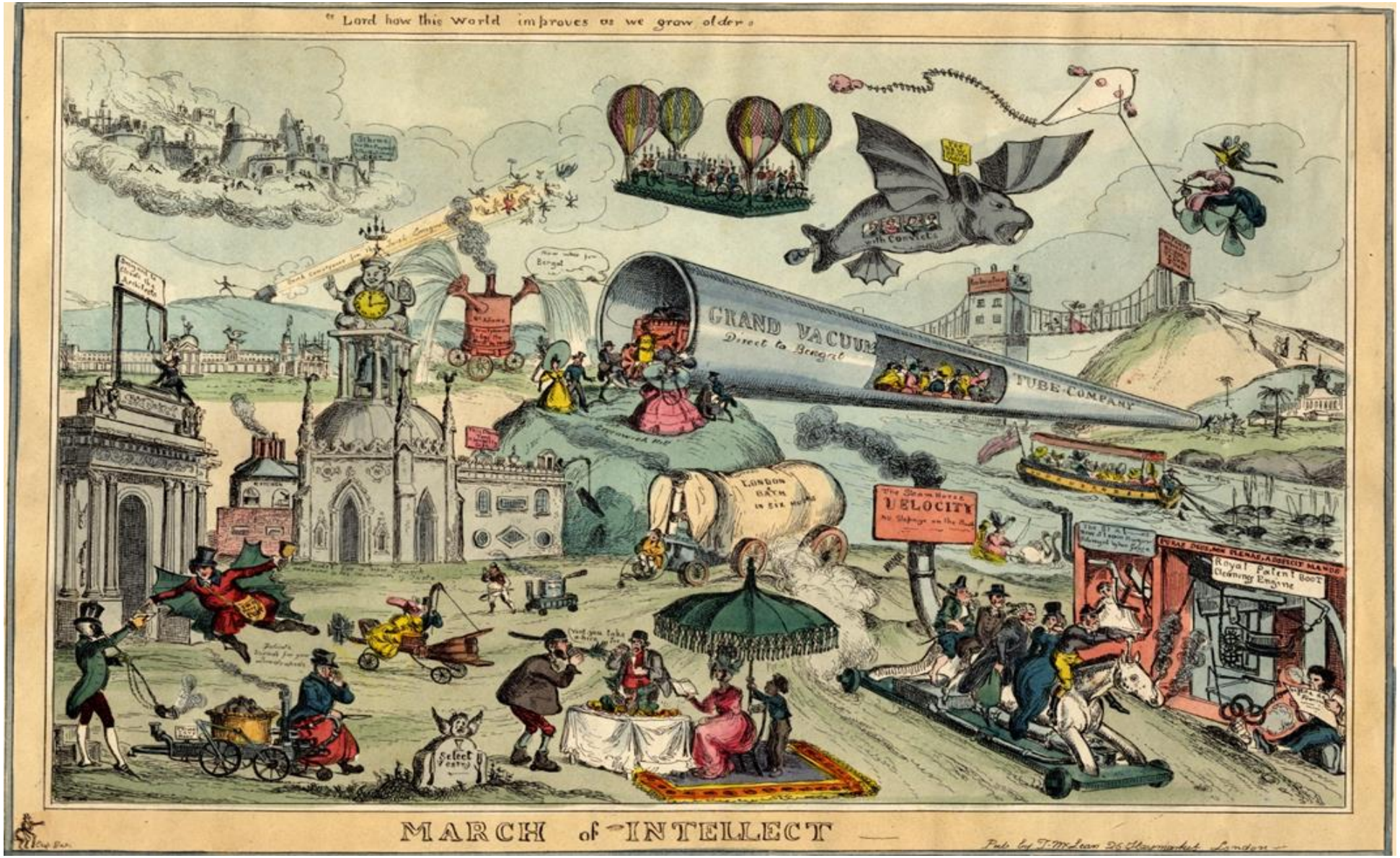
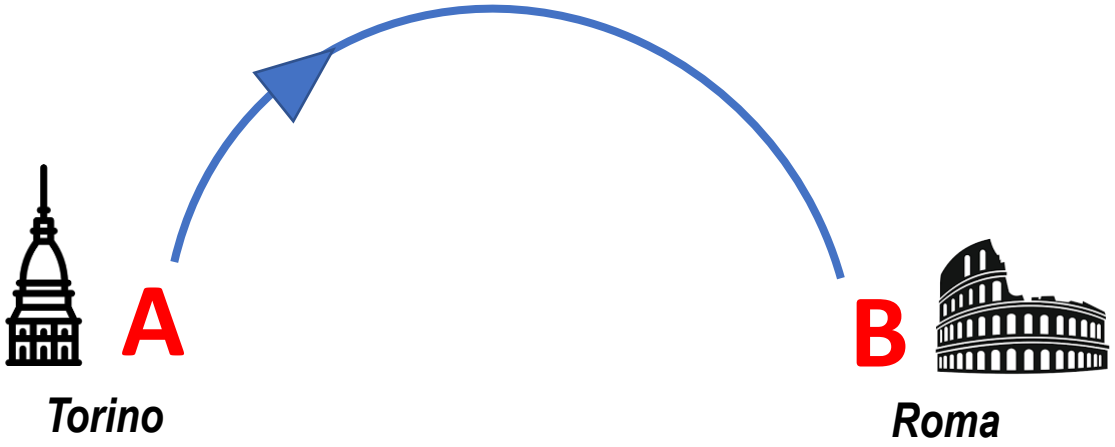
Uno sguardo ai sistemi di trasporto del futuro



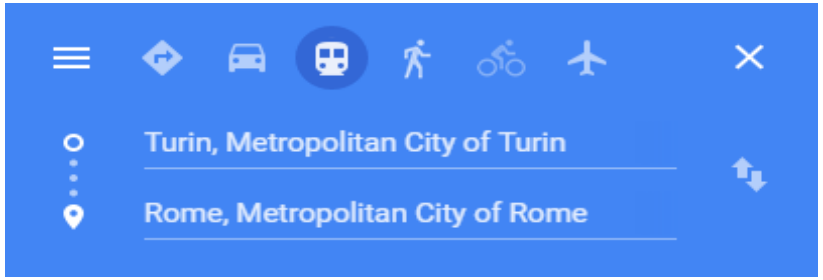
Dr. Ing. Andrea Santangelo
Ingegnere Trasportista Strutturale

Concetto di Viaggio



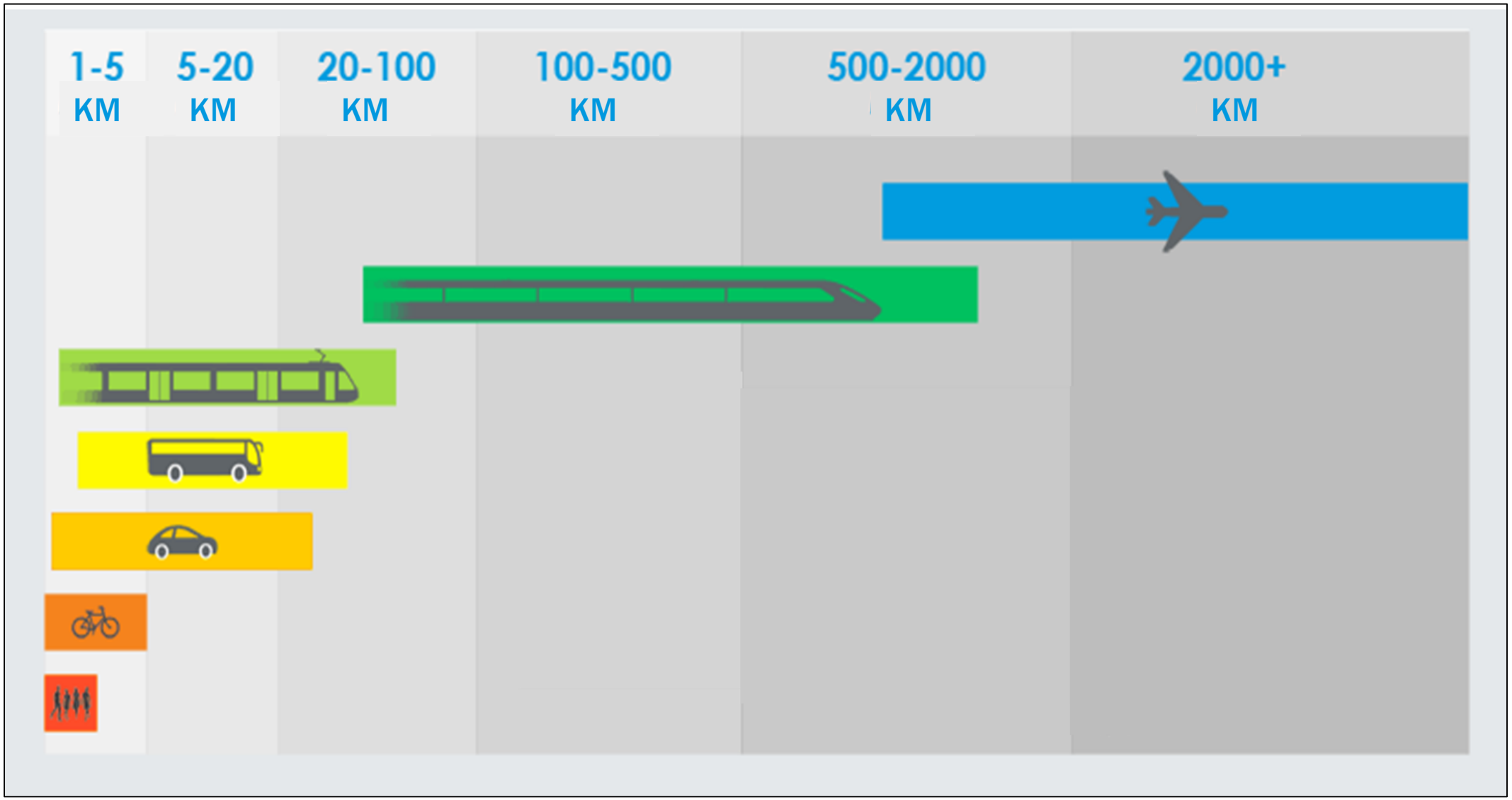
Parametri di scelta:

- Distanza da percorrere
- Tempo
- Disponibilità
- Costo



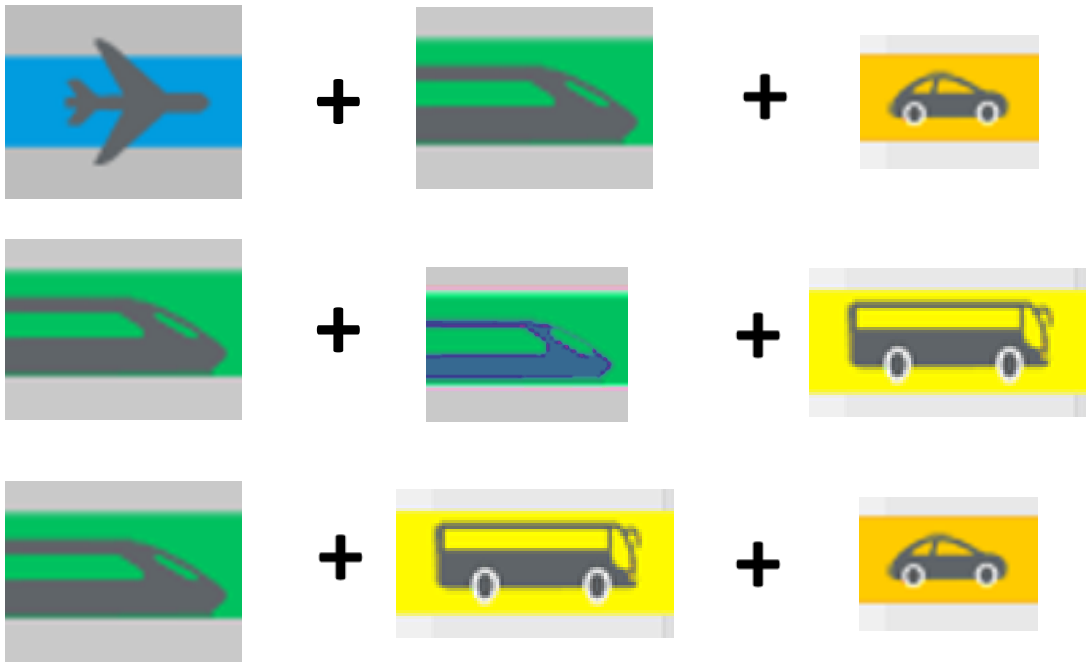
Opzioni di viaggio

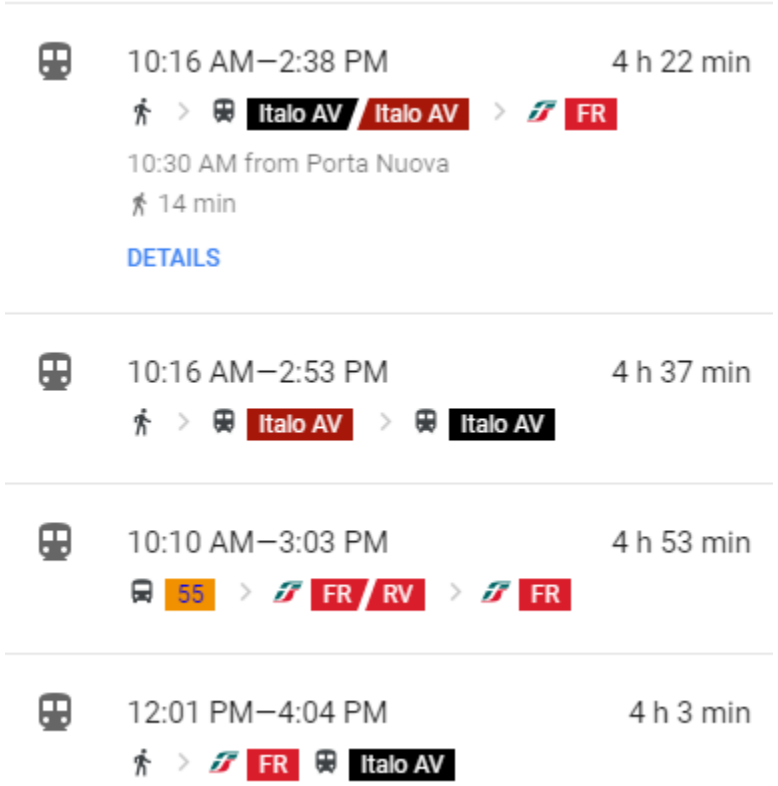
scelta ottimale in base alla distanza



Opzioni di viaggio

combinazione di mezzi diversi

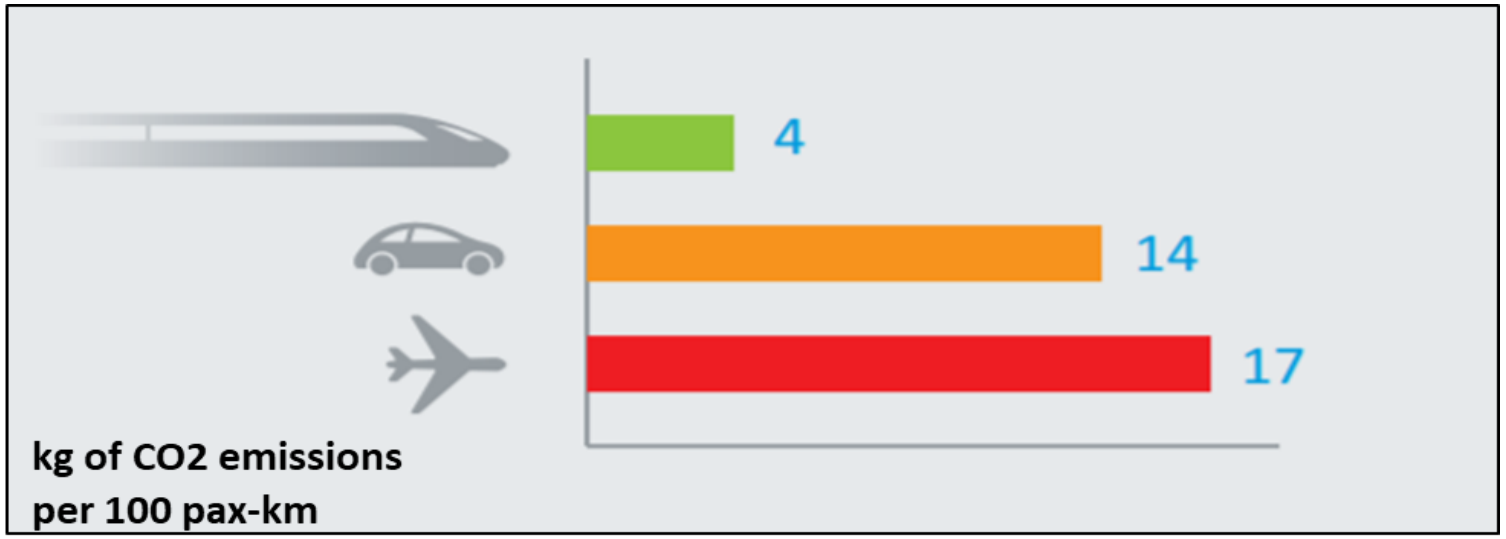


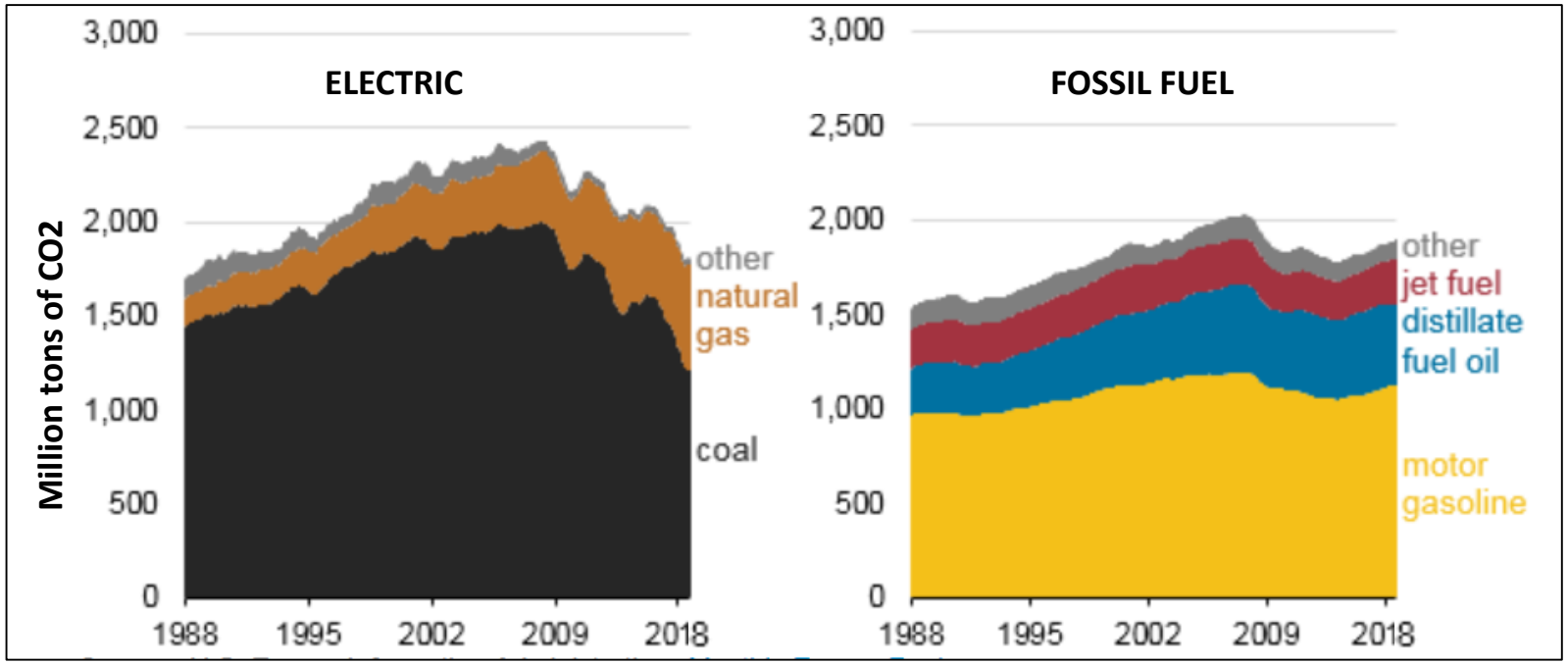


- Mezzi di trasporto differenti possono essere combinati nei loro segmenti più efficienti per ottimizzare l'intero viaggio.
- Quando si riesce ad ottimizzare ogni mezzo di trasporto , l'esperienza di viaggio è al meglio, e fornisce la migliore mobilità per la comunità.
- Quando invece l'ottimizzazione non è possibile, **il sistema si sovraccarica e la qualità del viaggio peggiora**.

