



# Evaluation of DER integration on distribution protection with Hardware in the loop using Low energy signals

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Supervisor: Prof. Ha

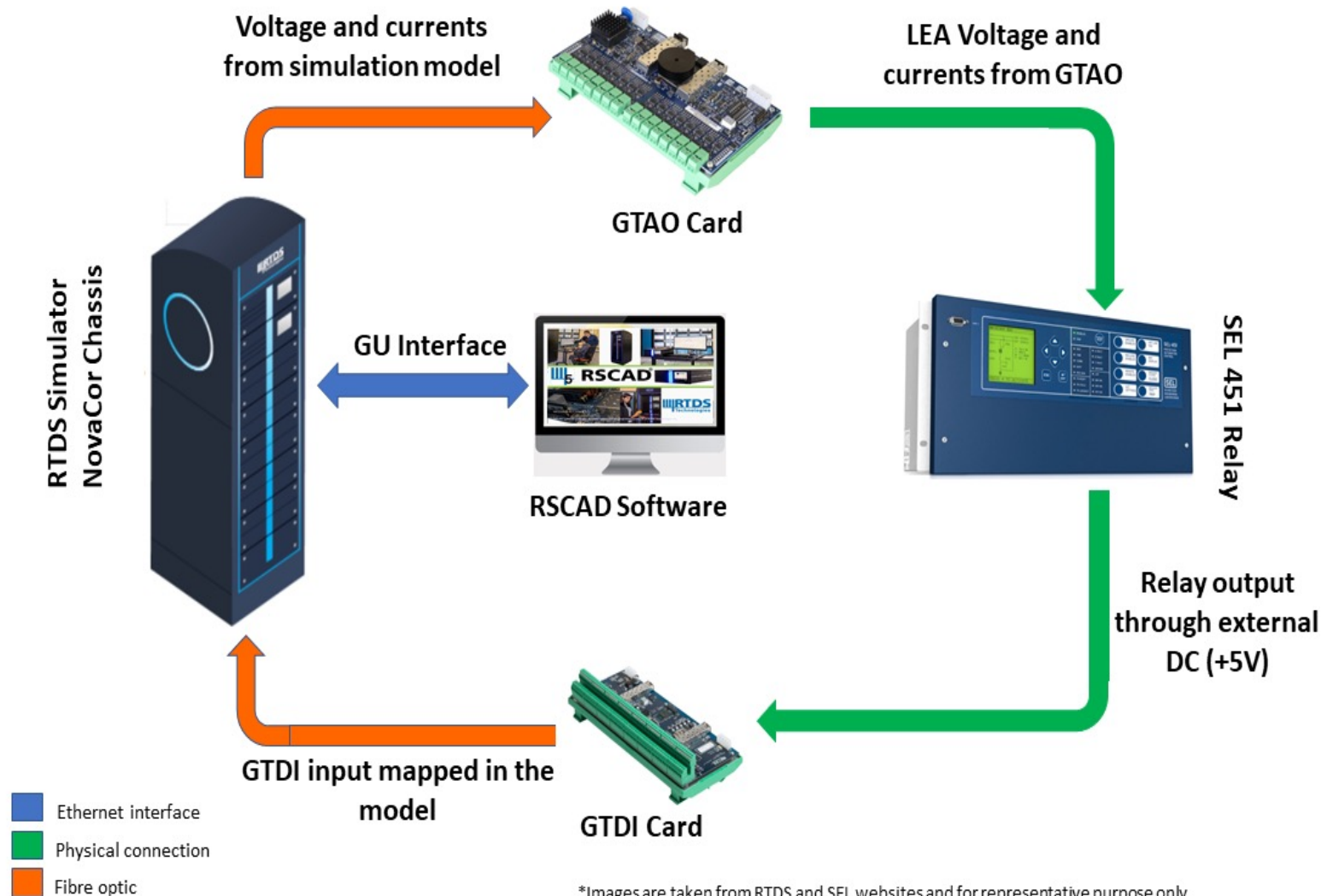


## Objective:

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- To develop a hardware in the loop test setup for the deep integration of renewable energy in the power system research work.
- Understanding the impact of the distribution energy resources integration on existing protection system at distribution level.
- Develop case studies of protection issues and validate them with test bed setup.

