City of Saskatoon
Community Standards

TANNERY CREEK SYSTEMS

# Electric Vehicles Versus Frigid Winters

**Wayne Sum Saskatoon**
**Bill Franklin Tannery Creek**

CPA ACS
HALIFAX 2024
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# Electric Vehicle Performance in Extreme Winter Conditions

Wayne Sum MBA City of Saskatoon
Bill Franklin P.Eng. Tannery Creek Systems

CPA ACS
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The road to reducing Saskatoon’s carbon footprint starts here....

# City of Saskatoon – Electric Vehicle Fleet

- Saskatoon began its Electrical Vehicle (EV) Adoption Roadmap July 2021
- Target: All municipal & transit fleet fully electric by 2030
- Objectives:
  - re-evaluate corporate fleet in context of EV
  - determine costs & savings associated with EVs
  - Assess durability, viability & required infrastructure change
  - Assess real world EV performance: pilot 4 EVs in 3 departments

# Viability of Electric Service Vehicles

- City wanted to pilot test electric vehicles to see if:
  - Too cold on occasion to operate vehicle?
  - Will it run 14 hours continuous? Is 24/7 operation possible?
  - Is it reliable? Day after day, month after month in same conditions as an ICE vehicle?
  - Able to operate ancillary equipment e.g. LPR?
  - Does it have the same productivity?
  - Which vehicles can be an EV?
    - Equipment where waste energy can be easily recovered and converted to electrical is good.
    - An SUV has considerable kinetic energy that can be recovered and stored in a battery and is a good choice
    - A bulldozer or grader does not have readily available convertible energy hence bad choice
- Bottom line: can we simply replace an ICE vehicle with an EV?

# Cold Increases Energy Needs

- Cold and especially snow significantly increases rolling resistance
- More equipment must be used such as:
  - Head lamps and running lights
  - Windshield defroster
  - Air conditioner (for defrosting)
  - Heaters: Seat, Cabin, Rear window, outside rearview mirror
  - Windshield wipers (front and rear windows)
  - Windshield fluid pump

# Electric Vehicles: Typical Range

Examples of EPA range at 25C

| Model | Range |
|---|---|
| Tesla 3 | 500 km |
| Nissan Leaf | 350 km |
| Chevrolet Bolt | 380 km |
| BMW i3 | 250 km |
| Volkswagen e-Golf | 200 km |

*Note: all use Lithium ion batteries*

# Nissan Leaf

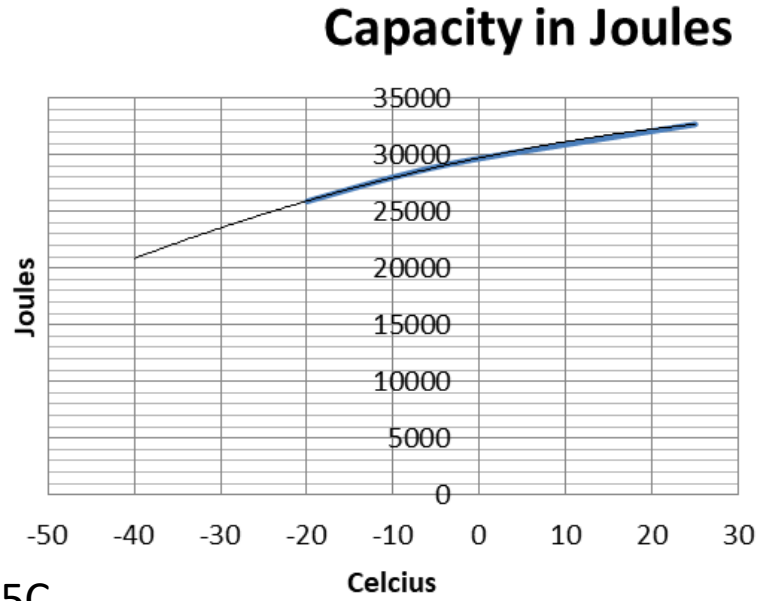
- One of the most popular electric cars globally
- Range of 370 km (EPA)
- Tesla, Bolt, BMW, e-Golf exhibit similar battery characteristics in cold, hence Leaf used as the study vehicle

# Impact of Cold on Lithium Batteries

Full charge typically rated at 25C

As temperature drops both voltage and amp hour capacity decline so total stored energy declines significantly

Graph of energy storage in Li-Ion battery (Panasonic)




- Stored energy at -40C roughly 65% of that at 25C
- Results in 1/3 loss of operation time and/or distance
- Moreover, Nissan recommends not using the Leaf or storing it in locations where the temperature is -25C or less.

