



# ENGINEERING

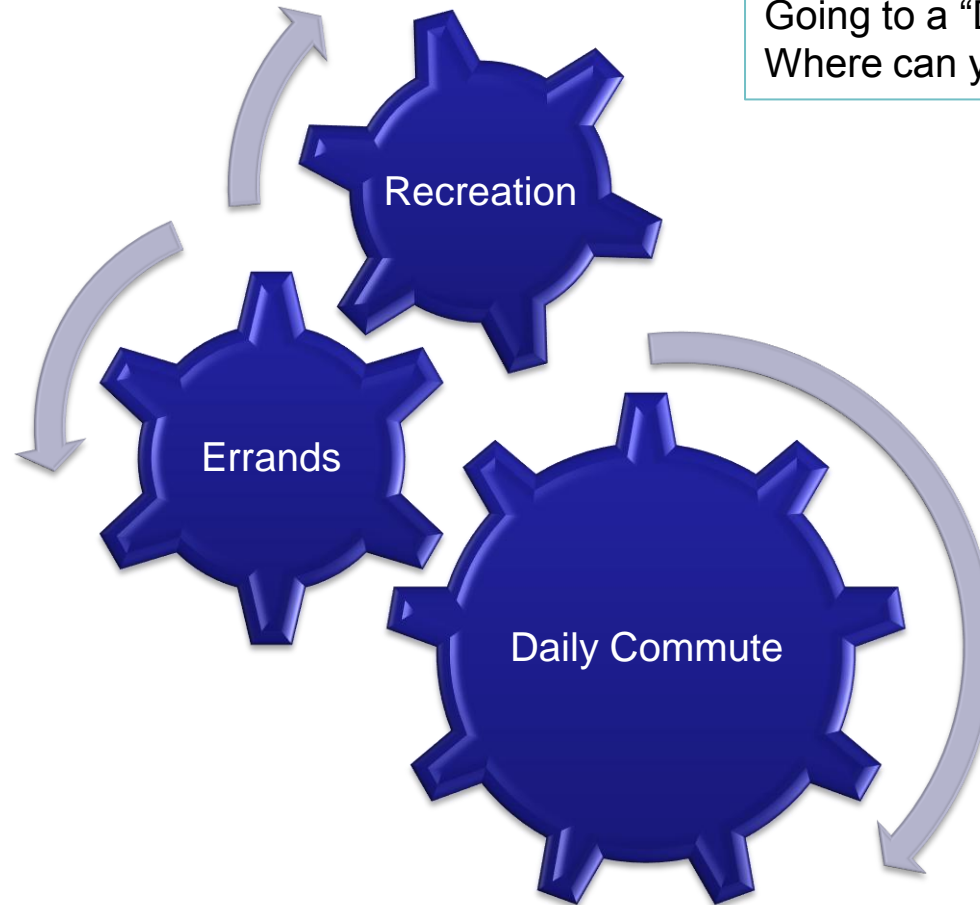
## Bridging the Gap Between Current Needs and Future Electric Vehicles

Greg Banish

# Common Vehicle “Needs”



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Going to a “Destination”?  
Where can you “fill up?”

Can easily add  
another 10-20 miles  
depending on route,  
traffic delays

Usually less than  
20 miles each way

# Single Vehicle for a Daily Driver?



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## Expected performance

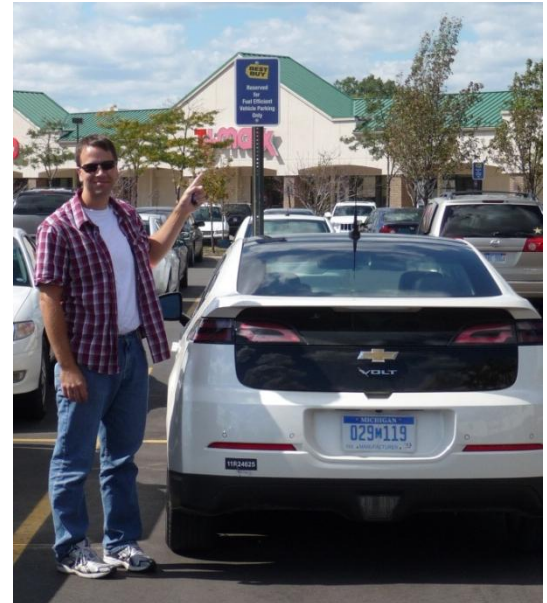
- driving experience
- passenger/cargo capacity

