energetics

Clean Energy Consulting

NGV UPTIME: Updated Performance Tracking Integrating Maintenance Expenses

FINAL Maintenance Data Analysis Results Summary

Database Structure and Terminology

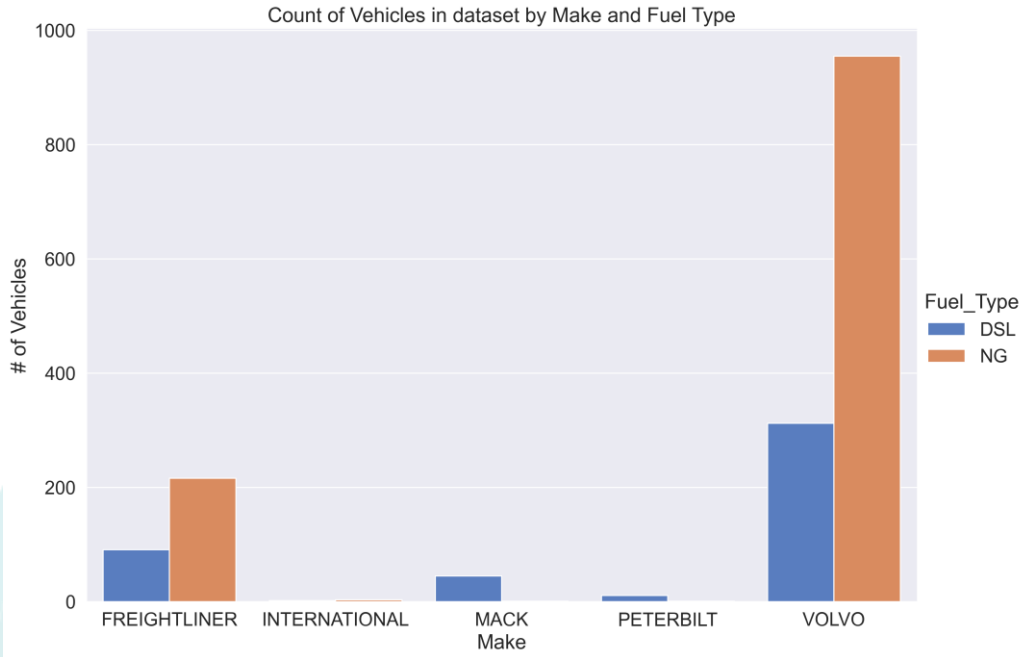
- Database composed of two main data tables and a handful of supporting reference tables.
  - Vehicle table - Contains all vehicle specific attributes
  - Maintenance table – contains individual VMRS code level data.
- Some field definitions:
  - RO_Number: Identifier for individual repair orders; a repair order can have multiple VMRS codes attached to it.
  - RO_Open/Close_Date: Dates when vehicle came into/left the shop.
  - Cost_Category: Labor or Parts
  - VMRS_Code: full 9-digit code to identify the part that needed service.
    - Also broken down into System, Assembly, and Component

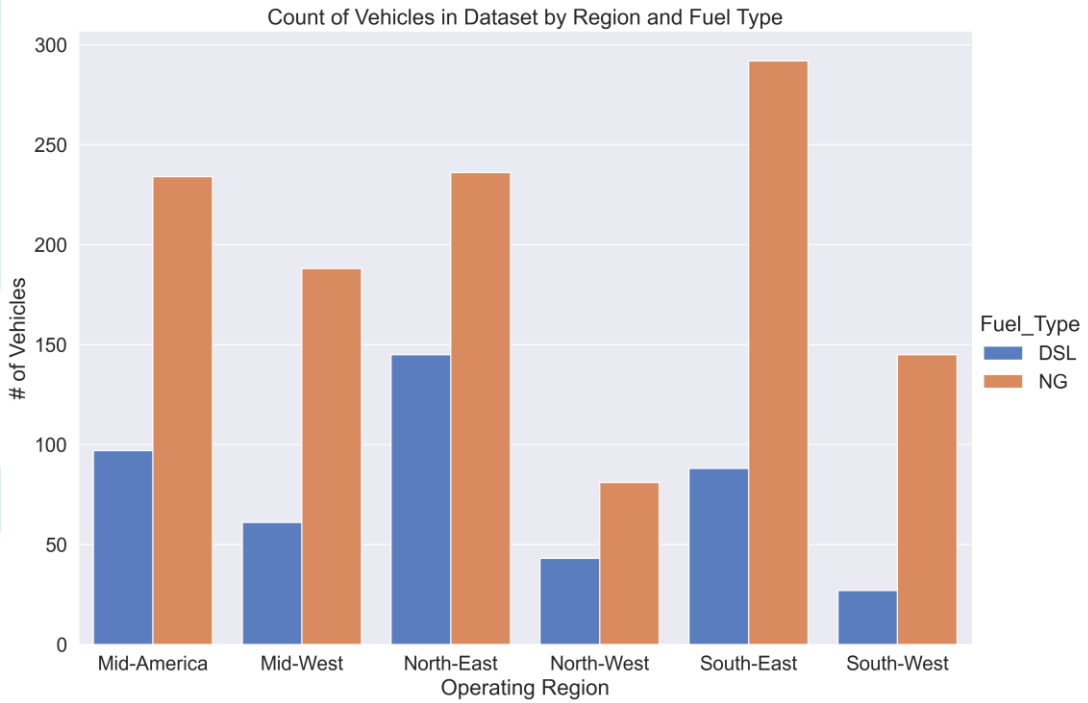
NGV UPTime	
Vehicle Fields	**Maintenance Fields**
Unit_ID	Unit_ID
Fleet_ID	RO_Number
Model_Year	Fleet_ID
Make	Odometer
Model	RO_Open_Date
Purchase_Date	RO_Close_Date
Purchase_Cond	Cost_Category
Engine_Year	VMRS_Code
Engine_Make_Model	VMRS_System_CK_31
Engine_Size_L	VMRS_Assembly_CK_32
Engine_Size_HP	VMRS_Component_CK_33
Fuel_System_provider	RO_Description
Exhaust_Aftertreatment	RO_Duration_days
Application	Cost
Typical_Load_lbs	VMRS_Work_Accomplished_CK_15
Avg_Route_Speed_mph	VMRS_Repair_CK_14
Avg_Terrain	Repair_Reason
Deadhead	Repair_Reason_Type
Fuel_Type	Work_Accomplished_Description
Operating_Regi	VMRS_Failure_Code_CK_18
	Failure_Description
	Labor_Hours
	Error_Flag_ID
	Predicted_Odometer

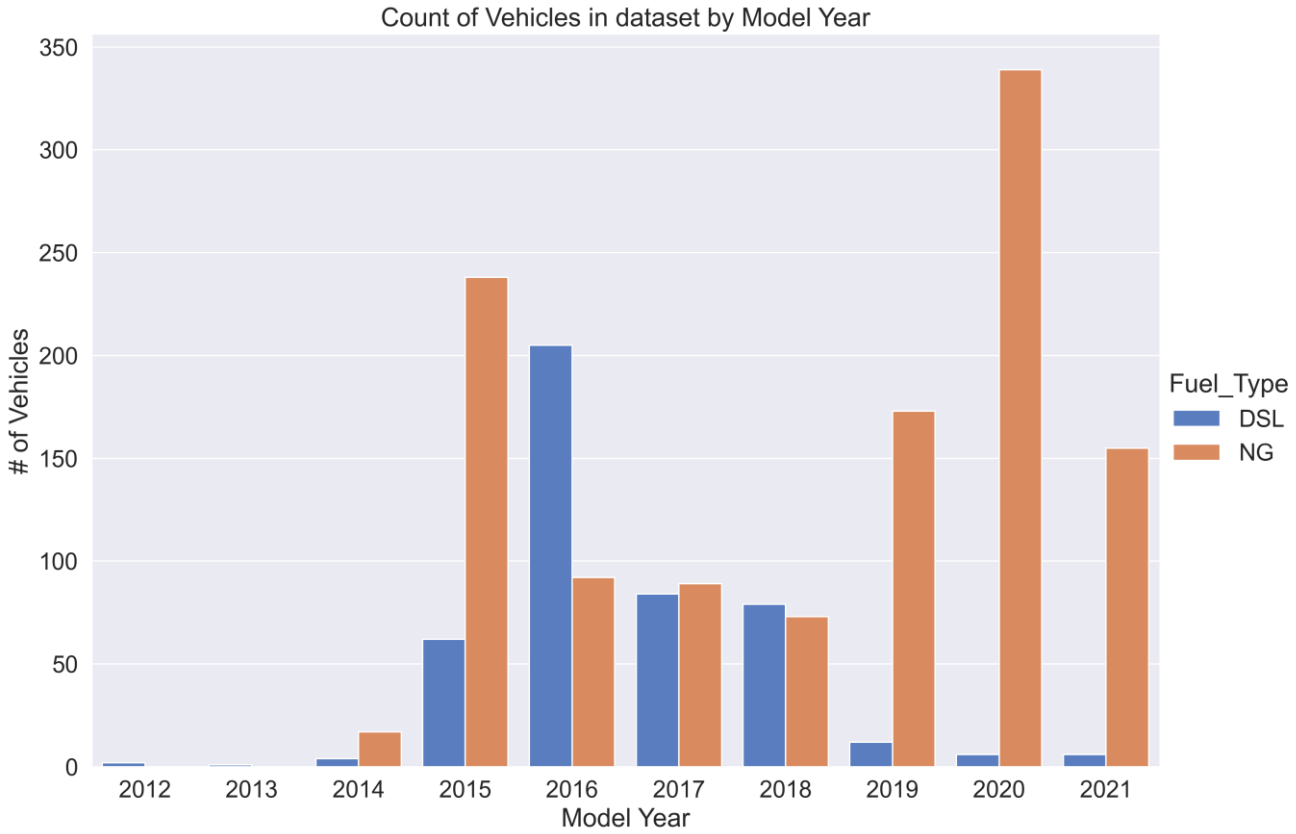
VMRS Codes and Descriptions

- The 9-digit code identifies the specific parts on the vehicles that required maintenance.
  - Code is hierarchical
- Supplementary codes provide additional information on failure reason, repair reason, and the type of work that was performed to correct the issues.

