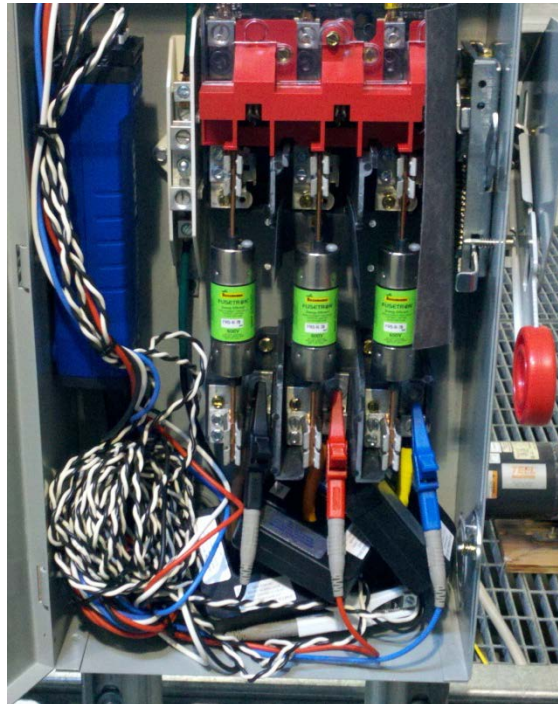


## ZLD Power Usage Monitoring for LaJunta

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To determine the power usage by the Veolia ZLD process during operation in LaJunta, Colorado, two DENT ELITEpro SP power meters were installed on the equipment. The voltage measurements were taken by directly connecting the power quality meter to the incoming voltage terminals at the equipment on all three phases, see Figure 1. Power to the meter is supplied from the connection on voltage channel 1, thus no external power is required. The current was measured using 3, DENT CT-SCM-0100 split-core current transformers, one per phase.



**Figure1. Installation of power monitoring equipment on incoming voltage terminals.**

Data loggers were setup using a standard 3-phase, 4-wire configuration collecting data every 5 minutes until the memory was full providing a maximum recording time of 267 days. A total of 4 channels were used to collect data. The first 3 channels were setup to collect data on each of the three phases and the 4th channel was setup to provide the total power measurement of the system; simply the sum of the three phases. The following quantities were measured:

- Voltage (V)
- Current (A)
- Watts (W)
- Volt-amps (VA)
- Power factor (PF)
- Volt-amp reactive (VAR)

Data was collected using ELOG 11 software from DENT Instruments and exported to Microsoft Excel for further analysis. The data was analyzed to ensure all values appeared to be correct and within standard constraints of the power system. Two time periods were selected for which to analyze power consumption based on steady, continuous operation of the ZLD process, see figures 2 and 3.

