

# Solar Podcars: A New Vision

Ron Swenson

*New Energy Systems: Electrifying Transportation*

***Solar 2018***

*August 6, 2018*



SPARTAN<sup>TM</sup>  
SUPERWAY



**International Institute of Sustainable Transportation**

**[www.inist.org](http://www.inist.org)**



# I'm going to talk about **Solar Powered Automated Rapid Transit Ascendant Networks**





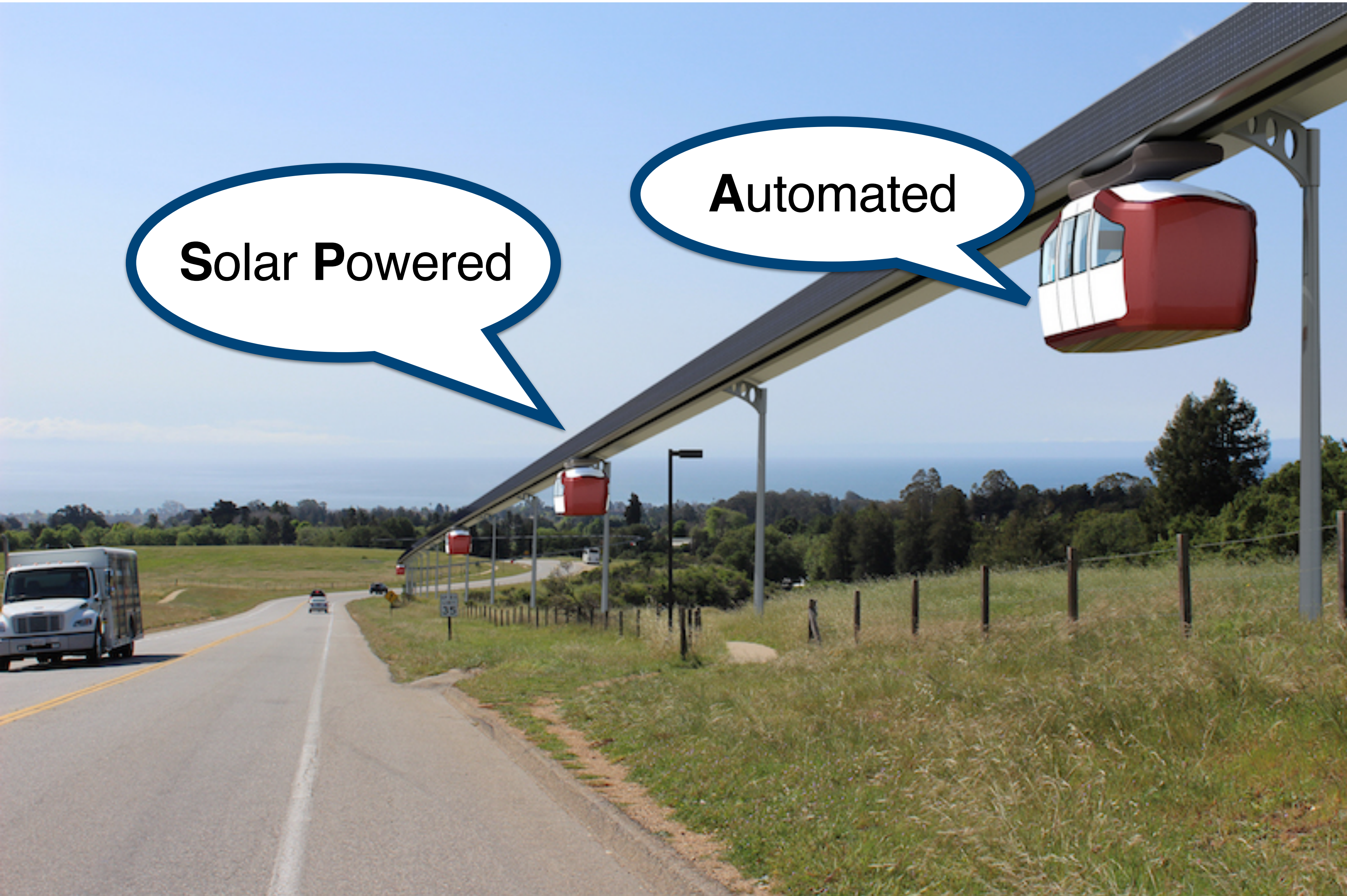
# I'm going to talk about **Solar Powered Automated Rapid Transit Ascendant Networks**

**Solar Powered**





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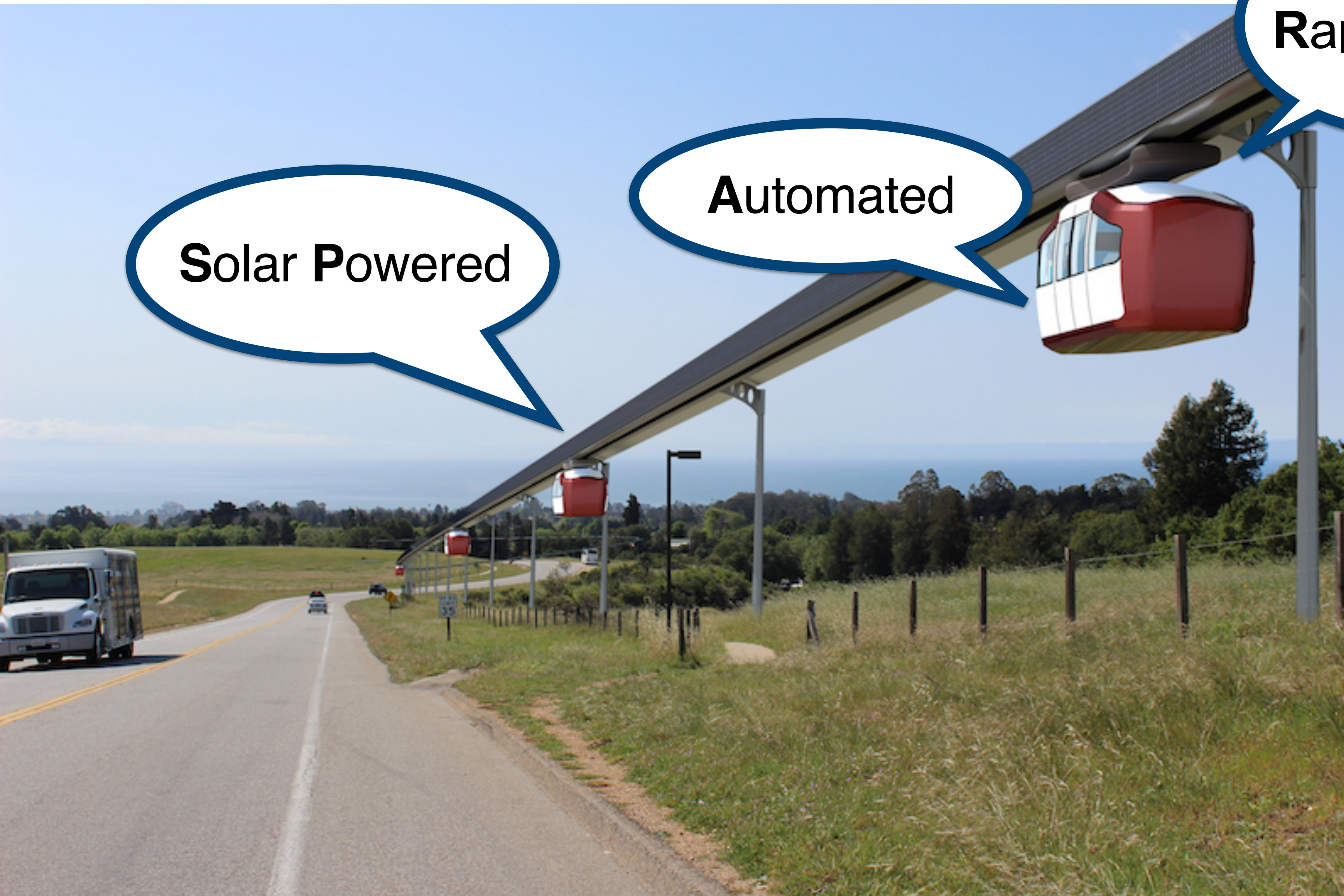


**Solar Powered**

**Automated**



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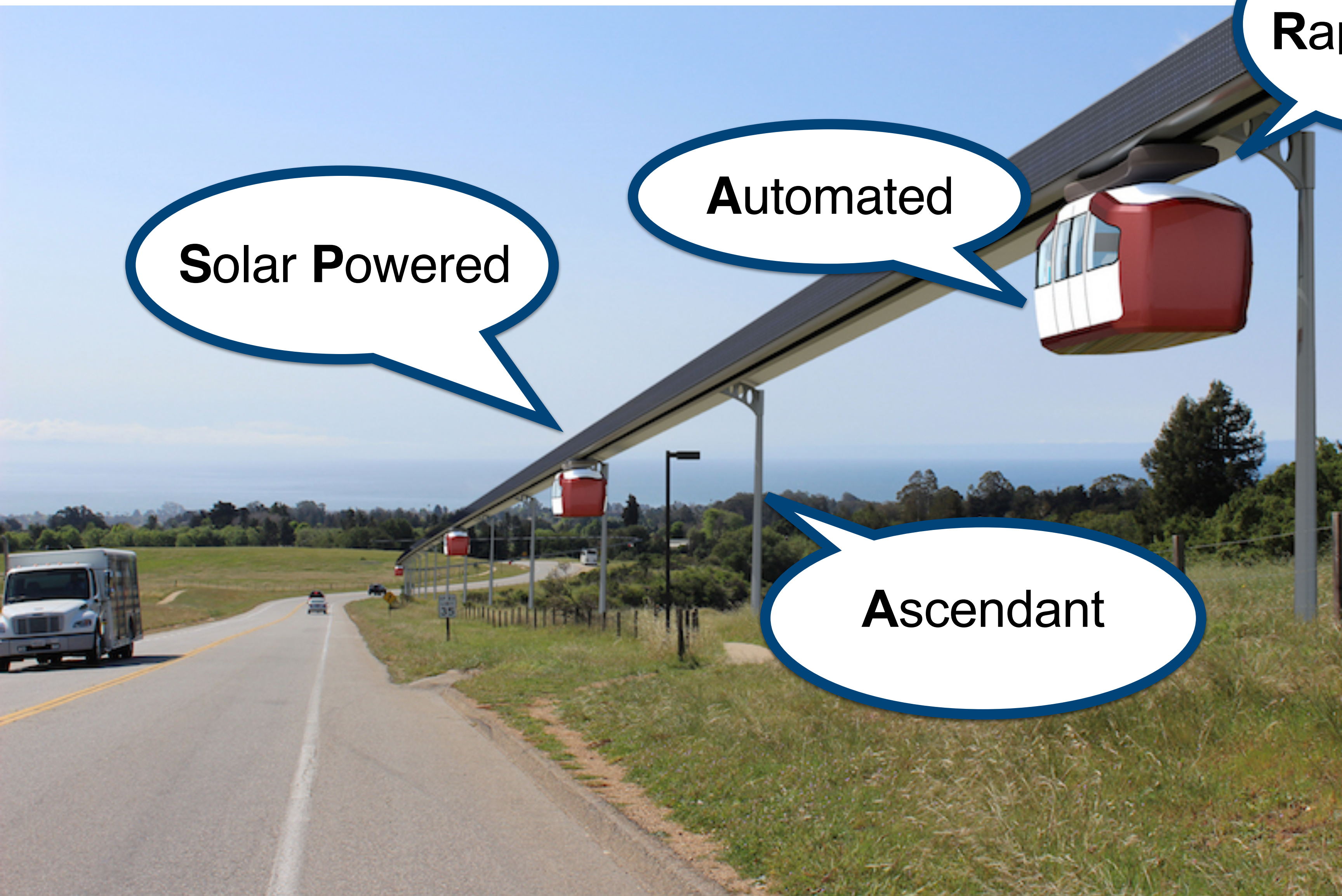
**Solar Powered**

**Automated**

**Rapid Transit**



# I'm going to talk about **Solar Powered Automated Rapid Transit Ascendant Networks**



**Solar Powered**

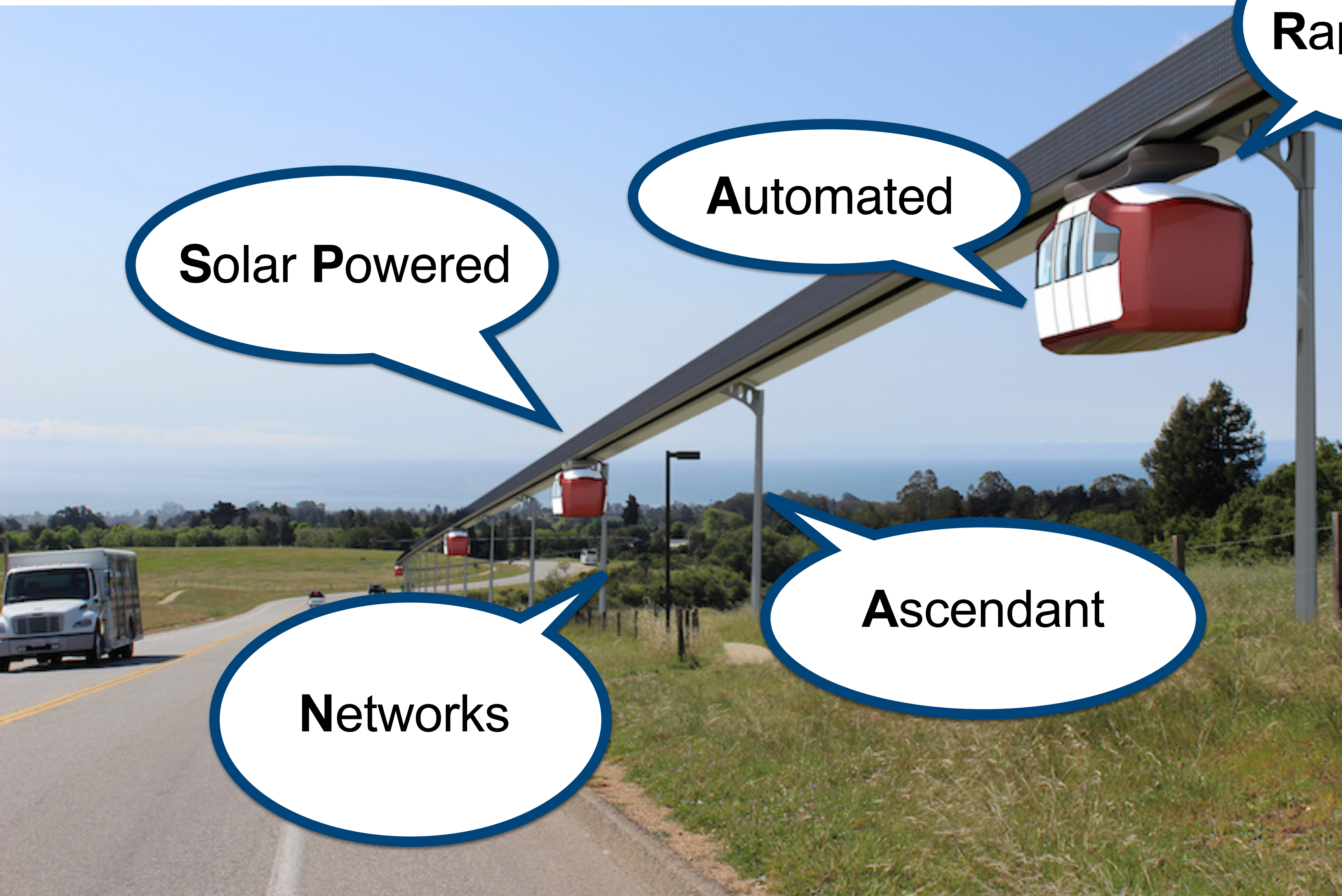
**Automated**

**Rapid Transit**

**Ascendant**



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**Solar Powered**

**Automated**

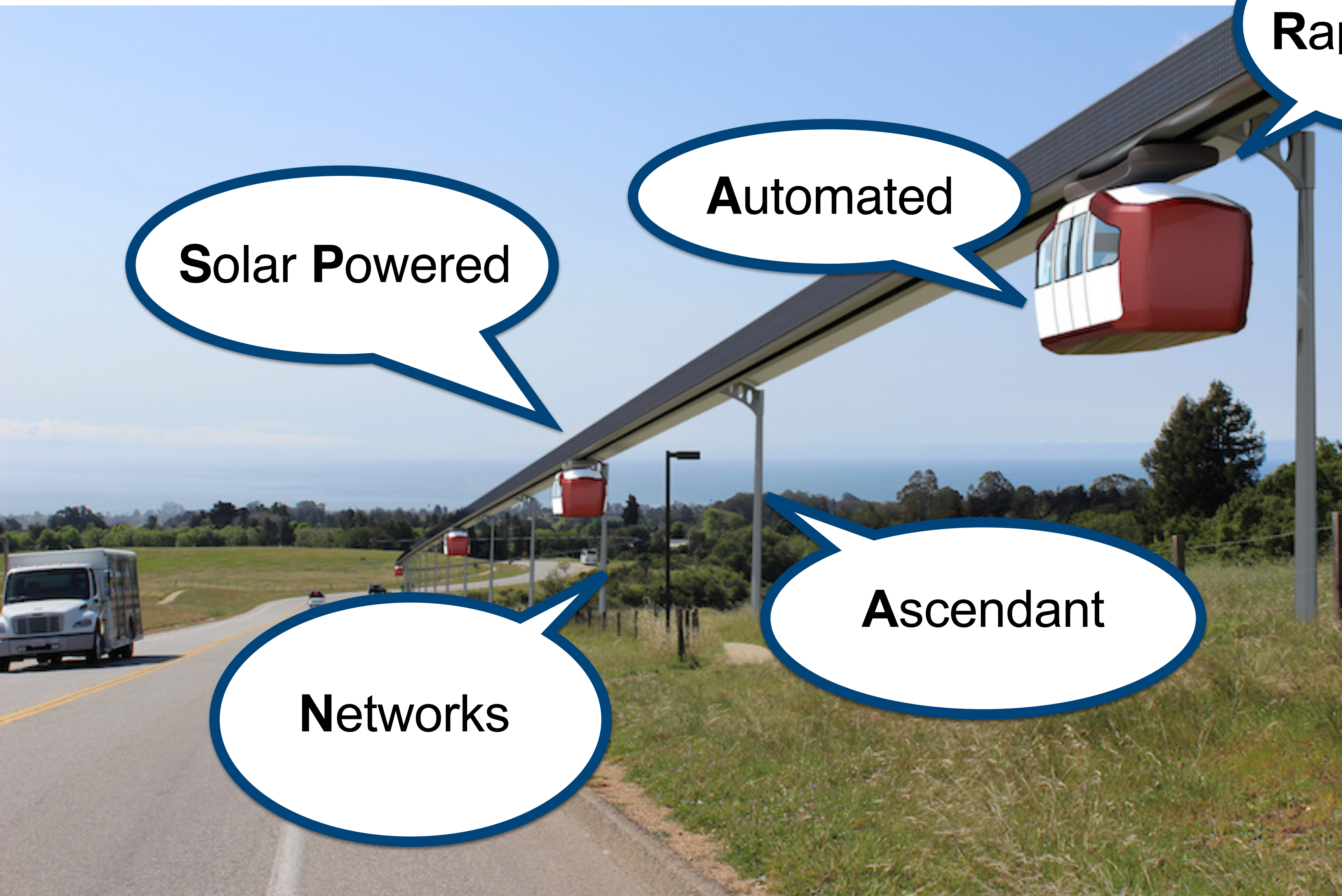
**Rapid Transit**

**Ascendant**

**Networks**



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**Solar Powered**

**Automated**

**Rapid Transit**

**Networks**

**Ascendant**

**S P A R T A N**





**Colorado experiences  
helped pave the way**



**I exhibited solar cars at ISES World Congress 1991**





# Tonatiuh raced to the finish line at NREL in 1995





**We know the issues**



**Mother Nature doesn't have to comply with our 2° C goal**

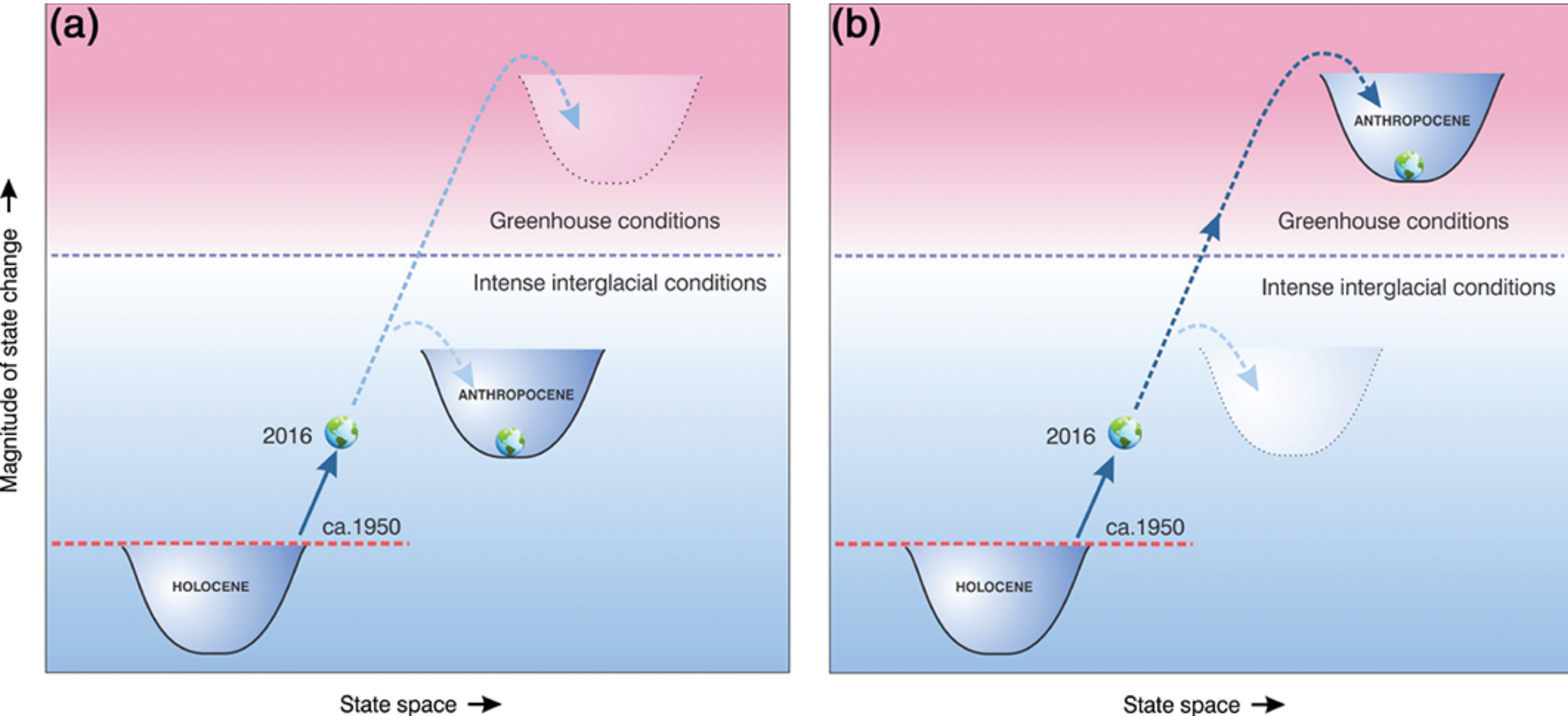


**Mother Nature doesn't have to comply with our 2° C goal**





# The climate *will* stabilize — with intense interglacial conditions or toward unknown greenhouse conditions





**Our nation has failed to stop climate change**

**Losing Earth: The Decade We  
Almost Stopped Climate Change**

**By Nathaniel Rich**

**Photographs and Videos by George Steinmetz**

**AUG. 1, 2018**

**The New York Times Magazine**



# **Our nation has failed to stop climate change**

**When it comes to our own nation, which has failed to make any binding commitments whatsoever, the dominant narrative for the last quarter century has concerned the efforts of the fossil-fuel industries to suppress science, confuse public knowledge and bribe politicians.**



# Our nation has failed to stop climate change

When it comes to our own nation, which has failed to make any binding commitments whatsoever, the dominant narrative for the last quarter century has concerned the efforts of the fossil-fuel industries to suppress science, confuse public knowledge and bribe politicians.



**Climate Mitigation  
is still waiting for that  
Political Leadership**



# COP21 set the stage for the clean energy revolution

## MISSION INNOVATION

Accelerating the Clean Energy Revolution

[www.mission-innovation.net](http://www.mission-innovation.net)





# Sam Liccardo commits to uphold the Paris accord



Sam Liccardo

[Follow](#)

Jun 1 · 4 min read

## Climate Mayors commit to adopt, honor and uphold Paris Climate Agreement goals

Mayor Sam Liccardo issued the following statement regarding the U.S. withdrawal from the Paris Accords. Below is an open letter from The Climate Mayors to President Trump that Mayor Liccardo signed on to:

“Today’s decision to withdraw from the Paris Accords represents a disappointing, but not surprising setback in the fight against climate change. While politicians in Washington continue to languish in a petroleum-fueled past, cities like San Jose will chart the path to a more sustainable future, such as our efforts to make San Jose the largest U.S. single city with Community Choice Energy. I reaffirm my commitment, along with mayors across the nation, to find innovative ways to reduce our greenhouse gas emissions and accelerate our transition to a 21st century clean energy economy.” —Mayor Sam Liccardo



# Sam Liccardo commits to uphold the Paris accord



Sam Liccardo

[Follow](#)

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# Sam Liccardo calls for cities to fight for environment



## SAN JOSE MAYOR SAM LICCARDO CALLS FOR CITIES TO FIGHT FOR ENVIRONMENT DESPITE TRUMP PRESIDENCY

January 24, 2017 / in San Francisco Bay Area, San Jose / by News Article Repost

SAN JOSE (BCN) — At a conference in Washington, D.C., Wednesday morning, San Jose Mayor Sam Liccardo called for cities across the country to continue fighting for the environment under a new presidential administration “not likely to be a significant partner in our battle against climate change.”

Liccardo is one of 16 Bay Area mayors in the nation’s capital this week for the U.S. Conference of Mayors’ 85th annual winter meeting, where 313 mayors convened Tuesday. The conference wraps up today.

San Jose, CA

City Profile | Climate Data | Risks / Hazards & Priority Action | Share



[f FACEBOOK](#) | [TWITTER](#)

Phases Completed: ?



