehicles and financial contributions for scrapping or converting commercial vehicles. Notably, in 2020, the region introduced its first electric boat for use on Lake Maggiore.

Electro-mobility in Canton of Ticino, South Tyrol and Verbano-Cusio-Ossola

The 28 best practices

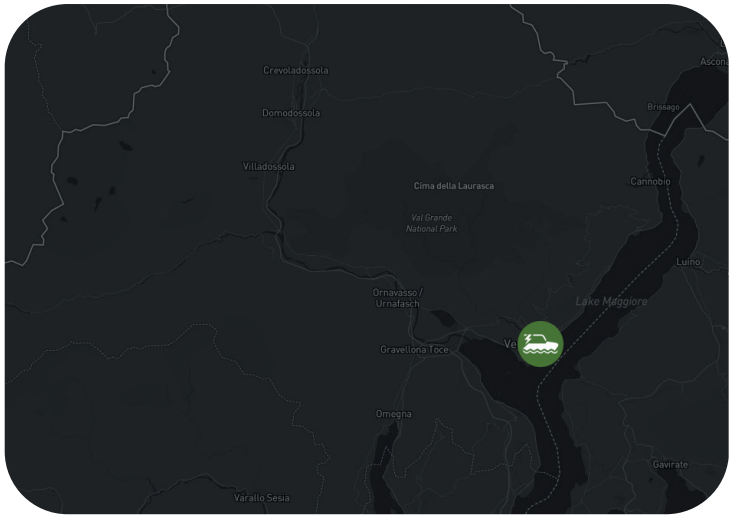


Regarding public charging infrastructure, VCO currently operates a single charging station in collaboration with VCO Trasporti, located in Intra, with plans for further expansion.
This initiative is supported through partnerships with Enel X Mobility, aiming to install additional electric charging stations at various points of tourist interest within the municipal area.
For e-bike charging, VCO has several charging points available, including those provided by a local company, ETraction. These charging stations offer free accessibility and the ability to charge multiple bicycles simultaneously, enhancing convenience for cyclists exploring the region.
Several hotels in VCO have also installed charging stations, including those offering Tesla's Destination Charging. Pricing policies for recharging vary among facilities, with some offering free services while others require payment.
Although VCO lacks dedicated e-bike itineraries, bicycle trails are featured on the official tourist website, demonstrating a commitment to promoting cycling tourism. Additionally, a linked website focuses exclusively on bicycle tourism in the region.
While VCO is in the early stages of developing its electro-mobility infrastructure, initiatives are underway to expand charging infrastructure and promote sustainable transportation options. These efforts align with broader regional and national strategies to encourage the adoption of electric vehicles and enhance the tourist experience in the area.

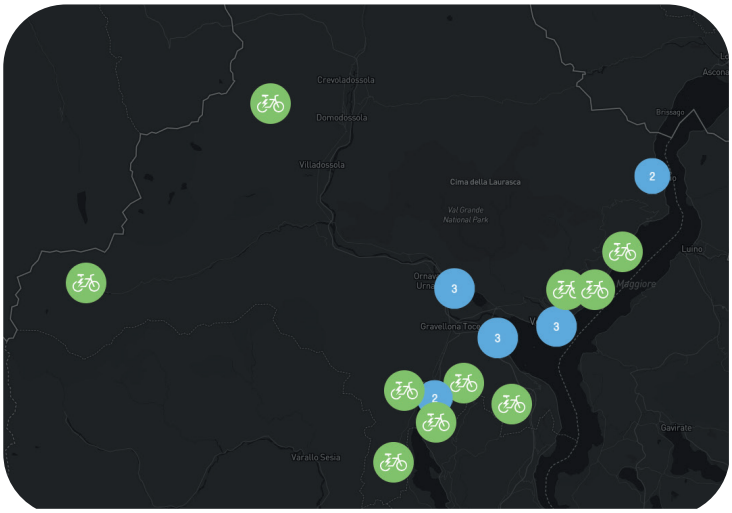
Electric Vehicle Sector in VCO

The electric vehicle sector in the Province of Verbano-Cusio-Ossola (VCO) is steadily growing, akin to the developments in Canton Ticino, although it has not yet reached the same level of advancement as its Swiss counterpart. According to the 2019 data from the Automobile Club d'Italia (ACI), the province had 24 electric cars and 722 hybrid cars (both petrol and diesel engines), marking a 60% increase from previous years. Despite this encouraging growth, the numbers are still significantly lower compared to traditional cars, both in absolute and relative terms. The Piedmont Region has made notable efforts to incentivize the purchase of electric and hybrid vehicles, offering incentives ranging from €2,500 to €10,000 based on emission levels.
In terms of charging infrastructure, there are currently around 30 public charging stations in the province, mostly managed by Enel X, the leading Italian operator in this sector. While this number is not particularly high, regional authorities are planning to expand the network by installing more charging points. Similar to Canton Ticino, the e-bike market in VCO is also on the rise. Due to the lack of specific provincial data, national statistics indicate a significant increase in e-bike sales, now accounting for 10% of the market share.
Efforts to improve the e-bike charging infrastructure have been undertaken by local authorities.

Currently, 11 charging points installed by the Piedmontese company Etraction are strategically located at squares, ferry terminals on the lakes, tourist offices, restaurants, and hotels. These initiatives align with the broader goal of promoting sustainable mobility and enhancing the tourist experience in the region.

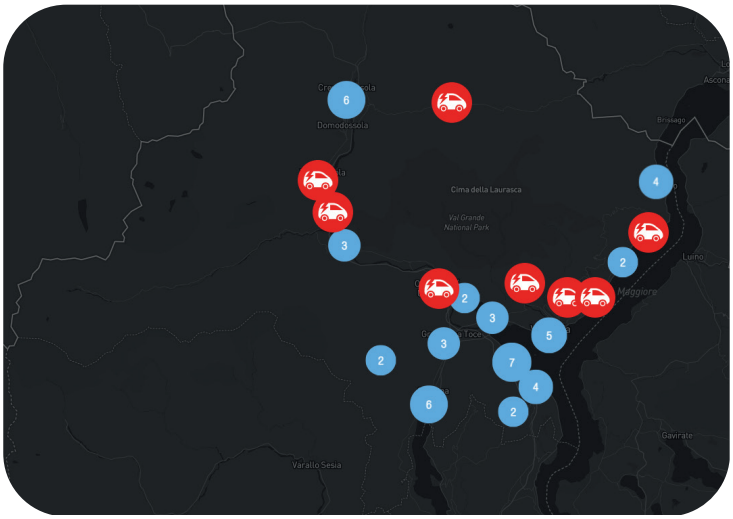


The Province of Verbano-Cusio-Ossola, along with neighboring areas, forms the Tourist District of the Lakes, attracting over three million visitors annually, making it the most significant international tourist destination in Piedmont. The hospitality sector, with 708 accommodation facilities, is crucial to the local economy. The increase in electric vehicle use among tourists has prompted these establishments to offer charging facilities and, for e-bikes, maintenance services.



Regional Legislation and Commitment to Sustainable Mobility

Regional legislation underscores the commitment to sustainable mobility. The Regional Mobility and Transport Plan focuses on reducing environmental risks and promoting energy-efficient choices throughout the lifecycle of vehicles and infrastructure. By encouraging low-impact and multimodal mobility models, the region aims to boost tourism competitiveness, improve livability, and enhance citizen well-being.



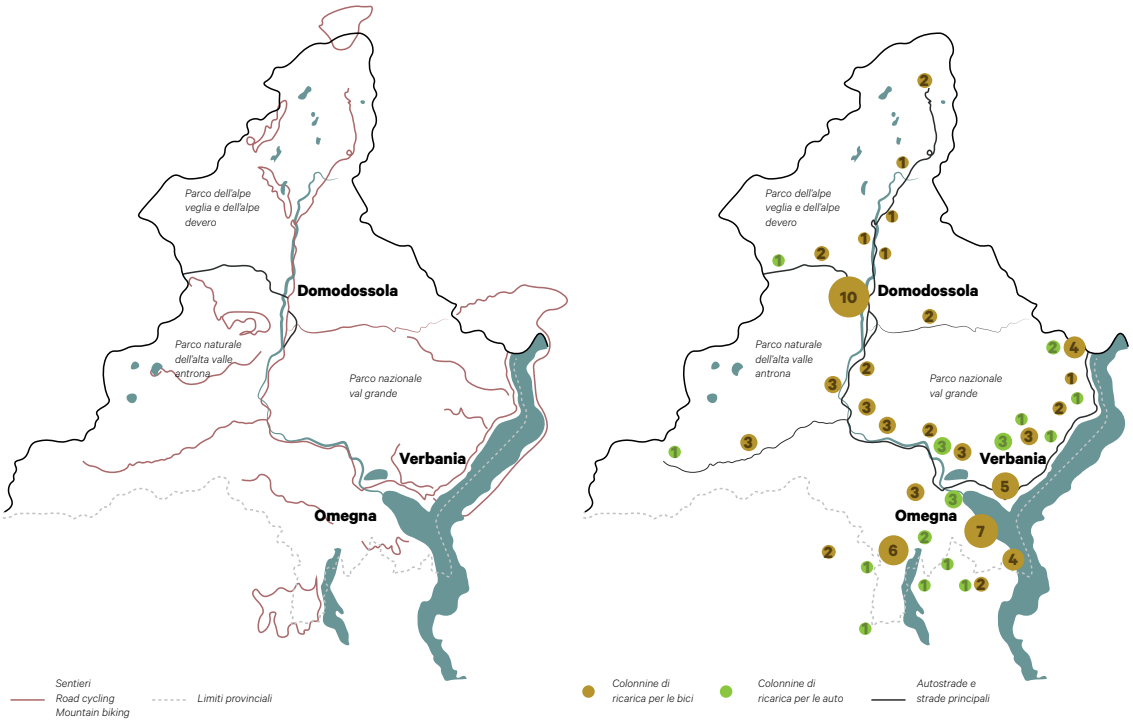
Challenges and Recommendations

infrastructure across the province. Spatial analysis reveals gaps in coverage, indicating the need for further expansion to ensure comprehensive accessibility. Similar challenges are noted in the provision of e-bike charging stations.

To effectively address the existing gaps in charging infrastructure across the Province of Verbano-Cusio-Ossola (VCO), collaborative initiatives between public and private stakeholders, coupled with targeted investments, are essential. These efforts are crucial not only for achieving sustainable mobility goals but also for maintaining the province's attractiveness as a destination for tourists seeking environmentally friendly transportation options.

As part of ongoing efforts, bilateral meetings with project partners have yielded valuable insights and suggestions for a sustainable charging infrastructure development strategy. For the pilot areas of Verbano-Cusio-Ossola and Alto Adige, where new charging station installations are planned, strategic locations have been identified based on comprehensive analyses of charging infrastructure needs. While specific locations are depicted in the project documentation, slight adjustments may occur post-report publication. Moreover, innovative off-grid charging columns for e-bikes are slated for installation at mountain huts and refuges in Alto Adige, with final locations currently under review.

In the Canton of Ticino, identifying suitable areas for electric car charging points has been deemed realistic.



However, discussions regarding the placement of charging points for electric bicycles have highlighted concerns, particularly regarding cycle route integration. The analysis has been refined to focus exclusively on official cycle routes listed by the Switzerland Mobile platform and municipal roads.

However, discussions regarding the placement of charging points for electric bicycles have highlighted concerns, particularly regarding cycle route integration. The analysis has been refined to focus exclusively on official cycle routes listed by the Switzerland Mobile platform and municipal roads.

in Verbano-Cusio-Ossola, the strategy for locating charging stations has deliberately excluded areas already served by existing operators like EnelX and Etraction. The overarching aim is to expand charging infrastructure coverage across the entire territory, prioritizing areas currently lacking adequate facilities.

Conclusion

The MOBSTER project represents a significant opportunity to enhance electric mobility and sustainable tourism in the Alpine region, including Verbano-Cusio-Ossola. By leveraging research insights, stakeholder collaboration, and innovative approaches, the project aims to create a blueprint for sustainable transport solutions that benefit both local communities and visitors. The recommendations for VCO underscore the importance of strategic planning, infrastructure investment, and stakeholder engagement in realizing the region's potential as a sustainable tourism destination.

1.4 Local Knowledge and Personal Connection

Being a native of the Verbano-Cusio-Ossola (VCO) region provides an invaluable advantage in understanding its intricacies and nuances. This deep-rooted familiarity extends beyond mere geographical knowledge to encompass cultural, social, and environmental aspects that significantly influence the region's dynamics.
Geographical Insights: Understanding the mountainous terrain, climate variations, and unique natural attractions of VCO is crucial. These factors influence decisions on where to deploy electric vehicle charging infrastructure and how to design sustainable tourist activities that integrate electric mobility seamlessly.
Cultural Sensitivities: Knowledge of local culture, traditions, and community values is essential. It ensures that sustainable tourism initiatives respect and align with the ethos of the residents, fostering acceptance and engagement within the community.
Environmental Awareness: Awareness of specific environmental challenges, such as biodiversity preservation and reducing carbon footprints, guides the selection of eco-friendly solutions in electric mobility and tourism development.

Personal Connection

Beyond academic interest, my personal connection to the VCO region adds authenticity and commitment to my thesis work. This personal stake underscores my dedication to making a tangible impact through sustainable tourism practices.

Emotional Investment: Growing up or living in VCO fosters a deep emotional connection to its well-being and future sustainability. This emotional investment motivates me to propose solutions that resonate on a personal level and contribute to the region's long-term prosperity.

Stakeholder Engagement: Personal connections with local stakeholders, including community leaders, businesses, and environmental organizations, facilitate collaboration and garner support for sustainable tourism initiatives. These relationships are built on trust and mutual understanding, crucial for implementing effective strategies.

Advocacy Role: As a local resident, I naturally assume an advocacy role for sustainable development in VCO. This role involves raising awareness, influencing policies, and inspiring others to embrace eco-friendly practices, thereby catalyzing broader societal change.

Three Reasons for Choosing Macugnaga
Strategic Location within VCO: Macugnaga's position within the VCO region makes it a strategic focal point for sustainable tourism development. Its natural beauty and accessibility attract tourists, while its current infrastructure gaps present opportunities for innovative solutions in electric mobility.
Alignment with Project MOBSTER Goals: Analyzing Macugnaga aligns with the objectives of Project MOBSTER, which promotes sustainable tourism and electric mobility across regions like South Tyrol, VCO, and Canton of Ticino. This alignment enhances the scalability and impact of my thesis project.

Integration with SNAI Italy Initiatives: Macugnaga's development aligns with SNAI Italy's strategic focus on enhancing internal areas through sustainable tourism initiatives. By focusing on Macugnaga, I contribute to national efforts while addressing local challenges and leveraging existing frameworks for development.

Final Remarks

The integration of local knowledge and personal connections with academic research enhances the credibility and effectiveness of sustainable tourism strategies in the VCO region. The MOBSTER project's findings and recommendations, supported by my in-depth understanding of the area and its unique challenges, validate the choice of this territory for implementing electric mobility services. This comprehensive approach not only benefits the local community but also sets a precedent for sustainable tourism practices in similar regions worldwide.

Chapter 13: Analysis of Electric Mobility Infrastructure Needs in Verbano-Cusio-Ossola Tourism

The Mobster project conducted an in-depth analysis of infrastructure needs for electric mobility within the tourism sector across three pilot areas, including Verbano-Cusio-Ossola (VCO). This analysis aimed to identify suitable locations for installing charging infrastructures to enhance network coverage within these territories.

Methodology and Approach
The analysis began by dividing the territory into hexagonal cells of 250,000 m^2 each, known as tessellation, to provide a standardized unit for comparison across different datasets. This methodological choice minimized errors associated with spatial distribution representation, leveraging the hexagon's geometric properties close to that of a circle.

The grid created was then filtered through a two-step process. First, cells intersected by the transport network (roads or cycle paths) were selected, and secondly, cells within a specific distance from existing charging points were excluded. A buffer of 5 km was applied for electric car charging stations and 2 km for e-bike columns to exclude already infrastructured areas.
Points of Interest (POIs) Analysis
The analysis incorporated the concept of Points of Interest (POIs), which are locations that generate attraction among tourists and residents alike. POIs were categorized into three types based on their function: accommodation facilities, historical-cultural sites, and refuges/mountain huts. Each category received a weighted score based on an evaluation questionnaire filled out by project partners, reflecting their importance in determining optimal charging infrastructure locations.
The geographical information from POIs was mapped onto the grid through spatial join operations, enabling the density of various POIs to be visualized across the territory. A weighted sum was then performed using map algebra to pinpoint areas most suitable for new charging infrastructure installations, after converting vector data to raster format for technical processing.
Findings and Recommendations
In Verbano-Cusio-Ossola, the analysis revealed disparities in the current distribution of charging stations, with uneven coverage throughout the province. Many areas, both central and marginal, were identified as lacking adequate infrastructure despite the presence of significant POIs. These findings underscored the need for strategic placement of new charging points to improve network capillarity and support sustainable tourism practices.

Specific strategic locations identified for potential charging infrastructure installations include:

-Fondotoce: Strategic for tourists at campsites and for various tourist

itineraries.

-Historic Centers: Such as Domodossola, Omegna, Macugnaga, and valley, critical for e-bike infrastructure.

-Railway Stations and Ferry

-Embarkations: Essential hubs for both bikes and cars.

-Public Gardens of Omegna: Potential sites for charging infrastructure.

-Toce Cycle Path: Significant for e-bikes, particularly near Fondotoce and Mergozzo.

-Along Cycling Paths: Near bars and restaurants.

