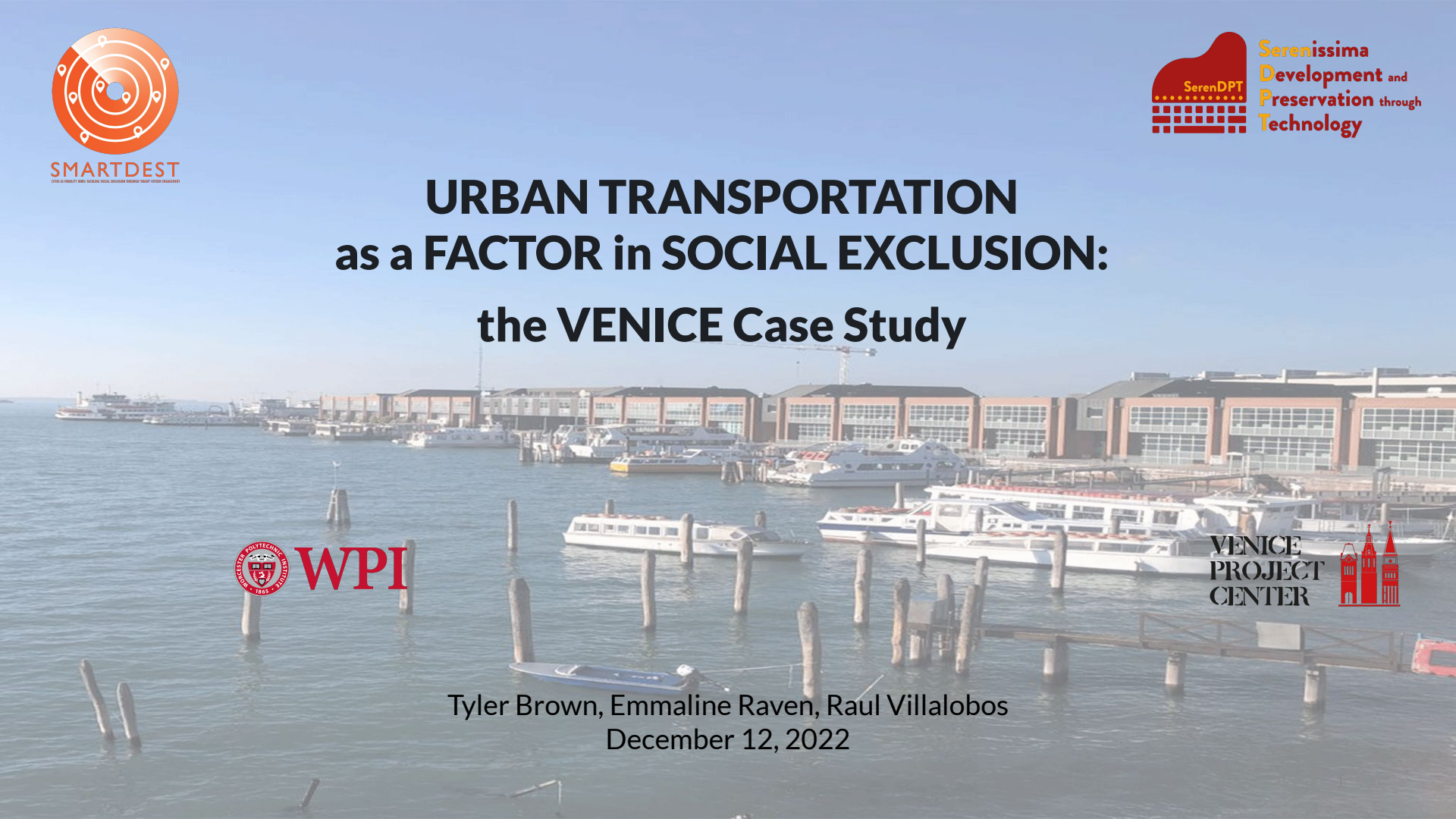


SMARTDEST

SerenDPT Serenissima Development and Preservation through Technology

URBAN TRANSPORTATION as a FACTOR in SOCIAL EXCLUSION: the VENICE Case Study

WPI

VENICE PROJECT CENTER

Tyler Brown, Emmaline Raven, Raul Villalobos

December 12, 2022

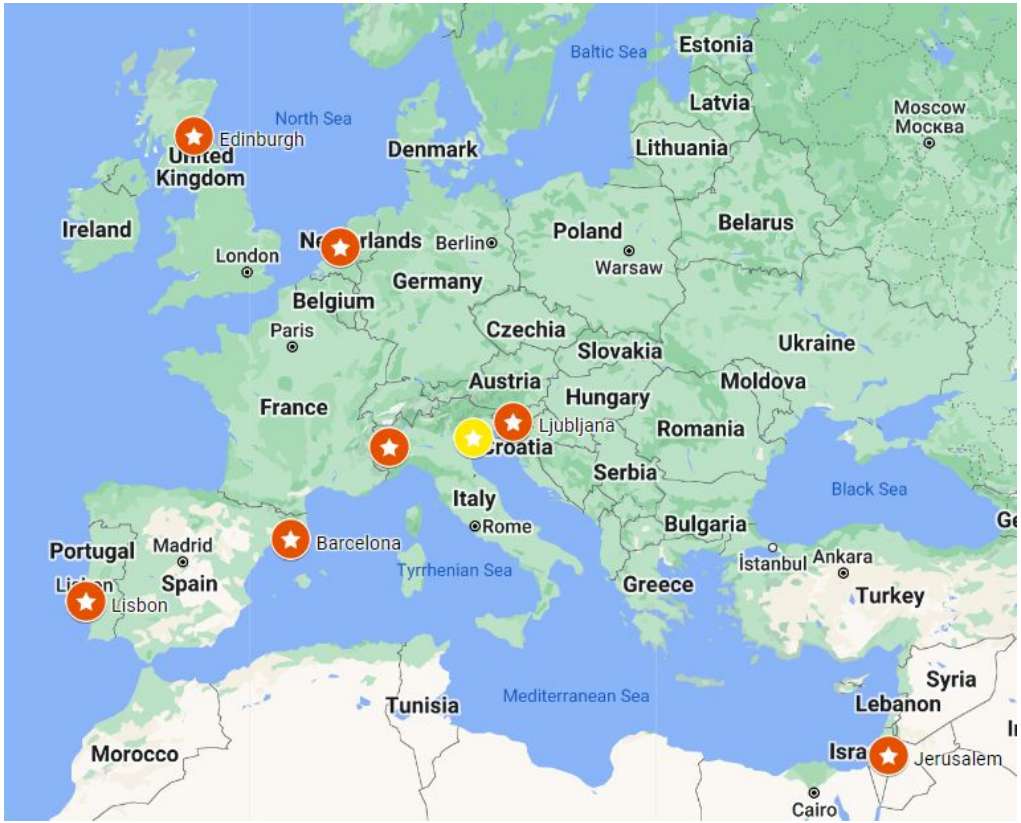
SMARTDEST

CITIES AS MOBILITY HUBS: TACKLING SOCIAL EXCLUSION THROUGH 'SMART' CITIZEN ENGAGEMENT

We are contributing to the SmartDest EU Project

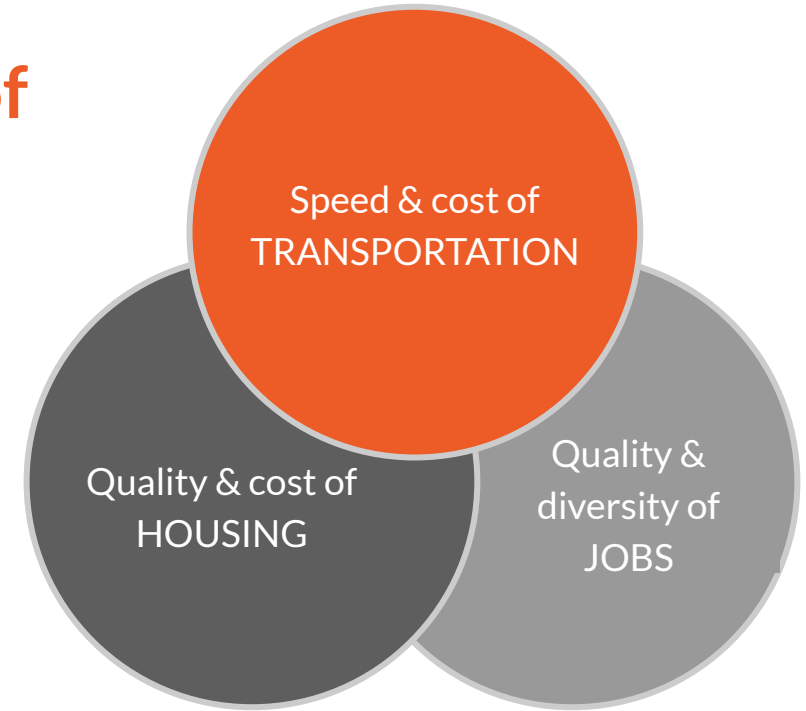
1. Identify social exclusions due to **overtourism**
2. Hypothesize possible **solutions**
3. Proposed shared corrective **policies**

Jan 2020 - Sept 2023
8 case study cities
funded by the EU:

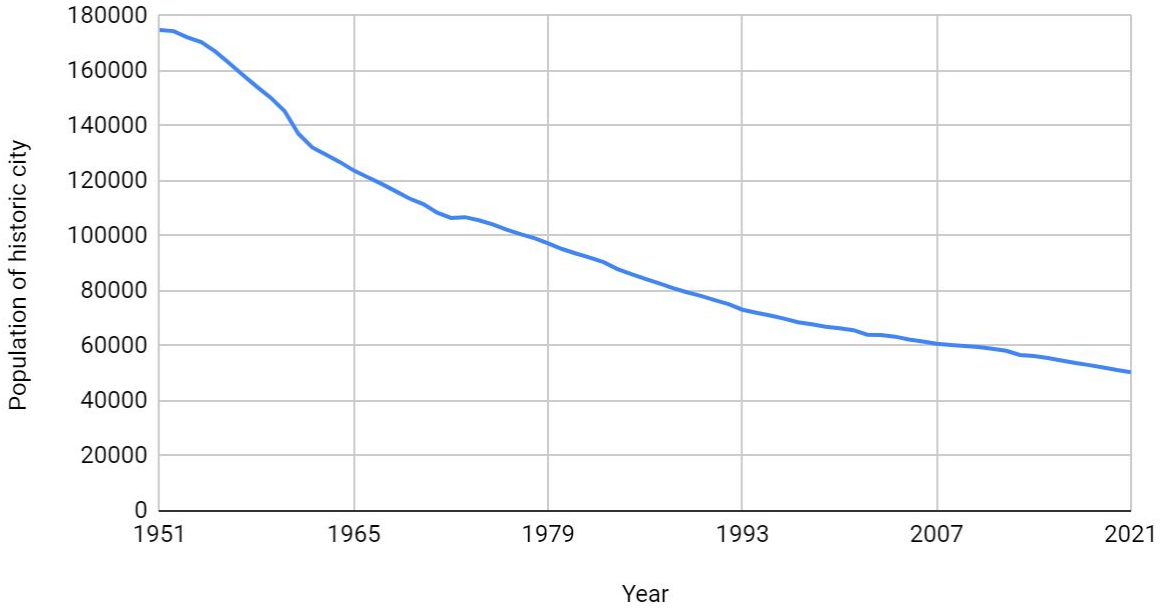


SerenDPT: Venice Case Study

Exclusion of residents

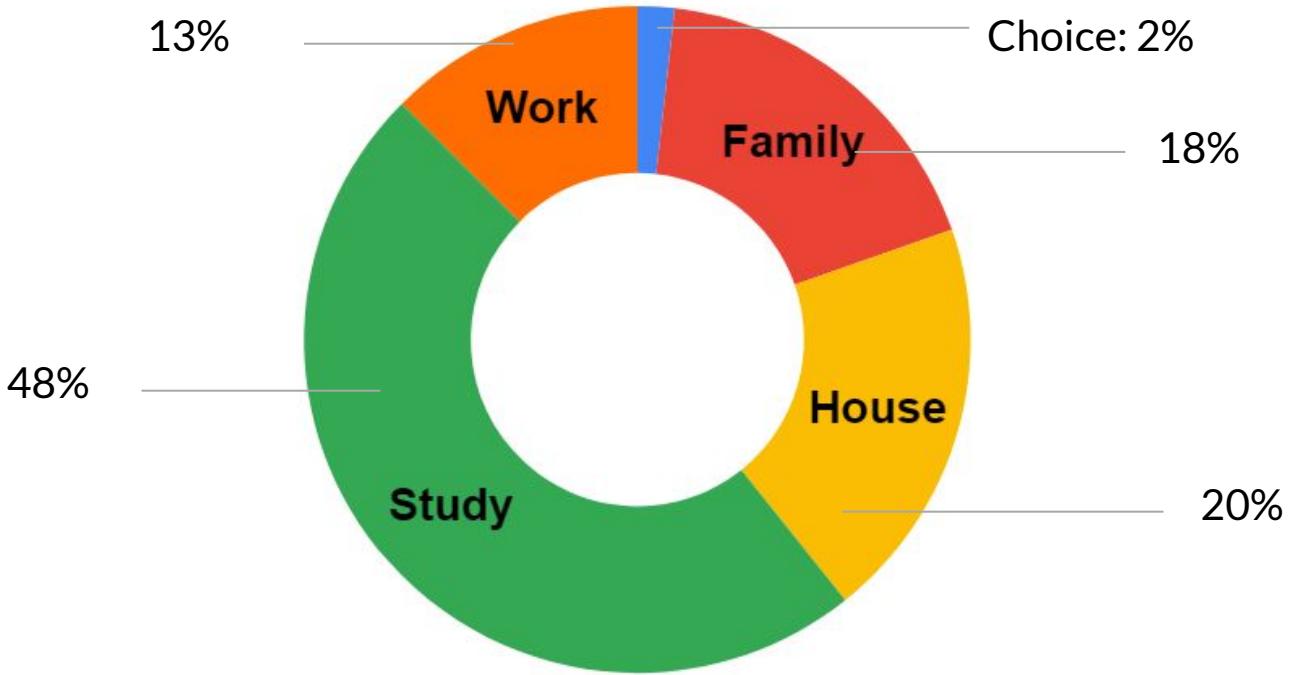


The population of Venice has decreased by 125,000 since 1951

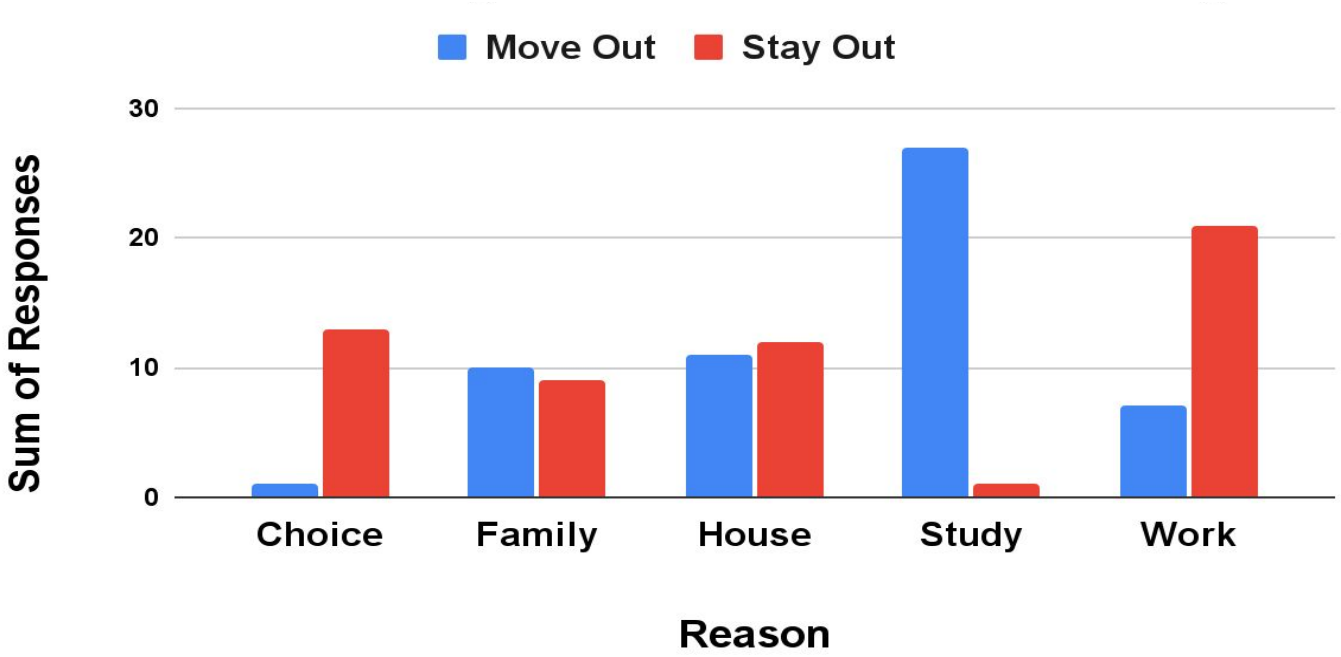


Istituto Centrale di Statistica

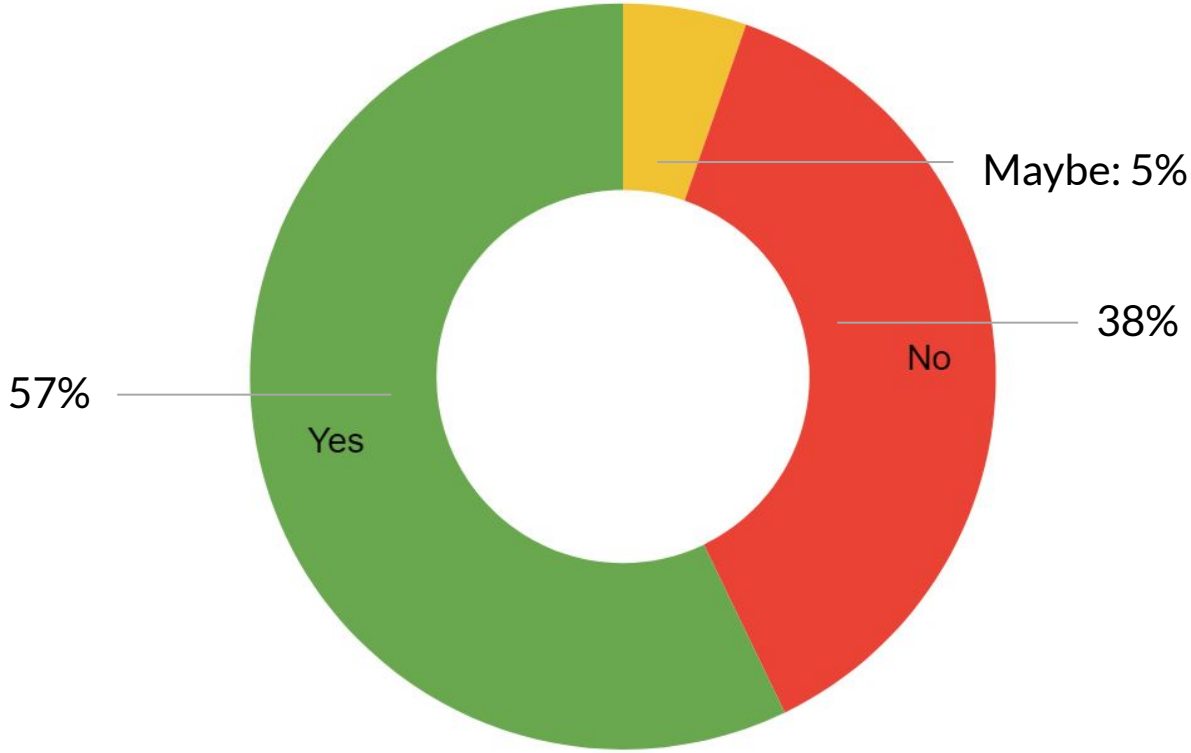
Results from 56 interviews conducted by SmartDest show that residents migrate out for school…



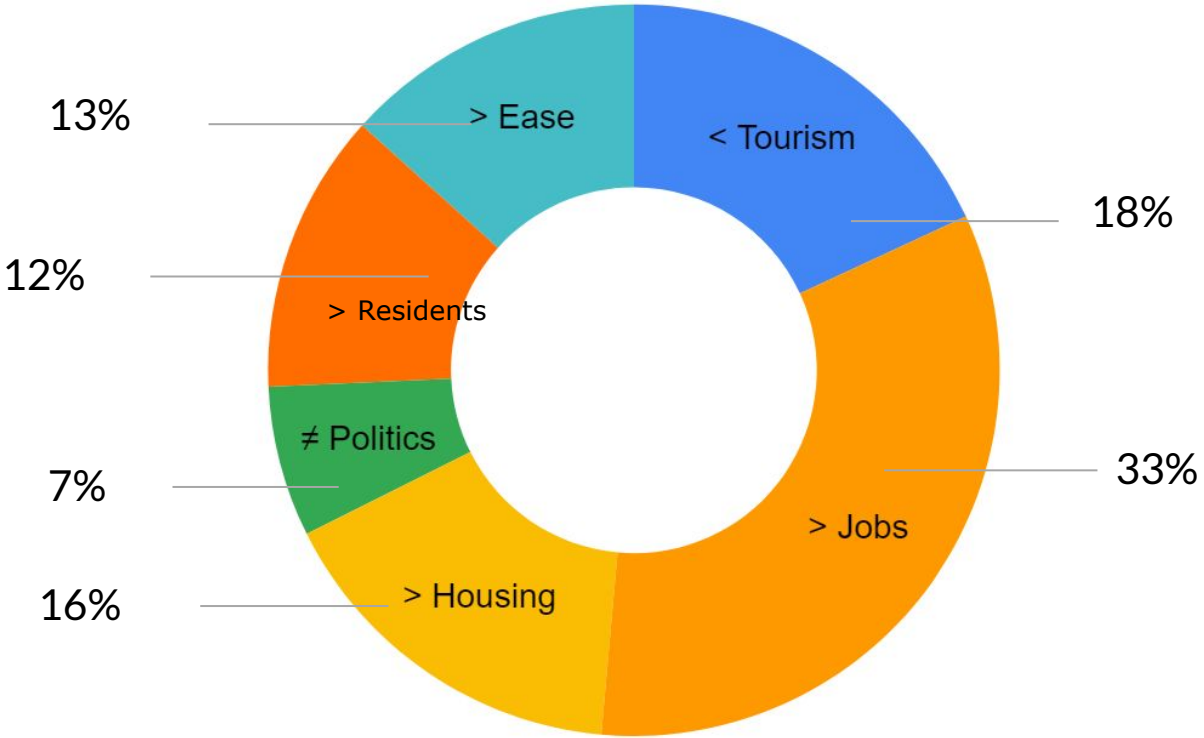
and remain away because of work



…but would love to return to Venice

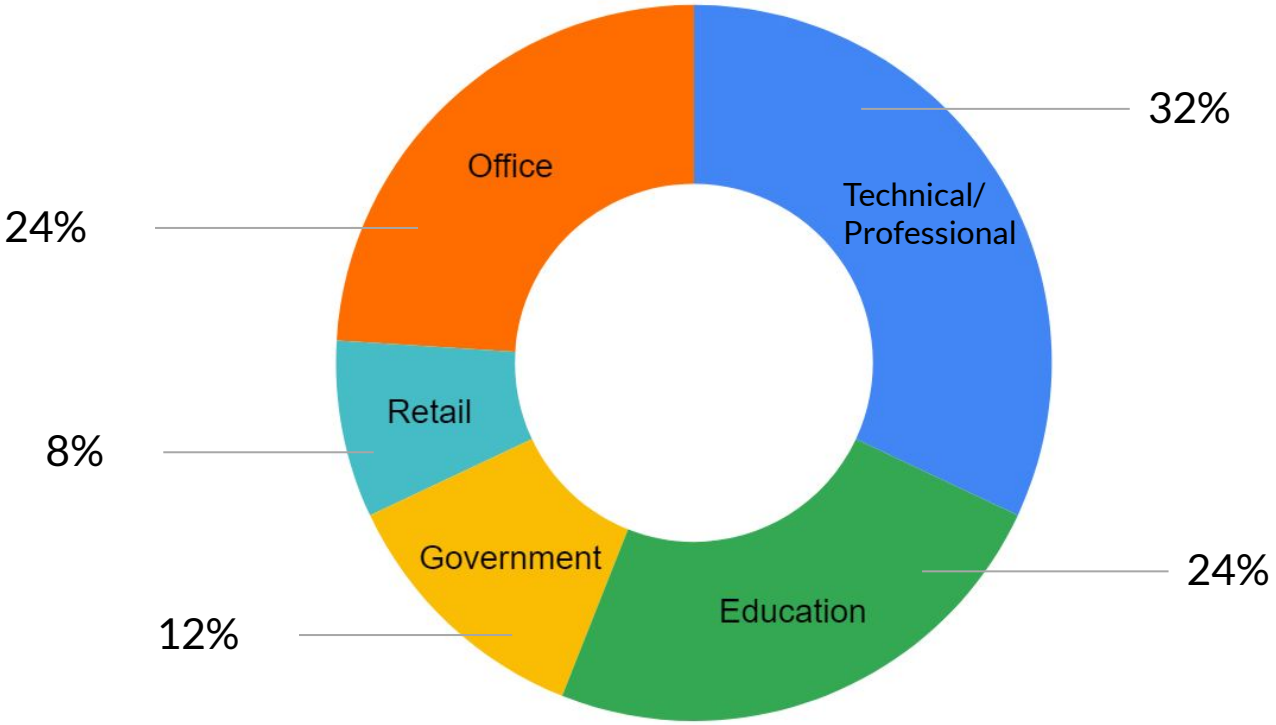


… if Venice had more jobs, more homes and fewer tourists

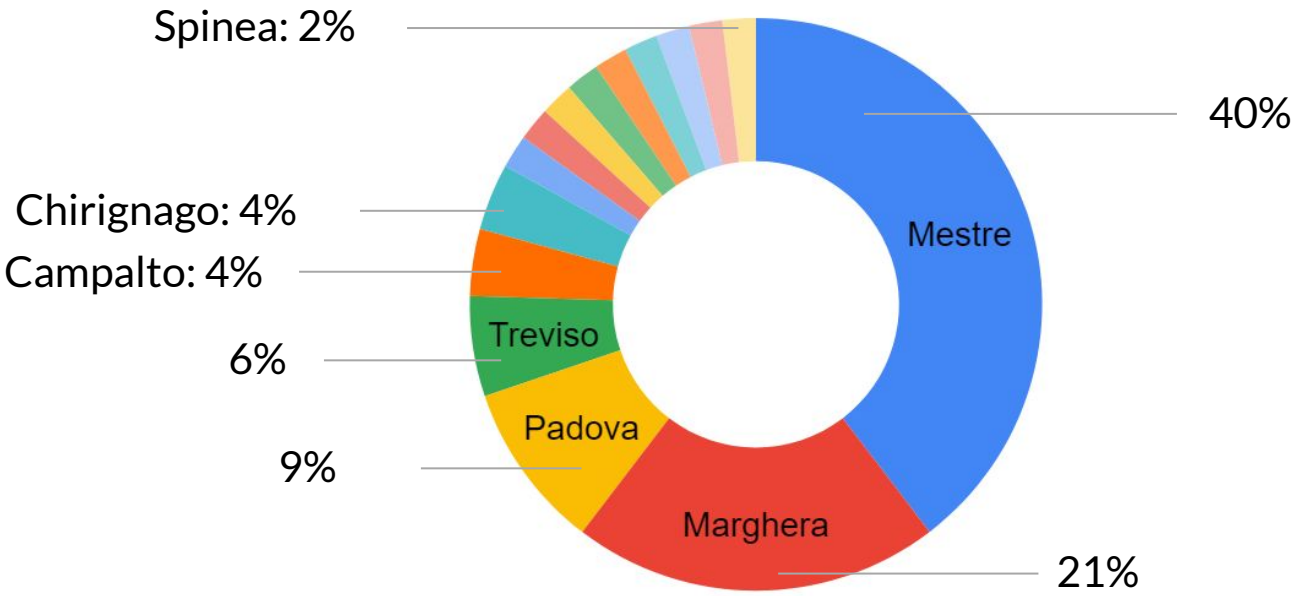


SmartDest Emigre Interviews

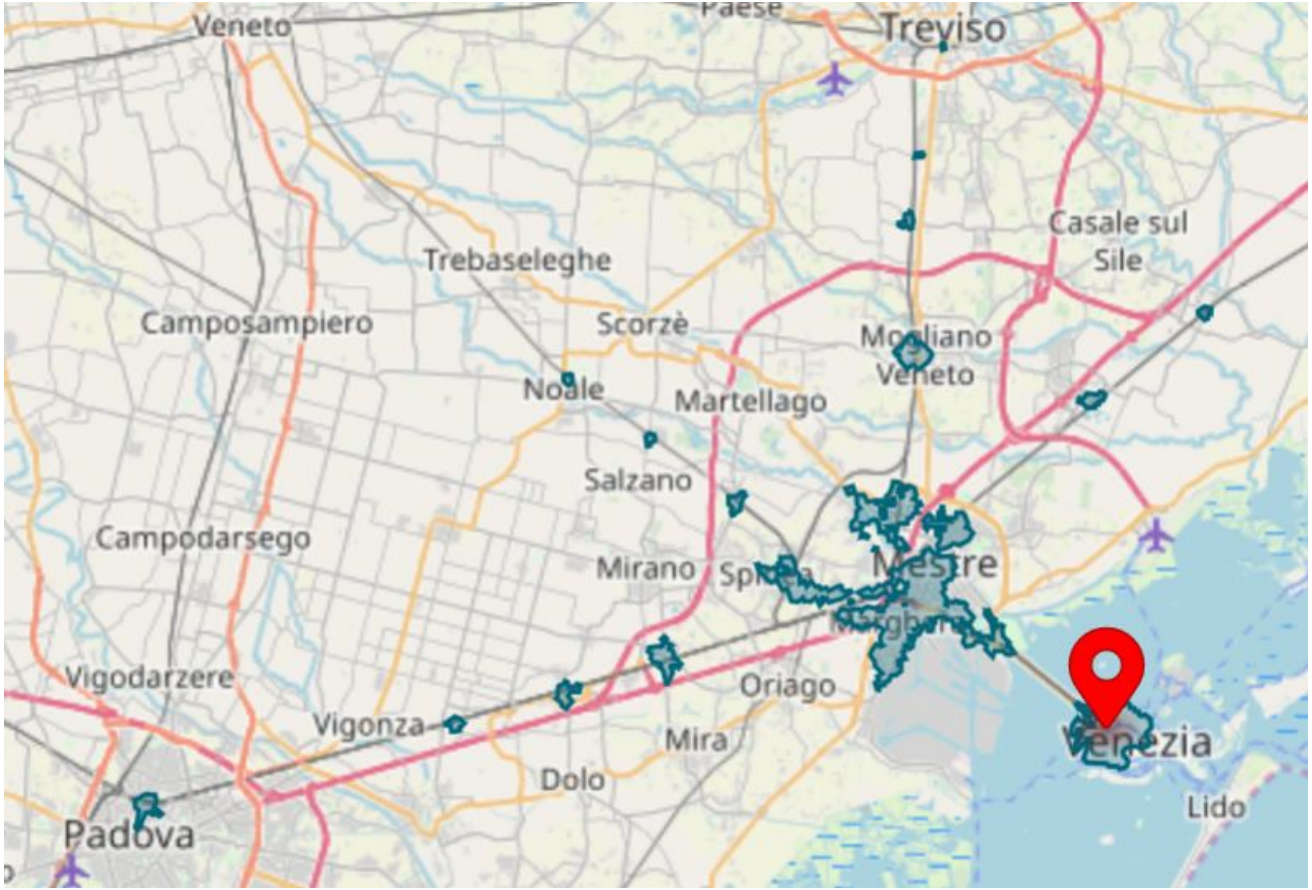
Some residents work outside of Venice in higher-end jobs



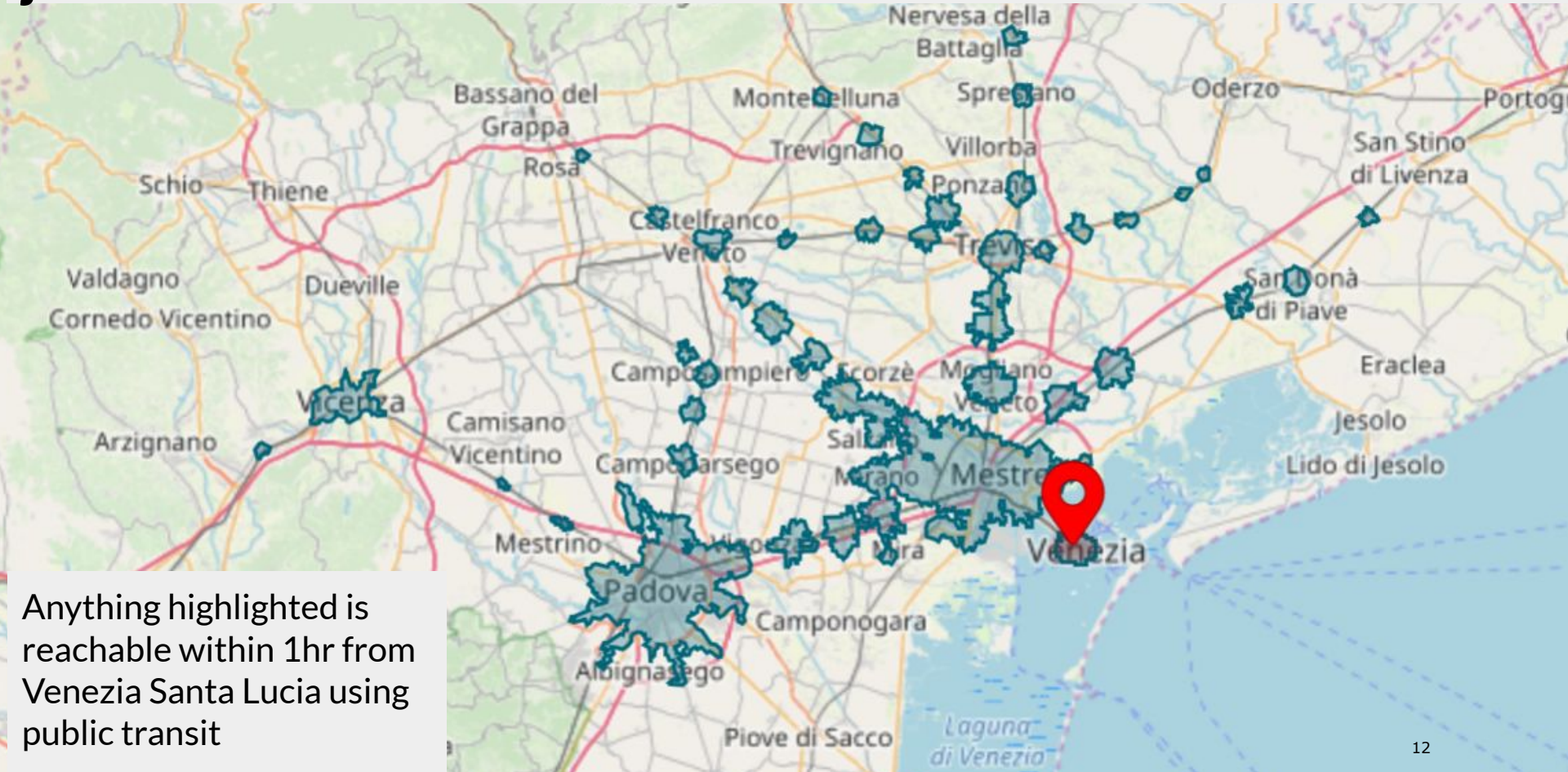
And commute to (and from) relatively close destinations on the mainland



