

IOWA STATE UNIVERSITY

Department of Electrical and Computer Engineering



**BLACK & VEATCH**

# 115/34.5kV Solar Plant & Substation

## Senior Design Project

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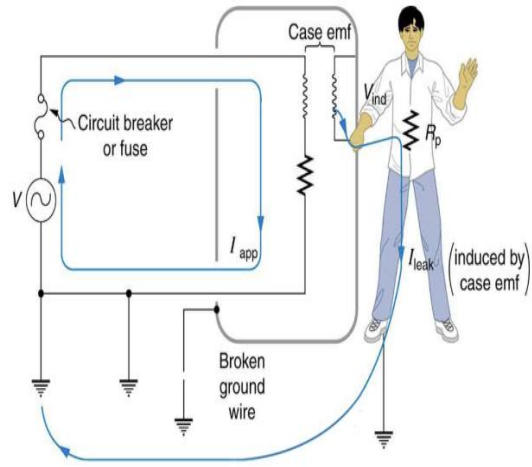
| Senior Design Team 41

| 02/10/2025

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## AGENDA

- Safety Moment
- New Technology
- One-Line Sec Rad bus configuration
- One-Line Ring bus configuration
- One-Line Double Bus Single breaker bus configuration
- One-Line using selected bus configuration
- Discuss Gantt Chart Feedback
- Finalize component selection



## SAFETY MOMENT

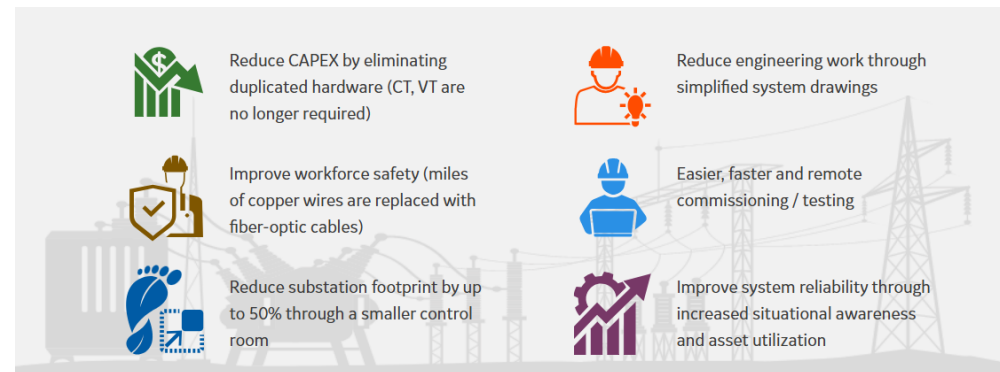
**key safety rules when working with circuit breakers:**

- 1. Turn Off Power** – Always de-energize the circuit and confirm it's off with a tester.
- 2. Wear Safety Gear** – Use insulated gloves, safety glasses, and protective clothing.
- 3. Lockout/Tagout (LOTO)** – Lock and tag the breaker to prevent accidental re-energization.
- 4. Use Proper Tools** – Work with insulated tools rated for electrical work.
- 5. Beware of Arc Flash** – Stand to the side when operating large breakers and maintain a safe distance.
- 6. Check for Damage** – Inspect for overheating, corrosion, or wear before working.
- 7. Work with a Partner** – Have someone nearby in case of emergencies.
- 8. Keep the Area Dry** – Avoid working in wet conditions to prevent electric shock.