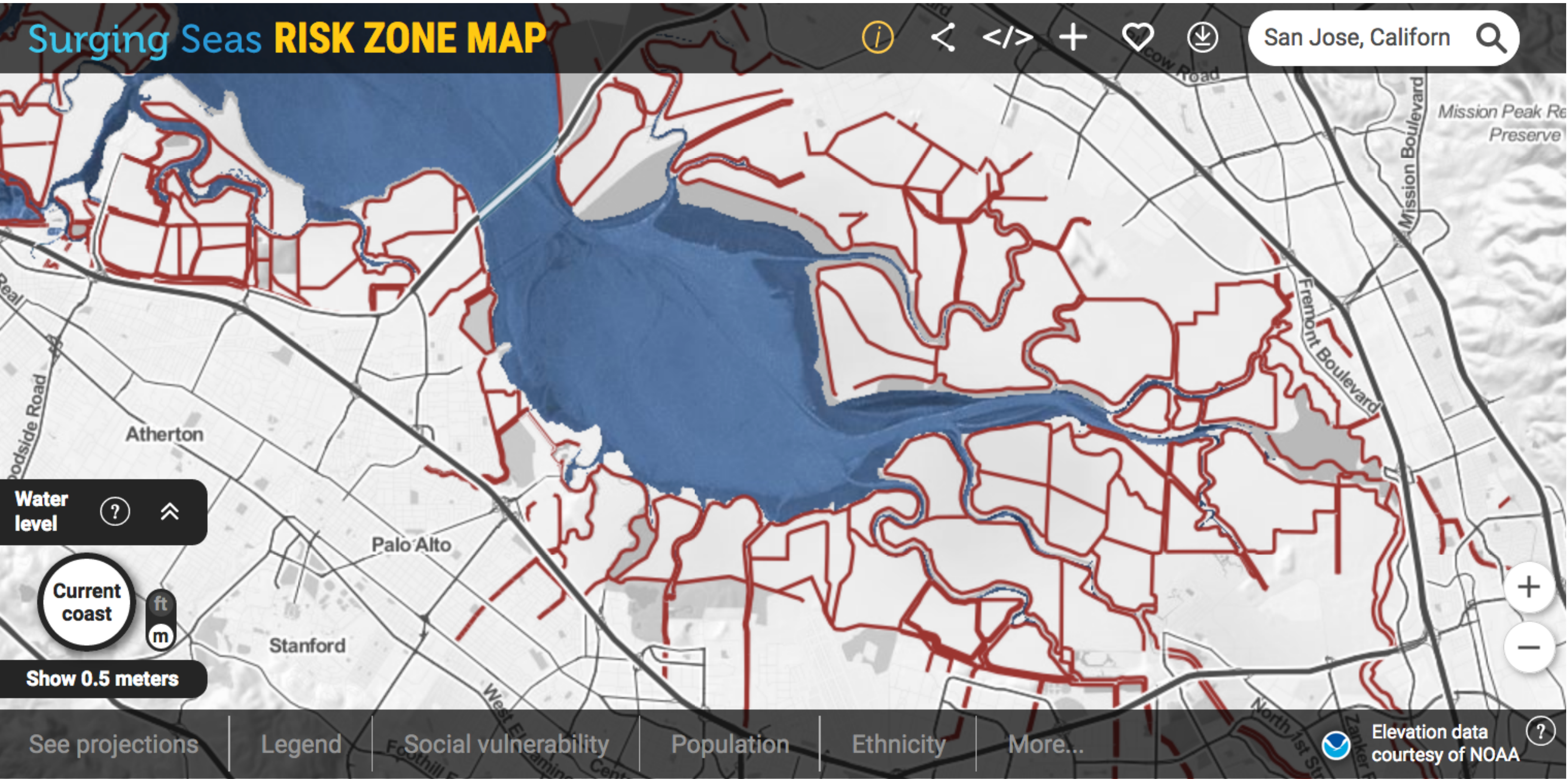
Population: **1,015,785**

Country: **United States**

Mayor: **Sam Liccardo**

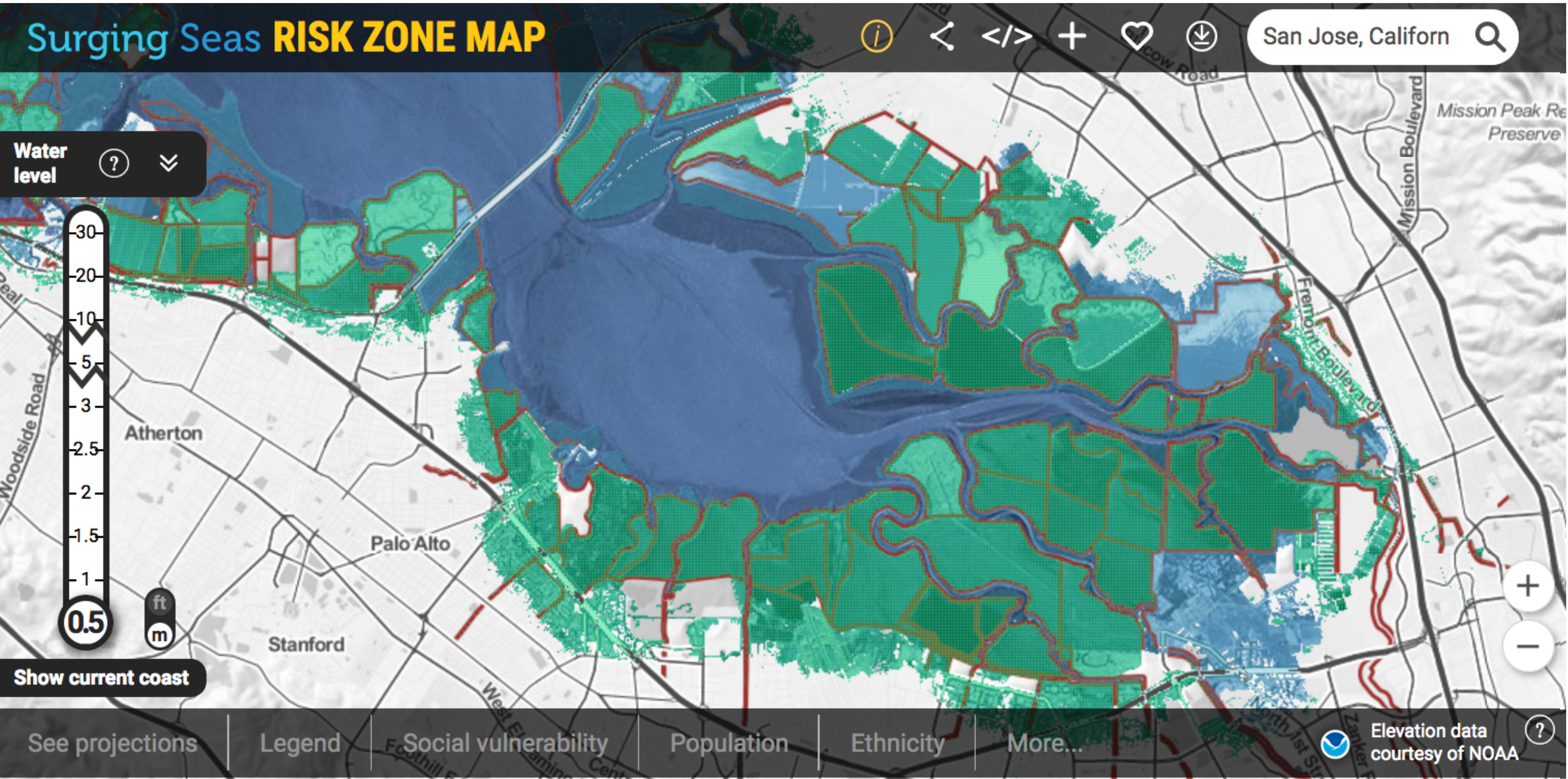


# We could imagine Silicon Valley leading that revolution



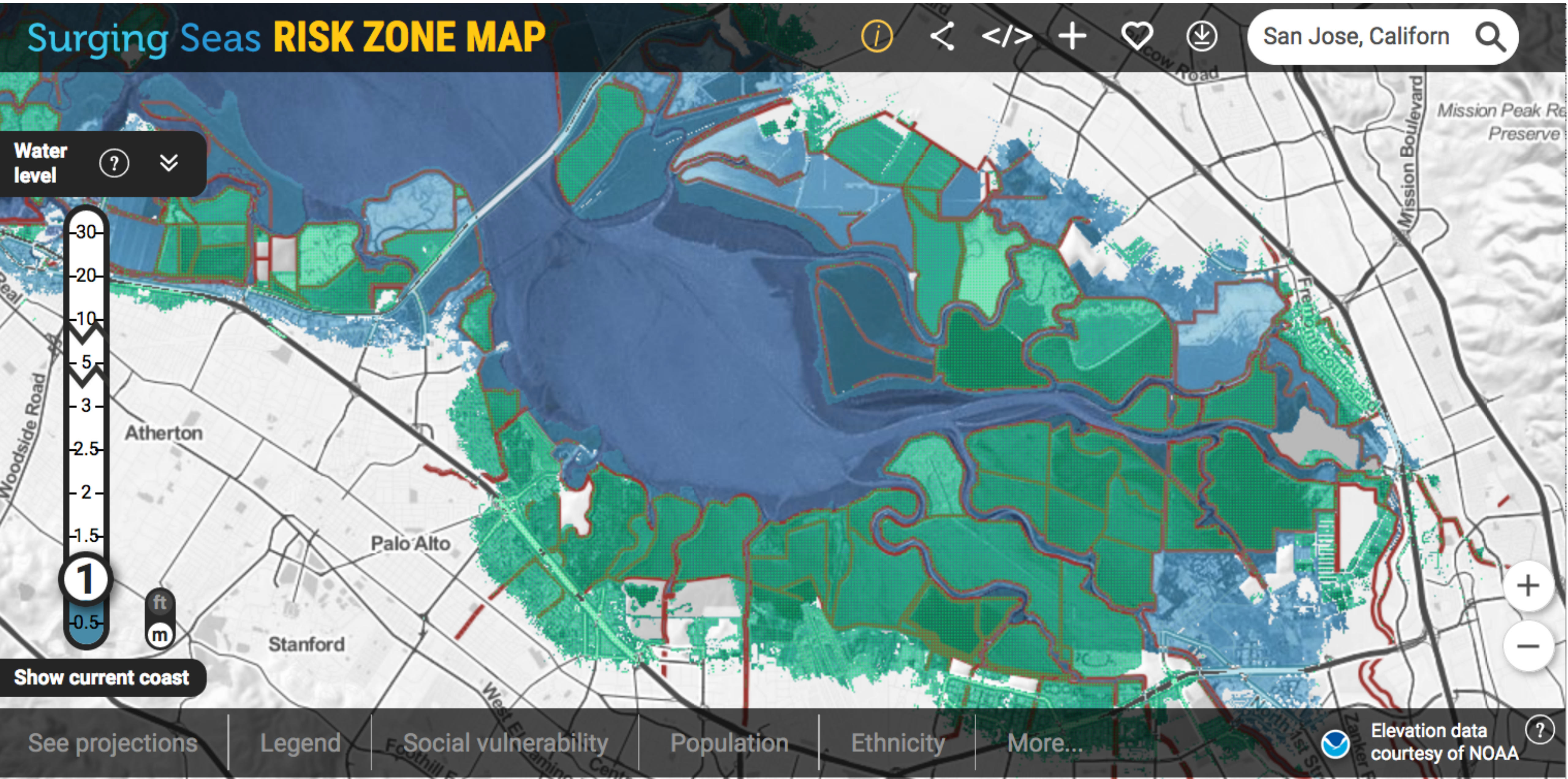


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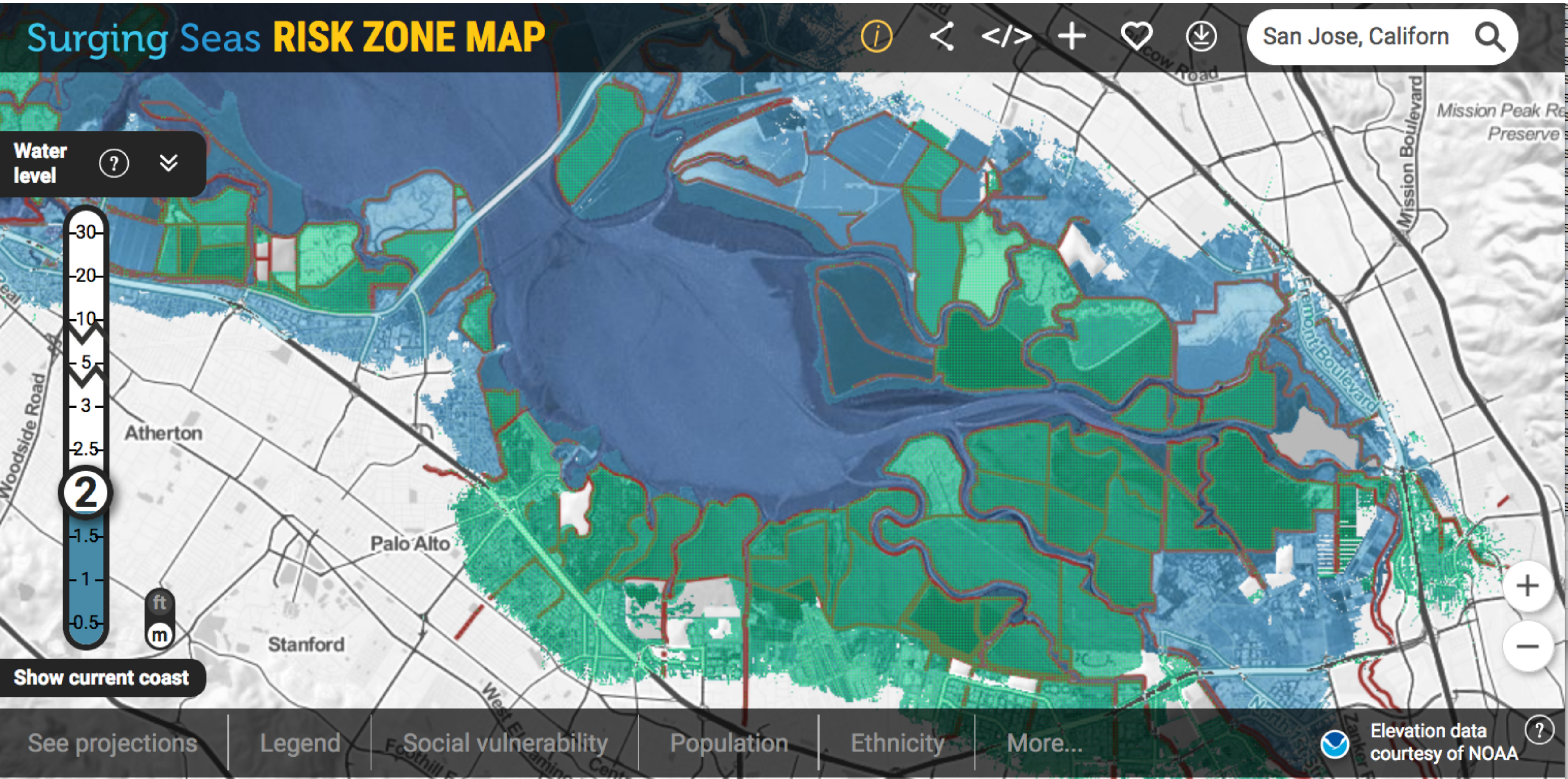


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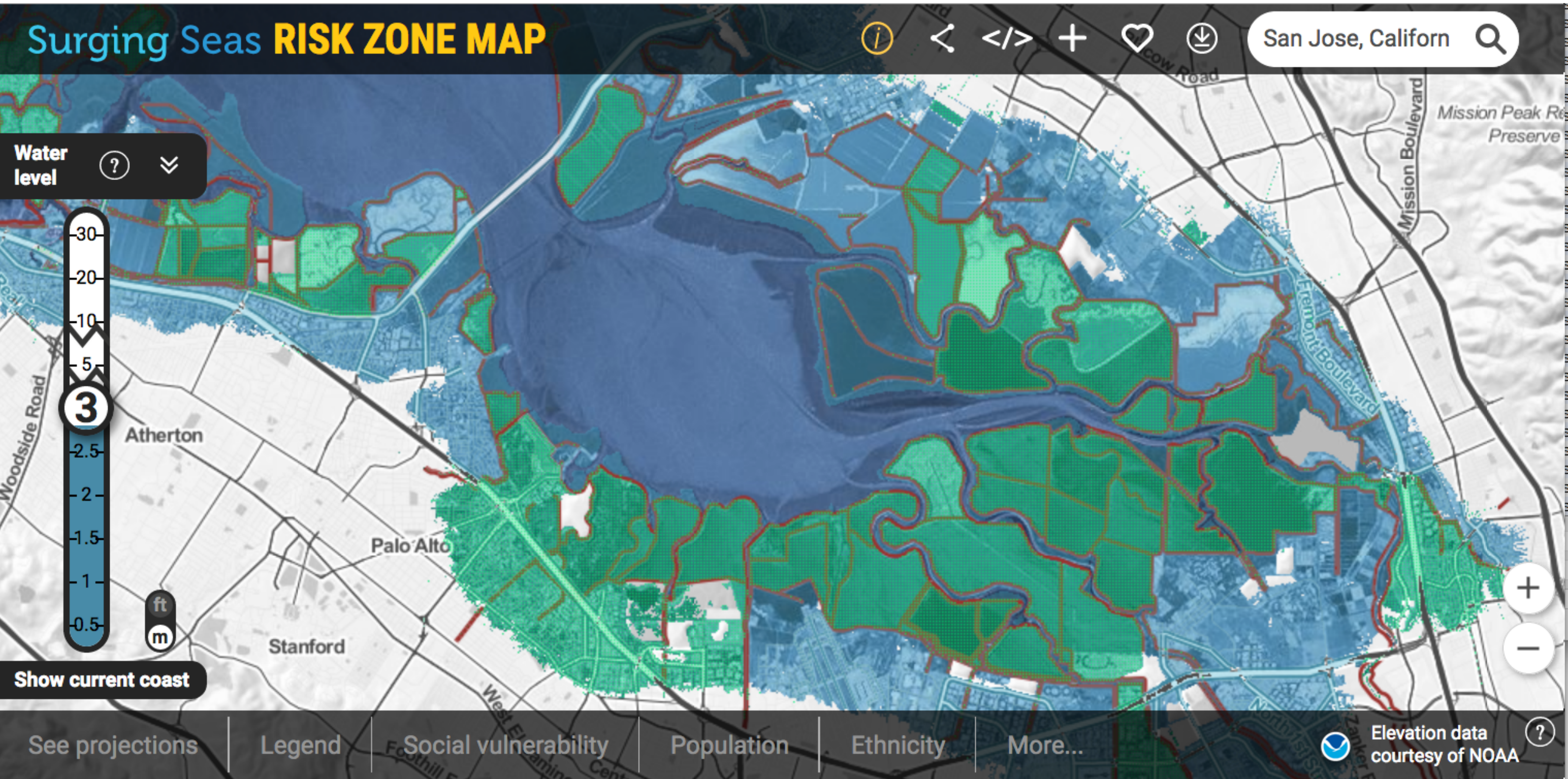


# We could imagine Silicon Valley leading that revolution





# We could imagine Silicon Valley leading that revolution





**But if Silicon Valley were perfect, with zero emissions, what good would it do?**

$$\frac{3,000,000}{7,400,000,000} = 0.04\%$$



**But if Silicon Valley were perfect, with zero emissions, what good would it do?**

$$\frac{3,000,000}{7,400,000,000} = 0.04\%$$

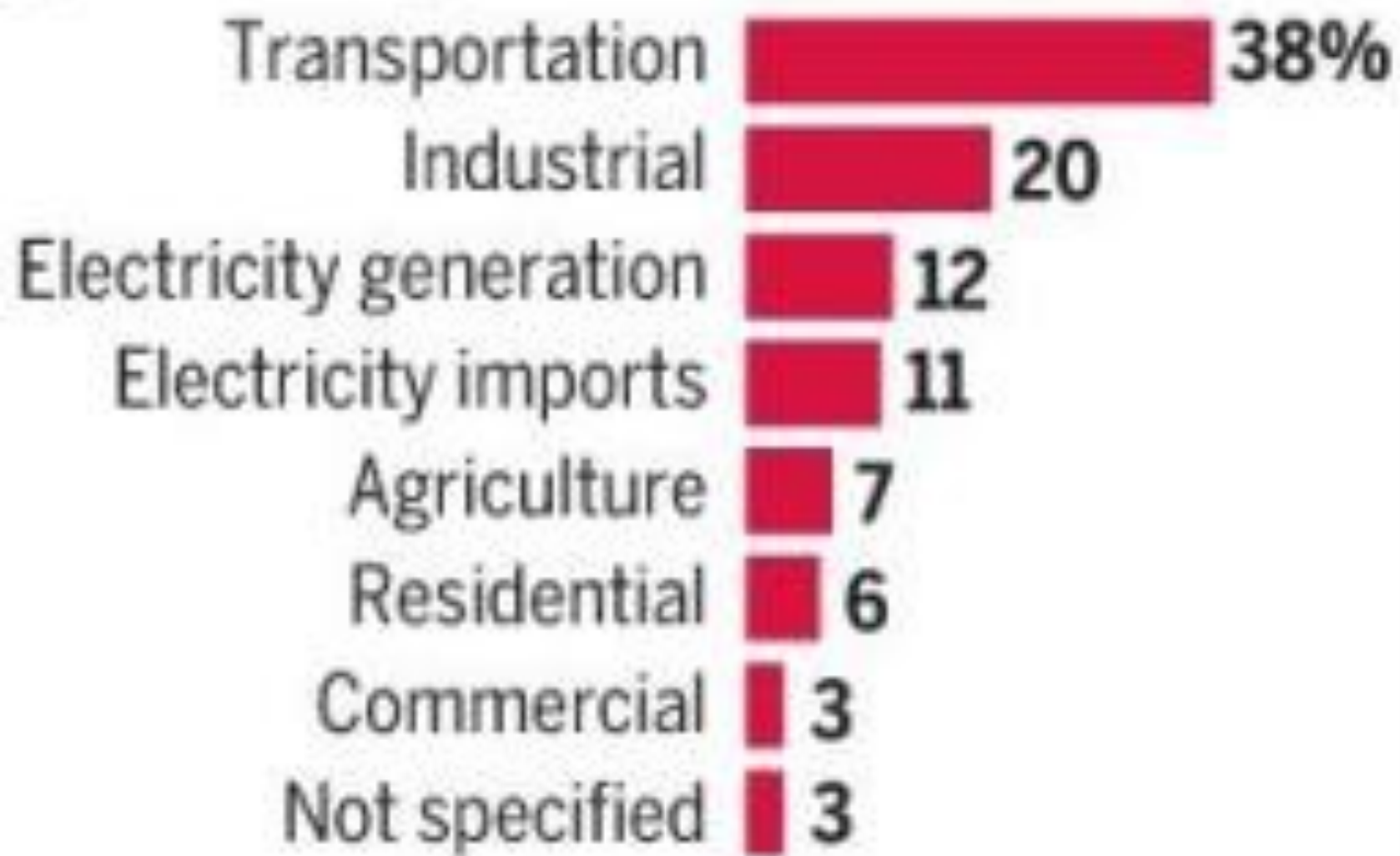
**If we Techies are serious about survival, our only option is to export zero emission solutions**



# Before exporting solutions, we have to come to terms with our own challenges

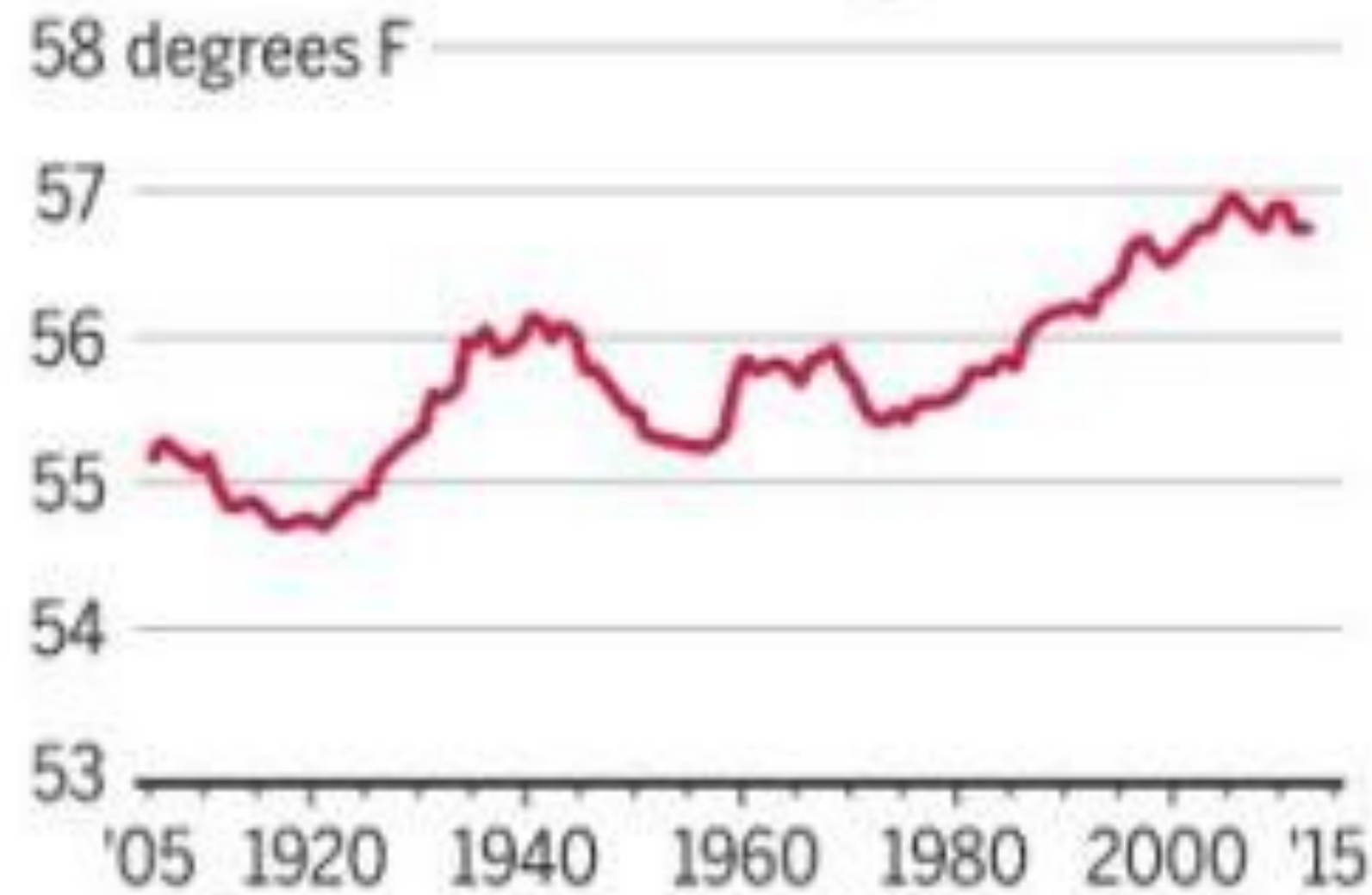
## Sources of emissions

Transportation, industry and electrical generation account for 81 percent of all greenhouse gas emissions in California.



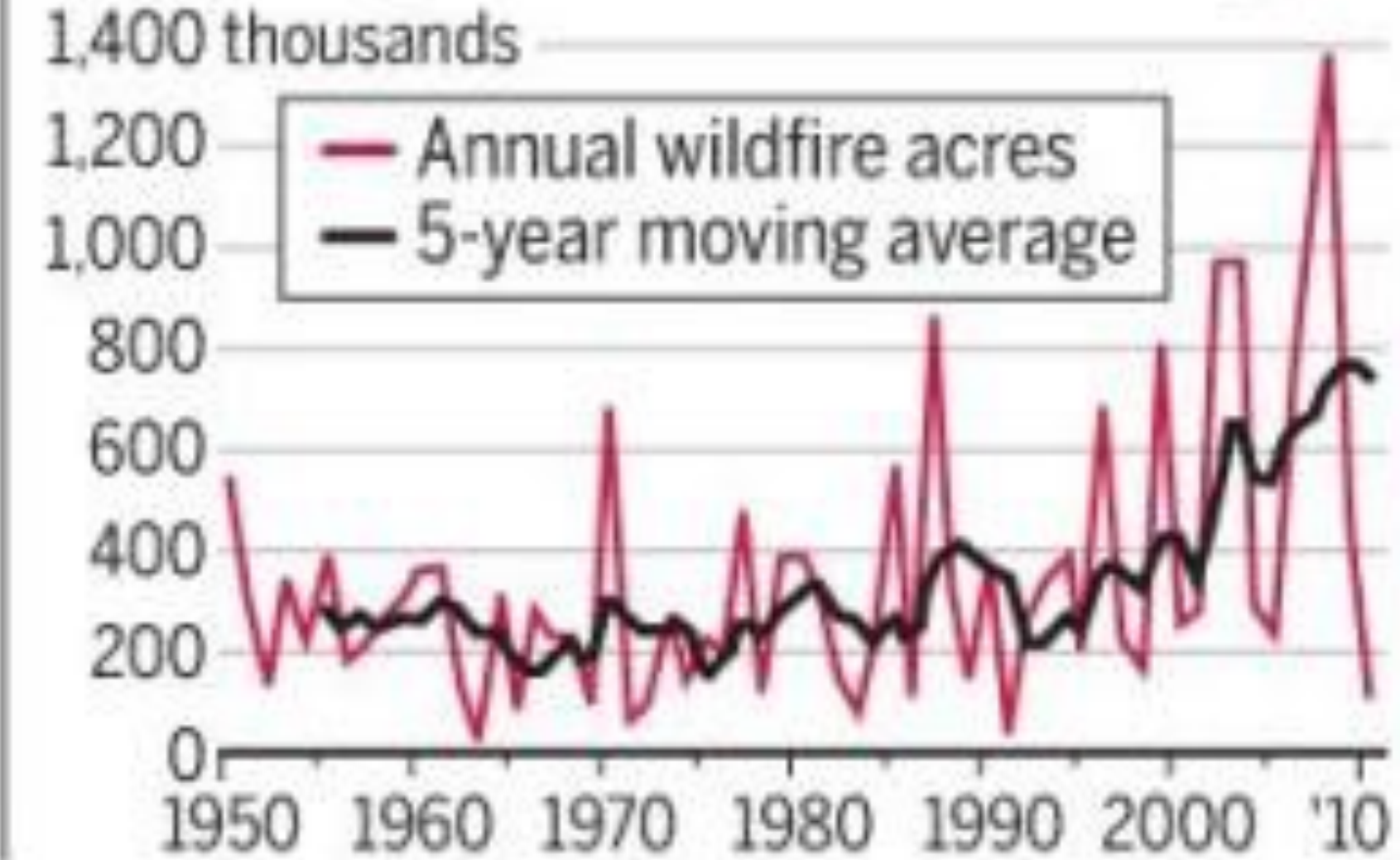
## Rising temperatures

Since 1895, annual average temperatures in California have increased by about 1.5 degrees.



## More severe fires

The average annual acreage burned in wildfires in the state since 2000 is almost twice as high as the 1950-2000 average.