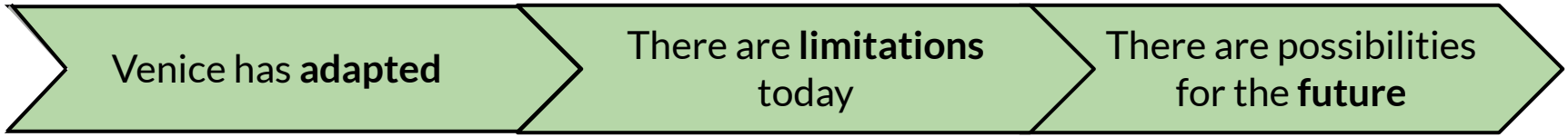
Commuters with high-paying jobs are commuting to destinations on the mainland that are reachable within 30 minutes



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



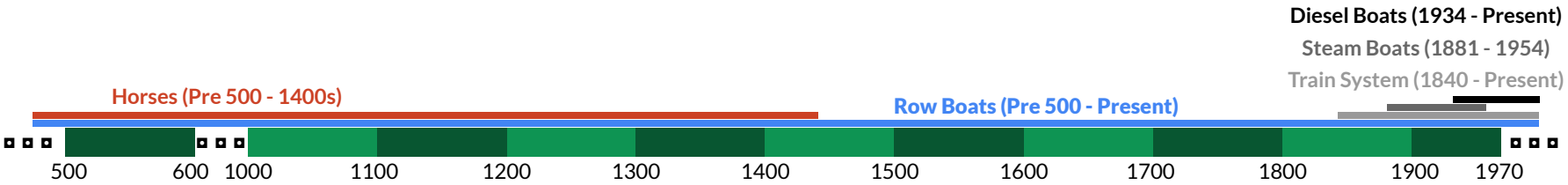
Anything highlighted is reachable within 1hr from Venezia Santa Lucia using public transit


Venice has **adapted**
There are **limitations** today
There are possibilities for the **future**

Venice has **adapted** | There are **limitations** today | There are possibilities for the **future**

Evolution of Transportation in Venice

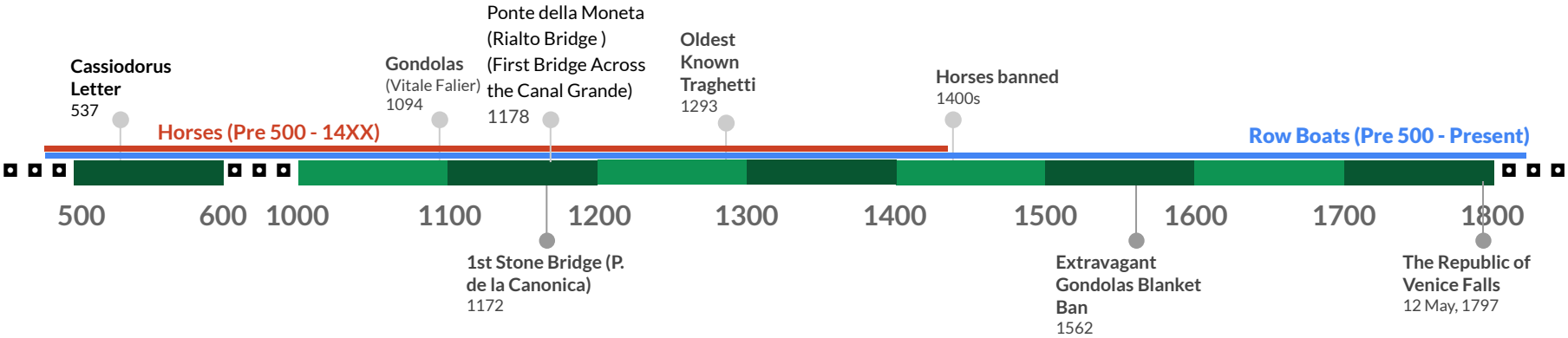
Evolution of Transportation in Venice



The Groundwork for Future Changes, 500 - 1800

Row Boats (Pre 500 - Present)

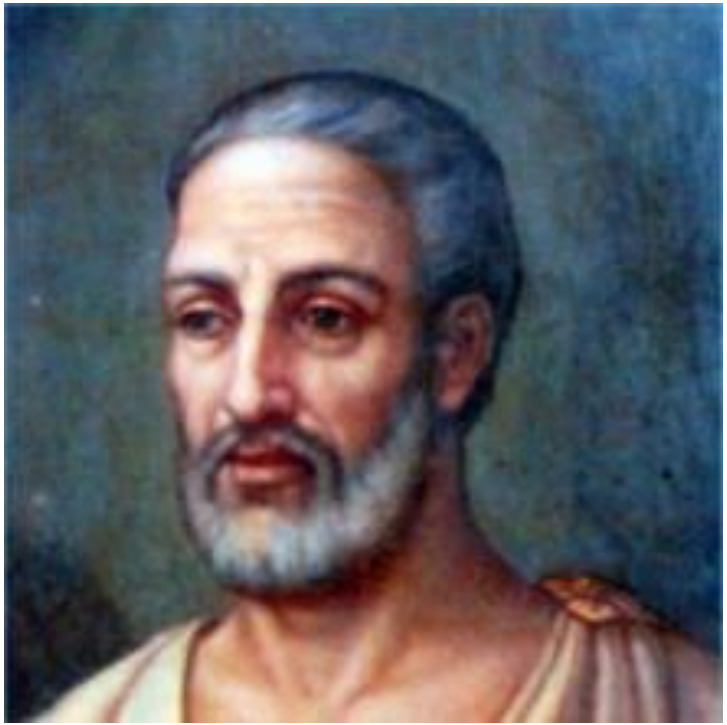
Since the founding of Venice in 497 AD, row boats have been used to traverse between the mainland and the historic city, as well as moving within the historic city. Many different types of row boats can be found throughout the history of Venice, but the most common and popular choice were Gondolas, thin, traditional, flat-bottomed Venetian rowing boat, well suited to the conditions of the Venetian lagoon and gifted to the people of Venice in 1094 by the Doge (leader) at the time, Vitale Falier. Today, traghetti are used to cross the Canal Grande in certain spots.



Horses (Pre 500 - 1400s)

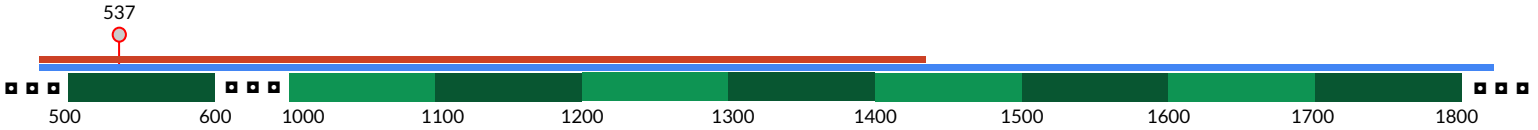
Horses were used to traverse within the historic city in the early history of Venice. They were useful in crossing smaller canals because they could wade through the waters while carrying products and people. As Venice began to add cobblestone walkways, horses became less popular because they would slip on the slick stones. When Venice added retaining walls to the sides of the islands, horses were no longer easily able to climb into and out of the water, making them even less popular. In the 15th century, they were outright banned by the Venetian noble class, preferring Gondolas as the main travel method within the historic city.

Cassiodorus wrote about early Venetians

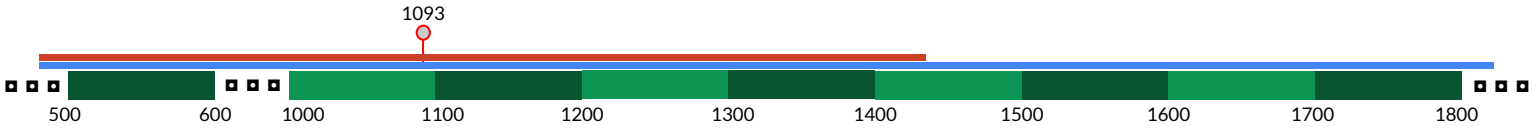


“Therefore diligently repair the ships which you keep tied to the walls of your houses like animals,”

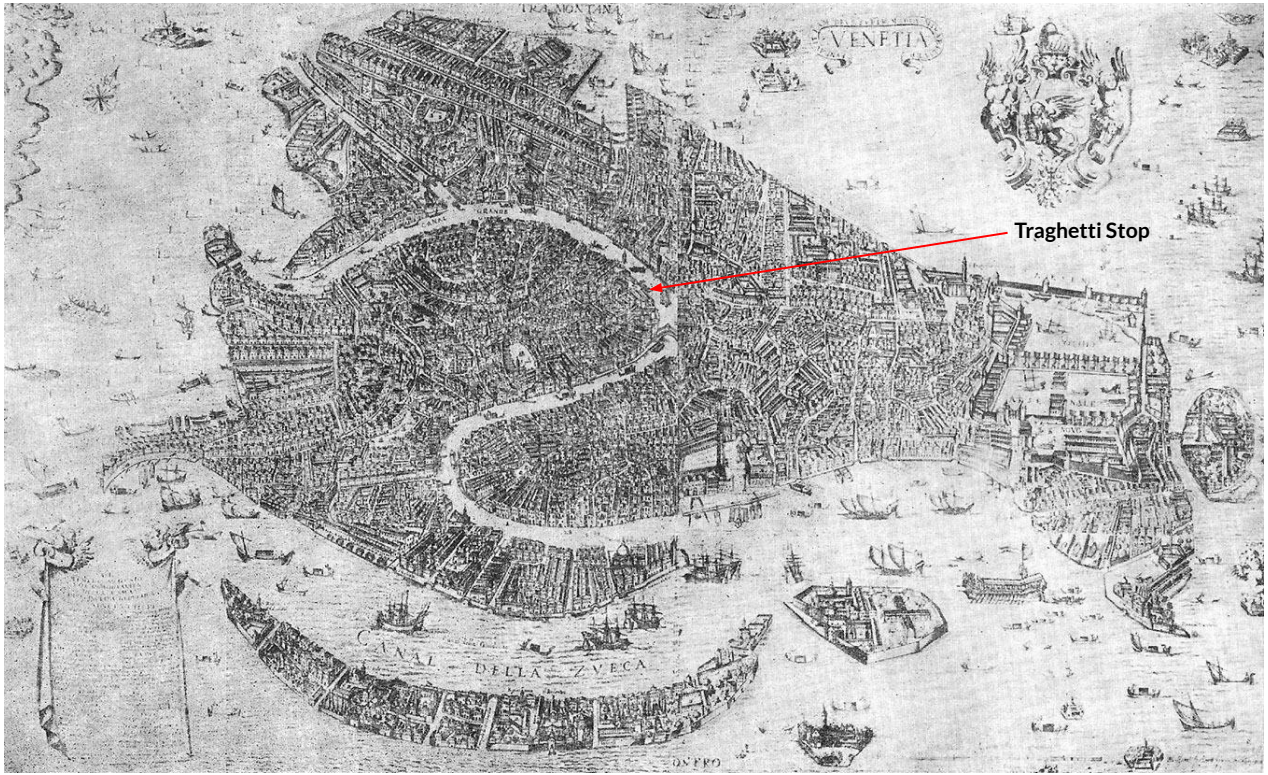
- Cassiodorus, 537



A new form of row boat is used to reduce canal crowding

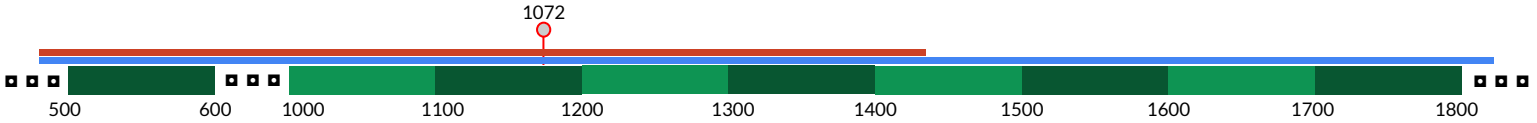


Traghetti are the most important transportation system

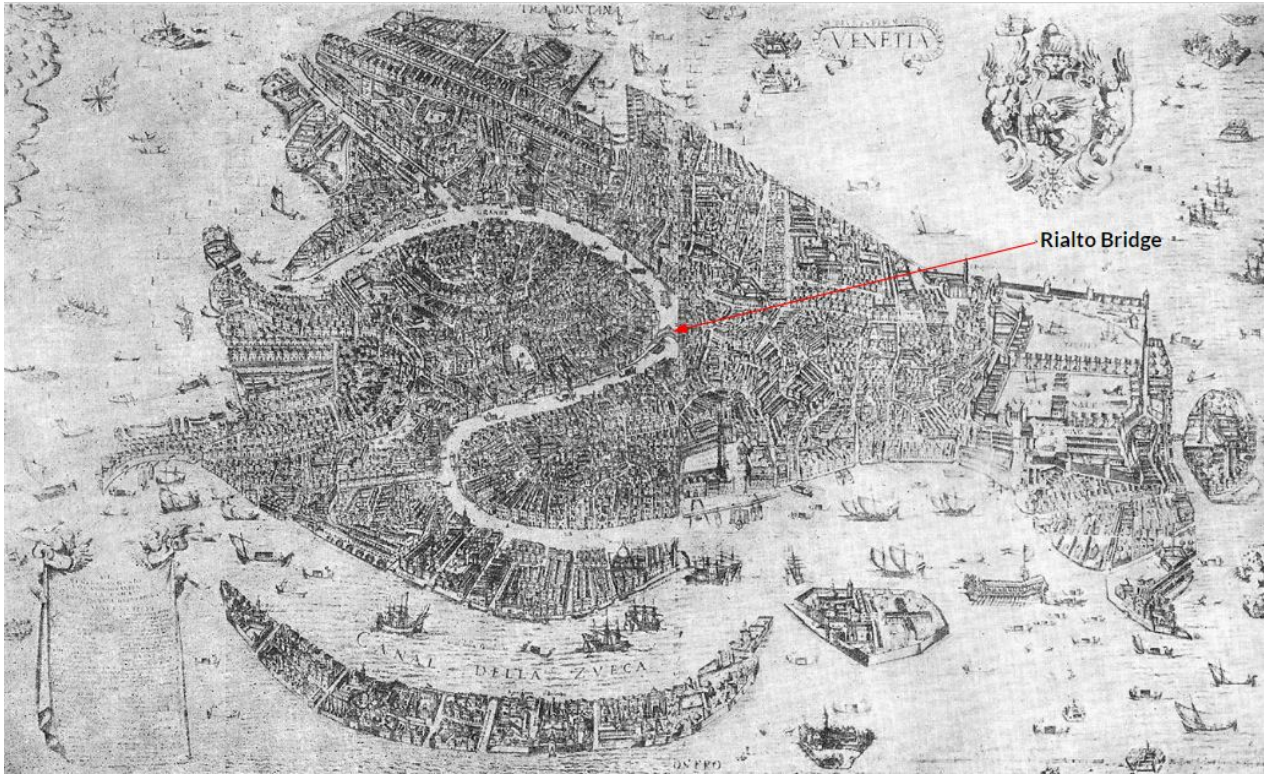


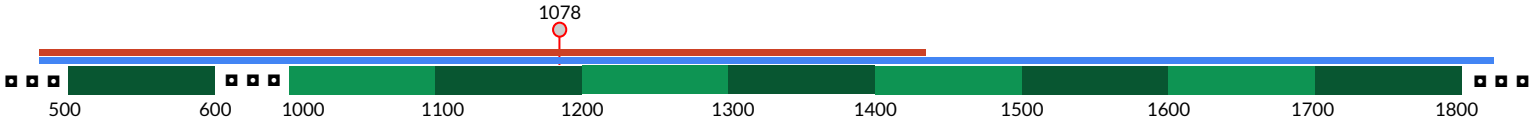
500 600 1000 1100 1200 1300 1400 1500 1600 1700 1800

The stonefication of Venice led to the downfall of horses

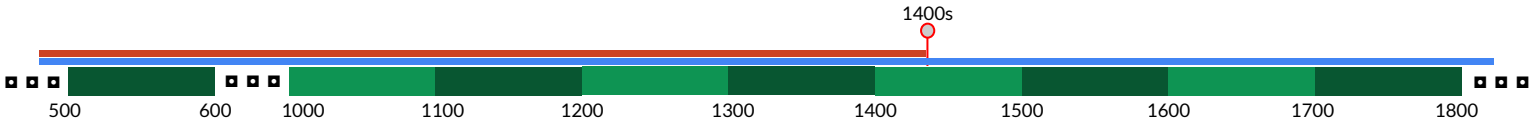


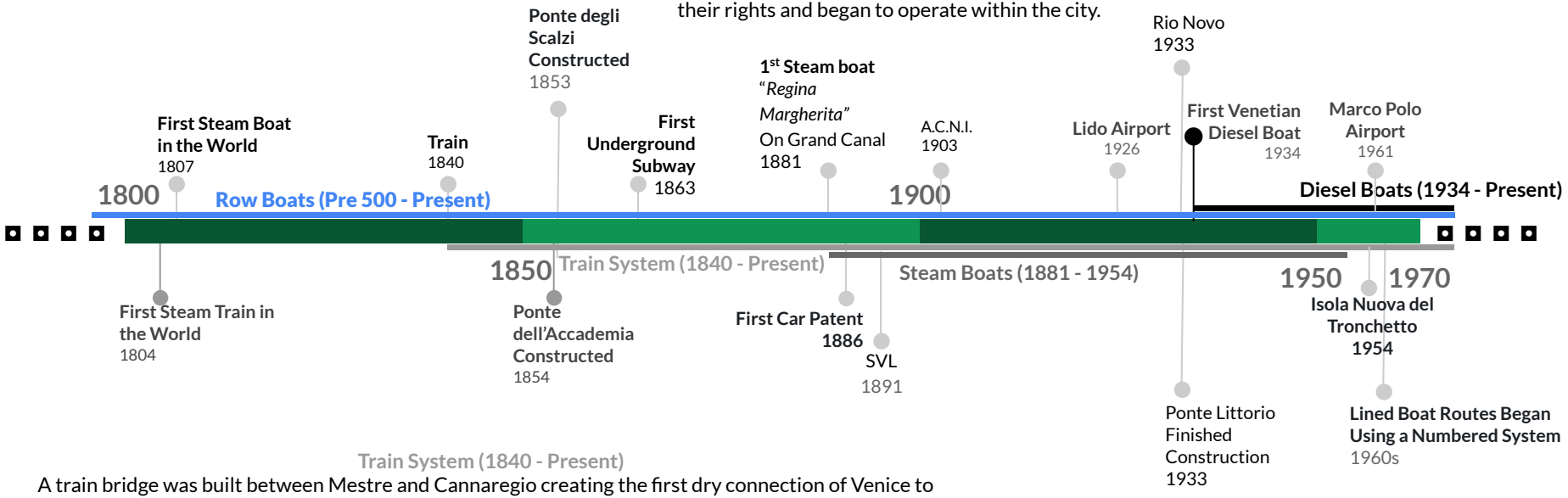
The Rialto was the first dry connection over the Canal Grande





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





Steam Boats (1881 - Present)

The first steamboats introduced to the Venetian transportation network were in a set of 9, the first 2 being built and operated by a French company and the ladder 7 being built in Italy. They were run by the French company until 1891 when SVL purchased their rights and began to operate within the city.

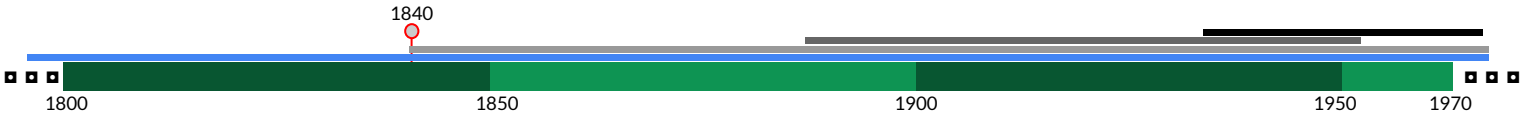
Train System (1840 - Present)

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.

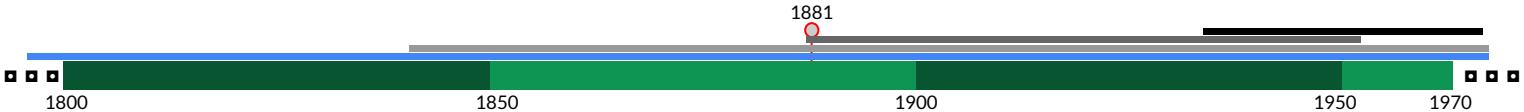
Train Bridge, 1840



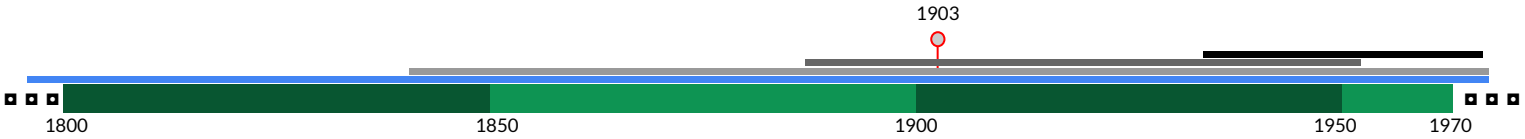
The second step in transportation evolution were steamboats

Regina Margherita

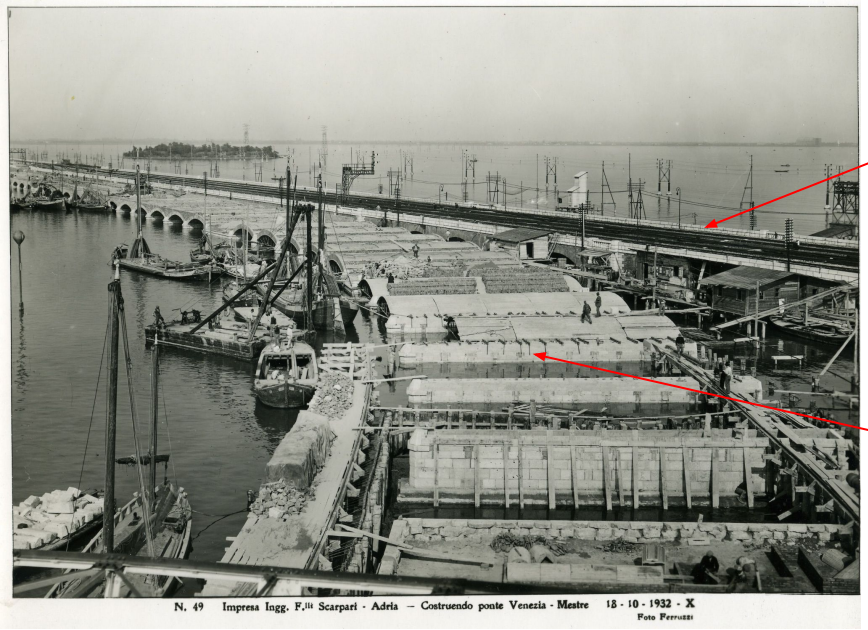
Venice's First Steam Powered Boat



ACNI takes over the public boat transportation



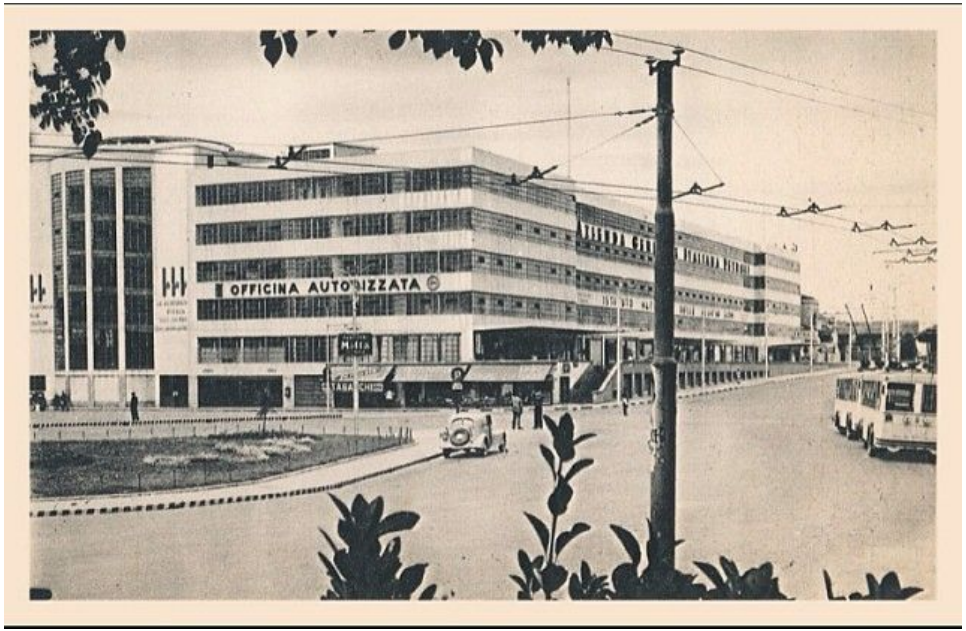
Car bridge allows for faster travel



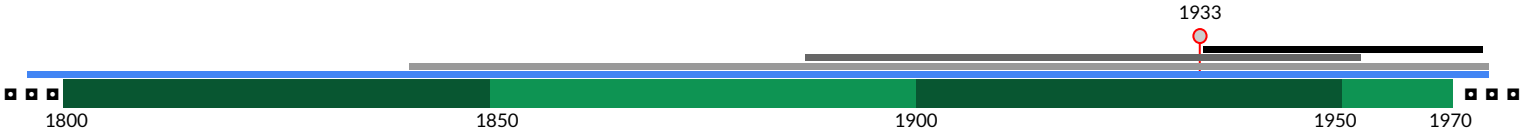
Train Bridge

Ponte del Littorio

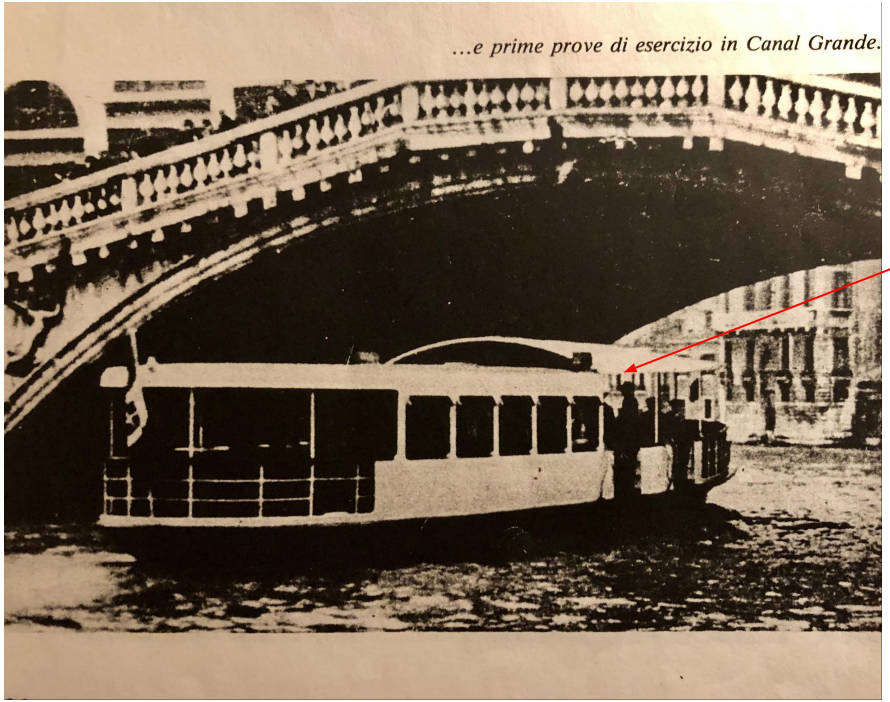
With a car bridge comes the need for parking



Rio Novo was constructed to connect Piazzale Roma



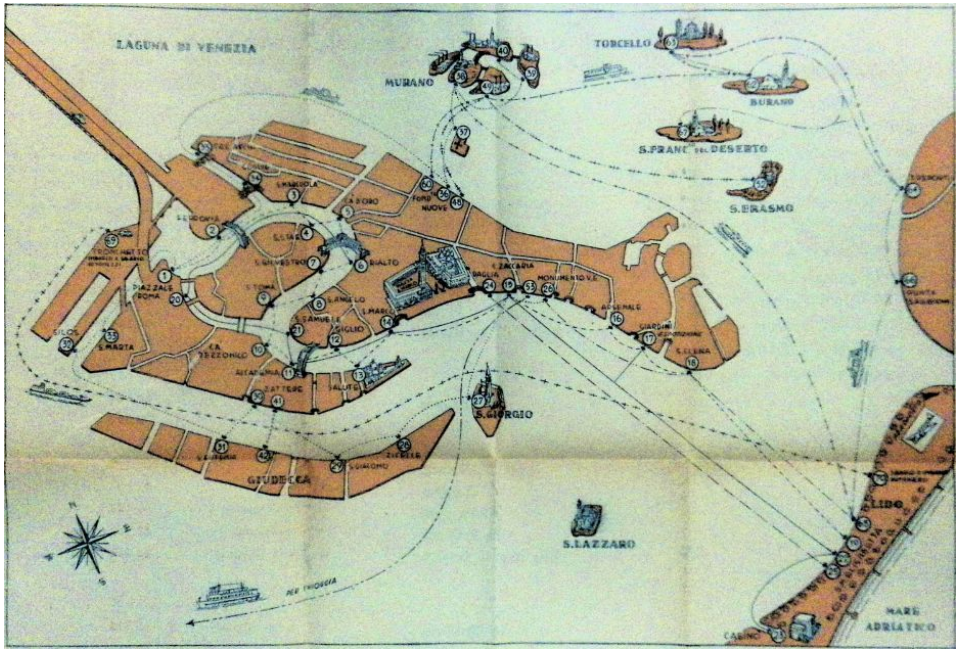
Diesel boats were also purchased and used before WWII



NO. 42 Annibale Foscari (now HIPOPOTAMO) on its Maiden Voyage

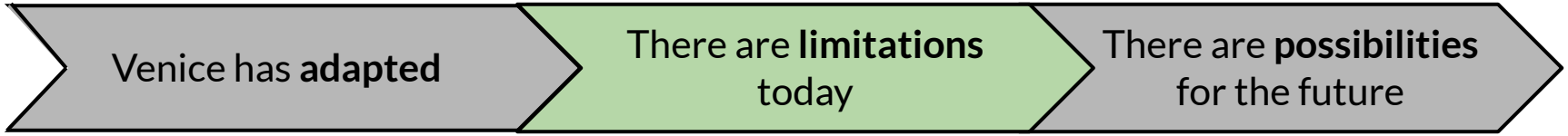
One of the boats in the First Fleet of Venetian Diesel Boats

