MYTH BUSTING

Municipal Climate Change Action Centre

Electric Vehicles in the Winter

Overview:

Each year more Albertan's are buying and driving electric vehicles (EVs). Despite their increasing popularity, cold weather performance is often cited as the key reason to not purchase an EV. While Alberta's winters are harsh, and cold weather does impact EV battery performance and charging speeds, the impacts are often exaggerated. To learn more and dispel some common winter performance myths and misconceptions we tested how a fully electric 2023 Hyundai Kona performed in cold weather.

Case Study One: Greater Edmonton Area (-23°C)

We drove the electric Hyundai Kona around the greater Edmonton area in -23 °C weather. The total route was 119 kilometres with two charging stops. The trip was divided into three parts:

- Part One: 53 kms
- Part Two: 35 kms
- Part Three: 31 kms

The Kona was unplugged and heated to a cabin temperature of 21 °C prior to leaving. Heating the cabin used approximately 3% of the battery capacity. Throughout the duration of the trip the internal cabin temperature was maintained at roughly 21 °C, however the fan speed was adjusted several times. In typical summer driving temperatures (15-25 °C), the Kona has an approximate range of 420 kilometres. However, after being parked in the -23 °C cold for several days, the Kona had a usable range of 260 kilometres.

Results

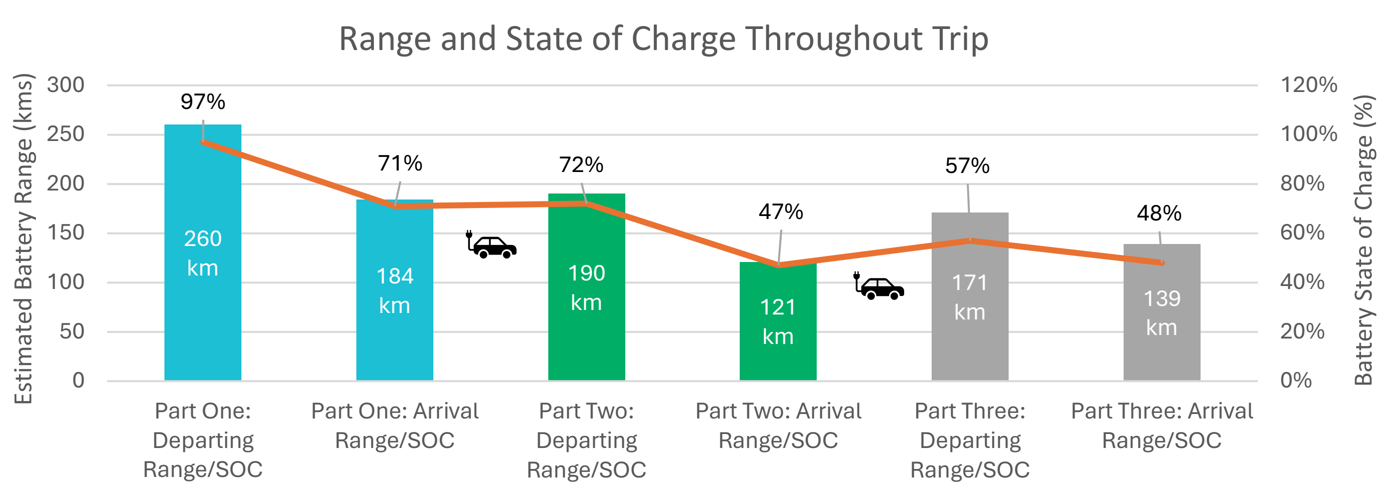


Figure 1: Kona's estimated remaining range (displayed as bars) and the remaining state of charge (displayed as a line) throughout the duration of the trip. The Kona was charged between parts one and two, and parts two and three.

Indicates charging period.