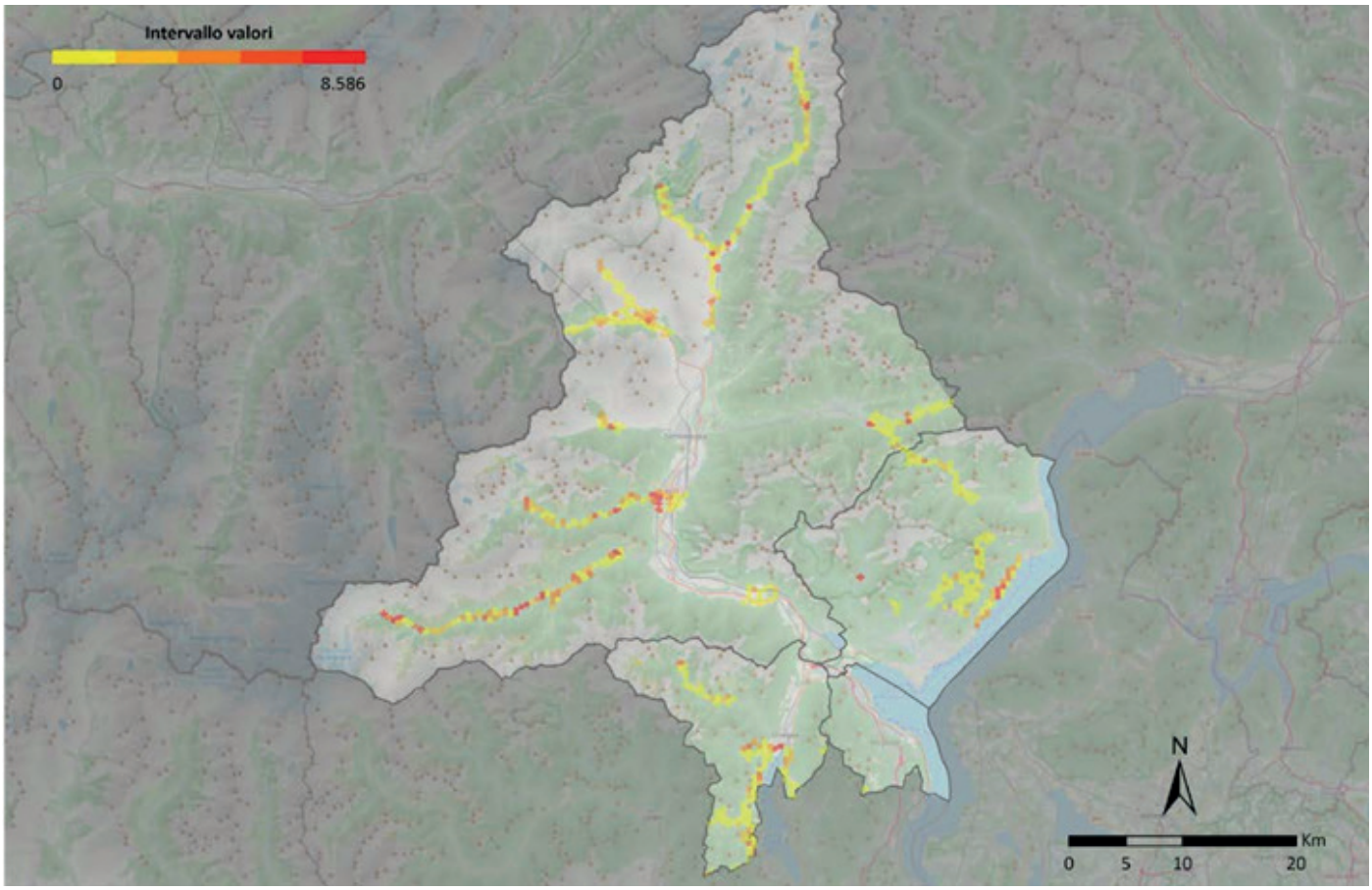
-Near Accommodation Facilities: Crucial for electric cars.

-Mountain and Hill Areas: Including Premeno, Mottarone, and mountain bike trail entrances.

-Lakefront Areas: Such as Intra/Pallanza, Stresa, and Baveno, important for car charging.

1.1 Macugnaga and Santa Maria Maggiore: Case Studies in Infrastructure Development

This thesis will explore the case study of Macugnaga for the reasons explained in the last chapter, and it will also examine Santa Maria Maggiore, a similar locale in terms of tourist attractions and visitor numbers. Both areas present unique opportunities and challenges for promoting sustainable tourism through enhanced electric mobility infrastructure.



n.	Categories and individual POIs
	Tourist hubs
1	accommodation facilities (hotels, B&Bs, hostels, campsites)
2	refuges and huts
3	sites of historical-cultural interest (castles, towers, monuments, etc.)
4	places for cultural activities (museums, cinemas, theatres)
5	places for outdoor activities and outdoor sports (parks, picnic areas, adventure parks, ski facilities, outdoor swimming pools)
6	environmental resources (lakes, rivers, natural parks)
7	sports centers for indoor activities (gyms, indoor swimming pools, sports halls)
8	shopping centers
9	public establishments (restaurants, bars, pubs)
	Existing infrastructure
10	stations (train, bus, cable car)
11	car and/or bike parking
12	exchanger parking lots
13	ferry mooring points (Lake Maggiore)
14	petrol stations (fuel stations)
	Mixed activities (serving residents and tourists)
15	hospitals and clinics
16	exhibitions
17	public offices
18	institutional headquarters

Macugnaga: A Growing Hub for EV Charging Stations

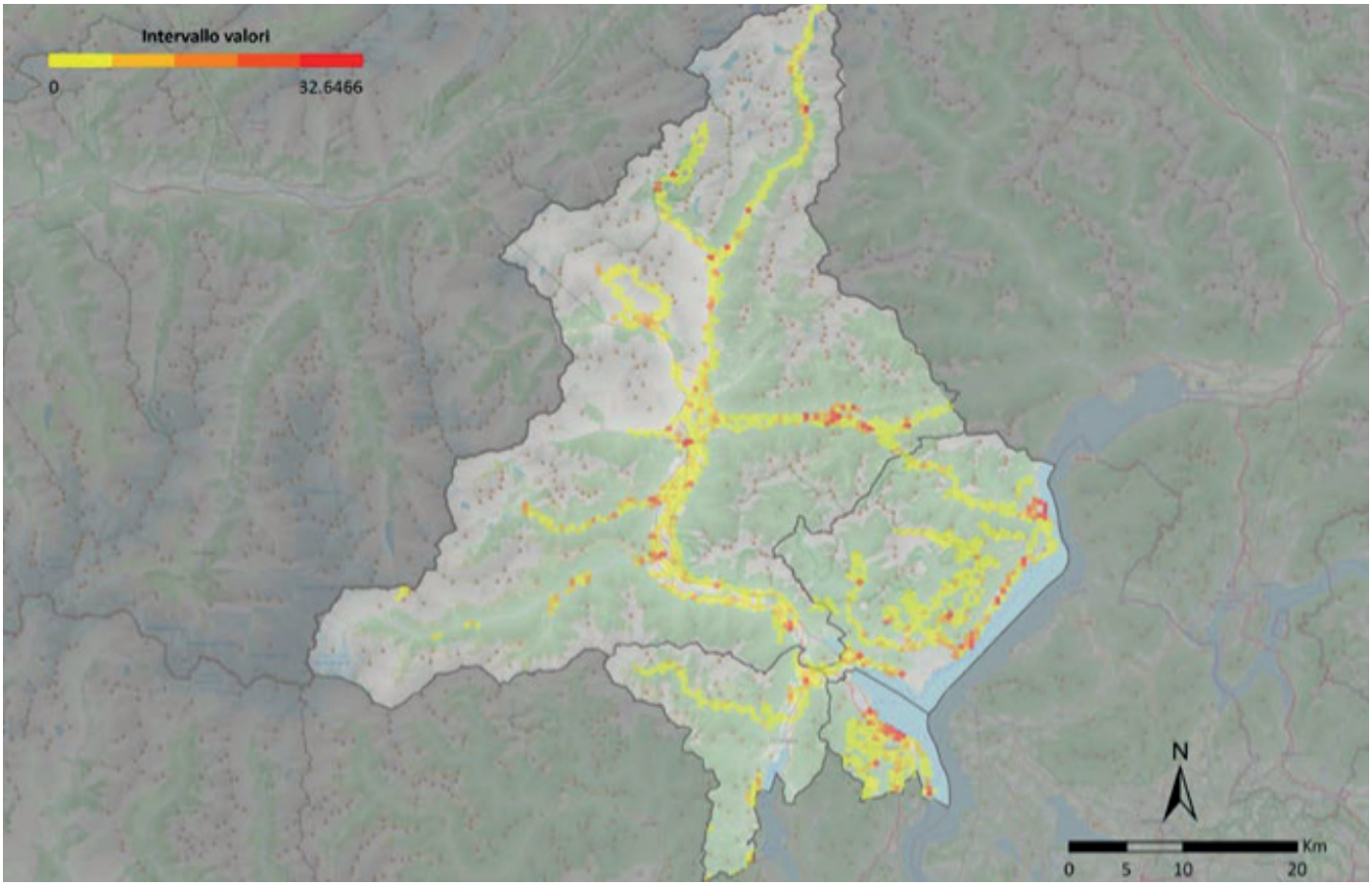
Macugnaga, renowned for its breathtaking mountain vistas and outdoor recreational opportunities, has recently seen the installation of new electric charging points. This development marks a significant step towards supporting sustainable tourism initiatives in the area.

Location and Attractions:

Nestled at the foot of Monte Rosa, Macugnaga is celebrated for its stunning alpine scenery and rich cultural heritage. Key attractions include the Monte Rosa Ski Resort, the Gold Mine of Guia, and various hiking trails such as the one to Lago delle Fate. Historical sites like the Walser House Museum and the Old Church with its ancient lime tree further enhance its appeal.

Tourist Flows:

Macugnaga attracts nature enthusiasts, hikers, and winter sports aficionados. Activities such as gliding with the Macugnaga Delta Club, mountain biking on trails in the Anzasca Valley, and rock climbing on meticulously equipped routes cater to outdoor adventure seekers.



The recent addition of EV charging stations is crucial in supporting this high tourist value and promoting eco-friendly travel.

Infrastructure Needs:
The installation of charging stations addresses a significant gap in Macugnaga's infrastructure, positioning it as a priority area for electric mobility. Continued focus on enhancing this infrastructure will support the area's high visitor numbers and promote sustainable tourism practices.

Santa Maria Maggiore: A Model for Electric Mobility and E-Bike Infrastructure
Santa Maria Maggiore, a charming town in Valle Vigezzo, represents another key area of interest for infrastructure development. Despite its virtuous electric vehicle charging point system, identified as a model for sustainable tourism, Santa Maria Maggiore faces challenges with its EV infrastructure for e-bikes, as highlighted by the MOBSTER project.

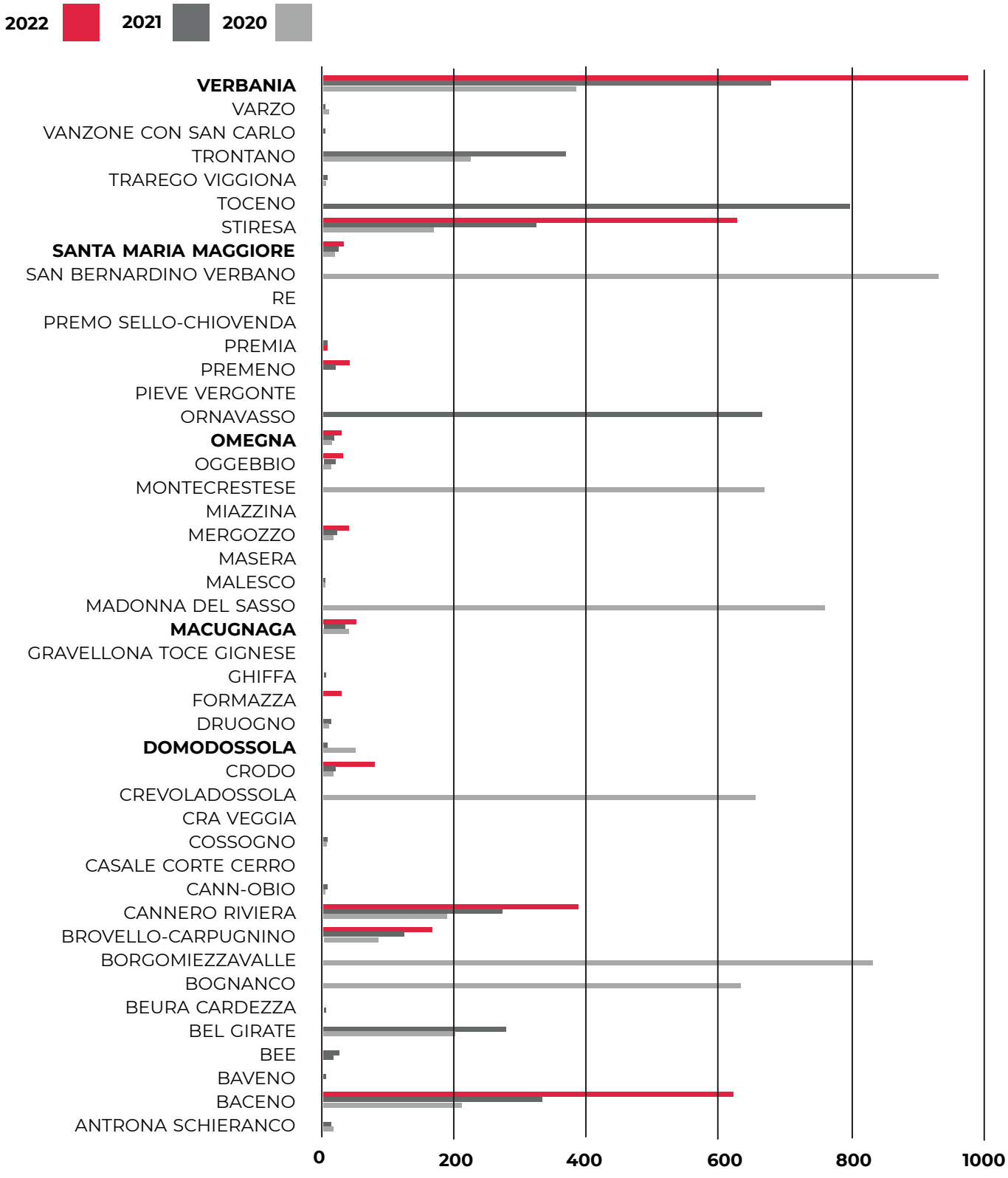
Location and Attractions:
Santa Maria Maggiore is known for its village atmosphere, cultural festivals, and historical buildings. Attractions include the Chimney Sweep Museum, the impressive Santuario di Re, and the scenic Vigezzo Valley Railway. The Praudina Adventure Park offers a thrilling zipline course, and the town features a beautiful nine-hole golf course set in a stunning pine forest.

Tourist Flows:
The town attracts a diverse range of tourists, including families and cultural tourists, who enjoy its well-maintained infrastructure and rich cultural offerings. Events like the International Chimney Sweep Meeting further boost its appeal. The nearly 15 km cycling path from Druogno to Re, with sports facilities like a golf course, stables, and courts for volleyball and tennis, is ideal for families and e-bike users.

Infrastructure Needs:
The case studies of Macugnaga and Santa Maria Maggiore illustrate the varying needs and opportunities for electric mobility infrastructure development. Macugnaga's recent advancements in EV charging stations highlight the importance of continued investment in this area to support sustainable tourism.

Pattern tourist mobility VCO

Presence of hotels other than VCO hotels



Source: Ufficio turistico VCO

1.2 Tourist Attractions in Macugnaga

Monte Rosa Ski Resort:

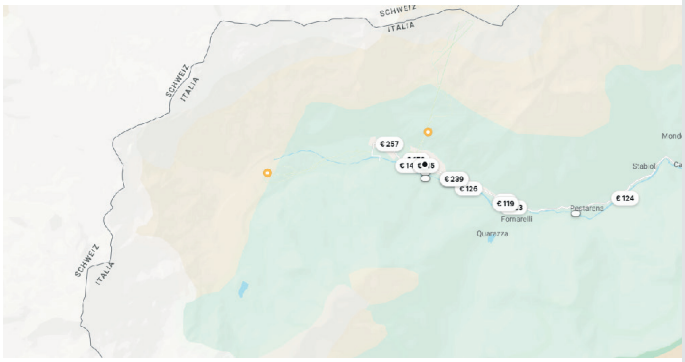
Monte Rosa Ski Resort is a premier destination for winter sports enthusiasts, offering a variety of slopes catering to all skill levels. With its breathtaking views of the Monte Rosa massif, the resort provides extensive ski runs, snowboarding parks, and cross-country skiing trails. State-of-the-art lift systems ensure minimal waiting times, while cozy mountain huts and restaurants offer a place to rest and enjoy local cuisine. The resort also features night skiing and snowshoeing trails, making it a year-round attraction for adventure seekers.

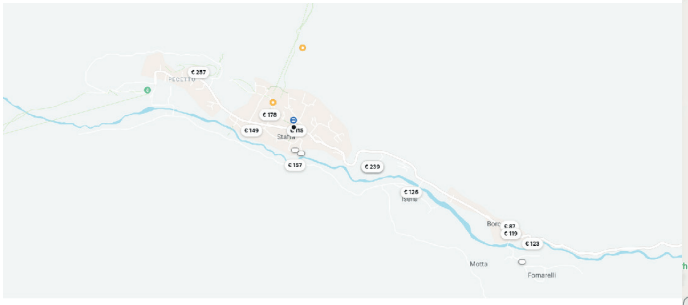
Gold Mine of Guia:
The Gold Mine of Guia is an intriguing historical site that takes visitors on a journey through the region's mining past. Located near the village of Macugnaga, this mine once produced significant quantities of gold. Guided tours lead visitors through the underground tunnels, showcasing the mining techniques and tools used throughout history. The cool underground environment and the fascinating stories of miners' lives make this a captivating experience for history buffs and adventurers alike.

