
# ETM 530/630 DECISION MAKING SPRING 2017

**CASE TITLE : Designing a Decision Model for Car Engine Selection in Oregon**

**GROUP #/NAME: TEAM C**

**GROUP MEMBERS: AMIT, ANCHAL, BOBBY, LIPISHREE & RAMI**

**DATE: 06/06/2017**

# INTRODUCTION

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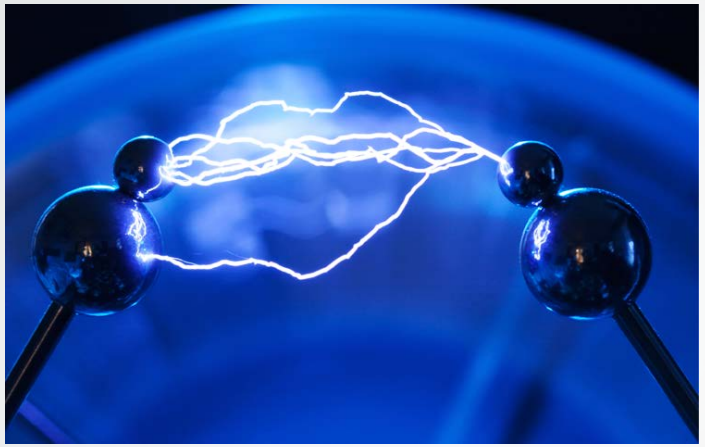
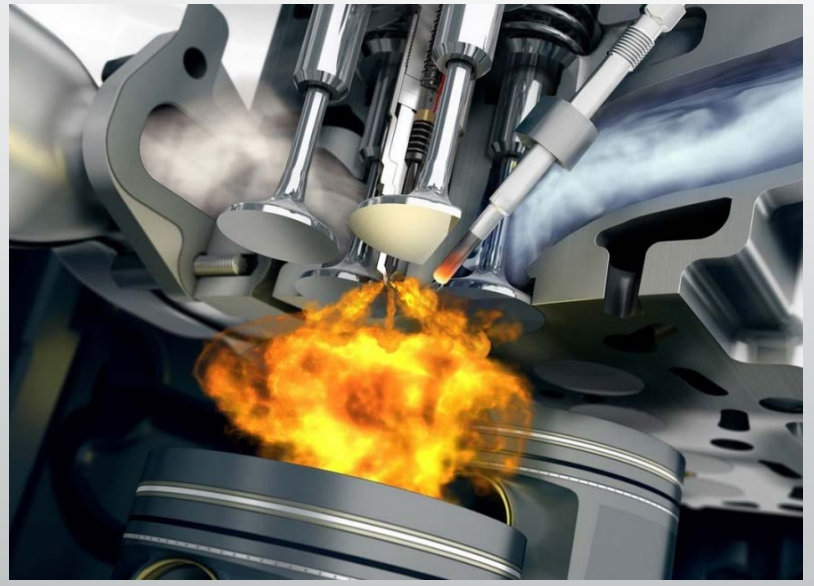
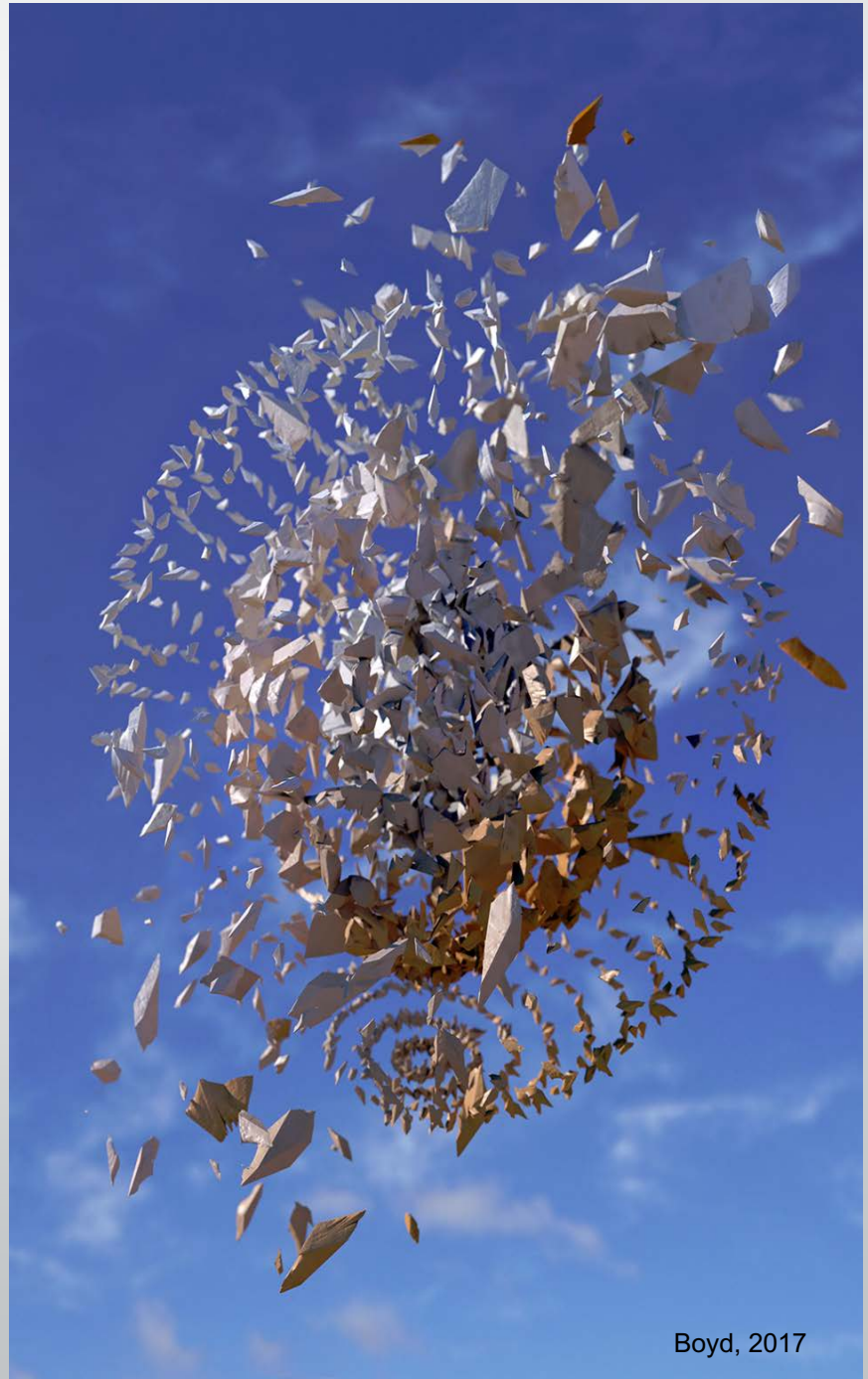


