Solar Podcars: A New Vision

Ron Swenson

New Energy Systems: Electrifying Transportation

Solar 2018

August 6, 2018
I’m going to talk about **Solar Powered Automated Rapid Transit Ascendant Networks**
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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 2º C goal
Mother Nature doesn’t have to comply with our 2º 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.
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
Sam Liccardo commits to uphold the Paris accord

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

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"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
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.
We could imagine Silicon Valley leading that revolution
We could imagine Silicon Valley leading that revolution.
We could imagine Silicon Valley leading that revolution.
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?

\[
\frac{3,000,000}{7,400,000,000,000} = 0.04\%
\]
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.
Before exporting solutions, we have to come to terms with our own challenges.
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

- Electric Power: 40%
- Transportation: 29%
- Industrial: 21%
- Residential & Commercial: 10%

Data source: US Energy Information Administration 2007

Solar & Wind can handle electricity demand
Solar & Wind can handle electricity demand.

100% Renewable needs Transportation

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

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Solar & Wind can handle electricity demand
100% Renewable needs 100% Renewable **Transportation**

The question is how to handle transportation with solar

Data source: US Energy Information Administration 2007
Profound change is possible
Things change
Things change

Camera production by type, 1933-2016
Things change

Camera production by type, 1933-2016
Things change

Camera production by type, 1933-2016
The coal industry has capsized in just 5 years
Politically motivated solar predictions are pathetic.
In fact, the solar industry is climbing, “hockey stick”

The Chilean Solar Market

Date: Greentech Media, Latin America PV Playbook; CleanTechnica
The Chilean Solar Market
EVs and AVs are like those point & shoot digital cameras.
I betcha I can beat the Google car on my bike
I betcha I can beat the Google car on my **bike**

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

©Tony Seba
But we can flip the tables on them …
But we can flip the tables on them …
But we can flip the tables on them …

(ooops…)
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.”
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)
Podcarts 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 10×
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... More economical
Cut capital costs $2 \times - 20 \times$

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

Public Transportation Investment History • Background Data • Table 23
APTA 2015
Cut capital costs $2 \times - 20 \times$

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Public Transportation Investment History • Background Data • Table 23
APTA 2015
Reduce operating costs per passenger-mile $10\times$

**Cost and Pollution per Passenger-mile**
- $/\text{passenger-mile}$
- CO2, lb/\text{passenger-mile}$
- Energy self-reliance

- **Bus**: $1.45$, $0.741$, $0%$
- **Light Rail**: $0.76$, $0.524$, $0%$
- **Commuter Rail**: $0.34$, $0.487$, $0%$
- **Car**: $0.38$, $0.613$, $0%$
- **JPods**: $0.03$, $0$, $100%$
- **Freight Rail**: $0.01$, $0.020$, $0%$

MassDOT cost data, US DOE energy data
Reduce operating costs per passenger-mile 10×

Cost and Pollution per Passenger-mile
- $/passenger-mile
- CO2, lb/passenger-mile
- Energy self-reliance

MassDOT cost data, US DOE energy data
Reduce operating costs per passenger-mile 10×

Operating cost per passenger-mile = 3¢ …

MassDOT cost data, US DOE energy data
Reduce operating costs per passenger-mile 10×

Cost and Pollution per Passenger-mile
- $/passenger-mile
- CO₂, lb/passenger-mile
- Energy self-reliance

Operating cost per passenger-mile = 3¢ ...
- 50× less than buses

MassDOT cost data, US DOE energy data
Reduce operating costs per passenger-mile 10×

Operating cost per passenger-mile = 3¢ …

- 50× less than buses
- 25× less than trains

Cost and Pollution per Passenger-mile

- $/passenger-mile
- CO2, lb/passenger-mile
- Energy self-reliance

Bus: $1.45 (0%)
Light Rail: $0.76 (0%)
Commuter Rail: $0.34 (0%)
Car: $0.38 (0%)
JPods: $0.03 (100%)
Freight Rail: $0.01 (0%)

MassDOT cost data, US DOE energy data
Reduce operating costs per passenger-mile 10×

Operating cost per passenger-mile = 3¢ …

- 50× less than buses
- 25× less than trains
- 10× less than cars

Cost and Pollution per Passenger-mile
- $/passenger-mile
- CO₂, lb/passenger-mile
- Energy self-reliance

MassDOT cost data, US DOE energy data
... More capacity
Increase capacity with podcars 6× … or more

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

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

2. COST
   ... 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 $10 \times$ 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 of two parking spots
- Stations on top of sidewalks
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
Join this growing international university network
(2) Urban International Design Contest
Help rebalance public space & create a city for people*

*Deputy Mayor Gilles Vesco
Lyon 2017
3. The Sputnik Crisis is instructive
It took the Sputnik Crisis to get things moving
It took the Sputnik Crisis to get things moving
It took the Sputnik Crisis to get things moving

The Sputnik Crisis

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

Engineers: spartansuperway.blogspot.com
Designers: facebook.com/uidc2018
Business: futrangroup.com

Ron Swenson • ecosystems@econet.org