## NEW TECHNOLOGY

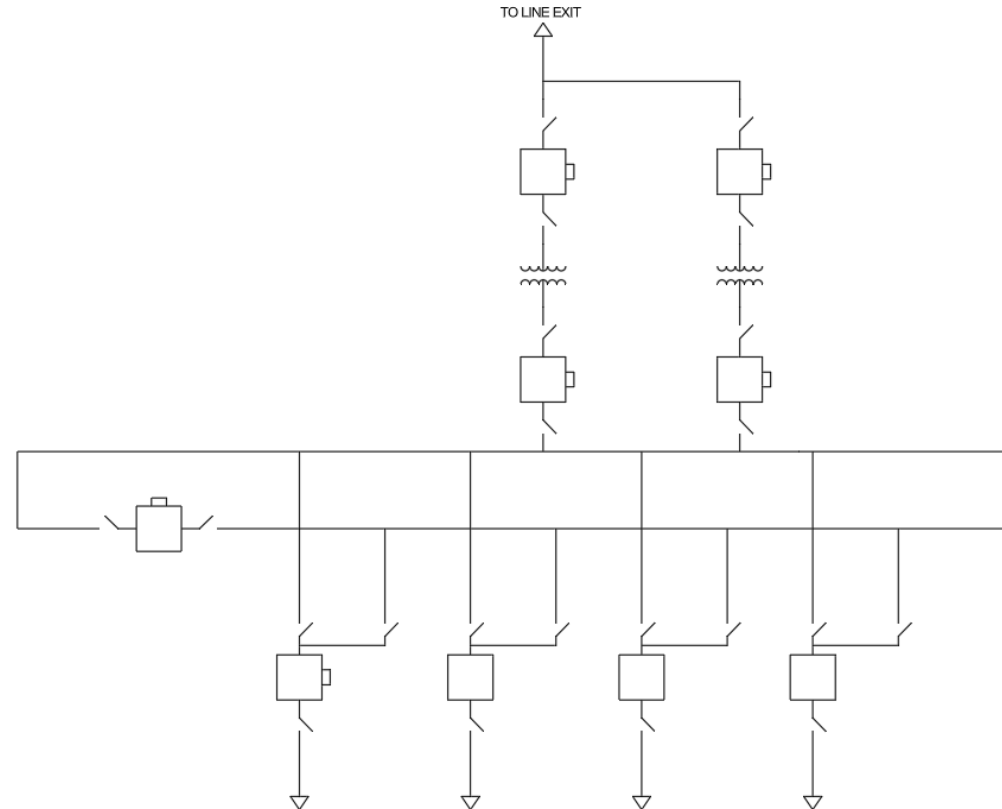
### Digital Substations

- It takes binary and analog data and makes it digital data right near the source
  - This allows the transmission of data to be in real time
- Fiber optic cables replace copper wires
  - Cuts down on land costs, and trenchwork and materials cost
- Better protection and control of the equipment will make the system more reliable
- New additions to the substation can be integrated fairly easily



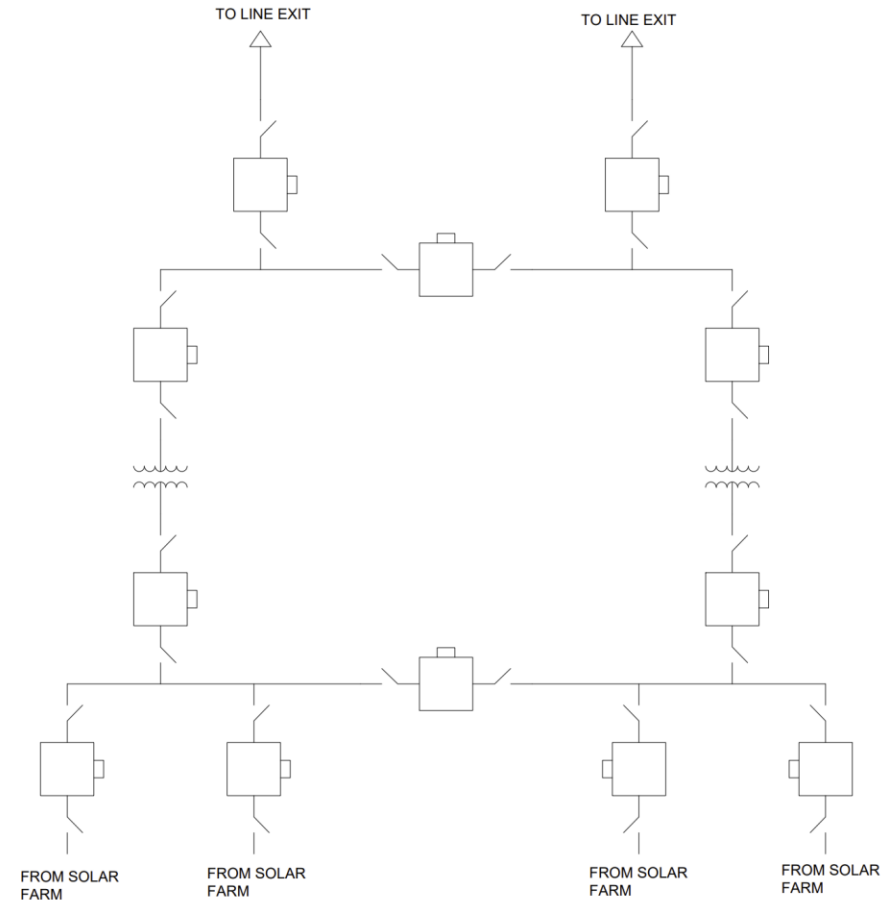
- <https://www.hitachienergy.com/us/en/products-and-solutions/substation-automation-protection-and-control/substation-automation-systems/digital-substation>
- <https://www.gevernova.com/grid-solutions/landing/digital-substation/>

