

Annex -2-

Micro Grid + Genset Paralleling



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**SCADA & Control System –
KYWWTP PV Power Plant**

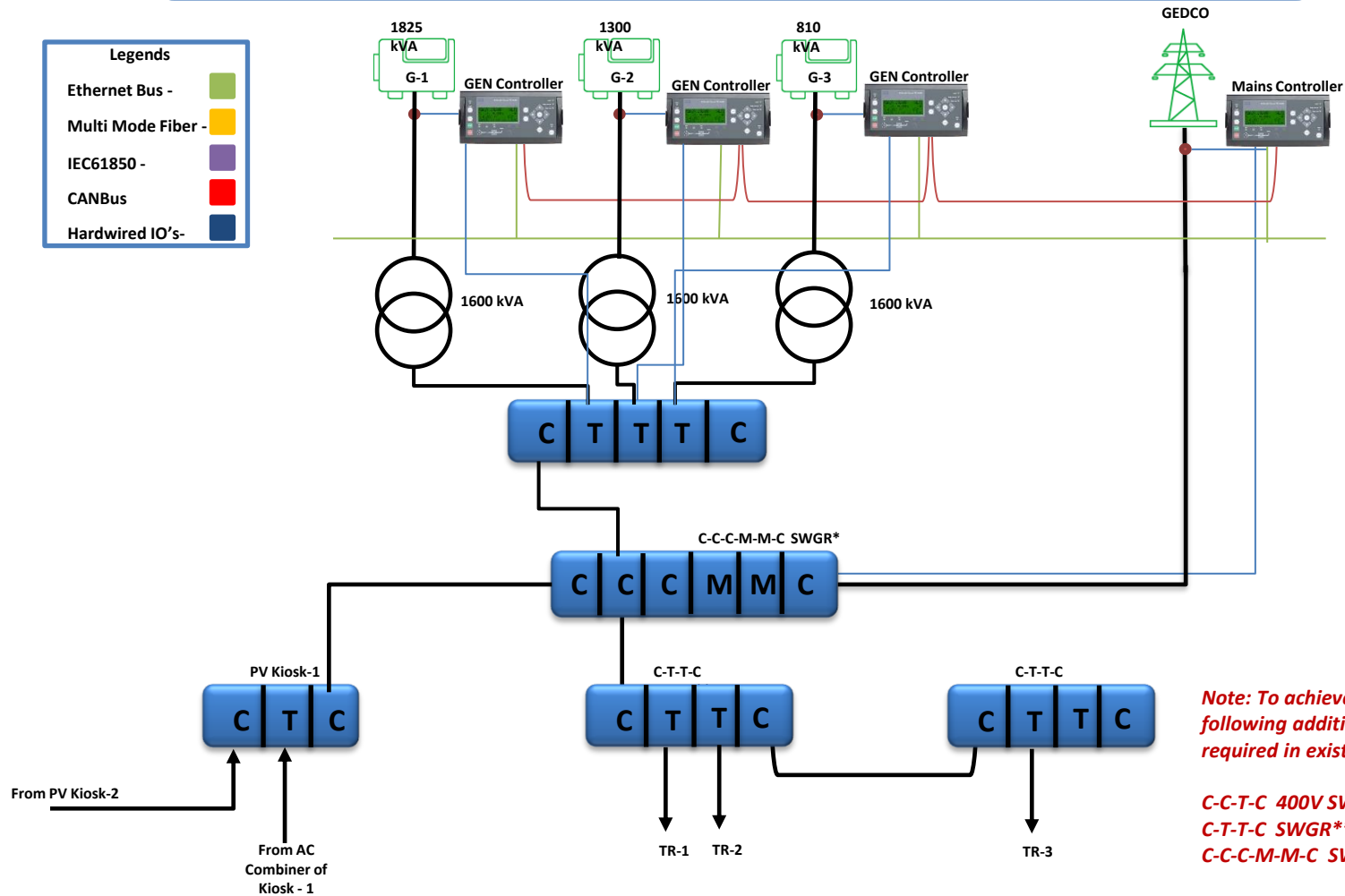
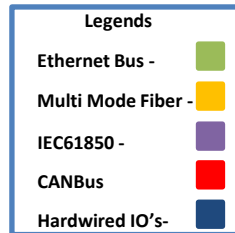


