National Renewable Energy Laboratory
Innovation for Our Energy Future

PHEV Parcel Delivery Truck Model – Development and Preliminary Results

Hybrid Truck Users Forum

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Atlanta, Georgia

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NREL

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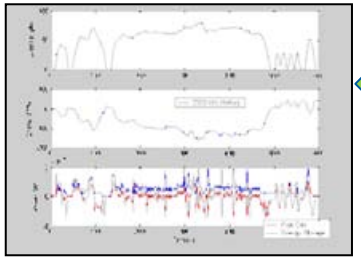
Project Design

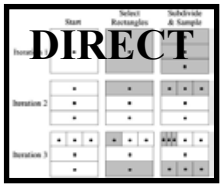
Laboratory Testing

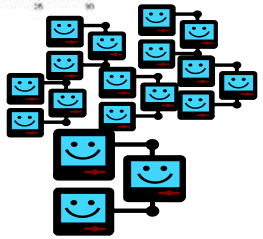


ReFUEL Laboratory

Modeling and Simulation

Validation

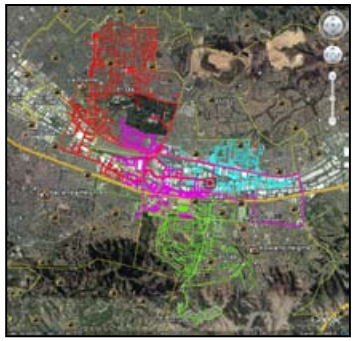


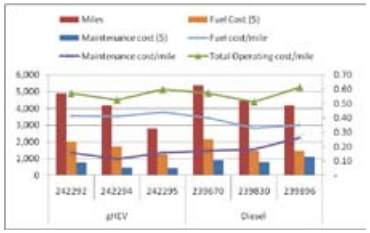


Calibration

Stakeholders

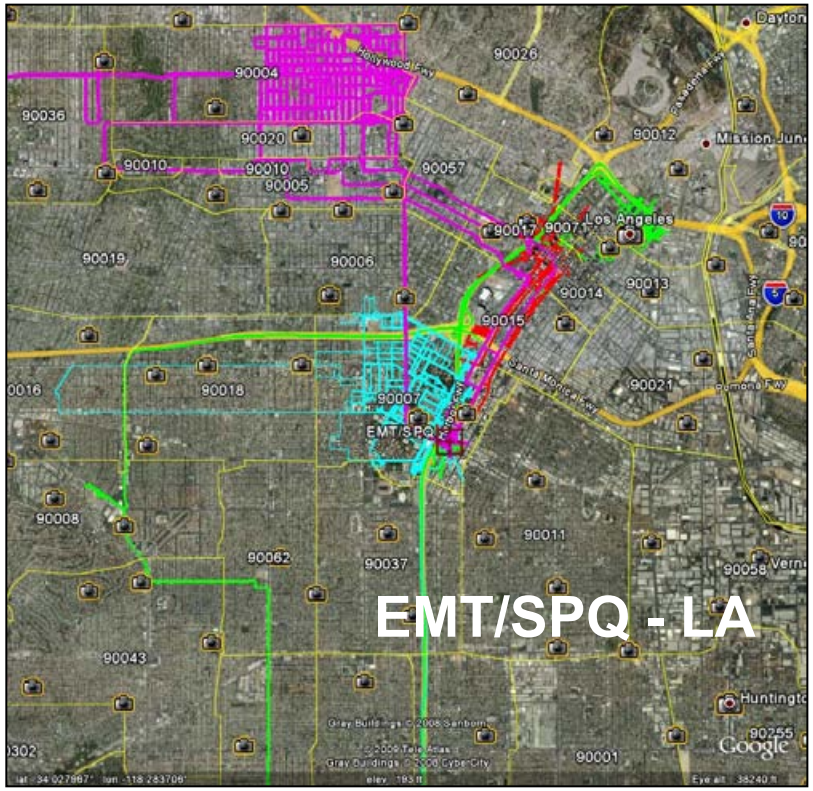
In-use Evaluation

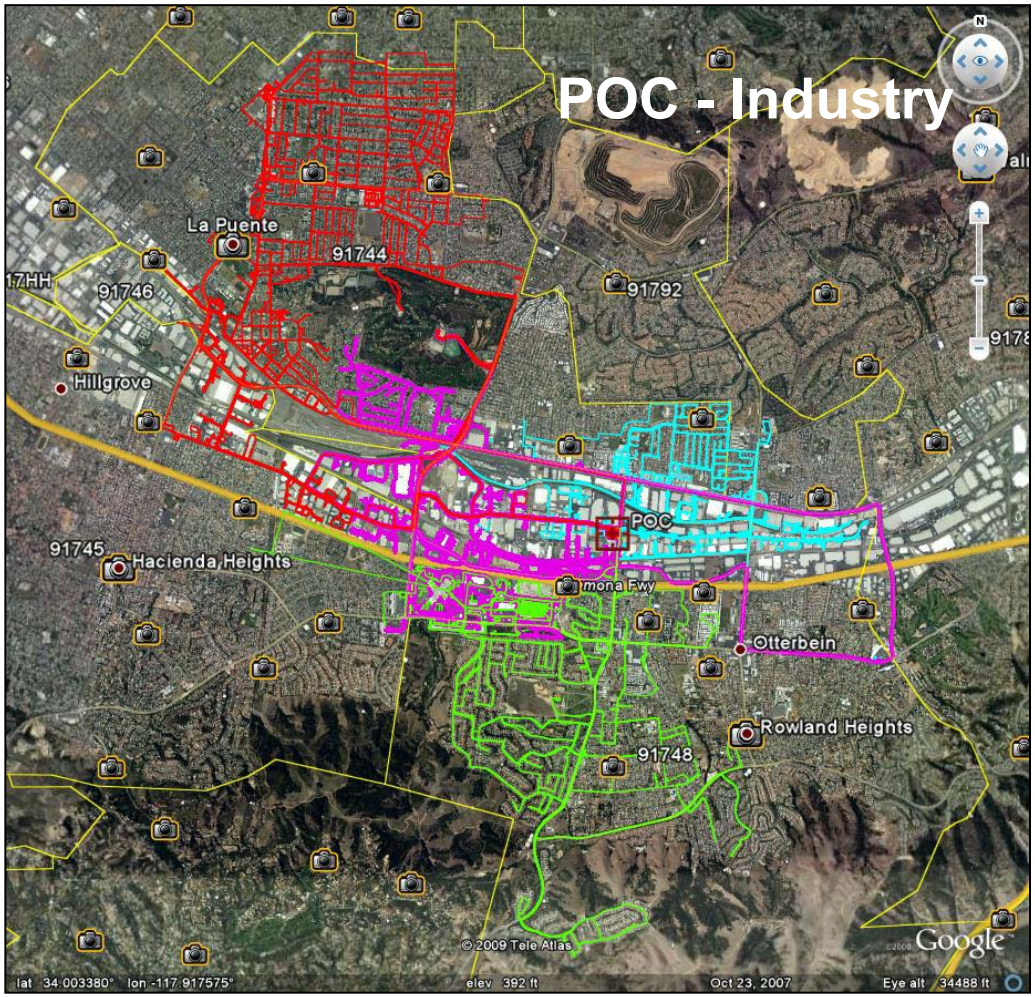




Route Visualization

- Latitude/longitude/speed data filtered, visualized using Google Earth to more completely understand vehicle usage
- Key considerations:
  - Screen out off-days
  - Day-to-day consistency
  - Route "zone" exclusivity