(A role play lesson for teaching about electricity)



(Direction Plus)



Boyd, 2017

# PROBLEM STATEMENT

To select the best engine based on the requirements.

The Car

- Sedan
- $60K
- Driven in Oregon

# METHODOLOGY

Model Development Using: Hierarchical Decision Model (HDM)

In this HDM model of choosing a car engine there are three phases :

- Criteria selection: To select and state different criteria for choosing a car engine
- Hierarchical modeling:
  - to evaluate the impacts of criteria on the objective,
  - determination of relative priority of criteria
  - relative importance of priorities under each criterion
- Criteria evaluation: to evaluate the impacts of priorities on the objective by using the pair-wise comparison.

# DATA USED

- An Expert Panel with nine experts from the IT sector who would like to buy a car in two months.
- The criteria have been selected with expert opinion.
- The HDM model was sent to the experts and they did pairwise comparison on the criteria.

# CRITERIA SELECTION

## 1. PERFORMANCE:

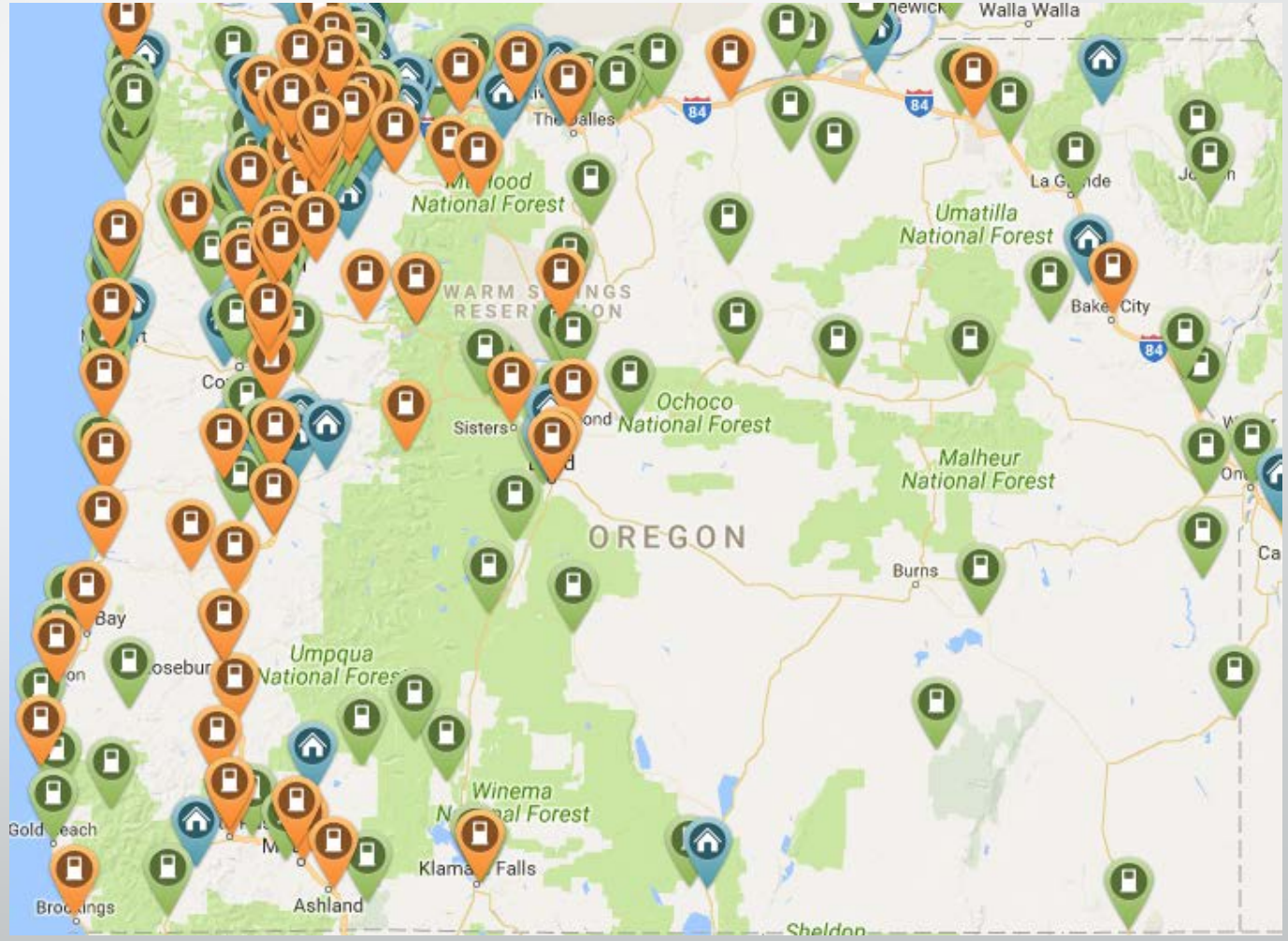
## a) Power and b)Mileage

| ENGINE TYPE | POWER<br>$ per Horse (300 hp) | MILEAGE |
|---|---|---|
| ELECTRIC | $200<br>(Tesla for $60K) | 120 miles<br>250 miles for tesla |
| GASOLINE | $200 (luxury car for $60K)<br>$100 (sports car for 60K) | 300 miles<br>General targeted mileage |
| DIESEL | $200<br>(Mercedes 350 CGI) | 375 miles<br>Petrol * 125% |
| HYBRID | $200<br>(Mercedes E400) | 391 miles<br>Petrol * 130% |