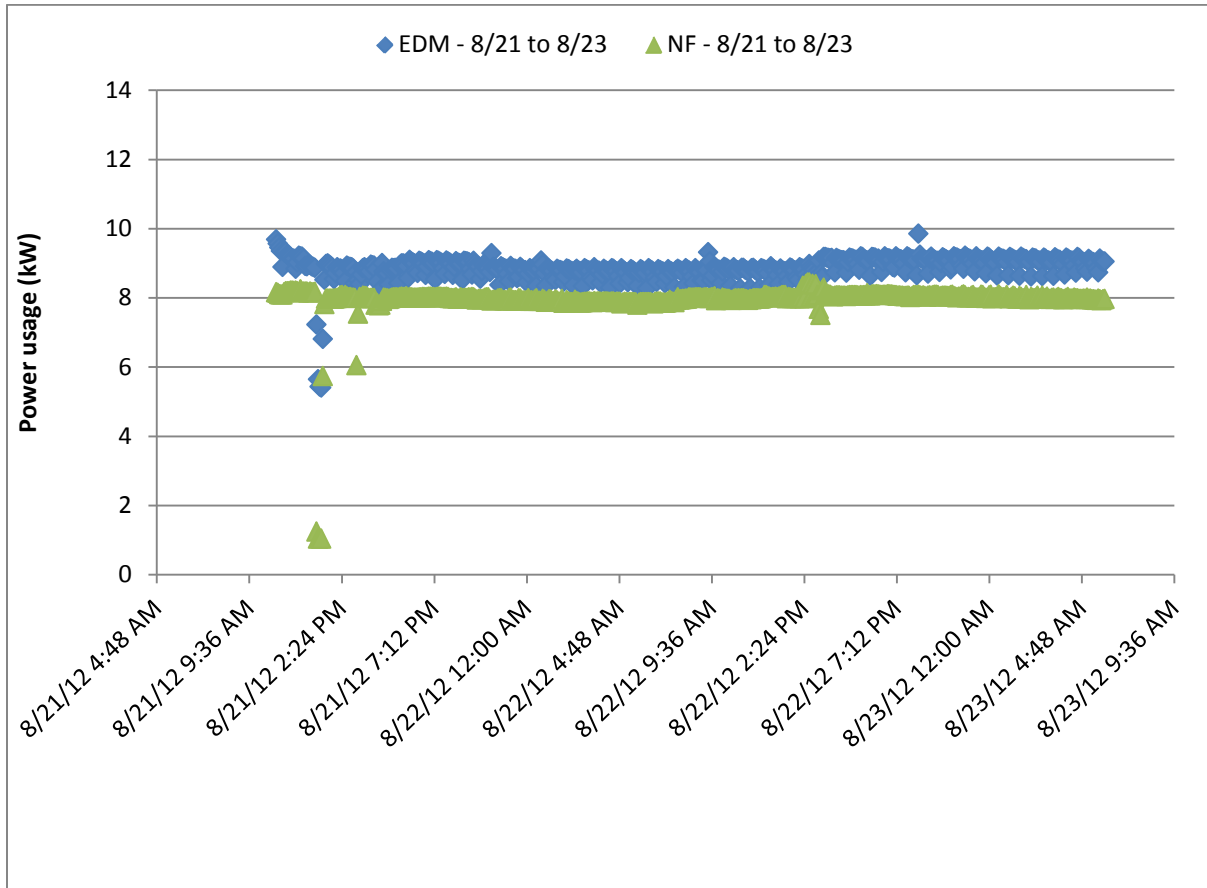


Figure 3. NF and EDM power usage from 8/21 to 8/23.