## Unexpected errands

- range anxiety

## Cold weather

- cabin heat
- battery range



# Family Vacation?



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monument valley utah



greg@calibratedsucco

Get directions

My places



A lax

B monument valley utah

Add Destination - Show options

GET DIRECTIONS

Suggested routes

I-40 E 658 mi, 10 hours 45 mins

## Driving directions to Olinto-Monument Valley, UT

L. A. International Airport  
1 World Way, Los Angeles, CA 90045

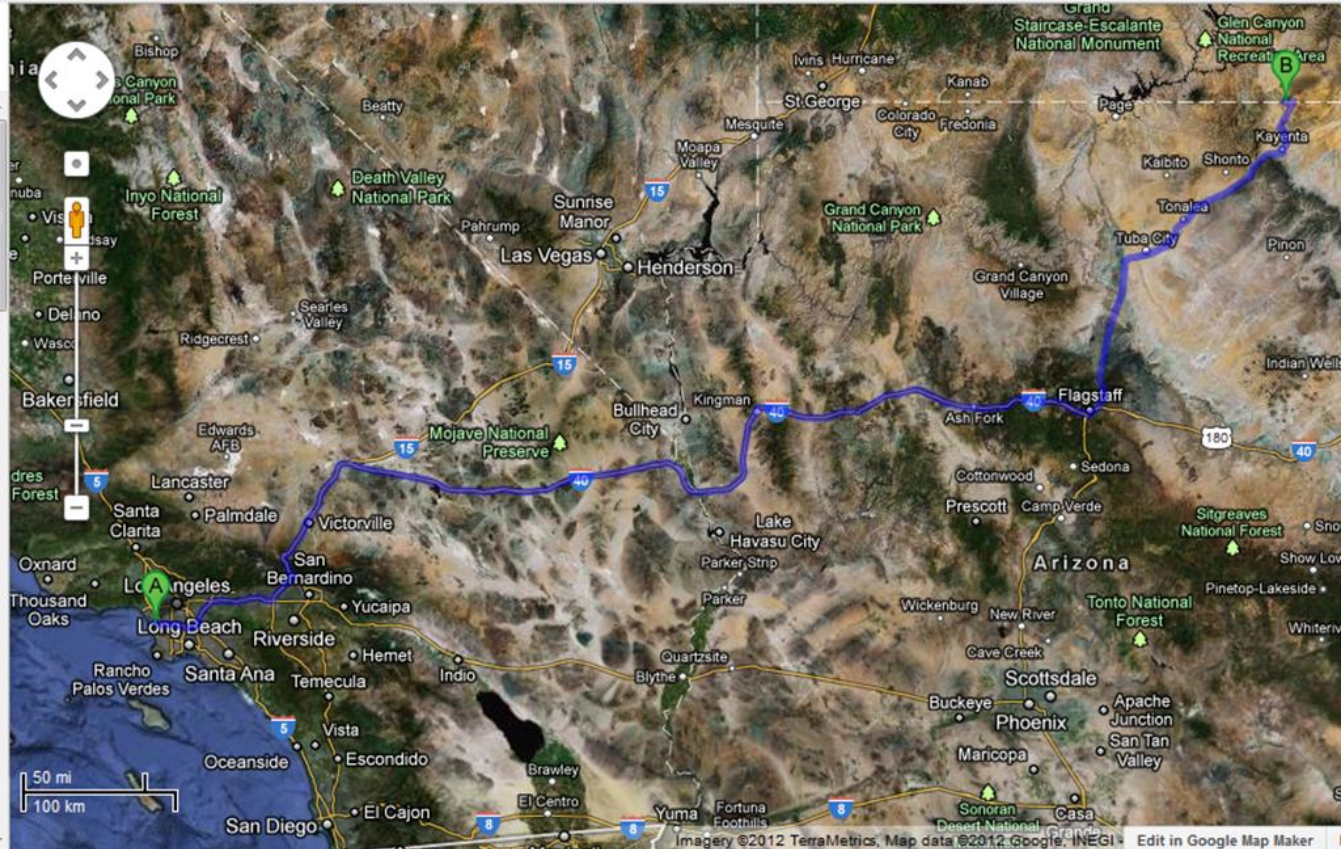
1. Head south on World Way toward West Way

0.7 mi

2. Keep right at the fork and merge onto S Sepulveda Blvd

0.7 mi

3. Slight right onto the I-105 E ramp



Anybody see an outlet we can use?