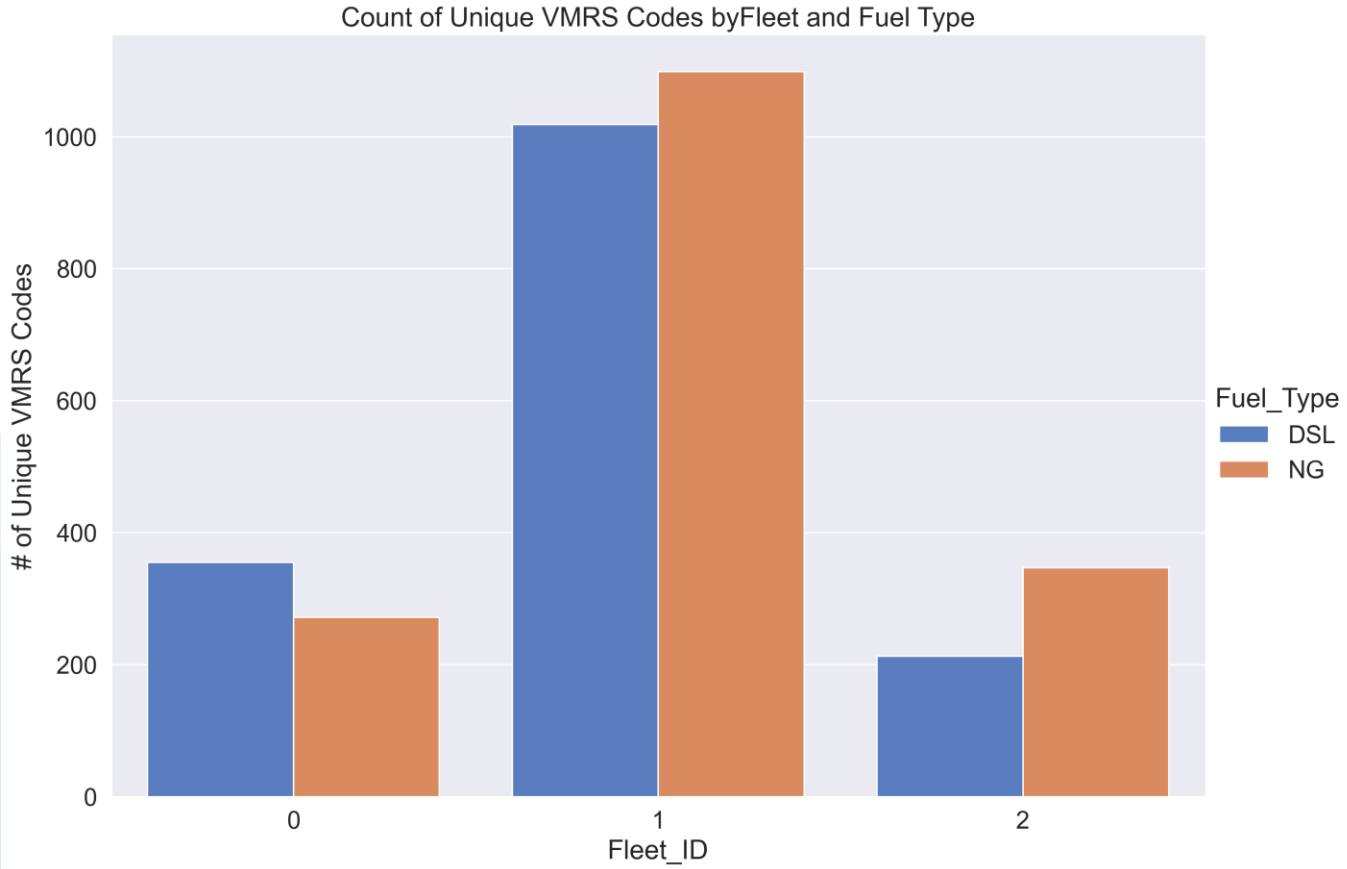
Dataset Profile Visuals

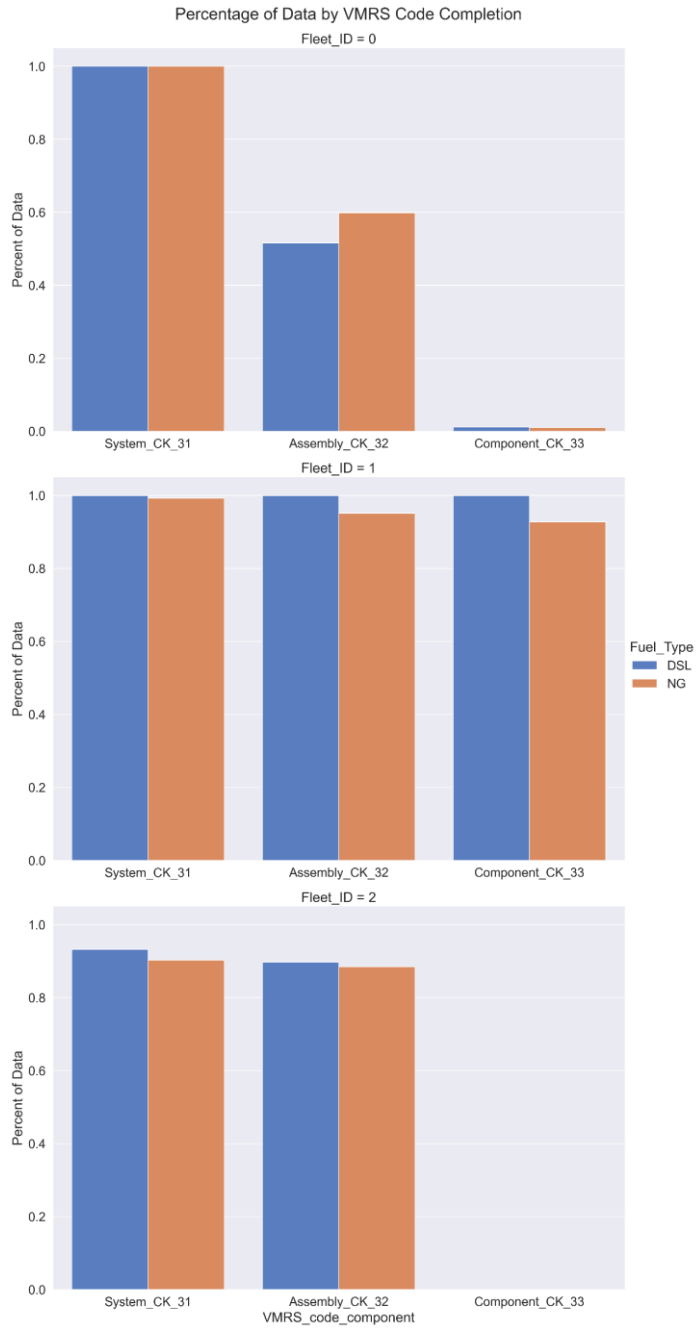






- Fleet 1 has an outsized influence on the demographics of the dataset due to their size.
- Fleet 1 also adopted a more aggressive sustainability initiative and are phasing out their diesel vehicles

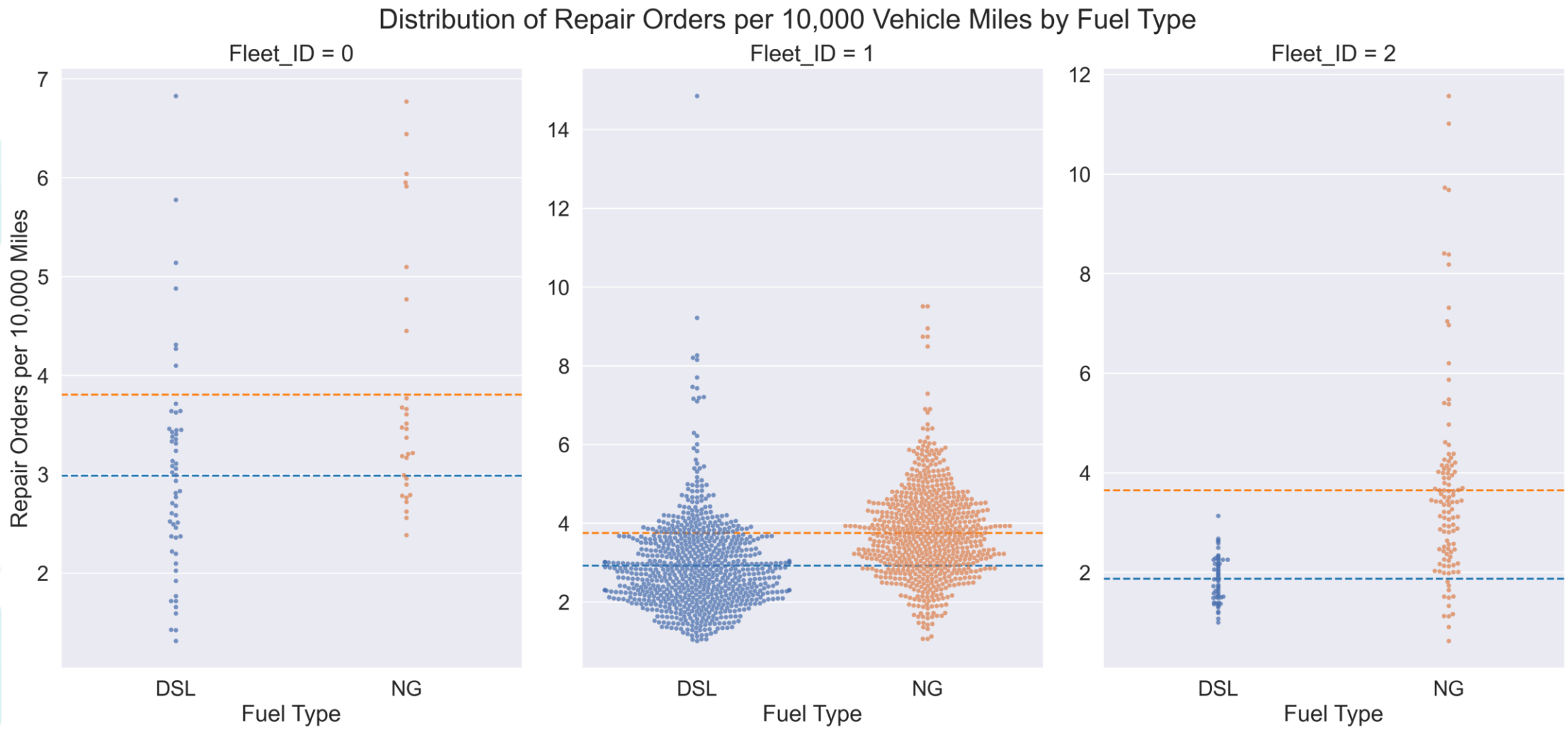


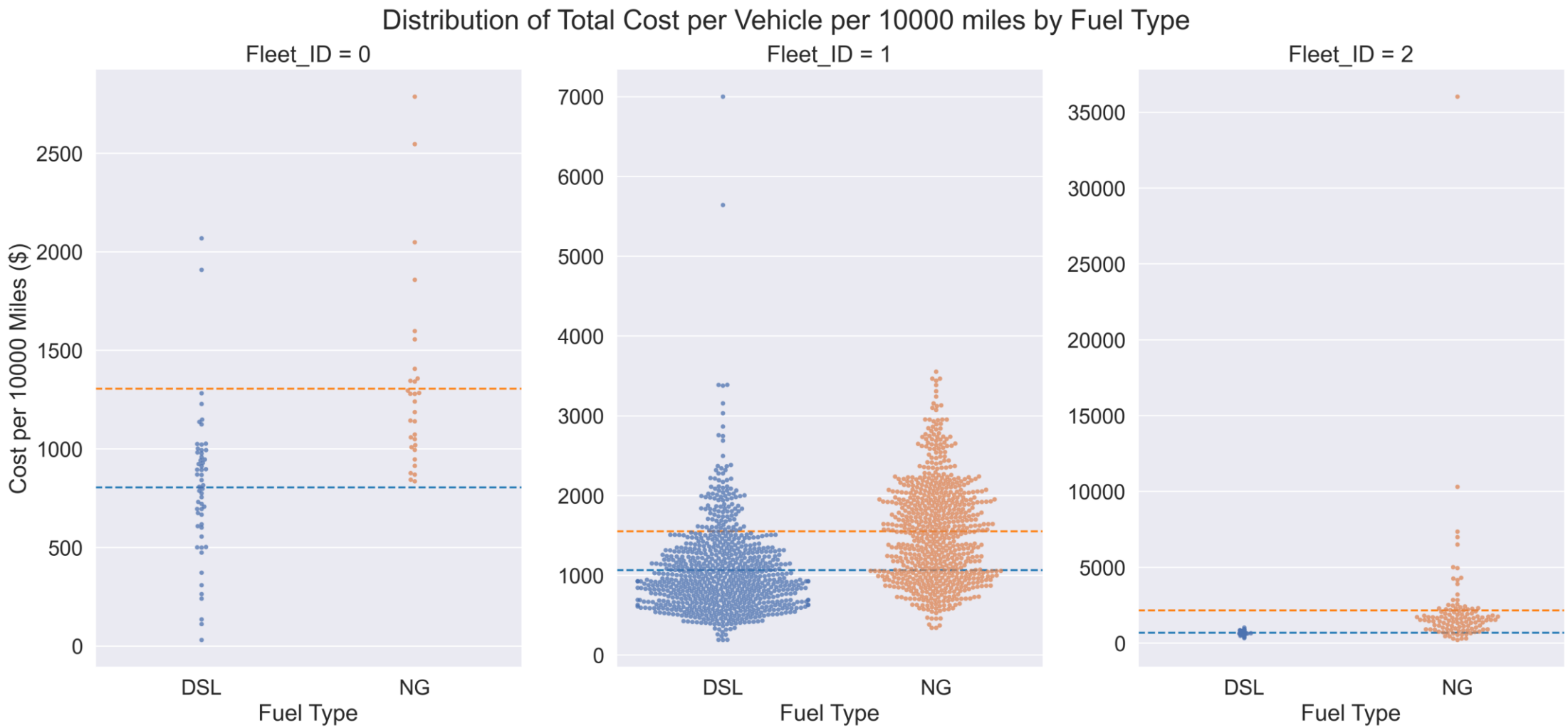


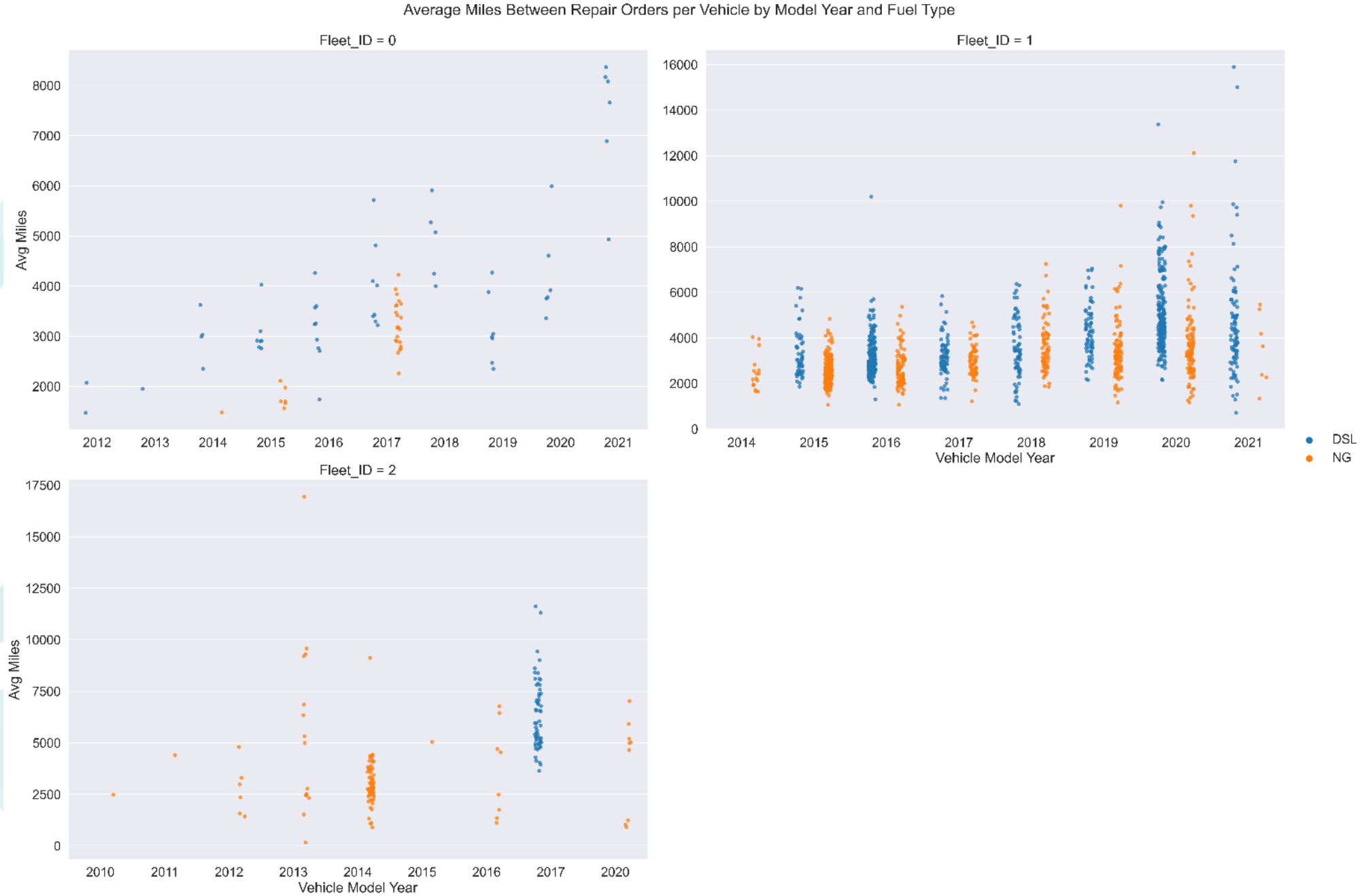
- These visuals are intended to show the thoroughness of the maintenance coding system used by each fleet
- Fleet 1 has the most comprehensive VMRS coding system, followed by Fleet 0 and Fleet 2

