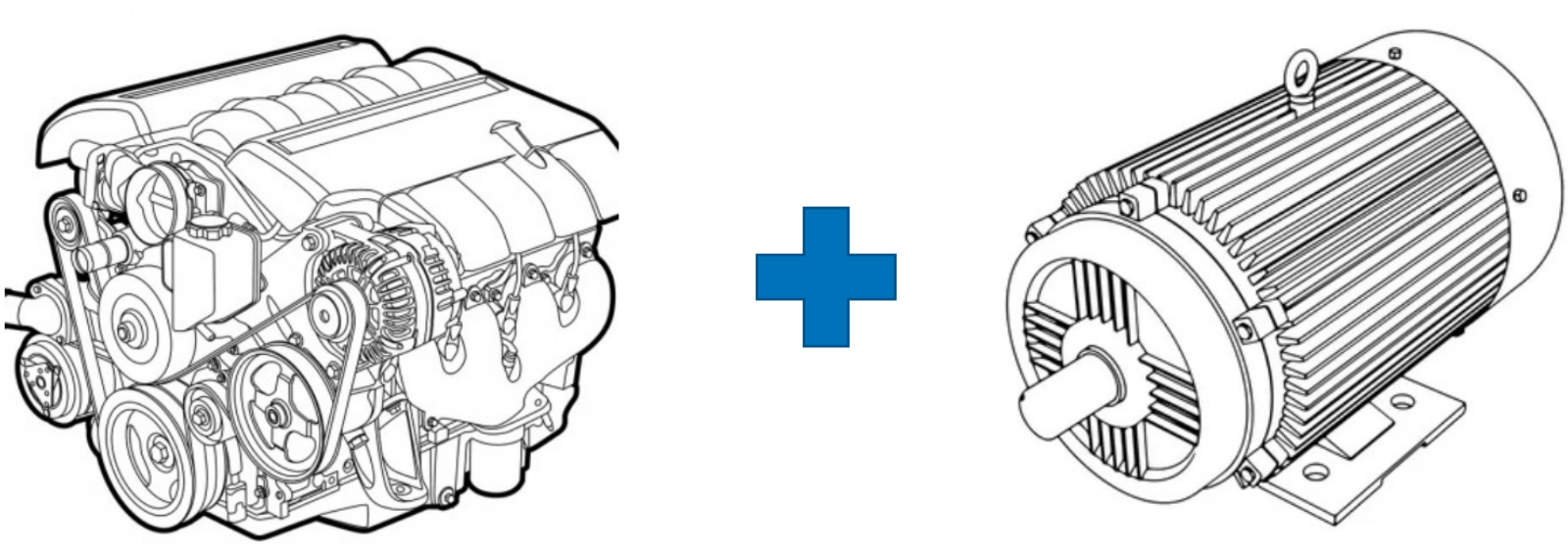
Hybrid Technology Parallel vs. Series

SFMTA Fleet Engineering

EMSC April 28, 2021 Meeting

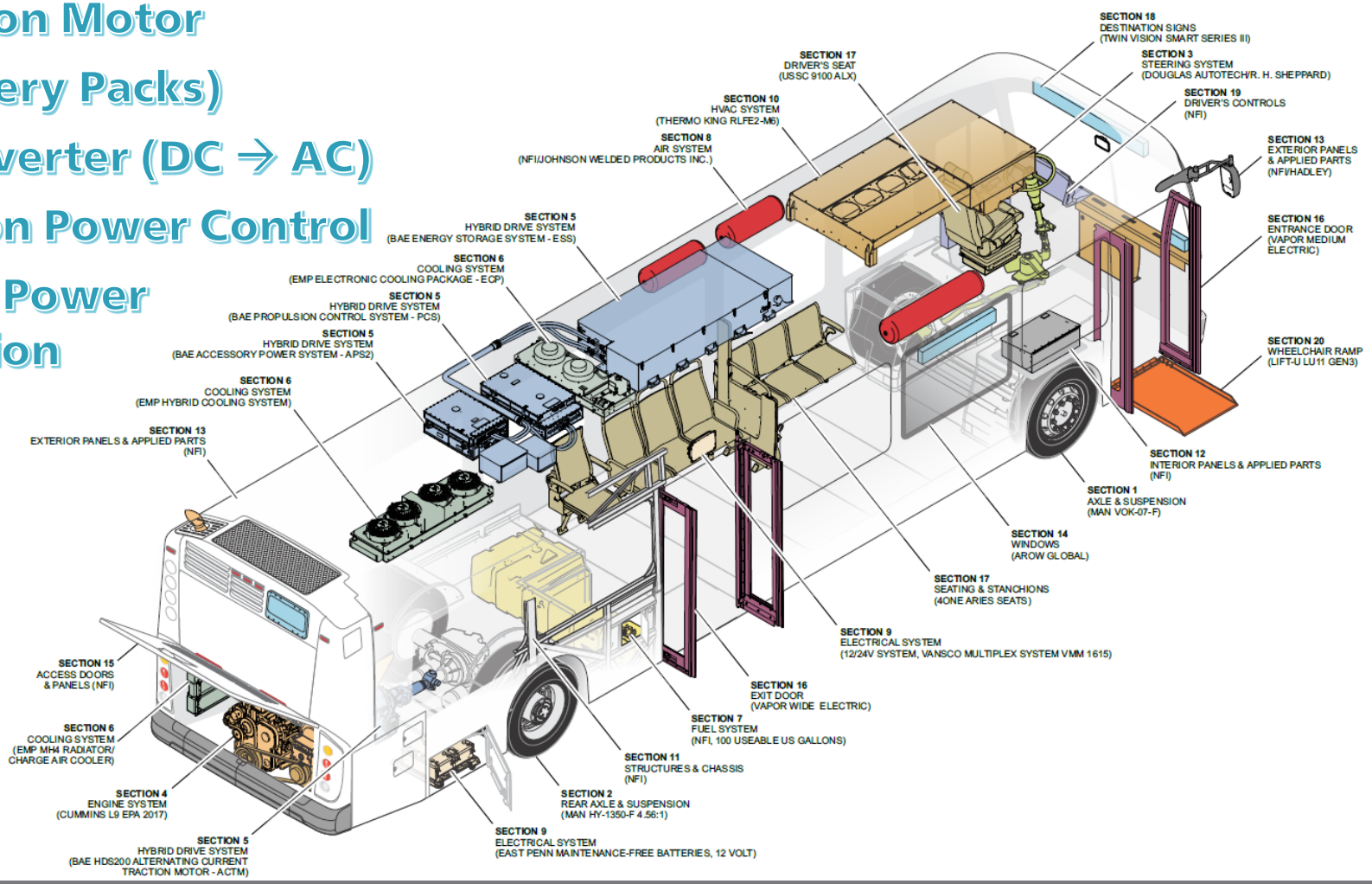
What is a Hybrid vehicle?

- A hybrid vehicle is one that uses **two or more distinct** types of power.
- **Hybrid electric vehicles** are powered by an internal combustion engine and an electric motor, which uses energy stored in batteries.