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



1960s

1800 1850 1900 1950 1970



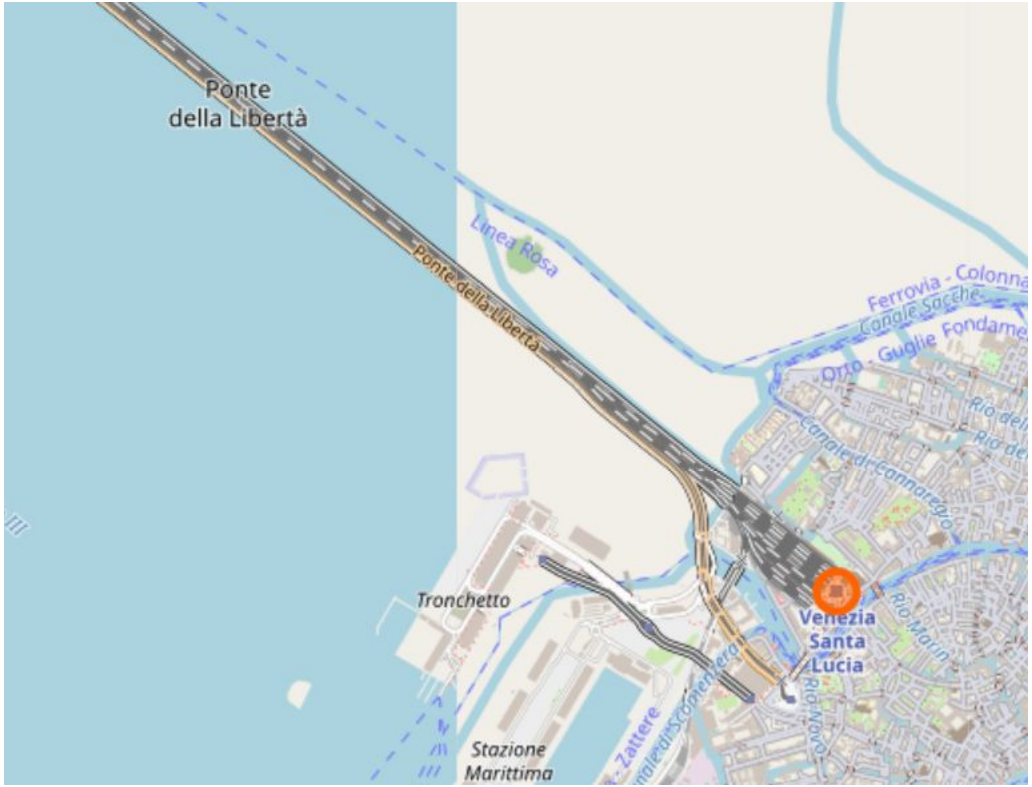
Current Transportation System

Getting in and out of Venice

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

Trenitalia, Italiarail, Italo

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

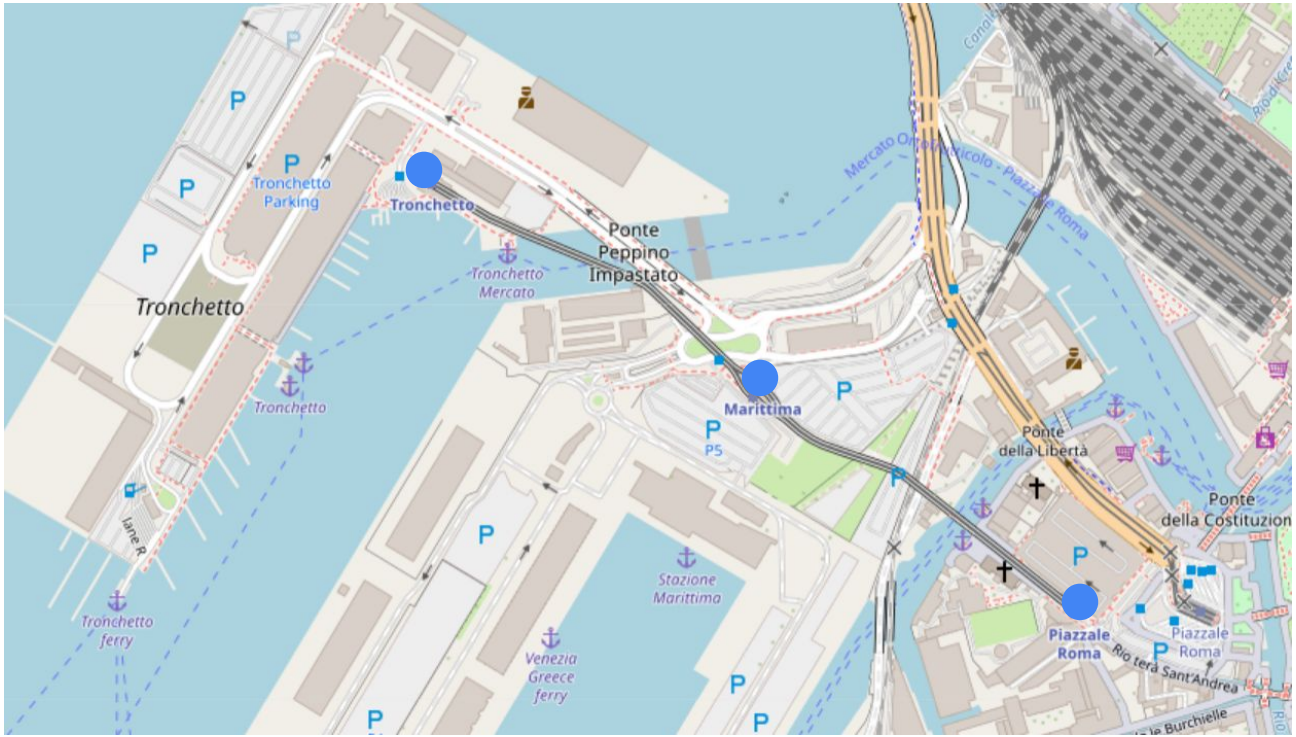


The Ponte della Libertà also carries transportation over road

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

Trams connect commuters to Mestre and Marghera

The People Mover moves 3200 people hourly between 3 transportation hubs in 4 minutes

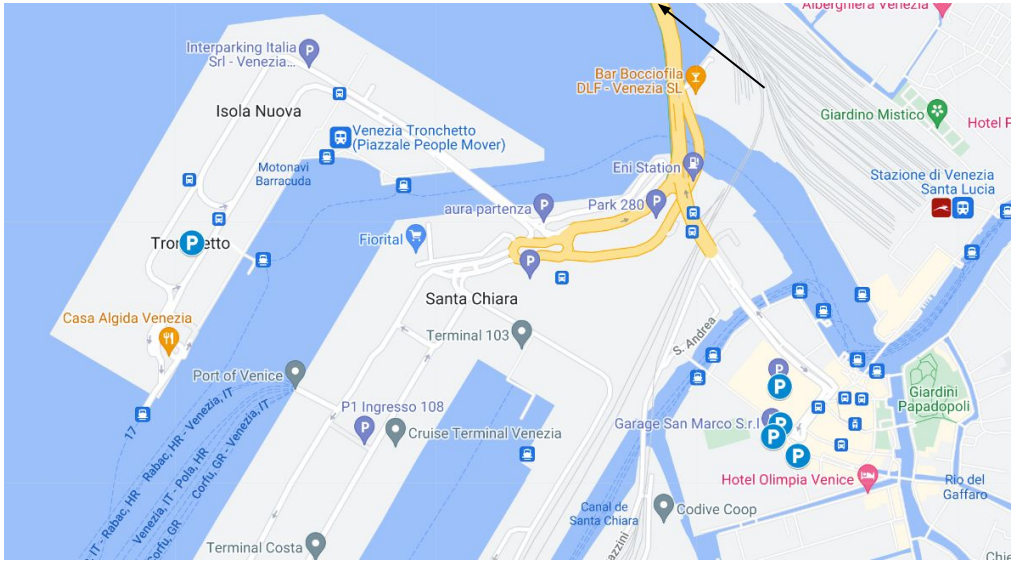


ACTV, OpenStreetMap

There are 8200 parking spots in the historic city

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

Parcheggio San Giuliano

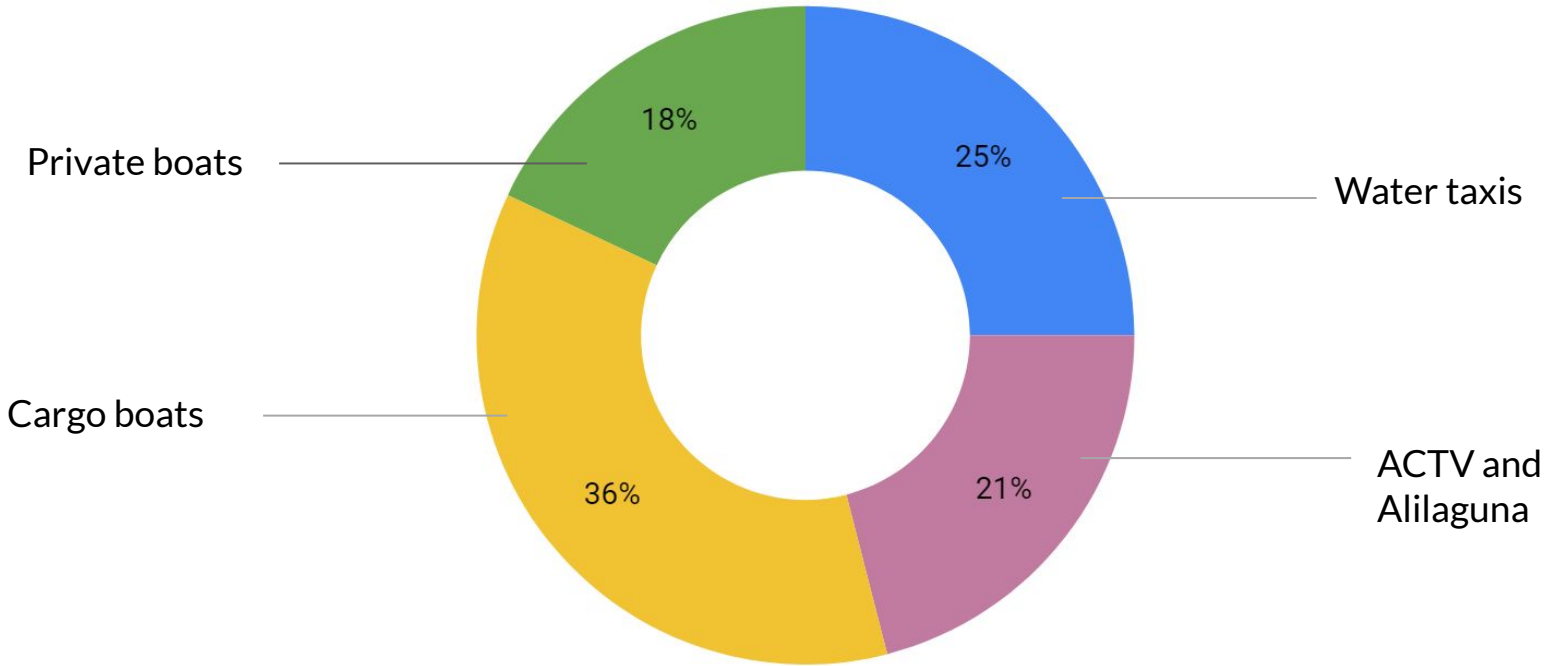


Ferry Boats transport cars and cargo between Lido and the mainland

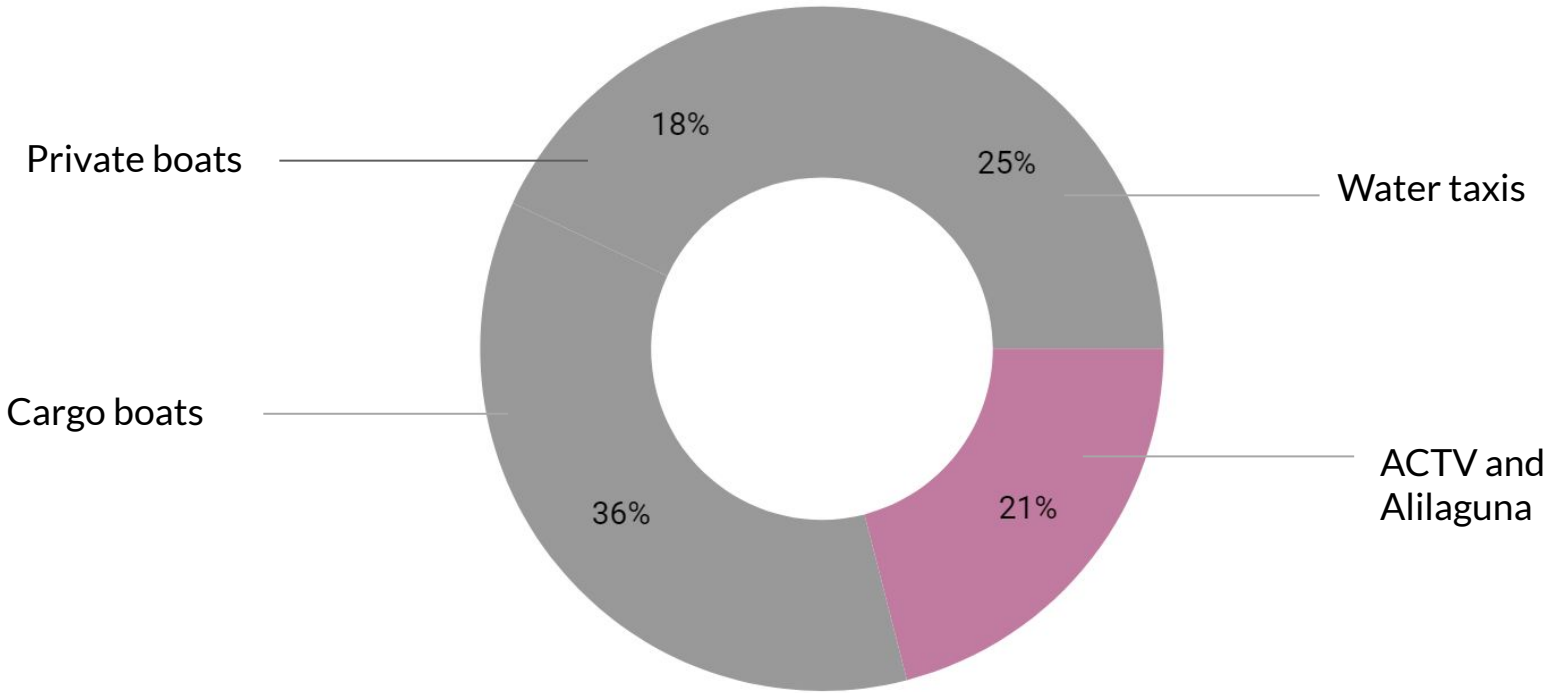
A trip on Line 17 from Lido S.Nicolò to Tronchetto lasts **35 minutes**
Approximately 70 cars can fit on a Ferry Boat

Boats can provide transportation over water to the historic city

There are four main types of boats in the Venetian canals



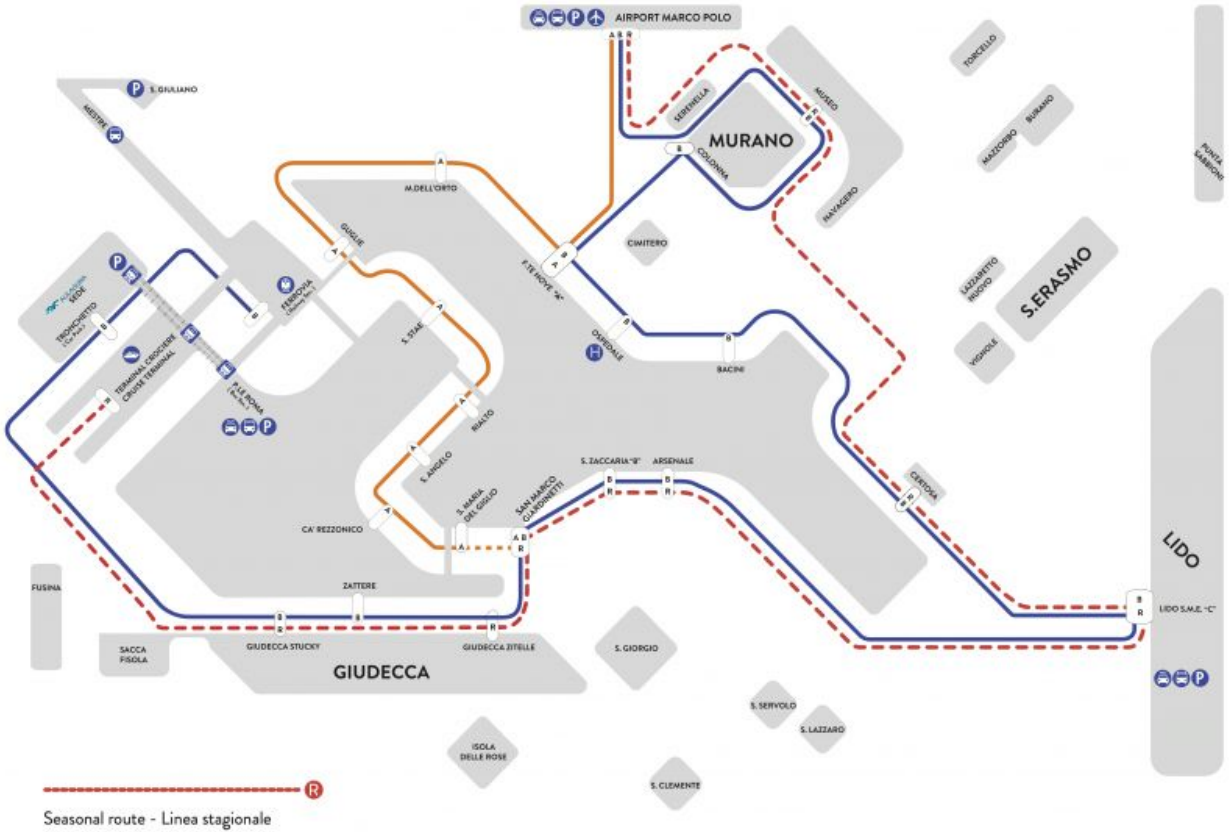
Lined public transportation boats don’t cause a lot of traffic



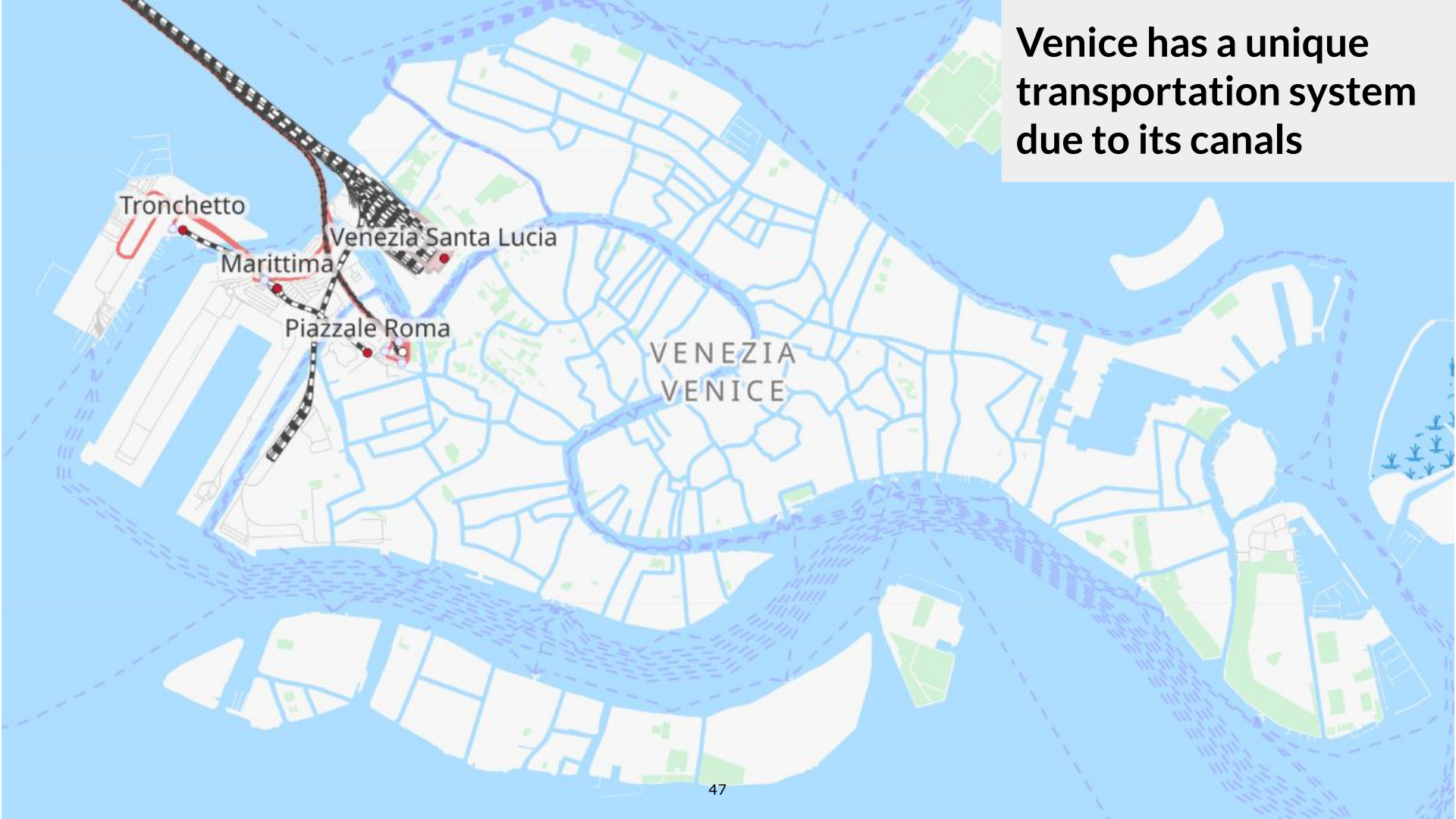
Gonclaves, Jasinski, Pauwels, & Tedesco, 2015

Alilaguna boats connect to the Marco Polo airport

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

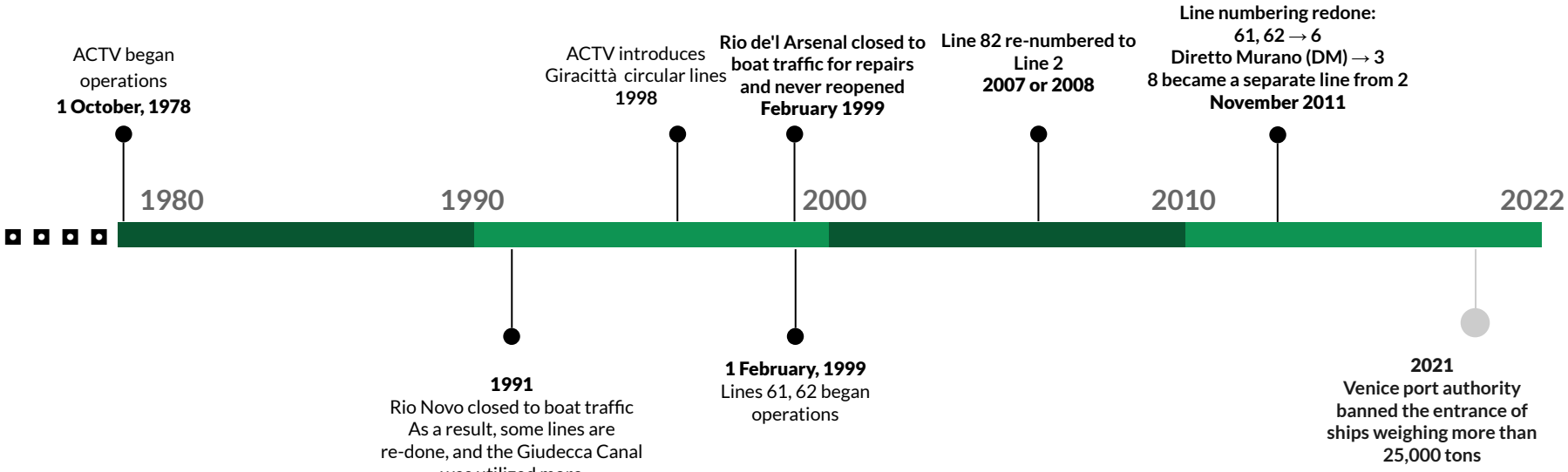


Getting around within the historic city



Venice has a unique transportation system due to its canals

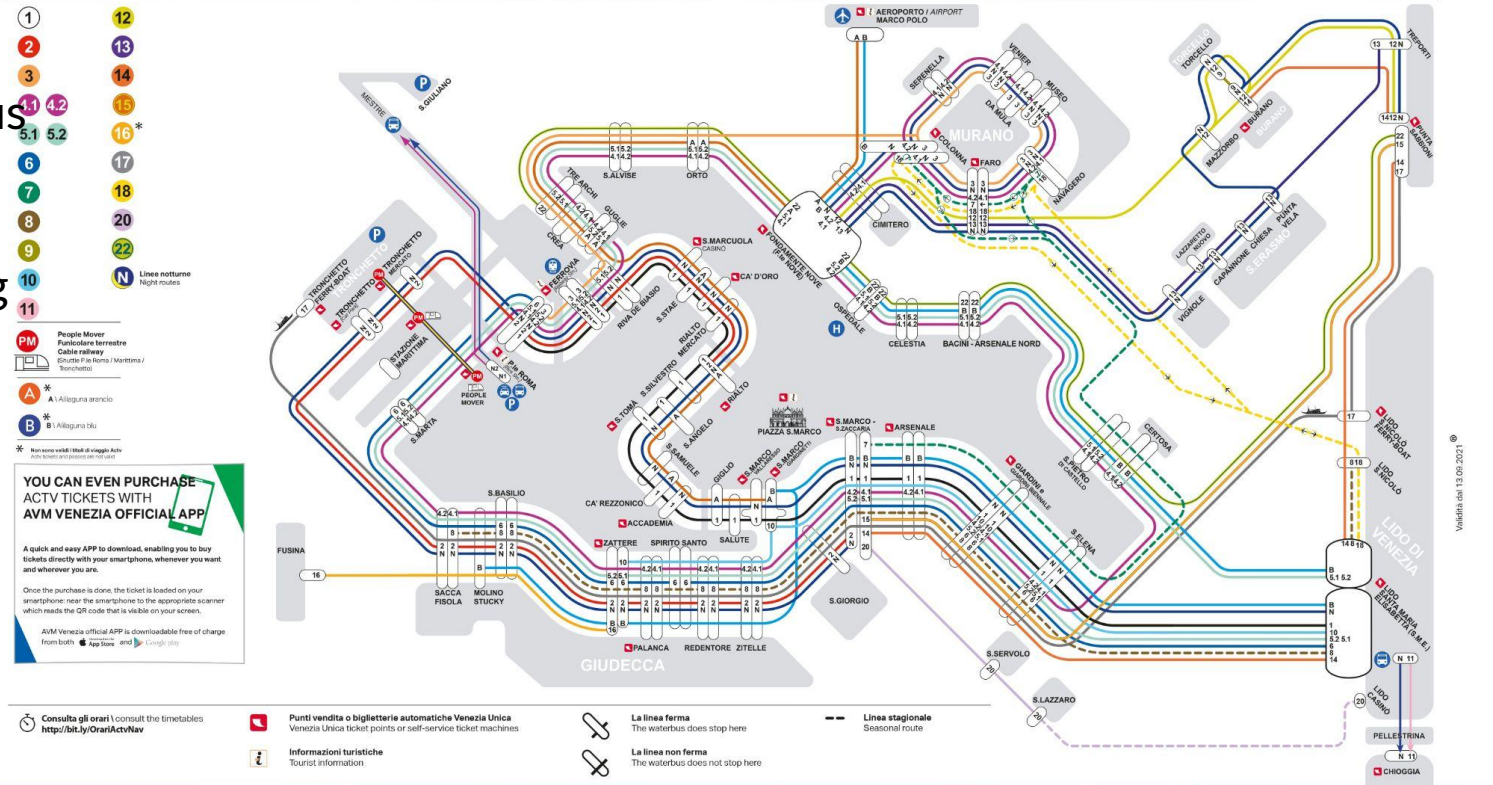
ACTV has adapted and evolved since its inception



Corposanto & Raven, 2022

Water buses are the main mode of transportation in the canals

- 26 water bus lines
- 160 boats
- 150 floating pontoons
- Up to 1150 passengers per hour on Line 1



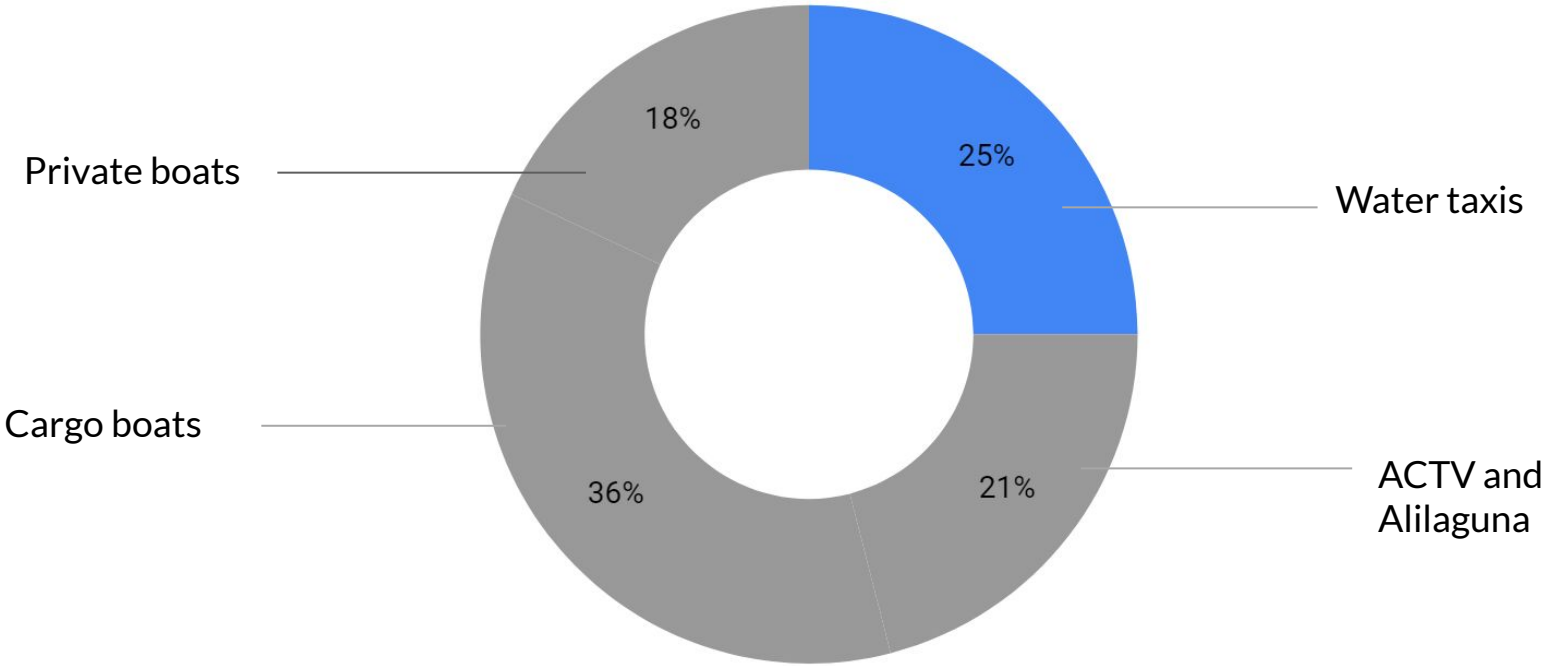
Vaporetti are used on Lines 1, 2, 7, 13, and Night lines

Passenger capacity: 215-230

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

Passenger capacity: 150

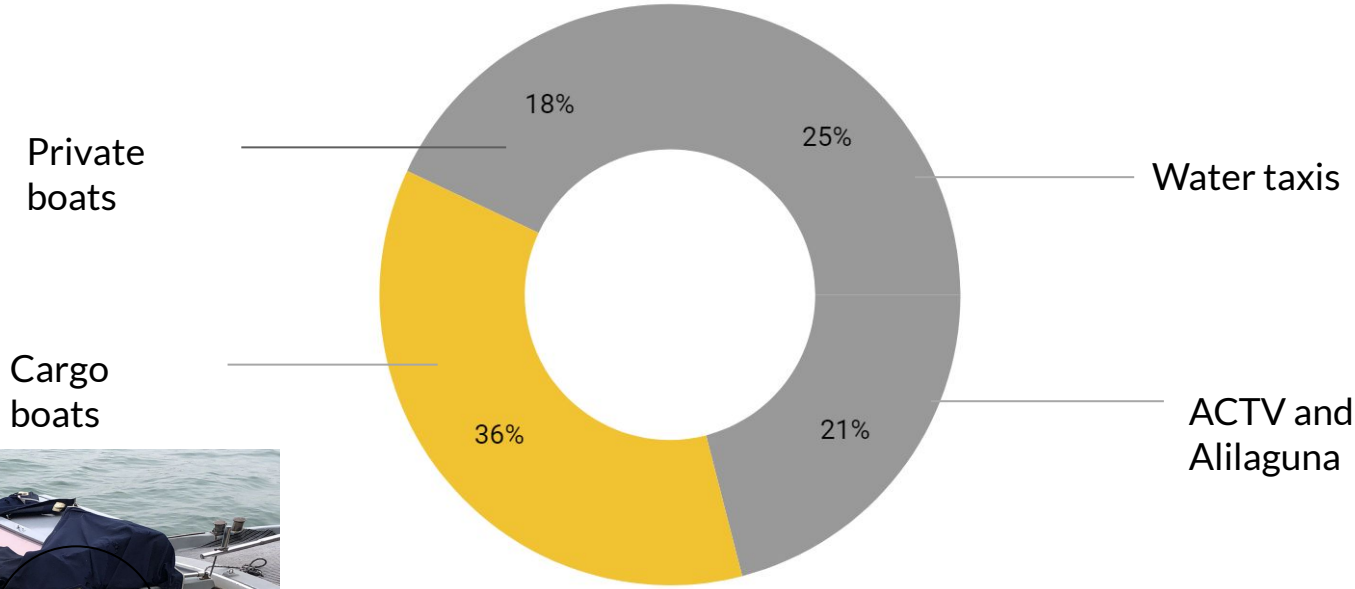
Private water taxis are point-to-point transportation



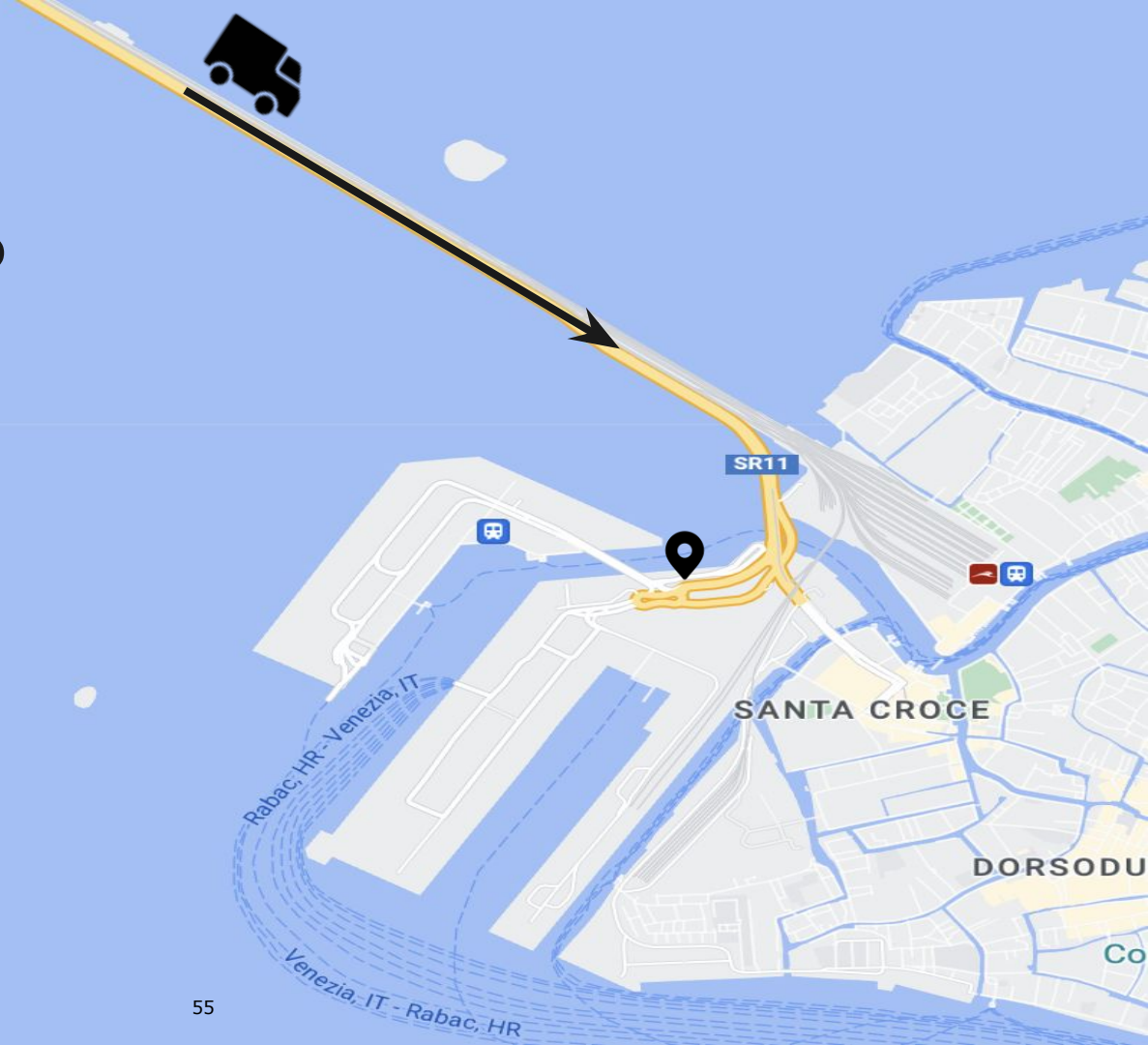
Gonclaves, Jasinski, Pauwels, & Tedesco, 2015