## 2.CONVENIENCE

Public Regeneration Infrastructure for automobile energy consumables

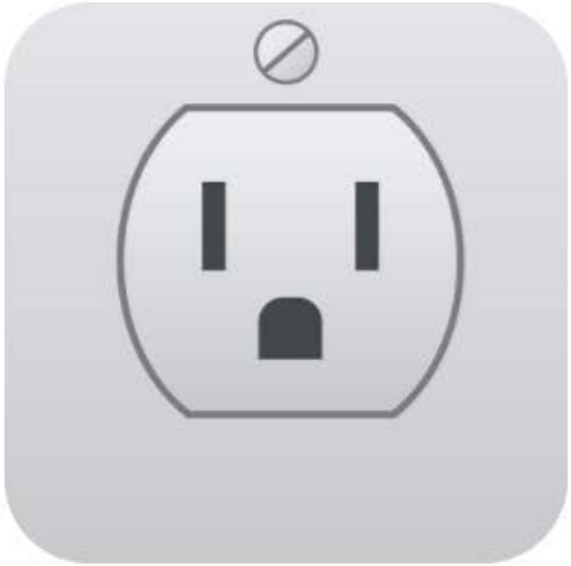
- Level 3 charging station are ubiquitous
- 0.25 - 1 hour charging time



## Convenience:
## Electric Regeneration Options

Charging Electric Vehicles at home results in negligible need to wait for regeneration when compared to fuels.

| Level | Power (kW) | Charging Time |
|---|---|---|
| 1 | 1 | 12 hours |
| 2 | 3 to 20 | 3 to 8 hours |
| 3 | 50 | 1 hour |



Level 1


Level 2


Level 3

## 3.IMPACT ON ENVIRONMENT

1.Electric cars:

- An electric car like Tesla does not need gas, but still gets its energy from burning carbon.
- The electric car has almost four times lower CO2 per mile than an equivalent gas-powered cars.1.Gasoline cars

2. Gasoline cars:

- The smog and carbon monoxide emitted by vehicles and the auto emission are of immediate health concern.
- The emission of Gasoline cars is hugely responsible for global warming

3. Diesel cars:

- Diesel engines can emit a fair amount of Nitrogen compounds.
- They emit high level of particulate matter which is airborne particles of soot and metal.

4. Hybrid cars:

- Hybrid electric vehicle are praised as being fuel efficient and good for the environment.
- The environment impact of hybrid vehicles is hard to quantify since it is kind of new to the automobile market.
- Hybrid cars produce fewer gas emission than conventional cars.

## 2.FINANCIAL ASPECTS:

### a)Maintenance

Gasoline Car:

- Gasoline-powered vehicles have many moving parts that require lubrication, things from changing oil and oil filters to replacing timing belts. Repairs are frequent, and often costly
- Scheduled maintenance required every 15,000, 30,000 and 60,000 miles

2. Electric Car:

- Apart from battery replacement, no regular maintenance will be required
- Electric cars have not captured a large share of the market, no strong infrastructure exists to handle maintenance and repair.

3. Hybrid Car:

- Lower maintenance and repair cost and higher resale value when compared to conventional cars.
- The air filter on its electric battery should be replaced every 40,000 to 50,000 miles.
- If the battery dies after the warranty period of 8 to 10 years, then the new batteries could cost as much as $2000.

4. Diesel Car

- Lower maintenance costs

## FINANCIAL ASPECTS:

## b)Taxes

- Electric Car:

  If we add the $7,500 Federal tax credit with the Oregon state $750 tax credit, this will decrease the initial capital investment. Likewise, the 10 year EUAC will decrease greatly so that the breakeven point would improve from $6 to $4 .

- Diesel & Petrol Car:

  For purchasing a diesel car the customer will get a federal tax credit of $130

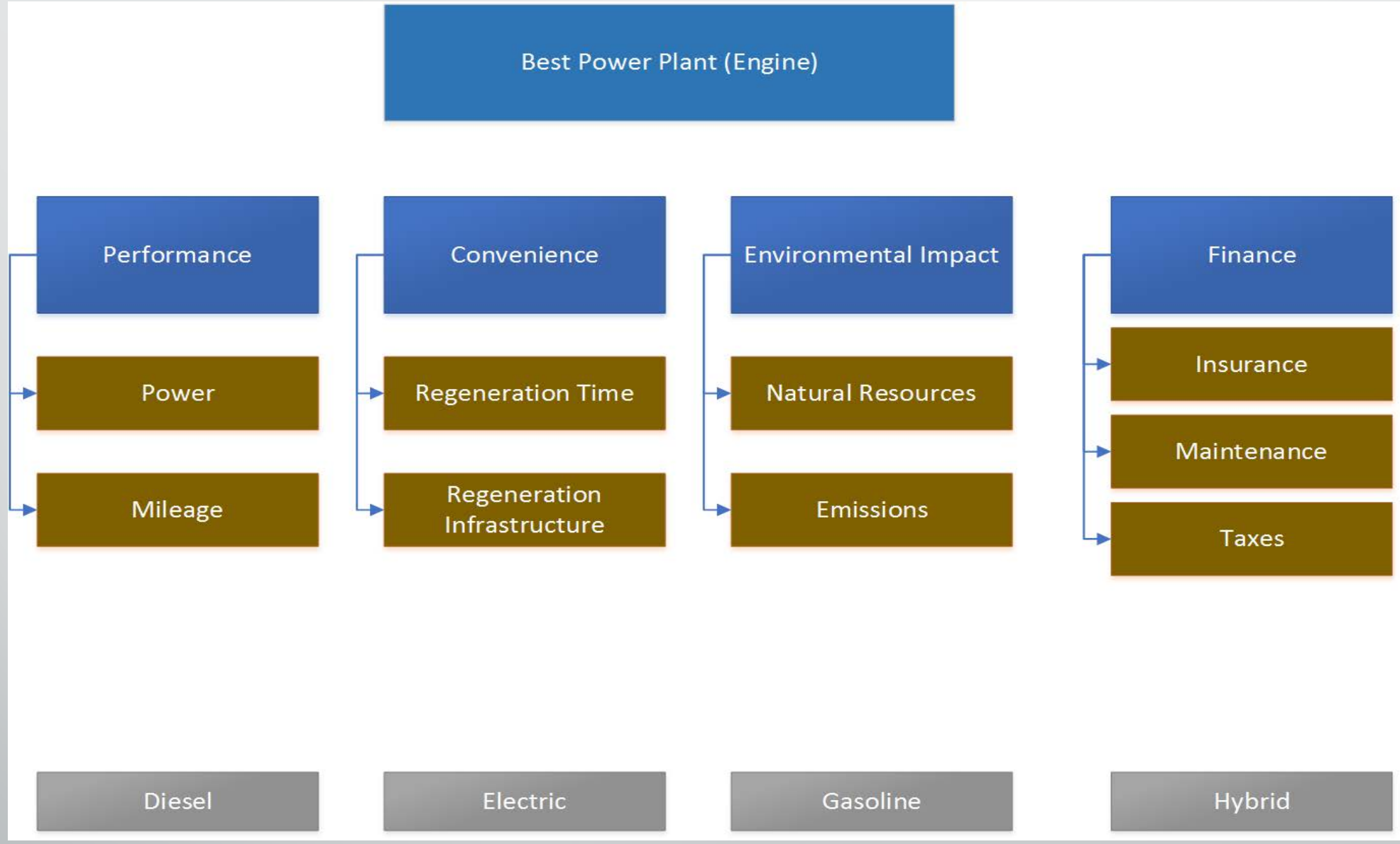
- Hybrid Car:

  Comparing to the EV's battery replacement cost ($10,000 ~ $15,000), hybrid car's replacement cost ($3000 ~ $4000) is much cheaper. Hybrid vehicle would be more economical if $3,400 federal tax credit or $750 state credit was available

## c)Insurance

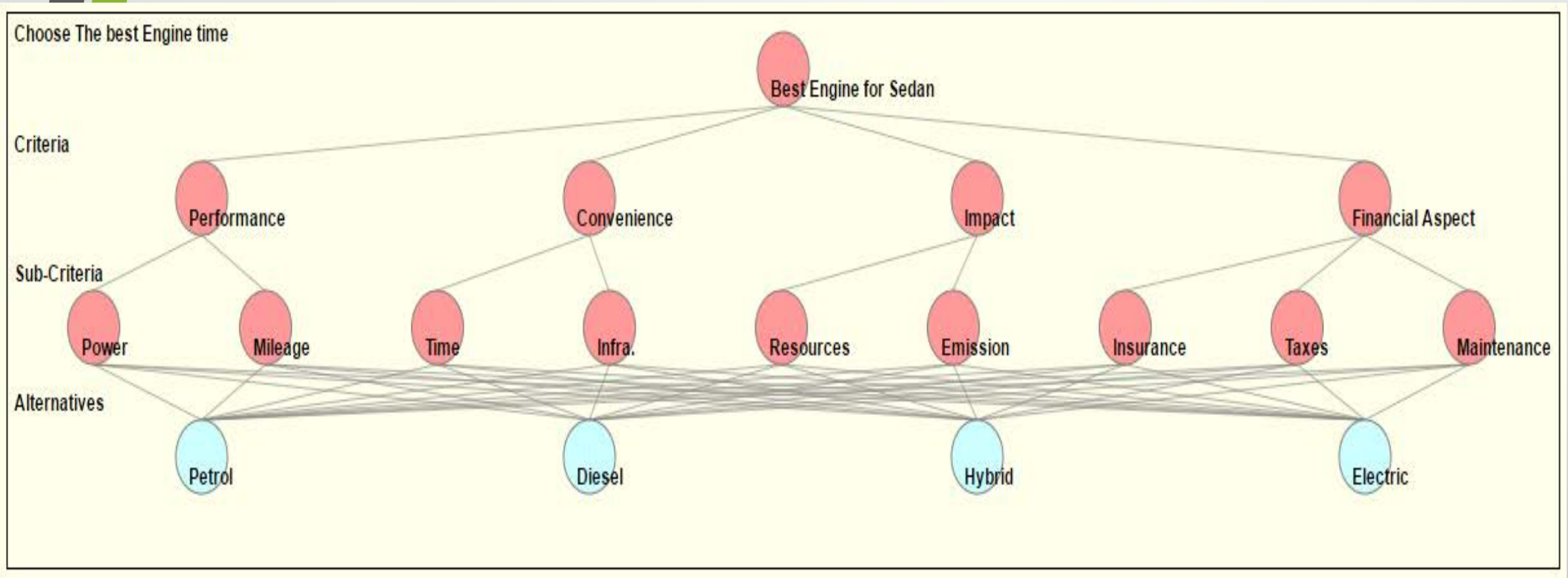
| ENGINE TYPE | 6 Months | Monthly |
|---|---|---|
| ELECTRIC | $1,475 | $245.83 |
| PETROL | $1,118 | $186.33 |
| DIESEL | $1,219 | $203.16 |
| HYBRID | $1,168 | $194.66 |