Opzioni di viaggio

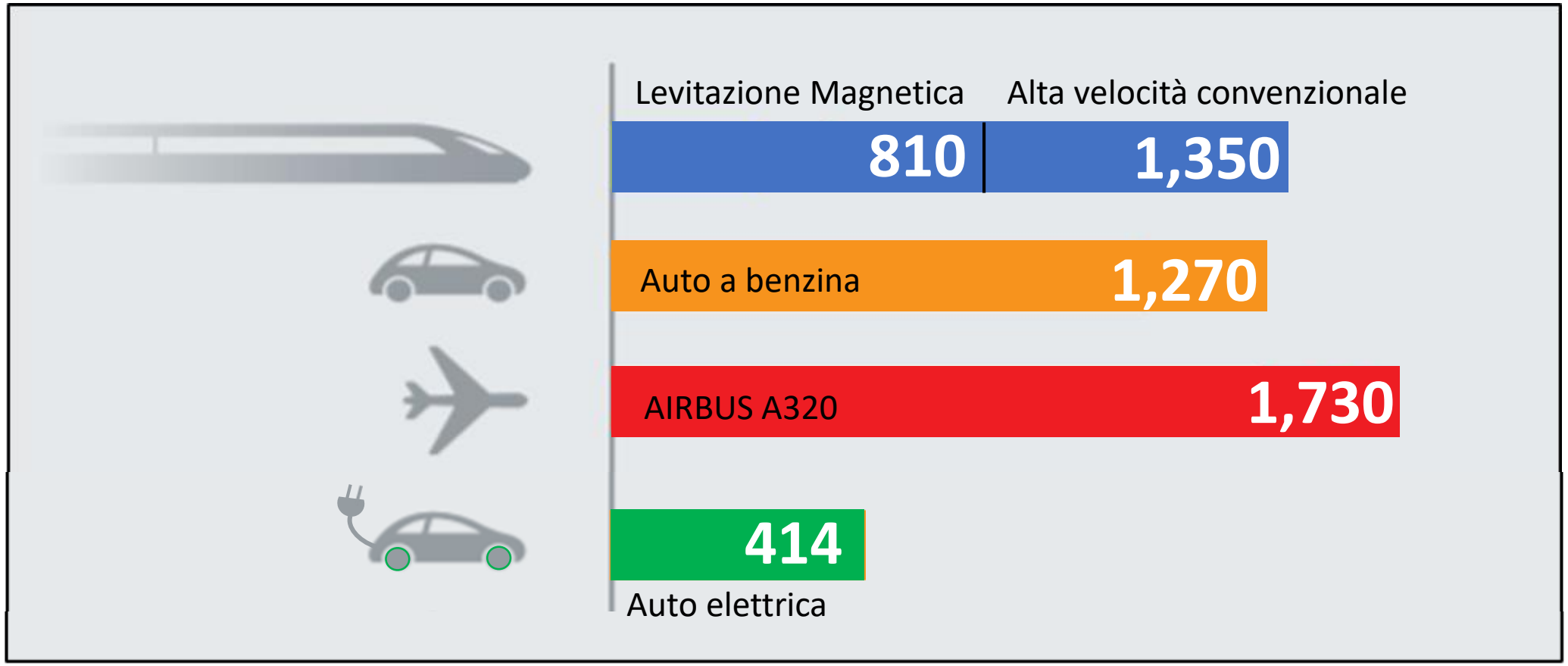
Emissioni di CO2





Opzioni di viaggio

Consumo energetico per passeggero (KJ x km)



NECESSITA’ DI UN NUOVO MEZZO DI TRASPORTO

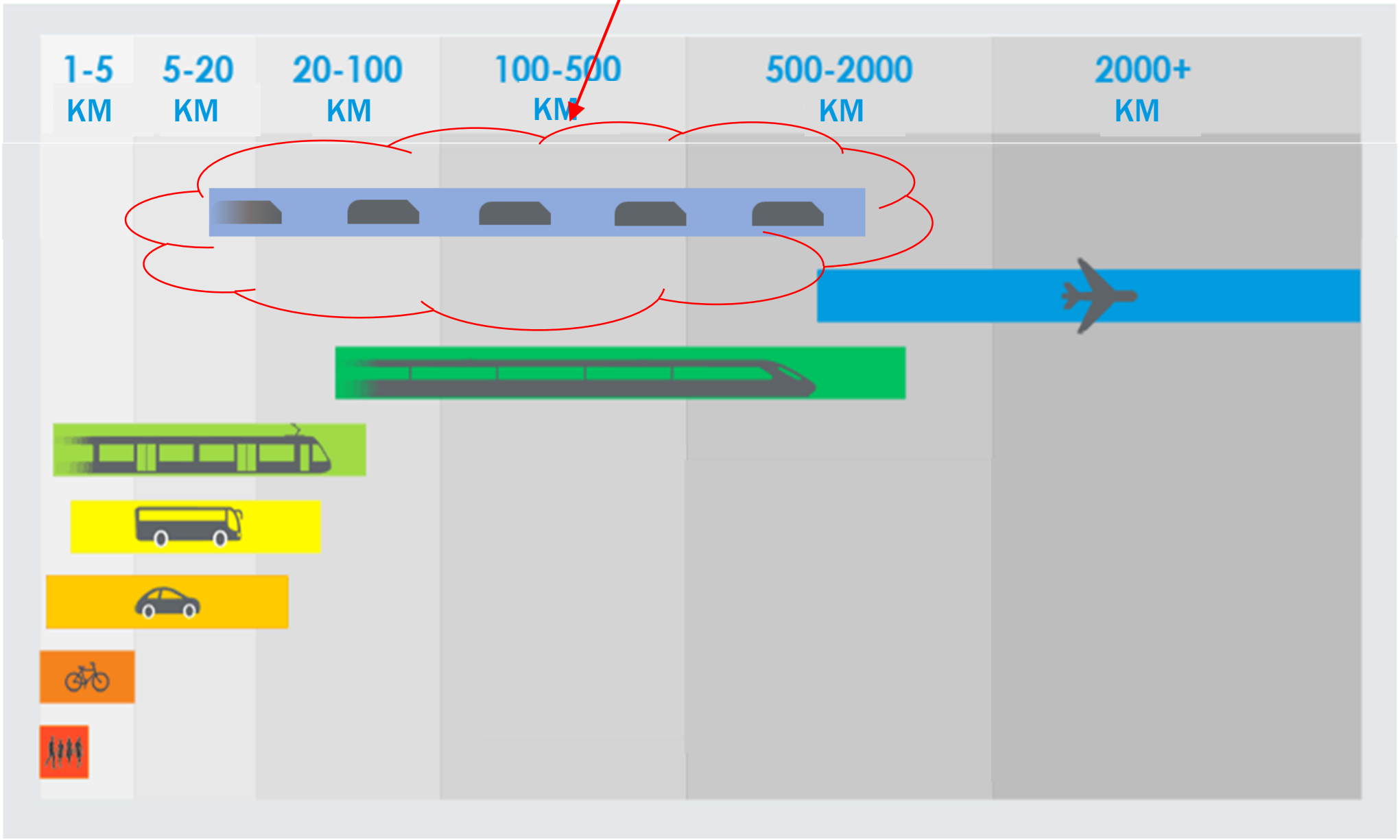
Un nuovo mezzo di trasporto che coniughi gli aspetti positivi di ciascun sistema cercando di eliminare o minimizzare queli negativi

Ridurre l’uso di sistemi di trasporto basati su combustibile fossile.
Ridurre il consumo energetico
Ridurre i tempi di viaggio

Aumento della eco-sostenibilità
Aumento dell’uso di energie rinnovabili
Aumento della flessibilità

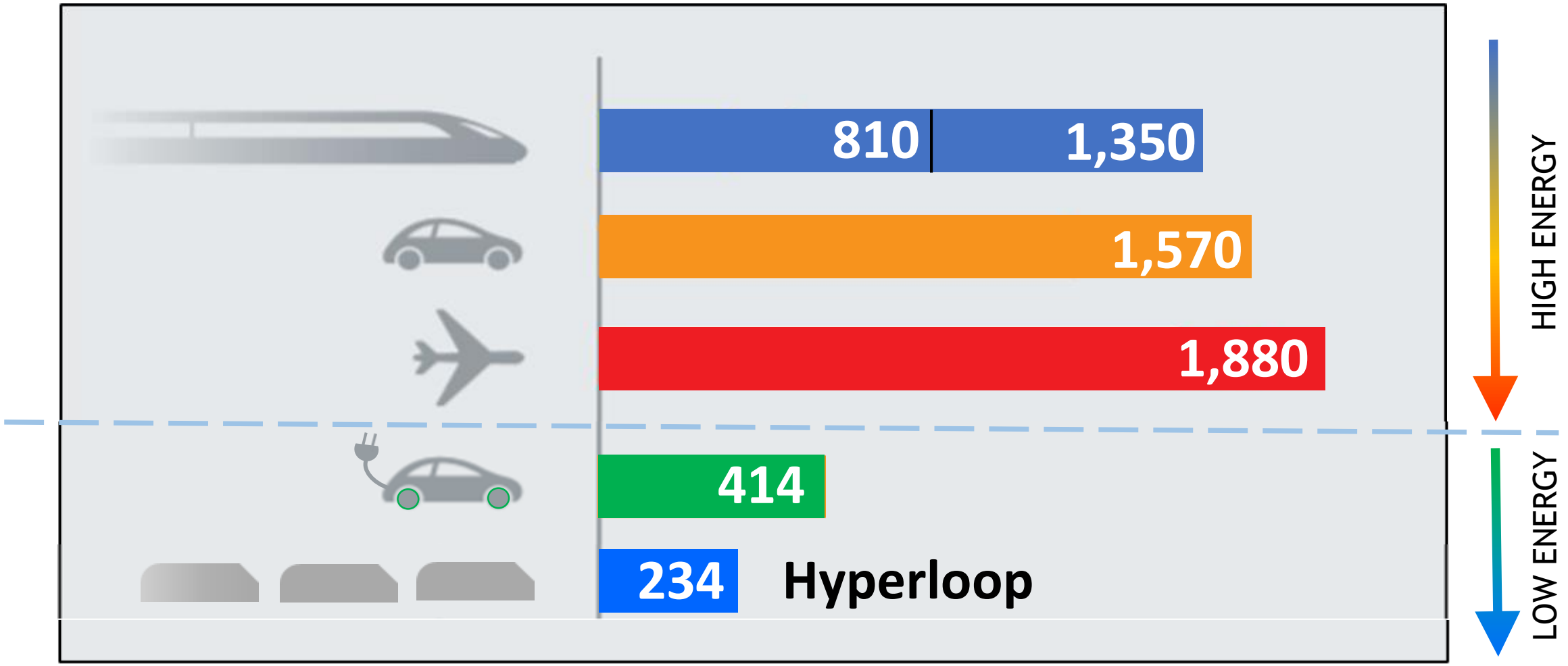
Sistema di trasporto ad altissima velocità «*hyperloop*»

Opzioni di viaggio (presente e ***futuro***)



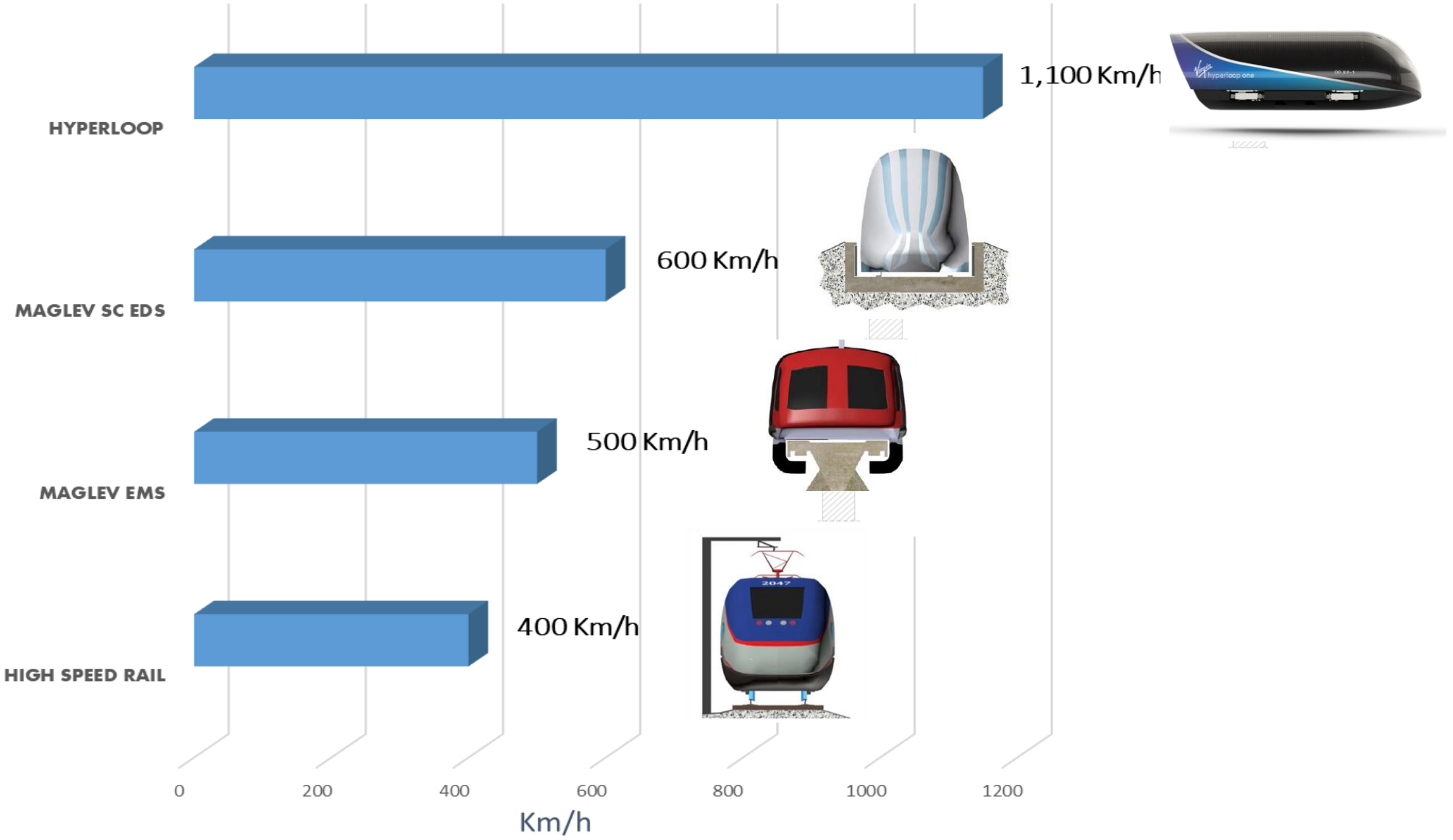
Opzioni di viaggio

Consumo energetico per passeggero (KJ x km) - Hyperloop



Sistemi di trasporto moderni terrestri

Velocità massima operativa



THE PNEUMATIC TUNNEL UNDER BROADWAY, N. Y.

We give this week illustrations of this remarkable work, which, with a brief description of the details of construction and mode of operation, will give the general reader a good understanding of the nature of this mode of transit. Having fully set forth the benefits to be derived from it in a previous article, we shall confine ourselves at present entirely to a description of the work and a brief history of the origin and progress of transit by means of air inclosed in tubes.

FIG. 1.

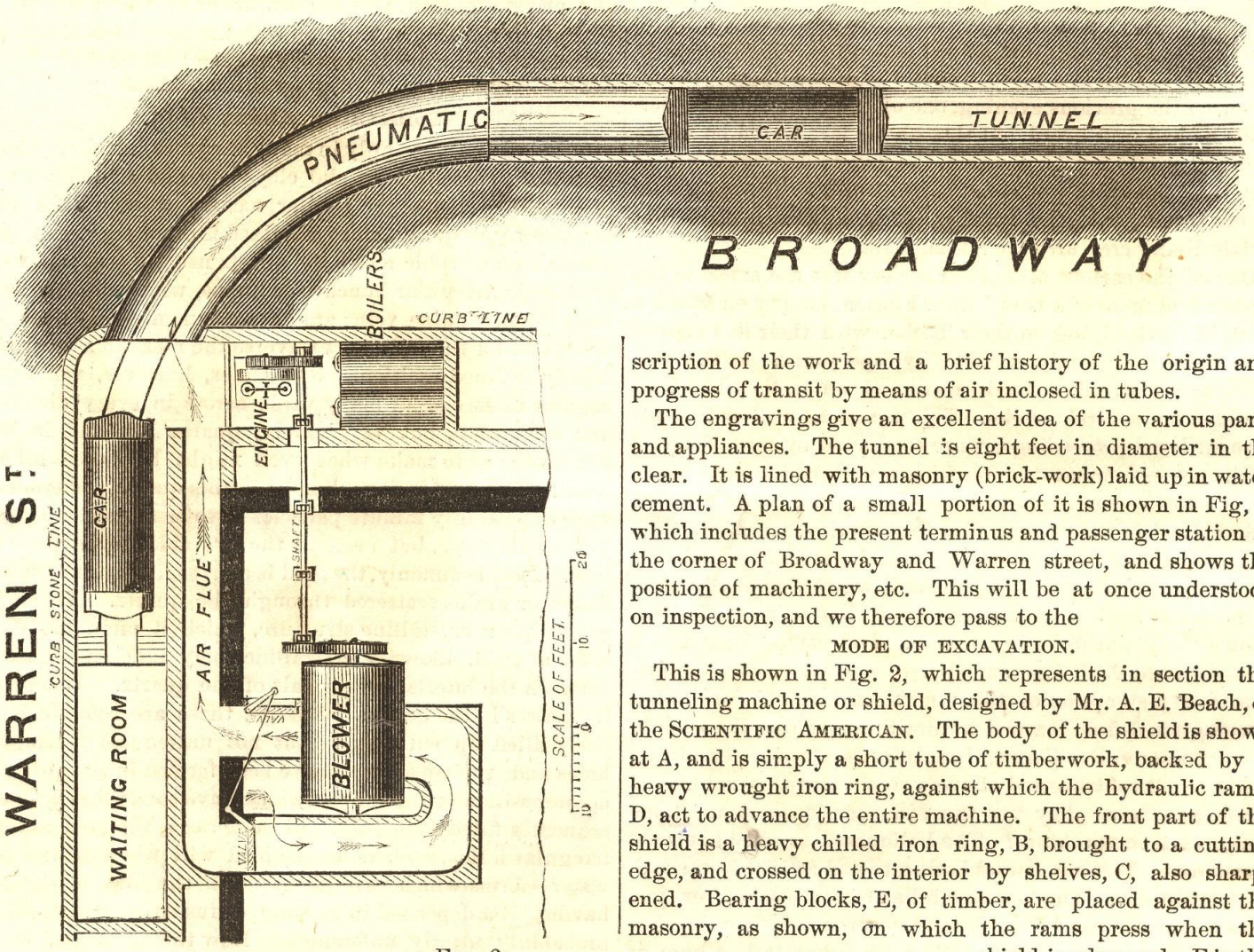


FIG. 2.

