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# India SMART UTILITY Week 2025

Supporting Ministries



**Session : India@100 in 2047: Vision for the Indian Power System**

**IEEE 2800 Complied Power Hardware-in-the-Loop (PHIL) Setup  
for Analyzing PV Plant's Behavior in Power Systems**

*Presented By*

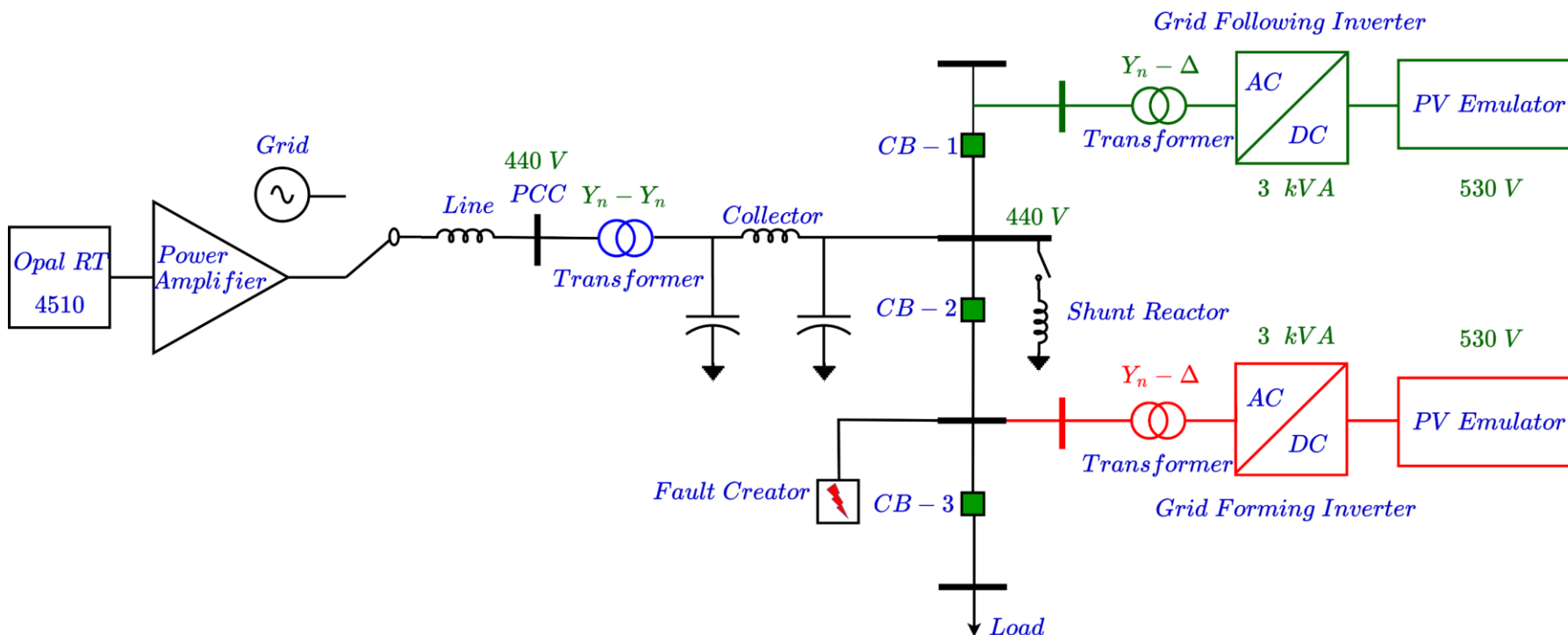
**Sarasij Das, Associate Professor, IISc Bangalore**

- Large-scale plants with Grid–Following (GFL) converters installed
- Dynamic and fault behavior of inverter-interfaced PV plants are different from the behavior of conventional synchronous generators
- IEEE 2800-2022 addresses interconnection and interoperability of Inverter-Based Resources at Transmission Level

- Many unexpected system oscillations, over-voltages, and protection trippings are being observed in the field specially in weak-grids
- How to model PV plants in grid connection studies?
- How do we choose various grid-code settings for PV plants?
- Do we need Grid Forming Inverters?

- Grid-India facing many technical challenges with renewable integrations
- Experimental Set-up on realistic PV plant needed for better understanding and modelling of inverters' behaviour
- Grid-India (SRLDC) funded following projects at IISc to build a laboratory-scale PV plant in Hardware
  - *"Development of Grid Following Inverter & Experimental Set-up on Grid Integration of Photovoltaic Power Plants: Phase-I"*
  - *"Development of Grid forming Inverter & experimental set-up on Grid Integration of Photovoltaic Power Plants (Phase-II)"*

# PRESENTATION ON THE TOPIC (1/2) (1 Min)



## Features:

- LVRT, HVRT
- Power Plant Controller
- Negative Sequence Injection
- Varying Short-Circuit Ratio

