Assessing the Future of Urban Mobility in Venice

Tyler Brown, Emmaline Raven, Raul Villalobos

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Abstract

From the introduction of rail to the historic city of Venice in 1846 to the introduction of diesel boats in 1934, the city has continually adapted its transportation system to technological advances and historical events. This project details the history of transportation in Venice, documents the current state and limitations of the public transportation system in 2022, and explores the possibilities and benefits of a new underwater subway system. We created an online repository of information documenting the research and analysis done for this project.

Team members
Tyler Brown
Emmaline Raven
Raul Villalobos

Advisors
Professor Lorraine Higgins
Professor Fabio Carrera

Sponsors
SmartDest
SerenDPT

B term
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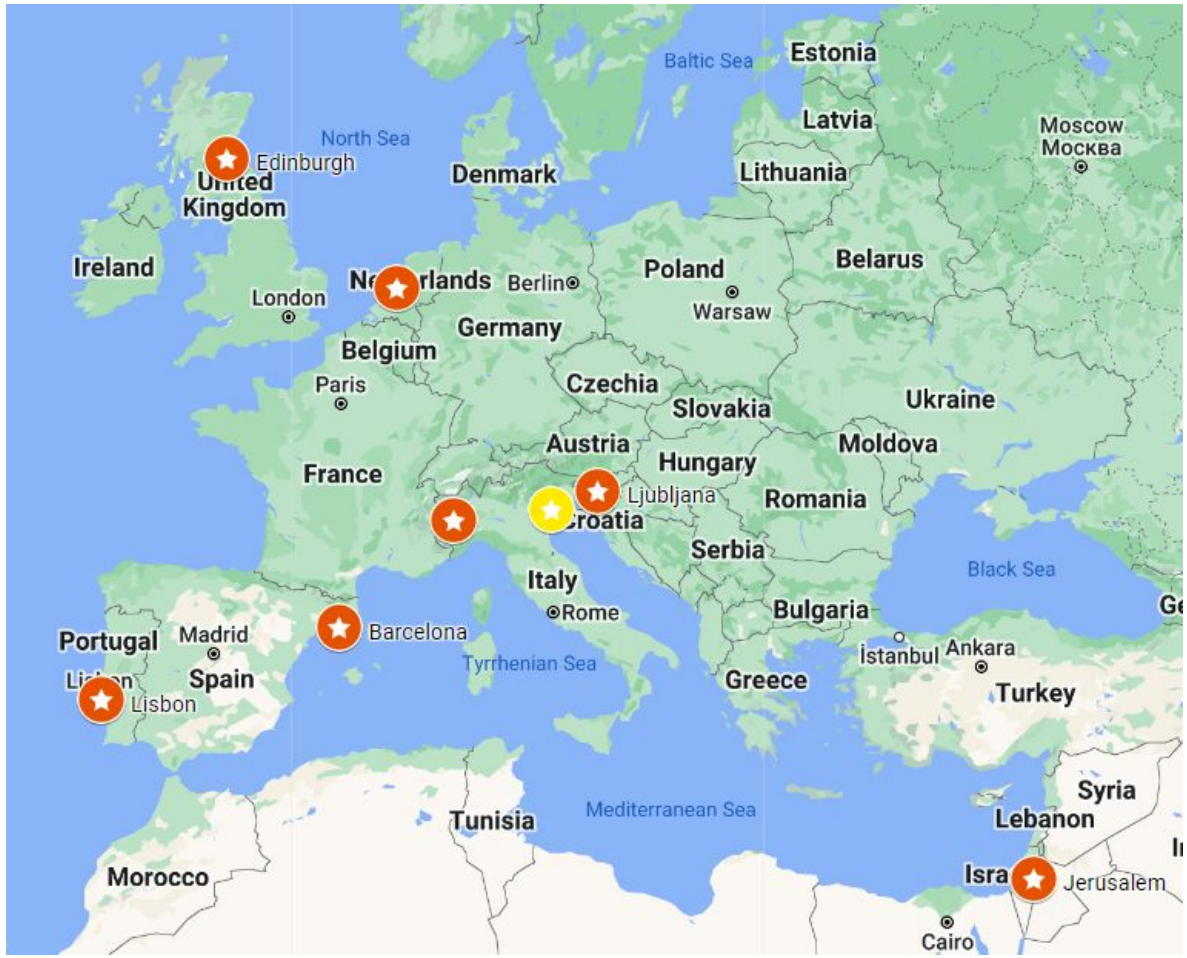
SmartDest

Our project aims to contribute to the SmartDest research project. The goals of SmartDest are:

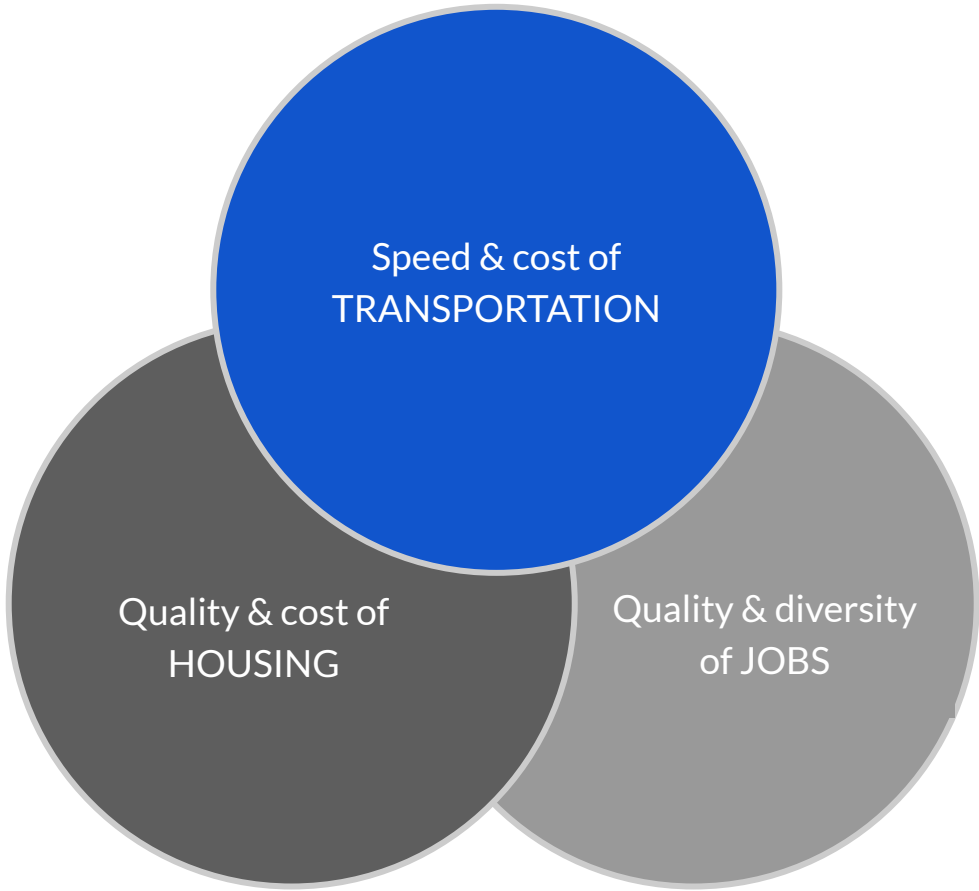
1. Identify social exclusions due to **overtourism**
2. Hypothesize possible **solutions**
3. Proposed shared corrective **policies**



8 case study cities funded by the EU

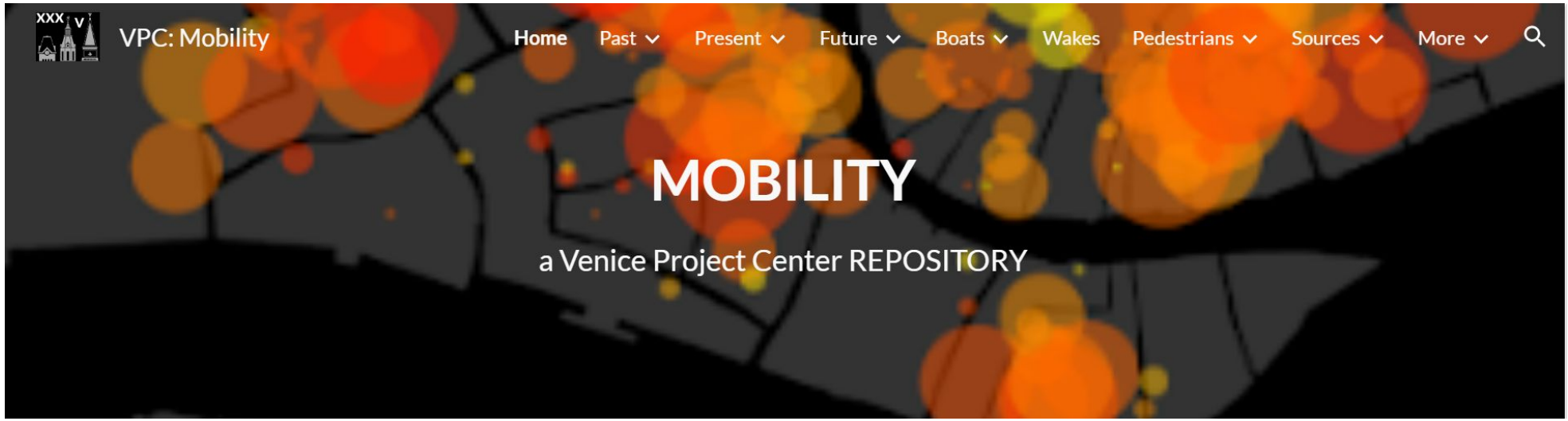
SerenDPT

SerenDPT is a benefit corporation whose goal is to repopulate Venice. It is one of the partners of the SmartDest project. It aims to improve mobility, housing, and jobs to repopulate the city.



Mobility Repository

Throughout this booklet, there are QR codes to the mobility repository we created. It's an online resource where you can learn more about all of the topics covered in this booklet.



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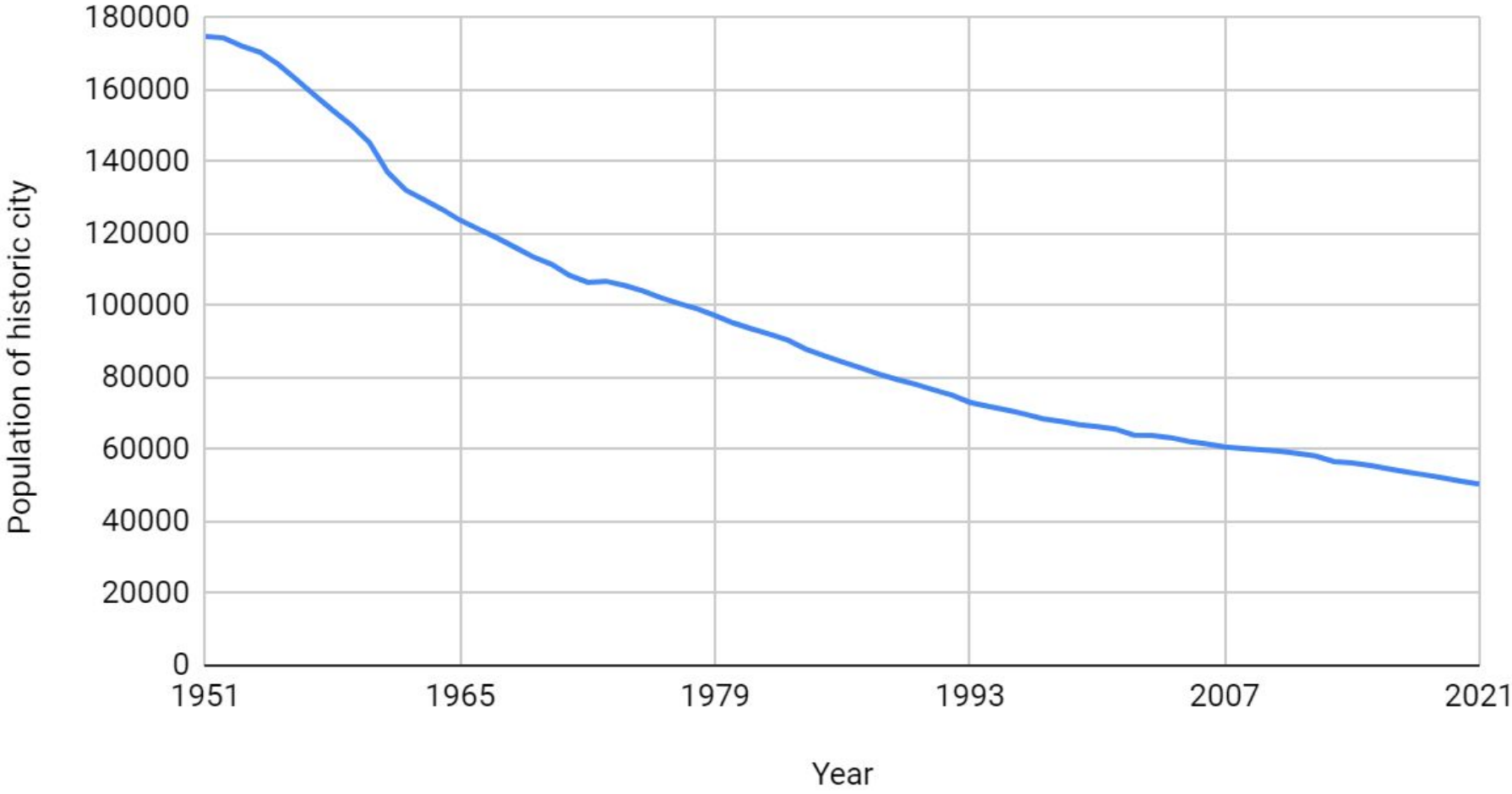
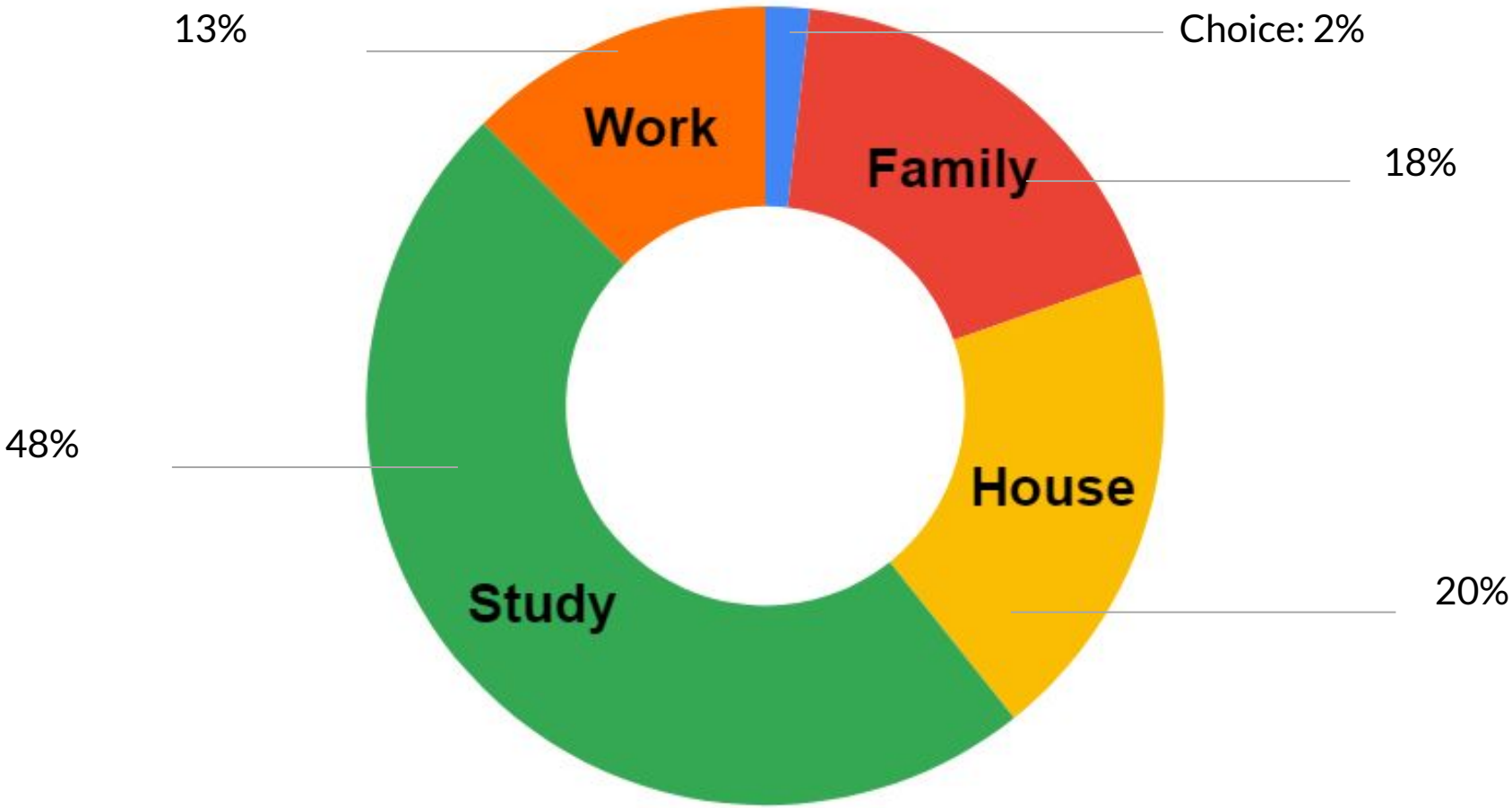
DEPOPULATION

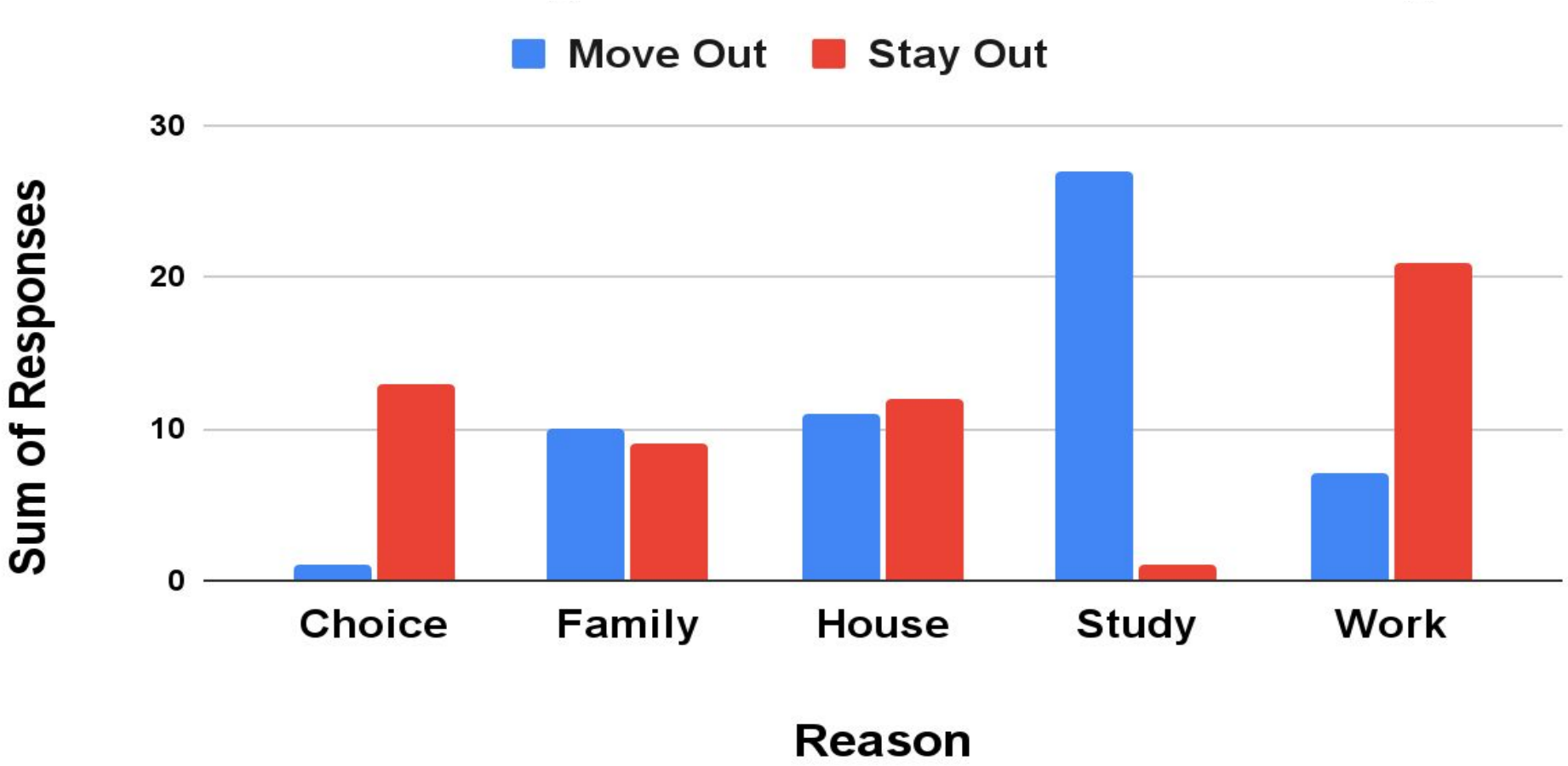
The population of the historic city of Venice has decreased by 125,000 by 1951



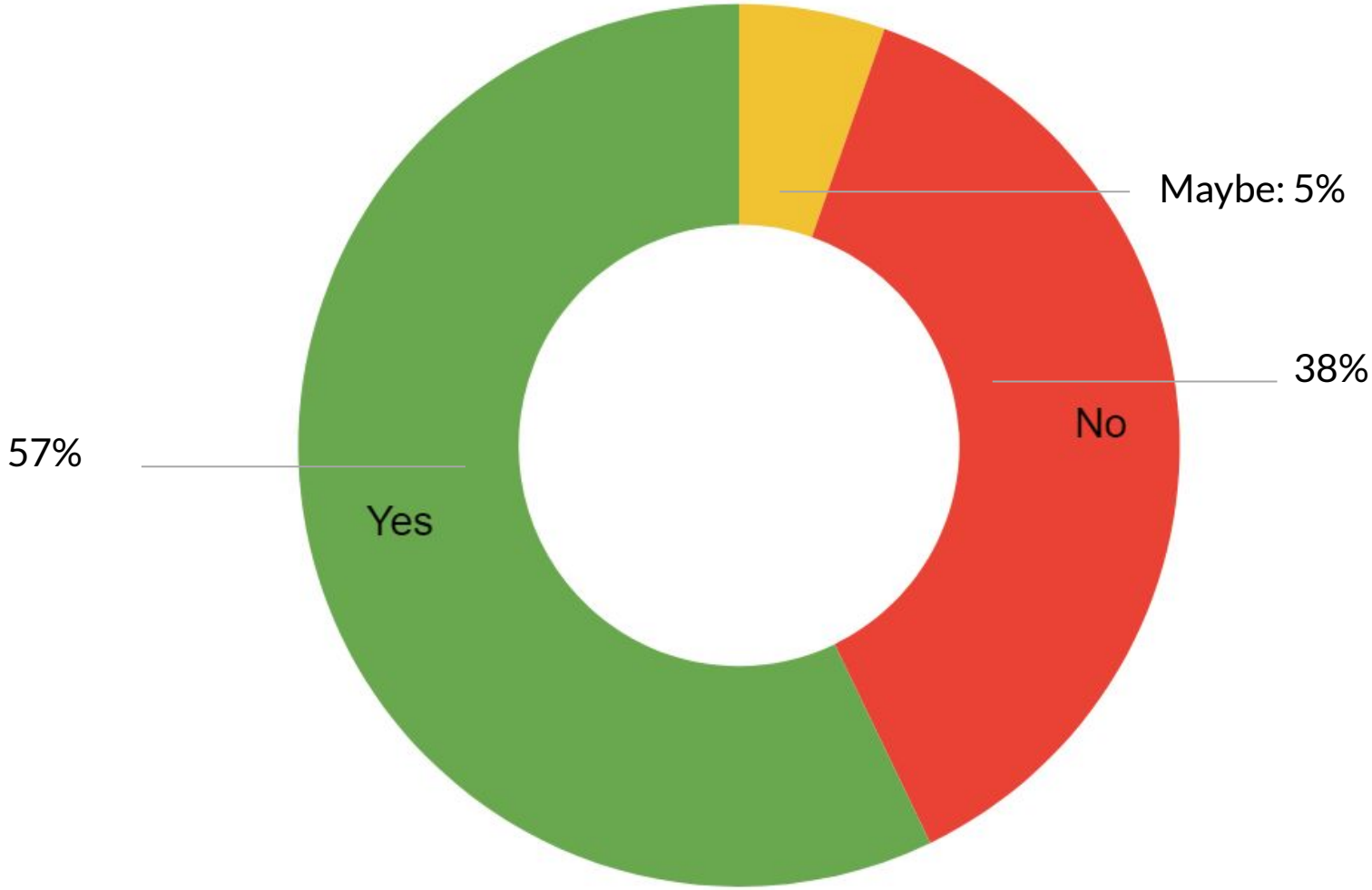
Results from 56 interviews conducted by SmartDest show that Venetians migrate out for school…



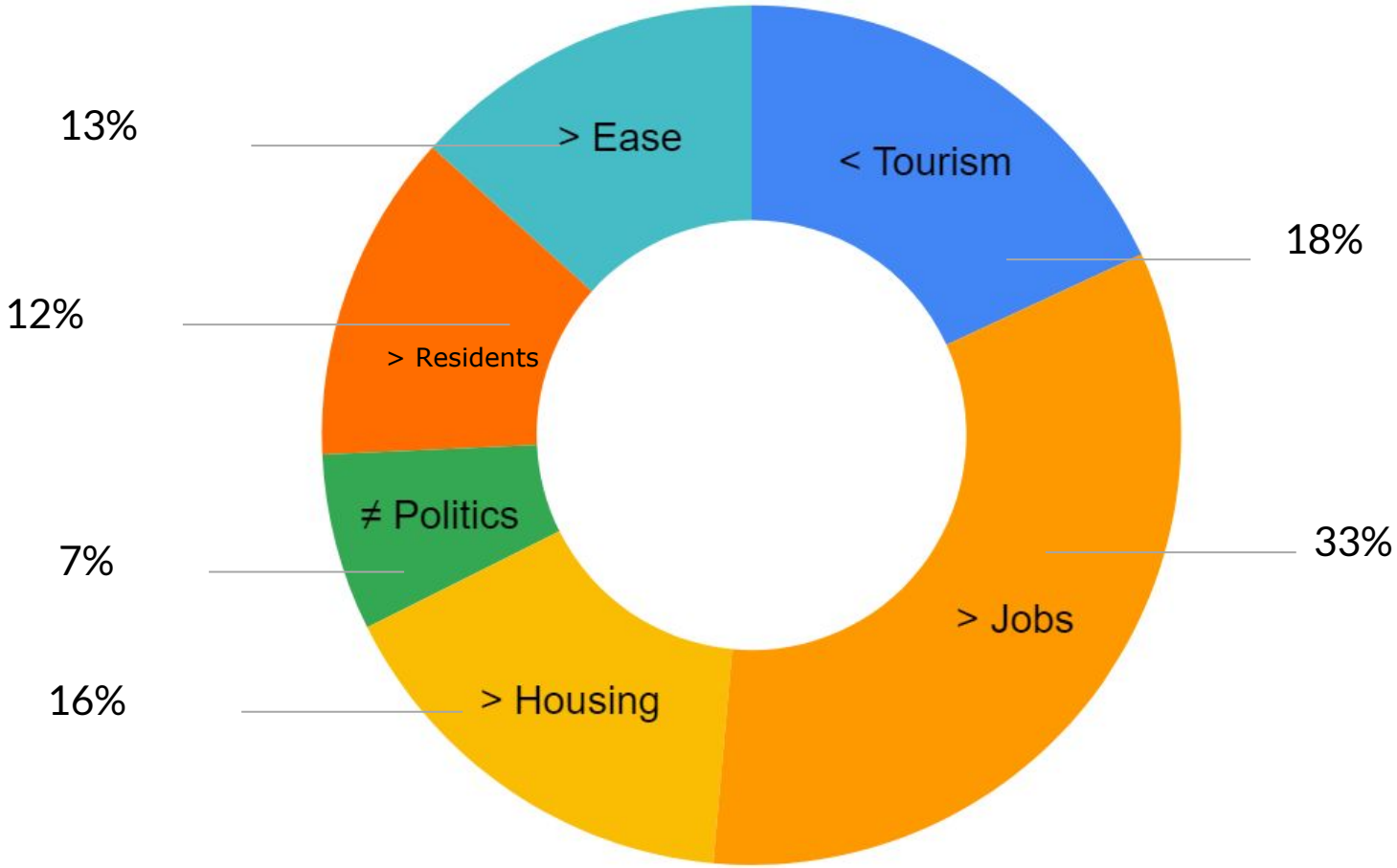
…and they remain away because of work opportunities



Most of these residents would love to return to Venice

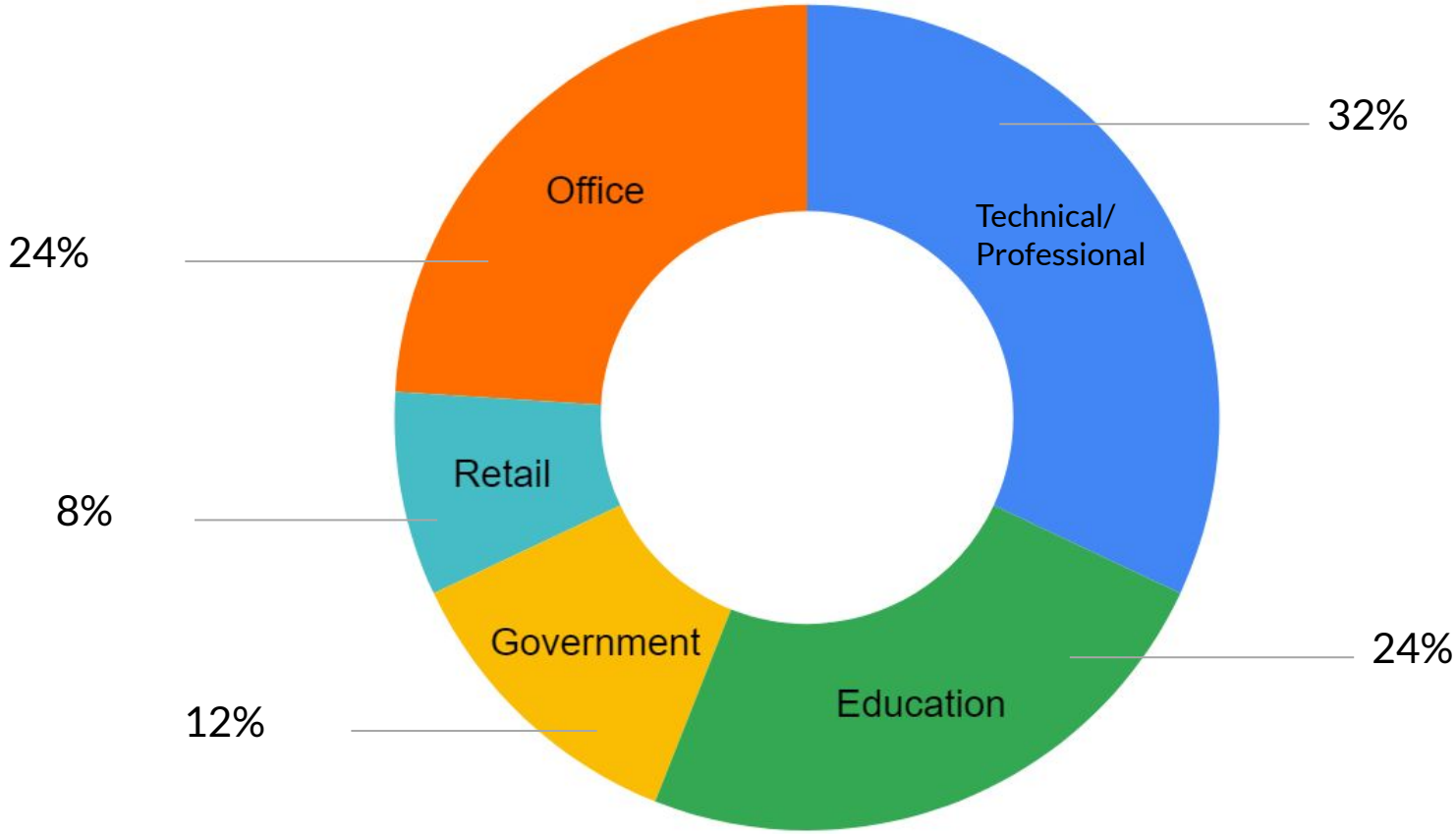


One-third of emigres cited “jobs” as the primary factor that would need to change before they would return to Venice