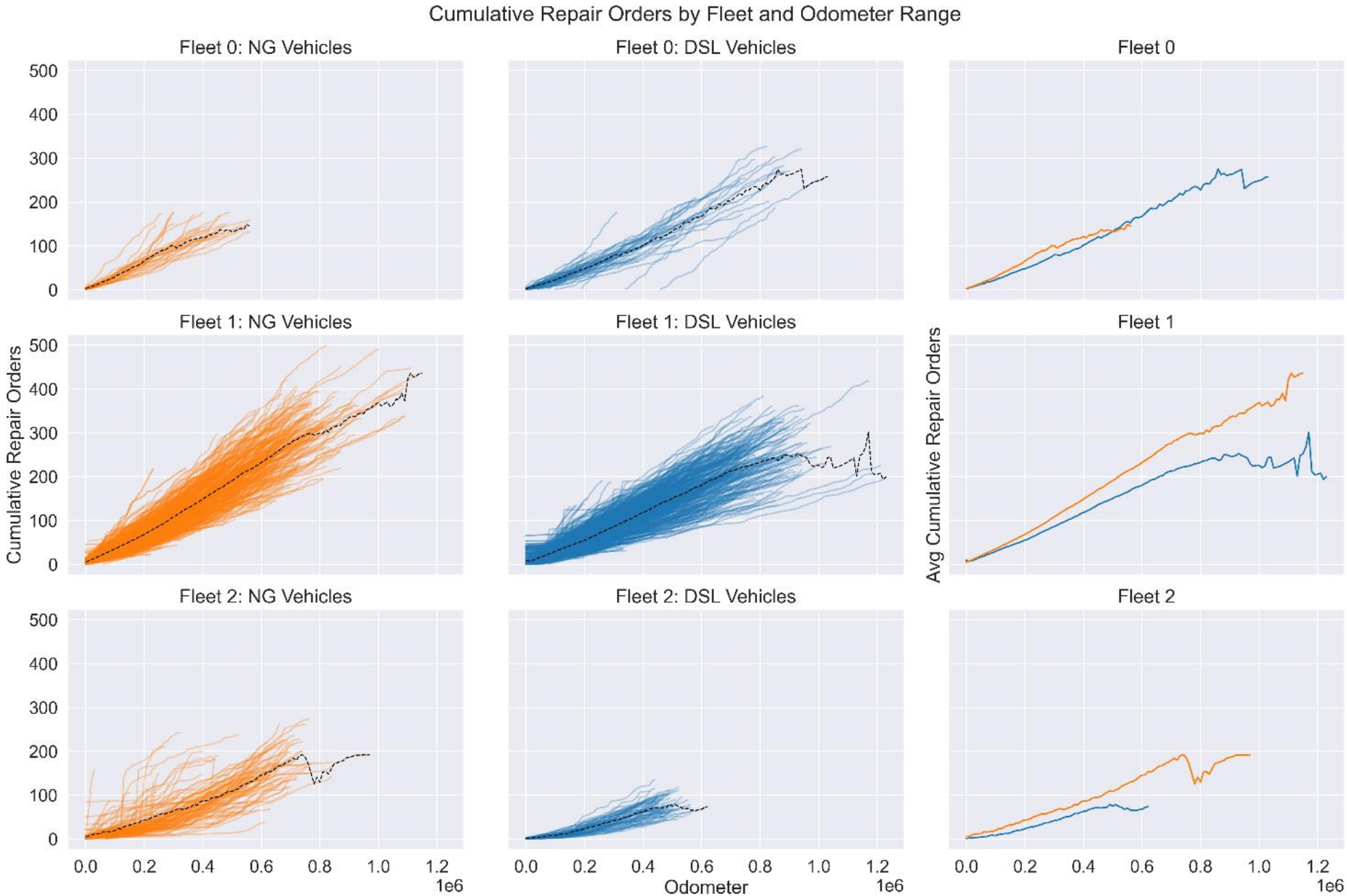
Overall Repair Frequency Visuals

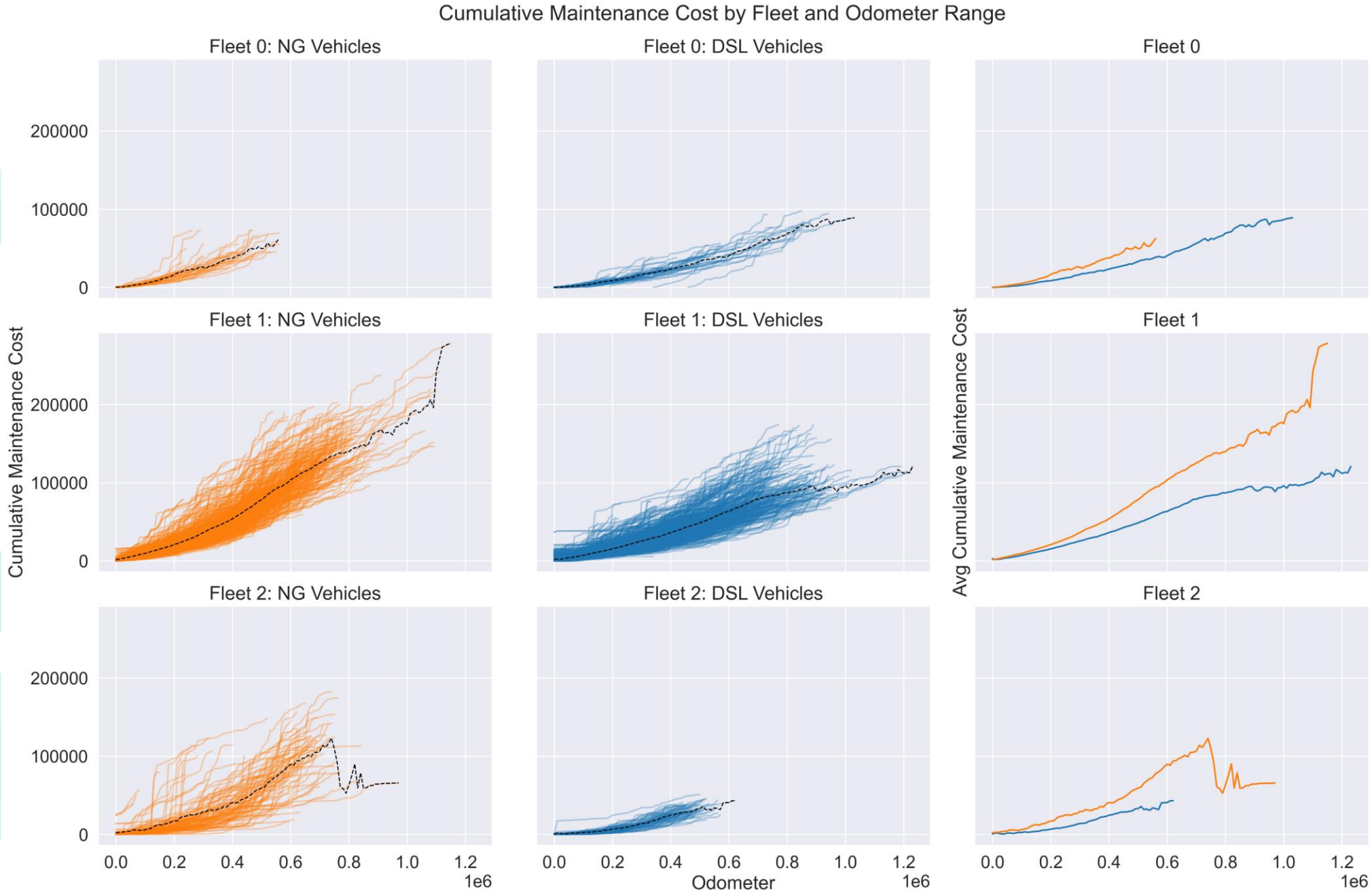
Note: The visuals on the following slides are for all repair orders created including parts/work common to both fuel types


Distribution of Repair Orders per 10,000 Vehicle Miles by Fuel Type
Fleet_ID = 0
Fleet_ID = 1
Fleet_ID = 2
Repair Orders per 10,000 Miles
DSL
NG
Fuel Type


Distribution of Total Cost per Vehicle per 10000 miles by Fuel Type
Fleet_ID = 0
Fleet_ID = 1
Fleet_ID = 2
Cost per 10000 Miles ($)
0
500
1000
1500
2000
2500
3000
4000
5000
6000
7000
10000
15000
20000
25000
30000
35000
DSL
NG
Fuel Type

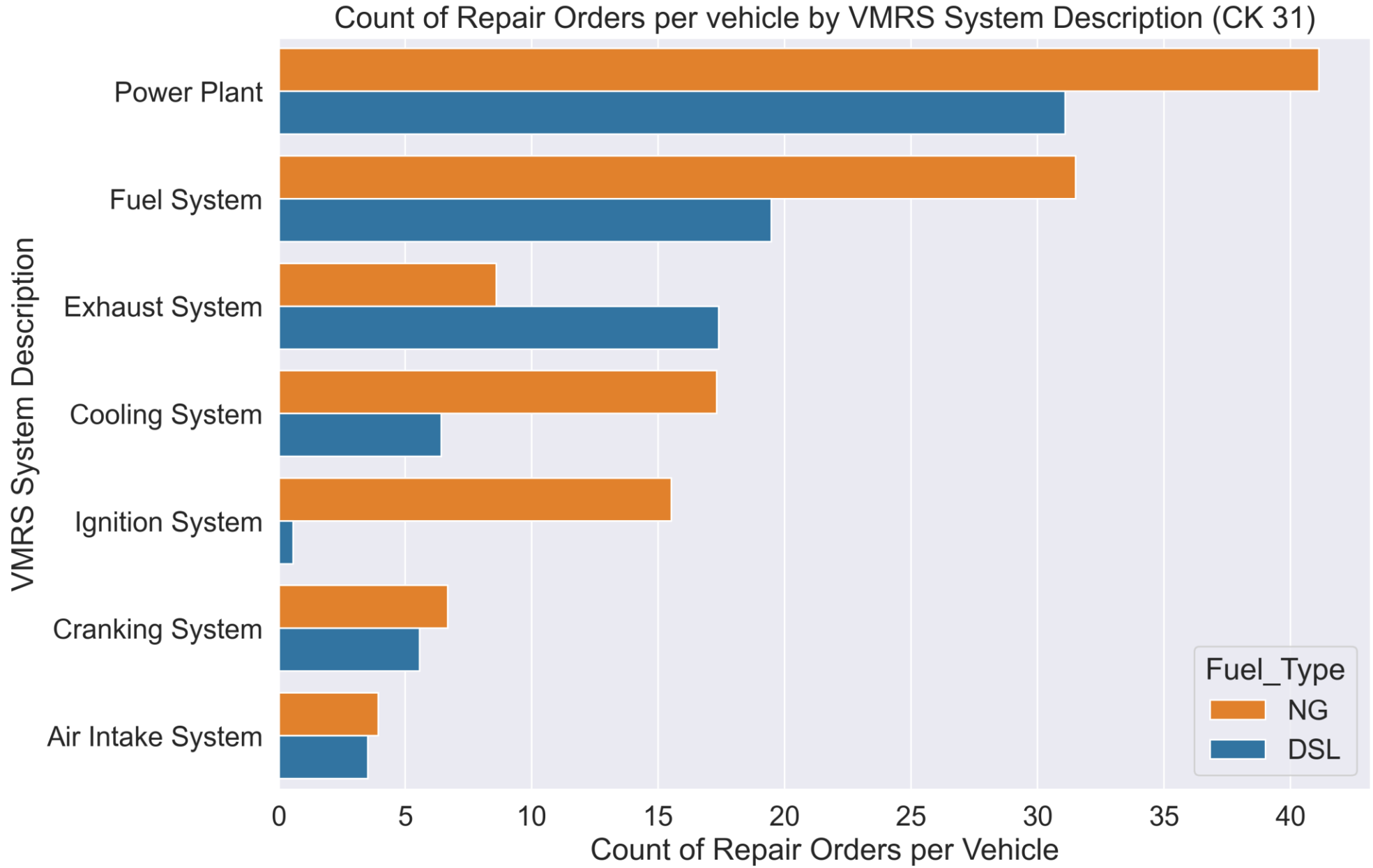

Average Miles Between Repair Orders per Vehicle by Model Year and Fuel Type
Fleet_ID = 0
Fleet_ID = 1
Fleet_ID = 2
Avg Miles
Vehicle Model Year
DSL
NG