The engravings give an excellent idea of the various parts and appliances. The tunnel is eight feet in diameter in the clear. It is lined with masonry (brick-work) laid up in water cement. A plan of a small portion of it is shown in Fig, 1, which includes the present terminus and passenger station at the corner of Broadway and Warren street, and shows the position of machinery, etc. This will be at once understood on inspection, and we therefore pass to the

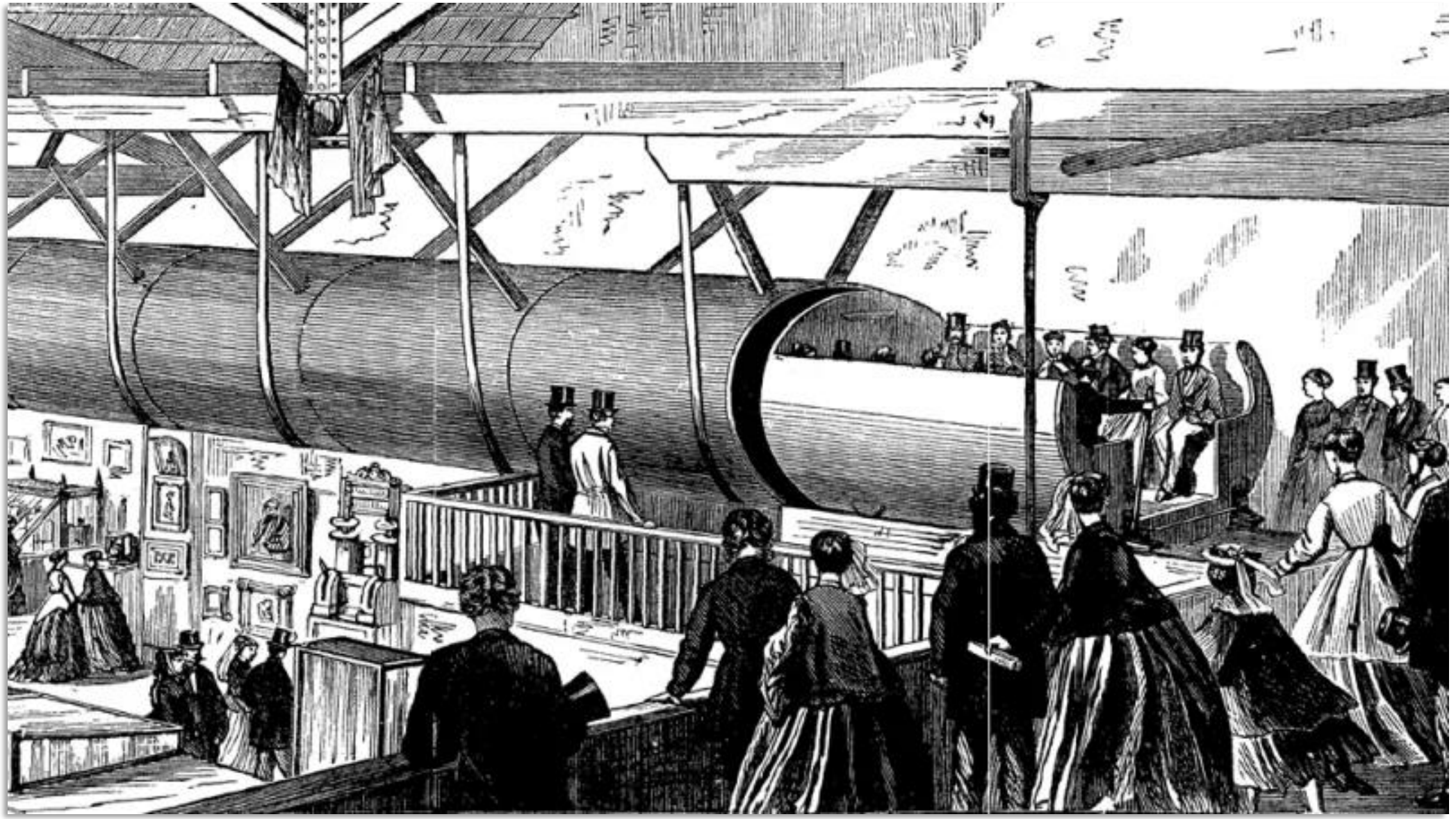
MODE OF EXCAVATION.

This is shown in Fig. 2, which represents in section the tunneling machine or shield, designed by Mr. A. E. Beach, of the SCIENTIFIC AMERICAN. The body of the shield is shown at A, and is simply a short tube of timberwork, backed by a heavy wrought iron ring, against which the hydraulic rams, D, act to advance the entire machine. The front part of the shield is a heavy chilled iron ring, B, brought to a cutting edge, and crossed on the interior by shelves, C, also sharpened. Bearing blocks, E, of timber, are placed against the masonry, as shown, on which the rams press when the shield is advanced. F is the

...quando è nato
il sistema *hyperloop*?

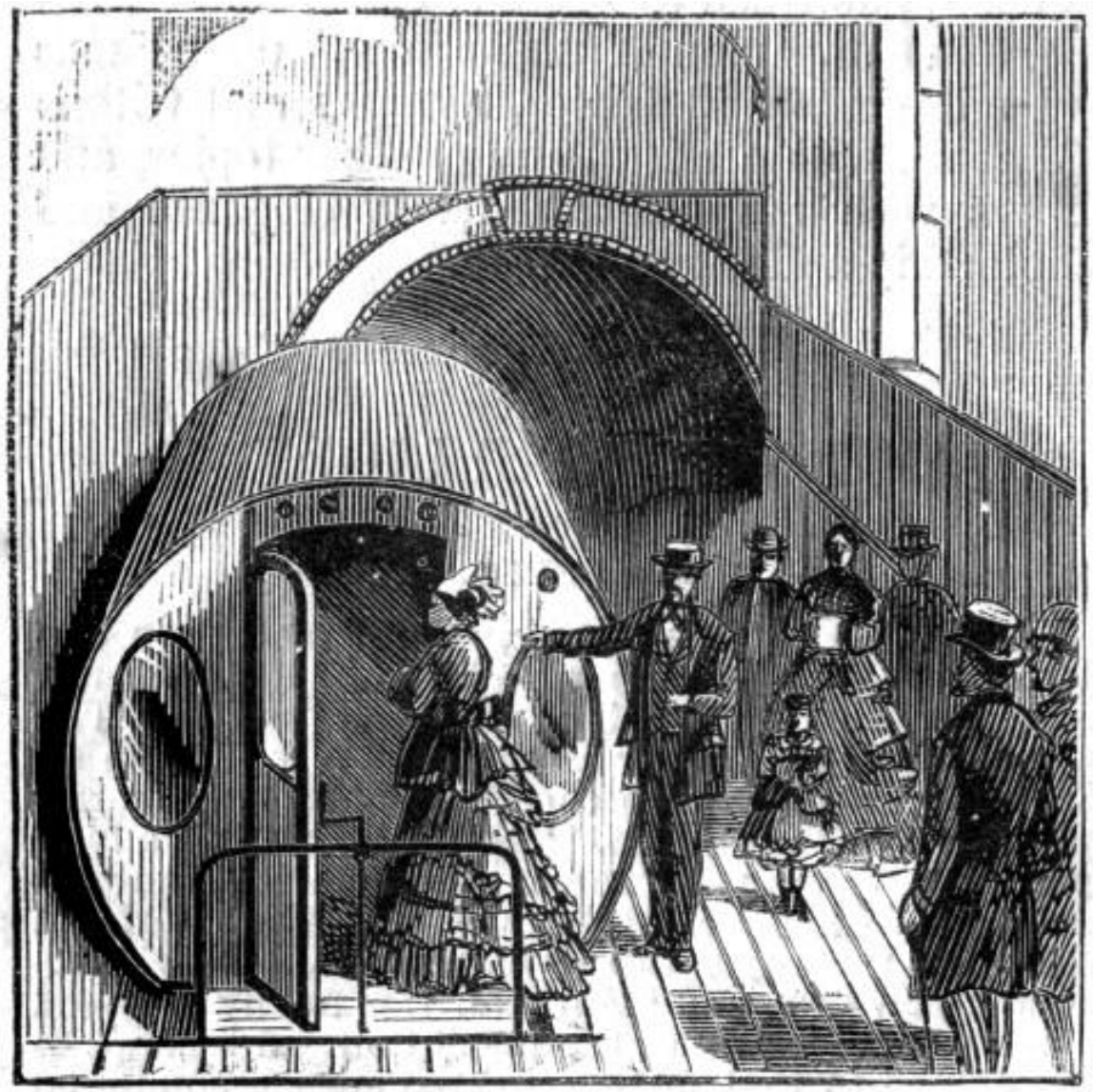
Primo Sistema di trasporto pneumatico – Alfred Ely Beach *"pneumatic transit"*

Metropolitana pneumatica con la pressione usata come propulsione - Broadway – New York City, USA 1867



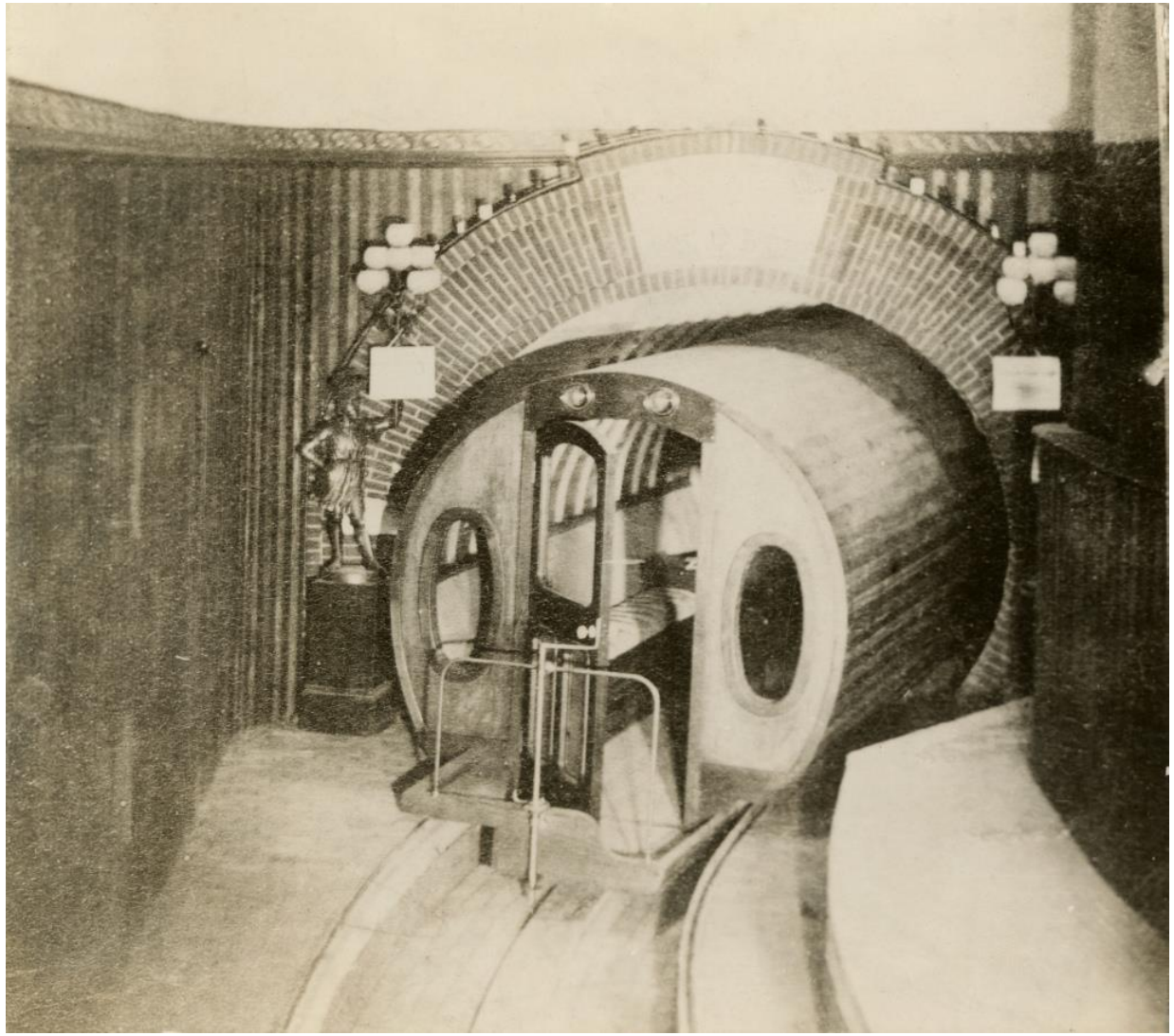
Primo sistema di trasporto pneumatico – Alfred Ely Beach “*pneumatic transit*”

Viaggio inaugurale: 26 Febbraio 1870 – lunghezza intorno 100 m profondità circa, diametro 1,7 metri -7 m dalla superficie



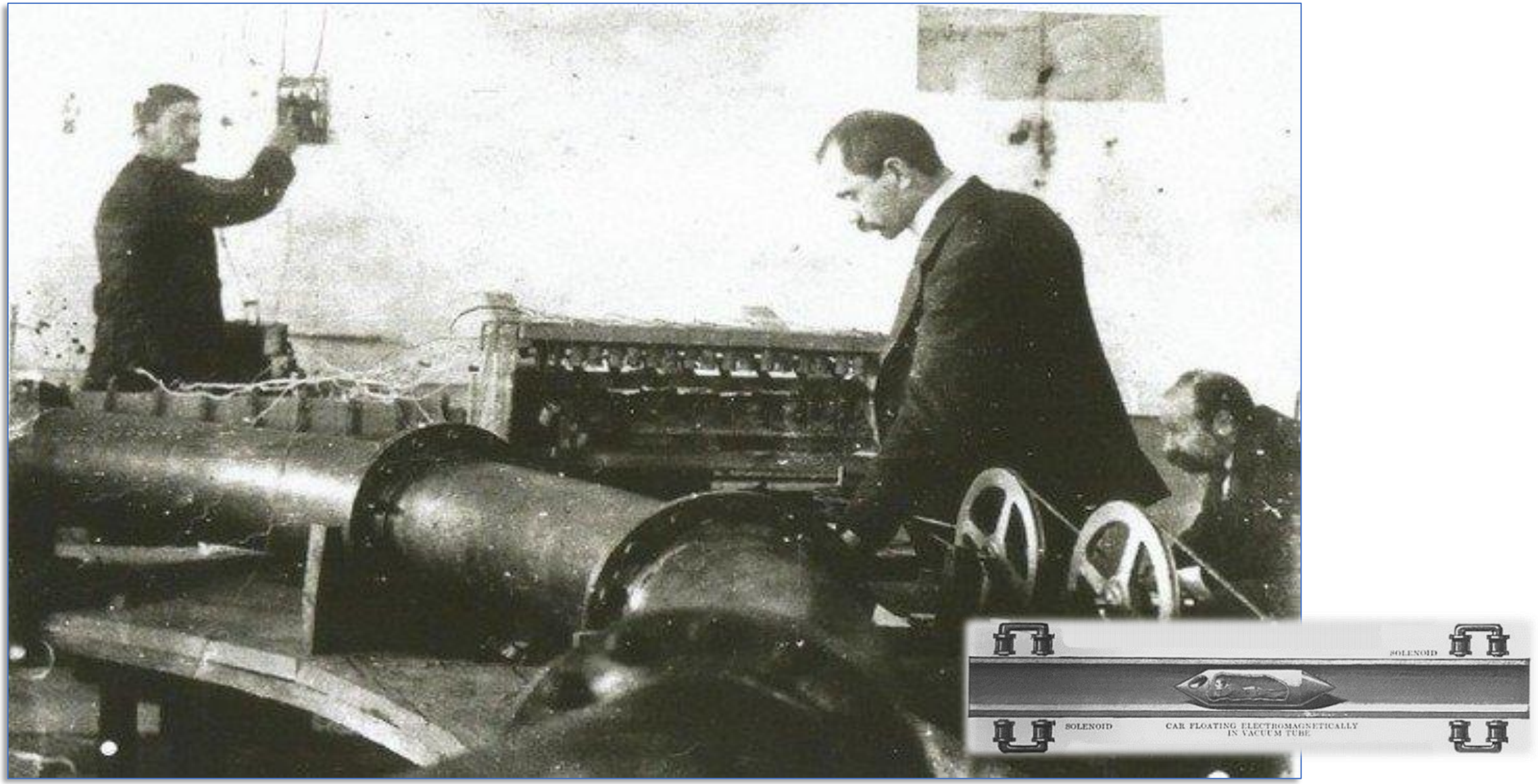
Primo sistema di trasporto pneumatico – Alfred Ely Beach “*pneumatic transit*”

Foto dell’epoca - Marzo 1870



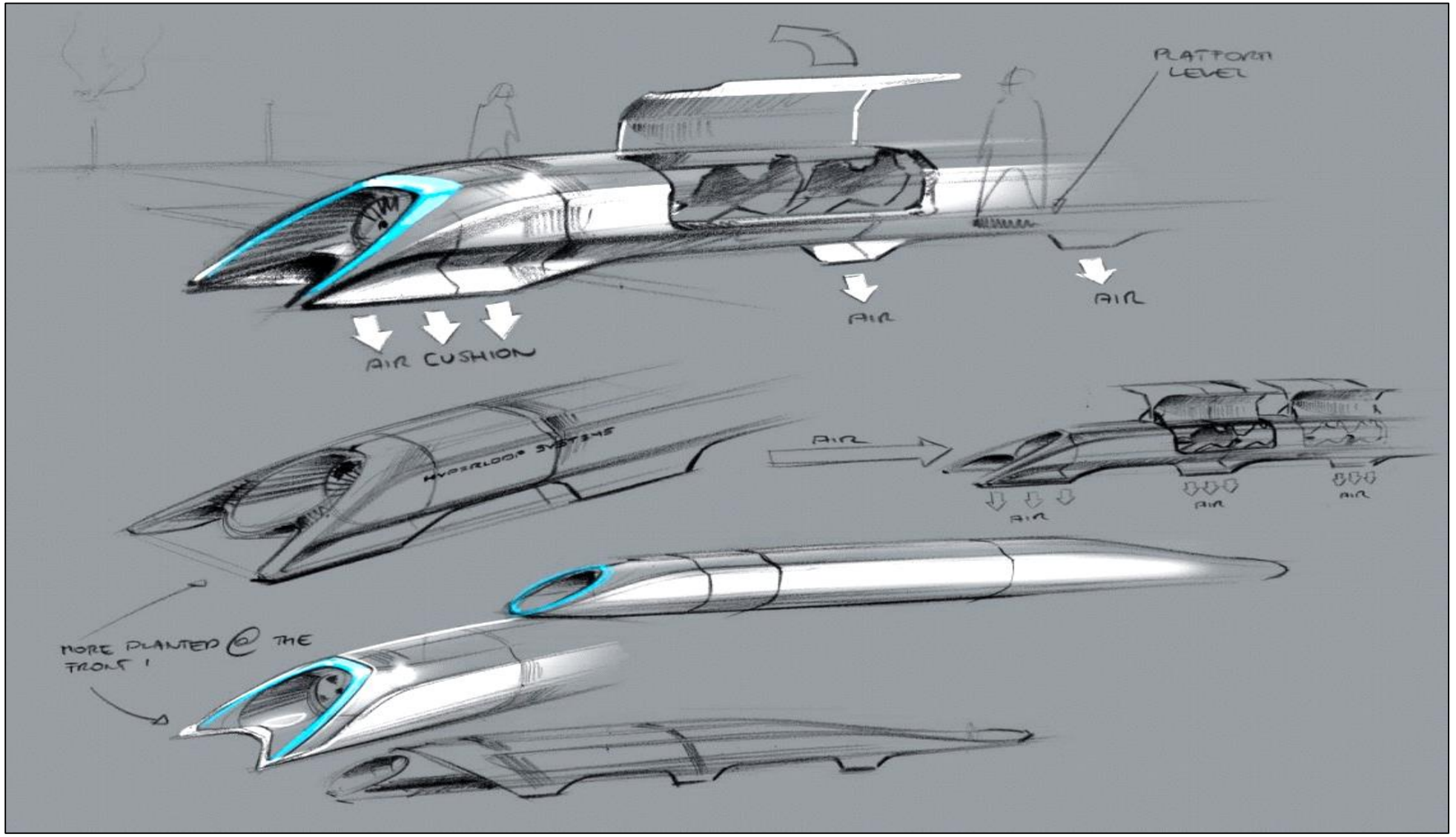
Sistemi di trasporto al vuoto - Boris Weinberg *"Motion without Friction"*

Sperimentazione di mezzi di trasporto al vuoto e veicoli sospesi elettromagneticamente – Russia 1913