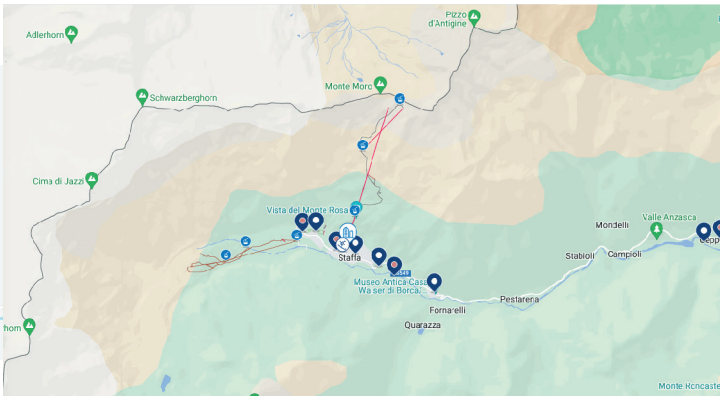
Walser House Museum:
The Walser House Museum in Borca offers a unique glimpse into the traditional life of the Walser community, a Germanic people who settled in the Anzasca Valley. The museum is housed in a well-preserved 17th-century building and features over 650 artifacts spread across three floors. Visitors can explore themed rooms that showcase daily life, craftsmanship, and historical documents. The museum highlights the architectural style, culture, and customs of the Walser people, providing an immersive experience into their way of life.

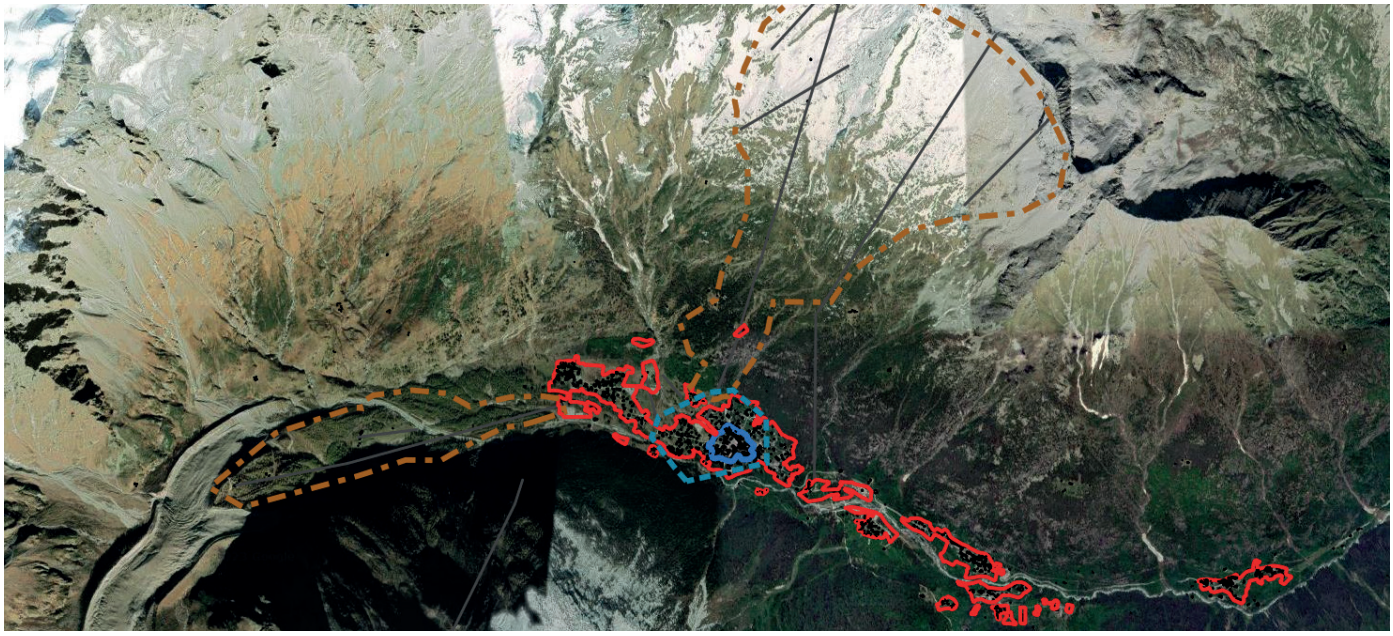
Lago delle Fate Panoramic Loop:
Lago delle Fate, or Lake of the Fairies, is a serene alpine lake surrounded by picturesque trails perfect for hiking and mountain biking. The panoramic loop around the lake offers stunning views of the surrounding mountains and lush forests. The trail is accessible to all levels of hikers, making it a popular spot for families and nature lovers. The crystal-clear waters of the lake and the enchanting scenery create a magical atmosphere, ideal for picnics and leisurely walks.

Old Church with Ancient Lime Tree:
The Old Church of Macugnaga, also known as Chiesa Vecchia, is a historical landmark dating back to the 13th century. The church is renowned for its ancient lime tree, which is believed to be over 700 years old. This sacred tree adds a mystical aura to the site. The church itself features beautiful frescoes, a wooden altar, and intricate architectural details that reflect the rich cultural heritage of the region. It serves as a peaceful place for reflection and appreciation of historical artistry.
Various Hiking Trails:
Macugnaga is a hiker's paradise, offering









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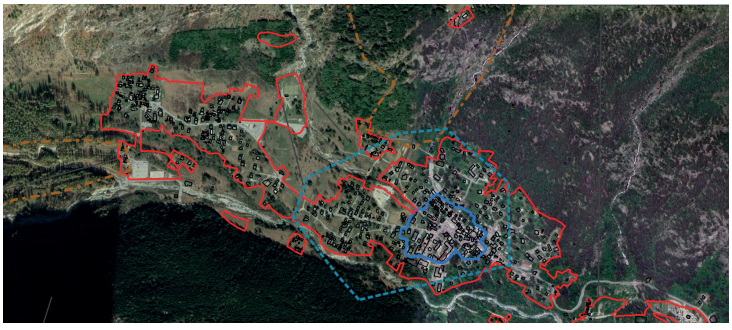
- Thickening A1
- Tourist infrastructure
- Delimitation of urban areas
- Leisure holiday
- Buildings



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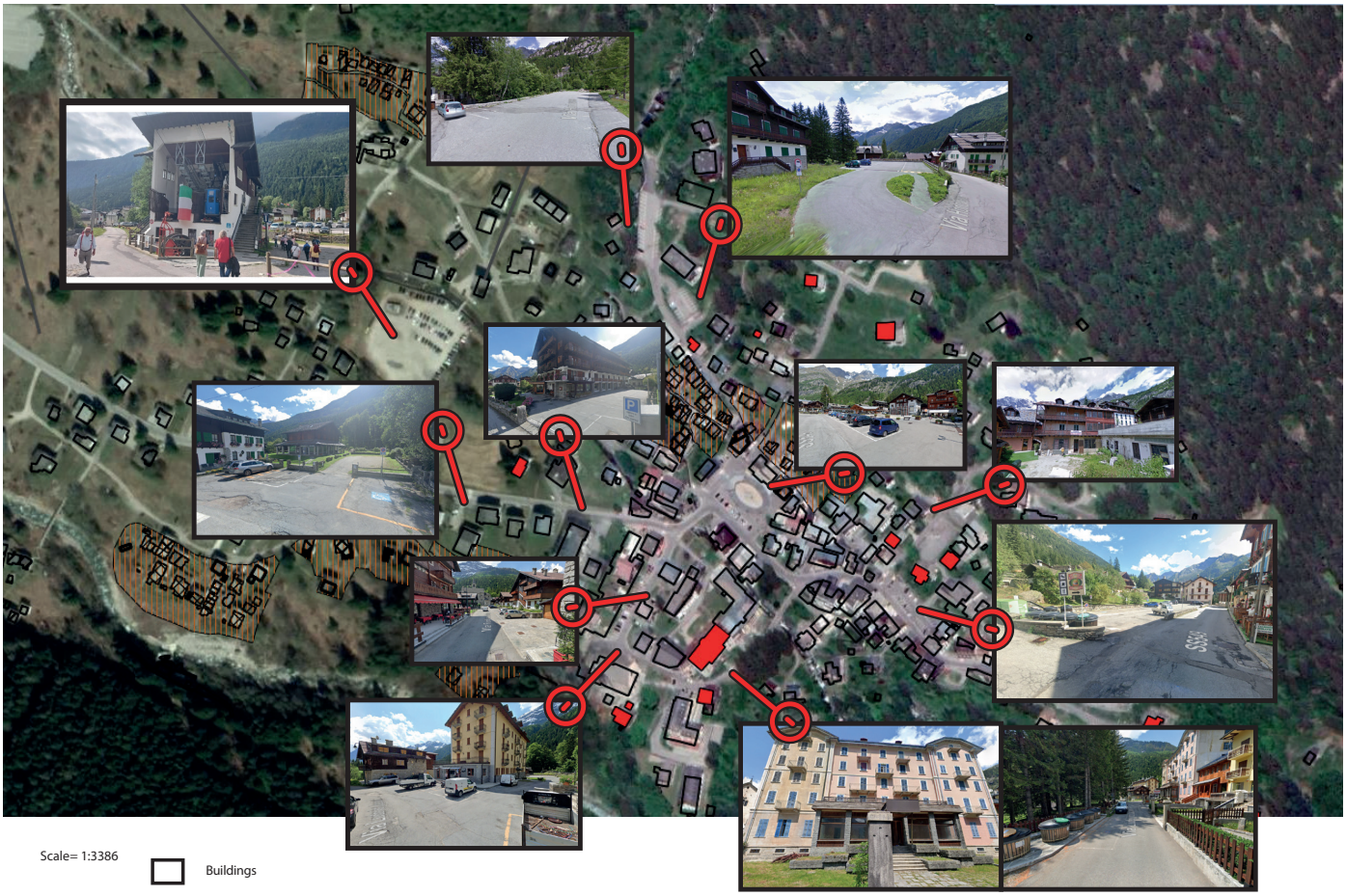
Buildings

Properties of notable interest

Properties with high aesthetic value



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Buildings

Properties of notable interest

Properties with high aesthetic value

numerous trails that cater to different levels of difficulty and experience. Popular routes include the path to Rifugio Zamboni, which offers spectacular views of the Monte Rosa glacier, and the trek to Alpe Fillar, known for its lush pastures and traditional alpine huts. These trails provide opportunities to experience the region's diverse flora and fauna, and to explore the pristine natural landscapes that make Macugnaga a top destination for outdoor enthusiasts.

Gliding with the Macugnaga Delta Club
Experience the exhilaration of gliding with the Macugnaga Delta Club, one of Italy's oldest and most reputable gliding clubs. Soaring high above the stunning alpine scenery, gliders can enjoy a bird's eye view of the valleys, forests, and snow-capped peaks. The sensation of floating above the earth offers a unique and unforgettable adventure, perfect for thrill-seekers and nature lovers alike. The club provides all necessary equipment and training, ensuring a safe and enjoyable experience for all participants.

Mountain Biking and E-biking Trails in the Anzasca Valley:
The Anzasca Valley is a haven for mountain biking and e-biking enthusiasts, offering a variety of trails that range from moderate to challenging. These routes wind through scenic landscapes, dense forests, and along riverbanks, providing exhilarating rides with breathtaking views. Popular trails include the Lago delle Fate Panoramic Loop and the Miners Path. Whether you are an experienced biker or a beginner, the trails in the Anzasca Valley promise thrilling adventures and stunning natural beauty.

Rock Climbing Routes:
Rock climbing in Macugnaga offers a thrilling experience for climbers of all levels. The area boasts numerous meticulously equipped routes that ensure safety while providing challenges for both beginners and seasoned climbers. The stunning natural landscapes, with sheer vertical faces and towering boulders, offer a dramatic backdrop for climbing adventures. Local guides and climbing schools are available to provide instruction and ensure a safe and enjoyable experience.

1.3 Tourist Attractions in Santa Maria Maggiore

Chimney Sweep Museum:

The Chimney Sweep Museum in Santa Maria Maggiore is a unique cultural institution dedicated to the history and heritage of chimney sweeps. The museum showcases tools, clothing, and memorabilia related to the trade, reflecting its significance in the region's history. Interactive exhibits and multimedia displays provide an immersive experience, telling the stories of chimney sweeps and their vital role in the community. The museum also highlights the emigration of chimney sweeps from the Vigezzo Valley to various parts of Europe.

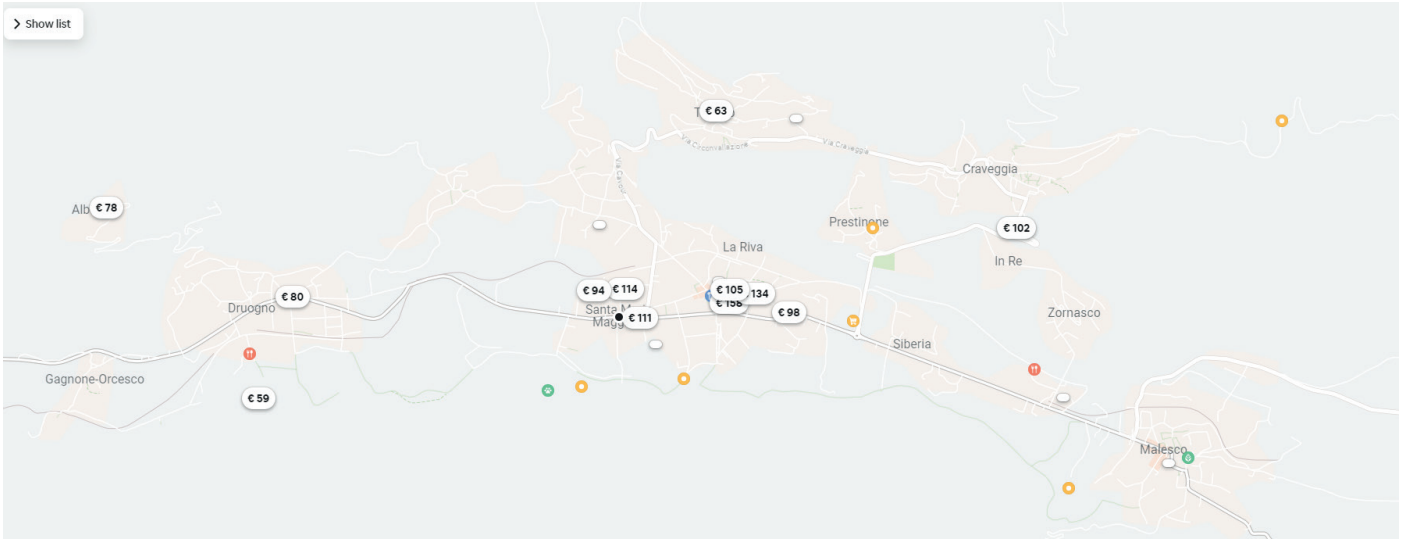
Santuario di Re:
The Santuario di Re is a stunning basilica located in the Vigezzo Valley, renowned for its impressive architecture and historical significance. Built in the 17th century, the sanctuary is dedicated to Our Lady of the Blood and is a major pilgrimage site. The interior features beautiful frescoes, intricate altars, and a serene atmosphere that invites contemplation and reverence. The sanctuary's picturesque setting and rich history make it a must-visit destination for those exploring the region.

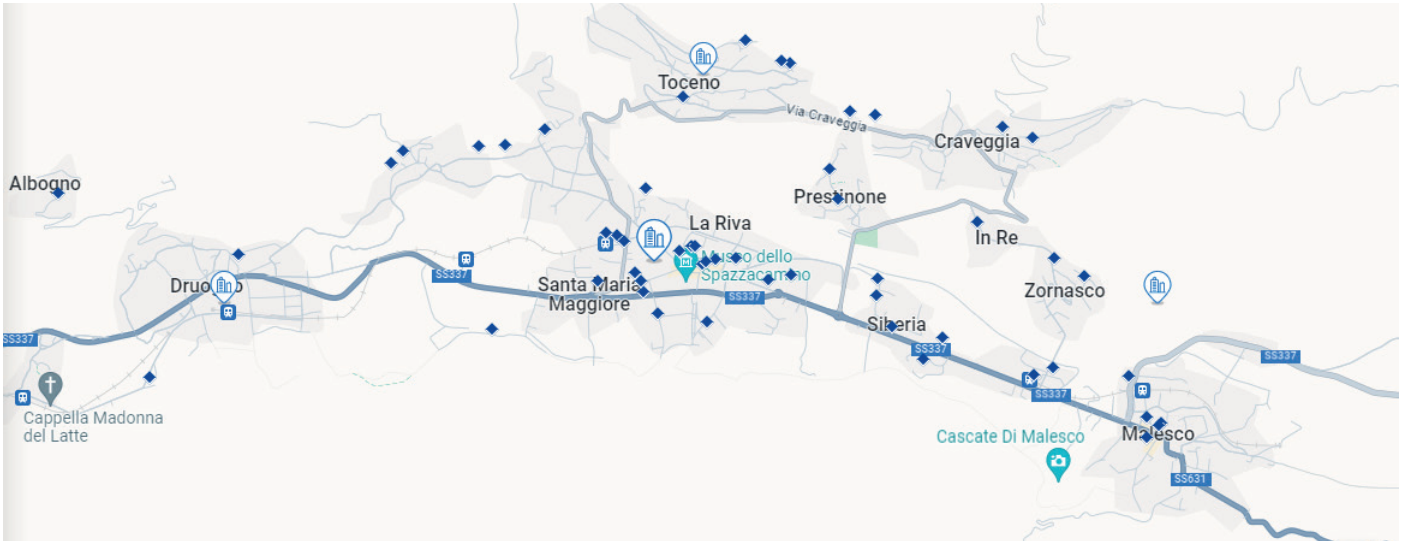
Vigezzo Valley Railway:
The Vigezzo Valley Railway, also known as the Centovalli Railway, offers a scenic journey through the heart of the Vigezzo Valley and the surrounding mountains. This narrow-gauge railway connects Domodossola in Italy to Locarno in Switzerland, passing through picturesque villages, deep gorges, and lush forests. The train ride provides breathtaking views and a unique way to experience the natural beauty of the region. The railway is particularly popular during the autumn months when the valley is adorned with vibrant fall foliage.