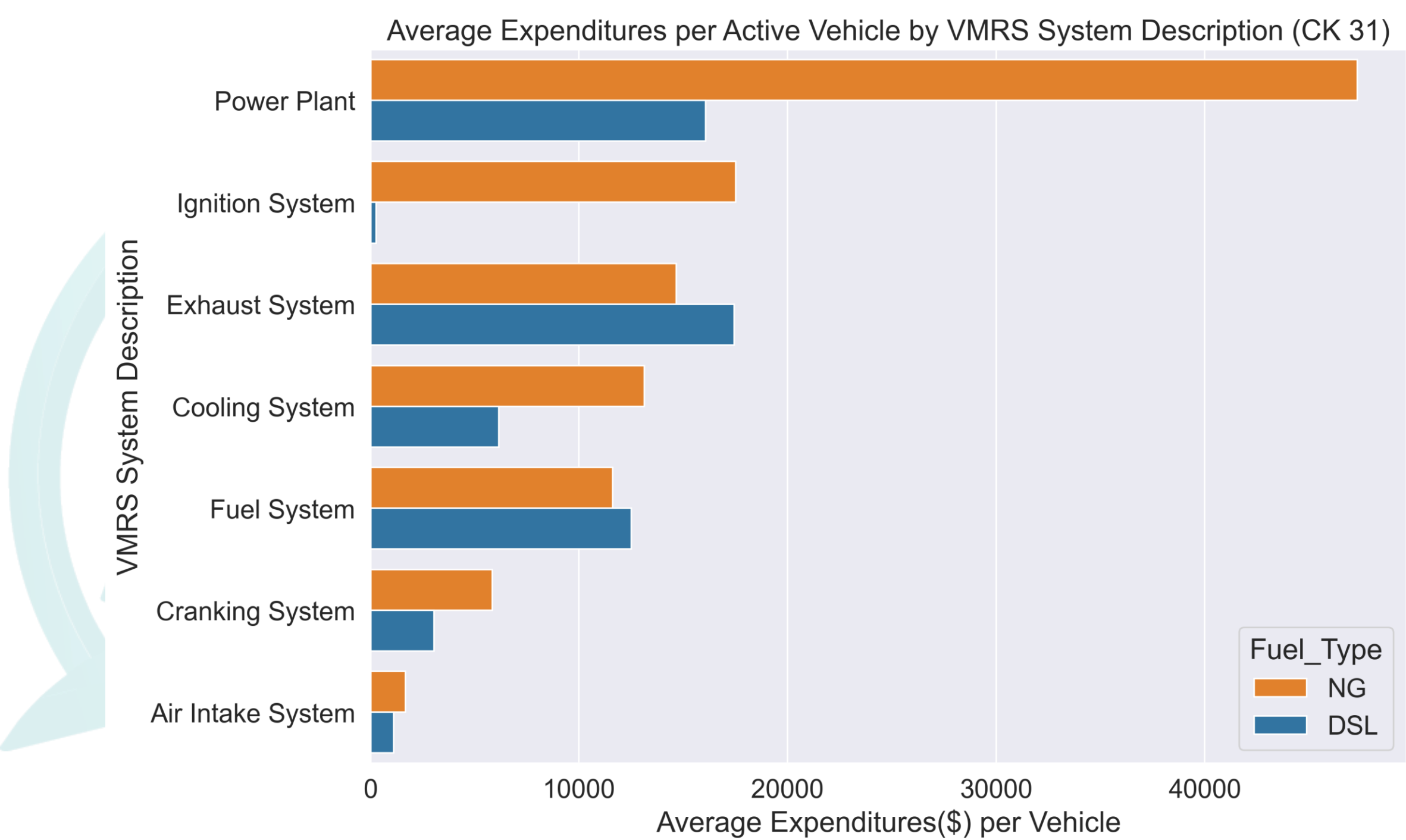

Cumulative Repair Orders by Fleet and Odometer Range
Fleet 0: NG Vehicles
Fleet 0: DSL Vehicles
Fleet 0
Fleet 1: NG Vehicles
Fleet 1: DSL Vehicles
Fleet 1
Fleet 2: NG Vehicles
Fleet 2: DSL Vehicles
Fleet 2
Cumulative Repair Orders
Avg Cumulative Repair Orders
Odometer
0
100
200
300
400
500
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1e6


Cumulative Maintenance Cost by Fleet and Odometer Range
Fleet 0: NG Vehicles
Fleet 0: DSL Vehicles
Fleet 0
Fleet 1: NG Vehicles
Fleet 1: DSL Vehicles
Fleet 1
Fleet 2: NG Vehicles
Fleet 2: DSL Vehicles
Fleet 2
Cumulative Maintenance Cost
Avg Cumulative Maintenance Cost
0
100000
200000
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1e6
Odometer

Component Level Repair Frequency and Cost Visuals

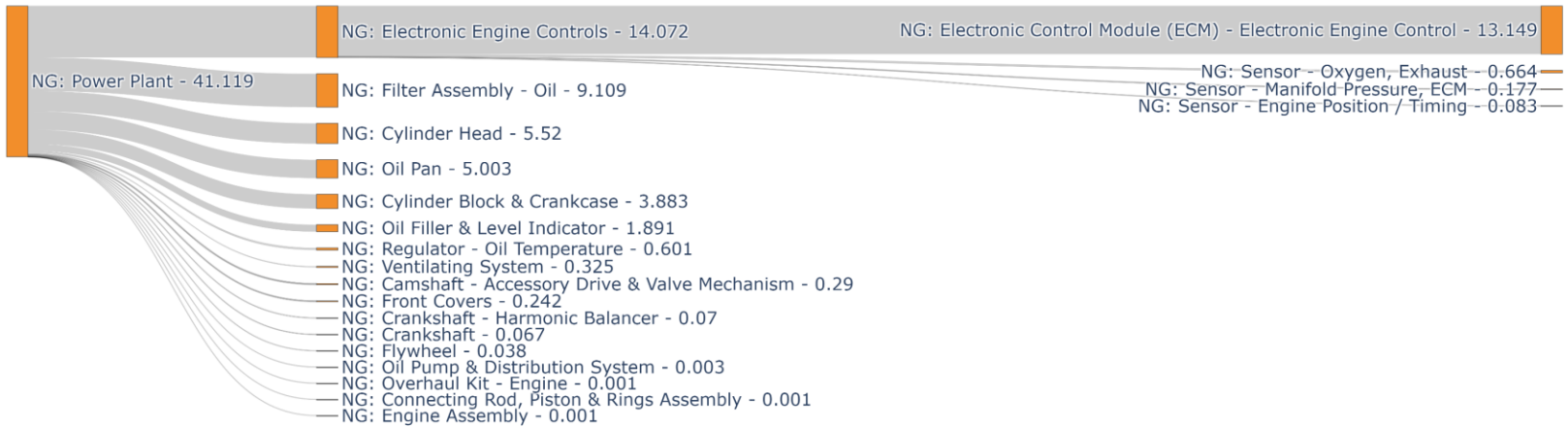
Note: The visuals below only include vehicle systems that could be impacted by fuel type


Count of Repair Orders per vehicle by VMRS System Description (CK 31)
VMRS System Description
Power Plant
Fuel System
Exhaust System
Cooling System
Ignition System
Cranking System
Air Intake System
0
5
10
15
20
25
30
35
40
Count of Repair Orders per Vehicle
Fuel_Type
NG
DSL

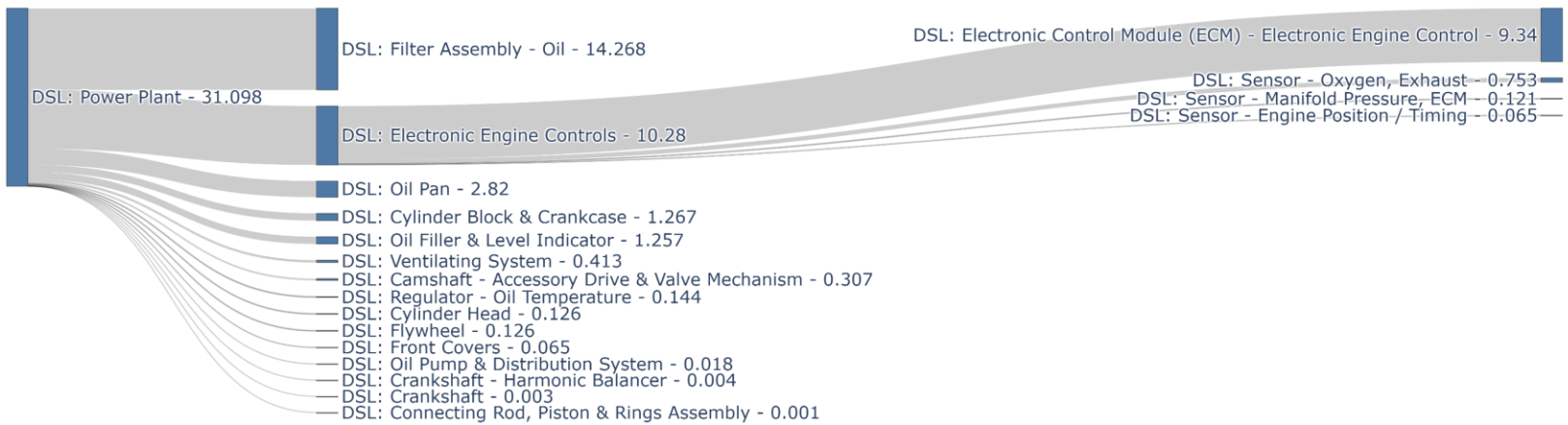

Average Expenditures per Active Vehicle by VMRS System Description (CK 31)
VMRS System Description
Power Plant
Ignition System
Exhaust System
Cooling System
Fuel System
Cranking System
Air Intake System
0
10000
20000
30000
40000
Average Expenditures($) per Vehicle
Fuel_Type
NG
DSL

