Off-the-Grid Air Quality Monitoring:
The Evolution of One Agency's Approach

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Abstract

With the continuing advancement in off-the-grid power generation technology, air quality monitoring in remote areas has become a less daunting task than in the past. As the interest in and the need for air quality monitoring in remote areas increases, organizations will need to consider available options for off-grid power systems for that monitoring.

The Great Basin Unified Air Pollution Control District (the District) has been conducting off-the-grid air quality monitoring for over twenty years. During that time, the off-grid power systems used by the District have evolved from trailer-mounted high-volume particulate samplers powered by propane-fired generators to complex temperature-controlled gaseous pollutant monitoring stations utilizing solar-powered battery systems with propane-fired supplemental generators to sophisticated passively-temperature-controlled continuous particulate matter monitoring stations with solar-powered battery systems. In the following document, each of the off-grid power systems used by the District will be discussed in detail, including: their complexity; ease-of-use; installation, operation, and maintenance issues; and the advantages and disadvantages of each system.

Methodology and Results

Faced with the challenge of monitoring in areas where the points of maximum impact are nowhere near the electric grid, the District took the step of constructing off-the-grid monitoring stations. In the beginning of this effort, high-volume (hi-vol) total suspended particulate (TSP) monitors were the order of the day. PM10 hi-vols followed in the late 1980s. Due to the sampler's current draw, from 7 up to 11 amps on startup, and the desire to minimize the footprint of some monitoring stations, District staff constructed a fixed station consisting of two 5.0KW Onan GenSet propane-fired generators for up to six TSP and PM10 samplers. The generators were set up to operate on alternate months to reduce downtime during maintenance and repair. The generators were connected to a timer that would start them approximately 30 minutes prior to the start of a 24-hour sample run. This buffer would allow the generator time to warm up sufficiently to handle the load of the hi-vols. A portable station was configured with the same generator to power one or two hi-vol PM10 samplers.

The District built low-power consumption PM10 monitors for operation on Owens Lake. These monitors used the 16.7lpm Sierra Andersen dichotomous sampler inlet that has become common today. These simple monitors utilized a pump and rotameter and were powered by two 50-watt solar panels and an 80Ah deep-cycle battery. These samplers performed adequately for the District's research project.

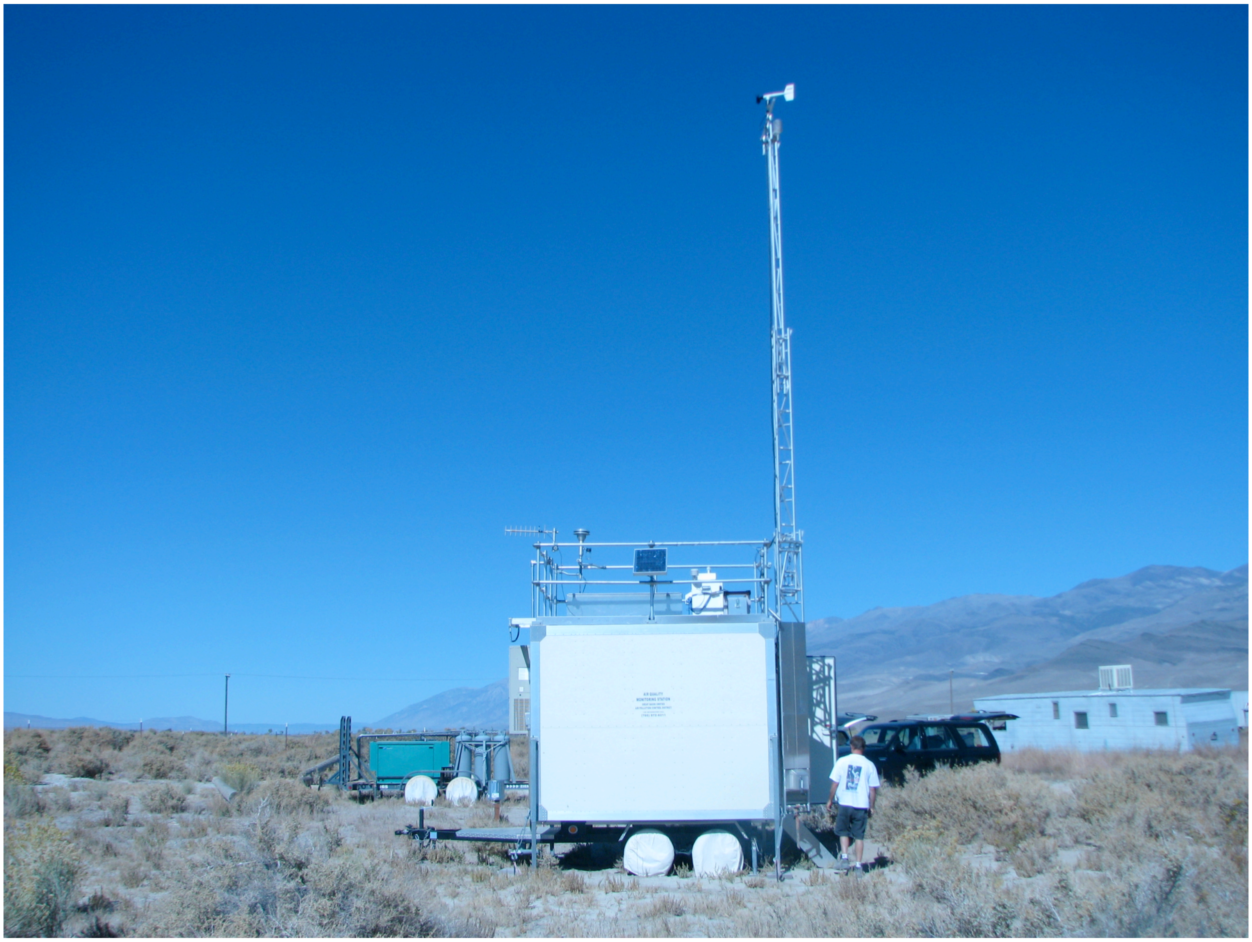
Survey monitoring is easily conducted with low-power consumption MiniVols. The District has used these monitors for determining where to locate permanent stations. They are useful, but the filter preparation is labor intensive and the MiniVol is not an EPA-certified method for particulate monitoring.