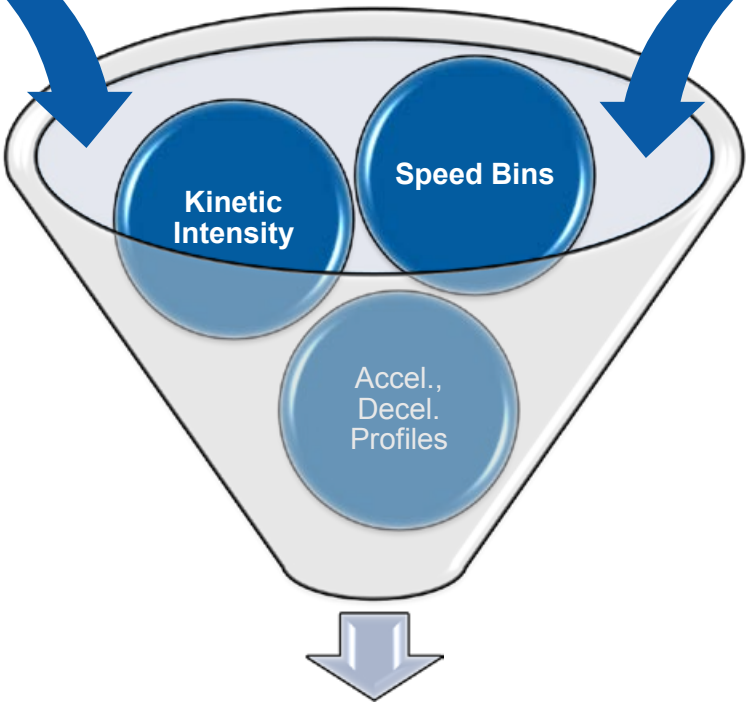




Drive Cycle Analysis

- Drive cycle comparisons based on average speed and stops/mile lack resolution and precision
- NREL performed comparative analysis of all 62 days of data **over 55 drive cycle characteristics**

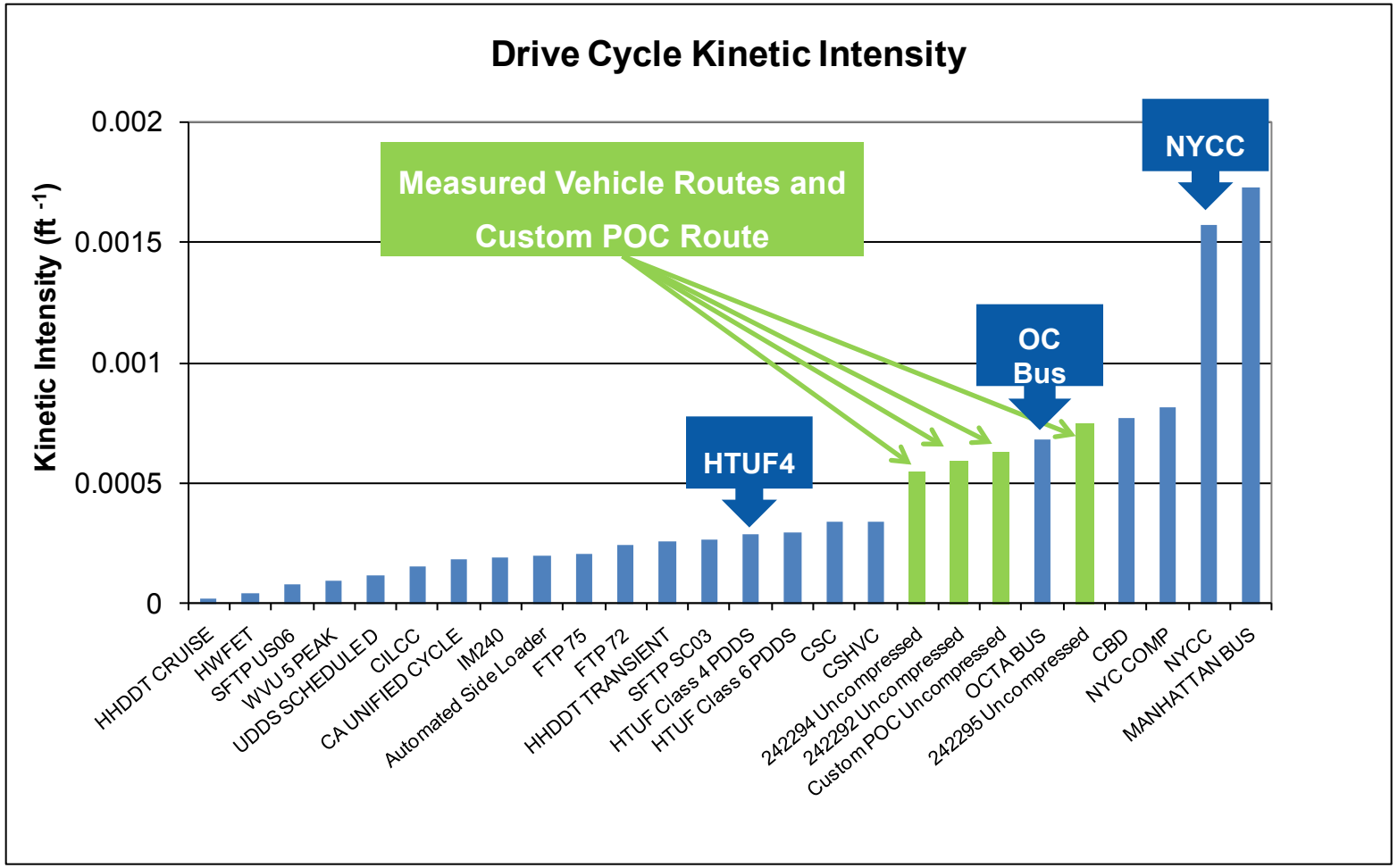
- ✓ Average driving speed
- ✓ Average cycle speed
- ✓ 0 mph time
- ✓ Average stop duration
- ✓ Stop time bins
- ✓ Idle time