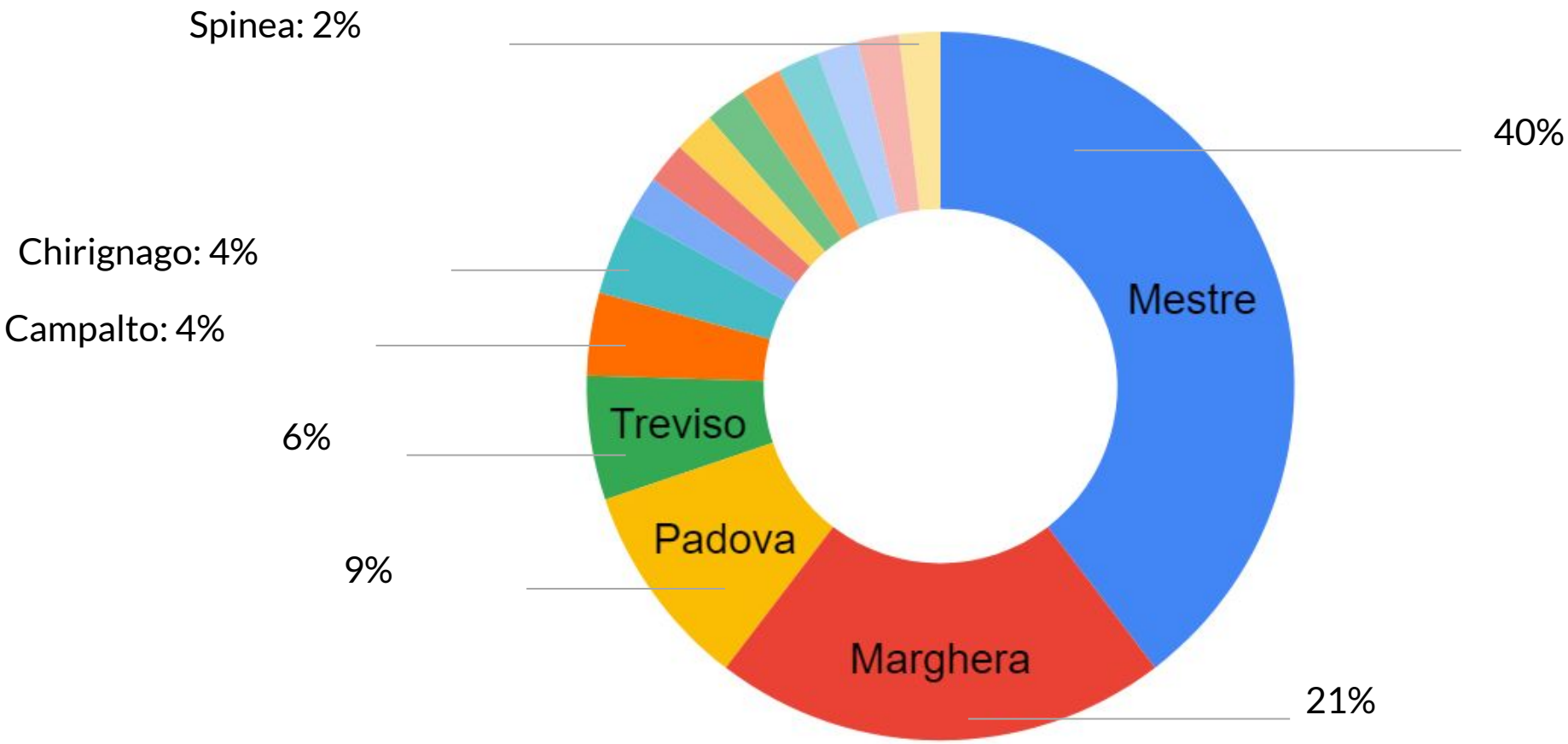


There are also Venetian residents who commute to the mainland

Many of them work in high-paying jobs

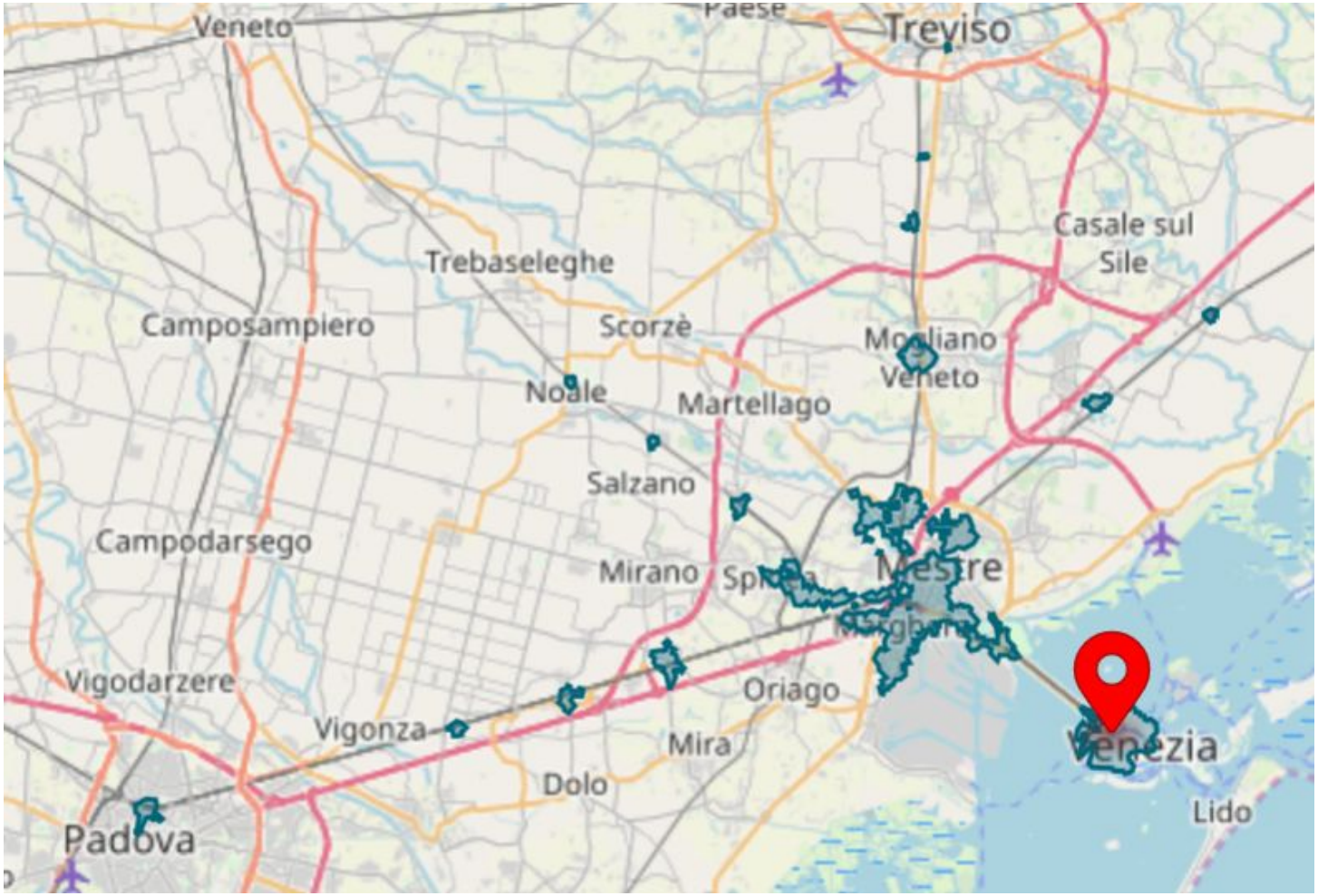


They commute to (and from) relatively close destinations on the mainland



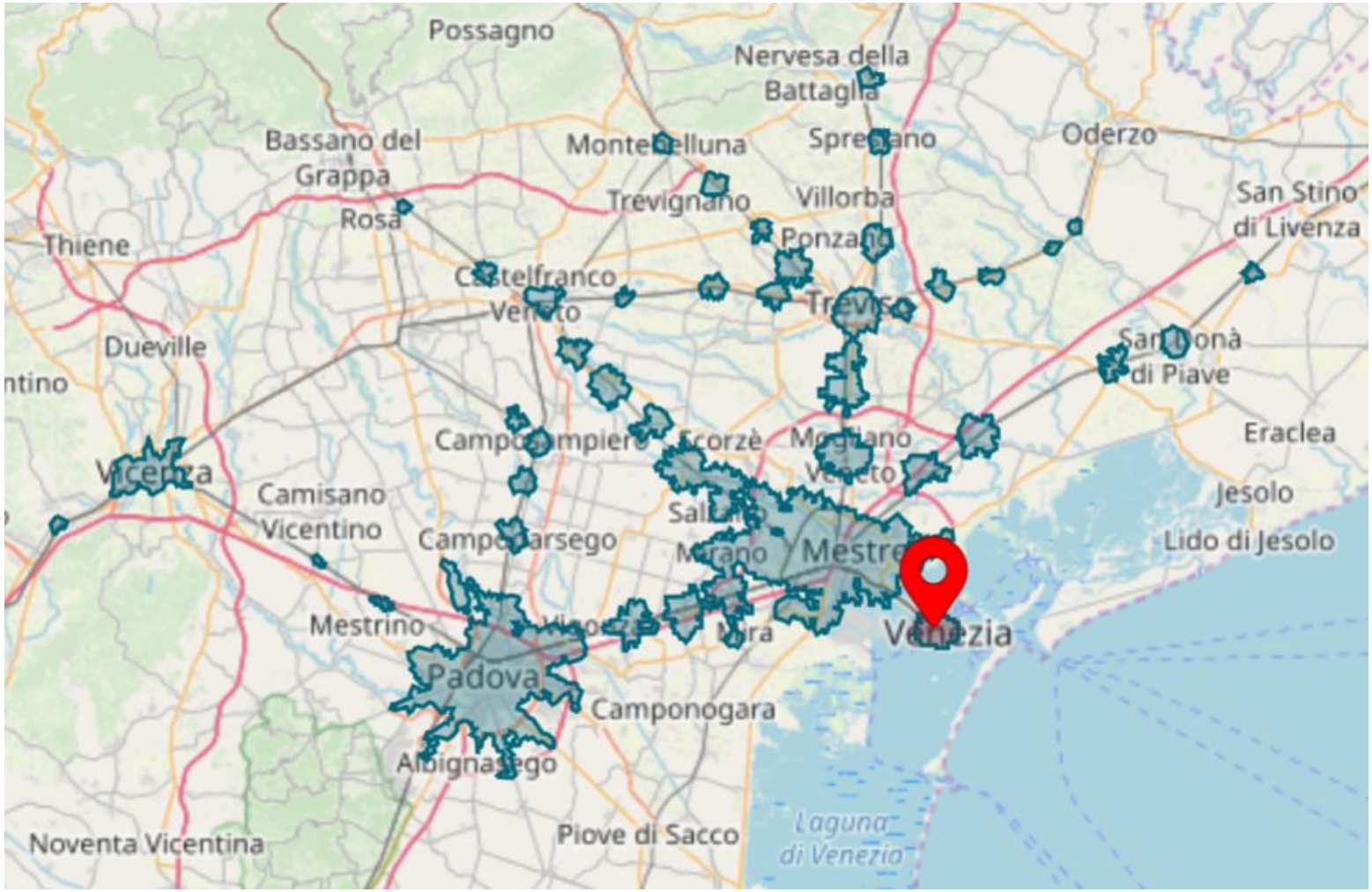
Commuters with high-paying jobs are commuting to destinations on the mainland that are reachable within 30 minutes

Highlighted areas are reachable within 30 minutes using public transit from Venezia Santa Lucia

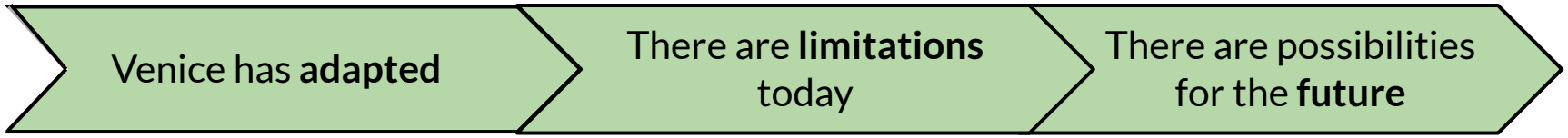


Getting commuters to the mainland faster would make more jobs accessible within a 1hr commute

Highlighted areas are reachable within 60 minutes using public transit from Venezia Santa Lucia



There were three stages to our project exploring mobility in Venice

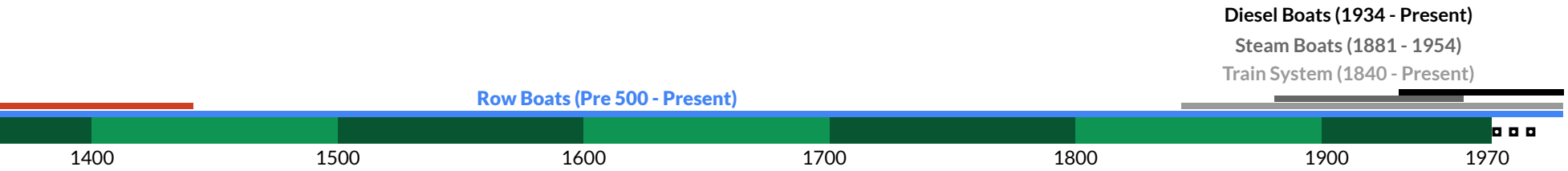


HISTORY

Evolution of Transportation in Venice

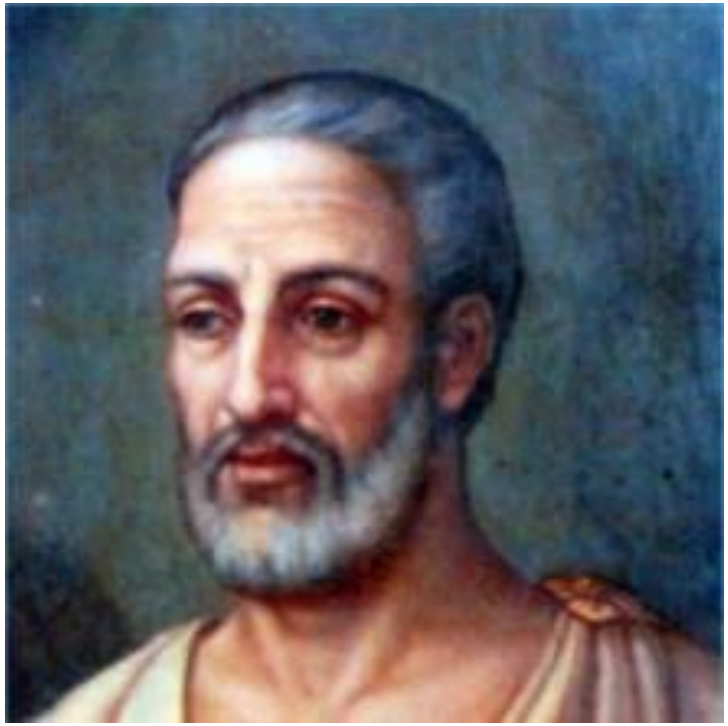
The dominant modes of transportation in Venice during its early stages were row boats and horses. As Venice grew as a city, the horse infrastructure became less and less prevalent and, eventually, horses were banned from being used within the city.

Major changes have only begun to appear in the last two centuries. As global technologies improve, Venice includes those improvements within its transportation network.



In 537, Cassiodorus wrote about early Venetians

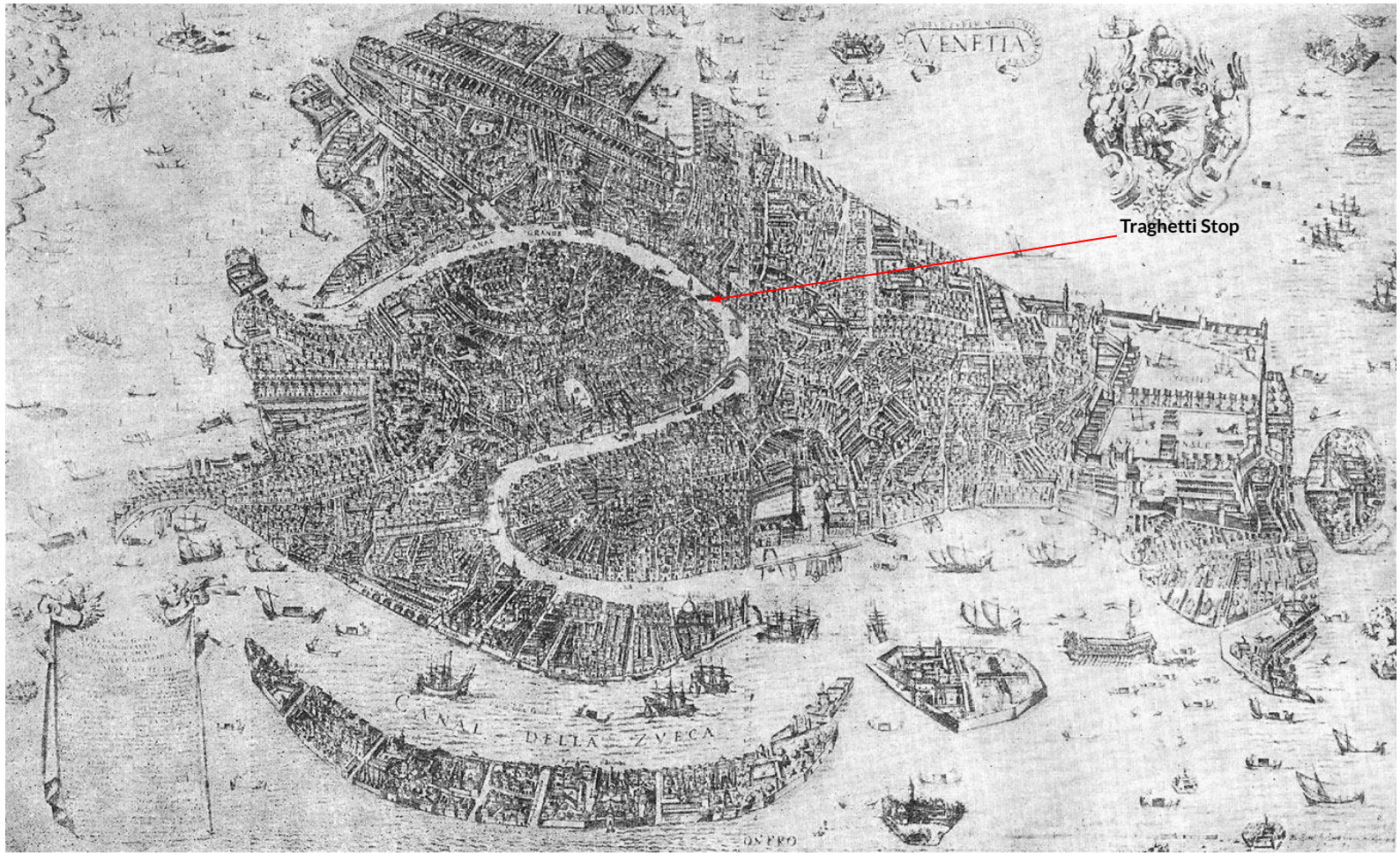
"Therefore diligently repair the ships which you keep tied to the walls of your houses like animals,"



A new form of row boat, gondolas, are used to reduce canal crowding

Traghetti are the most important transportation system

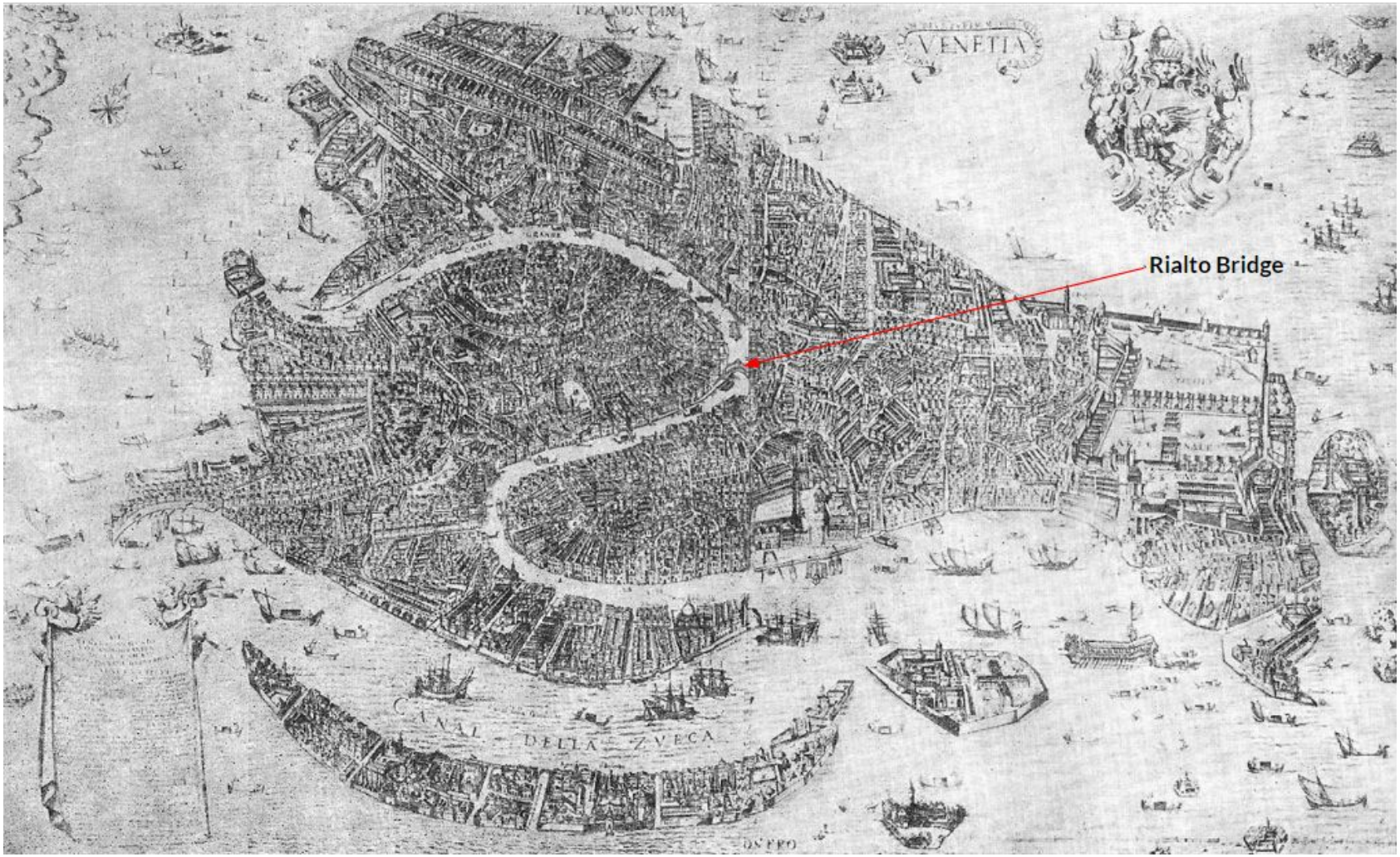
Traghetti were used to travel to the city and surrounding islands from the mainland.



The stonefication of Venice led to the downfall of horses

Horses could no longer easily traverse the canals or paths of the city

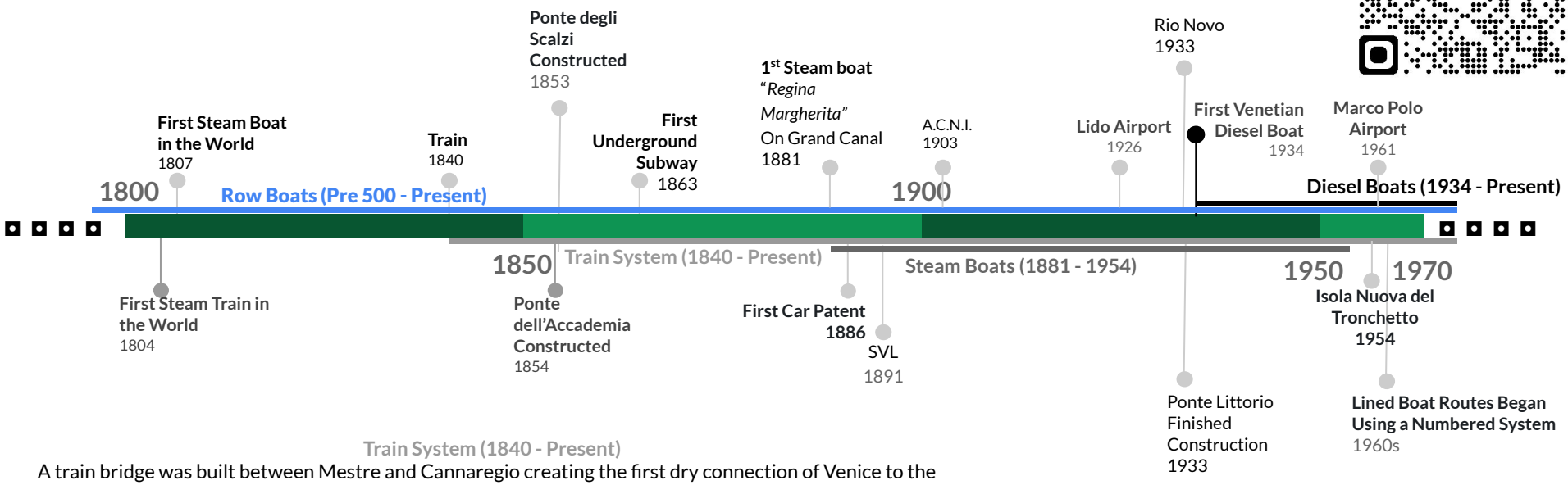
The Rialto was the first dry connection over the Canal Grande



There were only boats and bridges between the 14th and 19th century

Horses were banned in the 14th century, leaving only row boats and bridges to traverse within the city.

Modernization of Venice



Train System (1840 - Present)

A train bridge was built between Mestre and Cannaregio creating the first dry connection of Venice to the mainland. This bridge, being 2.4 miles long, ended with the Santa Lucia Train Station which was the last stop in the Milan to Venice railway line. The bridge allowed for more people and goods to arrive into the historic city and at a faster rate.

Diesel Boats (1934 - Present)

Diesel Boats were added to the A.C.N.I fleet in 1934 with the introduction of the first seven boats.

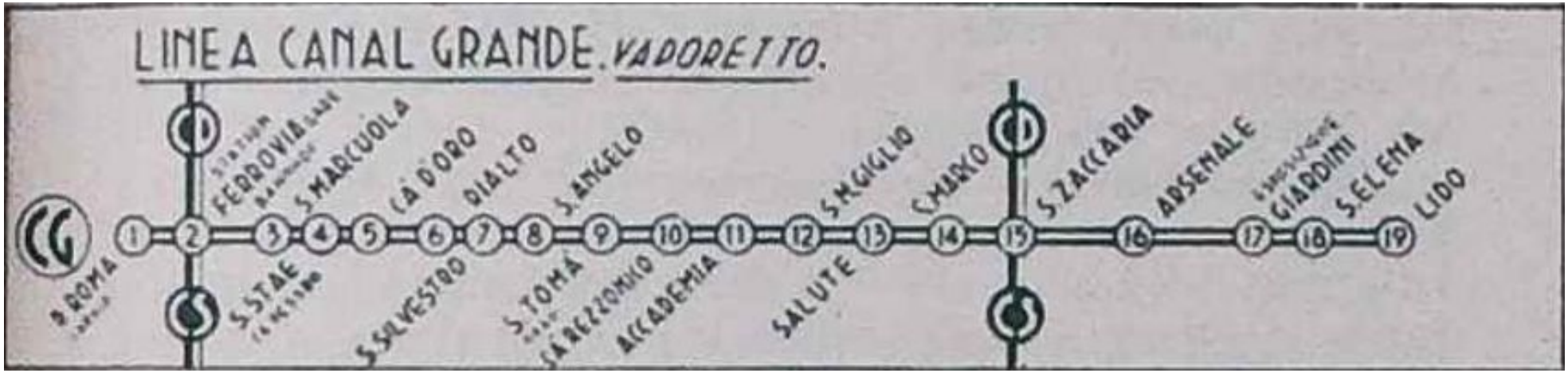
The train bridge connecting Venice to the mainland was constructed in 1840.

This is 40 years after the first steam train in the world existed and 40 years after Venice was put under Austrian occupation.

The second step in transportation evolution was steamboats

The Regina Margherita was Venice’s first steamboat, launched 70 years after the world's first steam boat.