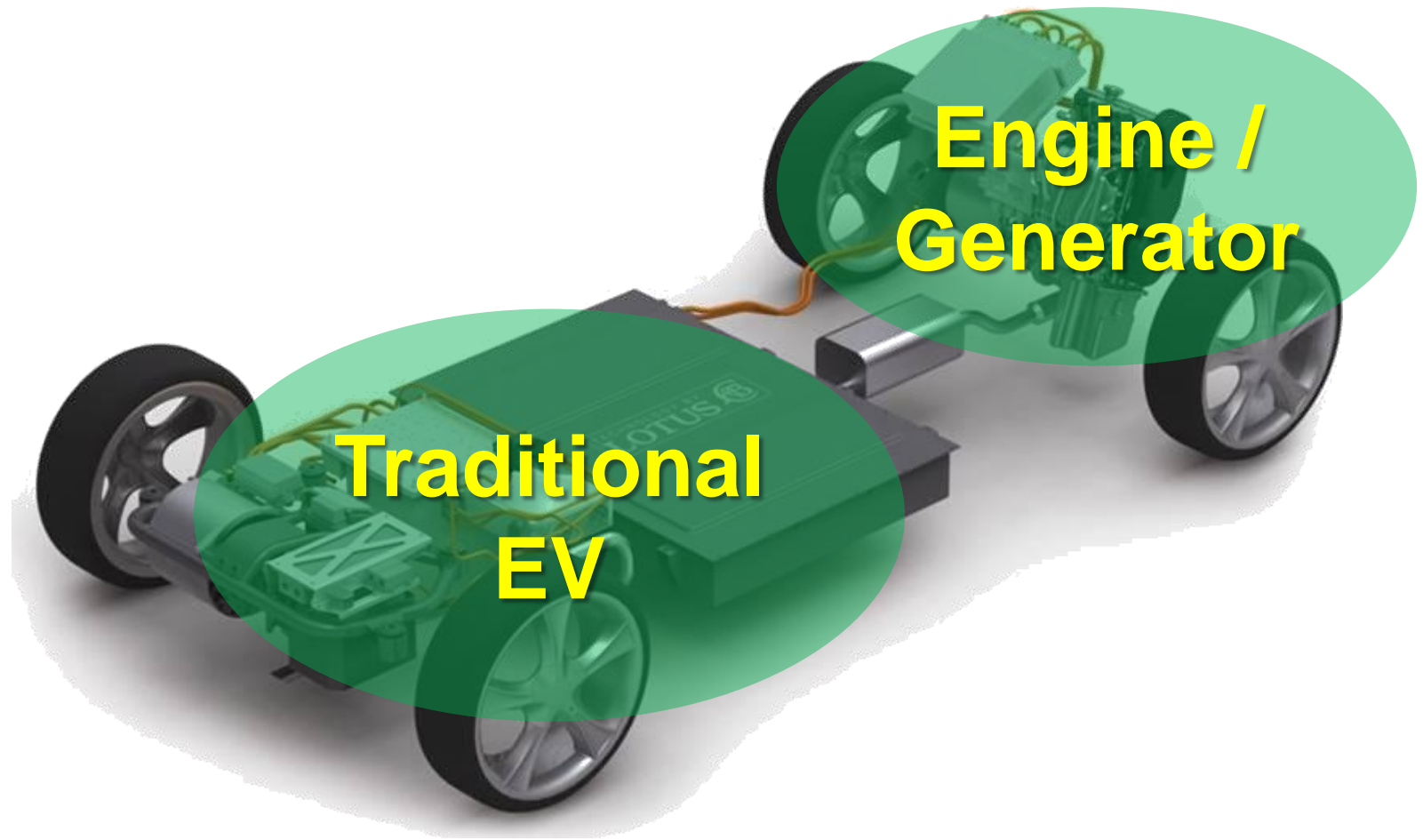
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# “Range Extended” Vehicle Architecture



