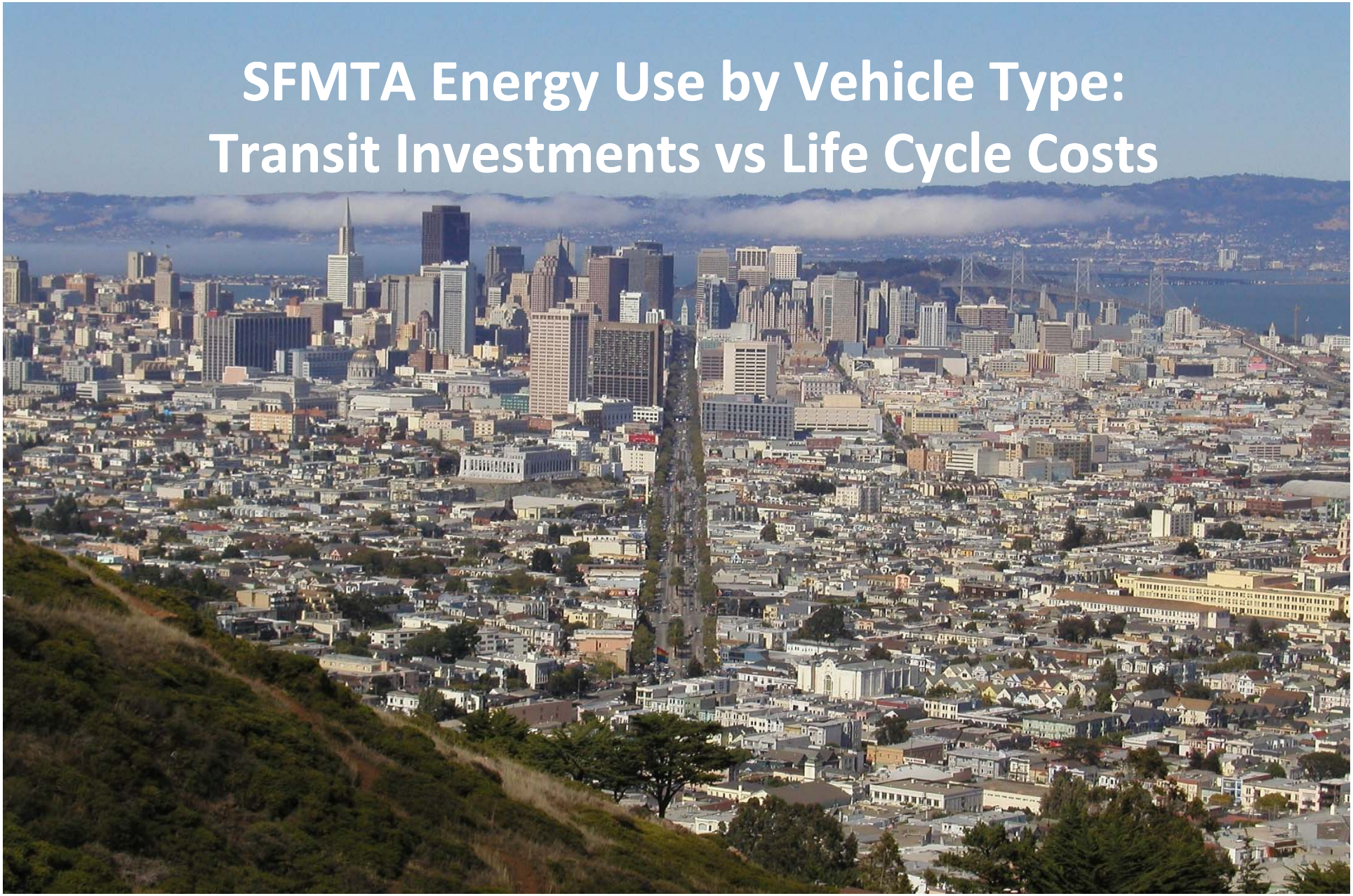
SFMTA Energy Use by Vehicle Type: Transit Investments vs Life Cycle Costs



Peter Brown
Project Manager, Long Range Planning
Sustainable Streets Division

10| 17 | 2011 | Lake Arrowhead, California

Outline of the Talk

1. SFMTA – what we do
2. Quantified capital and State of Good Repair needs
3. LCA factors versus traditional funding considerations
4. Energy consumption by vehicle type

Your challenge; what public policy changes do you envision to bring LCA forward?

SFMTA Today – Agency Background

- **Multi-modal transportation agency; planner, designer, builder, operator:**
  - Transit, Paratransit, Pedestrian & Bicycle Networks
  - Street Network, Signals & Systems
  - Parking Supply & Management
  - Station & Neighborhood Area planning/development review
  - Taxi Administration

Sustainability Strategies-Citywide

Travel Demand Management

STRATEGY 1

Travel Choices & Information

STRATEGY 2

Demand Pricing

STRATEGY 3

Transit-Oriented Development (TOD)

5%	17%	4%	5%	9%	10%	50% gap to reach target (389,000 metric tons CO_2)

2035 GHG Reduction Target: decrease GHG emissions to 1,023,000 metric tons of CO_2

STRATEGY 4

Transit Improvements

STRATEGY 5

Complete Streets

STRATEGY 6

Electric Vehicles

Table 4: Estimated Emissions in Metric Tons of CO_2 by Sector in San Francisco, 1990 to 2010[24]

	1990	2010	Change
Municipal Fleet	80,000	88,000	10%
SFMTA (buses & rail)	68,000	53,000	-22%
All Transit	135,000	133,000	12%
Private Vehicles	1,810,000	1,934,000	7%
Transportation Sector	2,020,000	2,155,000	7%
Built Environment	4,080,000	3,760,000	-8%
Total	8,193,000	8,123,000	-1%

