Comparison of EV, Hybrid and Diesel Vehicles

Dalhousie University – Mechanical Engineering

MECH 4810 – Energy Conversion Systems – Winter 2013

Team #1 – Project #7a

Comparison of EV, Hybrid and Diesel vehicles; examining energy losses from the point of purchase to traction

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Outline

- Motivation
- Technology
- Economic Feasibility
- Environmental Impact and Sustainability
- Conclusion

Motivation

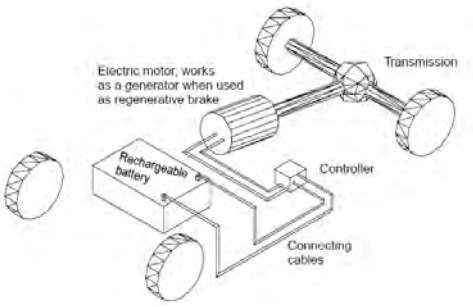
- Education/demystification of energy constraints
- Overall efficiency
- Considerations of fuel types used

Technology: Electric Vehicles

2013 Nissan Leaf

Technology: Electric Vehicles

- Energy stored as electricity in on-board rechargeable battery
- Motor/battery controller
- Electric motor to drive train
- Possibility of Electrical Regenerative Braking



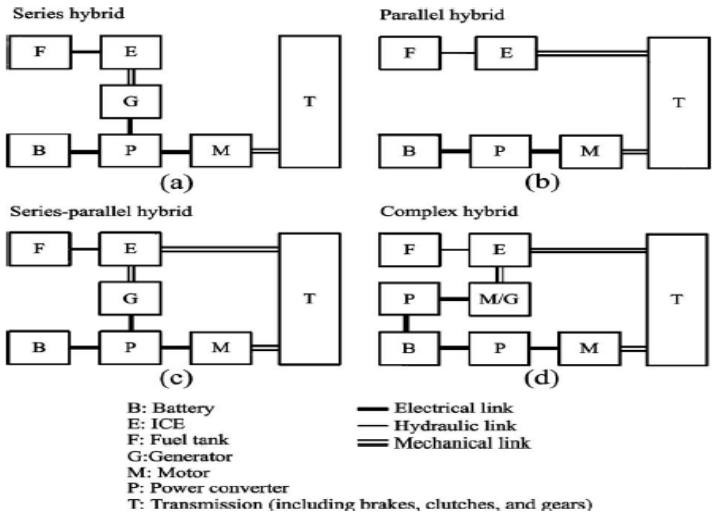
Technology: Electric Vehicles

Battery Type	Energy Density [Wh / L]	Amp-hour Efficiency (varies with rate of discharge)	Approximate Number of Cycles
Lead-Acid	54-95	80%	Up to 800
Nickel-cadmium	70-90	Good	Up to 1200
Nickel metal hydride	Approximately 150	Quite good	Up to 1000
Sodium Sulphur	150	Very good	Up to 1000
Sodium metal chloride	150	Very good	>1000
Lithium polymer	153	Very good	>1000
Aluminum air	195	N/A	>1000
Zinc air	270	N/A	>2000

Technology: Hybrid Vehicles

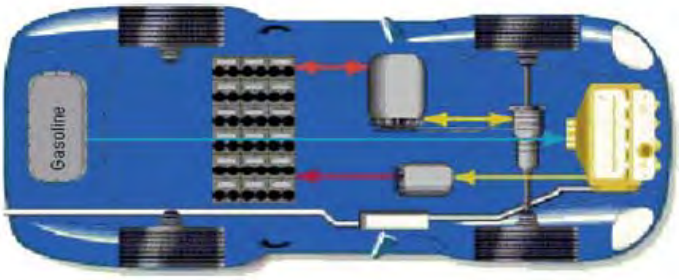
- 2013 Honda Civic Hybrid

Technology: Hybrid Vehicles



Technology: Hybrid Vehicles

- Usually done with gasoline IC engine and electric motor system
- Can be series, parallel or both with IC engine running traction or a generator



Technology: Hybrid Vehicles

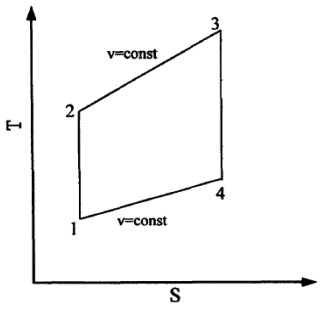
- Regenerative braking capabilities
- Electric motor drive/assist
- Auto Stat/Shutoff
- Compress intake air with Regen braking