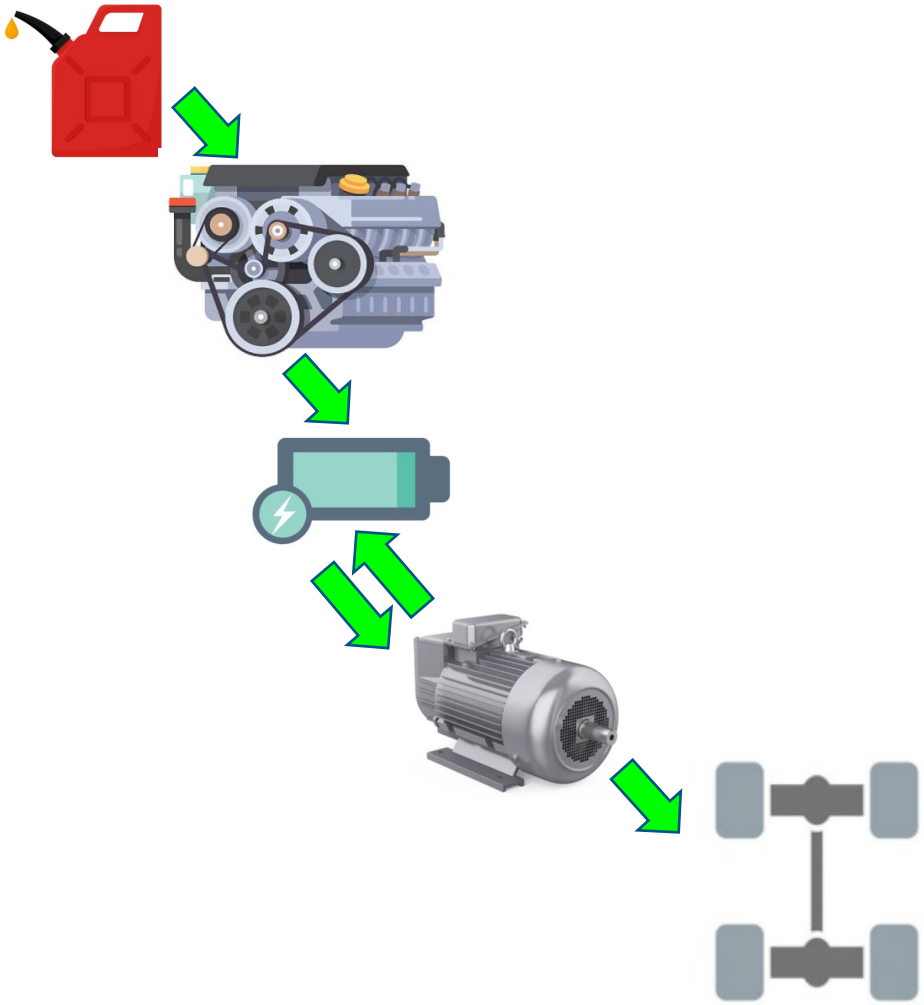
Common Propulsion Components

- Combustion Engine
- Fuel Tank
- AC Traction Motor
- ESS (Battery Packs)
- Power Inverter (DC → AC)
- Propulsion Power Control
- Auxiliary Power Distribution
- Axles

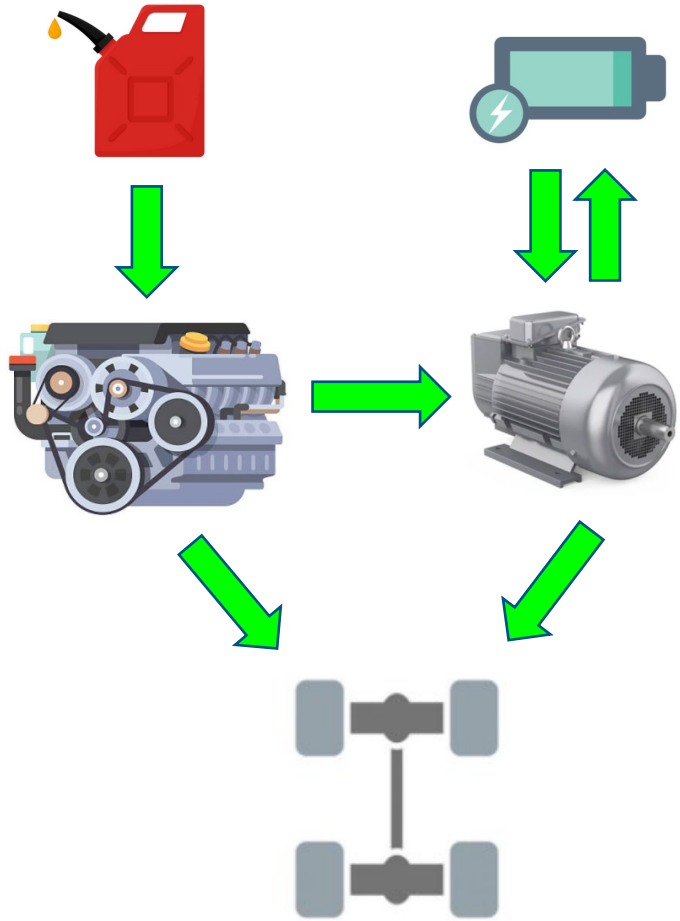


Series VS Parallel

BAE SYSTEMS



Allison Transmission.



