Site Layout Report

Lithium-Ion Battery Energy Storage System (BESS) Project

By: James Mendenhall, Oksana Grudanov, Cole Dustin, and Sarah Ebert

Organization: Iowa State University

Sponsor: Burns & McDonnell

Faculty Advisor: Dr. Zhaoyu Wang

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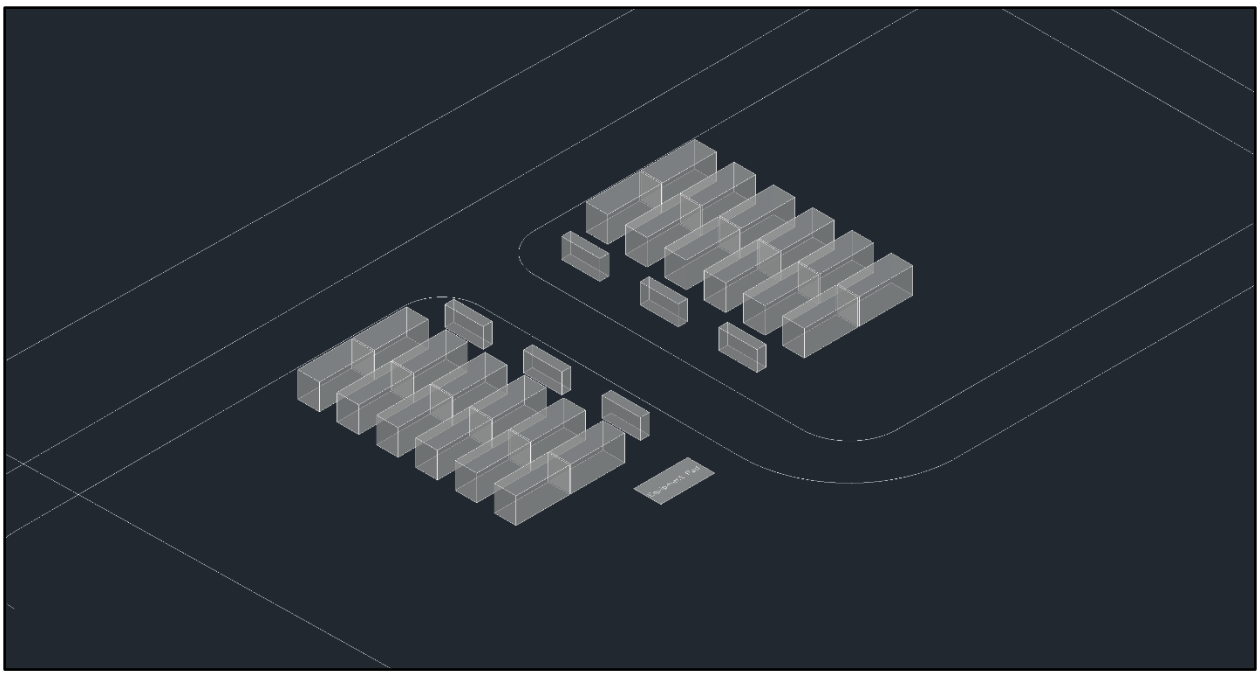

Figure 1: Site Overview

1.0 Overview

When designing a battery energy storage system, there are many steps to make the best product, including the site layout. Knowing where the equipment will go very early is crucial as other parts build upon their location and distancing. Finding a suitable location and completing the site layout early in the design process will make other steps manageable. Later in the design, the cables need to be placed on the site layout drawing after the cable schedule has been established.

2.0 Location

We first started with our site layout. We needed a plot of land of at least 10 acres to allow plenty of space for the BESS and its construction. The land needed to be flat to

allow for easy, level construction of the BESS. The site also needed a place to connect to the grid. We found a spot in South Ames for our site.

We decided to have our site in Ames on State Ave south of Mortenson Rd. The Ames location is ideal because of its proximity to a substation, the availability of land, and it's being right off a wide paved road, which allows it to accommodate the large trucks needed to get the equipment to the site.