Historical Village Center:
Santa Maria Maggiore's historical village center is a charming area characterized by its well-preserved architecture, cobblestone streets, and vibrant atmosphere. The center is home to numerous cafes, restaurants, and shops, offering a delightful place to explore local cuisine, crafts, and traditions. The village often hosts cultural festivals and events, providing visitors with opportunities to experience the local culture and community spirit. The blend of historical charm and modern amenities makes it a captivating destination for all.

Cultural Festivals and Events:
Santa Maria Maggiore is known for its lively cultural festivals and events, which celebrate the region's rich heritage and traditions. Highlights include the International Chimney Sweep Meeting, which attracts chimney sweeps from around the world, and the Chestnut Festival, which celebrates the local chestnut harvest with food, music, and crafts. These events offer visitors a chance to immerse themselves in local customs, enjoy traditional foods, and participate in various activities that showcase the region's unique culture.

Praudina Adventure Park with Zipline Course:
The Praudina Adventure Park in Santa Maria Maggiore offers an exciting outdoor experience for both kids and adults. Located in a beautiful pine forest, the park features a variety of high ropes courses and a thrilling zipline course. Managed by ASD Pulsar, the park provides a fun and engaging activity amidst the forest's rich sporting facilities. Funded by the Region of Piedmont and GAL Laghi e Monti del Verbano Cusio Ossola, the park is an eco-friendly destination that promotes adventure and environmental awareness.





1 Chiesa di S. Maria Assunta
Church/Église/Kirche

2 Centro culturale Vecchio Municipio
Cultural Centre
Centre Culturel
Kulturzentrum

3 Casa del Profumo
The House of perfume
Maison du parfum
Parfum-Haus

4 Municipio
Town hall/Maire/Rathause

5 Museo dello Spazzacamino
Chimney Sweeps Museum
Musée du Ramoneur
Schornsteinfeger Museum

6 Parco di Villa Antonia
Villa Antonia Park
Jardin de Villa Antonia
der Park von Villa Antonia

7 Monumento al pittore vigezzino
Monument to the painter
Monument au peintre
Monument des Malers

8 Scuola di Belle Arti 'Rossetti Valentini'
School of Fine Arts
Ecole des beaux-arts
Schule der Shönen Künste

9 Centro polifunzionale
Multipurpose Center
Centre polyvalent
Mehrzweckhalle

10 Oratorio di San Giovanni e San Rocco
Oratory/Oratoire/Oratorium

11 Oratorio di San Lorenzo
Oratory/Oratoire/Oratorium

12 Centro Visite Parco Val Grande
Visitor Centre
Val Grande National Park
Centre de visite
du Parc Valgrande
Besucherzentrum
des Naturpark Valgrande

13 Centro del Fondo
Nordic ski Center
Centre du ski nordique
Langlaufski Zentrum

14 Cinema Teatro
Cinema Theatre
Cinéma Théâtre
Kino-Theater

Nine-Hole Golf Course Set in a Pine Forest:
Santa Maria Maggiore boasts a scenic nine-hole golf course nestled within a tranquil pine forest, offering a peaceful retreat for golf enthusiasts. The 1,500-meter course features par 30 holes that blend seamlessly with the natural landscape, providing a challenging yet enjoyable experience for players of all skill levels. The practice area includes putting greens and pitching areas, ideal for honing skills and enjoying leisurely rounds of golf surrounded by mountain views and fresh alpine air. The golf course's serene setting and well-maintained facilities make it a popular destination for relaxation and recreation amidst nature.

Cycling Path from Druogno to Re:
The cycling path from Druogno to Re is a scenic route that winds through the picturesque landscapes of the Vigezzo Valley, offering cyclists a leisurely journey amidst nature's beauty. The nearly 15 km path follows a flat and shaded trail that meanders through lush forests, past tranquil streams, and alongside charming villages. Along the way, cyclists can discover various sports facilities, including a nine-hole golf course, equestrian centers, and tennis courts. The cycling path is suitable for families and cyclists of all ages and abilities, providing an opportunity to explore the natural wonders and cultural heritage of the Vigezzo Valley at a relaxed pace.

Feminis-Farina Perfume House:
The Feminis-Farina Perfume House in Santa Maria Maggiore is a cultural gem that celebrates the art and history of perfumery. This multimedia exhibition explores the legacy of Giovanni Maria Farina and Johann Maria Farina, Vigezzo natives who revolutionized the perfume industry with their creation of Eau de Cologne. Visitors can delve into the process of perfume making, discover the scents and stories behind iconic fragrances, and learn about the Farina family's global influence. The museum's interactive displays, historical artifacts, and aromatic experiences offer a sensory journey into the world of perfumery, highlighting the region's contributions to this timeless art form.

Rossetti Valentini School of Fine Arts:

The Rossetti Valentini School of Fine Arts in Santa Maria Maggiore is a prestigious institution dedicated to nurturing artistic talent and preserving cultural heritage. Housed in an elegant 19th-century building, the school offers courses in painting, drawing, comic art, and woodcarving taught by experienced instructors. The school's permanent exhibition showcases a collection of Vigezzo paintings spanning the 18th to 20th centuries, providing students with inspiration and historical context for their artistic endeavors. Visitors can explore the school's studios, galleries, and workshops, immersing themselves in the rich artistic traditions of the Vigezzo Valley while appreciating the beauty of its historic surroundings.

In the following chapter, we will delve into the contributions of two significant players in the development of electric charging infrastructure in the VCO region: Ewiwa and the Atlante Project. These initiatives have been instrumental in enhancing the region's electric mobility network, with notable investments in Santa Maria Maggiore. Their efforts exemplify successful models of sustainable infrastructure development, which could be replicated in other parts of the VCO and beyond. The upcoming discussion will explore their projects in detail, focusing on their impact, methodologies, and future plans for promoting electric mobility and sustainable tourism in the region.

1.4 ATLANTE and EWIWA project

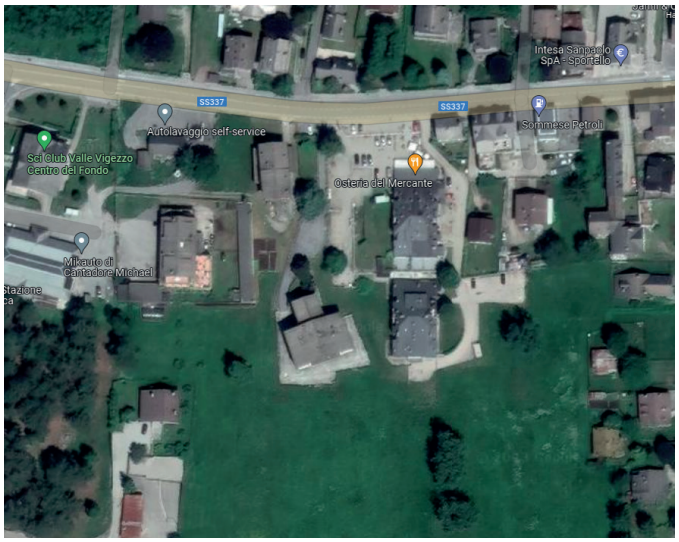
The Atlas project, spearheaded by Atlanters, funded by the NHOA Group, aims to contribute to the shift towards a more sustainable economy and address the challenges brought about by climate change. It focuses on establishing a vast network of fast and ultra-fast charging stations across Southern Europe to encourage the adoption of electric vehicles, thereby promoting sustainable mobility and reducing harmful emissions.

One of the primary goals of the project is to install over 5,000 fast and ultra-fast charging points by 2025, with a projected increase to more than 35,000 by 2030, covering key regions in Italy, France, Spain, and Portugal. These charging stations will be sustainably powered by renewable energy sources and seamlessly integrated into the existing vehicle infrastructure to ensure a reliable and environmentally friendly energy supply.
In order to successfully implement the project, Atlante collaborates closely with a diverse range of partners, encompassing both public and private entities. These potential partners include landowners, managers of various establishments such as restaurants, hotels, shopping centers, highways, as well as local authorities and agencies. Atlante provides a turnkey solution for partners, bearing the initial investment and infrastructure management costs upfront, thus offering a cost-effective and hassle-free partnership opportunity.

Partners who join Atlante's fast and ultra-fast charging network stand to benefit in several ways. Firstly, they have the chance to enhance the appeal and value of their businesses by providing a convenient and essential service to the public while becoming a sought-after destination for electric vehicle owners. Moreover, being a part of the Atlante network grants partners visibility across all major charging applications and access to round-the-clock customer support, ensuring a seamless and efficient experience for both customers and partners alike.

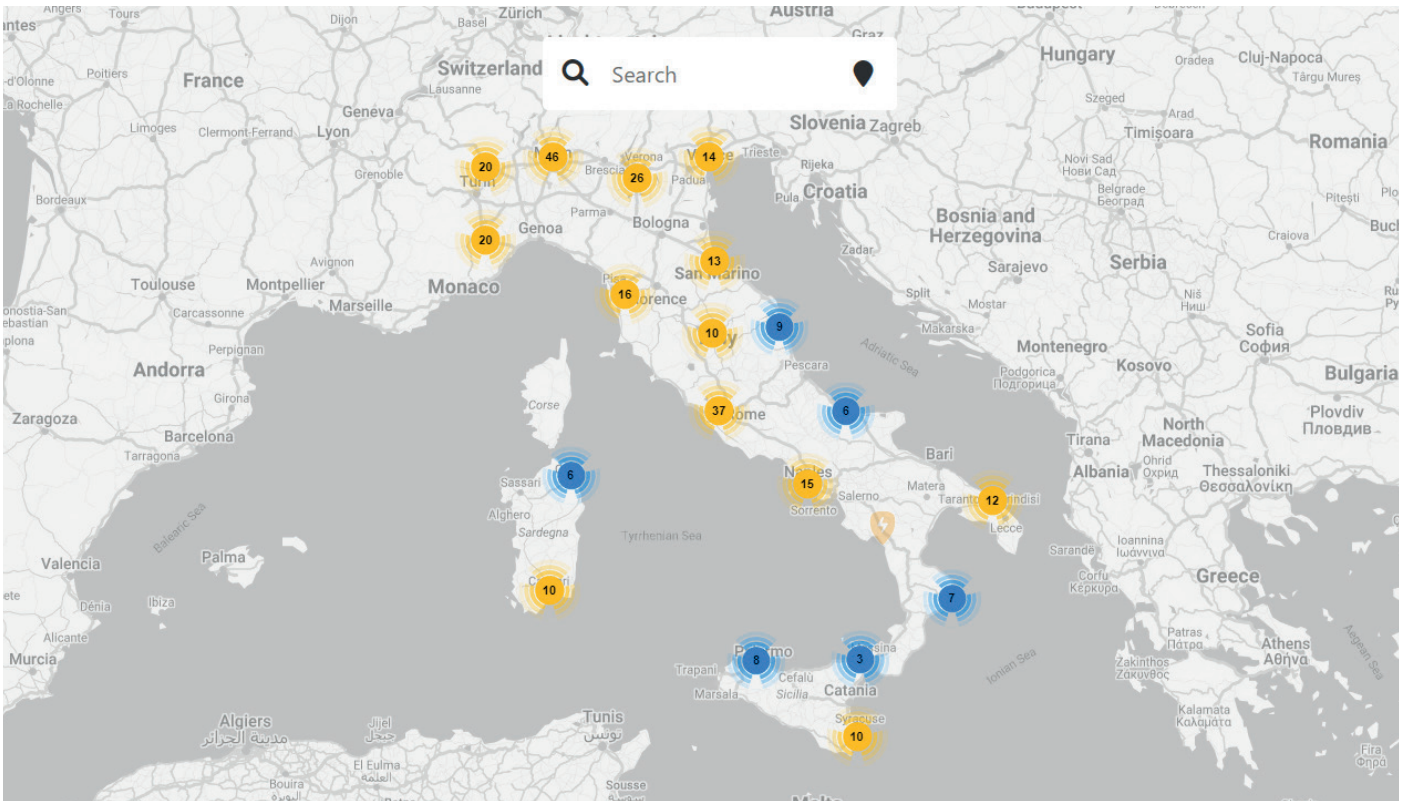
The inauguration of Europe's first rapid charging station in Santa Maria Maggiore marked a significant milestone in the region, drawing attention from regional authorities, industry experts, and international media. The event emphasized the strategic importance of the Vigezzo Valley as a hub for technological innovation and environmental sustainability, showcasing the area's commitment to green energy and its integration with the electricity grid. Santa Maria Maggiore has emerged as a trailblazer in electric mobility within Europe, setting a precedent for others to follow.

The impact of this event extends beyond the local community, resonating throughout Europe and highlighting the potential of electric mobility in mitigating greenhouse gas emissions and promoting a transition to a low-carbon economy. By showcasing Santa Maria Maggiore as a pioneer in electric mobility, the inauguration of the fast charging station has not only bolstered efforts to combat climate change but has also stimulated sustainable tourism in the Vigezzo Valley. The event's success has attracted investments and opened up new avenues for economic development in the region.



Standalone	Installation in confined areas	Power 100kW	Proximity to the city center	Services on site or within 400 meters
Basic	Installation in main arteries	Power 300kW	4 charging points	Services on site or within 400 meters
Convenience	Installation in main arteries	Power 300kW	6 charging points	Services in place
Premium	Installation in main arteries	Power 300kW	12 charging points	Lounge area and val-ue-added services

WC Food Wifi Parking area Shop



Ewiva, as the leading ultra-fast charging network for electric vehicles in Italy, plays a crucial role in advancing the country's sustainable transportation efforts. This initiative, established through a Joint Venture between Enel X and the Volkswagen Group, is dedicated to fostering Italy's shift towards electric mobility by creating an extensive infrastructure of high-voltage charging stations accessible nationwide.

The core mission of Ewiva is to deploy a comprehensive network of over 3,000 high-voltage charging stations by 2025, featuring power capabilities of up to 350 kW. This widespread infrastructure aims to offer electric vehicle owners convenient and rapid charging solutions, enabling smooth travel experiences throughout Italy's diverse terrains.

Currently operational, Ewiva's ultra-fast charging network is rapidly expanding to ensure coverage in all regions of Italy. The strategic placement of charging stations in urban areas, along commuter routes, and major highways guarantees accessibility for electric vehicle users across the country. Ewiva provides a range of charging solutions tailored to meet the diverse needs of electric vehicle users. These options include Standard, Basic, Convenience, and Premium choices, all equipped with high-voltage charging stations varying from 100 kW to 350 kW. Furthermore, these stations are powered exclusively by renewable energy sources, ensuring efficiency, reliability, and environmental sustainability.

The success of Ewiva is underpinned by collaborative efforts and partnerships with key stakeholders in the electric mobility sector. By leveraging the expertise of Enel X and the Volkswagen Group, Ewiva drives innovation and advocates for sustainable transportation solutions. Through strategic partnerships and shared goals, Ewiva aims to continue leading the way towards a more sustainable and efficient electric vehicle charging network in Italy.

Ewiva has also established a presence in Macugnaga with its charging stations. This addition includes a new charging station near the town center, providing a crucial service to visitors and residents alike. The specific technical specifications for this station are as follows:

1 Charging Station
1 CCS Type 2 Socket
100kW Power Capacity

Additionally, the station is conveniently located near several amenities:

On-site Restaurant
On-site Bar
Hotel within 400 meters
On-site Sports/Recreation Center
Seasonally Open Tourist Site

This strategic placement of Ewiva's charging stations in Macugnaga underscores the importance of accessible and efficient electric mobility infrastructure in promoting sustainable tourism and reducing emissions. By integrating charging stations with local amenities and attractions, Ewiva supports a seamless and eco-friendly travel experience for electric vehicle users.


300
300
enviva


enviva


Centro Sp
Casa Alpina De Filippi
Chalet del Frassino
Albergo Cristallo
Pasticceria
Gelateria Basaletti
Via Monte Rosa
Parche
Hotel Signal
Strad
Macugnaga Monte Rosa
Camper Park Monterosa


100
enviva
Happy to e-move

Chapter 14: Service blueprint

Time	15 minutes	3 hours	1 hour
Step	**Preparation**	**Drive to Ski Resort**	**Charging and Skiing**
Evidence	Electric vehicle charging stations	Ski rental facilities	Restaurant reservations
Customer journey	Laura exits her apartment in Turin at 6:30 to retrieve her undercharged car.	Laura arrives at the ski resort in Macugnaga at 9:00 after a 200km drive.	Laura arrives at the charging station at 9:35, charges the car, and rents skis.
Service	Preheating, Monitoring App	Slot reservation, Visible columns from a remote, Surveillance cameras, Tourist info	Charge Monitoring, Ski Rental
Front stage	Laura checking the car's battery level and starting the preheating process.	Laura checking available charging slots and accessing tourist info.	Laura plugging in the car, renting skis.
Back stage	Preheating system activating, Monitoring app sending alerts.	Reservation system managing slots, Surveillance system monitoring site.	Charging system monitoring, Ski rental system processing.
Support process	Automated preheating system, Monitoring app backend.	Slot reservation system, Remote monitoring system.	Charging system backend, Ski rental system backend.