Hybrid Architectures

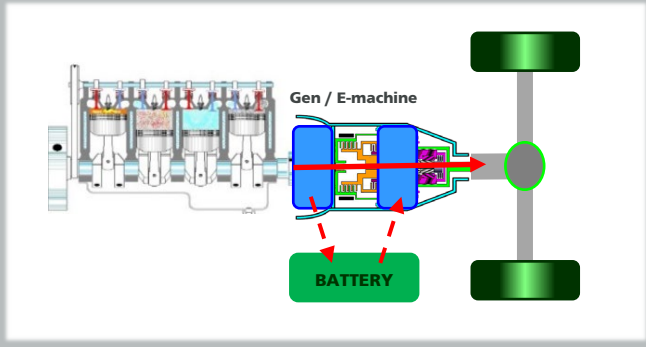
Parallel v. Series Hybrid System

Allison Transmissions

Compound Split Parallel Hybrid System: H 40/50

- Integral motor & generator & gearing
- Common e-machines
- Engine capable of operating independent of output speed
- Higher system efficiency when operating as a Hybrid due to the engine mechanical path to the output
- Full regenerative braking recovery from 50mph

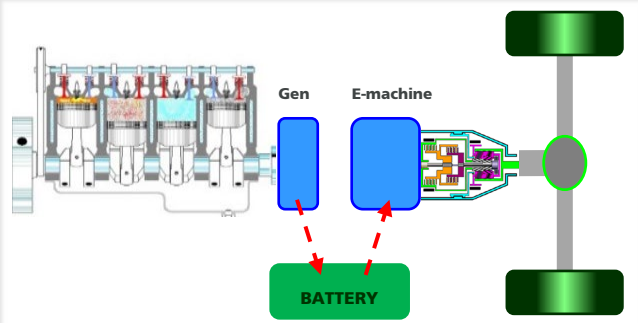
H40/50 EP: Compound Split Parallel Hybrid



Series Hybrid System

- Generator & traction e-motor w/potential gearing
- Electrical path from engine to output
- Engine operates independent of output speed
- Efficiency goes down as speed increases

Series Hybrid with Gear Module



Advantages and Disadvantages

Series

Advantages:

- No complicated multi-speed transmission and clutch design
- Small Engine required
- Anti-idling feature
- Operate without Engine running
- Lower cost

Disadvantages:

- Require larger battery pack
- More complicated motor to meet power requirement
- Max speed limitation

Parallel

Advantages:

- More powerful on high-speed condition

Disadvantages:

- Complicated multi-speed transmission and clutch design
- More expansive

Evolution of SFMTA Motor Buses

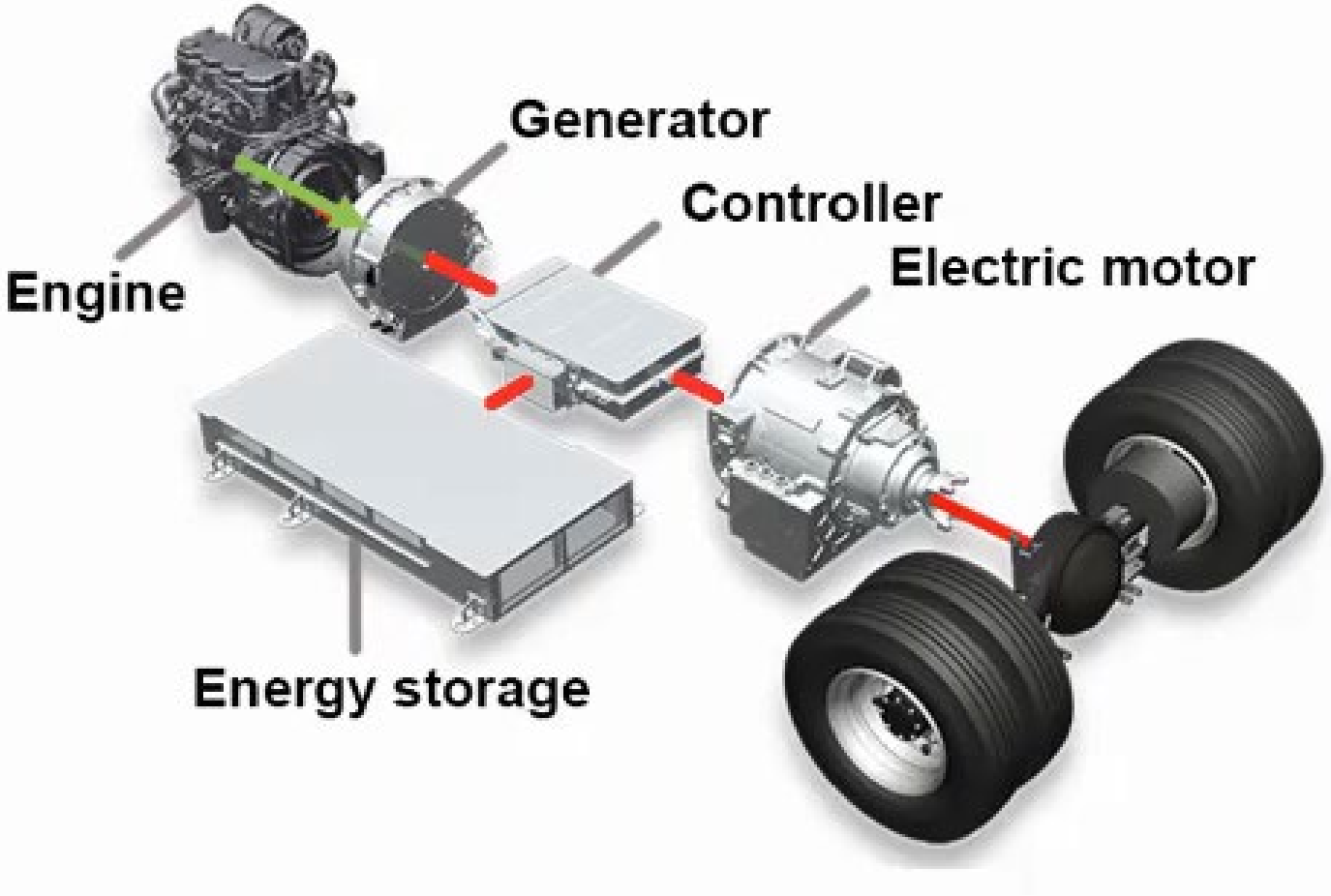
1999 – Neoplan (Diesel)

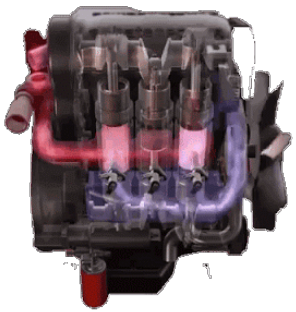
2007 – Orion (Parallel Hybrid)

2013 – New Flyer (Parallel & Series Hybrid)
2016 – Engine Start/Stop feature (Series Hybrid)

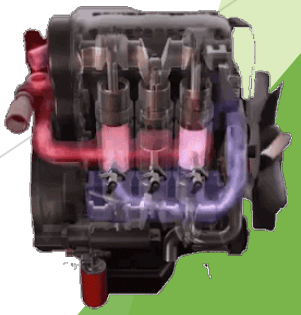
2018 – Part-time EV(Series Hybrid)