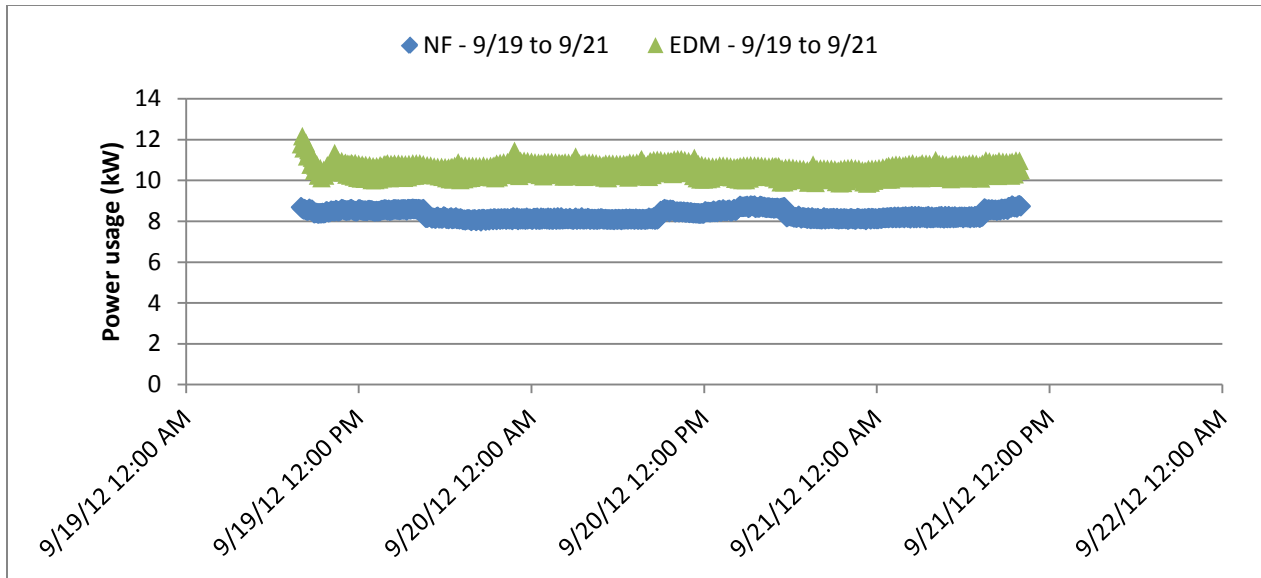


Figure 4. NF and EDM power usage from 9/19 to 9/21.

At the location the power was monitored, the values recorded included the power for auxiliary equipment such as lights, instrumentation, and forwarding pumps that would not be required for permanently installed system. The auxiliary power was measured by noting the time period in which the auxiliary equipment was powered, while the NF and EDM processes were not running. These values were subtracted from the total power usage. The auxiliary power was measured on 10/11/2012 from 9:15 through 10:15 am. The energy consumption was calculated by multiplying the power usage by the number of hours the unit was operational. The power usage for the 9/19 to 9/21 range was taken from 8 am on 9/19 to 10 am on 9/21 for a total of 50 hours of run time. The 8/21 to 8/23 range data ranch was from 11 am on 8/21 to 6 am on 8/23 for a total of 43 hours of run time.

The average power is calculated from the three phases. This power is multiplied by the number of hours of operation to obtain the electricity usage for the pilot testing periods. The normalized electricity usage represents the energy usage on a daily basis to account for the fact that one of the pilot runs was 7 hours longer than the other. This also allows for extrapolation of pilot data to full size system energy usage by dividing the normalized electricity usage by the daily water production.

To calculate the energy consumption as a function of volume of water produced, divide the normalized electricity usage by the daily water production. See Tables 1 and 2 for a summary of the power usage and estimate of the required annual electricity cost for each unit.

Table 1. Power usage data during ZLD operation from 9/19 to 9/21.

|    | A Phase (kW) | B Phase (kW) | C Phase (kW) | 3-phase Average (kW) | Auxiliary (kW) | ZLD component power (kW) | Run time (hours) | Electricity usage – pilot (kWh) | Normalized electricity usage (kWh/d) |
|----|--------------|--------------|--------------|----------------------|----------------|--------------------------|------------------|---------------------------------|--------------------------------------|
| NF | 3.09         | 2.73         | 2.47         | 8.29                 | 0.67           | 7.62                     | 50.0             | 380.8                           | 183                                  |

|       |      |      |      |       |      |       |      |       |     |
|-------|------|------|------|-------|------|-------|------|-------|-----|
| EDM   | 2.96 | 3.68 | 3.9  | 10.54 | 0.54 | 10    | 50.0 | 484.5 | 240 |
| Total | 6.05 | 6.41 | 6.37 | 18.83 | 1.21 | 17.62 | 50.0 | 865.3 | 423 |

Table 2. Power usage data during ZLD operation from 8/21 to 8/23.

|       | A Phase (kW) | B Phase (kW) | C Phase (kW) | 3-phase Average (kW) | Auxiliary (kW) | ZLD component power (kW) | Run time (hours) | Electricity usage – pilot (kWh) | Normalized electricity usage (kWh/d) |
|-------|--------------|--------------|--------------|----------------------|----------------|--------------------------|------------------|---------------------------------|--------------------------------------|
| NF    | 2.99         | 2.48         | 2.47         | 7.94                 | 0.67           | 7.27                     | 43.0             | 312.6                           | 174                                  |
| EDM   | 2.35         | 3.13         | 3.37         | 8.85                 | 0.54           | 8.31                     | 43.0             | 357.3                           | 199                                  |
| Total | 5.34         | 5.61         | 5.84         | 16.8                 | 1.21           | 15.58                    | 43.0             | 669.9                           | 374                                  |

