Developing Zero-Emission Vehicle Transition Recommendations for Glacier National Park

Supplemental Materials

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Abstract

In an effort to combat climate change, President Biden issued Executive Order 14008, which mandates that all federal agencies transition their fleets to zero-emission vehicles by 2050. We assisted Glacier National Park in developing a phased approach to this transition. We assessed the Park's fleet needs, examined current and projected zero emission technology, identified potential sources of funding, explored other government entities that had converted their fleet to zero emission vehicles, and developed recommendations. We proposed four scenarios for phased implementation timelines. Each scenario differed in amount and timeline of funding and technological advancements and recognized financial, technological, infrastructure, and energy uncertainties.

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Appendices

Appendix A
Informed Consent Preamble

“We are a group of students from Worcester Polytechnic Institute in Massachusetts and we are working with Glacier National Park. We are working to help the park’s fleet management transition their vehicles to zero-emission options by the year 2050. The motivation for this project is the release of EO 14008 by President Biden, which requires all federal fleets to transition to zero-emission vehicles by 2050. The interview should take about 30-45 minutes. Your participation in this study is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous unless you give approval to use your name. Your participation is greatly appreciated. If you have additional questions, you may reach out to our faculty advisors (cdehner@wpi.edu, stuler@wpi.edu, and bianchi@wpi.edu). If you would like, we are happy to share our results at the conclusion of the study, or you can find the final report at https://wp.wpi.edu/glacier/projects/.”

Appendix B
Representative Sample of GNP Fleet

Light truck Medium Truck Heavy TruckSUV Sedan Bus *classified by GPS' inventory of light, medium, and heavy

½ ton truck, 0I511250 2010 Ford F150,1/2 ton pickup, monthly average 471mi, daily approx 15.7mi
Ford Pickup 4x2 I271250 , monthly mileage 1328, daily approx 44.3 mi

1 ton truck, 0I410886 2005 Chev Sil3500,4X4,1 ton, monthly mileage 4460mi, daily approx 153.8mi
¾ ton truck, Chev,3/4 ton,4X4,Silpu I271806 0I271806: Month mileage 944 mi - daily average about 35 mi
4X4 Flatbd 0I515910 2015 Ford F-350, Stand Cab: 124 miles in one day, average is about 108 miles a day
Pump Truck HB Utilities 0I414472: Month mileage 1,380 mi - daily average about 81 mi

Becker fire equip 0I253980 1999,NPS Version: about 100 miles a day in sept 2020
Utility Truck,Unimog,4X4 2005 0I410893: Month mileage 1,133 mi - daily average about 37 mi (winter/off season)
Garbage Truck, 0I275384 Autocar, Front Load Compactor, Garbage, Monthly mileage 1006mi, Daily approx 30.5 mi
HB Roads Dumptruck/Snowplow Navistar Int 0I414037: Month mileage 261 mi - daily average 10 mi - not sure if accurate for plow

Chevy Tahoe 0I267575 - 1278 mi month, daily approx. 44mi
SUV? 0I253368 Jim Dalstrom - North Fork Ranger: Month mileage 843 mi - daily about 28 mi
Ford Explorer 2017 (SUV) 0I413994: Month mileage 738 mi - daily average about 24 mi
GMC Terrain 0I519279 2019 - CCRLC - Tara Carolin: daily avg. about 48 miles

Sedan,0I511242 2009 Toyota Prius hybrid, monthly 2760 mi, daily approx 92.3mi
Sedan - 2009 Chevy Impala 0I515766 Motorpool I515766: daily avg about 40 miles

Bus, 0I413992 2016 Glaval Concorde II Medium Duty Bus, monthly mileage 1200mi, daily approx 171.4mi
Freightliner Sprinter (van), 2015, 0I413218 : Month mileage 5,850 mi - daily average about 195 mi

