



SESSION 4B – ANCILLARY SERVICE ASPECTS / CASE STUDIES:

Energy Storage in Oil and Gas: A Spinning Reserve Application

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UC San Diego

Virtual 5th Hybrid Power Systems Workshop
May 18th 2021



Agenda

- Oil and Gas Energy Storage Potential
- Case Studies
 - Spinning reserve
 - Black start
- Hardware in the loop

SESSION 4B – ANCILLARY SERVICE ASPECTS / CASE STUDIES:
Energy Storage in Oil and Gas: A Spinning Reserve Application



Oil and Gas Energy Storage Potential

- Spinning reserve
- Black start
- Frequency and voltage regulation
- Large on/off load
- Fast start
- Load smoothing
- Peaker units

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Spinning Reserve

Remote Site with no utility

- Isolated Community
- Mine
- Off-Shore Platform / FPSO

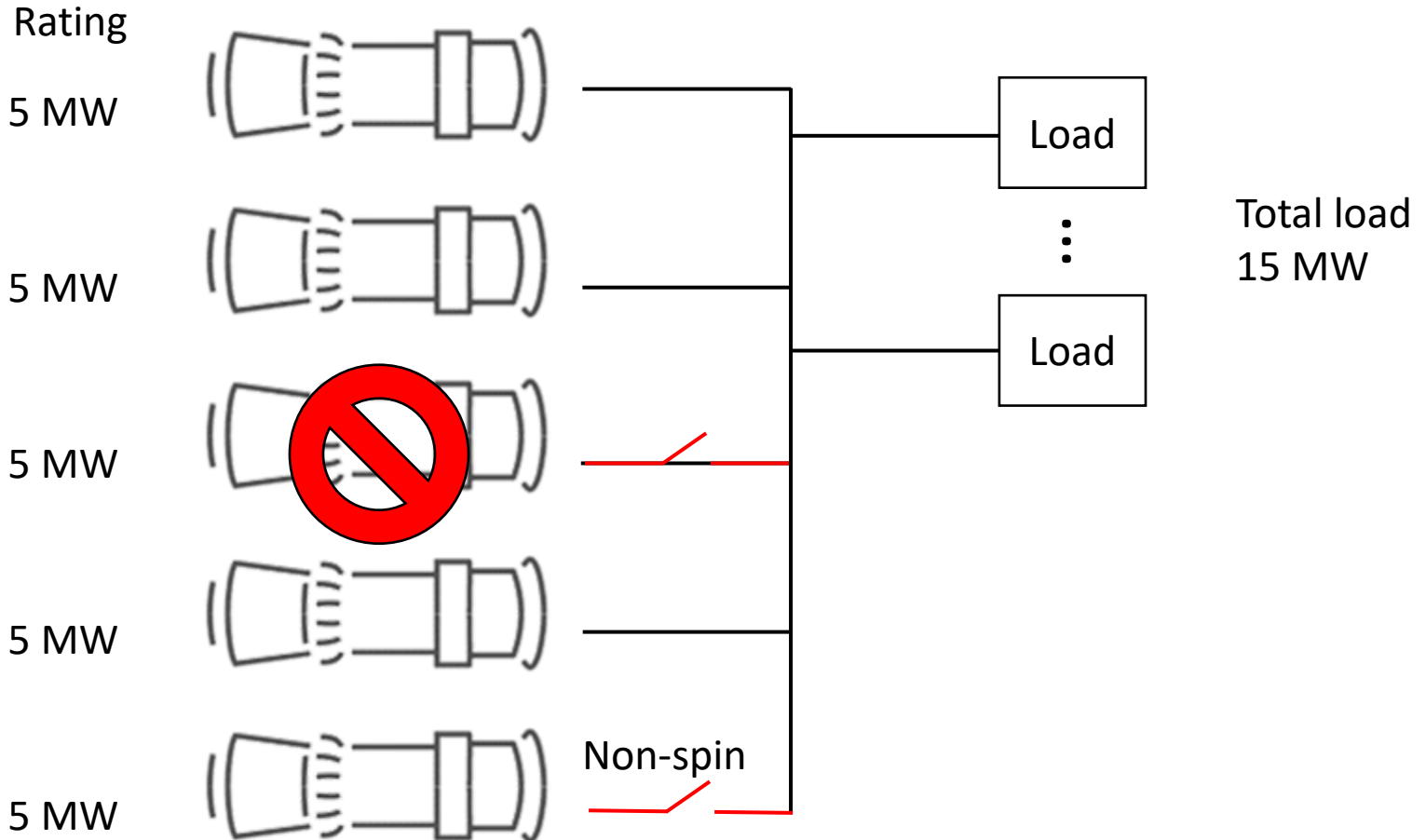
Power Plant is operated off-efficiency due to

- Generation must match load
- Must provide spinning reserve for
 - large load swings e.g. drilling rig
 - generation sources goes off-line





