







- Fixed-route Service RTC
 RIDE
- Paratransit Service RTCACCESS
- THE BRT's
 - 4th Street/Prater Way
 - Virginia Street Corridor
- Electric Bus Feasibility
- Electric Bus Roadmap
- The Future





How Green is RTC?



- 8 Hybrid electric RAPID articulated buses
- 10 Hybrid Electric RIDE 40' buses
- 4 Short range Electric SIERRIA SPIRIT/ RIDE Buses
- 5 Long range Electric Lincoln Line 4th Prater (on order)
- 4 Long range Electric Intercity Buses (on order)
- 8 Long range Electric RIDE buses (on order)
- 3 Proposed Long range Electric Articulated BRT Buses
- 50 CNG ACCESS Buses
- 1 Bifuel CNG Service Trucks











- RTC RIDE, INTERCITY
 & SIERRA SPIRIT
- 26 routes / 68 buses /
 1,000+ bus stops
- Defined route and schedule
- Operated by MV Transportation
- 8.2 million passenger trips per year
- Biodiesel, hybrid electric, and electric vehicles







- ADA service
- Eligibility screening process (Mobility Center)
- Demand-response: reserve rides 1-3 days in advance
- 221,000 trips per year
- 50 Cutaway Buses
- 100% Alt fuel (CNG)





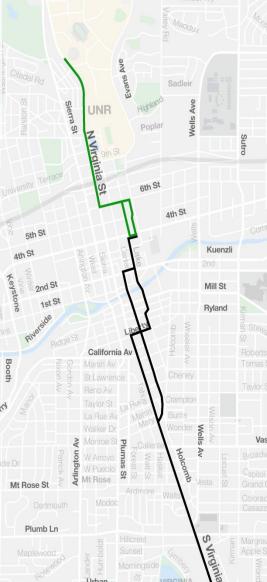
VIRGINIA STREE BRT EXTENSI



2.6 Miles - \$78 M Two (2) Articulated or Double Decker Buses **Completion Date - 2019**



Pedestrian safety, ADA & transit improvements



Feasibility of BEB's



- Agency Goals
 - RTC 100% alternative fueled by 2035
- Understanding electric buses Infrastructure
 - Local/Regional Power Infrastructure
 - Demand Charges and Energy Costs
 - New technology / Industry developments



Google to be powered 100% by renewable energy from 2017

Internet giant says renewable energy is increasingly lowest cost option and it will not rule out investing in nuclear power



Infrastucture



- Seattle Fast Charge (FC)
 - Large Fleet, long hours
 - overnight charging cost prohibitive
 - Existing Overhead Electric System
 - more conducive to FC infrastructure
- Stanford BYD's BEB
 - Own power plant
 - No demand charges
 - Commuter routes
 - Can recharge during mid-day
- Reno XR Proterra's BEB
 - High demand charges peak services mid-day
 - Shorter routes no need to recharge during the day





FC vs XR



- Calculating Electricity "fuel" costs
 - Kwh vs <u>Demand Charges</u>
- Lowering cost of energy
 - Off Peak Charging
 - Negotiate lower rate (wholesale power)
 - Demand management