# One-Line Double Bus Single breaker bus configuration



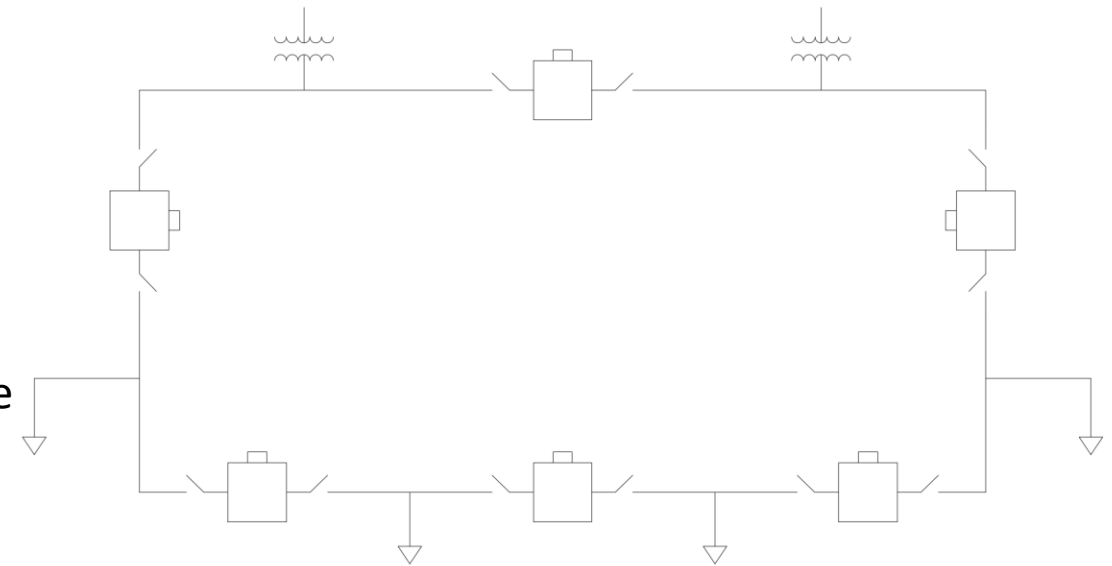
## Sectionalized Bus

- Pros
  - Each feeder gets a CB
  - Lots of protection and versatility
- Cons
  - Requires a large amount of breakers
  - Complex Relaying
  - Takes more land



## Ring Bus

- Pros
  - Very flexible
  - Reliable
  - Less breakers needed
- Cons
  - Complex Relaying
  - Ideally have 4 circuits connected to it. (We have 6)