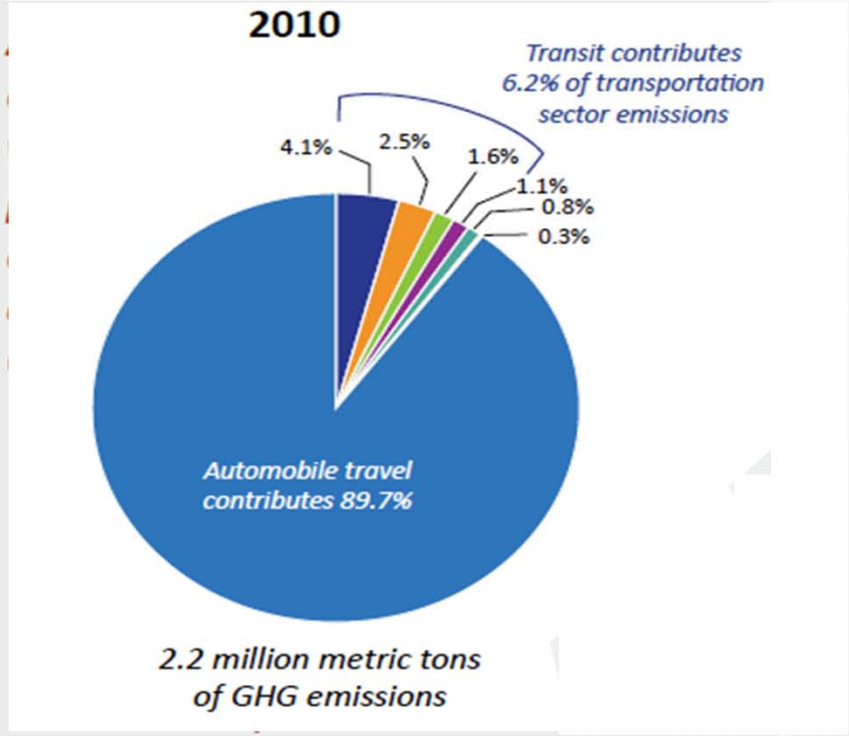
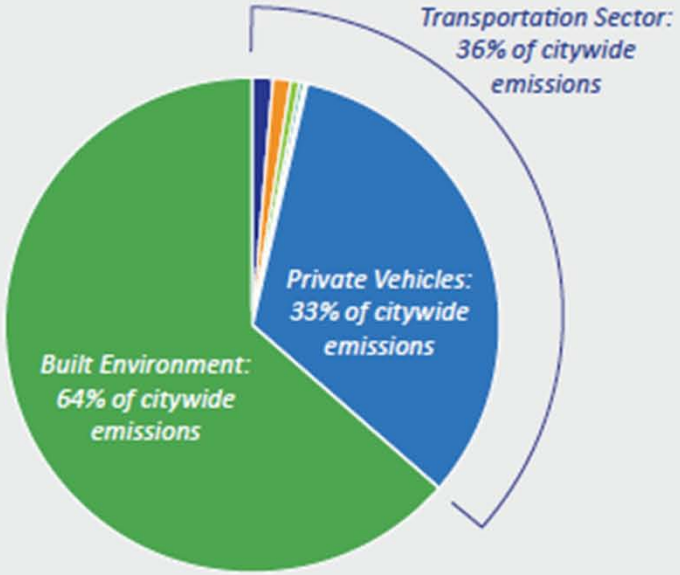
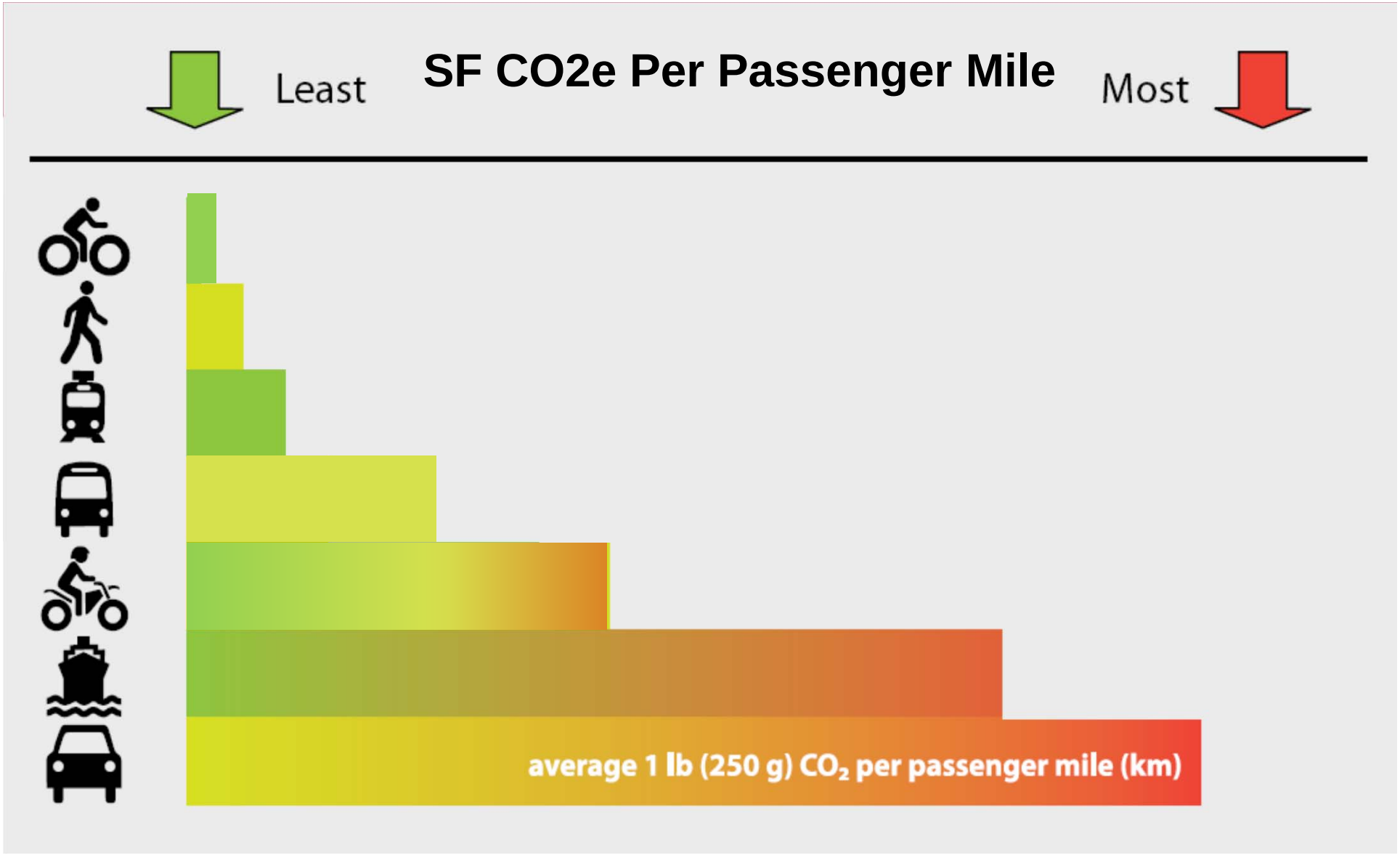


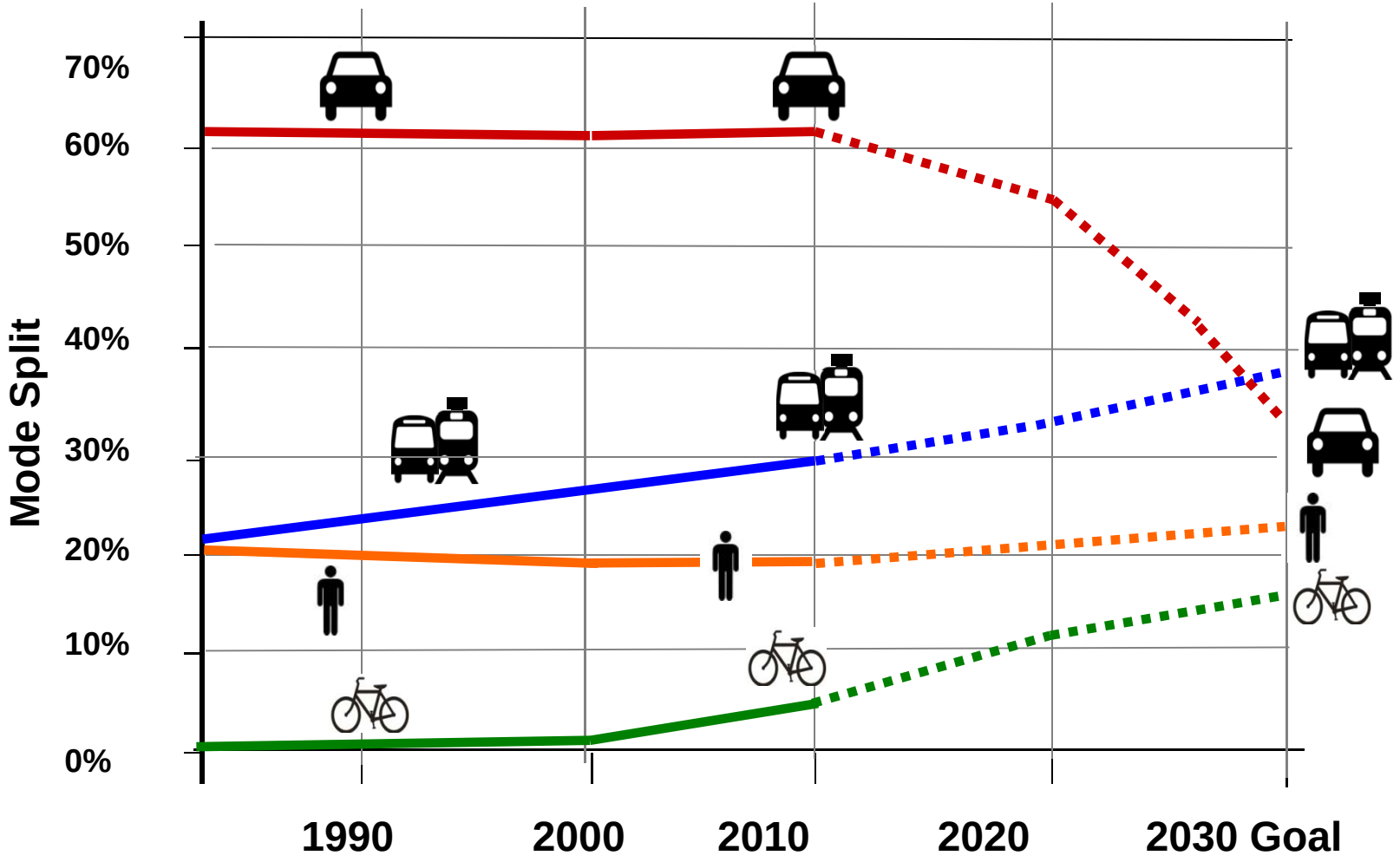
Figure 3: 2010 Citywide GHG Emissions[25]



