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MOTORWAY STATIONS (along A22) AS MULTIMODAL HUBS

Executive summary

The project addresses the strategic transformation of motorway toll stations into advanced multimodal hubs. With the implementation of the *free flow* system, which removes physical toll barriers, these infrastructural nodes can evolve from simple transactional points into gateways connecting the motorway network with public transport, rail, micro-mobility, and logistics. The overarching vision is to reduce traffic congestion and enhance regional accessibility through smoother and more integrated connections.

The research distinguishes between two station archetypes: traditional toll stations, limited to payment and basic maintenance functions, and new free flow stations, designed to maximize efficiency and continuity of movement. This shift enables the reuse of freed-up spaces for additional purposes, and reimagining all the motorway system, turning toll stations into multimodal hub and active interfaces with their surrounding territories. The project draws a parallel with medieval city gates, interport or LTZ area: system which regulated access, trade, and control: similarly, toll stations can evolve into strategic nodes mediating between diverse networks rather than remaining barriers.

Based on this perspective, a transformation matrix was developed to identify constant and variable features of toll stations and propose adaptable interventions. These range from public transport integration and electric vehicle charging to commercial, logistic, or recreational uses. Three scenarios along the Autostrada del Brennero (A22) illustrate practical applications: Bressanone (tourism and landscape regeneration), Trento Sud (micro-mobility and congestion mitigation), and Rovereto Sud (logistics, innovation, and EV infrastructure).

Finally, the study explores a future shaped by autonomous driving, electrification, and vehicle-to-infrastructure communication. In this context, toll stations become technologically advanced hubs, supporting sustainability and interconnection while providing replicable models for innovative infrastructural planning.