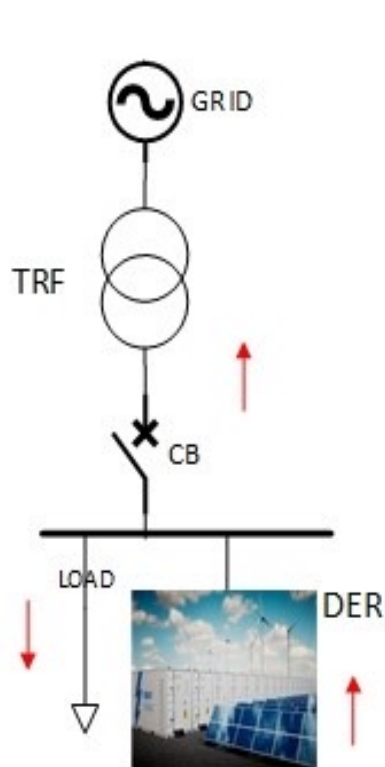
# Hardware in the Loop setup with LEA:



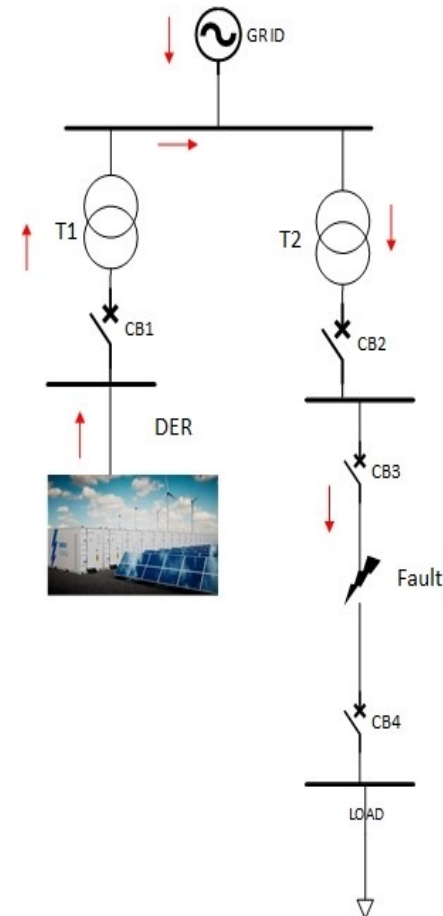
\*Images are taken from RTDS and SEL websites and for representative purpose only.

