Rocky Mountain Power
Exhibit RMP___(JAC-5)
Docket No. 20-035-34
Witness: James A. Campbell

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF UTAH

ROCKY MOUNTAIN POWER

Exhibit Accompanying Direct Testimony of James A. Campbell

USU Analysis

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UtahStateUniversity

ASPIRE
NSF Engineering Research Center

MEMO

To: Rocky Mountain Power

From: Utah State University / ASPIRE Engineering Research Center

Date: December 29, 2020

Subject: Utah EV Adoption Forecast and DC Fast Charger Utilization

Executive Summary

This report provides adoption forecasts for electric vehicles (EVs) in Utah resulting from Rocky Mountain Power programs and provides estimates for the demand, utilization, and revenue from public DC fast charging (DCFC).

In Utah, vehicles travel approximately 30 billion miles per year, with roughly 72% in urban and 28% in rural regions. Today, Utah has roughly 3 million total registered vehicles, with 1.28 million light duty passenger, 1.23 million SUVs and light trucks, and 87,000 heavy trucks.

In this report, it is estimated that by 2030 with a medium adoption curve, there will be an estimated 180,000 electric vehicles registered in Utah with an estimated total annual EV charging demand of 700 million kWh. It is further estimated that by 2030 the total demand for public DC fast charging (DCFC) will reach 140 million kWh, requiring approximately 100 DCFC locations with multiple charging plugs at a combined 700 kW peak power rating to meet the demand. Utilization levels of DCFC locations are expected to reach approximately 30% or higher by 2030, resulting in an annual revenue per station of roughly $230,000. Adoption levels and revenues are expected to be lower prior to 2030 during the early adoption years. Early investment in DCFC infrastructure at the levels shown through 2030 will be essential to reach the adoption levels predicted that will sustain the high levels of utilization and average revenue estimated per DCFC location.

Electric Vehicle Adoption Forecast

Dr. Ziqi Song at USU provided a forecast estimate for light duty electric vehicle (EV) adoption in Utah as part of the final report for the WestSmartEV project. The forecast included standard passenger vehicles and light-duty trucks (weighted 6,000 lbs or less, which include SUVs and pick-up trucks) in Utah. The forecast used the Bass model defined as:

$$F(t) = M\frac{1 - e^{-(p+q)t}}{1 + (q/p)e^{-(p+q)t}}$$

Where:

$F(t)$: cumulative adoption by time t

M: market potential, need to be estimated in advance

p: coefficient of innovation

q: coefficient of imitation

The coefficients p and q were calibrated by the historical EV adoption data collected from the Alliance of Automobile Manufacturers (AAM) and Utah DMV for passenger vehicles, and similar adoption patterns were assumed for light-duty trucks and SUVs. Three scenarios were considered: a low estimate with an EV market potential of 30%, a medium estimate with an EV market potential of 45%, and a high estimate with an EV market potential of 60%.

In this report, the adoption model is further modified to include adoption of heavy duty trucks and to include the growth rate in total vehicles. Heavy duty trucks were added starting with State of Utah motor vehicle statistics [State] and then applying similar adoption patterns as developed for light duty, but with a six year delay in adoption due to delayed availability of heavy duty vehicles. The growth rate was added by assuming vehicle growth rate tracks population growth rate, and population growth rates per year were applied according to the estimates from the Gardner Policy Institute projections [Table 5, Gardner]. The resulting updated adoption model results for predicted total combined light and heavy duty EVs in Utah are depicted in Figure 1 and summarized for 2026 and 2031 in Table 1. For example, by 2031 with the medium adoption curve, there will be an estimated 230,000 electric vehicles registered in Utah.