ACNIL took over public transportation in 1903



The new car bridge allowed for faster travel

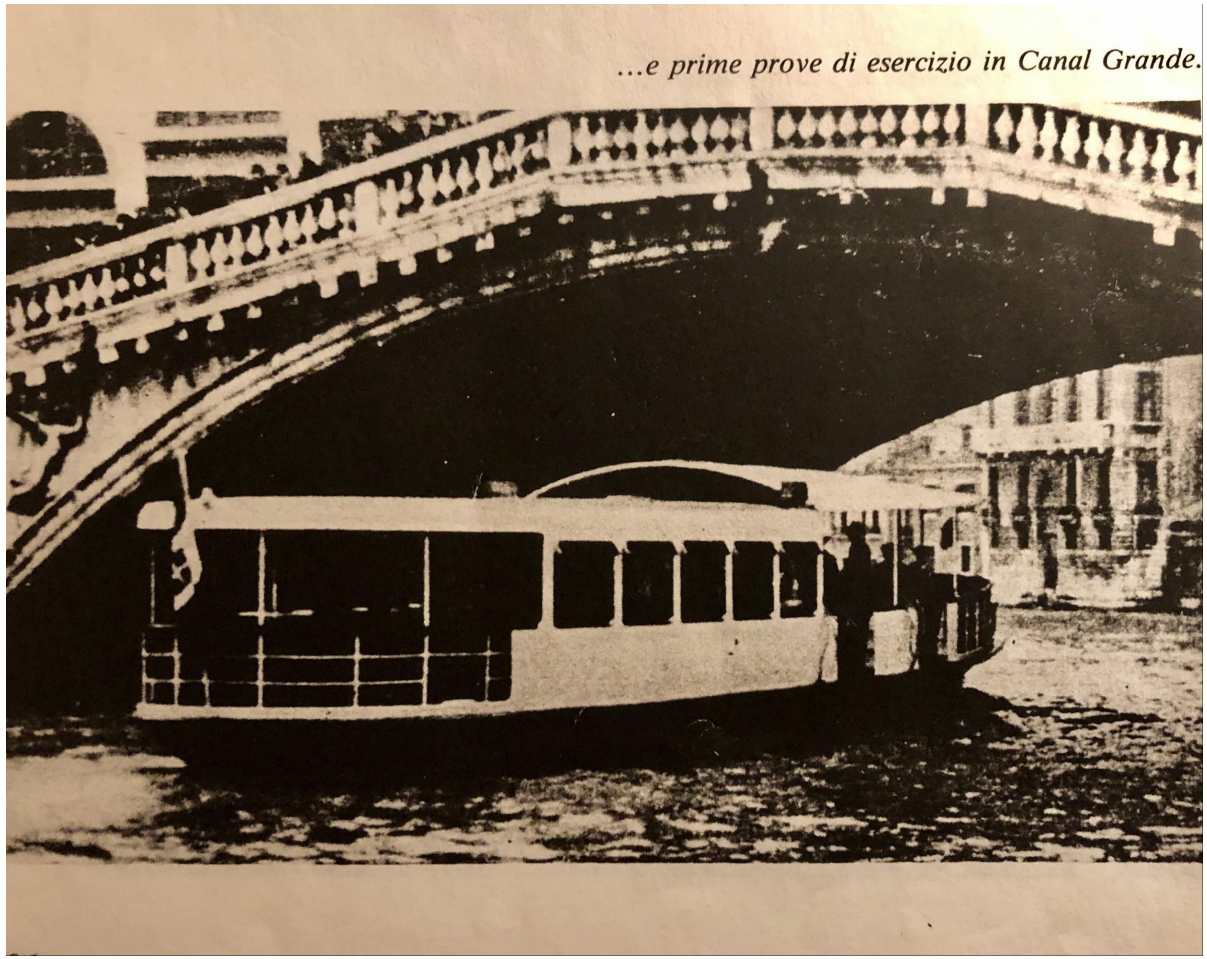
The car bridge was built only 40 years after the first car patent.

With a car bridge comes the need for parking

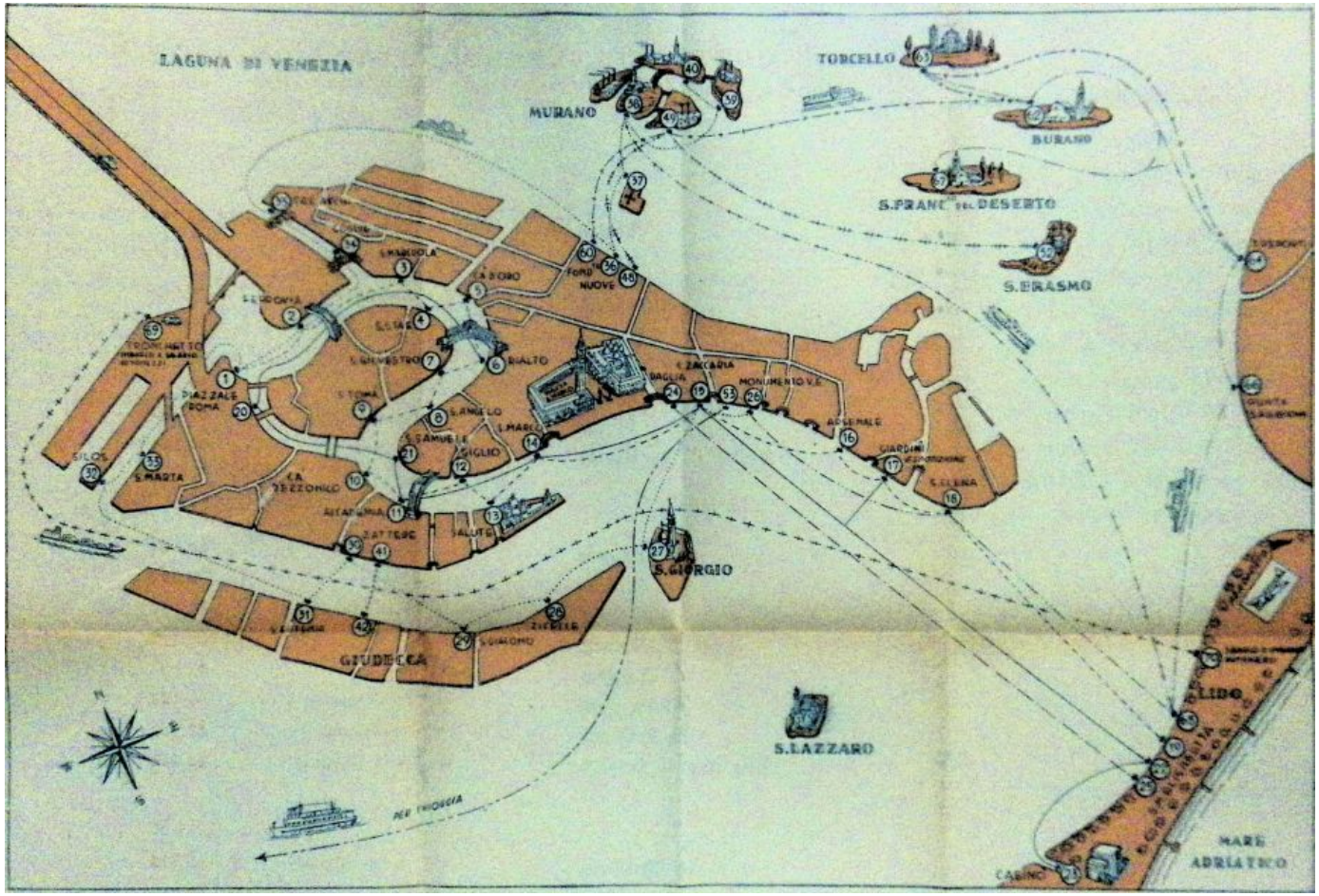
Rio Nuovo was constructed to connect Piazzale de Roma

Diesel boats were also purchased and used before WWII

One of the boats in the first fleet of Venetian diesel boats, NO. 42 Annibale Foscari (now HIPOPOTAMO) on its maiden voyage, just 20 years after the world's first diesel boat.



Prior to the 1960s, only linear routes (not circular) were used to traverse the historic city



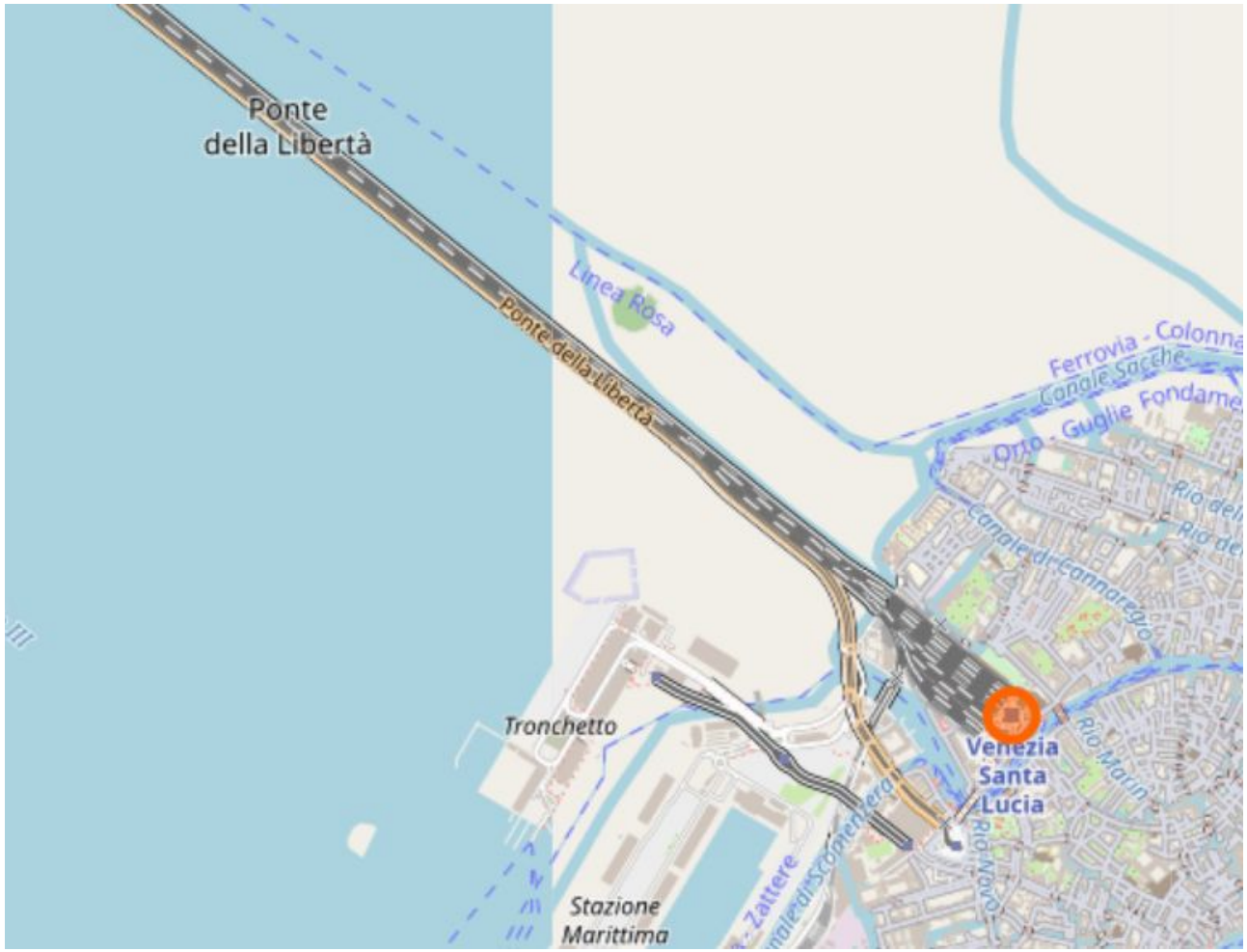

PONTE PANADA
FONDAMENTE NOVE


TODAY

Getting to Venice

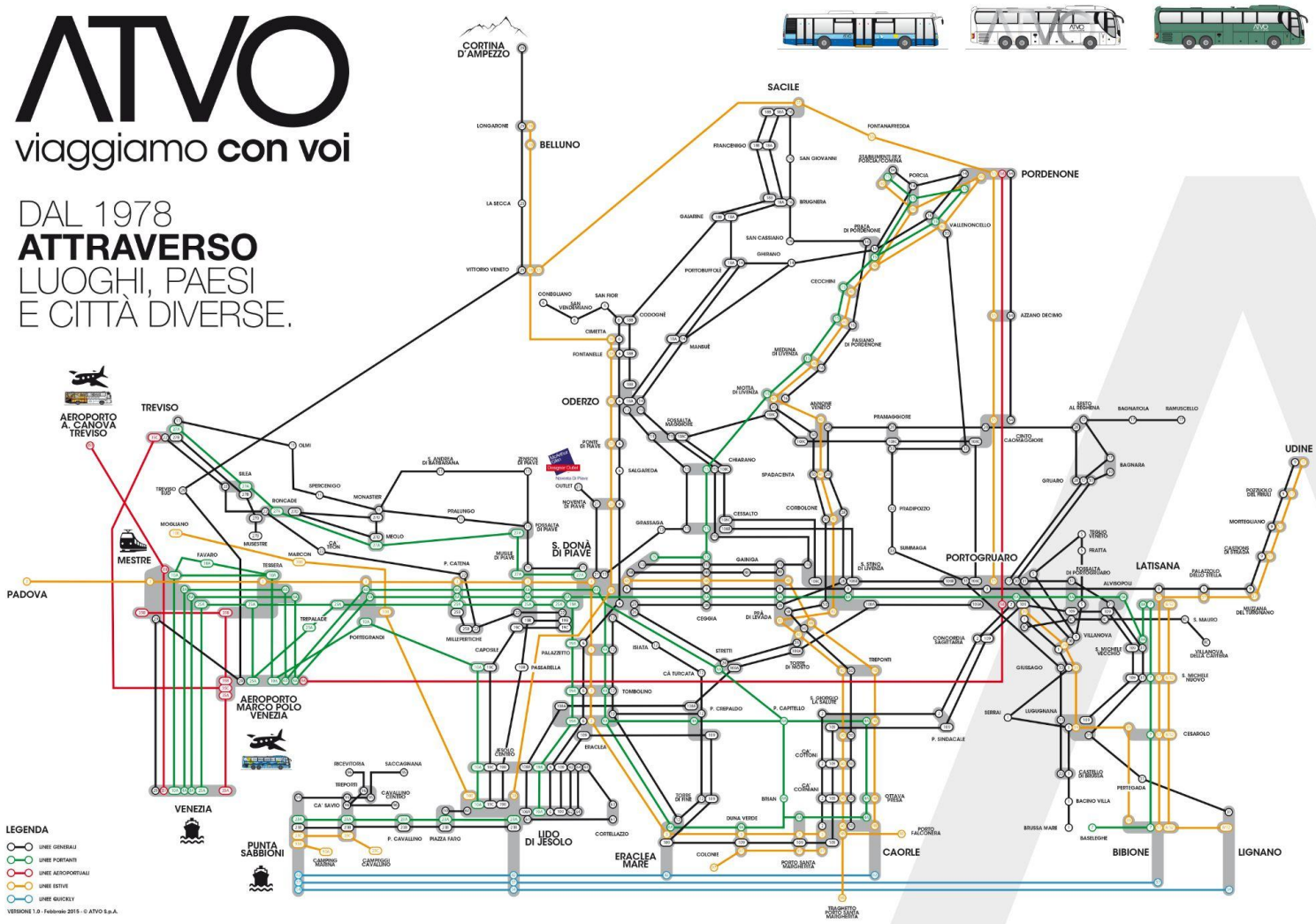
The Ponte della Libertà brings commuters out of Venice by road and rail. There are also boat routes, especially from Marco Polo airport

Everyday, 371 trains arrive at Venezia S. Lucia, and 378 trains depart from the station



Multiple bus companies, including ACTV and ATVO, have routes with termini at Piazzale Roma

ATVO operates buses in eastern Veneto



Facts about ATVO buses

ATVO operates various bus services, including lined transportation as well as school buses and rental buses. All of these are represented in the data below.

70 lines

- General lines
- Carrier lines
- Airport lines
- Summar lines
- 'Quickly' lines (shortcut from other cities to Punta Sabbioni)

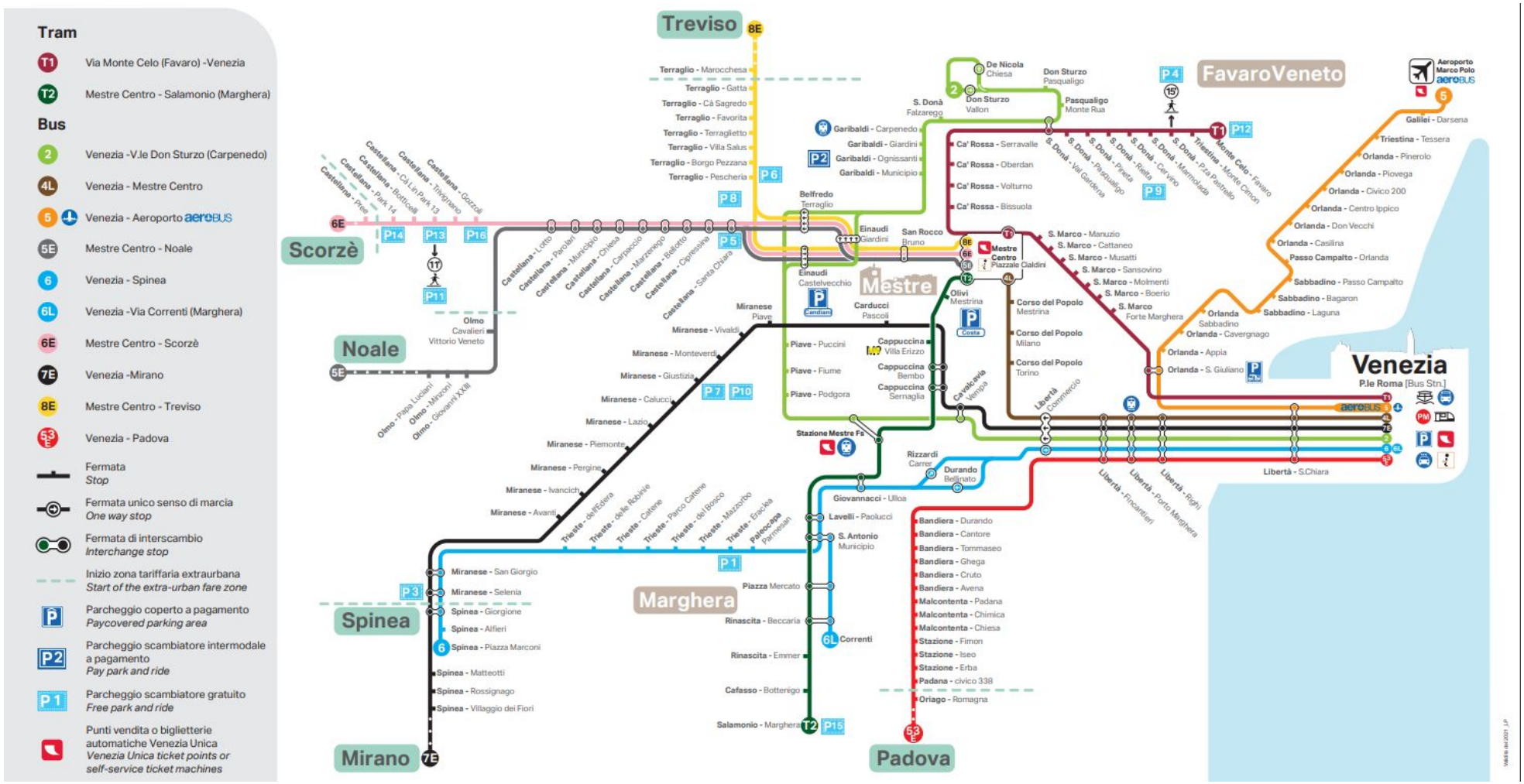
311 buses
as of 2020

- 100% of buses used for Urban Service are accessible
- 37% of buses used for Extra-Uran service are accessible
- 19% of buses used for rental and school buses are accessible

14,121,626 km traveled in 2019

- 13,324,257.30 km of subcontracting
- 510,862.90 km of school services
- 899,270 km of rental services

ACTV operates buses from Piazzale Roma to the suburbs of Venice



ACTV also operates buses on Lido

Facts about ACTV buses

110 lines

- 48 lines in Mestre
  - 5 Night lines
  - 2 School lines
- 8 lines in Chioggia
- 8 lines on Lido
  - 1 Night line
- 46 lines in suburban network
  - 4 school lines

620 buses
as of 2010

- Including 100 buses on Lido
- Newly purchased buses are equipped with accessibility features (ramp, reserved seating)

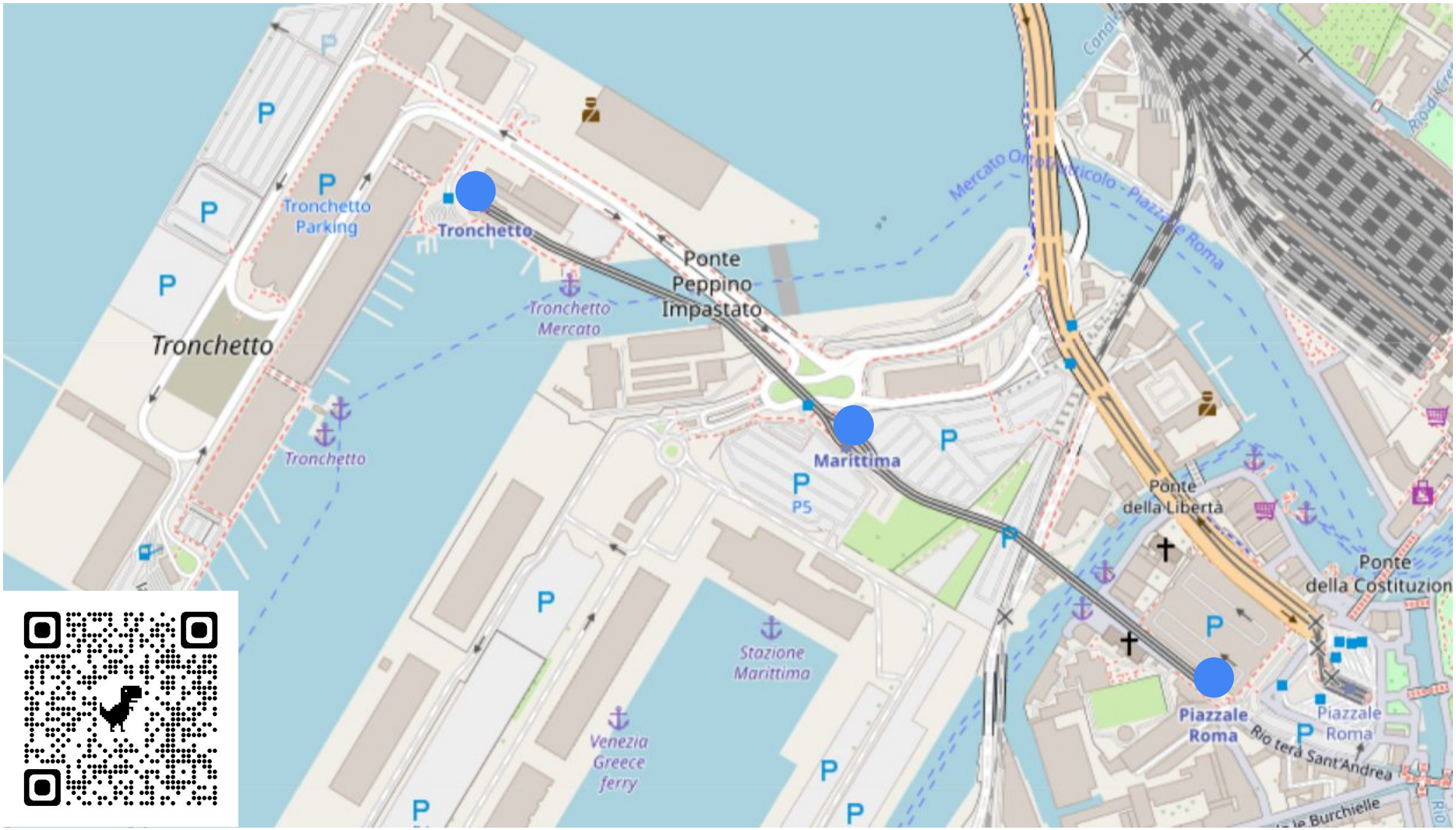
33.5 million km traveled in 2010

- Including all bus lines operated by ACTV

ACTV also operates trams on the mainland and at Piazzale Roma

On 20 December 2010, the Mestre tram system began operation. In the first year, each tram car travelled 390,000 km annually. On 16 September 2015, the tram arrived in Piazzale Roma, connecting the historic city of Venice with the mainland.

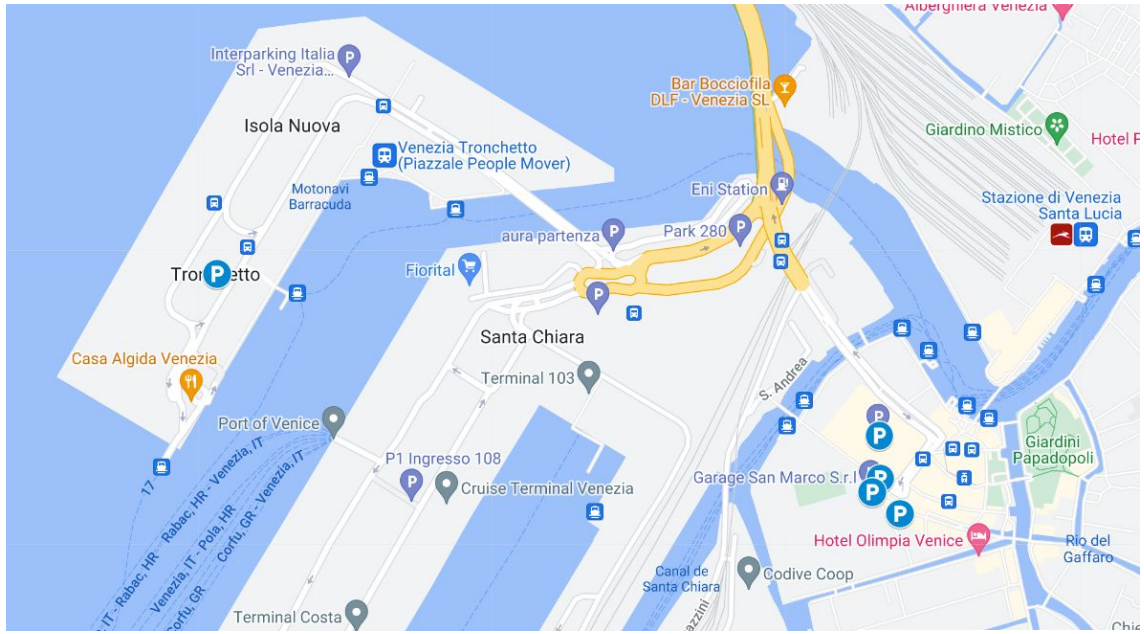
The People Mover is a cable car with stops at Tronchetto, Marittima, and Piazzale Roma



Cars and parking provide a link to the mainland and to Lido

Tronchetto is one of the main parking facilities, accessible via the People Mover. Additionally, ACTV operates the Municipal Parking Garage, San Andrea Parking Garage, and San Giuliano Parking Garage.

Parking Facility	Number of car parking spots available	Cost to park for a day
Tronchetto	3957	€ 22 for 24h
Municipal Parking	2196	€ 35 for 24h
San Andrea	102	€ 72 for 24h
Aree portuali	1000	€ 78 for 24h
San Marco	900	€ 45 for 24h
Parcheggio Doge	45	€ 45 for 07:00 - 01:00 (not open 24/7)
Total	8200	n/a



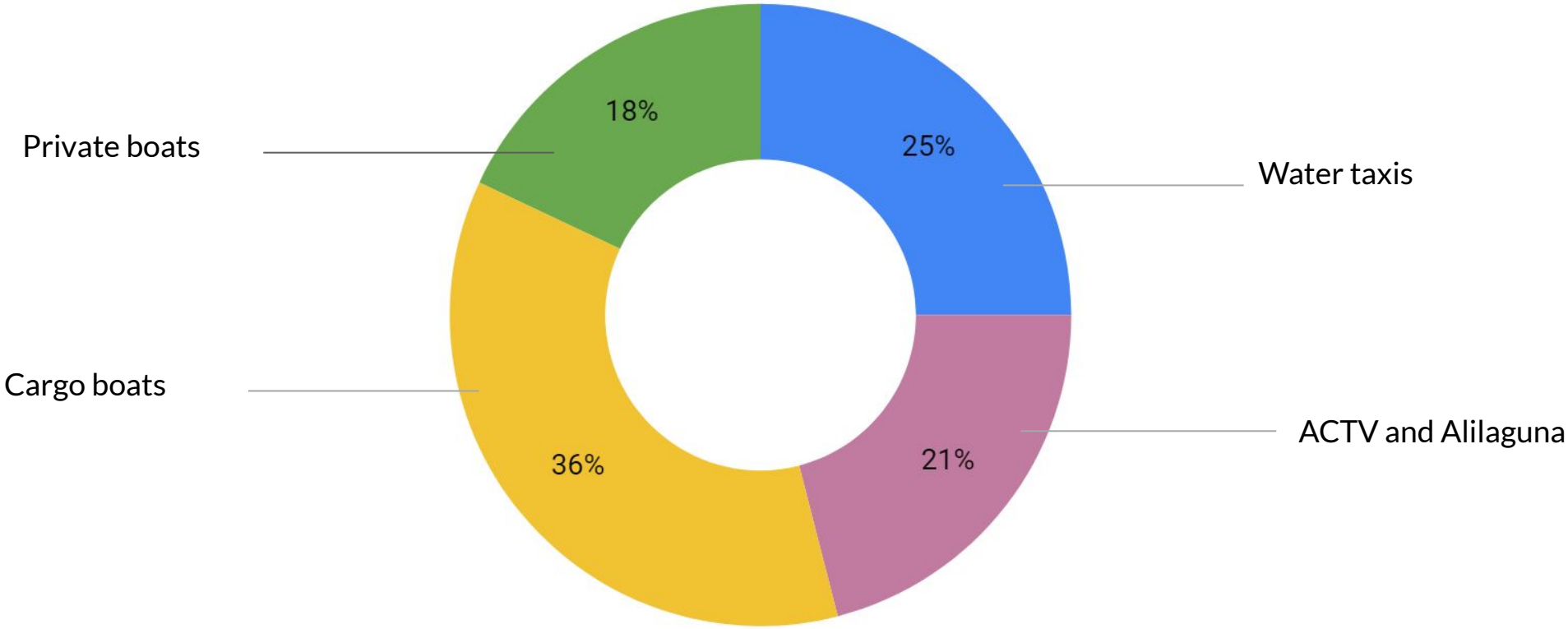
Ferry Boats transport cars between Lido and the mainland

Since Lido has paved roads, car owners can drive there. They can move their car there from Tronchetto, Chioggia, or other mainland locations. A trip on Line 17 from Lido S.Nicolò to Tronchetto lasts 35 minutes. Approximately 70 cars can fit on a Ferry Boat.

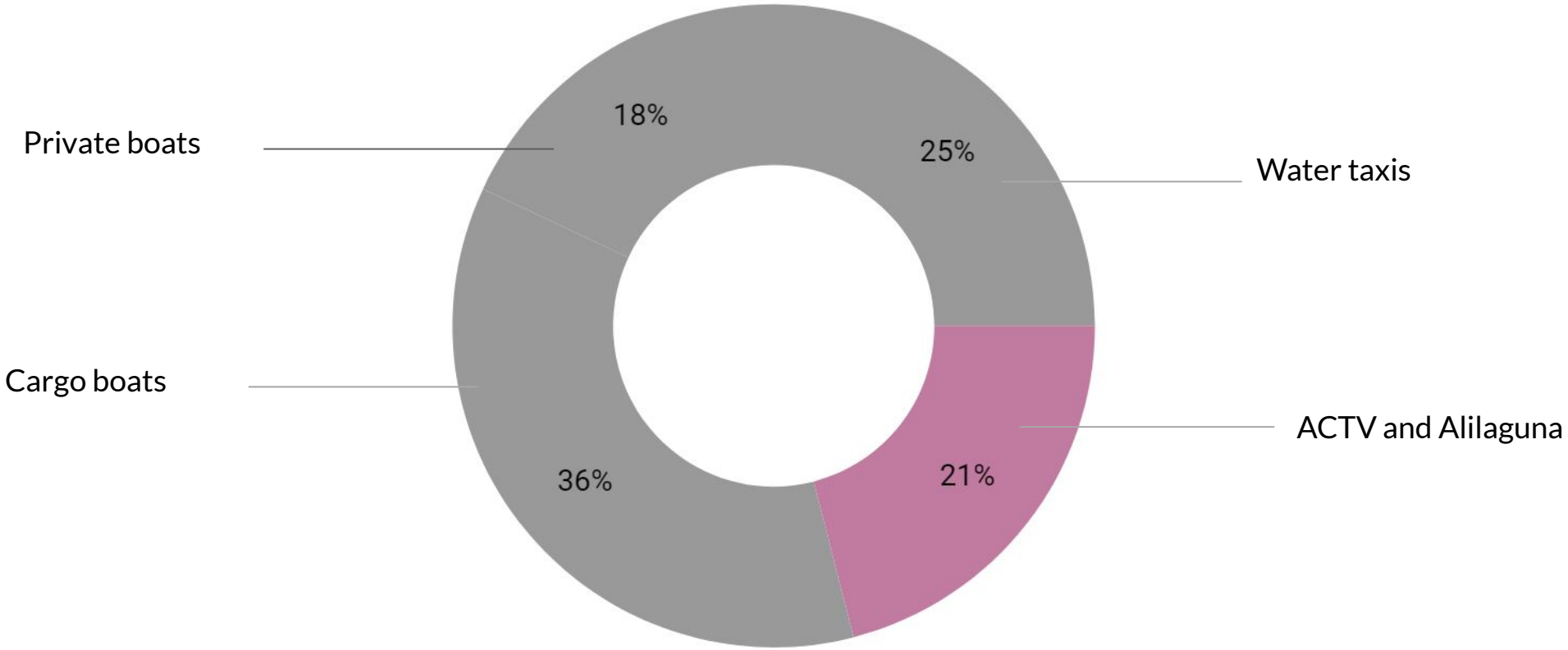
Boats can provide transportation over water to the historic city

There are four main types of boats in the Venetian canals

Boat traffic is based on counts of boats in real time, not the absolute number of boats present. If a boat circulated quickly, it may have been counted multiple times.