2.5 hours	1 hour	3 hours	Time
Lunch Break and Snowshoeing	**Arrival at B&B**	**Dinner and Evening Activities**	**Morning Charging**
Sustainable dining options	B&B check-in counters	Billing and recharge data records	Bike rental stations
Laura and friends have lunch and go snowshoeing.	Laura and friends arrive at the B&B at 17:00.	Laura attaches and detaches the charging column, goes to dinner, and spends the evening stargazing.	Laura charges the car at the plant in the morning.
Reservation service, Lunch service, Virtual tour guides	Facility reservation and car parking, Bike and water sports services, Technical assistance	Dinner reservation, App management	Internet connection, Heated lounge
Laura making reservations, enjoying lunch, using virtual tour guides.	Laura checking in, accessing bike and water sports services.	Laura managing app, enjoying dinner.	Laura relaxing in the heated lounge.
Reservation system managing bookings, Kitchen preparing meals.	Reservation system processing check-in, Maintenance team preparing services.	Reservation system processing dinner booking.	Charging system monitoring.
Reservation system backend, Kitchen operations.	Reservation system backend, Maintenance operations.	Reservation system backend.	Charging system backend.

Service blueprint

Time	4 hours	1.5 hours	1.5 hours
Step	**Return Journey**	**Stop in Candelo**	**Disconnect and Departure**
Evidence	Billing and recharge data records	Tour guide brochures	Billing and recharge data records
Customer journey	Laura returns to Turin with friends at 13:00.	Laura stops in Candelo for activities.	Laura disconnects the car and departs for Turin.
Service	Billing and recharge data	Bike rental, Tour guide, Shopping center	Billing and service data, Reviews of the place
Front stage	Laura accessing billing and recharge data.	Laura renting a bike, engaging with tour guide.	Laura reviewing service data, leaving reviews.
Back stage	Billing system processing data.	Bike rental system processing rental.	Billing system processing data.
Support process	Billing system backend.	Bike rental system backend.	Billing system backend.

30 minutes

Arrival in Turin

Parking spaces

Laura arrives safely in Turin at 17:30.

Parking for electric car

Laura finding parking.

Parking system managing spaces.

Parking system backend.

1.1 Service Blueprint and User Journey Analysis

This chapter presents a detailed service blueprint and user journey analysis for Laura, a persona designed to illustrate the challenges and experiences of electric vehicle (EV) users in sustainable tourism.

Laura's Journey to Macugnaga (Cold Weather Scenario)
Overview: This journey covers Laura's trip from Turin to Macugnaga during winter. The analysis considers the challenges posed by cold weather on battery performance and the limited charging infrastructure.

Impact of Temperature on EV Performance

Temperature plays a crucial role in battery efficiency. Cold temperatures during Laura's journey to Macugnaga necessitate more frequent charging stops and result in increased range anxiety. This highlights the importance of preheating and monitoring systems to mitigate the adverse effects of cold weather on battery performance.

Interaction with Charging Infrastructure

The interaction with charging infrastructure in Macugnaga, with its limited charging stations, poses significant challenges. This underscores the need for strategic placement and management of charging facilities to support EV tourism.

Integration of Activities and Charging

Integrating tourist activities with EV charging services enhances the travel experience. By utilizing the waiting times during charging sessions for activities such as dining, skiing, or exploring, users can make the most of their journey. This approach not only alleviates range anxiety but also promotes sustainable tourism..

Back-Stage Interactions and Support Processes

Back-stage interactions and support processes play a critical role in ensuring the smooth operation of services. In mountainous regions like Macugnaga, maintaining a reliable electricity supply can be challenging due to potential weather disruptions. Implementing robust backup systems, such as solar panels or wind turbines, can ensure continuous power availability for charging stations.

Technical Advice for Back-Stage Operations:

Redundancy in Power Supply: Implementing redundant power systems, including renewable energy sources and battery storage, can mitigate the risk of power outages.

Remote Monitoring Systems: Utilizing IoT-based remote monitoring can provide real-time data on charging station status and help in proactive maintenance.

Automated Reservation Systems: Enhancing the reservation systems with AI to predict and manage peak times can reduce wait times and improve user satisfaction.

Pain Points in the User Journey

Frequent Charging Stops: Cold weather reduces battery efficiency, leading to more frequent stops which can be frustrating

.

Potential Wait Times: Limited charging stations can result in longer wait times, especially during peak travel periods.

Interrupted Charging Sessions: Power outages or technical issues at charging stations can interrupt charging sessions, causing delays.

The service blueprint provides a comprehensive visualization of Laura’s user journey, highlighting key touchpoints and interactions. It contributes to the thesis by:

Identifying Pain Points: Pinpointing specific areas where users experience challenges, such as frequent charging stops and wait times.

Enhancing Service Design: Offering insights into back-stage processes and support systems that can be improved to enhance the overall user experience.

Stakeholder Involvement

The successful development and implementation of the EV charging service in mountainous regions

like Macugnaga require the active involvement of various stakeholders.

The stakeholder map below categorizes stakeholders based on their power and interest, which helps in formulating appropriate engagement strategies.

1.2 Stakeholder Map:

Key Stakeholders to Involve:
High Power - High Interest (Manage Closely):

Tour Operators and Guides: Their close interaction with tourists makes them valuable in promoting the service and gathering feedback.

Eco-Tourism Agency: Their focus on sustainable tourism aligns with the project goals, making them key partners in strategic planning and promotion.

High Power - Low Interest (Keep Satisfied):

Rental Companies (Ski, Bike): Ensuring these companies are satisfied will help in seamless service delivery to tourists who rent equipment during their stay.

Tourists: As the end-users, maintaining their satisfaction through reliable services and engaging experiences is crucial.

Retail and Service Businesses (Restaurants, Shops): Collaboration with these businesses can offer additional conveniences to tourists, enhancing their stay.

Low Power - High Interest (Keep Informed):

Environmental Organizations and Advocacy Groups: Keeping them informed ensures alignment with environmental standards and can help in gaining support for sustainable practices.

Electric Vehicle Charging Station Providers: Continuous communication can facilitate technical support and improvements in charging infrastructure

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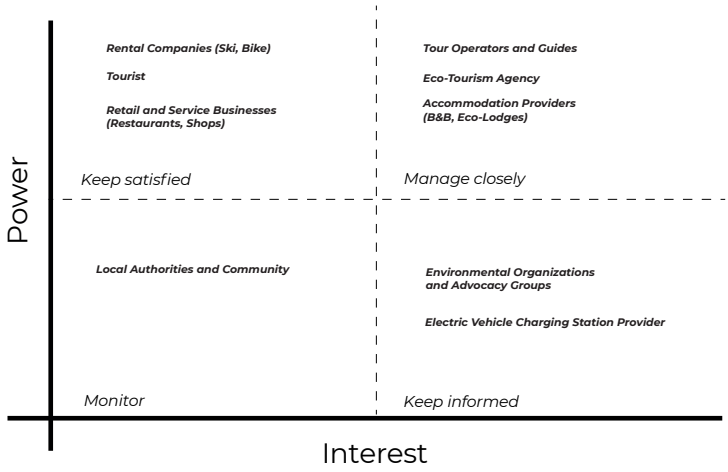
Low Power - Low Interest (Monitor):

Local Authorities and Community: Monitoring their concerns and feedback can help in addressing any local issues and ensuring community support.



Harvest HUB

Chapter 15: Communication

1.1 Logo

This chapter explores the creative process involved in designing the logo and selecting the typography for HarvestHub, an app dedicated to promoting sustainable tourism and local food sourcing.

Conceptualizing the Logo

Promoting Sustainability

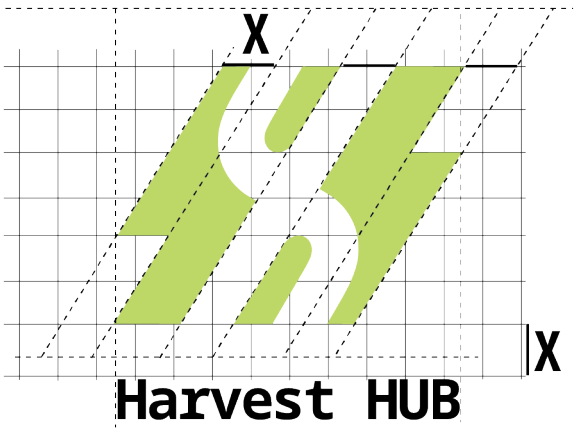
The name “HarvestHub” was carefully chosen to underscore the app’s dedication to sustainability and eco-friendly practices. The word “harvest” evokes the natural abundance of the earth, emphasizing a connection to fresh, seasonal, and locally-sourced foods. This element is crucial in the logo design, highlighting HarvestHub’s commitment to sustainable food sourcing and consumption.

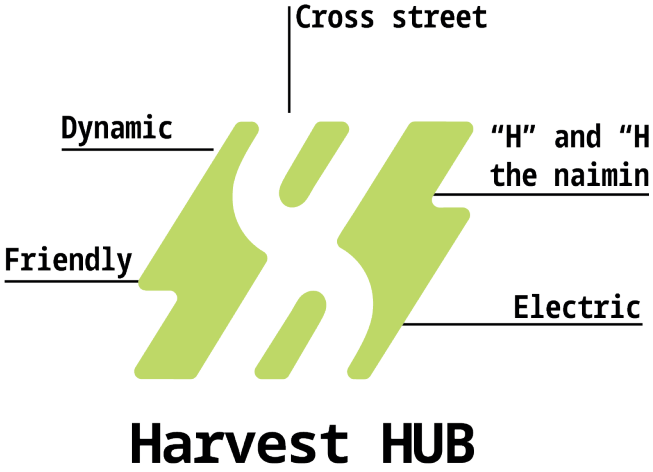
Reflecting the Service Offering

HarvestHub’s mission is to promote sustainable tourism and local food experiences. The logo needs to clearly reflect this mission. The name itself is a powerful asset, aligning directly with the app’s objectives. The design process focused on creating visual elements that effectively convey this message, ensuring the logo represents the essence of HarvestHub.

Symbolizing Community and Gathering

A significant aspect of HarvestHub is its role as a central point for people to connect, whether to access fresh, locally-sourced foods or to interact with local farmers and producers. The word “hub” suggests a gathering place, a central point of connection. By combining “harvest” with “hub” in the logo, we imply a community-oriented approach, reinforcing the idea of bringing people together around sustainable and local food sources.





Harvest HUB

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Noto Sans Mono ExtraCondensed

abcdefghijklmnopqrstuvwyz

ABCDEFGHIJKLMNOPQRSTUVWYZ

Evoking Natural Bounty
The imagery associated with the word "harvest" is rich with connotations of abundance and natural wealth. It signifies the gathering of crops at their peak, a metaphor for the high-quality, fresh foods that HarvestHub aims to provide. The logo design incorporates elements that evoke this sense of abundance, using shapes and colors that suggest growth, vitality, and the richness of nature.

1.2 Typography: Noto Sans Mono ExtraCondensed

Unique Style and Character
For the typographic element of the HarvestHub logo, Noto Sans Mono ExtraCondensed was selected for its unique and distinctive style. This font stands out due to its condensed form, which gives it a modern and sleek appearance. Its uniqueness helps in creating a memorable brand identity that distinguishes HarvestHub from competitors.

Readability
Despite its condensed nature, Noto Sans Mono ExtraCondensed offers excellent readability, even at smaller sizes. This is crucial for ensuring that the logo is versatile and effective across various mediums, from mobile app icons to large-scale signage. The font's clarity ensures that the brand name remains legible and impactful in all applications.

Association with Speed and Dynamism
The condensed and compact appearance of Noto Sans Mono ExtraCondensed can evoke a sense of speed and dynamism. This is particularly relevant for HarvestHub, as the service includes aspects of sustainable mobility and quick access to local resources. The font's design subtly suggests efficiency and modernity, aligning well with the innovative nature of the app.

Technological Context
Given that HarvestHub operates within the realm of electric mobility and contemporary technology, it was essential to choose a typographic font that integrates seamlessly with this context. Noto Sans Mono ExtraCondensed, with its clean lines and modern aesthetic, complements the technological aspect of the service, creating a cohesive visual identity that speaks to the app's cutting-edge nature.

Harvest HUB

Harvest HUB

Color

Black

Logo Composition

The final logo for HarvestHub combines the natural and communal connotations of the name with the sleek, modern characteristics of Noto Sans Mono ExtraCondensed. The text “HarvestHub” is rendered in this distinctive font, providing a strong, readable brand name that stands out. Additional visual elements, such as iconography or color schemes inspired by nature, may be incorporated to enhance the overall design and reinforce the brand’s message.

Visual Analysis of the Logo

The HarvestHub logo, as depicted in the image, consists of a stylized “H” emblem accompanied by the brand name rendered in Noto Sans Mono ExtraCondensed. The design of the “H” emblem is dynamic and modern, featuring clean, bold lines that convey a sense of movement and growth. This emblem not only represents the initial of “HarvestHub” but also evokes imagery related to paths or roads, aligning with the app’s focus on mobility and connectivity.

Color Scheme

The official color of the HarvestHub logo is green with the color code #CAD85A. This shade of green reinforces the app’s connection to nature, growth, and sustainability. It is vibrant and fresh, aligning well with the themes of local food sourcing and eco-friendly practices. Additionally, the logo is designed to be versatile and can also be used in black and white versions. This flexibility ensures that the logo maintains its visual impact and readability across different backgrounds and media.

Harvest HUB

Chapter 16: Design of Harvest Hub app

In this chapter, we delve into the UX (User Experience) and UI (User Interface) design principles applied in the development of the EV Adventure App. This application aims to deliver a seamless and engaging experience for users exploring adventure, culinary, and cultural activities, while also providing robust infrastructure for electric vehicle (EV) charging. The app's design is crafted to meet the needs and expectations of modern users, particularly those who prioritize environmental consciousness and seek convenience in their travel experiences.

The design of the EV Adventure App is anchored in three core principles:

- User-Centric Design: Prioritizing the needs and behaviors of users.
- Intuitive Navigation: Ensuring easy and seamless navigation through the app.
- Aesthetic Appeal: Creating a visually pleasing interface that enhances user engagement

1.1 Methodology User-Centric Design

Understanding our target users adventurers, food enthusiasts, and culture seekers who also drive electric vehicles was paramount. Starting from the analysis in the previus chapter, I began by comprehending customer needs and gathered insights through surveys and interviews. These insights shaped every aspect of the app's design, from onboarding to content presentation and integration of EV-specific features.

The app aims to provide quick access to information without the need to navigate through complex menus. Users expressed a strong preference for personalized recommendations tailored to their specific interests and travel habits. This led us to incorporate features such as customized activity suggestions and tailored EV charging solutions based on the user's vehicle and location.

Visual appeal was another key insight. Users are more likely to engage with an app that is functional and visually appealing. Therefore, the app significant emphasis on creating a visually engaging interface that captures users' attention from the moment they launch the app. This involved careful selection of color schemes, typography, and imagery that resonate with themes of adventure, culinary exploration, and cultural enrichment.

Intuitive Navigation

The app is designed to be intuitive and easy to navigate, minimizing the learning curve for new users. Key elements include:

Clear and Consistent Icons: Three main flow represent each main section (adventure, culinary, culture) and are used consistently throughout the app.

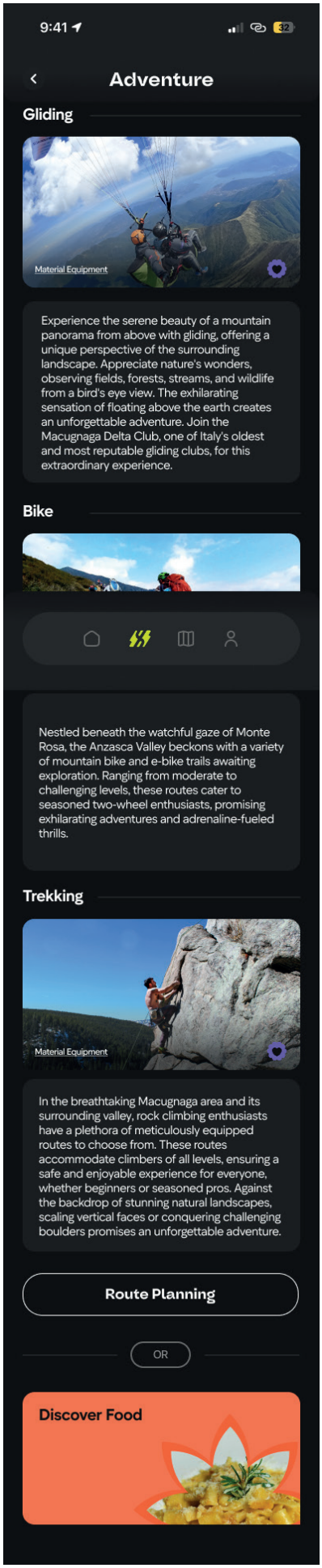
Simple Onboarding Process: A step-by- step onboarding process introduces users to the app's features and navigation.

Logical Flow: The user journey is designed to progress logically, ensuring users can easily discover and engage with content of interest. To achieve intuitive navigation, I adopted a user-centered design approach, emphasizing clarity and simplicity.

The navigation visually represents the harvest hub, symbolized by the electric charging station, and activities available in the area along with the remaining distance in kilometers.

During the onboarding process, users are guided through the app's core features with clear instructions. This process includes pop up and tooltips that explain how to use the app's primary functions, such as finding activities, booking experiences, and locating EV charging stations. By gradually introducing these features, we aim to prevent users from feeling overwhelmed and ensure a smooth transition into using the app.

The logical flow of the user journey is designed to minimize friction and enhance user satisfaction. For example, once an activity is selected, users are seamlessly guided through subsequent steps such as choosing a date, selecting a location, and accessing additional information about the activity. This structured approach ensures that users can easily follow the process without confusion or frustration.