(“esurance”)




# HDM MODEL DEVELOPMENT

# HIERARCHICAL DECISION MODEL

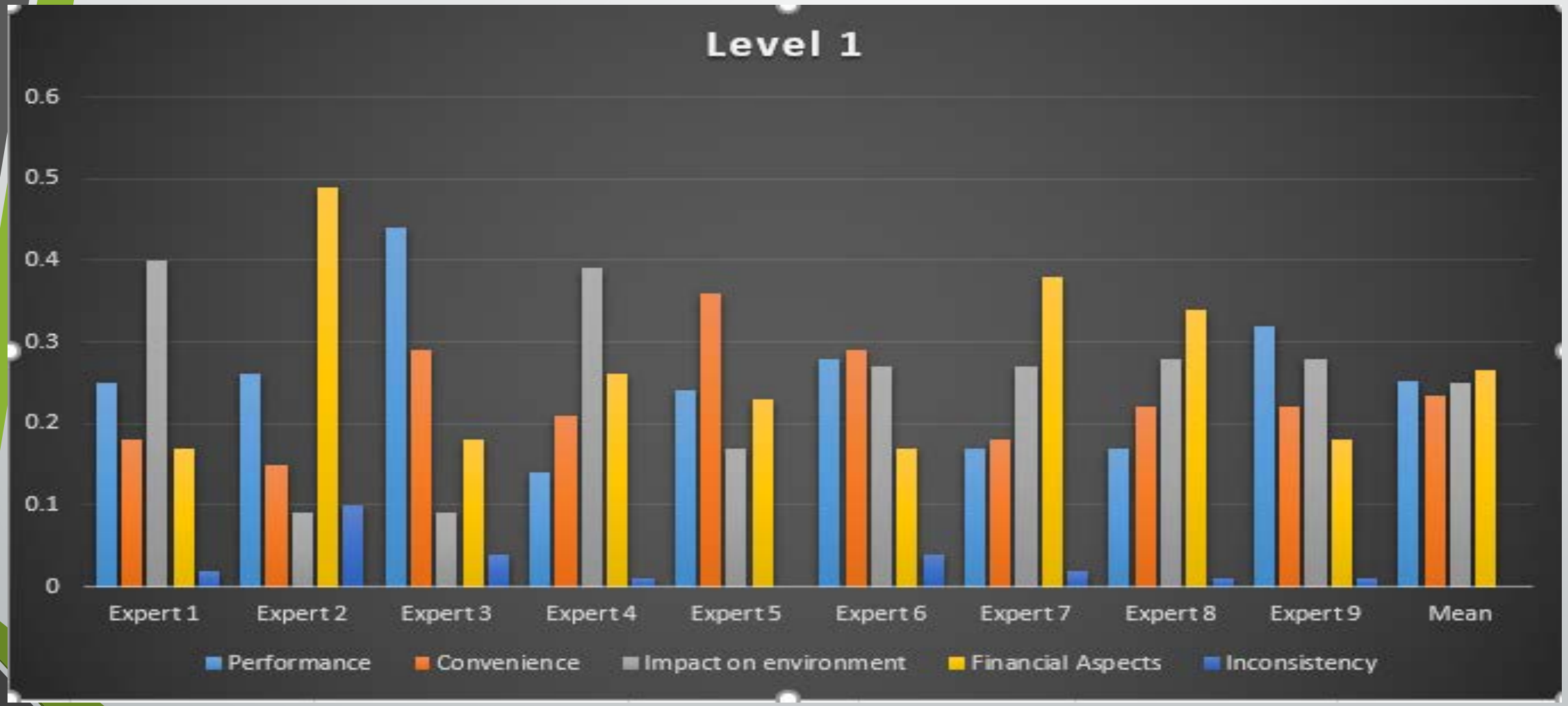


# Analysis and Key Findings

| Level 1 | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Expert 8 | Expert 9 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| Performance | 0.25 | 0.26 | 0.44 | 0.14 | 0.24 | 0.28 | 0.17 | 0.17 | 0.32 | 0.252222222 |
| Convenience | 0.18 | 0.15 | 0.29 | 0.21 | 0.36 | 0.29 | 0.18 | 0.22 | 0.22 | 0.233333333 |
| Impact on environment | 0.4 | 0.09 | 0.09 | 0.39 | 0.17 | 0.27 | 0.27 | 0.28 | 0.28 | 0.248888889 |
| Financial Aspects | 0.17 | 0.49 | 0.18 | 0.26 | 0.23 | 0.17 | 0.38 | 0.34 | 0.18 | 0.266666667 |
| Inconsistency | 0.02 | 0.1 | 0.04 | 0.01 | 0 | 0.04 | 0.02 | 0.01 | 0.01 | |