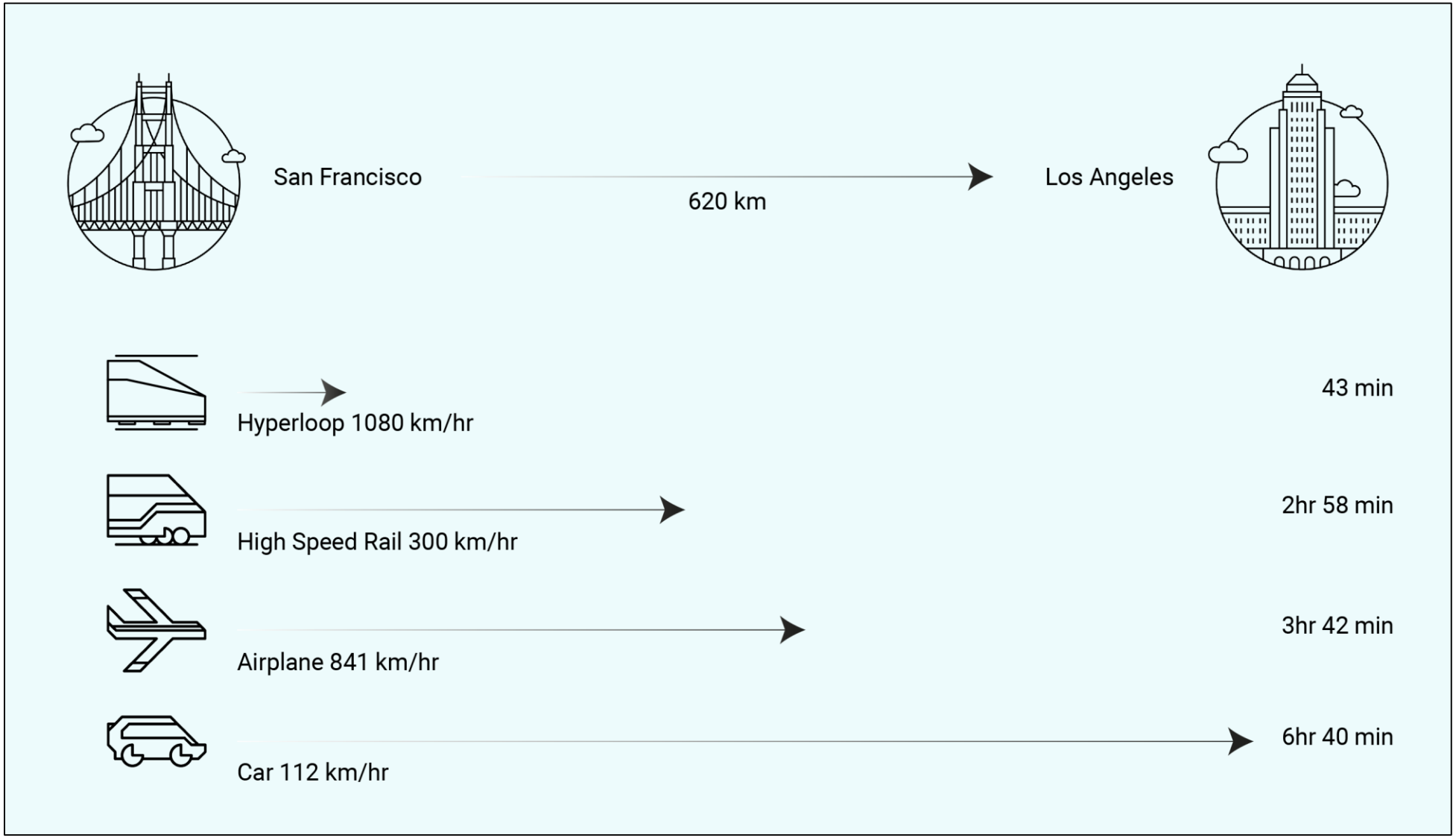
Evoluzione sistemi di trasporto al vuoto – Elon Musk «*hyperloop Alpha*»

Primo studio dell'era moderna che introduce una nuovo sistema di trasporto chiamato "*hyperloop*". Questo Sistema verrà chiamato come il "quinto" Sistema di trasporto dopo aerei, automobili, treni e navi. USA, 2013



Hyperloop Alpha San Francisco – Los Angeles route

Transport mode comparison

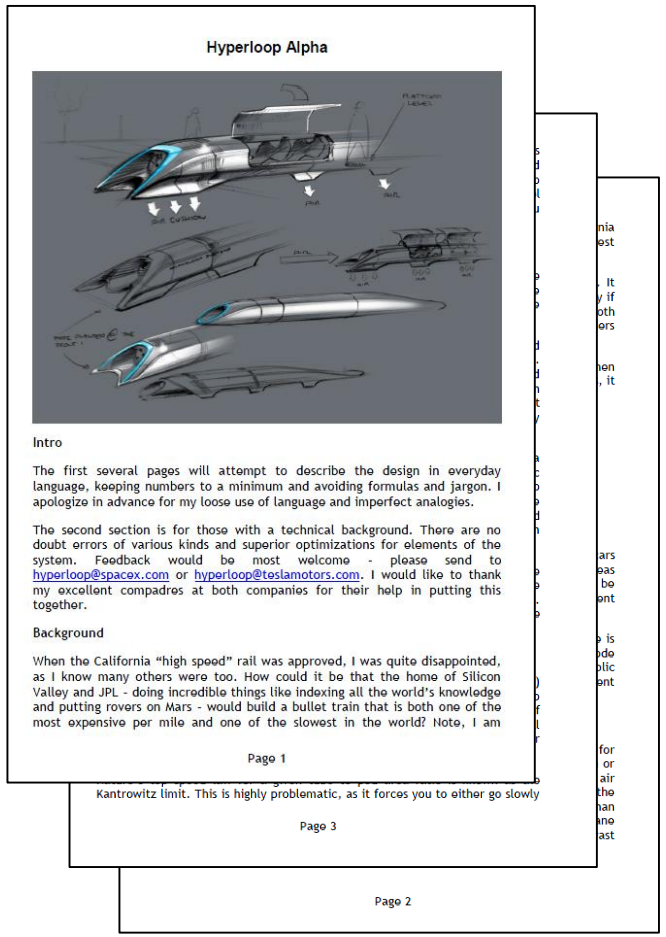


Hyperloop alpha

Caratteristiche principali

VANTAGGI PRINCIPALI

- Piu' sicuro
- Piu' veloce
- Tempi di attesa eliminati
- Costi inferiori
- Immune ai condizioni climatiche
- Energie rinnovabili
- Resistente ai terremoti



CARATTERISTICHE PRINCIPALI

- Veicoli sospesi
- Motore ad induzione elettrica
- Condizioni prossime al vuoto

Elon Musk riprende Il vecchio concetto di sistemi di transporto al vuoto inspirato alla moderna tecnologia Maglev

SOLUZIONI TECNICHE PER LA TECNOLOGIA HYPERLOOP

- Veicoli (capsule)
- Tubi
- Propulsione
- Tracciato
- Sicurezza
- Costi

Hyperloop: vantaggi e svantaggi

Caratteristiche principali e vantaggi

- Utilizza simili principi e tecnologie di propulsione e levitazione magnetica provati, testati ed utilizzati nei sistemi MagLev
- Riduzione significativa dei tempi di viaggio comparati con gli attuali sistemi di trasporto.
- Drastica riduzione della resistenza aerodinamica in quanto opera in ambiente a bassa pressione
- Comsumi estremamente ridotti rispetto ai sistemi attuali ad alta velocità o anche MagLev
- Può operare in qualsiasi condizione climatica ed ambientale

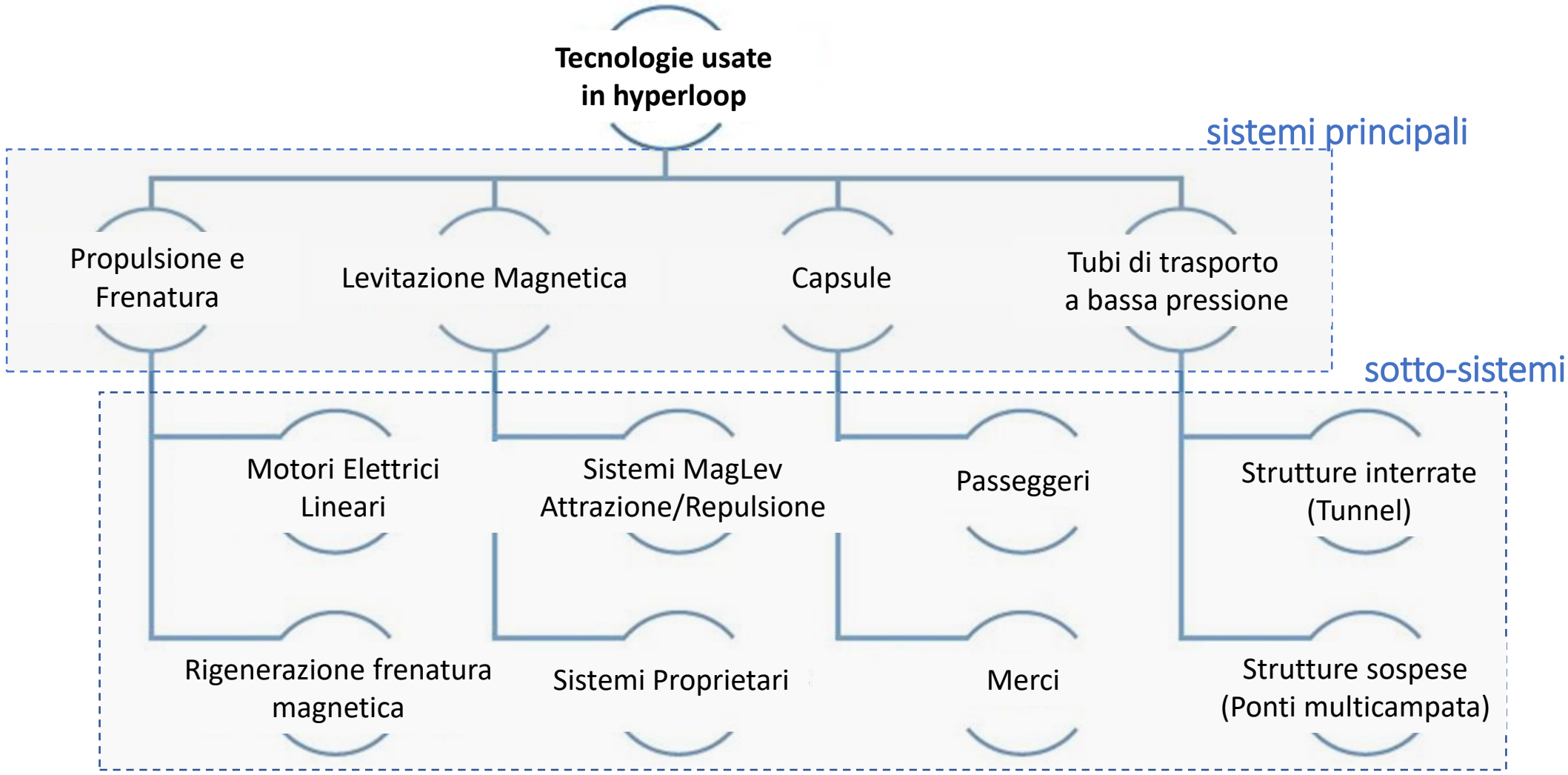
Complessità e svantaggi principali

- La altissima velocità richiede studi approfonditi dello studio delle massime accelerazioni e vibrazioni accettabili per l'organismo umano
- La dinamica del veicolo e la interazione dinamica con la infrastruttura diventa molto complessa operando ad altissime velocità
- Raggiungere e mantenere l'ambiente operativo a bassa pressione
- Sicurezza del sistema di trasporto
- Lo spazio interno è inferiore a quello degli attuali treni A/V
- I carichi termici e l'espansione termica dei tubi influenza in maniera sostanziale la progettazione della infrastruttura

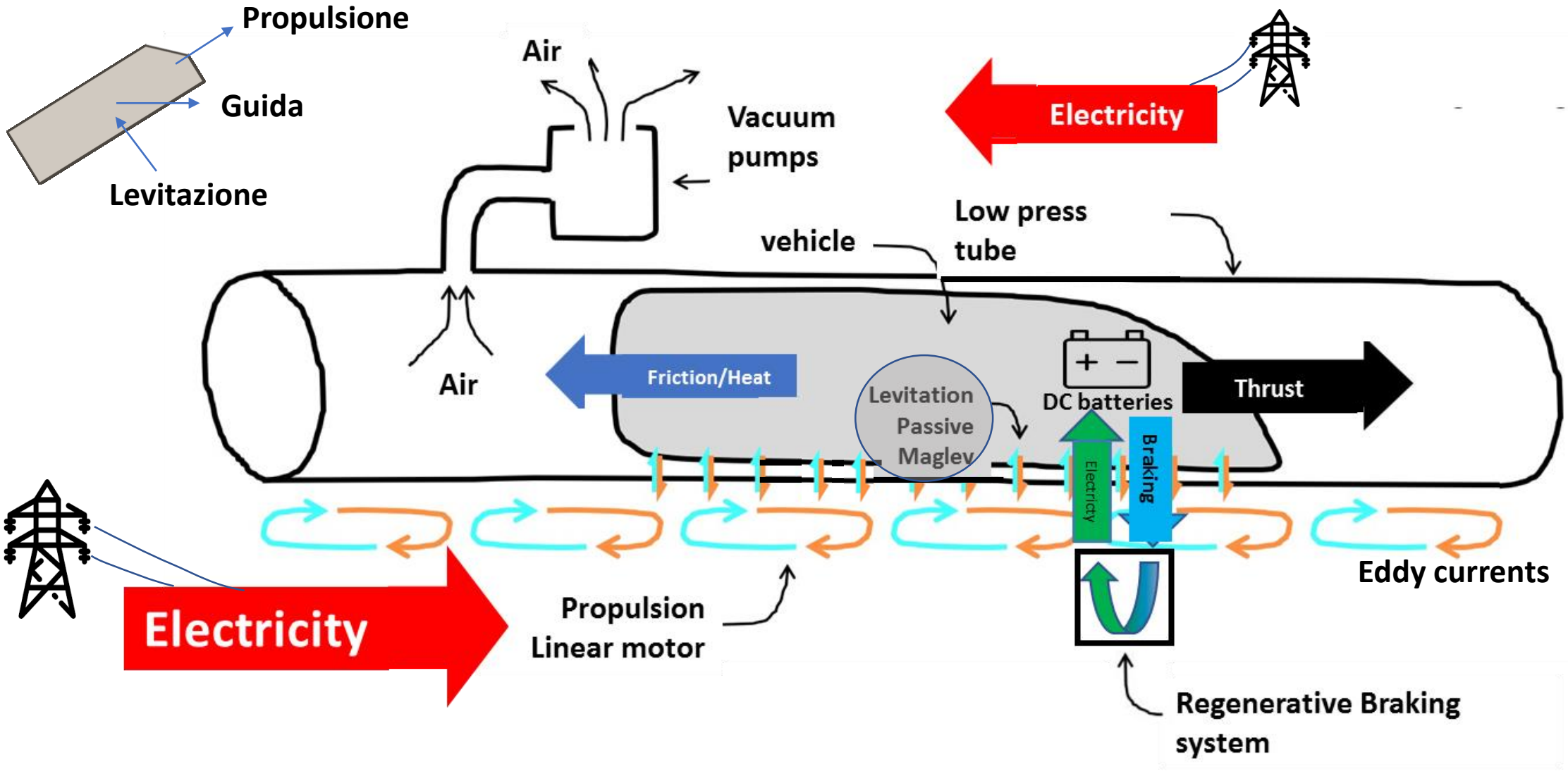
La tecnologia *hyperloop* in pillole

Dentro il sistema di trasporto *hyperloop*

sistemi e sotto-sistemi

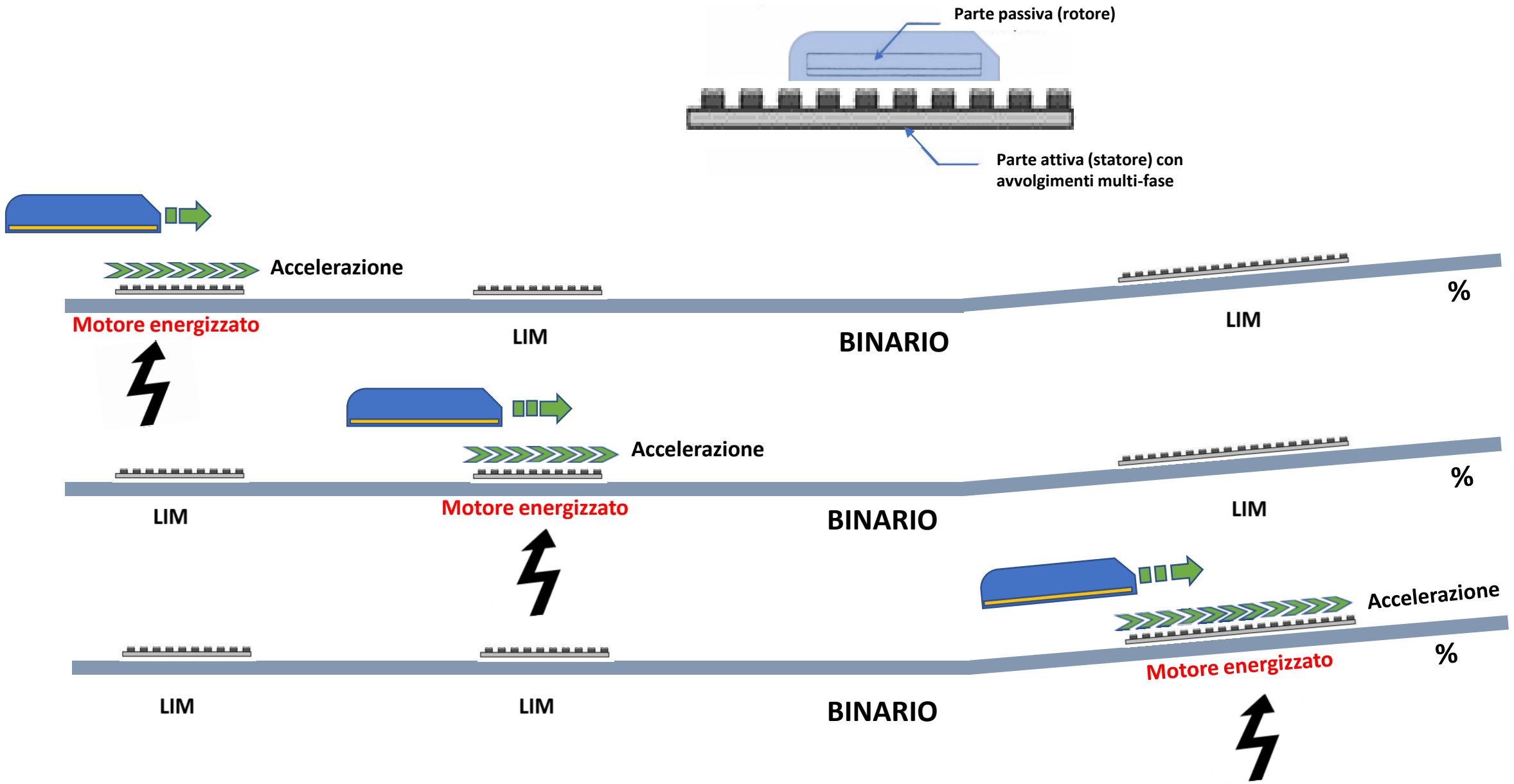


hyperloop: dettagli di funzionamento



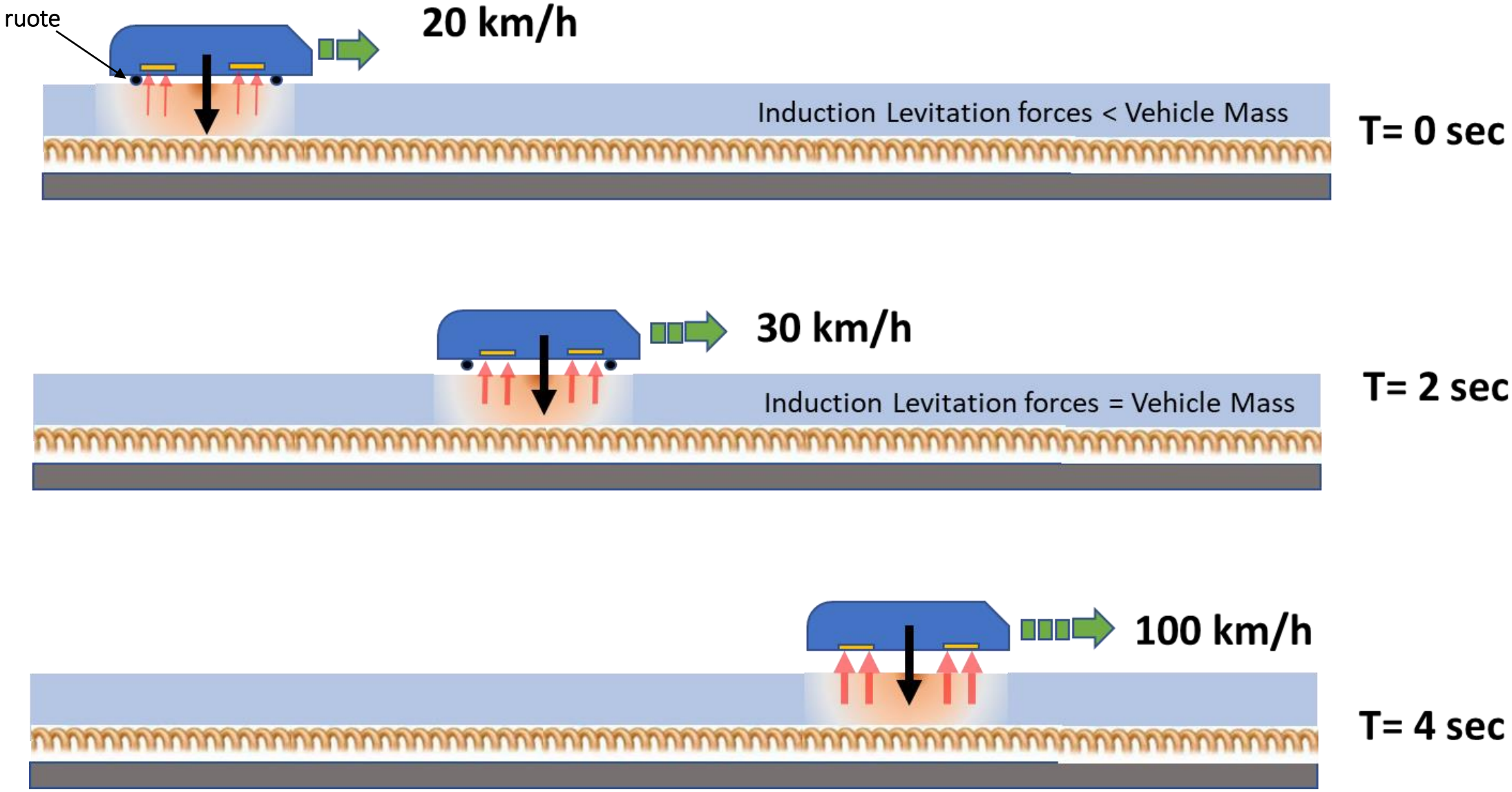
Principi di propulsione *hyperloop*

Motore elettrico ad induzione lineare (LIM) in configurazione (LP)



