The Feasibility of Implementing Solar Power on Construction Sites

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The purpose of the research conducted in this project is to determine the feasibility of implementing solar on a construction site as means of providing power. Power requirements as well as costs from the established sources were compared to the current costs of solar, more importantly, to the current cost of the specific solar setup needed to provide consistent power to the site. As a baseline, the project power requirements were based of the requirements of the civil site the generator data was pulled from.

Key Words: Temporary Power, Solar Power, Site Sustainability, Civil Construction

Introduction

Every construction site, no matter the size or location, has the requirement for temporary services including electrical, water, etc. for site operations. Among the most important is electricity, as most every trade depends on it to some extent as well as site security and safety (lighting, fire alarm, etc.) services largely being supported on it until established power is brought to the site. Currently the two main sources to bring power to a site are either through temporary power brought to site by the local power authority or by renting generators for the duration of the project. This paper will be analyzing the latter and the feasibility of potential alternatives to generator electricity, in effort to bring down costs and help with the sites overall sustainability.

A large reason I decided to focus my research on this topic was through experiences with temporary power, rather lack thereof, on a project I worked on that was unable to have established power brought to it. This resulted in the need to rent several diesel-powered generators to provide power across the site, something that was not only very costly in both renting and fueling costs but costly from an environmental standpoint, as the generators ran 6-7 days a week for more than a year. To put the costs of providing power to a site into perspective, a Department of Commerce study estimated that "Out of $648 billion in total non-labor expenses in 2002, the construction industry spent $15 billion on energy, of which $11 billion was spent on gasoline and diesel fuel, $1.1 billion on natural gas, and $2.6 $x10^9$ on electricity." On a related note, statistics published by the Energy Information Administration suggests that "construction represents 1% of the overall electricity use in the United States and 5.3% of all industrial electricity purchases". Given these statistics along with my personal experiences in the field, I was in search of a more economically viable and environmentally friendly alternative to generators; one that could provide the required power demands of the site, match the mobility and suitability for remote sites and one that could reduce the financial burden to both the owner of the project as well as the contractor. Amongst the many alternatives to a generator, I found that solar power was probably the most practical option as it is a ballooning energy and the most popular method of power generation after the established methods. When first starting out, I looked at traditional panels, something I thought was a decent idea but one that posed a problem with mobility and the ability to power the site at night- something necessary for vital systems like fire and security alarms. Searching through the alternatives, ranging from battery backup to hybrid diesel generators, I eventually came across Mobile Solar, an appropriately named company based out of Atascadero, CA that specializes in mobile solar power solutions for sites not within reach of established power, with many of their customers stemming from wineries, off-the-grid housing and remote construction sites. To keep the data and analysis thereafter consistent, the data presented on solar in this report will be based on the solar generator series that Mobile Solar manufactures and the diesel generator data will be based on the typical generator found on the site I was working on. Additionally, pricing for utility power will be included in

the analysis for a baseline cost and to show the magnitude the requirement of generator power to site has on the financials of a project.

General Background

On sites that are positioned within close proximity to existing electrical utilities or are being built on an existing site, a temporary power connection (such as the one pictured in figure 1) is established on site in an area that is free of overhead and adjacent activities. The connection can be overhead or underground depending on the service and typically has a meter and main shutoff, with an attached accessory "spiderbox" that acts as a circuit breaker as well as providing outlets (220V, 120V) for connecting extension cords to tools and equipment (Hoffmann). As the panel is hardwired, it is also possible to have a wired connection feed a distribution box with the structure being constructed.

Figure 1 – Typical established temporary power connection and panel with meter and shutoff box

As previously mentioned, generators of any variety whether it be gasoline, natural gas or diesel (pictured in Figure 2) are a common and necessary tool throughout the construction industry as a means of effective power generation (temporary or prime) but are also used commonly in instances requiring backup power in case of power failure. Generators in one form or another have been used on construction sites since their rapid popularity made the cost of ownership a financially feasible option to most consumers. On sites relying on a generator for prime power, the generator is used to power the jobsite trailer— alone needing a lot of power for the air conditioning, computers, refrigerators, etc. and is also used to power construction site lights, contractor equipment and charging stations, security systems, fire alarms and other auxiliary equipment necessary for a functioning construction site ("Power Generators and Engines"). Generators used in temporary power situations are commonly used in instances where a reliable power source is not available, being advantageous as they are mobile and capable of supplying power to multiple devices simultaneously as long as the generator is sized for the work at hand ("Power Generators and Engines"). Generators are also used in the construction industry for backup power, ensuring that a loss of main power either through forces of nature or mistakes on site do not cause the site or area of the building to lose power,

something that is of importance in the medical or tech industry that could be adversely affected with a loss of power. The generator that will be analyzed in this research is a 45KW towable generator as offered by United Rentals.