- Important Criteria: Financial Aspects with a mean of 0.266

# Analysis and Key Findings



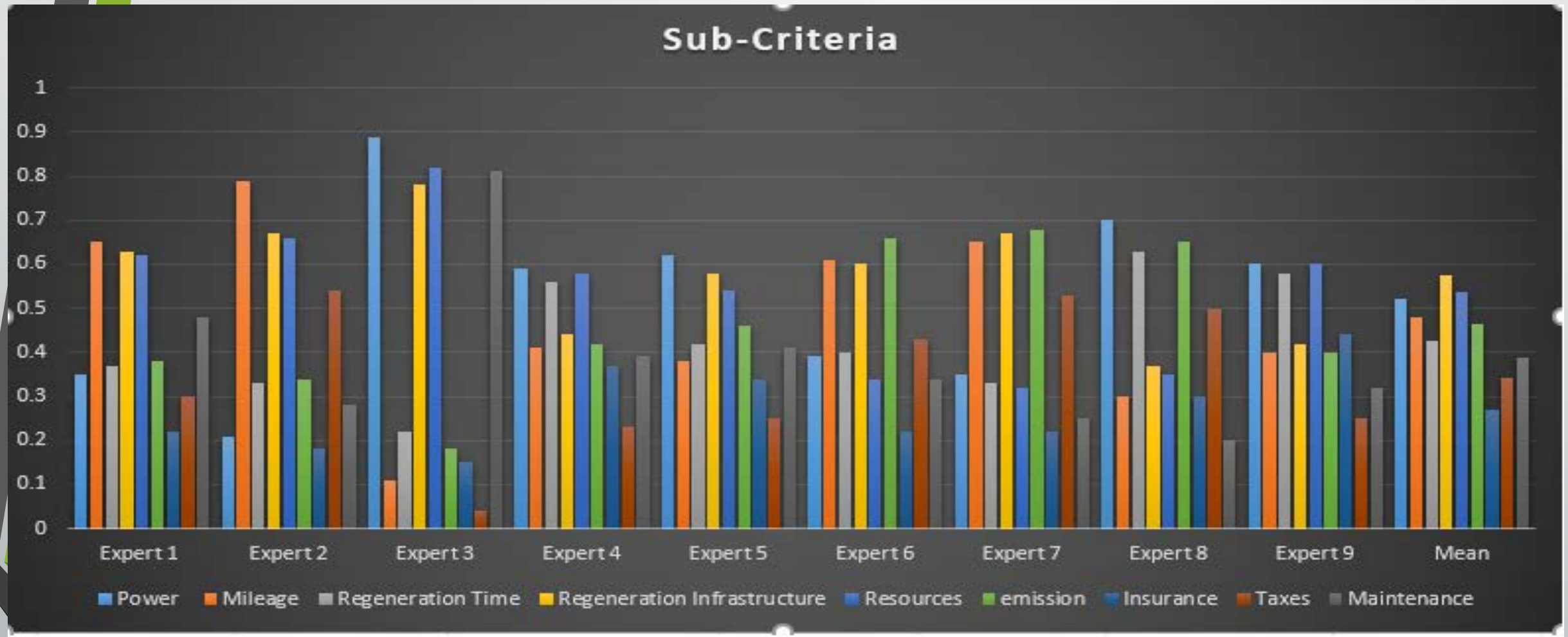
# Analysis and Key Findings

Evaluation of each Sub criteria

| | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Expert 8 | Expert 9 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| Power | 0.35 | 0.21 | 0.89 | 0.59 | 0.62 | 0.39 | 0.35 | 0.7 | 0.6 | 0.522222222 |
| Mileage | 0.65 | 0.79 | 0.11 | 0.41 | 0.38 | 0.61 | 0.65 | 0.3 | 0.4 | 0.477777778 |
| Regeneration Time | 0.37 | 0.33 | 0.22 | 0.56 | 0.42 | 0.4 | 0.33 | 0.63 | 0.58 | 0.426666667 |
| Regeneration Infrastructure | 0.63 | 0.67 | 0.78 | 0.44 | 0.58 | 0.6 | 0.67 | 0.37 | 0.42 | 0.573333333 |
| Resources | 0.62 | 0.66 | 0.82 | 0.58 | 0.54 | 0.34 | 0.32 | 0.35 | 0.6 | 0.536666667 |
| emission | 0.38 | 0.34 | 0.18 | 0.42 | 0.46 | 0.66 | 0.68 | 0.65 | 0.4 | 0.463333333 |
| Insurance | 0.22 | 0.18 | 0.15 | 0.37 | 0.34 | 0.22 | 0.22 | 0.3 | 0.44 | 0.271111111 |
| Taxes | 0.3 | 0.54 | 0.04 | 0.23 | 0.25 | 0.43 | 0.53 | 0.5 | 0.25 | 0.341111111 |
| Maintenance | 0.48 | 0.28 | 0.81 | 0.39 | 0.41 | 0.34 | 0.25 | 0.2 | 0.32 | 0.386666667 |