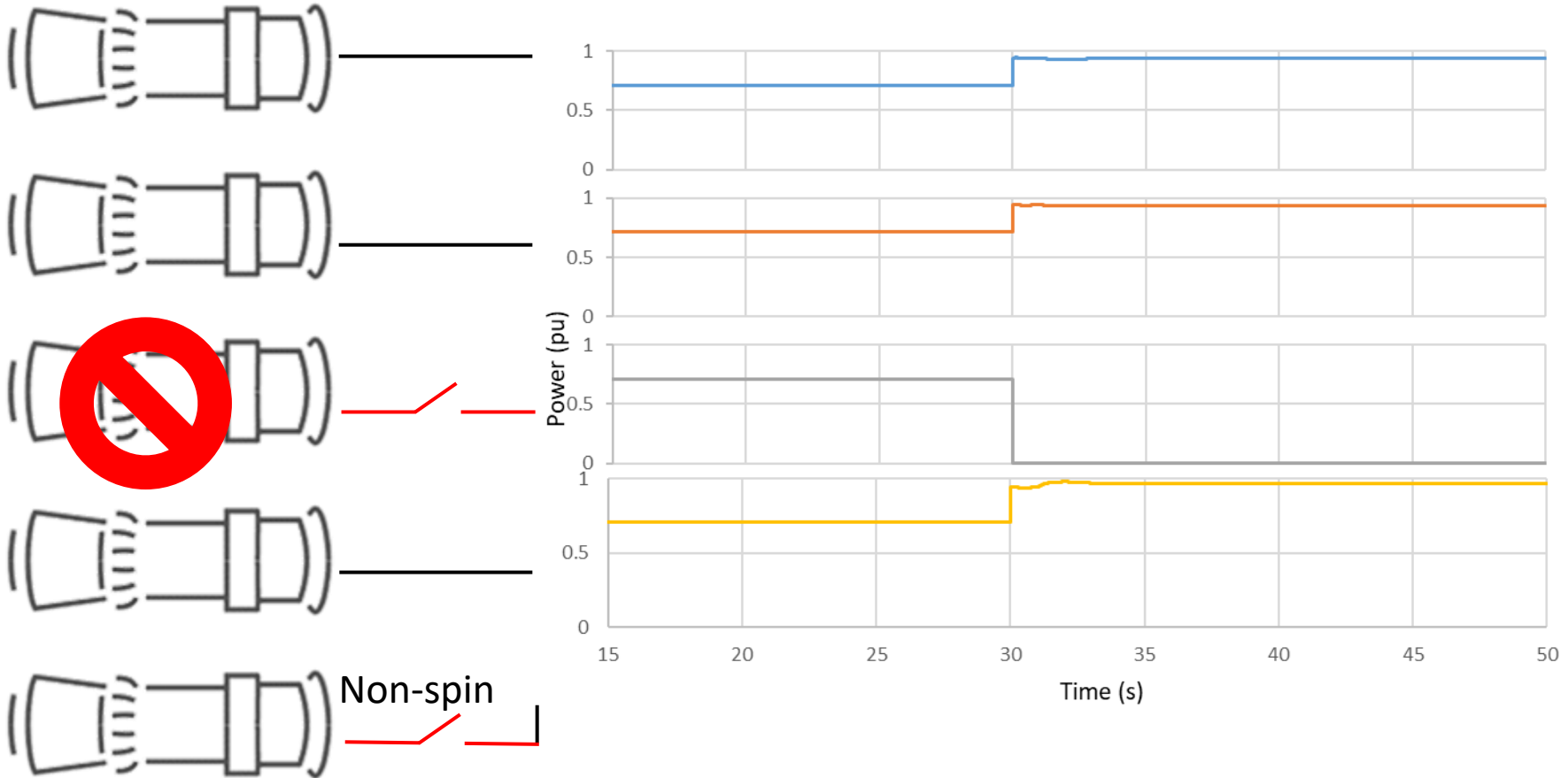
Spinning Reserve Example



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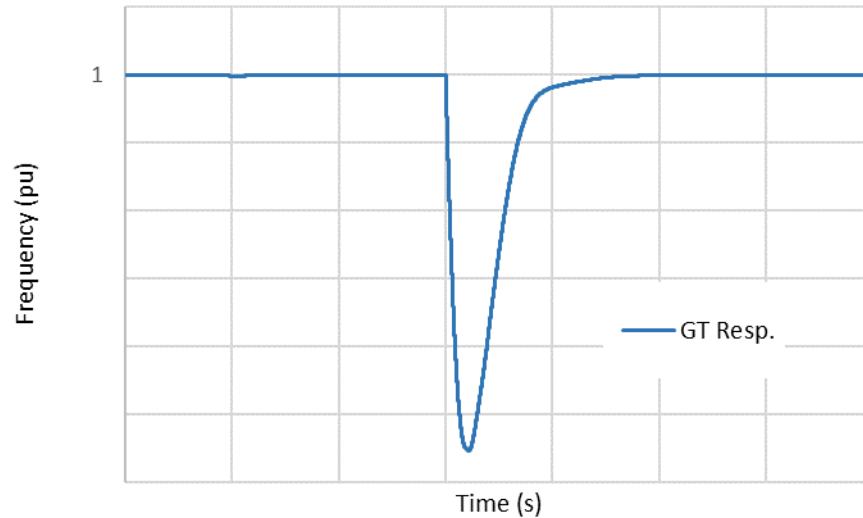
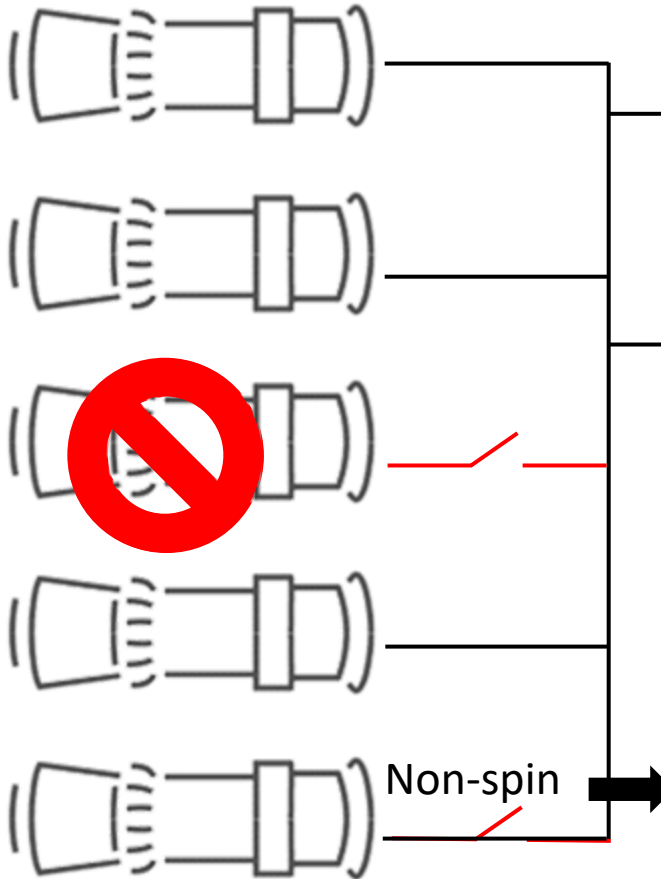
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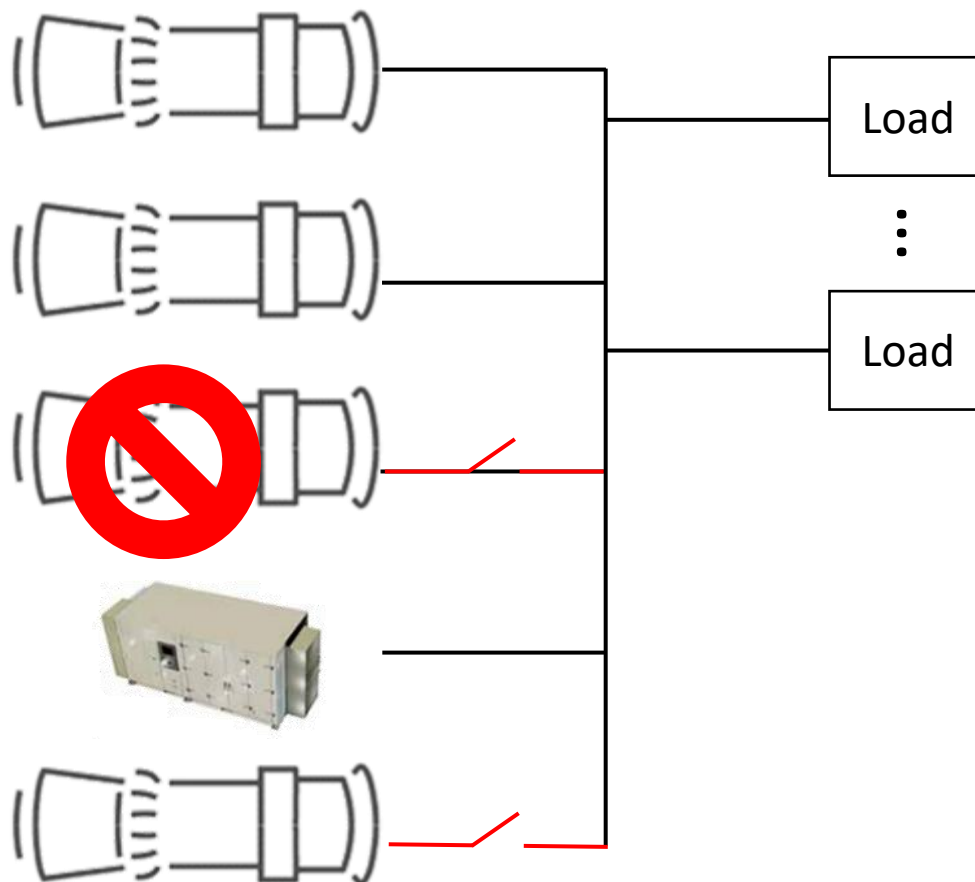