The electricity usage during the September testing period is higher than that for the August testing period. The runtime was for the September testing was 7 hours longer than the August testing period (34.7 A and 24.4 A for September and August, respectively). Additionally, the EDM stack current was higher for the September testing period. Other explanations for differences in power usage have not been investigated.

Data was also gathered for the following two ranges and presented in Tables 3 and 4. The range of time includes ZLD operation from 9/6/2012 09:00 (am) to 9/7/2012 08:45 (am) and 9/10/2012 10:00 (am) to 9/12/2012 16:00 (pm). Figures 5 and 6 display the overall power use of the system in those time ranges as well.

|       | A Phase (kW) | B Phase (kW) | C Phase (kW) | 3-phase Average (kW) | Auxiliary (kW) | ZLD component power (kW) | Run time (hours) | Electricity usage – pilot (kWh) | Normalized electricity usage (kWh/d) |
|-------|--------------|--------------|--------------|----------------------|----------------|--------------------------|------------------|---------------------------------|--------------------------------------|
| NF    | 2.89         | 2.47         | 2.41         | 7.77                 | 0.67           | 7.09                     | 23.75            | 168.44                          | 170                                  |
| EDM   | 2.98         | 3.70         | 3.90         | 10.58                | 0.54           | 10.04                    | 23.75            | 238.44                          | 241                                  |
| Total | 5.86         | 6.17         | 6.31         | 18.35                | 1.21           | 17.13                    | 23.75            | 406.88                          | 411                                  |

Table 3. Power usage data during ZLD operation from 9/6/2012 09:00 (am) to 9/7/2012 08:45 (am)

|       | A Phase (kW) | B Phase (kW) | C Phase (kW) | 3-phase Average (kW) | Auxiliary (kW) | ZLD component power (kW) | Run time (hours) | Electricity usage – pilot (kWh) | Normalized electricity usage (kWh/d) |
|-------|--------------|--------------|--------------|----------------------|----------------|--------------------------|------------------|---------------------------------|--------------------------------------|
| NF    | 2.89         | 2.57         | 2.41         | 7.87                 | 0.67           | 7.20                     | 53.00            | 381.48                          | 173                                  |
| EDM   | 3.04         | 3.79         | 4.00         | 10.83                | 0.54           | 10.29                    | 53.00            | 545.62                          | 247                                  |
| Total | 5.93         | 6.36         | 6.41         | 18.71                | 1.21           | 17.49                    | 53.00            | 927.10                          | 420                                  |

Table 4. Power usage data during ZLD operation from 9/10/2012 10:55 (am) to 9/12/2012 15:55 (pm)