Technology: Diesel Vehicles

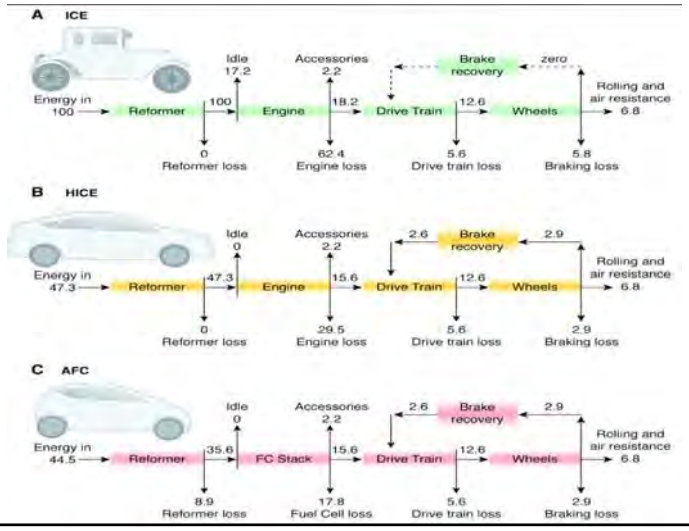
- 2013 Jetta TDI

Technology: Diesel Vehicles

- Compression combustion cycle
- Ideal cycle never occurs
- Friction, pressure drop, environmental factors
- Fuel-dependant efficiency



Technology: Diesel Vehicles

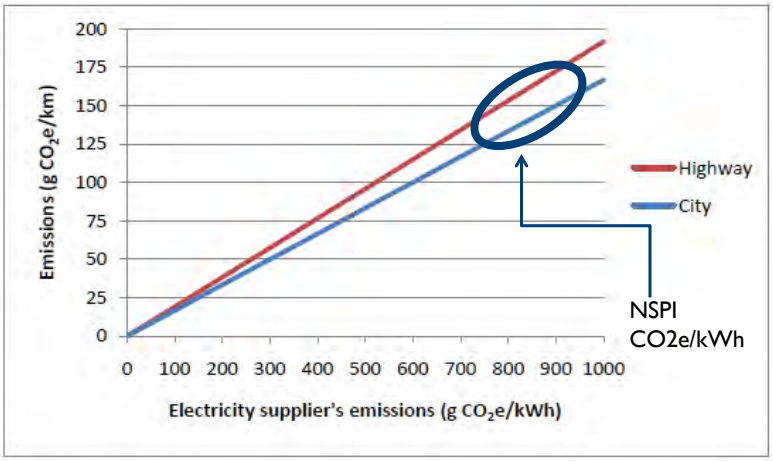


Economic Feasibility

Vehicle	Type	MSRP [$]	Annual Fuel Cost	Total Fuel Cost (5 years)	5 Year Maintenance Cost *3)	Residual Value in 2018 *2)	Total 5-Year Cost of Ownership
Nissan Leaf	Electric	$38395	$491	$2455	$1349	$7600	$34 599
Honda Civic	Hybrid	$24990	$903	$4515	$1849	$6450	$24 904
Volkswagen Jetta	Diesel	$23990	$1334	$6670	$1867	$6400	$26 127

Environmental Impact and Sustainability: Electric Vehicles

- Estimated 130 to 145 g CO_2e/km



Environmental Impact and Sustainability: Electric Vehicles

Fuel Type	Average Distance (km/year)	Average Fuel Economy (kWh/km)	CO_2e Intensity (g/kWh)	Total Annual CO_2e (kg/year)
Electric Vehicle	17,427	0.178	804.7	**2,496.2**

- $\frac{g\ CO_2}{Year} = \frac{km}{year} * \frac{kWh}{km} * \frac{g\ CO_2}{kWh}$

Environmental Impact and Sustainability: Hybrid Vehicles

Fuel	CO_2 (g/L)	CH_4 (g/L)	N_2O (g/L)	Total CO_2e (g/L)
Gasoline	2289	0.14	0.022	2,304.22

- $\frac{g\ CO_2}{Year} = \frac{km}{year} * \frac{L}{km} * \frac{g\ CO_2}{L}$

Fuel Type	Average Distance (km/year)	Average Fuel Economy (L/km)	CO_2e Intensity (g/L)	Total Annual CO_2e (kg/year)
Gasoline	17,427	0.0430	2,304.22	**1,726.7**

Environmental Impact and Sustainability: Diesel Vehicles

Fuel	CO_2 (g/L)	CH_4 (g/L)	N_2O (g/L)	Total CO_2e (g/L)
Diesel	2663	0.133	0.400	2,789.79

- $\frac{g\ CO_2}{Year} = \frac{km}{year} * \frac{L}{km} * \frac{g\ CO_2}{L}$

Fuel Type	Average Distance (km/year) [1]	Average Fuel Economy (L/km) [1][2]	CO_2e Intensity (g/L) [3]	Total Annual CO_2e (kg/year)
Diesel	17,427	0.0688	2,789.79	3344.9

Environmental Impact Comparison

Fuel Type	Total Annual Carbon Dioxide Emissions
Gasoline	1,726.7
Electric Vehicle	2,496.2
Diesel	3,344.9

Conclusion

- Each vehicle has pros and cons in terms of energy efficiency and total direct emissions.
- Hybrid emits least emissions per km driven
- In terms of energy used in traction vs. primary energy potential…

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