

## ABSTRACT

The transition to a smarter grid, requires the power industry to become more flexible in developing new methods and mapping techniques, for many to interpret and understand the power network.

The understanding of a power network begins with the single line diagram (SLD). SLDs are conceptual maps of the power network used by engineers to understand the connectivity between assets of the network, study power flow, and maintain grid stability and security.

We introduce an interactive visualisation that combines a spatial element to the SLD, to enable users with varying degrees of electrical knowledge to understand its geographical aspect.

## THE SINGLE LINE DIAGRAM

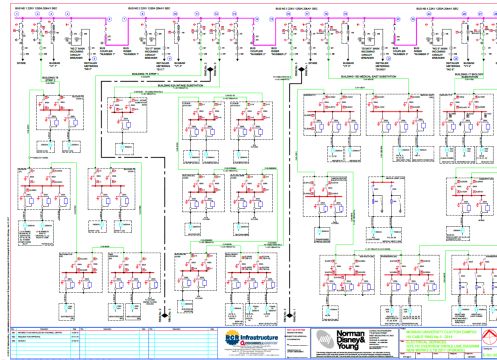


Figure 1. Monash University Clayton Campus High Voltage Single Line Diagram 2017

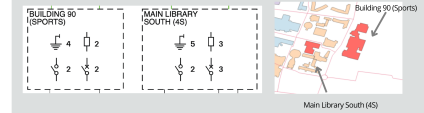
SLDs:

- Do not reflect the geographical location of its elements
- Are often used in conjunction with a map
- Interpretability is limited to power engineers with extensive experience about specific networks

An example of how the SLD lacks a spatial element.

Is Main Library South east of Building 90?

No.



## THE VISUALISATION PROTOTYPE

The interactive visualisation prototype, embeds a geographical element into the Monash SLD. It provides a tailored animated transition between two interactive views, a SLD view and a geographical map view. It can be accessed at the link: <https://www.sgsep.com.au/maps/merry/sldvisualisation/>

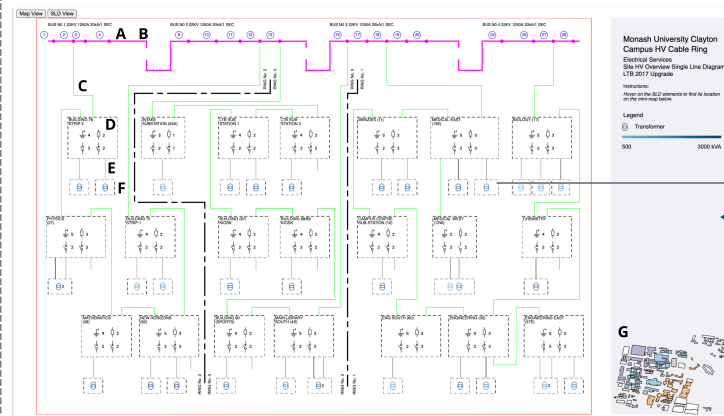


Figure 2. Visualisation prototype SLD view. Hover interactions are available at A-G. A: Detailed feeder information on each centroid. B: Details of all the feeders on that bus bar. C: High voltage transmission line spec. D: Detailed substation view as well as the location of the building highlighted in red in G. E: Low voltage transmission line spec. F: Detailed transformer view. G: Buildings highlighted red as user hover over D elements.



Figure 3. Visualisation prototype Map view. Hover interactions A-H in the SLD view remain active in the map view. Two additional interactions are included here H and I: Interactive legend to turn layers on and off to focus on a specific section of the network. I: Hovering on the building polygons will provide building metadata including its name, address, use, energy consumption or image.

## THE DESIGN METHOD

The visualisation prototype was developed iteratively through a process involving expert interviews with participants of varying power knowledge and experience. This included:

- 2 preliminary interviews
- 5 feedback interviews and
- 1 evaluation survey

The process helped refine:

- Hover interactions
- Interactive legend
- Inclusion of critical assets such as solar panels, batteries and electric vehicle charging stations on the map view

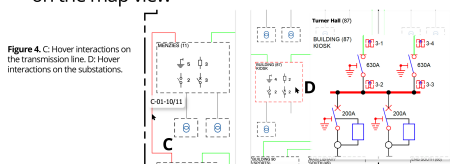


Figure 4. C: Hover interactions on the transmission line. D: Hover interactions on the substations.

## THE BENEFITS

The research indicates that geography plays a role in network communication and opens further opportunities. There are several potential instances where the visualisation could provide practical benefits.

### Sharing and understanding

- Promotes knowledge sharing between technical and non-technical users
- Ability to communicate how power is structured

### Education and training

- Use in tertiary teaching to help students understand the SLD
- Assist junior power engineers on the field

### Precinct planning

- Explain precinct strategies to stakeholders

## FUTURE WORK

There are multiple opportunities for further development of this research including:

- Reproduction with different grids and also the distribution and transmission network
- Whether a juxtaposed approach across multiple screens may be beneficial
- Updating the visualisation prototype with the latest Monash Clayton SLD
- Locating the transmission line spec and represent the transmission lines faithfully in the map view
- Integrate more building metadata concerning electrical and behavioural use in the map view

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## Visualisation URL

<https://www.sgsep.com.au/maps/merry/sldvisualisation/>