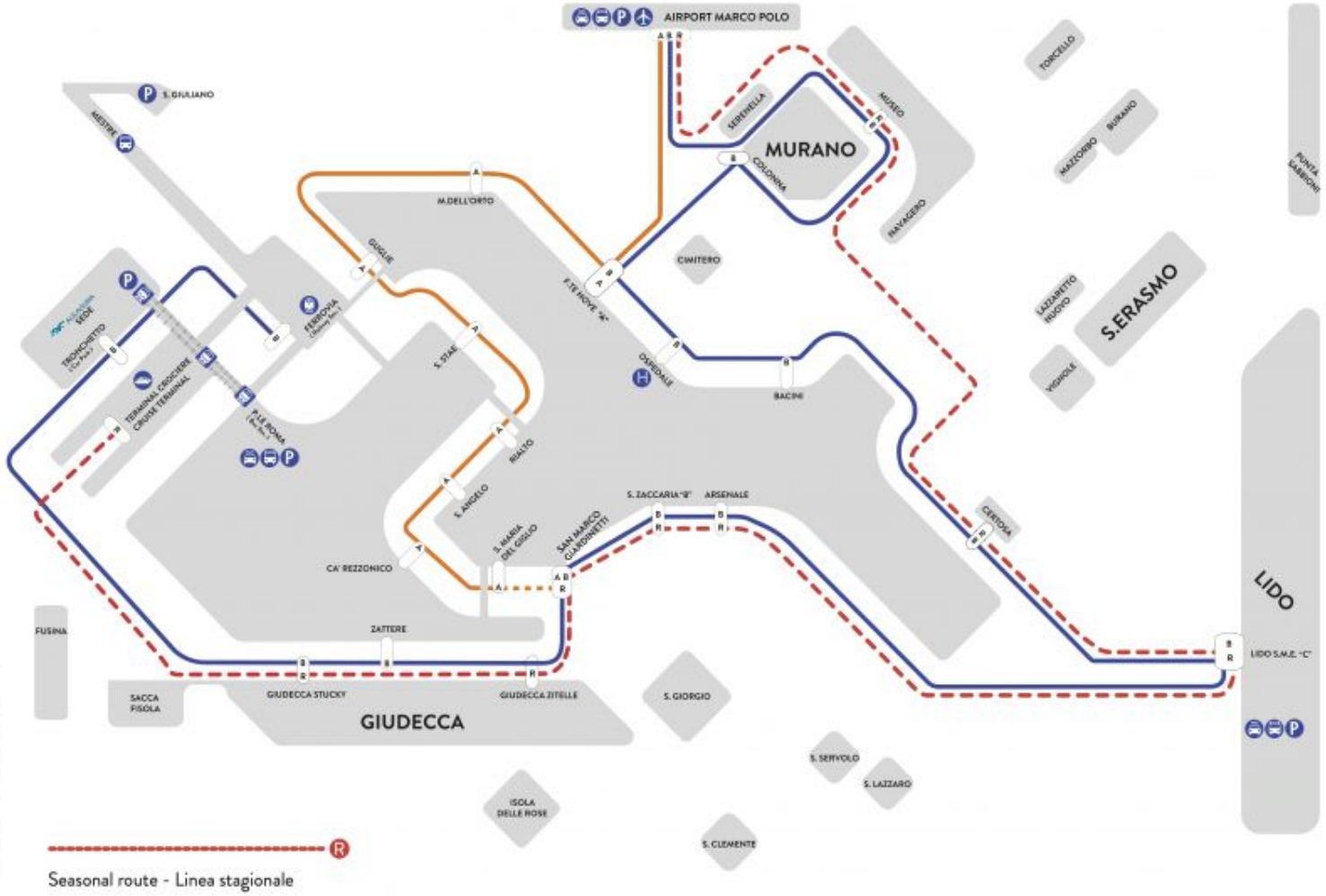


Lined public transportation boats don’t cause a lot of traffic



Alilaguna boats connect to the Marco Polo airport

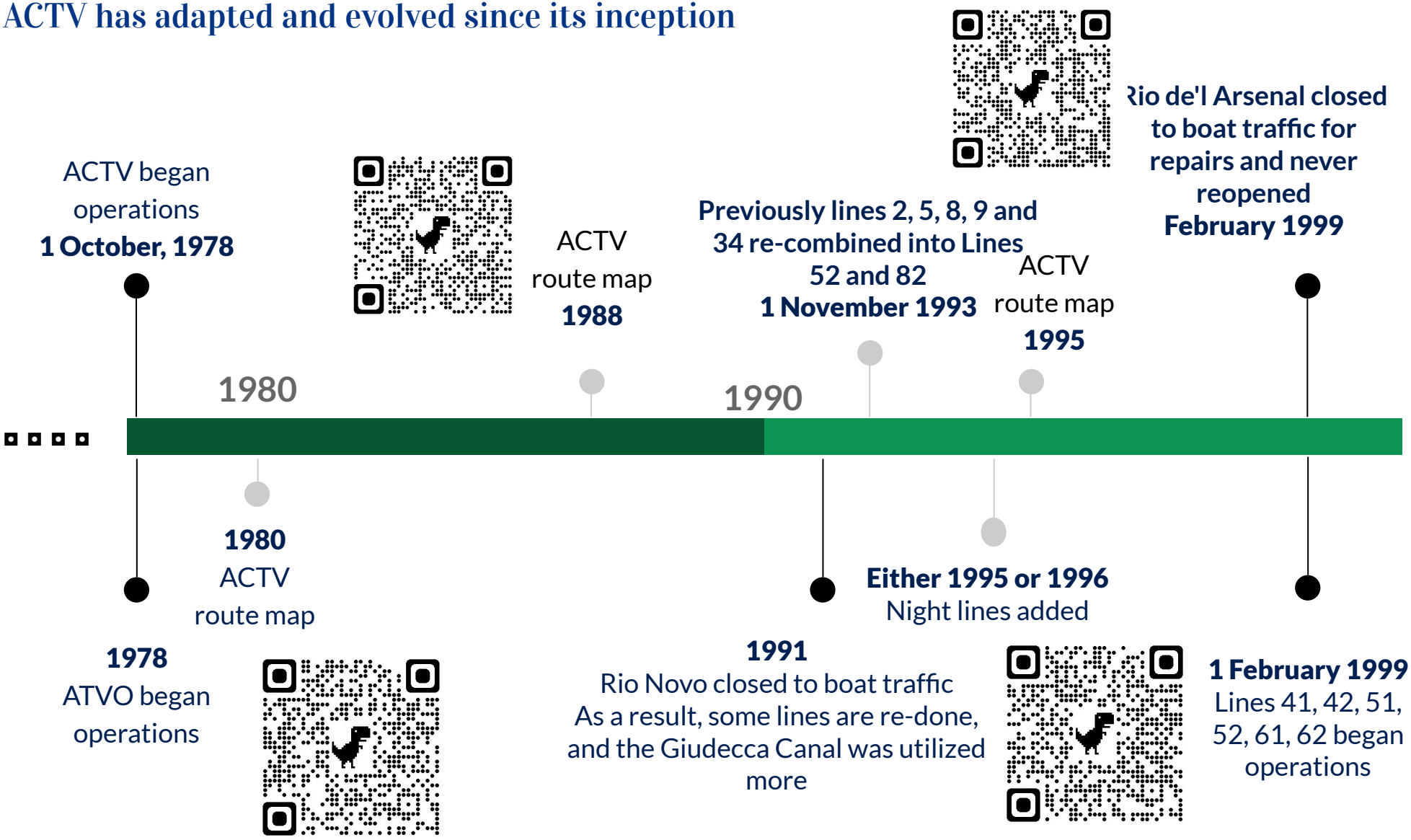
There are a total of **5 lines** operated by Alilaguna, including 2 seasonal lines.

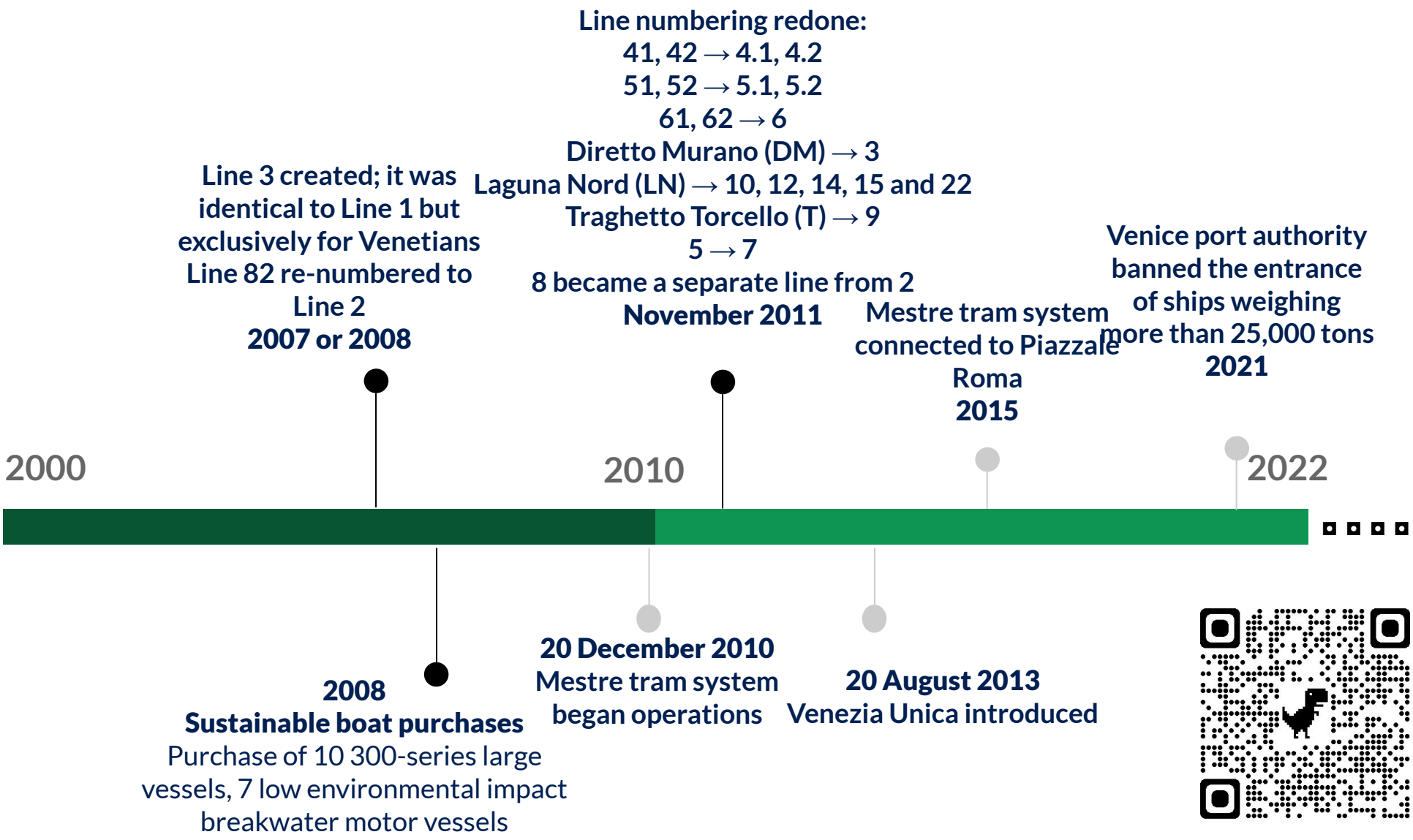


Moving around within the historic city

Venice has a unique transportation system because of its canals

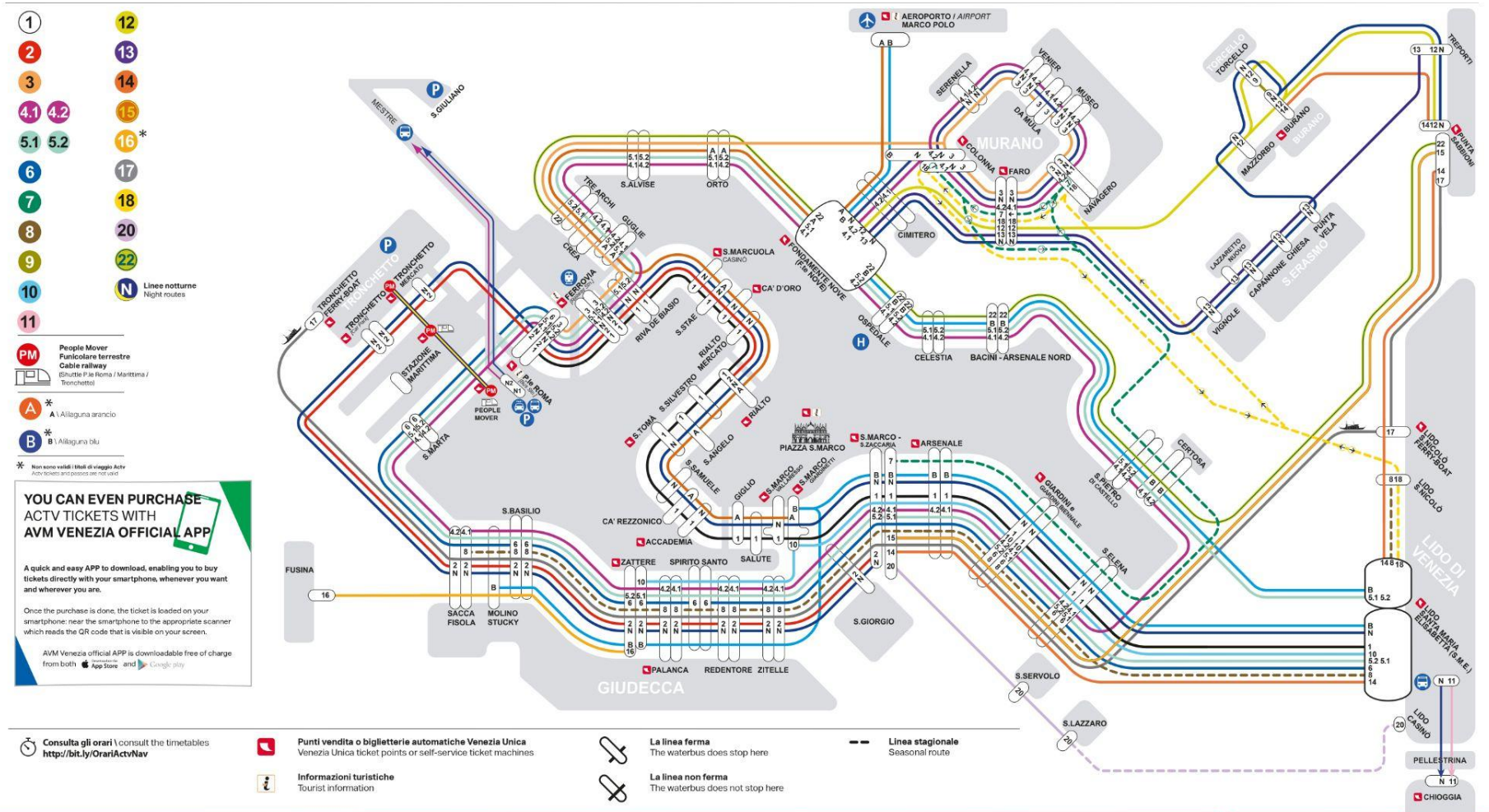
ACTV has adapted and evolved since its inception




Line 3 created; it was identical to Line 1 but exclusively for Venetians
Line 82 re-numbered to Line 2
2007 or 2008
Line numbering redone:
41, 42 → 4.1, 4.2
51, 52 → 5.1, 5.2
61, 62 → 6
Diretto Murano (DM) → 3
Laguna Nord (LN) → 10, 12, 14, 15 and 22
Traghetto Torcello (T) → 9
5 → 7
8 became a separate line from 2
November 2011
Mestre tram system connected to Piazzale Roma
2015
Venice port authority banned the entrance of ships weighing more than 25,000 tons
2021
2000
2010
2022
2008
Sustainable boat purchases
Purchase of 10 300-series large vessels, 7 low environmental impact breakwater motor vessels
20 December 2010
Mestre tram system began operations
20 August 2013
Venezia Unica introduced

Water buses are the main mode of transportation in the canals

ACT V operates 26 water bus lines with 160 boats which dock at 150 floating pontoons . Up to 1150 passengers can be carried per hour on Line 1



Vaporetti are used on Lines 1, 2, 7, 13, and Night lines

They have a passenger capacity of 215-230

Motoscafi are used for Lines 3, 4.1, 4.2, 5.1, 5.2, 6

Their passenger capacity is 150. They are smaller vessels because they go under shorter bridges on their routes compared to bridges passed under by vaporetti.

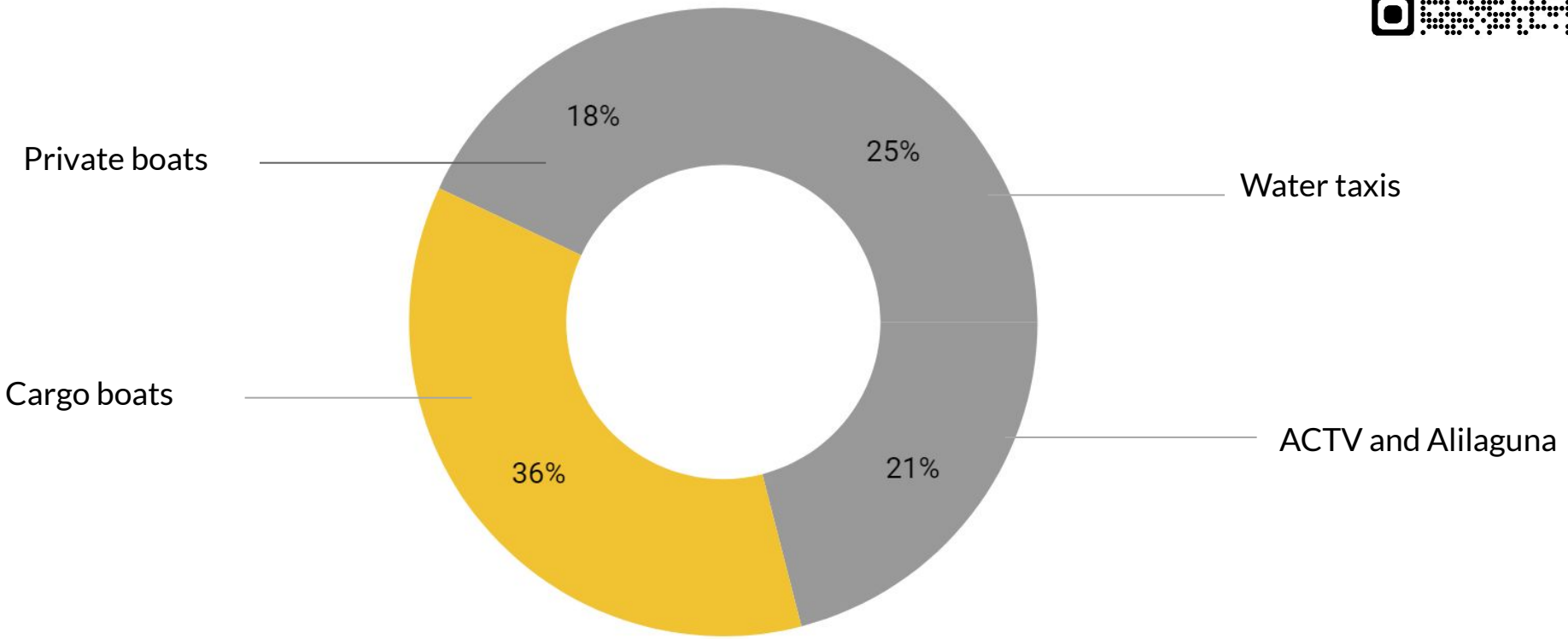
There are 250 licensed taxis

The Comune di Venezia has issued 193 bivalent licenses (including taxi license and rental with driver authorization), 7 bivalent licenses for gondolier cooperatives, and 50 taxi-only licenses (25 of which are for boats equipped with a lifting platform for accessibility), for a total of 250 licensed water taxis

Cargo Transportation

Cargo boats make up 36% of boat traffic in the lagoon

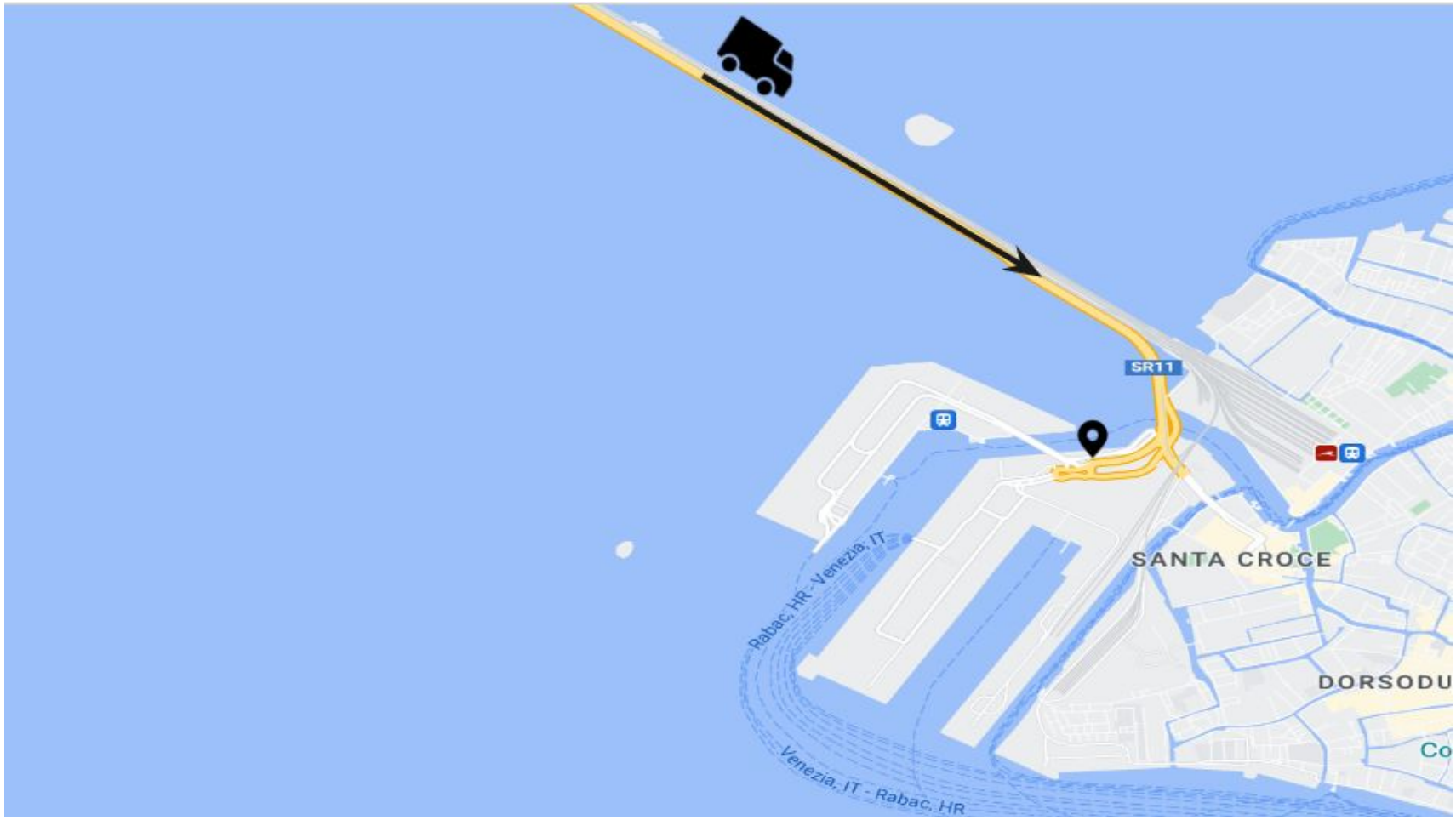
However, they cause 66% of the *moto ondoso* in the city.



There are 410 licensed cargo boats

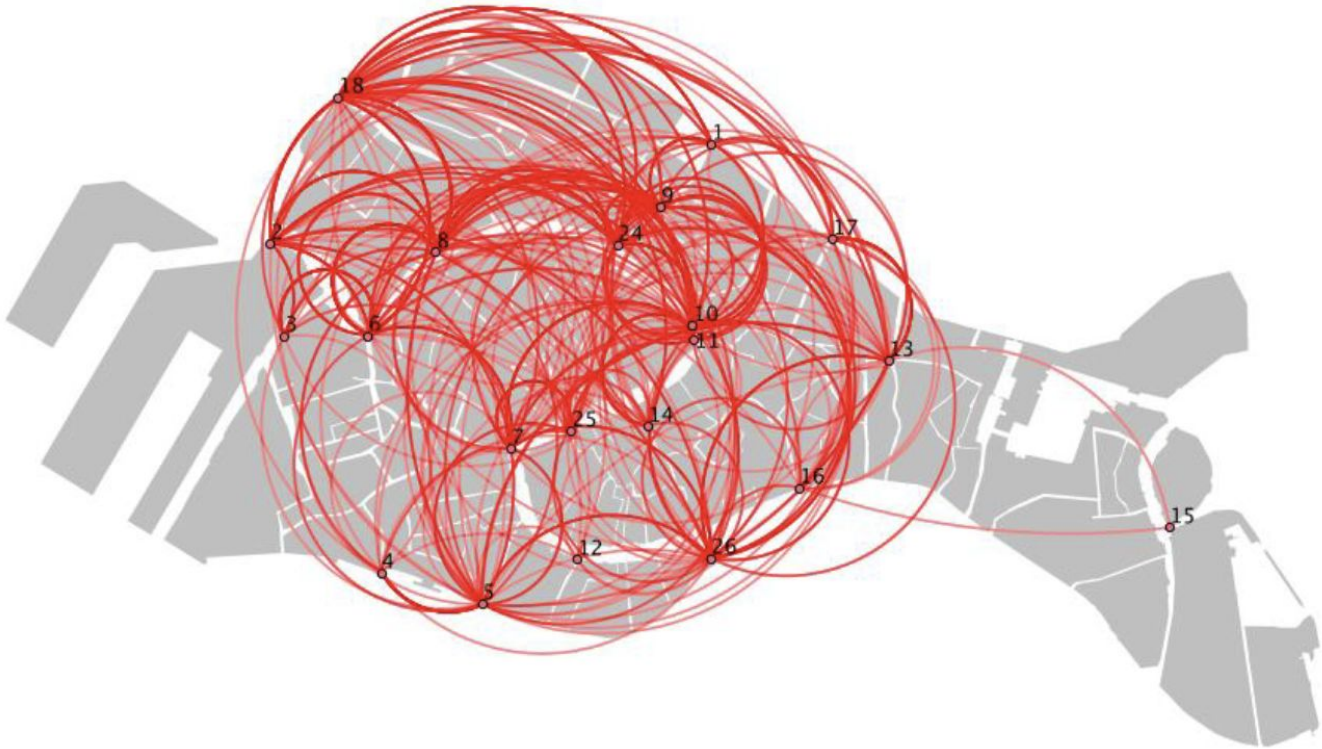
There are two type of cargo boat conto proprio and conto terzi. Conto Proprio delivers its own product, and conto Terzi delivers all the for the city of Venice.

Trucks deliver cargo products to Venice



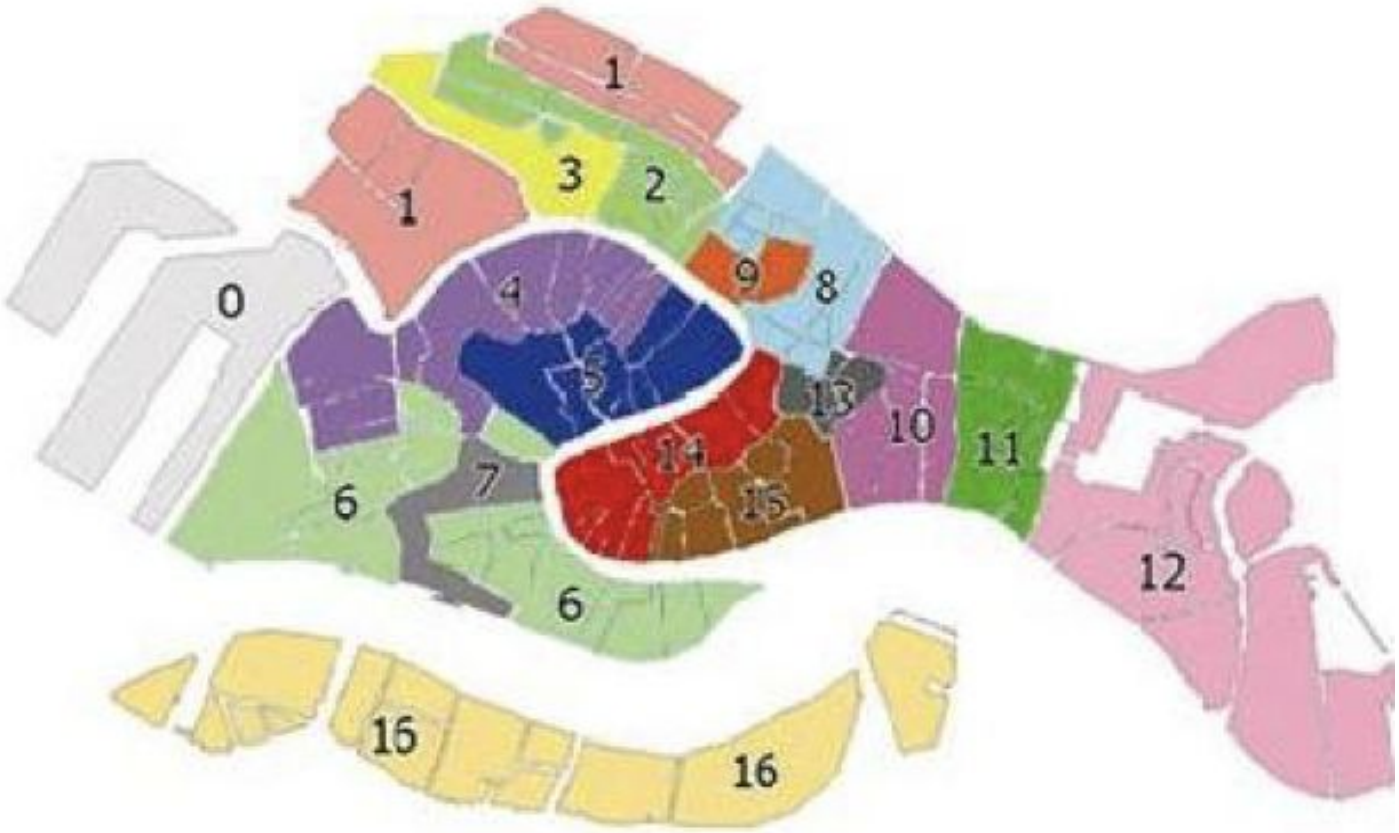
Cargo boats deliver around 32,000 packages every day with a total distance of 3,000km

Each boat has to travel around different areas of the city to deliver the same product to several locations.