- **Municipal Fleet:** 1.5%
- **SFMTA** *(buses and rail)*: 0.9%
- **BART:** 0.6%
- **Ferry:** 0.3%
- **Caltrain:** 0.4%
- **Regional Bus:** 0.1%
- **Private Vehicles:** 32.7%
- **Built Environment:** 63.6%
  (Residential, Commercial, Industrial and Municipal uses)



Modal Analysis- bike, walk, transit is most efficient

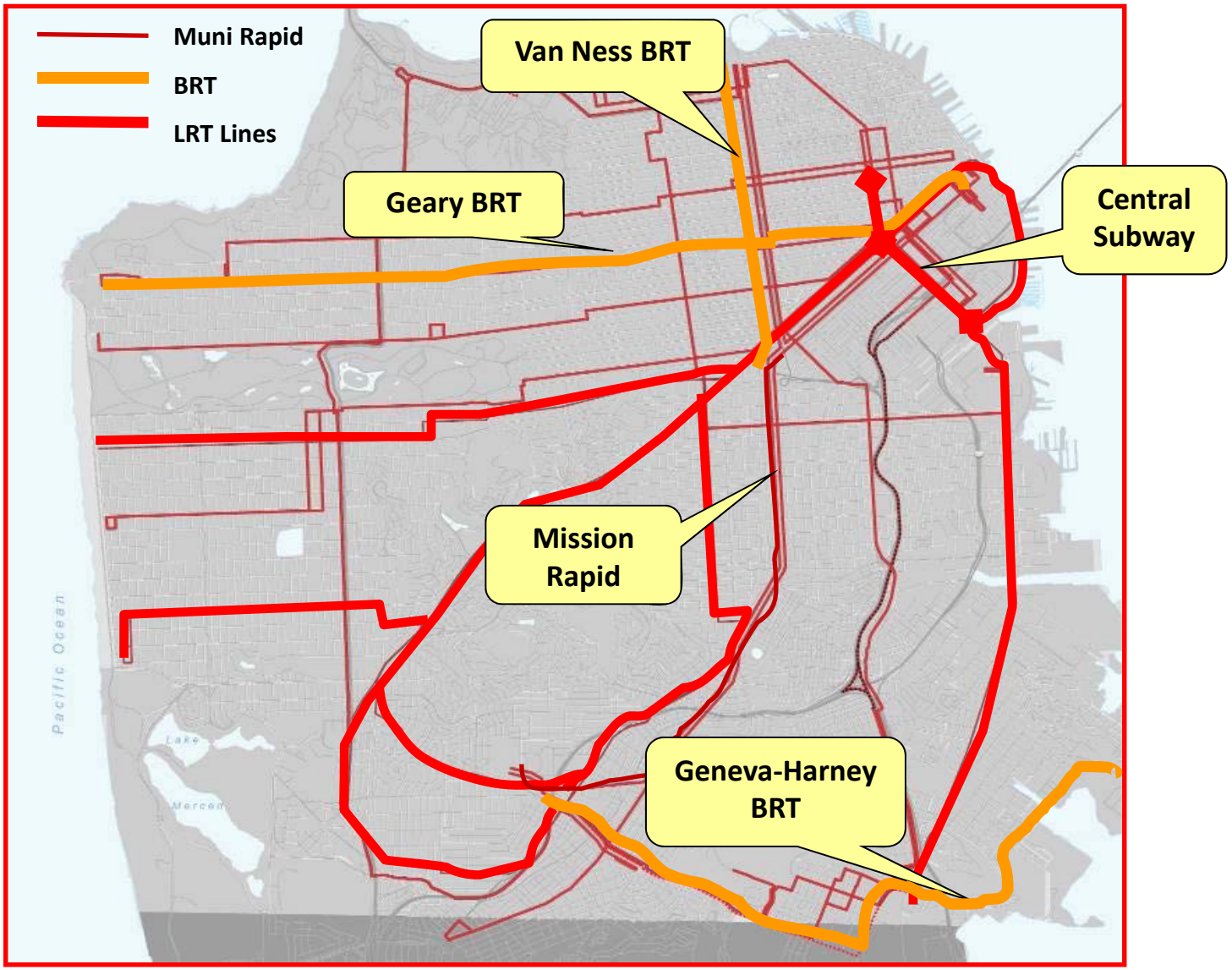


Bold Sustainable Mobility Goals

Combined Land-use/Transportation Policies

Sustainable Mobility - Local and Regional Transit Integration

Current Rapid & Future BRT Network



SFMTA Capital/Operational Needs

1. <u>Capital sources</u>: Federal 60%, State 18%, Local 22%

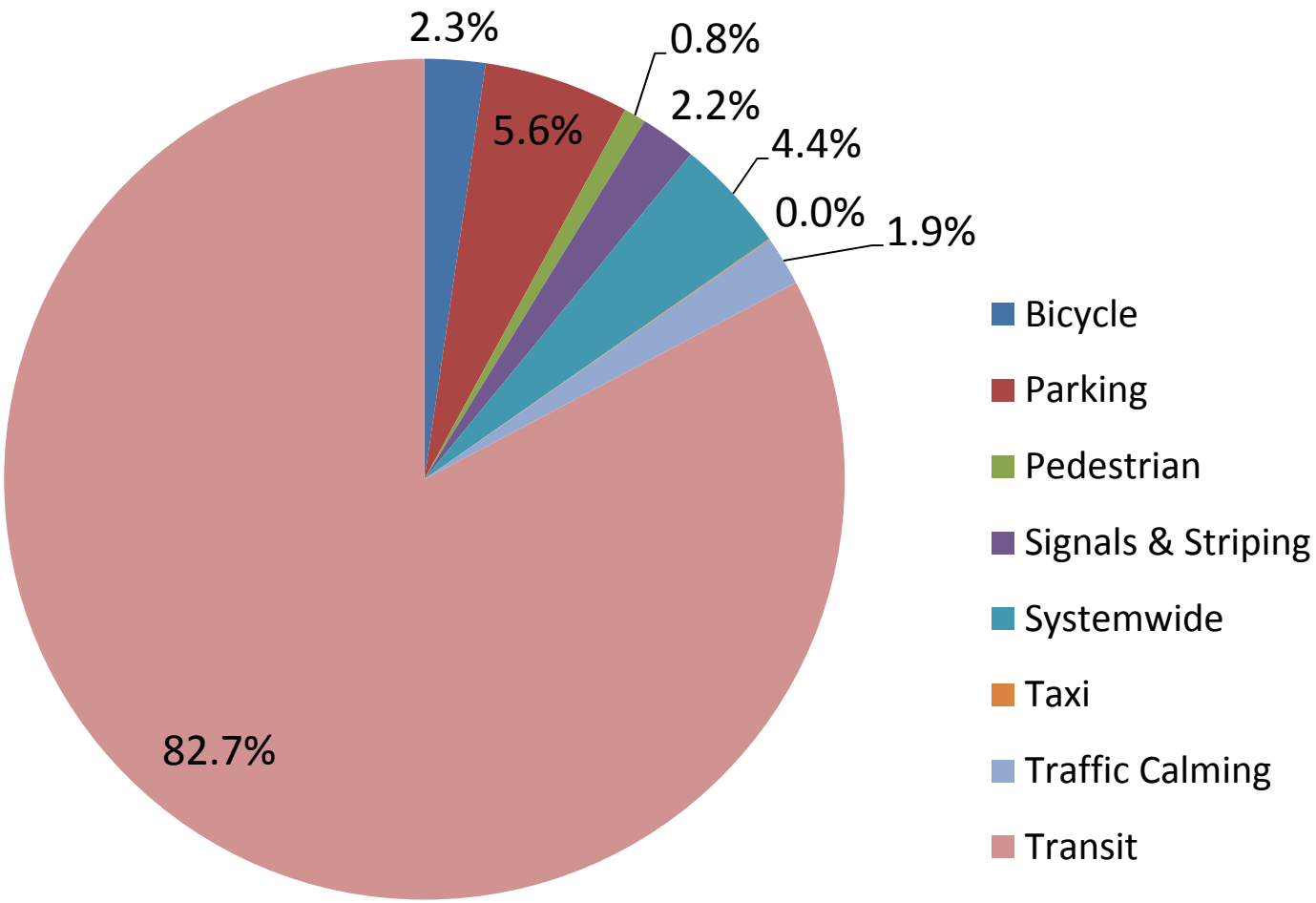
20 year agency needs of $24 billion

2. <u>Operating</u>: Parking revenue 35%, Farebox 26%, Gen Fund 25%, Op Grants/other 14%