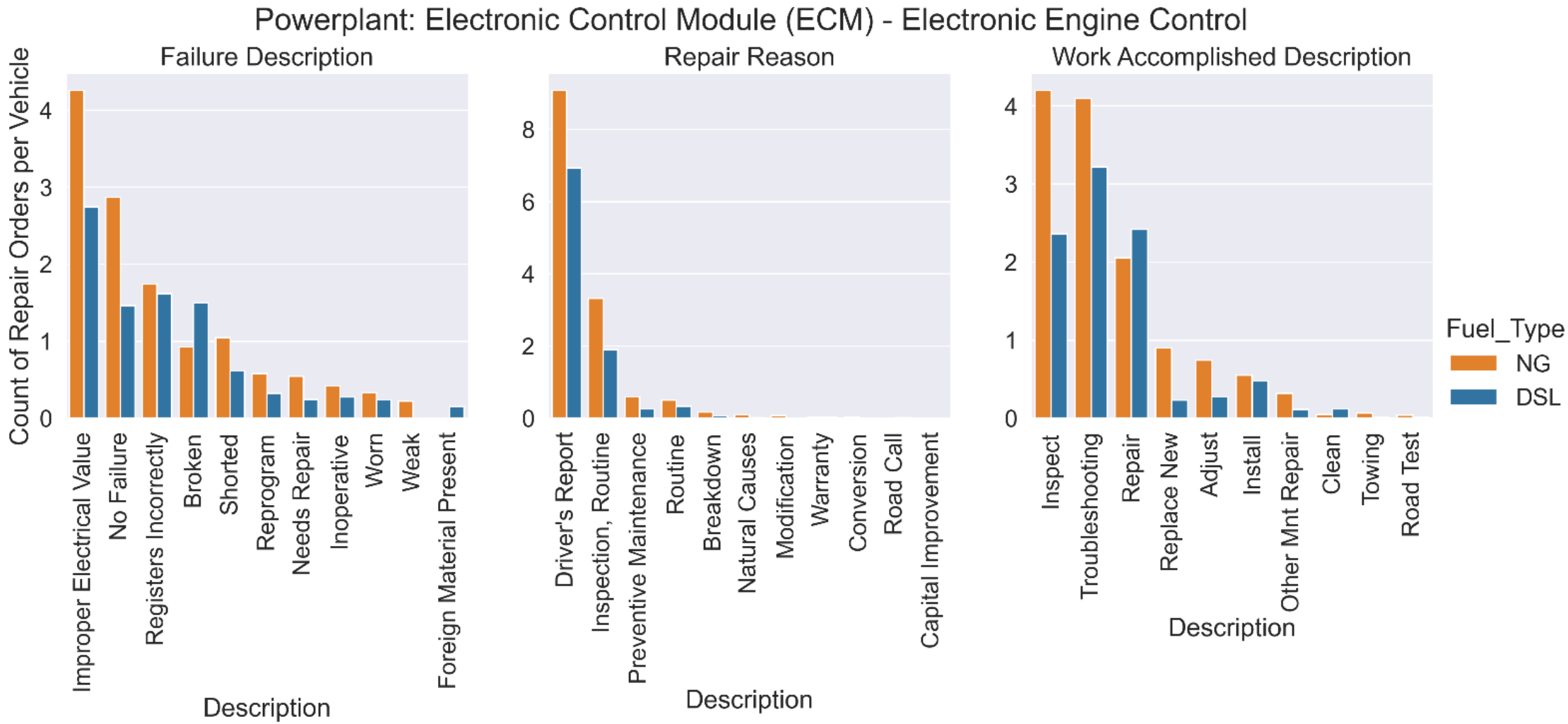
Powerplant

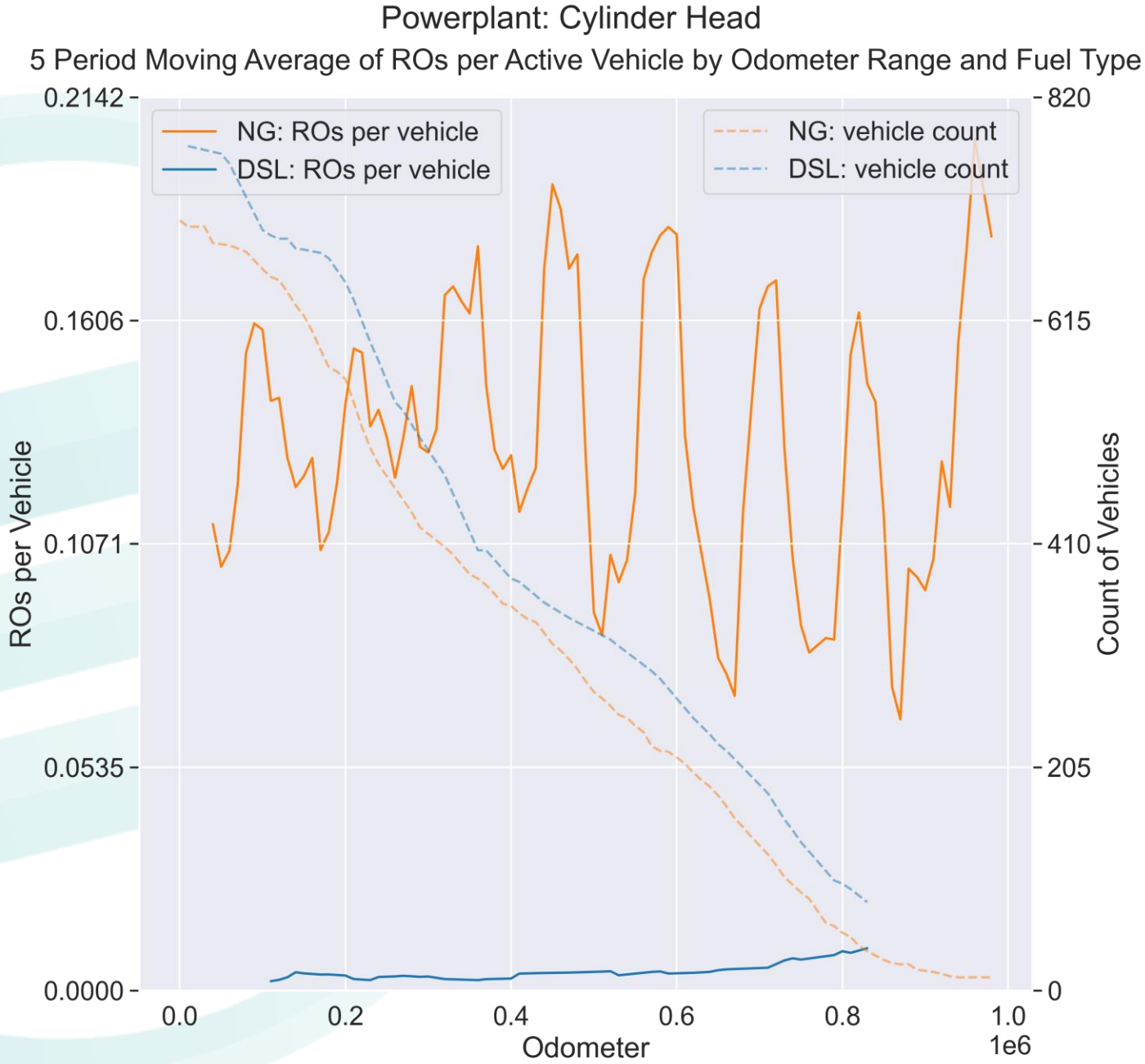
NG - Power Plant: Count of Repair Orders per Vehicle



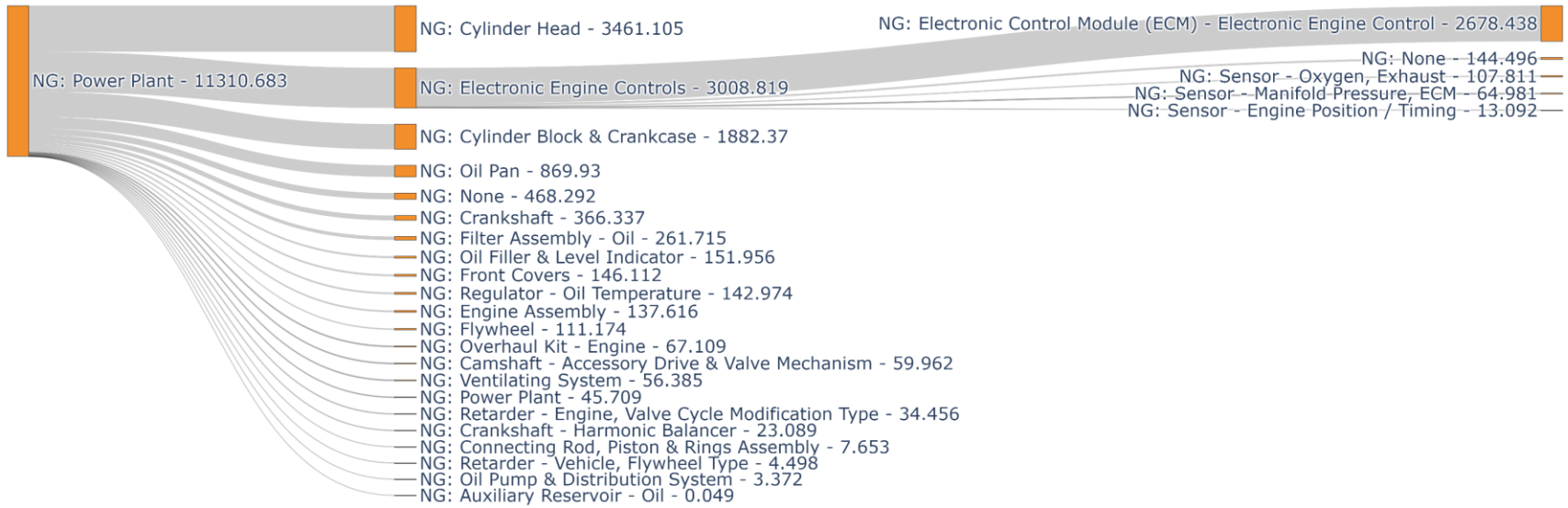
DSL - Power Plant: Count of Repair Orders per Vehicle



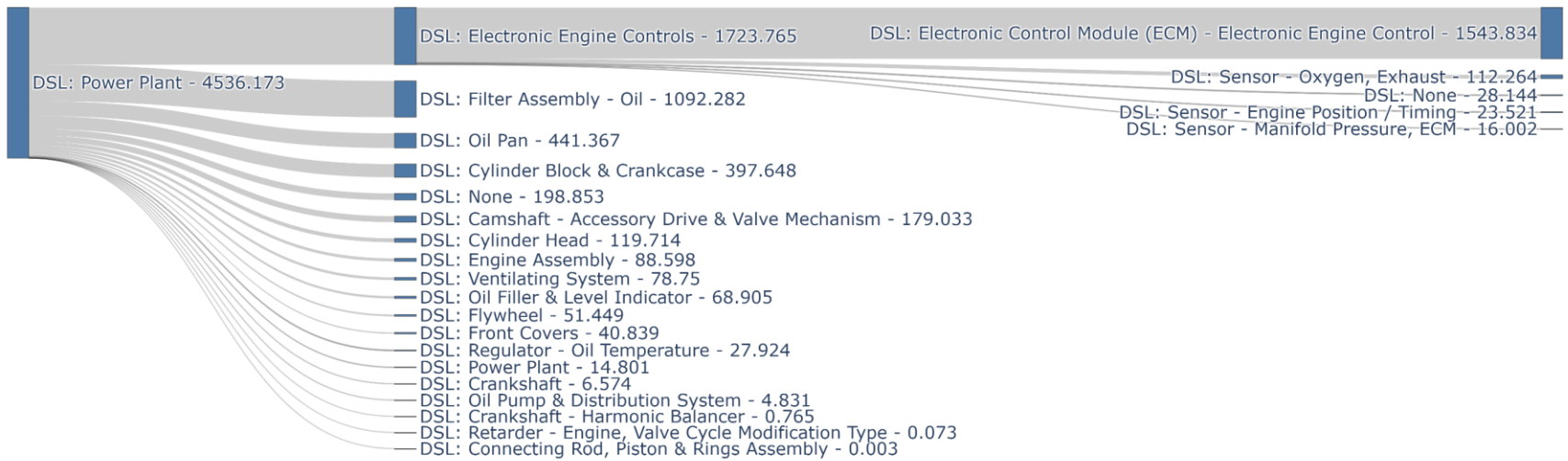

Powerplant: Electronic Control Module (ECM) - Electronic Engine Control
Failure Description
Repair Reason
Work Accomplished Description
Count of Repair Orders per Vehicle
0
1
2
3
4
6
8
Improper Electrical Value
No Failure
Registers Incorrectly
Broken
Shorted
Reprogram
Needs Repair
Inoperative
Worn
Weak
Foreign Material Present
Driver's Report
Inspection, Routine
Preventive Maintenance
Routine
Breakdown
Natural Causes
Modification
Warranty
Conversion
Road Call
Capital Improvement
Inspect
Troubleshooting
Repair
Replace New
Adjust
Install
Other Mnt Repair
Clean
Towing
Road Test
Description
Description
Fuel_Type
NG
DSL


Powerplant: Cylinder Head
5 Period Moving Average of ROs per Active Vehicle by Odometer Range and Fuel Type
NG: ROs per vehicle
DSL: ROs per vehicle
NG: vehicle count
DSL: vehicle count
ROs per Vehicle
Count of Vehicles
0.2142
0.1606
0.1071
0.0535
0.0000
820
615
410
205
0
0.0
0.2
0.4
0.6
0.8
1.0
1e6
Odometer

