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Department of Electrical and Computer Engineering

115/34.5kV Solar Plant & Substation
Senior Design Project

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| Senior Design Team 41

| 03/03/2025

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AGENDA

- Safety Moment
- New Technology
- AC, DC Calculations
- Substation layout
- ETAP Update

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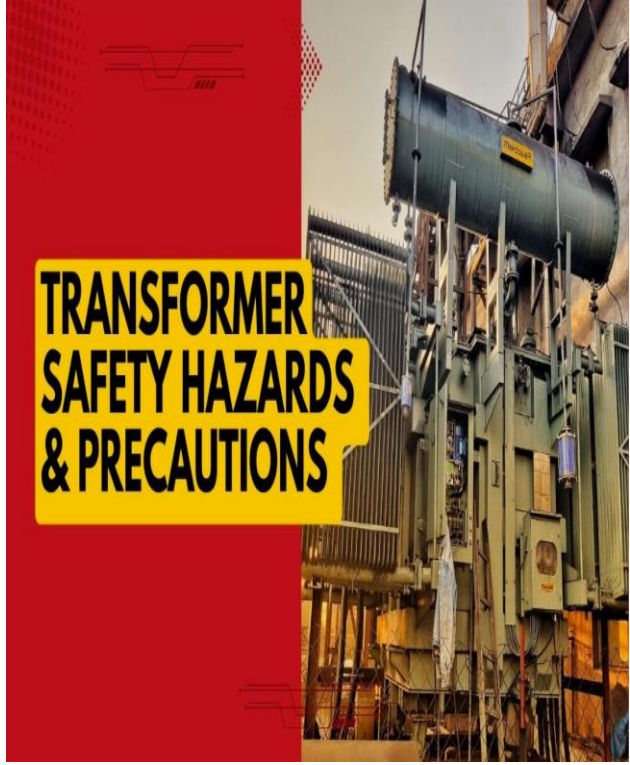
Safety Moment

Transformer Maintenance & Inspection



- **Why It Matters:**

  Regular maintenance keeps transformers safe, prevents failures, and reduces downtime.

- **Key Steps:**

  Check for Damage – Look for leaks, rust, or wear.

  Use Infrared Scans – Find hot spots and loose connections early.

  Test Protective Devices – Ensure relays and breakers work properly.

  Monitor Oil & Insulation – Keep insulation strong and free from contamination.

  Keep Records – Track maintenance for better reliability.

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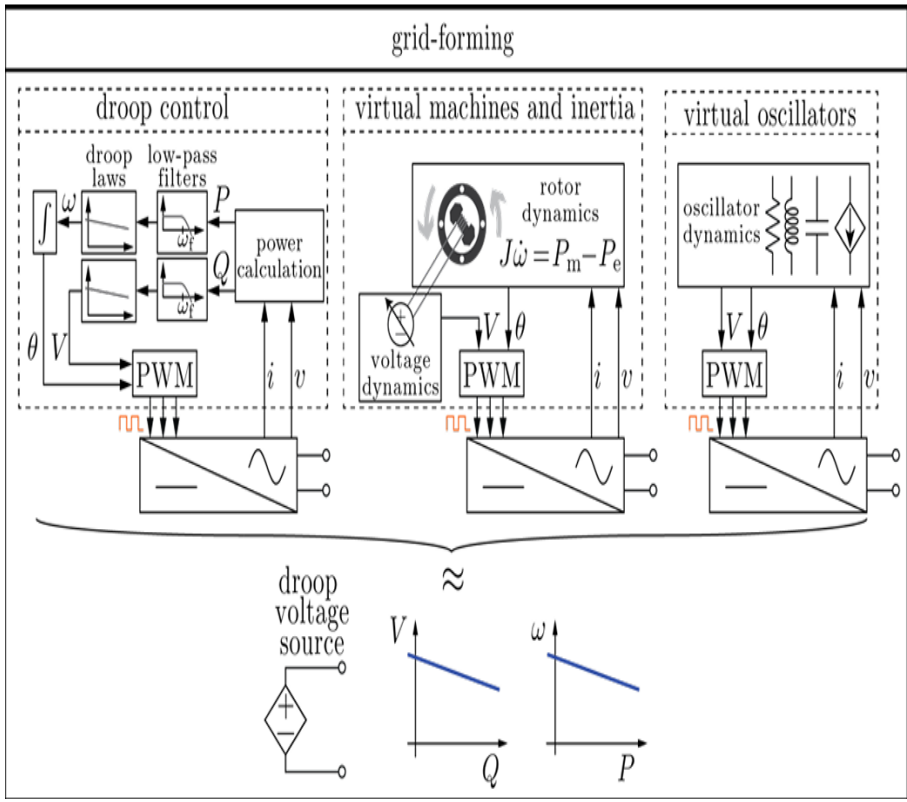
NEW TECHNOLOGY