Important Sub-Criteria: Regeneration Infrastructure with a mean of 0.573

# Analysis and Key Findings



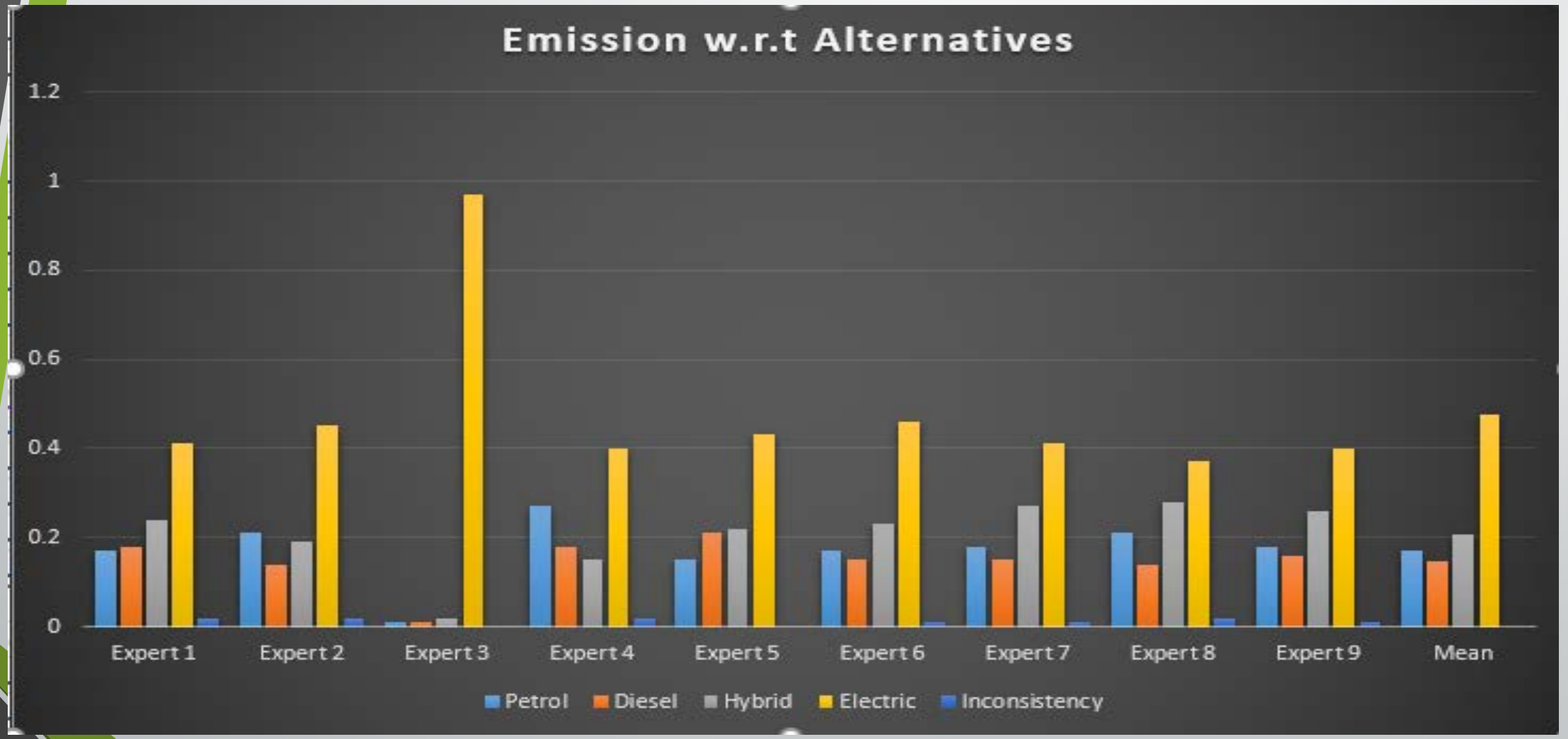
# Analysis and Key Findings

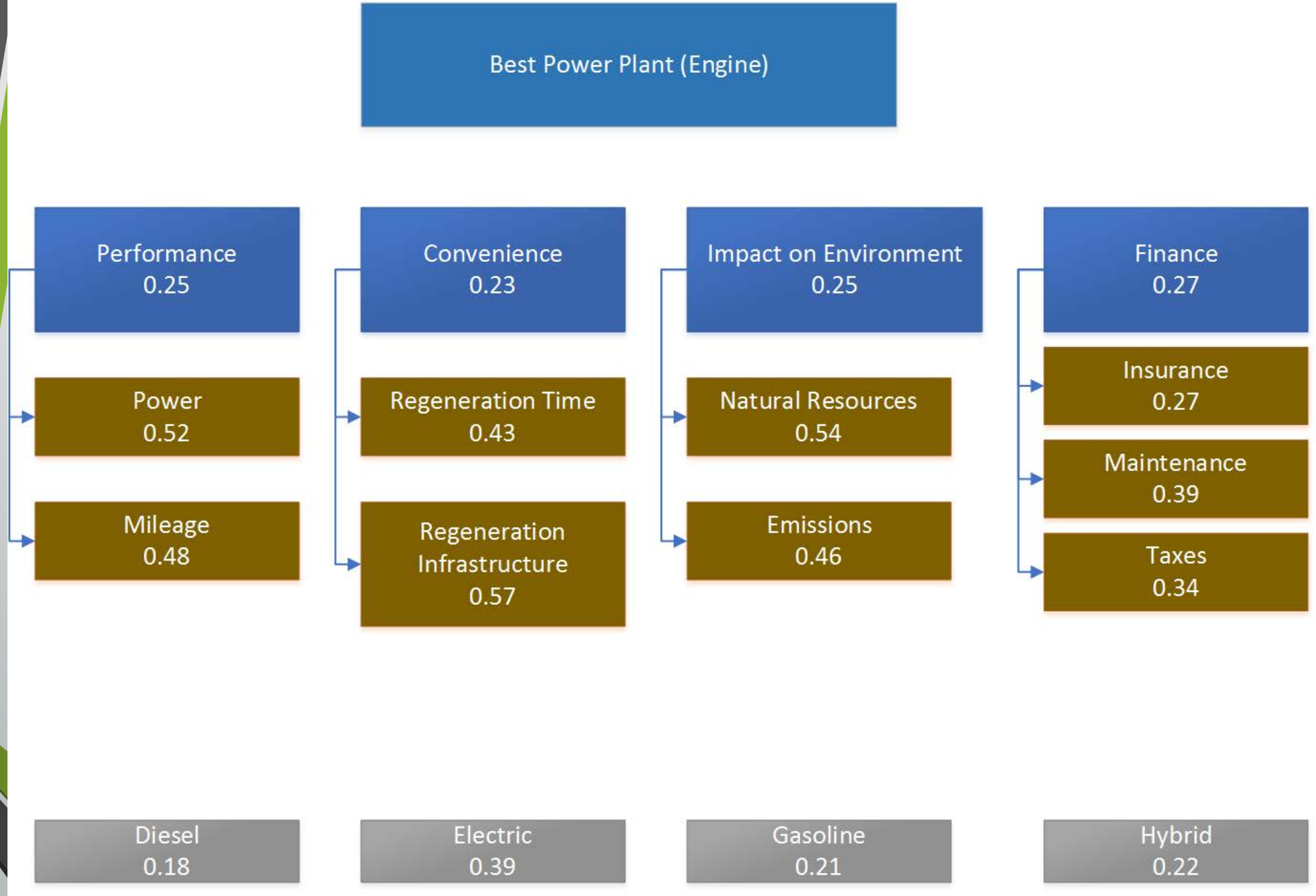
Evaluation of Sub-Criteria w.r.t Alternatives