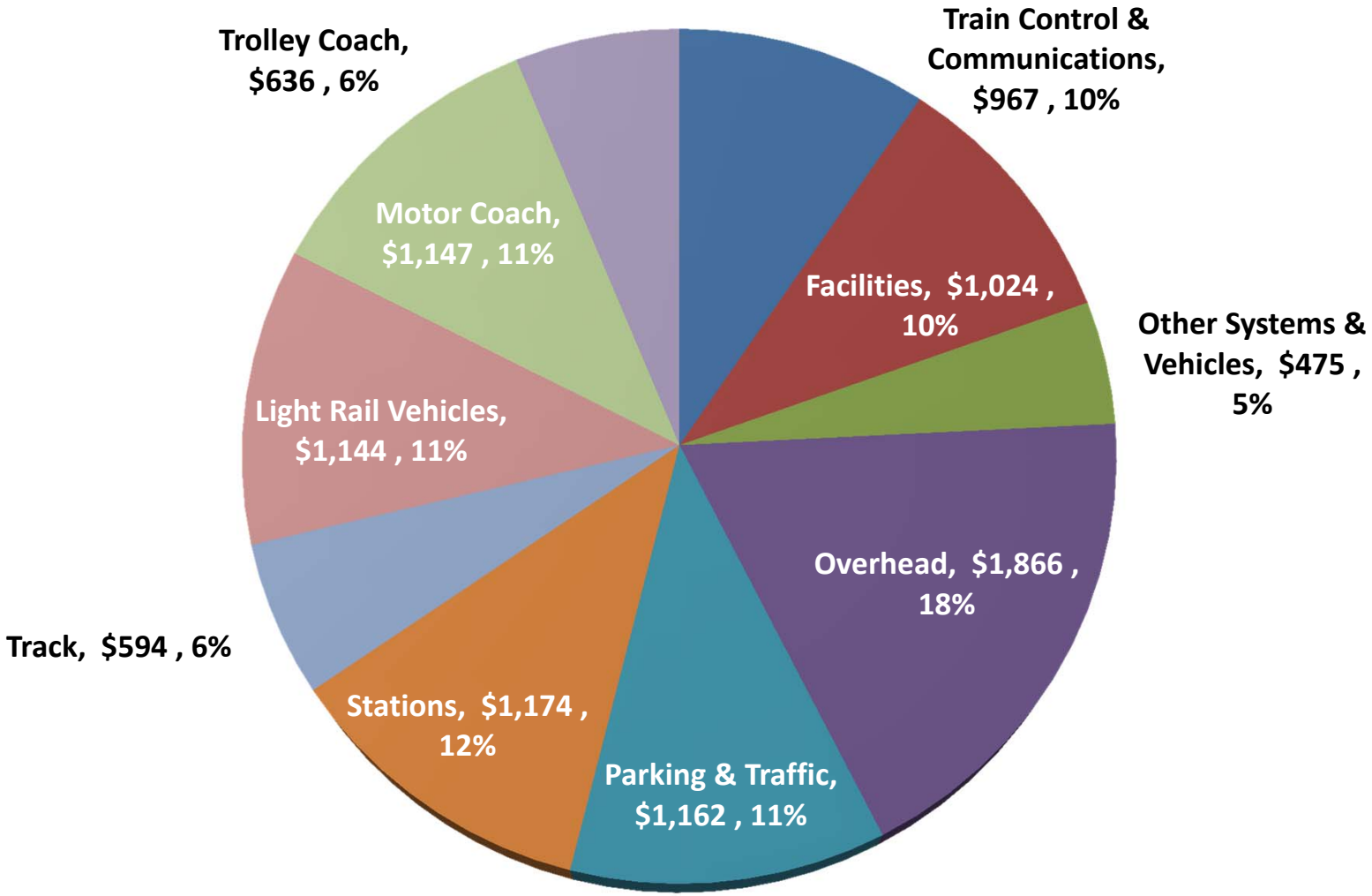
$800 million annual operating budget

Life Cycle Analysis is absent from today's investment decisions

Capital Needs by Mode
20 year need = $24 billion



20-year needs = $10.2 Billion



Life Cycle Analysis vs Transit Funding

LCA Considerations

- total cost over project life
- cumulative energy consumption
- cumulative env. impact
- asset payback period/ROI
- public benefit, internalized societal costs
- sustainability of investment (i.e. solar v fossil fuels)

Traditional $

- age of the asset to be rehabilitated
- verified deferred maintenance
- fleet management plan?
- condition of the asset to be replaced
- project's conformity w FTA's spare ratios

How can we make policy changes to direct $ toward LCA?