Figure 2 – 45KVA Diesel Generator as used on site (Purplewave)

Mobile Solar was founded in 2005 with the goal of "provid[ing] an environmentally friendly alternative to fossil fuel generators by harnessing the sun's power to provide clean, safe, and reliable energy" ("About Mobile Solar"). They have established themselves as a premier mobile solar provider, having clients across the globe including remote sites in Africa, Malaysia and in every state in the United States, and services industries ranging from Agriculture to residential and commercial construction sites. Their services range from standard solar panel arrangements, to solar power packs (batteries) and solar light arrays to the product that will be analyzed in this report; mobile solar generators, namely the MS-375. The MS-375 generator (pictured in Figure 3) is the flagship of the company's product line and has extensive use in the commercial and residential construction markets. The generator is comprised of a twin-axle travel trailer that houses a 45KW batteries and the solar inverter. Mounted to the exterior is a 16-panel solar array capable of harvesting 32kWH of power a day ("MS-375 Solar Trailer"). With the size of the batteries combined with the harvesting capabilities of the panel array, this solar generation option is more than capable of competing with the power output of its diesel counterpart. With the ability to be towed behind a vehicle, the generator is also equally as mobile as its counterpart, the range of generator sizing being equitable to those offered in the diesel variety as well.

Figure 3 – Mobile Solar, Inc. MS-375 Solar Generator ("MS-375 Solar Trailer")

Methodology

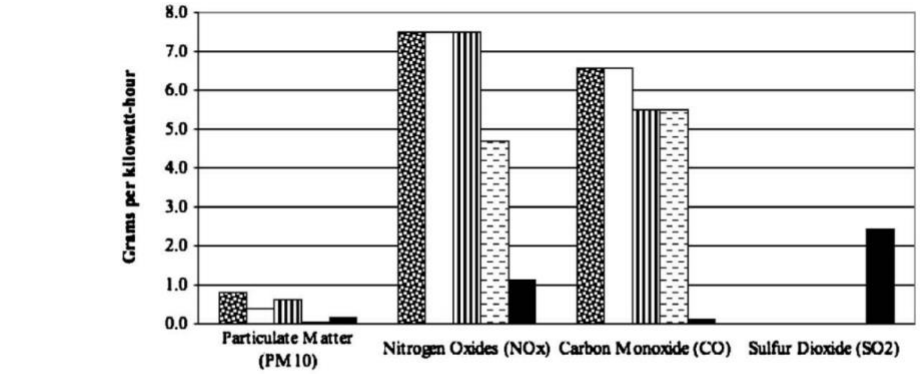
The primary objectives of this paper are to inform the reader of the possibilities of solar implementation on construction sites along with providing quantitative analysis to establish whether or not the switch from fossil-fuel powered generators to the solar alternative is an economically feasible one. This determination was made through comparisons of costs, both initial and reoccurring While there is not much research on the topic of electrification options to construction sites during construction, quantitatively, there was much information readily accessible from internet resources, interview sources in both the construction and solar industries as well as pulling information from my prior experiences dealing with generators on jobsites. With this research, I hope to provide anyone, including contractors, with an analysis of their options for temporary site power and how they compare to each other. This will include analysis of the monthly cost of all options as well as the costs to own and operate the generating equipment in lieu of renting to see what approach works best for the person.

Through my methodology, my objective for this case study follows as such:

- Provide an overall better understanding of how power is delivered to a construction site and the different methods of doing so (i.e. utility power and generator power)
- Analyze the specific benefits and detriments of using traditional generator power and proposed solar generation
- With the data analyzed in my research, I hope to give construction companies who rely on generator power an alternative option to traditional diesel along with its benefits.
- Assess the feasibility of switching from traditional diesel-powered generators to solar generators.