Key Words

Free-flow tolling systems, multimodal transportation hubs, territorial vocations

MoSt **A22** Hubs

Image 1: logo

MOTORWAY STATIONS (along A22) AS MULTIMODAL HUBS

Resilience

Trento Sud

2075

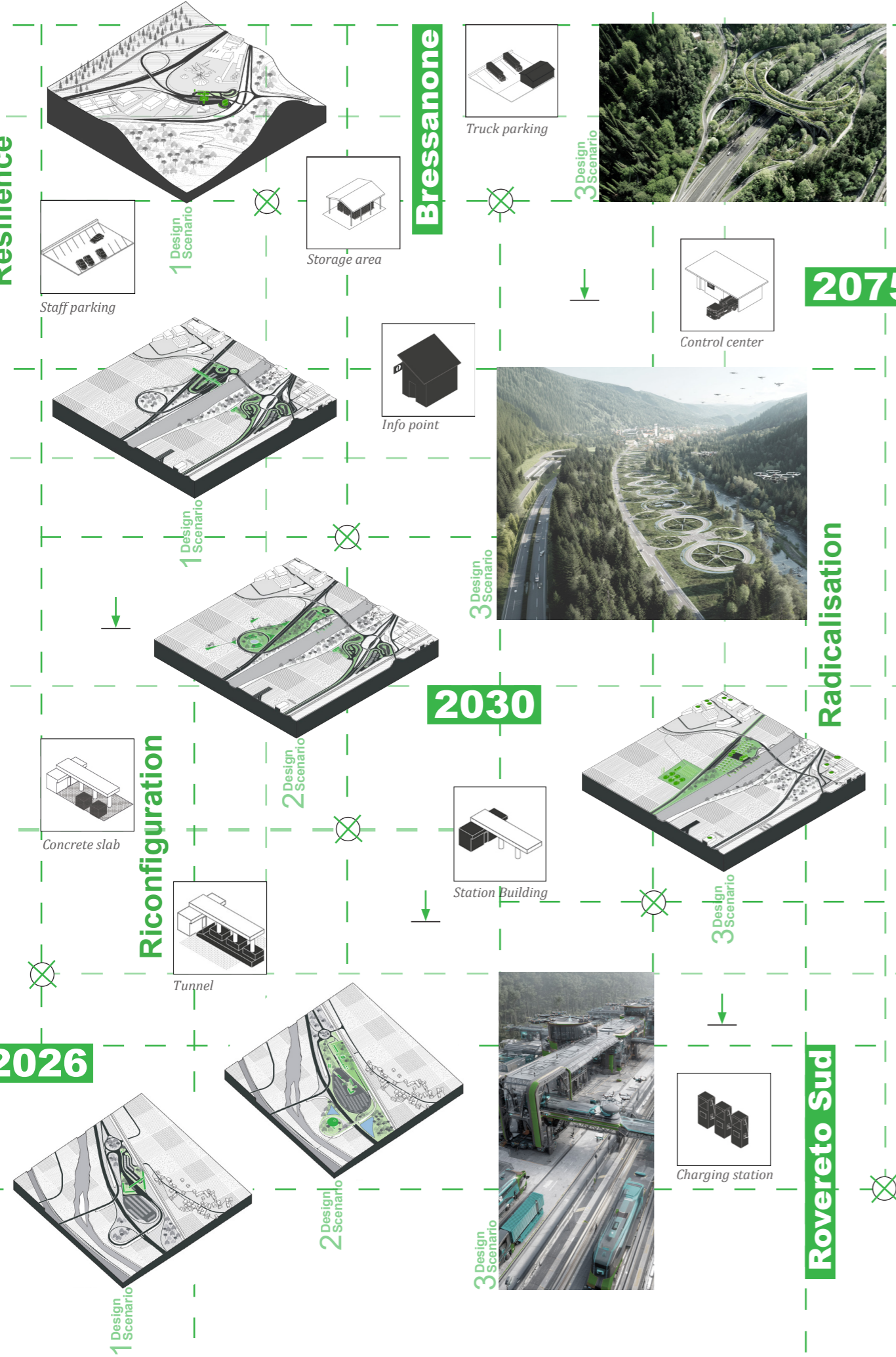
Radicalisation

2030

Riconfigurazione

2026

Rovereto Sud



Project description written by the Principal Academic Tutor

MoSt A22 Hubs develops contextual theoretical and design research on motorway stations. It focuses on these complex infrastructure nodes to improve spatial articulation, adapt them to Free Flow systems, increase technological efficiency, and expand their potential to offer advanced services based on Mobility as a Service (MaaS).

The research concentrates on motorway stations along the A22 motorway. The stakeholder of MoSt A22 Hubs is Autostrada del Brennero SpA, which ensures maximum efficiency between the Brenner Pass and Modena through safe, digital and environmentally sustainable mobility. Its long-term goal is to create a green corridor for people and goods, reducing emissions through renewable energy and by integrating motorway and rail systems.

The project seeks to:

- Analyse and interpret the system of motorway stations along A22;
- Examine the evolution of stations within and beyond the case study, examining best practices;
- Redefine the scope of offered services by future hubs and strengthen integration—both spatial and procedural—between diverse mobility systems, supporting the energy, ecological and digital transition;
- Identify recurring and variable features in motorway stations, and explore their transformation through the Free Flow system, ensuring better integration with the surrounding territory;
- Propose pilot projects for the Bressanone, Trento Sud and Rovereto Sud stations, to enhance spatial and structural complexity, foster decarbonisation, and to introduce new symbolic and functional values through innovative services.

With its multidisciplinary approach, the project engages three main fields:

- *Architectural, urban and interior design*, developing solutions to interpret the relationship between infrastructure and its context;
- *Ecological and environmental design*, encouraging new forms of integration between infrastructure and landscape across different scales;
- *Management engineering, information engineering and computer science*, focusing on the implementation of Free Flow systems and the adoption of MaaS platforms.

Team description by skill

The MostA22Hubs team is composed of five students, two coming from the field of architecture, one from the field of design, and two from the field of engineering. According to the course of study, the team has been split into different groups during different phases.

Alessandro Santo, **Lorenzo Trevisan** (both students of the MSc in Architettura, Costruzione e Città, PoliTO) and **Chiara Torri** (MSc in Interior Design, PoliMI) have been fundamental for the realization of the project under an architectural point of view: the hard skills in the use of programs inherent to their field of study have been essential to develop all the visual documentation and the deliverables, while the soft ones regarding their creativity helped to develop a general solution and to deepen the opportunities of our project.