Technical Requirements - Micro Grid + Genset Paralleling



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Note: To achieve the microgrid application following addition & modification shall be required in existing switchgear

*C-C-T-C 400V SWGR'' – New switchgear addition
C-T-T-C SWGR** - Existing Switchgear no change
C-C-C-M-M-C SWGR* - Modification in Switchgear*



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Microgrid Philosophy & Modes of Operation

Requirement:

- Requirement is to have complete power management of genset based on failure of GEDCO & upon restoration of grid, automatic de-loading of gensets has to be done by the control system.
- To keep run the system in island mode, this is mandatory requirement to have load dependent start/stop of genset & during peak hour of PV availability the genset should turnoff as per the setpoints set from the SCADA system. The overall system requires modification in the switchgear & addition of LV synch panel for gensets alongwith it centralize monitoring
- Addition of LV switchgear as synchro-panel to parallel the gesnets
- Modification of 22kV MV switchgear with addition of switchgear panel
- To control the Governer(Woodward/Heizman) & AVR(Leroy-Somer R450) through external control voltages (0-10, +/-10V or 0-20mA) or PWM Outputs

Solution:

To meet with the requirements, complete power management is requested that has ability to detect the failure of Grid through voltage or ROCOF method & will isolate the breaker to send the start command to gensets.

Following are the basic key elements must be available in synchronizing controller to run the whole plant in island mode

Island mode:

Power plant with synchronizing generators or a stand-alone generator. Also applicable in critical power plants.

Automatic Mains Failure – AMF: (Applicable in our case)

Critical power/emergency standby plants, black start generator.

Fixed power/Base load: (Applicable in our case)

Power plant with fixed kW set point (including building load).

Peak shaving: (Not applicable as back synch is not allowed)

Power plant where generator supplies peak load demand paralleled to the mains.



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Microgrid Philosophy & Modes of Operation

Load takeover:(Applicable in our case)

Plant mode where the load is moved from mains to a generator, for example, peak demand periods or periods with the risk of power outages.

Mains power export:(Not applicable in our case)

Power plant with fixed kW set point (excluding building load).

Remote maintenance: :(Applicable in our case)

Used when the generator has to supply the load while a distribution transformer is disconnected for service.

Note: Back synch of genset is not allowed with GEDCO, the controllers would always keep in AMF mode where genset will start upon failure of Grid.

Once Grid is isolated, Genset will switch into island mode where Auto start/stop of Genset would be enable to maintain the minimum Gensets to run based on loading

The controller can be operated in different running modes that user/manager can be selected from SCADA. Following are the running modes that can be selected from SCADA

- 1- Auto Mode
- 2- Semi Auto Mode
- 3- Block Mode of individual Genset
- 4- Test Mode



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Microgrid Philosophy & Modes of Operation

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- 1- Auto Mode
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Auto Mode:

The controller automatically starts the genset and switches to generator supply at a mains failure after an adjustable delay time. Upon this mode remote start of Genset could be initiated when system switched to island once the GEDCO supply failed. It is possible to adjust the controller to change to genset operation in two different ways.

1. The GEDCO breaker will be opened upon the detection of voltage failure of ROCOF protection. The opening command shall be send by the mains controller
2. Once Mains/GEDCO breaker are detected as open, immediately synchronizing controller running in PMS shall send start command to gensets & once V/F settled at the Genset, the controller would immediately start synchronizing & closing the Genset breaker automatically. The genset will keep running till the mains Ok signal is received at Mains controller.
3. Once the signal received for healthiness of GEDCO & changover to feed load is switched to GEDCO then immediately the Genset

In auto mode, upon failure of GEDCO, all available gensets in Auto-mode shall be started & after sometime(configurable) few of them could be deload based on load dependent stop limit defined by the Operator from SCADA. Similarly if 2 Genset are running & if the load exceeds from the defined %age limit then immediately next available Genset will start based on priority.

In Auto-mode, Genset shall always be switched based on priority calculated by controller PMS upon running hour of each genset.