Source: Indicators of Climate Change in California, Office of Environmental Health Hazard Assessment

BAY AREA NEWS GROUP



# Before exporting solutions, we have to come to terms with our own challenges

Sources of emissions

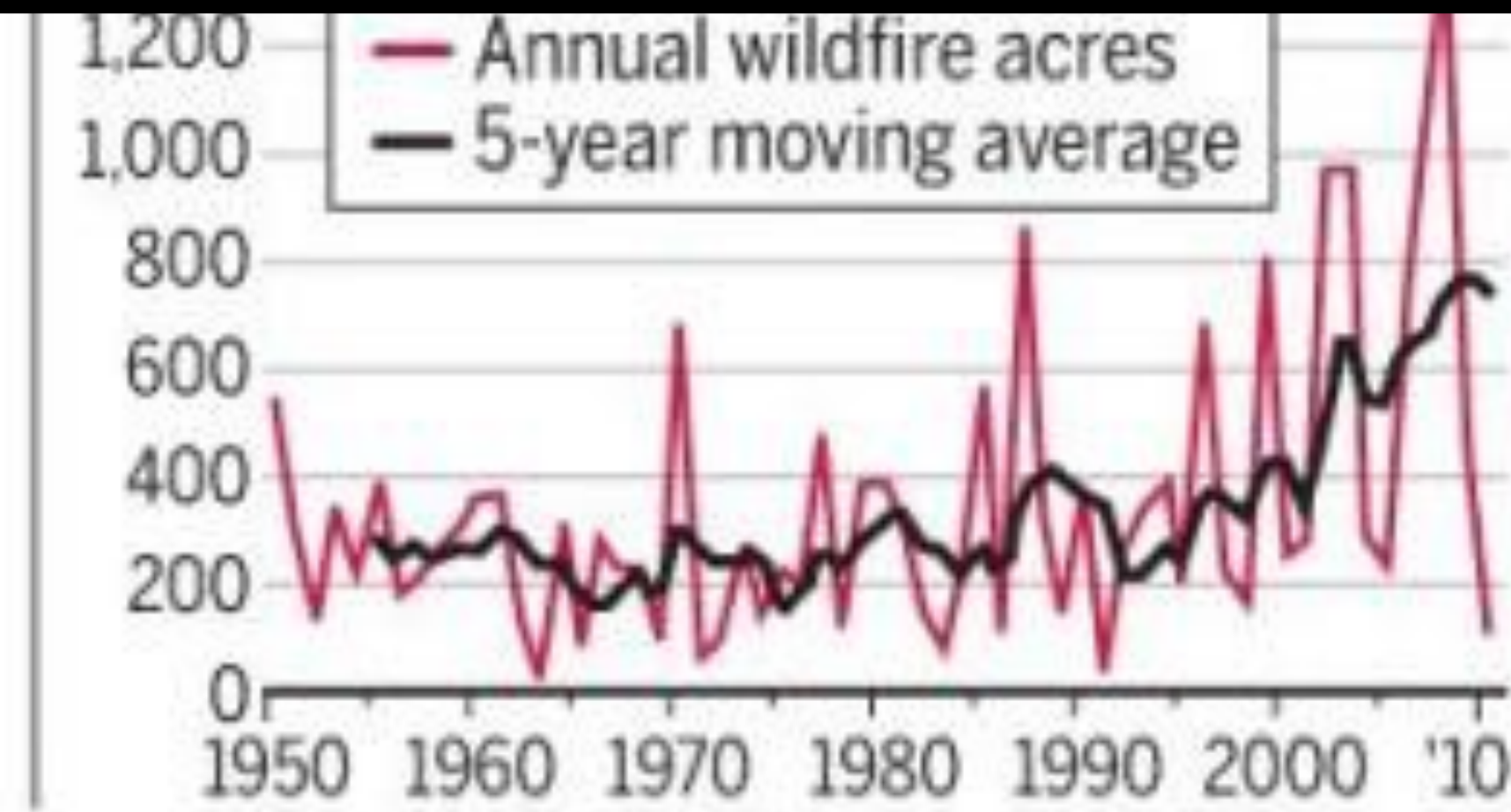
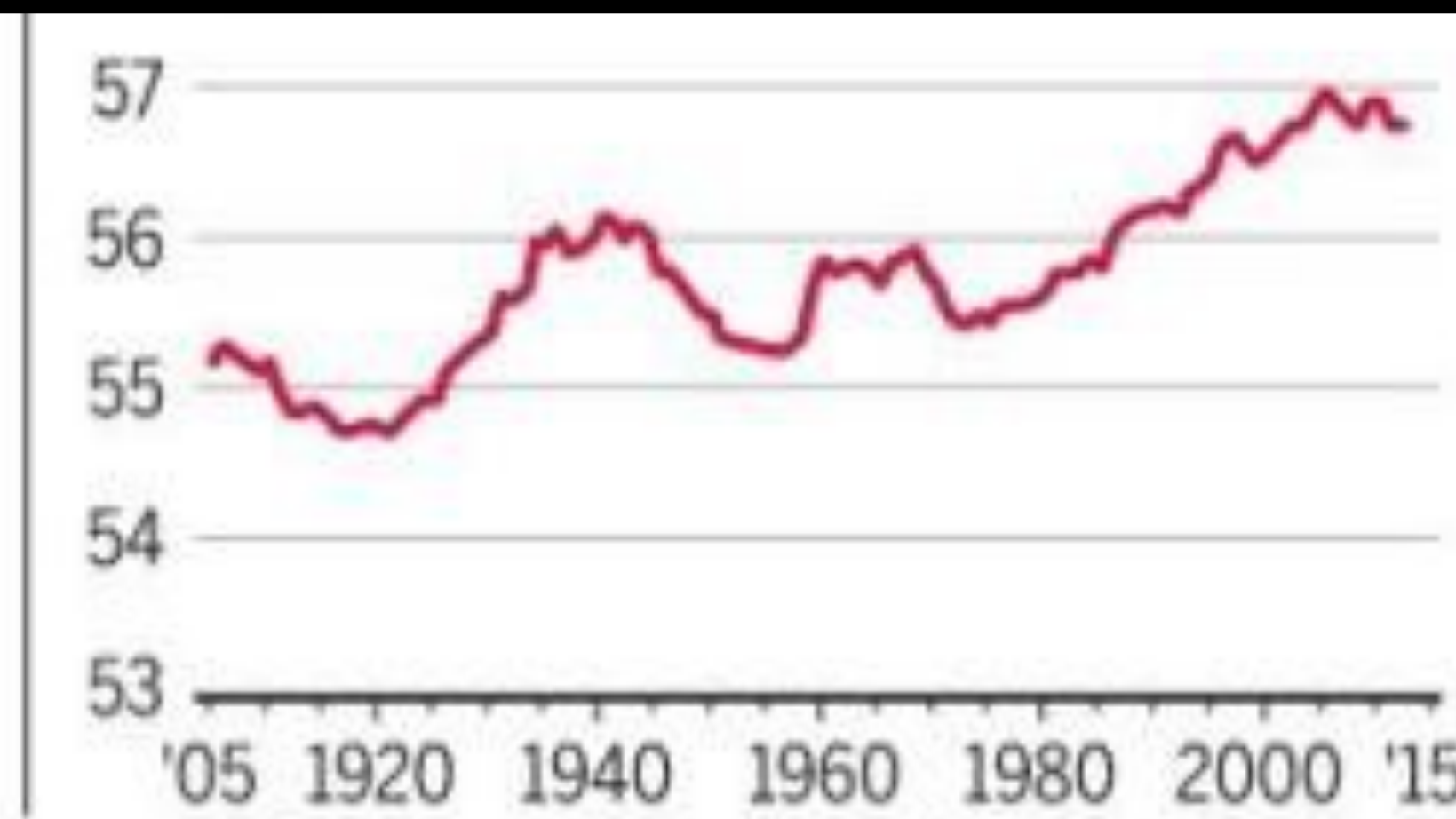
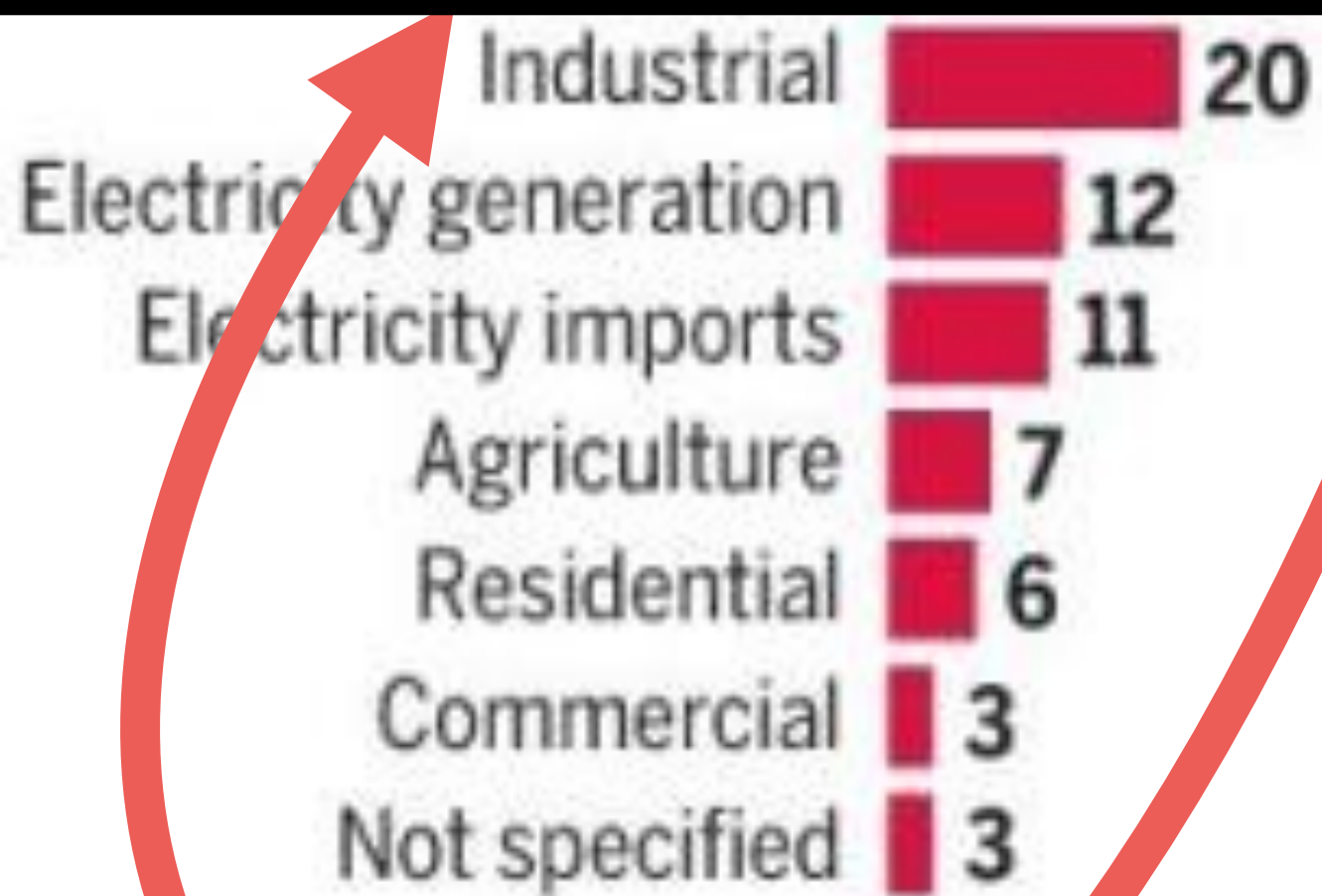
Rising temperatures

More severe fires

Transportation



38%



Source: Indicators of Climate Change in California, Office of Environmental Health Hazard Assessment

BAY AREA NEWS GROUP



**Consider the big buzz...  
EVs and AVs**



# Congestion looks like this





# EV congestion looks like this





# Parking at the Tesla factory looks like this





**Parking at the Tesla factory looks like this**





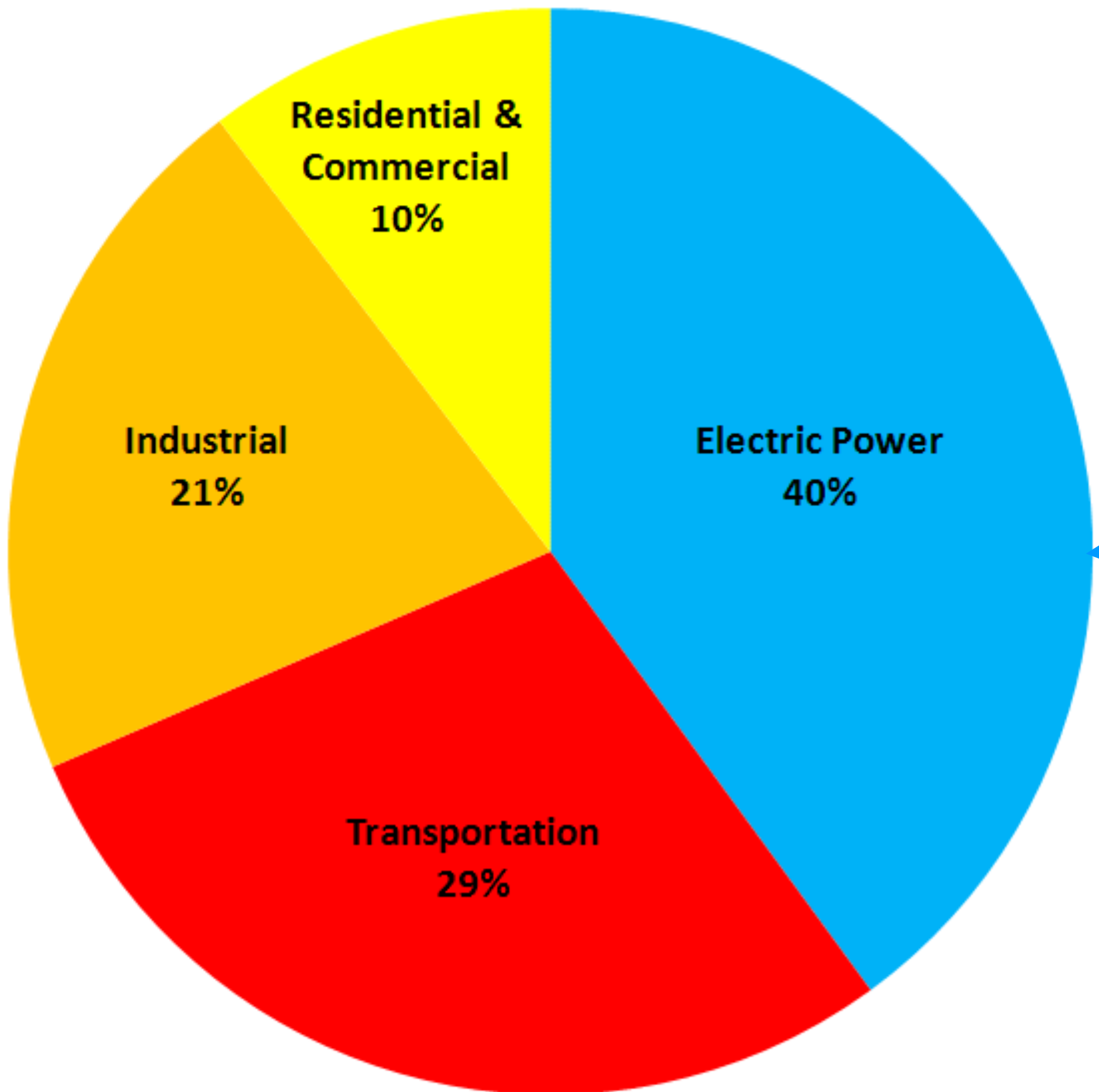
# AV congestion looks like this





# 100% Renewable needs 100% Renewable Transportation

US Energy Consumption by Sector



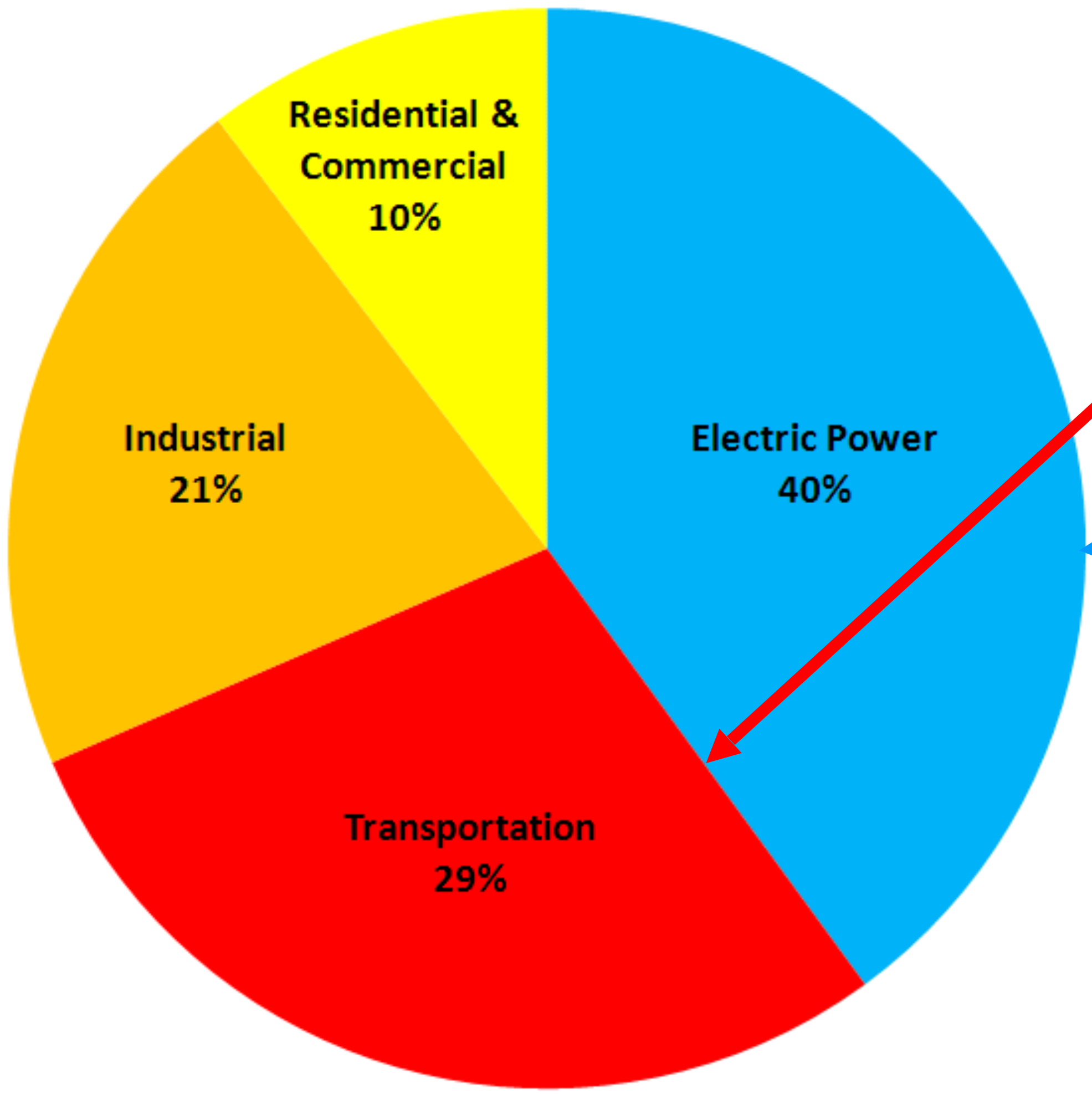
Solar & Wind can handle electricity demand

Data source: US Energy Information Administration 2007



# 100% Renewable needs **100% Renewable Transportation**

US Energy Consumption  
by Sector



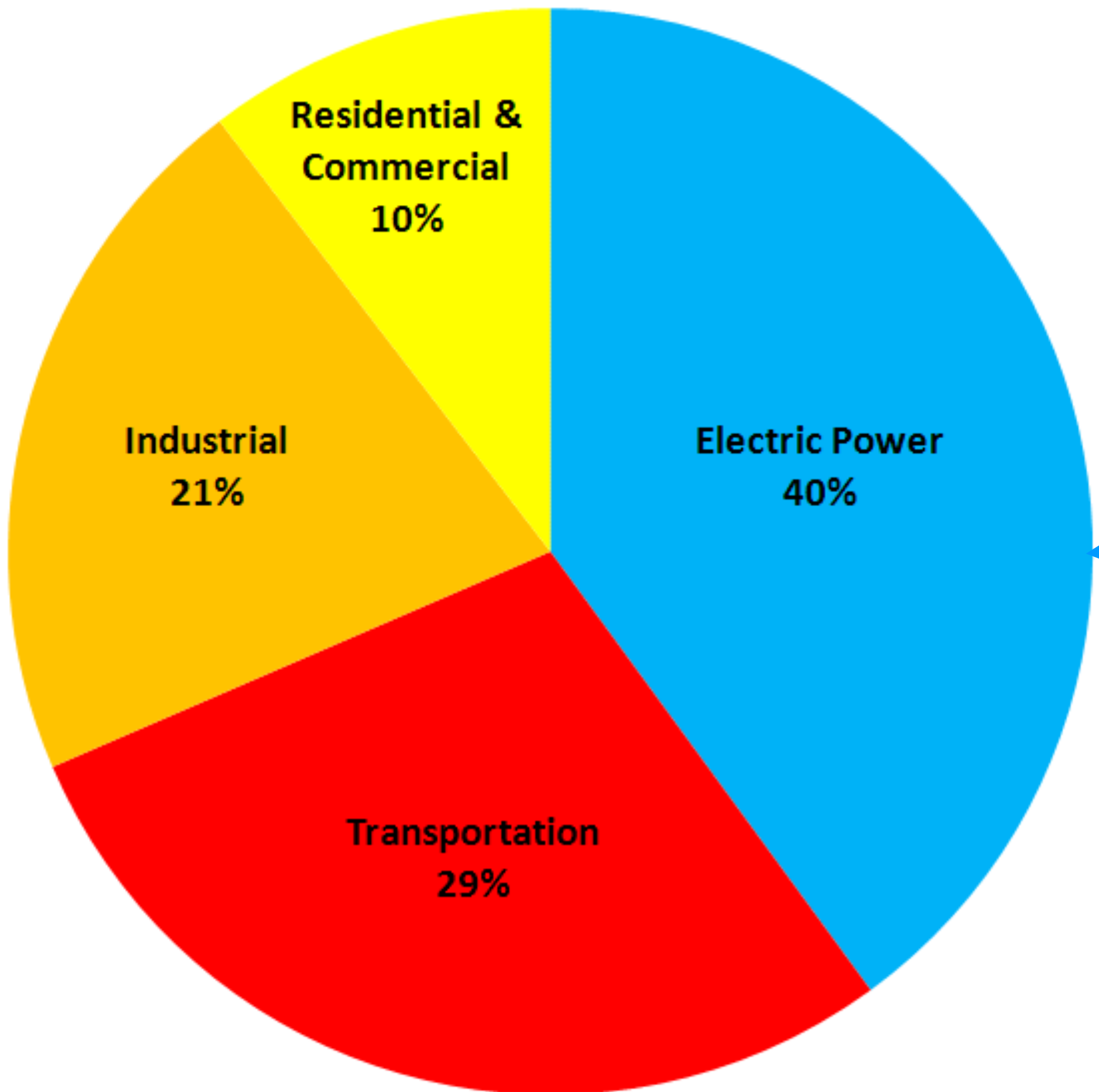
Solar & Wind  
can handle electricity  
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# 100% Renewable needs 100% Renewable Transportation

US Energy Consumption  
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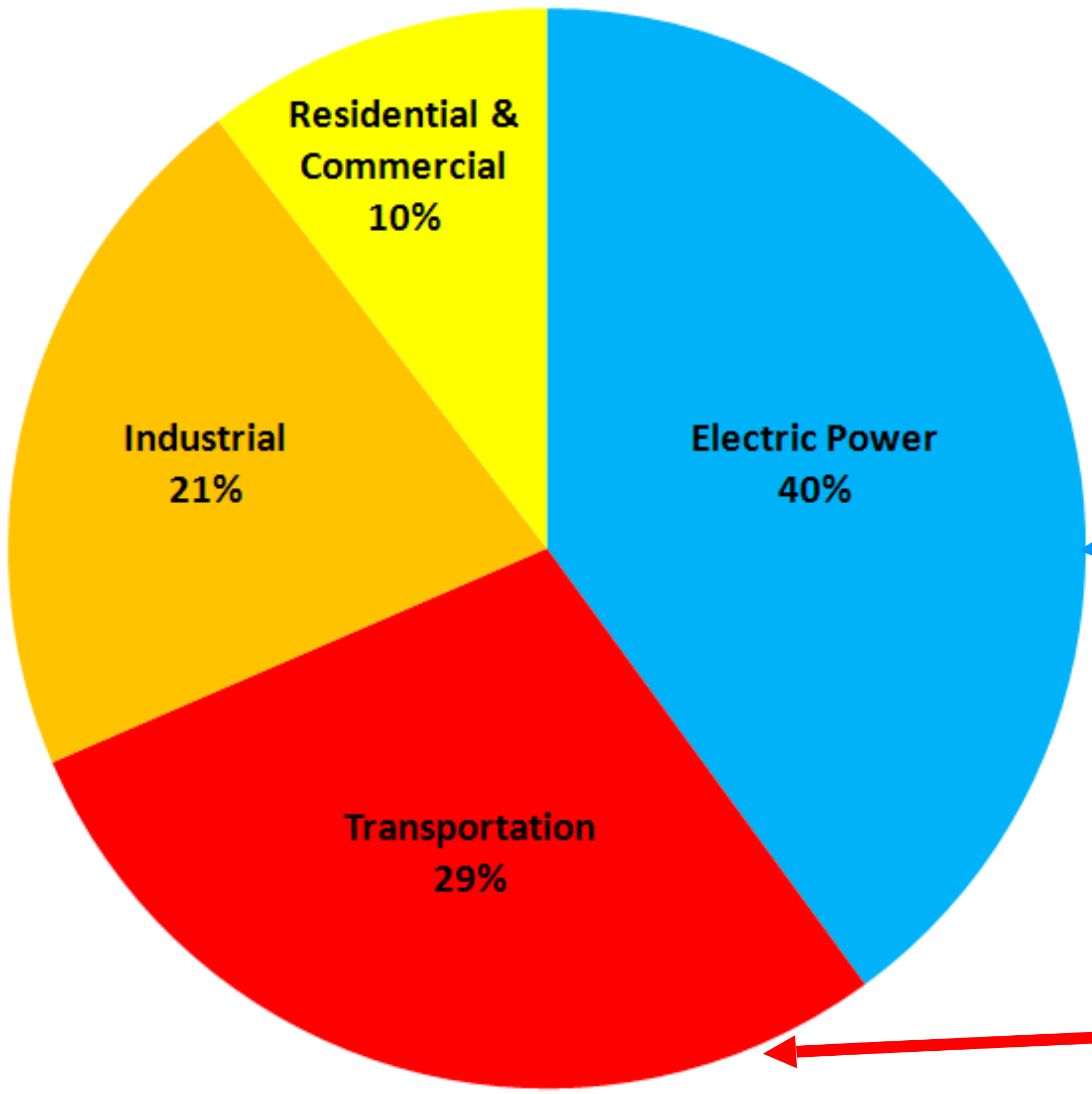
Solar & Wind  
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# 100% Renewable needs **100% Renewable Transportation**

US Energy Consumption  
by Sector



Solar & Wind  
can handle electricity  
demand

*The question is how to  
handle transportation  
with solar*

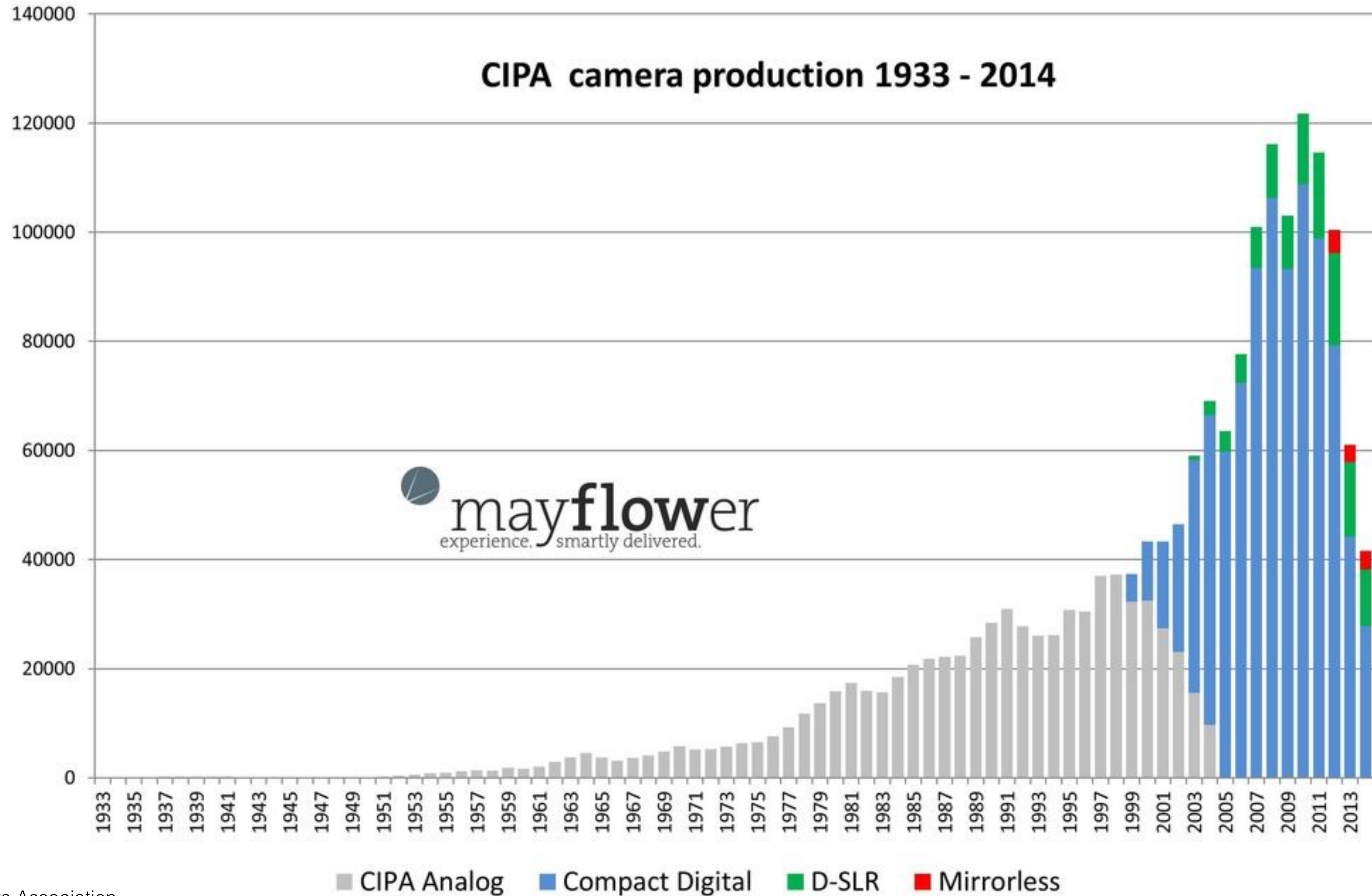
Data source: US Energy Information Administration 2007