NG - Power Plant: Maintenance Expenditures per Vehicle

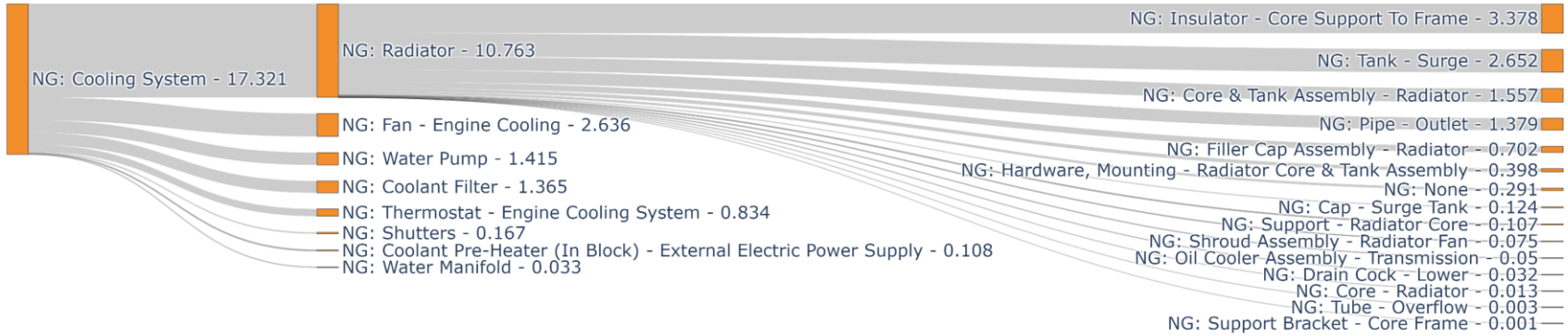


DSL - Power Plant: Maintenance Expenditures per Vehicle

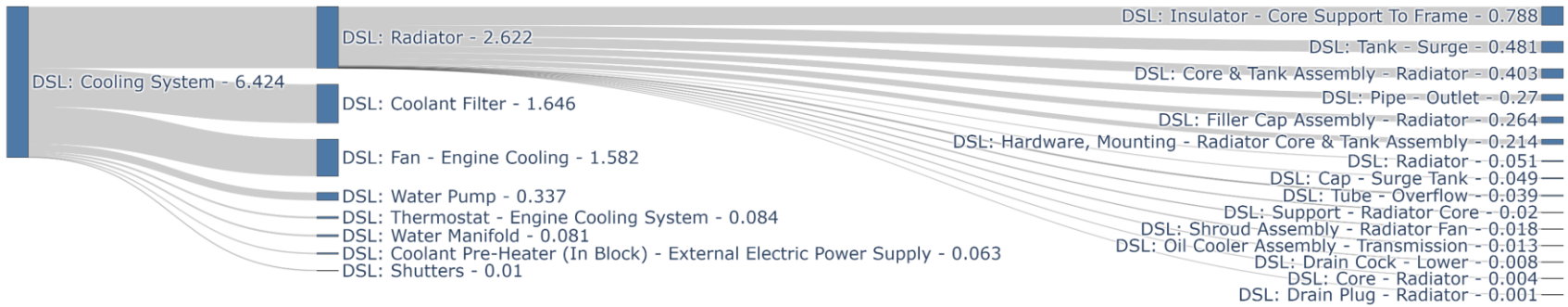


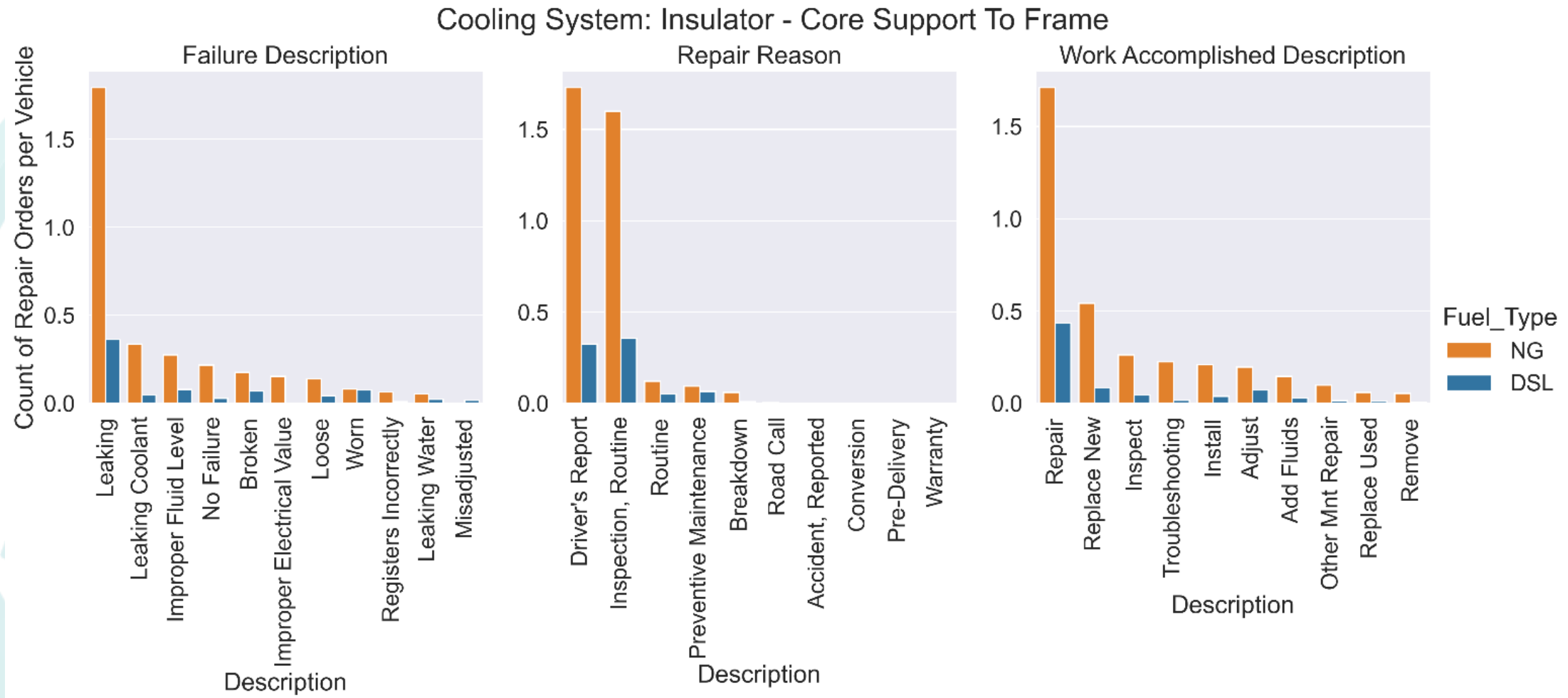
Cooling System

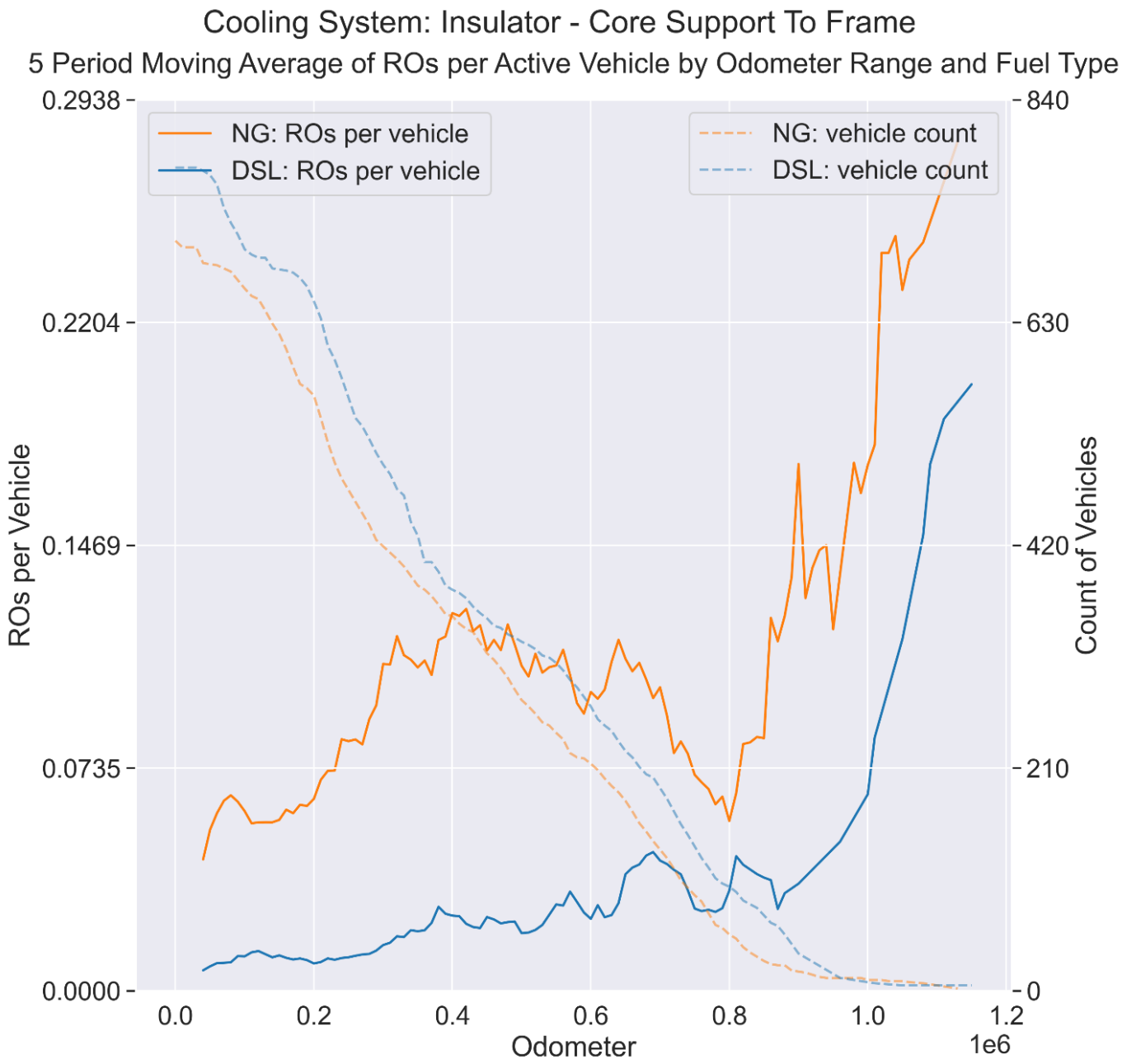
NG - Cooling System: Count of Repair Orders per Vehicle

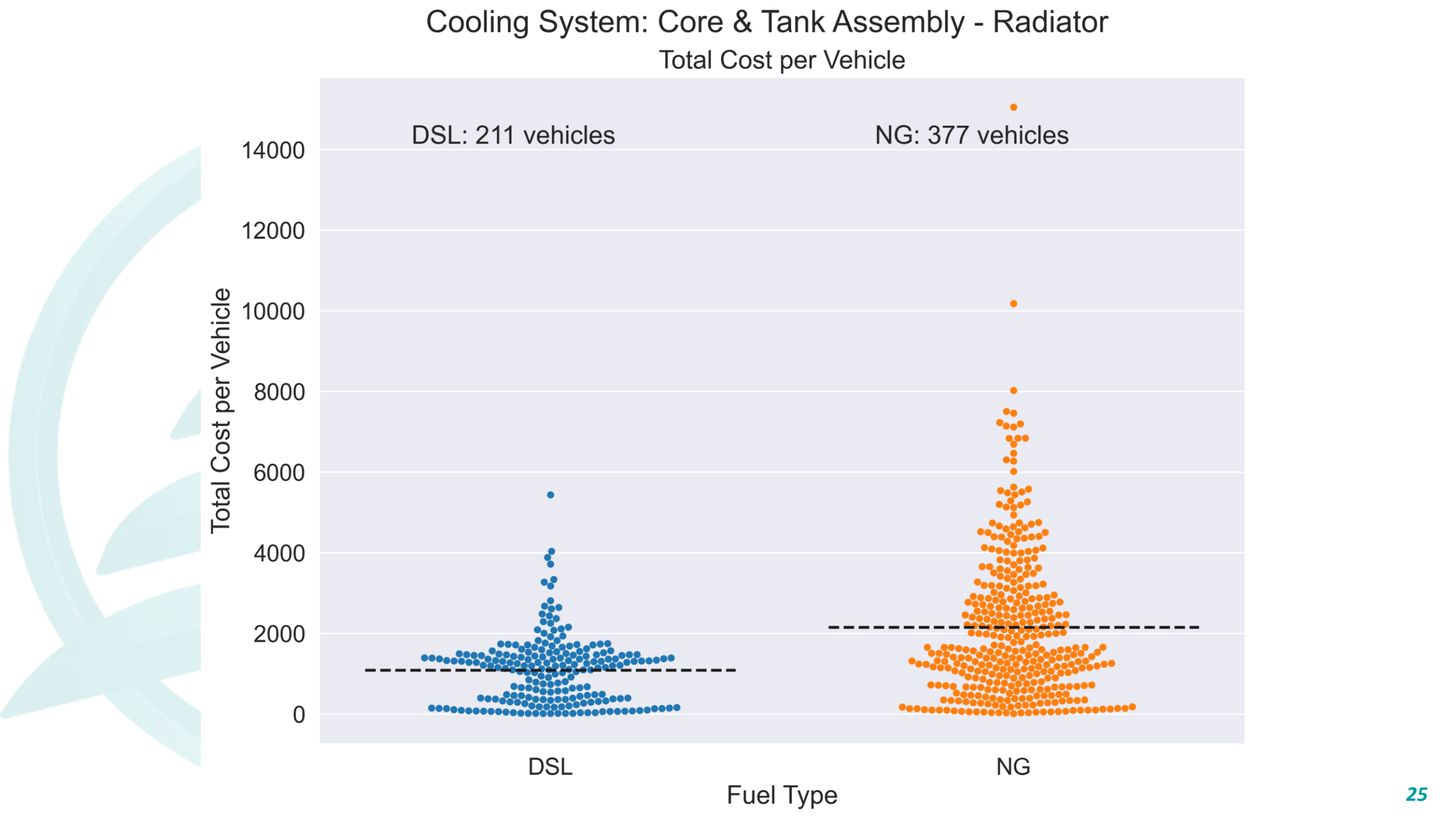


DSL - Cooling System: Count of Repair Orders per Vehicle



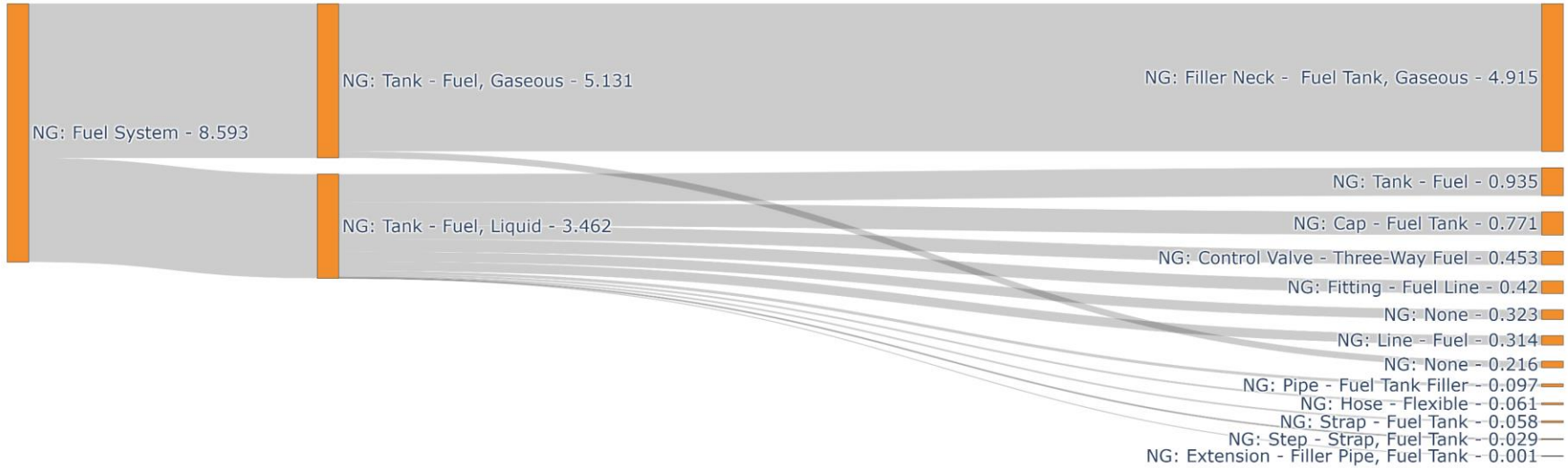

Cooling System: Insulator - Core Support To Frame
Failure Description
Repair Reason
Work Accomplished Description
Count of Repair Orders per Vehicle
0.0
0.5
1.0
1.5
Leaking
Leaking Coolant
Improper Fluid Level
No Failure
Broken
Improper Electrical Value
Loose
Worn
Registers Incorrectly
Leaking Water
Misadjusted
Description
Driver's Report
Inspection, Routine
Routine
Preventive Maintenance
Breakdown
Road Call
Accident, Reported
Conversion
Pre-Delivery
Warranty
Description
Repair
Replace New
Inspect
Troubleshooting
Install
Adjust
Add Fluids
Other Mnt Repair
Replace Used
Remove
Description
Fuel_Type
NG
DSL