There are 250 licensed taxis

There are 410 licensed cargo boats

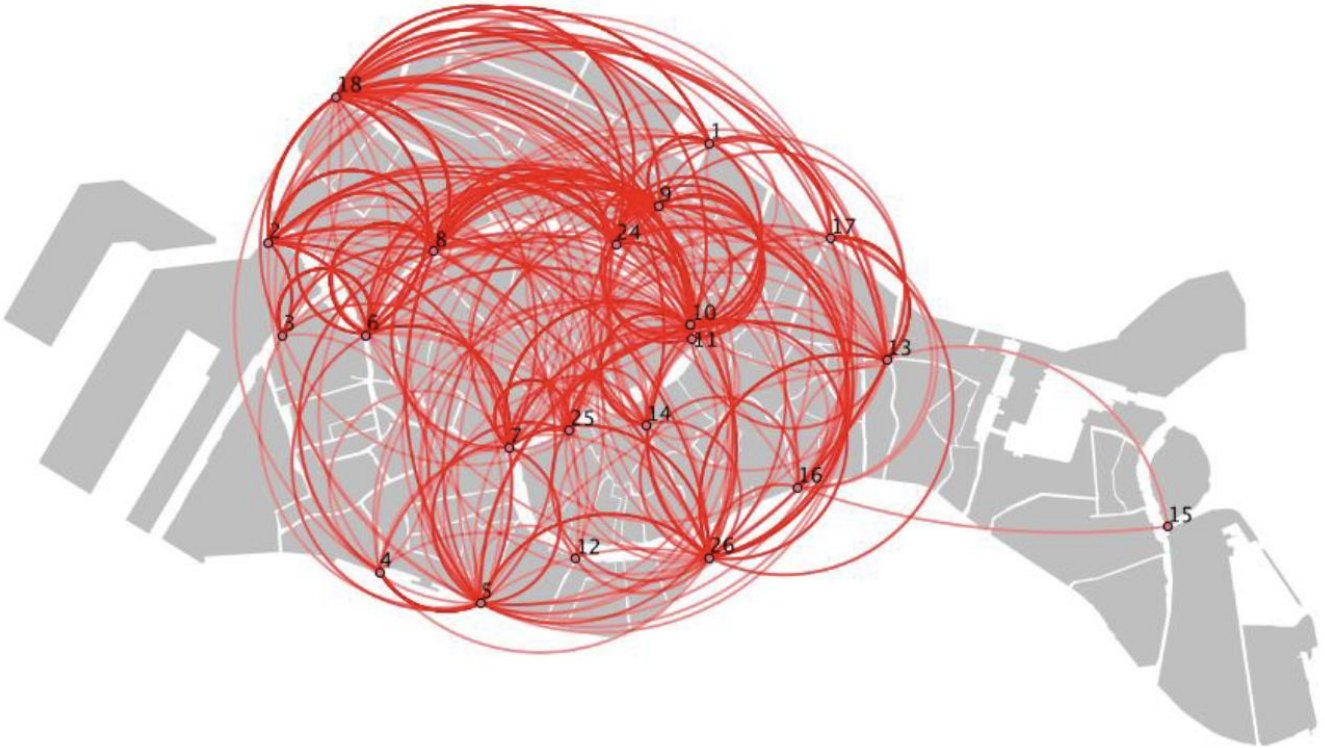


Trucks deliver cargo products to Venice



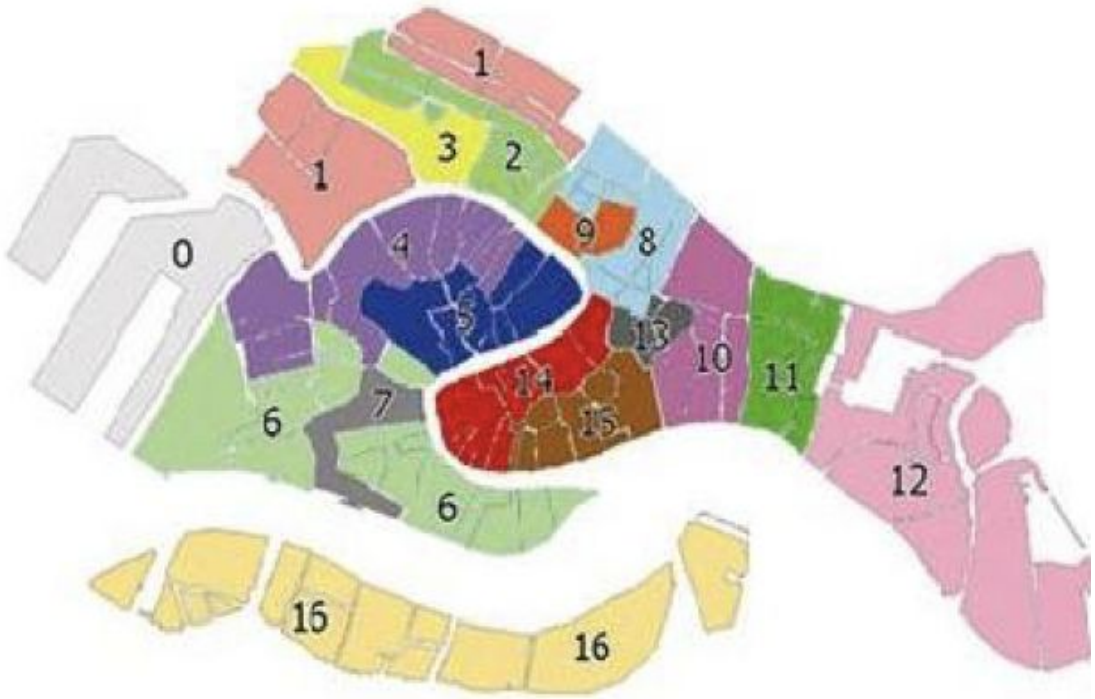
Villalobos

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



WPI

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



WPI

Problems with the current system

There are too many boats in the canals

Fog limits the operation of boats

There are cancellations and delayed to regular ACTV lines because it’s not safe to navigate

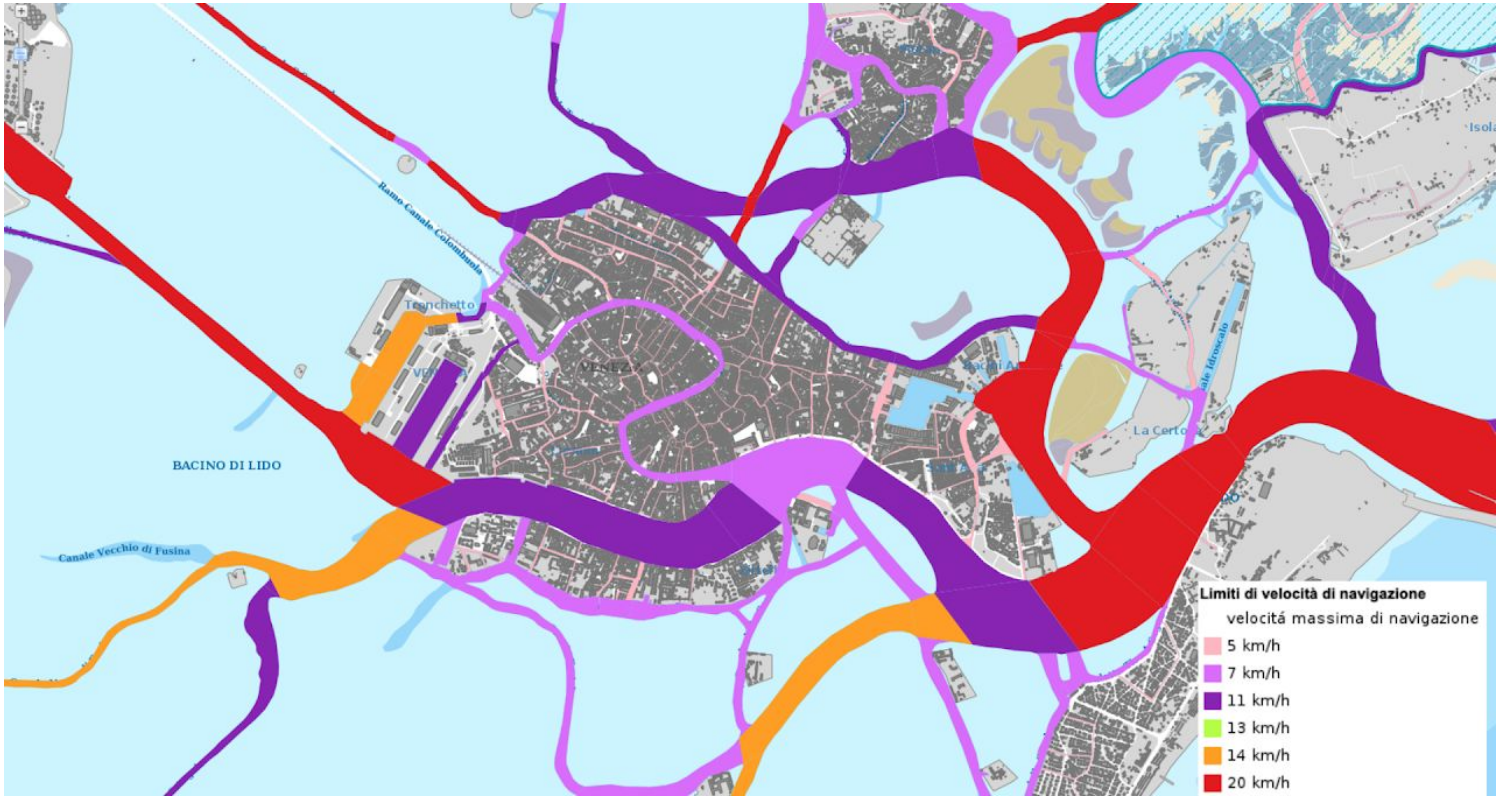
Acqua alta limits the ability of boats to cross under bridges

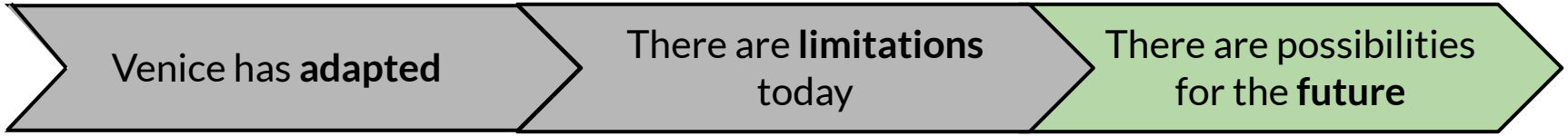
Boats can usually get to their destination, but need to re-route to avoid low bridges

Moto ondoso causes damage to canal walls and buildings

It's estimated that it costs up to **$11,680** to fix one square meter of damaged canal wall (2013)

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





Exploration of a Sublagunare in Venice

- 1911
- Ing. Daniele Donghi
- Set of bridges, trams, and underwater passages
- Throughout the historic city, mainland, Lido, Pellestrina, and Chioggia
- Underwater connection between Lido Quattro Fontane and San Zaccaria

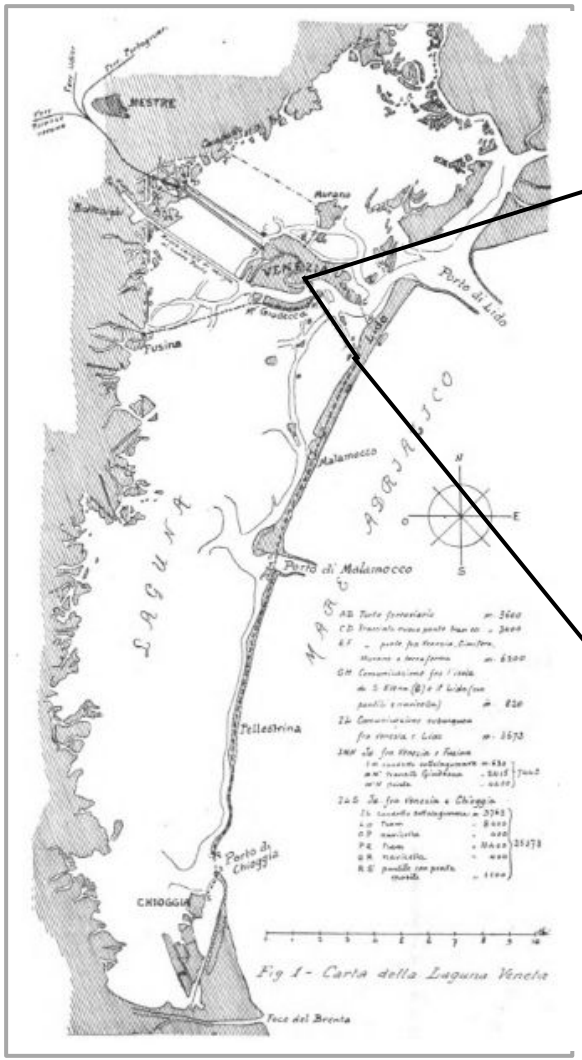


Fig. 1 - Carta della Laguna Veneta

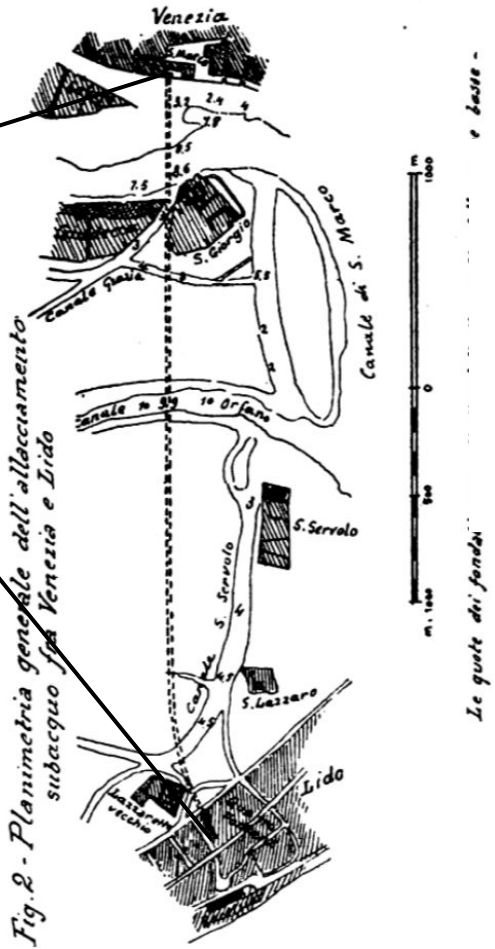


Fig. 2 - Planimetria generale dell'allacciamento subacqueo fra Venezia e Lido

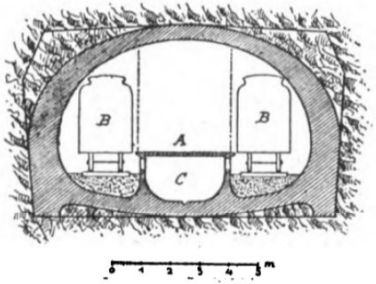


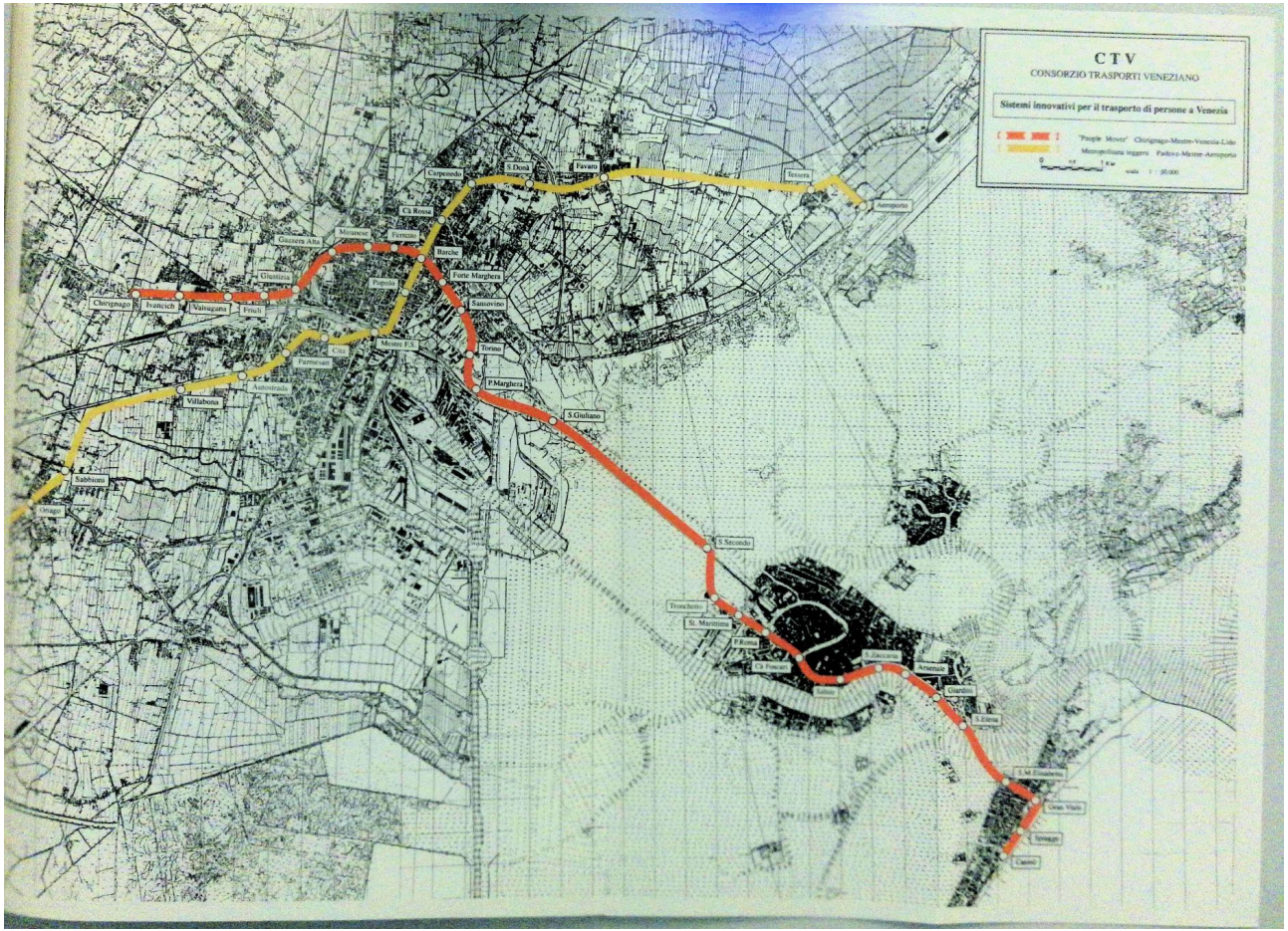
Fig. 4 - Sezione dei tratti in galleria

Pedestrian tunnel flanked by electric trams

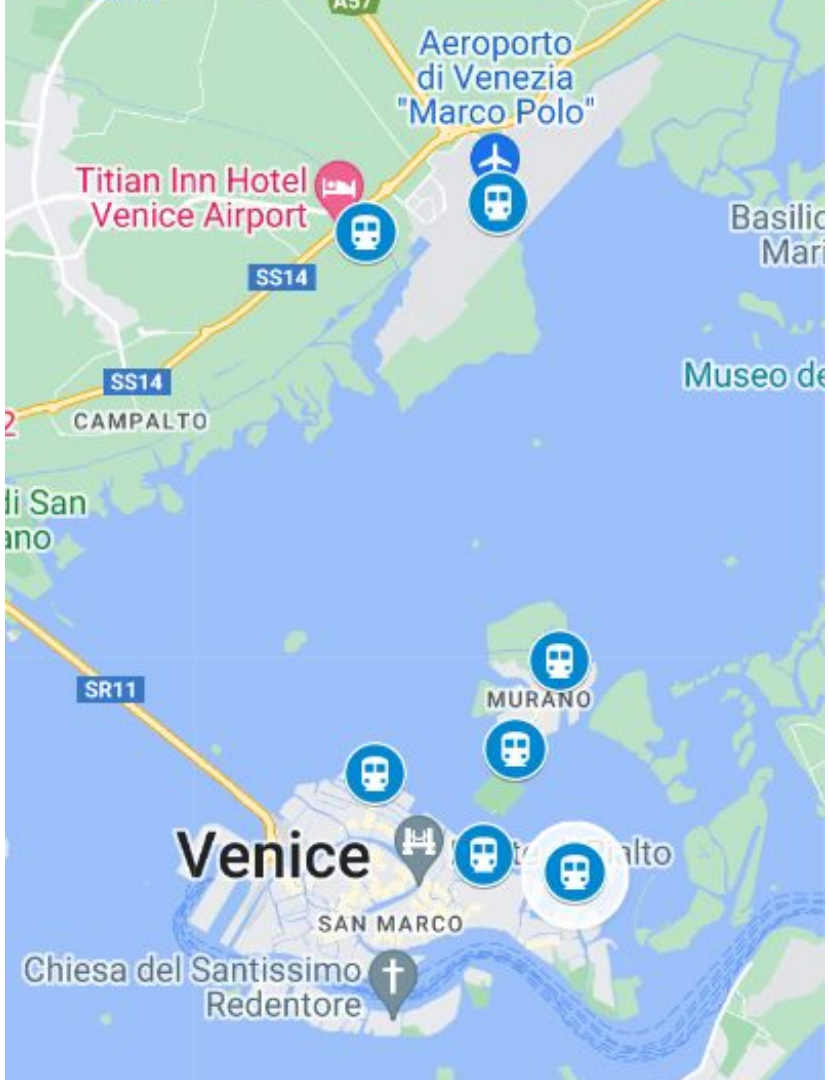
- 1933
- Ing. Miozzi
- *1 sublagunare route*
- Connecting Venice, Mestre, Lido, Chioggia

- 1959
- Town Plan
- Motor road and underground highway
- Ponte della Libertà to a proposed eastern terminal via F.te Nove

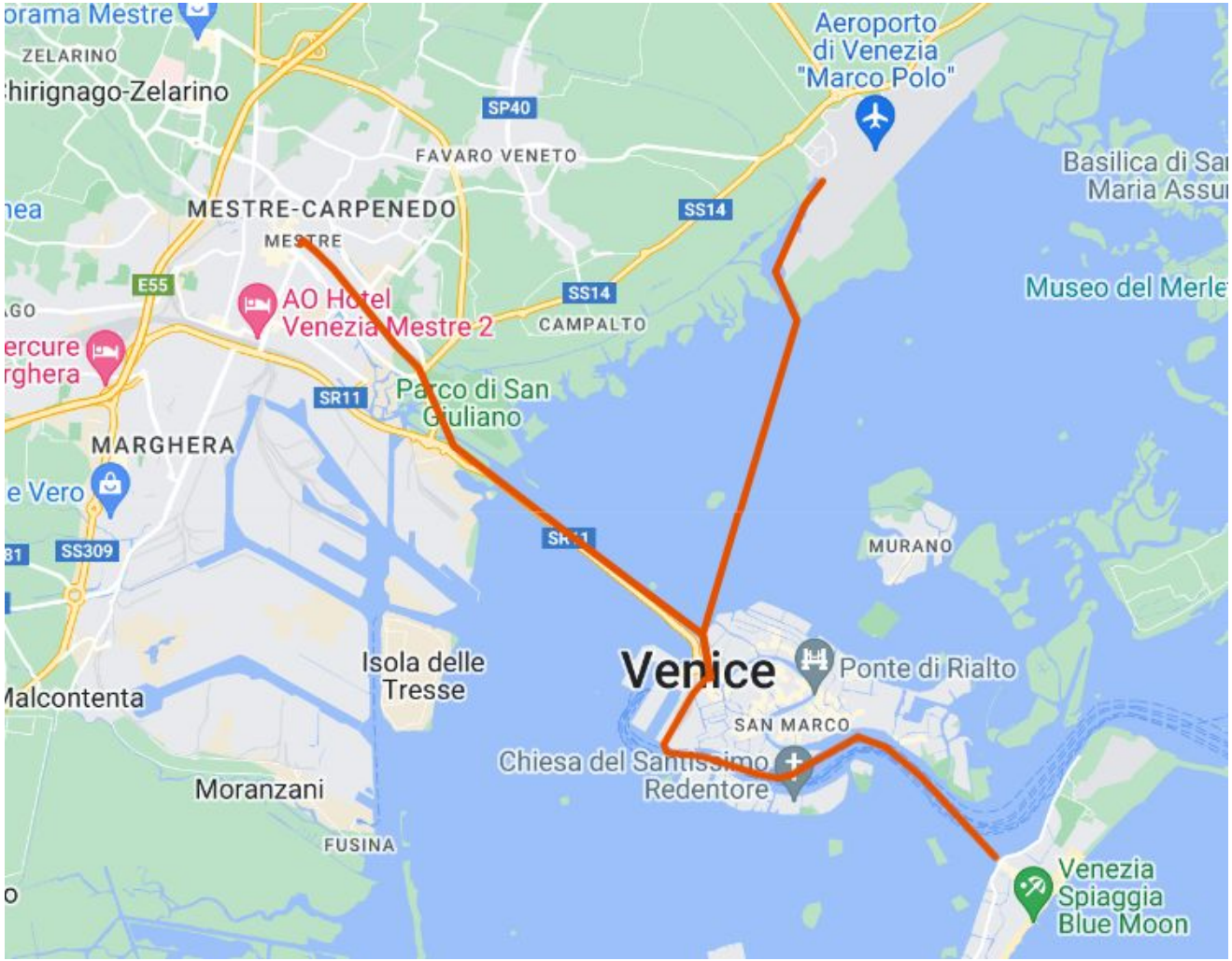
- 1990
- Consorzio Trasporti Veneziano
- 2 lines of tram and *sublagunare*
- Mestre/Marghera, historic city, Lido

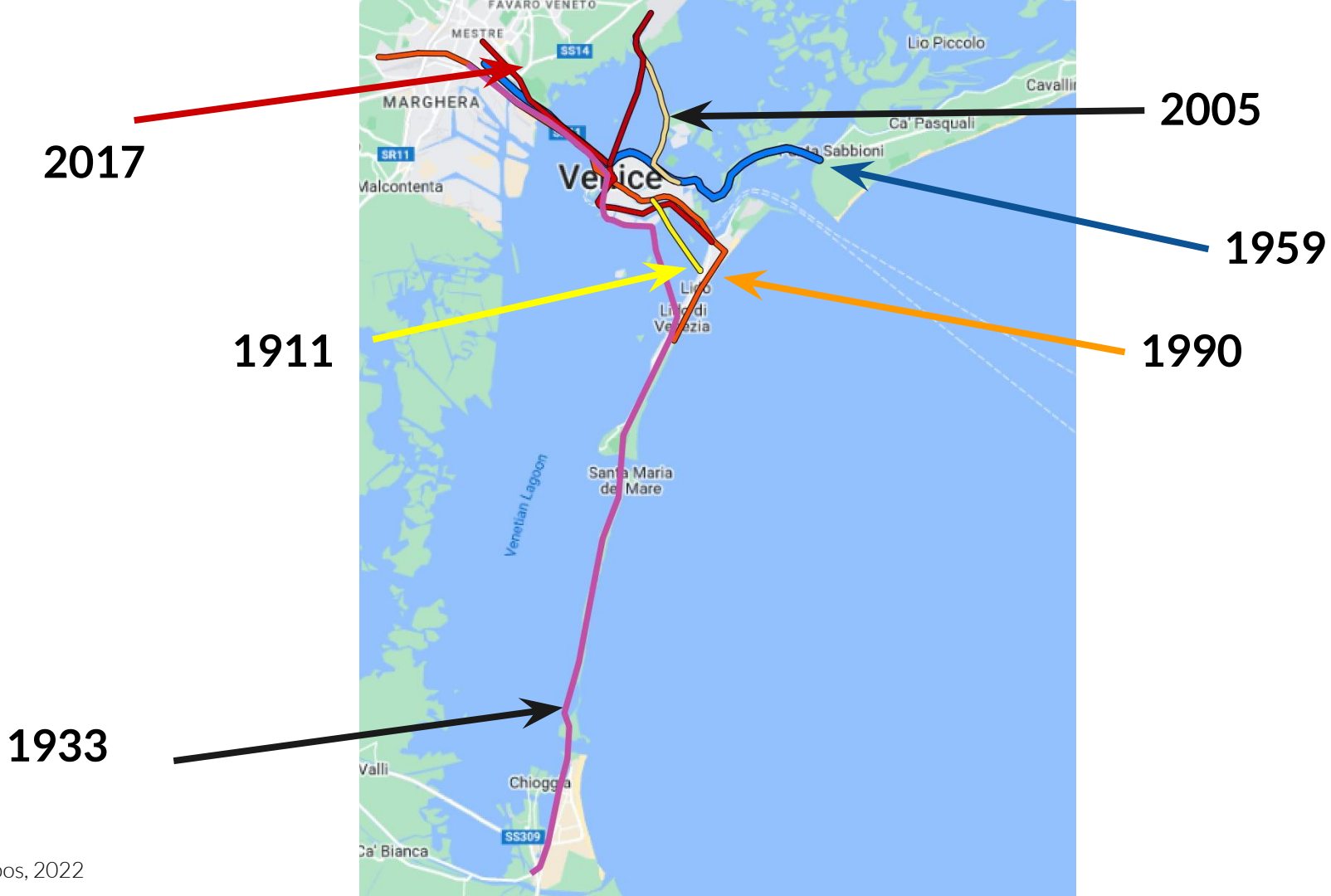


- 2005
- Mayor of Venice
- *Sublagunare*
- Airport/Favaro, Murano, historic city

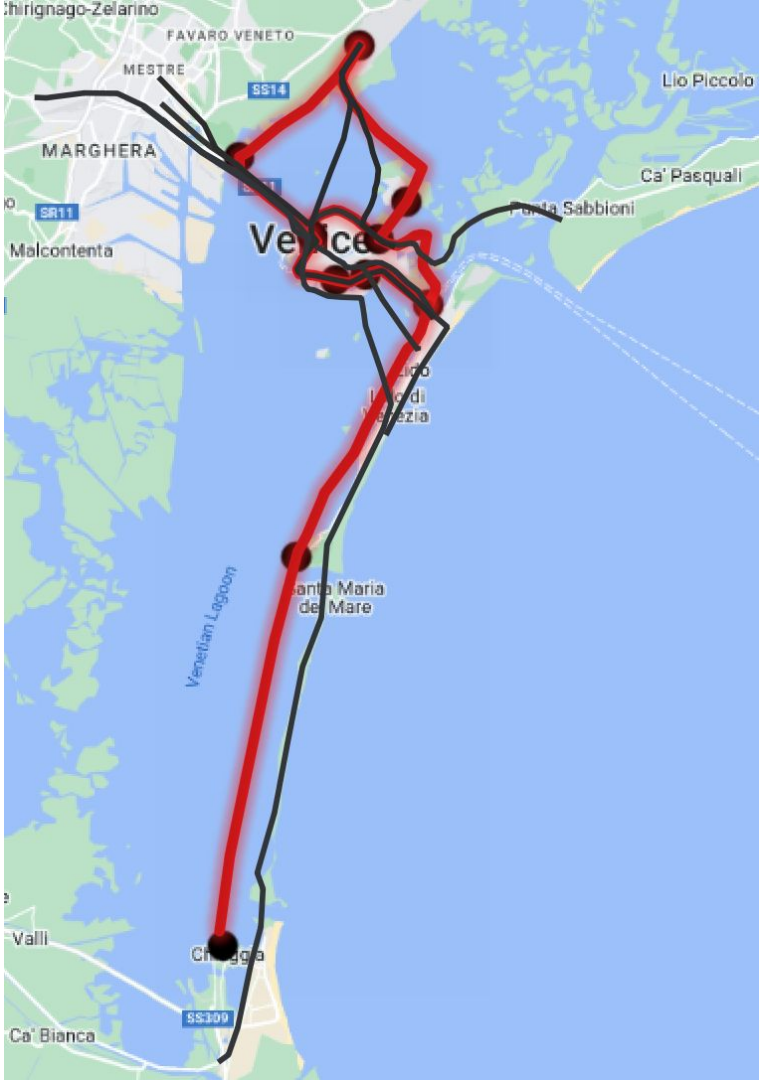


- 2017
- WPI students
- Extension of 2005 proposal



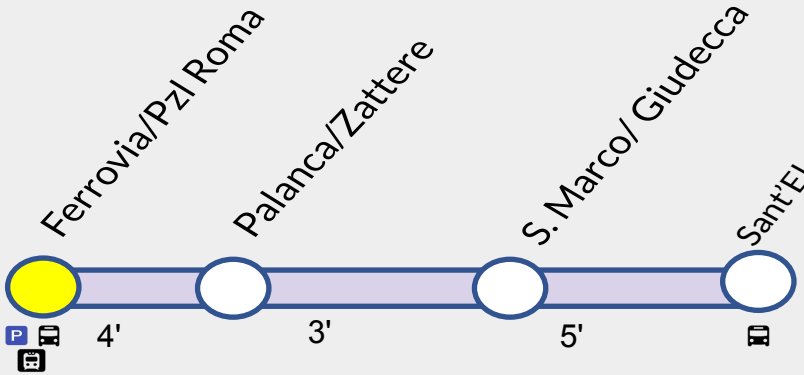

2017
2005
1959
1911
1990
1933
FAVARO VENETO
MESTRE
SS14
MARGHERA
SR11
Malcontenta
Venice
Lio Piccolo
Cavallino
Ca' Pasquali
Sabbioni
Lido di Venezia
Santa Maria del Mare
Venetian Lagoon
Chioggia
SS309
Ca' Bianca