**Profound change  
is possible**

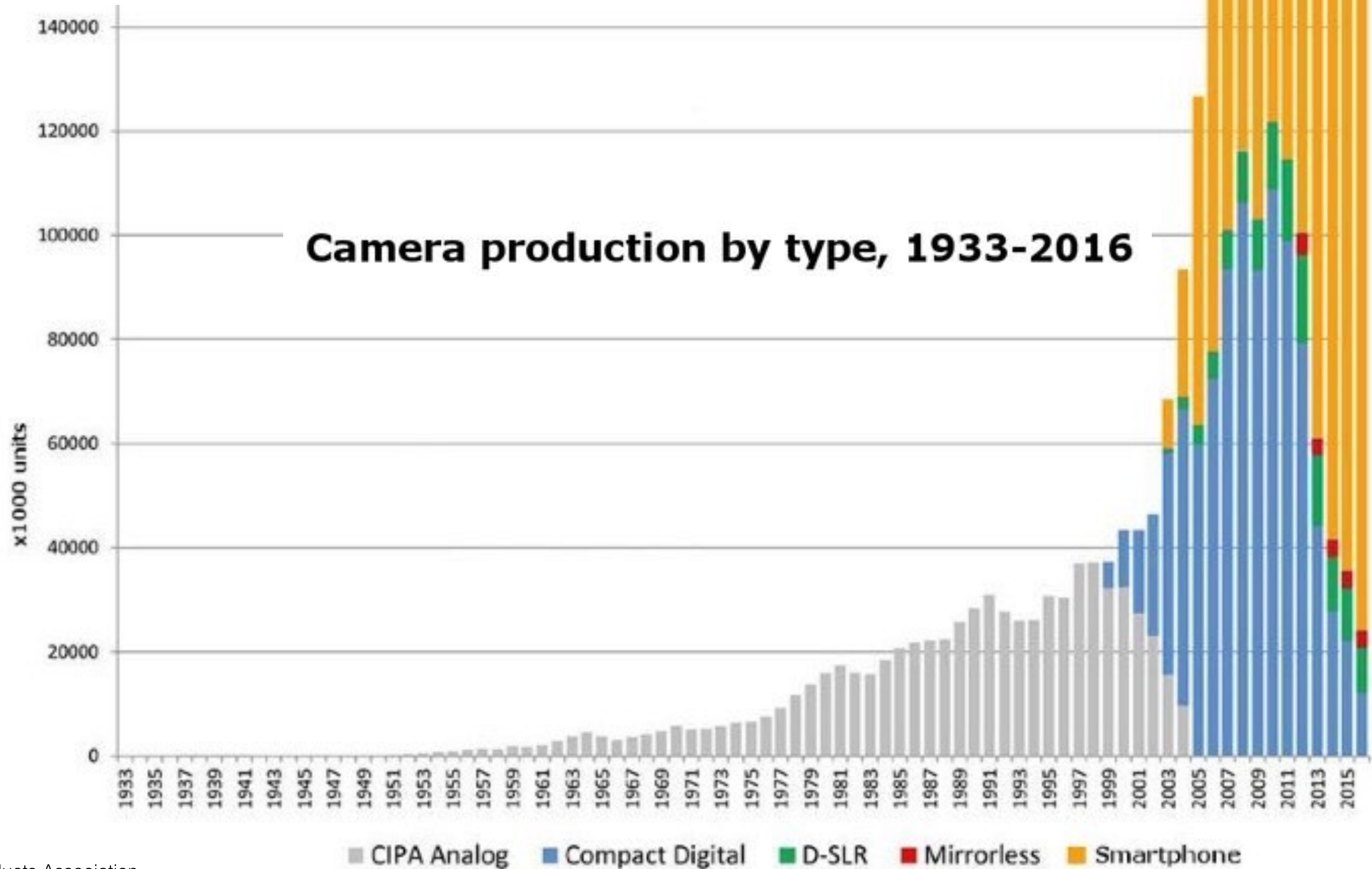


# Things change



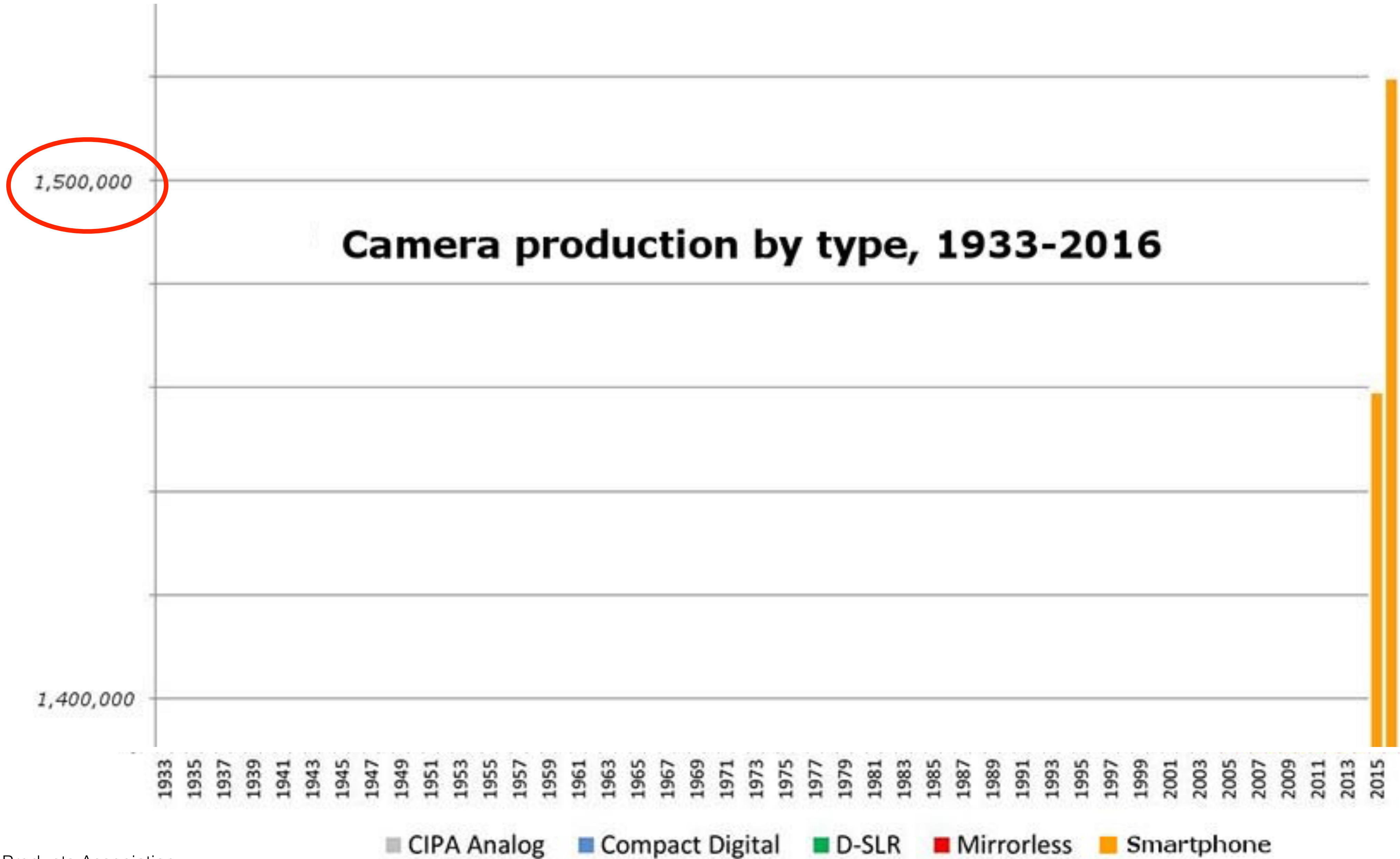


# Things change



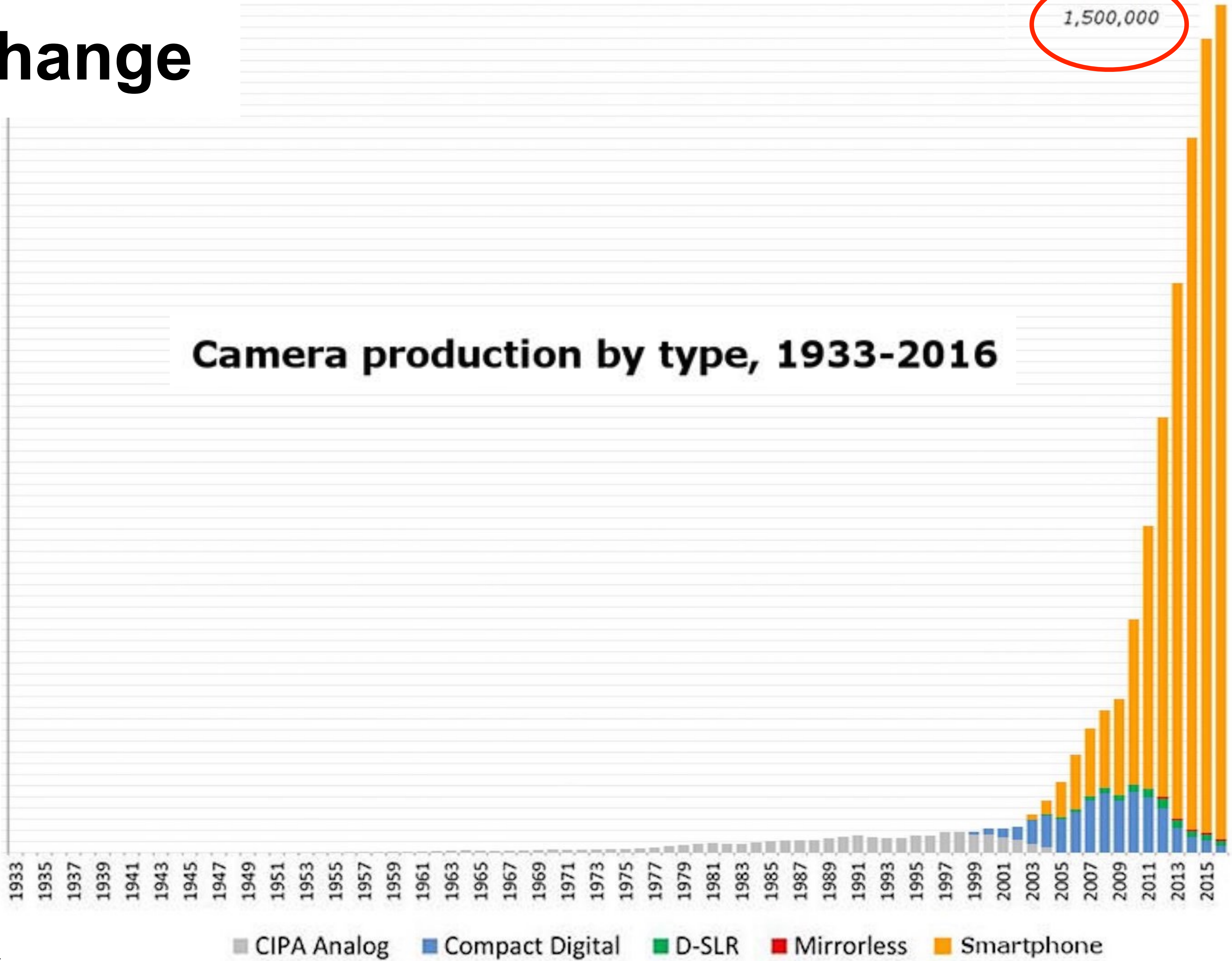


# Things change



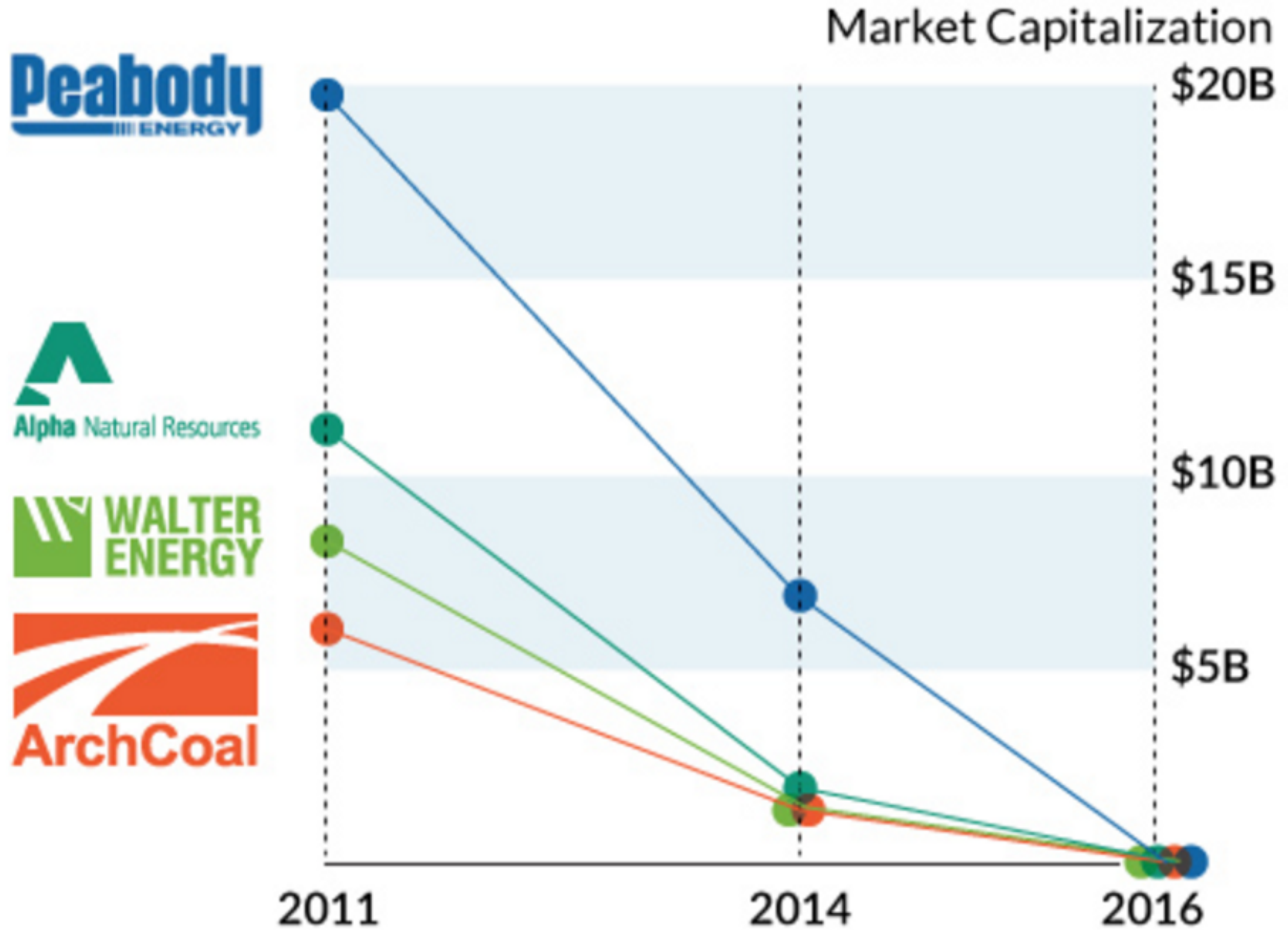


# Things change





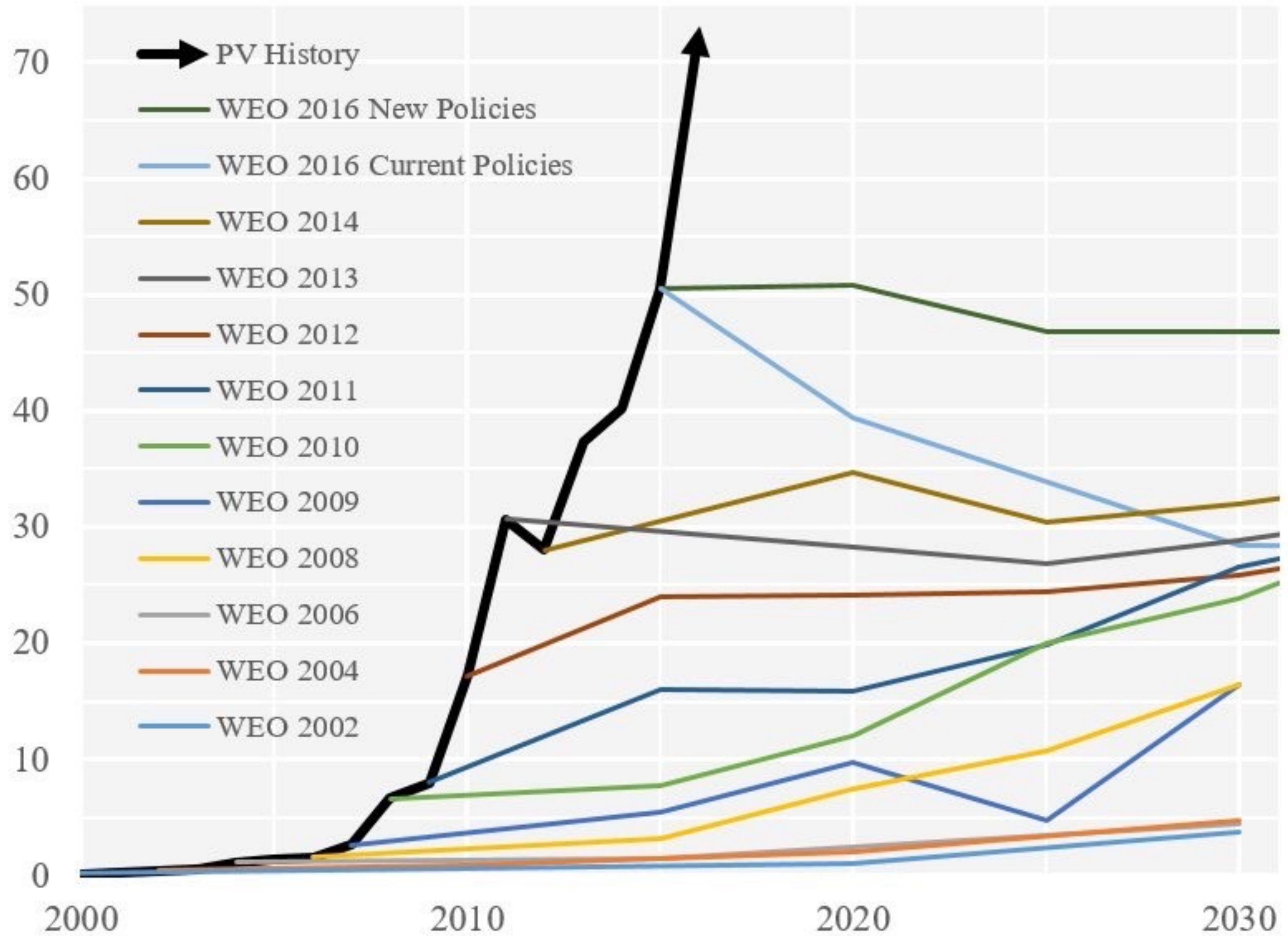
# The coal industry has capsized in just 5 years





# Politically motivated solar predictions are pathetic

Annual PV additions: historic data vs IEA WEO predictions  
In GW of added capacity per year - sources World Energy Outlook and PVMA





# The Chilean Solar Market

Total Installed Solar Capacity (Gigawatts)

1.00  
0.75  
0.50  
0.25  
0.00

End of 2013

End of 2014

End of 2015

Data: Greentech Media, *Latin America PV Playbook*; CleanTechnica



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End of 2014

End of 2015

Data: Greentech Media, *Latin America PV Playbook*; CleanTechnica



**EVs and AVs are like those  
point & shoot  
digital cameras**



I betcha I can beat the Google car on my bike

MountainView

WORLD

APRIL 11, 2014 VOLUME 22, NO. 11

[www.MountainViewOnline.com](http://www.MountainViewOnline.com)



I betcha I can beat the Google car on my bike



MICHELLE LE

**A cyclist** passes a Google self-driving car (with the camera on top) along Shoreline Boulevard during the morning rush hour on April 8.



The problem's not the fuel or the driver: *it's the car*





**Livable Cities**  
*require*  
**Livable Streets**



**Back in the day, people had access to the streets**





**Back in the day, people had access to the streets**





# Many applaud electric and autonomous vehicles





**But we can flip the tables on them ...**





**But we can flip the tables on them ...**





**But we can flip the tables on them ...**



*(oops...)*



**But we can flip the tables on them ...**



*ahh, that's better!*



**... to make room for people, pets, pedals, and petals!**





# Sam Liccardo wants a people-centered city

“The future of Silicon Valley critically depends on our development of a vibrant urban center,” Mayor Sam Liccardo of San Jose said in an interview.

**The New York Times**

*California Today*

*Google's Idea for a New Silicon Valley*

*June 20, 2017*





# Sam Liccardo wants a people-centered city

“The future of Silicon Valley critically depends on our development of a vibrant urban center,” Mayor Sam Liccardo of San Jose said in an interview. ***“We’re trying to retrofit the city that was built for automobiles into a city built for people.”***

**The New York Times**

*California Today*

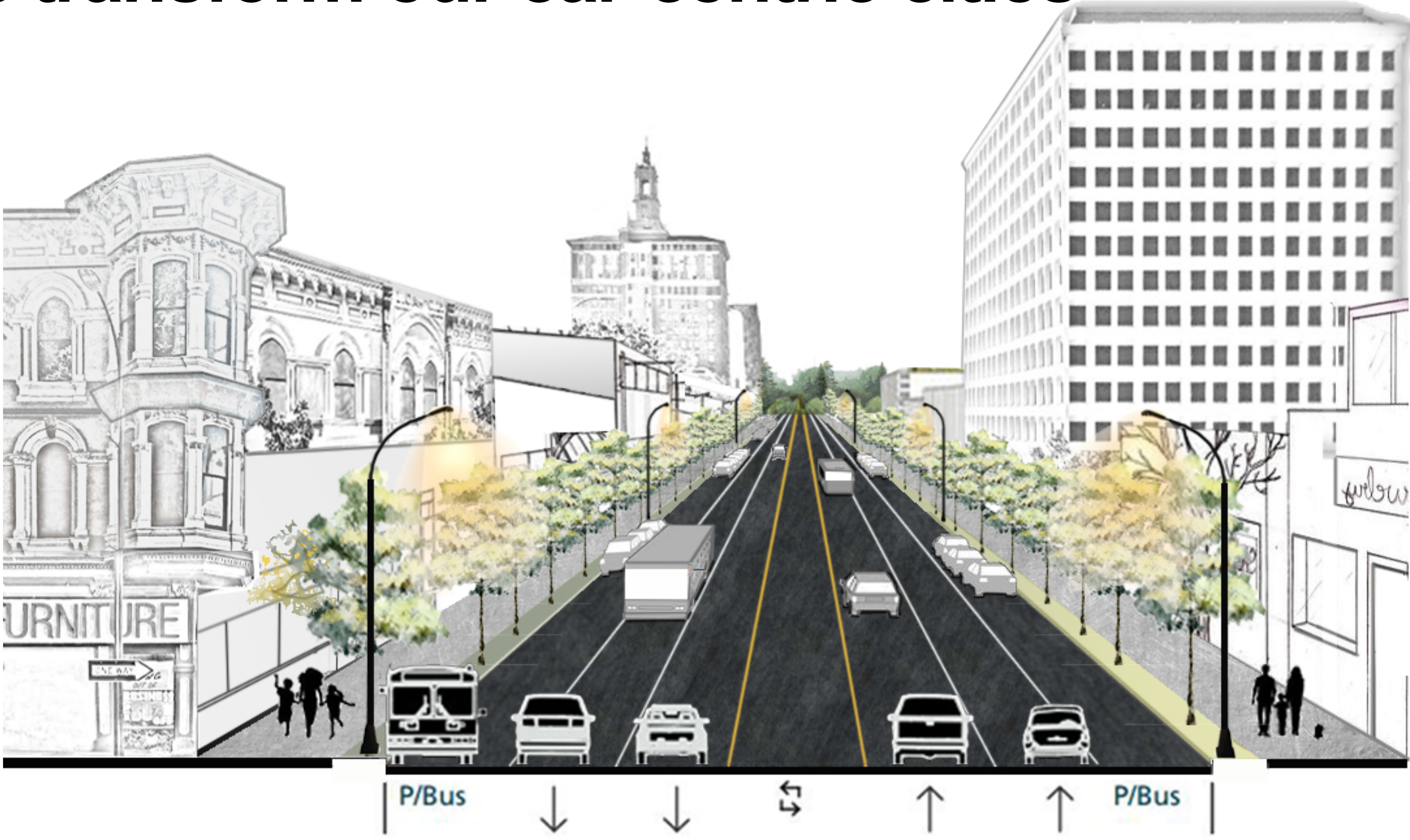
*Google’s Idea for a New Silicon Valley*

*June 20, 2017*





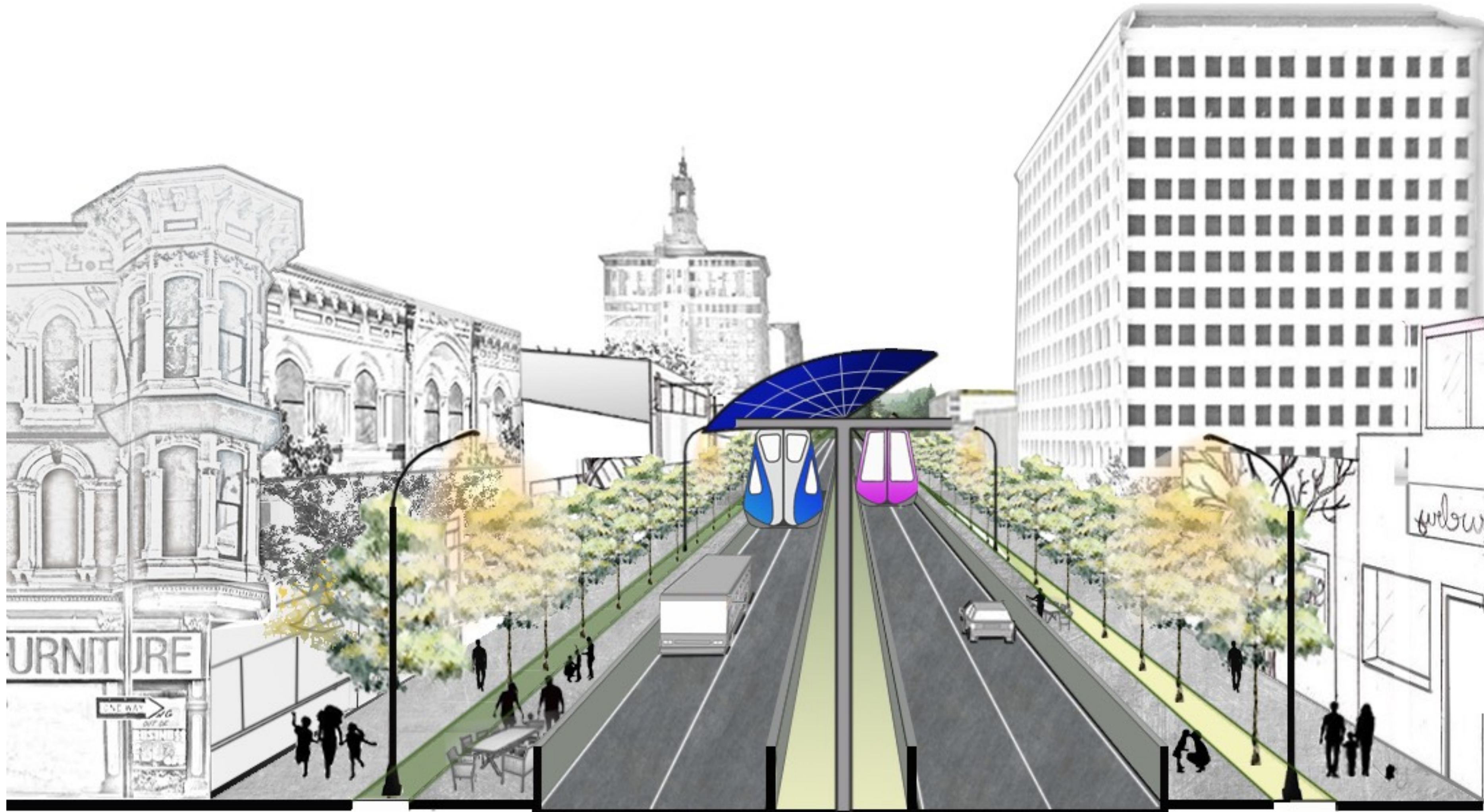
# Let's transform our car-centric cities