Semi-auto mode:

Semi-auto means that the controller will not initiate any sequences automatically, as is the case with the auto mode. It will only initiate sequences, if external signals are given.

An external signal may be given in three ways:

1. Push-buttons on SCADA
2. Digital inputs are used
3. Modbus command

When the genset is running in semi-auto mode, the controller will control the speed governor and AVR. In semi-auto mode all type of regulations are remained active in system



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Microgrid Philosophy & Modes of Operation

Block mode:

When block mode is selected, the controller is locked for certain actions. Block mode can either be selected by pressing the MODE button on SCADA. If the Block mode on a genset controller is selected, it cannot start the genset or perform any breaker operations. If the genset is running when block mode is selected, the breaker will be opened and the genset will shut down without cooling down. The purpose of the block mode is to make sure that the genset does not start during maintenance work.

Test Mode:

The test mode function is activated by selecting test with the mode push-button from SCADA on master panel or by activating a digital input. This function is required to test genset healthiness time to time specially when system is designed to run as standby power.

Following are the types of tests that shall be conducted under the test mode.

- **Simple test - Applicable in our case**

The simple test will only start the genset and run it at nominal frequency with the generator breaker open. The test will run until the timer expires.

- **Load test – Not applicable in our case**

The load test will start the genset and run it at nominal frequency, synchronize the generator breaker and produce the power typed in the set point in menu 7041. The test will run until the timer expires. To run the load test, it is required that "Sync. to mains" is enabled in menu 7084. When running a load test sequence, the overlap function is ignored.

- **Full test – Not applicable in our case**

The full test will start the genset and run it at nominal frequency, synchronize the generator breaker and transfer the load to the generator before opening the mains breaker. When the test timer expires, the mains breaker will be synchronized, and the load is transferred back to the mains before the generator breaker is opened and the generator is stopped.



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Technical Requirements - SCADA & Controls Architecture





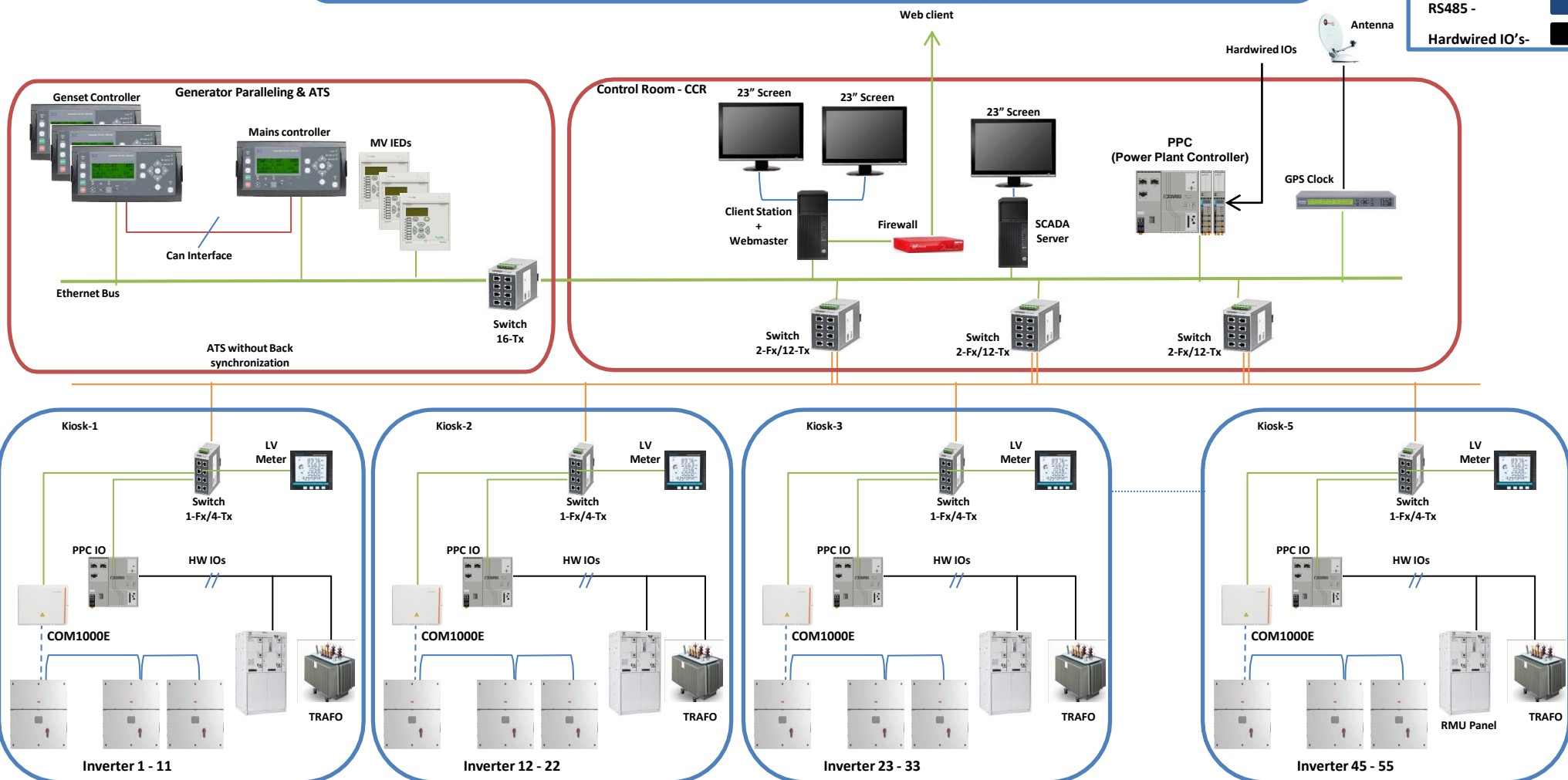
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Legends