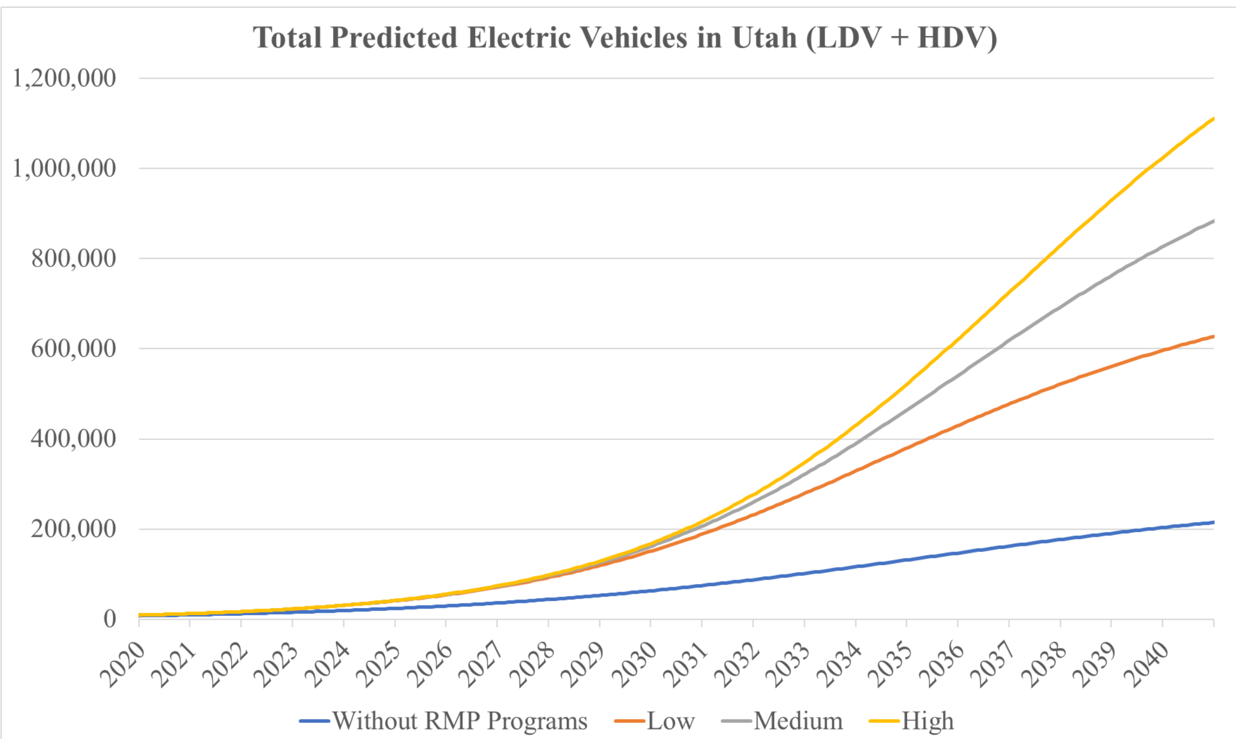

Figure 1. Plot of total predicted EVs in Utah (combined light to heavy duty) for low, medium and high adoption scenarios.

Table 1. Total predicted EVs in Utah (combined light to heavy duty) in 2026 and 2031.

	W/out RMP	Low	Medium	High
2026	32,000	61,000	63,000	63,000
2031	80,000	208,000	230,000	243,000

Charging Demand and Charger Utilization Forecast

The total charging demand for EVs in Utah was estimated by assuming the following averages for vehicle energy usage and miles driven. The impacts of EVs from Utah charging while out of state and of EVs from out of state charging while in Utah were neglected. It is expected that these impacts would result in higher demand than predicted due to the high levels of tourism and freight in Utah from out of state.

Table 2. Assumptions for EV energy consumption and miles traveled per year in Utah.

Average light duty vehicle kWh per mile	3
Average light duty vehicle miles per year	10,000
Average heavy duty vehicle kWh per mile	0.5
Average heavy duty vehicle miles per year	50,000

The total charging demand was calculated based on the total vehicles predicted in Figure 1 and the vehicle consumption information from Table 2. The resulting forecast for the total charging demand for EVs in Utah is depicted in Figure 2 and summarized for 2026 and 2031 in Table 3. For example, by 2031 with the medium adoption curve, the estimated total annual EV charging demand in Utah will reach 882 million kWh.