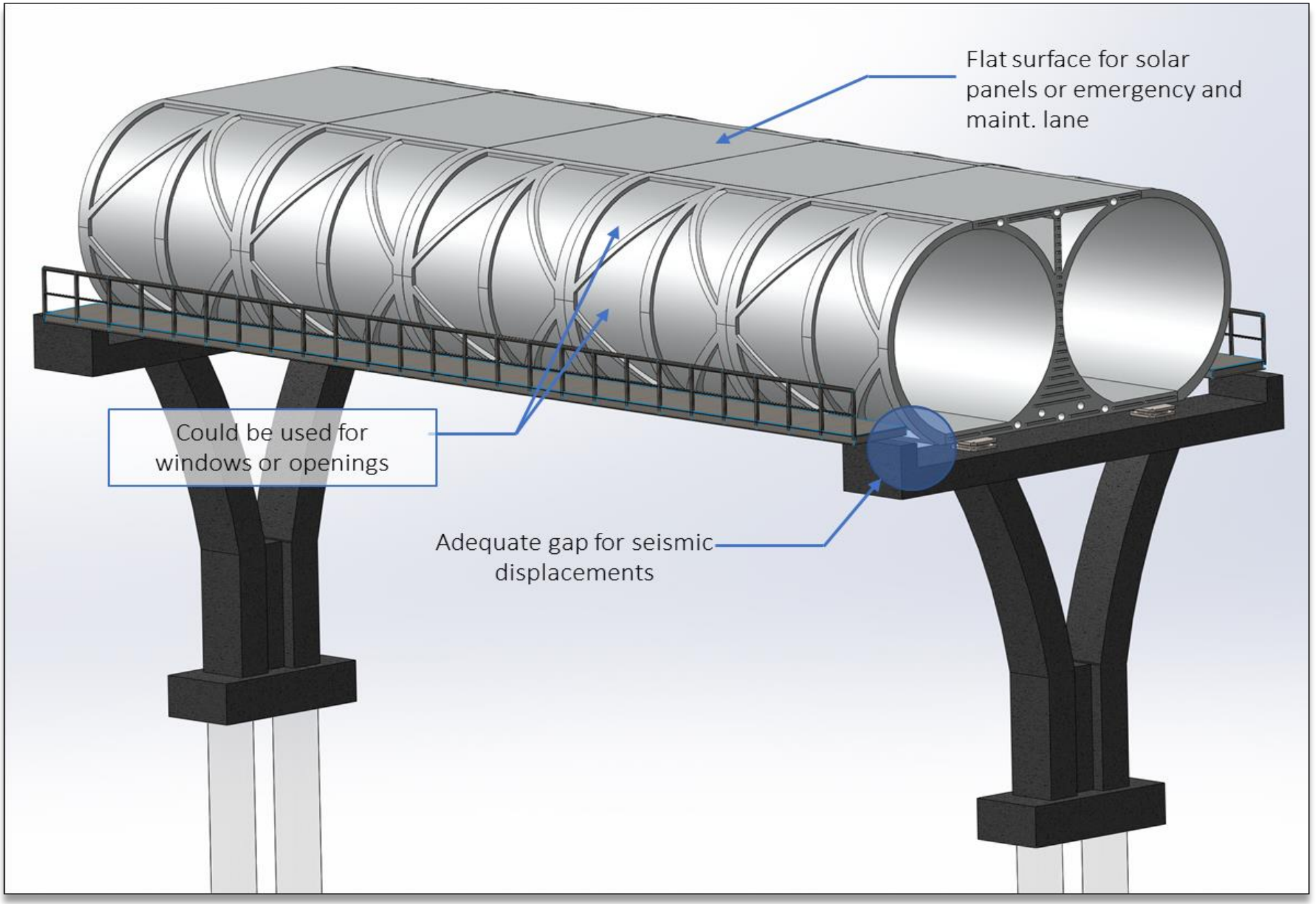
Principi di levitazione *hyperloop*

Campo magnetico indotto proporzionale alla velocità della capsula



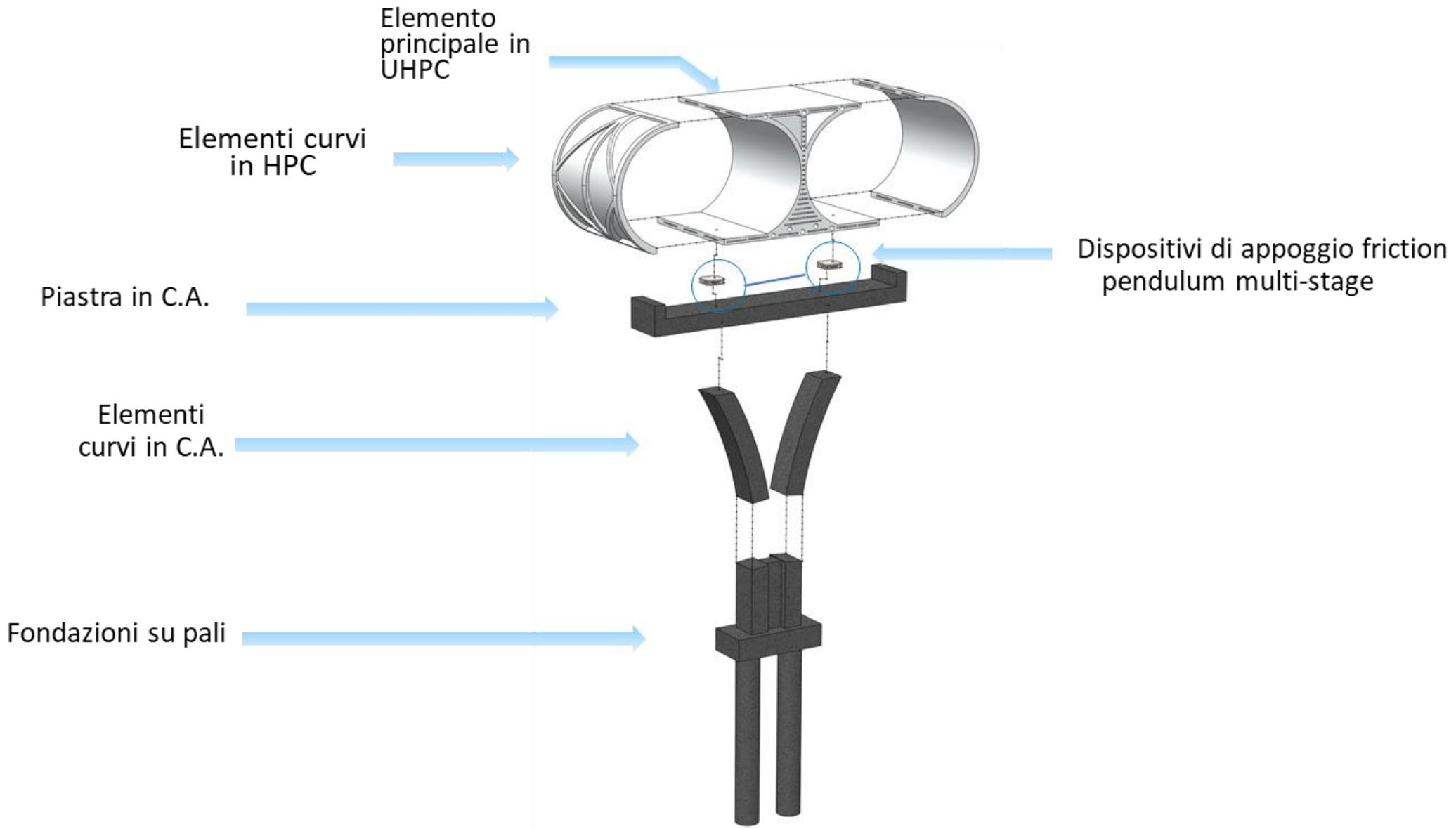
Progettazione preliminare infrastruttura *hyperloop*

Progetto preliminare infrastruttura *hyperloop*



Progetto preliminare infrastruttura *hyperloop*

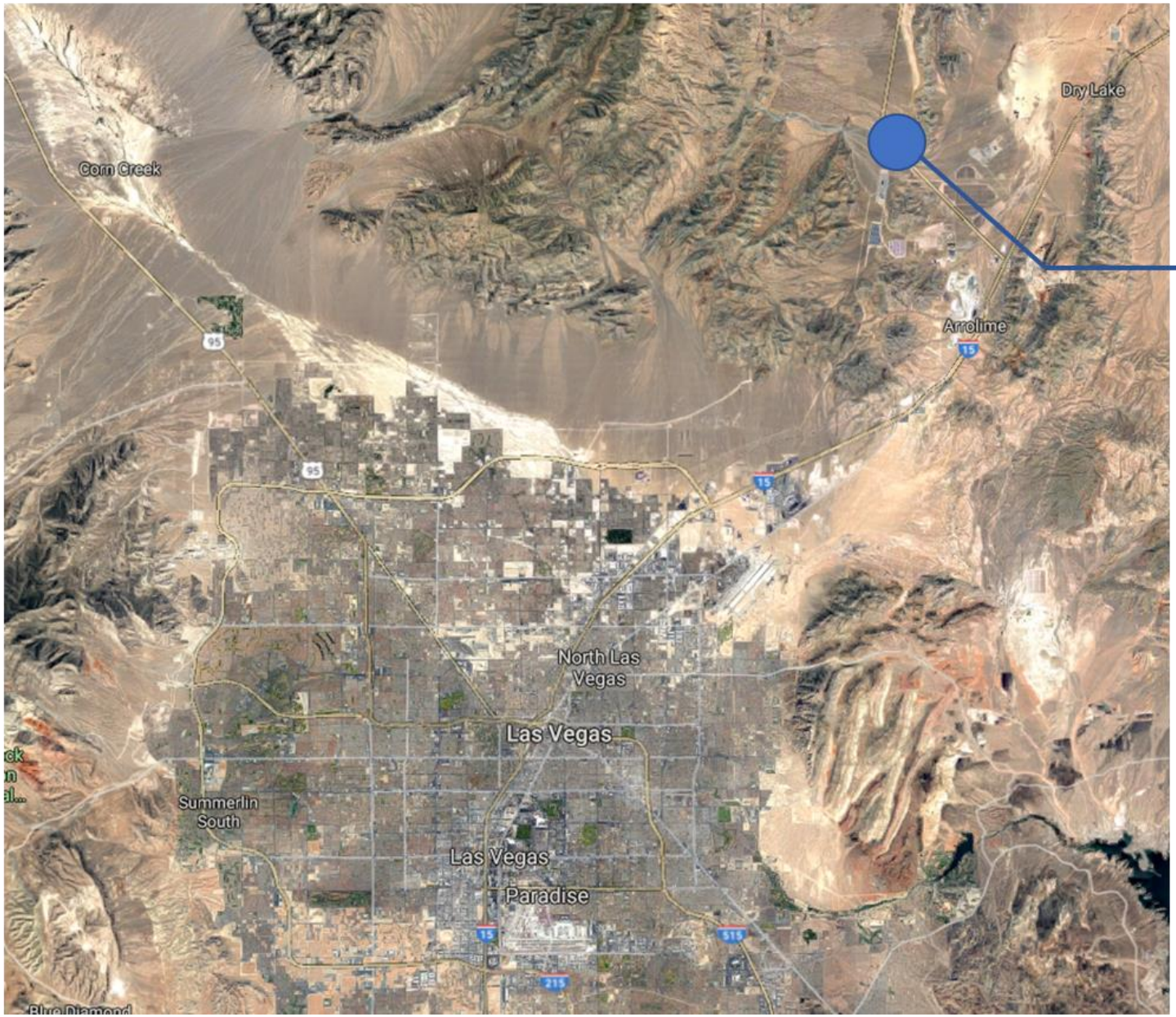
Dettagli costruttivi



Prima struttura test
hyperloop: Las Vegas, NV

Febbraio 2016- Ottobre 2017

Test structure location: North Las Vegas, NV



NORTH APEX
PROJECT SITE

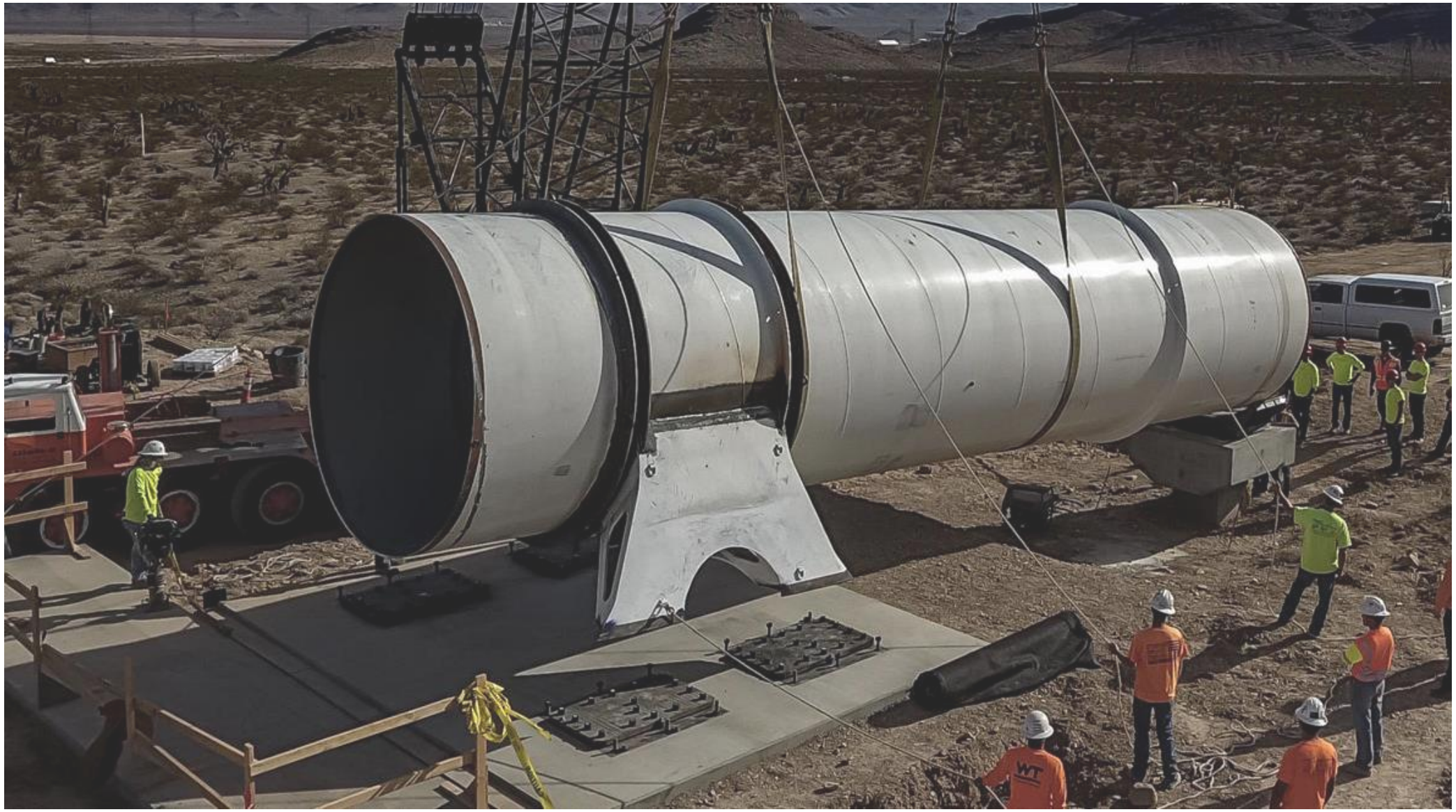
114.951W – 36.42 N

Colonne in c.a. e selle di appoggio in acciaio

Veicolo test – XP1 Pod

- Max OP Weight: 18 kN
- Length: 8.7 m – 2.7 x 2.4 m
- Bogie distance: 4.5 m
- Max bracking force: 270 kN
- Transition speed: 5.5 m/s
- AeroShell: Carbon Fiber panels
- Frame: Aluminium

Allineamento del punto fisso della struttura del tubo



Posizionamento dell’ultimo tratto di tubo

Ispezione delle selle di supporto

Vista generale della struttura test

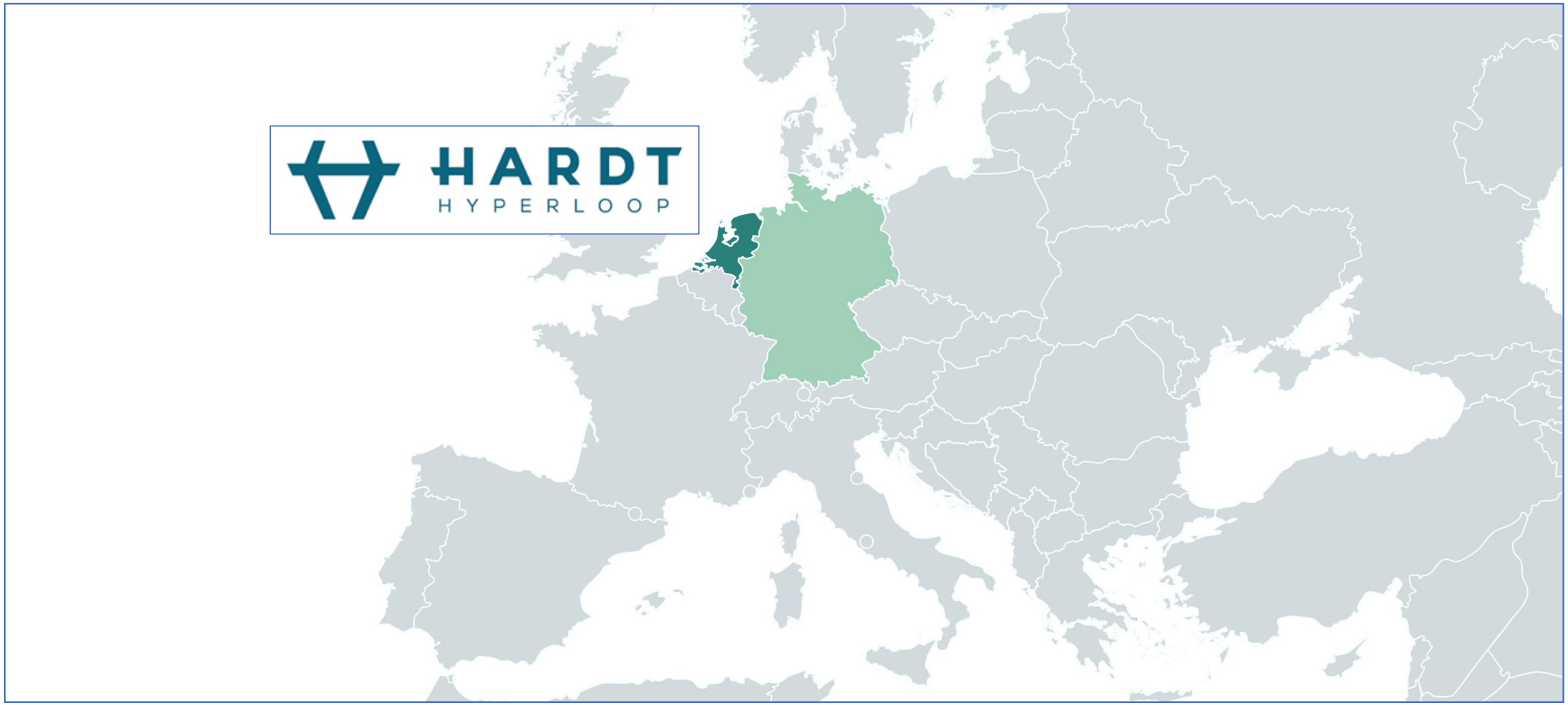
Principali società *hyperloop*
(Marzo 2019)