Spinning Reserve Example





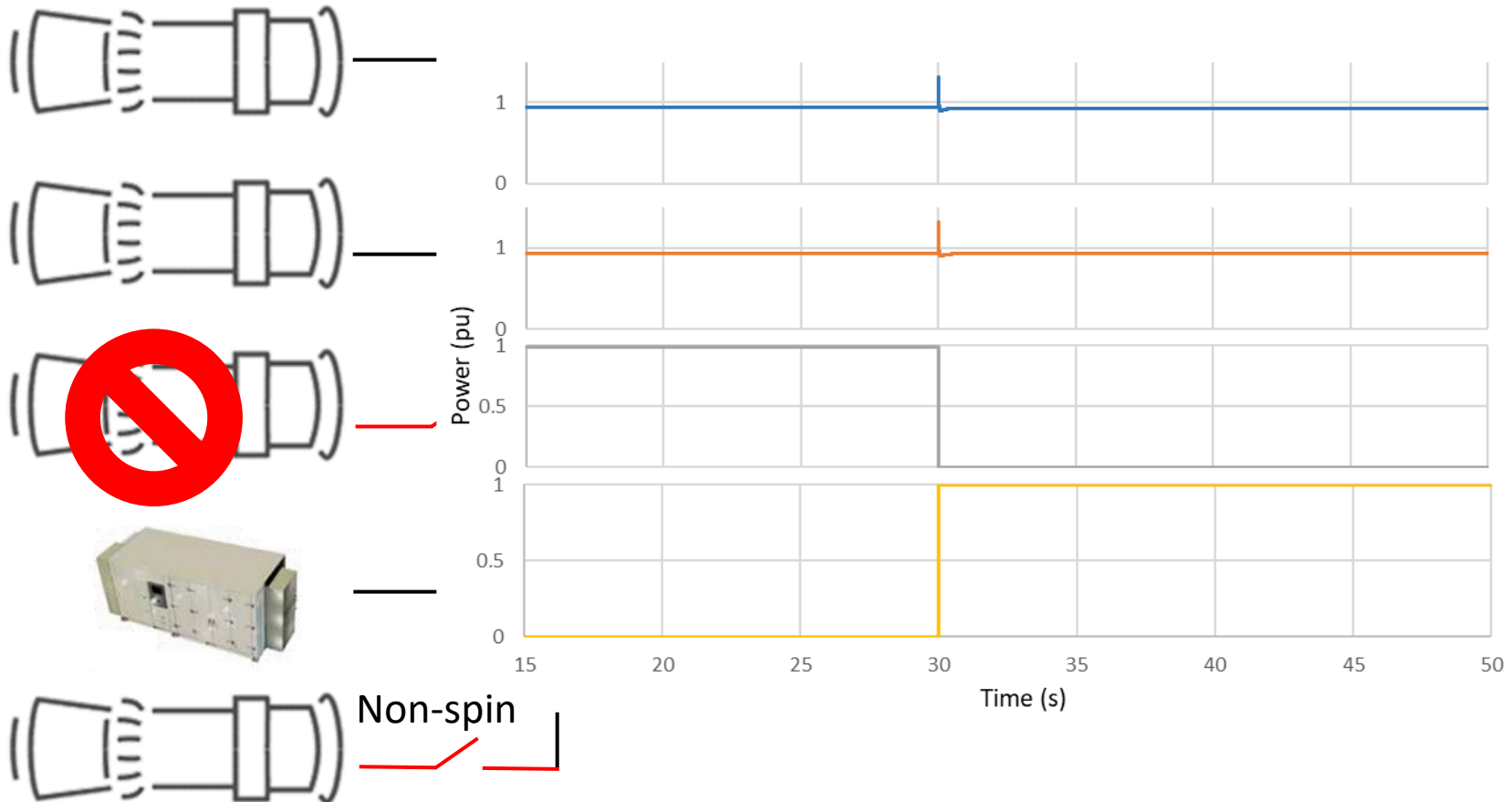
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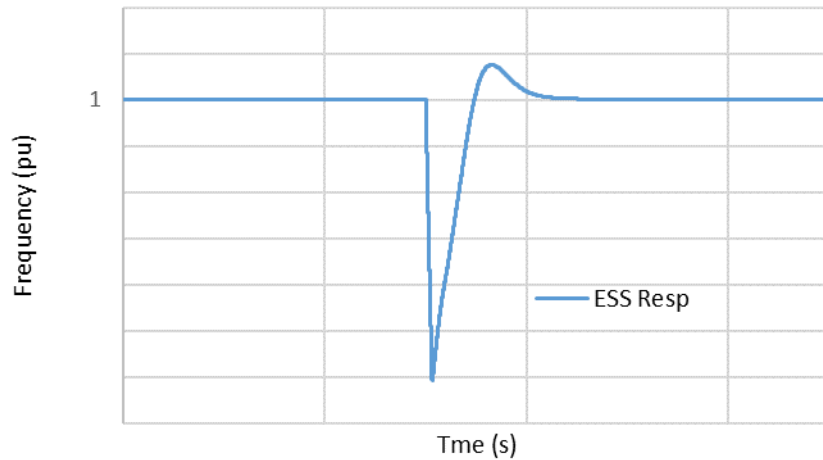
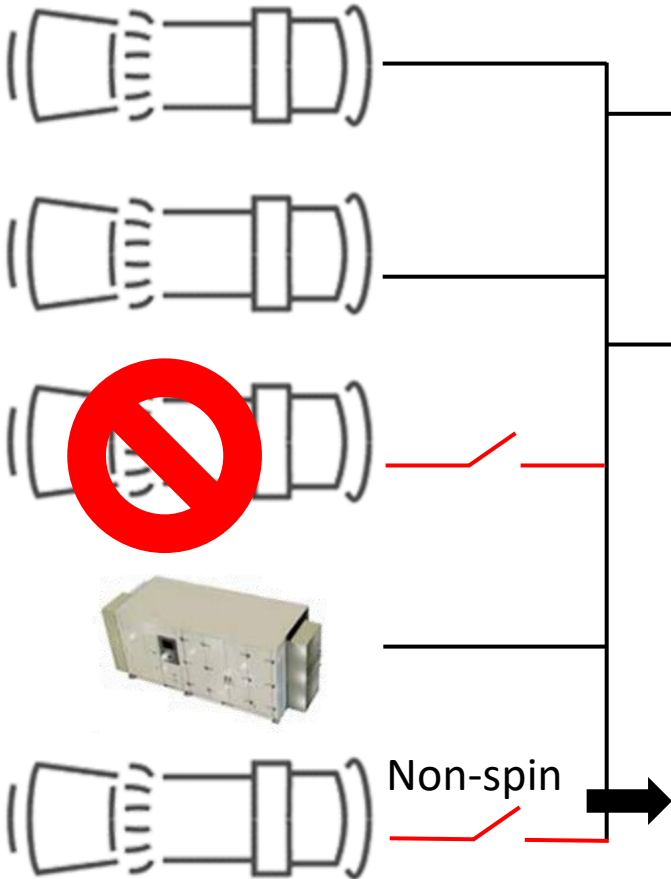
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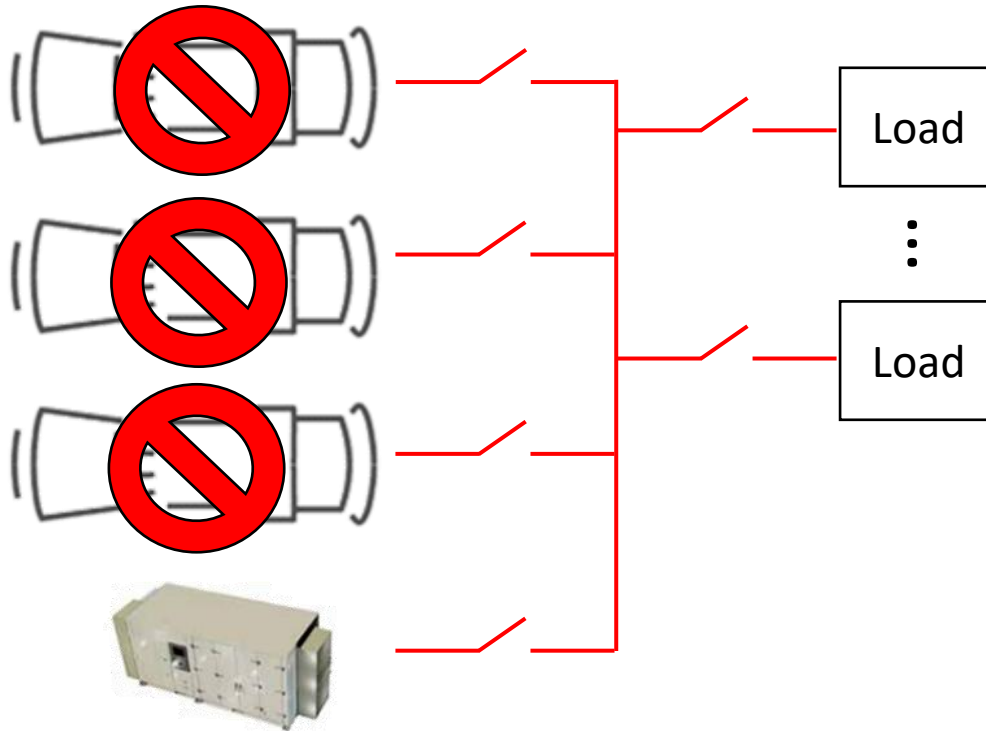
Spinning Reserve Example