Robust Drive Cycle Characterization

- ✓ Aerodynamic speed
- ✓ Characteristic acceleration
- ✓ STDEV of speed
- ✓ Max., average, % time accelerations
- ✓ Max., average, % time decelerations
- ✓ and many more…

ReFUEL Test Cycle Selection



- HTUF4 and NYCC represent “boundary cycles”
- OC Bus cycle most closely matches Custom POC data

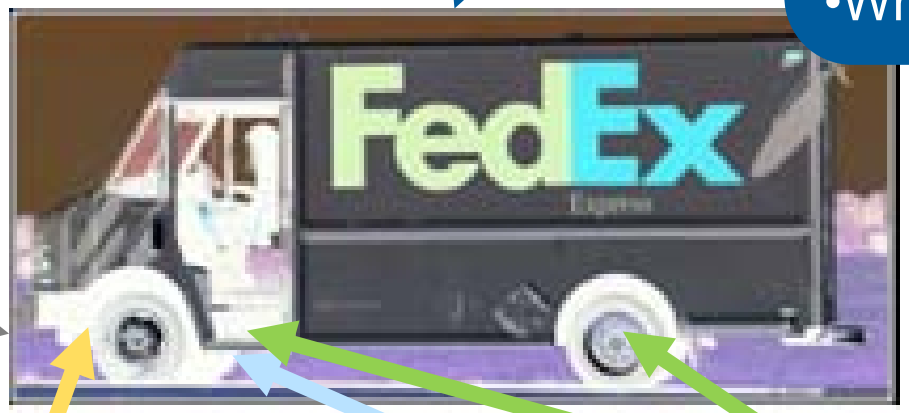
Preliminary FE (ReFUEL)