In 2001, a group of students from WPI suggested a system of cargo delivery by location instead of by product

The city of Venice was broken down into 16 potential zones for daily delivered cargo organized by location instead by product.



Problems with the Current System

The canals are congested with boats of various sizes and capacities

Crowding can cause slowing of scheduled routes or point-to-point trips

Fog limits boat operations

There are cancellations and delayed to regular ACTV lines because it’s not safe to navigate. Limited visibility can affect the operability of any type of boat.

Acqua alta limits boat operations

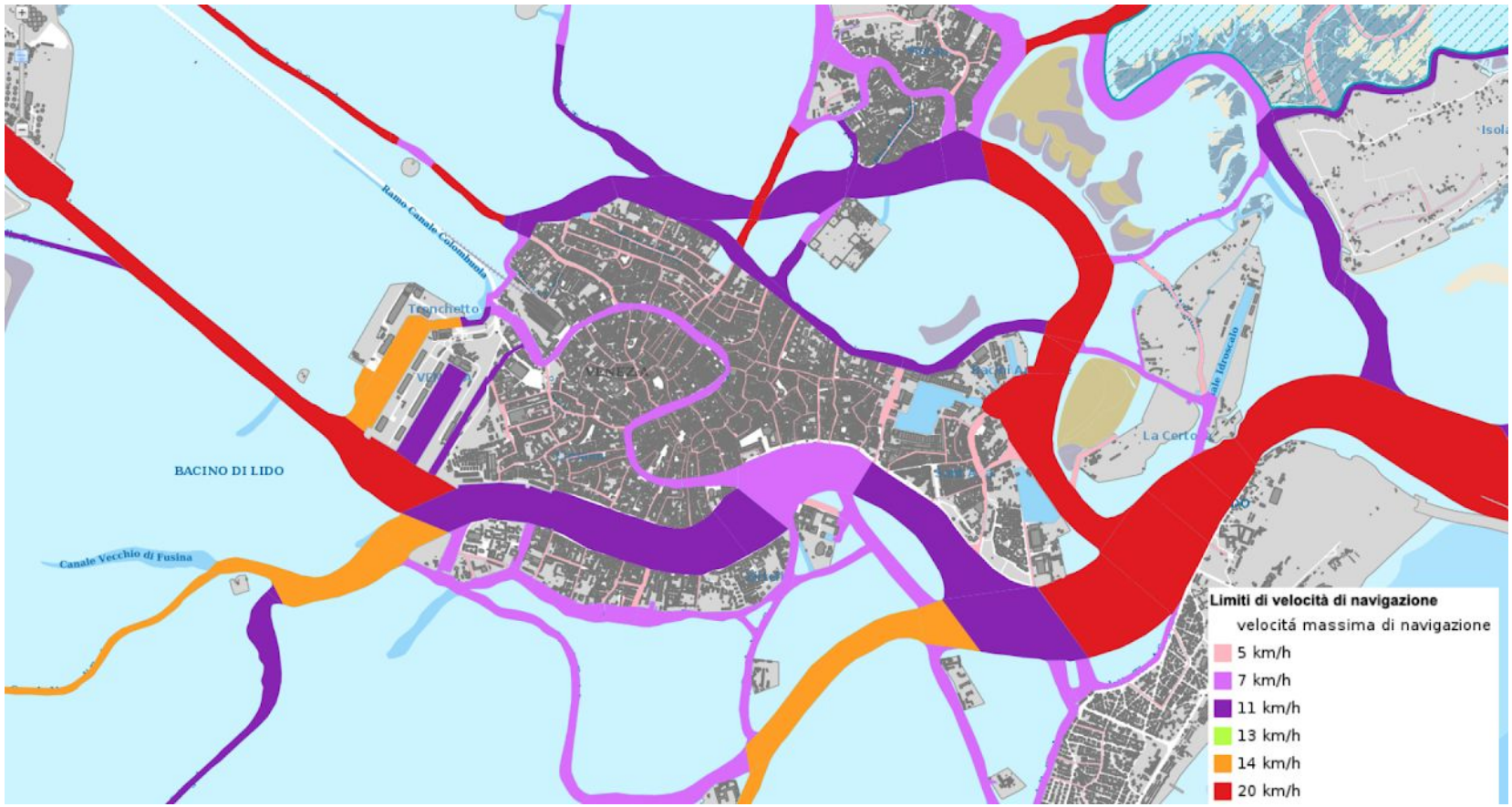
All boats are affected by *acqua alta*, especially those which traverse smaller canals with shorter bridge crossings.

Moto ondoso causes damage to canal walls and buildings

Moto ondoso means wave motion, referring to the energy transferred to the water behind a motor boat as seen below. It's estimated that it costs up to $11,680 to fix one square meter of damaged canal wall

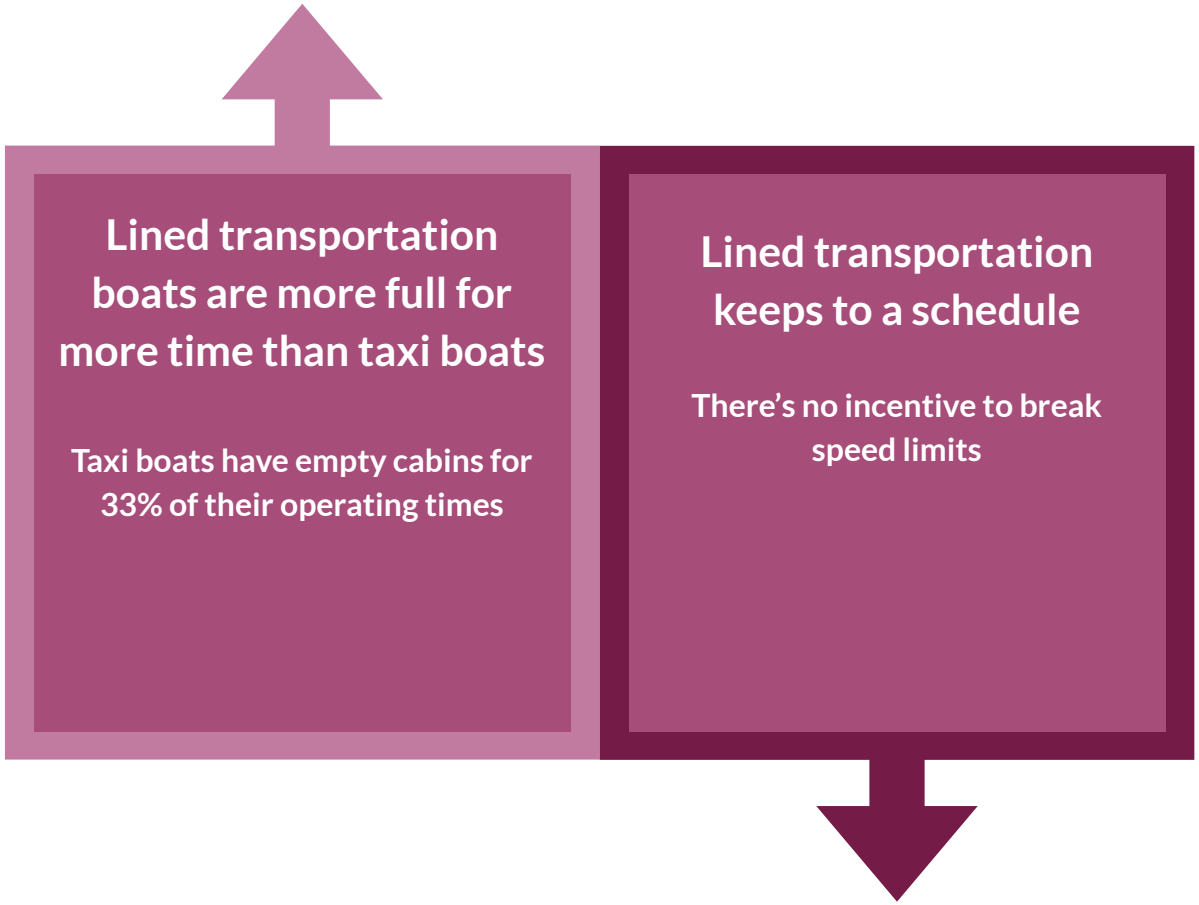
Speed limits can mitigate the effects of *moto ondoso*, but they slow down traffic

Increased speed means more energy transferred into the water and more *moto ondoso*. In 2002, it was found that the average taxi boat travels at 11.7 km/h, despite the speed limit being 5 km/h in most canals.



Lined transportation produces less *moto ondoso* than taxi boats

By increasing the use of lined transportation (ACTV and Alilaguna) compared to taxi boats, the amount of *moto ondoso* will decrease.



Reducing cargo boat traffic would reduce *moto ondoso*

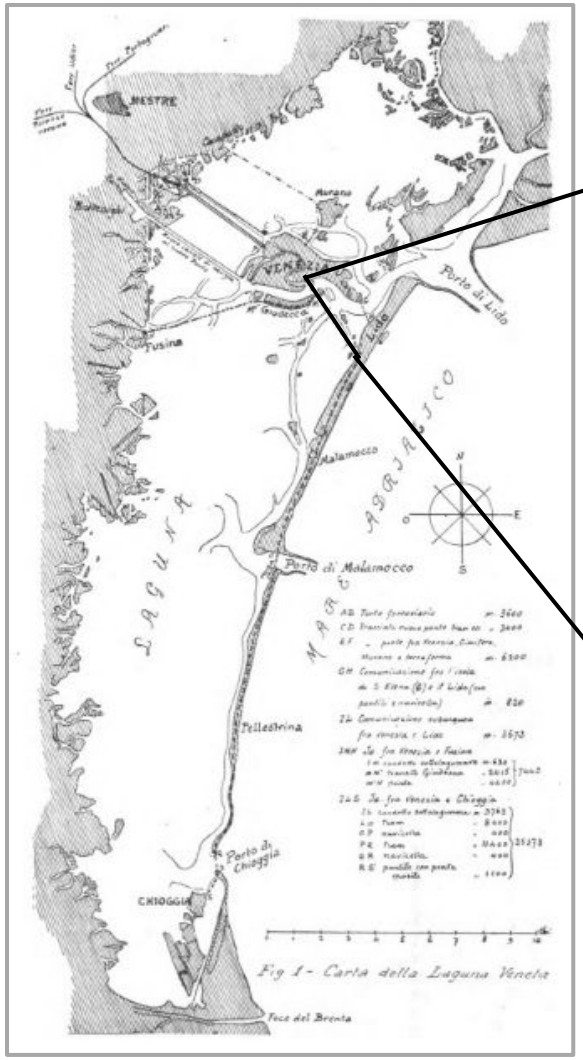
Cargo boats delivering by location, instead of by product, produce less *moto ondoso*

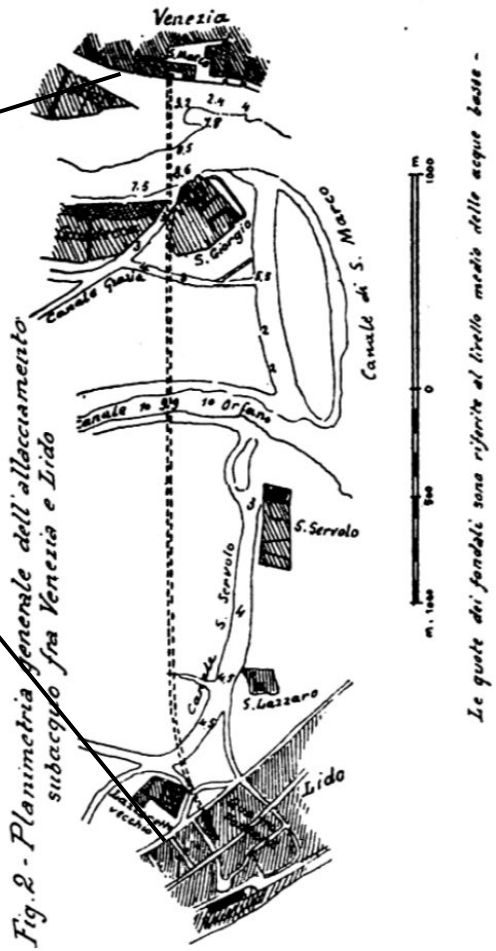
Predicted **86% reduction** in distance traveled by cargo boats following a per-location scheme

Less *moto ondoso*

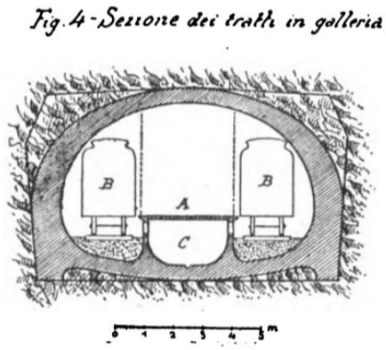
Exploration of a *Sublagunare*

1911 Proposal to Connect the Lagoon





This proposal includes multiple bridges, trams, and a *sublagunare* going from San Zaccaria to Lido Quattro Fontane



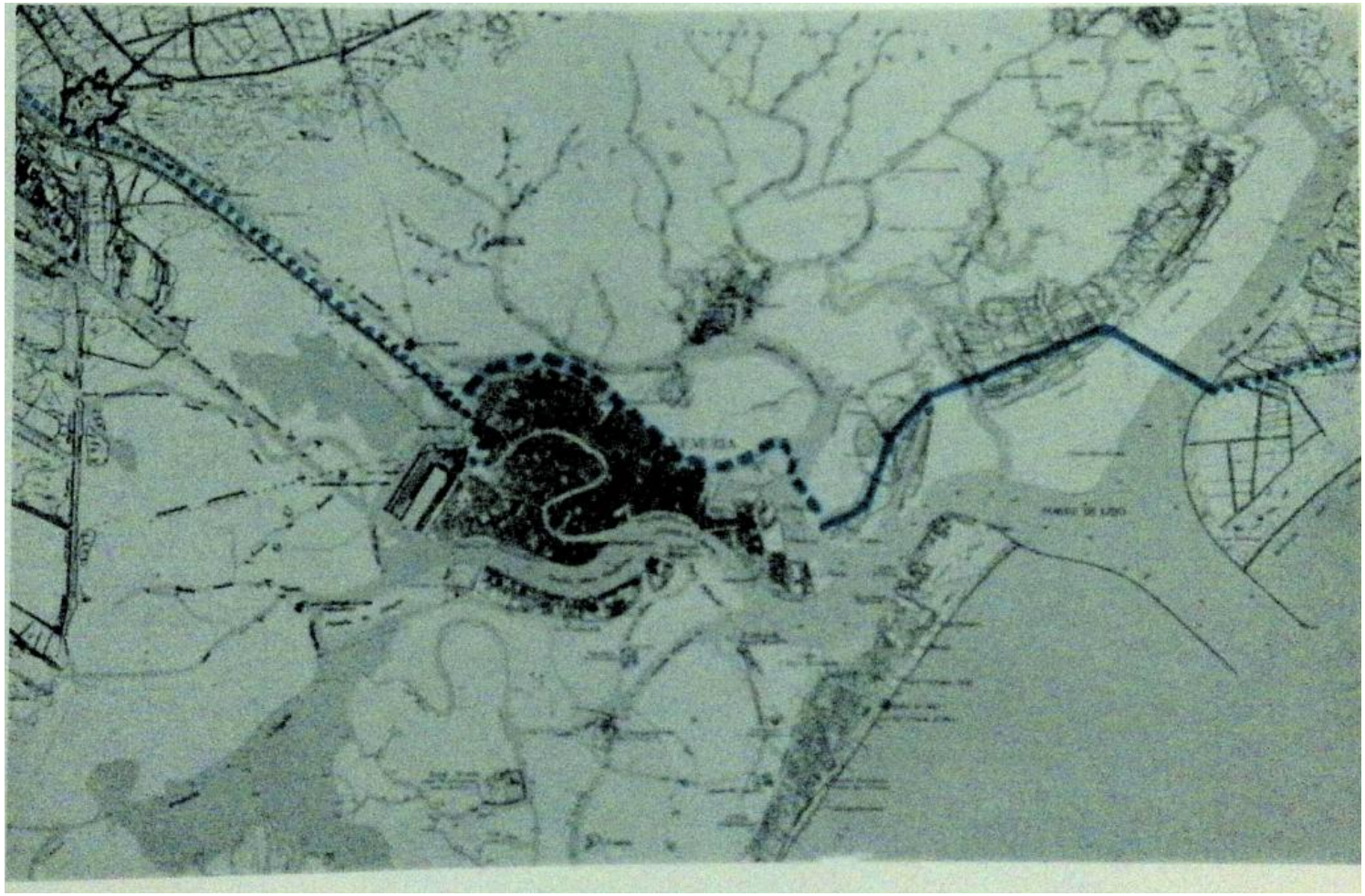
Pedestrian tunnel flanked by electric trams

1933 *Sublagunare* Proposal

In 1933, Ing. Miozzi proposed a single *sublagunare* route that would have connected Mestre, the historic city of Venice, Lido, and Chioggia

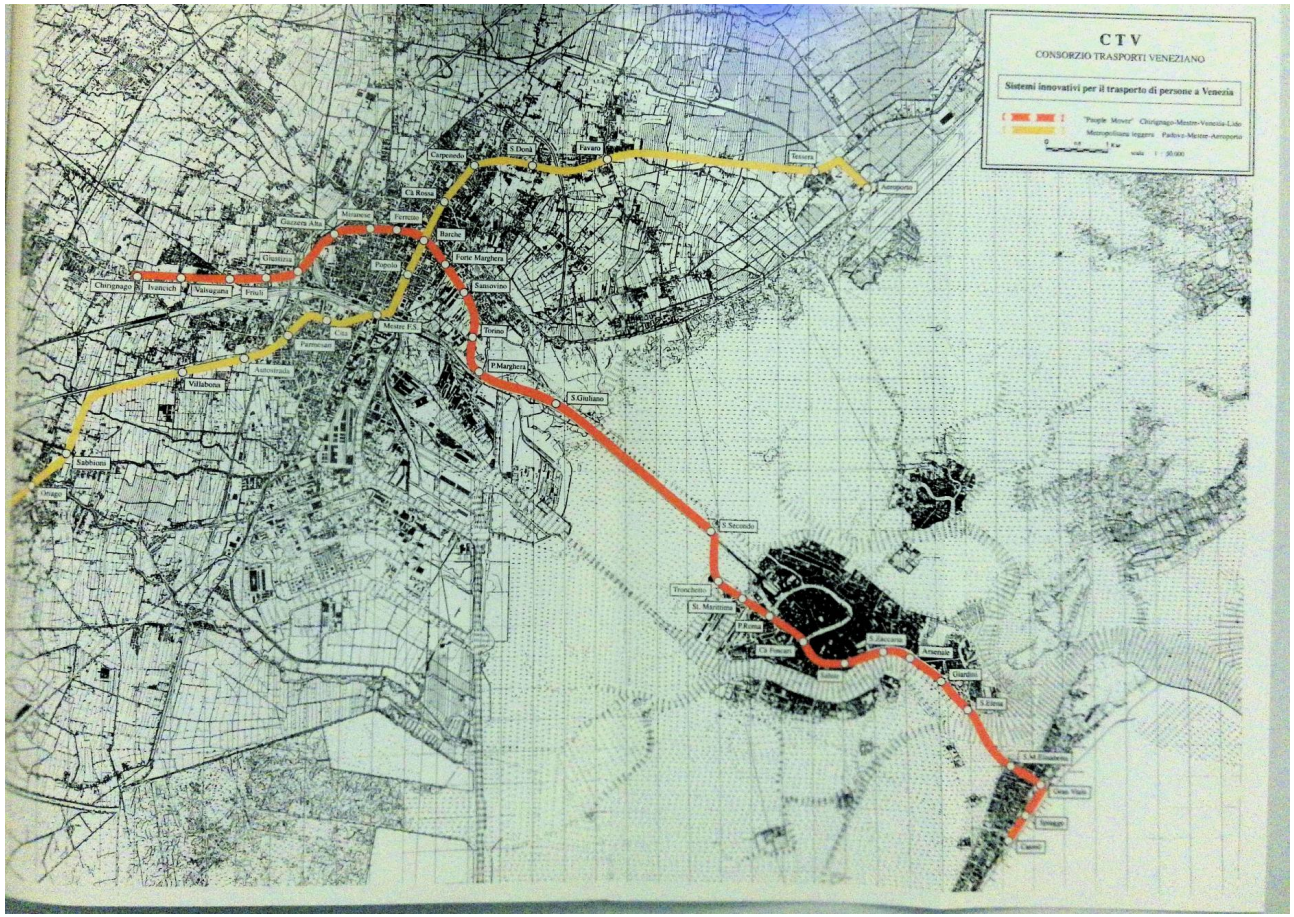
1959 Certosa Highway Plan

This proposal included a motor highway, partly underground, from Mestre to Punta Sabbioni along Fondamente Nove



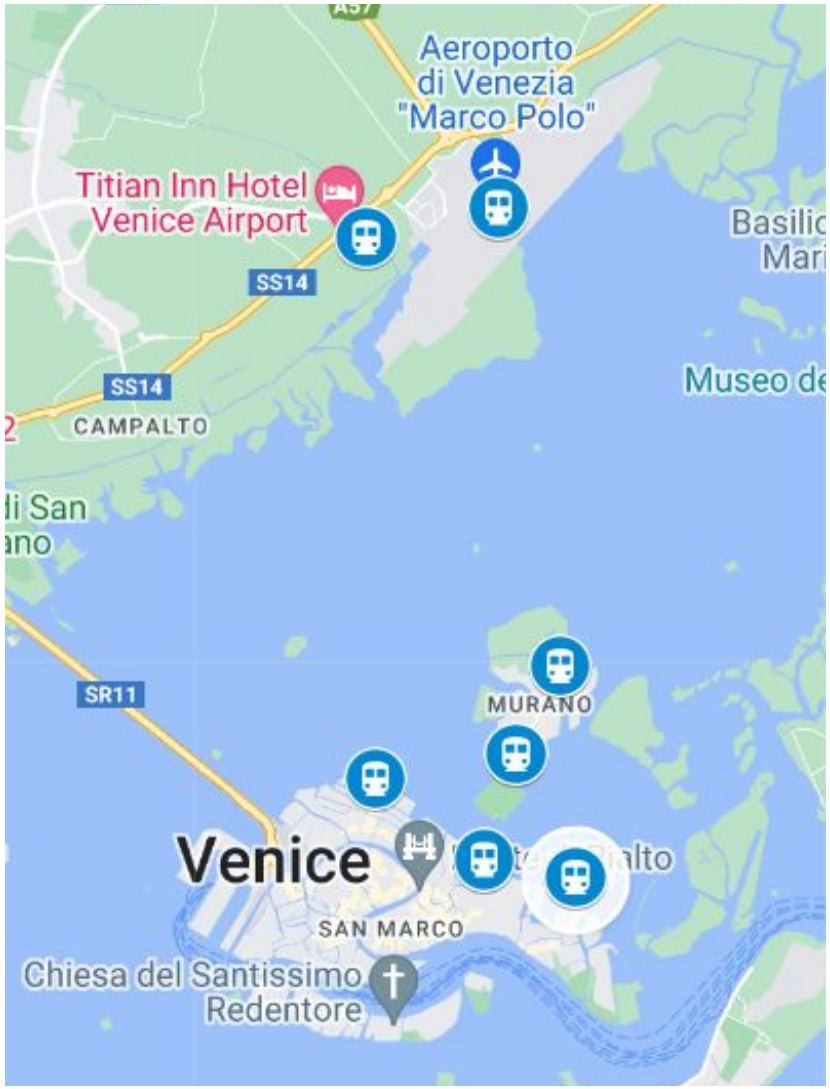
1990 People Mover Proposal

In 1990, the Consorzio Trasporti Veneziano proposed a system of two tram lines (partly underground) connecting Mestre/Marghera to the historic city (including Lido) at population hubs and transportation hubs



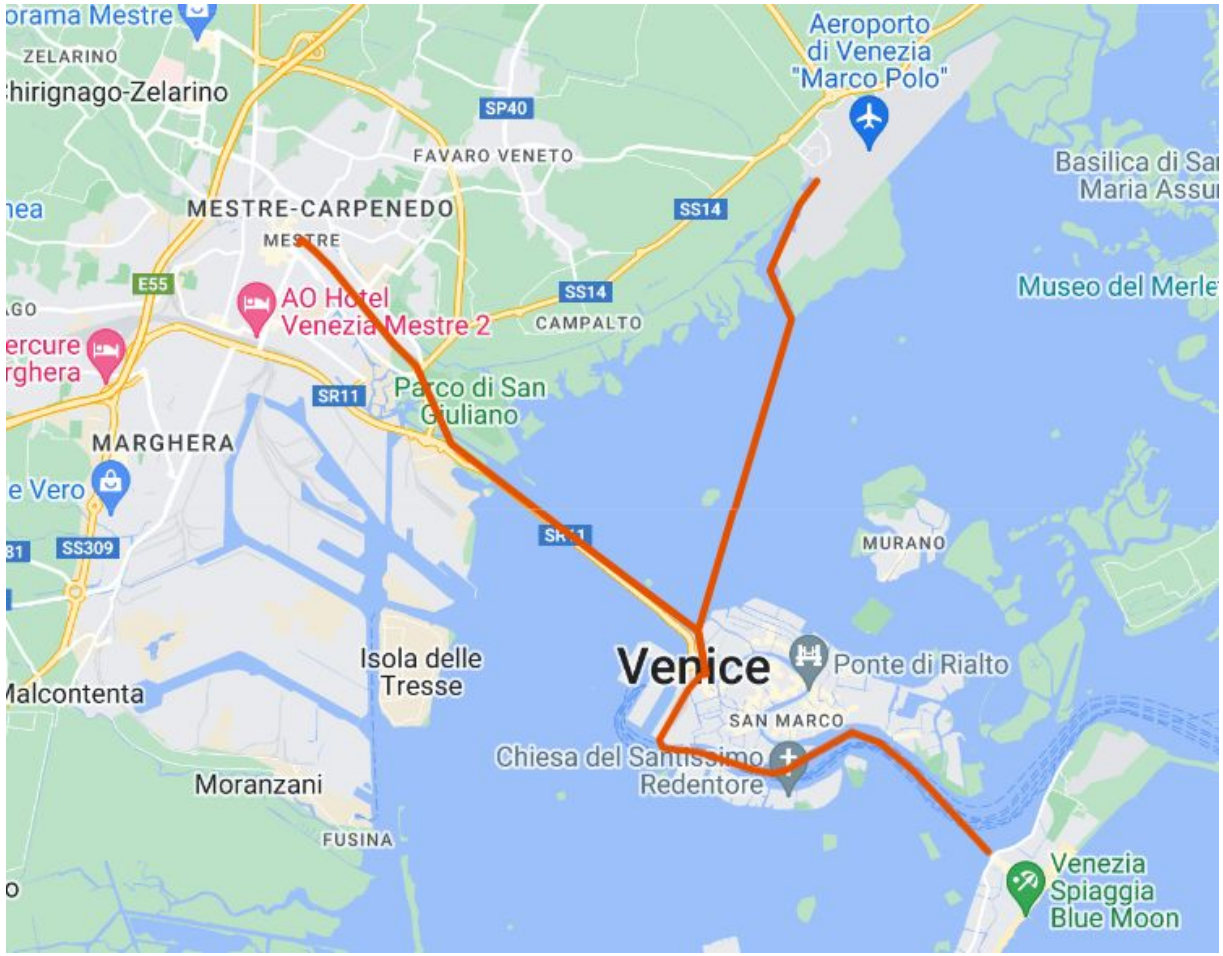
2005 *Sublagunare* Proposal

The 2005 proposal from Mayor Paolo Costa included a *sublagunare* proposal that would have connected the historic city, including Murano, to the Marco Polo airport

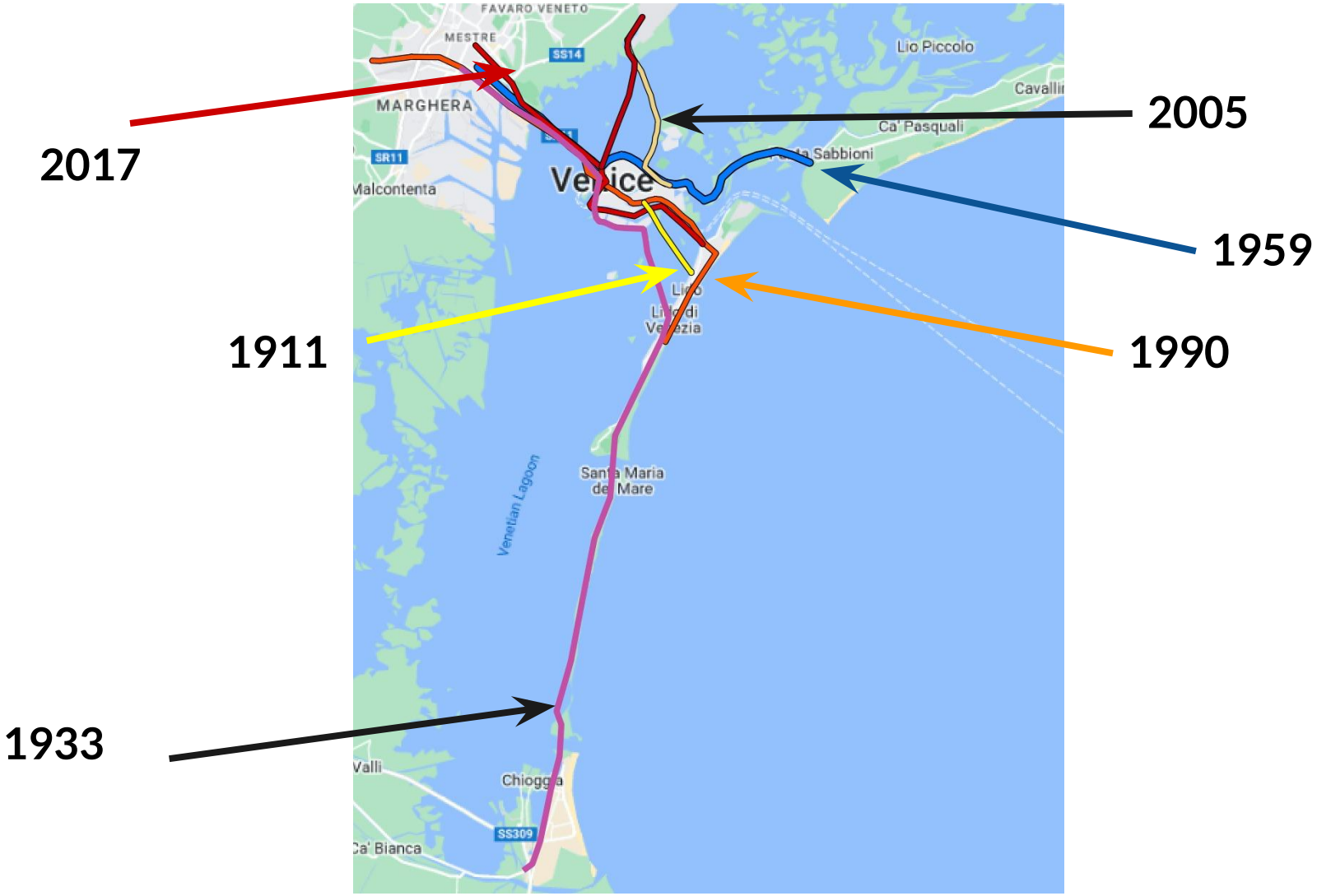


2017 *Sublagunare* Proposal

In 2017, a group of WPI student researchers proposed an extension to the 2005 proposal that would have provided a connection to Mestre/Marghera