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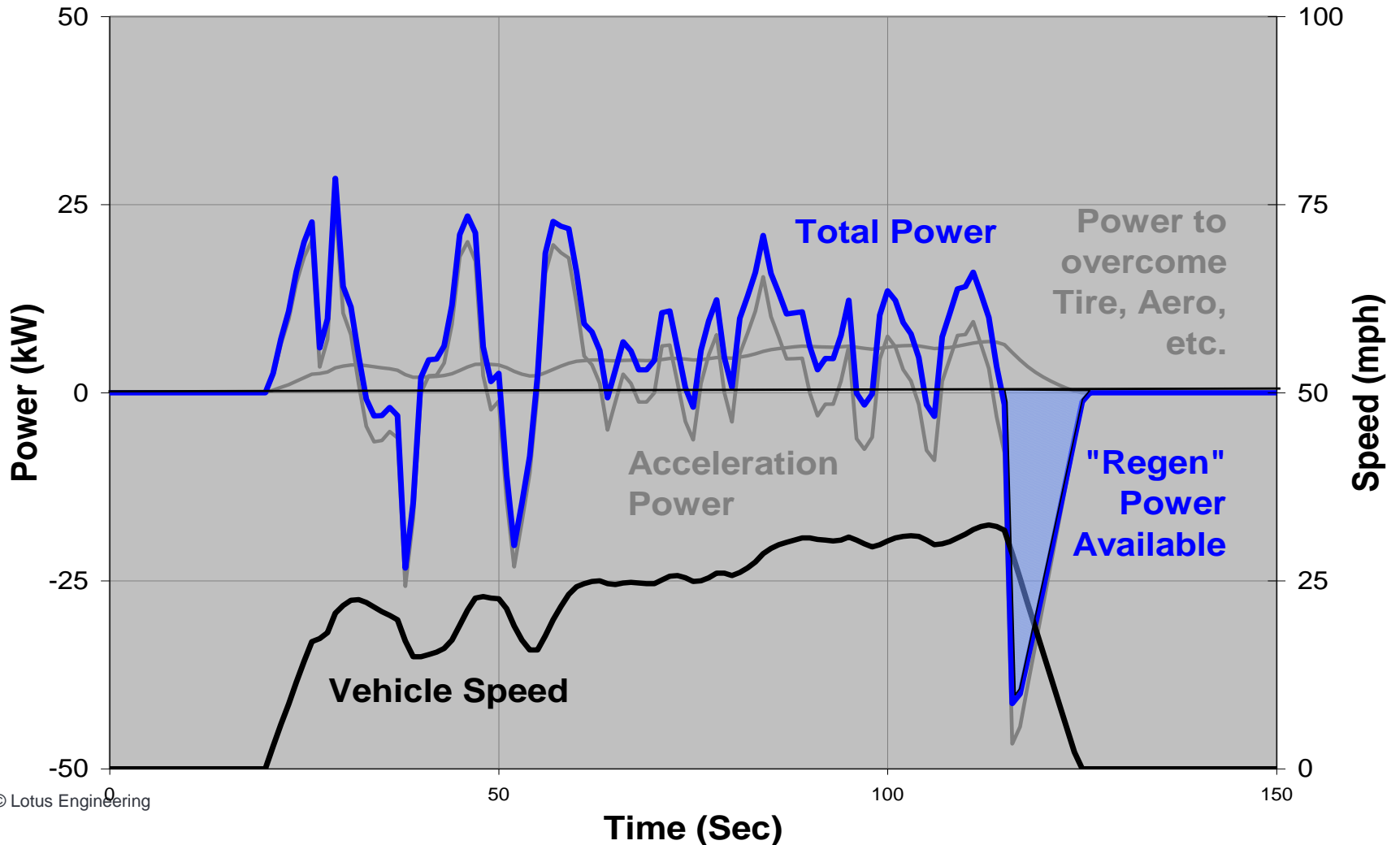