TABLE I: Modes of Operation of the Setup

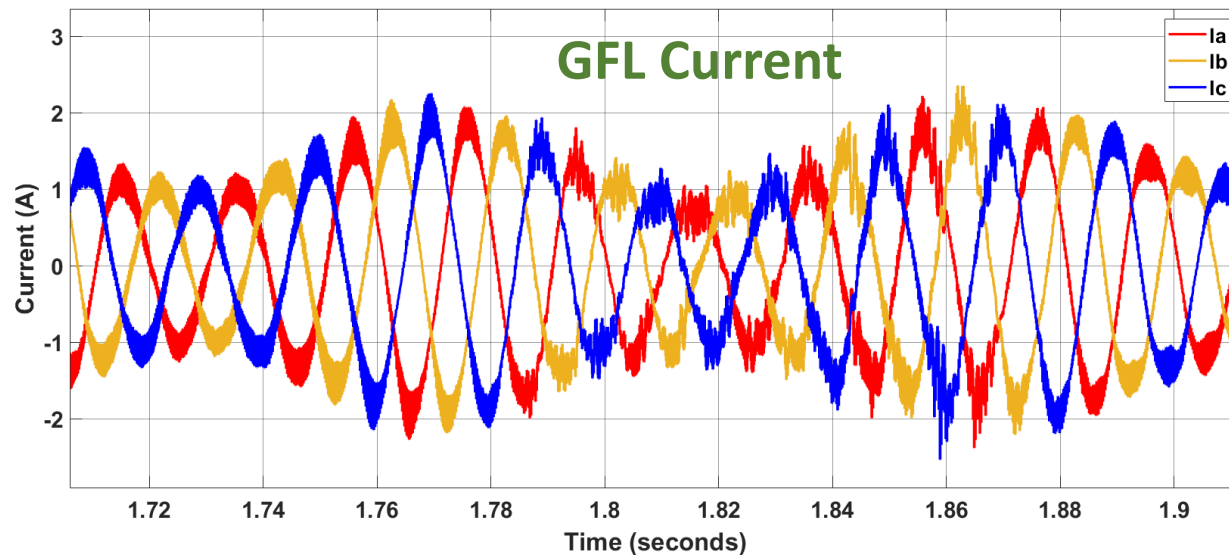
Mode	Configuration	CB-1 Status	CB-2 Status	CB-3 Status
1	GFM with Load	Open	Open	Close
2	GFM	Open	Close	Open
3	GFL	Close	Open	Open
4	GFL, GFM Parallel	Close	Close	Open

IEEE 2800-2022 Requirements	Implemented in the GFL Inverter
Voltage Ride Through	Yes
Frequency Ride Through	Yes
Reactive Power Control	Yes
Automatic Voltage Regulation	Yes
Balanced Current Injection	Yes
Unbalanced Current Injection	Yes



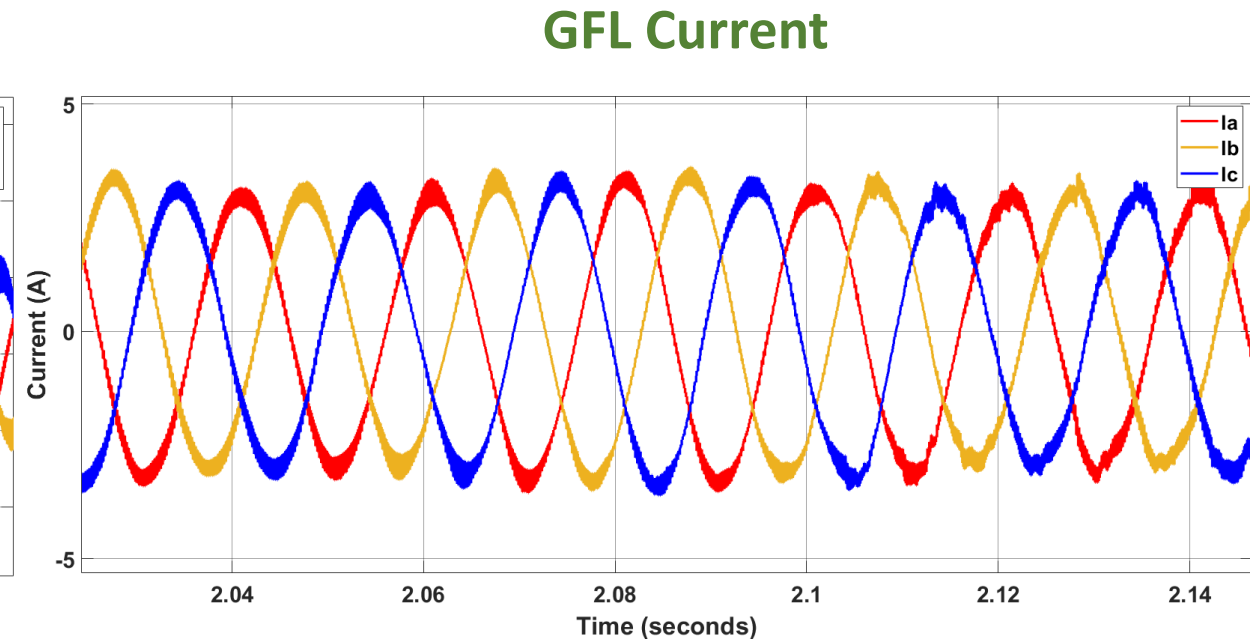


- Case Study: Weak Grid Scenario (**SCR 1.9**)
- **Case-1:** Only GFL
- **Case-2:** GFL+GFM



**Case-1**

- GFL became unstable after Oscillations
- MPPT could not be reached



**Case-2**

- GFL was stable when GFM running in parallel
- MPPT was reached

- IEEE 2800 Complied PHIL set-up developed
- Practical Inverter behaviour with a portion of Indian grid can be tested
- Model validation can be done
- Performance of Power Plant Controller can be checked
- Grid code settings can be experimentally validated





## Future Extensions:

- Development of STATCOM in hardware to study interactions
- Development of HVDC Line in hardware to study interactions
- We are looking for more industry collaborations

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# THANK YOU

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[Links/References \(If any\)](#)