Appendix C
ICE and ZEV comparison tables

Trucks Criteria Comparison						
Truck GVWR [lbs]	**Criteria**					
	Special Uses	**Seasons of Operation**	**Off Road Capabilities [Drive train]** [1]	**Mileage Range [Miles]** [1]	**Cost [$]** [1]	**Passenger Capacity** [1]
0-14,000 (Light) ICE	-Personal Transport -Equipment and tools storage	All Seasons	4x4 4x2	380-530	40,000 - 46,000	6
0-14,000 (Light) ZEV	-Personal Transport -Equipment and tools storage	Possible performance decline during winter	4x4 4x2	250-500	39,974-80,000	5-6
14,001-26,000 (Medium) ICE	- Personal transport - Flatbed towing - Equipment and tools storage - Dump bed	All Seasons	4x4 4x2	310-570	55,000-62,000	5-6
14,001-26,000 (Medium) ZEV	-Cargo transportation -Waste Collection -Light Construction Transports	Possible performance decline during winter	4x4	No data available	No data range available yet	2-4
26,001->33,000 (Heavy) ICE	- Special equipment - Garbage Truck -Fire Truck -Snowplows -Rotaries -etc.	All Seasons	Caterpillars Untypical wheel count	*conclusive data could not be gathered from research*	*conclusive data could not be gathered from research*	2
26,001->33,000 (Heavy) ZEV	-Cargo transportation -Fire trucks -	Possible performance decline during winter	4x2 6x2 6x4	No data available	No data available	2-4

Citations:
(Edmunds, n.d.)
(Loveday, 2021)
(Volvo, n.d.)

(Ford, n.d.)

SUVs and Sedans and Buses Criteria Comparison						
Vehicle Type	**Criteria**					
	Special Uses	**Seasons of Operation**	**Off Road Capabilities [Drive train]**	**Mileage Range [Miles]**	**Cost [$]**	**Passenger Capacity**
SUV ICE	Personal transportation, light equipment transportation, law enforcement	All Seasons	4x4 4x2	297- 377	35,000-52,000	5-7
SUV ZEV	Personal transportation, light equipment transportation, law enforcement	Possible performance decline during winter	4x2 AWD	247-400	33,000 - 106,000	5-7
Sedan ICE	Personal Transport	Summer (primarily)	4x2	323 - 571	25,000-32,000	5
Sedan ZEV	Personal Transport	Possible performance decline during winter	4x2 AWD	259 - 400	31,995-80,000	5
Bus/Shuttle ICE	Transportation of people	Summer (primarily)	4x2 4x4	320-440	30,000-145,000	15-45
Bus/Shuttle ZEV	Transportation of people	Possible performance decline during winter	4x2 4x4	158-329	$750,000	20-40

Citations:
Citations:
(Department of Transportation, n.d.)
(Edmunds, n.d.)
(EVAdoption, n.d.)
(Dodge Cars, n.d.)
(GMC, n.d.)
(Proterra, n.d.)
(BYD, n.d.)

Appendix D
ZEV Infrastructure Requirements

ZEV Infrastructure Requirements						
Vehicle Type	Efficiency [kwh/mile]	Vehicle Miles Travelled per Day [miles]	Average Power Demand per Vehicle [kw] *Assuming 12 hour overnight charge*	Quantity	Average Total Power Demand per Vehicle Type [kW] *Assuming 12 hour overnight charge*	Type of Chargers Required
Sedan	0.35	40-90	1.2 - 2.6	7	8.4 - 18.2	Level 1
SUV	0.4	25-100	0.8 - 1.7	18	14.4 - 30.6	Level 2
Buses	2.84	170-200	40.2 - 47.3	74	2974.8 - 3500.2	Level 3
Light Duty Truck	0.75	15-45	0.9 - 2.8	39	128.7	Level 2
Medium Duty Truck	1.0	80-150	6.7 - 12.5	52	348.4 - 650	Level 3
Heavy Duty Truck	3.4	30-100	8.5 - 28.3	33	280.5 - 933.9	Level 3

Citations:
(Eco, 2021)
(Eudy & Jeffers, 2018)
(Kane, 2020)
(PG&E, 2019)

Appendix E
Basic Charging Infrastructure Information

Charger Type	Level 1	Level 2	Level 3 (DC Fast Charge)
Voltage	120	240	480
Charging Rate*	3-5 miles/hour	10-20 miles/hour	80% in 30 minutes
Number of Chargers Recommended **	5	20	40
Cost of Installation per 1 charger ($)***	0	1,354 - 3,108	22,626

*Charging rates vary between electric vehicles and chargers
**Assuming constant usage of entire park fleet
***Cost as of 2018

Appendix F

Funding/Grants Suggested by Department of Energy Vehicle Technologies Office

The following information was given by the Department of Energy as suggestions for grants and funding opportunities that Glacier National Park may be eligible for.