# Instant Power vs. "Average Power"



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## Power and Speed vs Time

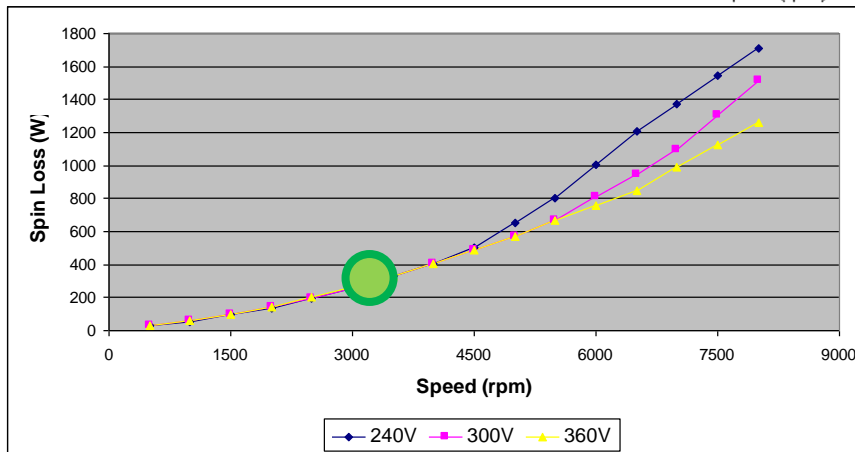
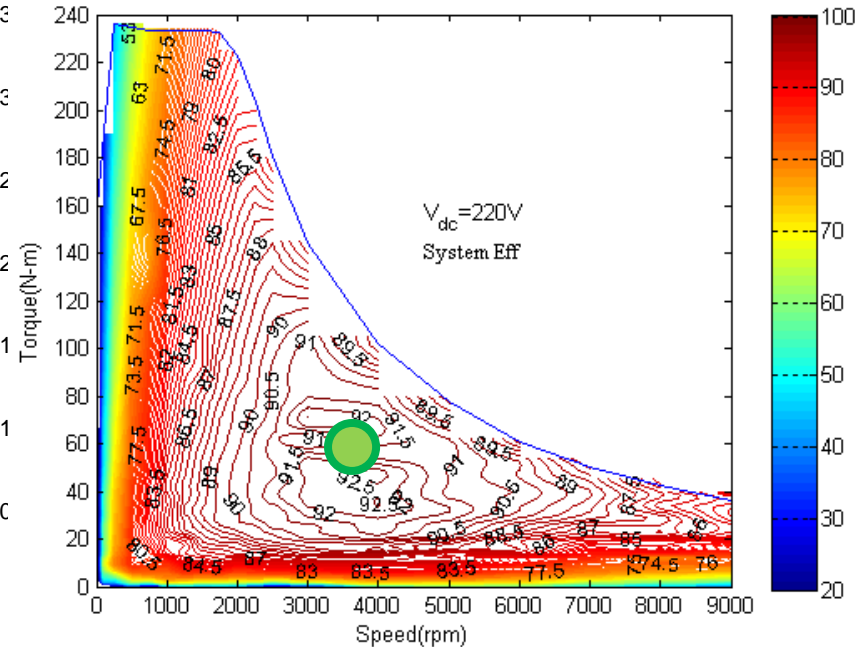
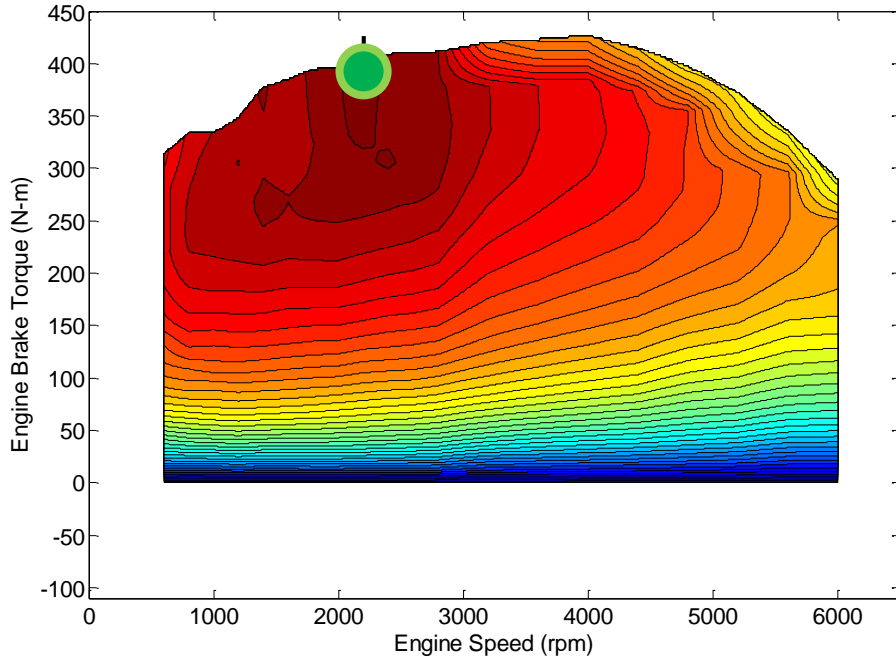