# Impact of Cold on Power Consumption

| Weather | Battery Capacity | Average Speed | Power to move car* | Auxiliary equipment power | LPR Power | Total Power | Total Duration (hours) | Total Distance (km) |
|---|---|---|---|---|---|---|---|---|
| Summer 25C | 62 kWh | 40 km/h | 4000 W | 100 watts | 100 watts | 4.2 kW | 15 hours | 590 km |
| Winter -30C (1) | 43 kWh | 40 km/h | 4000 W | 1700 watts | 100 watts | 5.8 kW | 7.5 hours | 300 km |
| Winter -30C (2) | 43 kWh | 40 km/h | 5000 W | 4000 watts | 100 watts | 9.1 kW | 4.7 hours | 190 km |

*Notes: (1) Defrost (and air conditioner) on intermittently (20%)*
*(2) Defrost & AC always on, hard packed snow increases rolling resistance & energy consumption 25%*

- In theory, driving Leaf at 40 km/h on a smooth road, no wind, 25C should reach close to 600 km
- Reduced when using equipment e.g. air conditioning, radio, fans
- Cold weather performance drops distance and operating duration about 50%
- Running defrost continually will drop it further to about 30% of ideal range
- Snow greatly increases rolling resistance, requiring 25% more energy to move car
- Ancillary equipment consuming 100 to 200 watts has little impact (2 to 4%)

# Studies: American Automotive Association & Consumer Reports

- Both organizations did quantitative road tests at cold temperatures.
- At -20C all vehicles' range dropped to about 50% of that at 25C.

# Challenges with Charging at Colder than -20C

- Cold weather charging can be problematic and not recommended
- Parking outdoors not recommended
- Optional battery heaters degrade driving distance and duration
- See additional precautions from Nissan Leaf Operators manual (see next page).
- All EV manufacturers have similar precautions.

# Precautions from Nissan Leaf Manual

## COLD WEATHER DRIVING

**CAUTION**

**To prevent damage to the Li-ion battery: Do not store the vehicle in temperatures below -13˚F (-25˚C) for over seven days. If the outside temperature is -13˚F (-25˚C) or less, the Li-ion battery may freeze and it cannot be charged or provide power to run the vehicle. Move the vehicle to a warm location.**

**NOTE:**

- **Connect the charger to the vehicle and place the power switch in the OFF position when parking the vehicle if temperatures may go below -4˚F (-20˚C). This provides external power to the Li-ion battery warmer (if so equipped) when it operates and does not discharge the Li-ion battery. Vehicle driving range is reduced if the Li-ion battery warmer (if so equipped) operates (Li-ion battery temperature approximately -4˚F (-20˚C) or colder) while driving the vehicle. You may need to charge the Li-ion battery sooner than in warmer temperatures.**
- **The Li-ion battery requires more time to charge when the Li-ion battery warmer (if so equipped) operates.**
- **The predicted charging time displayed on the meter and navigation system increases when the Li-ion battery warmer (if so equipped) operates.**
- **Vehicle range may be substantially reduced in extremely cold conditions (for example under -4˚F (-20˚C)).**
- **Using the climate control system to heat the cabin when outside temperature is below 32˚F (0˚C) uses more electricity and affects vehicle range more than when using the heater when the temperature is above 32˚F (0˚C).**
- **Climate control performance is reduced when using the Climate Ctrl. Timer or Remote Climate Control while the Li-ion battery warmer (if so equipped) operates. Set only the charging timer [End Time] when charging in cold weather. The vehicle automatically determines when to start charging to fully charge the Li-ion battery, even if the Li-ion battery warmer operates. Charging ends before the set end time if the Li-ion battery is fully charged.**

### FREEING A FROZEN DOOR LOCK

To prevent a door lock from freezing, apply deicer through the key hole. If the lock becomes frozen, heat the key before inserting it into the key hole or use the remote keyless entry key fob.

