Study Committee B3

Substations and Electrical Installations

10210_2022

USING BIM TECHNOLOGY TO PROMOTE THE SUSTAINABILITY OF ELECTRICAL SUBSTATIONS

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Source: https://www.climatecentral.org/climate-matters/peak-co2-heat-trapping-emissions

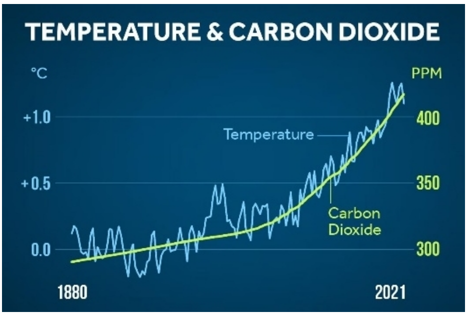

Figure 1: Carbon Emissions and Average Global Temperature

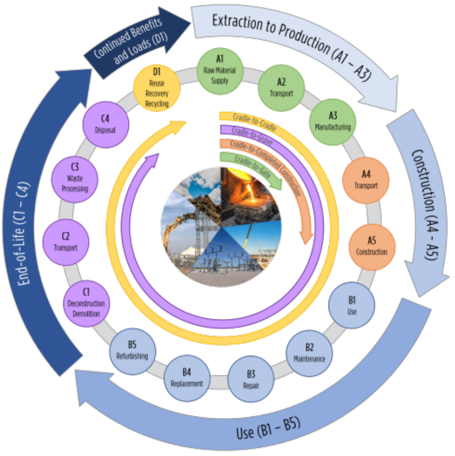

Figure 2: Lifecycle Analysis

Motivation for Sustainable Substation Design

- An upward trend in carbon emissions, shown in Figure 1, causes global average temperature rise, which threatens quality of life and critical infrastructure.
- Due to its overall emission contribution, the electric power industry is increasingly scrutinized to commit to emission reduction targets. Several utility providers worldwide have already established plans toward this goal.
- Embodied carbon is an important indicator that is commonly used to track and help quantify the sustainability of a project. Figure 2 shows how it is tracked for each stage throughout a project lifecycle. Embodied carbon is normally tracked in stages A1 thru A3. Although tracking embodied carbon throughout a project lifecycle provides complete information, various variables make it challenging to track this information after Stage A3.
- Manual embodied carbon quantification is time consuming, prone to errors, and cost prohibitive; therefore, the utility industry is seeking innovative solutions to overcome this challenge.
- Building Information Modelling (BIM) frameworks have already been widely and successfully adopted by the Architecture Engineering and Construction (AEC) industry with its strength in handling large sets of data and could prove as beneficial in other industries, the utility included.
- BIM provides utility owners and engineers with the ability to optioneer cost-effective low carbon solutions and make more informed decisions to optimize the sustainability of a design.
- Through embodied carbon quantification with BIM technology in the design process it can provide an innovative solution to utilities carbon reporting and carbon reduction goals.

General Approach to Sustainable Substation Design Using BIM Technology

1. Gather embodied carbon metadata from Environmental Product Declarations (EPD) and carbon databases from available resources.
2. Integrate embodied carbon metadata of substation equipment and all materials into model elements developed for 3D substation model using BIM design approach. Example of outputs can include embodied carbon intensity mapping, highlighting areas of significant carbon, and project total embodied carbon.
3. Apply embodied carbon quantification and sustainable design considerations into a weighted design decision-making matrix to produce a final optimized design.

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Use Case 1: Embodied Carbon Intensity Map

- With the inclusion of 3D BIM models in the design stage, interpretation of changes is now much more visual.
- By integrating embodied carbon data with 3D BIM model, we can now create heat maps of carbon intensity highlighting areas of high carbon intensity, shown in Figure 3.
- This type of visualization is useful in better identifying areas where consideration of sustainable alternatives could be beneficial.