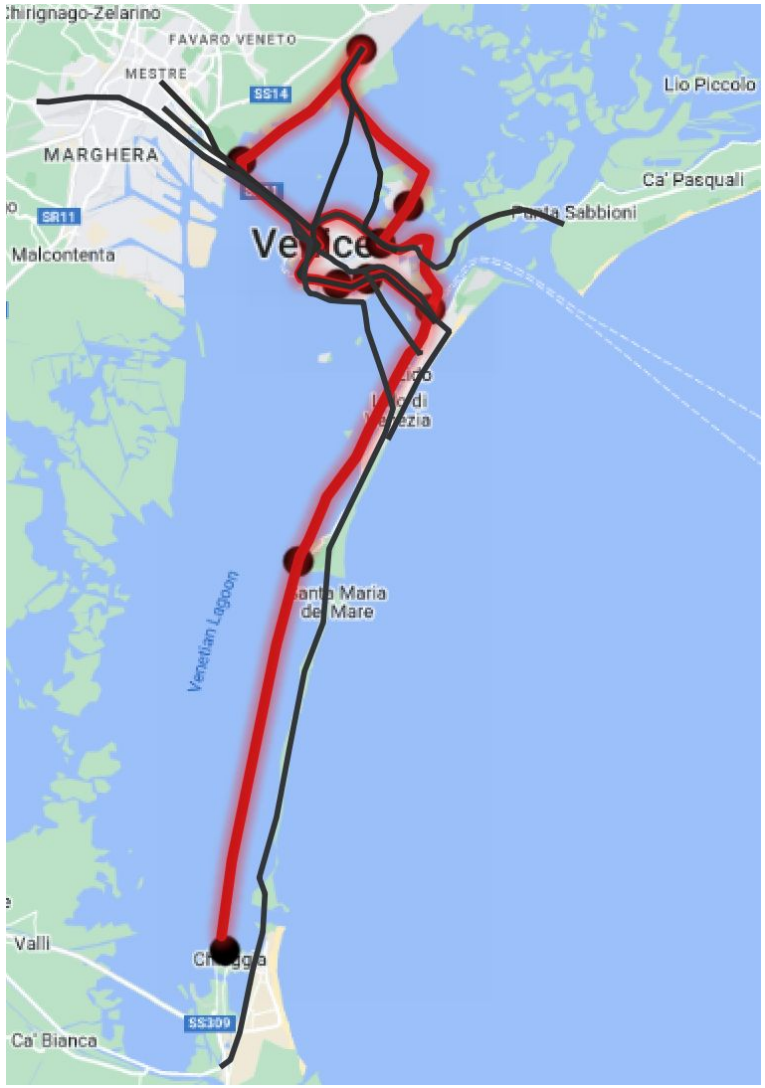


The previous proposals have commonalities

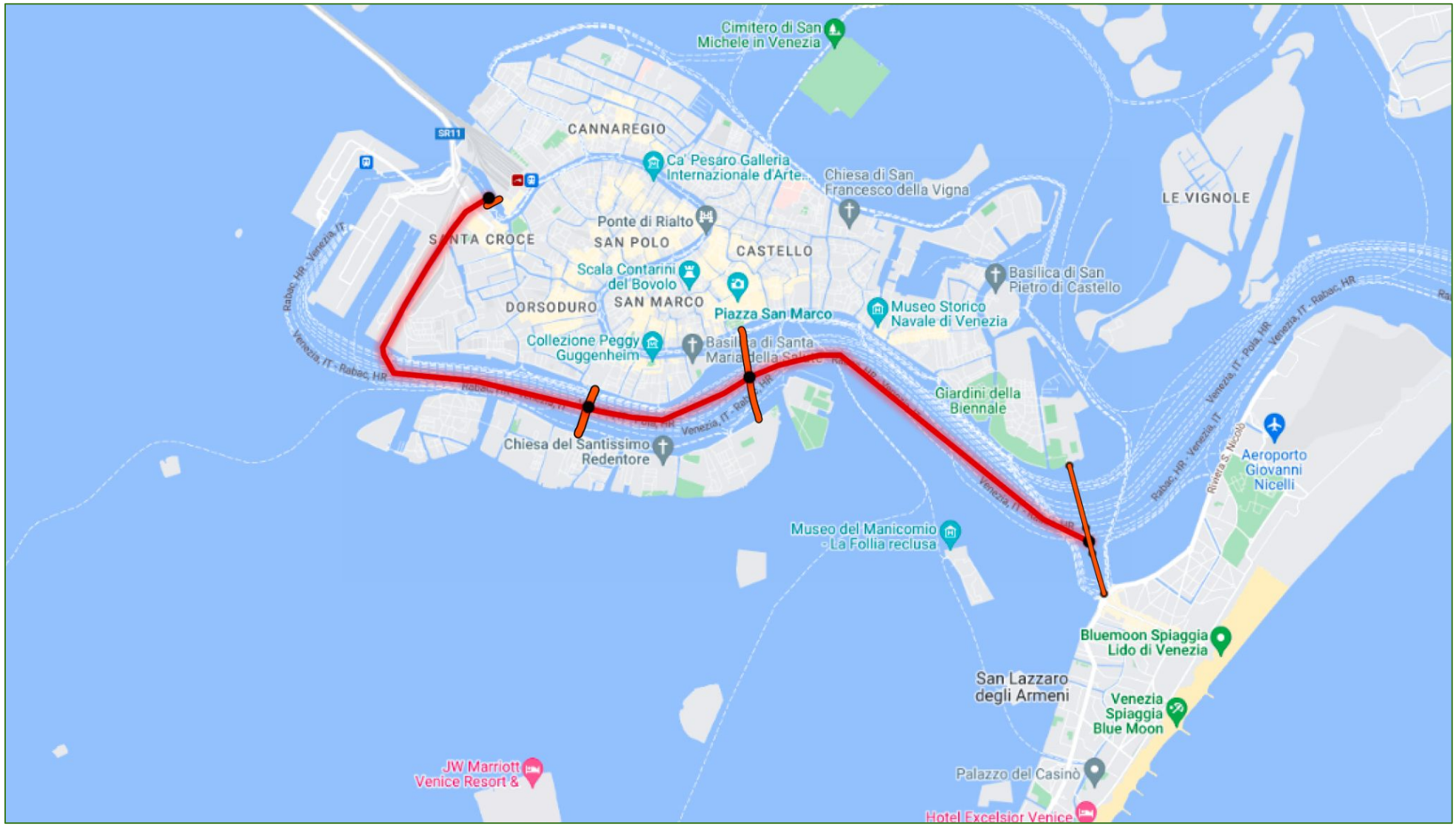


2022 *Sublagunare* Proposal

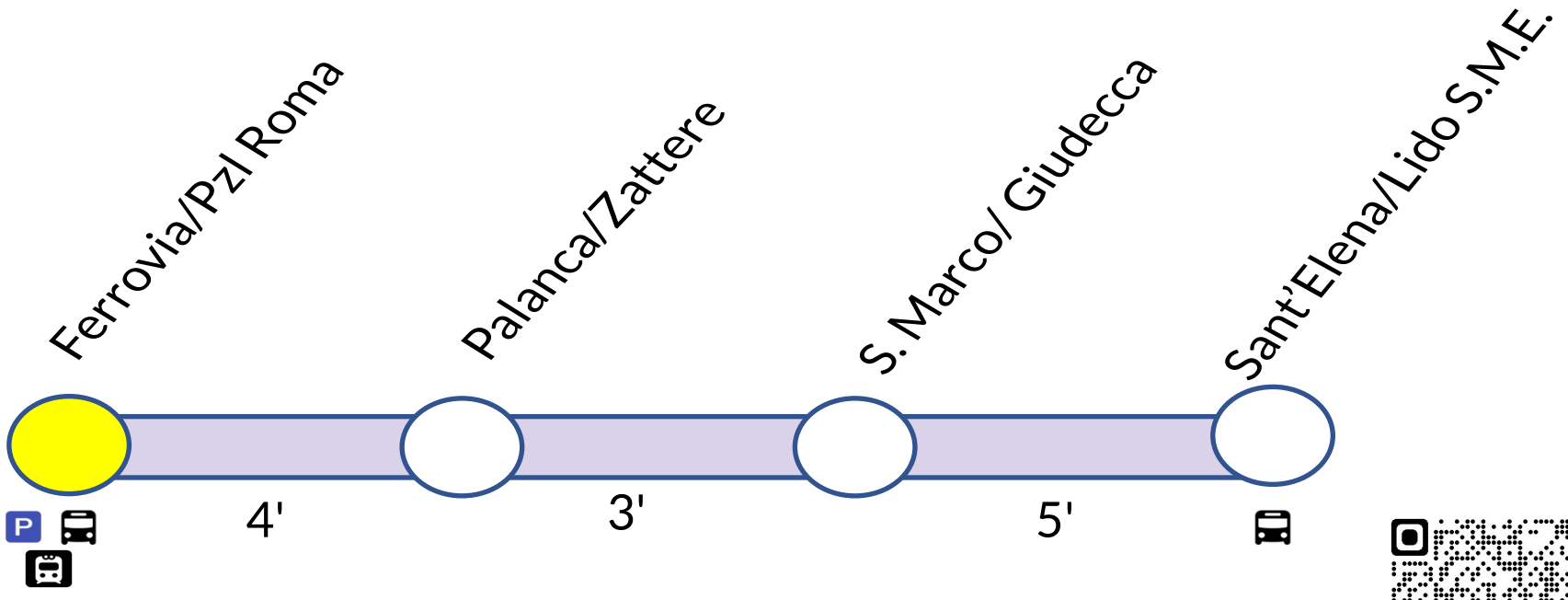
This proposal aims to connect commuters to the mainland of Venice faster. There are stops in the historic city, on Lido, Murano, and the mainland (including Marco Polo Airport, San Giuliano, and Chioggia).



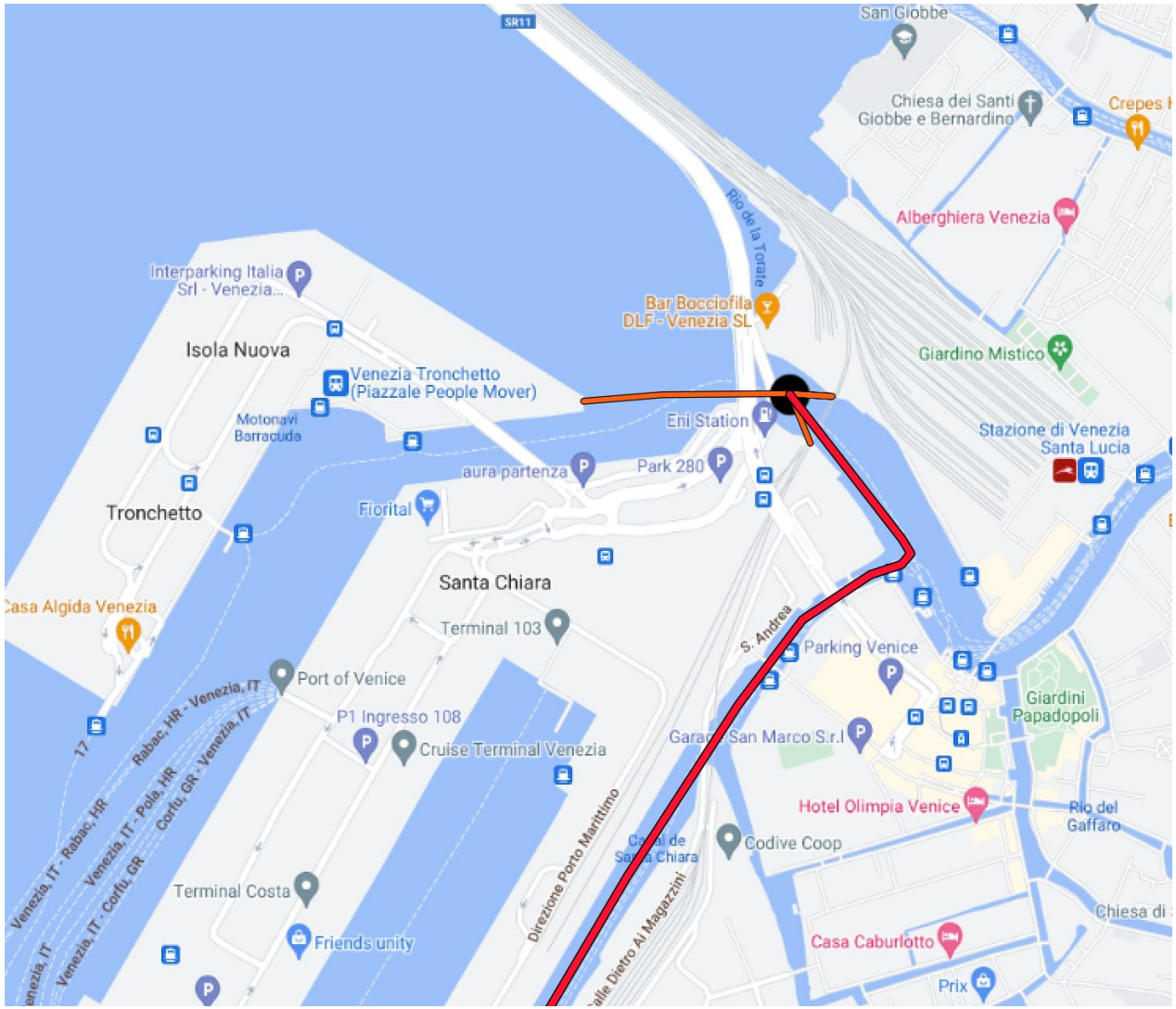
Phase 1 of the New Proposal



Phase 1 of the *Sublagunare* Proposal



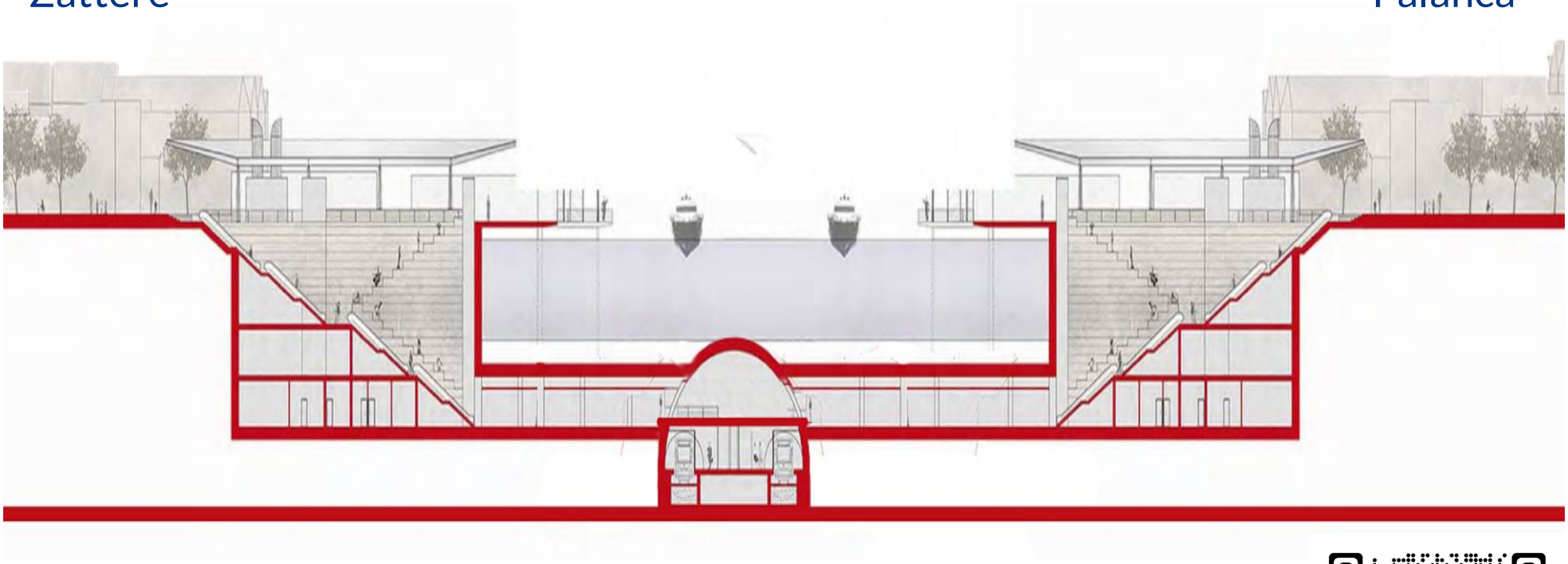
The most complicated station connects the three transportation hubs with pedestrian tunnels



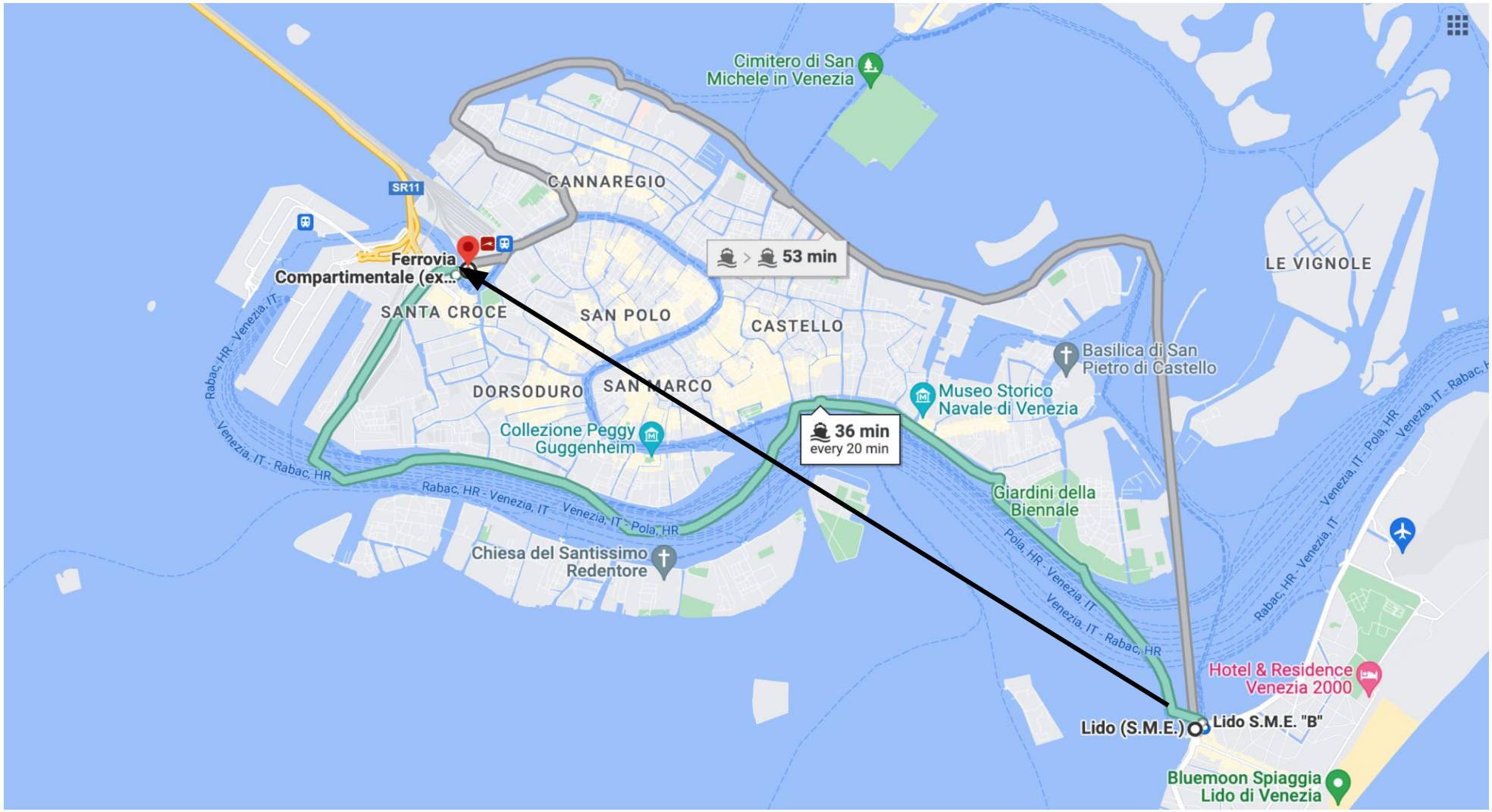
Many of the stations have two pedestrian tunnels to connect nearby locations across canals

Zattere

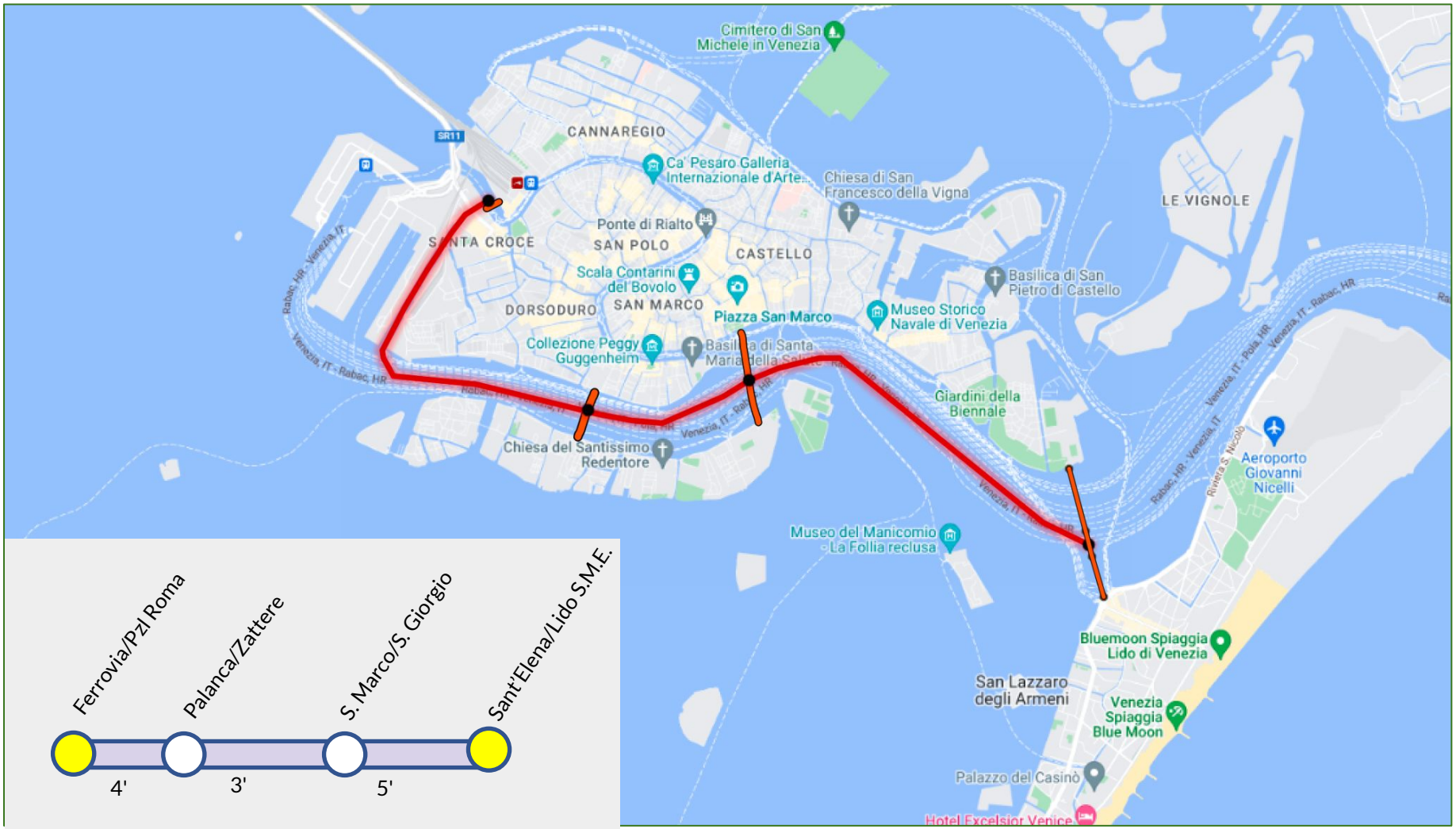
Palanca



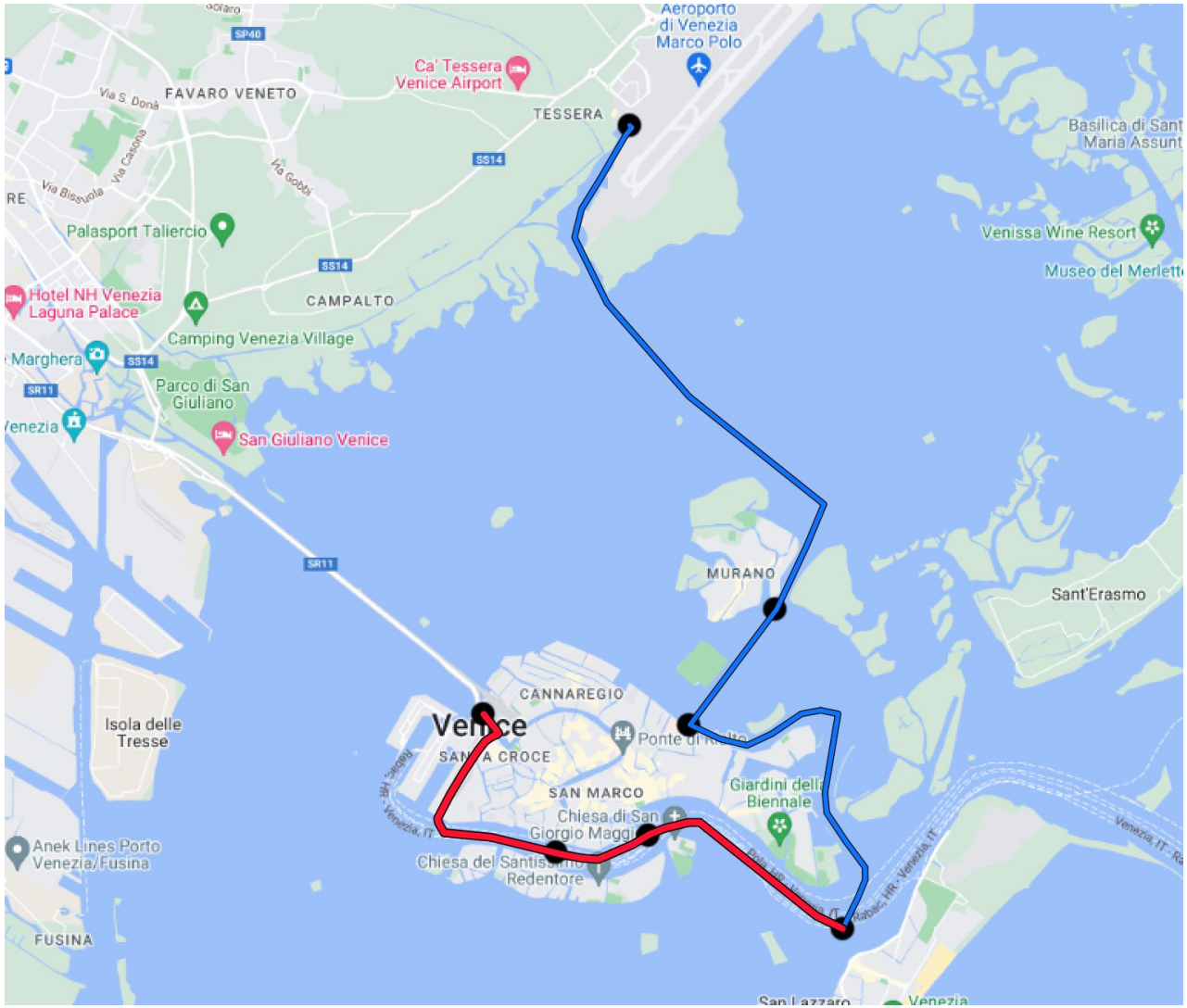
Today, transporting from Lido S.M.E. to Ferrovia takes 36 minutes



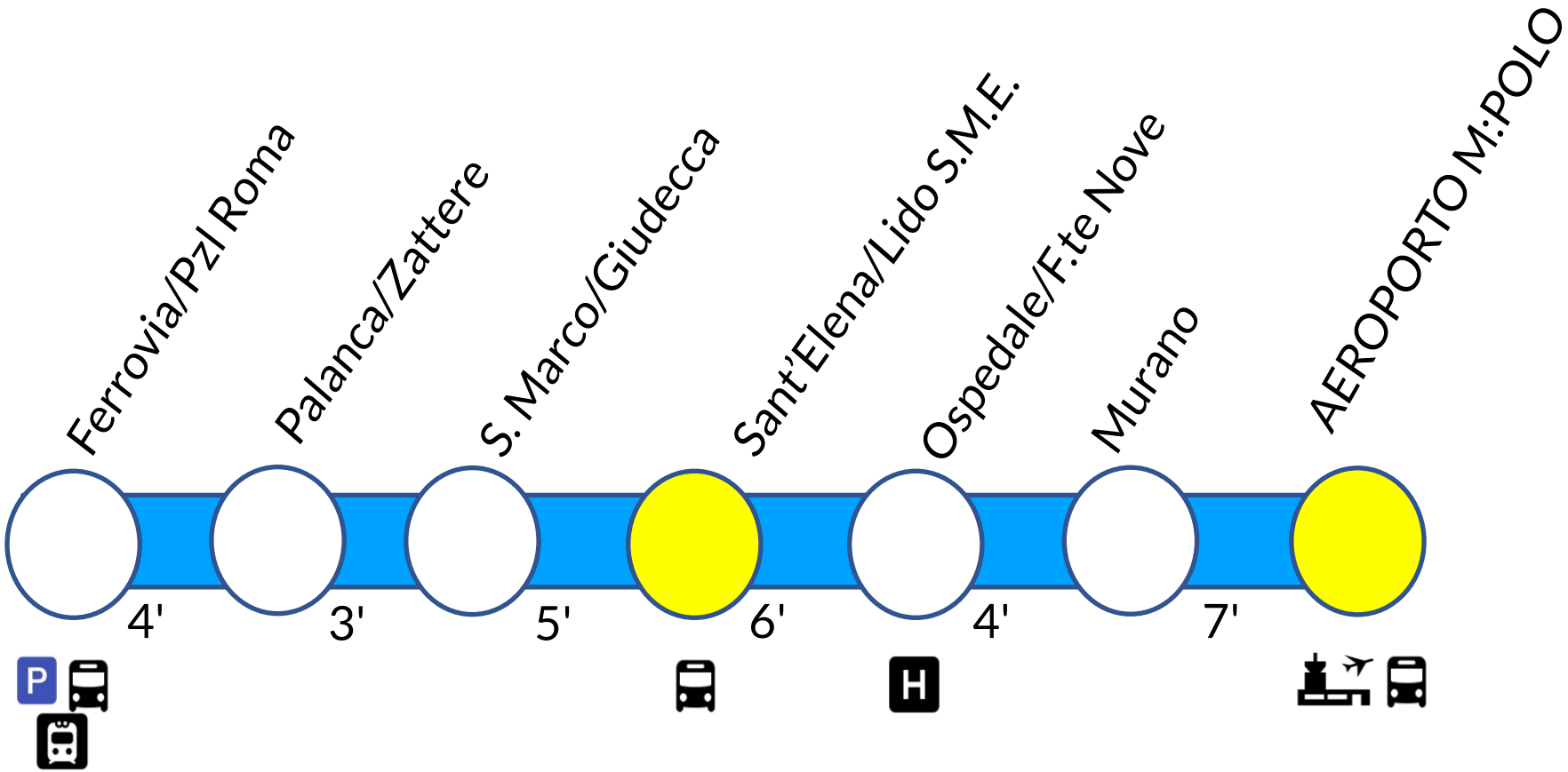
With the *sublagunare*, the same trip would only take 12 minutes