Figure 2: Site outline

3.0 Layout

At the design stage, there are many standards and common practices for the site layout. The batteries and inverters have spacing specifications, which are found in their installation manuals. Common industry practices also allow the design and construction of the BESS to be as seamless as possible. The client provided these industry standards.

Everything must be placed on a cement pad to prevent the ground from sinking due to the heavyweight. For simplicity, this is not shown in the site layout.

3.1 Batteries

The batteries have spacing specifications as shown in Figure 3 and must be placed 0.5 feet apart on the short side and 6.5 feet apart on the broad side. These distancing specifications have several purposes. It will allow the service doors to swing freely, provide proper cable space, and follow safety standards.

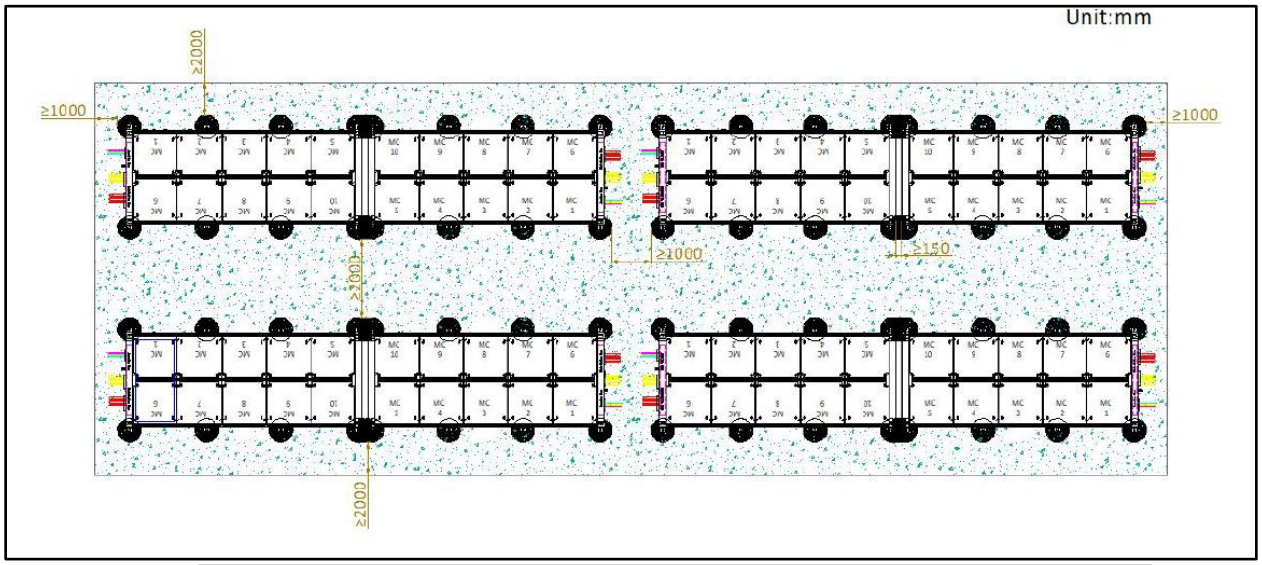

Figure 3: Battery distancing requirements from installation manual

3.2 Inverters

We have chosen to keep the inverters 10 feet apart from the batteries. There is also an equipment pad in the SW corner of the site. The equipment pad will house the

switchboard, aux power cabinet, and station service transformer. It is also the location where the 30 auxiliary power cables will converge.

3.3 Site Roads

Large trucks will drop off the equipment when construction starts on the battery energy storage system. The roads on the site are 20 ft wide, with the turns having an inner radius of 25 ft and an outer radius of 40ft. The on-site road also connects directly to a paved road to ensure the site is accessible in all weather.

The road is in the shape of the letter 'p'. This makes the construction process more accessible and allows trucks to make a loop around the site without turning around to back out of the site while still being able to access the required parts of the site. The roads also allow for an expansion of the site's capacity later in its life cycle. If the capacity increases, the site's roads will be long enough to double capacity and mirror the existing batteries and inverters.