### ANTIFREEZE

In the winter when it is possible that the outside temperature will drop below 32˚F (0˚C), check the antifreeze to ensure proper winter protection. For additional information, refer to "Cooling system" in the "Maintenance and do-it-yourself" section of this manual.

### 12-VOLT BATTERY

If the 12-volt battery is not fully charged during extremely cold weather conditions, the 12-volt battery fluid may freeze and damage the 12-volt battery. To maintain maximum efficiency, the 12-volt battery should be checked regularly. For additional information, refer to "12-volt battery" in the

# Mitigation

Electric vehicles likely to run out of juice even before a single shift is over

However, quick charge options recharge to 80% capacity within 45 minutes

Hence the vehicle is capable of operating for 14 hours if two or three “quick charge” periods were utilized say over lunches and shift change

Requires specialized charging equipment & extreme cold may interfere

Note: fast charging may reduce battery life by 10% or more

https://thenextweb.com/shift/2020/03/13/scientists-fast-charging-destroys-electric-vehicle-batteries-tesla-panasonic/

# Saskatoon Picked Chevrolet Bolts

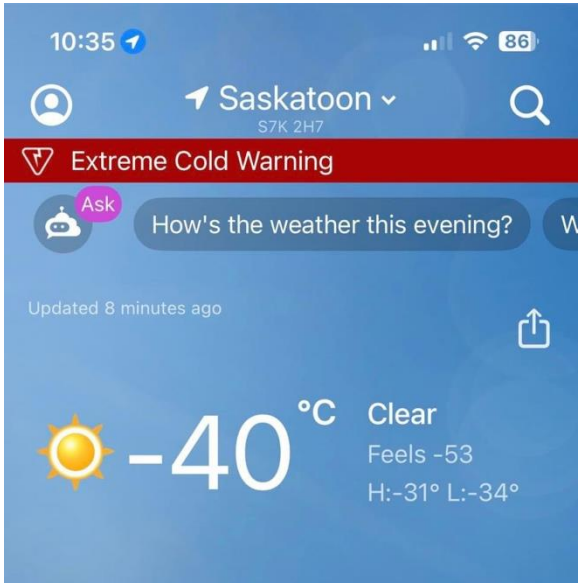


Electrons instead of gasoline

# City of Saskatoon - “The Winter City”

- Winter weather typical 5C to -30C
- 4 months a year with visible snow
- Mid-winter snow averages 20 cm
- Coldest in 2024 was -39.5C, windchill -53C
- Average coldest temperature since 1893 is -39.6C(1)
- Average in last 5 years -39.4 C(1)

(1) Source ExtremeWeatherWatch.com



# “The Winter City” Snow Adventures

- City experienced two major snowstorms in 2024.
- Record breaking snowfall (~40cm in 24 hours) & high winds
- City-wide “snow day” declared with civic services shut down.

# Deep Freeze

- Depleted battery reduced range (down ~20 to 30%)
- Constantly getting stuck
- Cabin temperature was hard to heat
- Battery recall forced outdoor parking
- Charging station issues

# Future Considerations

- Upfront capital costs?
- Charging outdoors vs. indoors?
  - Infrastructure?
  - Grid capacity?
  - How do you capture charging costs?
- Vehicle specifications? ie. Vehicle type, power draw, ground clearance, additional equipment, etc.

# EV Positives

- Excellent range & mileage in the warmer months
- Positive reduction in overall fuel costs
- Reduction in overall corporate GHG emissions


# We’re at a crossroads.....

# EV’s Frosty Reception

- Only 100 Battery EV’s registered in Saskatchewan
- City of Saskatoon built 4 free charging stations
- Collectively used only 3 times a day
- Tepid interest has raised considerable debate
- Some public questioning expense
- Does the city lead or follow public adoption?

# Ideas for Piloting EV

- Pilot EV with demands that are not critical
  - equipment that will not be missed if not working
  - e.g. SUV's used for staff
- Mission critical transport not advisable
  - Police, ambulance, fire
  - Snowplows, service vehicles (e.g. grid support)

# Pragmatic EV Alternatives

- Hybrids and Plug in hybrids
- Significantly reduce carbon fuel consumption
- Work reliably in bitter cold
- Makes a big step to carbon reduction
- A reliable solution for cold climates