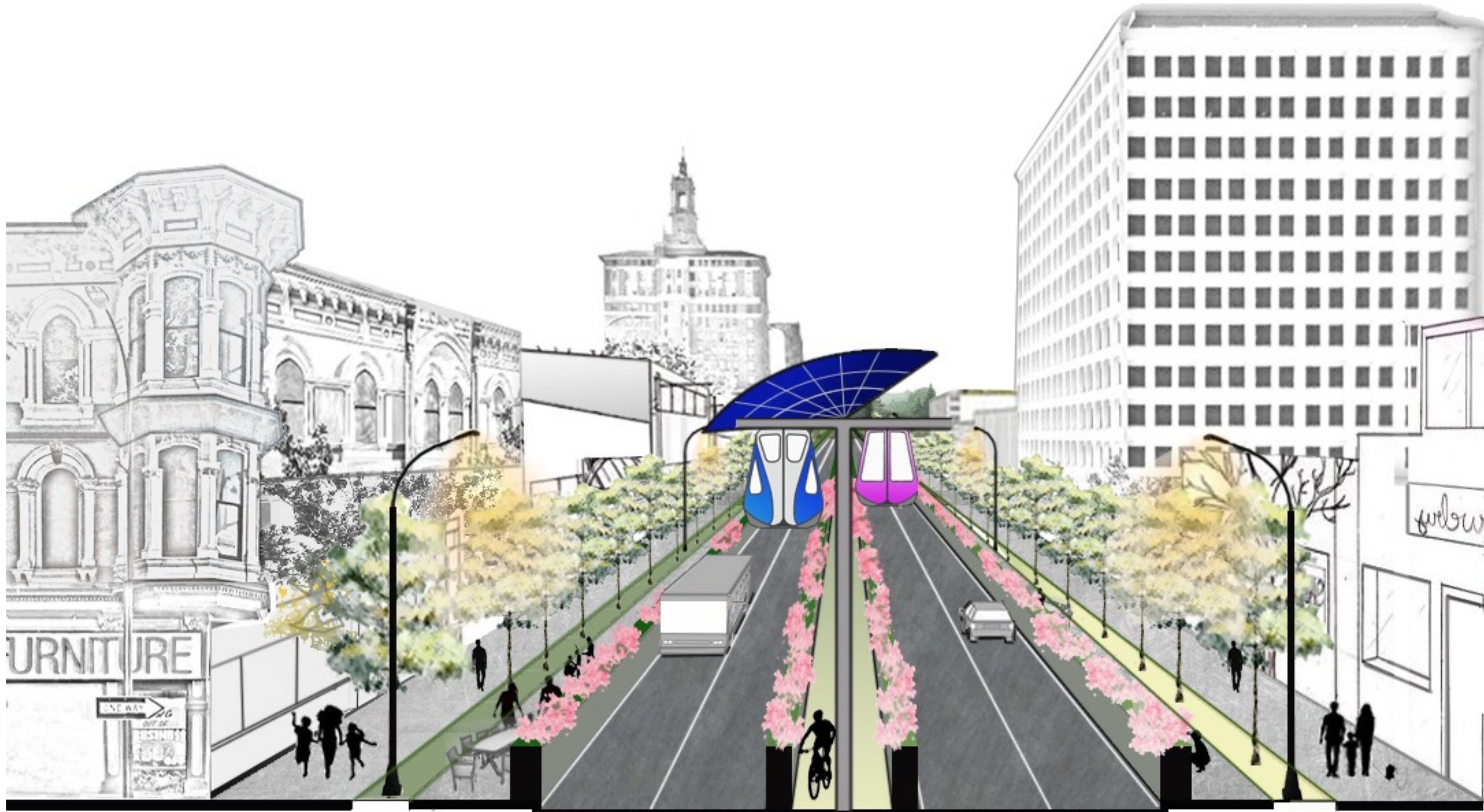








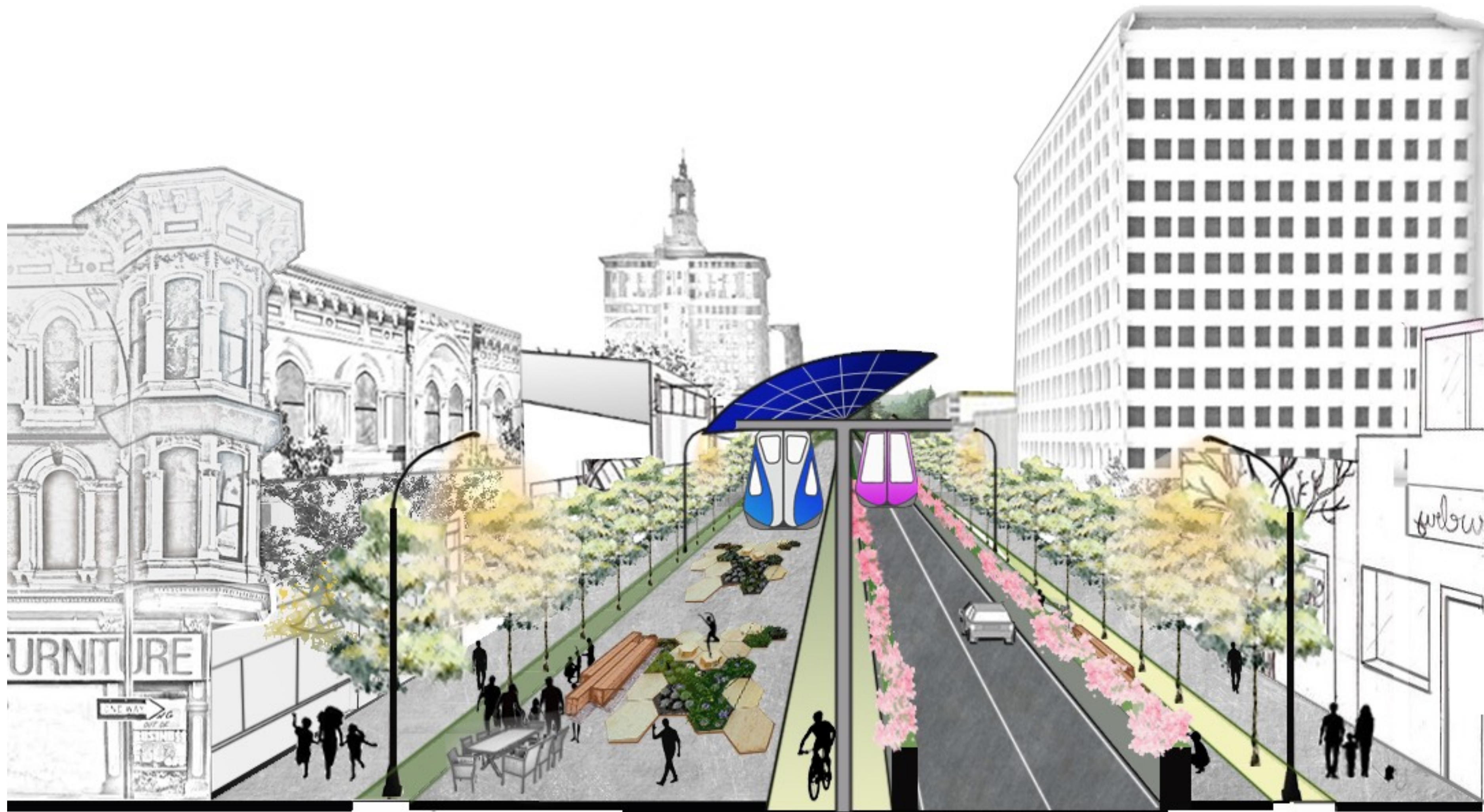




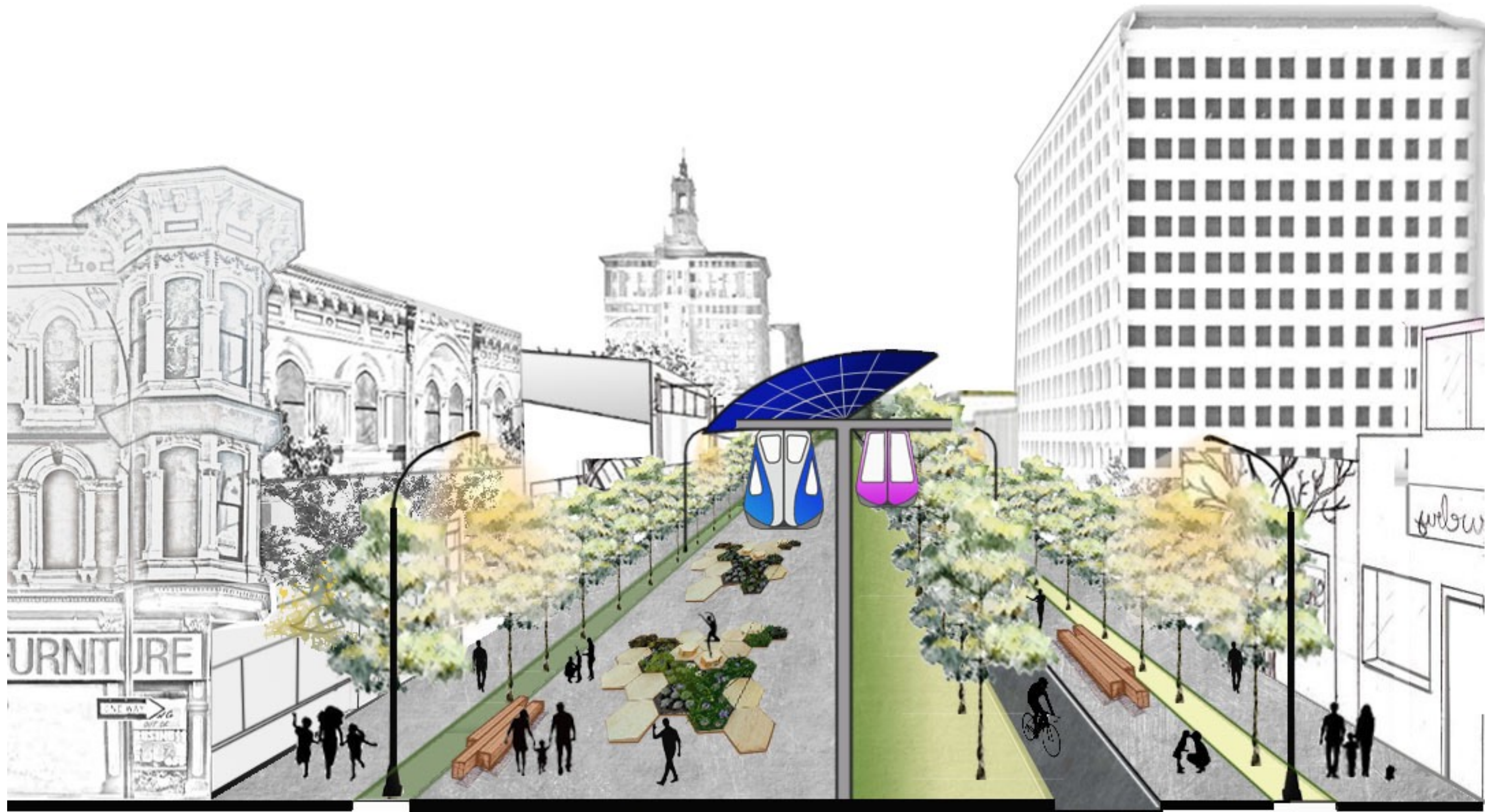














**I'm placing my bets on  
young people**



# Success depends on youth stepping up to the plate





# This is Spartan Superway Team 6 (2017-2018)





# This is Spartan Superway Team 5 (2016-2017)





# These are Spartan Superway Teams 1 – 4 (2012-2016)





**Podcars can do it...**

**10× better**



... **Less disruptive**



# Underground Metro costs are through the roof





# Overhead heavy rail costs are through the roof





**... Take up less space**

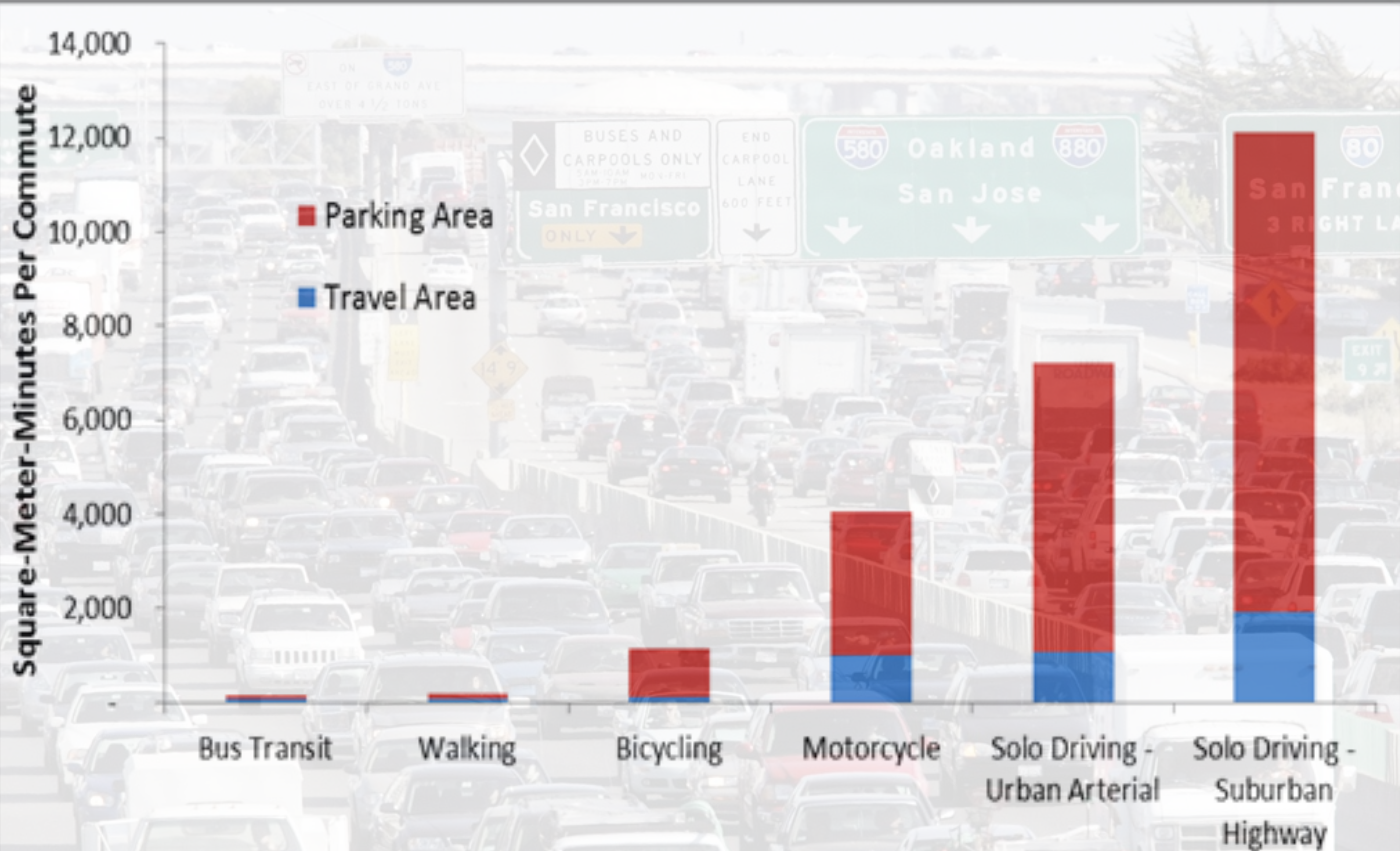


# Podcars reduce real estate use by 10x



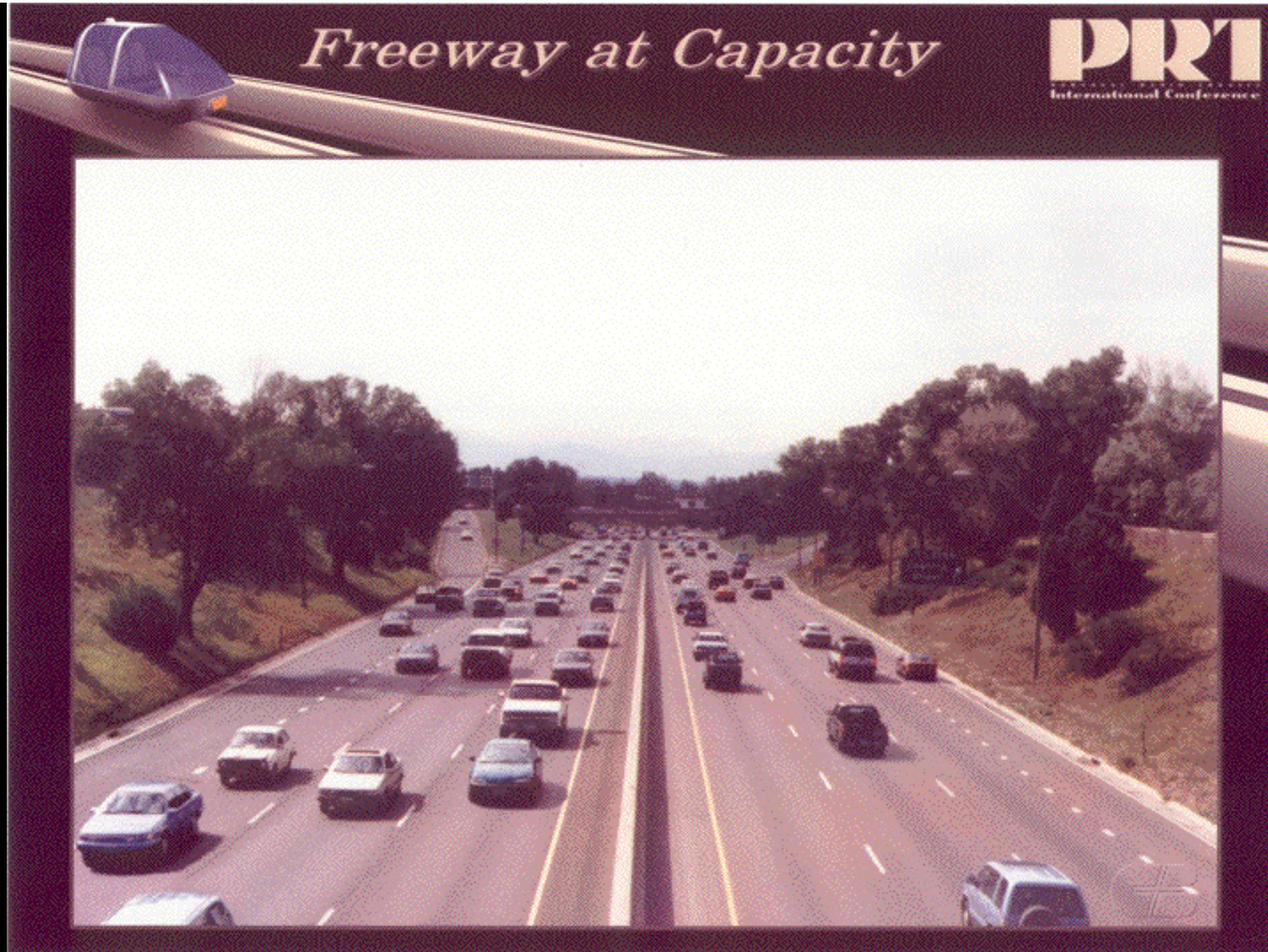


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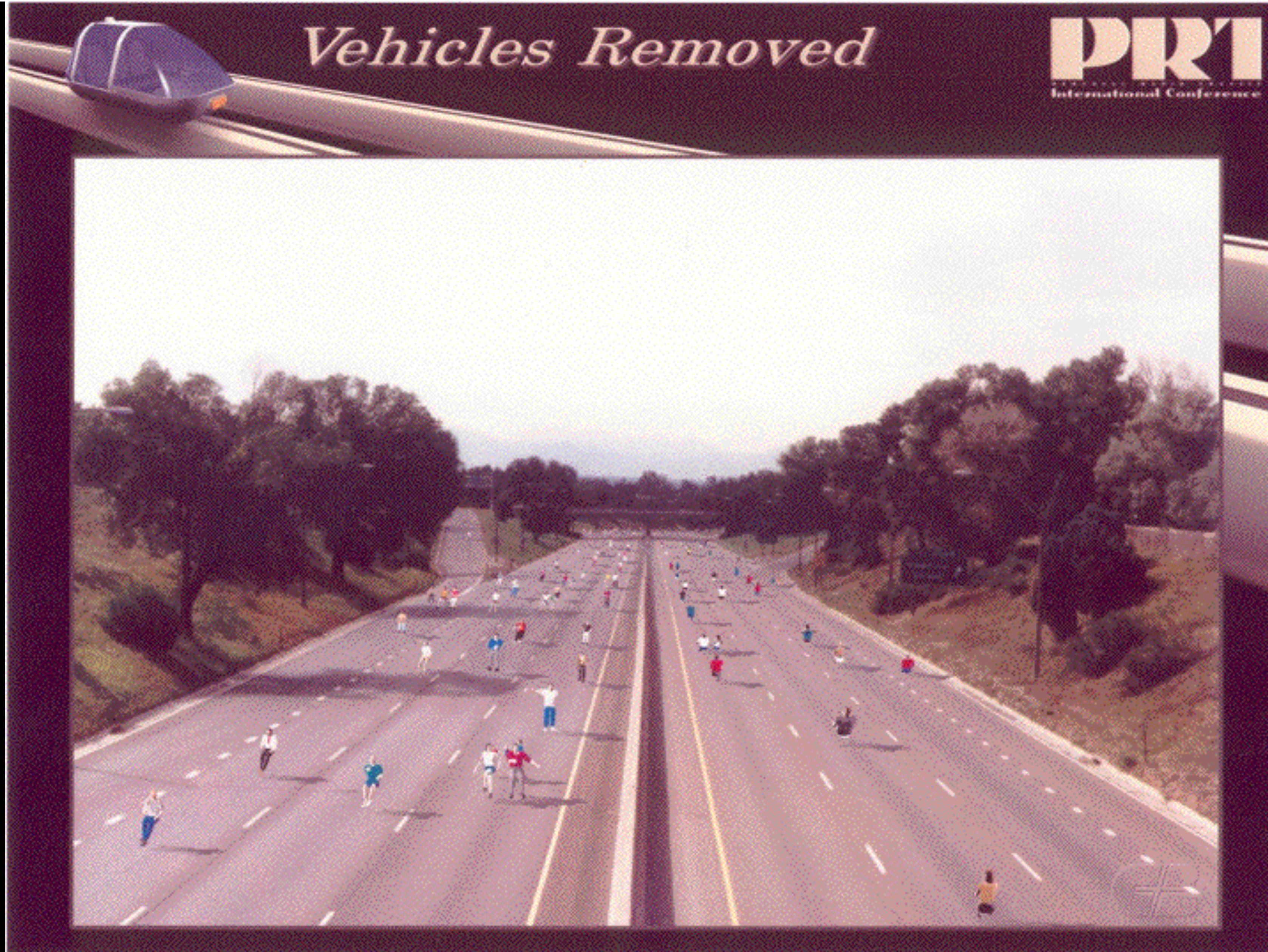


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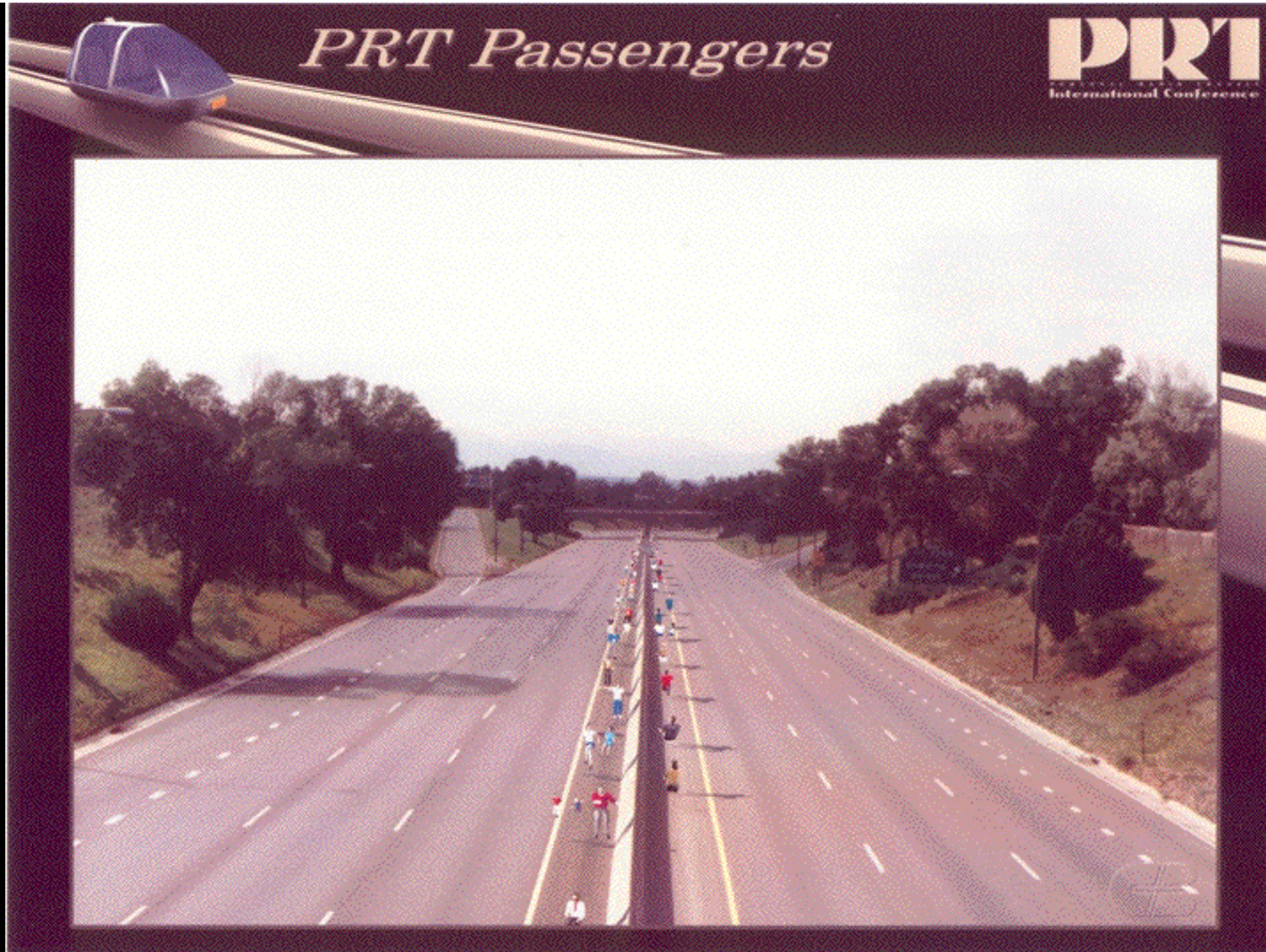


# Podcars reduce real estate use by 10x





# Podcars reduce real estate use by 10x





# Podcars reduce real estate use by 10x





# Podcars reduce real estate use by 10x





**... More economical**



# Cut capital costs 2x – 20x

<b>Mode</b>	<b>Cost/mile</b>	<b>Cost/km</b>
Heavy Rail	\$262 million	\$162 million
High Capacity Rail	\$256 million	\$159 million
Light Rail	\$171 million	\$106 million
Streetcar	\$38 million	\$24 million
Commuter Rail	\$36 million	\$22 million
Bus Rapid Transit	\$9 million	\$6 million
Average All Modes	\$89 million	\$55 million

Public Transportation Investment History • Background Data • Table 23

APTA 2015



# Cut capital costs 2x – 20x

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Podcars	\$15 million	\$9 million
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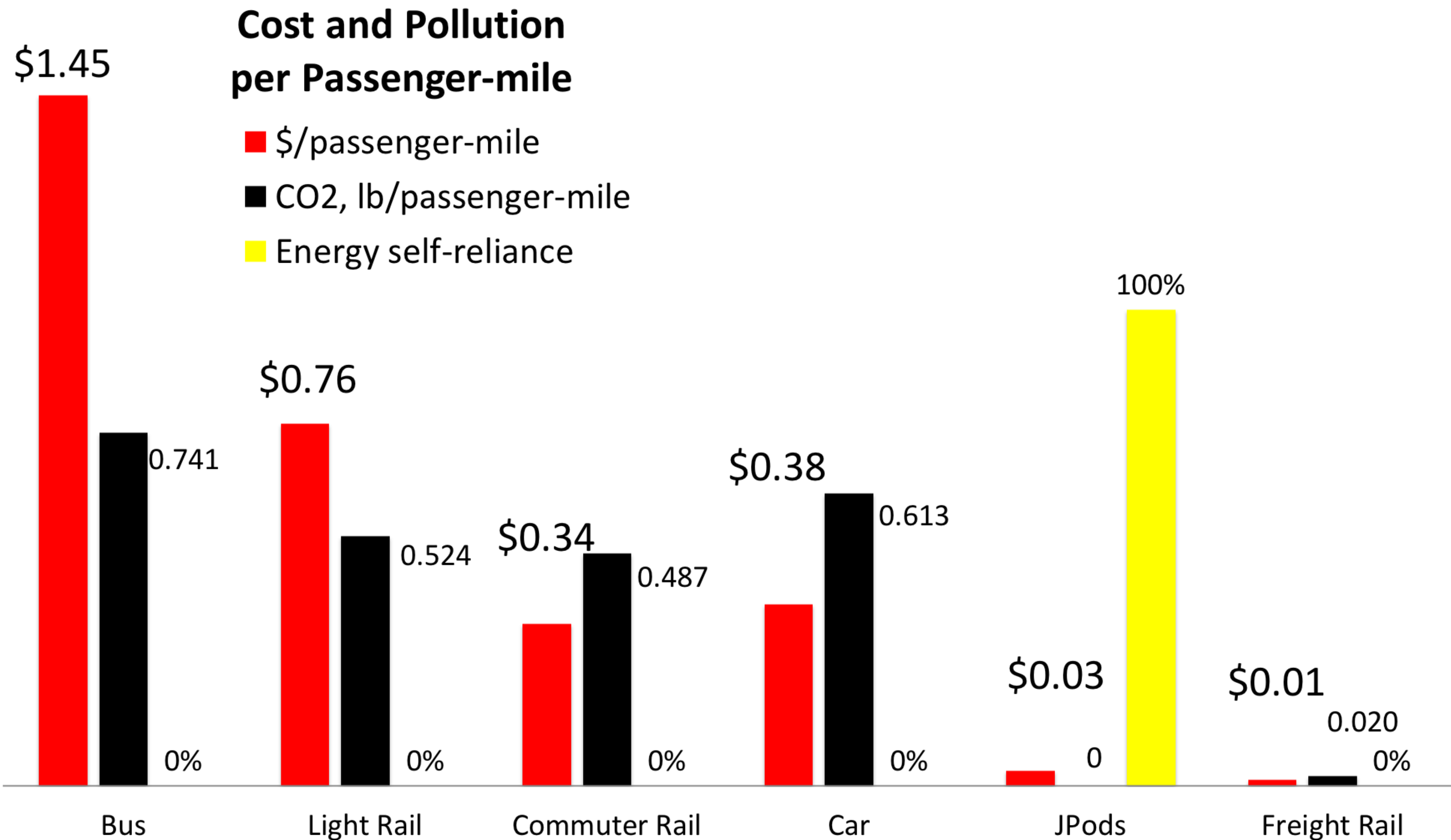
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Public Transportation Investment History • Background Data • Table 23

APTA 2015



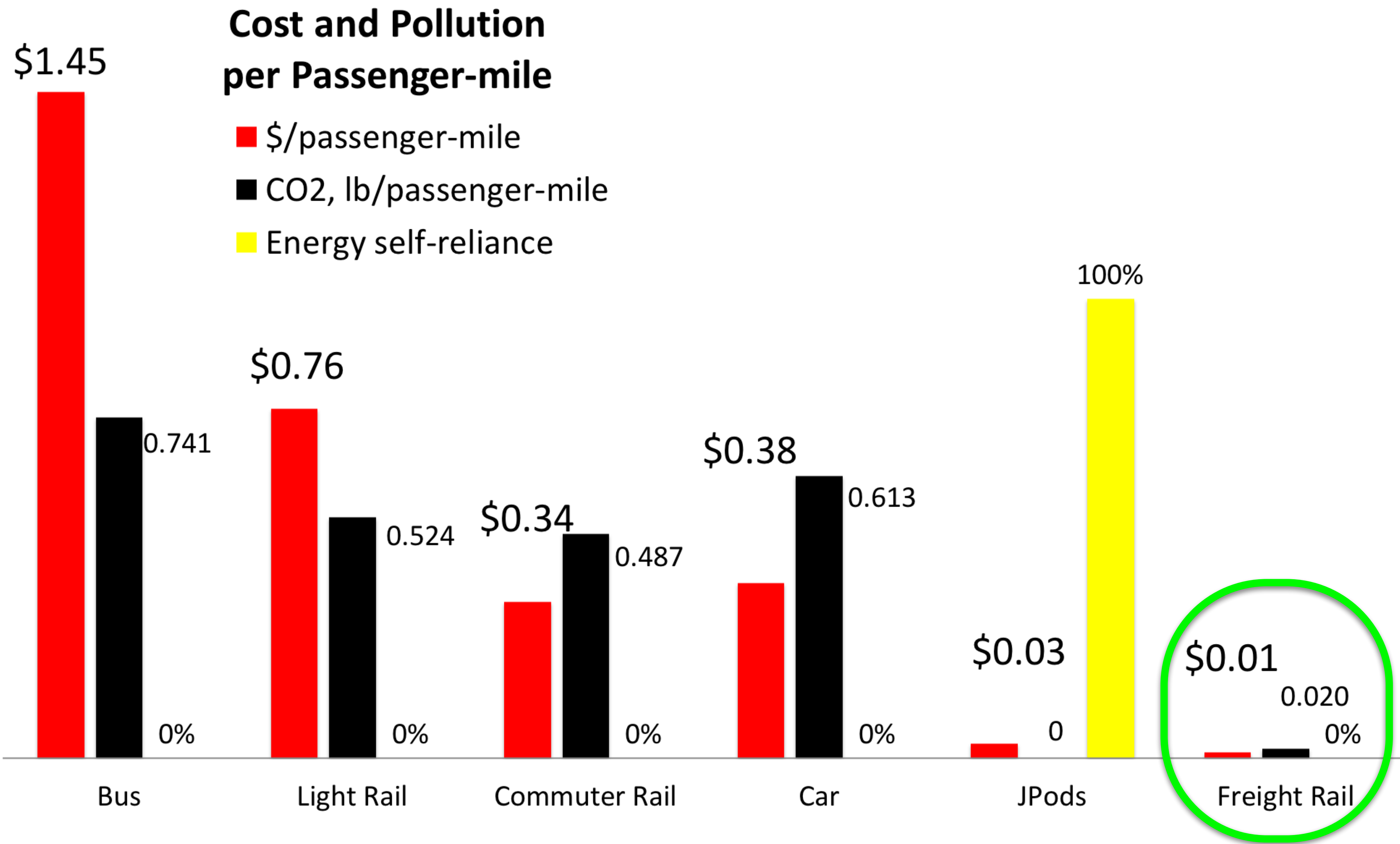
# Reduce operating costs per passenger-mile 10x