Will come online and ESS will start charging



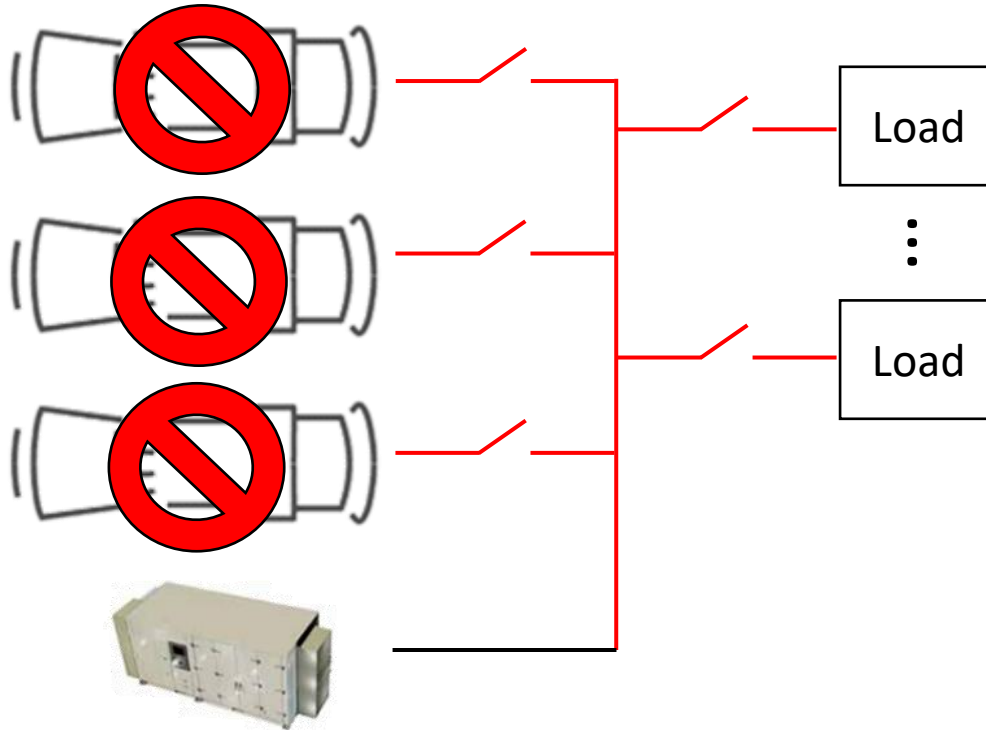
Black Start Example



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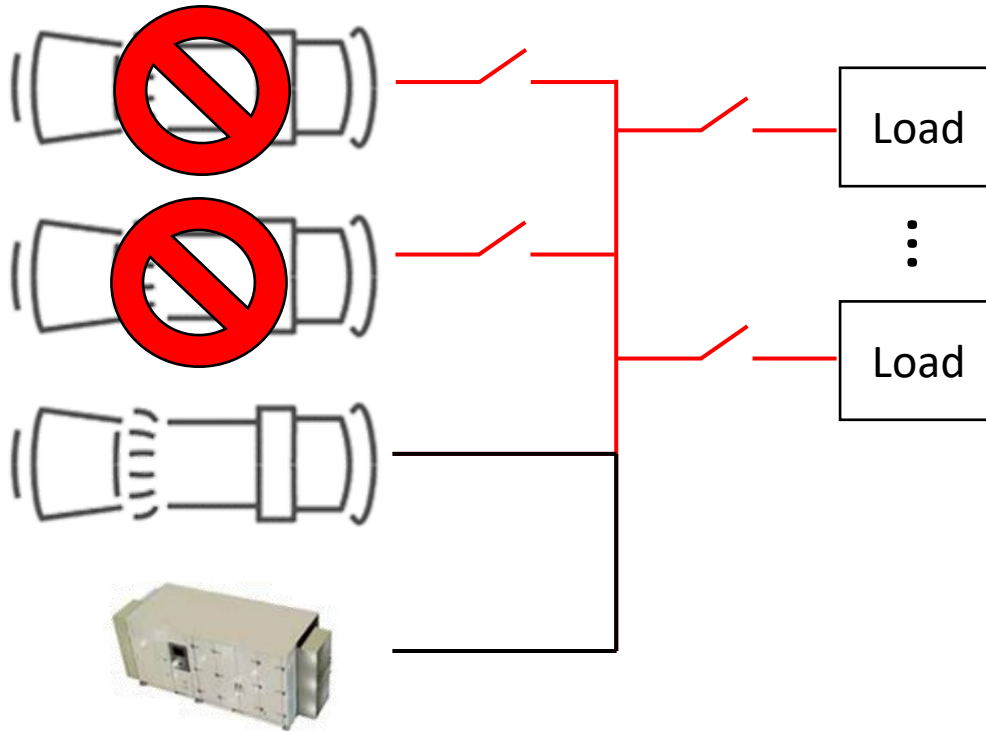
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