Series Hybrid System



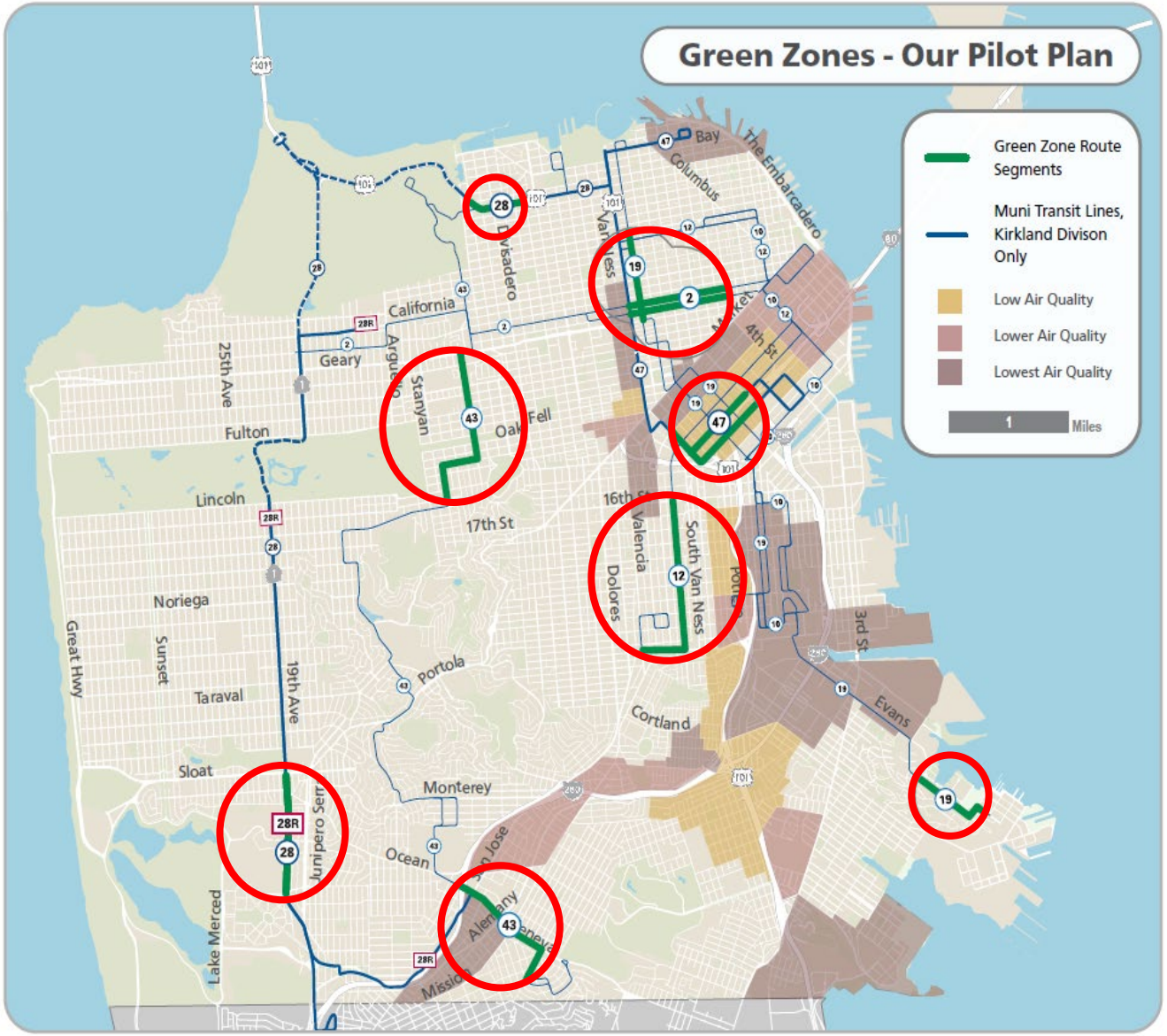


Green Zone



68 Series Hybrid on Part-time EV

Route	Route Total Distance (miles)	Green Zone Distance (miles)	Percentage of Total Distance
2	5.43	0.81	15%
12	6.72	1.20	18%
19	8.4	1.36	16%
28	12	1.58	13%
28R	8.45	0.93	11%
43	12.4	2.78	22%
47	5.35	1	19%



Part-Time EV for Parallel Hybrid

- Allison Propulsion offer eGen Flex.
- Similar operation s the Series Hybrid Part-Time EV
- Same Power output
- Not retrofittable for existing bus

Thank You!
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Questions?