# Protection related issues with DER integration:

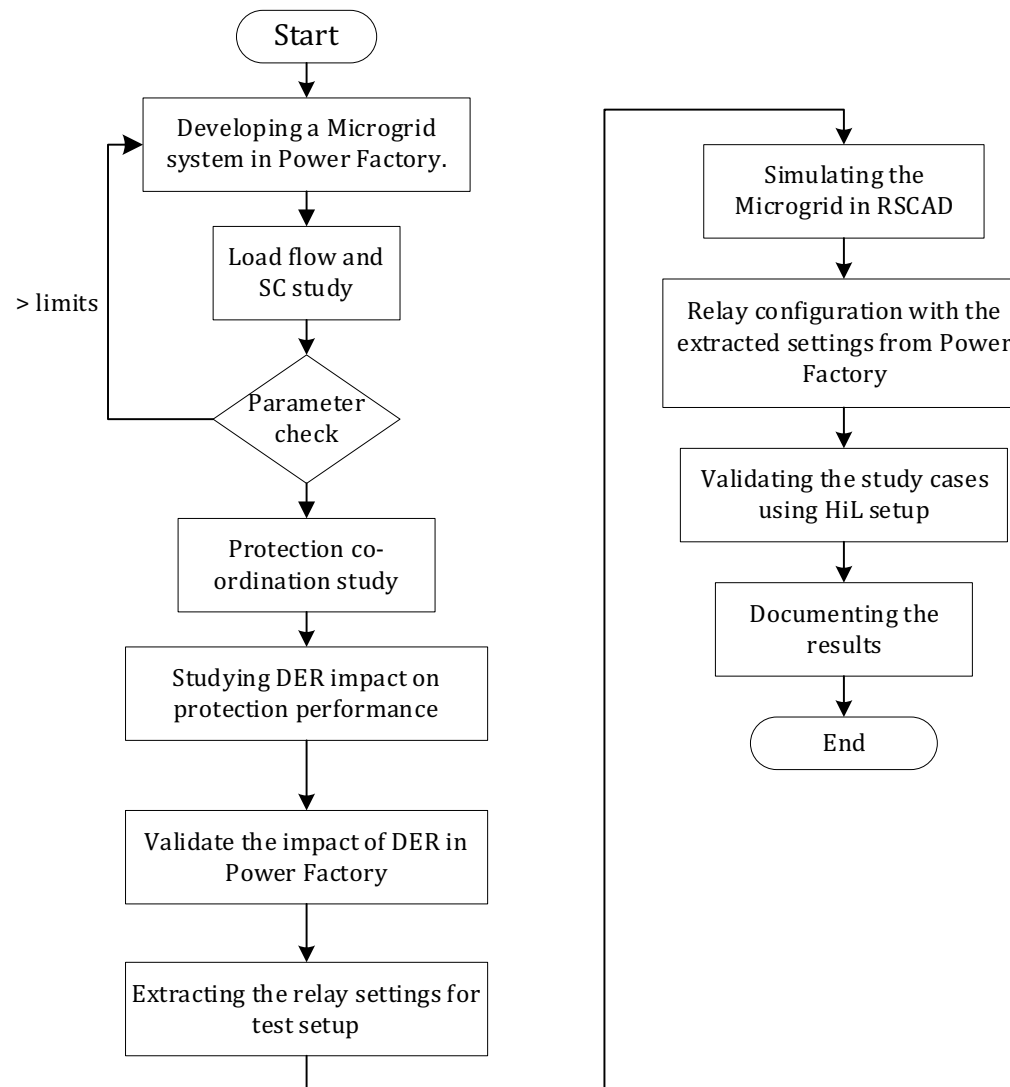
## Reverse power flow:



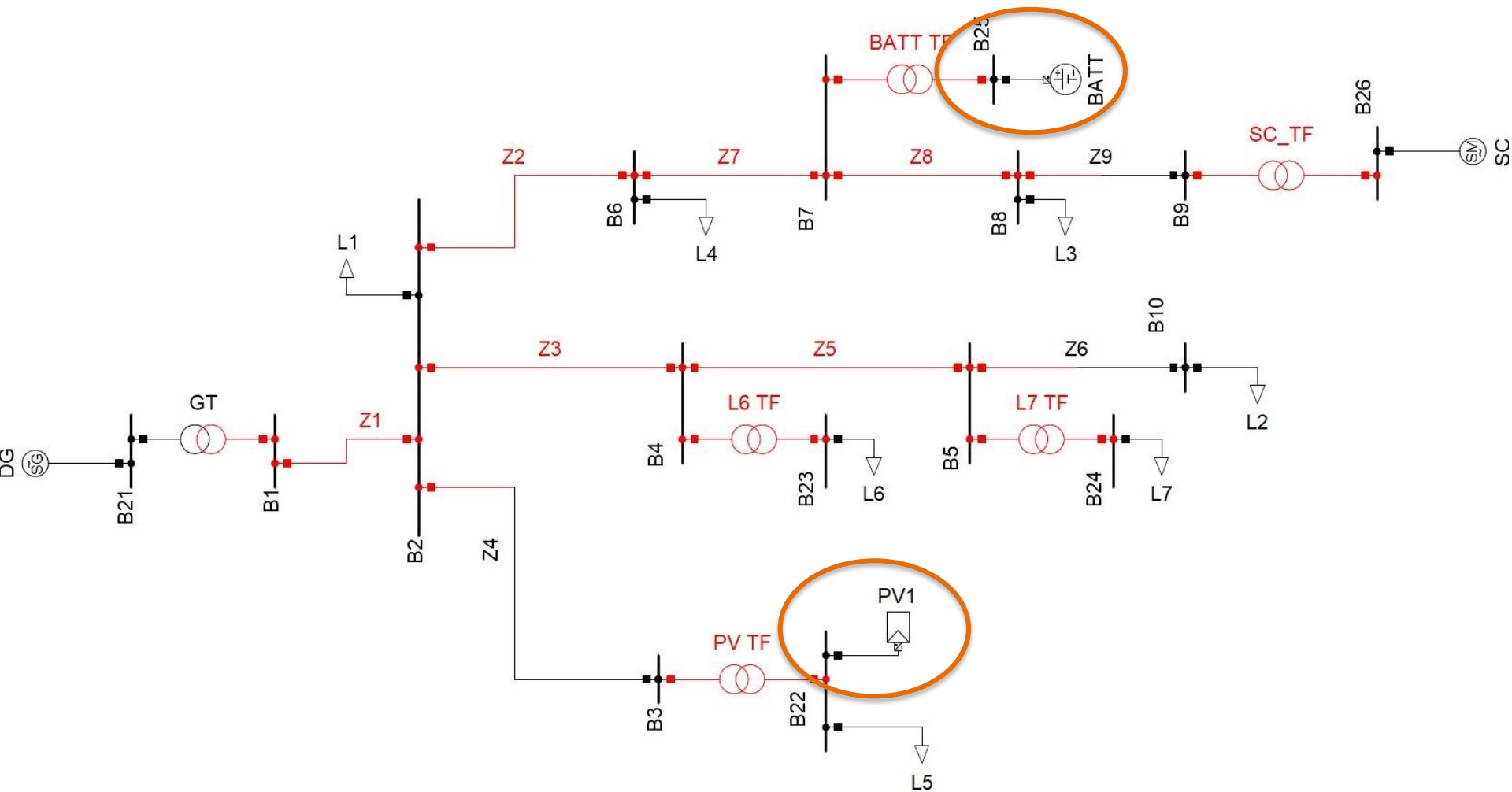
## Sympathetic tripping:



# Project flow:

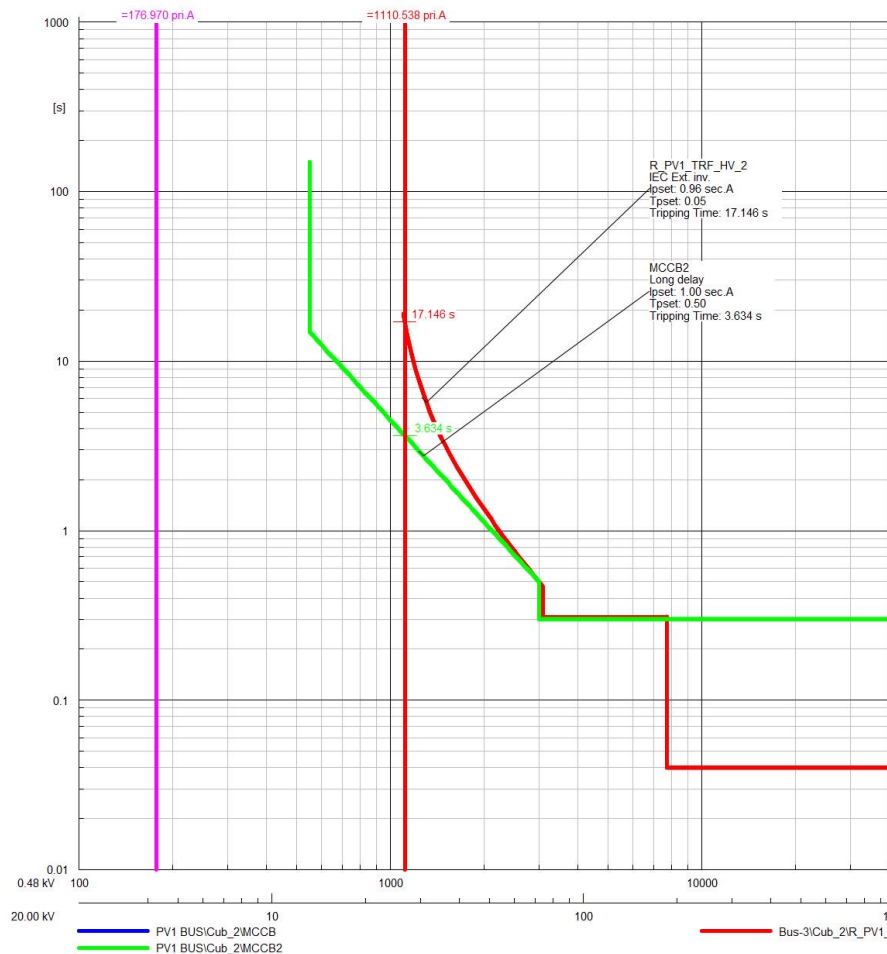


# Microgrid model in PowerFactory:

