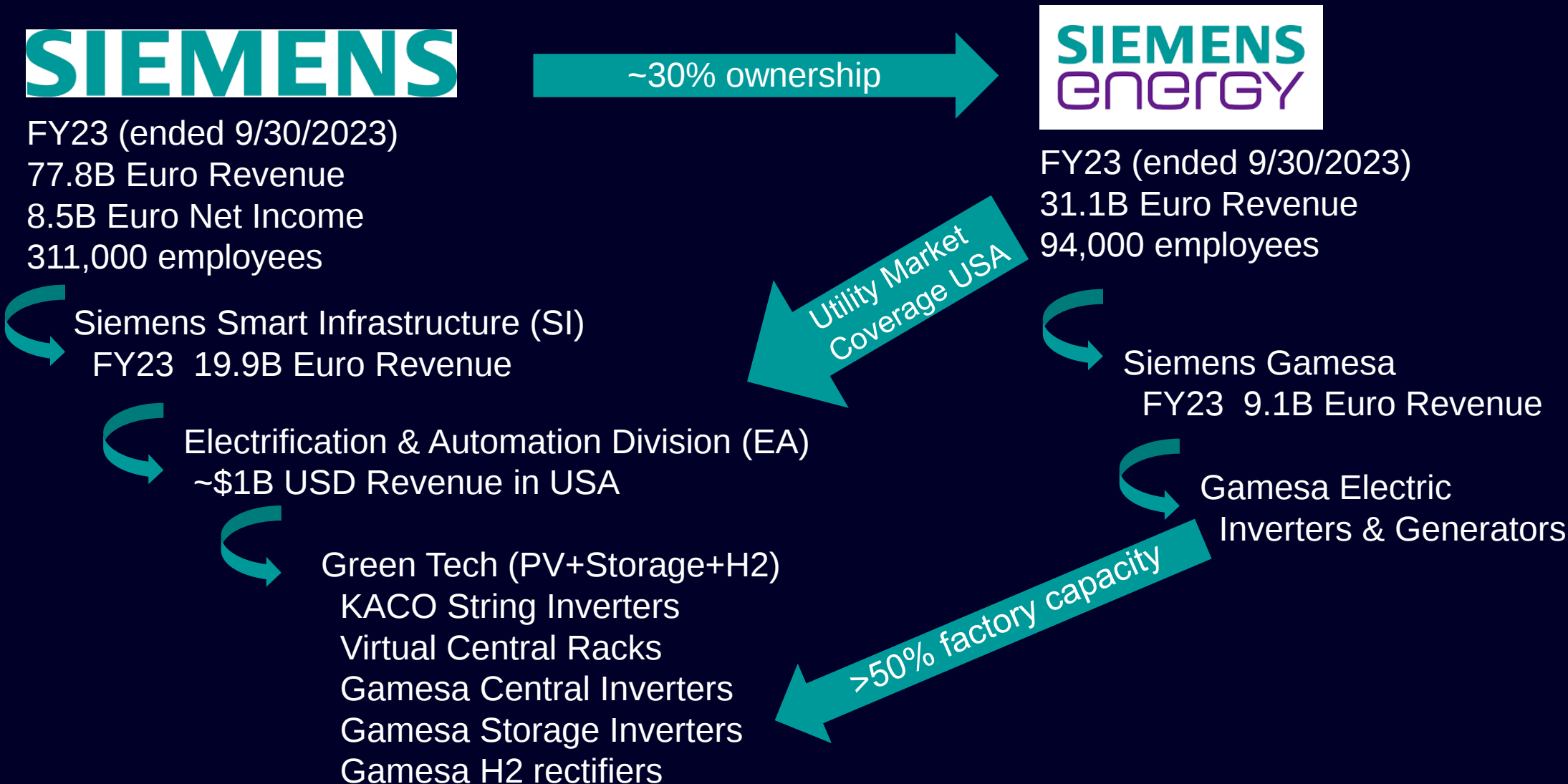




# Green Technologies

## Power Conversion for Solar, Energy Storage and Hydrogen

# Organizational Structure



# Smart Infrastructure - Our broad offering



## Building Products

- Integrated building management software
- Building automation and control systems
- Room automation and lighting control
- Sensors, valves and actuators
- HVAC<sup>1)</sup> OEM controls
- Fire safety products and systems
- Cloud applications and gateways