4.0 Cables

Once all of the equipment is in place on the site layout, the cables will need to be placed to connect the equipment. Cable location is critical for the construction process. The cable routes for the Ames BESS project might be subject to change when more things are known.

Our site currently has 64 cables from power and auxiliary cables on the cable schedule. Figure 4 shows a sample set of the cable schedule and includes the raceway

length, which is the length of the total amount of underground wire. The 'length' section also contains the vertical offset lengths.

Cable ID	Current flow	From	To	Description	Voltage Type	Conductor Size	Length		Conductors per phase	Qty	Raceway Length
1	20.92 A	Surge Arrestor	PCS A1	Fuse/ Surge Arrestor	Medium AC	6 AWG	45.57	ft	1	3	29.57 ft
2	103.66A	PCS A1	PCS A2	PCS1	Medium AC	4 AWG	53.02	ft	1	3	37.02 ft
3	186.39A	PCS A2	PCS A3	PCS2	Medium AC	1/0 Kcmil	53.02	ft	1	3	37.02 ft
4	269.13A	PCS A3	Substation Breaker	PCS3	Medium AC	4/0 Kcmil	53.02	ft	1	3	37.02 ft
5	258.67A	Substaion Breaker	Substation Breaker	Home run 1	Medium AC	4/0 Kcmil	572.05	ft	1	3	556.05 ft
6	258.67A	Substation Breaker	PCS B4	Home run 2	Medium AC	4/0 Kcmil	563.99	ft	1	3	547.99 ft
7	248.21A	PCS B4	PCS B5	PCS4	Medium AC	4/0 Kcmil	53.02	ft	1	3	37.02 ft
8	165.47A	PCS B5	PCS B6	PCS5	Medium AC	1 AWG	53.02	ft	1	3	37.02 ft
9	82.74A	PCS B6	PCS B6	PCS6	Medium AC	6 AWG	53.02	ft	1	3	37.02 ft
10	1274A	Inverter	Battery B12	DC Battery B12	Low DC	500 Kcmil	30.86	ft	4	4	16.86 ft
11	1274A	Inverter	Battery B11	DC Battery B11	Low DC	500 Kcmil	74.19	ft	4	4	60.19 ft
12	1274A	Inverter	Battery B10	DC Battery B10	Low DC	500 Kcmil	72.62	ft	4	4	58.62 ft
13	1274A	Inverter	Battery B09	DC Battery B09	Low DC	500 Kcmil	24.03	ft	4	4	10.03 ft
14	1274A	Inverter	Battery B08	DC Battery B08	Low DC	500 Kcmil	30.86	ft	4	4	16.86 ft
15	1274A	Inverter	Battery B07	DC Battery B07	Low DC	500 Kcmil	74.19	ft	4	4	60.19 ft
16	1274A	Inverter	Battery B06	DC Battery B06	Low DC	500 Kcmil	72.62	ft	4	4	58.62 ft
17	1274A	Inverter	Battery B05	DC Battery B05	Low DC	500 Kcmil	24.03	ft	4	4	10.03 ft
18	1274A	Inverter	Battery B04	DC Battery B04	Low DC	500 Kcmil	30.86	ft	4	4	16.86 ft

Figure 4

4.1 Power Cables

In the design process, the cables need to be placed on the site layout after you have started on the cable schedule. This accomplishes many things; it will help determine the length of the cables needed as well as the raceway length. This is used in construction to know where to trench the cables. When making this, you will need to find the installation manual for the piece of equipment. This will tell the location of the X, Y, and Z so the total vertical change can be calculated.

The cables in between the inverters, aux power, and the MPT are medium-voltage AC; this will put them three feet underground to meet the minimum depth requirements from the NEC. The cables between the batteries and the inverters are low-voltage DC; they are required to be two feet underground. This allows us to cross over between the two types of cables and not have to worry about the cables interacting with each other.