Please refer to the Alternative Fuels Data Center (AFDC) Laws and Incentives page (https://afdc.energy.gov/laws/) for information on current incentives and laws pertaining to alternative fuels and advanced vehicles. The Search page (https://afdc.energy.gov/laws/search) allows you to identify specific incentives by jurisdiction (e.g., federal, Montana), technology/fuel type (e.g., electric vehicles (EV)), incentive type (e.g., grants), and user type (e.g., government entity). You may view federal and state incentives at https://afdc.energy.gov/laws/fed_summary and https://afdc.energy.gov/laws/state, respectively. In addition to ZEV Infrastructure and Advanced Vehicle Grants (https://afdc.energy.gov/laws/12620), the following funding programs may also be available to national parks.

Congestion Mitigation and Air Quality (CMAQ) Improvement Program (https://afdc.energy.gov/laws/284)
The CMAQ Program provides funding to state departments of transportation (DOTs), local governments, and transit agencies for projects and programs that help meet the requirements of the Clean Air Act by reducing mobile source emissions and regional congestion on transportation networks. Eligible activities include transit improvements, travel demand management strategies, congestion relief efforts (such as high occupancy vehicle lanes), diesel retrofit projects, and alternative fuel vehicles and infrastructure. Projects supported with CMAQ funds must demonstrate emissions reductions, be located in or benefit a U.S. Environmental Protection Agency (EPA)-designated nonattainment or maintenance area, and be a transportation project. For more information, see the FAST Act CMAQ fact sheet (http://www.fhwa.dot.gov/fastact/factsheets/cmaqfs.cfm) and CMAQ Improvement Program website (http://www.fhwa.dot.gov/environment/air_quality/cmaq/). (Reference Public Law 112-141, 23 U.S. Code 149, and 23 U.S. Code 151)

Low and Zero Emission Public Transportation Research, Demonstration, and Deployment Funding (https://afdc.energy.gov/laws/11552)
Financial assistance is available to local, state, and federal government entities; public transportation providers; private and non-profit organizations; and higher education institutions for research, demonstration, and deployment projects involving low or zero emission public transportation vehicles. Funding opportunities include the Public Transportation Innovation Program (https://www.transit.dot.gov/funding/grants/public-transportation-innovation-5312) and the Low or No Emission (Low-No) Vehicle Program (https://www.transit.dot.gov/funding/grants/low-or-no-emission-vehicle-program-5339c, https://www.transit.dot.gov/notices-funding/low-or-no-emission-program-low-no-program-fy2021-notice-funding). Eligible vehicles must be designated for public transportation use and significantly reduce energy consumption or harmful emissions compared to a comparable standard vehicle. For more information, see the FAST Act Section 5312 fact sheet

(https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/5312_Public_Transportation_Innovation_(Research)_Fact_Sheet.pdf) and the MAP-21 website (https://www.transit.dot.gov/regulations-and-guidance/legislation/map-21/map-21). (Reference Public Law 113-159, Public Law 114-94, 49 U.S. Code 5312, and 49 U.S. Code 5339(c))

Point of Contact
Federal Transit Administration, Office of Program Management
U.S. Department of Transportation (DOT)
Phone: (202) 366-2053
http://www.fta.dot.gov

Appendix G

Funding/Grants Opportunities Suggested by Department of Energy Vehicle Technologies Office

The following information was given by the Department of Energy as suggestions for grants and funding opportunities that Glacier National Park may be eligible for.