Comparisons

Diesel power generation is the most common form of delivering temporary power to a site other than utility power and thus has a well-established presence on most sites. Advantages to having a generator are endless, as power can travel with the work rather than having to extend established wiring alongside the work. One of the best cases for the use of generator power is simply how easy it is to get. For instance, on the site I was on this summer, we had two generators when starting the job, as the scope was sequenced in a way that lead to a slow start and a ballooning of the scope in last couple of months of the job. Besides being able to move the two generators we had around anywhere we desired, the later part of the project required substantially more power in many different areas of the site, something that is very easy to do when you have United Rentals 20 minutes from the site. Within a few hours, I was able to have 5 more generators mobilized to site with little more effort than a phone call, something that not only kept laborers working along uninterrupted but something that would not have been possible if using temporary power from a utility. In summation, the largest advantage a generator has is its mobility and the ability to have more easily delivered in times requiring larger power demands or power demands that are scattered across site. In terms of disadvantages, rental and fueling costs of the generators can be costly (analyzed in the following section) and running generators on a consistent basis can be problematic from an emissions standpoint both in governmental regulation and environmental degradation. One such example of a governmental regulation issue occurred in September of 2017 when Jonathan Lund was powering much of his site through a series of diesel generator units after a wildfire destroyed a substation and transmission lines to his site. Getting power restored to the site took longer than expected and ended in Jonathan having to pay a carbon tax to the California Air Resources Board to offset the large amount of pollutants emanating from the generators on his site (Lund). As energy and emissions standards become more stringent it will be a more common occurrence to have to deal with air resource fees and others to offset the damage diesel generators do to the environment. the following graph lends perspective on just how substantial a generators greenhouse gas emissions compare to utility power.



11 to 25 Horsepower Tier 2 Generator	0.80	7.51	6.57	—
11 to 25 Horsepower Tier 4 Generator	0.40	7.51	6.57	—
25 to 50 Horsepower Tier 2 Generator	0.60	7.51	5.50	—
25 to 50 Horsepower Tier 4 Generator (2013)	0.03	4.69	5.50	—
Overall Electricity Grid	0.16	1.11	0.12	2.43

Air Pollutant by Electricity Generation Method

Figure 4 – Electricity Generation Emissions Between Generator and Utility Power

While not widely established, it would appear that solar power generators such as the MS-375 have an advantage over their fossil fuel competitors and utility power when it comes to greenhouse gasses, with an emissions threshold of 0. As will be analyzed in the proceeding data analysis, the solar generator is also advantageous as the initial upfront cost is also the total purchase price of the generator, meaning no rental costs. Since it is solar powered, this also means that fueling costs are non-existent, maintenance costs are little to none, with most maintenance being checks every quarter, taking about a minute of time (Semmes). The downsides to the solar generator stem mostly from the fact that it is solar, meaning it must be positioned on site to optimize sunlight intake for the panel and battery system and cannot be used inside like a diesel powered one (given ventilation is adequate to do so).As a result of it being solar, it is possible that a diesel generator would have to be brought in in times when the solar generator couldn't generate enough electricity as would be the case during stormy days and or/ reduced sunlight times of the year as in winter. It's initial upfront cost could also be off-putting for a contractor that is needing more than one generator and/or needing it within a matter of hours, as the main manufacturing facility for the solar generator is in the rural city of Atascadero, California. It appears then, that the solar generator is not a readily mobilized as the diesel alternative but has advantages in meeting environmental requirements, forgoes rental, fueling and maintenance costs and helps to please owners that are concerned about sustainability and the environment.

Results and Discussion

The following data was collected and based on a 14 month schedule as was the case in the civil project I was working on over the summer, monthly costs are broken down accordingly. Rental costs are based on United Rentals pricing as of August 2017, breaking up the cost of the solar generator was done into 14 increments and PG&E costs are based on discussions with Katie Hoffmann.