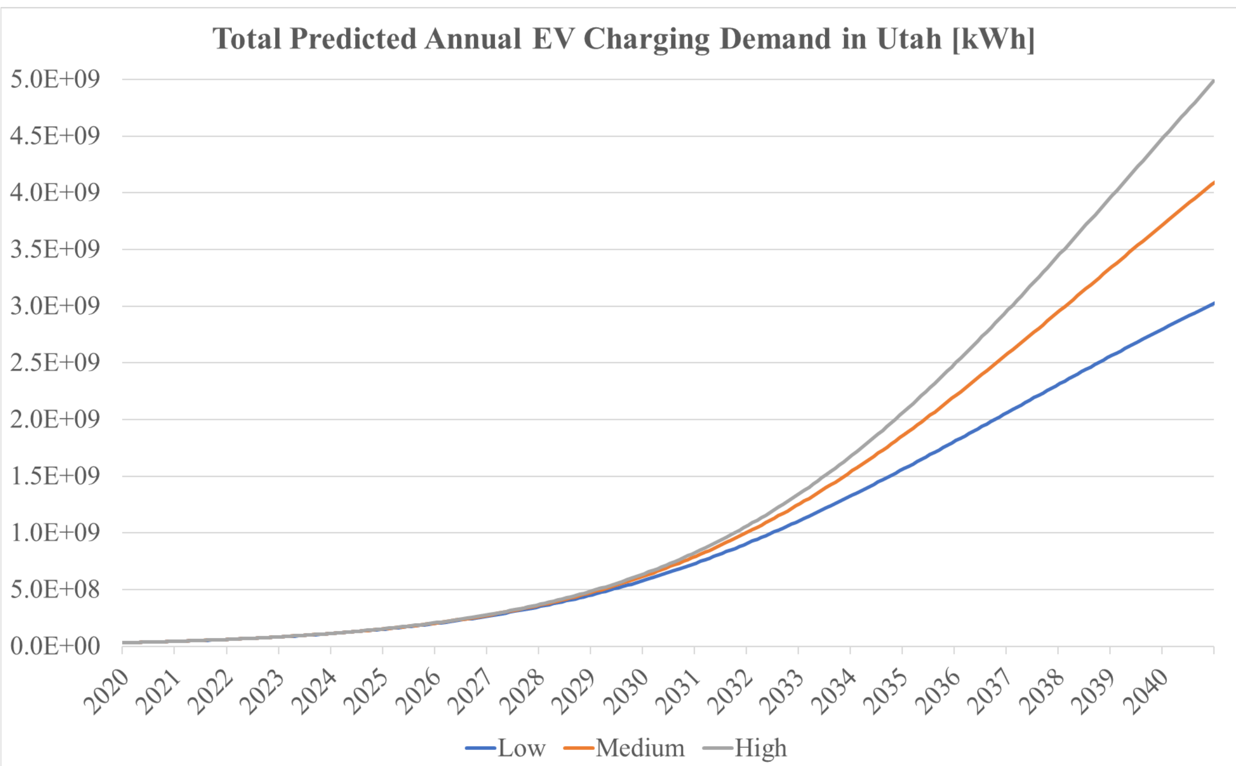

Figure 2. Total predicted annual charging demand in kWh for EVs in Utah (combined light to heavy duty, all charging from level 1 home charging to public DC fast charging).

Table 3. Total predicted annual charging demand in kWh for EVs in Utah in 2025 and 2030 (combined light to heavy duty, all charging levels from level 1 home charging to public DC fast charging).

	Low	Medium	High
2026	230,000,000	235,000,000	237,000,000
2031	807,000,000	882,000,000	926,000,000

The forecast total demand for DC fast charging in Utah was predicted by estimating the percentage of EV charging that will utilize DC fast charging. This estimate was based on the McKinsey study [McKinsey], showing significant growth in the need for public and fast charging at higher adoption levels, particularly in more urbanized regions, to accommodate vehicle owners without private parking at home or work and scenarios where vehicles are operated more continuously throughout the day (e.g. fleet, taxi, Uber/Lyft).

The resulting forecast for EV DC fast charging demand in kWh in Utah is depicted in Figure 3 and summarized in Table 4 for 2026 and 2031. For example, the estimated total annual demand in Utah for DCFC in 2031 with the medium adoption curve is 191 million kWh (i.e., 191,000 MWh).