A faster way in and out of Venice


Chirignago-Zelarino
FAVARO VENETO
MESTRE
SS14
MARGHERA
SR11
Malcontenta
Lio Piccolo
Ca' Pasquali
Venice
Venetian Lagoon
Valli
SS309
Ca' Bianca

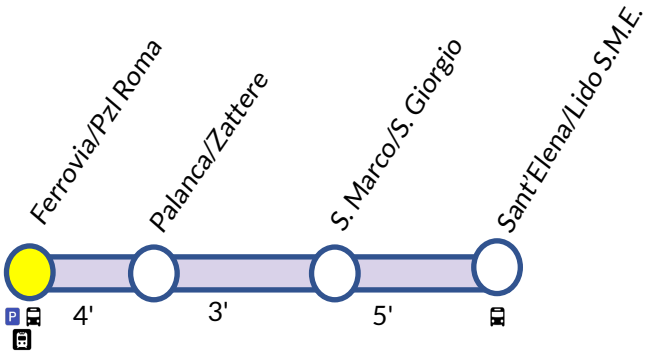
Phase1

Ferrovia/Pzl Roma

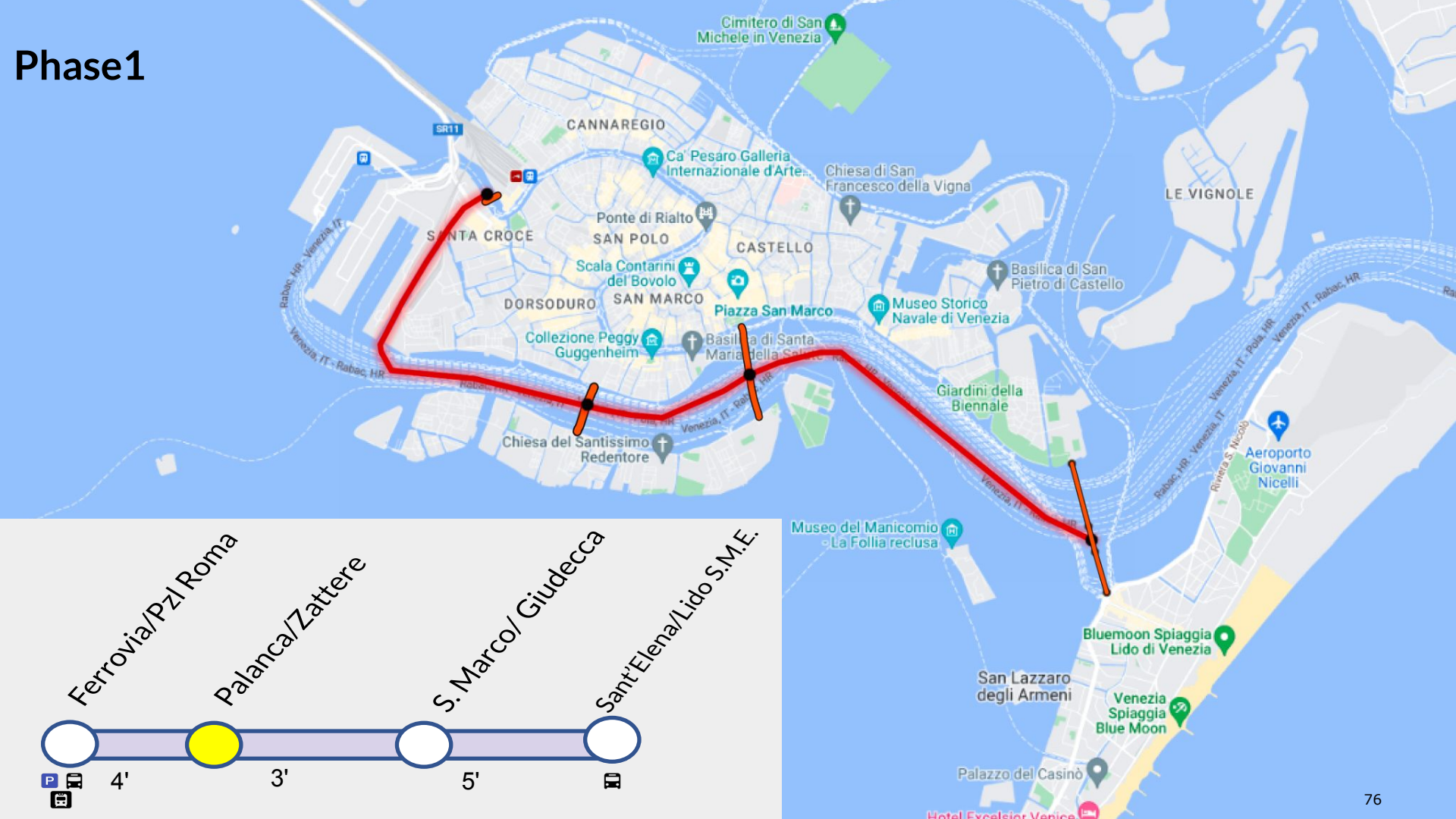


Ferrovia/Pzl Roma/Tronchetto

- Access to the mainland
- Quick access to Ferrovia



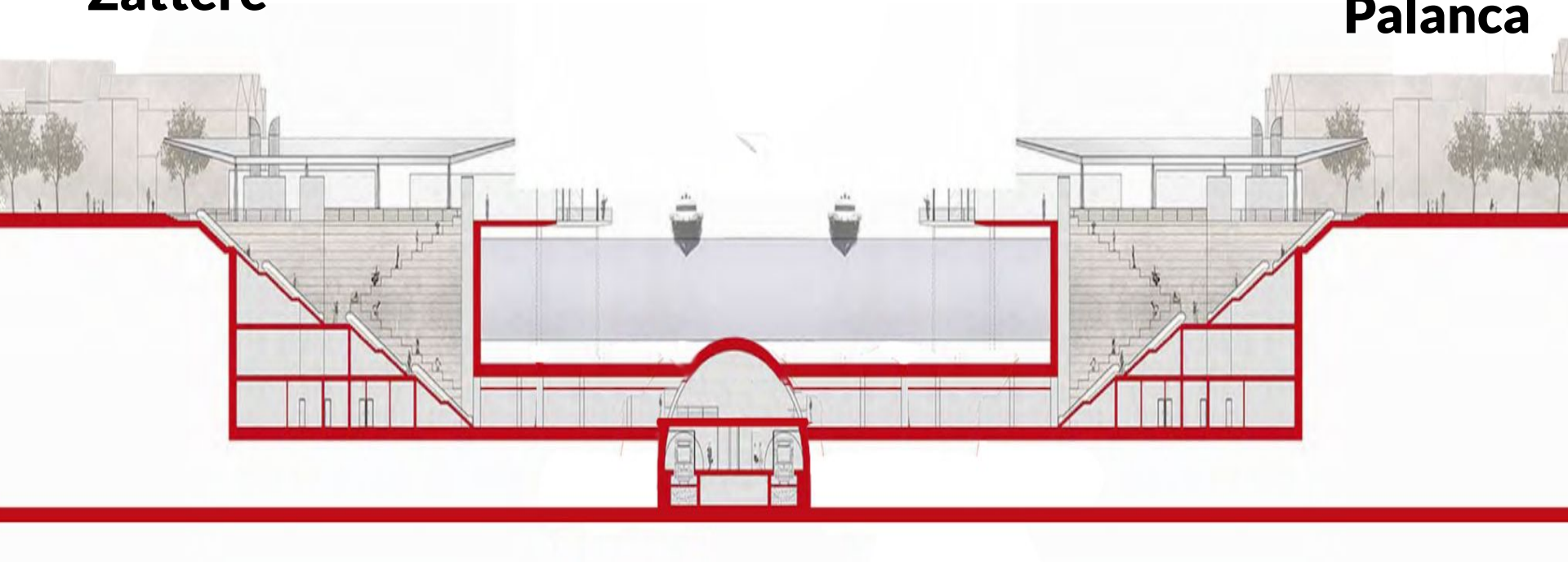
Phase1


Cimitero di San Michele in Venezia
CANNAREGIO
SR11
Ca' Pesaro Galleria Internazionale d'Arte...
Chiesa di San Francesco della Vigna
LE VIGNOLE
Ponte di Rialto
SAN POLO
CASTELLO
SANTA CROCE
Scala Contarini del Bovolo
Basilica di San Pietro di Castello
DORSODURO
SAN MARCO
Piazza San Marco
Museo Storico Navale di Venezia
Collezione Peggy Guggenheim
Giardini della Biennale
Chiesa del Santissimo Redentore
Aeroporto Giovanni Nicelli
Museo del Manicomio - La Follia reclusa
Bluemoon Spiaggia Lido di Venezia
San Lazzaro degli Armeni
Venezia Spiaggia Blue Moon
Palazzo del Casinò
Ferrovia/PzI Roma
Palanca/Zattere
S. Marco/ Giudecca
Sant'Elena/Lido S.M.E.
4'
3'
5'

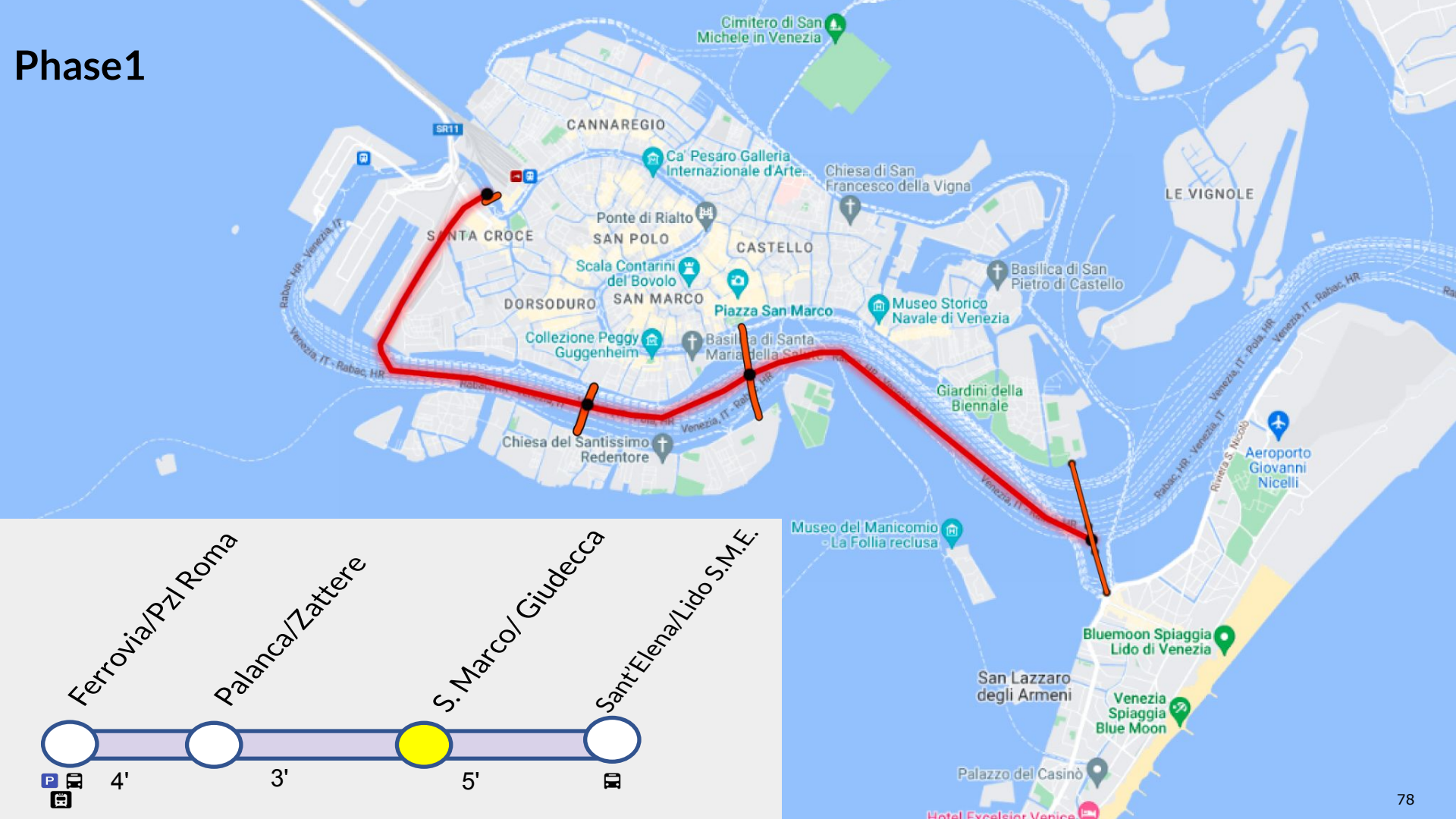
Station with two pedestrian connections

Zattere

Palanca



Phase1


Cimitero di San Michele in Venezia
CANNAREGIO
SR11
Ca' Pesaro Galleria Internazionale d'Arte...
Chiesa di San Francesco della Vigna
LE VIGNOLE
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SANTA CROCE
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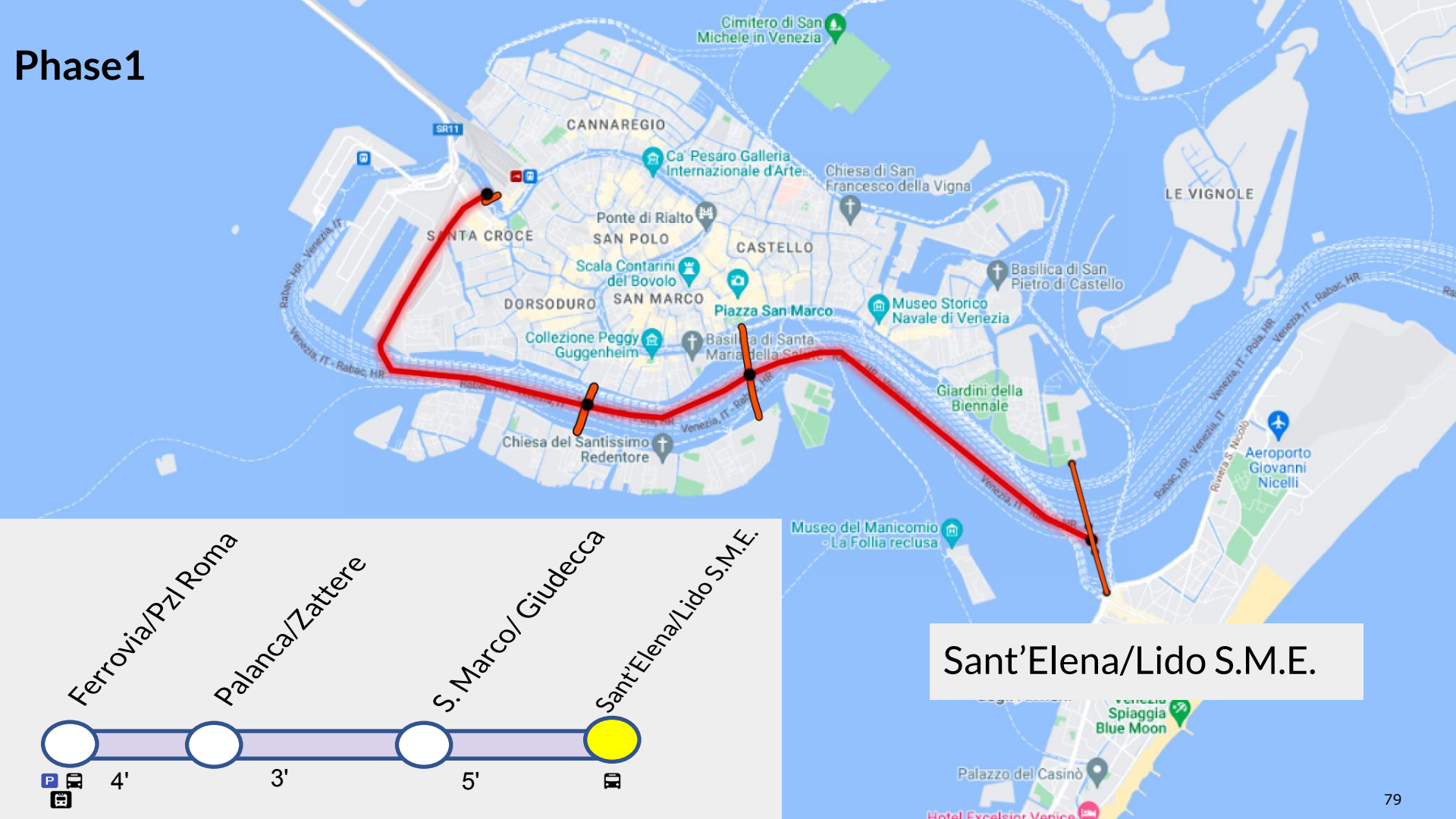
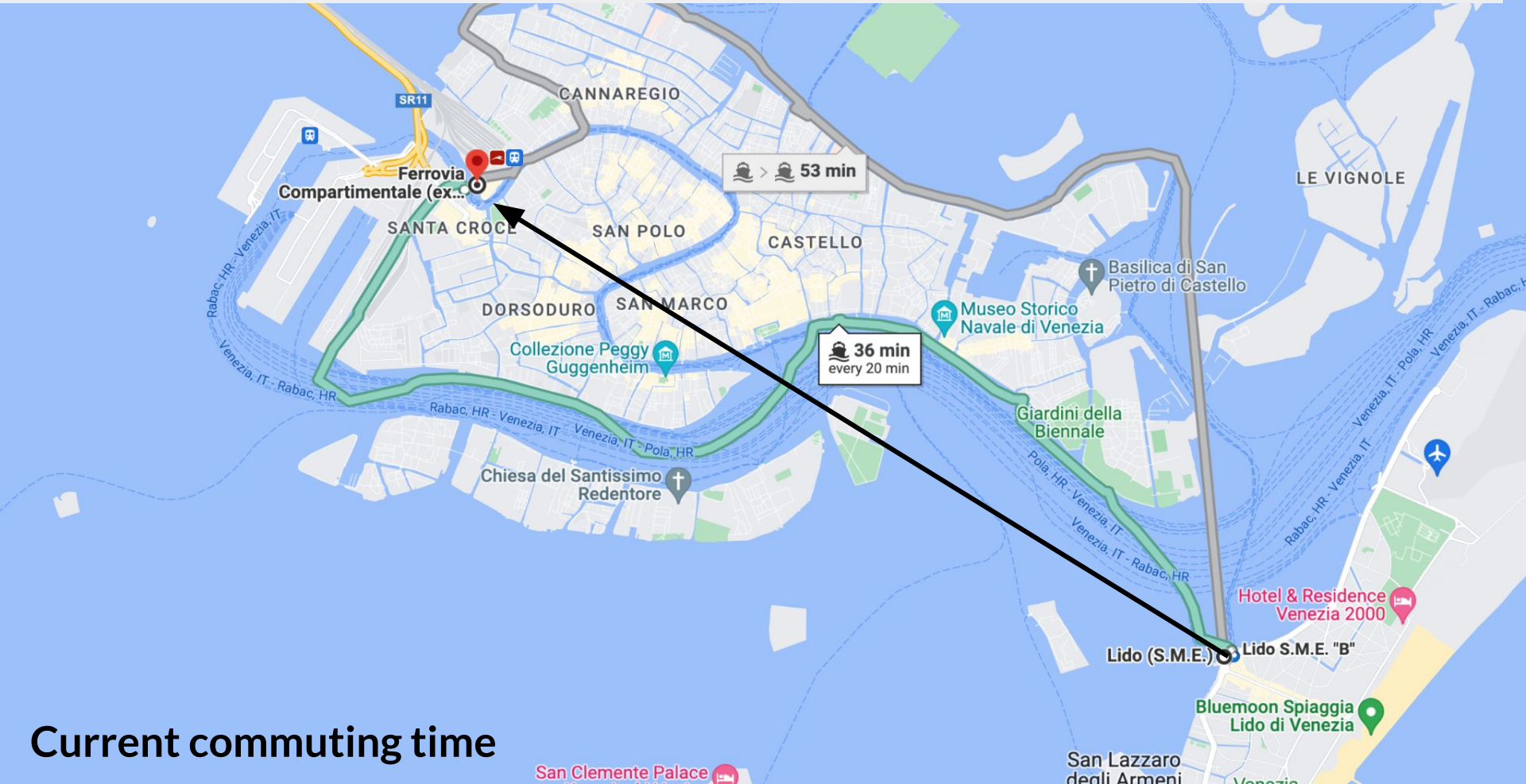
Palazzo del Casinò
Ferrovia/PzI Roma
Palanca/Zattere
S. Marco/ Giudecca
Sant'Elena/Lido S.M.E.
4'
3'
5'

Phase1



Sant'Elena/Lido S.M.E.

Connecting Ferrovia/Pzl Roma/Tronchetto to Lido S.M.E.



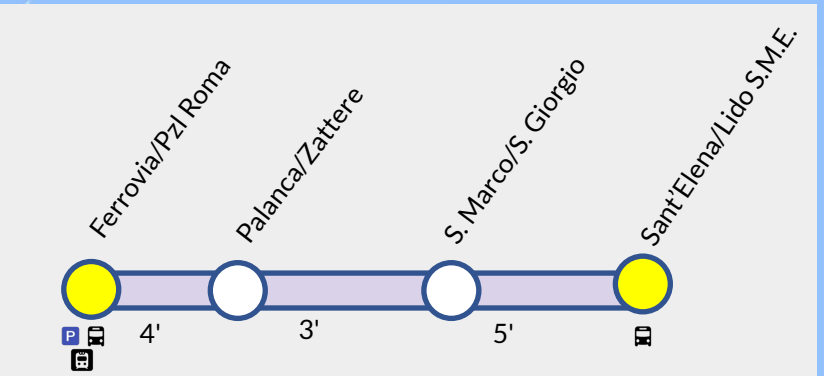
Current commuting time

Ferrovia/Pzl Roma/Tronchetto

Current time: 36 minutes

Total time: 12 minutes

Phase 1



Sant'Elena/Lido S.M.E.

Phase 2

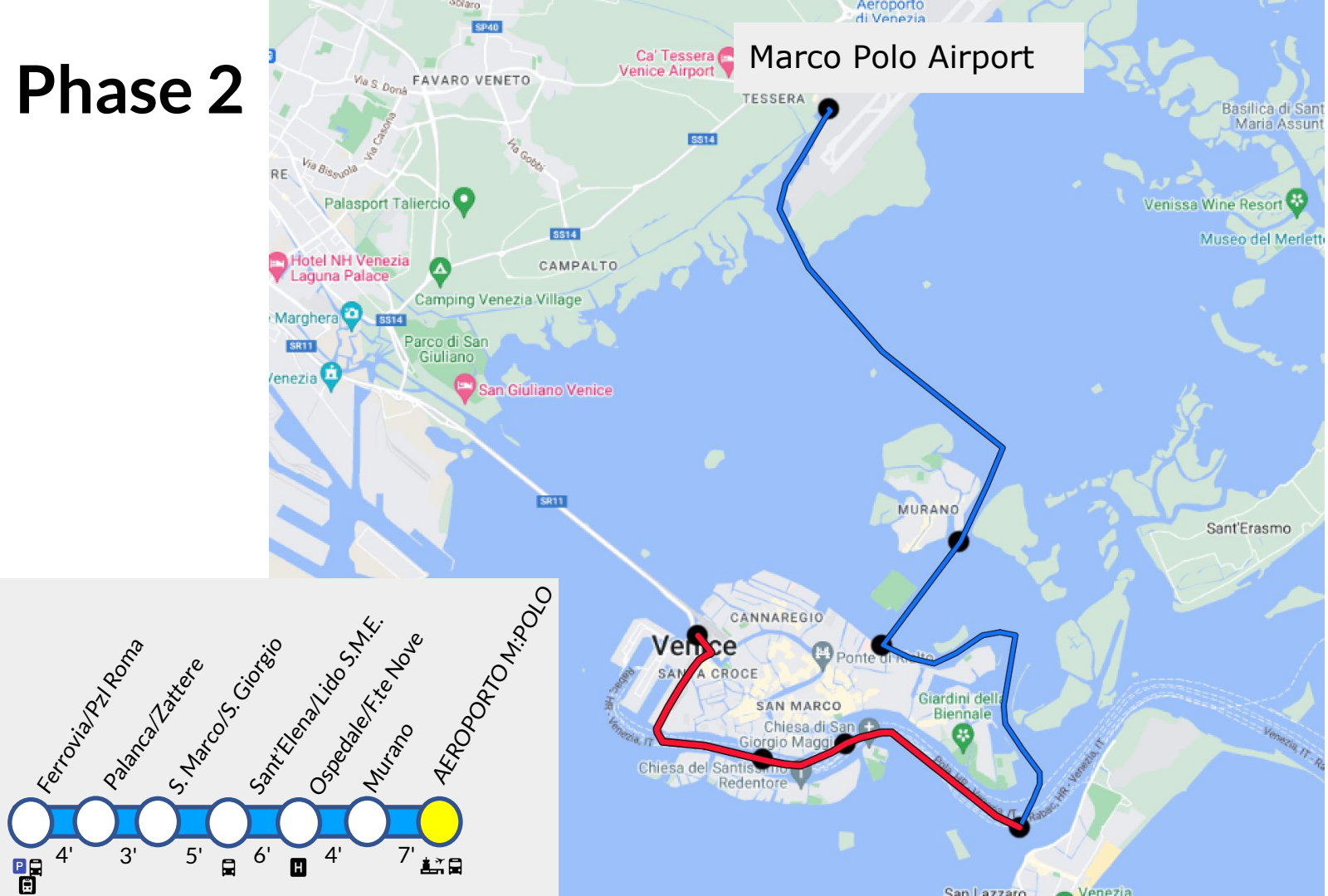
Ospedale/F.te Nove

Phase 2

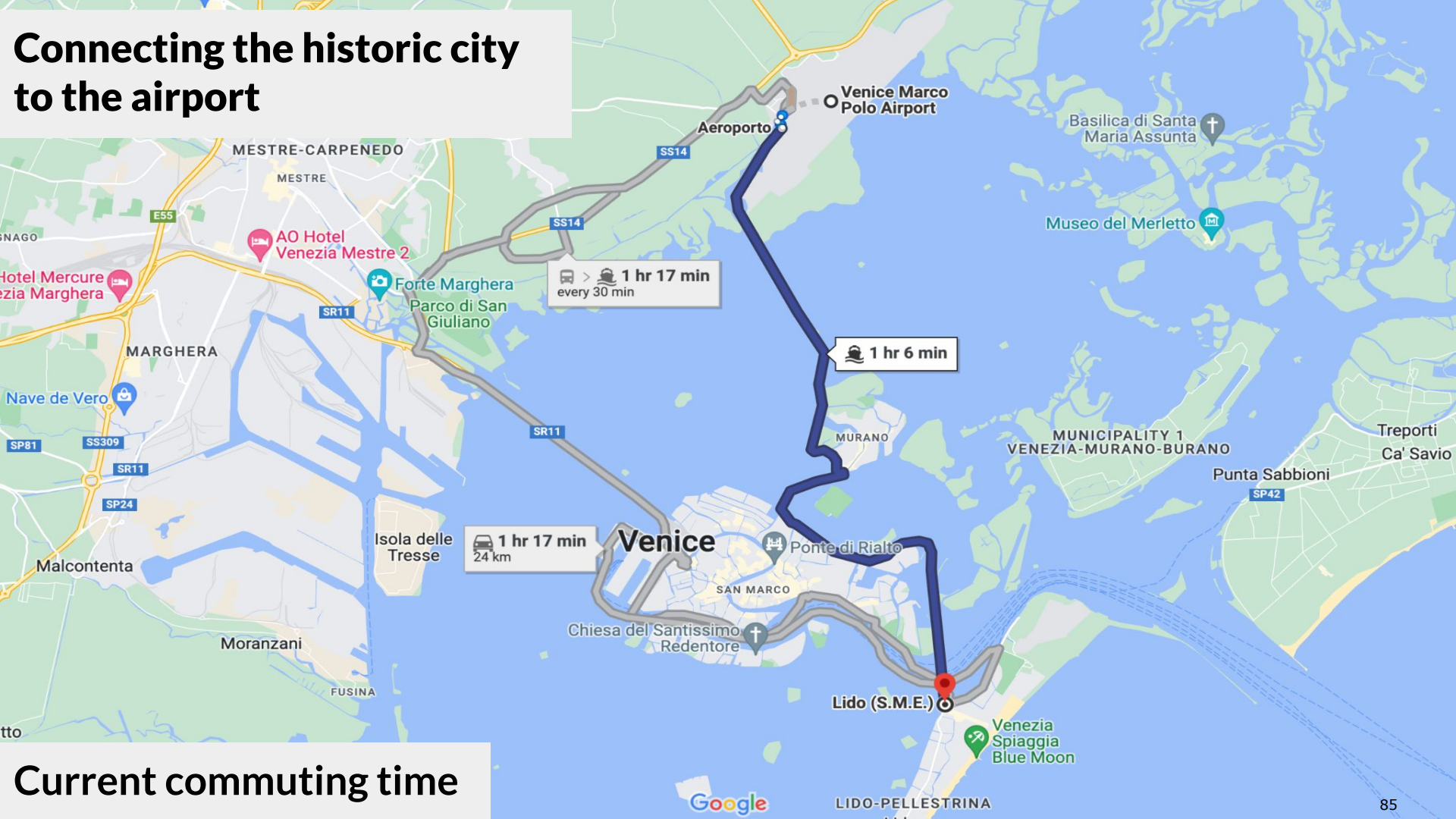

Ferrovia/PzlRoma
Palanca/Zattere
S. Marco/S. Giorgio
Sant'Elena/Lido S.M.E.
Ospedale/F.te Nove
Murano
AEROPORTO M:POLO
4'
3'
5'
6'
4'
7'

Aeroporto di Venezia Marco Polo
Ca' Tessera Venice Airport
TESSERA
FAVARO VENETO
Palasport Taliercio
Hotel NH Venezia Laguna Palace
CAMPALTO
Camping Venezia Village
Parco di San Giuliano
San Giuliano Venice
Marghera
Venezia
Basilica di Sant Maria Assunt
Venissa Wine Resort
Museo del Merlett
MURANO
Sant'Erasmo
Murano
CANNAREGIO
Venice
SAN MARCO
Chiesa di San Giorgio Maggi
Chiesa del Santissimo Redentore
Giardini della Biennale
San Lazzaro
SS14
SR11
SP40

Phase 2


Marco Polo Airport
TESSERA
Ca' Tessera
Venice Airport
FAVARO VENETO
Palasport Taliercio
Hotel NH Venezia
Laguna Palace
CAMPALTO
Camping Venezia Village
Marghera
Parco di San
Giuliano
San Giuliano Venice
MURANO
Sant'Erasmo
Venissa Wine Resort
CANNAREGIO
Venice
SAN MARCO
Giardini della
Biennale
Chiesa di San
Giorgio Maggi
Chiesa del Santissimo
Redentore
Ferrovia/P.zl Roma
Palanca/Zattere
S. Marco/S. Giorgio
Sant'Elena/Lido S.M.E.
Ospedale/F.te Nove
Murano
AEROPORTO M.POLO
4'
3'
5'
6'
4'
7'

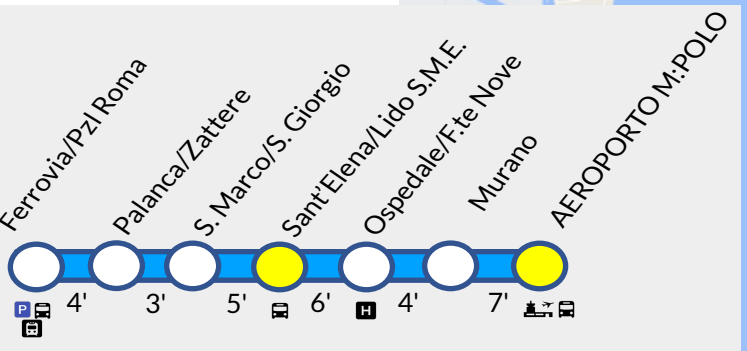
Connecting the historic city to the airport



Current commuting time

Current Time: 1 hr 06 minutes

Total Time: 17 minutes

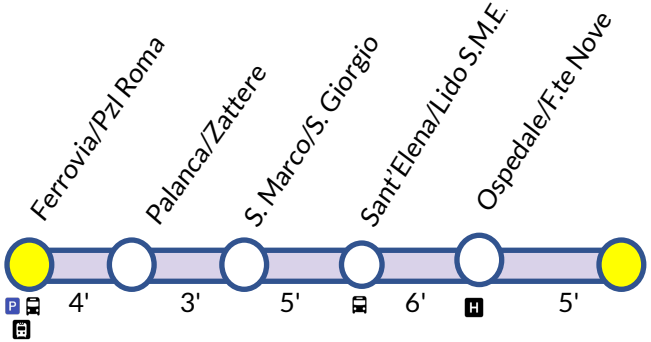


Marco polo Airport

Sant'Elena/Lido S.M.E.