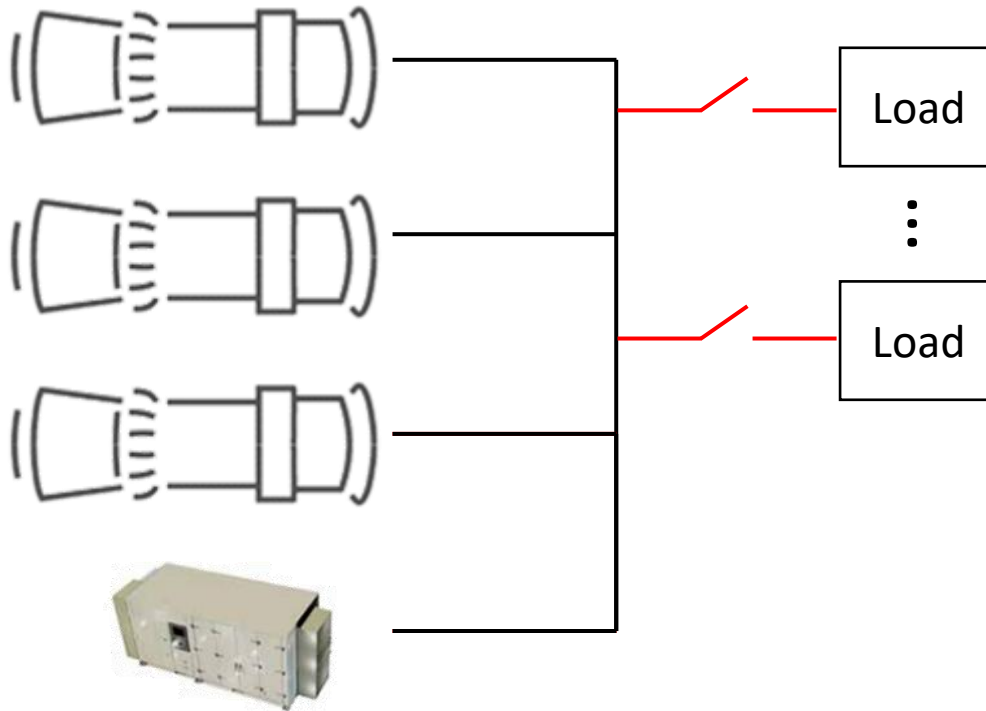
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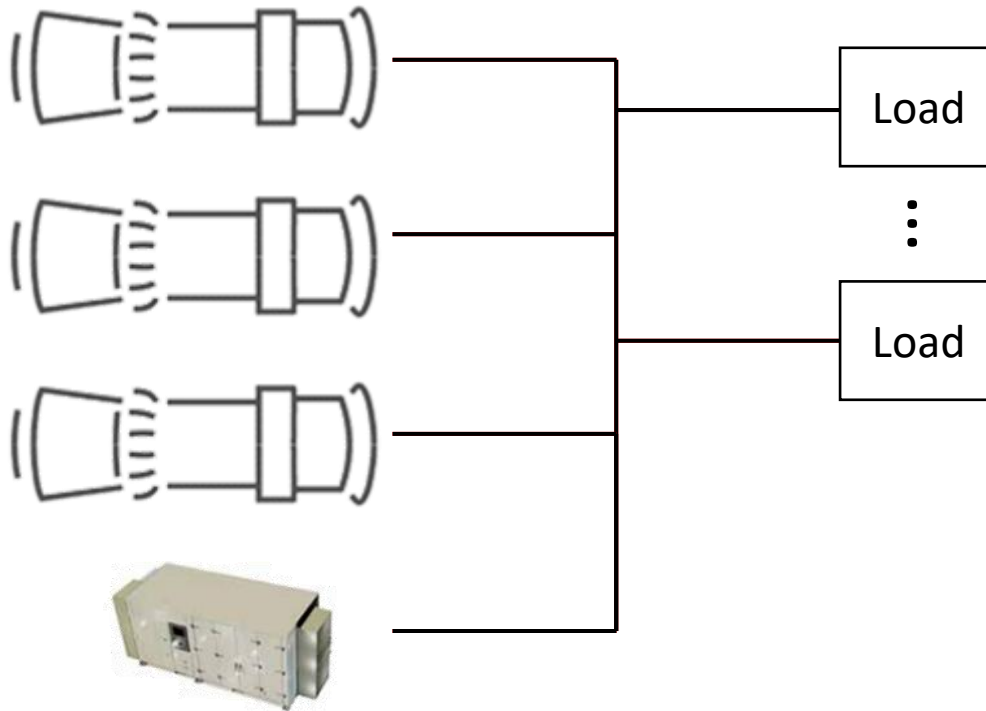
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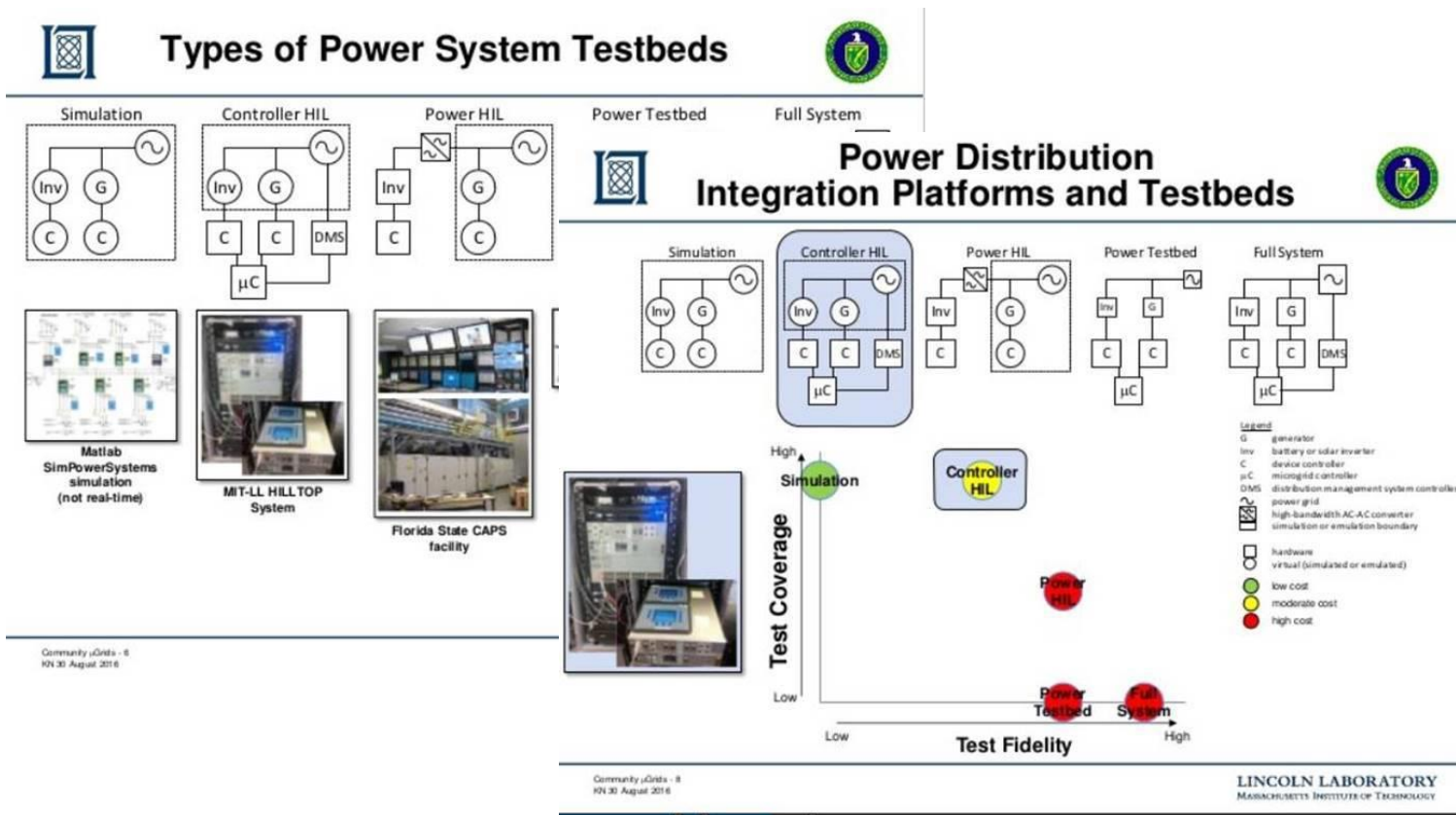