Drive Cycle	gHEV FE (mpg)
HTUF4	10.5
Orange County Bus	8.6
NYCC	6.8

Parcel Delivery Model Development

Propulsion
- Engine
- ESS, motors

Glider
- Frontal area, C_d
- Mass
- Axle weight fractions
- Wheels, tires

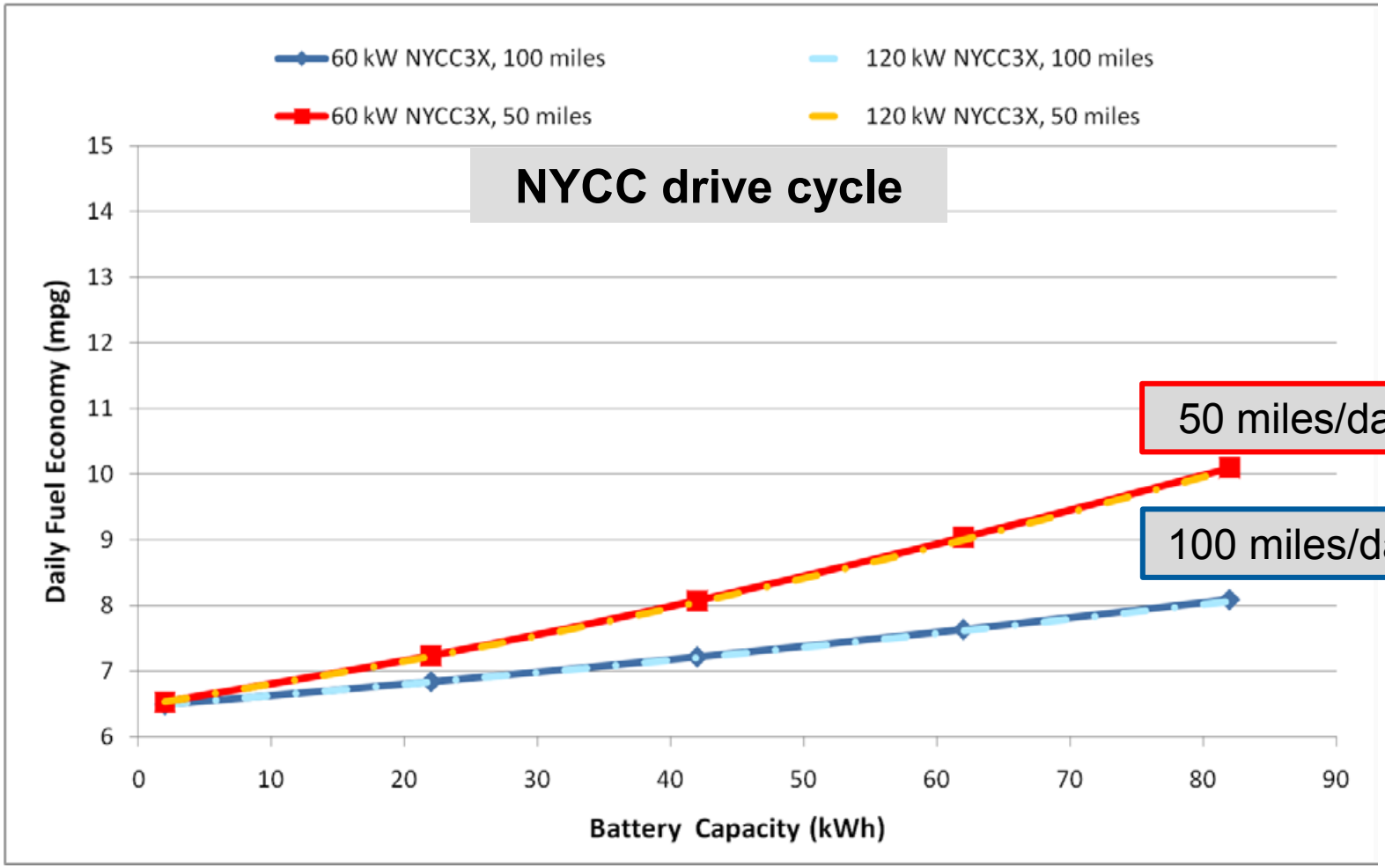


Auxiliary Loads
- Mechanical
- Electrical

Control Strategy

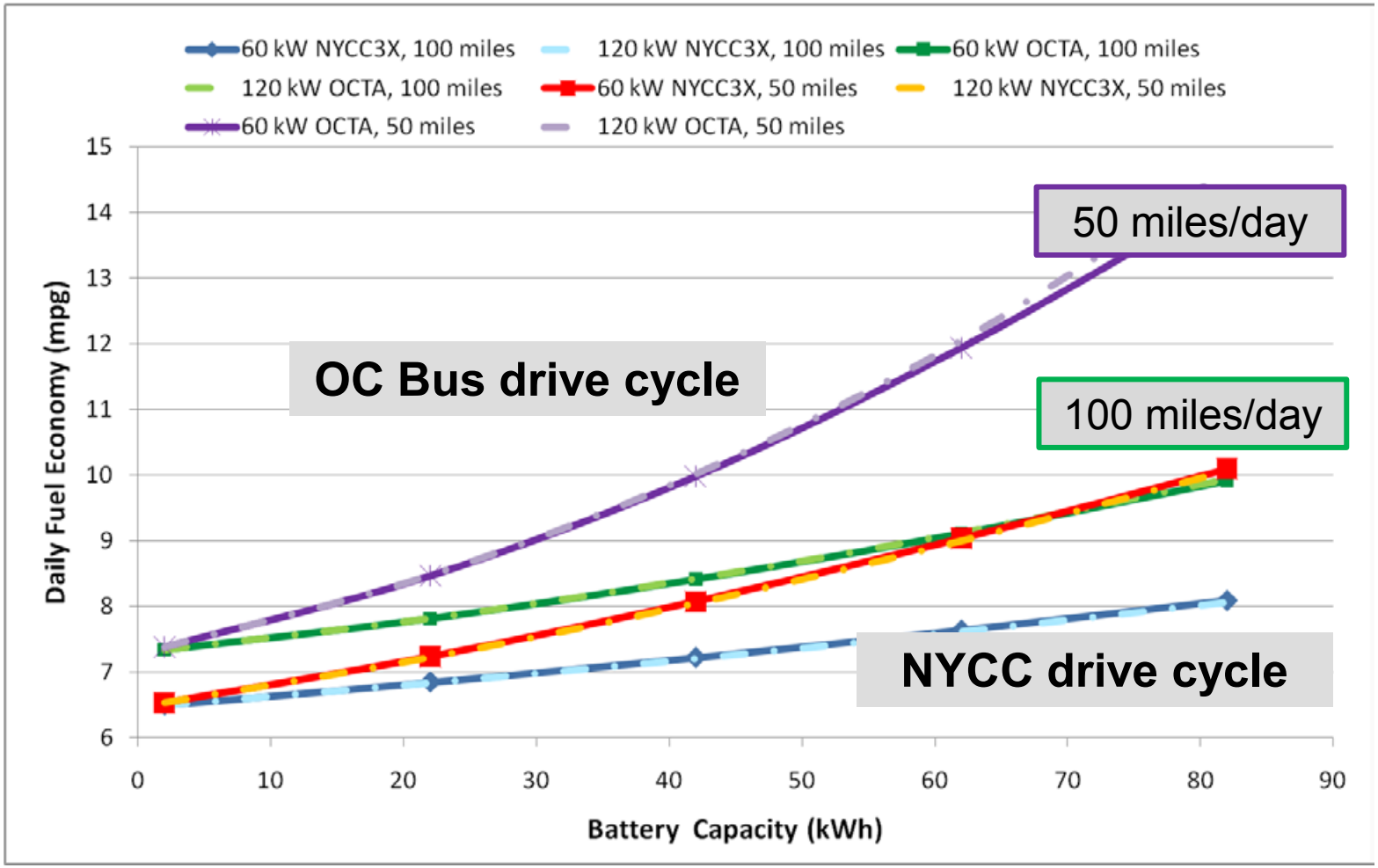
Gearing
- Transmission gear ratios
- Final drive ratio