Phase 2

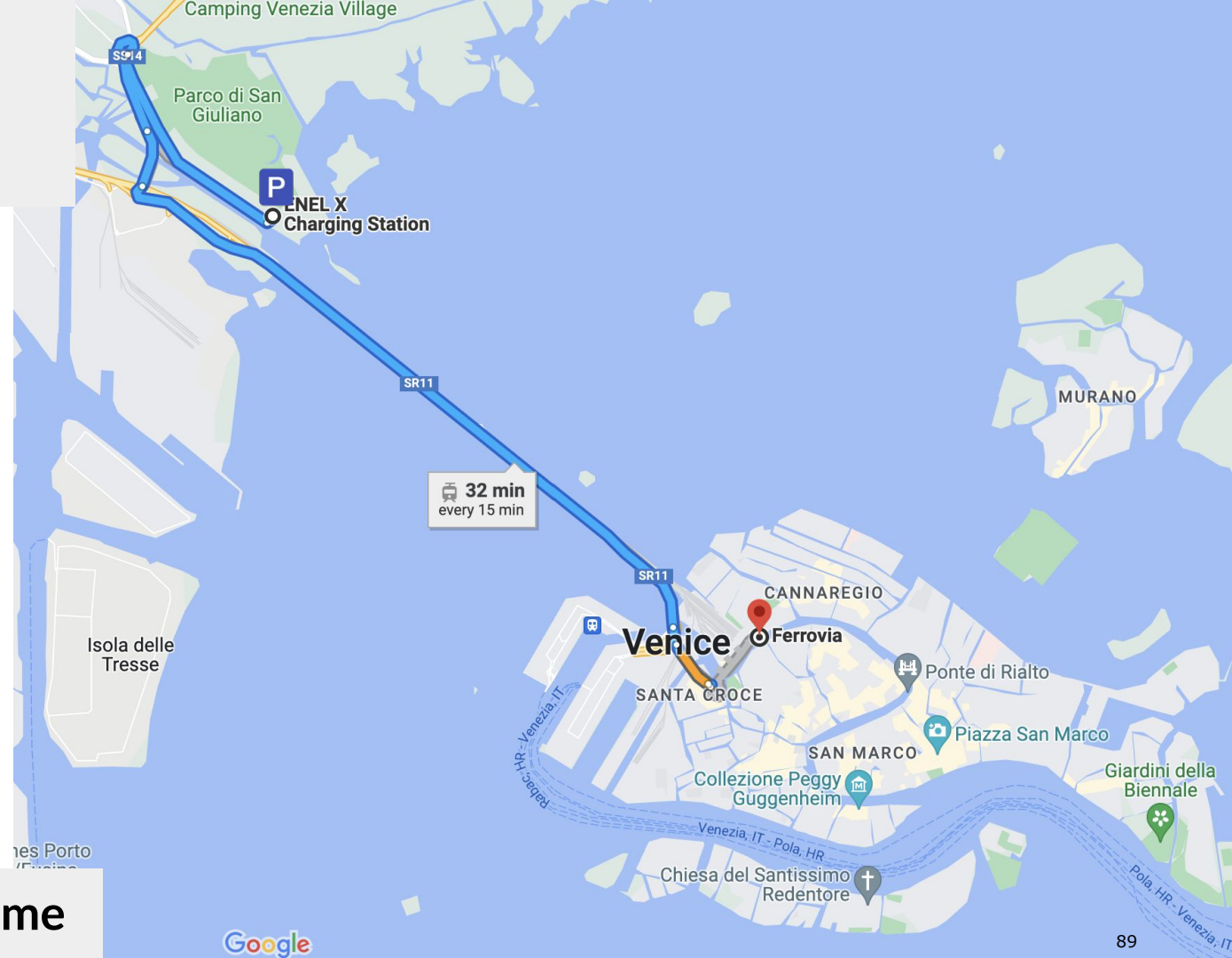
Total Time loop 23 minute



Phase 3


FAVARO VENETO
TESSERA
SS14
SS14
CAMPALTO
MURANO
Venice
SAN MARCO
Chiesa del Santissimo Redentore

Connecting San Giuliano to the historic city

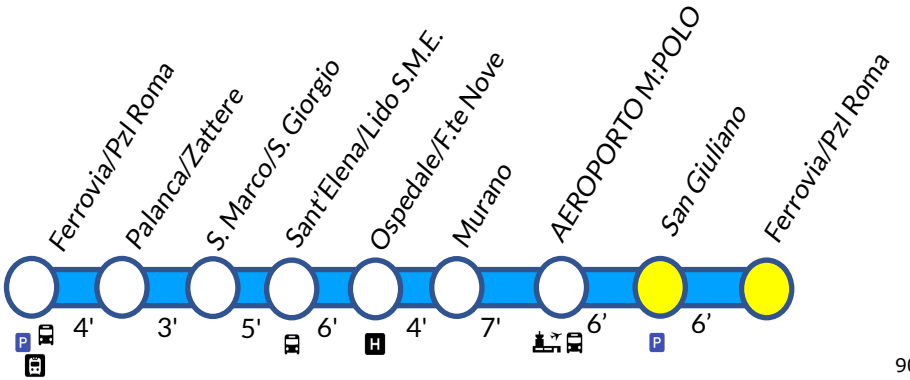


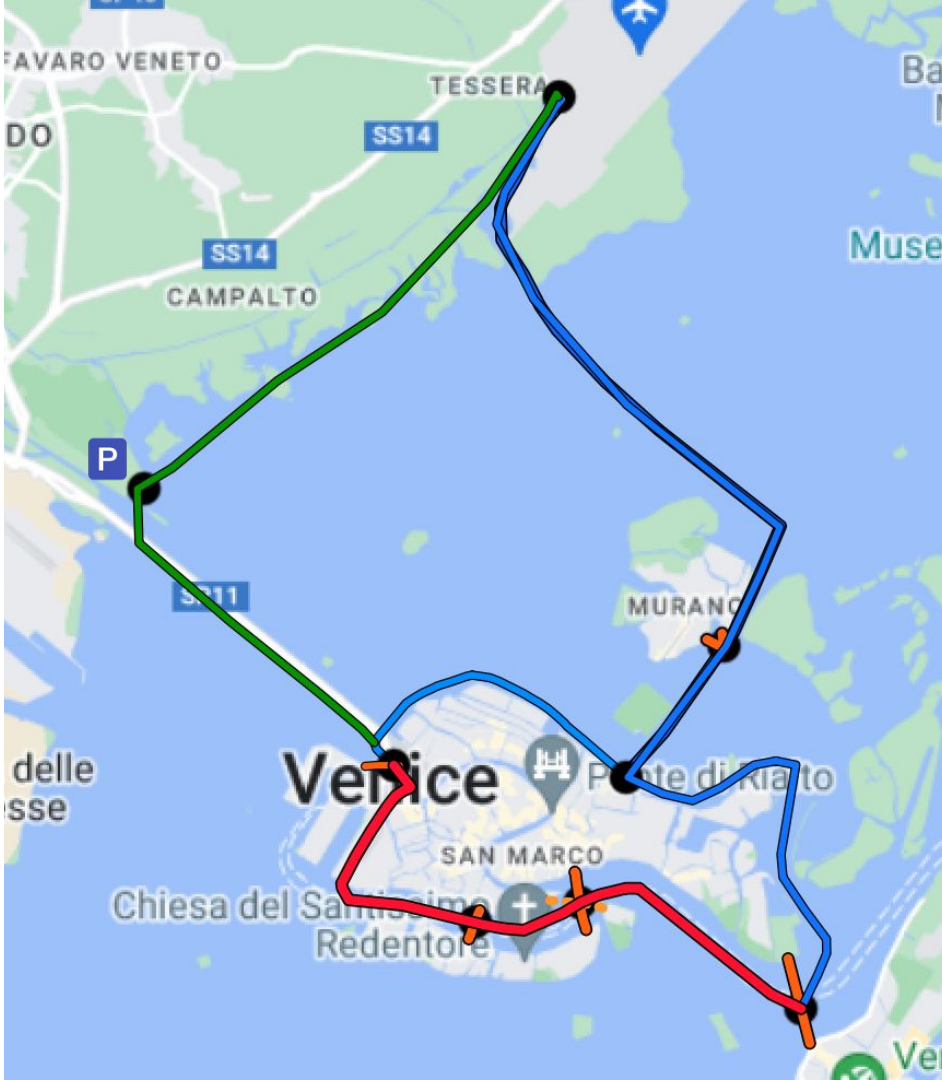
Current commuting time

Phase 3

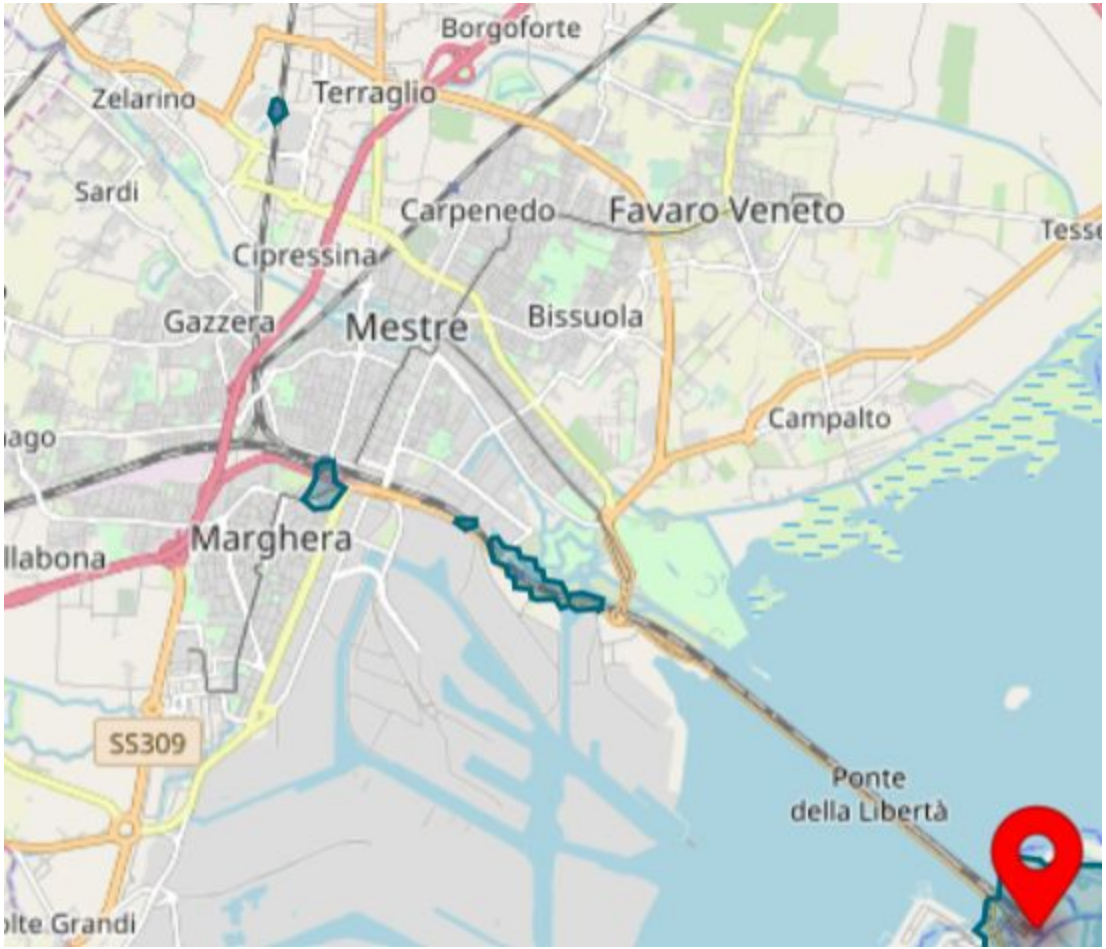
Current time: 32 minutes

Total Time: 6 minutes



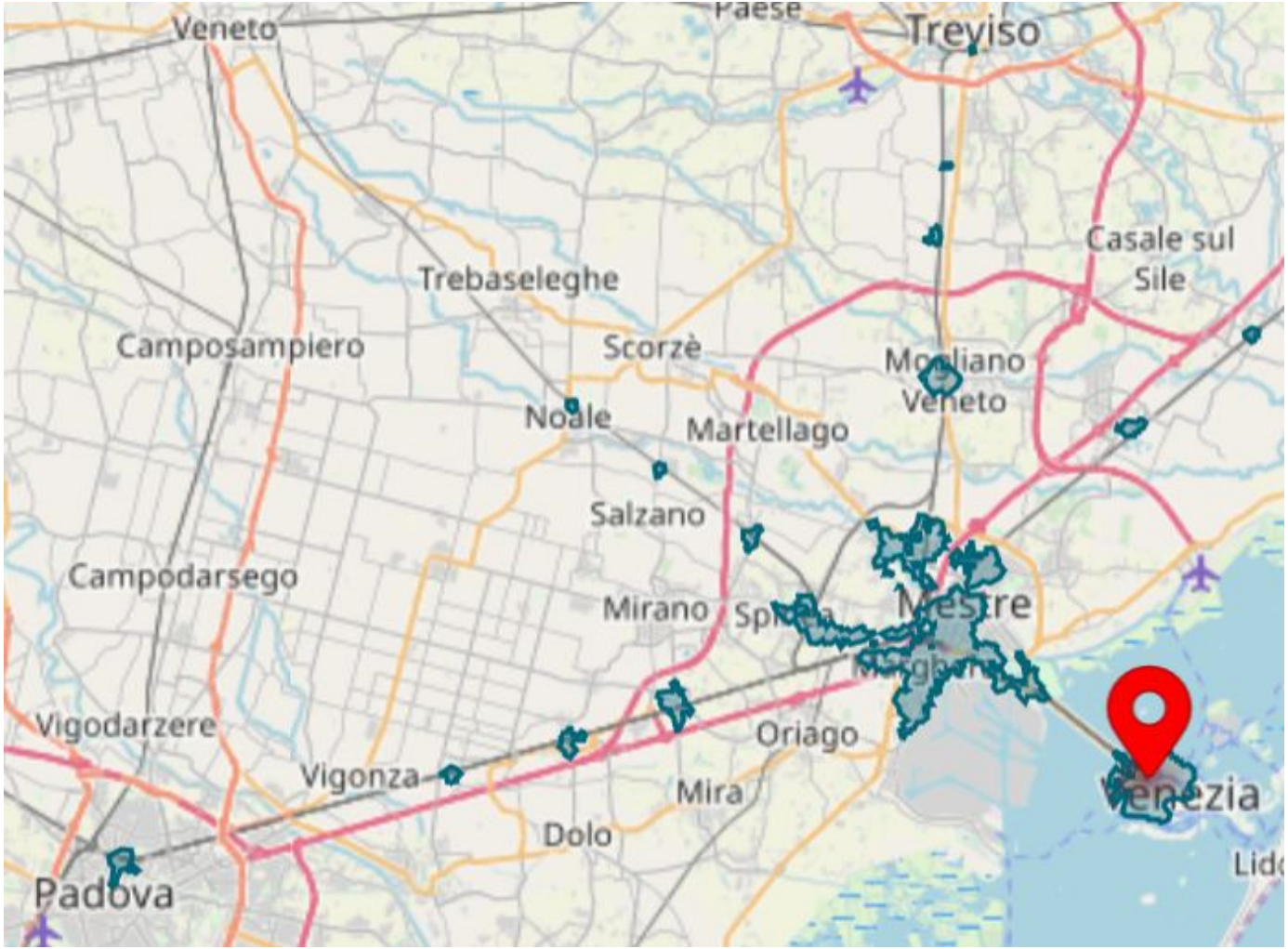


Most Venetians aren't commuting >15 minutes on the mainland



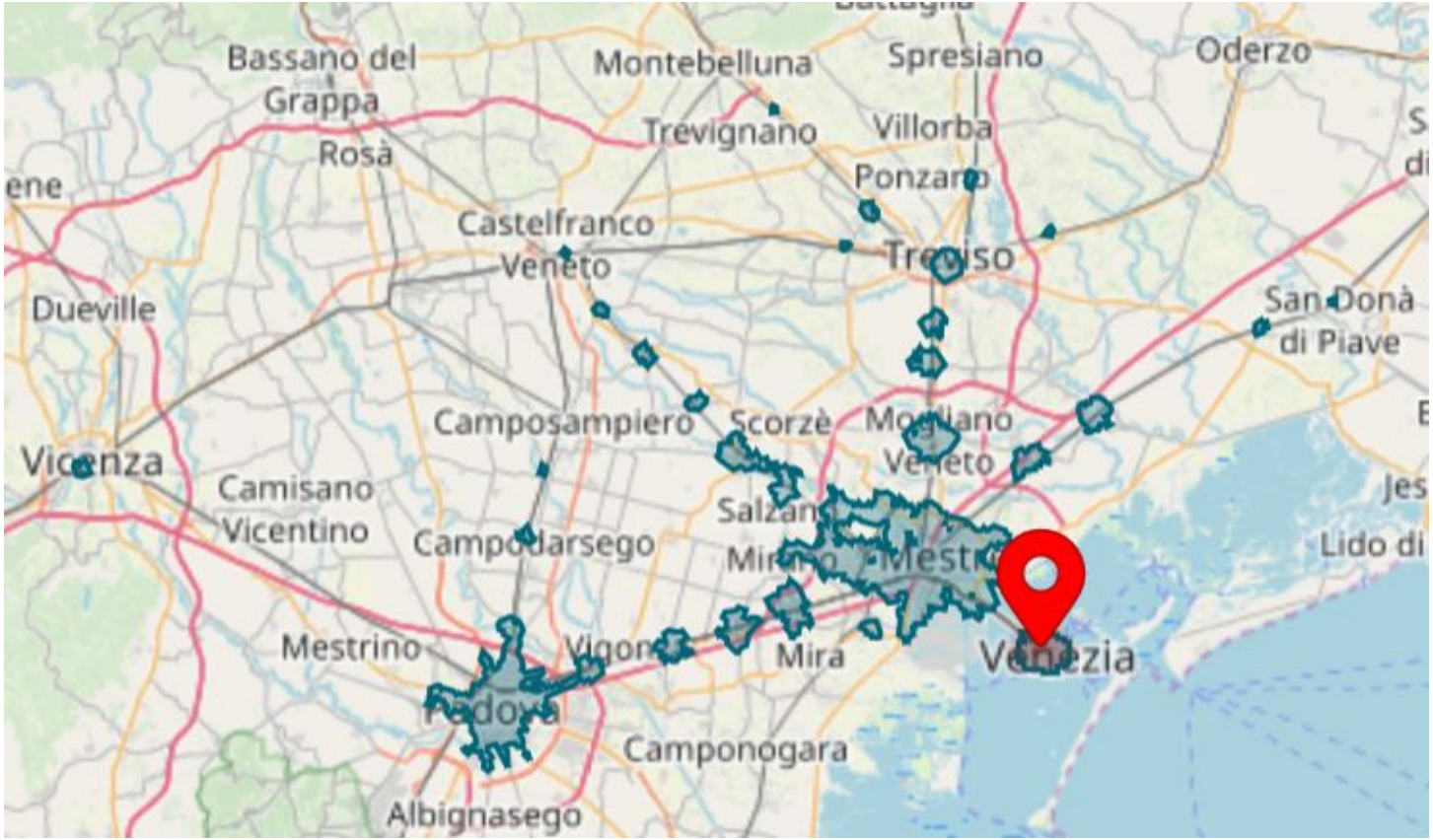
Highlighted areas are reachable within 15 minutes from Ferrovia

Some Venetians commute up to 30 minutes on the mainland



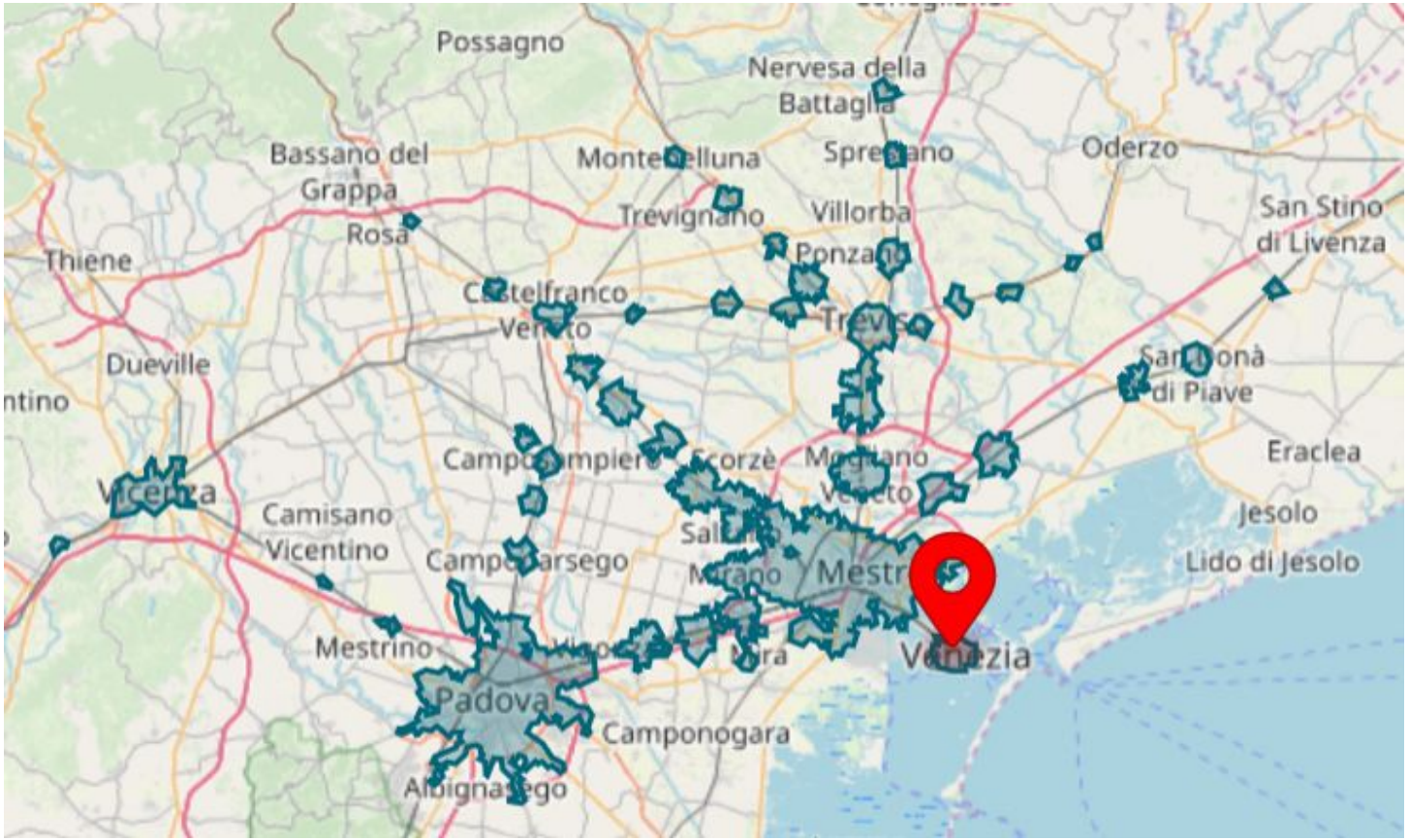
Highlighted areas are reachable within 30 minutes from Ferrovia

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

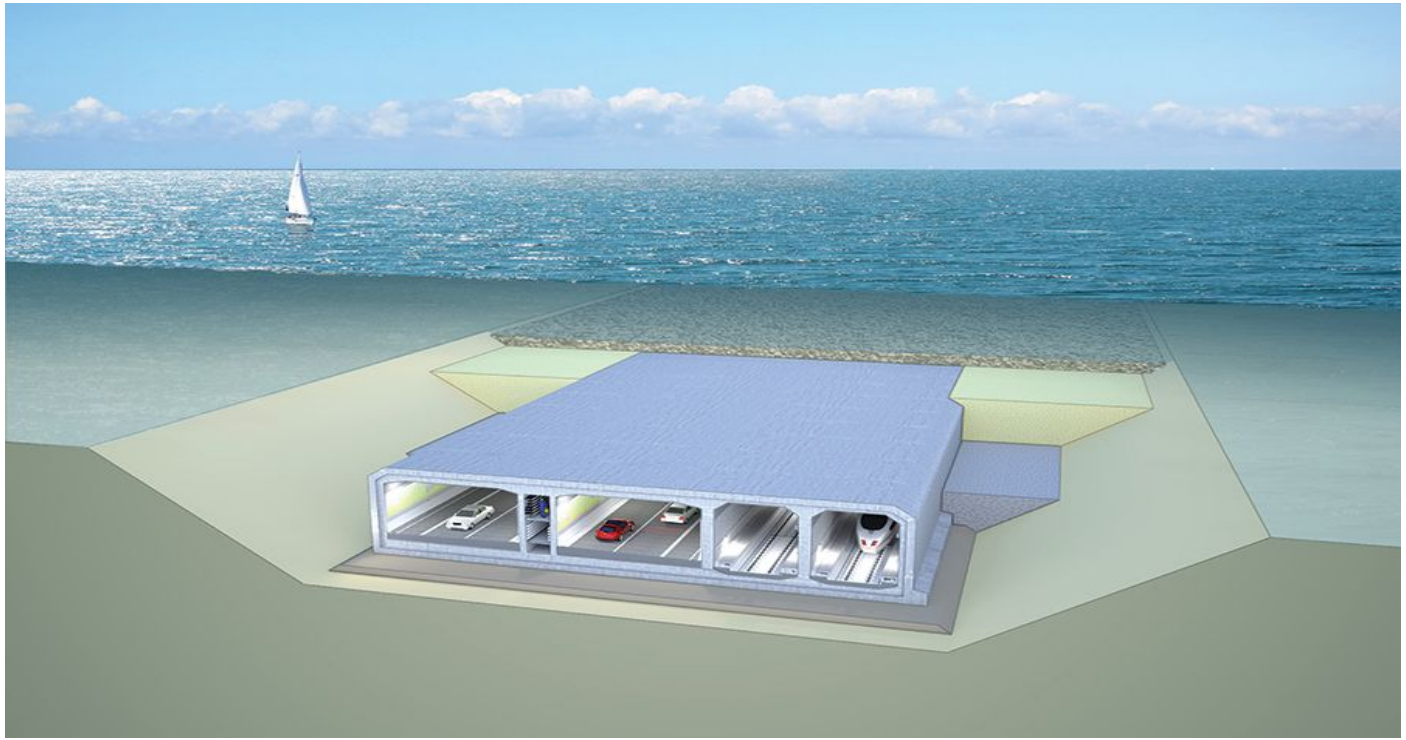
…and would be able to reach even more jobs within a 60+ minute commute



Highlighted areas are reachable within 60 minutes from Ferrovia

How do we build an underground subway?

The Immersed Tube Tunnel construction method will be the cheapest for a *sublagunare* in Venice



MOSE used the Immersed Tube Tunnel method

MOSE Venezia

MOSE's immersed tunnels are located at three ports on the eastern side of the Venetian Lagoon

MOSE Venezia

The trains used in the new Milan subway system, which could also be used in Venice, 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**

Potential future phase

Benefits to having a *sublagunare*

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

MOBILITY

Venice Project Center REPOSITORIES

Mobility Timeline

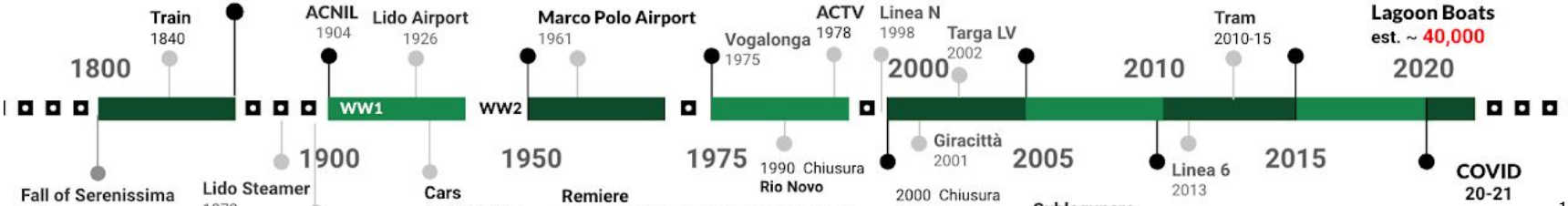
Row boats
Personal and cargo transportation was primarily by row boats until WWII. Until 1840, arriving in Venice entailed a gondola ride from Mestre

Steam Boats
Vaporetti provided steam-powered public transportation from 1900 until 1945

Motor boats
WWII brought widespread use of gasoline and diesel -powered motors in the general population. Taxis and cargo boats were first

Plastic boats
Since the 1980's gradually more and more boats were made of plastic, leaving only a niche market for traditional wooden boats

Electric/Hybrid boats
The first ACTV electric passenger boat debuted in 1996. In 2017, Alilaguna introduces *Scossa*, a hybrid passenger boat. Several entrepreneurs began developing electric/hybrid systems applicable in Venice



Remiere
With the demise of row boats as the main means of transportation of people and cargo, rowing became a leisure activity promoted

Sublagunare
The proposal of a subway system under the lagoon began anew in the early 2000's. Many alternatives were

Thank you!

Contact us at

ve22.mobi@gmail.com

gr-ve22-mobi@wpi.edu

https://sites.google.com/view/ve22-mobi/home?authuser=9

Tyler Brown, Emmaline Raven, Raul Villalobos

Cargo transportation is divided into two categories :

Conto proprio

Conto terzi

Proprio (Own) licenses are for those who are transportation goods for their own businesses

source

Conto Terzi (third parties) are licenses for transporting things on behalf of third parties

Currently: 410 authorizations

Villalobos, 2022

Unit load products are raw materials, heavy machinery, and construction materials

Refrigerated products are one type of cargo product delivered to Venice

total capacity of refrigerated cargo 293 m³

Dry products are one type of cargo product delivered to Venice

The total volume of dry cargo is 6278 m^3

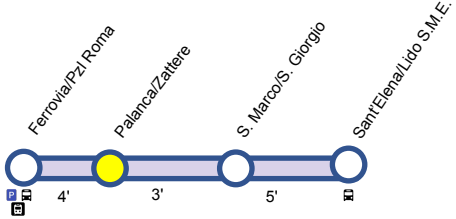
Dry and refrigerated products are delivered to the businesses by cargo dolly

Villalobos, 2022

1
1
1

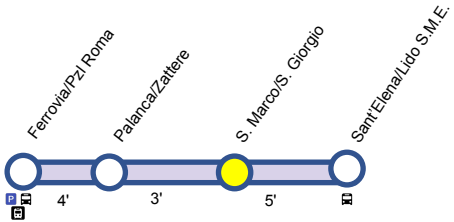
Palanca/Zattere

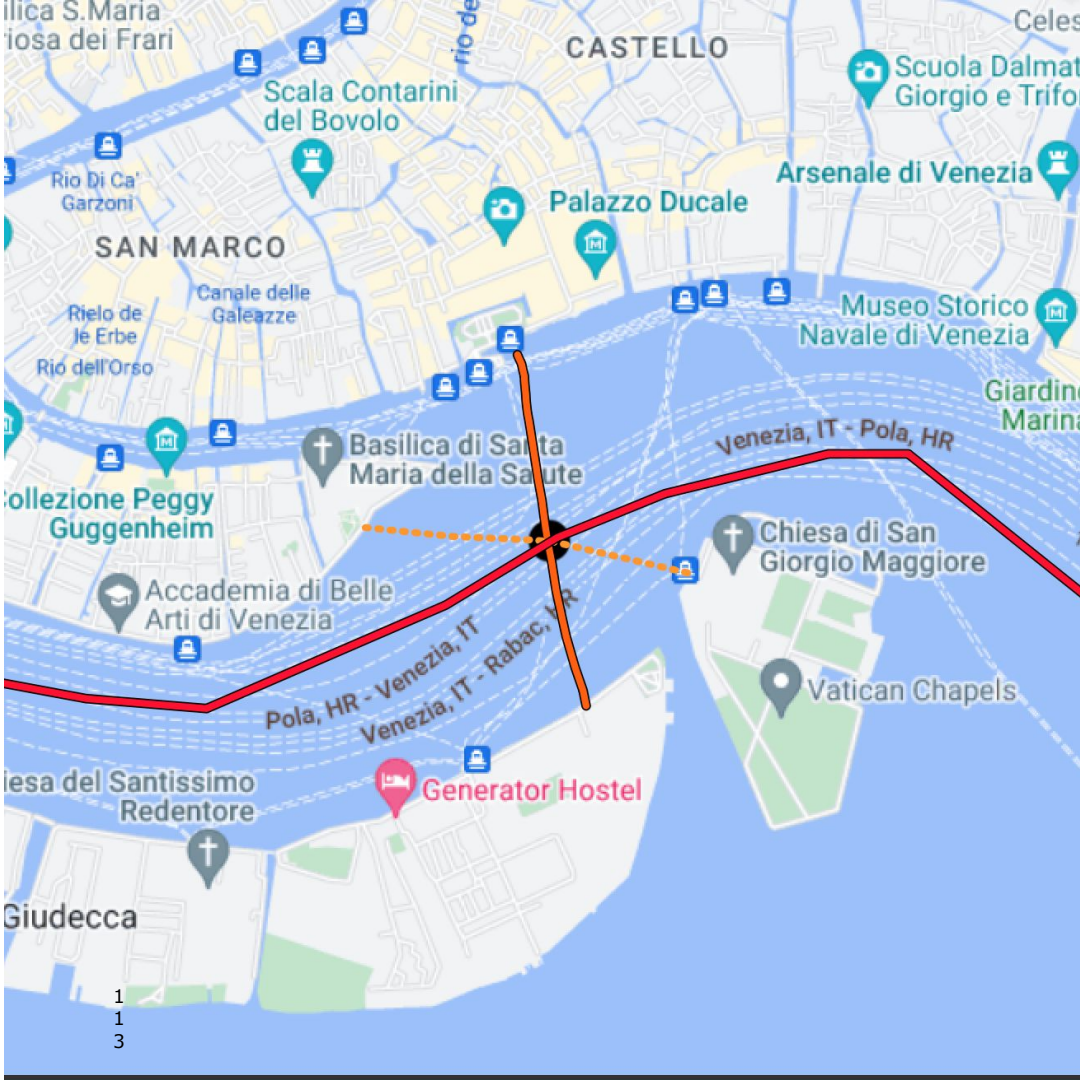
- Pedestrian tunnel between central Giudecca Palanca and Zattere
- Zattere is near universities and the Accademia Bridge



S. Marco/S. Zaccaria/ S. Giorgio

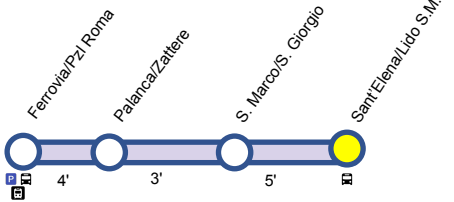
- Pedestrian tunnel between East Giudecca and San Marco.
- One of the most visited sestieri.
- Piazza San Marco and the Basilica di San Marco

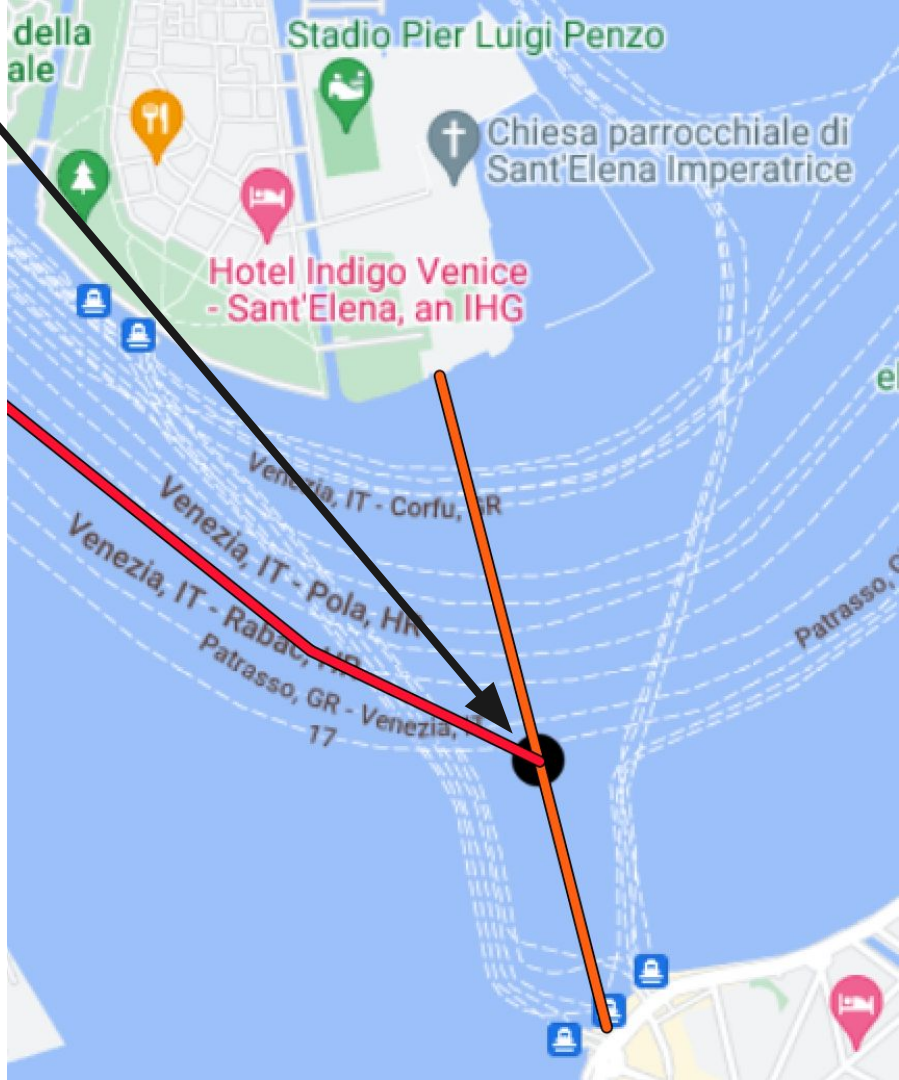




Stop Rationale: Sant'Elena/Lido S.M.E.