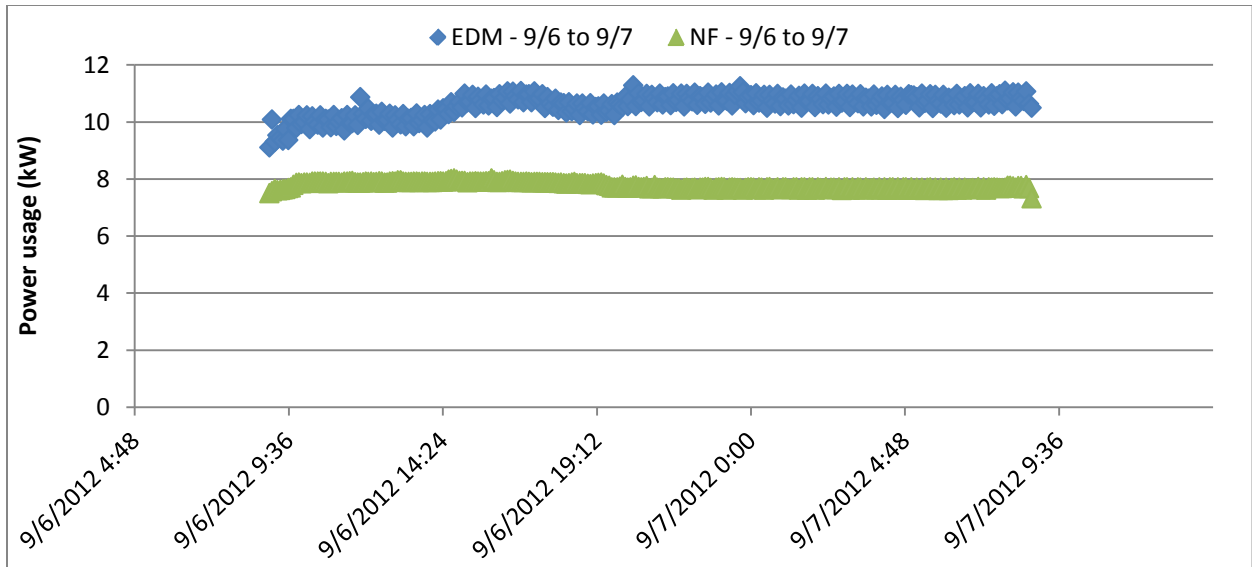


Figure 5. NF and EDM power usage from 9/6 to 9/7.

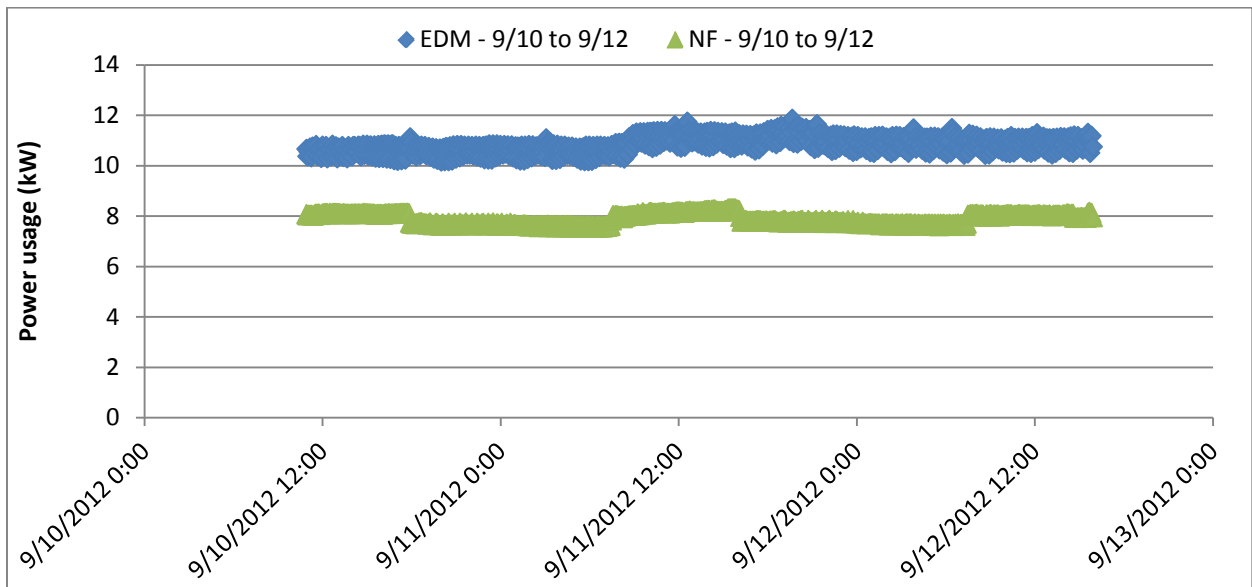


Figure 6. NF and EDM power usage from 9/10 to 9/12.