Aesthetic Appeal

The visual design is crucial in creating an engaging user experience. The app uses a harmonious color palette and soft, rounded shapes to evoke a sense of friendliness and approachability. The symbols for the three sections—adventure, culinary, and culture—are designed to be visually distinct yet cohesive, using floral motifs that resonate with the themes of nature and exploration.

Color Scheme

The main color of the app is green lime, which is used for accents throughout the application. This vibrant color helps indicate the flow users should follow and enhances accessibility by providing clear visual cues. It symbolizes energy, growth, and the connection to nature, aligning perfectly with the app's themes of exploration and sustainability.

Purple: Represents adventure, symbolizing creativity and excitement.

Red: Represents culture, evoking passion and warmth.

Green: Represents culinary experiences, symbolizing freshness and sustainability, and serves as the primary accent color throughout the app.

By strategically using green lime as the accent color, we create a consistent visual language that guides users through the app. For example, green lime is used to highlight buttons, links, and other interactive elements, making it immediately clear where users should click or tap to proceed. This color coding not only enhances the overall aesthetic but also improves usability by providing intuitive visual guidance.

The use of green lime also extends to accessibility features. High-contrast elements ensure that users with visual impairments can easily distinguish important information and navigate the app effectively. This commitment to accessibility reflects our broader goal of making the app inclusive and user-friendly for all.

Copy

The app uses a clean, modern typeface that is easy to read on various screen sizes. Headings are bold to draw attention, while body text is kept simple and legible. The use of lime green in headings and important text elements ensures that key information stands out.

The choice of typography balances aesthetics with functionality. The primary typeface is a sans-serif font known for its readability and contemporary appearance. This choice aligns with the app's modern and dynamic character. Headings and subheadings use a bold version of the font, creating a clear hierarchy that helps users quickly scan and find relevant information.

Icons and Imagery
Icons are designed to be simple and intuitive, using floral motifs to maintain

thematic consistency.

High-quality images and illustrations enhance the visual appeal and provide users with a glimpse of the activities available.

Methodology of the Wireframe Design

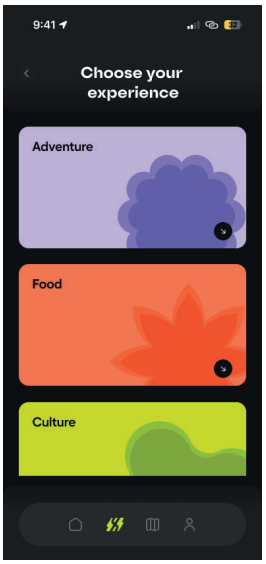
In designing the wireframe for our gamification tool, we aimed to create a user-friendly interface that ensures intuitive navigation and optimal functionality. The wireframe is divided into two primary sections: Onboarding and Usage. This division reflects the user's journey from initial interaction with the app to regular usage, providing a clear structure that enhances user experience.

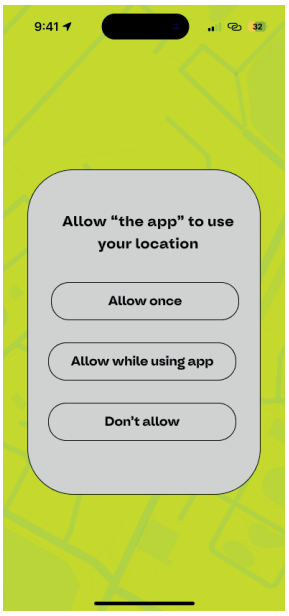
Wireframe Structure

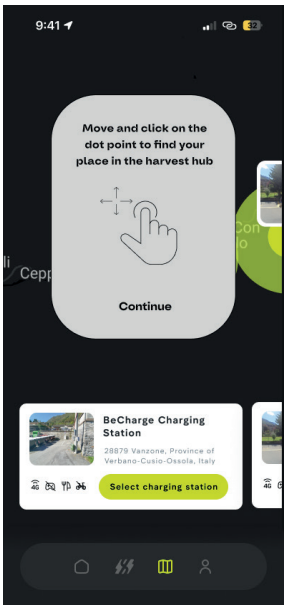
The wireframe, as illustrated in the accompanying diagram, employs a five-column grid system. This grid system is a common design framework for smartphone interfaces, providing a balanced layout that accommodates various screen sizes and orientations. The use of a five-column grid helps maintain consistent spacing and alignment, ensuring that the interface elements are well-organized and accessible.

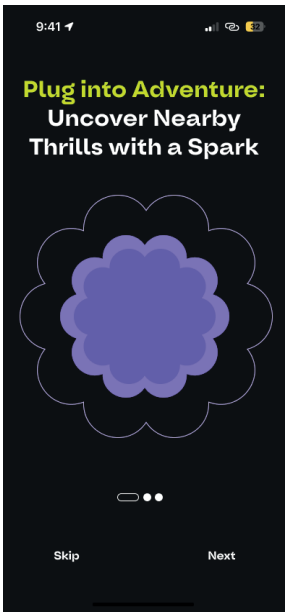
Loading Logo: The initial screen displays the app's logo, establishing brand identity.

3 Steps of Knowledge: This section provides introductory information to familiarize users with the app's features and benefits.









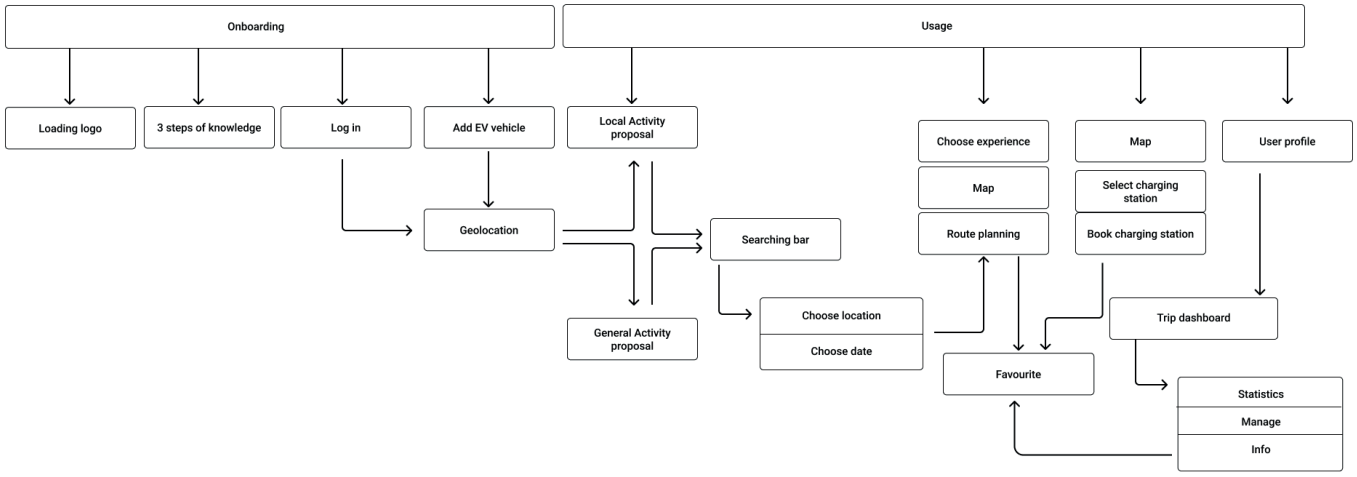
Log In: Users are prompted to log in to access personalized features.
Add EV Vehicle: Users input details about their electric vehicle, enabling the app to tailor recommendations and calculations.
Geolocation: The app uses geolocation to suggest local activities and relevant information based on the user's location.

Local Activity Proposal: Based on the user's location, the app proposes local activities.
General Activity Proposal: In the absence of specific local data, the app provides general activity suggestions.
Usage
Choose Experience: Users can select from various experiences, such as scenic routes or efficient travel plans.
Map: An interactive map feature allows users to visualize routes and points of interest.
Route Planning: Users can plan their routes, considering factors such as charging stations and travel time.

Select Charging Station: The app helps users find and select nearby charging stations.
Book Charging Station: Users can book charging stations directly through the app.

Trip detail: This detail provides an overview of the user's trips, including statistics of the travel.
User Profile: Users can manage their profile information and view their app activity.
Favourite: Users can save favorite experiences.
Statistics: This section provides detailed statistics on the user's travel
Manage: Users can manage the charging station connect or disconnect the car and also see the benefit of using and travel thanks to an EV car.
Info: Additional information and support are available here.

Wireframe



Grid System and Margins

The five-column grid system is chosen for its effectiveness in smartphone UI design. It ensures that:

Consistency: Interface elements are uniformly spaced and aligned, providing a clean and organized look.
Accessibility: Buttons and interactive elements are appropriately sized and spaced, making them easy to tap and interact with on small screens.
Scalability: The layout adapts well to various screen sizes and resolutions, ensuring a consistent user experience across different devices.
Margins are set to provide adequate spacing around the edges of the screen and between interface elements. This spacing helps prevent clutter, making the interface more readable and navigable. The margins ensure that users can interact with the app comfortably, without accidentally tapping adjacent elements.

Onboarding

The onboarding process is the user's first interaction with the app, designed to be informative and engaging:

Welcome Screen: A brief welcome message introducing the app's purpose and benefits.
Introduction to Sections: Each of the three main sections (adventure, culinary, and culture) is introduced with its respective icon and a brief description.
Permission Requests: The app requests permissions for location services and vehicle information, explaining how these enhance the user experience.
Section Exploration
Once onboarded, users can explore the three main sections of the app:

Adventure (Explorer DNA): Users can browse various adventure activities, view detailed descriptions, and select activities based on their interests and available dates. The tagline here is "Plug into Adventure: Uncover Nearby Thrills with a Spark."
Culinary (Taste & Memories): This section offers insights into local cuisine, including restaurant recommendations

Activity Selection and Planning

Users select an activity by choosing a date and location. The app provides recommendations for related activities and nearby EV charging stations, ensuring a seamless travel experience. Each activity page includes detailed descriptions, user reviews, and essential information such as required equipment and booking options.

Material Equipment and Route Planning

In the adventure section, users can access information on necessary material equipment for activities such as gliding, biking, and trekking. This feature helps users book activities, rent equipment, or discover shops for their needs. Similarly, in the food section, users can explore local culinary shops, while in the culture section, users can book museum visits. The route planning

tool allows users to navigate through the map, showing the harvest hub centers for activities and their proximity to charging stations and points of interest.

Booking Charging Stations

the booking of charging stations, providing practical information and icons. Each icon has specific meanings:

-Power Plug Icon: Indicates the type of connection (e.g., CCS Type 2)

-Battery Icon with Percentage: Shows the estimated battery level upon arrival

-4g Icon: In case of internet cover in the area

-Game and Restaurant: In case there are activities to do near by or restaurants

-Wheel chair: For highlight the possibility to use the charging station for disabled

-Euro Symbol: Displays the cost of charging

-Bicycle Icon: Indicates facilities for e-bikes.

-Lightning Bolt: Denotes high-power charging (e.g., 100kW).

These icons correlate with the app's ability to mitigate range anxiety by providing real-time updates on battery levels and estimated charging costs. When users add their vehicle information, the app immediately calculates these estimates, ensuring users have all necessary details before starting their journey. At the end of the flow users can also see their favorite activities selected previously, integrating their travel plans seamlessly with their charging needs.

User Profile Management

The user profile section of the Harvest Hub app is an integral component, designed to provide users with a comprehensive view of their EV usage and overall engagement with the app. This section is divided into three primary screens: Statistics, Manage, and Info.

Manage

The Manage screen empowers users to control their charging sessions and optimize their travel experience. Key features include:

Remote Charging Management: Users can start and stop charging sessions remotely, providing flexibility and convenience. This feature ensures that users can manage their vehicle's charging status even when they are not physically present at the charging station.

Earn Benefits: The app incorporates gamification to incentivize sustainable practices. Users earn rewards and benefits for actions such as saving g CO_2eq/km. These rewards can be redeemed for discounts on future

activities, charging sessions, or other perks within the app.
The coupon incentive Local Engagement: The app encourages users to explore local areas and use various modes of transportation. Information on local mobility options and intermodal transport (such as combining EV use with public transport or bike rentals) is provided, promoting a more integrated and sustainable travel experience.

In case of charging problem useful numbers and support users can access important contact information and support services directly from the Manage screen. This include, customer service for charging stations, and local support for travel-related inquiries.
These features aim to enhance user engagement with the app and promote the use of local resources, fostering a sense of community and sustainability.

Clarification on Gamification Tool for Calculating g CO2eq/km

The gamification tool designed to calculate the greenhouse gas emissions (g CO2eq/km) of passenger cars under real-world conditions. This tool is the result of a collaboration between Concawe, a division of the European Fuel Manufacturers Association, and IFP Energies nouvelles (IFPEN).

Concawe and IFPEN Overview
Concawe was established in 1963 to conduct research on environmental issues pertinent to the fuel manufacturing industry. Its scope has expanded to include fuel quality, emissions, air and water quality, soil contamination, waste management, occupational health and safety, petroleum product stewardship, and cross-country pipeline performance. Concawe's mission is to provide impartial scientific information to:

Improve understanding of the environmental, health, safety, and economic performance of petroleum refining and refined products.
Assist in developing cost-effective policies and legislation for EU institutions and Member States.
Enable informed decision-making and legislative compliance by its members.
Concawe operates with principles of sound science, transparency, and cost-effectiveness, engaging in partnerships and maintaining observer status at international organizations such as UNECE, OSPAR Commission, and WHO.

IFP Energies nouvelles (IFPEN) is a major player in research and training in energy, transport, and the environment. IFPEN's activities are centered on innovation across four strategic directions: climate, environment and circular economy, renewable energies, sustainable mobility, and responsible oil and gas. IFPEN supports ecological transition and the creation of value in French and European economic activities, particularly in sectors related to mobility, energy, and eco-industry.

Tool Overview and Parameters
The tool allows users to set variables for Hybrid Electric Vehicles (HEV) and

Battery Electric Vehicles (BEV) and compare their life cycle greenhouse gas emissions. For this study, the following parameters were selected:

BEV: Battery capacity set to 80 kWh, reflecting the specifications of a Tesla Model Y.
HEV: Battery capacity set to 2 kWh, representing a typical value for a diesel-equivalent hybrid vehicle.
Electricity Carbon Intensity: Set to 395 gCO2eq/kWh, corresponding to the average value for Italy.
Fuel: E10 bioethanol, one of the most commonly used biofuels.
The tool considers various emission sources, including manufacturing, fuel Well-to-Tank (WTT), and recycled CO2. By comparing the emissions between HEV and BEV, the tool calculates the g CO2eq/km saved, providing users with rewards and coupons within the app.

The decision to compare BEV and HEV, rather than including traditional fuel or diesel cars, is based on several scientific and methodological considerations:

Relevance to Current and Future Mobility Trends: The transition towards electrification is a critical pathway for reducing greenhouse gas emissions in the transport sector. BEVs and HEVs represent the current spectrum of electrification technologies, making them highly relevant for comparative analysis.

Lifecycle Emissions Focus: The study aims to provide a comprehensive life cycle assessment (LCA) of emissions. While traditional fuel and diesel cars have well-documented emissions profiles, the nuanced differences between HEV and BEV emissions, especially in terms of manufacturing and fuel production, require detailed comparison.

Consistency with Policy and Market Trends: European policies and market trends are increasingly favoring electrified vehicles. Understanding the emissions implications of various electrification levels supports policy development and consumer decision-making aligned with these trends.

Scientific Methodology: The tool's design ensures an impartial comparison by considering standard parameters and publicly available data. The focus on electrified vehicles aligns with scientific methodologies that emphasize emerging technologies' role in sustainability

The tool's gamification approach not only quantifies emissions but also incentivizes users to adopt greener transportation options by offering tangible rewards, thereby promoting sustainable mobility practices.

Statistics

The Statistics screen is a hub of user analytics, providing detailed insights into charging history and energy consumption over time. This section allows users to:

Track Progress: Users can monitor the kilometers driven with their electric vehicle each month. This data is crucial for estimating CO2 savings and understanding the environmental impact of their travels. By visualizing the distance covered in different months, users can see their driving patterns and identify opportunities to increase their eco-friendly travel.

By providing these detailed statistics, the app not only informs users about their energy consumption but also encourages them to adopt more eco-friendly driving habits through continuous feedback and incentives.

Info

The Info screen serves as a comprehensive resource center, providing users with all the necessary information to maximize their app experience. This section includes:

Edit Profile: Users can update their personal information, including their name, contact details, and vehicle information. This ensures that the app's recommendations and analytics are tailored to their specific needs and preferences.

Support: A dedicated support section provides answers to frequently asked questions, troubleshooting tips, and contact information for customer service. This ensures that users can quickly resolve any issues they encounter.

My Favorites: Users can save their favorite activities, charging stations, and locations for easy access in the future. This feature enhances the convenience and personalization of the app.

Change Vehicle: Users can update their vehicle information if they switch to a different electric vehicle. This ensures that the app's recommendations and analytics remain accurate and relevant.

By offering a wealth of resources and support options, the Info screen ensures that users have access to all the information they need to make the most of the Harvest Hub app.

Copywriting and Concept

The app uses the metaphor of "charging" to connect the themes of electric vehicles with personal enrichment through adventure, culinary experiences, and cultural exploration. This metaphor is consistently reinforced throughout the app, from the visual design elements to the copywriting. The idea is that just as electric vehicles need to be charged to continue their journey, users can "charge" their lives with new experiences and discoveries through the app.