HARDT HYPERLOOP

HYPERLOOP TRANSPORTATION TECHNOLOGIES

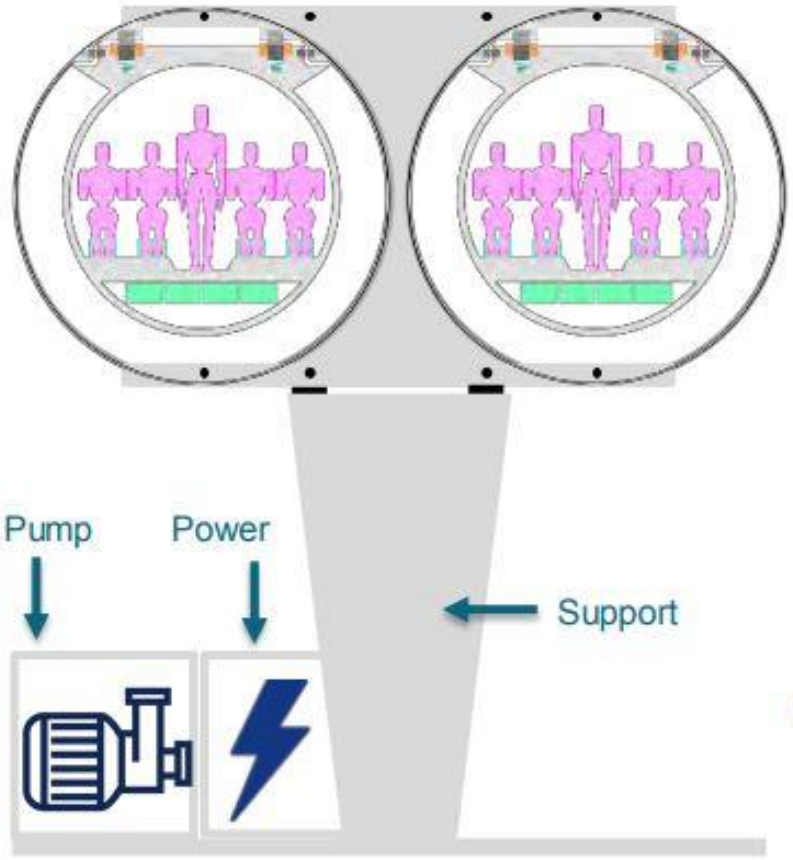
TRANSPOD

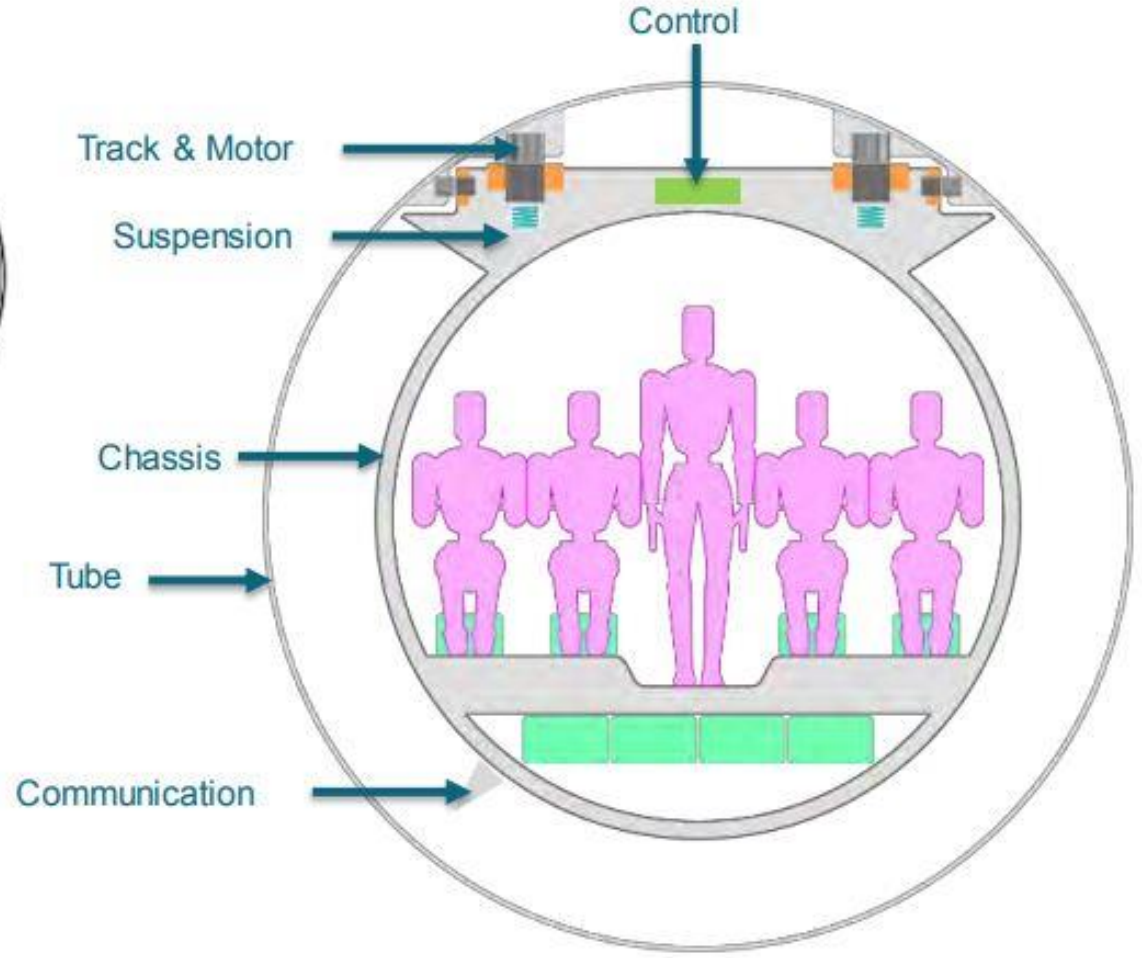
Virgin hyperloop one


HARDT
HYPERLOOP

HARDT HYPERLOOP

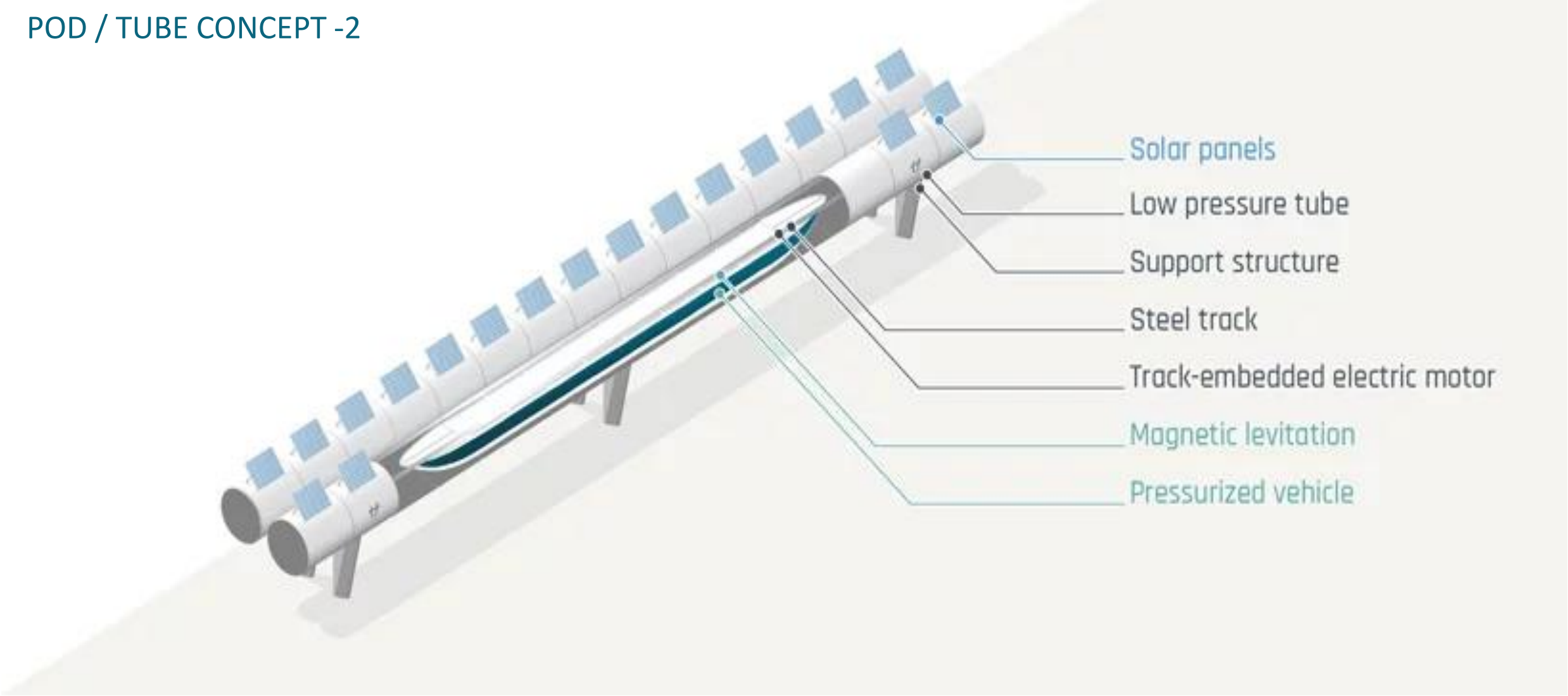
POD / TUBE CONCEPT -1





HARDT HYPERLOOP

POD / TUBE CONCEPT -2



HARDT
HYPERLOOP

HIGH SPEED TEST STRUCTURE (TBC)

- Location: Flevoland, NL
- Length: 5km
- Tube diameter: 3 meters , steel
- Open access to test other companies vehicles

HYPERLOOP
TRANSPORTATION TECHNOLOGIES

HYPERLOOP
TRANSPORTATION TECHNOLOGIES

LOW SPEED TEST TRACK - Toulouse

Length: 320 m -Lifespan: 2 yrs

Material: Carbon Steel S355

HYPERLOOP
TRANSPORTATION TECHNOLOGIES

ABU- DHABI ROUTE EXPO 2020 TBC

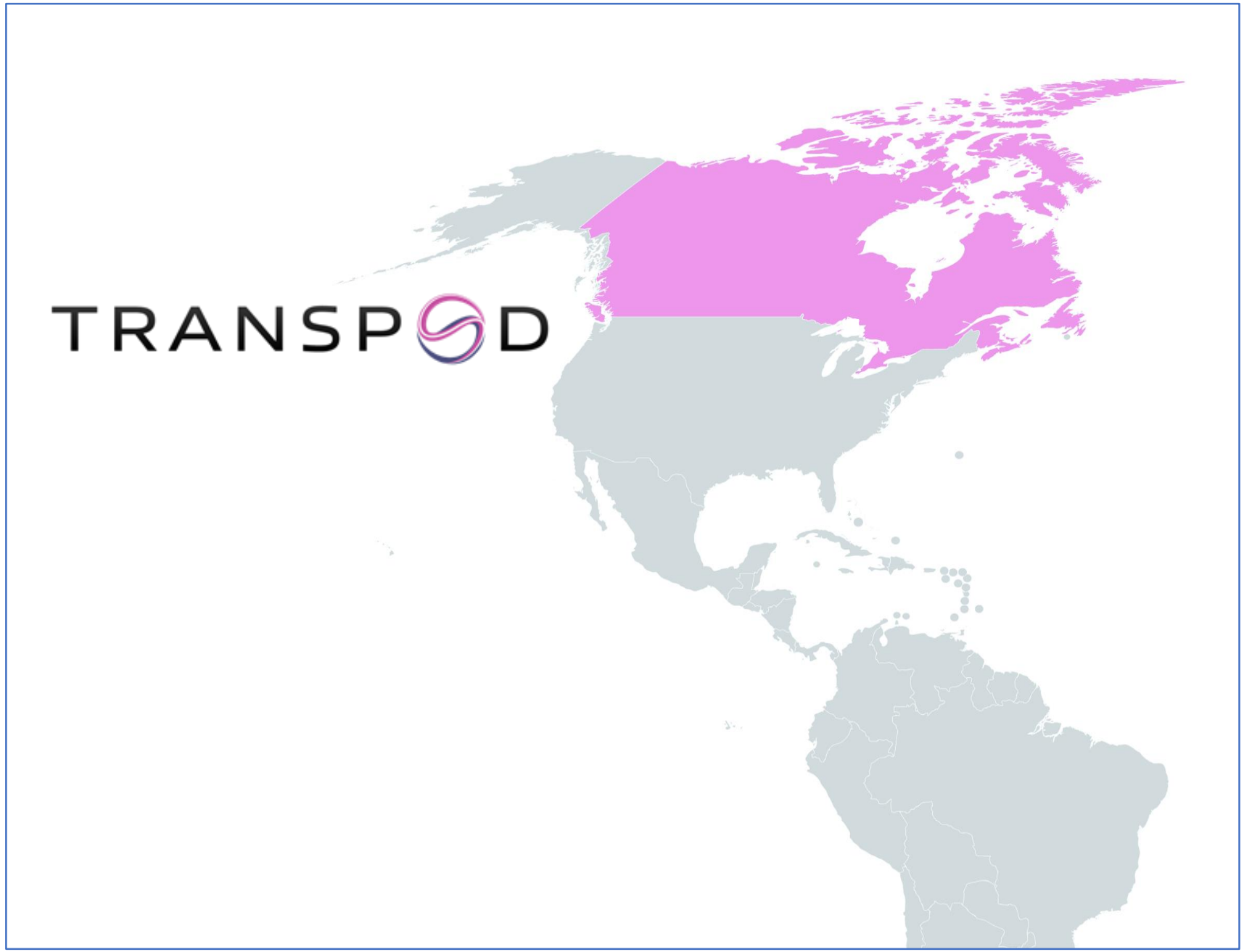
Start Construction :Q3 2019?
Total Route: 87 km

- ABU DHABI CITY
- YAS ISLAND (TOURISTIC PORT)
- AUH (INTL. ABU DHABI AIRPORT)
- AL GHADEER VILLAGE

Single Tube bidirectional
First 10 km to be operational 2020 (!)

General Contractor: ALDAR
(Same of Al Ghadeer Village)

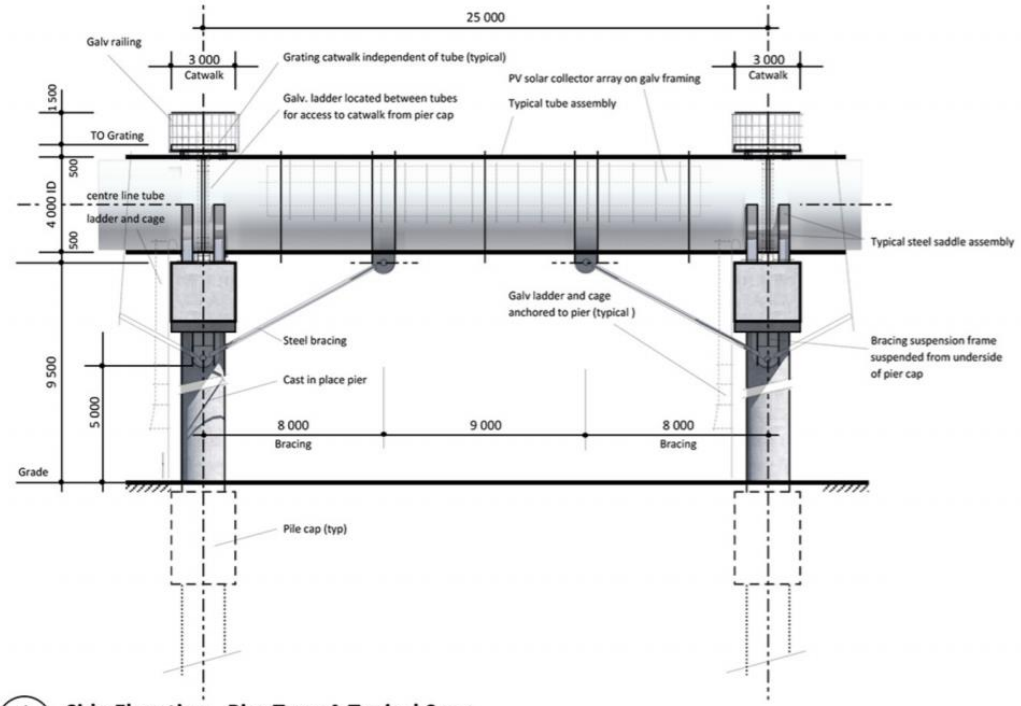
No preliminary design disclosed
No tests performed (Nov 2019)


TRANSPOD

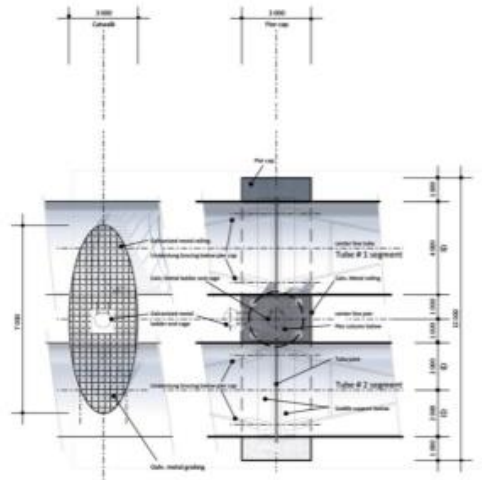
TRANSPOD

Conceptual infrastructure (TYP)
Spiral Welded Steel tube – 4m diam

Typical Pier Loading Assumptions		
Tube dead load	2.5	tons per meter
Tube dead load safety factor	1.8	
Tube dead load per 25 m segment	112.5	tons
Vehicle dead load per tube, incl safety factor	60	tons
Tube + vehicle dead load	172.5	tons
Number of tubes per pier	2	
Total tube + vehicle dead load	**345**	**tons**