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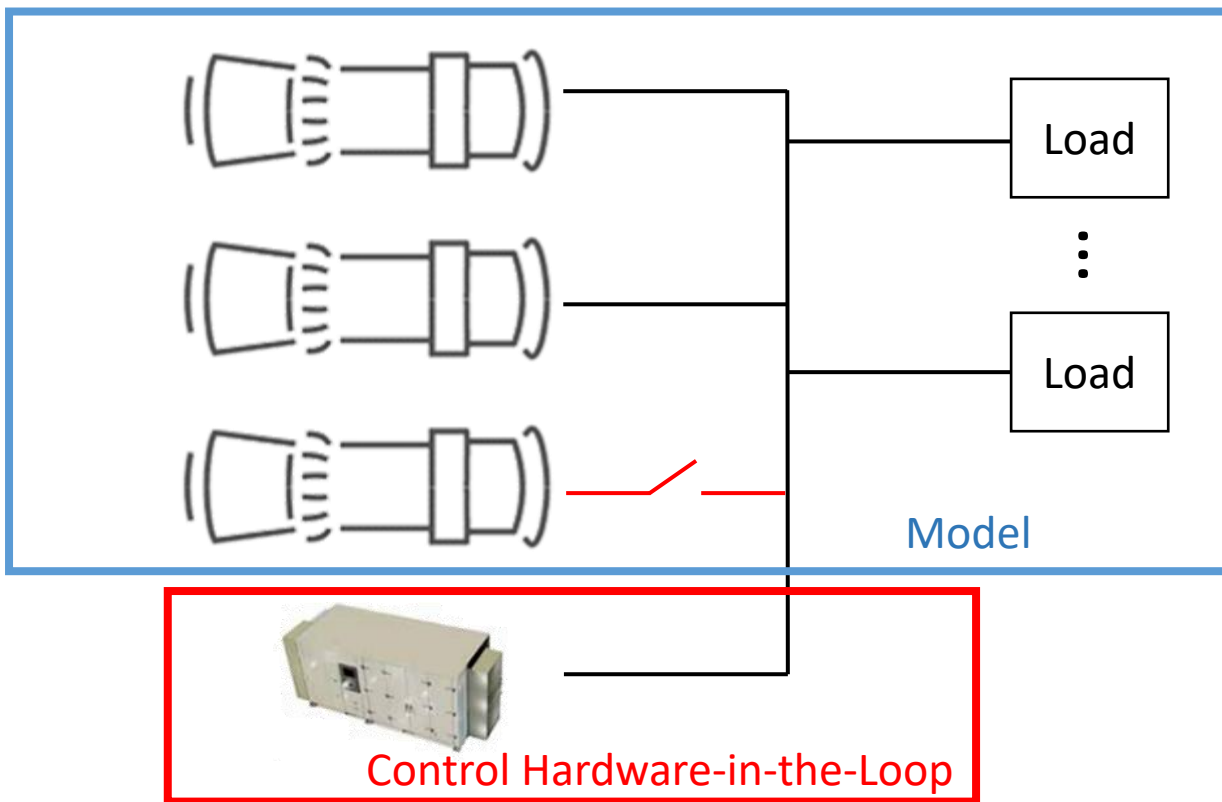
Simulation Evolution