Cost of Power Delivery Options

Provider	Month	Operating Costs (per Mo.)	Project Duration	Δ from cheapest
PG&E	$790	-	$11,060	-
United Rentals	$1,194	$1,320	$35,196	68%
Mobile Solar	$2,148	-	$30,072	63%

Figure 5 – Cost Breakdown of Power Sources (Monthly and Total)

Based on the data collected and presented in table above, it can be assessed that using utility power is by far the cheapest option with a 63% increase in cost when looking at the next viable option, which was found to be the solar generator. Costs of the solar generator were based on a payoff time of the total cost to own the generator ($30,072) within the project duration (i.e. $30,072/14 mo.= $2,148/mo.), this does not consider financing charges or delivery to site and setup, however that would most likely be the duty of the site superintendent. This cost does also not take into consideration any of the power accessories included with the diesel generator rental including a spiderbox and cabling for power transmission. There are no maintenance fees or fueling costs associated with the solar generator, something that ended up making it the cheapest of the two generator options when considering everything. The diesel generator option was cheaper to rent than the calculated payment on the solar generator, however when fuel costs were added to the monthly cost of the generator— a cost greater than the monthly rental cost itself, it was found to be the most expensive of all options surveyed.

A major issue to be considered by anyone being swayed by the lesser cost of the solar generator, is the cost of the generator itself. According to Travis Semmes of Mobile Solar, the MSRP of the MS-375 is actually $47,730, a price that would have made the solar generator the most expensive option at a cost of $3,409/month, again with a 14 month payoff period. It is through government incentives both at the state and federal level that make the solar generator option feasible, with an overall credit to the purchaser of $17,658. This should be a major red flag for anyone considering the mobile solar option, as these incentives are just that, incentives. Once solar has solidified itself in the marketplace— something it is well on its way of doing— these incentives are likely to be phased out, something that immediately makes the diesel option much more alluring.

As the comparison between the solar and diesel generators in this data is not exactly apples-to-apples (amortization to rental cost), I decided to compare the costs of owning both generators outright, and based the depreciation of the equipment over a determined lifespan of 10 years, the results are listed in figure 6 below.

Cost of Ownership Breakdown

Option	Monthly Cost	Overall Cost	Δ from cheapest
Mulitquip 45KW Diesel Generator	$382	$45,840	-
Mobile Solar MS-375	$397.75	$47,730	3.9%

Figure 6 – Cost Breakdown of Power Sources Over Expected Lifetime

As provided by the data above, when the incentivized reduction in the solar generators cost is taken away, the cost of the diesel generator in both cases (rental and ownership) becomes the most viable option, if only just. When taking into consideration the costs of operation, the solar generator retains its position as best option.

Conclusion

In summation, the data provided in this report suggests that the two generator options are quite comparable in price and utility. When comparing the two to established power, it is obvious that anyone with access to such should take advantage of it, as it is cheaper by over half when analyzed on a monthly basis. As for the other two, the choice would likely stem from what sites are typically worked on as well as other considerations such as how long you plan on using the equipment, which would factor into lifespan decisions, and the opinion that one should wait for the cost of solar to decline more and allow technology to advance before buying.

References

"About Us." *Mobile Solar*, www.mobilesolarpower.net/about/.

Alves, Jordan, and Jonathan Lund. "Dealing with Remote Site Power." 17 May 2018.

Alves, Jordan, and Katie Hoffmann. "Established Power to Site." 12 May 2018.

Alves, Jordan, and Travis Semmes. "The MS-375 Generator ." 1 June 2018.

Comstock, Owen. "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." *Today In Energy*, 7 July 2017, www.eia.gov/todayinenergy/detail.php?id=31912.

Matthews, H. Scott, et al. "Environmental Implications of Construction Site Energy Use and Electricity Generation." *Journal of Construction Engineering and Management*, vol. 133, no. 11, 11 Nov. 2007. *ASCE Library*, doi:https://doi.org/10.1061/(ASCE)0733-9364(2007)133:11(846).

"MQ Power WhisperWatt 45 KVA Generator." *Multiquip Power Equipment*, www.multiquip.com/multiquip/DCA45SSIU4F.htm.

"MS-Series - Mobile Solar Generators." *Mobile Solar*, www.mobilesolarpower.net/products/ms-series-solar-trailers/.

"Worldwide Power Products." *Worldwide Power Products Types of Industrial Generators Comments*, www.wpowerproducts.com/sales/industries-we-serve/construction.