Preliminary Simulation Results



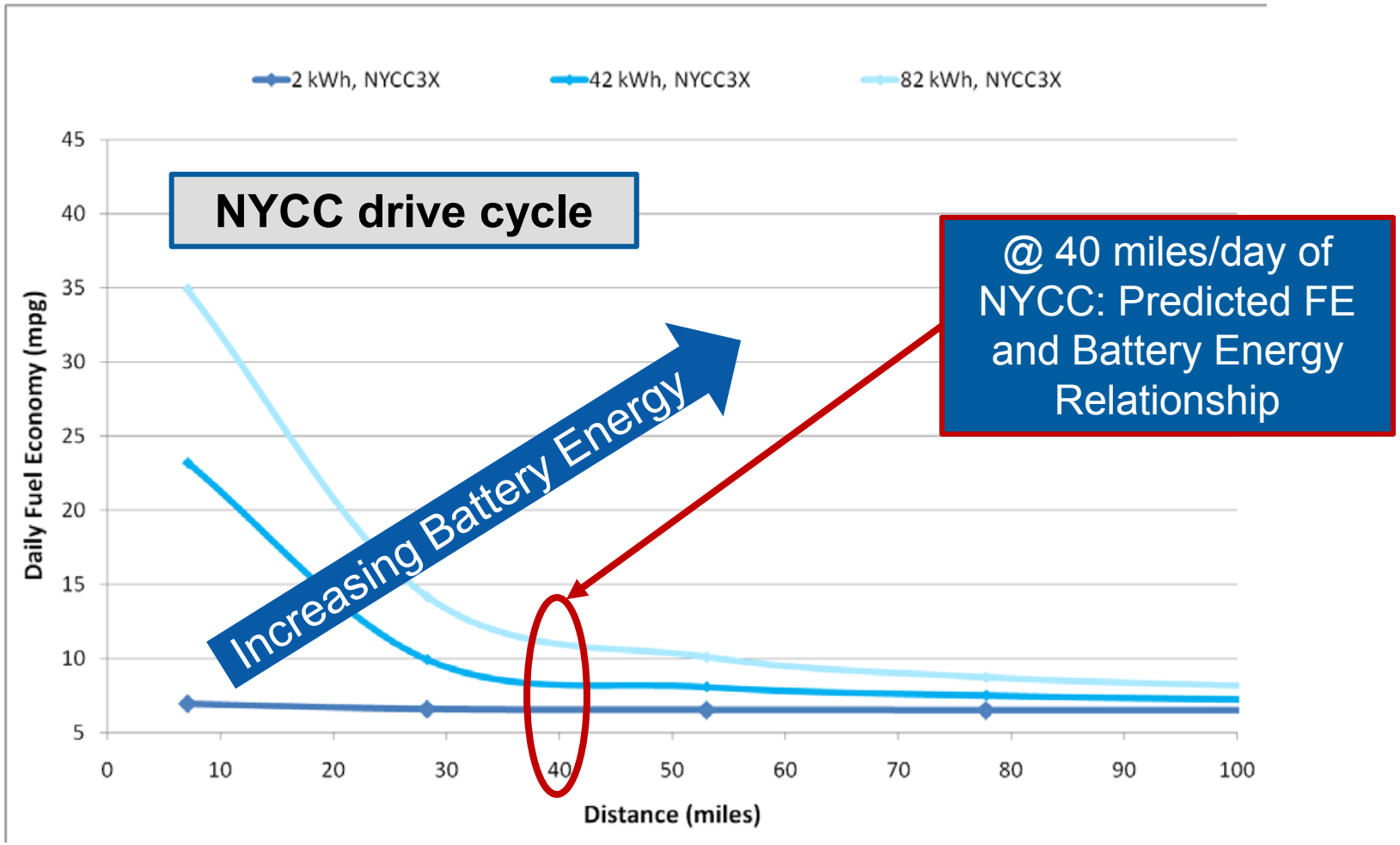
- 60 kW is plenty for vehicle and route
- Daily distance traveled matters!