Gantt Chart

|    | A               | B                                           | C               | D              | E         | F        | G                                   | H | I | J | K | L | M | N | O | P | Q | R | S | T | U |
|----|-----------------|---------------------------------------------|-----------------|----------------|-----------|----------|-------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1  | Project:        | 115/34.5 kV Solar Power Plant & Substation  | Company Name    | Black & Veatch |           |          |                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 2  | Project manager | Adam Schroeder, Eli Schaffer, Utsavee Desai |                 |                |           |          |                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 3  |                 |                                             |                 |                |           |          |                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 4  |                 |                                             |                 |                |           |          |                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 5  |                 | TASK TITLE                                  | TASK OWNER      | START DATE     | DUE DATE  | DURATION | TASK COMPLETE                       |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 6  |                 |                                             |                 |                |           |          |                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 7  |                 | SUBSTATION                                  |                 |                |           |          |                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 8  | 1               | Documentation                               |                 |                |           |          |                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 9  |                 | Weekly Agenda                               | All             | 1/27/2025      | 5/16/2025 | 109      | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 10 |                 | Meeting Minutes                             | All             | 1/27/2025      | 5/16/2025 | 109      | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 11 |                 | Weekly Report                               | All             | 1/27/2025      | 5/16/2025 | 109      | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 12 |                 | Presentation Slides                         | All             | 1/27/2025      | 5/16/2025 | 109      | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 13 |                 | Project Design Document                     | All             | 1/27/2025      | 5/16/2025 | 109      | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 14 |                 | Final Report                                | All             | 1/27/2025      | 5/16/2025 | 109      | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 15 |                 | Revamp Gantt Chart                          | All             | 1/27/2025      | 2/3/2025  | 7        | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 16 | 2               | Research                                    |                 |                |           |          |                                     |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 17 |                 | Substation Components - Transformers        | David & Ben     | 1/27/2025      | 2/10/2025 | 14       | <input checked="" type="checkbox"/> |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 18 |                 | Substation Components - Disconnect Switches | David           | 1/27/2025      | 2/10/2025 | 14       | <input checked="" type="checkbox"/> |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 19 |                 | Substation Components - Circuit Breakers    | Mohamed & Ben   | 1/27/2025      | 2/10/2025 | 14       | <input checked="" type="checkbox"/> |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 20 |                 | Substation Components - CCVTs               | Sergio & Andrew | 1/27/2025      | 2/10/2025 | 14       | <input checked="" type="checkbox"/> |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 21 |                 | Bus Configuration                           | Select          | 2/3/2025       | 2/17/2025 | 14       | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 22 |                 | One-Line Plan                               | Select          | 2/3/2025       | 2/17/2025 | 14       | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| 23 |                 | Design Standards                            | Select          | 2/3/2025       | 2/17/2025 | 14       | <input type="checkbox"/>            |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

- Will continue to update and add any changes
- Any feedback at the moment?

## Final Components Selection

### 1. Transformer:

- Voltage Rating : 115 kV/34.5 kV
- Standards: IEC
- Cooling method: ONAN (Oil Natural, Air Natural) & ONAF (Oil Natural, Air Forced)
- On Load Tap Changer (OLTC): 32 Steps Huaming or Equivalent



## Final Components Selection

### 2. Disconnect switches:

- Maximum voltage rating: 38Kv-362Kv
- Continuous Current ratings: 1200A-5000A
- Standards: ANSI
- BIL Rating (Basic Insulation Level): 200-1050/1300 Kv



## Final Components Selection

### 3. CCVTs (coupling capacitors Voltage Transformers):

- Standards: IEC & IEEE
- Capacitive voltage transformers: 254 – 1270 Kv
- Coupling Capacitors: 115-1095 KV





## Final Components Selection

### Circuit Breakers

#### Low kV Side: Mitsubishi EDD 38kV

- Rated Voltage: 38kV
- Interrupting Medium: Vacuum

- <https://0aab1c21-cdn.agilitycms.cloud/Attachments/EDD%2038kV%20VCB%20Overview.pdf>

#### High kV Side: Mitsubishi 120-SFMT-40F

- Rated Voltage: 145kV
- Interrupting Medium: SF6 Gas

- [https://0aab1c21-cdn.agilitycms.cloud/AttachmentLists/File/BR0020301001\\_145kVGCB\\_Brochure\\_Pgs.pdf](https://0aab1c21-cdn.agilitycms.cloud/AttachmentLists/File/BR0020301001_145kVGCB_Brochure_Pgs.pdf)

THANK YOU