Lab #11: Electric Cars (EP #1)

1. Retrieve Background Information

- Determine the before-tax cost (CAD), for the base model for each of the four vehicles:
  - Use manufacturer's consumer website.
  - Deduct any government-funded and manufacture credit from the base price.
- Determine the estimated range of each vehicle from one full battery charge cycle in km and determine fuel consumption in litres/100 km.
  - Refer to the 2017 Fuel Consumption Guide (NRCAN.gc.ca).
  - Refer to manufacturer's website.

	Base Price (CAD)	Government Credit (CAD)	Manufacturer Rebate (CAD)	Battery Capacity (kWh)	Estimated Battery Range (Km)	Recharge Time (h)	Fuel Consumption (L/100 Km)
Tesla's Model S	96 650 [1]	14 000 [2]	---	75 [1]	417 [3]	12 [3]	---
Ford Fusion Energi	33 588 [4]	7 000 [2]	1 500 [4]	7.2 [4]	35 [4]	2.5 [4]	5.6 [4]
Nissan Leaf	35 998 [5]	14 000 [2]	---	40 [6]	242 [6]	8 [6]	---
Chevrolet Bolt	43 095 [7]	14 000 [2]	---	60 [8]	383 [3]	9.3 [3]	---

- Determine the cost of fuel / electricity bills by each electric car.
  - Gasoline Fuel Cost: $1.129/liter
  - Electricity Cost (Off-Peak): $0.065/kWh [9]
    - Refer to Toronto Hydro electricity cost chart.
    - Assume a 9:00 AM – 6:00 PM school day.
      - Assume a one-hour commute time between work and home.
      - Assume charging times to be from 7:00 PM – 7:00 AM (Off-Peak) since the recharge times of all vehicles are equal or less than the 12-hour duration.
      - Assume the vehicles are charged only at home.
- Ignore any maintenance and/or licencing cost along with car insurance costs.

2. Choose Ten Points Within 50 Km Radius of UofT

- Assume Ford Fusion Energi depletes battery first before using gasoline.
- Assume each vehicle's city and highway electric and fuel consumption is identical.
- Assume route of shortest distance is travelled from location to Bahen.
- Choose 2 locations for each interval of 10 Km distance increase away from Bahen.
  - Bahen Location: 40 St George St, Toronto, ON M5S 2E4

- Shortest distance between Bahen and the location is retrieved from Google Maps [10].

	Location	Shortest Distance (Km)
1.	Eaton Center: 220 Yonge St, Toronto, ON M5B 2H1	1.7
2.	Sky Zone Trampoline Park: 45 Esandar Dr, Unit 1A, Unit 1A, Toronto, ON M4G 4C5	8.0
3.	Lambton Golf & Country Club: 100 Scarlett Rd, York, ON M6N 4K2	10.7
4.	Bluffer's Park Beach: 1 Brimley Road S, Scarborough, ON M1M 3W3	19.2
5.	Toronto Pearson International Airport: 6301 Silver Dart Dr, Mississauga, ON L5P 1B2	25.1
6.	Highcastle Public School: 370 Military Trail, Scarborough, ON M1E 4E6	28.4
7.	Canada's Wonderland: 1 Canada's Wonderland Drive, Vaughan, ON L6A 1S6	30.9
8.	Pickering Nuclear Generating Station Information Centre: 675 Sandy Beach Rd, Pickering, ON L1W 3X5	39.6
9.	Pine Farms Orchard: 2700 16th Sideroad, King City, ON L7B 1A3	45.3
10.	Casino Ajax: 50 Alexander's Crossing, Ajax, ON L1Z 2E6	49.3
11.	Niagara Falls, ON	130

3. MATLAB Script Layout

- Create variables to represent the values of the given background information.
- Calculate cost of operation (electricity and gasoline) per kilometer travelled for each car:
  - Electricity:
    - $C_e\left[\frac{\$}{Km}\right] = \frac{battery\ capacity\ [kWh] \times electricity\ cost\ [\frac{\$}{kWh}]}{range\ (Km)}$
  - Gasoline (Ford Fusion for distance > 35 Km):
    - $C_g\left[\frac{\$}{Km}\right] = fuel\ cost\ \left[\frac{\$}{L}\right] \times fuel\ consumption\ \left[\frac{L}{100Km}\right] \times (100)$
  - Create a function that represents the cost of operation for each car.
- Create a plot showcasing the relationship between distance travelled in Km (x-axis) and operation cost in $CAD ($y$-axis).
  - Include TTC adult fare of $3.00 CAD for comparison on plot.
- Create another plot showcasing the distance in Km (x-axis) required to pay back the cost in $CAD ($y$-axis) of the vehicle using money saved when compared to an assumed standard average fuel economy of 9.0 L/100Km.
- The two plots will be used to answer the three proposed questions and determine which vehicle is the most economical (cost-effective) transportation solution for various distances.

References

[1] Tesla, “Order a Model S,” *Order a Tesla Model S | Tesla Canada*. [Online]. Available: https://www.tesla.com/en_CA/models/design. [Accessed: 30-Mar-2018].

[2] Ministry of Transportation, “Incentives and Eligible Vehicles under the Electric and Hydrogen Vehicle Incentive Program,” *Eligible Electric Vehicles*, 25-Oct-2013. [Online]. Available: http://www.mto.gov.on.ca/english/vehicles/electric/electric-vehicle-rebate.shtml. [Accessed: 30-Mar-2018].

[3] Government of Canada, “2018 model year electric vehicles,” *Natural Resources Canada*, 06-Feb-2018. [Online]. Available: http://www.nrcan.gc.ca/energy/efficiency/transportation/cars-light-trucks/buying/20239. [Accessed: 30-Mar-2018].

[4] Ford, “2018 Fusion Energi SE,” *2018 Ford® Fusion Energi SE Sedan | Model highlights | Ford.ca*. [Online]. Available: https://www.ford.ca/cars/fusion/models/fusion-energi-se/?gnav=header-hybrids. [Accessed: 30-Mar-2018].

[5] Nissan, “Reserve the 100% Electric 2018 Nissan LEAF,” *Nissan Canada*. [Online]. Available: http://www.nissan.ca/en/future-and-concept-vehicles/2018-leaf-reservation/. [Accessed: 30-Mar-2018].

[6] Nissan Motor Company Ltd., “2018 Nissan Leaf.” Nissan, Yokohama , 2018.

[7] Chevrolet, “Chevrolet Bolt 2018 - View Specs, Prices, Photos & More,” *Driving*. [Online]. Available: http://driving.ca/chevrolet/bolt/. [Accessed: 30-Mar-2018].

[8] Chevrolet, “2018 Chevrolet Bolt EV Base Specifications - The Car Guide,” *Chevrolet Bolt EV*, 2018. [Online]. Available: https://www.bing.com/cr?IG=929ABB1531B34213A96A100FE38B9301&CID=2379FB8F33046EED0203F04D324B6F9C&rd=1&h=uKHZTgCmcYWCNAyJn75SRcxJp8TX8xVaHkyAg2_kVWA&v=1&r=https://www.guideautoweb.com/en/makes/chevrolet/bolt-ev/2018/specifications/base/&p=DevEx,5037.1. [Accessed: 30-Mar-2018].

[9] Toronto Hydro, “Electricity Rates,” *Toronto Hydro*, 01-Nov-2017. [Online]. Available: https://www.torontohydro.com/sites/electricsystem/business/rates/Pages/busrates.aspx. [Accessed: 30-Mar-2018].

[10] *Google*. Google Maps. 2018