Produced as part of the **Zero-Emission Vehicle Awareness Initiative**

Partially funded by Canada

Partially funded by Alberta

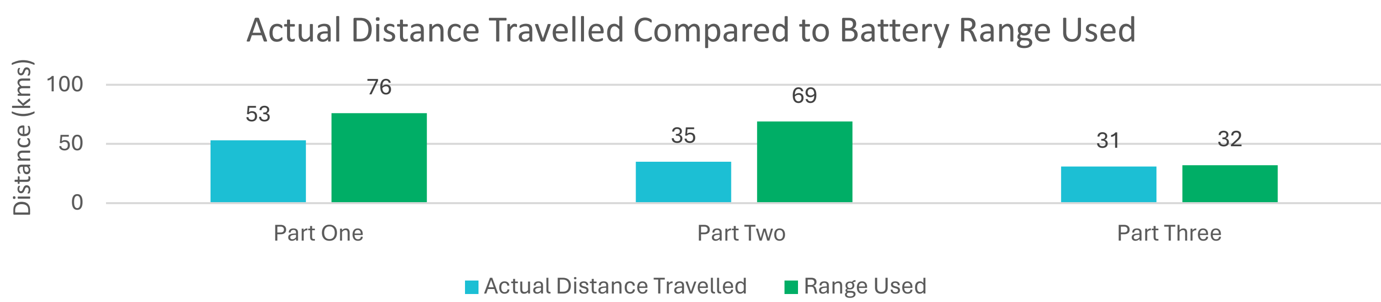


Figure 2: Outline of the actual distance travelled (kms) compared to the range used by the Kona (km).

Average Outdoor Temperature (C°)	Average Indoor Temperature (C°)	Actual Distance Travelled (km)	Total Range Used (km)	Average Efficiency (kWh/100 km)
-23	21	119	171	24.5

Figure 3: Average outdoor/indoor temperatures, the total distance travelled, total range used, and average efficiency.

Charge One – 50 kW Rated DC Fast Charger		
Time Spent Charging (mins)	Energy Delivered to Kona (kWh)	Peak Power Output (kW)
5	1	12
Charge Two – 50 kW Rated DC Fast Charger		
Time Spent Charging (mins)	Energy Delivered to Kona (kWh)	Peak Power Output (kW)
20	8.6	45

Figure 4: Time spent charging, the energy delivered, and maximum power output of both charging stops.

Case Study Two: Round Trip - Edmonton to Calgary (-7C)

We took the electric Kona on a round trip in mild winter temperatures (-4 °C to -10 °C). The total route was 606 kilometres, with three fast charging stops (two stops in Red Deer and one stop in Calgary). The trip was divided into four parts:

- Part One: 145 kms
- Part Two: 142 kms
- Part Three: 171 kms
- Part Four: 147 kms

Prior to departing the charging stations, the Kona was pre-heated while plugged in to maximize usable range. Throughout the duration of the trip the internal temp was maintained at 21 C°, however the fan speed was adjusted several times.