We recommend reviewing the following websites to identify additional transportation-related funding opportunities:

- **DOT, Federal Highway Administration -** https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/resources/ev_funding_report_2021.pdf
  - Summarizes which programs are available to plan for and build EVSE; support workforce training for new technologies; and integrate EVs as part of strategies to address commuter, freight, and public transportation needs.
- **DOT Grants -** https://www.transportation.gov/grants
  - Provides information on grants for programs and projects to help build up and maintain a fast, safe, efficient, accessible, and convenient transportation system.
- **Grants.gov -** http://www.grants.gov/
  - This provides information in a standardized format across federal agencies and includes a "Search Grants" feature to help applicants find potential funding opportunities.
- **U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Funding Opportunity Exchange -** https://eere-exchange.energy.gov/
  - DOE makes funding available through competitive funding opportunity announcements (FOAs), published on grants.gov or the EERE Exchange. You may review frequently asked questions about a specific FOA or general guidance at https://eere-exchange.energy.gov/FAQ.aspx.
- **Clean Cities Coalition Network Funding Opportunities -** https://cleancities.energy.gov/funding-opportunities/
  - Lists current financial opportunities available for Clean Cities Coalition Network projects, related financial opportunities available through other organizations and federal agencies, and previously funded Clean Cities Coalition Network projects.
- **EPA Grants -** https://www.epa.gov/grants
  - Provides links to resources with information on available EPA funding, instructions on how to apply, and additional grant resources.

As you may be aware, the National Park Service is subject to President Biden's Executive Order (EO) that calls for the deployment of clean and zero-emission vehicles in the U.S. fleet (https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad). Under said EO, the General Service Administration (GSA) must carry out the following directives:

- Develop a comprehensive plan to facilitate clean and zero-emission vehicles for federal, state, local, and tribal government fleets, including vehicles of the U.S. Postal Service.
- Submit the plan to the National Climate Task Force by April 27, 2021.

In an update on April 22, 2021, the White House announced progress on the transition to a ZEV fleet (https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/22/fact-sheet-biden-administration-advances-electric-vehicle-charging-infrastructure/).

> *"The Council on Environmental Quality and the General Services Administration are announcing early progress in response to the Executive Order directing the federal government to transition to a ZEV fleet. Since inauguration day, the administration has acquired more ZEVs than in the whole previous fiscal year. Additionally, we are on track to triple the number of total ZEVs added to the fleet this year compared to last. Installing EV charging infrastructure at federal facilities is a key component of the transition to a zero-emission fleet."*

More funding for national parks may become available as progress is made on the above EO.

Appendix H
Interview Questions for Patrick Glynn, GPS Fleet Manager

1. What tasks do [insert group of vehicles] perform? - can be answered generally
    a. trucks
    b. buses
    c. SUVs
    d. sedans
    e. vans
    f. station wagons
2. What do these tasks involve? About how far/long must the vehicle travel to perform such a task? How often is this task usually performed?
3. Which vehicles have an off-season, and when does this off-season occur?
4. Are there any employees that have knowledge about any or all the vehicles that you could direct us toward for further questions about vehicle tasks?
5. Do you collect any data on how much fuel the vehicles use, mileage, costs of fuel?
6. Which vehicles are currently first in line for replacements?
7. How many vehicles are usually replaced each year? (In the past five or so years, how many vehicles were replaced?)
8. Where are vehicles kept? (trucks, buses, SUVs, vans, etc.)
9. Which vehicles are you especially worried about when it comes to the replacement with a ZEV that needs regular charging?

Appendix I
Interview Questions for Chriz Baltz, GPS Fleet Clerk

1. Can you tell us more about your job with Glacier National Park?
2. Do you have any data on fleet utilization? If so, what kind of data?
    a. What vehicles are utilized the most?
        i. How is heavy equipment/vehicles utilized within the park? How frequently?
    b. Do you have data on vehicle mileage?
    c. Do you have data on fuel consumption?
    d. Is our team able to access this data? If yes, where can we find it?
3. Do you have concerns about a full fleet transition to zero emission vehicles?
4. Is there anyone else you recommend we speak with?