Transit Vehicle Stats and Energy Use

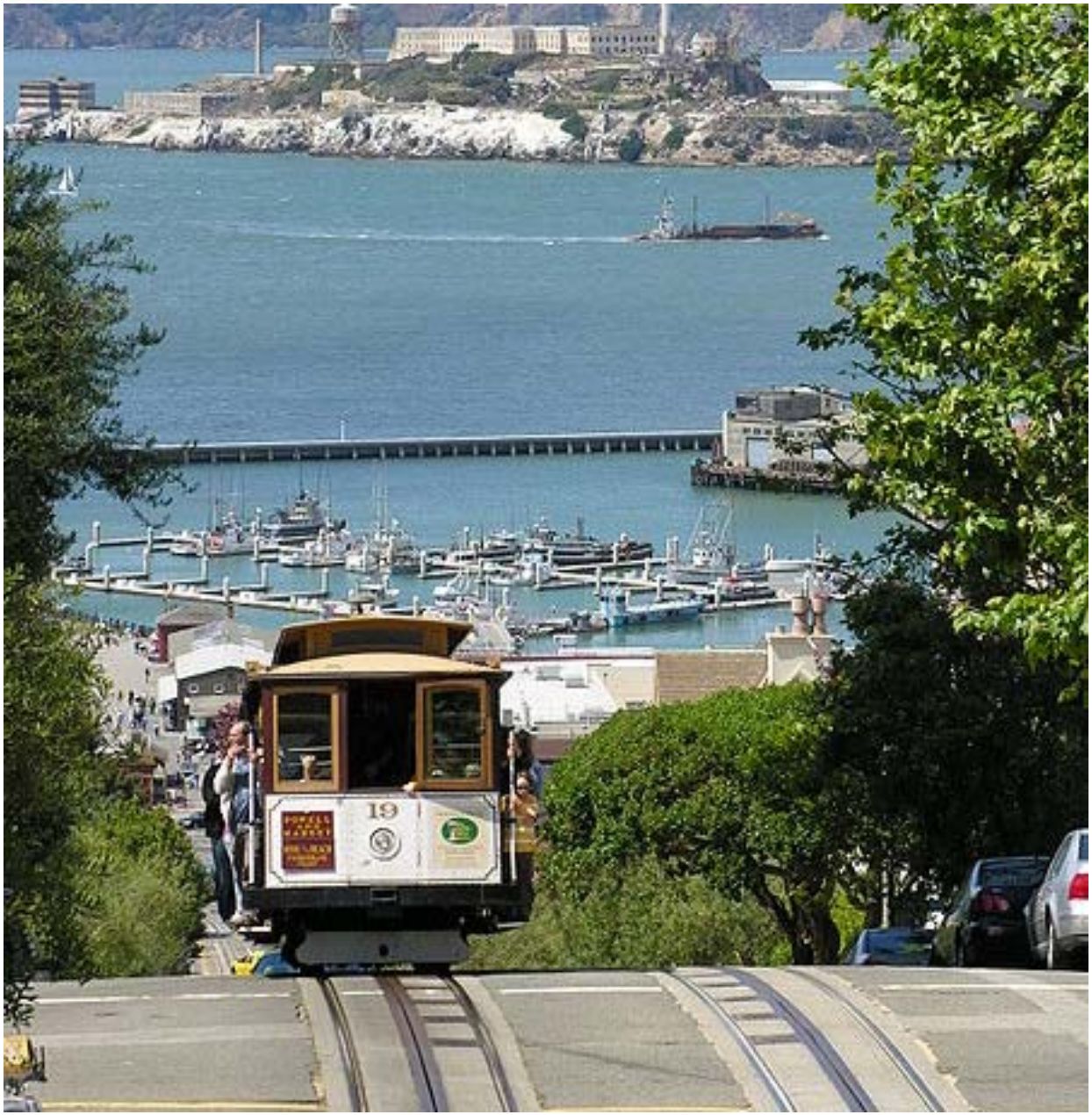
- **SFMTA moves the city population (750,000 trips) each day**

Five Vehicle Types:		Daily Ridership:
512	Motor coaches (Biodiesel)	300,000
313	Trolley coaches	247,000
151	Light Rail Vehicles (LRVs)	160,000
40	Cable Cars	27,500
35	Historic streetcars	20,000

"zero" emissions

Note: Energy – LRVs, CC and Historic all = 5 kWh per mile


POWELL & HYDE Sts.
UNITED RAILRO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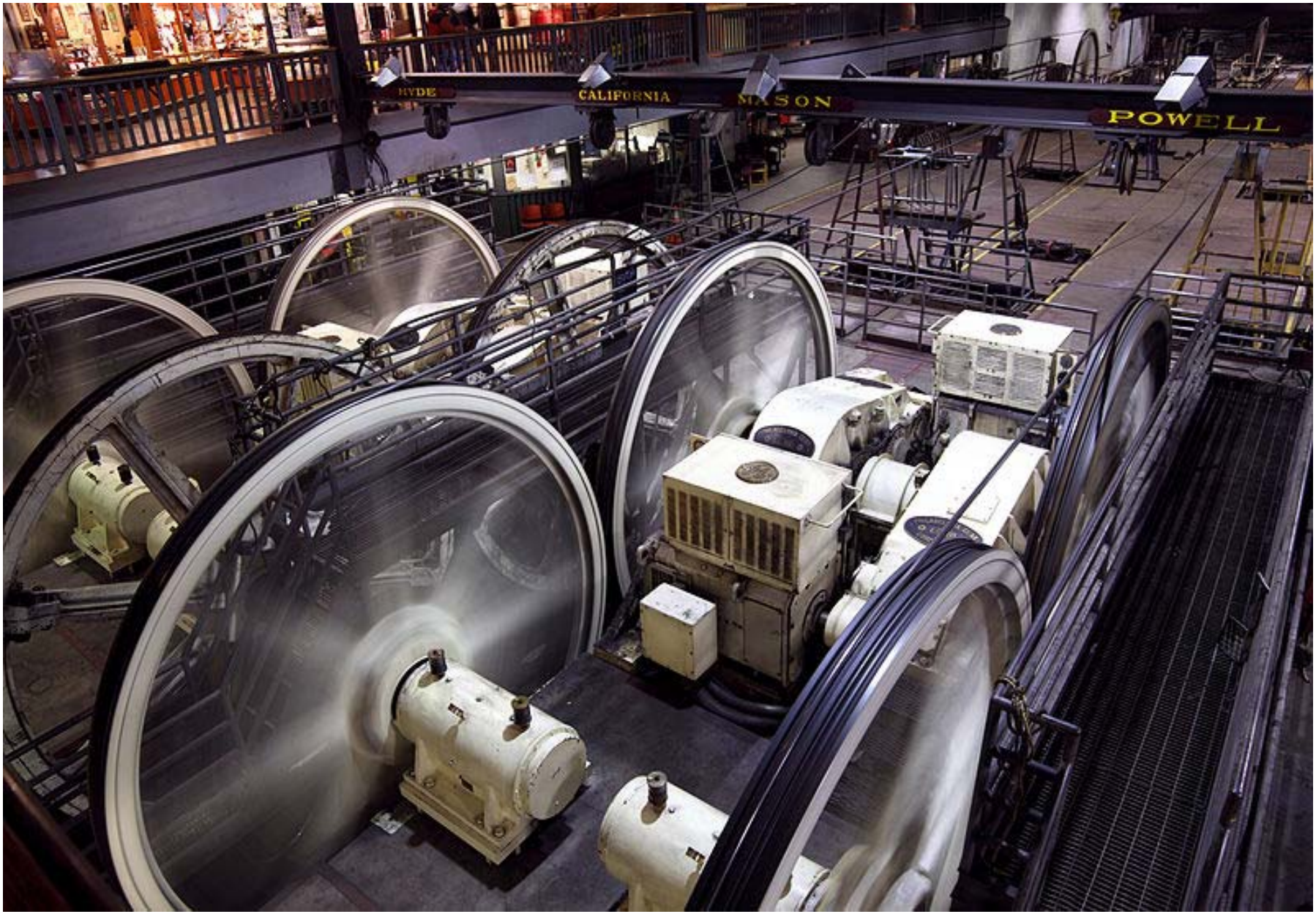