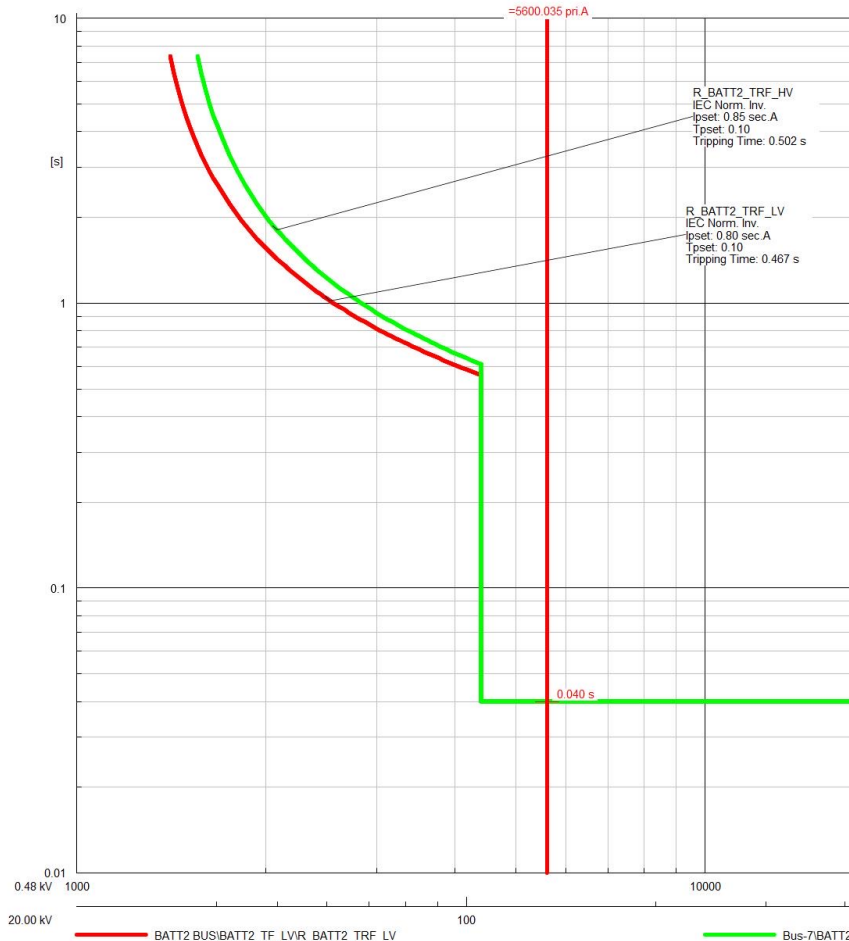


# Relay operating curves:

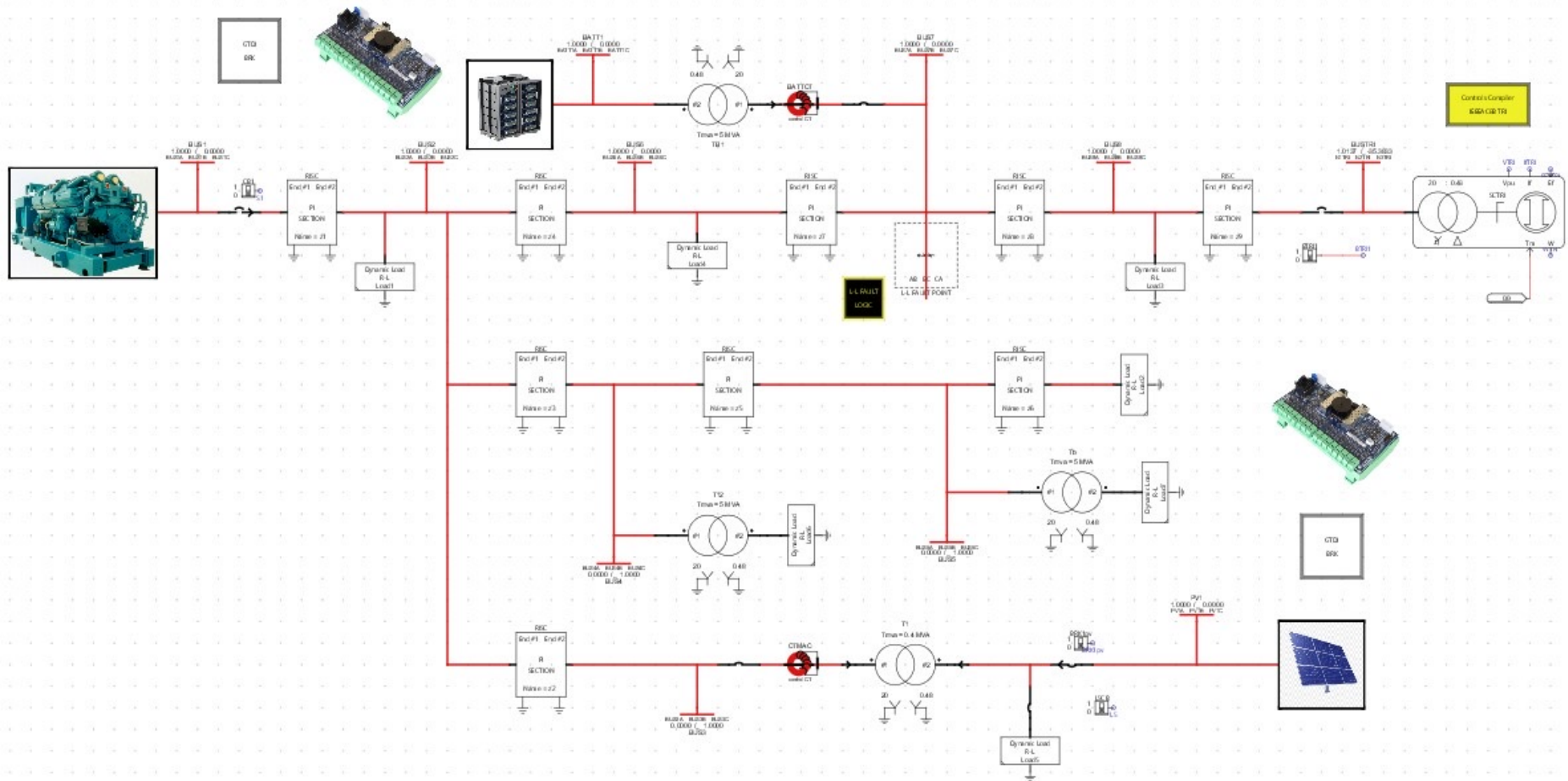
## Reverse power flow:



## Sympathetic tripping:



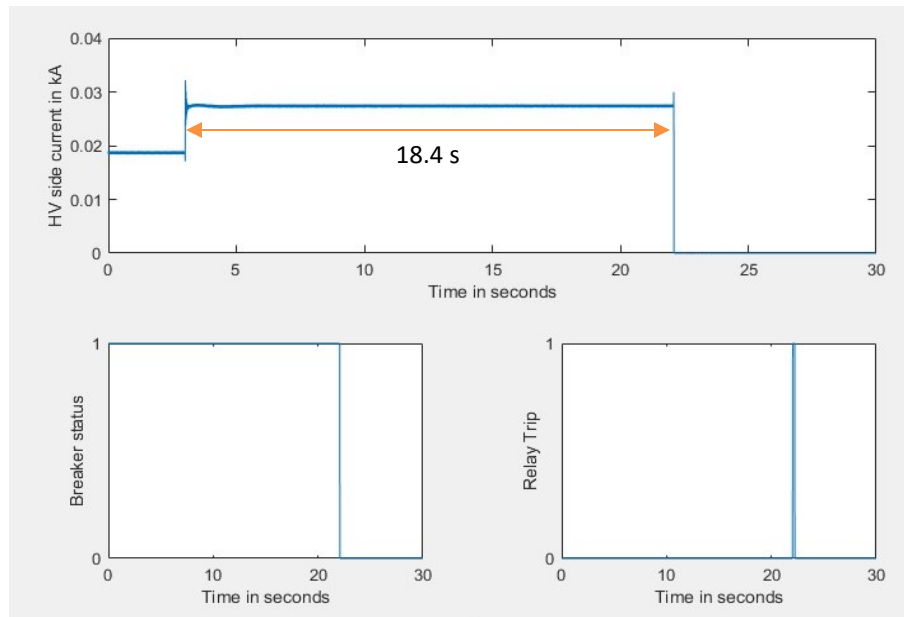
## Microgrid model in RSCAD:



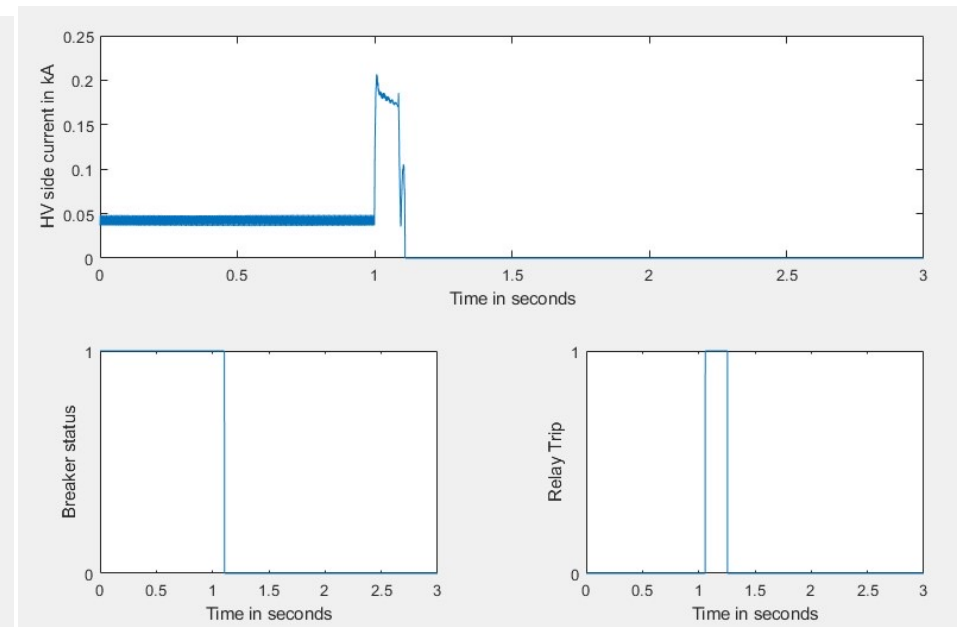


# Results:

## Reverse power flow:

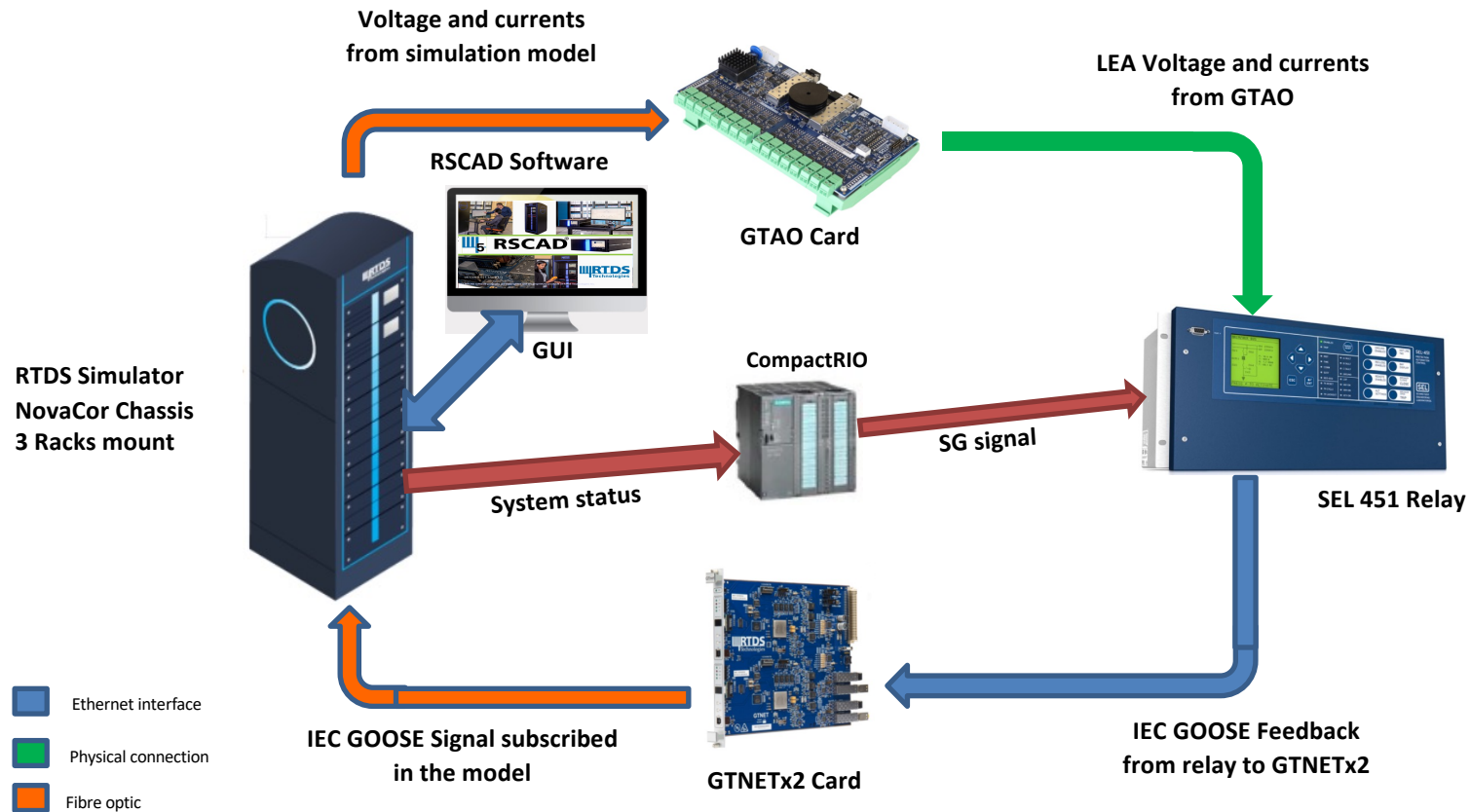


## Sympathetic tripping:



- Power output of the PV is increased from 735kW to 1.01 MW and the relay is observed to trip on inverse time over current protection.
- A 3-Ph SC fault is created at B7 bus and the fault current contribution from batteries have resulted in activation of instantaneous trip at Transformer HV side relay.

# Future research:



\*Images are taken from RTDS and SEL websites and for representative purpose only.