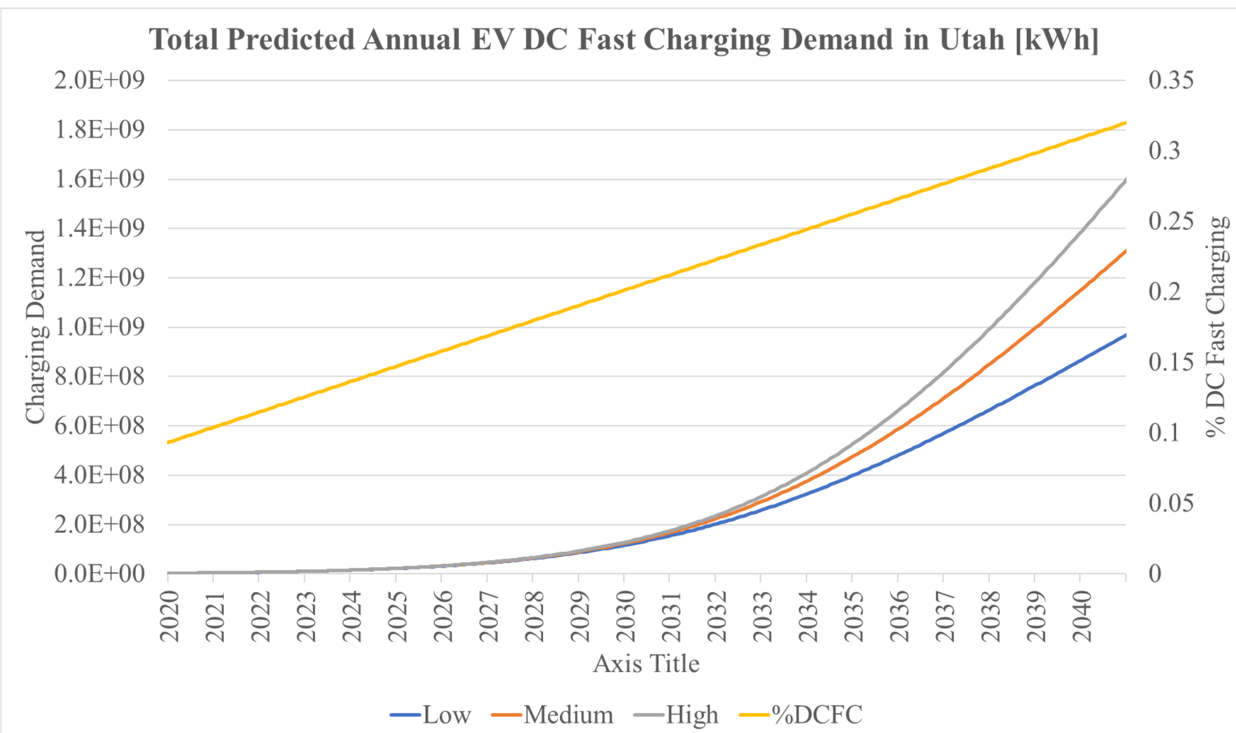

Figure 3: Total predicted annual DC Fast Charging demand in kWh for EVs in Utah

Table 4. Total predicted annual DC Fast Charging demand in kWh for EVs in Utah by 2025 and 2030.

	Low	Medium	High	% DCFC
2026	375,000,000	382,000,000	386,000,000	16.3%
2031	175,000,000	191,000,000	201,000,000	21.7%

The number of DC Fast Charging (DCFC) locations needed in Utah to support charging demand was estimated by considering a fixed 20% utilization target (e.g. 9.6 hours per day at 50% rated power) and a fixed charging site peak power rating of 700 kW. Such a DCFC station may include, for example, multiple plugs capable of 50 kW to 350 kW and a total site power limit of 700 kW. Some sites may offer higher power and others lower power, where 700 kW was considered a reasonable estimate for the average peak power of DCFC needs. At this utilization and peak power rating, each charging station is assumed to deliver on average 3,360 kWh per day, or 1,226 million kWh per year. The estimated total annual DCFC demand in Utah was then divided by the average energy delivered by each DCFC location to estimate the number of DCFCs needed to meet the demand. The results are depicted in Figure 4 and summarized in Table 5 for 2026 and 2031. For example, it is estimated that 156 DCFC locations with 700 kW peak power each will be needed in Utah by 2031 with the medium adoption curve. Or, instead of considering by location, the estimate can be converted to the total rated DCFC plugs needed by multiplying the estimate by the ratio of the site power to the plug power. For example, at 50 kW rating per DCFC plug, the total number of 50 kW plugs needed by 2031 for the medium adoption curve would be 2,184 plugs.