Results

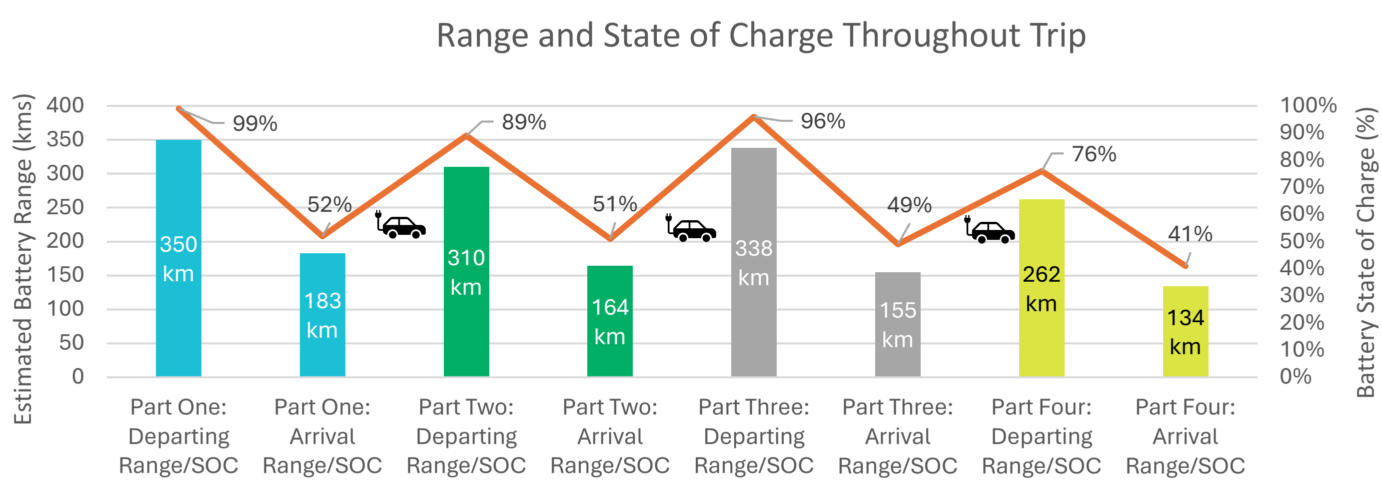


Figure 5: Kona's estimated remaining range (displayed as bars) and the remaining state of charge (displayed as a line) throughout the duration of the trip. The Kona was charged between parts one and two, two and three, and three and four.

Produced as part of the **Zero-Emission Vehicle Awareness Initiative**

Partially funded by Canada

Partially funded by Alberta

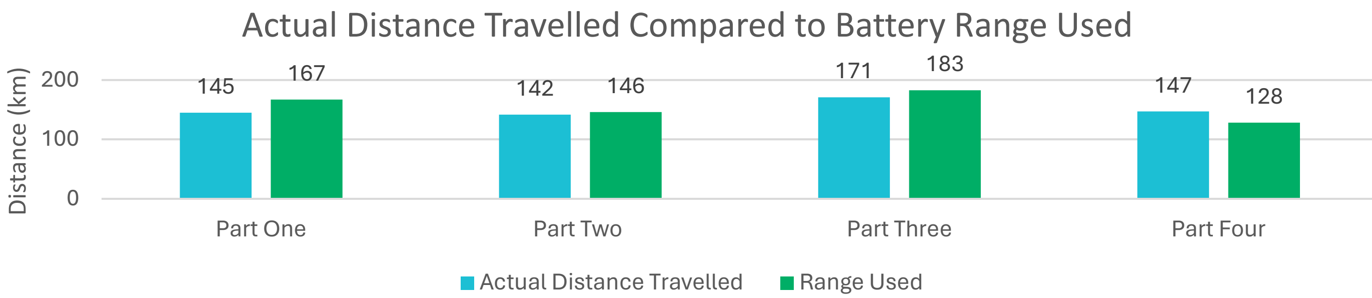


Figure 6: Outline of the actual distance travelled (km) compared to the range used by the Kona (km).

Average Outdoor Temperature (C°)	Average Indoor Temperature (C°)	Actual Distance Travelled (km)	Total Range Used (km)	Average Efficiency (kWh/100 km)
-7	21	606	624	19.2

Figure 5: Outline of the average outdoor/indoor temperatures, the total distance travelled, total range used, and average vehicle efficiency.

Red Deer Charge One – 350 kW Rated DC Fast Charger		
Time Spent Charging (mins)	Energy Delivered to Kona (kWh)	Peak Power Output (kW)
68	30	43
Red Deer Charge Two – 350 kW Rated DC Fast Charger		
Time Spent Charging (mins)	Energy Delivered to Kona (kWh)	Peak Power Output (kW)
33	24	40

Figure 6: Outline of the time spent charging, the energy delivered, and max power output of the charging stops in Red Deer. Both charging stations were rated as 350 kW, however the Hyundai Kona can only accept up to 100 kW of power.

Key Observations

1. Heating and climate control had the greatest impact on usable battery range. Increasing heat and fan speed immediately reduced the vehicle's range and state of change.
2. The Hyundai Kona's estimated available range was not always accurate. In each leg of the trip except one, more range was consumed than actual distance driven. For Case Study One, on average, for every 1 kilometre driven the estimated range dropped by approximately 1.5 kilometres. This was likely due to adjustments of the internal fan speed and temperature at various times, and the changing outdoor temperature.
3. Charging station performance and reliability was more of an issue than driving range and vehicle performance. Unfortunately, the first charging stop in Case Study One was cut short as the Direct Current Fast Charger (DCFC) had issues connecting to the network and maintaining power output, so only 1 kWh of energy was delivered over 5 minutes. In Case Study Two, we were unable to gather sufficient data from the DCFC due a display error, however, the charger was able to maintain power output. In all charging scenarios, the time required to charge was longer than anticipated, and the maximum power output (kW) of the chargers was significantly reduced. This was likely due to the cold temperature of the Kona's battery, which limits the amount of power it can accept, as well as the inability of the charger to output rated power at colder temperatures.
4. Despite the cold temperatures, the Kona performed very well in certain aspects. There were no issues starting the vehicle, the cabin heated very quickly, the vehicle handled very well in the winter conditions, and due to the shorter duration of the trip there were no issues regarding usable range.
5. The cost to charge the Kona was significantly cheaper than the cost to refuel a comparable Internal Combustion Engine (ICE) vehicle. For reference, the cost to charge in Red Deer at the Electrify Canada stations was $0.60/kWh. This equates to approximately $38.40 to recharge the entire 64 kWh battery. However, the cost to refuel a ICE Kona with a 50-litre tank would be roughly $70.00 ($1.40/litre of gasoline).