- Ethernet Bus -
- Multi Mode Fiber -
- IEC61850 -
- RS485 -
- Hardwired IO's -





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Features of PPC & Modes of Operation

- **Integration with Grid & DGs**

Grid & DGs are considered to be integrate in PPC through proposed synchronization controller over TCP/IP. The controller shall be integrated over TCP protocol. The modbus maps, especially(P, Q, PF & Breaker status) from each source will be read from through the meters to control the individual termination point

- **Power Import to Grid:**

When GEDCO/Grid is connected as primary source, then zero feed-in from PV is must required along with control of PF at Grid.. On low load demands there is always a chance of PV backfeed to the Grid, to maintain this part some import at Grid will be fixed by the operator from SCADA & then PPC is responsible to calculate & write over the inverters to suppress PV . In this mode, PPC is also responsible to maintain the PF of the Grid, if we only pump active component, then reactive will always import from the Grid cause major PF penalties. So to keep maintain the PF at Grid PPC will run in Power Export/Import mode with Cosphi superior. In this mode PPC will always pump reactive power along with active power from inverters.

- **Minimum loading of DGs:**

For island cases, when PV runs in support of only DGs.. This function is to maintain the fuel efficiency of DGs to keep system run in better economical proportion. The setpoint for min. load of source has to be provided by customers during stage of commissioning. The PPC will always keep maintain the load limits & will start curtailing the PV if load demand is less & rotating machines can go below to defined min. limits after pumping active & reactive component in system.

- **DGs reverse power protection**

Sources can be protected with PPC, since the system will work in island mode. For the cases of low load demand is less then PV generation the power will backflow to Genset cause blackout of complete system. With PPC power will be managed, based on loading at Genset. The curtailment/Suppression will start upon low load at genset

- **Fixed Power:**

This function we called as Semi-Auto mode function, where whatsoever power setpoint operator need to set from SCADA, the PV will start pump that active/reactive power in system. This setpoints in kW is adjustable where min. loading or reverse power protection would remain disabled during this mode & PPC will give commands to inverter to pump active & reactive power based on setpoint of active power & PF by the operator



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Features of PPC & Modes of Operation

- **Ramp-Up/down of Inverters:**

PV ramps & steps can be adjusted by PPC in order to avoid oscillations in the system,. Those ramps can be adjusted for up (loading) or down (unloading) setpoints calculated by PPC based on load demand & system requirements.