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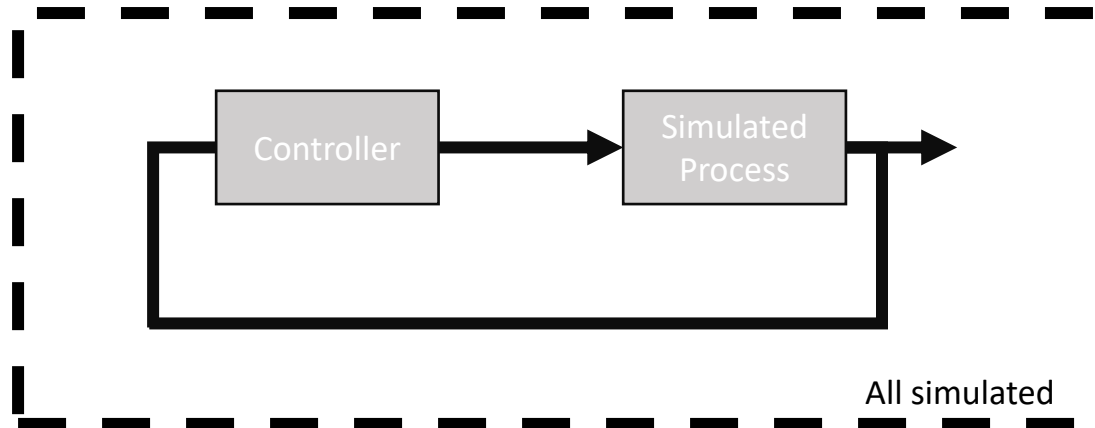
Simulation on Hardware-the-Loop



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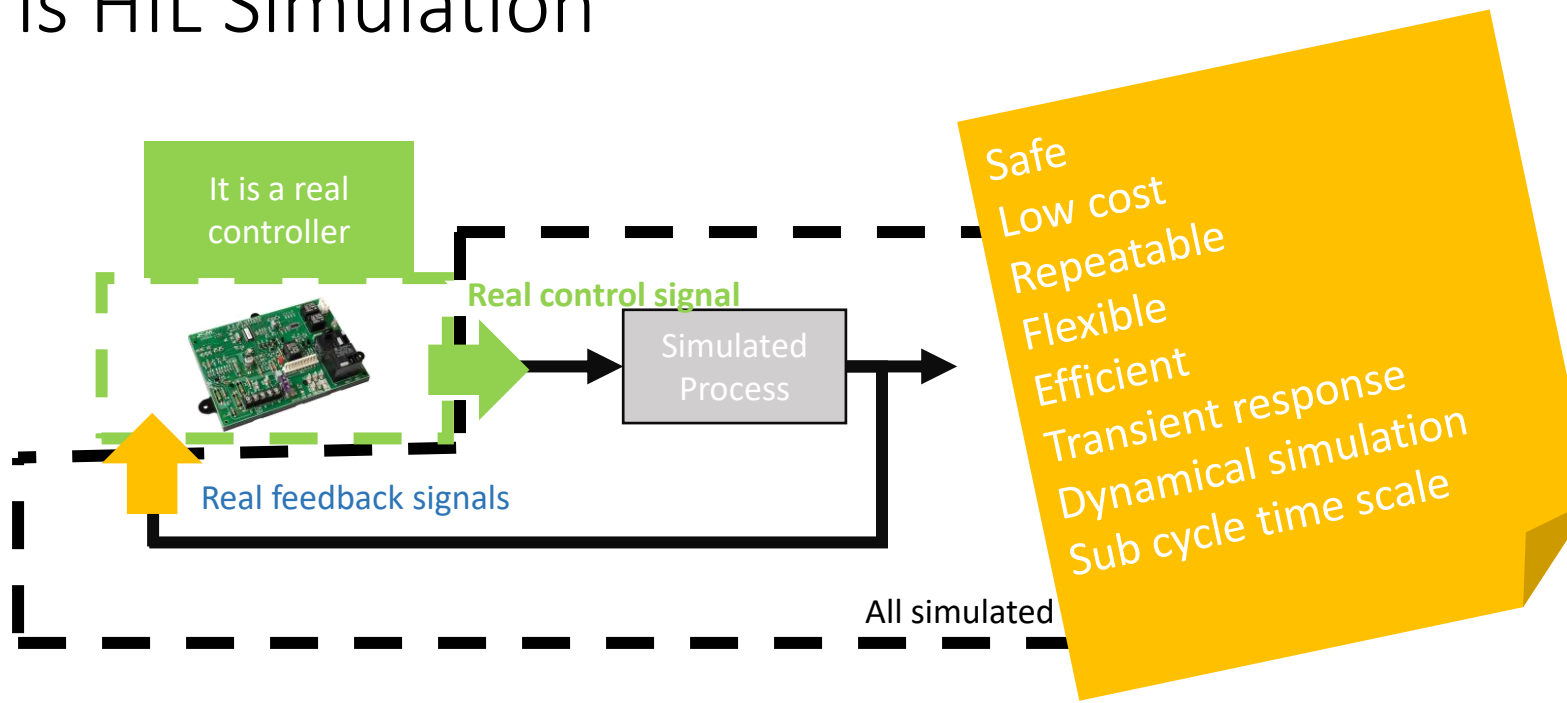