HYDE
CALIFORNIA
MASON
POWELL


F MARKET
FISHERMAN'S WHARF
dreamstime


SORRY - NO
PASSENGERS
1479B


It's time for
street corner offices.
5629


38 GEARY
Ocean Beach
6269


89 LAGUNA HONDA
Hospital
8503

SFMTA | Municipal Transportation Agency

SFMTA Vehicle Energy Use / Cost / Emissions Estimates by Mode

	Mode							SFMTA	
	BART	LRV	Trolleys	30' Hybrids	40' Hybrids	40' Biodesiel	60' Biodeisel	Totals	Table notes:
Vehicles Per Mode	669	151	313	30	56	290	130	970	Virgil Dennis, Senior Maint. Controller, 10-
			(140-73)	506				506	
CO2e lbs / passenger per mile	0.11	0.020	0.022	0.706	0.735	0.971	1.235		CO2 lbs per mile / Passengers per mile
Energy use / passenger per mile (kWh)	2.32	0.42	0.47	1.20	1.25	1.64	2.09		kWh per mile / Passengers per mile
Energy use / mile (kWh)	4.0	5.0	6.1	9.0	9.4	12.4	15.8		See notes below
Energy use / mile (DGE)	0.11	0.13	0.16	0.24	0.25	0.33	0.42		See notes below
MPG equivalent	20.3	7.53	6.17	4.17	4.00	3.03	2.38		Inverse of DGE / mile
Energy use / mile (joule)		18,000,000	21,960,000	32,538,240	33,894,000	44,740,080	56,941,920		See conversion factors below
Energy use / mile (BTU)		17,060	20,813	30,839	32,124	42,404	53,968		See conversion factors below
Energy cost / mile	$0.20	$0.25	$0.31	$0.72	$0.75	$0.99	$1.26		See notes below
Cost per passenger-mile	$0.33	$0.02	$0.02	$0.10	$0.10	$0.13	$0.17		Energy Cost per mile / Passergers per mile
PM lbs / mile (local pollutant)				1.03	1.03	1.03	1.03		Based on new engine certification
NOx lbs / mile (regional pollutant)				129	129	206	206		Based on new engine certification
CO2e lbs / mile (global pollutant)	0.19	0.24	0.29	5.33	5.56	7.33	9.33		See conversion factors below
Avg weekday passengers (mode total)	345,256	160,000	247,000	300,000				707,000	See Avg Wkday Pass. and Miles tab
Average Miles / Day (mode total)	200,000	13,356	19,088	39,709				72,153	See Avg Wkday Pass. and Miles tab
Passenger-miles by mode	1.7	12.0	12.9	7.6					Average Passengers / Mile
Pax miles (trips x ave trip length)	4,643,693	544,000	839,800	1,020,000				2,403,800	
Average daily miles by mode	299	88	61	78				228	Average Fleet Daily Miles / Vehicles

Conversion Factors:	*Source:*
1 kWh = 3,600,000 joules	SI conversion (International System of Units).
1 DGE (B10) = 37.66 kWh	USDOT GREET Model conversion tables.
1 kWh = 3,412 BTU	USDOT GREET Model conversion tables.
1 kWh = 0.047 lbs CO2	Calculated from DepCAP 2009-2010 metric ton totals (from PUC)
1 DGE = 22.22 lbs CO2	Calculated from DepCAP 2009-2010 metric ton totals (from Agency fuel records together with fuel vendor invoices)
1 kWh = $0.05	Cost for kWh based on FY2009-2010 SFMTA Finance records
1 DGE = $3.00	Cost based on B10 biodiesel and $3.00 average from FY2006-FY2010 SFMTA fuel invoices.

BTU = British Thermal Unit

DGE = Diesel Gallon Equivalent

Calculation notes:	
Passenger miles = total unlinked trips are multiplied by average trip length	3.4

Emissions from liquid fuel is B10 biodiesel and represents tailpipe only.

Emissions from electricity represents source (non-hydroelectric content ~ 1% of annual total).

LRV energy use calculated by Nathan Grief, SFMTA Senior LRV Engineer, based on vehicle specifications and route performance.

LRV does not include historic streetcars and cable car fleets (70 vehicles)

Trolley bus energy use from on-board data collection logs taken by Albert Fang, SFMTA Fleet Engineering.

Trolley bus number represents 40' and 60' fleets combined.

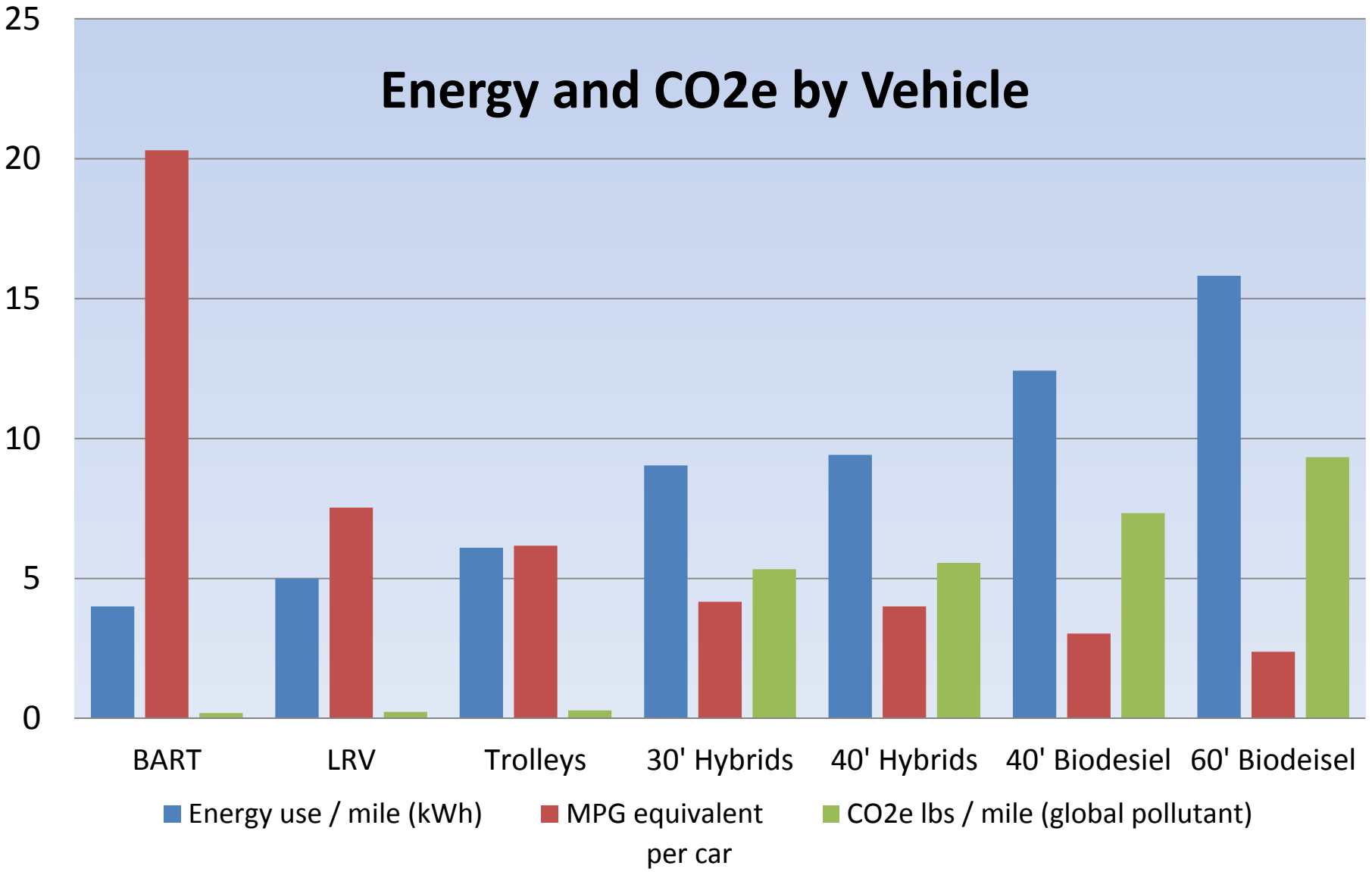
BART emissions are system wide and 67% percent of BARTs electricity comes from hydro electric and renewable energy

Hybrid bus and diesel bus fuel economy calculated by Enoch Chu, SFMTA Fleet Engineering, based on SHOPS records for fuel use by mode.