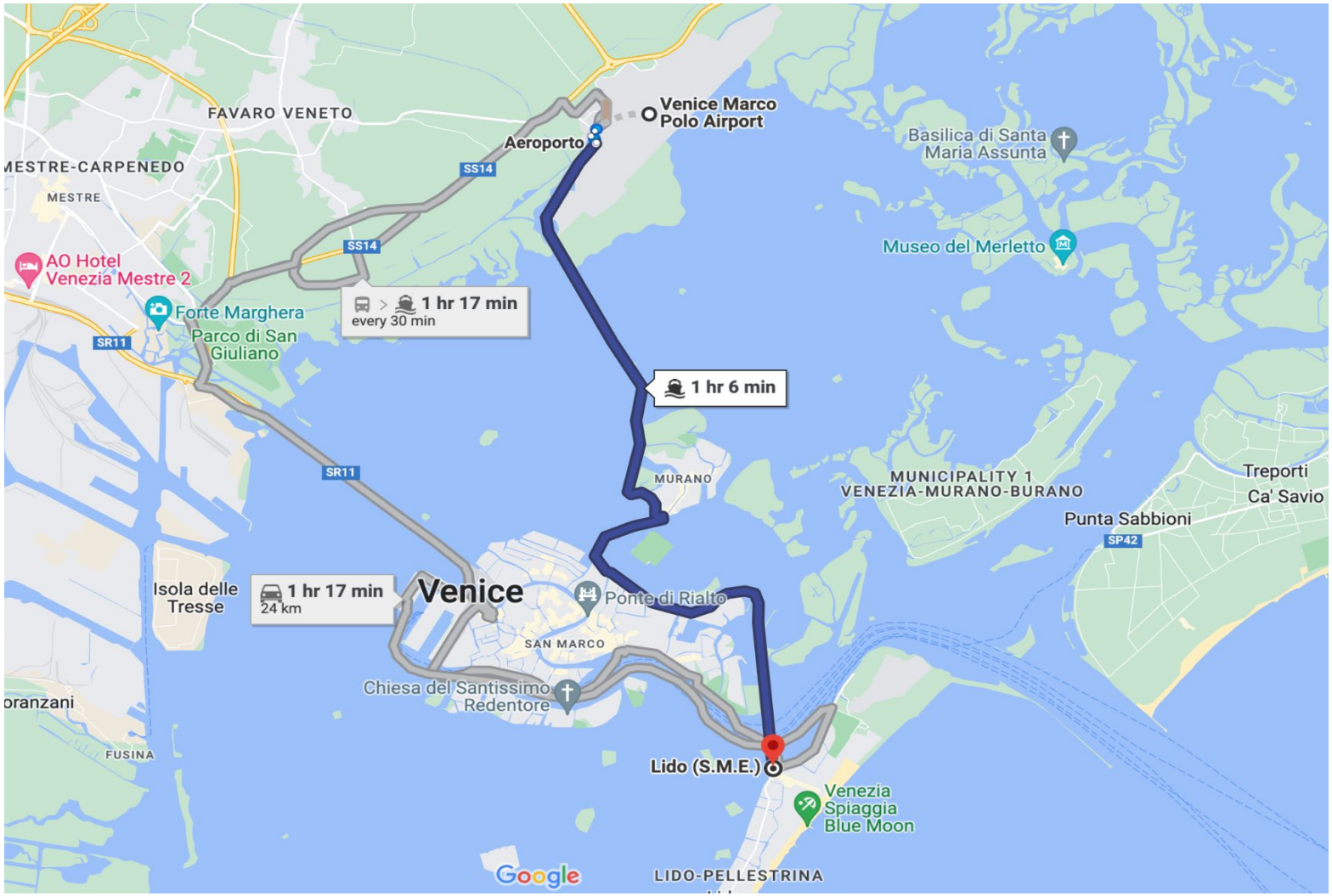
Phase 2 of the *Sublagunare* Proposal



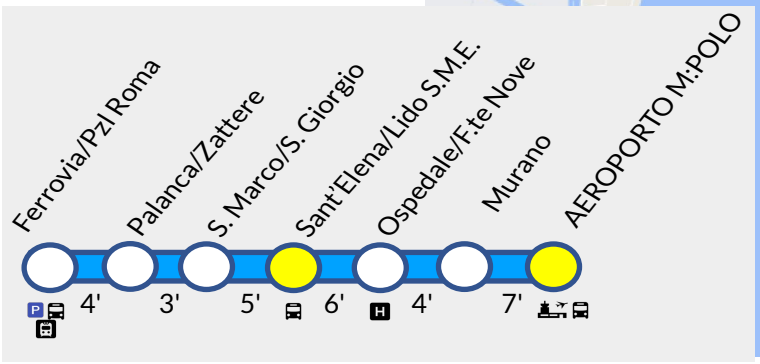
Phase 2 of the *Sublagunare* Proposal



Today, transporting from Lido S.M.E. to Marco Polo airport takes 1h6min

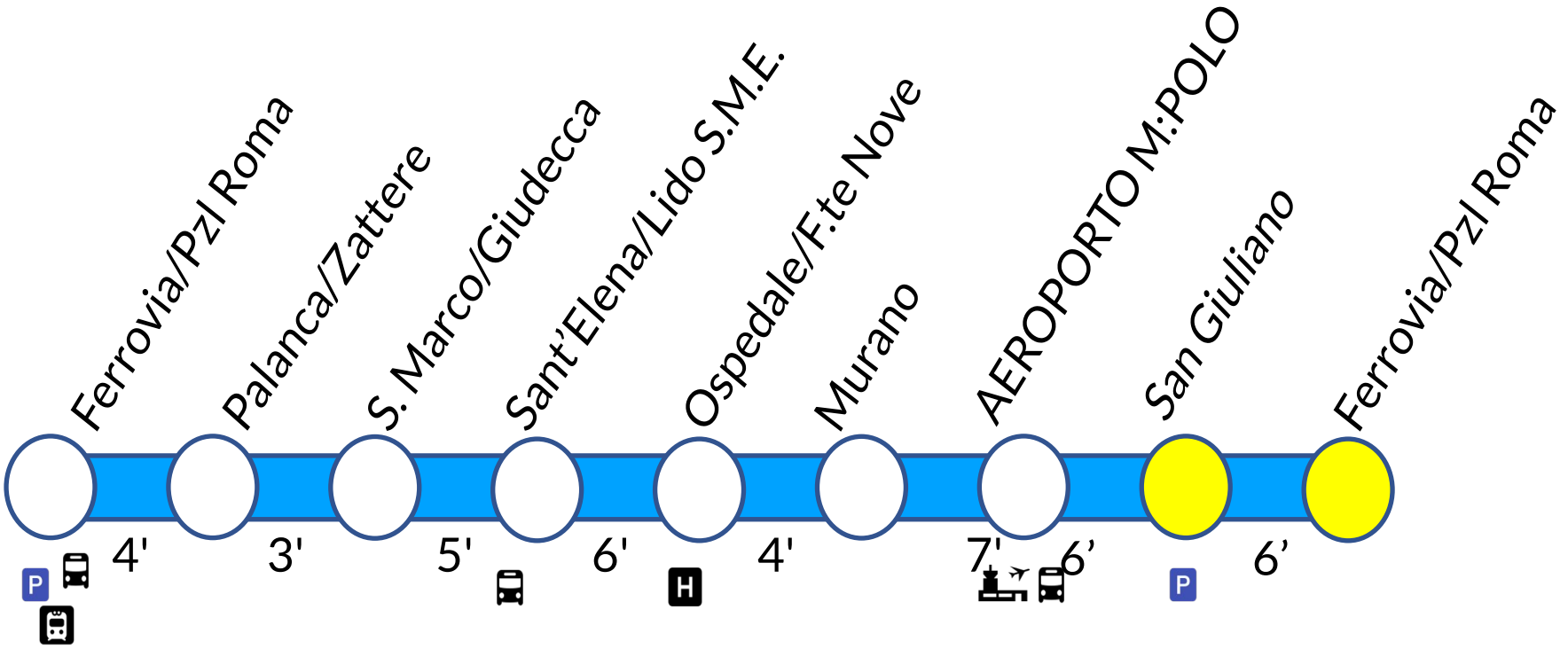


With the *sublagunare*, the same trip would only take 17 minutes

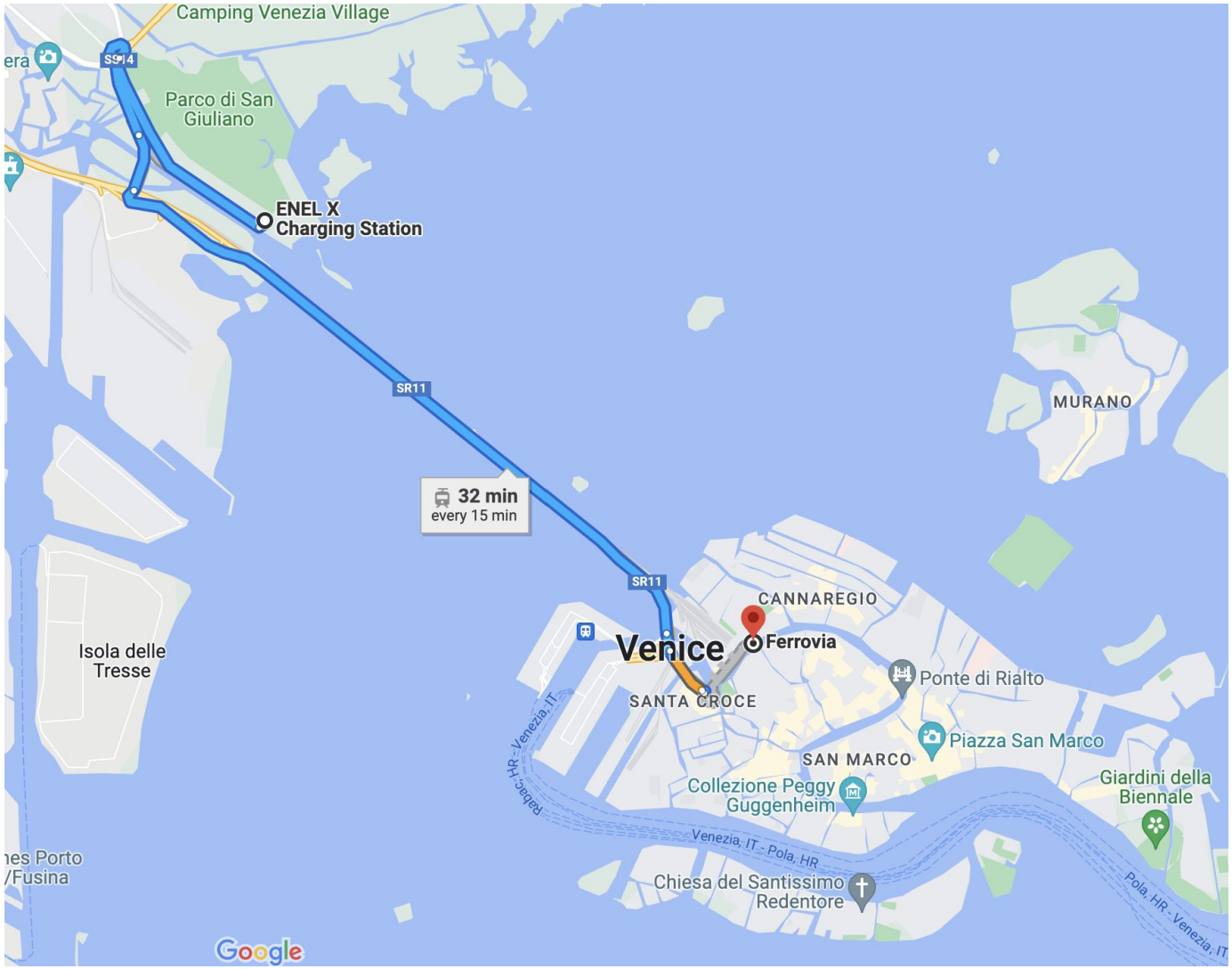


Phase 3 of the *Sublagunare* Proposal

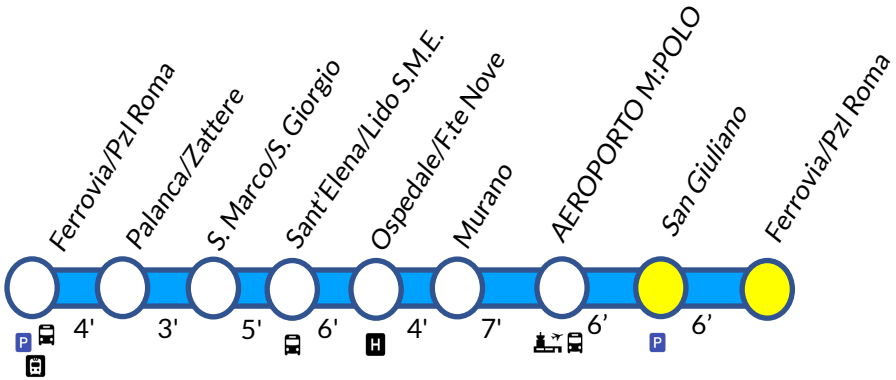
Phase 3 of the *Sublagunare* Proposal



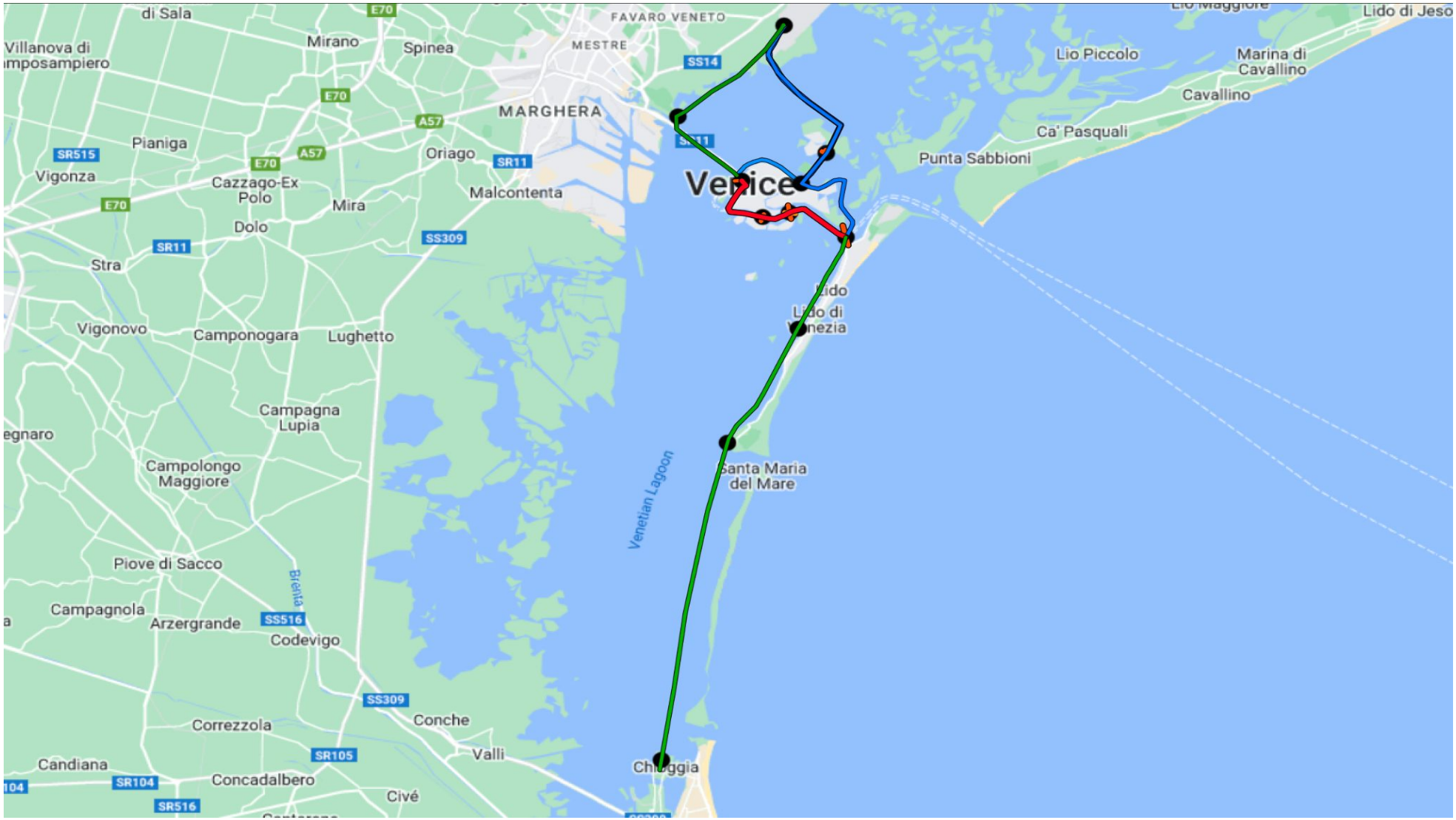
Today, transporting from Ferrovia to San Giuliano takes 32 minutes



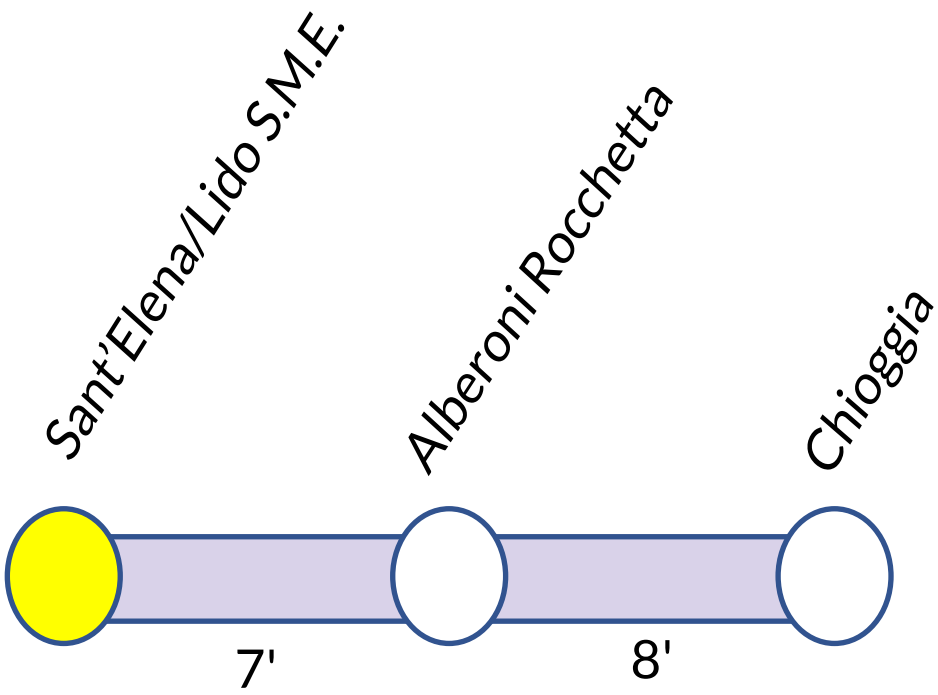
With the *sublagunare*, the same trip would only take 6 minutes



Potential Phase 4 of the *Sublagunare* Proposal



Potential Phase 4 of the *Sublagunare* Proposal

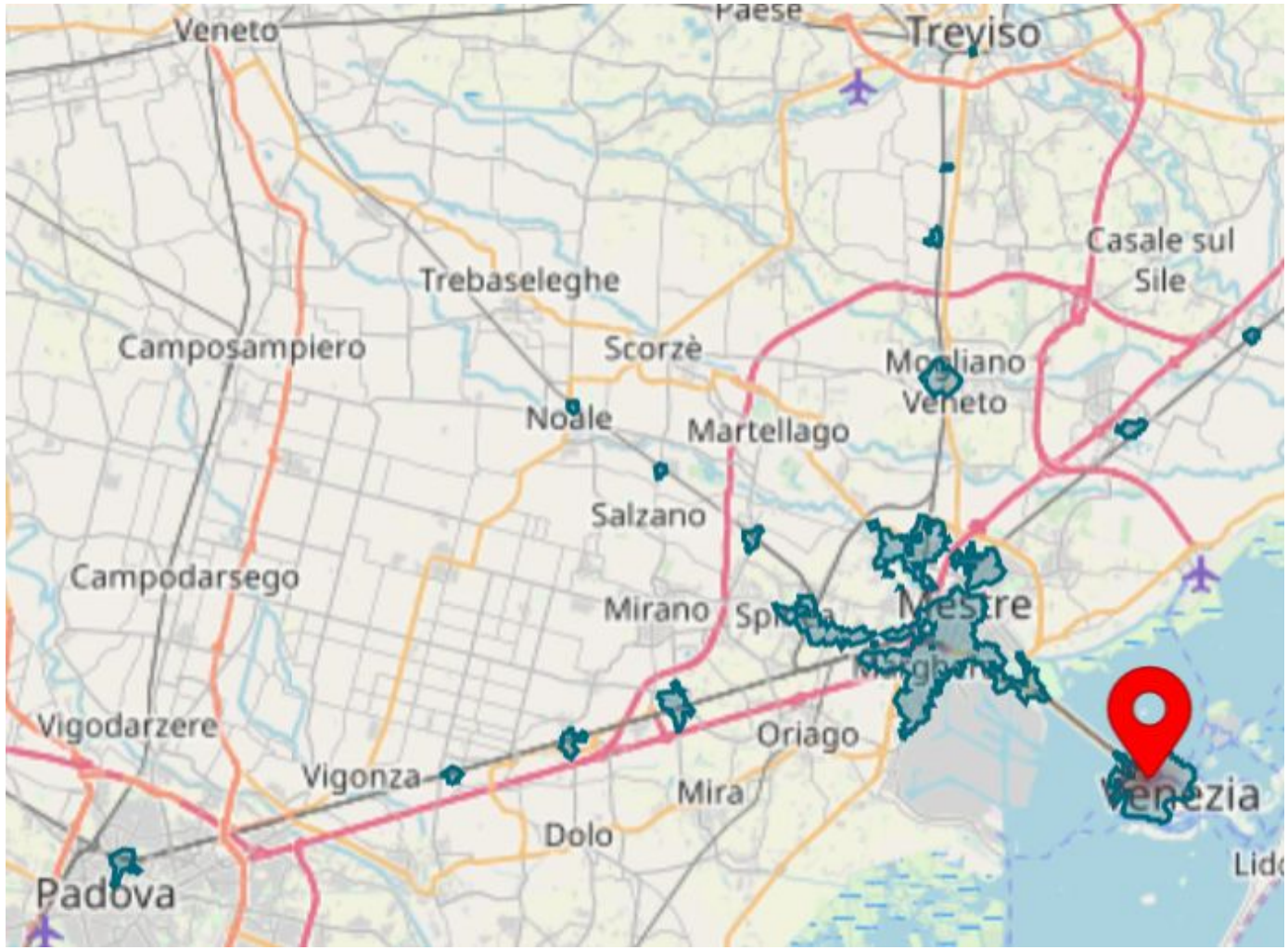


Most Venetians aren't commuting >15 minutes on the mainland

Highlighted areas are reachable within 15 minutes from Ferrovia

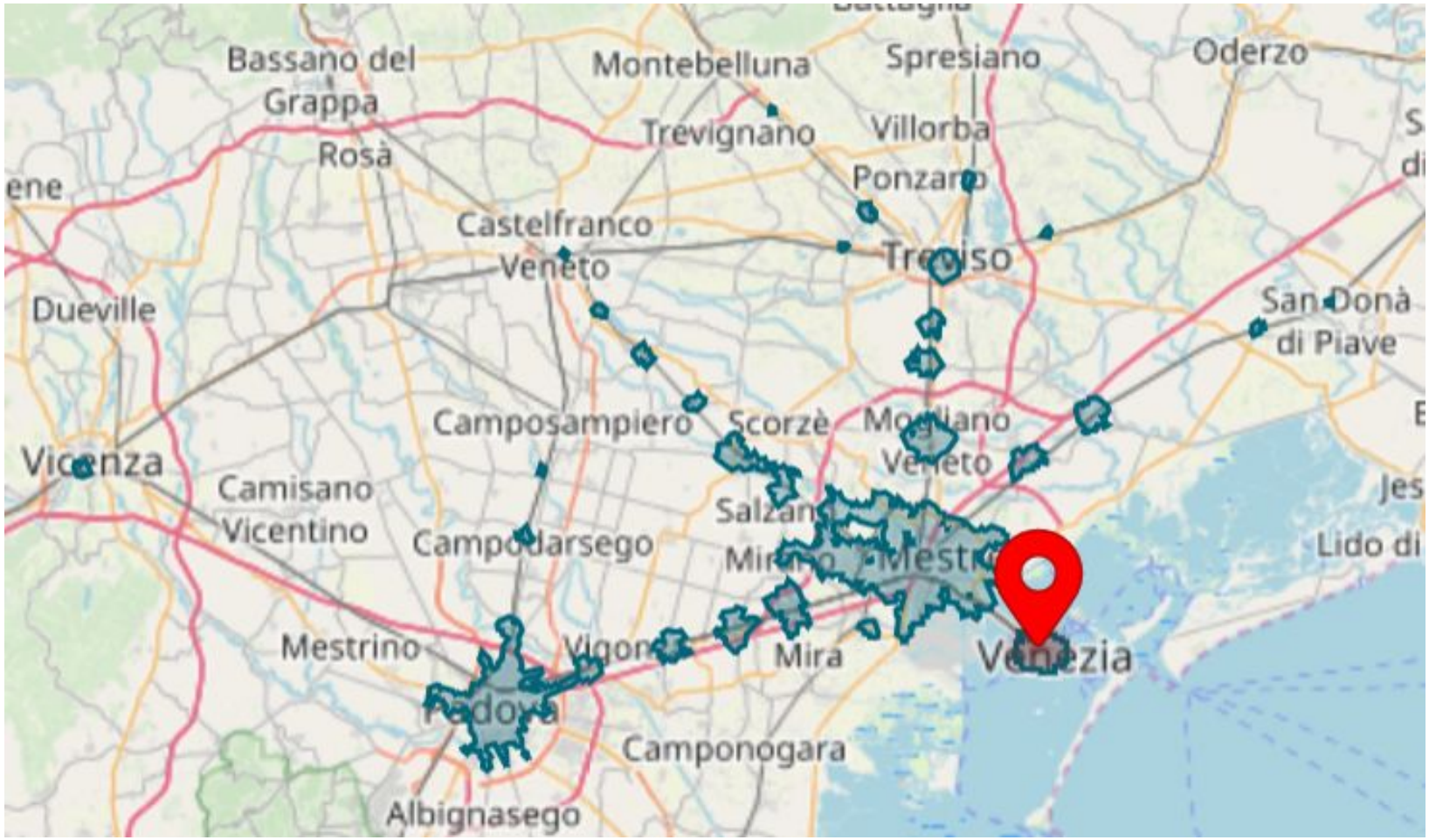
Some Venetians commute up to 30 minutes on the mainland

Highlighted areas are reachable within 30 minutes from Ferrovia



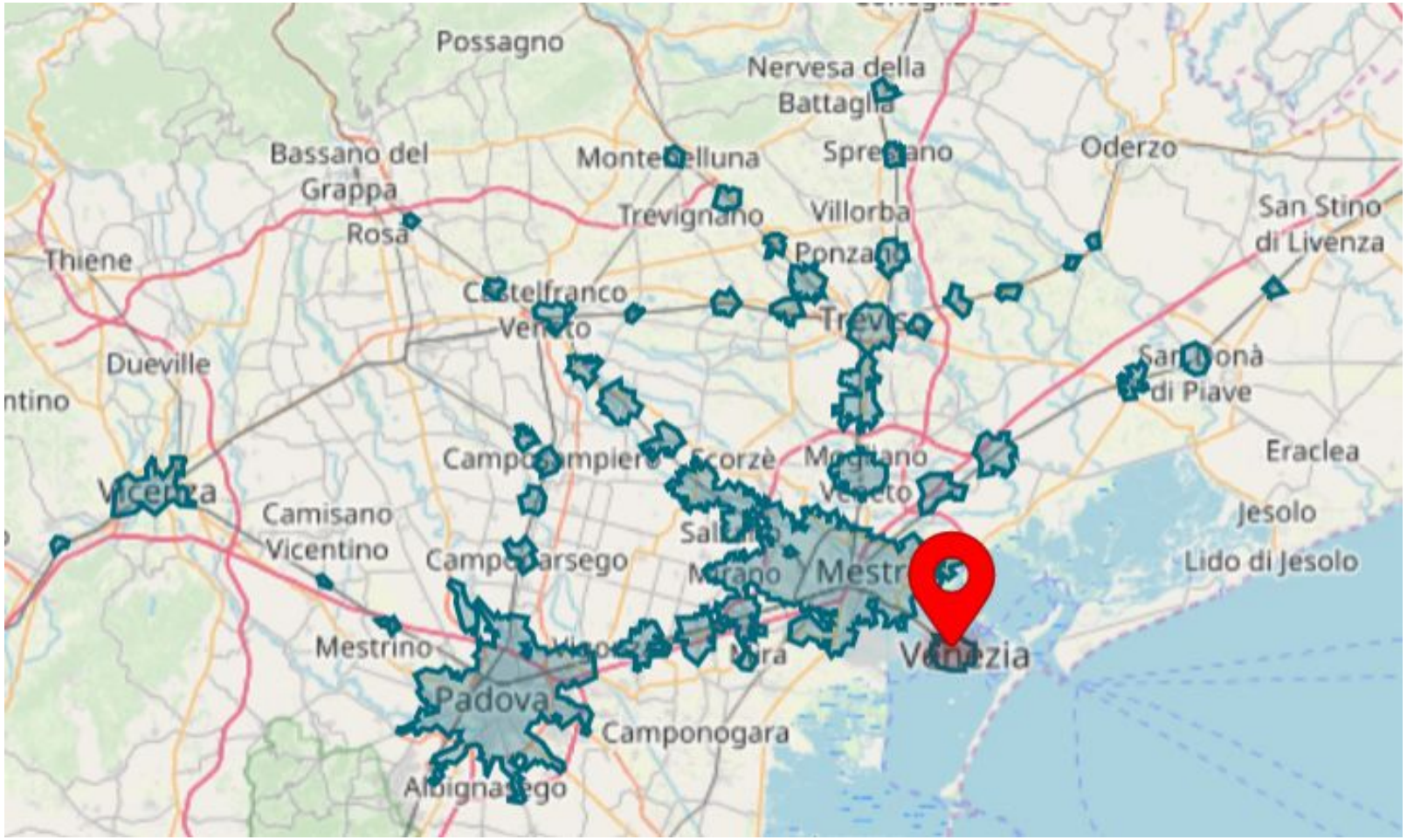
If commuters could get to Ferrovia/Pzl Roma faster, they could spend more time (up to 45 minutes) commuting on the mainland…