What is HIL Simulation





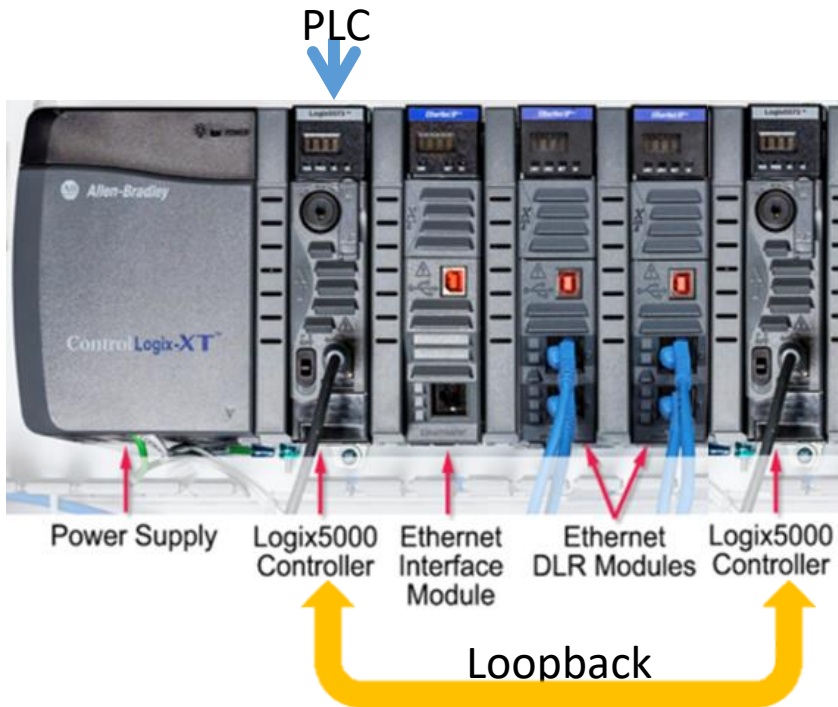
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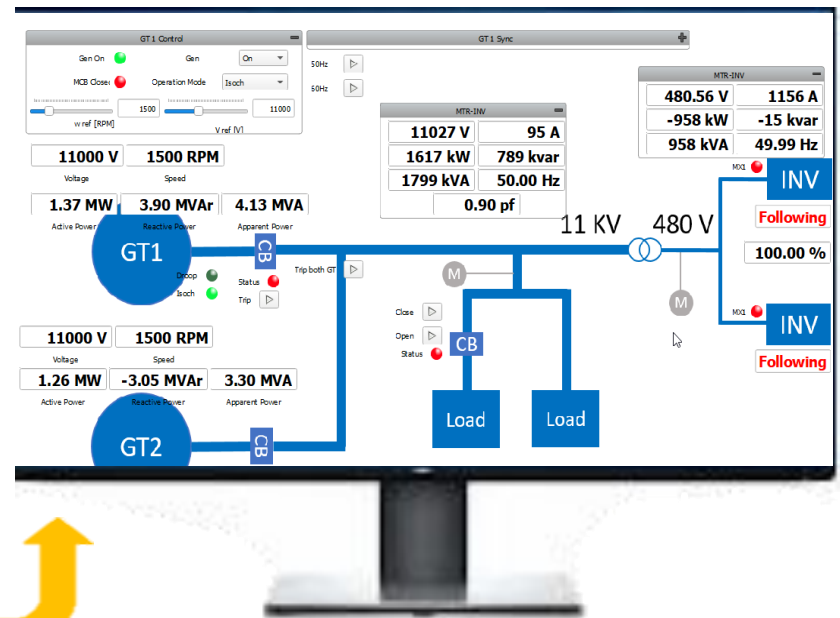
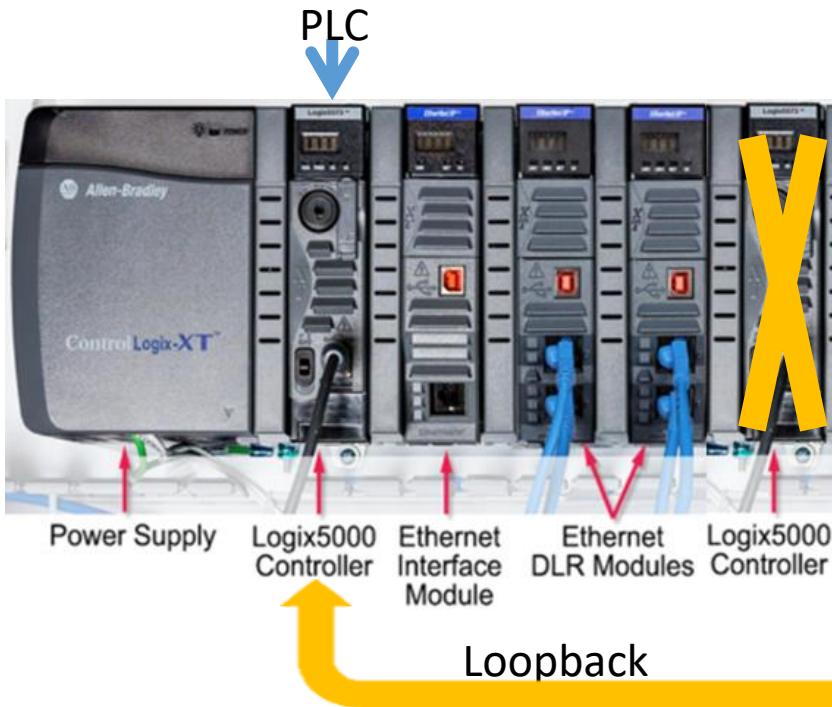
Loopback PLC



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Loopback PLC

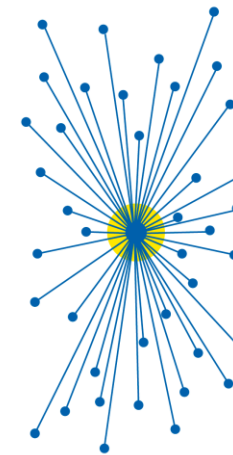


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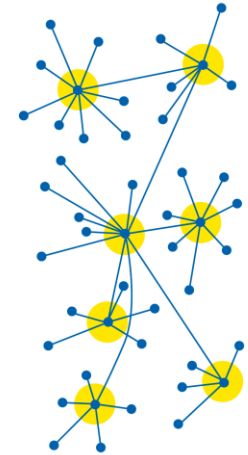


Control Philosophy

- Centralized vs Decentralized controller
- Unit control vs microgrid
- Decentralized:
 - Monitor grid power quality (droop controller)
- Centralized:
 - Monitor genset circuit breaker status
 - Monitor genset and turbomachinery health
 - Monitor grid power quality



Centralized



Decentralized



https://www.youtube.com/watch?v=gEV_sYRHkHY

GWA offshore generator dispatch & load profile

Proposed operation with 3 generators online being implemented

Current operation: 4 Online

	Rated Capacity	Online	Load MW	Load-factor
Gas Generator 1	3.2	3.2	1.75	55%
Gas Generator 2	3.2	3.2	1.75	55%
Gas Generator 3	3.2	3.2	1.75	55%
Gas Generator 4	3.2	3.2	1.75	55%
Gas Generator 5	3.2			0%
Gas Generator 6	3.2			0%
		12.8	7.0	
Spinning Reserve			6.8	
No of GenOnline		4.0		

Proposed operation: 3 Online + BESS

	Rated Capacity	Online	Load MW	Load-factor
Gas Generator 1	3.2	3.2	2.3	73%
Gas Generator 2	3.2	3.2	2.3	73%
Gas Generator 3	3.2	3.2	2.3	73%
Gas Generator 4	3.2			0%
Gas Generator 5	3.2			0%
Gas Generator 6	3.2			0%
Battery System	1.0	1.0	0.0	0%
		7.6	7.0	
Spinning Reserve			5.6	
No of GenOnline		3.0		

Contingency operation after trip: 2 Online + BESS

	Rated Capacity	Online	Load MW	Load-factor
Gas Generator 1	3.2	3.2	3.0	94%
Gas Generator 2	3.2	3.2	3.0	94%
Gas Generator 3	3.2			0%
Gas Generator 4	3.2			0%
Gas Generator 5	3.2			0%
Gas Generator 6	3.2			0%
Battery System	3.2	1.0	1.0	0%
		7.4	7.0	
Spinning Reserve			0.4	
No of GenOnline		2.0		

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	Grid	DGS	BESS	Load	
Scenario 4	0	1	1	1	Island Operation, Inverter is Grid Supporting, both battery and DGS are supporting to maintain the frequency and voltage. Battery and DGS also participate to share the load.