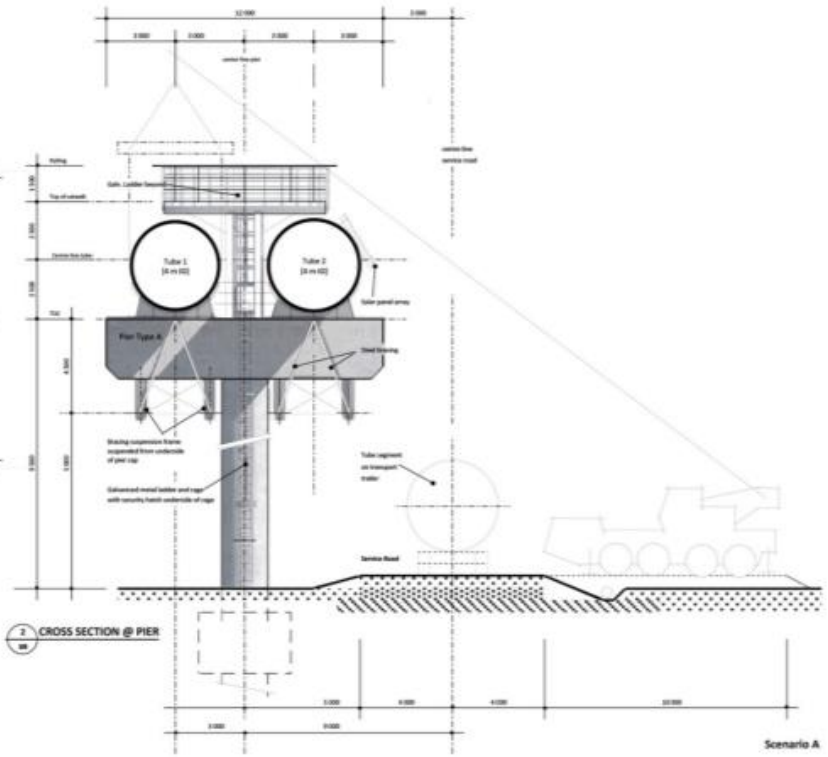


1/102 **Side Elevation - Pier Type A Typical Span**



1/102 PLAN @ CATWALK

2/102 PLAN @ PIER CAP



2/102 CROSS SECTION @ PIER

Scenario A

TRANSPOD

Conceptual pod

Aircraft-based fuselage

Axial Compressor to bypass air flow

Linear magnetic propulsion drive

Pressurization and thermal management

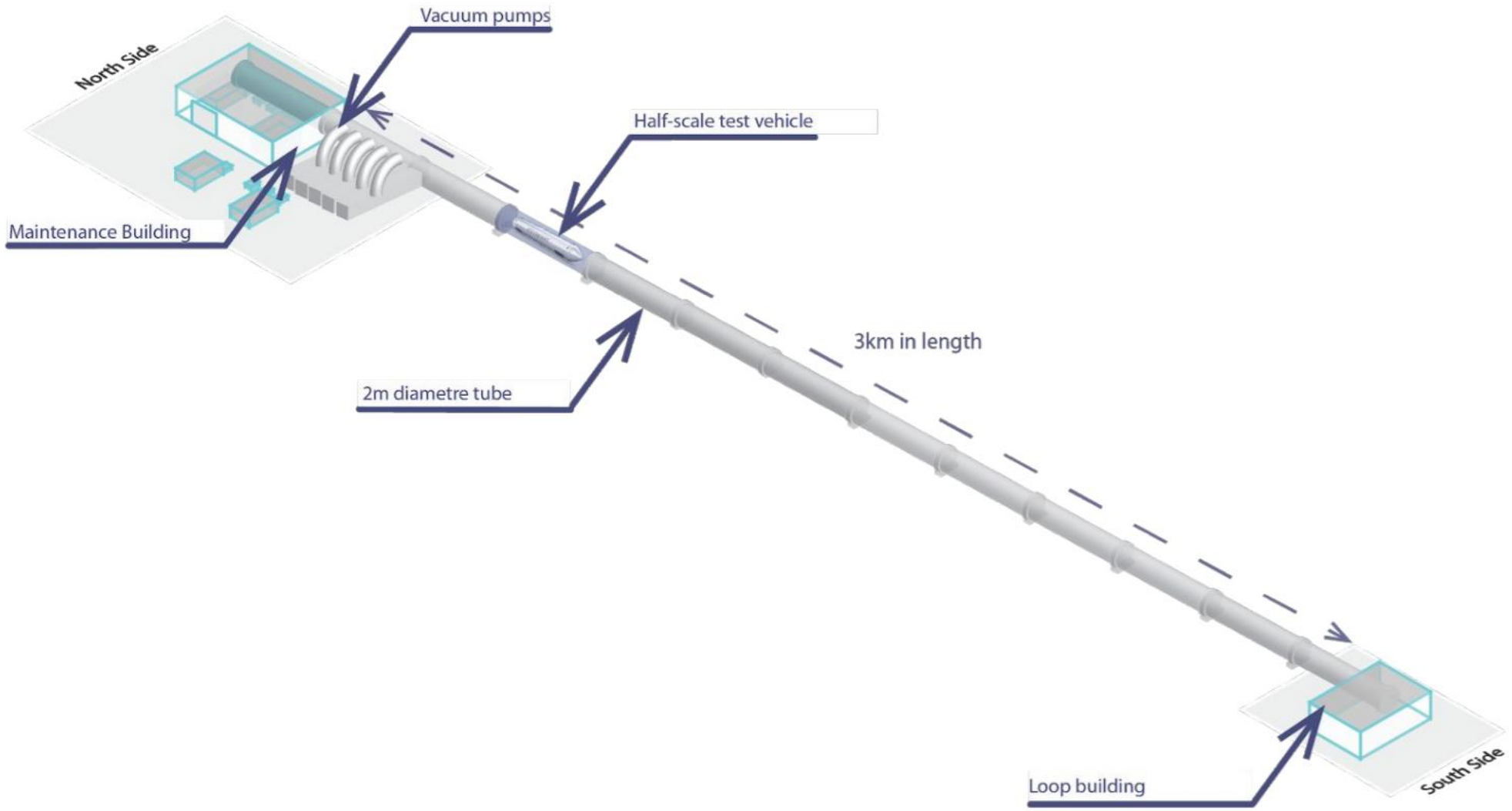
Aircraft-based cabin air system

Levitation System for reduced friction

TRANSPOD

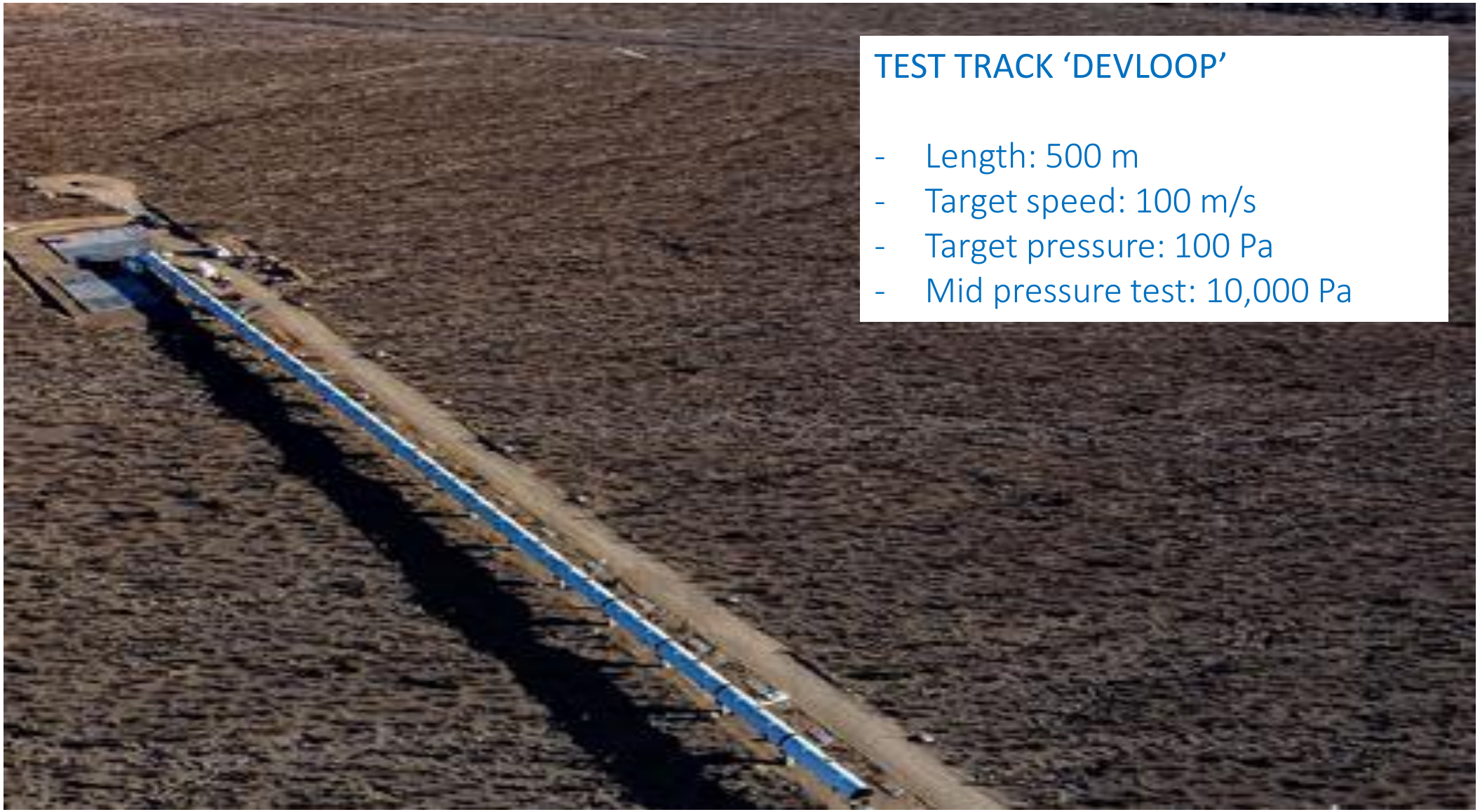
TEST STRUCTURE (coordinated by Hyperloop Limonges)

Scheduled 1Q2018 – not yet started construction



Virgin hyperloop one

Virgin hyperloop one



TEST TRACK ‘DEVLOOP’

- Length: 500 m
- Target speed: 100 m/s
- Target pressure: 100 Pa
- Mid pressure test: 10,000 Pa

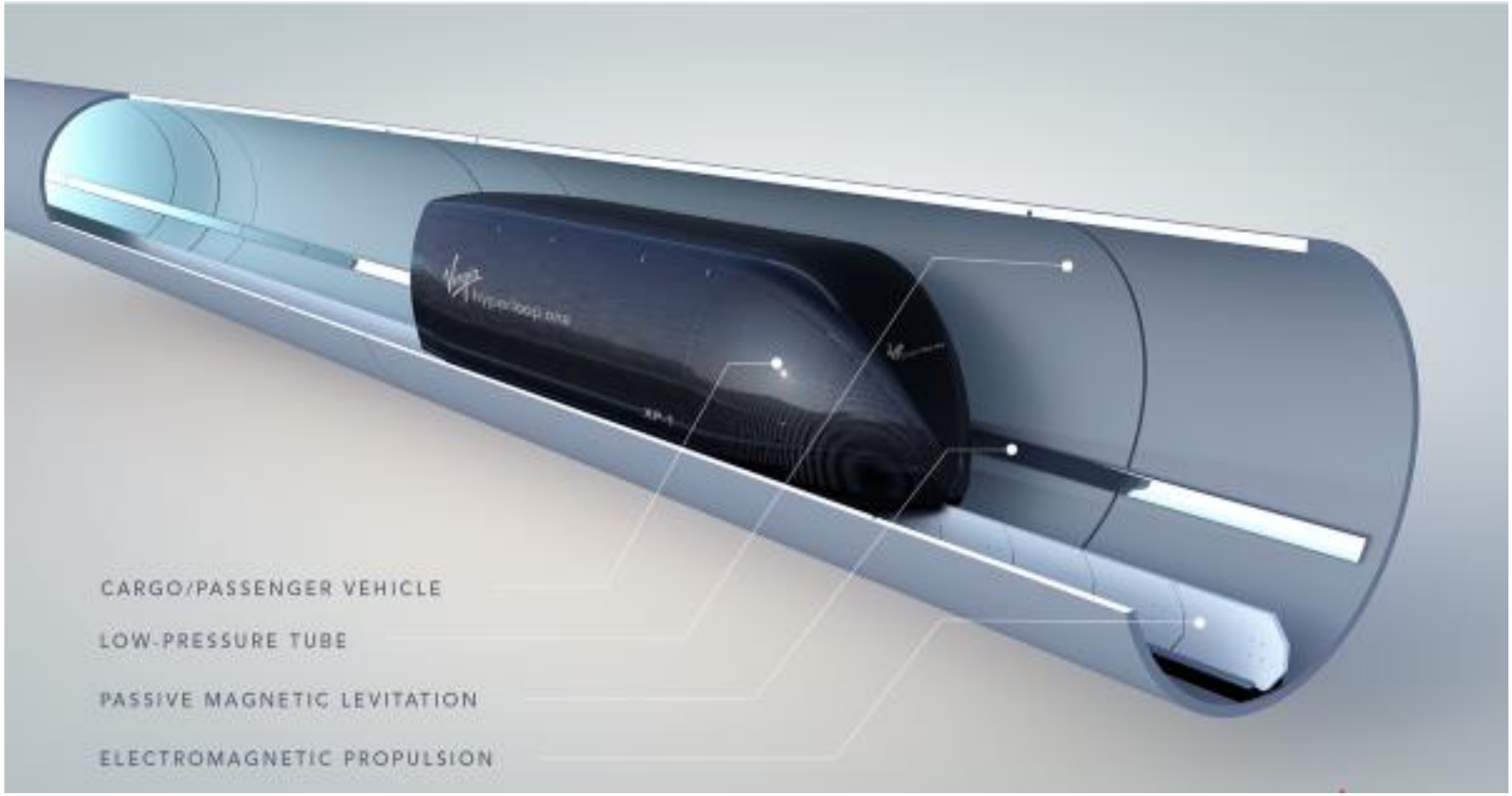
Virgin hyperloop one

TEST CAPSULE: XP1

- Max OP Weight: 18 kN
- Length: 8.7 m – 2.7 x 2.4 m
- Bogie distance: 4.5 m
- Max bracking force: 270 kN
- Transition speed: 5.5 m/s
- AeroShell: Carbon Fiber panels
- Frame: Aluminium

Virgin hyperloop one

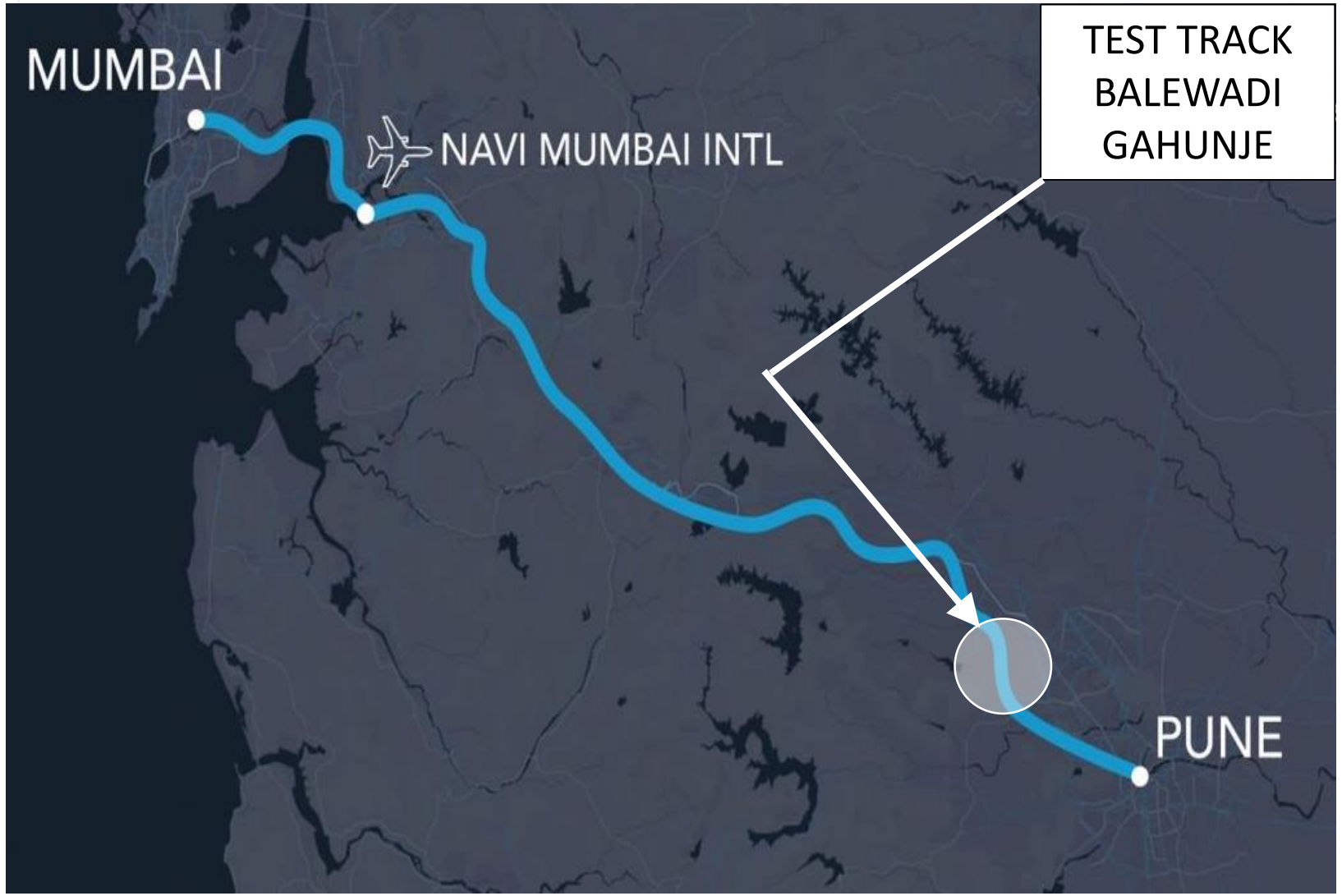
TEST TRACK ‘DEVLOOP’ -Tube 3.3 m tk 19.4 thk



Virgin hyperloop one

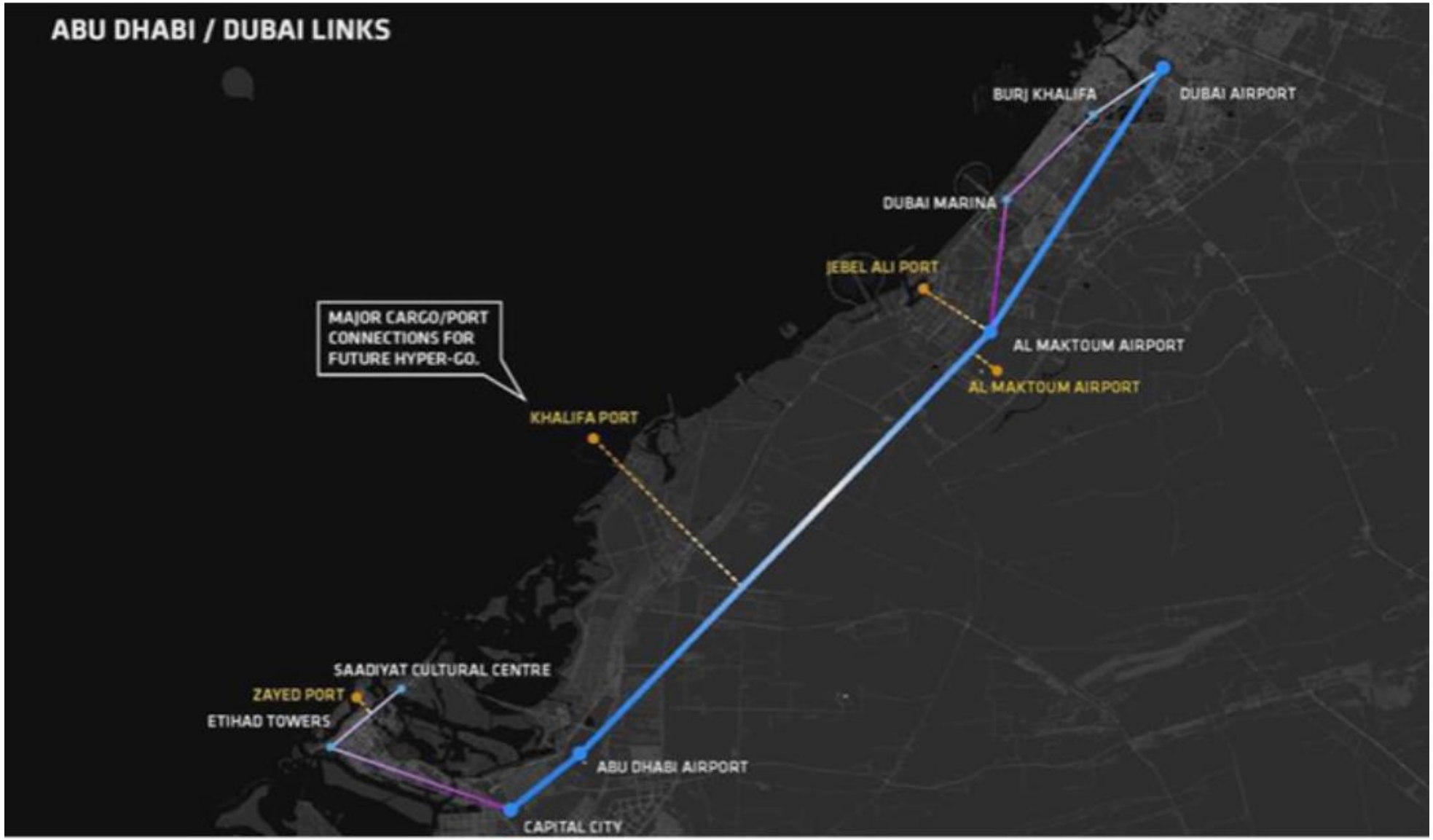
FIRST REAL-SCALE TRACK
Location: Balewadi – Gahunje (Maharashtra region)
Length: 15 km
Tube diam: 4.7 m (TBC)
Material: Concrete (TBC)
Configuration: Single / Double tube system
Peak speed: 750 km/h
Estimated min travel time: 127 sec
Starting construction: Q1 2020
Ending constructio: Q2 2022