Edoardo Pedrotti (MSc in Management Engineering, PoliMI) and **Alessandro Saccone** (MSc in Computer Science and Engineering, PoliMI) instead, have been fundamental for the realization of the project under two other points of view: firstly they could give a distant, different way of thinking about the principal object addressed by our research, helping to understand the problem, the opportunities and to provide solutions influenced by a different background; secondly they could give their technical competence where needed in terms of choices regarding feasibility, giving their help in the use of new AI driven tools.

An honorable mention needs to be done to **Jihao Zhong** (MSc in Architecture and urban design), which has been fundamental to the starting phases of our project.

Image 2: Matrix of main tools used to develop the project

Goal

The main goal is to transform traditional motorway toll stations along the A22 Brenner corridor into advanced multimodal hubs through the implementation of free-flow toll collection technology. The primary objective is to eliminate physical barriers and reimagine these infrastructural nodes as comprehensive mobility gateways that seamlessly integrate multiple transportation modes including road, rail, public transit, and micro-mobility systems. This transformation aims to reduce urban traffic congestion, improve regional accessibility, and support sustainable transportation options while contributing to local economic development. The project seeks to develop replicable transformation strategies that respond to specific territorial vocations while serving broader regional mobility networks across the diverse geographical contexts of the Alpine corridor

Understanding the problem

Current motorway toll stations create significant operational and environmental challenges that urgently require technological solutions. Traditional toll booth infrastructure generates substantial traffic congestion, with vehicles experiencing stop-and-go patterns that increase fuel consumption and emissions by up to 45% compared to free-flowing conditions (A. Sapkota et al., "Effects of the manual and electronic toll collection systems on the particulate pollutant levels on highways in Taiwan,"). These facilities consume 15-20 hectares of land per installation, contributing to landscape fragmentation while requiring extensive physical infrastructure for multiple payment methods. The complexity of managing diverse payment systems accounts for up to 30% of operational costs, creating user confusion particularly for foreign visitors. Additionally, air quality studies near toll booths show elevated pollution levels affecting workers and nearby communities.

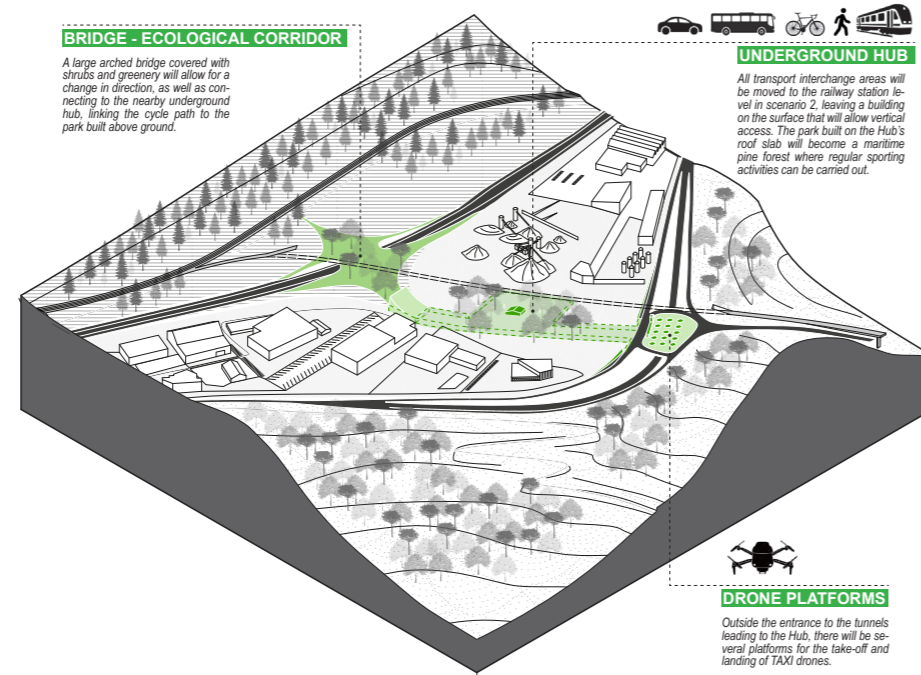


Image 3: Design proposal for Bressanone - Val Pusteria hub, Scenario 3 - radicalisation