Grid-Forming Inverters

- **Definition:** are an advanced technology that enhances the stability and reliability of power systems with a high penetration of renewable energy.

- **What they Do?**
  GFMIs enable solar plants to **support** and **stabilize** the grid, reducing dependence on fossil fuel-based generation for frequency and voltage regulation.



https://www.nrel.gov/docs/fy24osti/90256.pdf

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NEW TECHNOLOGY

Benefits of Using GFMIs in a Solar Plant & Substation

- **Enhancing Grid Stability**: They help maintain grid **voltage and frequency** in areas with high renewable energy penetration.
- **Black Start Capability**: GFMIs can **restart the grid** without relying on fossil-fuel-based power plants, making them crucial for grid resilience.
- **Improved Fault Ride-Through**: Unlike conventional inverters, GFMIs can continue operating during grid disturbances, reducing the risk of **voltage collapses**.
- **Inertia Support**: They mimic the **rotating inertia** of synchronous generators, stabilizing grid fluctuations caused by sudden demand or supply changes.

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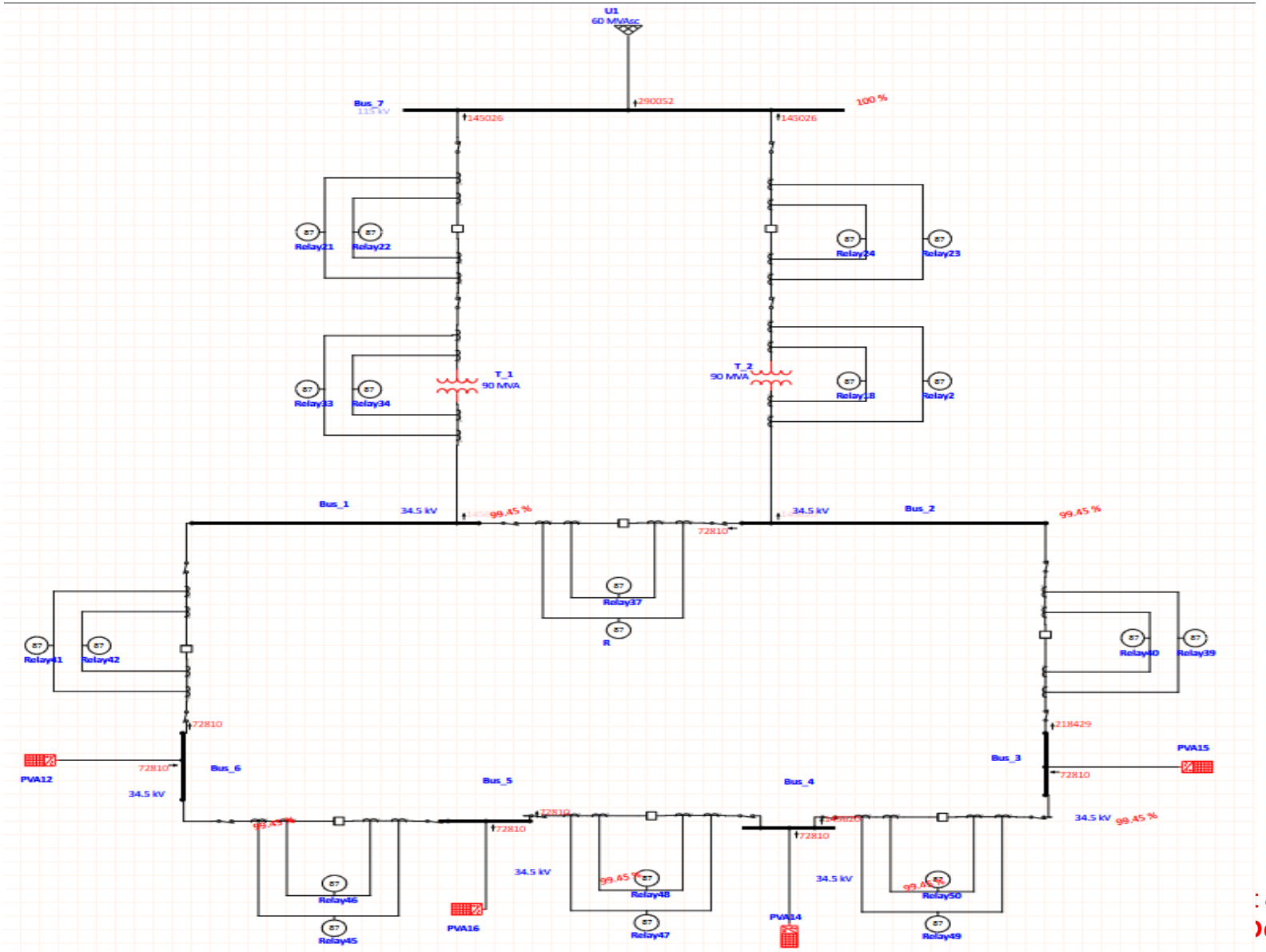
ETAP Update