To make the system more smooth specially during the cloudy weather, Met-Mast will be integrated in PPC where P-available will always calculate by PPC to set new reference of ramping-up the system. This would be must necessary to avoid the swings on DGs

- **Reactive(Q) Control**

Reactive control is also very key element of inverter, which also can be pumped in overall system though PV-Hybrid controller. This would also help to keep sustain Power factor at the Genset in off grid mode. If only active power is pump through PV then there factor of reactive will remain on Genset & results in bad PF of Genset & reduction of voltage on busbar. So to keep maintain the voltage & PF of source, PV reactive power portion also needs to pump in system. PPC must have the capability to give command of reactive control also along with P control.



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Features of Monitoring System & Data Management System(DMS)

Features of SCADA system:

- ✓ Plant performance analysis , Calculation and logging of plant Performance ratio
- ✓ Monthly & Daily reporting
- ✓ Suppressed energy numbers will be calculated as separate cumulative counter. This counter will help to calculate the real PR of system which could be based on generated Energy + suppressed energy
- ✓ Automated real-time monitoring system for the acquisition, processing, transmission, storage and archiving & graphic representation
- ✓ Display on-site with real time monitoring + historian will also be maintained in the server placed at each site
- ✓ Visualization of all measurement values and calculations.
- ✓ Integration of multiple plants, identification of each plant and central monitoring
- ✓ Lists indicating the precise date and time as well as the specified solution, in the actual occurrence order of events.
- ✓ Operator access to control and operate downstream devices. If provision of command would be available in protection relay the breaker of RMU could also be controlled
- ✓ Recording and monitoring of ISKARA energy meter over Modbus TCP protocol
- ✓ Integration of RMU relay in SCADA over Modbus TCP or IEC61850
- ✓ Weather Station for measurement of ambient conditions: Temperature, Wind speed, horizontal and incident irradiance to calculate insolation & availability of plant.
- ✓ Identification of Grid & genset failure time in a month & also Indicate the suppressed energy based on failure of busbar.

Data Visualization:

- All data, counters & alarms will be integrate in SCADA & will be displayed on Screen as per requirements.

Integration with Inverters:

- Inverters will be integrated in SCADA through Inverter manager/logger where IM would give access of data to the inverters as translator mode to the main server

Reports:

- Advance level of custom reports are proposed in system. These reports will collect data from historical data collected in SCADA.

Scalability:

- All quoted software's/hardware's are scalable in nature, right now 5000 Tags are considered to monitor all the data of system.



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Bill of Material





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Master Control & SCADA Panel

Particular	Qty	Brand
SCADA - 5000 Tags Server License with Advnace Reporting Features	1	PCVue/Equivalent
License for Client Station	1	
Web Client	1	
Server Station with 19inch Screen	1	Dell/HP
Client Station with 23inch Screen	1	Dell/HP
PPC - Power Plant Controller	1	Phoenix Contact/Schneider/Equivalent
GPS clock	1	Phoenix Contact/Equivalent
Unmanaged Switch 2Fx/4Tx	3	Phoenix Contact/Schneider/Equivalent
Redundant Power Supply 220VAC/24Vdc - 10Amp	2	Phoenix Contact/Schneider/Equivalent
Firewall	1	Phoenix Contact/Schneider/Equivalent
SCADA Server Panel	1	Rittal

At PV Kiosk

PPC coupler with 8DI/DO	5	Phoenix Contact/Schneider/Equivalent
Unmanaged Switch 1Fx/4Tx	5	Phoenix Contact/Schneider/Equivalent
Power Meter – with Modbus TCP/IP	5	Phoenix Contact/Schneider/Equivalent
Power Supply 220VAC/24Vdc - 5Amp	5	Phoenix Contact/Equivalent
UNO UPS - .8Ah of Battery	5	Phoenix Contact
Panel Boards with all ancillaries & Integration	5	Rittal

Synchronization control system

Synchronization controller for Mains	1	DEIF/COM-Ap
Synchronization controller for Genset	3	DEIF/COM-Ap
Battery Charger	1	DEIF/COM-Ap
Ethernet Switch -16Tx	1	Phoenix Contact/Schneider/Equivalent
Panel Boards with all ancillaries & Integration	2	Local