Exploring the opportunities

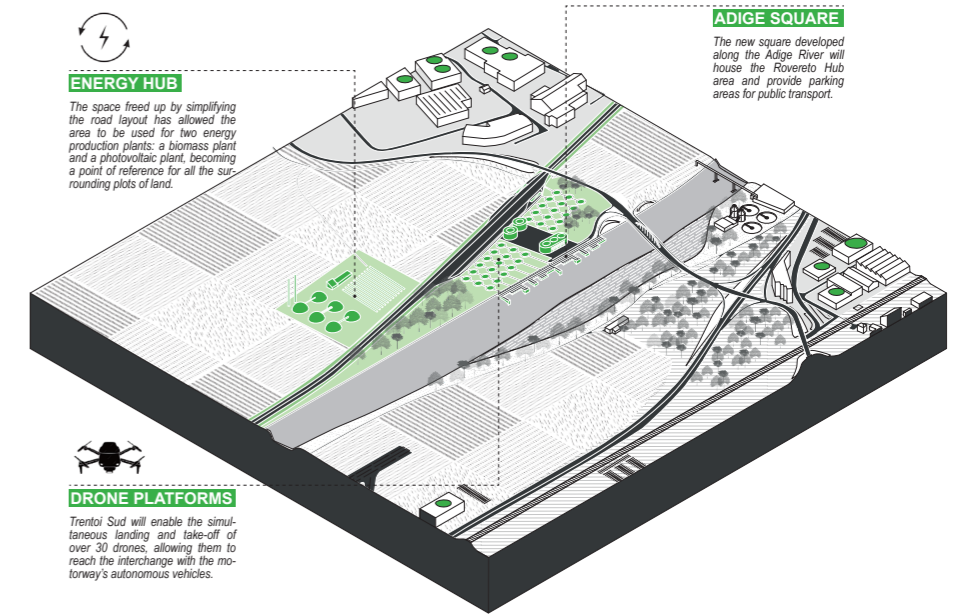


Image 4: Design proposal for Trento Sud hub, Scenario 3 - radicalisation

Free-flow toll collection technology liberates spatial resources previously dedicated to toll infrastructure, creating unprecedented opportunities for reconceptualizing motorway stations as integrated transportation nodes. The elimination of physical barriers enables seamless transfers between different mobility modes while supporting sustainable transportation options. Each of the three case study stations, namely Rovereto Sud, Trento Sud, and Bressanone, presents distinct territorial vocations and transformation potentials. Advanced sensor technologies, electronic payment platforms, and cloud-based processing systems enable sophisticated traffic management and environmental monitoring integration. The transformation can facilitate park-and-ride solutions, electric vehicle charging infrastructure, micro-mobility hubs, and logistics platforms. Drawing parallels with successful intermodal nodes like airports and major railway stations, these transformations can create comprehensive mobility ecosystems that enhance connectivity, sustainability, and urban vitality



Image 5: Top view of Trento Sud motorway vertiport station hub, AI elaboration

Generating a solution

The project develops a comprehensive transformation methodology through three graduated scenarios: *Reconfiguration*, *Resilience*, and *Radicalization*. Each scenario represents increasing levels of technological adoption and infrastructural change over time. The transformation matrix framework we created identifies core components within motorway toll stations and proposes adaptable modifications based on varying use scenarios and destination-specific objectives. Site-specific vocational analysis guides tailored transformation strategies that respond to local characteristics while contributing to corridor-wide vision. Our methodology includes systematic evaluation tools, with some proposals as the use of decision trees for the generalization of our approach. Implementation ranges from immediate improvements within existing constraints to radical reimagining of infrastructure-territory relationships. The framework provides stakeholders with practical guidelines for evidence-based decision-making while maintaining flexibility to accommodate technological developments and changing mobility patterns.

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