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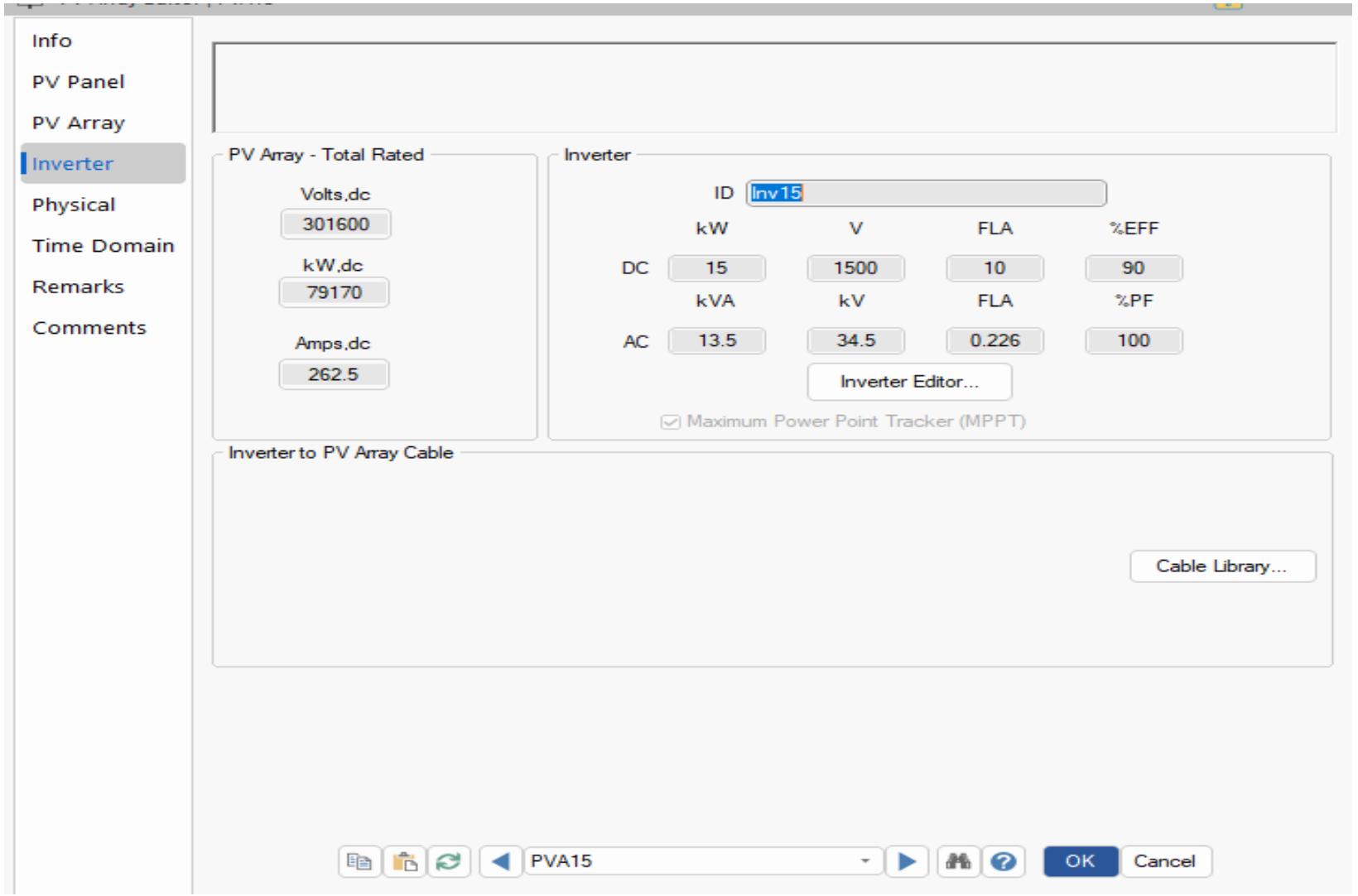