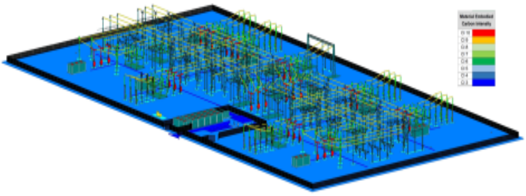

Figure 3: Example of Embodied Carbon Intensity Map

Use Case 2: Design Options

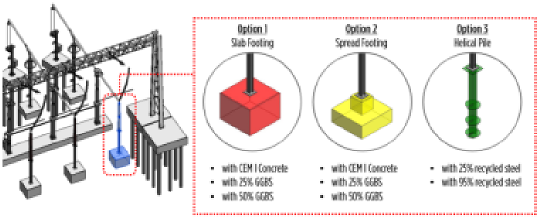

Figure 4: Design Optimization using BIM Enabled Carbon Comparison

- To fully realise design optimization we need to have a number of design options to compare against, Using BIM framework, we have the capability to create multiple design options quickly and easily.
- Figure 4 shows an example of an optioneering exercise for three different foundation options with different materials. A summation of material embodied carbon values for each design alternative can be quickly and accurately determined based on metadata provided within the model.
- Creating multiple alternative options allows us to efficiently find a balance between sustainability and cost and optimise our designs dependant on the outcome required.

Use Case 3: Project Visualization

- A sustainable design is not just an impact on CO_2 levels, but it can also extend to an impact to a neighboring community.
- BIM serve as a powerful visual tool for creating a project visualization in the early stages of design for project stakeholders and public engagement.
- Figure 5 is an example of a project visualization that would be used to discuss with the local community showing the visual impact on the surrounding areas.
- By using these tools in the early stages, it enables greater understanding of the project by all parties and allows earlier opportunity to find design alternatives that suit the environment.

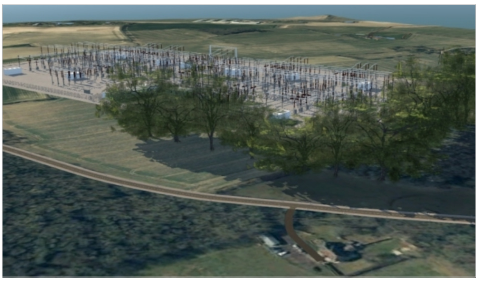

Figure 5: Project Visualization with Impact to the Local Community

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Potential Challenges

- BIM adoption in the electrical utility industry is in the early stages compared to the general AEC industry meaning that resources and guidelines necessary to fully enable BIM integration into a substation project can be limited.
- While this process is not a requirement in all countries, there is a growing demand for BIM enabled design across the industry. Support from government policies and regulations can expedite the utility adoption rate of a BIM framework to improve substation project sustainability.
- The initial gathering and integration of embodied carbon data into BIM models is likely require upfront custom design automations and more resources/investments since manual process is time consuming and may not even be practical.
- Embodied carbon data particularly for utility equipment and materials are not widely available. There is also inconsistency among the data sources posing challenges in pulling data across resources.

Conclusion

- Integrating sustainable considerations into substation design will be vital to electrical utilities to meet their carbon emission reduction targets and to progress towards more sustainable practices.
- BIM frameworks have already been widely and successfully adopted by the AEC industry with its strength in handling large sets of data and could prove as beneficial in other industries, utility industry included.
- BIM enables embodied carbon quantification for substation projects and allows utility owners and engineers to compare a tangible value against traditional design considerations for more optimized and sustainable designs. Several other benefits are shown in Figure 6.
- Utilizing a BIM framework to track embodied carbon throughout a substation project life cycle will better provide visual and quantifiable data for more sustainable design decisions. It could also aid in finding possible solutions to reduce any negative impacts to the local community.
- With careful coordination, industry wide investment, and robust standard practices, implementation of BIM for utility projects could be an innovative solution to support the industry in achieving carbon reduction and broader sustainability goals.

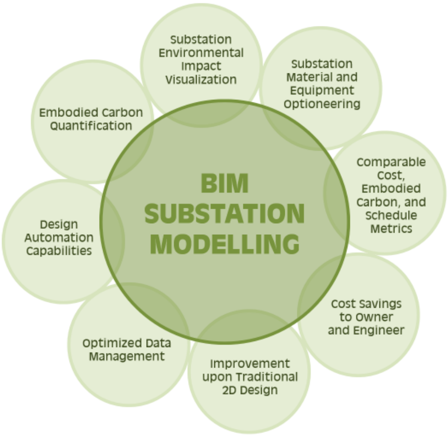

Figure 6: Sustainable Substation BIM Design Benefits