Cooling System: Insulator - Core Support To Frame
5 Period Moving Average of ROs per Active Vehicle by Odometer Range and Fuel Type
NG: ROs per vehicle
DSL: ROs per vehicle
NG: vehicle count
DSL: vehicle count
ROs per Vehicle
Count of Vehicles
0.2938
0.2204
0.1469
0.0735
0.0000
840
630
420
210
0
0.0
0.2
0.4
0.6
0.8
1.0
1.2
Odometer
1e6

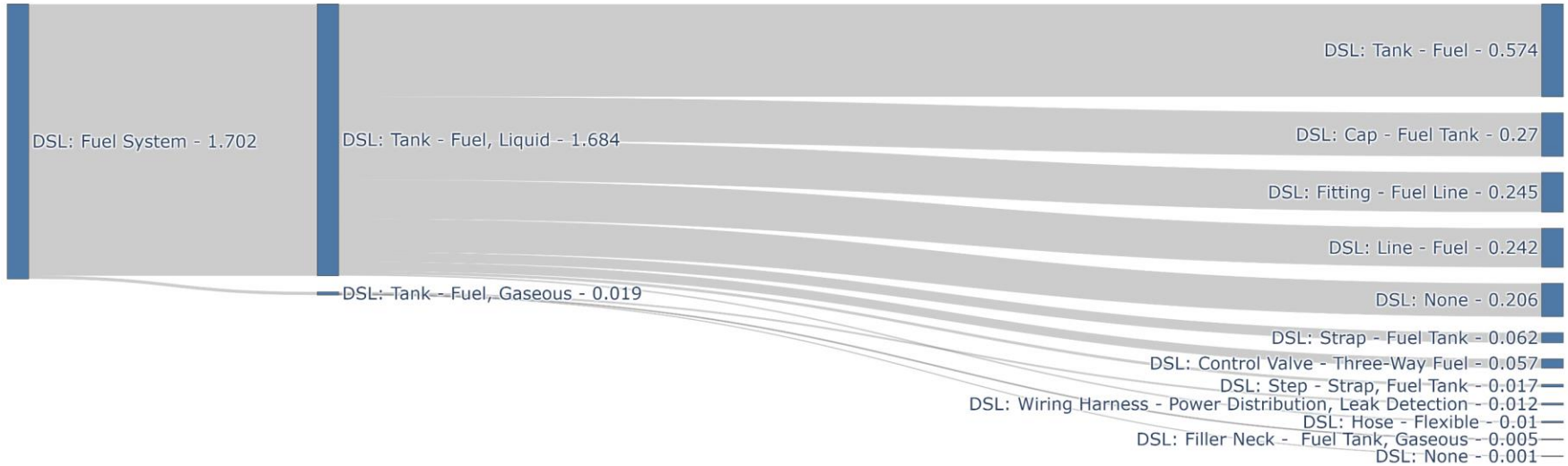

Cooling System: Core & Tank Assembly - Radiator
Total Cost per Vehicle
DSL: 211 vehicles
NG: 377 vehicles
14000
12000
10000
8000
6000
4000
2000
0
Total Cost per Vehicle
DSL
NG
Fuel Type

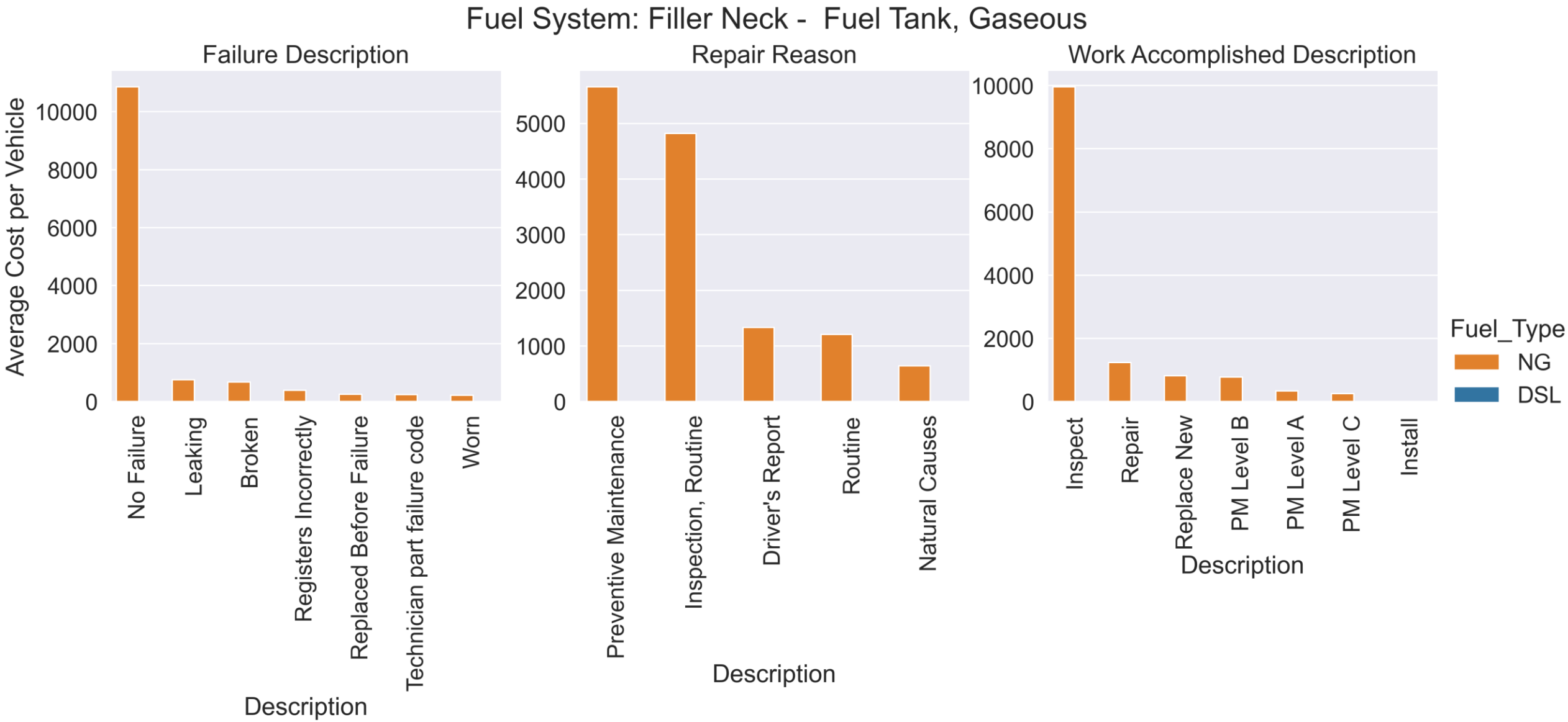
Fuel System

NG - Fuel System: Count of Repair Orders per Vehicle



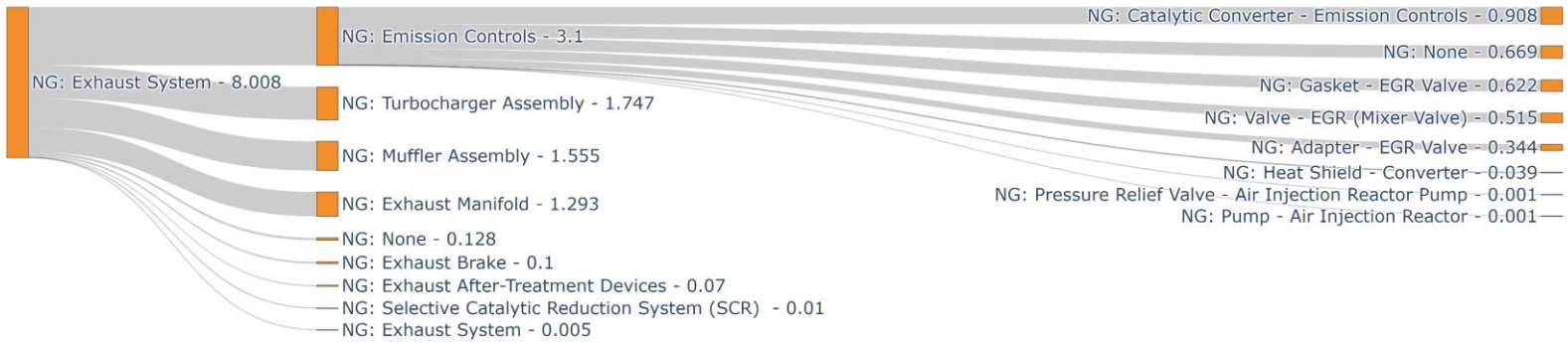
DSL - Fuel System: Count of Repair Orders per Vehicle



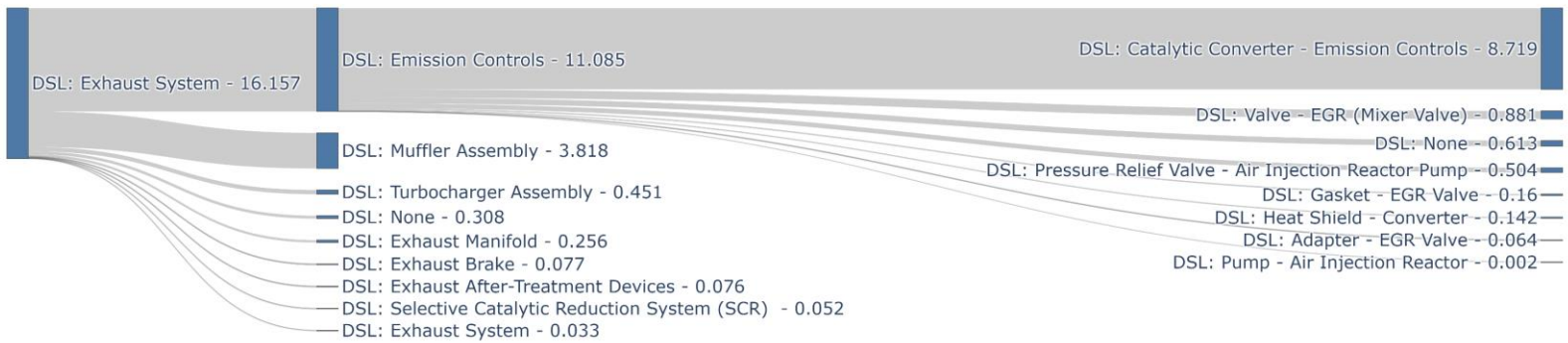

Fuel System: Filler Neck - Fuel Tank, Gaseous
Failure Description
Repair Reason
Work Accomplished Description
Average Cost per Vehicle
0
2000
4000
6000
8000
10000
1000
3000
5000
No Failure
Leaking
Broken
Registers Incorrectly
Replaced Before Failure
Technician part failure code
Worn
Preventive Maintenance
Inspection, Routine
Driver's Report
Routine
Natural Causes
Inspect
Repair
Replace New
PM Level B
PM Level A
PM Level C
Install
Description
Fuel_Type
NG
DSL

Exhaust System

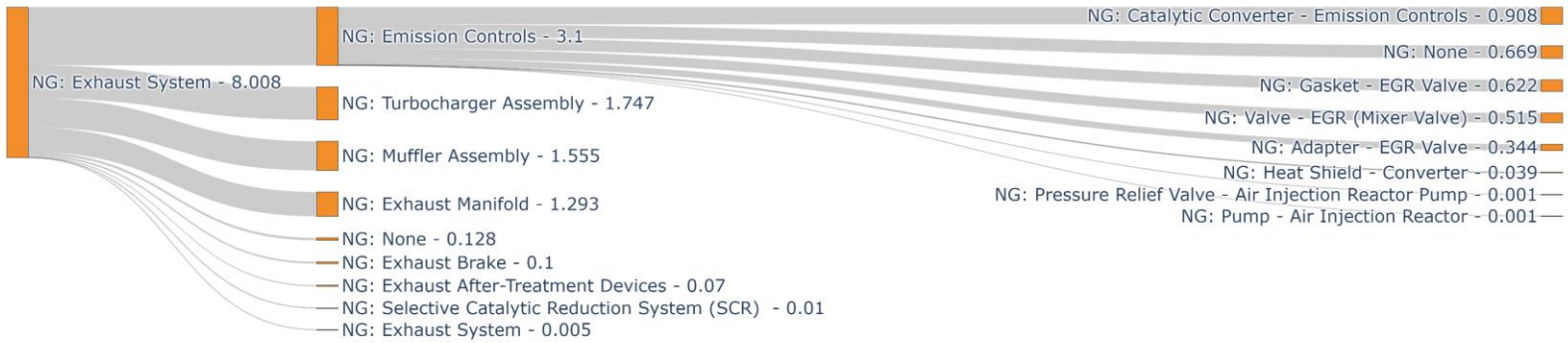
NG - Exhaust System: Count of Repair Orders for top VMRS Assembly Codes