Partially funded by Canada
Partially funded by Alberta

Why EV Performance Dips in Winter

EVs have less usable range in colder temperatures. A study of over 10,000 EVs by Recurrent found that EVs lose roughly 30% of their range in freezing conditions. There are two key reasons for this loss of range:

Battery Chemistry

Battery reactions occur more slowly in colder temperatures. This temporarily reduces the battery's range. As temperature rises, reactions occur more easily, increasing usable range.

Climate Control

Combustion vehicles use waste heat generated from the engine to heat the cabin. In EVs, heat is generated from the battery, as more heat is needed, more energy from the battery must be used, therefore decreasing range.

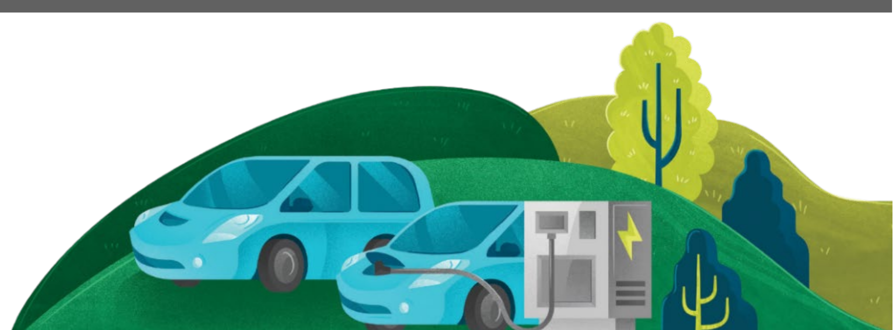
How to Improve Winter Performance

1. **Pre-heat the cabin:** Heat the cabin while plugged in. This uses energy from the charger rather than the battery. Many EVs can schedule automatic cabin heating before your trip.
2. **Reduce unnecessary cabin heating:** When possible, try to avoid excessive cabin heating and continuous high fan speeds. Many EVs have the option to focus air flow and heating on the driver only.
3. **Prepare the battery for charging:** Some EVs will heat the battery to an optimal charging temperature when a charging stop is added to the onboard navigation system. This will increase charging speeds upon arrival.
4. **Plan fast charging ahead of time:** Charging is the most challenging and time-consuming aspect of winter EV road trips as the charging network is still evolving. Plan charging stops at charging stations with high charging speeds (100 kW and above) if possible. Use PlugShare.com to plan stops at highly rated fast chargers.

Advantages of Driving an EV in the Winter

Despite the challenges of decreased range and charging speeds, EVs do boast several winter driving advantages.

1. **Reliability:** Unlike a combustion engine vehicle, an EV will always start regardless of the temperature.
2. **Improved control:** On average EVs are roughly 30% heavier than ICE vehicles and have a lower centre of gravity. This can increase traction and driver control in winter driving conditions.
3. **Instant heat:** As heat is produced instantly via electric resistance, drivers do not have to wait long for windows to defrost or for the cabin to warm.
4. **No need to idle:** Since EVs produce heat through electricity, there's no need to idle the vehicle waiting for the cabin or engine to warm up. Just get in and go.
5. **Reduced travel costs:** EVs are more efficient and cheaper to operate. This leads to significantly reduced fuelling costs in all seasons, including winter.



Produced as part of the **Zero-Emission Vehicle Awareness Initiative**

Partially funded by Canada

Partially funded by Alberta