# Matching The Engine to the Generator



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Engine Fuel Consumption Brake Efficiency





# A Unique Approach to Engine Design



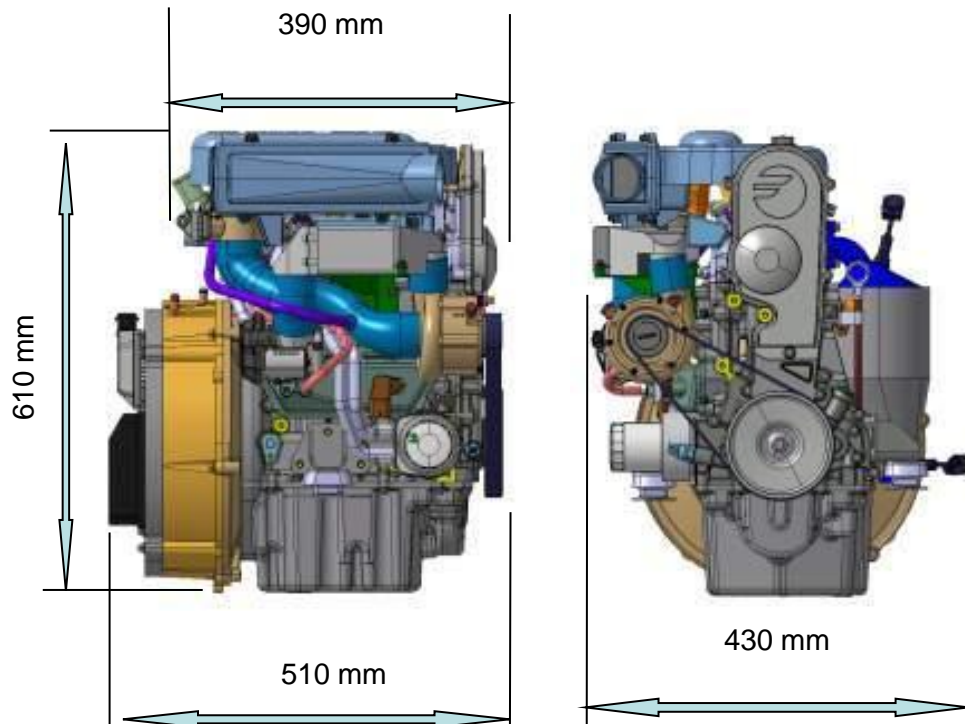
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# A Unique Approach to Engine Design



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## Minimum weight

- light materials
- small physical size
- improves fuel economy

## Minimum complexity

- avoid unnecessary parts
  - VVT, variable intake, accessories, transmission

## Minimum cost

- easy maintenance

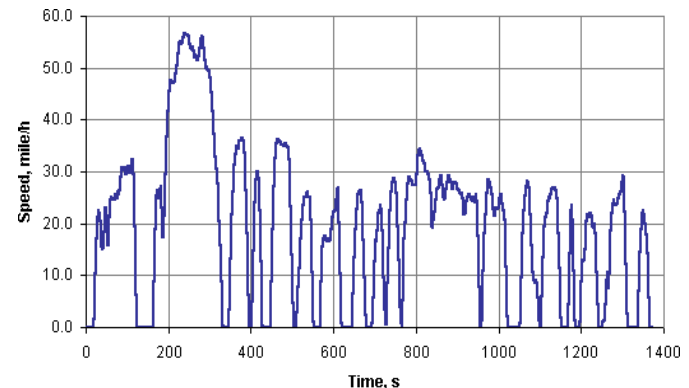
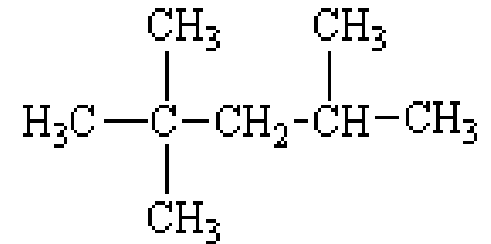
Engine sized to match average power consumption of vehicle

# Summary



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- Limited range and usefulness of current battery technology
- Liquid fuels have unmatched energy density at a reasonable cost
- Range extenders greatly increase the flexibility of the vehicle
- An optimized range extender engine can be significantly cheaper than a conventional propulsion engine
- Emissions and fuel consumption can be reduced if the engine is controlled to operate in a specific target window





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THANK YOU

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