Part of the project MUMBAI-PUNE
Peak speed: 900 km/h
Avg speed: 500 km/h
Travel distance: 200 km
Travel time: 25 min



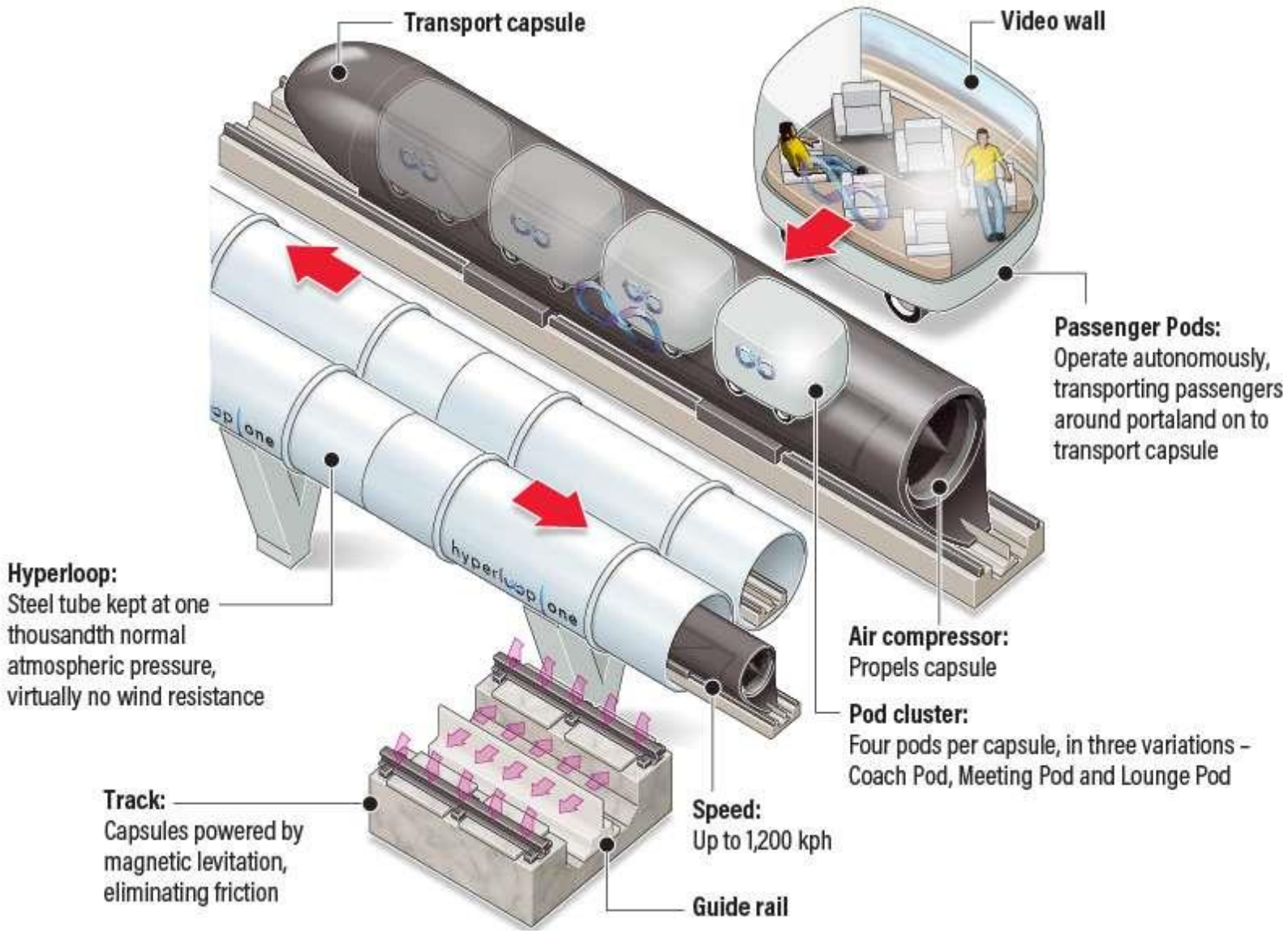
UAE Hyperloop

Proposed routes



UAE Hyperloop

Proposed autonomous capsule system(Passengers / Freight)



Renderings della infrastruttura *hyperloop*

UAE Hyperloop renderings

Docking station

UAE Hyperloop renderings

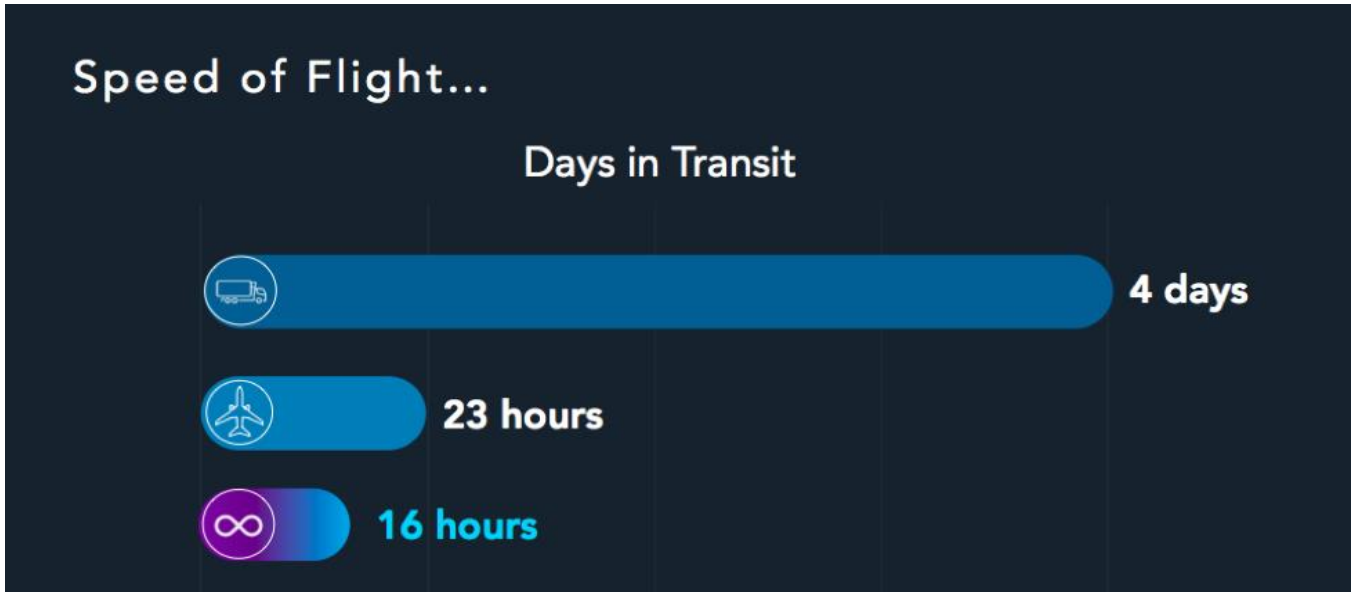
Transfer Passenger Station

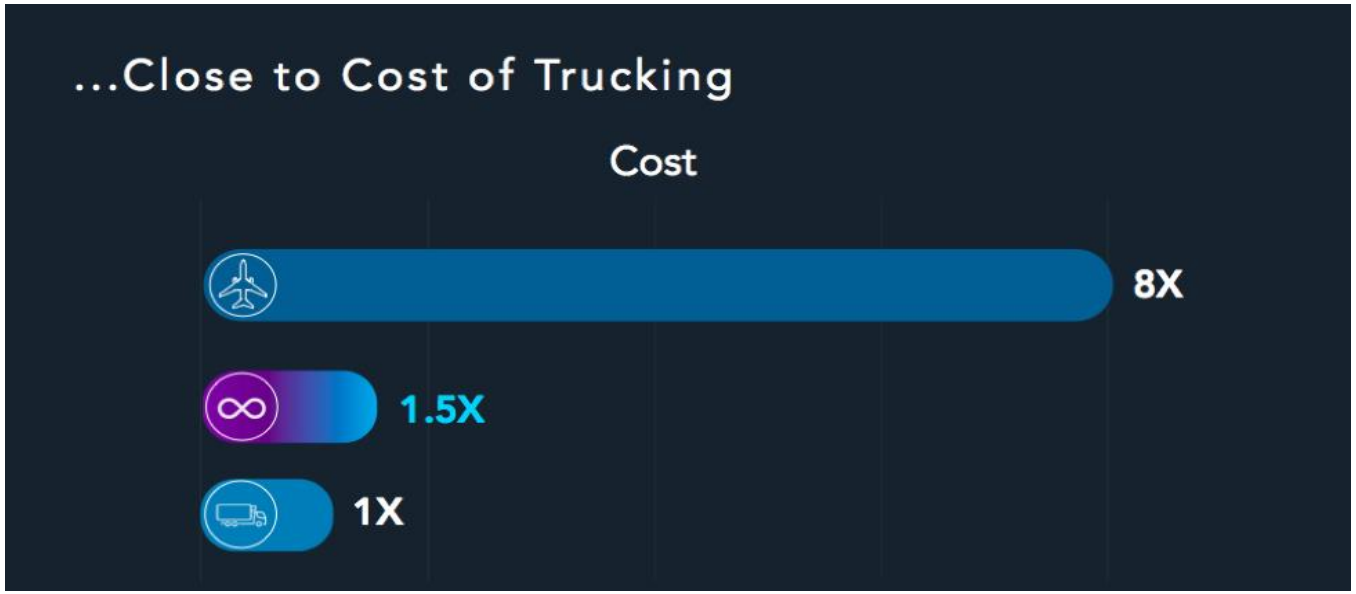
UAE Hyperloop Cargo

Sistema di carico capsule hyperloop (cargospeed)

UAE Hyperloop Cargo

comparazione con sistemi attuali di trasporto





Hyperloop: Creazione delle Macro-regioni


Hamburg
Copenhagen
Stockholm
Gdansk
Kaliningrad
Tallin
Helsinki
Ust-Luga
Saint-Petersburg
The Nordic Hyperloop
Гамбург 1600
610
о. Борнхольм (Дан.)
о. Эланд (Швец.)
о. Сааремаа (Эст.)
Аландские о-ва (Фин.)
Ботнический залив
Рижский залив
ВАЛТИЙСКОЕ МОРЕ
ВСКАНДИНАВСКИЙ П
РИГА
ЭСТОНИЯ
ЛАТВИЯ
ЛИТВА
ВИЛЬНЮС
ПСКОВ
Балтийск
Медвежьегорск
Беломорск
Кола
Выборг

Tempi medi di percorso capitali europee Stochholm/Helsinki/Tallinn

Aereo

Ferry

Nordic Super Region – alternativa *hyperloop*

Studio di Fattibilità Sweden to Finland / Estonia to Finland

FS LINKS – KPMG - RAMBÖLL

Collegare Stockholm con Helsinki e Tallinn (ed alter città lungo il percorso) creerebbe una attiva “Super-Regione” a tessuto urbano.

Queste rotte hanno un grande potenziale di traffico merci e passeggeri.

Milioni di passeggeri transitano su queste rotte annualmente e molti di questi utilizzano attualmente le navi (anche se non per tutto l’anno)

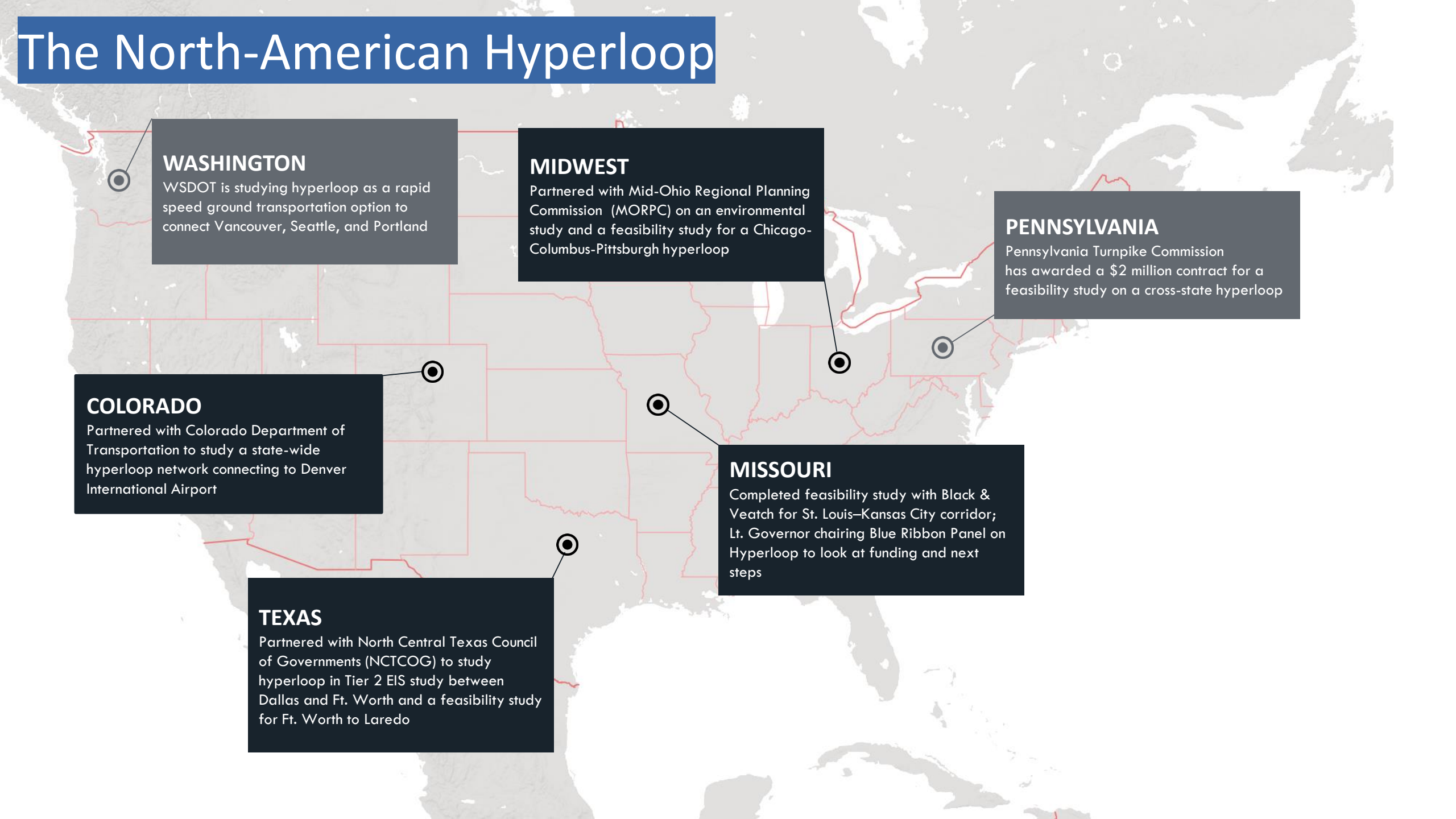
Il notevole impatto economico aumenterebbe il GDP pro-capite ed il valore del suolo.

Nordic Hyperloop con espansione verso la Russia – St. Petersburg gateway verso l'oriente

Nordic Hyperloop renderings

Docking station / Port – (Helsinki – Tallinn link)

The North-American Hyperloop



WASHINGTON

WSDOT is studying hyperloop as a rapid speed ground transportation option to connect Vancouver, Seattle, and Portland

MIDWEST

Partnered with Mid-Ohio Regional Planning Commission (MORPC) on an environmental study and a feasibility study for a Chicago-Columbus-Pittsburgh hyperloop

PENNSYLVANIA

Pennsylvania Turnpike Commission has awarded a $2 million contract for a feasibility study on a cross-state hyperloop

COLORADO

Partnered with Colorado Department of Transportation to study a state-wide hyperloop network connecting to Denver International Airport

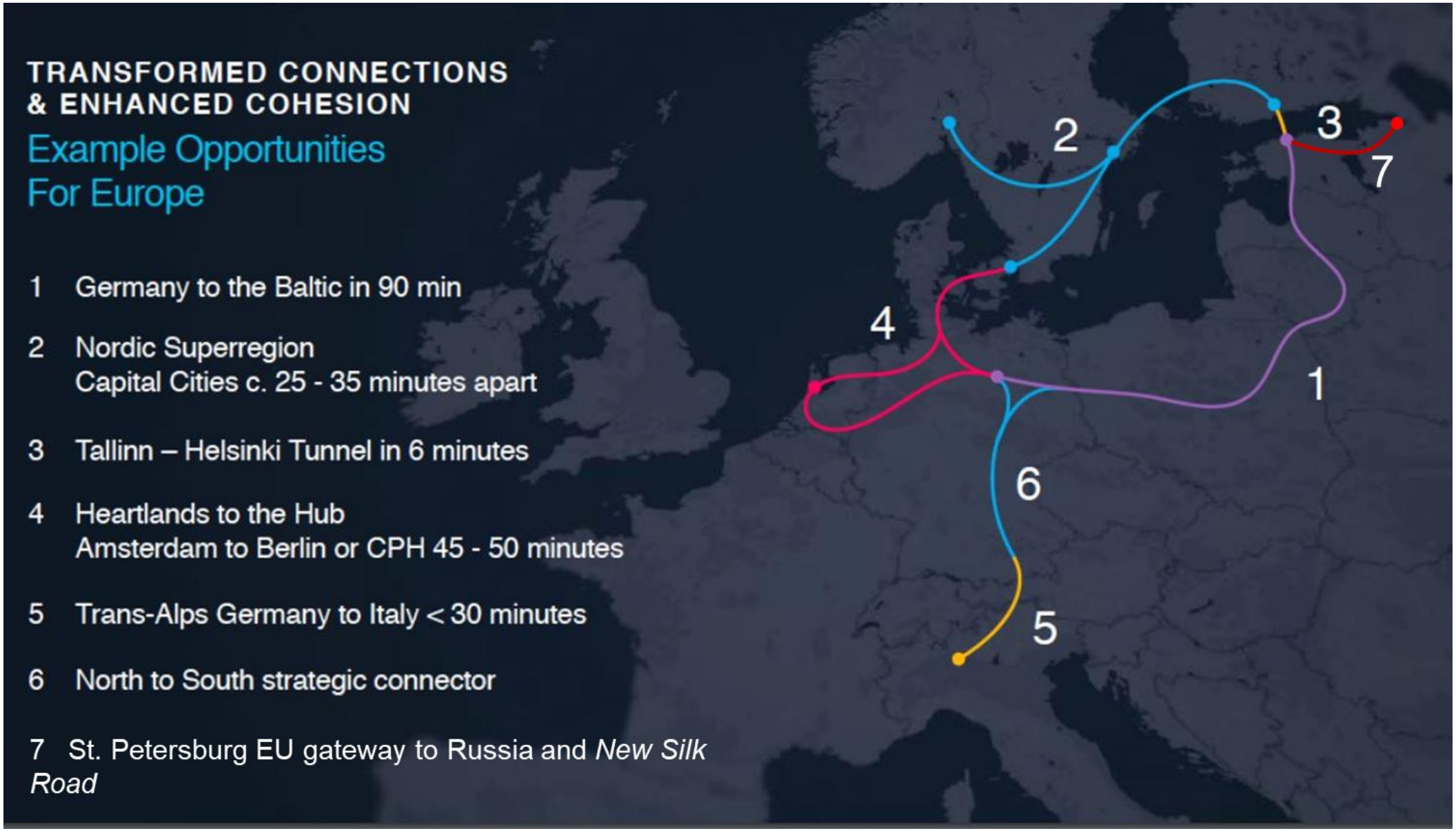
MISSOURI

Completed feasibility study with Black & Veatch for St. Louis–Kansas City corridor; Lt. Governor chairing Blue Ribbon Panel on Hyperloop to look at funding and next steps

TEXAS

Partnered with North Central Texas Council of Governments (NCTCOG) to study hyperloop in Tier 2 EIS study between Dallas and Ft. Worth and a feasibility study for Ft. Worth to Laredo

The European Hyperloop



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Grazie!