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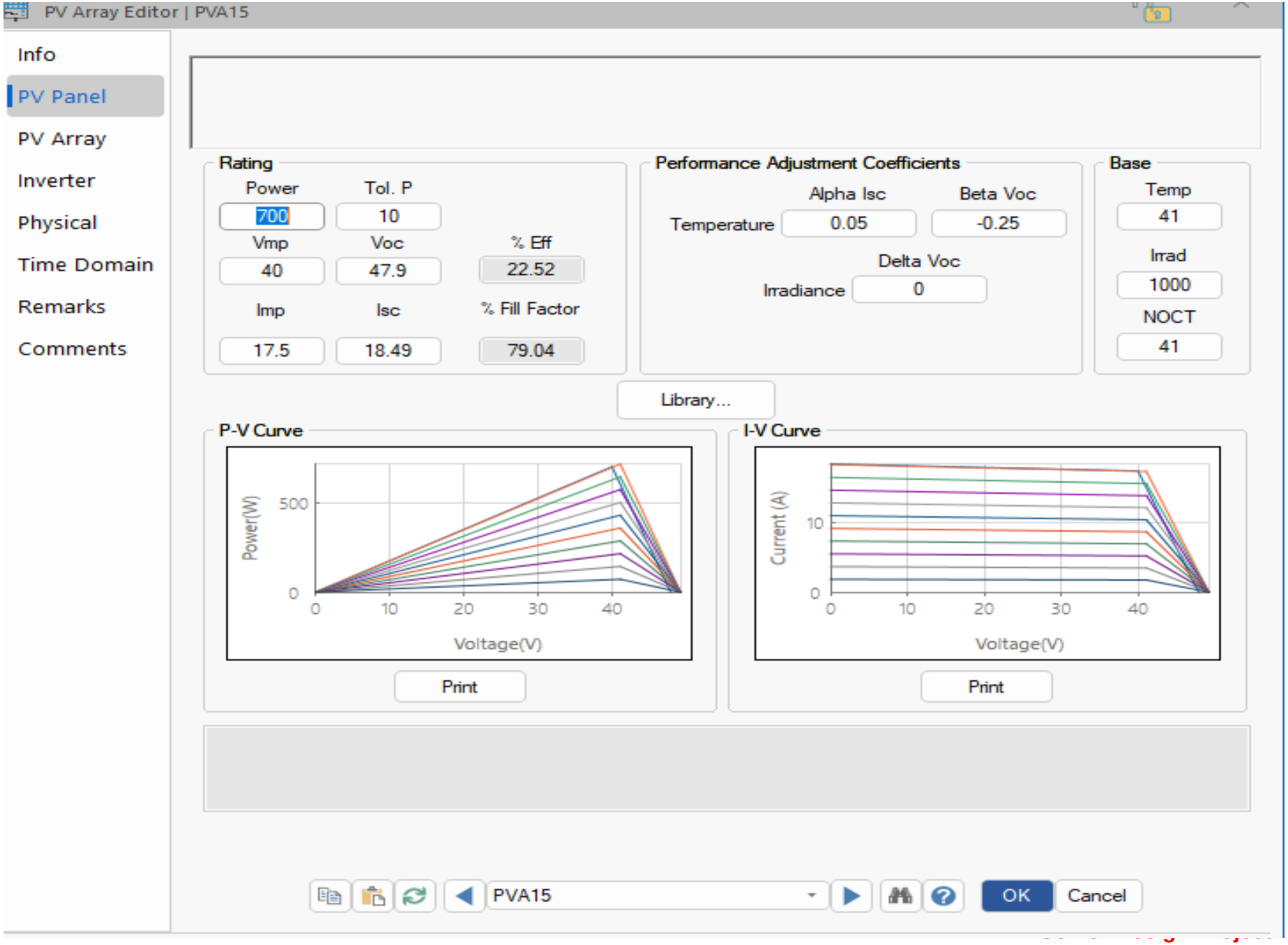