Cost of Demand Charges



	Feb 2015			September 2015			October 2015		
	Diesel	Hybrid	Proterra	Diesel	Hybrid	Proterra	Diesel	Hybrid	Proterra
	Gillig	Gillig	Electric	Gillig	Gillig	Electric	Gillig	Gillig	Electric
Mileage ^(A)	8,585	8,585	8,585	12,163	12,163	12,163	12,422	12,422	12,422
Efficiency (kWh/mi or MPG) ^(B)	3.96	4.60	2.16	3.48	4.15	2.19	3.63	4.71	2.11
Usage (Gallons or kWhs)	2,168	1,866		3,495	2,931	26,590	3,422	2,637	26,230
Fuel Cost (\$/gal or \$/kWh) ^(C)	\$ 2.20		-			-	\$ 1.93	\$ 1.93	\$ 0.06
Usage \$'s	\$ 4,763	\$ 4,100	\$ 1,112	\$ 1.97	\$ 1.97	\$ 0.07	\$ 6,605	\$ 5,090	-
				\$ 6,885	\$ 5,774	\$ 1,861	7 -,-	Ψ -/	Ψ -,-
Demand, kW ^(D)									
Demand Charge (\$/kW) (E)						366			
On Peak Demand, kW ^(D)			226			\$ 5.25			221
On Peak Demand Charge (\$/kW) (E)			\$ 0.97			297			\$ 0.92
Mid Peak Demand, kW ^(D)			273			\$ 6.73			267
Mid Peak Demand Charge (\$/kW) (E)			\$ 5.38	\$ -	\$ -	\$ 3,920			\$ 5.38
Total Demand Charges	\$ -	\$ -	\$ 1,688				\$ -	\$ -	\$ 1,641
				\$ 6,885	\$ 5,774	\$ 5,782			
Total Fuel Cost	\$ 4,763	\$ 4,100	\$ 2,800	φ 0,005	у 5,771	7 3,732	\$ 6,605	\$ 5,090	\$ 3,215
				¢ 0.57	\$ 0.47	¢ 0.49			
Cost/Mile	\$ 0.55	\$ 0.48	\$ 0.33	\$ 0.57	\$ 0.47	\$ 0.48	\$ 0.53	\$ 0.41	\$ 0.26
Savings vs. Diesel (Cost \$)			\$ 1,963			\$ 1,104			\$ 3,390
Savings vs. Hybrid (Cost \$)			\$ 1,300			-\$ 8			\$ 1,876
Savings vs. Diesel (\$/mile)			\$ 0.23			\$ 0.09			\$ 0.27
Savings vs. Hybrid (\$/mile)			\$ 0.15			-\$ 0.001			\$ 0.15

Feasibility of BEB's



Risk Factors

- Diesel price volatility
- Diversify fuel types
- Dependence upon foreign oil
- Reliability of buses
- Reliability of manufacturer
- Technician training and availability

– Bus

- Economics
- Pros (Benefits)
- Cons

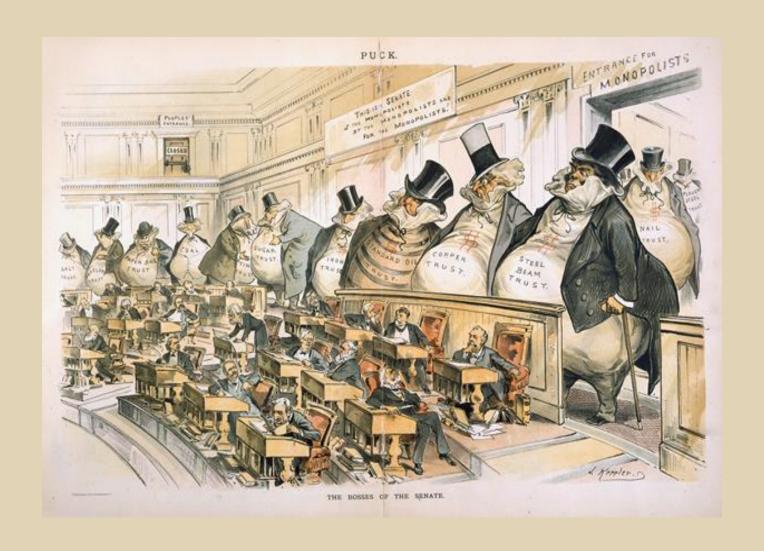






Big Oil





35' Low Floor 100% FAST CHARGE ELECTRIC BUS





Manufacturer: Proterra

 Engine: UQM PowerPhase 220 permanent magnet electric motor

•220 kW (294 hp)

•a peak torque 516 lb-ft

•Charge time: Avg 4-5 min.