Highlighted areas are reachable within 45 minutes from Ferrovia

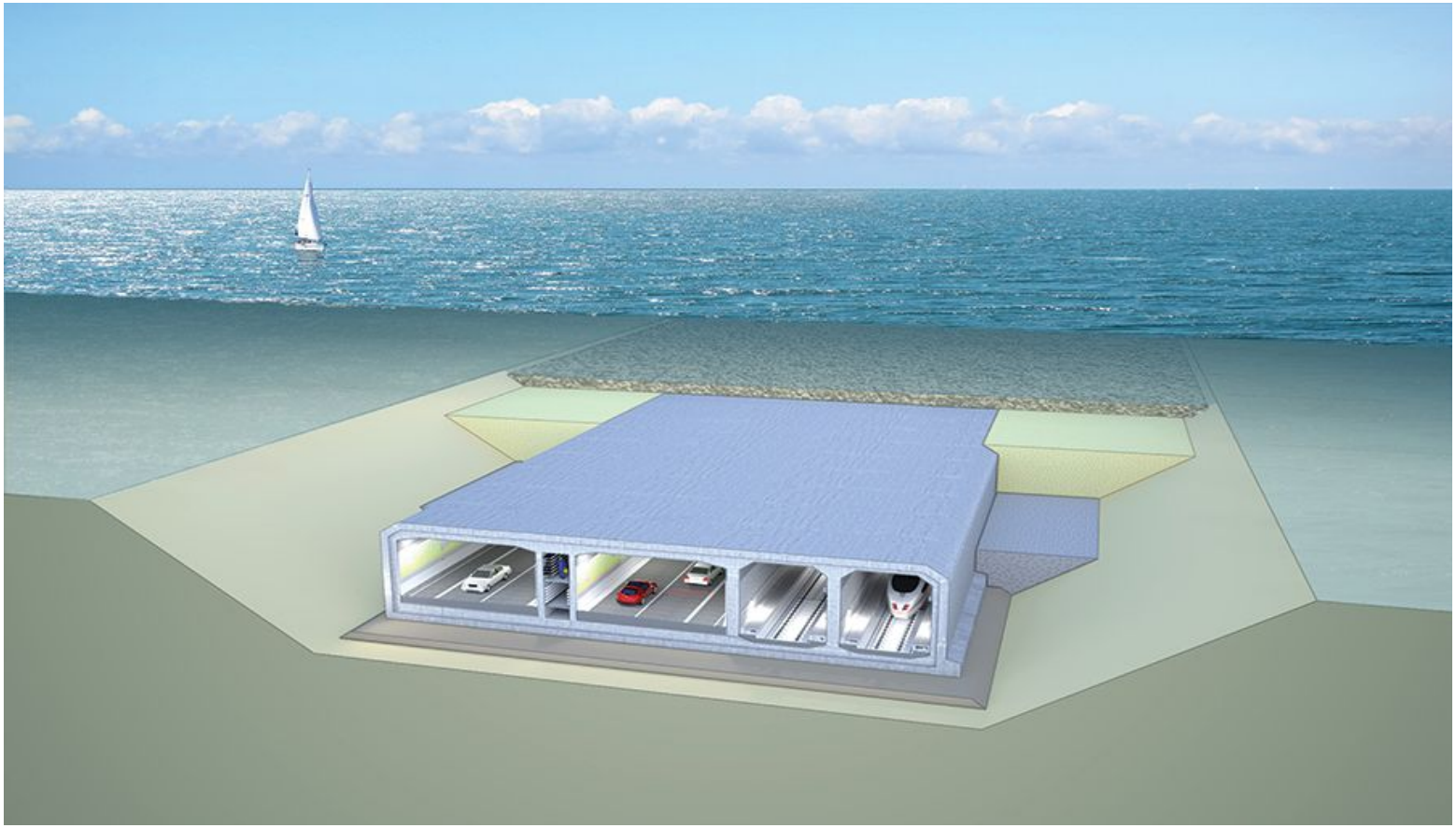


…and they would be able to reach even more jobs within a 60+ minute commute

Highlighted areas are reachable within 60 minutes from Ferrovia



The Immersed Tube Tunnel construction method will be the cheapest way to build a *sublagunare* in Venice



The immersed tube tunnel method has already proved successful with the MOSE project

MOSE is a floodgate system at the ports that enter the Venetian Lagoon

The Venice *sublagunare* could use the same trains used in the new Milan subway system, which are **driverless**

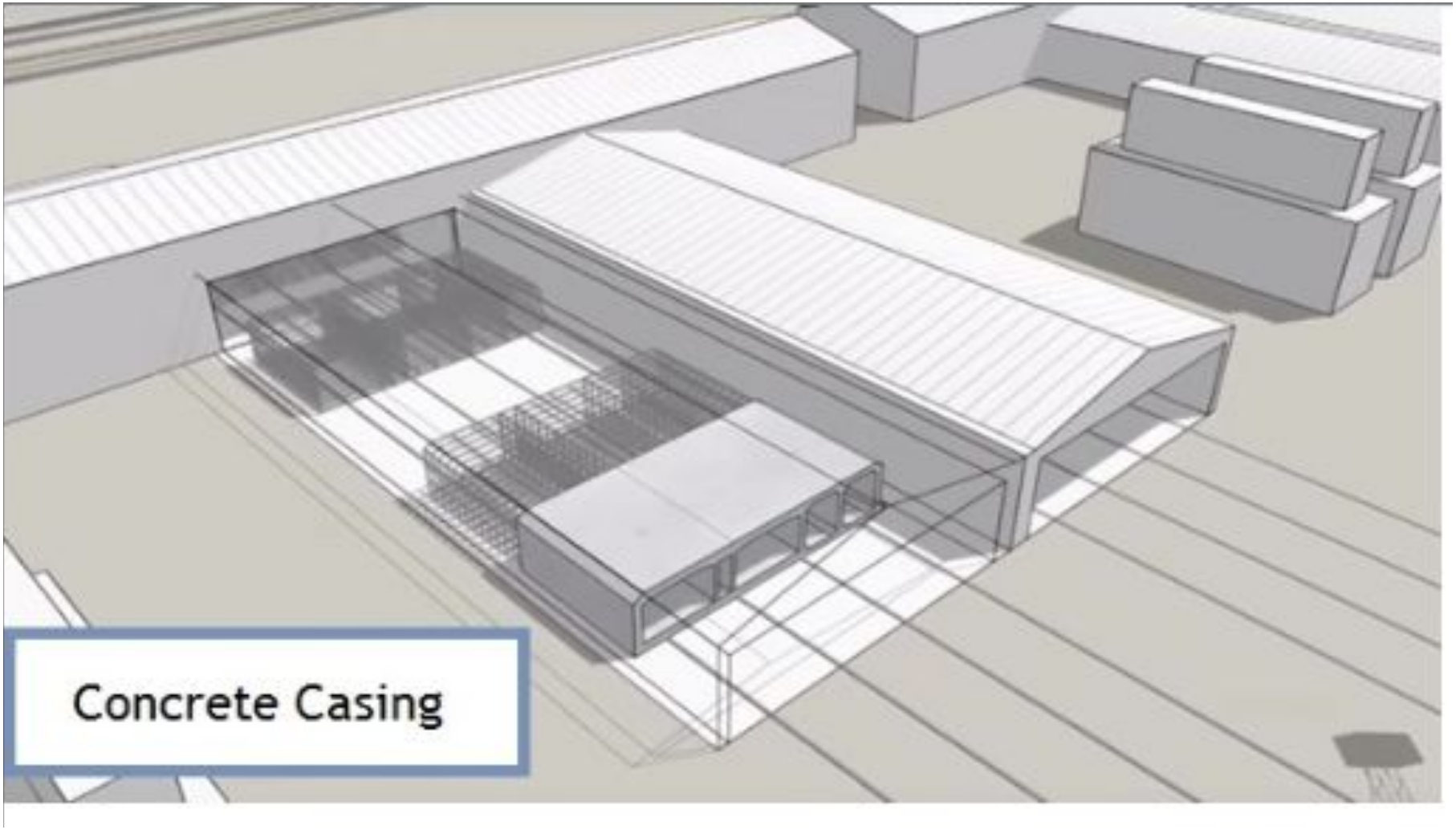
Based on previous projects, the estimated cost to build an underground subway system using the Immersed Tube Tunnel method is € 7.5 Billion

Phase 1		Phase 2		Phase 3
€2 **Billion**	+	€ 4 **Billion**	+	€ 1.5 **Billion**

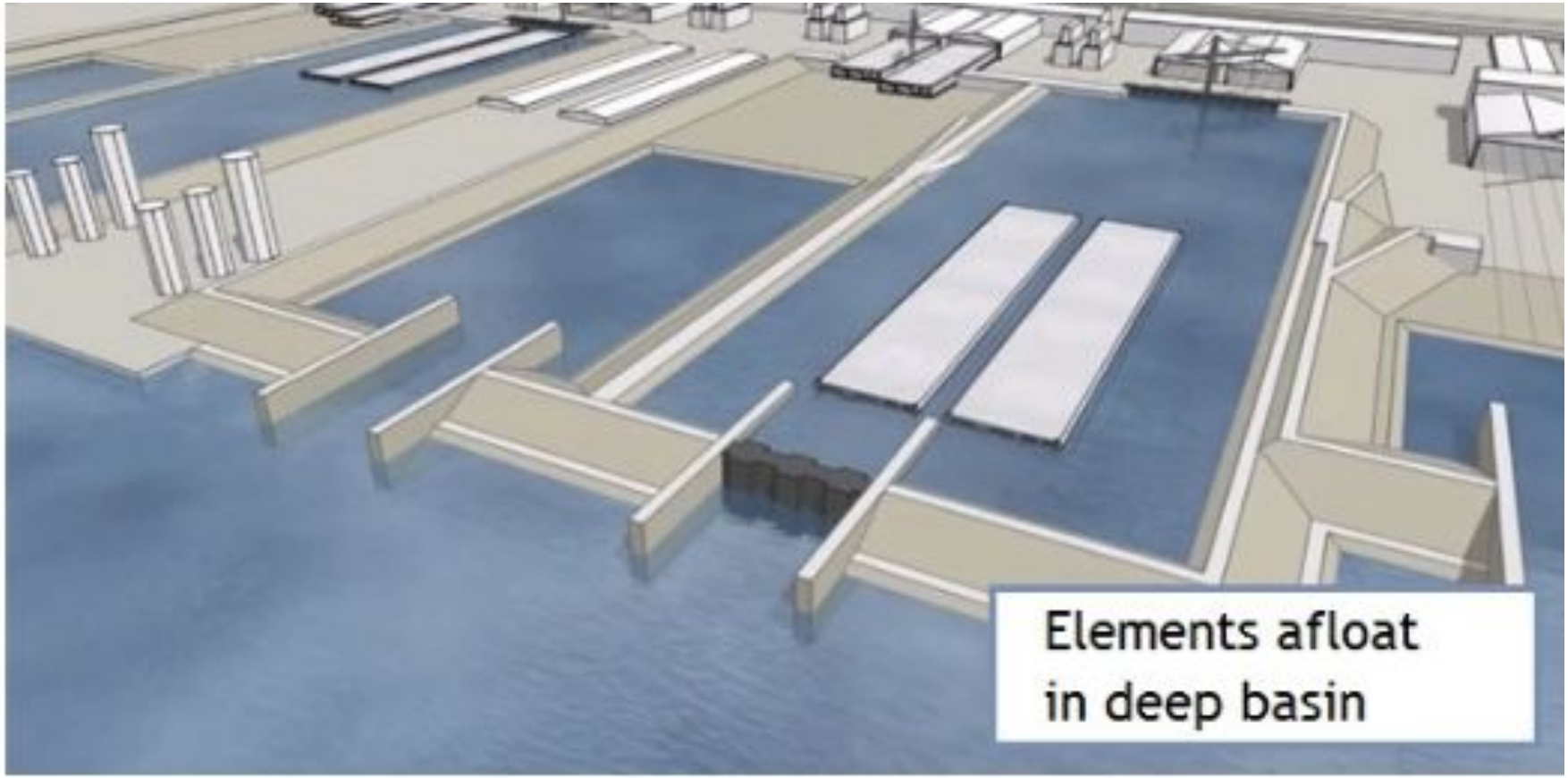
Total cost

€ 7.5 **Billion**

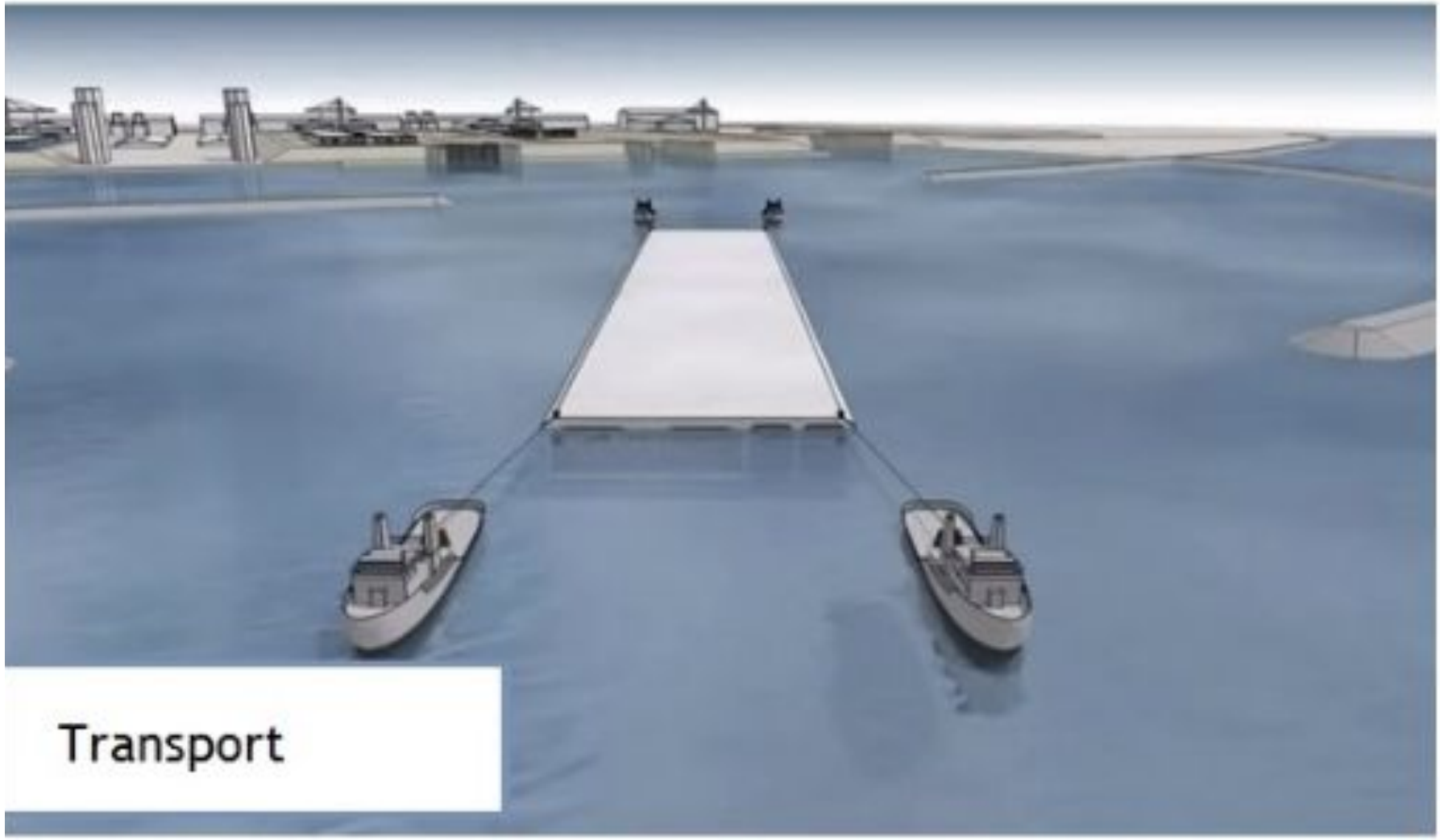
The tunnel is developed in several segments and is constructed above the ground



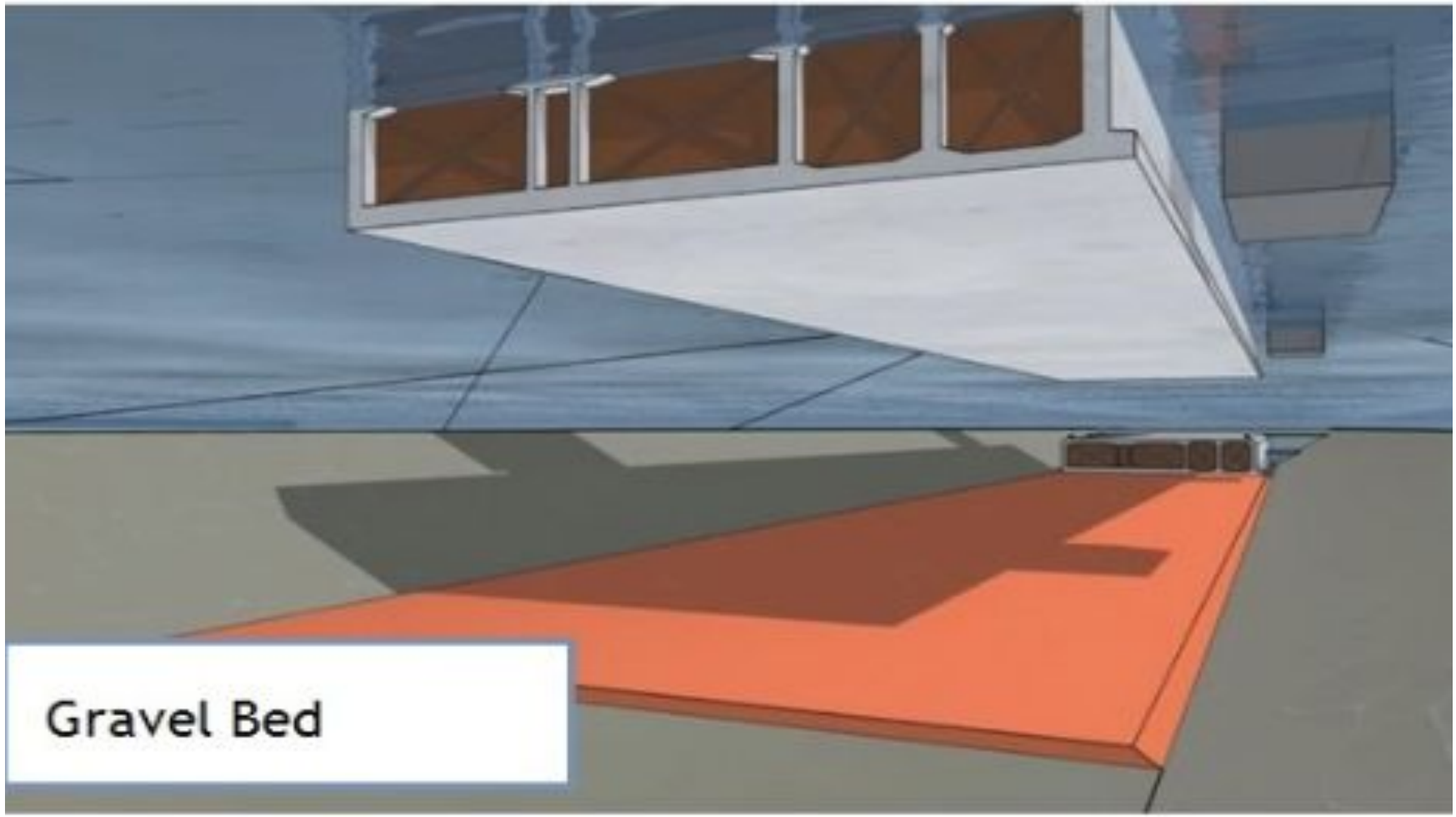
The tunnel is constructed on land and tested in the early stages



The immersed tunnel is transported to the destination where it will be immersed

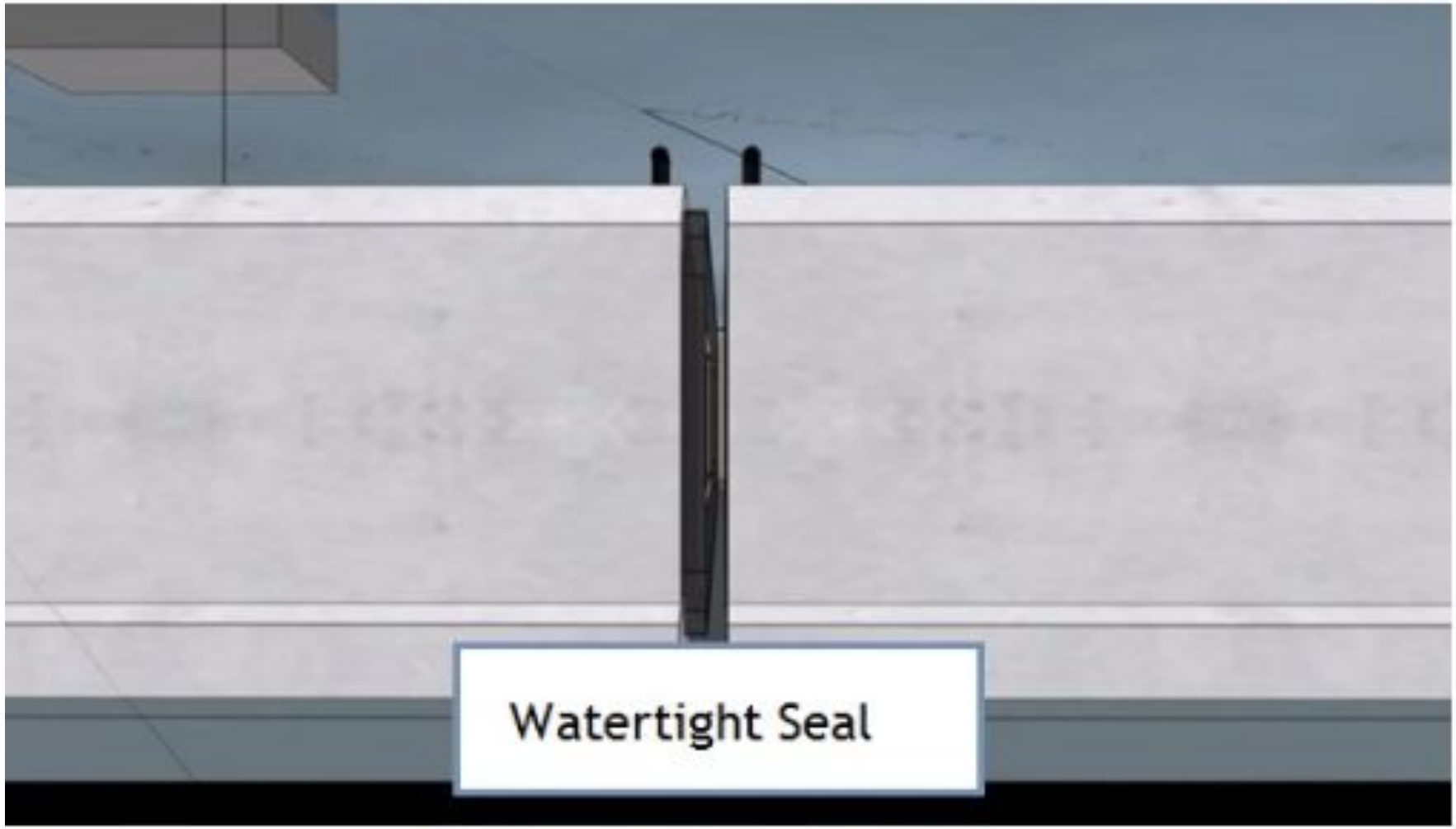


A gravel bed is placed underneath where the tunnel will be placed to form a strong base

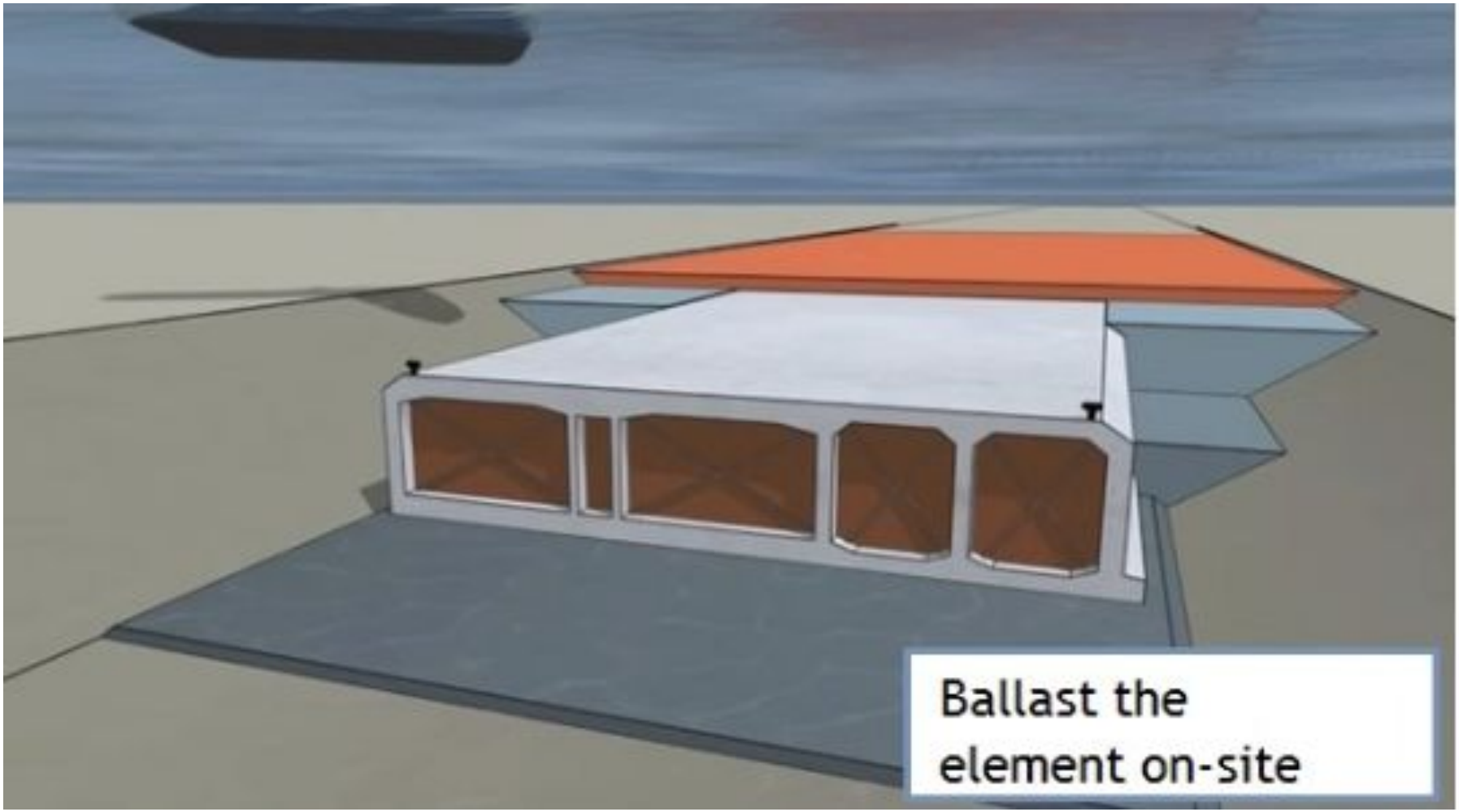


The tunnel is moved underwater

The immersed tunnel will be installed with high precision along the length of the tunnel

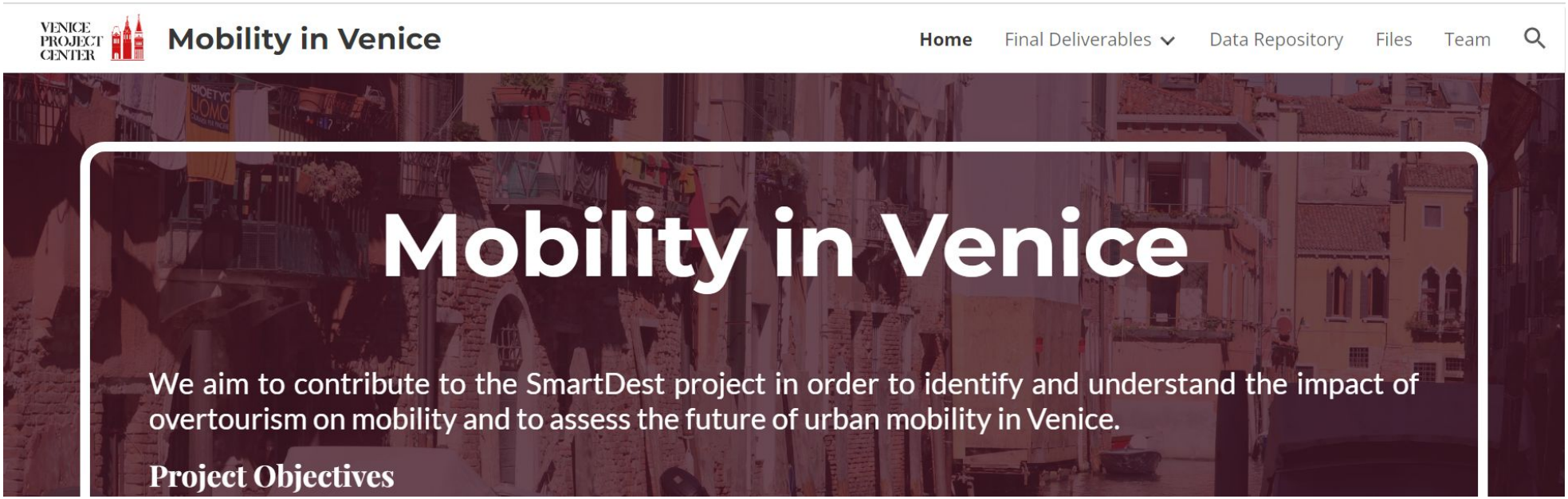


To protect the tunnel, a layer of stone is added on top and on the sides of the tunnel



Benefits of the *sublagunare* for Venice

- Reducing commuting time, **expanding job market for Venetians**
- Reducing *moto ondoso*
- Reducing congestion in the canals
- Ability to work in any weather



Please visit our team website for more information about the project!

Contact us at
ve22.mobi@gmail.com
gr-ve22-mobi@wpi.edu

Team website

Repository

Tyler Brown, Emmaline Raven, Raul Villalobos