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AC Calculations

- Will update control house components once our team discusses a design

AC STUDY							
		Quantity	Load/Unit (W)	Amps (ea)	Voltage (V)	Total (W)	Amps Total
AC Panel - Control Building	Breaker Recepticle and Lights	2	210	1.75	120	420	3.50
	Transformer Fans	2	24000	100	240	48000	200.00
	Transformer Sump Pump	2	2000	8.333333	240	4000	16.67
	Control House Lighting	20	36	0.3	120	720	6.00
	Yard Lights (Assuming lights are off)	8	55	0.458333	120	440	3.67
	HVAC System	2	4721	22.69712	208	9442	45.39
	Fire Detection Equipement	1	150	1.25	120	150	1.25
	Exhaust Fan	1	132	1.1	120	132	1.10
	AC Battery Charger	1		0	240	0	0.00
	Power Outlet	10	180	1.5	120	1800	15
				0	1	0	0
				0	1	0	0
				0	1	0	0
	Worst Case Tripping						
	High Side Breaker Trip	1	720	3	240	720	3
	Low Side Breaker Trip	2	720	3	240	1440	6
	Total Worse Case AC Panel Load					65104	292.58
			Total Worst Case Load (+10%)			71614.4	321.83532

Assumed Values:

Breaker Motor 720W at 240V
Feeder Motor 720W at 240V
Breaker Recepticle and Lights 210W at 120V
Transformer Fans 24,000W, 100A at 240V
Transformer Sump Pump 2000W at 240V
Control House Lighting 20 Qty at 36W each running at 120V
Yard Lights 55W at 120V
HVAC System 10,000W at 240V
Fire Detection Equipment 150W at 120V
Exhaust Fan 132W at 120V

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DC Calculations

60 Cell Sysem	Continuous Load	Discontinuous Current
	4.404A	19.8 A

Power Supply Burden (W)	t = 0 min	t = 1 min	t=240min
	32.60	4.404 A	27.604 A

T1= 0, Discontinuous load (trip current) & continuous load
T2= 1 min, Total continuous load
T3= 240 min, Discontinuous load (closing current) & continuous load

Components	Load Current (A)	Nominal Voltage (V) DC	Inception and Active Shutout Time	number of components	Total Load Current (A)	Power Requirement
34.5kV Breaker:	Tripping Current: 3.3A Closing Current: 2.6A	70 – 140 90 - 140	0 -1	6.00	Tripping Current:19.8A Closing Current :15.6A	231 - 343W 234 - 364W
115kV Breaker:	Tripping Current : 4.2A Closing Current : 3.8A	125.00 125	239- 240	2.00	Tripping Current: 8.4A Closing Current : 7.6 A	1050W 950W
SEL-311C	0.20	125.00	1 - 240	8.00	1.60	25.00
SEL-311L	0.20	125.00	1 - 240	8.00	1.60	25.00
SEL-587	0.044	125.00	1 - 240	2.00	0.08	5.50
SEL-487E	0.280	125.00	1 - 240	2.00	0.56	35.00
Battery Monitoring Equipment	0.024	50 -180	1 - 240	1.00	0.02	6 VA
DC Ammeter	0.048	125.00	1 - 240	1.00	0.048	3 VA
DC Voltmeter	0.048	120.00	1 - 240	1.00	0.048	3 VA
SACO Annunciator (L8)	0.150	125.00	1 - 240	2.00	0.30	15 W
Edwards Bell	0.012	125.00	1 - 240	1.00	0.012	1.5 VA
Power Line Indicating Lamps (LEDs)	0.017	125.00	1 - 240	8.00	0.136	2.125 W