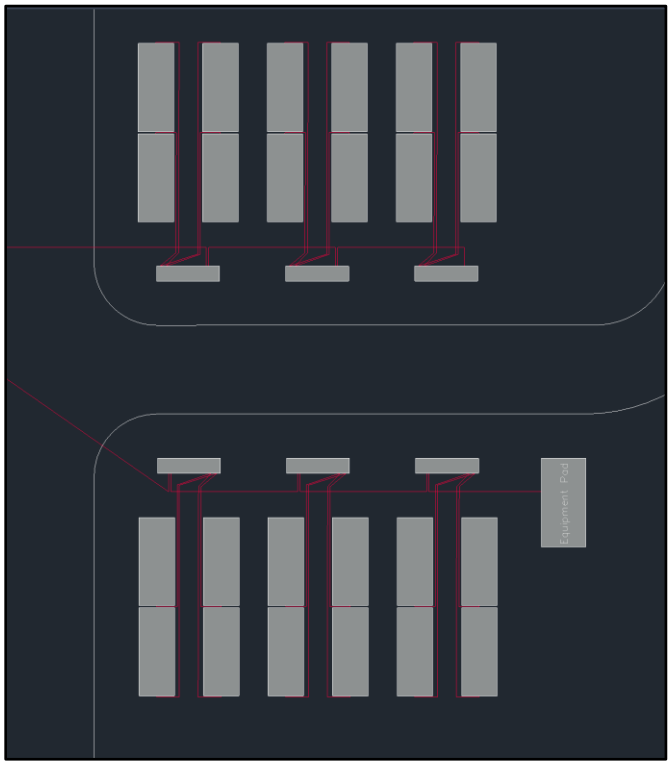

Figure 5: Power cable routing

4.2 Auxiliary Cables

The auxiliary cables are very similar to the power cables. They are medium-voltage cables that go from the switchboard to each of the 30 pieces of equipment. These cables are used to provide power to the batteries and inverters for the cooling system, communication, and monitoring.

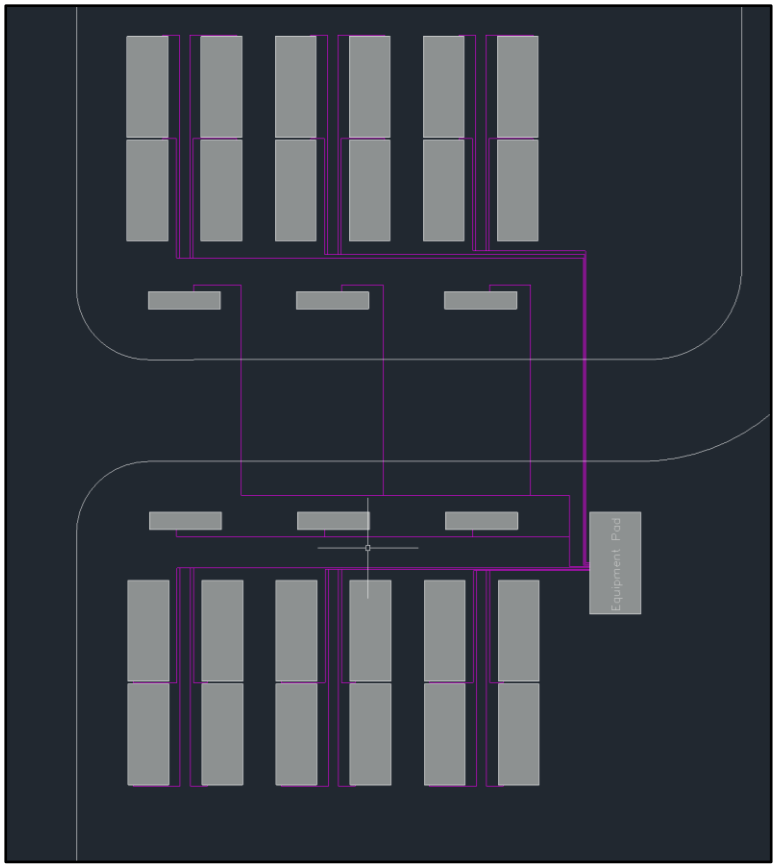

Figure 6: Auxiliary power cable routing