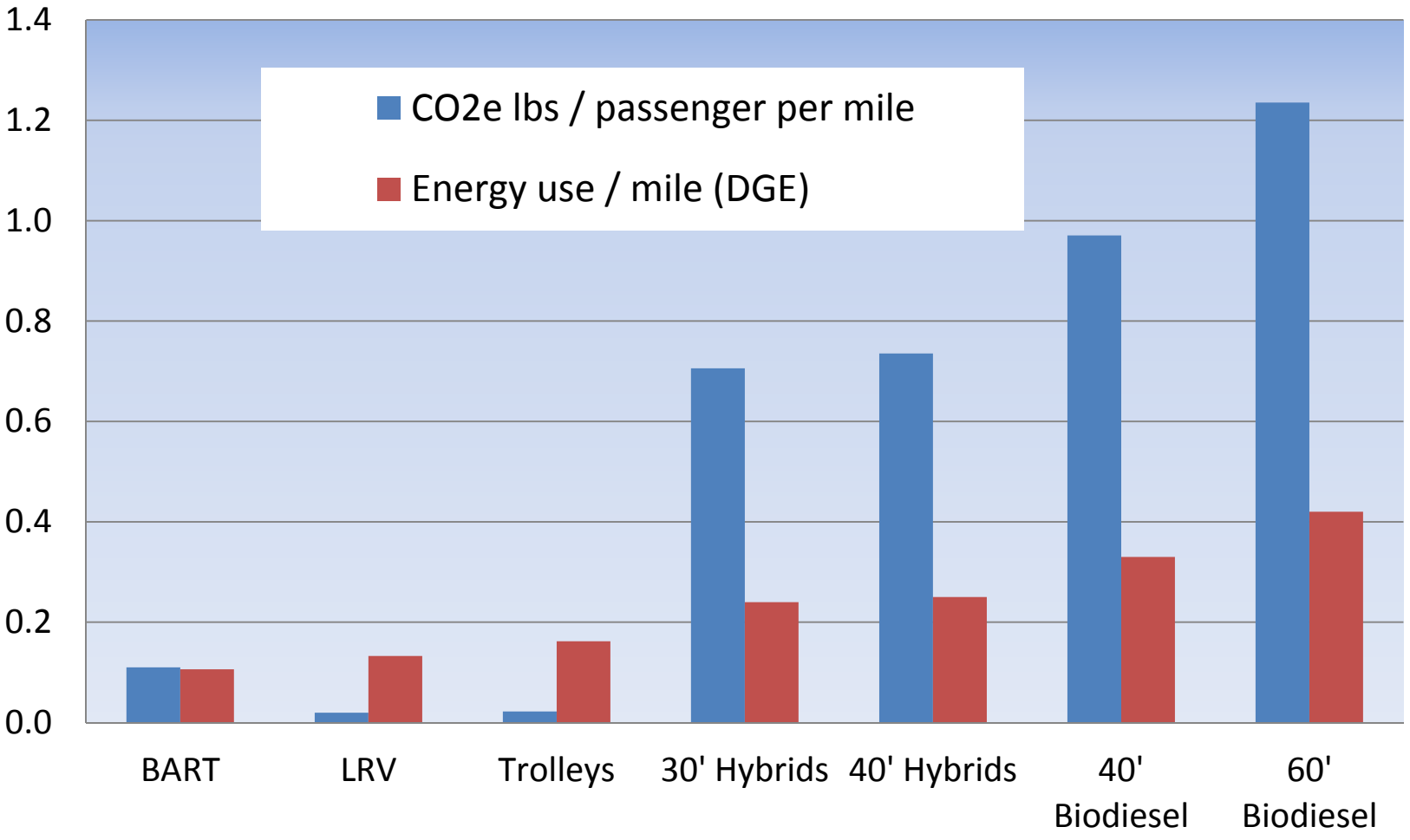
Projections:

Electricity energy mix will vary annually based on Sierra water reserves for hydroelectric (assume roughly 99% hydroelectric)

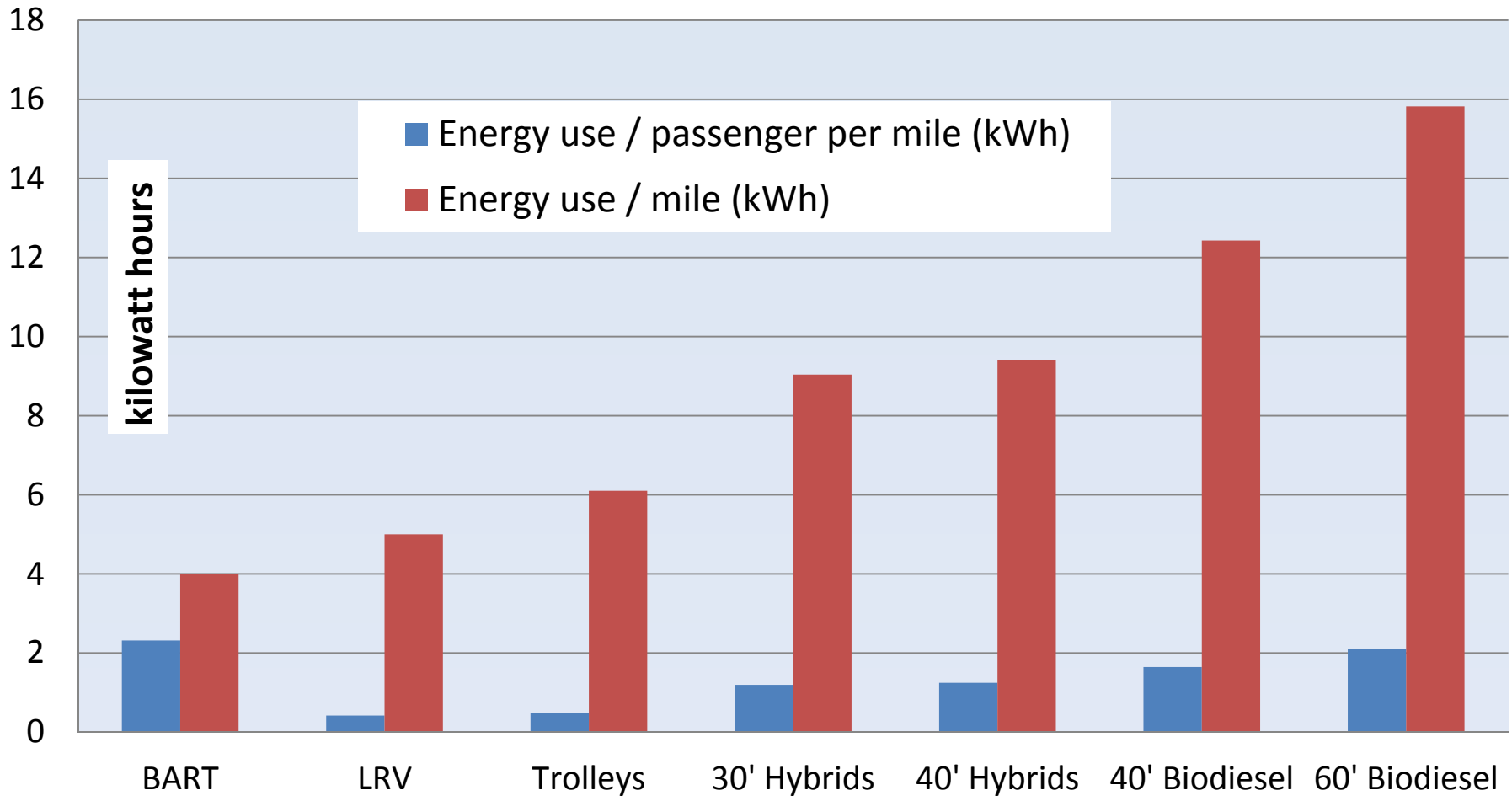
Liquid fuel energy CO2 will decrease with higher blends of biodiesel (closed CO2 cycle - biogenic content)