• Length: 35'

Height: 135.5"

• Width: 102"

Seating Capacity 35

Proterra Performance



- 4 buses
- 7 days/week operations
- 303,000 miles
- 40,000 charges
- 5min 20 sec average charge time
- 57,000 gallons of diesel fuel
- 1.9m lbs of tailpipe GNG emission prevented
- Minimum down time
- On site repair tech
- Upgrades and updates (i.e.Tesla)



Feasibility of BEB's





Feasibility of BEB's



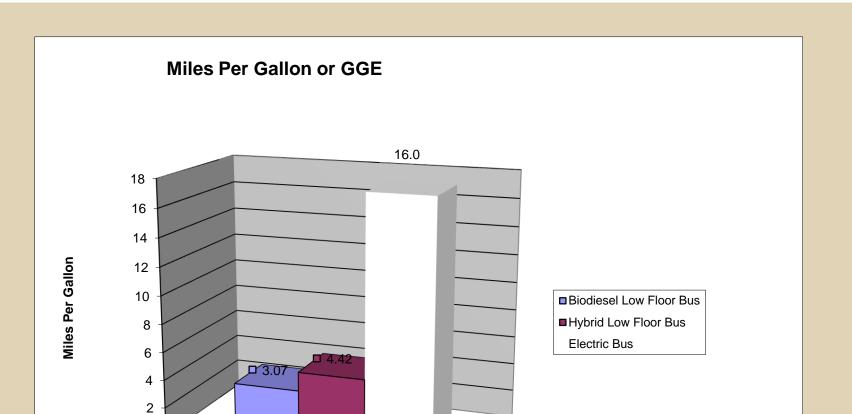
- Purchase price of BEB's are comparable to hybrid diesel electrics
- Fuel cost savings from \$63k to \$112k per bus
- Lower maintenance costs
 - PM intervals extended
 - Regenerative Brakes
 - Fewer Service Parts and Less Fluids





Biodiesel vs. Hybrid Miles Per Gallon





Feasibility of BEB's



- Benefits (Pro's)
 - Lower costs
 - Zero emissions
 - Health Benefits
 - Quality of life
 - Quieter
 - Lighter weight



Feasibility of BEB's



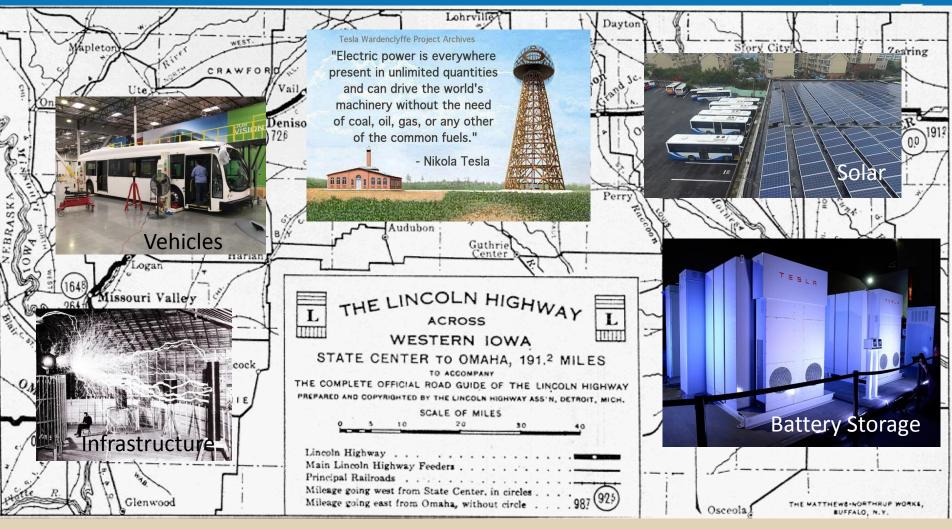
- Con's
 - Initial capital cost higher
 - Electrical infrastructure upgrades
 - Comparable to CNG
 - Demand Charges and Energy Management
 - Calculating Electricity "fuel" costs
 - KWh vs <u>Demand Charges</u>
 - Range / range anxiety
 - Initially working with prototypes
 - R&D
 - New technology, terms, data and training





Designing the Electric Vehicle Road Map







Infrastructure - Cost of Energy



Infrastructure - Design



- Designed for expansion
- Upgraded transformers
- New switch gear
- Distribution switch board
- Separate meters
- Smart Charging





"Advances in transportation technologies, including electric vehicles, hydrogen fuel cell stations and the electrification of mass transit and fleet vehicles will power a more sustainable transportation future,"

Fred Ellermeier, Vice President and Chief Operating Officer of Black & Veatch's Smart Integrated Infrastructure business

Infrastructure - Chargers



Express Plus is a future-proof ultra-fast DC charging platform that grows with demand and accommodates the battery technologies of today's and tomorrow's EVs. The modular, scalable architecture allows one Power Cube to serve as many as eight charging stations and send up to 400 kW to a single vehicle.