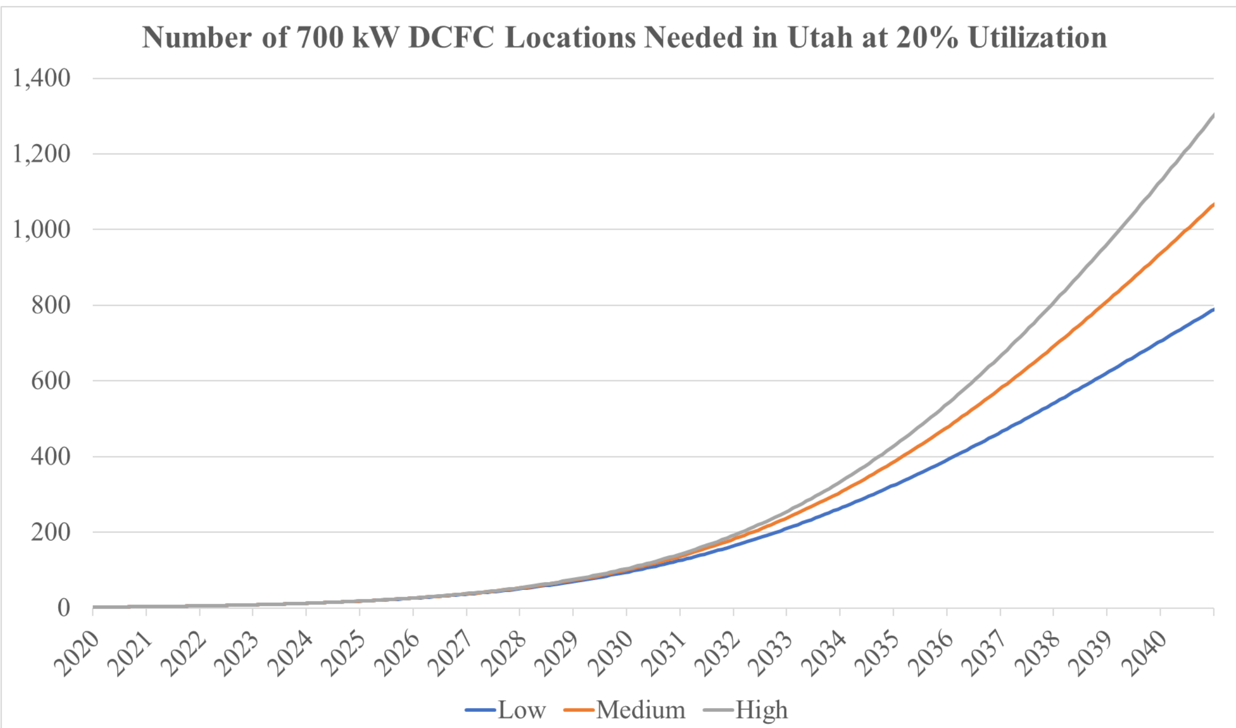

Figure 4. Number of 700 kW DCFC locations needed in Utah at 20% utilization.

Table 5. Number of 700 kW DCFC locations needed in Utah at 20% utilization.

	Low	Medium	High
2026	30.6	31.2	31.5
2031	143	156	164

While the results from Figure 4 and Table 5 consider the number of charging locations needed to maintain a fixed 20% utilization, another approach is to consider the expected utilization for a given incremental deployment of DCFC locations. This approach provides a more accurate estimate on the anticipated level of utilization of charging locations during the early years of adoption. Results are depicted in Figure 5 and Table 6 for a scenario with 20 locations starting in 2020, an additional 20 locations in 2025, and additional increments of 20 locations as indicated to keep the utilization level around 30% to 40%. For example, in 2031 with the medium adoption curve, and 100 charging locations with 700 kW power rating, the utilization per location is estimated to average 31.2%.

Utilization levels above 30% may be possible with smart charge management solutions to maintain quality of service and avoid waiting time and reduced charging rates to EV operators. Without smart charge management solutions, additional DCFC locations or higher site power ratings would be needed for the medium and high adoption curves.