MassDOT cost data, US DOE energy data



# Reduce operating costs per passenger-mile 10x

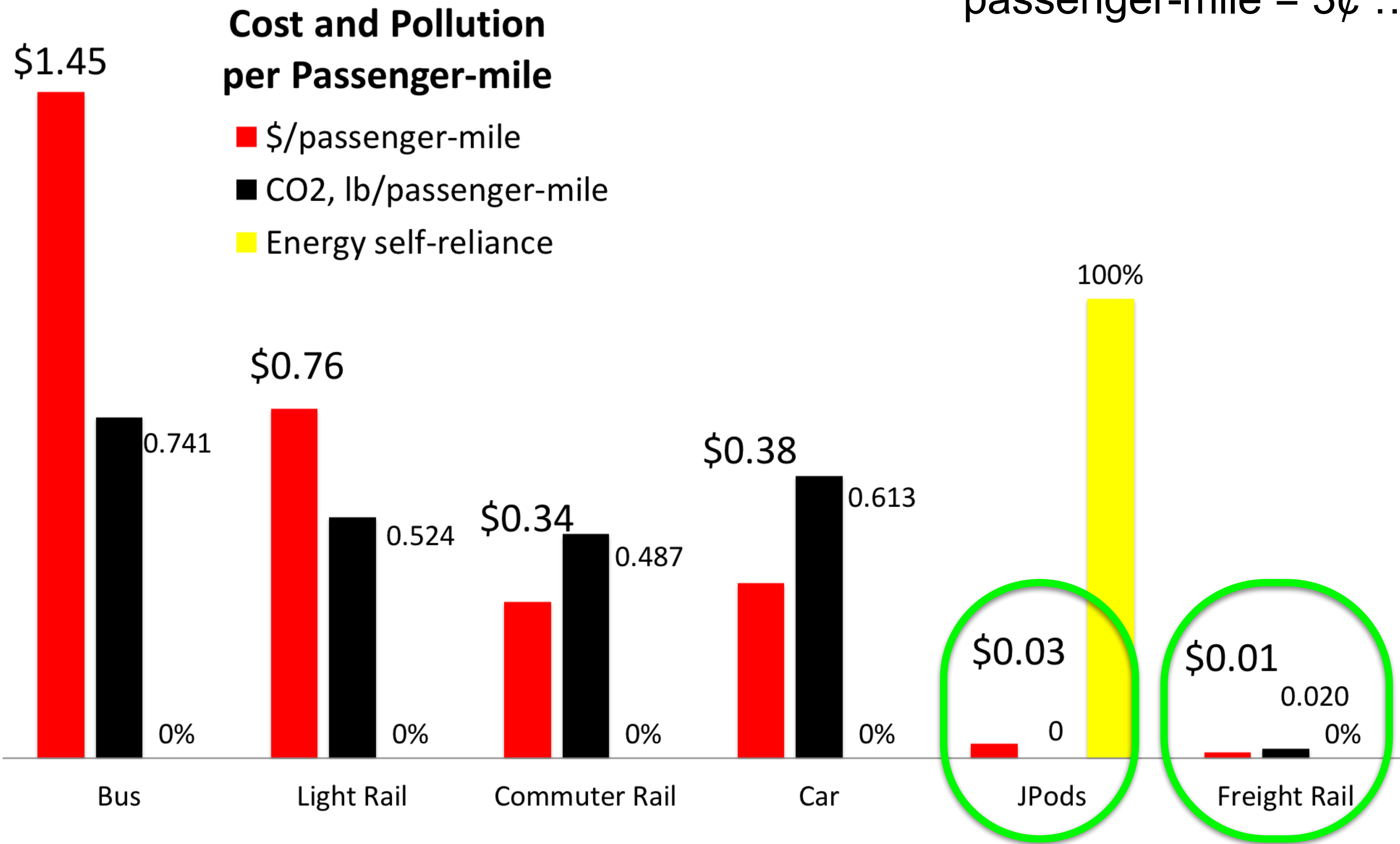


MassDOT cost data, US DOE energy data



# Reduce operating costs per passenger-mile 10x

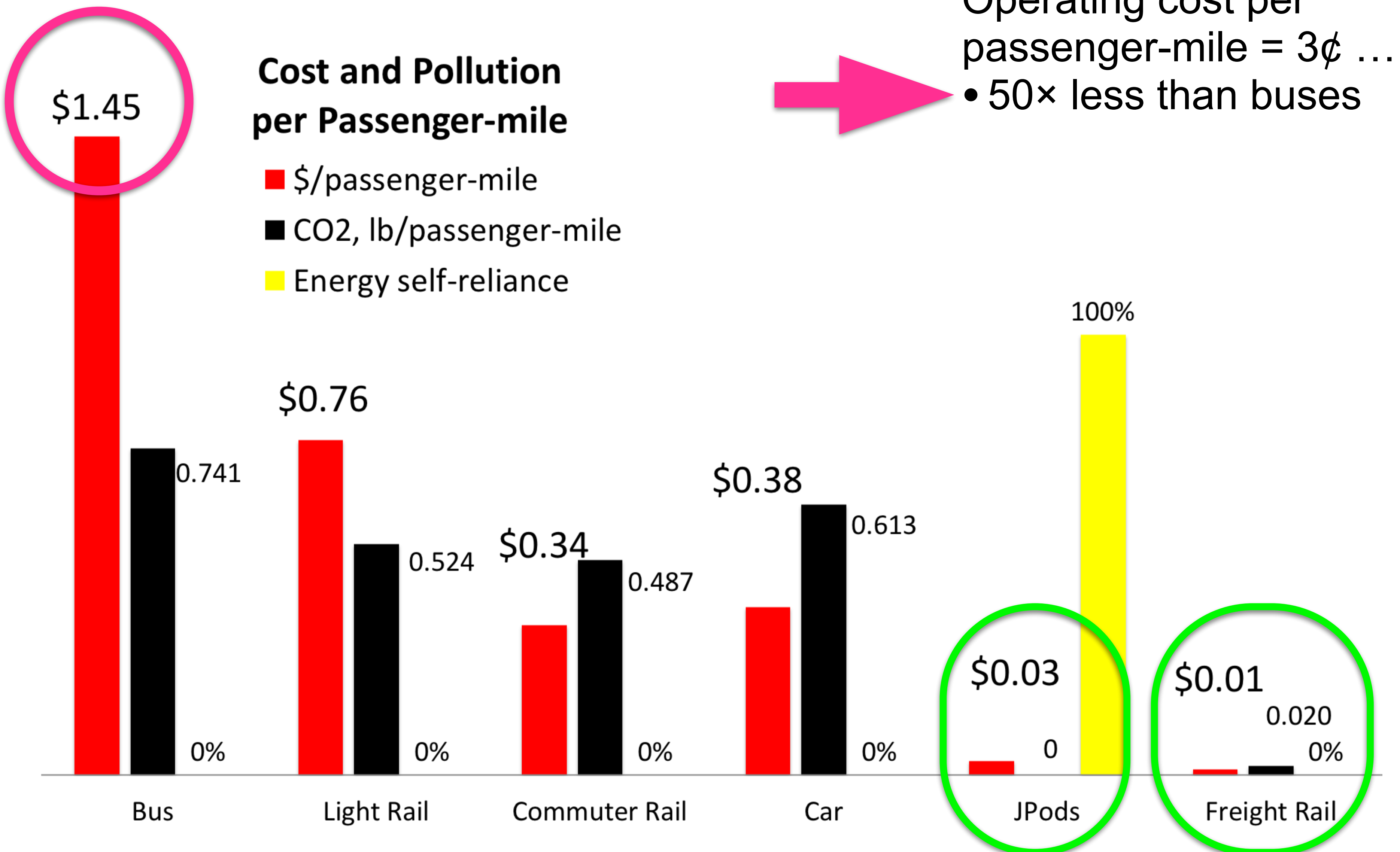
Operating cost per passenger-mile = 3¢ ...



MassDOT cost data, US DOE energy data



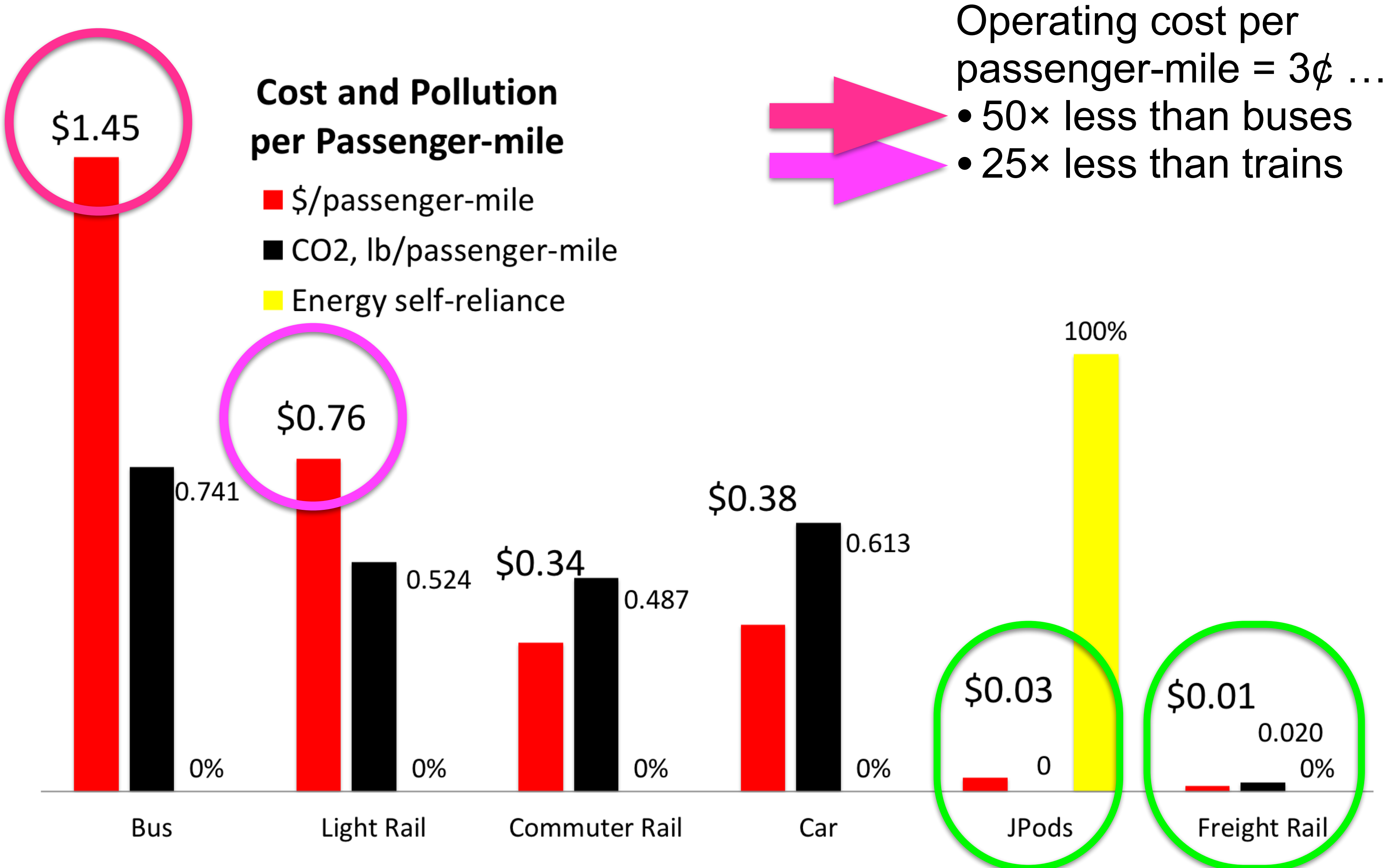
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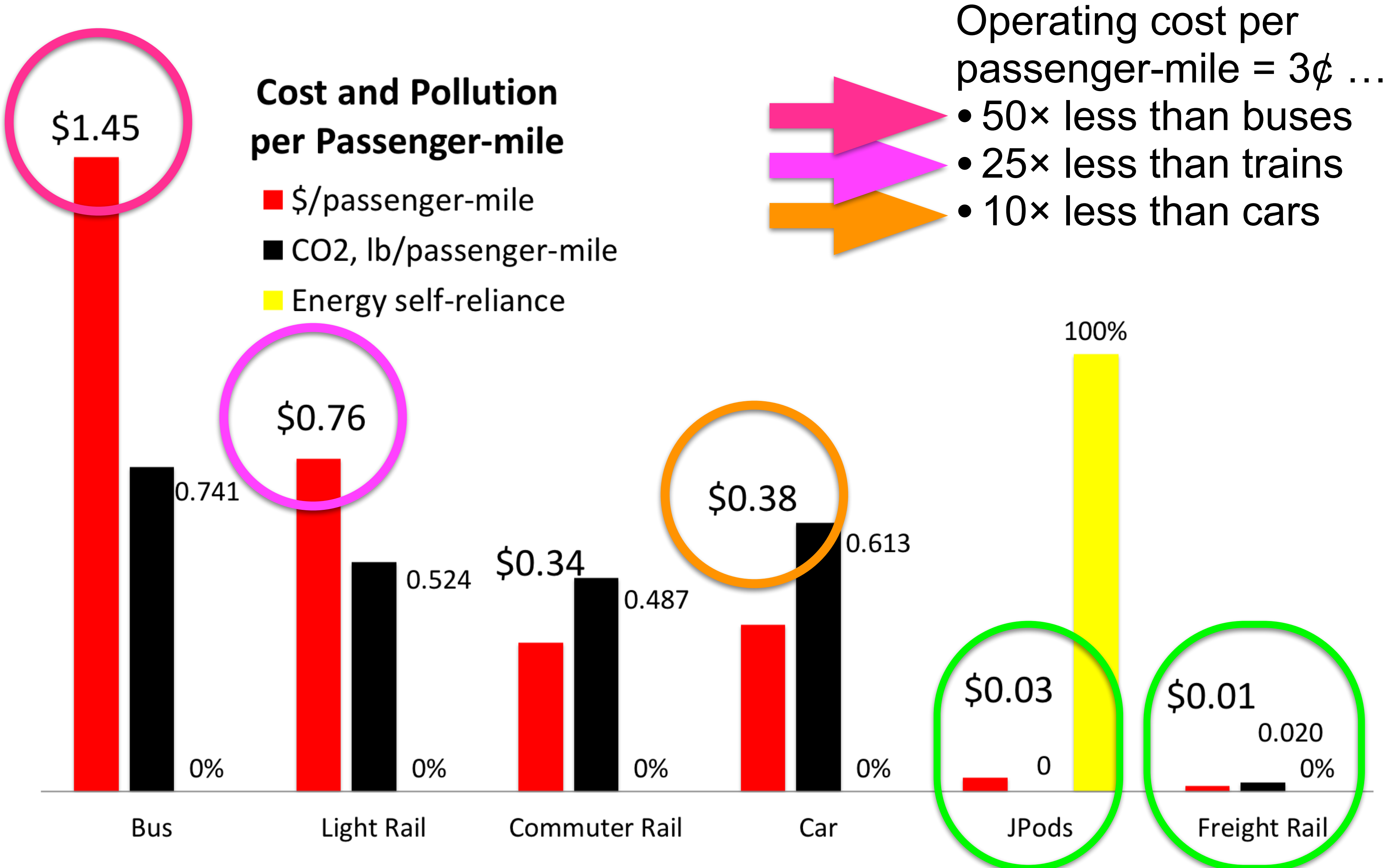
# Reduce operating costs per passenger-mile 10x



MassDOT cost data, US DOE energy data



# Reduce operating costs per passenger-mile 10×



MassDOT cost data, US DOE energy data



**... More capacity**



# Increase capacity with podcars 6× ... or more

## Relative Capacity per Hour *(not all seats are filled)*

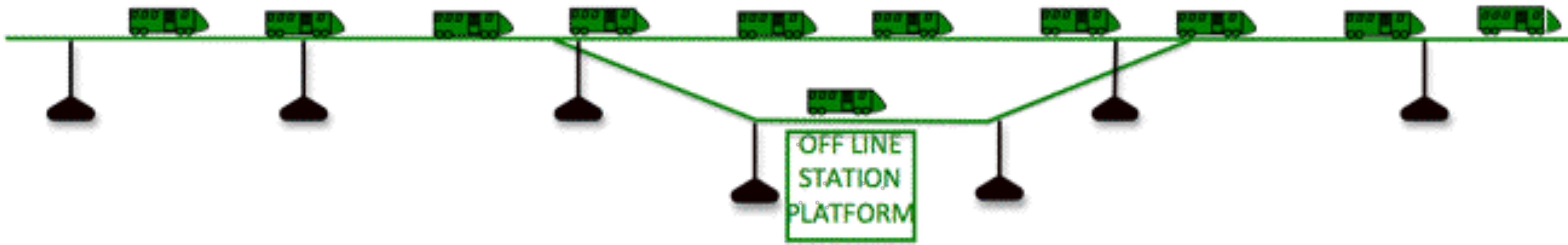
Mode	Seats per Vehicle	Headway	Seats per Hour
Bus	0-50, 50 used	5 mins	600
Light Rail	0-200, 200 used	10 mins	1,200
Automobiles	1-6, 4 used	(3 legal) 1-6 secs	4,800
Podcars	1-8, 4 used	3 secs	4,800
Podcars	1-8, 4 used	1 secs	14,400
Podcars	1-8, 4 used	0.5 secs	28,800
Podcars	1-8, 4 used	0.25 secs	57,600