Energy and CO2e by Vehicle
25
20
15
10
5
0
BART
LRV
Trolleys
30' Hybrids
40' Hybrids
40' Biodesiel
60' Biodeisel
Energy use / mile (kWh)
MPG equivalent per car
CO2e lbs / mile (global pollutant)

CO2e and Energy (DGE) by Vehicle Type



SF Vehicle Energy Usage (electricity)



BART

30-90 min peaks

4.6 million pax miles

350k daily pax

200k daily miles

0.5-1.0 load factors

SFMTA

3-4 hour peaks

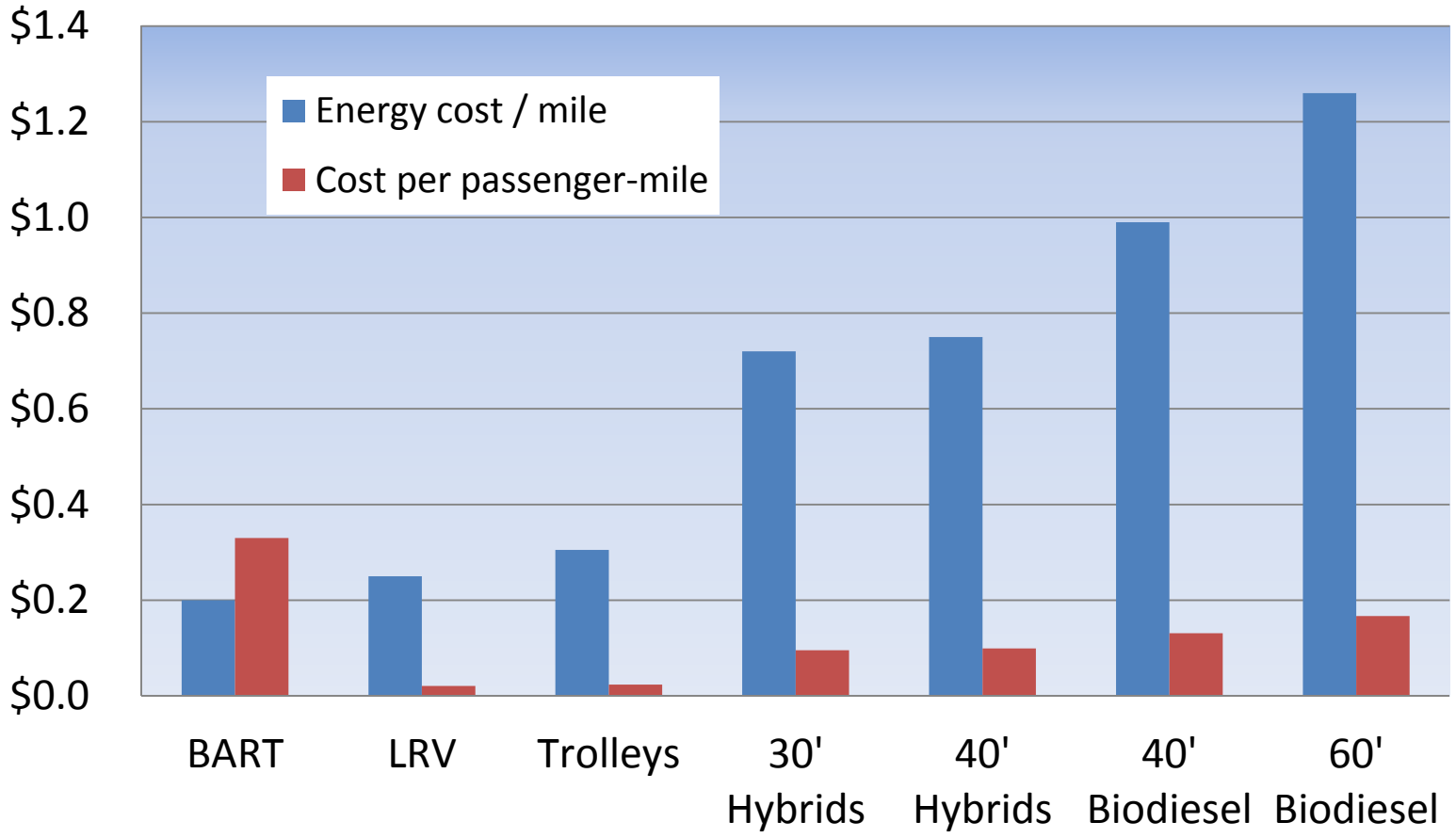
2.4 million pax miles

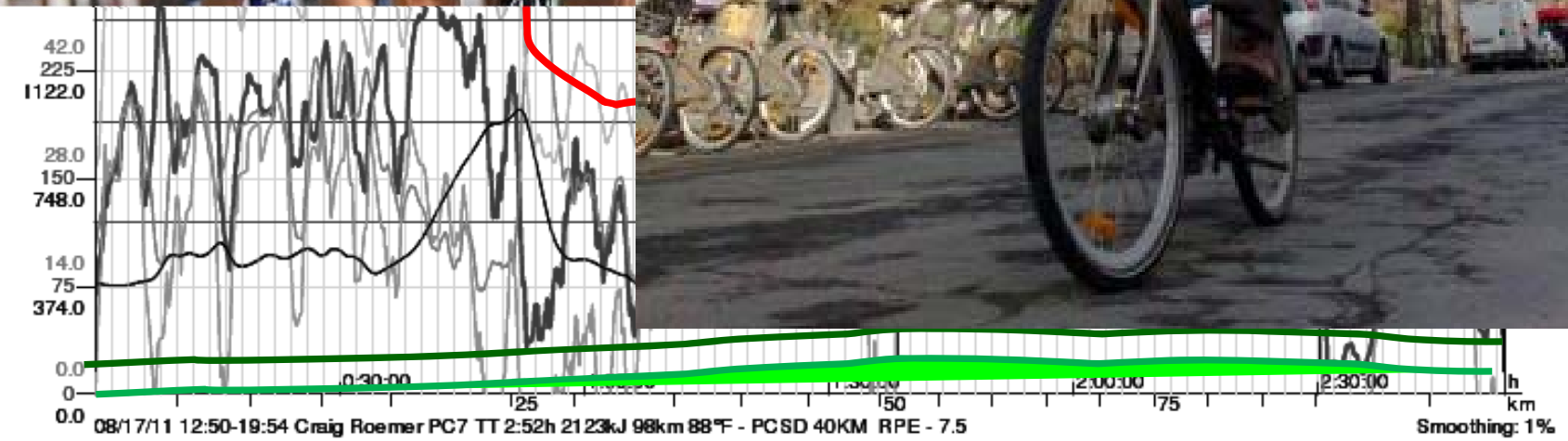
750k daily pax

70k daily miles

0.8-1.5 load factors

Energy Cost per mile & per pax mile




42.0
225
122.0
28.0
150
748.0
14.0
75
374.0
0.0
0
0.0
0:30:00
25
50
75
2:00:00
2:30:00
h
km
08/17/11 12:50-19:54 Craig Roemer PC7 TT 2:52h 2123kJ 98km 88°F - PCSD 40KM RPE - 7.5
Smoothing: 1%

Commuters generate electricity by walking on special panel at Shibuya station in Tokyo.

Conclusions

1. San Francisco is performing well in: land use, ridership, passenger load and energy efficiency
2. Electric powered transit vehicles pass all tests
3. An LCA pilot is needed on the SFMTA system
4. Policy changes are needed to incorporate LCA; such as?
   - LCA requirement in lieu of just Cap/Operational?
   - Air Quality/GHG assessments to include LCA?

Thank you!

Peter Brown
Project Manager, Long Range Planning
Sustainable Streets Division
SFMTA | Municipal Transportation Agency
phone: 415.701.5485
peter.brown@sfmta.com