Error Handling: The 404 Page

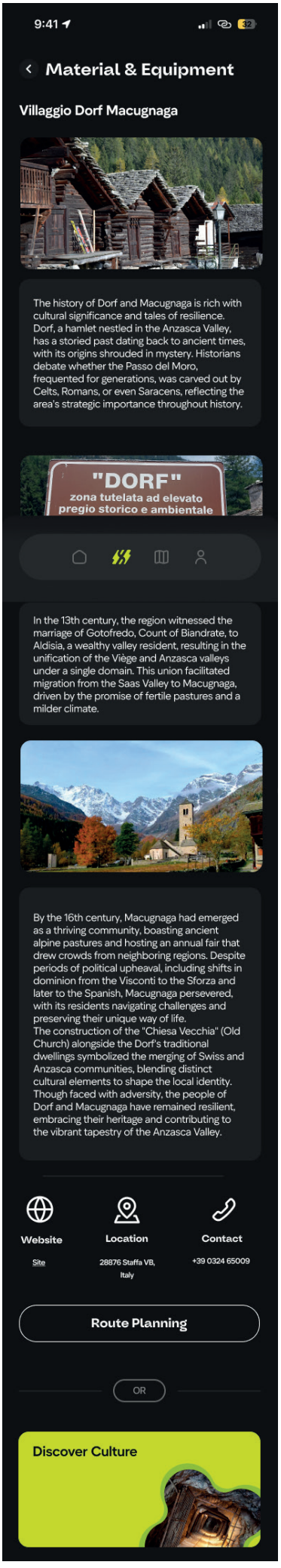
When users encounter a part of the app that is not yet developed, they are redirected to a custom 404 page:

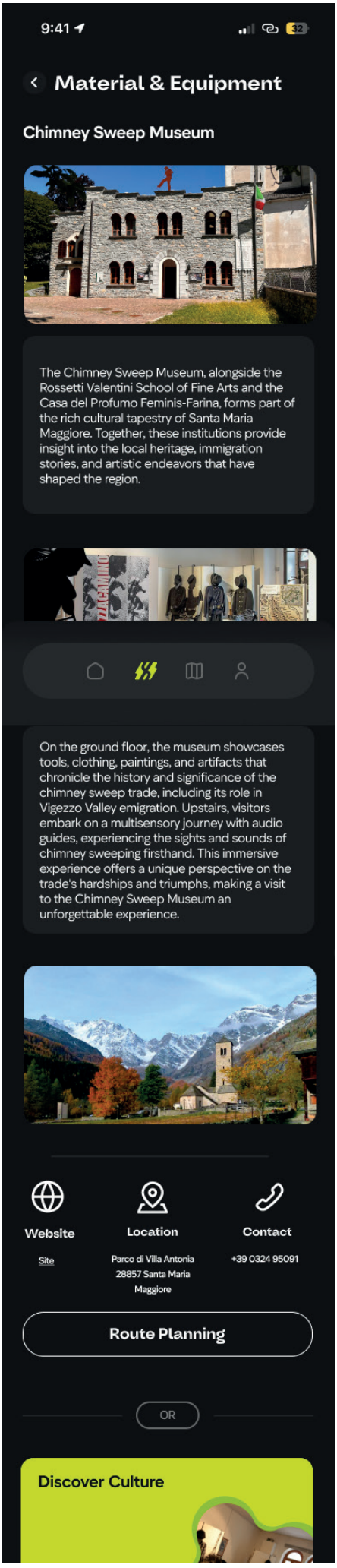
Design: The background mimics Google Maps with distorted electric charging station symbols, creating a sense of confusion.
Message: A friendly message informs users that they have ventured into an undeveloped part of the app.
Navigation Aid: A clickable path guides users back to the Harvest Hub, the central point for finding activities.

Proactive Suggestions

The EV Adventure App proactively suggests activities and experiences based on user preferences, location, and the sustainability of the surrounding area.

Exploring Sustainability and Culture
The app's proactive suggestion feature allows users to discover sustainable practices and cultural activities in their vicinity. The Harvest Hub acts as the central point where users can explore

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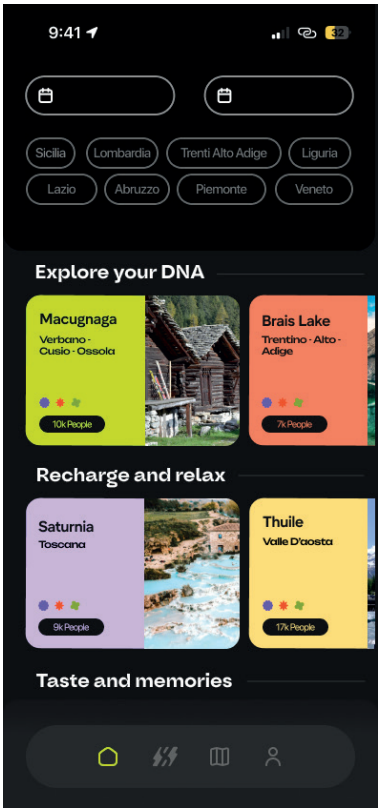
Material & Equipment
Chimney Sweep Museum
The Chimney Sweep Museum, alongside the Rossetti Valentini School of Fine Arts and the Casa del Profumo Feminis-Farina, forms part of the rich cultural tapestry of Santa Maria Maggiore. Together, these institutions provide insight into the local heritage, immigration stories, and artistic endeavors that have shaped the region.
On the ground floor, the museum showcases tools, clothing, paintings, and artifacts that chronicle the history and significance of the chimney sweep trade, including its role in Vigezzo Valley emigration. Upstairs, visitors embark on a multisensory journey with audio guides, experiencing the sights and sounds of chimney sweeping firsthand. This immersive experience offers a unique perspective on the trade's hardships and triumphs, making a visit to the Chimney Sweep Museum an unforgettable experience.
Website
Site
Location
Parco di Villa Antonia
28857 Santa Maria
Maggiore
Contact
+39 0324 95091
Route Planning
OR
Discover Culture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Sicilia
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Trenti Alto Adige
Liguria
Lazio
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Piemonte
Veneto
Explore your DNA
Macugnaga
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10k People
Brais Lake
Trentino · Alto · Adige
7k People
Recharge and relax
Saturnia
Toscana
9k People
Thuile
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Taste and memories


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Error
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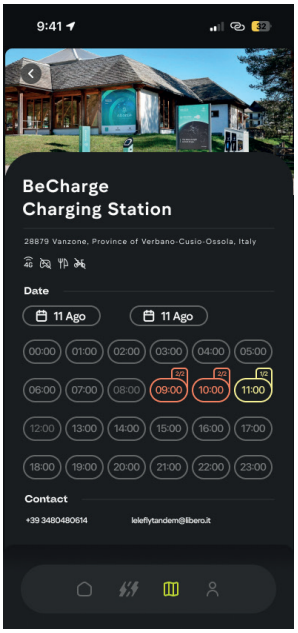
Return in your
Harvest HUB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BeCharge
Charging Station
28879 Vanzone, Province of Verbano-Cusio-Ossola, Italy
Date
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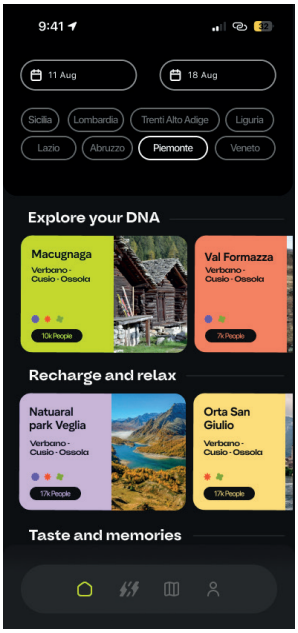
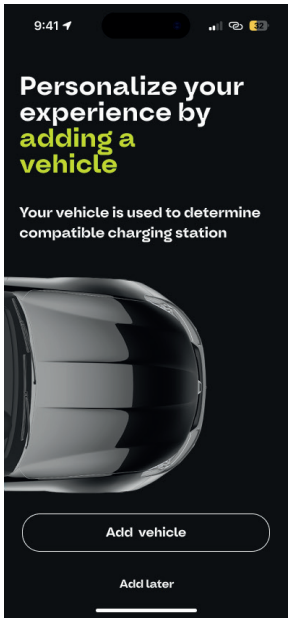
Contact
+39 3480480614
lelefiytandem@libero.it


9:41
11 Aug
18 Aug
Sicilia
Lombardia
Trenti Alto Adige
Liguria
Lazio
Abruzzo
Piemonte
Veneto
Explore your DNA
Macugnaga
Verbano-Cusio-Ossola
10k People
Val Formazza
Verbano-Cusio-Ossola
7k People
Recharge and relax
Natuaral park Veglia
Verbano-Cusio-Ossola
17k People
Orta San Giulio
Verbano-Cusio-Ossola
17k People
Taste and memories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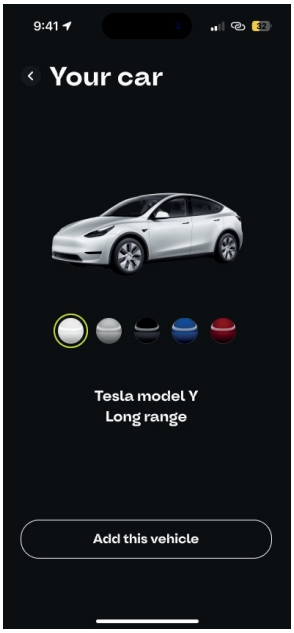
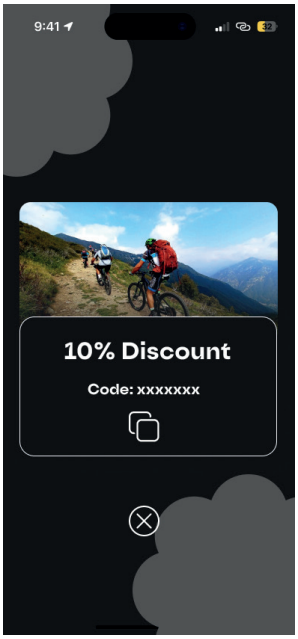
Personalize your experience by adding a vehicle
Your vehicle is used to determine compatible charging station
Add vehicle
Add later


9:41
Your car
Tesla model Y
Long range
Add this vehicle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10% Discount
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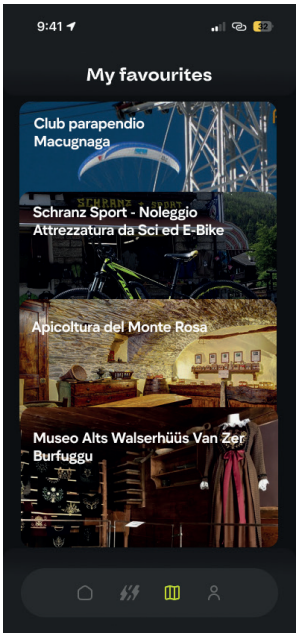
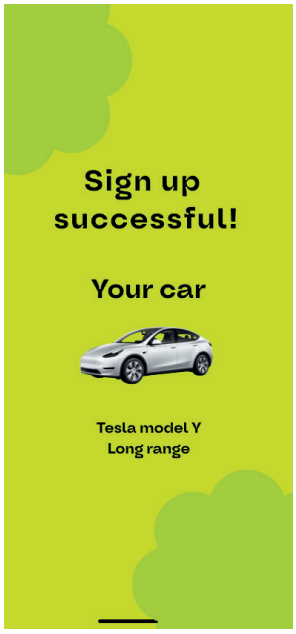
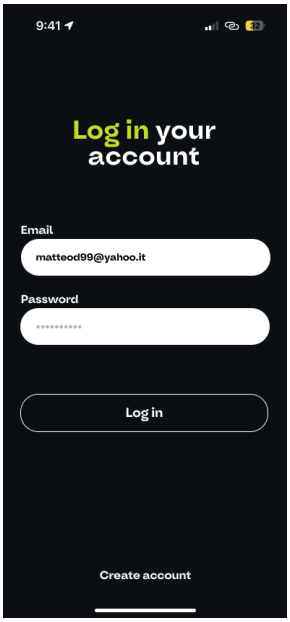

9:41
My favourites
Club parapendio Macugnaga
Schranz Sport - Noleggio Attrezzatura da Sci ed E-Bike
Apicoltura del Monte Rosa
Museo Alts Walserhüüs Van Zer Burfuggu


Sign up successful!
Your car
Tesla model Y
Long range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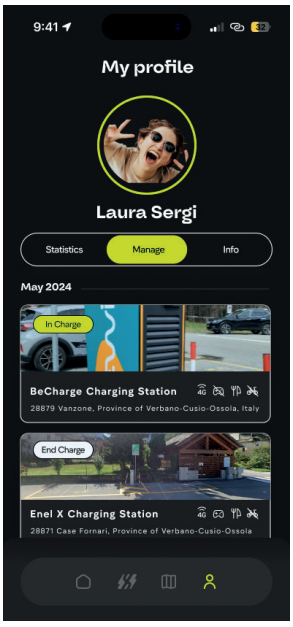
Log in your account
Email
matteod99@yahoo.it
Password
Log in
Create account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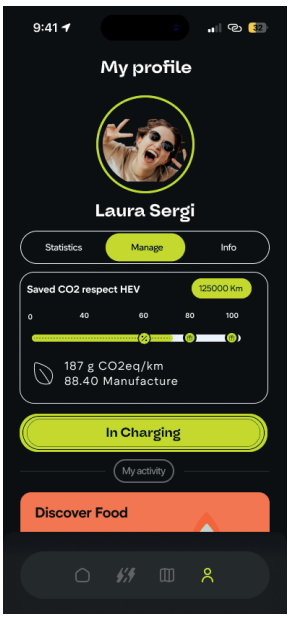
My profile
Laura Sergi
Statistics
Manage
Info
May 2024
In Charge
BeCharge Charging Station
28879 Vanzone, Province of Verbano-Cusio-Ossola, Italy
End Charge
Enel X Charging Station
28871 Case Fornari, Province of Verbano-Cusio-Ossola


9:41
My profile
Laura Sergi
Statistics
Manage
Info
Saved CO2 respect HEV
125000 Km
0 40 60 80 100
187 g CO2eq/km
88.40 Manufacture
In Charging
My activity
Discover Food


Toceno
Via Cravaggia
Prestinone
La Riva
Siberia
0.3 km

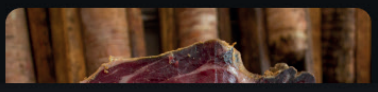
9:41

Food

Honey Valle Anzasca

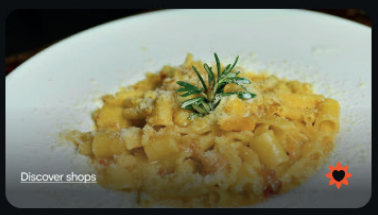
In Val d'Ossola, honey is a key product, including the alpine millefiori and linden varieties, abundant in the region. Rhododendron essence, honeydew, and propolis are also sought after. Chestnut honey pairs well with aged cheeses, while acacia honey is ideal for snacks or with medium-aged cheeses.

Nero Piemontese



Known as Nero Piemontese or Nero di Cavour, the Nero di Razza is characterized by a black coat, white face, and white socks on the front legs. This rustic breed, with males weighing over 200 kilograms, is suitable for free-range or semi-free-range farming, ensuring high-quality meat due to the animals' freedom of movement and nutrition.

Pasta alla macugnaghese



Try the delicious Pasta alla Macugnaghese, a hearty and flavorful dish from the Italian town of Macugnaga, nestled at the foot of the eastern wall of Monte Rosa. This mountain classic features pasta, potatoes, pancetta, onion, and Toma cheese. It's a must-try for a taste of authentic Piedmontese cuisine!

Route Planning

OR

Discover Culture

9:41

Adventure

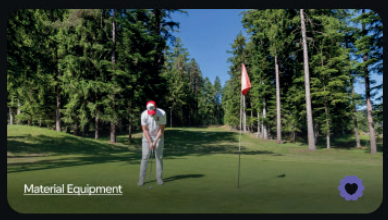
Praudina Adventure Park

Located in the heart of Valle Vigezzo's "green" activities, the Praudina Adventure Park in Santa Maria Maggiore offers a renewed experience since spring 2019. Managed by ASD Pulsar, this eco-friendly park now features an exciting zipline course, funded by the Region of Piedmont and GAL Laghi e Monti del Verbano Cusio Ossola. Suitable for both kids and adults, it provides a fun and engaging activity amidst the pine forest's rich sporting facilities.

Vigezzo Bike lend

Valle Vigezzo in Val d'Ossola is an ideal nature retreat, offering a variety of outdoor activities. A highlight is the nearly 15 km cycling path from Druogno to Re, perfect for families. This flat, shaded trail winds through lush forests, providing a safe and scenic ride for cyclists of all ages. It's a perfect way to enjoy the serene beauty of the valley.

Golf Santa Maria



Santa Maria Maggiore boasts a beautiful 1,500-meter, nine-hole golf course set in a stunning pine forest. The course, featuring par 30 holes, includes a practice area with putting and pitching greens. Nestled in a valley surrounded by mountains and coniferous woods, Golf Santa Maria offers a rejuvenating experience for players of all ages. The 180-meter practice range is perfect for beginners looking to try this increasingly popular sport.

Route Planning

OR

Discover Food

9:41

Material & Equipment

Piana di Vigezzo

The modern 8-seater cable car from Prestinone in Craveggia takes you to the Vigezzo Plain ski resort in just ten minutes. Enjoy breathtaking views of Val Grande and Monte Rosa. With over 20 km of slopes suitable for all levels, including easy snowshoeing and tobogganing tracks, there's something for everyone at Vigezzo Plain.