*\* 0.25 second headway gives each vehicle 3.91 meters of space*

*Adapted from JPods 2018*



# Capacity increases with automation & off-line stations



ATN systems use off-line stations for better use of the tracks

**1. CAPACITY** **2. COST**

... with ~500% improvement over state-of-the-art controls

... and a very low cost onboard controller

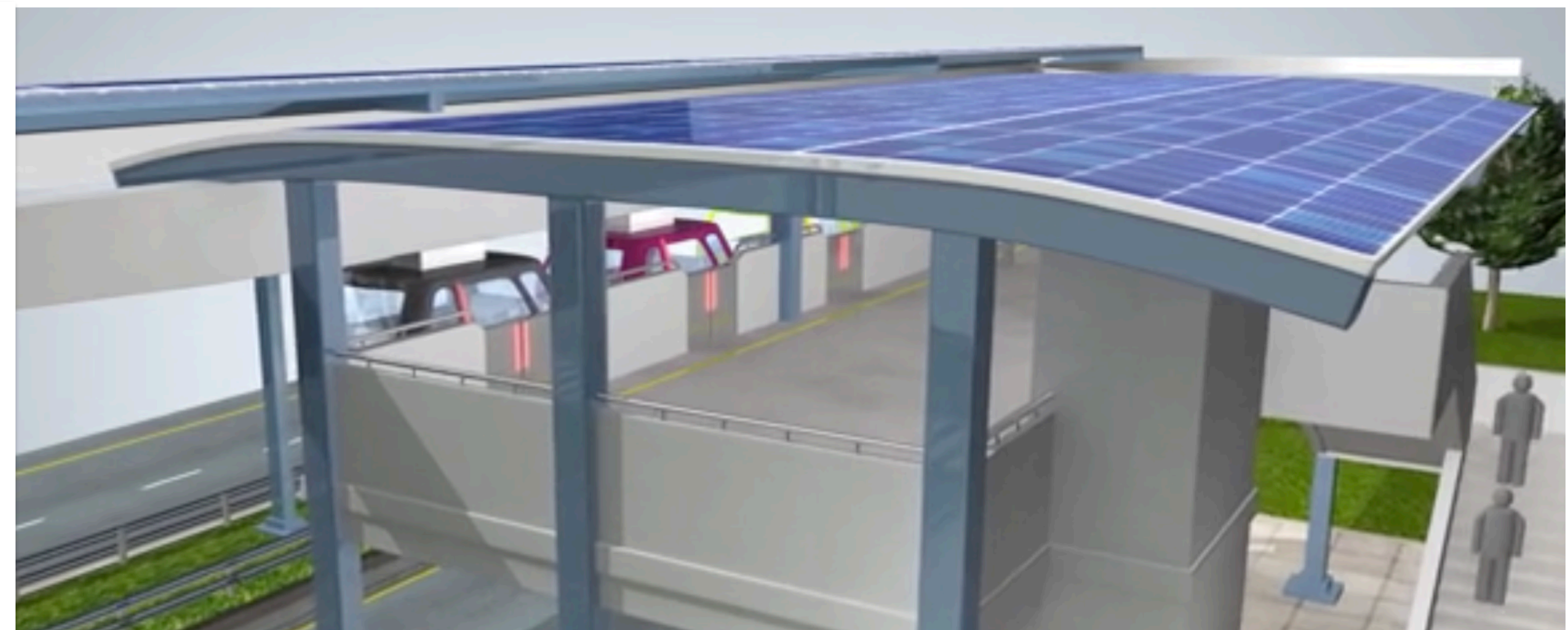




**... Better service**



# Podcars provide 10× better service

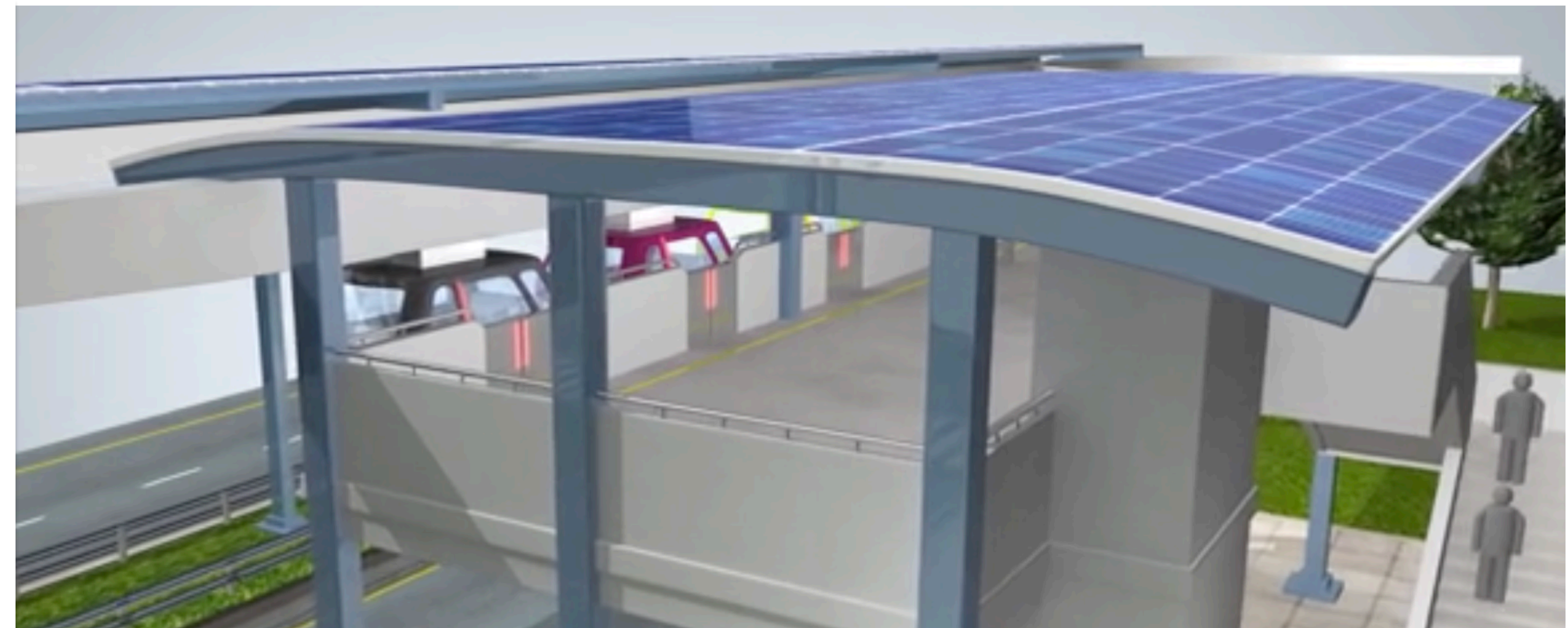




# Podcars provide 10× better service



**People wait for machines**

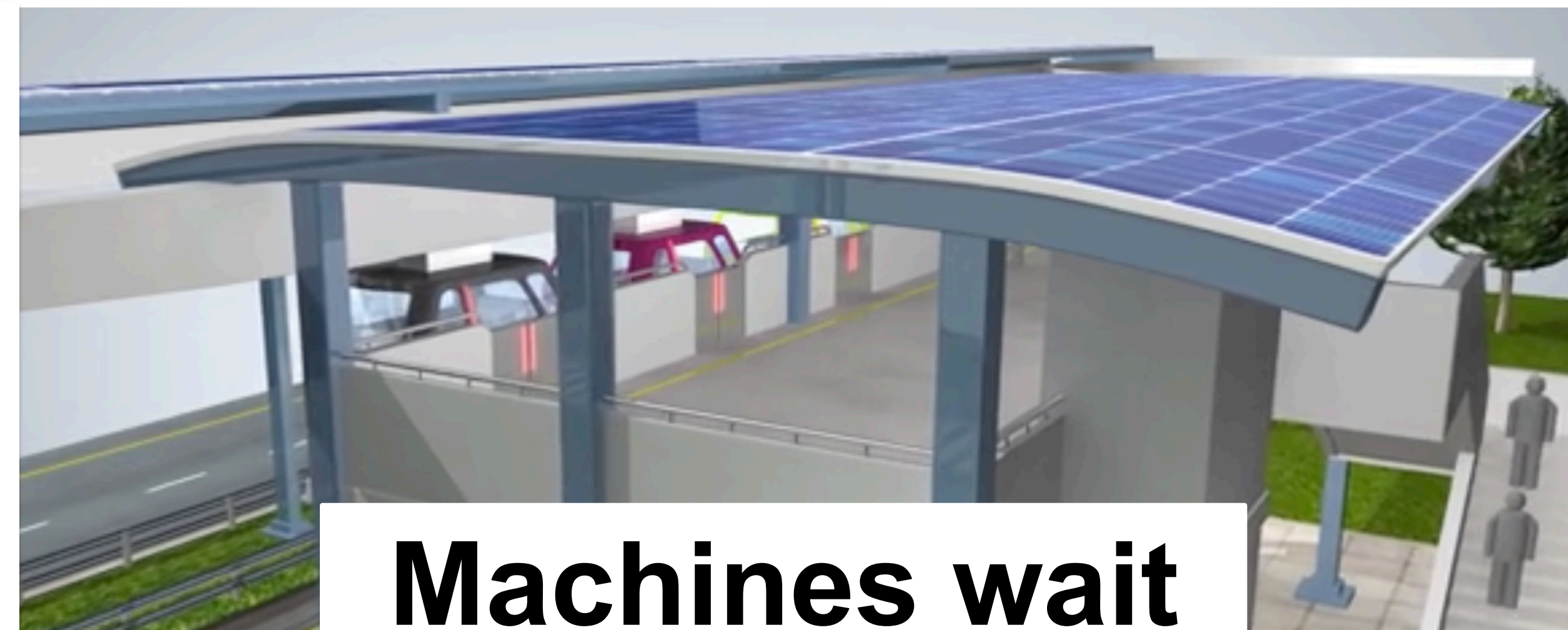




# Podcars provide 10× better service



**People wait for machines**



**Machines wait for people**



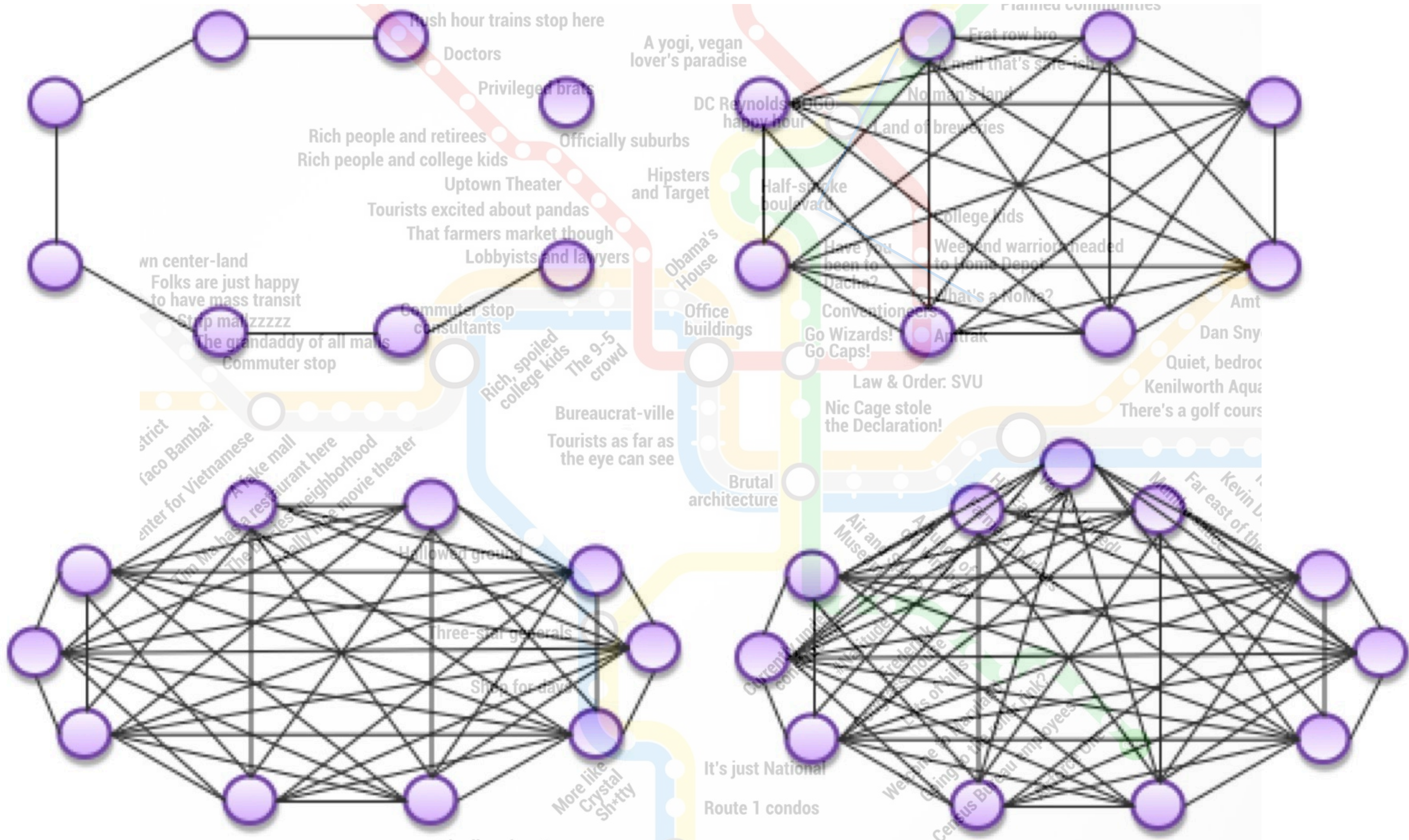


# We can convert “star” metros into mesh networks





# We can convert “star” metros into mesh networks

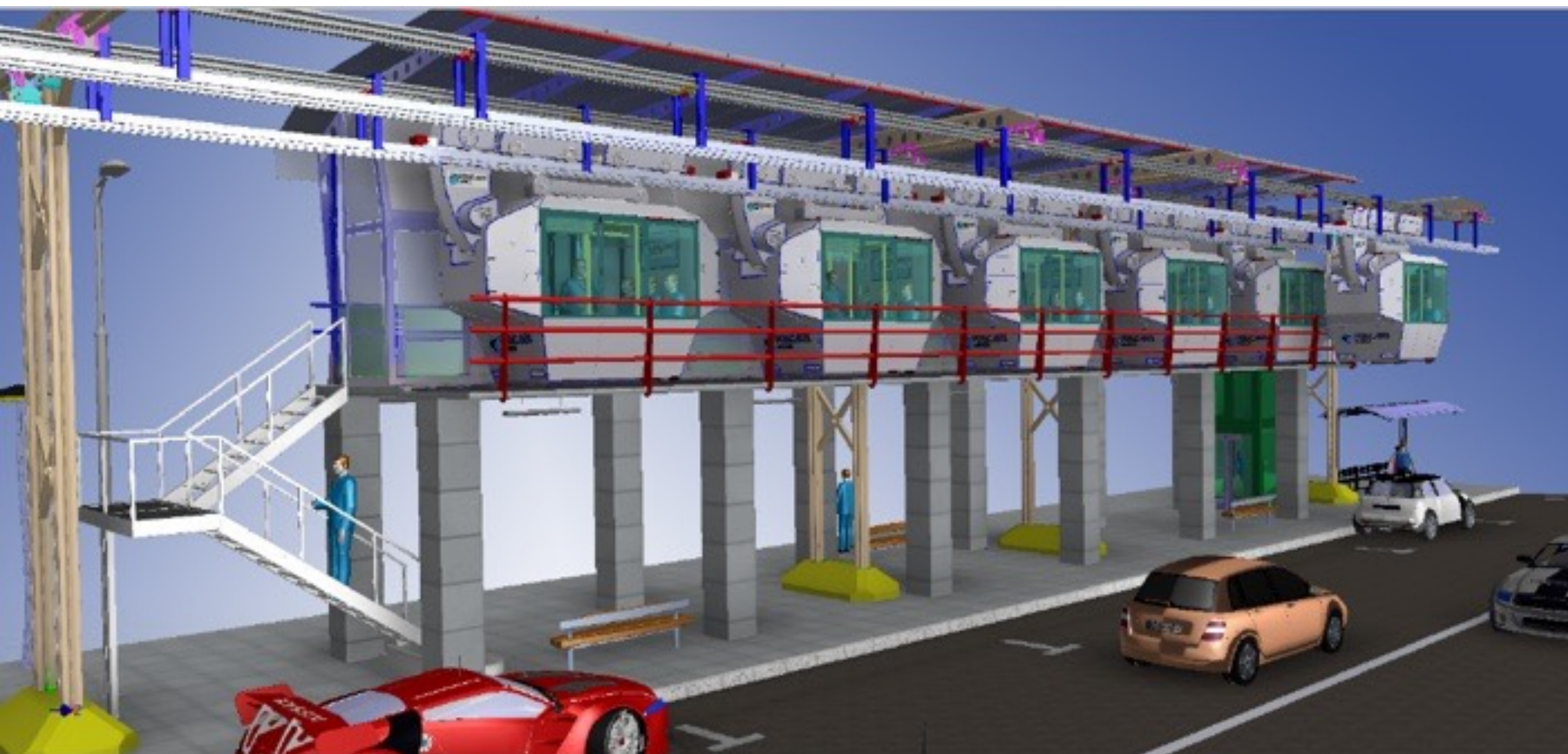




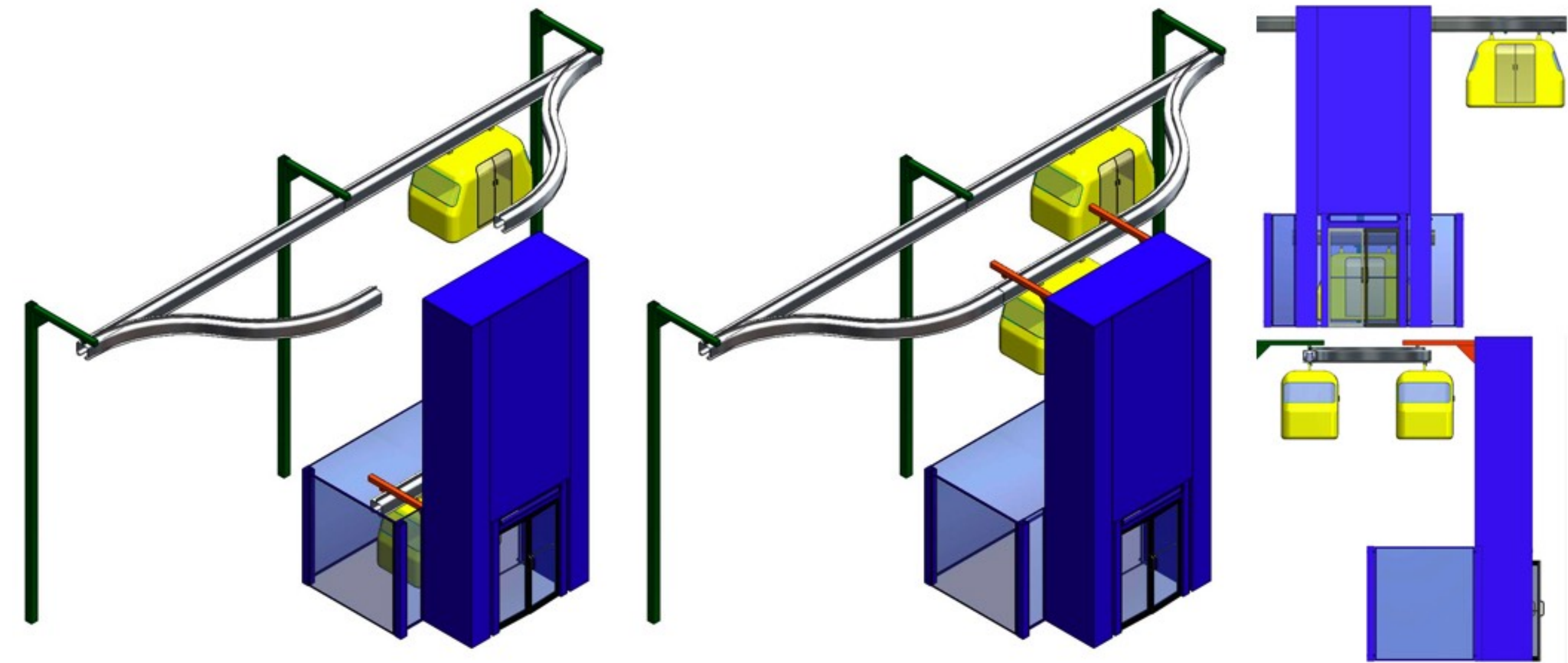
# Podcar networks can grow with 10× more stations



**Multiple level stations**



**Stations on top of sidewalks**



**Stations of two parking spots**



**Podcars can roll in & out of buildings**



# Podcars can roll in & out of buildings





**3 ways**  
**to get involved**



# **(1) Solar Skyways Network**



# Join the Spartan Superway Summer Internship Program, next June–July 2019 in Silicon Valley



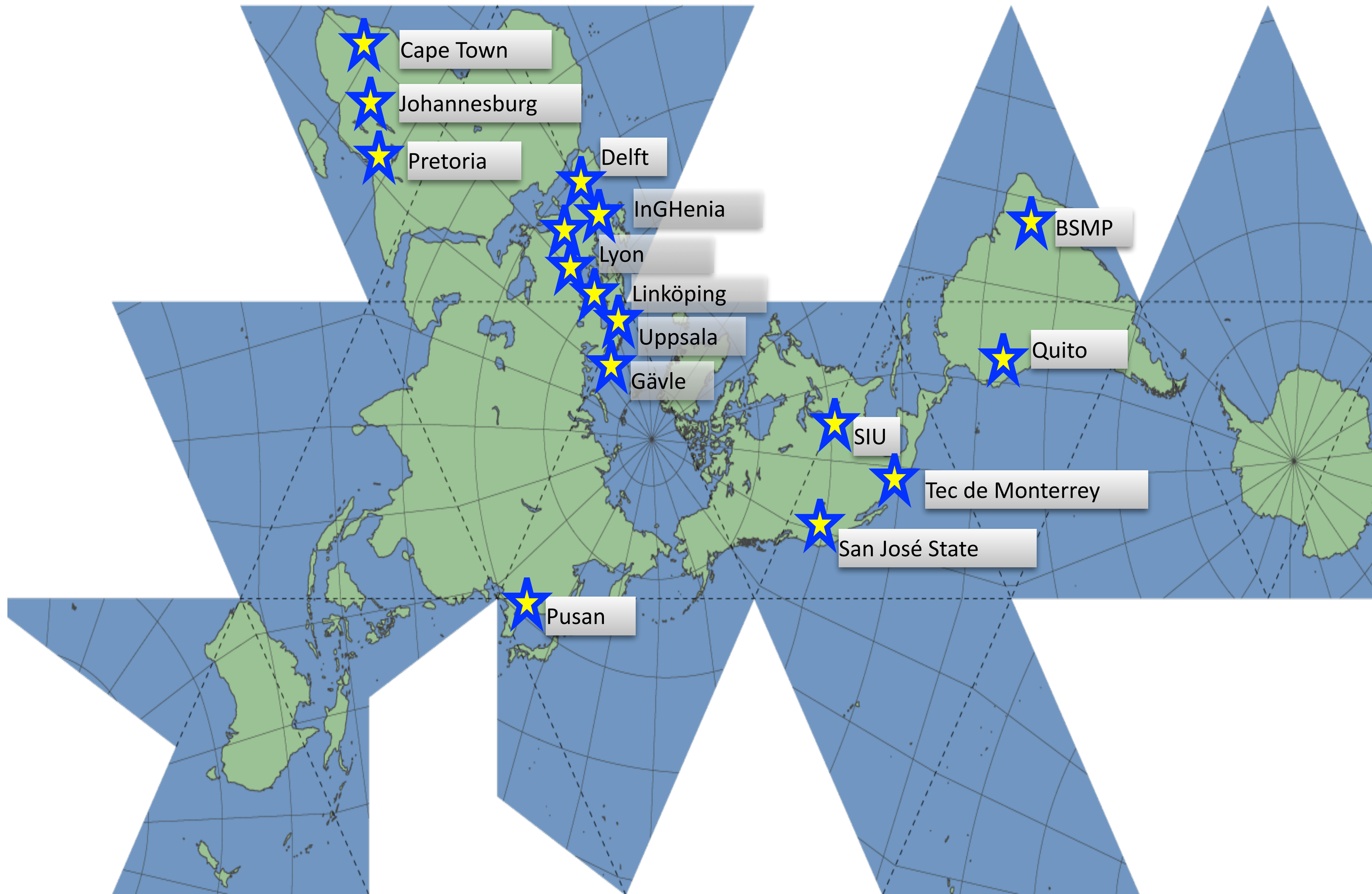


# Join the Spartan Superway Summer Internship Program, next June–July 2019 in Silicon Valley

**Spartan Superway  
Summer  
Internships**

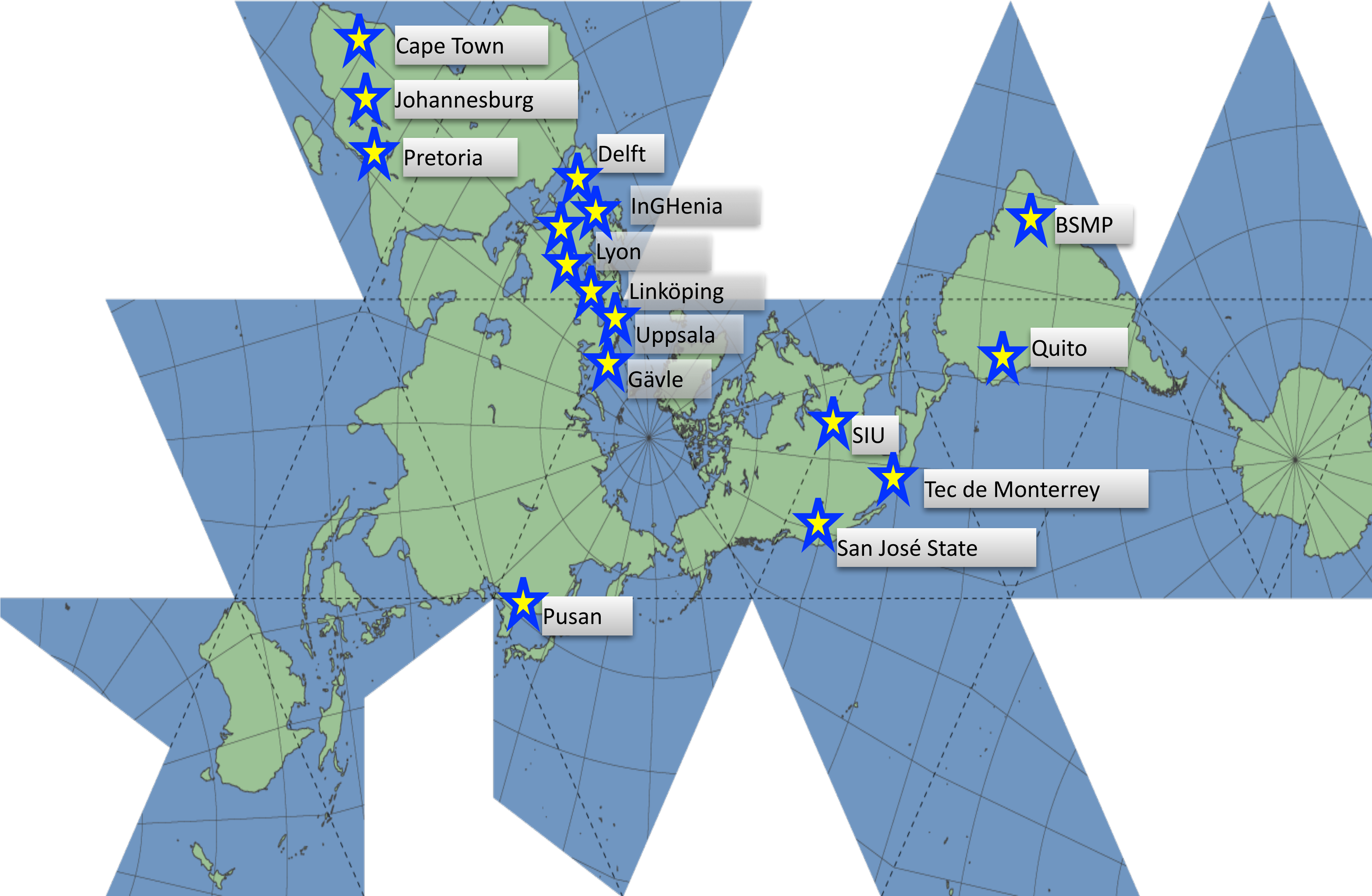








# Join this growing international university network





# **(2) Urban International Design Contest**



**Help rebalance public space & create a city for people\***

URBAN INTERNATIONAL

February 6 -  
October 1  
2018

DESIGN  
CONTEST

practices  
and Public Transit

*\*Deputy Mayor Gilles Vesco  
Lyon 2017*



# **3. The Sputnik Crisis is instructive**



It took the Sputnik Crisis to get things moving

"All the News That's Fit to Print"

# The New York Times.

INTERNATIONAL EDITION  
Printed in Amsterdam  
October 6, 1957

VOL. CVII, No. 36,414.

© 1957, by The New York Times Company.

NEW YORK, SATURDAY, OCTOBER 5, 1957.

Printed and Published in Amsterdam by P. M. B. van der Stoep, Proprietor.

## SOVIET FIRES EARTH SATELLITE INTO SPACE; IT IS CIRCLING THE GLOBE AT 18,000 M. P. H.; SPHERE TRACKED IN 4 CROSSINGS OVER U. S.

### HOFFA IS ELECTED TEAMSTERS' HEAD; WARNS OF BATTLE

Defeats Two Foes 3 to 1  
—Says Union Will Fight 'With Every Ounce'

By A. H. RASKIN  
Special to The New York Times  
MIAMI BEACH, Oct. 4—The scandal-scattered International Brotherhood of Teamsters elected James R. Hoffa as its president today.



### COURSE RECORDED

Navy Picks Up Radio Signals—4 Report Sighting Device

By WALTER SULLIVAN  
Special to The New York Times  
WASHINGTON, Saturday, Oct. 5—The Naval Research Laboratory announced early today that it had recorded four crossings of the Soviet earth satellite over the United States.  
It said that one had passed near Washington. Two crossings were recorded near New York.



### 680 MILES HIGH

Visible With Simple Binoculars, Moscow Statement Says

Part of Text announcement appears on Page 1.  
By WILLIAM J. BORDEN  
Special to The New York Times  
MOSCOW, Saturday, Oct. 5—The Soviet Union announced this morning that it successfully launched a man-made earth satellite into space yesterday.



# It took the Sputnik Crisis to get things moving

**The Weather**  
 Paris: Today's forecast: Cool, foggy with sunny spots. Yesterday's temperature: Max. 45 (13 Cels.); min. 48 (10 Cels.). Today's probable temperature: Max. 51 (12 Cels.).  
 London: Warm and misty early, but rain. Yesterday's temperature: Max. 42 (10 Cels.); min. 38 (10 Cels.).  
 Channel Crossing: Smooth.  
 New York: Cool, windy, occasional rain. Yesterday's temperature: Max. 50 (10 Cels.).

NEW YORK

# Herald Tribune

European Edition

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Established in Europe 1861 .. PARIS, MONDAY, OCTOBER 7, 1957 Established in New York 1861

# U.S. Views Satellite as Russian Victory

## Fights Flare In Warsaw for Fourth Night

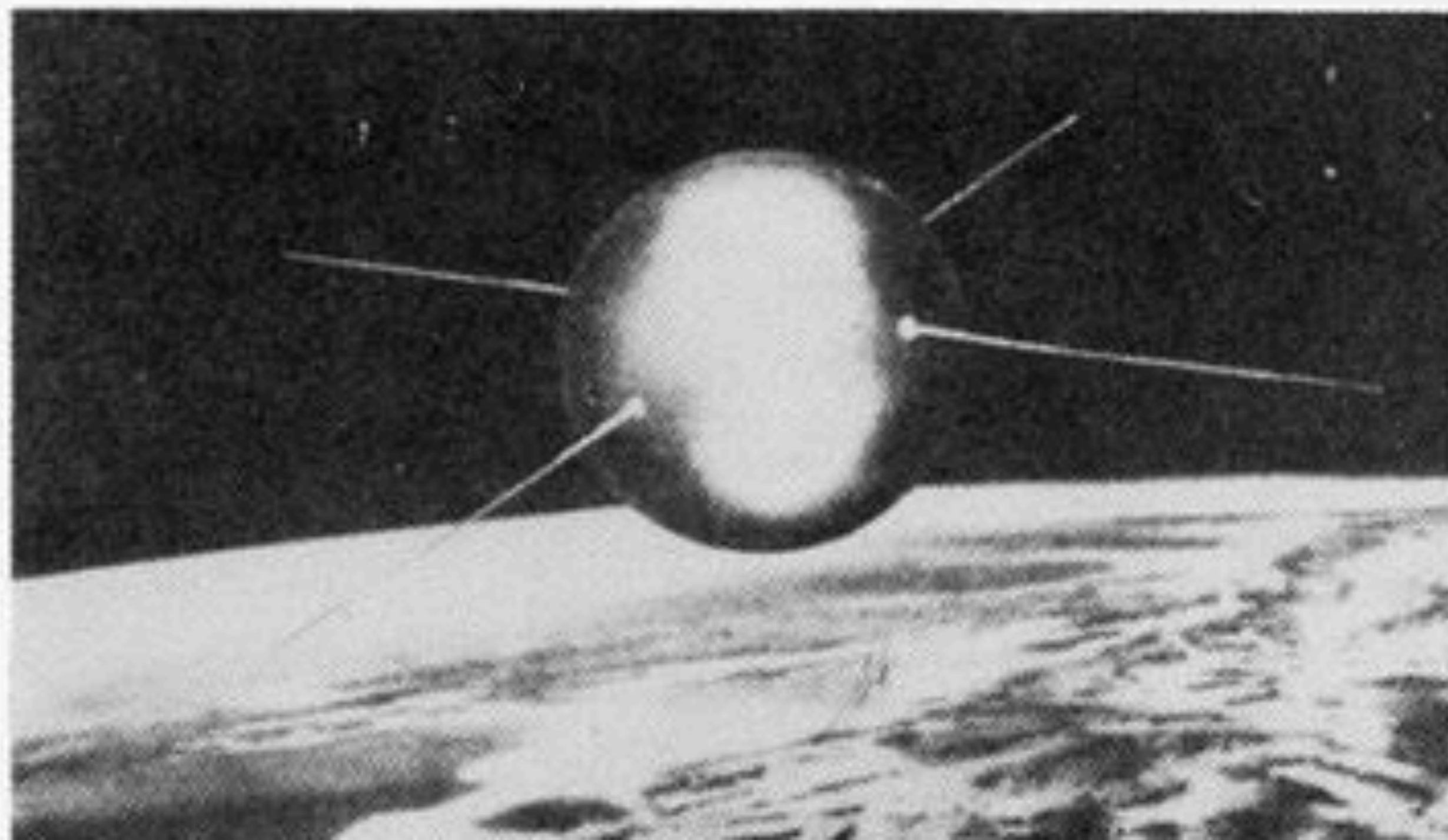
By William J. Humpherys  
*Special to the Herald Tribune*  
 WARSAW, Oct. 6. — Clashes between riot police and civilians flared off Thursday by university students holding for the right of free speech, tonight raged up and down the principal thoroughfares of Warsaw for the fourth consecutive night.  
 At the same time, Stefan Cardinal Wyszyński, Roman Catholic Primate of Poland, told the nation's students that while he could understand their "fight," they had to remember "that our country is in a particularly difficult situation."

## Braves Nip Yanks, 7-5, In Tenth

Those listening to the cardinal's remarks on the occasion of the university's scheduled reopening, got the impression that he was warning that hot-headed actions

## Russians Work on New One It May Get Down With Instruments

By B. J. Catler  
*From the Herald Tribune Bureau*  
 MOSCOW, Oct. 6.—The Soviet Union is working on a new satellite designed to return to earth undamaged and with its delicate instruments intact.  
 This was disclosed today by Yegor Fedorov, scientist in charge of Russia's upper-atmosphere research program, which already has sent history's first artificial satellite into its orbit around the earth.  
 The statement came as the nation's newspapers and radio stations erupted in a torrent of applause over Friday's successful launching of the satellite and fired taunts that the Soviet Union had "trounced" the United States and



## Cold-War Effect Is Assayed Symington Calls For Investigation

Editorial—Page 4  
 By Robert J. Donovan  
*From the Herald Tribune Bureau*  
 WASHINGTON, Oct. 6.—The tumultuous reaction here yesterday to news of the Soviet earth satellite was that the United States has had the daylight's trial run of it in an epoch event of the 20th century.  
 While the Soviet projectile whizzed over this disgraced capital, the perils and consequences of Russia's new conquest of space loomed large and unproven. In the view of many observers here, this is what the Soviet triumph means:  
 1.—That the Russians have scored a tremendous propaganda victory in the cold war—a victory likely to strengthen their hand diplomatically



# It took the Sputnik Crisis to get things moving

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Established in Europe 1881

## U.S. V


## Fights F In Warsaw Fourth N

By William J. Humphrey  
 Special to the Herald Tribune  
 WARSAW, Oct. 6. — Clashes between rival socialist bloc Thursday by university students in five speeches, tonight raged up and down the street of Warsaw for the fourth consecutive night.  
 At the same time, Stefan Cardinal Wyszyński said that Poland's students should understand the meaning of the word "solidarity."

## Braves Nip Yanks, 7-5, In Tenth

# The *Sputnik* Crisis

- The next year, Congress created the **National Aeronautics and Space Administration (NASA)** and also passed the **National Defense Education Act (NDEA)**.



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U.S. Military	10 Cents		

Established in New York 1881

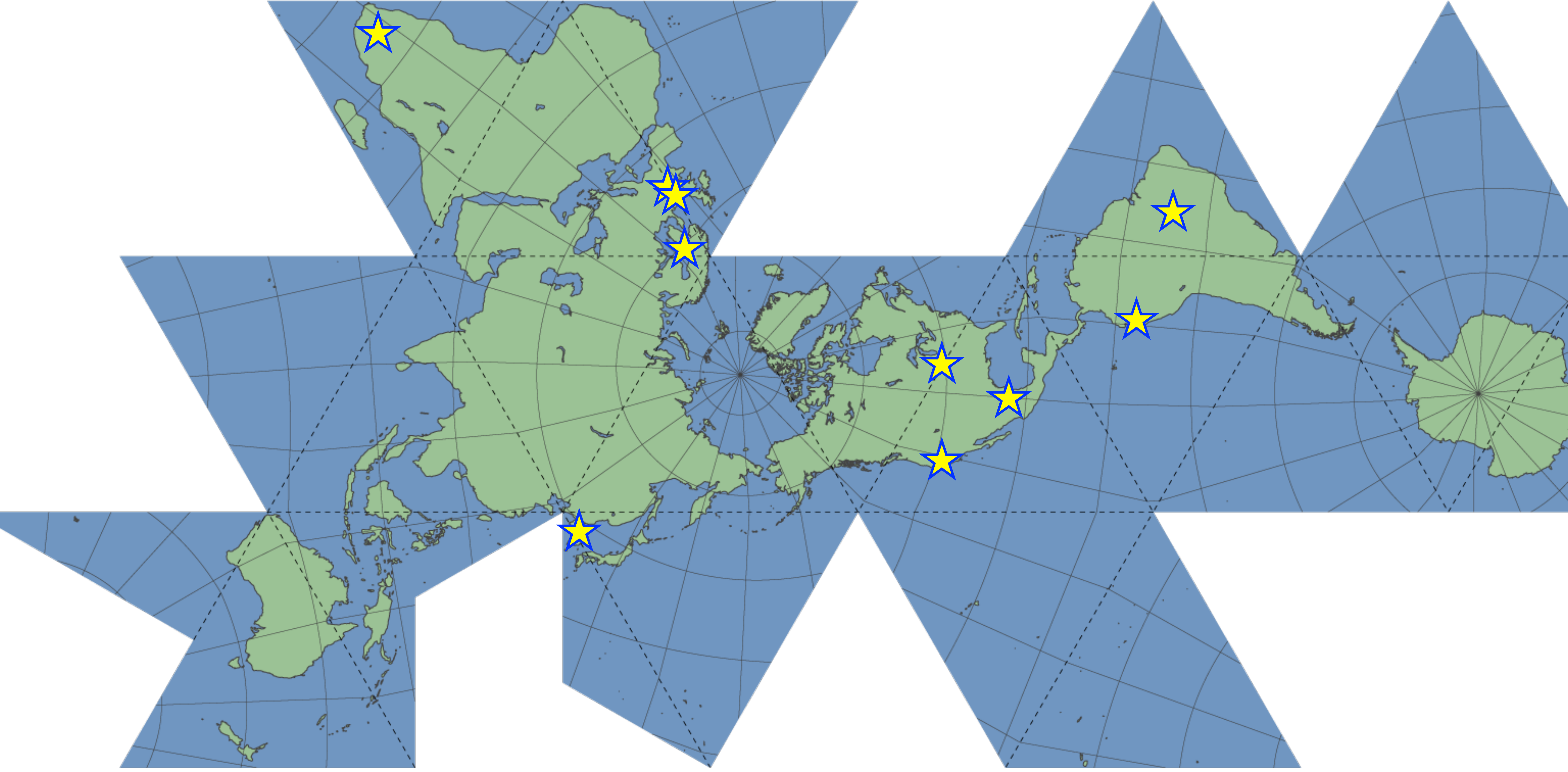
## Victory

## Cold-War Effect Is Assayed Symington Calls For Investigation

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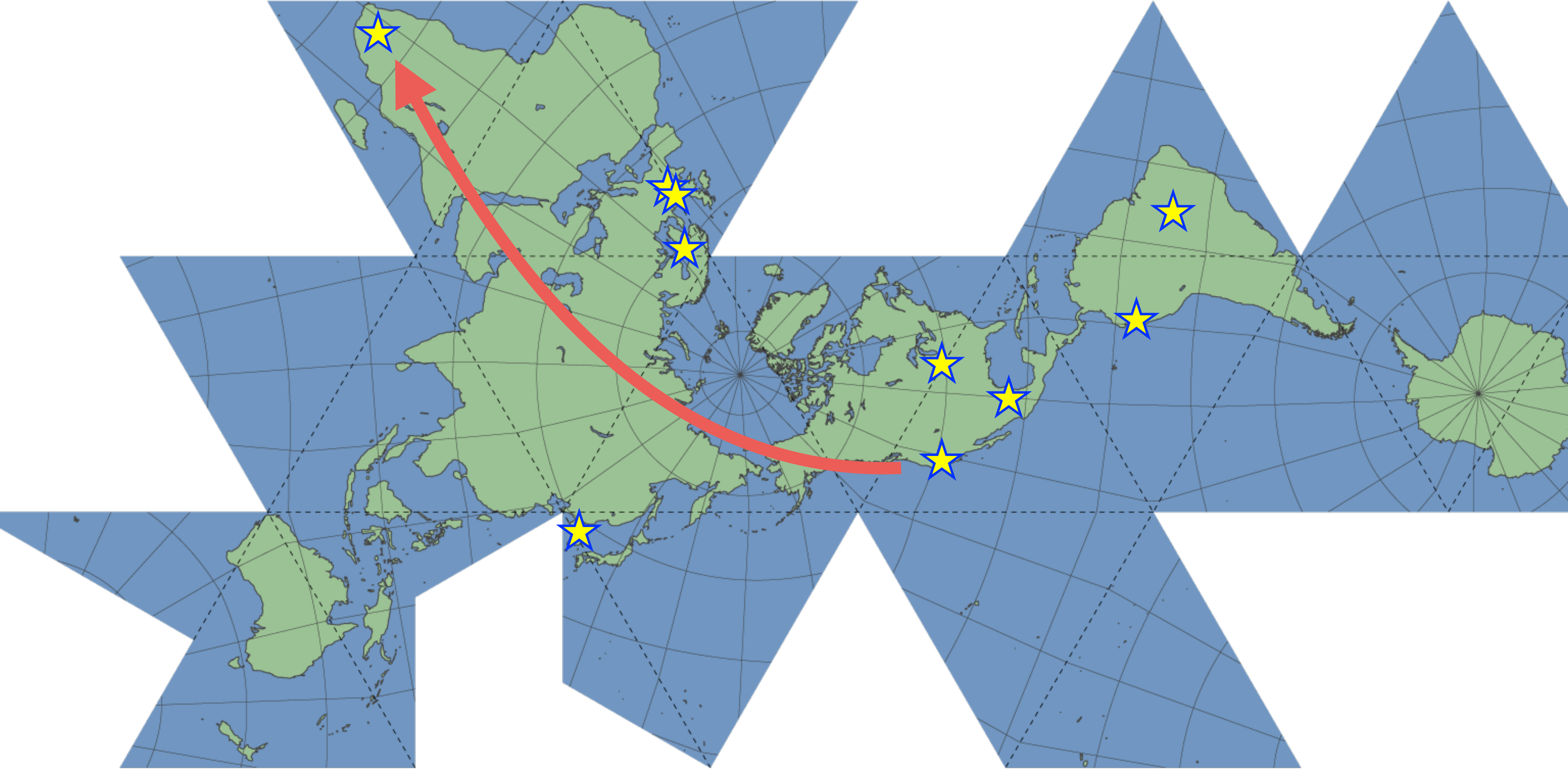