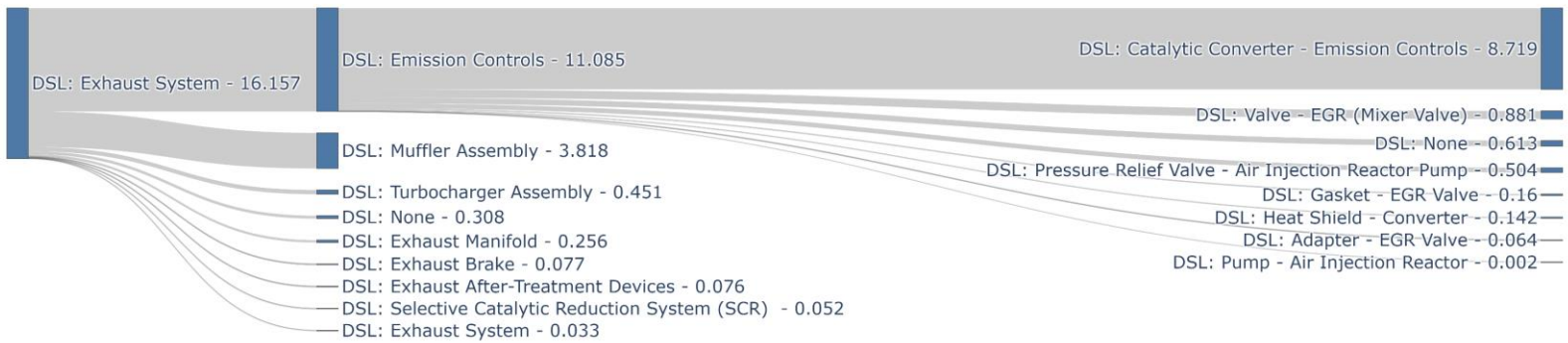
DSL - Exhaust System: Count of Repair Orders for top VMRS Assembly Codes

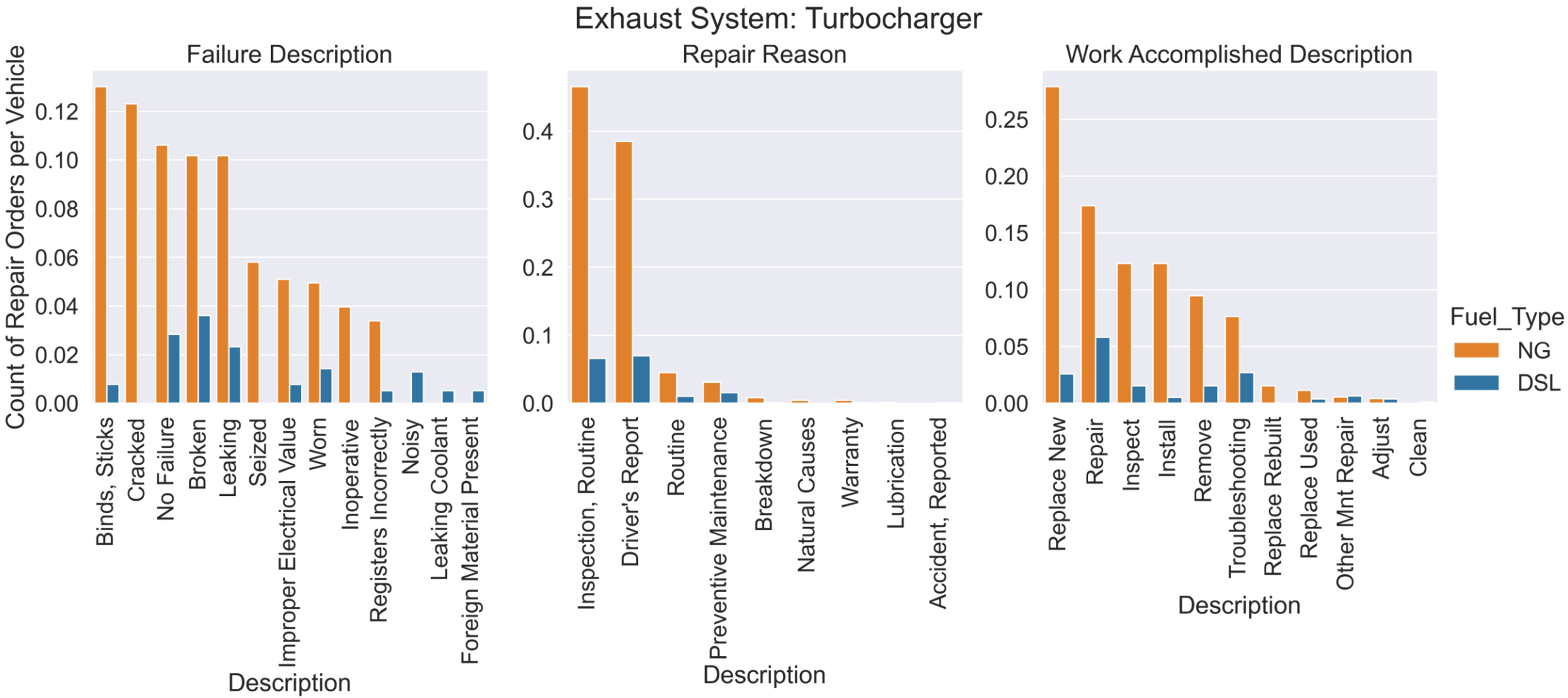


NG - Exhaust System: Count of Repair Orders for top VMRS Assembly Codes

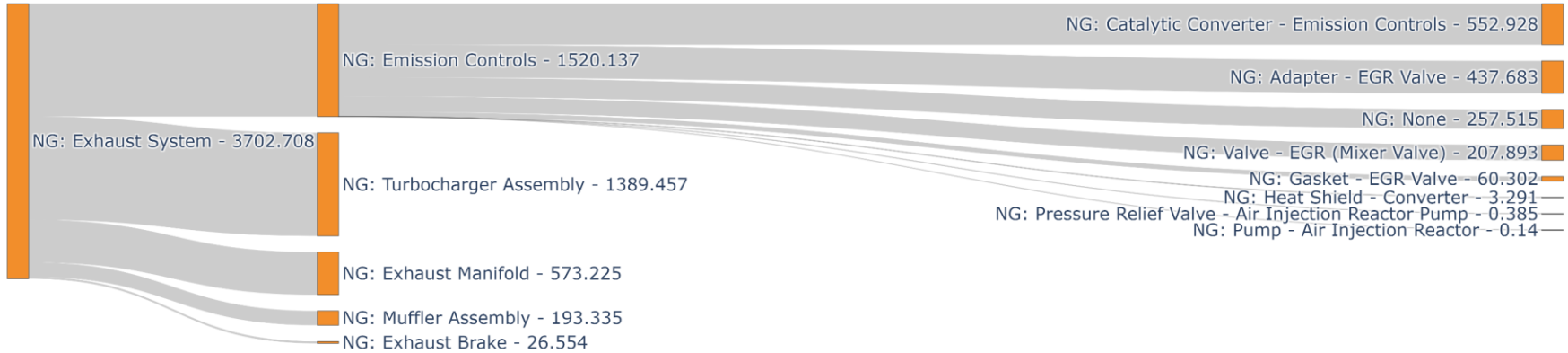


DSL - Exhaust System: Count of Repair Orders for top VMRS Assembly Codes

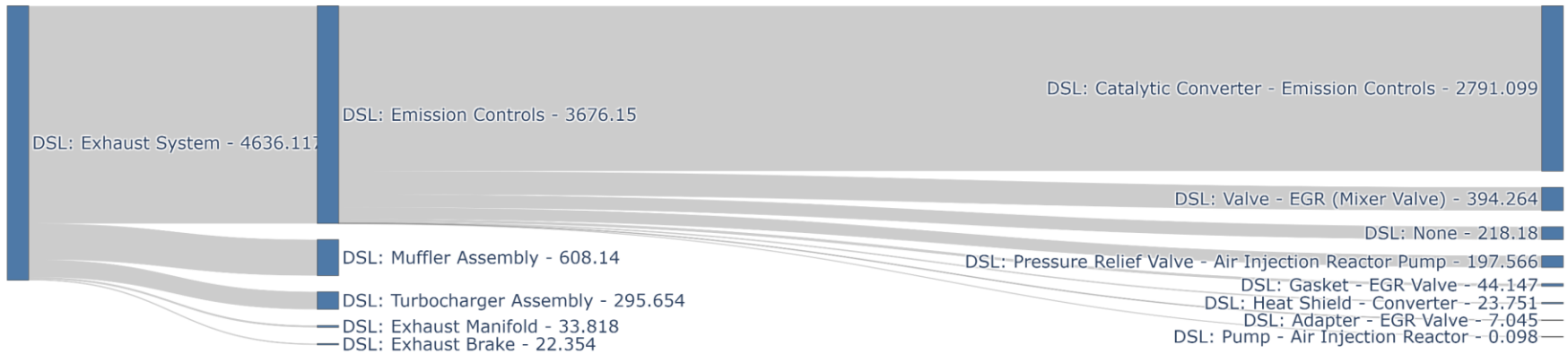


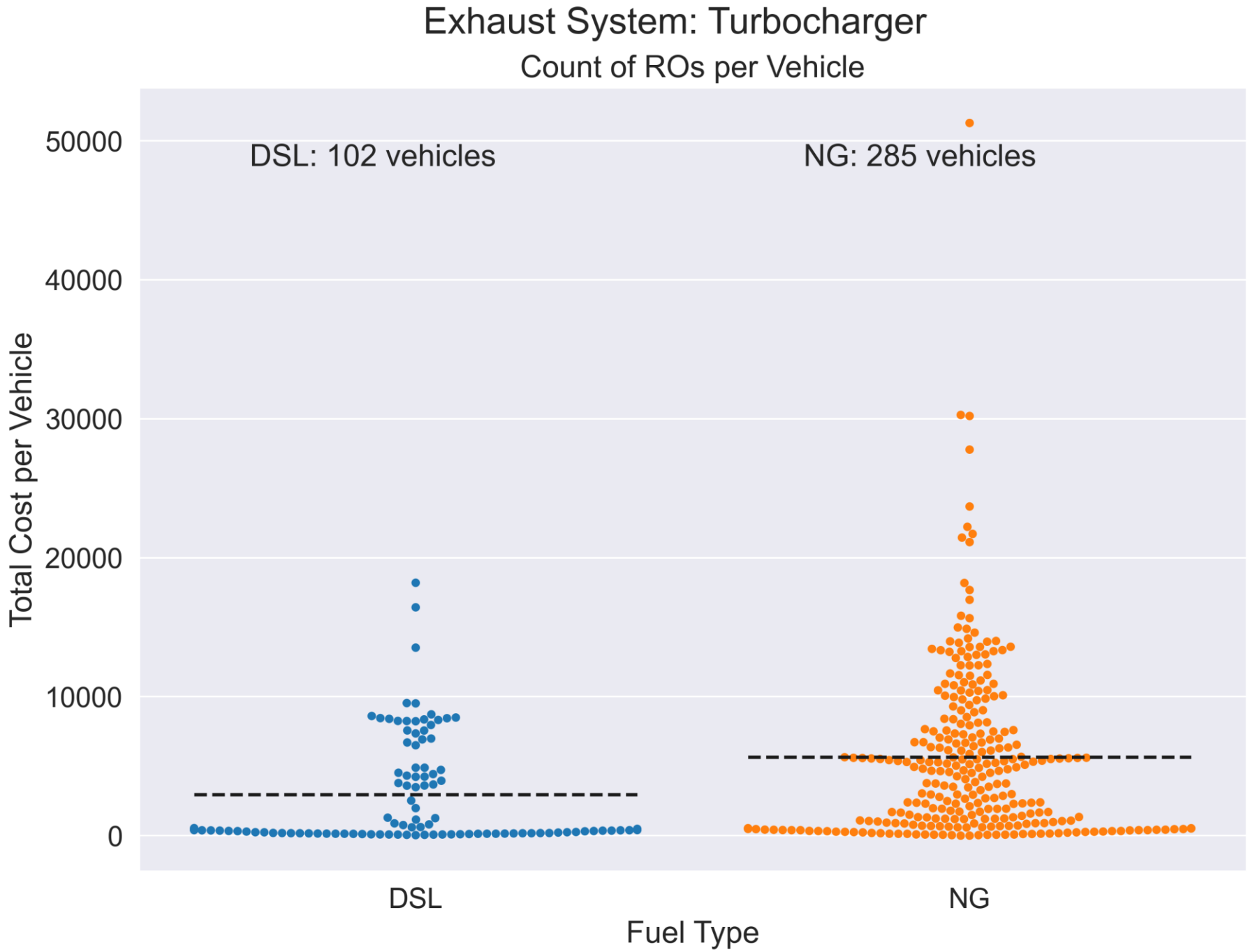

Exhaust System: Turbocharger
Failure Description
Repair Reason
Work Accomplished Description
Count of Repair Orders per Vehicle
0.00
0.02
0.04
0.06
0.08
0.10
0.12
Binds, Sticks
Cracked
No Failure
Broken
Leaking
Seized
Improper Electrical Value
Worn
Inoperative
Registers Incorrectly
Noisy
Leaking Coolant
Foreign Material Present
Description
0.0
0.1
0.2
0.3
0.4
Inspection, Routine
Driver's Report
Routine
Preventive Maintenance
Breakdown
Natural Causes
Warranty
Lubrication
Accident, Reported
Description
0.00
0.05
0.10
0.15
0.20
0.25
Replace New
Repair
Inspect
Install
Remove
Troubleshooting
Replace Rebuilt
Replace Used
Other Mnt Repair
Adjust
Clean
Description
Fuel_Type
NG
DSL

NG - Exhaust System: Maintenance Expenditures per Vehicle



DSL - Exhaust System: Maintenance Expenditures per Vehicle




Exhaust System: Turbocharger
Count of ROs per Vehicle
DSL: 102 vehicles
NG: 285 vehicles
Total Cost per Vehicle
50000
40000
30000
20000
10000
0
DSL
NG
Fuel Type


energetics
Clean Energy Consulting