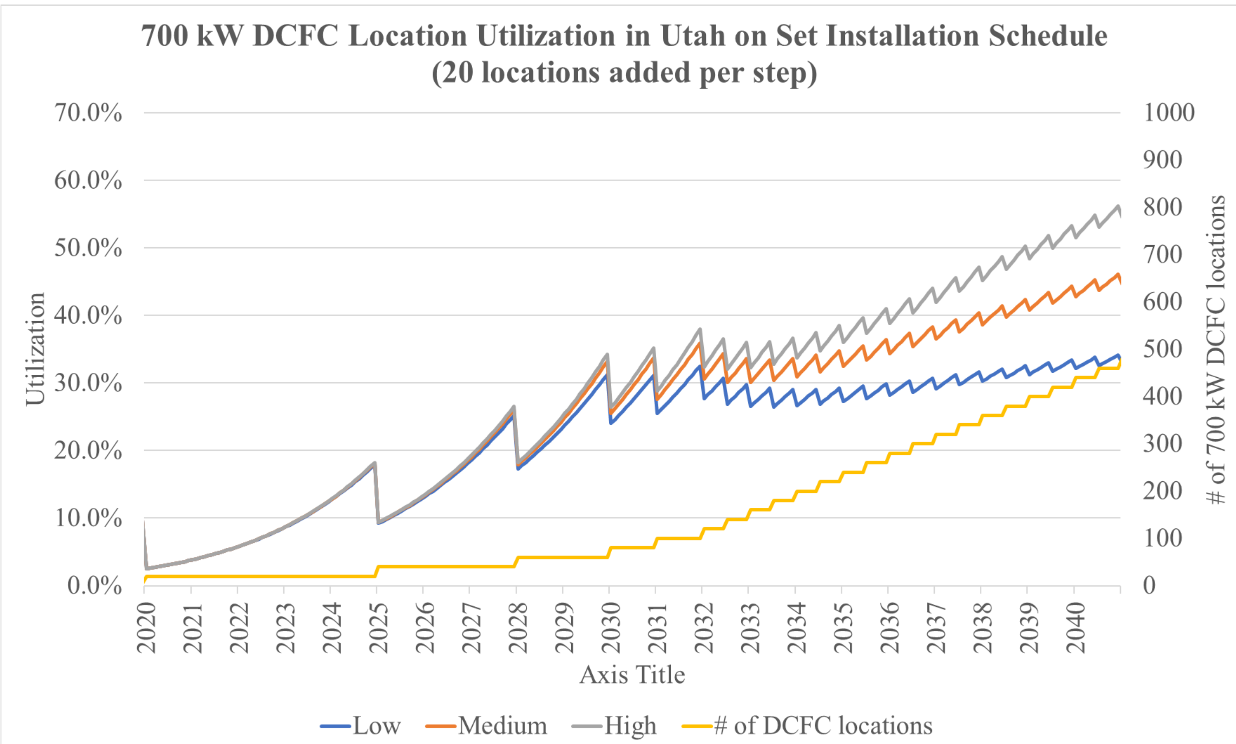

Figure 5: Utilization of 700 kW DCFC locations in Utah for the specified number of locations each year.

Table 6. Utilization of 700 kW DCFC locations in Utah for the specified number of locations each year.

	Low	**Medium**	**High**
2026: 40 locations	15.3%	15.6%	15.7%
2031: 100 locations	28.5%	31.2%	32.7%

Charging Station Revenue Forecast

Charging station revenue can be estimated by calculating the revenue as a function of utilization and anticipated rates per kWh and per session, then applying the revenue per year to the appropriate curve in each year from Figure 5 (or a modified figure according to the scheduled number of DCFC locations deployed in each year).

The anticipated billing rates for use of the DCFC locations were assumed as follows:

- **Billing price per kWh: $0.15**
- **Billing price per session: $1.00**
  - Assumed one session per utilized hour of charging (rounded up)
- **Energy cost per kWh: $0.03**

The resulting estimated annual revenue per station is shown in Table 7 for utilization from 10% to 40%. For example, at 30% utilization, the annual revenue per station is estimated to be $232,432. As shown in Figure 5, these revenue rates are expected to be sustained after approximately 2030, whereas the revenue rates will be lower before 2030 during the early adoption years. Investment in infrastructure at the levels indicated is critical in these early years despite reduced annual revenue to support adoption growth and reach the turning point around 2030 where sustained high utilization and average revenue per station is achieved.

Table 7. Annual Revenue per 700 kW DCFC station location

Annual Revenue per 700 kW DCFC station location				
Utilization (LF)	***kWh / year***	***# Sessions / year***	***Energy Cost ($)***	***Annual Rev Price@ $0.15***
10%	613,200	4,380	$18,396	$77,964
15%	919,800	5,840	$27,594	$116,216
20%	1,226,400	7,300	$36,792	$154,468
25%	1,533,000	8,760	$45,990	$192,720
30%	1,839,600	11,680	$55,188	$232,432
35%	2,146,200	13,140	$64,386	$270,684
40%	2,452,800	14,600	$73,584	$308,936

References

(State) State of Utah motor vehicle statistics. https://tax.utah.gov/econstats/mv.

(Gardner) P. Perlich, M. Hollingshaus, E. Harris, J. Tennert, M. Hogue, "Utah's Long-Term Demographic and Economic Projections Summary," Kem C. Gardner Policy Institute, University of Utah, Research Brief, July 2017.

(McKinsey) H. Engel, R. Hensley, S. Knupfer and S. Sahdev, "Charging ahead: electric-vehicle infrastructure demand -- The basics of charging infrastructure," McKinsey & Company, August 2018. [Online]. Available: https://www.mckinsey.com/industries/automotive-and-assembly/ourinsights/charging-ahead-electric-vehicle-infrastructure-demand.