**The political will was lacking here, so I looked around**





**The political will was lacking here, so I looked around**





# The Futran Group



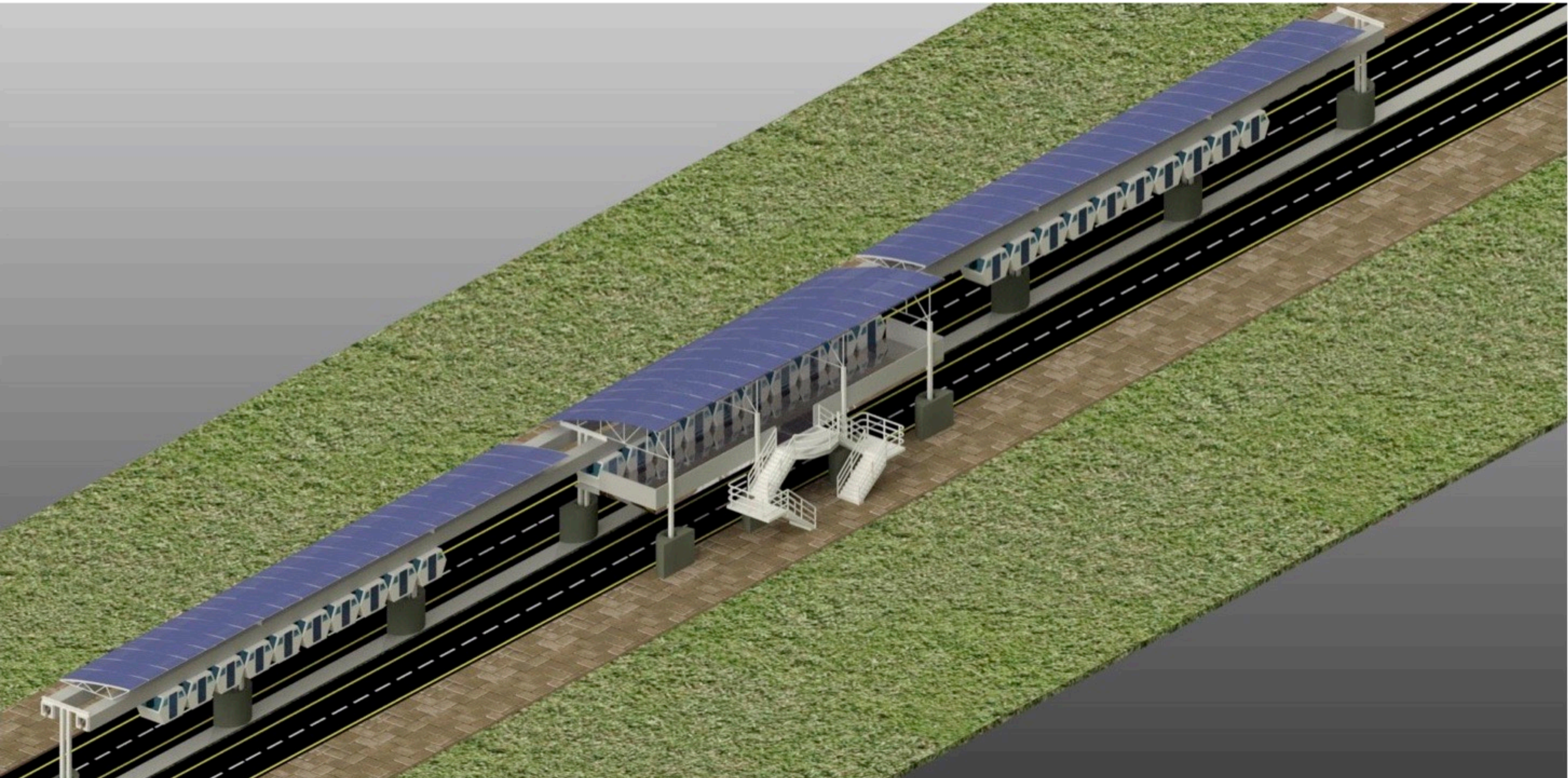
**The Futran test track has been operational 3 years**



**The system shake-down has been successful**

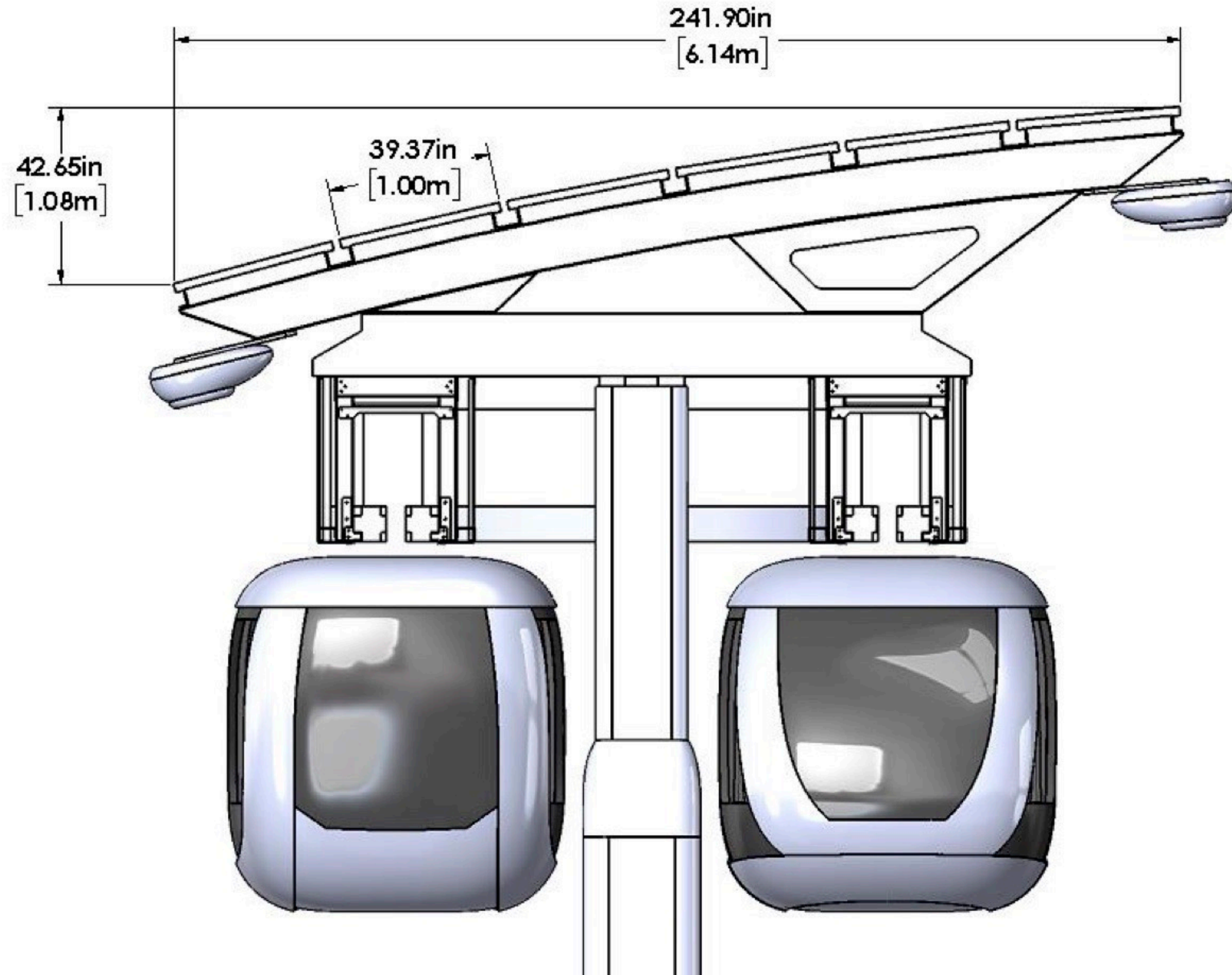


**The solar canopy is typically 6 meters wide**



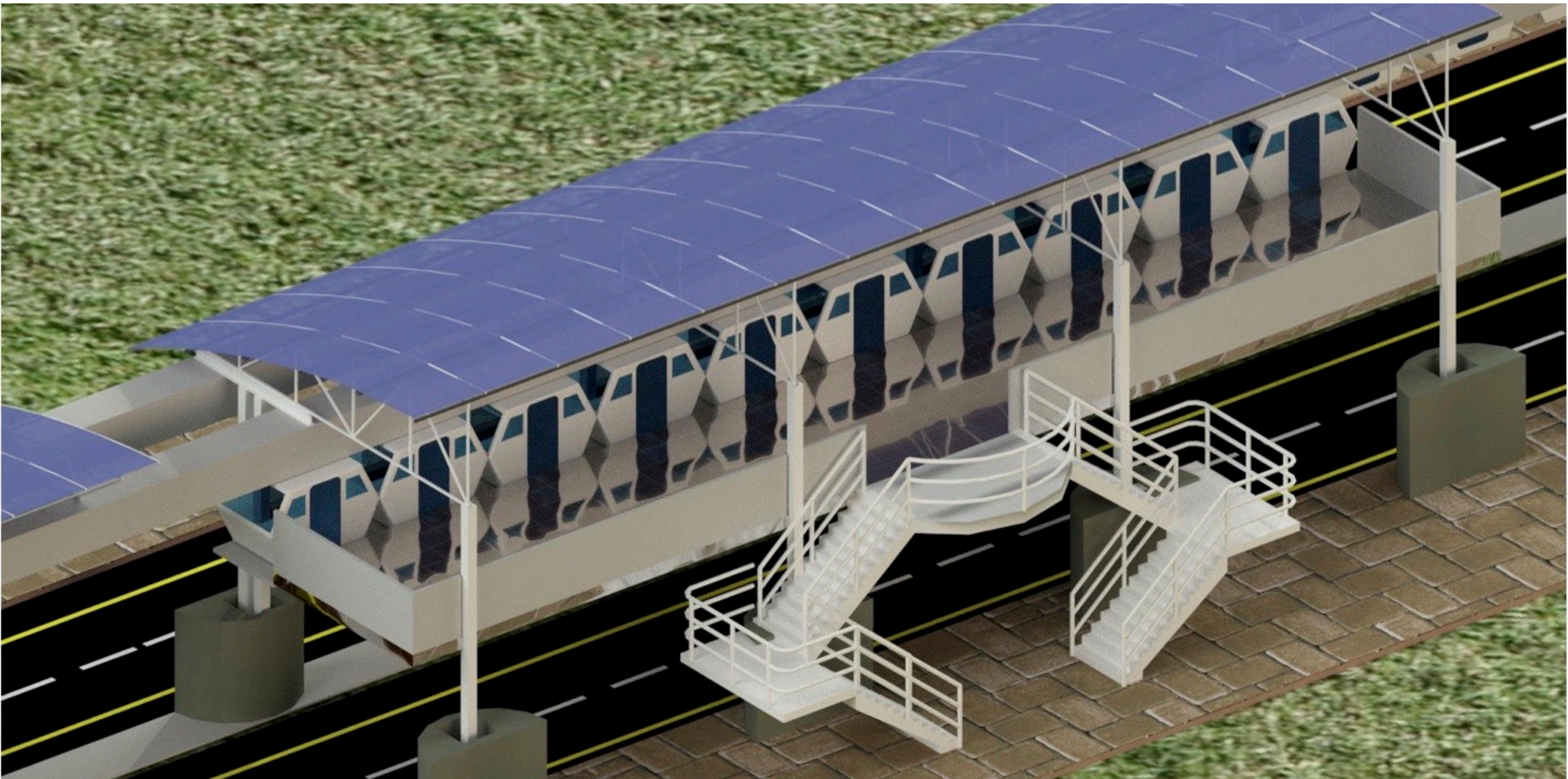


**The solar canopy is typically 6 meters wide**





**... and the station roof is typically 10 meters wide**





# Solar elevated metros can fit along regular streets



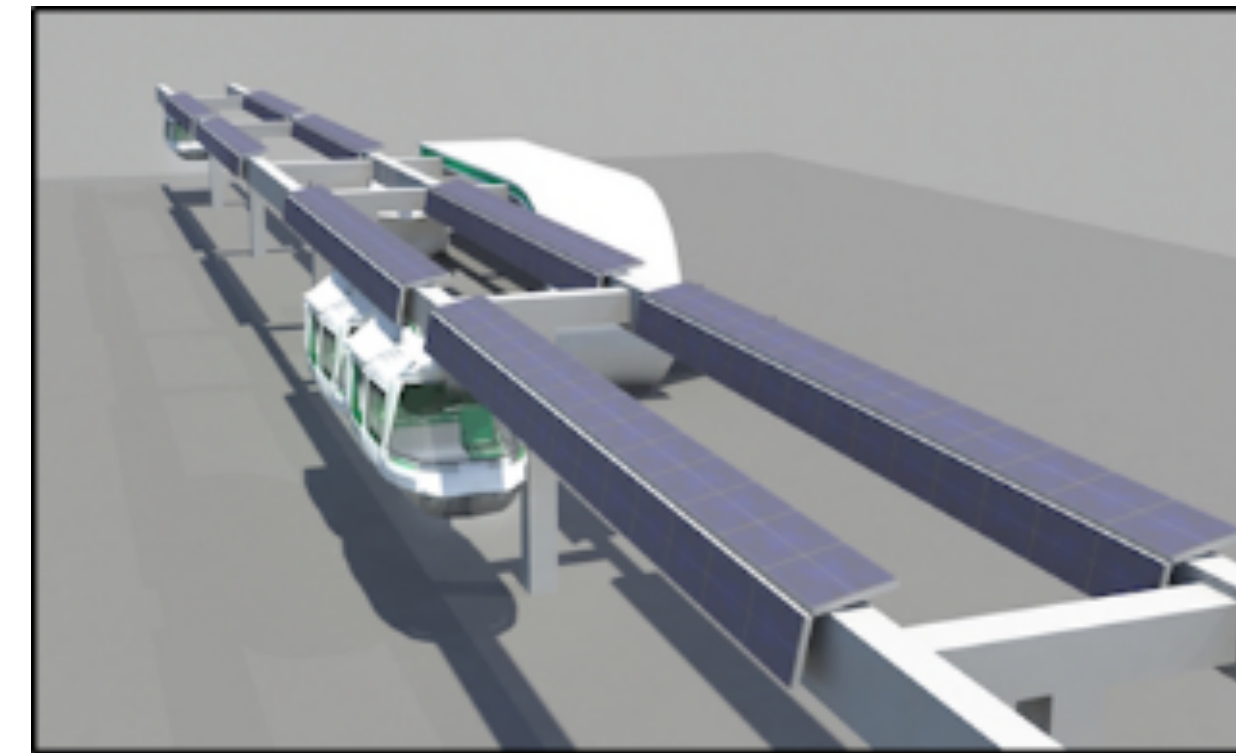
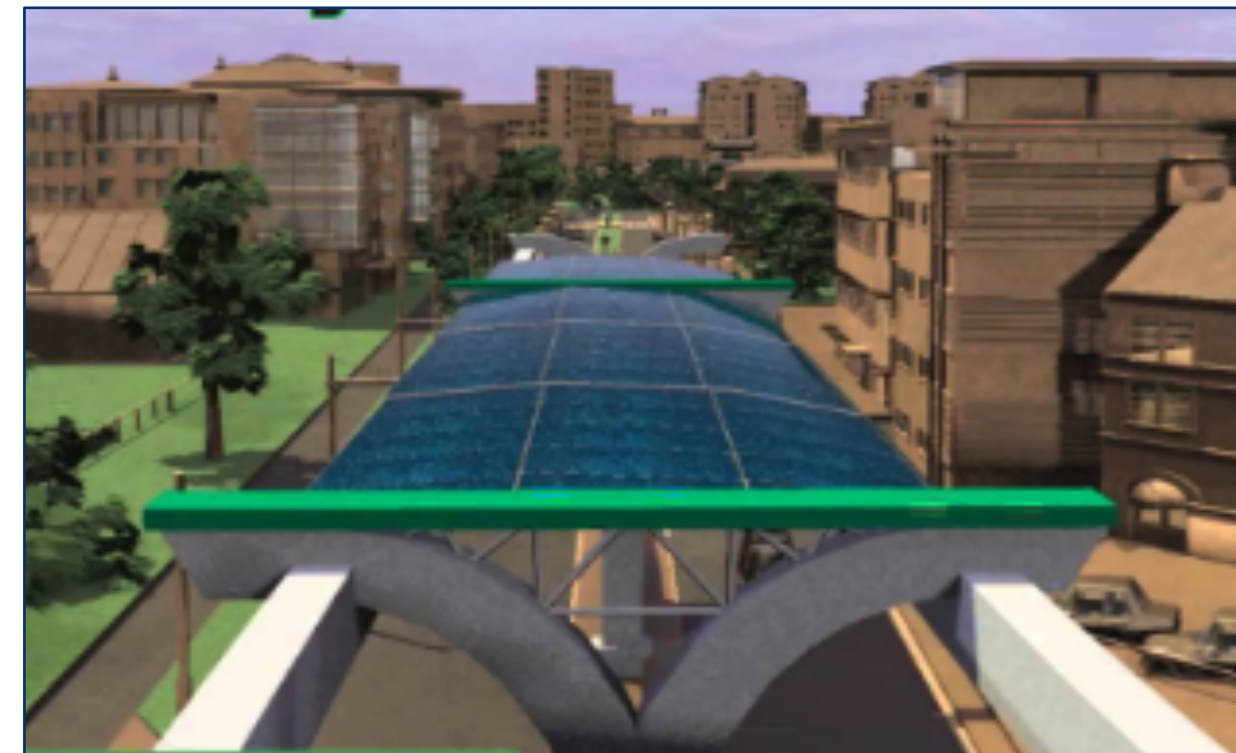
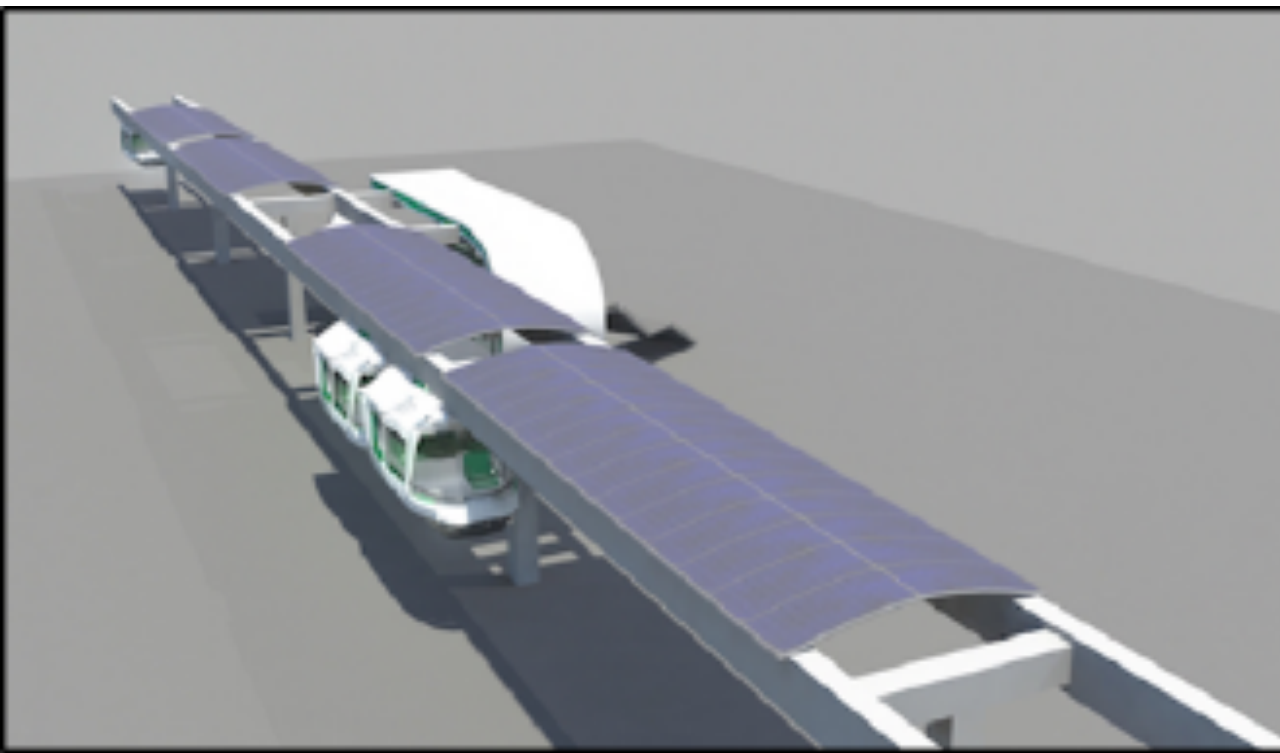


# Solar elevated metros can fit along regular streets



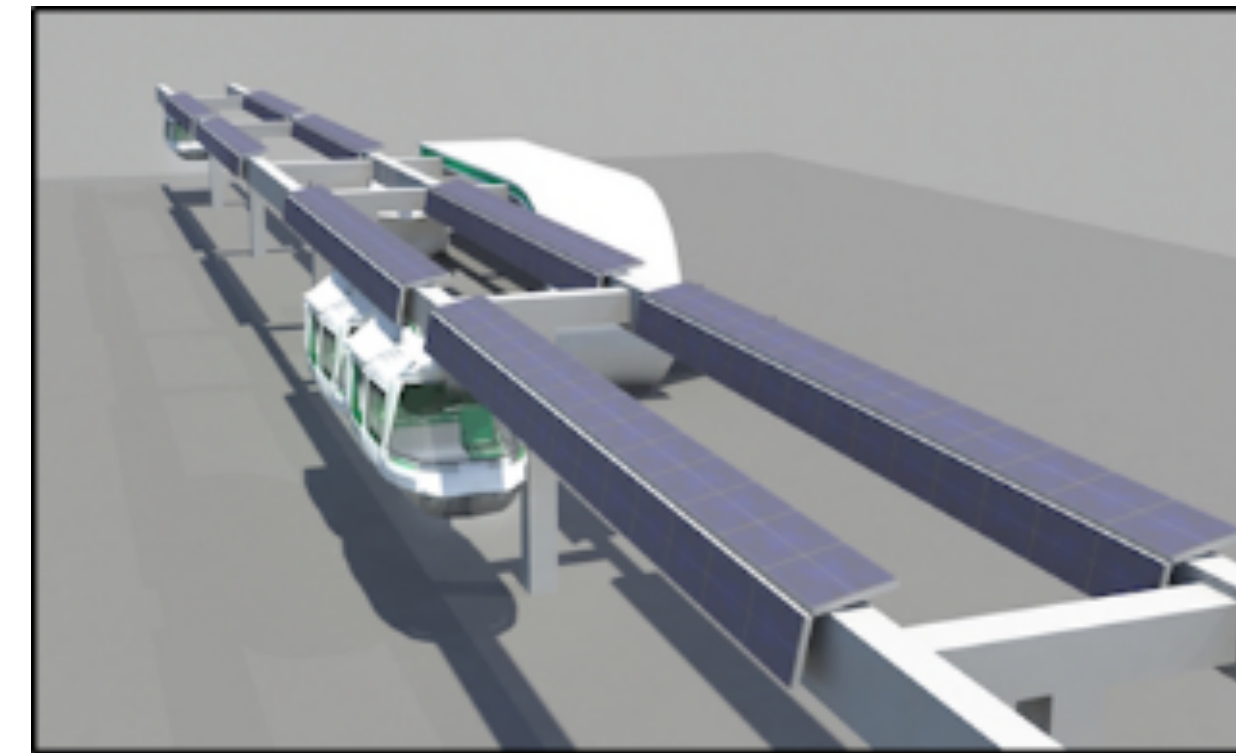
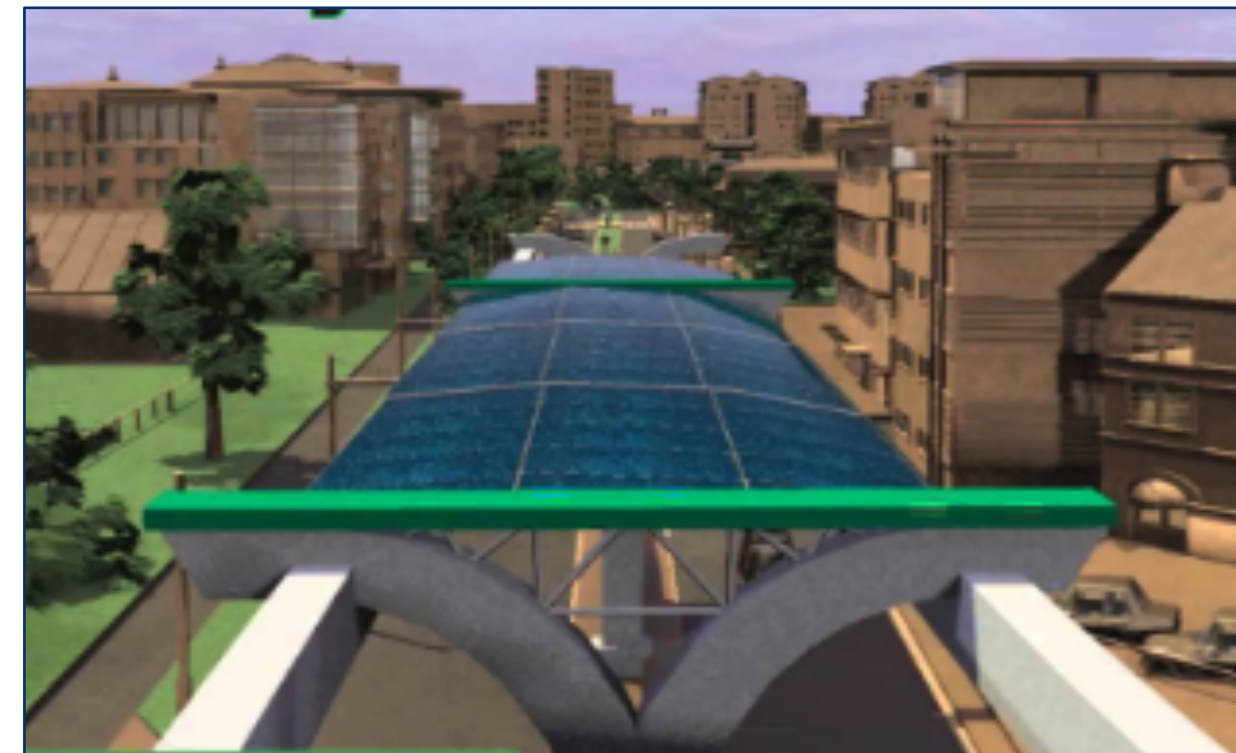
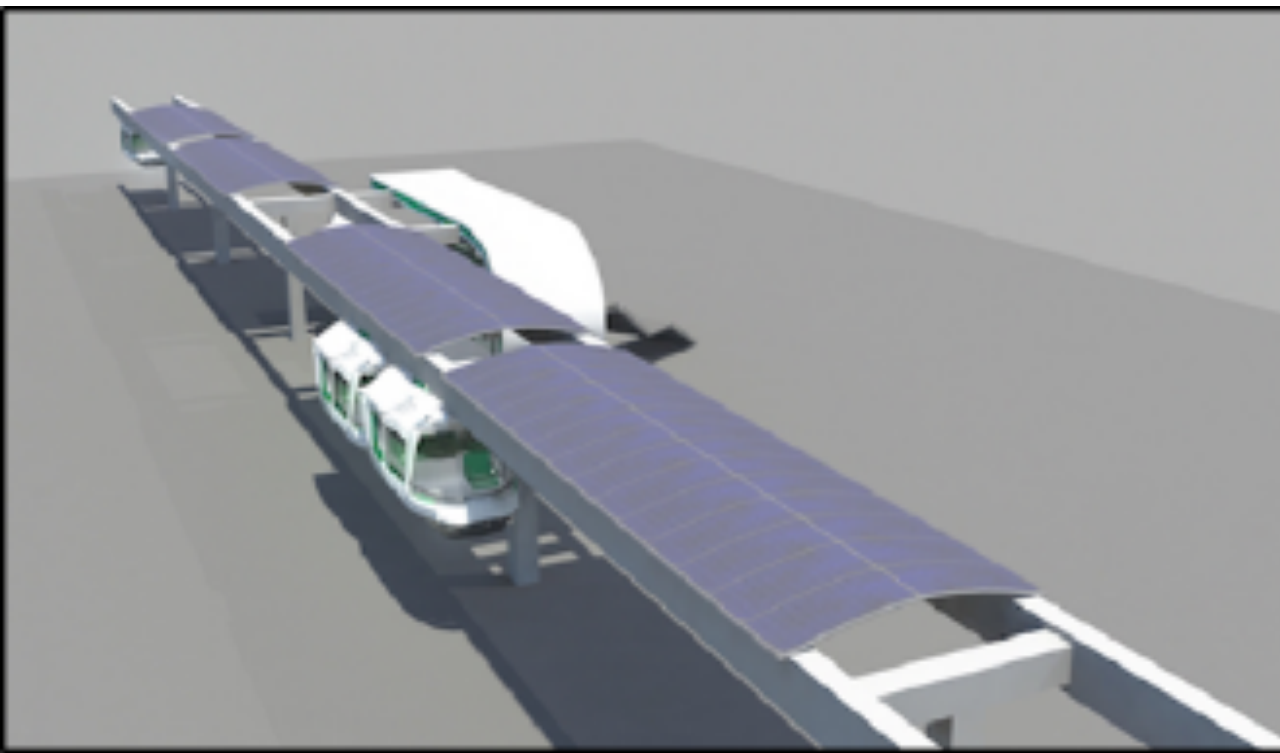


# Smart Cities need innovative tools to become livable, sustainable, and resilient





# Smart Cities need innovative tools to become livable, sustainable, and resilient



**The Futran Elevated Metro is a superb solar system, grid optimizer, and public transit platform for Smart Cities!**



**Thanks!**



# You are invited to join the solarevolution!

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Ron Swenson • [ecosystems@econet.org](mailto:ecosystems@econet.org)

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