Preliminary Simulation Results



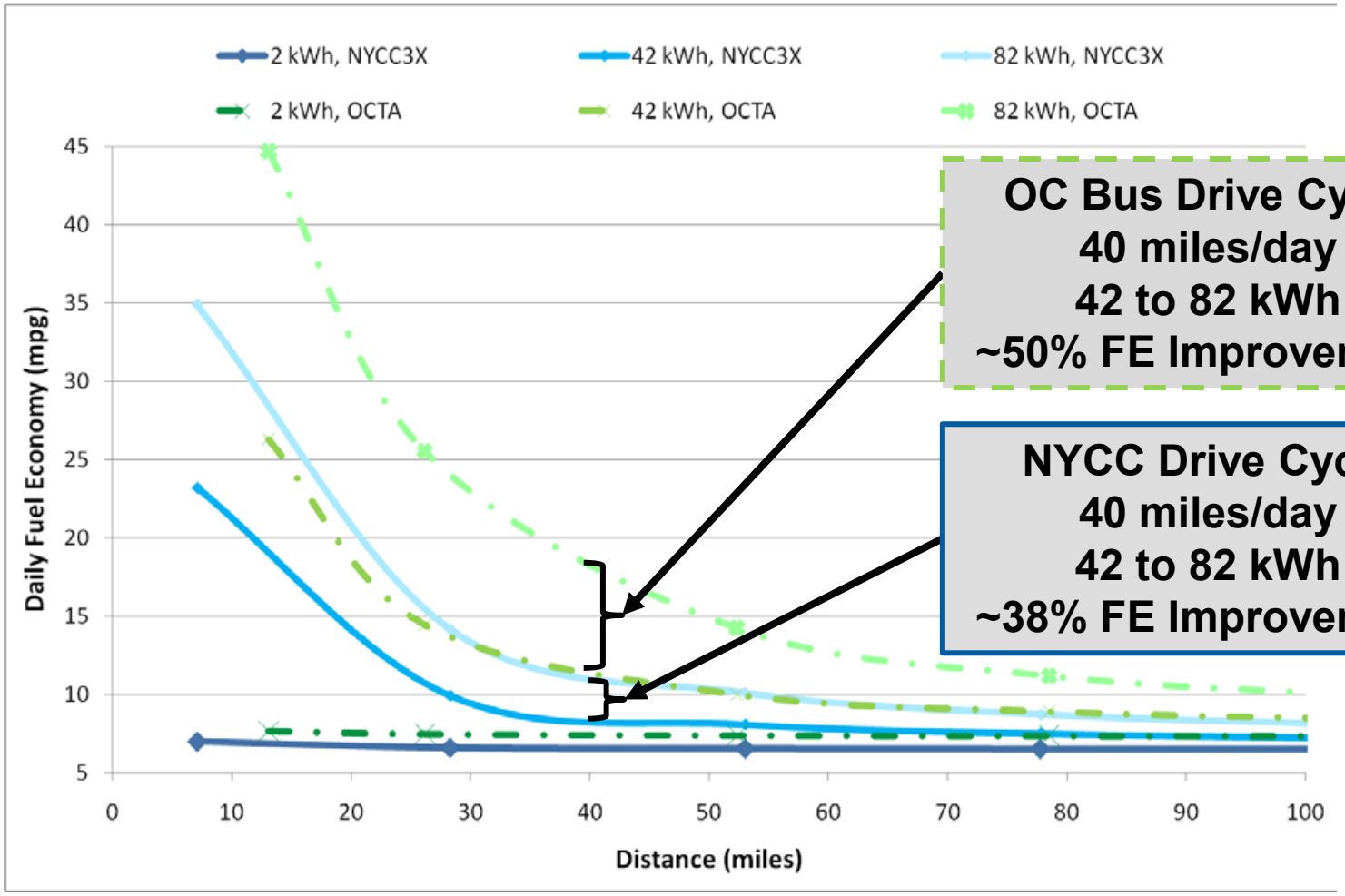
- Duty cycle matters!
- Daily distance traveled matters!

Preliminary Simulation Results



- **Daily distance traveled matters!**
- **Diminishing returns: larger battery capacity with dVMT**

Preliminary Simulation Results



- Duty cycle and dVMT influence capacity decision
- dVMT and lifetime mileage drive ROI

Key Points

- GPS-based route logging, when properly analyzed, allows for effective comparison of existing standard drive cycles and real-world data based drive cycles
  - Allows for **selection of relevant drive cycles** for chassis dyno test programs and vehicle simulations, and better matching of vehicle groups in field evaluations
- Validated vehicle platform model allows for more precise exploration of design-performance tradeoffs
- Knowledge of **drive cycle, daily miles traveled** is critical in assessing **PHEV battery trade-offs**
  - Increased capacity for improved daily fuel economy
  - Diminishing returns with daily distance traveled
  - Vehicle lifetime mileage also drives ROI

Future Work

1. Vocational and route power and energy requirements
   - Traction
   - Work site
2. AER and blended CD strategies
3. Engine usage changes and emissions impacts
4. Economics

5. Next two platforms…..

Thanks to:

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