The District operated a low-power H2S survey monitor (not EPA or California approved) at an off-grid station in the Coso mountains in the vicinity of a geothermal power station. The monitor was housed in a refrigerated cooler and utilized an earth tube to attenuate the diurnal swings in ambient temperature. The station was powered by eight 40-watt solar panels and a small bank of deep-cycle batteries. There were problems maintaining consistent power levels at the station and data capture rates were low.

The District moved to install a more robust monitoring station for H2S capable of maintaining environmental conditions and power levels for operation of EPA or California state-approved pollutant gas monitors. Two stations were installed, each configured essentially the same: a climate-controlled shelter with a 6900 BTU air conditioner and a 6900 BTU propane heater, a 2.4KW solar array, a 1020Ah battery bank, and a 5KW propane-fired generator. These stations have sufficient battery capacity to operate for three days without sunshine. The generator will kick in, if needed, to charge the power system.

After the instrument manufacturers began producing monitors to measure PM2.5, the District made the decision to configure a new off-grid station at the modeled point of maximum PM10 impact on Mono Lake. This station consisted initially of twelve BGI PQ200 monitors configured for PM10 monitoring. These low-power monitors (18 watts) were installed in pairs, each pair powered by a 45-watt solar panel and a deep-cycle 100Ah battery. The system was set up to collect daily PM10 samples and to minimize site visits and downtime.

The District determined there was a need for a portable monitoring station that was capable of monitoring gaseous pollutants and particulate matter. The station would need to be climate-controlled and of sufficient power to support EPA-certified instrumentation. The station built is an EKTO 8'x10' shelter mounted on a trailer. The station is fully climate-controlled and currently houses a Rupprecht & Patashnick (now Thermo) FDMS/TEOM PM10 monitor. The station has a deployable 10-meter telescoping meteorological tower. The station is equipped to support EPA-certified pollutant gas analyzers as well, but the need for them has not yet arisen. The station is line-powered when berthed, but has a trailer-mounted 6.3KW prime power propane-fired generator for power when placed in an off-grid monitoring location.



A need for a smaller, more portable PM10 TEOM monitoring station came to light as work on the Owens Lake project continued. The District is constructing a small portable station utilizing the standard Thermo TEOM outdoor enclosure and a 3KW compact propane-fired generator all mounted on a sturdy but lightweight aluminum trailer. Two 15-gallon propane tanks will be mounted on the trailer. This configuration will allow the TEOM to be operated in its climate-controlled enclosure for up to four days before refilling the propane tanks. The lightweight design of this station will allow it to be deployed using an all-terrain vehicle.

The last off-grid station the District currently operates and its most sophisticated to date is located in the District's Mono Lake network. This station consists of a PM10 TEOM housed in a passively-climate-controlled station (Cool Cell®) built by Zomeworks. This station utilizes a system of four radiators on top of the station and four polyethylene tanks inside the insulated box. The radiators and tanks are filled with water. The heating and cooling and natural convection of the water maintains the temperature in the station in a fairly consistent range. The power system consists of a solar panel array producing 5.28KW and a battery bank of 2370Ah capacity. The batteries are also housed in Cool Cells that are designed to prolong the life of the batteries from a typical span of 3 to 5 years to 10 to 15 years.

Conclusion

Off-the-grid power systems, like pollutant monitoring systems, are always changing and improving. The last systems discussed above have served the District's monitoring needs very well. They have been both efficient and cost-effective. All of the systems have maintenance requirements and associated costs that go along with having an off-grid power system over and above the cost of a typical grid-powered monitoring station. Those costs are not insignificant and must always be taken into account when considering an off-grid monitoring station. However, a well-planned, well-designed, and well-maintained off-grid pollutant monitoring station will provide high quality defensible data as well as any grid-powered monitoring station.

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