Website	Location	Contact
Site	Piana di Vigezzo Via Carlo Fornara Pittore, 13 28852 Prestinone VB	+39 351 6333560 info@pianadivigezzo.it

Route Planning

OR

Discover Culture

9:41

Material & Equipment

Schranz Sport - Noleggio Attrezzatura da Sci ed E-Bike

Schranz Sport provides a comprehensive range of rental services to cater to all your skiing and e-biking needs. Our expertly maintained ski equipment includes skis, boots, and poles, ensuring a comfortable and enjoyable experience on the slopes

Route Planning

OR

Discover Culture

Chapter 17: Interview

This thesis investigates the critical role of sustainable mobility solutions in transforming the tourism landscape within the Verbano-Cusio-Ossola (VCO) province. By examining the perspectives and contributions of key stakeholders involved in the promotion and implementation of electric vehicle (EV) tourism, this study aims to elucidate the challenges, opportunities, and impacts of e-mobility on local tourism and the economy.

To gain a comprehensive understanding of this topic, interviews were conducted with influential figures such as Francesco Gaiardelli, President of the Distretto Turistico dei Laghi, and Andrea Grotto, a researcher involved in the MOBSTER project. These discussions provide valuable insights into strategic planning, stakeholder engagement, and innovative initiatives that drive sustainable tourism in the region.

Francesco Gaiardelli's extensive experience and leadership in the Distretto Turistico dei Laghi highlight the efforts to integrate eco-friendly transportation options with cultural and environmental preservation. His role underscores the importance of strategic coordination among various stakeholders to achieve a balanced and sustainable tourism model. As President, Gaiardelli oversees tourism initiatives, ensuring alignment with sustainability goals. His responsibilities include strategic planning, stakeholder engagement, and promoting eco-friendly transportation options. Andrea Grotto's involvement in the MOBSTER project illuminates the practical aspects of implementing e-mobility infrastructure. His research and project management expertise in localizing charging points and developing prototypes offer a detailed perspective on the technical and logistical challenges encountered during the project's execution. Grotto's role involved researching and managing the implementation of charging infrastructure, contributing significantly to the project's success. The interviews also address the broader context of sustainable mobility, focusing on the main challenges and opportunities faced by the VCO province. Key issues include the uneven distribution of charging infrastructure, the need for increased awareness and acceptance of electric vehicles, and the integration of sustainable mobility solutions with existing tourism infrastructure. Gaiardelli and Grotto highlight the primary challenge of integrating sustainable mobility with the current tourism framework while promoting electric vehicles to locals and tourists. By analyzing these interviews, this thesis aims to contribute to the broader discourse on sustainable tourism and e-mobility. It seeks to provide practical recommendations for policymakers, stakeholders, and tourism operators to foster a more sustainable and environmentally conscious tourism industry in the VCO province and beyond.

Section 1: Understanding the Stakeholder's Role and Perspective

Interview Andrea Grotto

Role of the Stakeholder in the MOBSTER Project

Q: Could you describe your role within the MOBSTER project?

A: I was a researcher involved in the localization of charging points and project management for the creation of two charging prototypes.

Q: How long have you been involved, and what are your main responsibilities?

A: I have been involved from 2020 until the end of the project in 2022. My main responsibilities included researching and managing the implementation of charging infrastructure.

Perception of Current Challenges and Opportunities

Q: From your perspective, what are the main challenges that the VCO province faces in terms of sustainable mobility and tourism?

A:The main challenge is to make tourism more sustainable through the use of electric mobility. We aim to promote sustainable tourism by integrating electric boats and other eco-friendly transport options. The uneven knowledge of new technologies among stakeholders and citizens is also a challenge, as these technologies were relatively new and emerging during the COVID-19 pandemic.

Q: What opportunities arise from initiatives like MOBSTER?

A: Initiatives like MOBSTER provide the opportunity to experiment with sustainable tourism that incorporates eco-friendly transportation. For example, the use of electric bikes in Barcelona aimed to enhance sustainability in tourism.

Section 2: Impact of E-mobility on Tourism and the Local Economy

Impact on Tourism

Q: How has the introduction of e-mobility solutions (e.g., e-bike networks, electrification of public transport) influenced tourism in the VCO region?

A:The planning and identification of points of interest were methodically approached to study their effects. While the full impact will be seen in the future, strategic placement allows us to monitor and control the outcomes. Preliminary feedback indicates a positive direction, but it's still a transitional period.

Q: Have there been noticeable changes in visitor behavior or tourist patterns?

A:It's difficult to quantify the benefits during this transitional phase. However, feedback from local administrations and monitoring of mobile charging infrastructure in remote areas indicate that visitors' patterns are gradually shifting. For instance, in South Tyrol, post-project information shows increased tourist flows to mountain huts due to better accessibility.

Q: What communication methods were used?

A: During the project, meetings with

public administrations and communities were held to discuss interventions and potential impacts. We also utilized websites and social media platforms like LinkedIn and Facebook to keep the community informed.

Economic Aspects
Q: How do you think sustainable mobility initiatives contribute to the local economy?
A: Sustainable mobility initiatives can boost the local economy by attracting more tourists who prefer eco-friendly travel options.

Q: Are there specific sectors (e.g., hospitality, local businesses) that have visibly benefited?
A:Yes, sectors such as hospitality and local businesses have benefited. For example, hotels and restaurants have seen an increase in visitors due to improved accessibility and the novelty of sustainable transport options.

Section 3: Integration of Sustainable Mobility with Local Culture and Environment

Cultural and Environmental Sustainability
Q: How does the promotion of sustainable mobility align with efforts to preserve local culture and protect the environment?
A:Promoting sustainable mobility aligns with cultural and environmental preservation efforts by reducing pollution and traffic congestion, thereby protecting natural landscapes and cultural sites. It fosters a tourism model that respects and preserves local heritage.

Q: Are there challenges or considerations regarding the integration of new mobility solutions with existing cultural and environmental landscapes?
A:Yes, integrating new mobility solutions with existing landscapes requires careful planning to ensure that these solutions complement rather than disrupt the local environment and culture.

Community Involvement and Acceptance
Q: How has the local community responded to initiatives promoting sustainable mobility?
A: The local community has shown a positive response, particularly when initiatives include educational components such as school trips using electric boats to explore local lakes.

Q: What strategies have been successful in engaging residents and stakeholders in these initiatives?
A:Successful strategies include involving the community in planning stages, providing educational opportunities, and ensuring that local needs and preferences are considered in the implementation of sustainable mobility solutions.

Section 4: Future Directions and Recommendations

Future Projects and Initiatives
Q: What are the upcoming projects or initiatives to further promote

sustainable mobility in the VCO region?
A: Future projects include expanding the charging infrastructure and enhancing its interoperability to make it more user-friendly for tourists. We aim to provide high levels of assistance and support in multiple languages.

Q: Are there innovative ideas or plans that could further enhance the attractiveness of the region for sustainable tourism?
A: Yes, innovative plans include developing a comprehensive network of charging stations and promoting the use of electric public transportation, which will further enhance the region's appeal to eco-conscious tourists.

Research Recommendations
Q: Based on your experience, which areas or aspects related to sustainable mobility and tourism in the VCO could benefit from further research?
A: Further research is needed on the long-term impacts of sustainable mobility on local communities, including interdisciplinary studies on economic, technological, and environmental effects. Additionally, investigating the best ways to integrate traditional and electric mobility options could be beneficial.

Q: Any additional insights that might be relevant to my research?
A: It's important to conduct post-project evaluations to assess the effectiveness of implemented solutions and their impact on tourist flows and local economies. A comprehensive approach that includes technological, economic, and environmental studies will provide a clearer picture of the benefits of sustainable mobility.

Conclusion
Q: Is there any additional information or insight you would like to share that might be relevant for my research?
A:Evaluations after project completion are crucial. Understanding how increased tourist flows impact local communities and ensuring interdisciplinary research that includes technological, economic, and environmental impacts is essential for a holistic assessment.

Interview with Francesco Gaiardelli

Role of the Stakeholder in the EV Tourism Project

Q: Could you describe your role within the Distretto Turistico dei Laghi and how it relates to the promotion of sustainable tourism?
A: As President of the Distretto Turistico dei Laghi, my role involves overseeing tourism initiatives and ensuring they align with our sustainability goals. This includes coordinating with various stakeholders, promoting eco-friendly transportation options, and integrating cultural and environmental preservation into our tourism strategies.

Q: How long have you been involved in this role, and what are your main responsibilities?
A: I have been involved with the organization since 2018. My main responsibilities include strategic planning, stakeholder engagement, and promoting sustainable tourism initiatives. This involves working closely with local communities, businesses, and government agencies to develop and implement projects that benefit the region economically and environmentally.

Perception of Current Challenges and Opportunities

Q: From your perspective, what are the main challenges that the VCO province faces in terms of sustainable mobility and tourism?
A: The primary challenge is integrating sustainable mobility solutions with existing tourism infrastructure. There is also a need to increase awareness and acceptance of electric vehicles among locals and tourists. Additionally, we must address the uneven distribution of charging infrastructure to ensure accessibility across the region.

Q: What opportunities arise from initiatives like the promotion of EV tourism?
A: Initiatives like EV tourism provide the opportunity to reduce the environmental impact of travel, attract eco-conscious tourists, and enhance the overall visitor experience. They also encourage the development of related services, such as electric bike rentals and eco-friendly accommodations, which can boost the local economy.

Impact of E-mobility on Tourism and the Local Economy

Q: How has the introduction of e-mobility solutions influenced tourism in the VCO region?
A: E-mobility solutions have begun to transform tourism in the VCO region by making it more sustainable and appealing to environmentally conscious travelers. The availability of electric vehicle charging stations and e-bike rentals has improved accessibility to various attractions, leading to increased visitor satisfaction and longer stays.

Q: Have there been noticeable changes in visitor behavior or tourist patterns?

A: Yes, there has been a gradual shift in visitor behavior, with more tourists opting for sustainable transportation options. This shift is evident in the increased use of e-bikes and electric vehicles, as well as a growing interest in eco-friendly accommodations and activities.

Q: What communication methods were used to promote these initiatives?
A: We have employed a multi-faceted communication strategy, including social media campaigns, informational websites, and collaboration with local media. We also engage with the community through workshops and public meetings to raise awareness and encourage participation in sustainable tourism initiatives.

Economic Aspects

Q: How do you think sustainable mobility initiatives contribute to the local economy?
A:Sustainable mobility initiatives can significantly boost the local economy by attracting more tourists and encouraging longer stays. Eco-friendly travel options and related services create new business opportunities and jobs, particularly in the hospitality and transportation sectors.

Q: Are there specific sectors that have visibly benefited from these initiatives?
A: Yes, sectors such as hospitality, retail, and local crafts have seen a positive impact. Hotels and restaurants, in particular, have benefited from increased tourist traffic, while local businesses have experienced a surge in demand for eco-friendly products and services.

Integration of Sustainable Mobility with Local Culture and Environment

Q: How does the promotion of sustainable mobility align with efforts to preserve local culture and protect the environment?
A:Promoting sustainable mobility is closely aligned with our efforts to preserve local culture and protect the environment. By reducing pollution and minimizing the carbon footprint of tourism, we help maintain the natural beauty and cultural heritage of the VCO region. This approach fosters a tourism model that respects and preserves our local assets.

Q: Are there challenges or considerations regarding the integration of new mobility solutions with existing cultural and environmental landscapes?
A: Integrating new mobility solutions with existing landscapes requires careful planning to avoid disrupting the local environment and culture. It is crucial to ensure that these solutions complement the region’s unique characteristics and contribute to its preservation.

Community Involvement and Acceptance

Q: How has the local community responded to initiatives promoting sustainable mobility?

A: The local community has generally responded positively to these initiatives, particularly when they see the benefits in terms of reduced traffic congestion and improved air quality. Educational campaigns and community involvement in the planning stages have also helped gain acceptance and support.

Q: What strategies have been successful in engaging residents and stakeholders in these initiatives?
A: Successful strategies include involving the community in the planning process, providing clear and accessible information, and demonstrating the tangible benefits of sustainable mobility. Initiatives that include educational components and opportunities for local businesses to participate have also been effective.

Future Directions and Recommendations

Q: What are the upcoming projects or initiatives to further promote sustainable mobility in the VCO region?
A: Upcoming projects include expanding the network of charging stations, enhancing the interoperability of these systems, and promoting electric public transportation.

Q: Are there innovative ideas or plans that could further enhance the attractiveness of the region for sustainable tourism?
A: Yes, we are exploring innovative plans such as developing comprehensive networks of charging stations in scenic locations, promoting electric boat tours, and creating packages that combine sustainable transport with local cultural and culinary experiences. These initiatives aim to attract eco-conscious tourists and enhance the overall appeal of the region.

Q: Based on your experience, which areas or aspects related to sustainable mobility and tourism in the VCO could benefit from further research?
A: Further research is needed on the long-term impacts of sustainable mobility on local communities, particularly in terms of economic, environmental, and social effects. Investigating best practices for integrating traditional and electric mobility options and studying the effectiveness of different communication strategies could also be beneficial.
Conclusion

Q: Any additional insights that might be relevant to my research?
A: It is essential to conduct post-project evaluations to assess the effectiveness of implemented solutions and their impact on tourist flows and local economies. A holistic approach that includes technological, economic, and environmental studies will provide a clearer picture of the benefits of sustainable mobility.

Chapter 12: Conclusion

The journey toward electrifying mobility and integrating electric vehicles (EVs) into sustainable tourism and energy systems represents a pivotal step in addressing the urgent environmental challenges of our time. This thesis has examined the multifaceted landscape of EV adoption, focusing on technological innovations, infrastructure development, and user-centric service design to foster sustainable mobility.

Summary of Findings

1. Technological and Environmental Impact:

   EVs play a critical role in reducing greenhouse gas emissions and improving air quality. The shift from traditional internal combustion engine vehicles to electric vehicles is essential for mitigating climate change and enhancing public health.
   The adoption of EVs influences the broader energy ecosystem, necessitating the integration of renewable energy sources and the development of efficient charging infrastructure.
2. Infrastructure and Market Services:

   Comprehensive infrastructure is vital for the widespread adoption of EVs. This includes strategically placed charging stations, effective vehicle-to-grid (V2G) systems, and robust communication networks.
   Case studies, such as Tesla and Edison, illustrate successful models of EV infrastructure and market services. These cases highlight the importance of user-friendly design, efficient service delivery, and continuous innovation in the EV sector.
3. User-Centric Design and Service Methodology:

   Emphasizing user experience (UX) and user interface (UI) design is crucial in developing EV services. This includes creating intuitive apps, streamlined charging processes, and educational tools that encourage sustainable travel behaviors.
   The Harvest Hub app serves as a practical example, offering users seamless access to EV charging stations, local activities, and sustainable travel options.
4. Case Studies in Verbano-Cusio-Ossola (VCO):

   The analysis of Santa Maria Maggiore and Macugnaga provides insights into the successes and challenges of integrating EV infrastructure in tourist destinations. Santa Maria Maggiore showcases the benefits of well-planned infrastructure, while Macugnaga highlights areas for improvement and growth.
   These case studies demonstrate how targeted interventions can enhance both environmental sustainability and economic development, serving as models for other regions aiming to promote sustainable tourism

through EV adoption.

Implications for Sustainable Tourism

The integration of EV infrastructure into tourist destinations not only addresses environmental concerns but also offers significant economic and social benefits. By attracting eco-conscious tourists, regions can diversify their tourism offerings, stimulate local economies, and foster a culture of sustainability. This, in turn, inspires a gradual shift towards more eco-friendly travel behaviors, ensuring long-term positive impacts on the environment and local communities.

Future Directions

To fully realize the potential of electric mobility in promoting sustainable tourism, several key areas require ongoing attention:

Enhanced Infrastructure Development:

Continued investment in EV charging infrastructure, particularly in underserved areas, is essential. This includes both public and private sector involvement to ensure comprehensive coverage.
Technological Innovation:

Advancements in battery technology, V2G systems, and smart grid integration will further enhance the efficiency and appeal of EVs. Continued research and development are necessary to overcome existing barriers and improve the overall EV ecosystem.

Policy and Incentives:

Policymakers play a crucial role in facilitating EV adoption through supportive legislation, incentives, and public awareness campaigns. Collaboration between government, industry, and academia is vital for creating an enabling environment for sustainable mobility.
User Education and Engagement:

Educating users about the benefits of electric mobility and sustainable travel choices is crucial. Interactive tools, such as the Harvest Hub app, can empower users to make informed decisions and contribute to a greener future.

This thesis underscores the transformative potential of electric vehicles in achieving sustainable mobility and promoting eco-friendly tourism. By addressing the multifaceted challenges of EV adoption through technological innovation, infrastructure development, and user-centric design, we can pave the way for a brighter, greener future. The service design-based model demonstrated in the Verbano-Cusio-Ossola district exemplifies how targeted interventions can enhance both environmental sustainability and economic growth, with the potential for broader application across diverse global contexts. Embracing electric mobility and sustainable tourism not only mitigates environmental impacts but also enriches the tourism landscape, fostering a culture of sustainability that benefits both current and future.

Ringraziamenti

Volevo esprimere la mia più sincera gratitudine al mio professore Andrea Di Salvo, che è stato una guida fondamentale durante tutto il percorso della mia tesi. La sua competenza, dedizione e umanità sono state una fonte costante di ispirazione e motivazione. Grazie alla sua pazienza e al suo supporto, sono riuscito a superare i momenti più difficili e a raggiungere questo importante traguardo.

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Dedico questo grande traguardo a mia nonna Rina, che purtroppo ci ha lasciati quest'anno. La sua forza e il suo spirito combattivo mi hanno sempre ispirato, e il suo ricordo mi ha spinto a dare il massimo in ogni momento. Nonna, questo è per te.

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In conclusione, ringrazio tutti coloro che, in un modo o nell'altro, hanno contribuito a questo percorso. Ogni insegnamento, ogni consiglio e ogni gesto di supporto hanno avuto un ruolo cruciale nel mio viaggio. Grazie di cuore a tutti.

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