Appendix J
Interview Questions for Micah Alley, GPS Ranger Operations Coordinator

1. Can you tell us more about your job as a ranger with Glacier National Park?
2. What park-owned vehicle do you typically drive?
3. Where/when do you fuel your park-owned vehicle? Do you typically keep track of fuel consumption and costs spent on refueling your vehicle?
4. Are there any periods of time during the day in which your vehicle is not in use? How long/consistent are these breaks?
5. Do you personally use vehicles during the off-season? If so, how often and what your typical tasks are?
6. What is a typical daily route for you?
    a. Mileage
    b. Terrain
7. Do you have any experience with zero-emission vehicles (electric, hydrogen fuel cell, etc.)? Do you have any concerns about this zero-emission vehicle transition that the Glacier fleet must undergo by 2050?
8. Is there anyone else you recommend we speak with?
9. If we have additional questions, is it okay if we follow up with you?

Appendix K
Interview Questions for Michael Madej, NPS Alternative Transportation Program Manager

1. Can you tell us more about your role as Alternative Transportation Program Manager?
    a. What are the other parks within the region that you work with?
2. What past alternative transportation projects have you managed in the past? What were some challenges faced? How did you respond to these?
3. Do you know anything about the park's that have already begun transitioning their bus fleet to battery electric buses such as Zion and Yosemite?
4. Have you started considering how you will advise funding for federal fleet transitions to zero-emission vehicles?
    a. Are there any financial incentives/programs that you rely on the most?
5. What are your concerns with entire national park fleets converting to zero-emission vehicles?
    a. What is your forecast on how the fleets will be re-arranged? How do you think funding will be distributed up to the 2050 deadline?

Appendix L
Interview Questions for Lacy Kowalski, Glacier Conservancy Associate Director of Programs and Policy

1. Can you tell us more about your job with the Glacier Conservancy
2. We understand from our research that the Conservancy fundraises for park related projects, can you tell us a bit about the Glacier Conservancy and its relationship with the park?
3. Are you able to inform us of the details of the largest fundraising project you have conducted for Glacier National Park (project type, donation sources, total cost)
4. Has this kind of project (zero-emissions vehicle transition) been discussed already by the conservancy?
5. Is helping to fund a transition to zero-emission vehicles for Glacier National Park within the scope of your partnership?
6. Do you know of any potential funding sources, financial incentives or other financial opportunities that could help the park transition its fleet of 250 vehicles to zero emissions?
7. Is there a specific person you know who would be best to discuss this kind of project with or anyone else you recommend we speak with? If so, could their contact info be provided?
8. If we have additional questions, is it okay if we follow up with you? Would you prefer email or phone?

Appendix M
Interview Questions for Deirdre Hanners, Zion National Park Safety, Health, and Wellness Manager, and Jenny Staroska, Zion National Park Transportation Manager

1. How is Zion National Park planning on responding to President Biden's executive order calling for all federal fleets to be fully zero-emission by 2050?
2. Have you started transitioning to zero emission vehicles (ZEVs)? If so, how many vehicles have you successfully transitioned?
3. What challenges did you encounter in transition planning and/or implementation?
4. What was/is your approach to transitioning? For example, did you develop possible transition scenarios, and if so, how did this process go?
5. Have you developed any charging infrastructure within the park? If so, what type(s) and how did you decide what locations would be most suitable for the charging stations?
6. Did you have any discrepancies with energy consumption? If so, how did you work around this?
7. Did you receive financial assistance from any outside organizations? If so, can you provide the names of the organizations?
8. Do you have any general advice for us in creating ZEV transition scenarios for Glacier National Park?

Appendix N
Interview Questions for Joni Gallegos, NPS PFMD Transportation

1. Can you tell us more about your role at the National Park Service?
2. What are some of the projects you have worked on?
3. Has the National Park Service begun thinking about how it will respond to President Biden's executive order about all federal fleets converting to zero emissions by 2050?
4. Do you know anything about the park's that have already begun transitioning their bus fleet to battery electric buses such as Zion and Yosemite?
5. Do you have any concerns with the complete transition of federal fleets to zero-emission options by 2050?