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DC Calculations

EnerSys
Power/Full Solutions

Summary Margin Report

Customer:	Iowa State University
Location:	
Project:	
Date Prepared:	2/28/25
Prepared By:	Sergio Sanchez Gomez
Phone:	5155679974
E-Mail:	sergiosg@iastate.edu

Sizing Parameters

Application:	Utility
Lowest Temp (°F):	77.00
Min. Voltage (Vpc):	1.75
Design Margin:	1.10
Aging Factor:	1.25

Line	Cell Model	Margin
1	ESG-05	1.2%
2	6 OGi 170	4.0%
3	6 OGi 80 (2 Strings)	4.0%
4	CA-09M	9.6%
5	CA-05M (2 Strings)	9.6%
6	CC-09M	9.7%
7	CC-05M (2 Strings)	9.7%
8	EA-05M	13.2%
9	EC-05M	13.6%
10	4 OPzS 200	21.3%
11	DSG-05	63.3%
12	GC-09M	369.8%
13	Vb 2408	425.2%

Battery Load Details

Number of Cells:	60
Total Time (Minutes):	241.00
Amp Hour Removed:	110.47

Period	Time (Mins.)	Load
1	0.00	32.60 A
2	1.00	4.40 A
3	240.00	27.60 A

Sizing report using IEEE-485 ??

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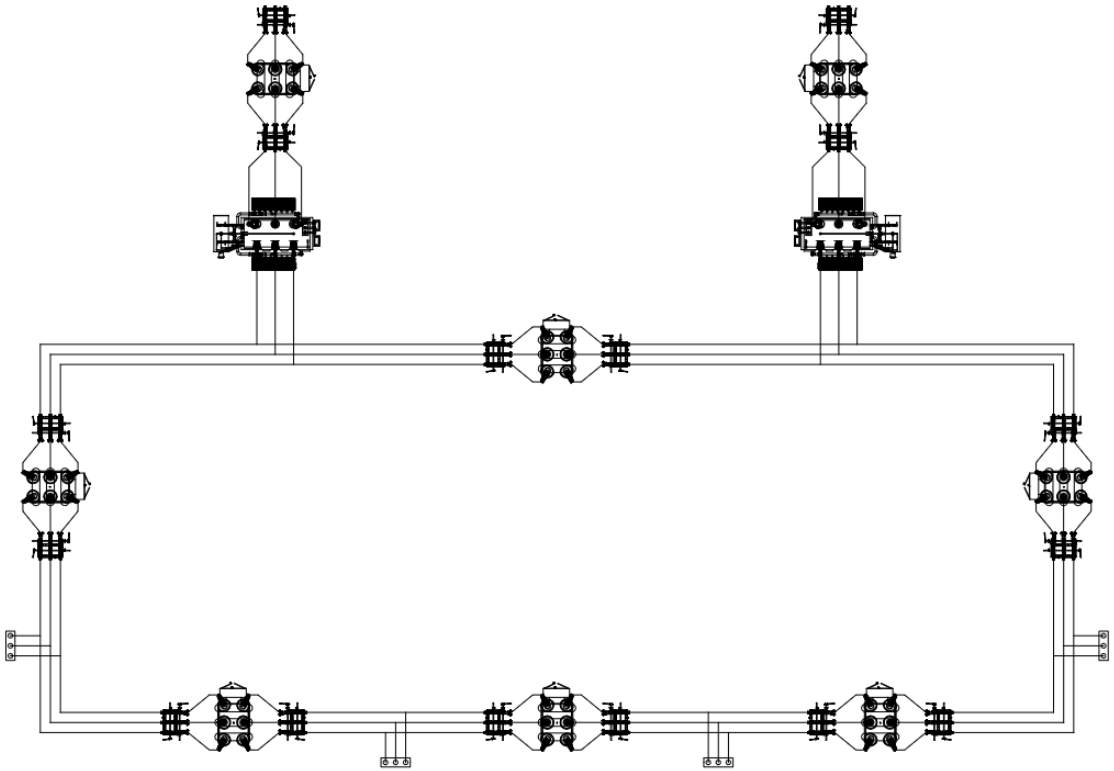
Physical Layout

- Initial draft completed and sent to BV
- Still need more details such as a control building, line exit structures, section views etc.



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THANK YOU

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