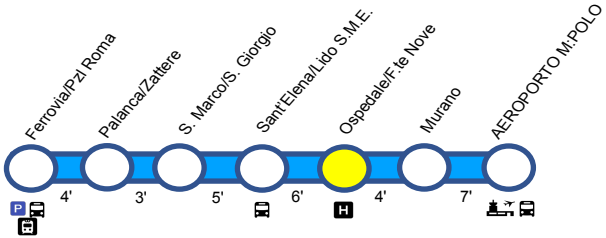
- Pedestrian tunnel between Lido and S.Elena
- Home to nearly 20,000 residents
- Lido is an 11 km-long area and it is considered the city's beach

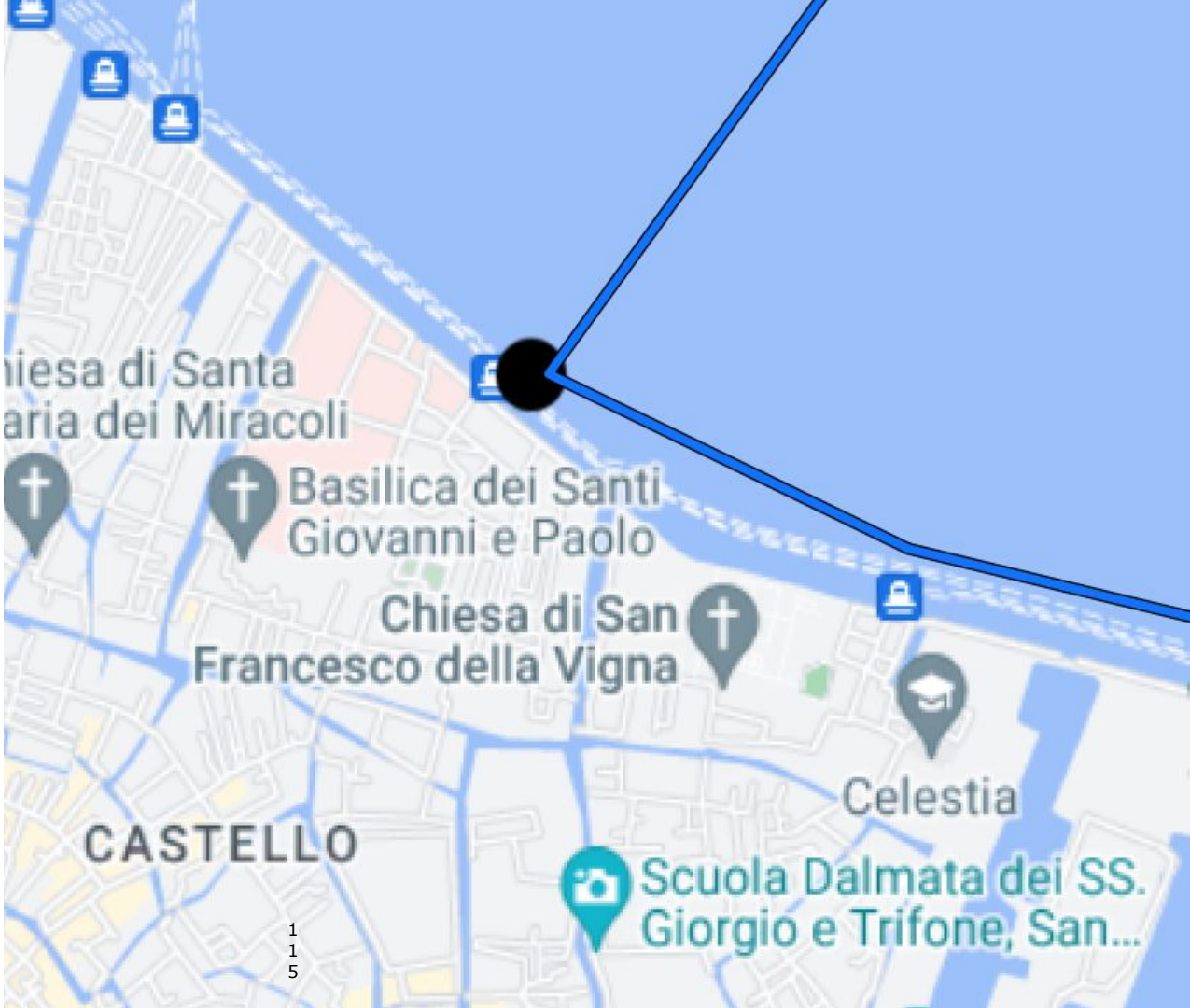




Ospedale/F.te Nove

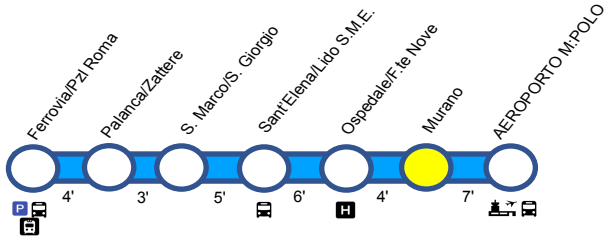
- Accessibility for healthcare workers, and patients.

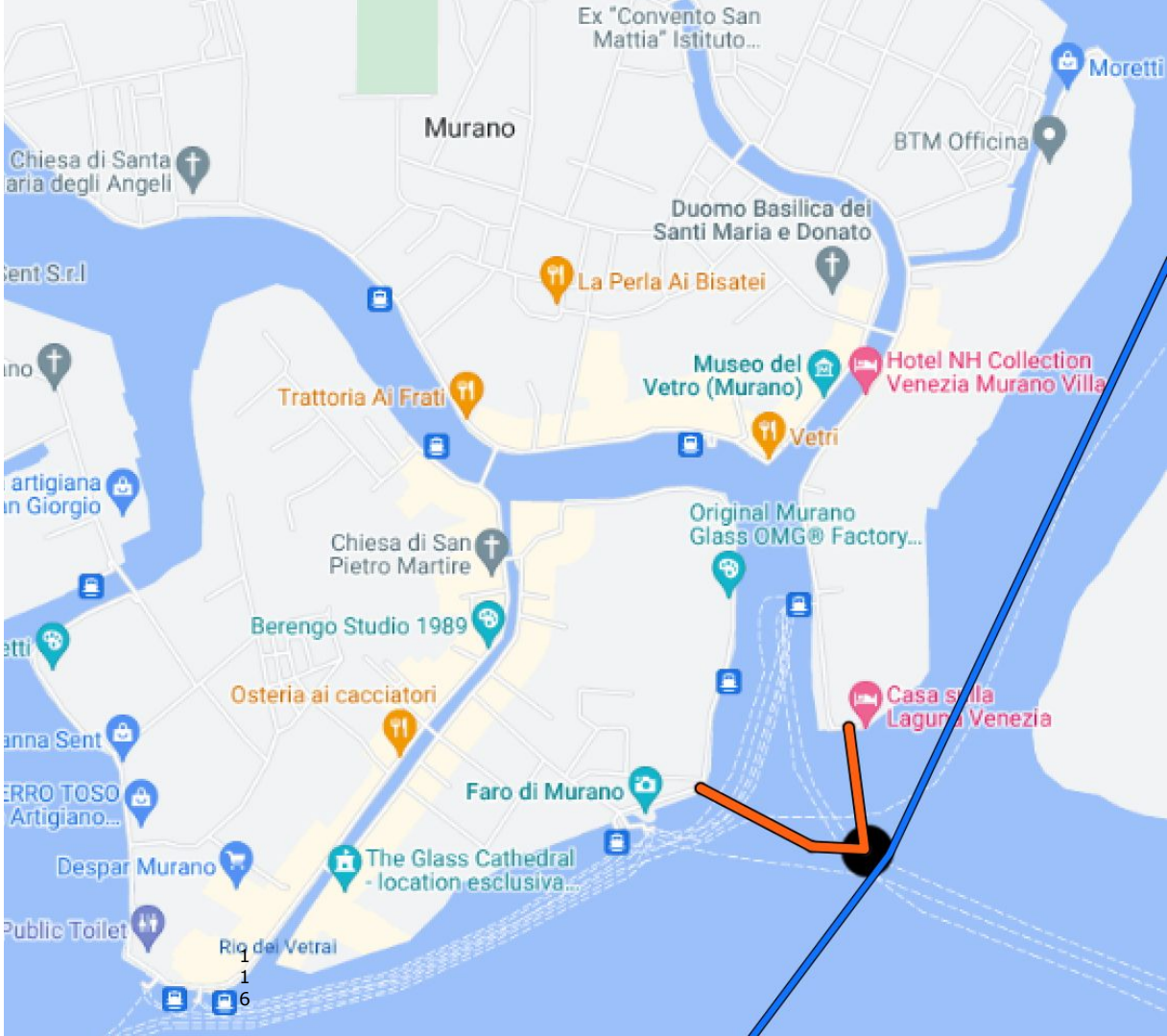


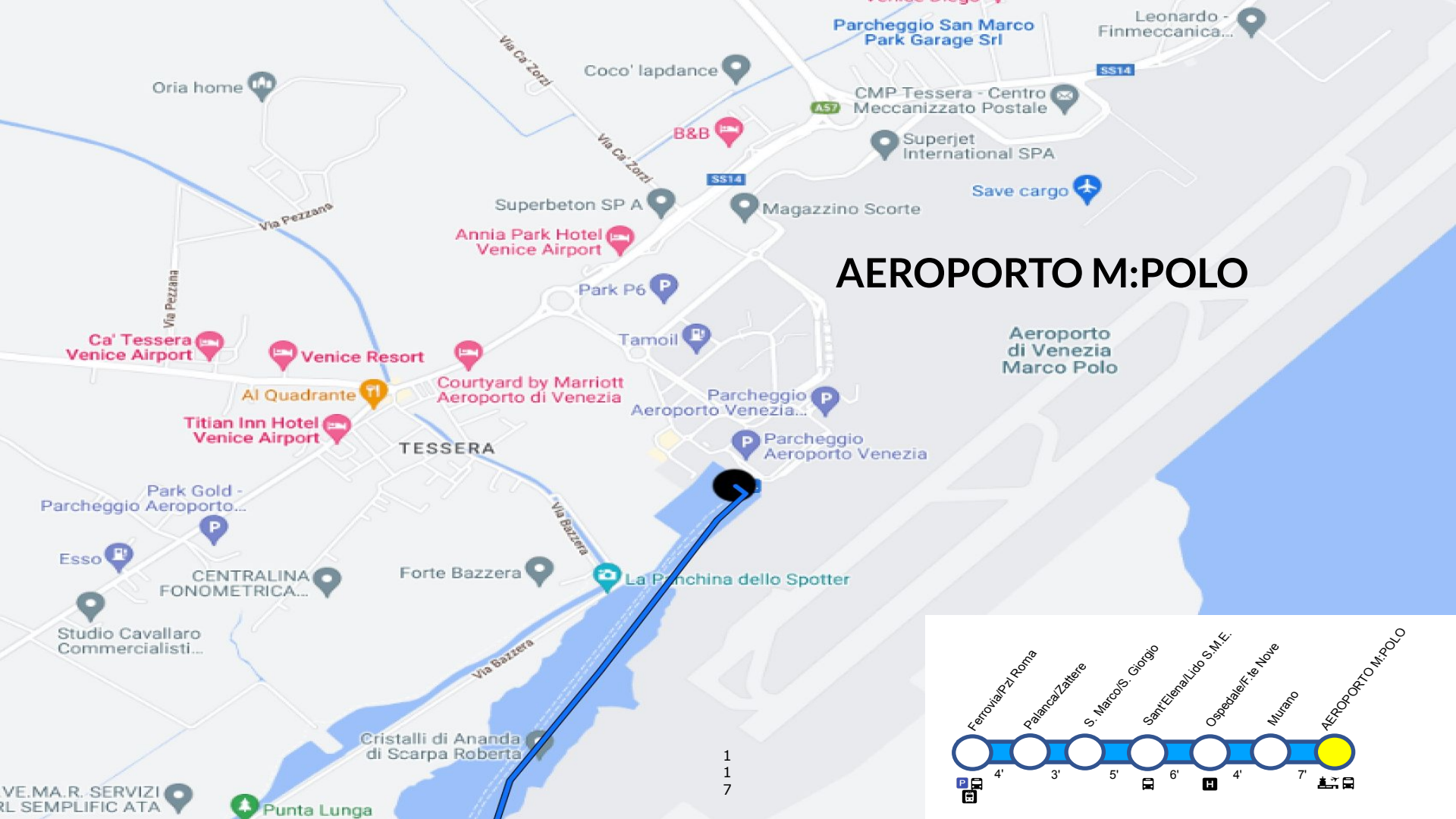


Murano

- Accessibility for residents, workers and tourists.
- Murano's population is about 4,506 as 2011.





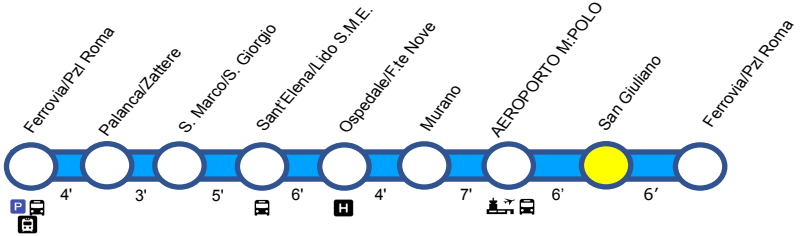

AEROPORTO M:POLO
Parcheggio San Marco
Park Garage Srl
Leonardo -
Finmeccanica...
Coco' lapdance
Oria home
CMP Tessera - Centro
Meccanizzato Postale
B&B
Superjet
International SPA
Save cargo
Superbeton SP A
Magazzino Scorte
Annia Park Hotel
Venice Airport
Park P6
Tamoil
Aeroporto
di Venezia
Marco Polo
Ca' Tessera
Venice Airport
Venice Resort
Courtyard by Marriott
Aeroporto di Venezia
Al Quadrante
Titian Inn Hotel
Venice Airport
TESSERA
Parcheggio
Aeroporto Venezia...
Parcheggio
Aeroporto Venezia
Park Gold -
Parcheggio Aeroporto...
Esso
CENTRALINA
FONOMETRICA...
Forte Bazzera
Studio Cavallaro
Commercialisti...
Cristalli di Ananda
di Scarpa Roberta
VE.MA.R. SERVIZI
RL SEMPLIFIC ATA
Punta Lunga
Via Ca' Zorzi
Via Pezzana
Via Bazzera
SS14
A57
Ferrovia/P.zl Roma
Palanca/Zaltere
S. Marco/S. Giorgio
Sant'Elena/Lido S.M.E.
Ospedale/F.te Nove
Murano
AEROPORTO M:POLO
4'
3'
5'
6'
4'
7'

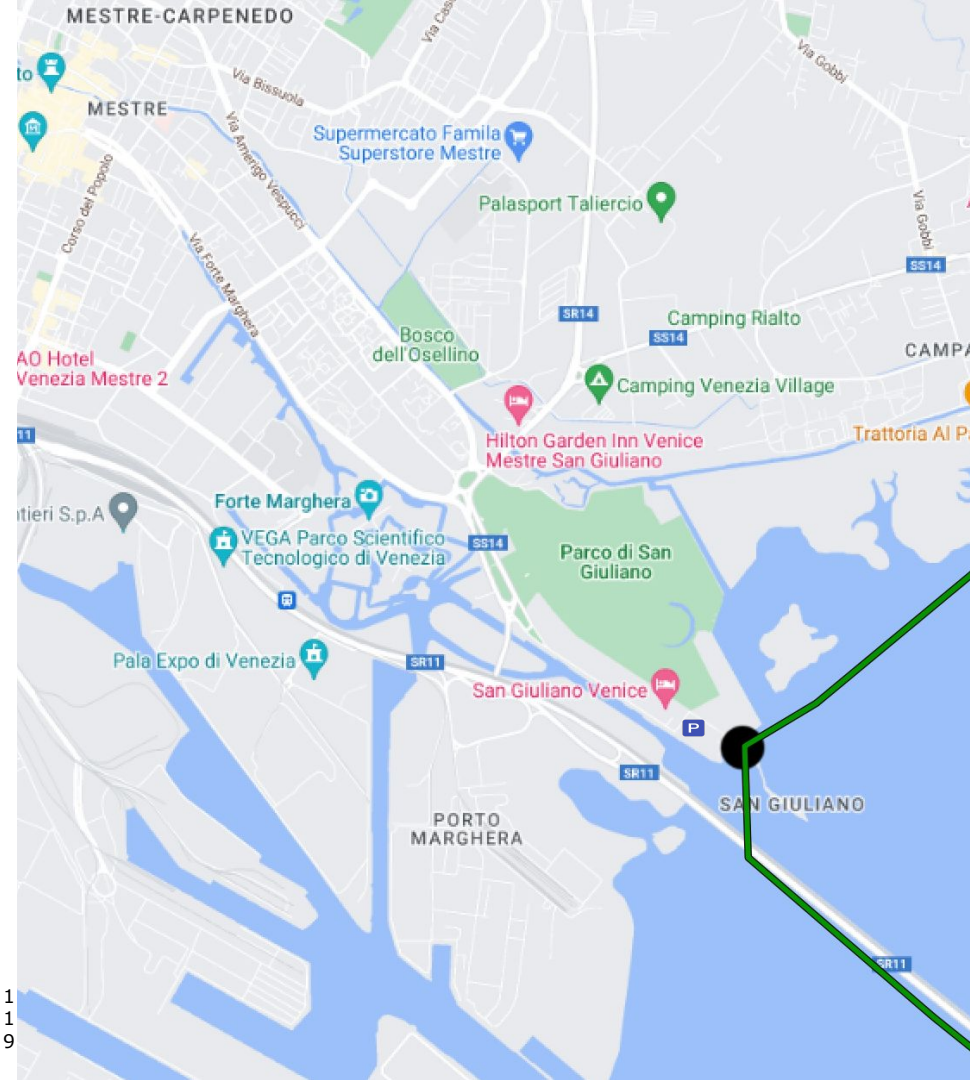
1
1
7


TESSERA
SS14
TRE-CARPENEDO
MESTRE
SS14
CAMPALTO
Marghera
SR11
SR11
Basilica di Santa Maria Assunta
Museo del Merletto
Total Time loop 23 minute
MURANO
Punta Sabbioni
Isola delle Tresse
Venice
SAN MARCO
Chiesa del Santissimo Redentore
FUSINA
1
1
8
Ferrovia/P.zl Roma
Palanca/Zattere
S. Marco/S. Giorgio
Sant'Elena/Lido S.M.E.
Ospedale/F.te Nove
4'
3'
5'
6'
5'

Villalobos

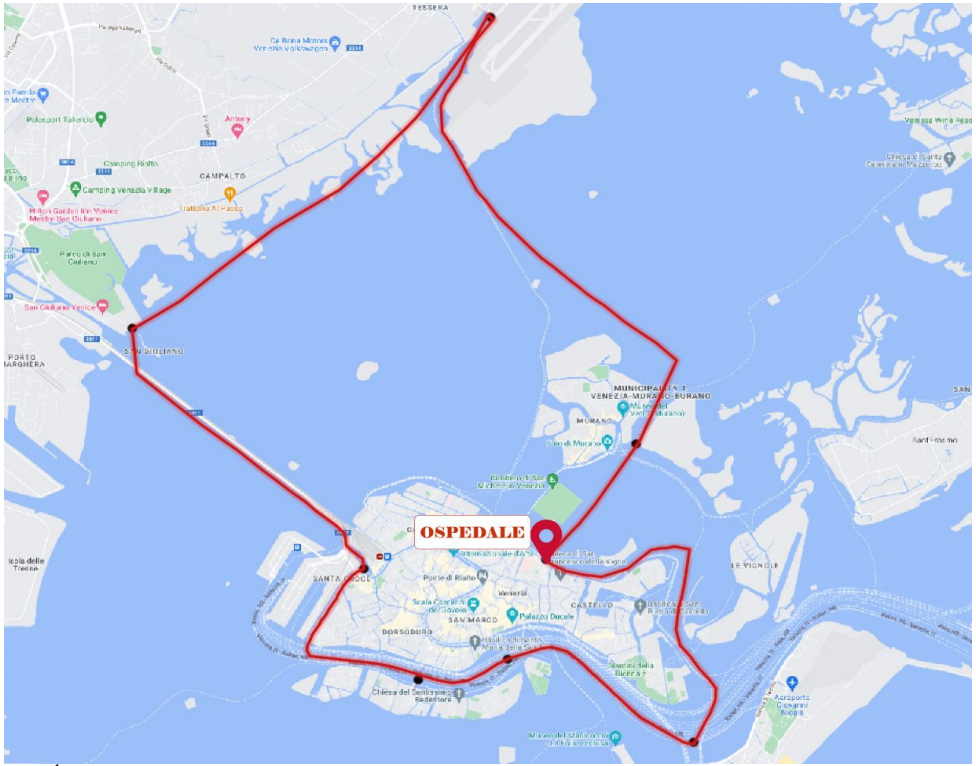
San Giuliano





Stop Rationale: Ospedale

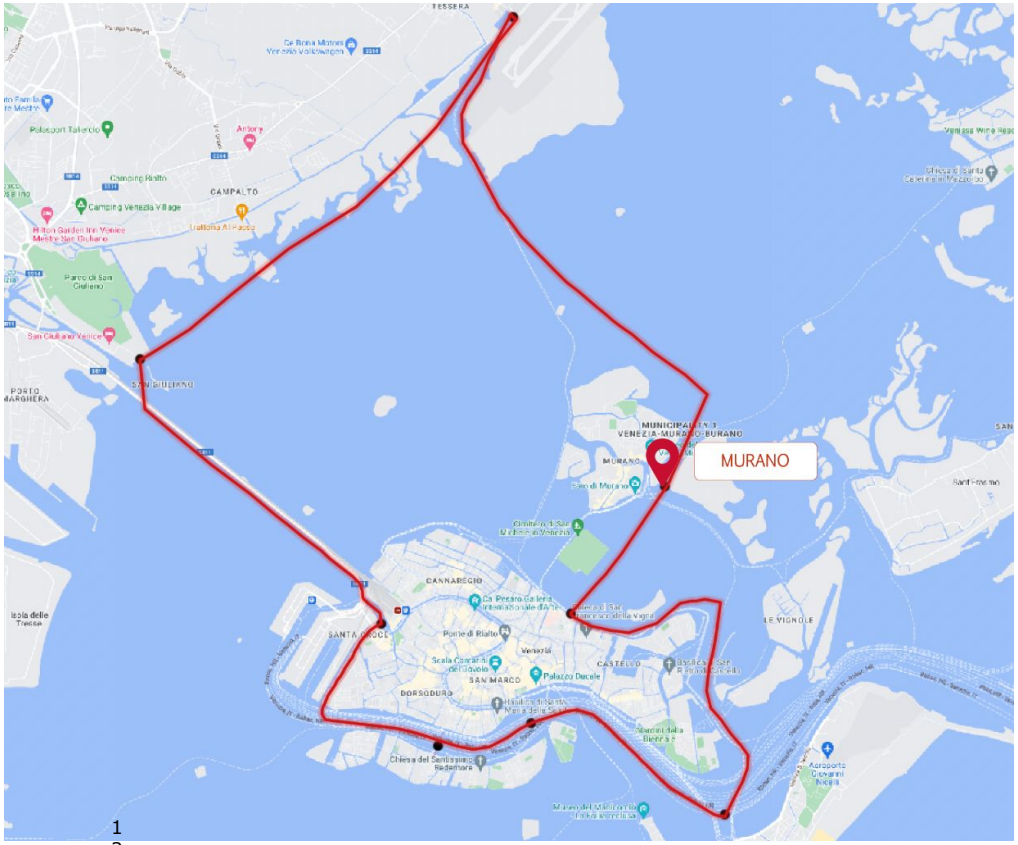
- Accessibility for healthcare workers, and patients.
- Castello is consider it as the working class area where the locals live and work



1
2
0

Stop Rationale: Murano

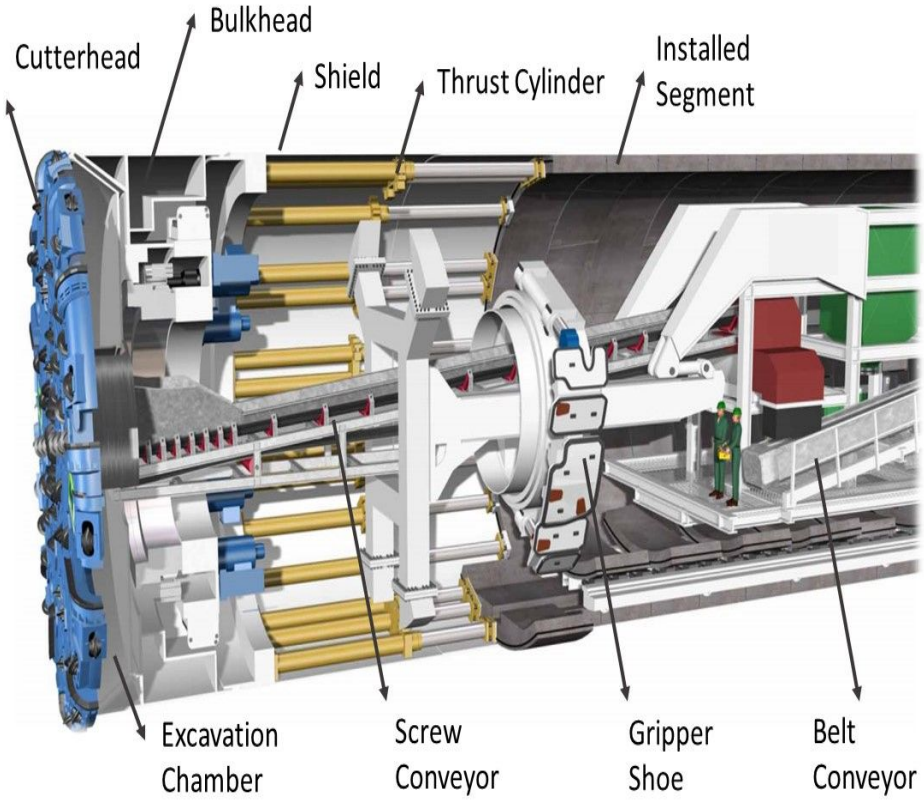
- Accessibility for residents, workers and tourists.
- Public transportation such as the Vaporetto takes longer around 40 - 60 minutes. Vaporetto stops all along the way around the island.
- Murano's population is about 4,506 as 2011.



Methods for building a *sublagunare in Venice*

- Tunnel Boring Machine (TBM)
- Immersed tunnel

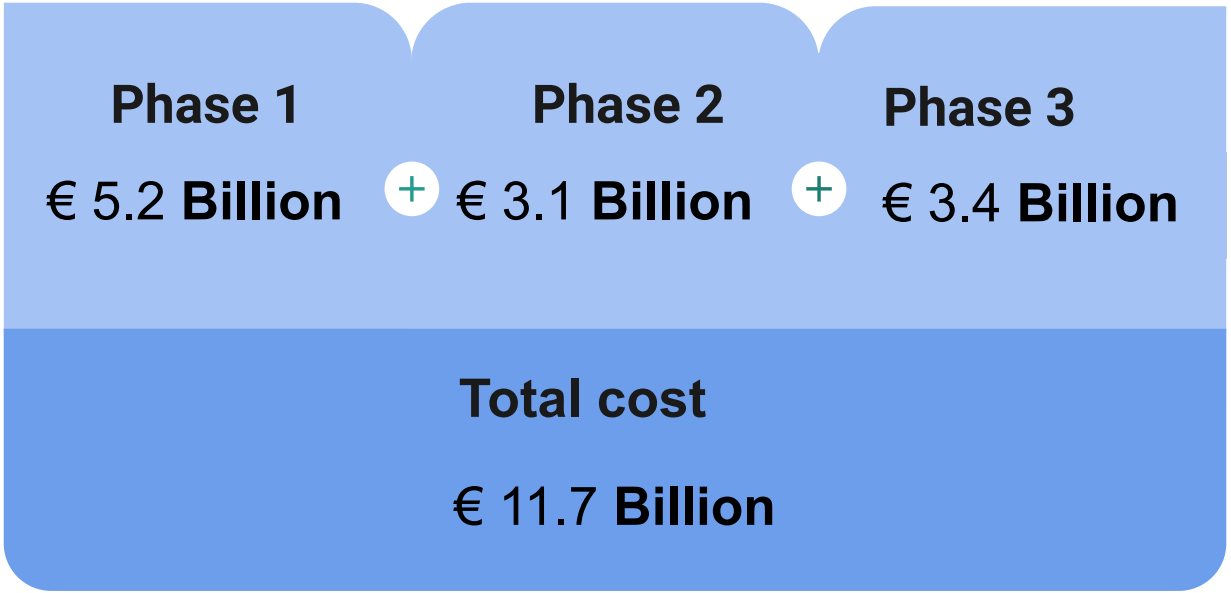
Tunnel Boring Machine (TBM)



Tunnel Boring Machine (TBM).