Infrastructure - Cost of Energy

A single vehicle can charge from 50 to 400 kilowatts



VEHICLES - BEB PROGRAM







- Fewer Parts / Most ReliableBuses in RTC Fleet
- Eliminated over 57,000 gallons of fuel use



VEHICLES - BEB PROGRAM





- Five (5) Proterra Electric 40' for 4th Prater
- Exercise option for 12 more in May 2017
- RFP for Two (2) Electric Artic's or Double
 Decker for Virginia Street Project and up to
 21 replacement buses (NOLO?) in 2018



VEHICLES - BEB PROGRAM





VEHICLES – BEB PROGRAM





Manufactured in California

The Future (Down the road)



- Solar
 - In route charging supplement by solar
 - Solar "skin" on buses
 - Charge during day and discharge at night
- Battery Storage
 - Solar storage
 - Peak Shaving







ADVANCED MOBILITY PLANNING





U.S. Proposes V2V Mandate to Reduce Crashes

Separately, the U.S. DOT's Federal Highway Administration will soon issue guidelines for vehicleto-infrastructure (V2I) communications.



ADVANCED MOBILITY PLANNING RTG

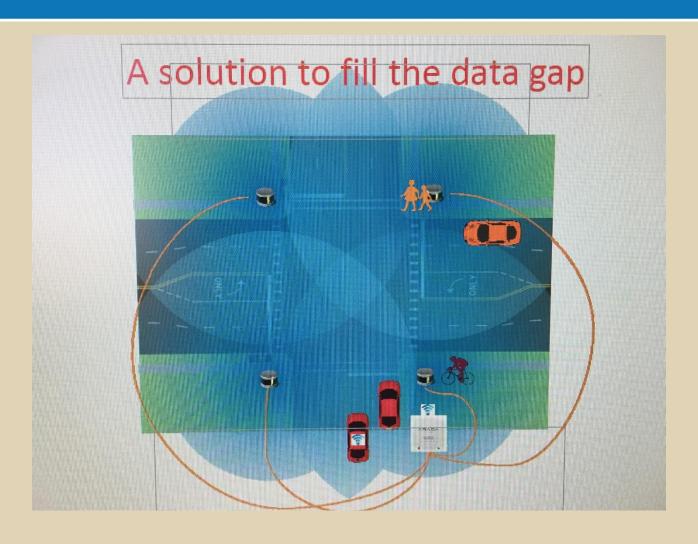


An ideal connected world



ADVANCED MOBILITY PLANNING

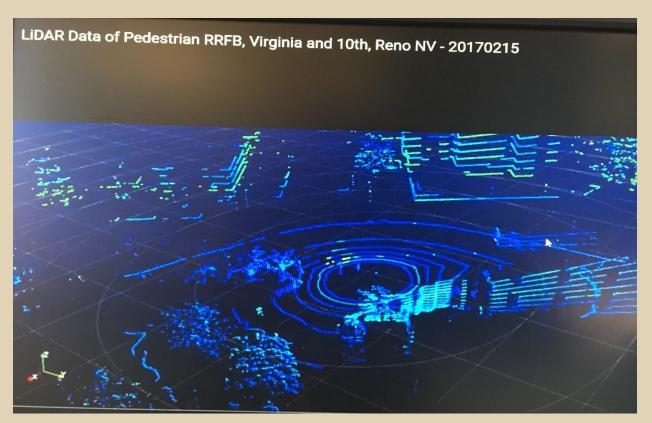




ADVANCED MOBILITY PLANNING



https://www.youtube.com/watch?v=UtJjRx1fERI



UNR Autonomous Vehicle Project