| Emission | Expert 1 | Expert 2 | Expert 3 | Expert 4 | Expert 5 | Expert 6 | Expert 7 | Expert 8 | Expert 9 | Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| Petrol | 0.17 | 0.21 | 0.01 | 0.27 | 0.15 | 0.17 | 0.18 | 0.21 | 0.18 | 0.172222222 |
| Diesel | 0.18 | 0.14 | 0.01 | 0.18 | 0.21 | 0.15 | 0.15 | 0.14 | 0.16 | 0.146666667 |
| Hybrid | 0.24 | 0.19 | 0.02 | 0.15 | 0.22 | 0.23 | 0.27 | 0.28 | 0.26 | 0.206666667 |
| Electric | 0.41 | 0.45 | 0.97 | 0.4 | 0.43 | 0.46 | 0.41 | 0.37 | 0.4 | 0.477777778 |
| Inconsistency | 0.02 | 0.02 | 0 | 0.02 | 0 | 0.01 | 0.01 | 0.02 | 0.01 | |

Electric Engine with a mean of 0.477

# Analysis and Key Findings




Best Power Plant (Engine)
Performance
0.25
Power
0.52
Mileage
0.48
Convenience
0.23
Regeneration Time
0.43
Regeneration Infrastructure
0.57
Impact on Environment
0.25
Natural Resources
0.54
Emissions
0.46
Finance
0.27
Insurance
0.27
Maintenance
0.39
Taxes
0.34
Diesel
0.18
Electric
0.39
Gasoline
0.21
Hybrid
0.22

# Analysis and Key Findings

## Final Results

| Best Engine for Sedan | Petrol | Diesel | Hybrid | Electric | Inconsistency |
|---|---|---|---|---|---|
| Expert 1 | 0.19 | 0.19 | 0.24 | 0.38 | 0.01 |
| Expert 2 | 0.27 | 0.17 | 0.25 | 0.3 | 0.04 |
| Expert 3 | 0.2 | 0.2 | 0.19 | 0.41 | 0.03 |
| Expert 4 | 0.17 | 0.17 | 0.22 | 0.44 | 0.02 |
| Expert 5 | 0.21 | 0.17 | 0.24 | 0.38 | 0.01 |
| Expert 6 | 0.22 | 0.2 | 0.24 | 0.35 | 0.01 |
| Expert 7 | 0.25 | 0.2 | 0.23 | 0.32 | 0.01 |
| Expert 8 | 0.22 | 0.19 | 0.16 | 0.43 | 0.01 |
| Expert 9 | 0.12 | 0.16 | 0.21 | 0.52 | 0.01 |
| **Mean** | **0.21** | **0.18** | **0.22** | **0.39** | |
| **Minimum** | **0.12** | **0.16** | **0.16** | **0.3** | |
| **Maximum** | **0.27** | **0.2** | **0.25** | **0.52** | |
| **Std. Deviation** | **0.04** | **0.01** | **0.03** | **0.06** | |
| **Disagreement** | | | | | **0.036** |

# Analysis and Key Findings

The statistical F-Test for evaluating the null hypothesis

| Source of Variation | Sum of Square | Deg. of freedom | Mean Square | F-test value |
|---|---|---|---|---|
| Between Subjects: | 0.25 | 3 | 0.083 | **33** |
| Between Conditions: | 0 | 8 | 0 | |
| Residual: | 0.06 | 24 | 0.003 | |
| **Total:** | **0.31** | **35** | | |
| **Critical F-value with degrees of freedom 3 & 24 at 0.01 level:** | | | | **4.72** |
| **Critical F-value with degrees of freedom 3 & 24 at 0.025 level:** | | | | **3.72** |
| **Critical F-value with degrees of freedom 3 & 24 at 0.05 level:** | | | | **3.01** |
| **Critical F-value with degrees of freedom 3 & 24 at 0.1 level:** | | | | **2.33** |

# FUTURE RESEARCH

- Our study focuses on
  - Car Engine type
  - Assumptions Made: State, Car Cost and Model type

➢ Criteria Selected: Performance, Financial Aspect, Convenience and Impact on Environment

➢ To expand the model for a more geographical diverse audience

- Discuss criteria like terrain and weather

➢ Personal preferences on exterior and interior features

# REFERENCES


Boyd, Jennifer. "A Taxonomy of Explosions." A Taxonomy of Explosions. N.p., n.d. Web. 03 June 2017.

Diesel Parts Specialist - Direction Plus | Home. (n.d.). Retrieved from http://direction-plus.com/

"Esurance". Esurance.com. N.p., 2017. Web. 5 June 2017.

A role-play lesson for teaching about electricity. (2015, October 12). Retrieved June 03, 2017, from https://www.tes.com/news/blog/a-role-play-lesson-teaching-about-electricity

Heavy traffic passing by fast on the highway. Day... (n.d.). Retrieved June 03, 2017, from https://www.shutterstock.com/video/clip-3026290-stock-footage-heavy-traffic-passing-by-fast-on-the-highway-day-time-hi-angle-wide-shot-time-lapse.html

n.d.Electric Car Charging Guide. How to Charge My Electric Car at Public Stations? | ChargeHub. Retrieved from https://chargehub.com/en/electric-car-charging-guide.html

(2015, July 13). 6 Tips for Installing a Home Electric Car Charger. 6 Tips for Installing a Home Electric Car Charger - Pro.com Blog. Retrieved from https://pro.com/blog/installing-home-electric-car-charger/

n.d.Electric Vehicle Charging Stations. San Francisco Public Utilities Commission : Electric Vehicle Charging Stations. Retrieved June 3, 2017, from http://www.sfwater.org/index.aspx?page=516

United States. Department of Energy. (2017). Fuel Economy Guide (Online).