1
2
3

Based on previous projects, the estimated cost to build an underground subway system using the Boring Machine method is € 11.7 Billion



Immersed Tube Tunnel

Advantages	Disadvantages
• The **speed** of construction • Minimal disruption to the canal, if crossing a shipping route • **Safety** of construction (for example, work in a drydock as opposed to boring beneath a canal)	• on the lagoon bed, risking a sunken ship/anchor strike • Direct contact with water necessitates careful waterproofing design around the joints

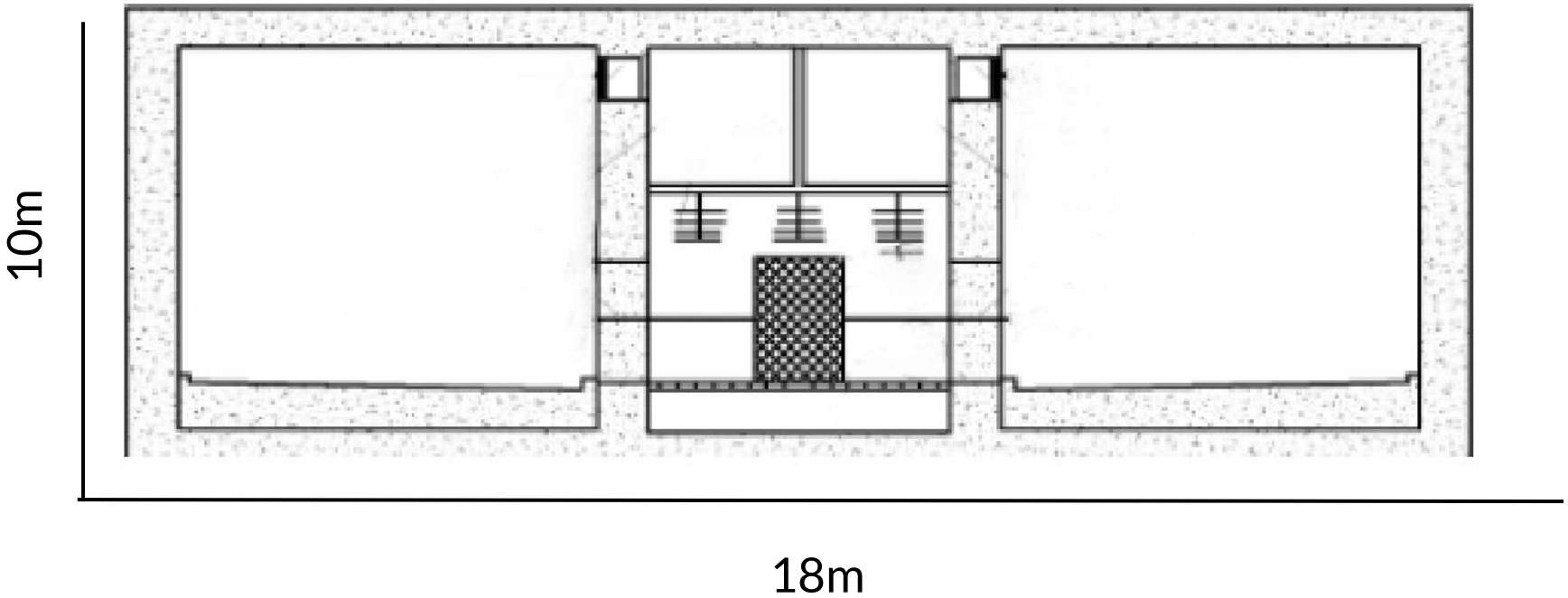
Example of Immersed Tube Tunnel

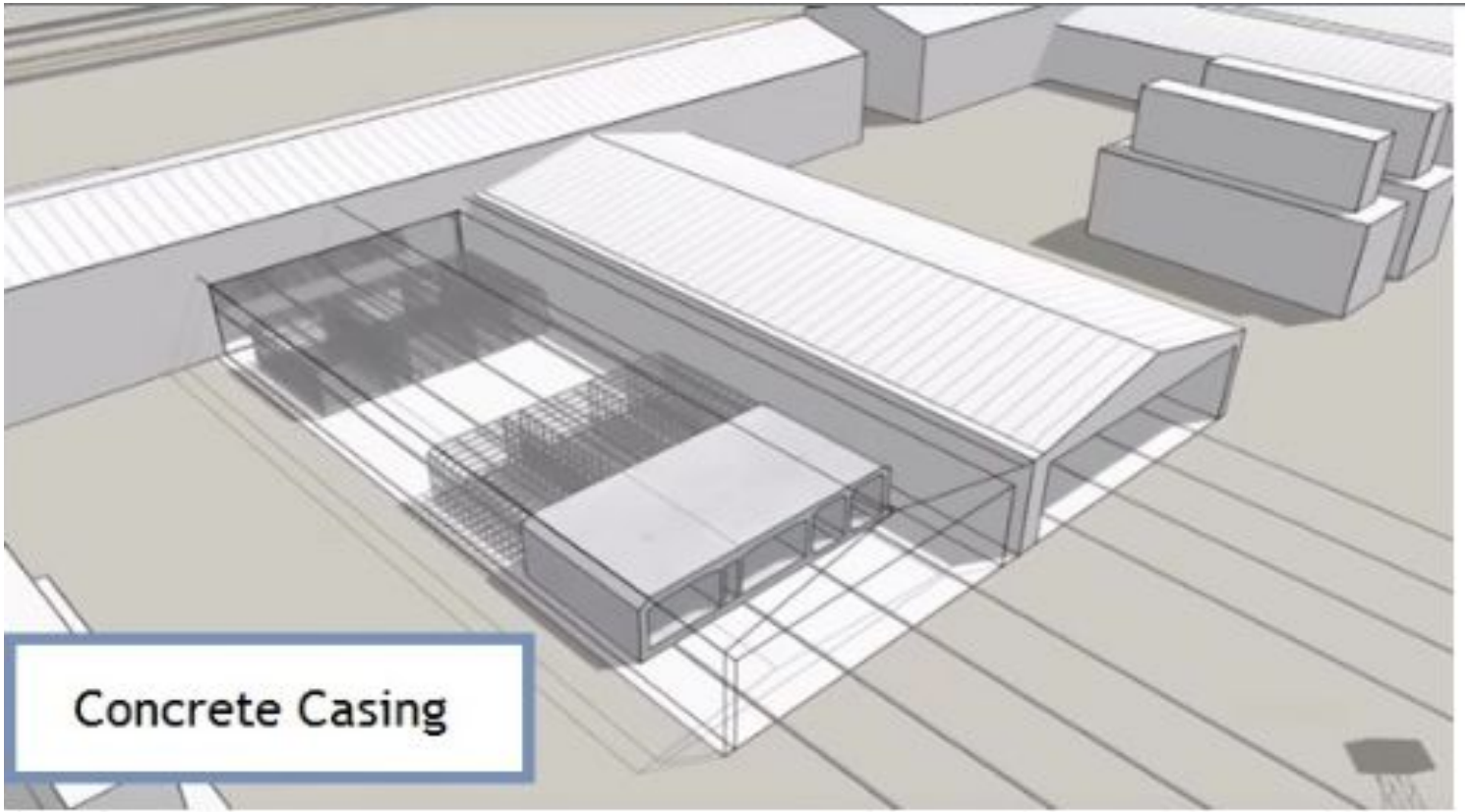
Fehmarnbelt Fixed Link

Germany and Denmark
Cost: € 7.1 Billion
Distance: 18 Km
Width: 42m
Start construction : 2020
Cost per km: €394 million

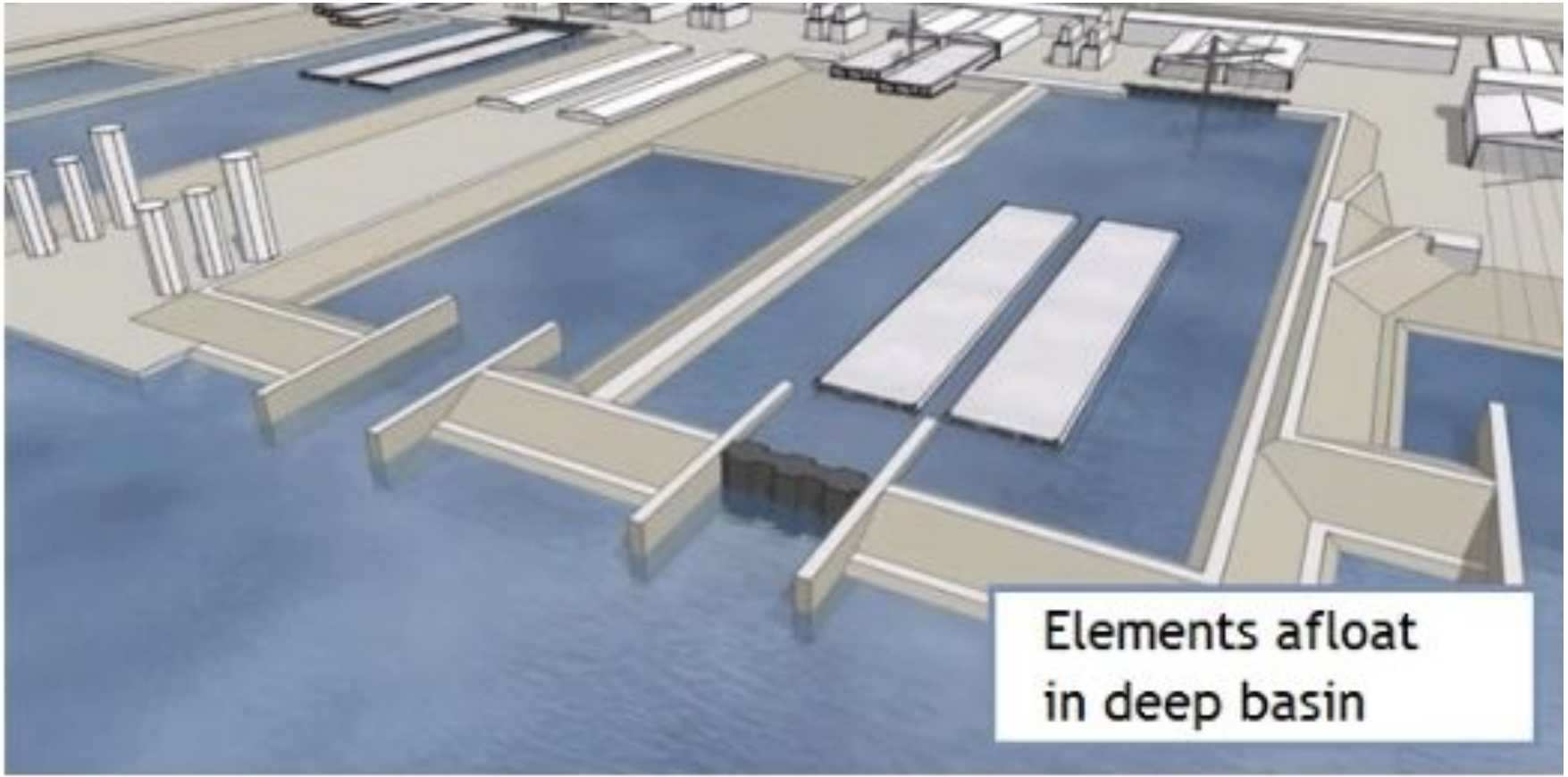
SOURCE

The width of the cross section of the underground tunnel system is 18m, and it's 10m tall

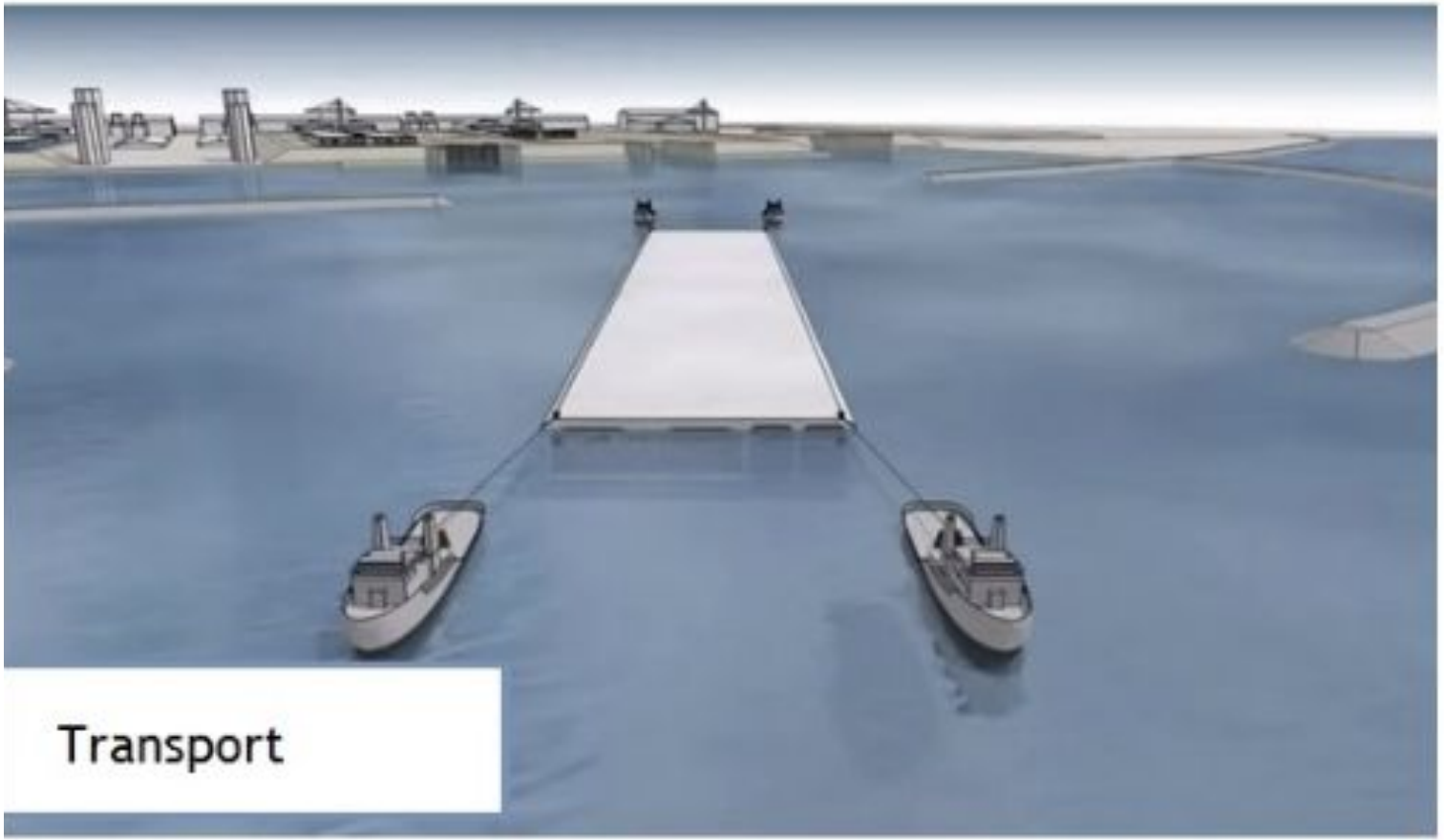


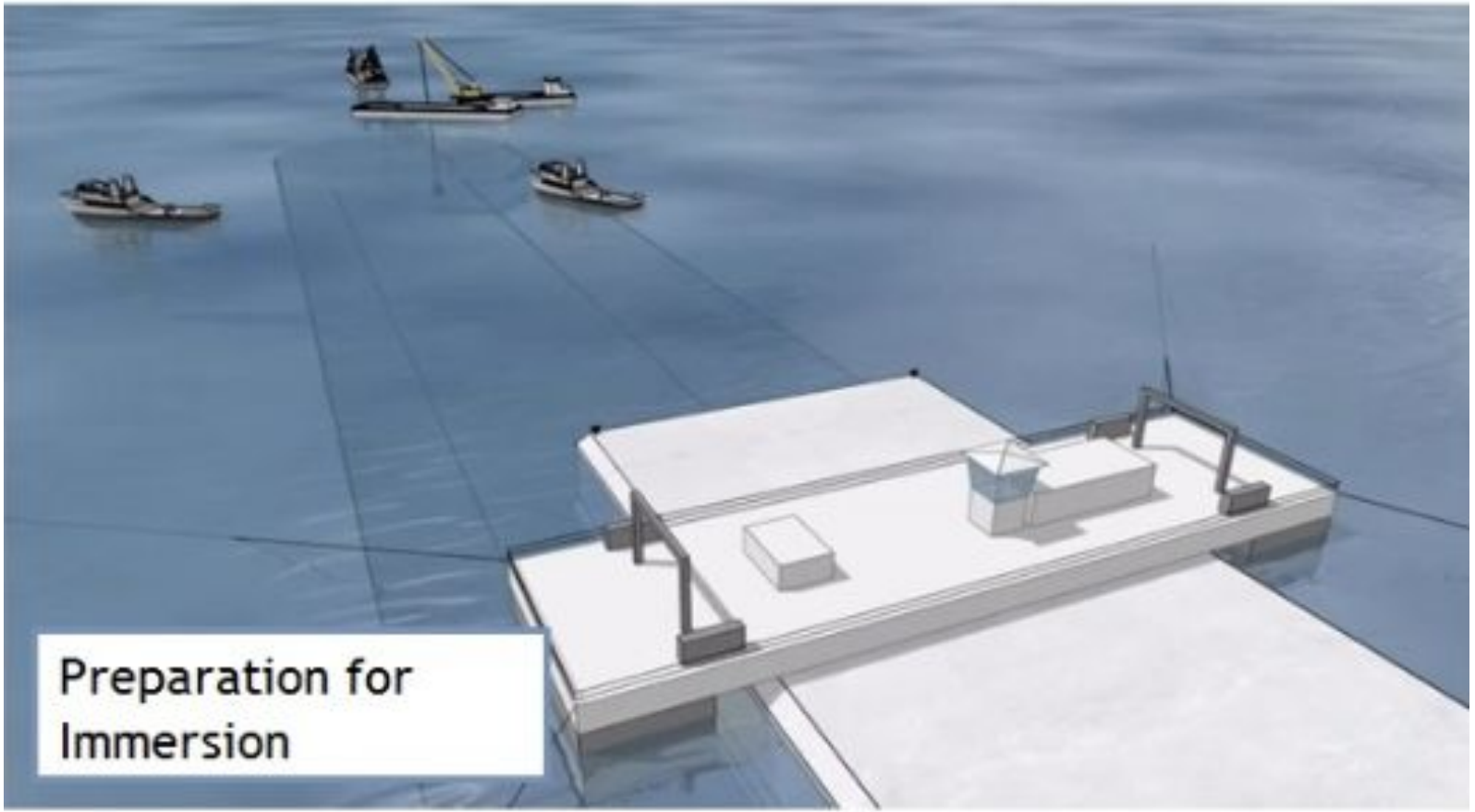


Immersed Tube Tunnel

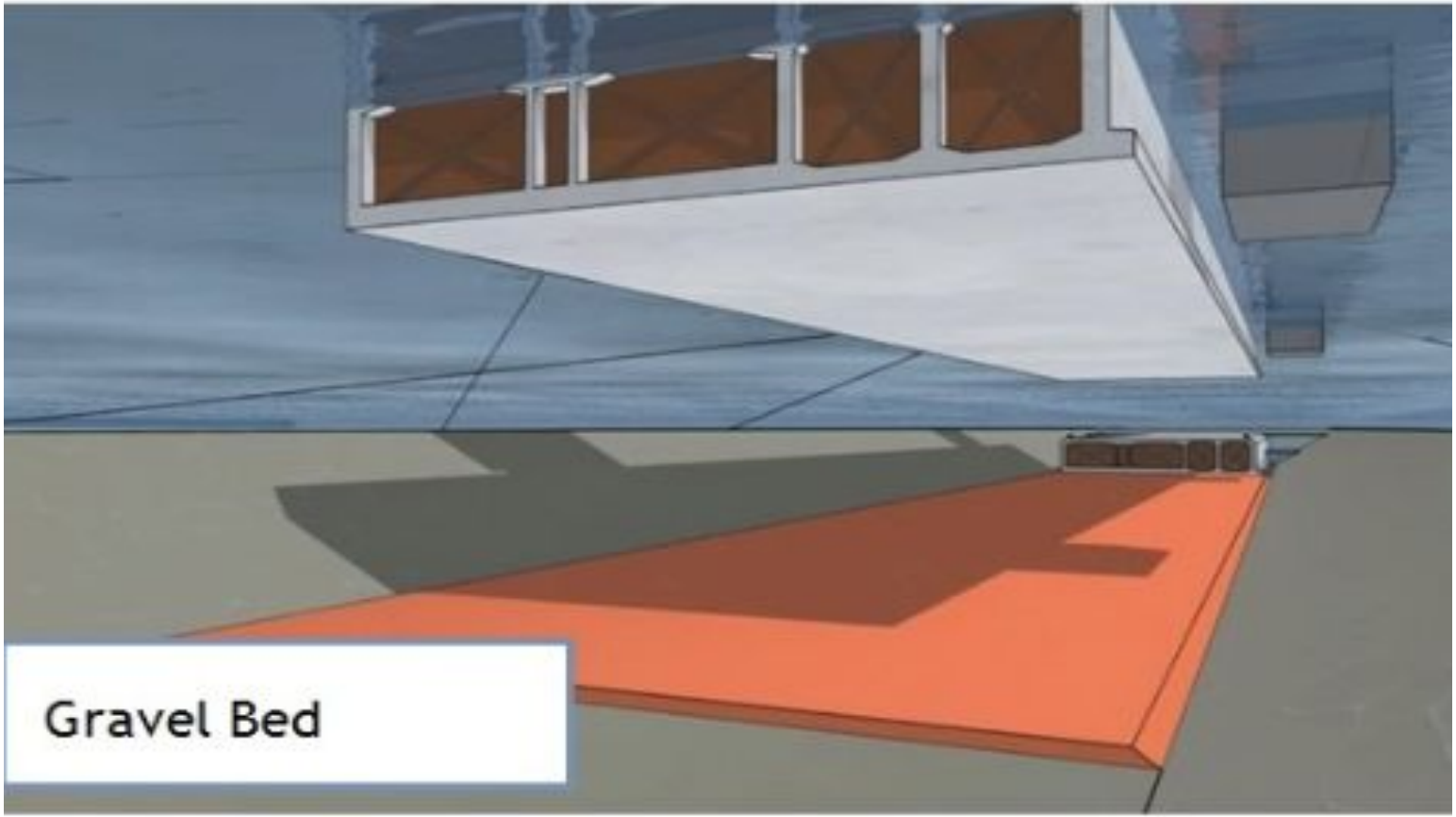


Immersed Tube Tunnel


Transport

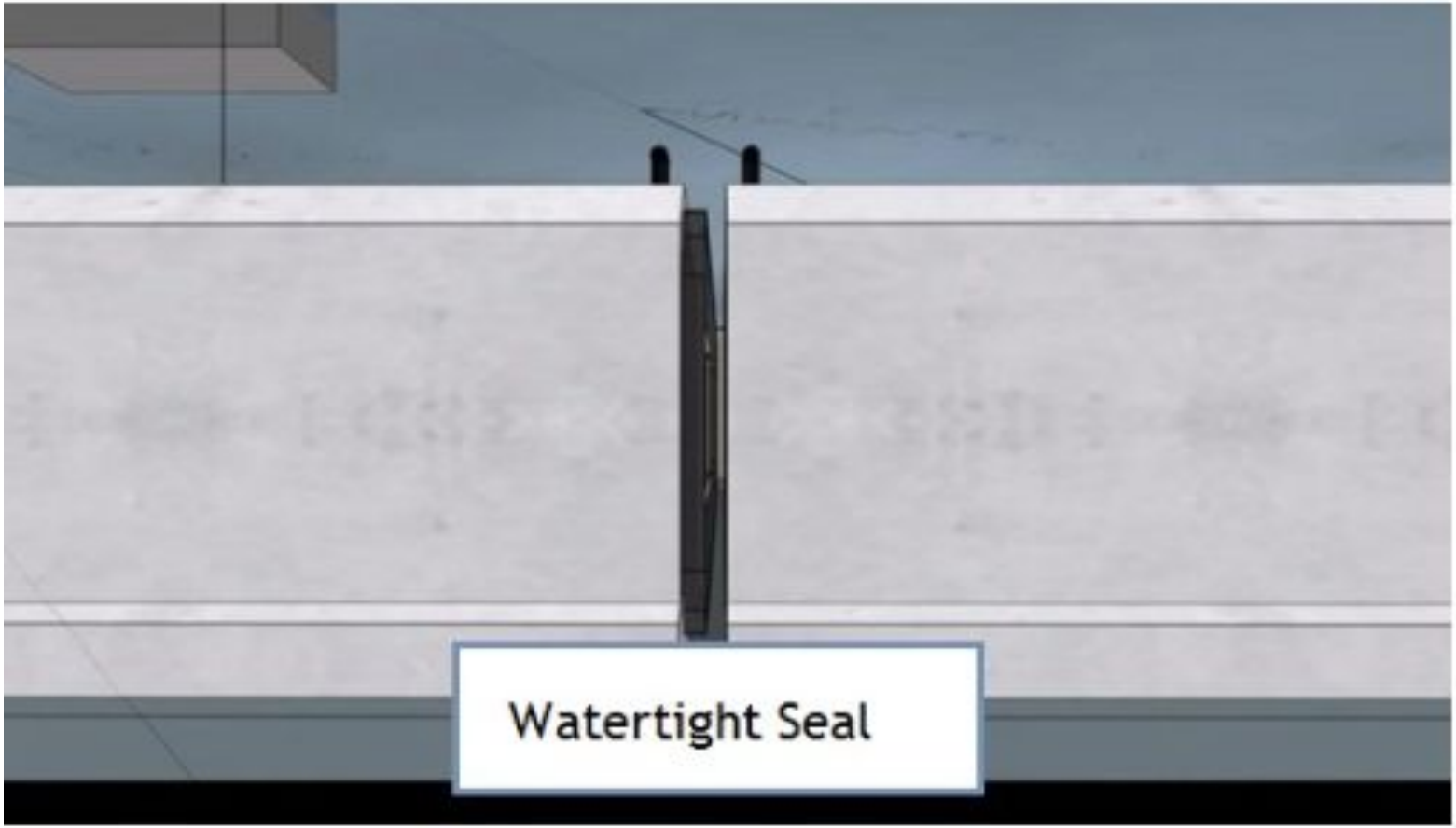


Immersed Tube Tunnel

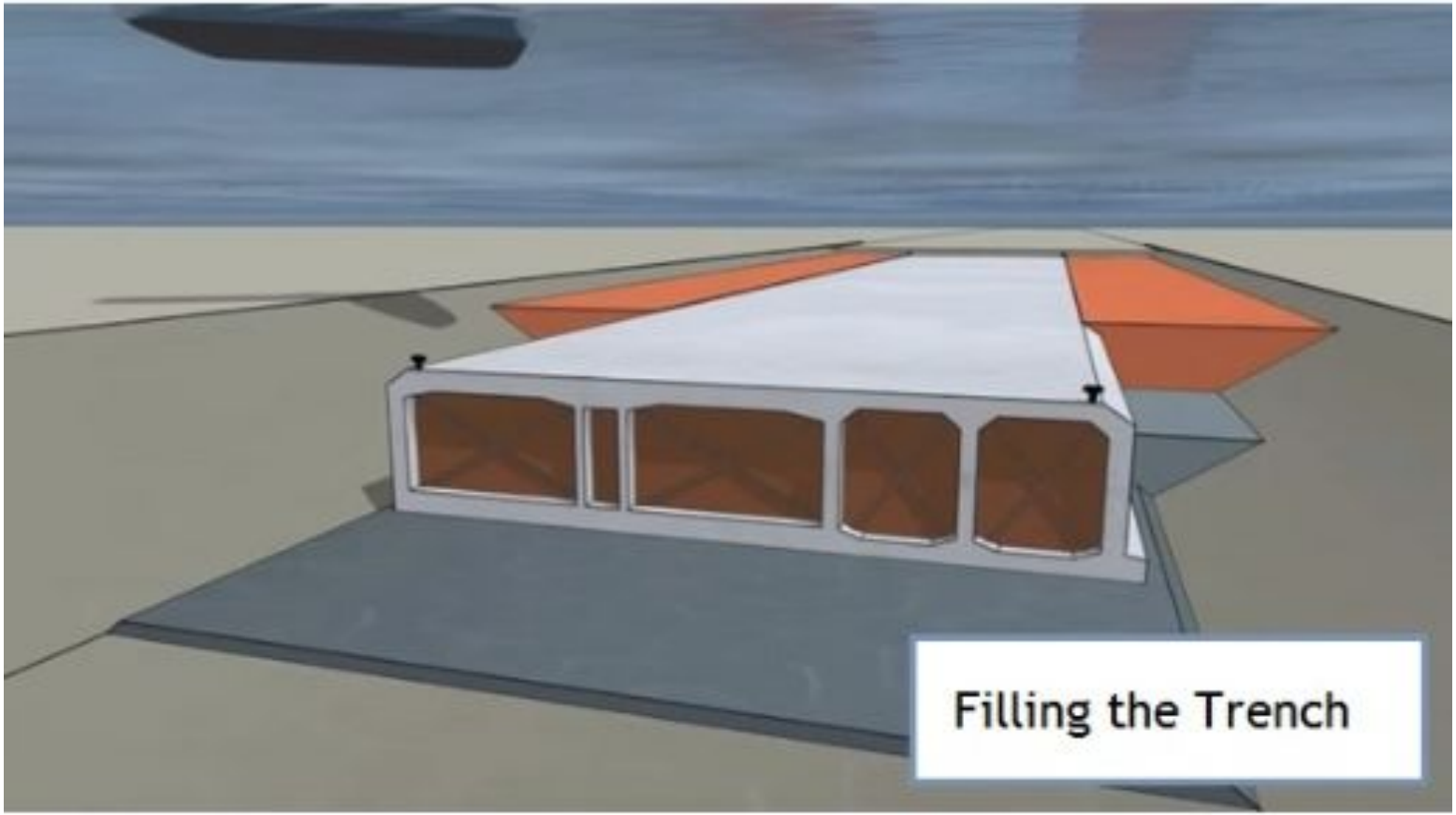


Immersed Tube Tunnel

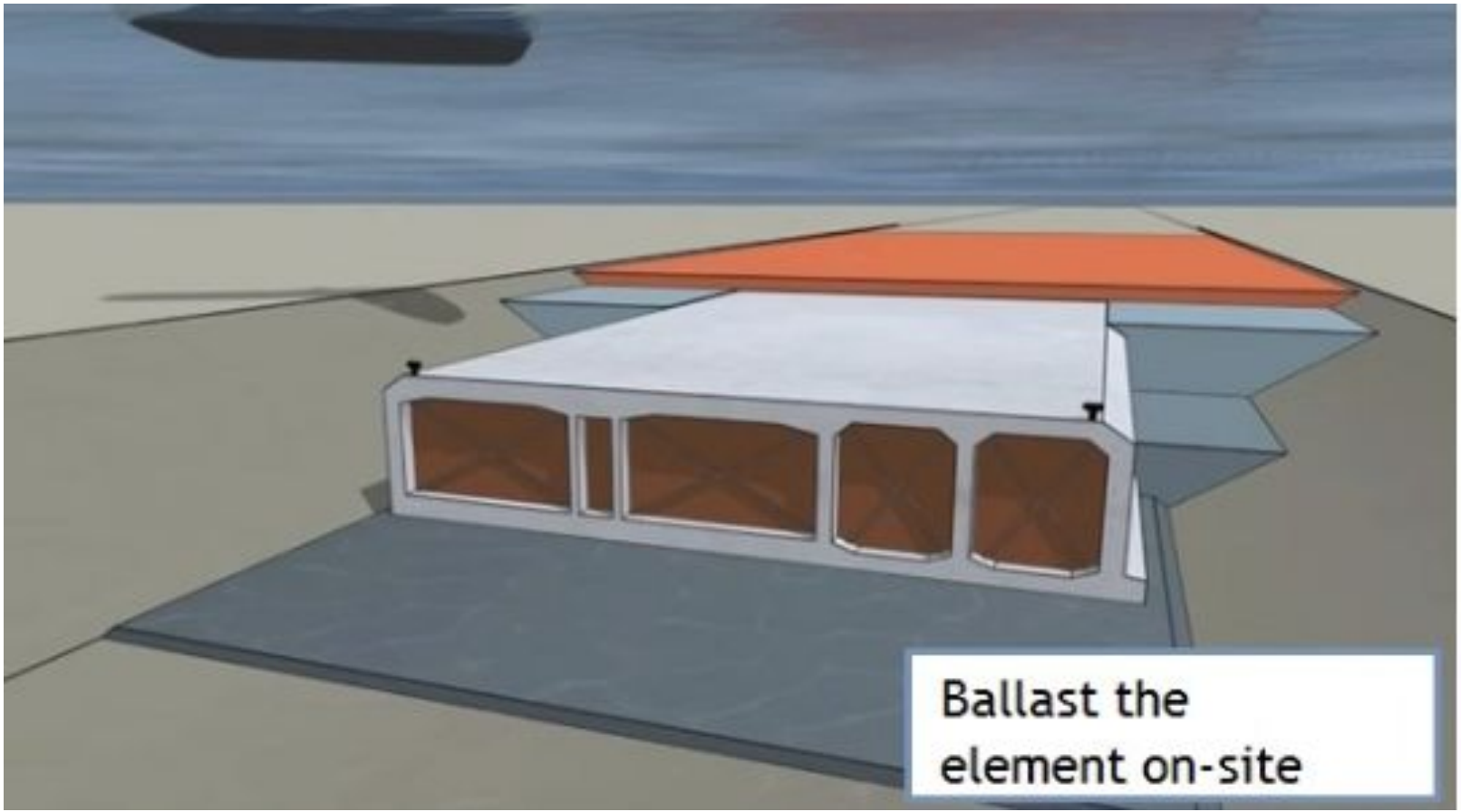
Immersed Tube Tunnel



Immersed Tube Tunnel



Immersed Tube Tunnel



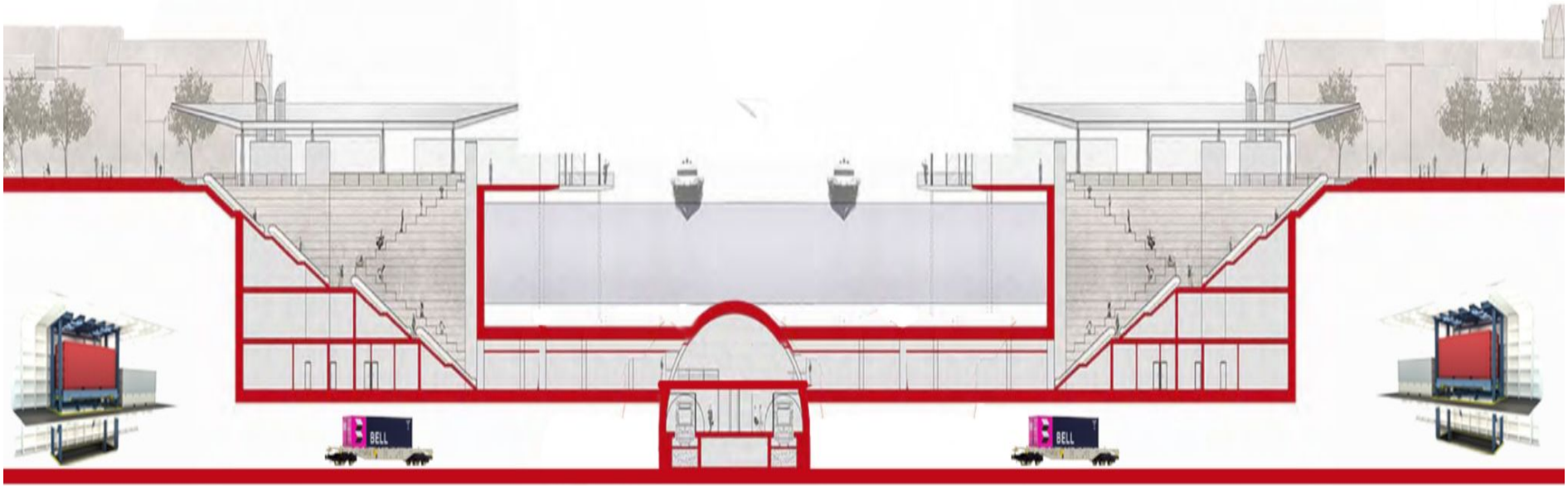
Immersed Tube Tunnel

Immersed Tube Tunnel

Station with cargo hitching integration

Zattere

Palanca



SOURCE