## Electrical Products

- Low-voltage protection, switching, measuring and monitoring devices
- Low-voltage distribution boards and systems UL
- Products and solutions for OEMs including medium-voltage vacuum circuit breakers, skeletons, and contactors
- Electric vehicle charging and storage for residential
- Contactors, overload relays and motor starter protectors
- Hybrid starting including soft starters
- Push buttons and pilot lights
- Functional relays, safety relays and monitoring devices

1 Heating, Ventilation, Air Conditioning 2 Photovoltaics



## Digital Grid

- Substation automation, protection, metering and communications
- Grid operation and control
- Smart grid applications, analytics / IoT offerings and managed services
- Grid planning and simulation
- Power system consulting and energy business
- Advisory communications



## Electrification and Automation

- Medium-voltage switchgear
- Low-voltage motor control centers and medium-voltage motor controllers
- Overhead distribution products and outdoor distribution circuit breakers
- Energy storage systems
- Green Technologies inverter systems
- eMobility charging



## Regional Solutions and Services

- Solutions and Services for building automation, fire safety, security and other domains
- Energy performance services, including digital services and distributed energy systems
- Vertical markets specific offerings (data centers, life sciences, smart spaces)



## Electrical Services

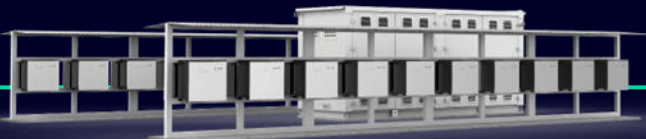
- Power system studies
- Technical Field Assistance
- Start-up, installation, commissioning
- Change-out/capital projects
- Extended warranties
- Service agreements
- Preventive Maintenance
- On-site condition assessment
- Modernization and retrofit
- Repair and refurbishment
- Upgrades, uprates, extensions
- Monitoring and diagnostics
- Thermography
- Asset management
- Spare parts
- Customer training

# What is Green Technologies (GT) ?

GT stands for Green Technology in the power conversion stage of green energy

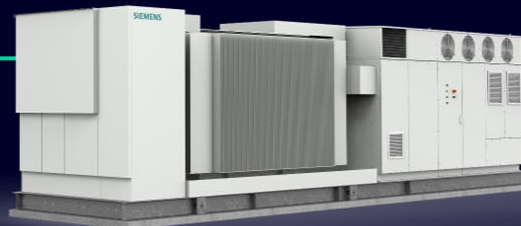
## Solar PV

- Gamesa Central Inverters
- KACO String Inverters
- Virtual Central Racks + Switchgear + Transformers
- MV Switchgear (34.5KV)
- Main Power Transformer (SE)
- Grid Tie Substation / HV (SE)
- Power Plant Controller



## Energy Storage

- Gamesa Storage Inverters
- KACO Storage Inverter (behind-the-meter)
- Battery partnerships and/or consortium bids
- MV Switchgear (34.5KV)
- Main Power Transformer (SE)
- Grid Tie Substation / HV (SE)
- BMS & PPC



## Green Hydrogen

- Gamesa IGBT Rectifier
- Gamesa Central PV and Storage Inverters
- MV Switchgear (34.5KV)
- Main Power Transformer (SE)
- Grid Tie Substation / HV (SE)
- BMS, PPC and H2 Controls
- Electrolyzer (SE)





# String Inverter and Virtual Central Inverter Stations

# Domestic Manufacturing – shipments commence April 2024

- Regional Manufacturing Center in Kenosha, Wisconsin with longstanding Contract Manufacturing partner, Sanmina
- Convenient for shipping throughout the USA
- Facility 200,000 sq ft
- >100 employees
- PCBA, System Integration, Order Fulfillment
- Box Build and Burn-in Test
- ISO/TL 9000 operating standards
- Certified ISO 9001, TL 9000-H,V R5.0
- Certified ISO 14001
- Certified 13485
- 2024 Capacity: 3,000 Units (450MW)
- 2025 Capacity: 5,200 Units (800MW)

## 1,500 Vdc Models

### blueplanet 125 TL3

- DC MPP range: 875 – 1,300 V
- AC voltage: 600 V
- 125KW / 137.5KVA up to 42°C

### blueplanet 155 TL3

- DC MPP range: 875 – 1,300 V
- AC voltage: 600 V
- Derating above 30°C

## Available Options

- DC Disconnect with bending Box
- AC Surge Protection
- Communication Surge Protection
- Blank or Grommet gland plates

## Inverter Domestic Content per IRA Guidelines\*:

- Initial shipments: 20-25% US Content
- Within 12-15 months: 40-50% US Content

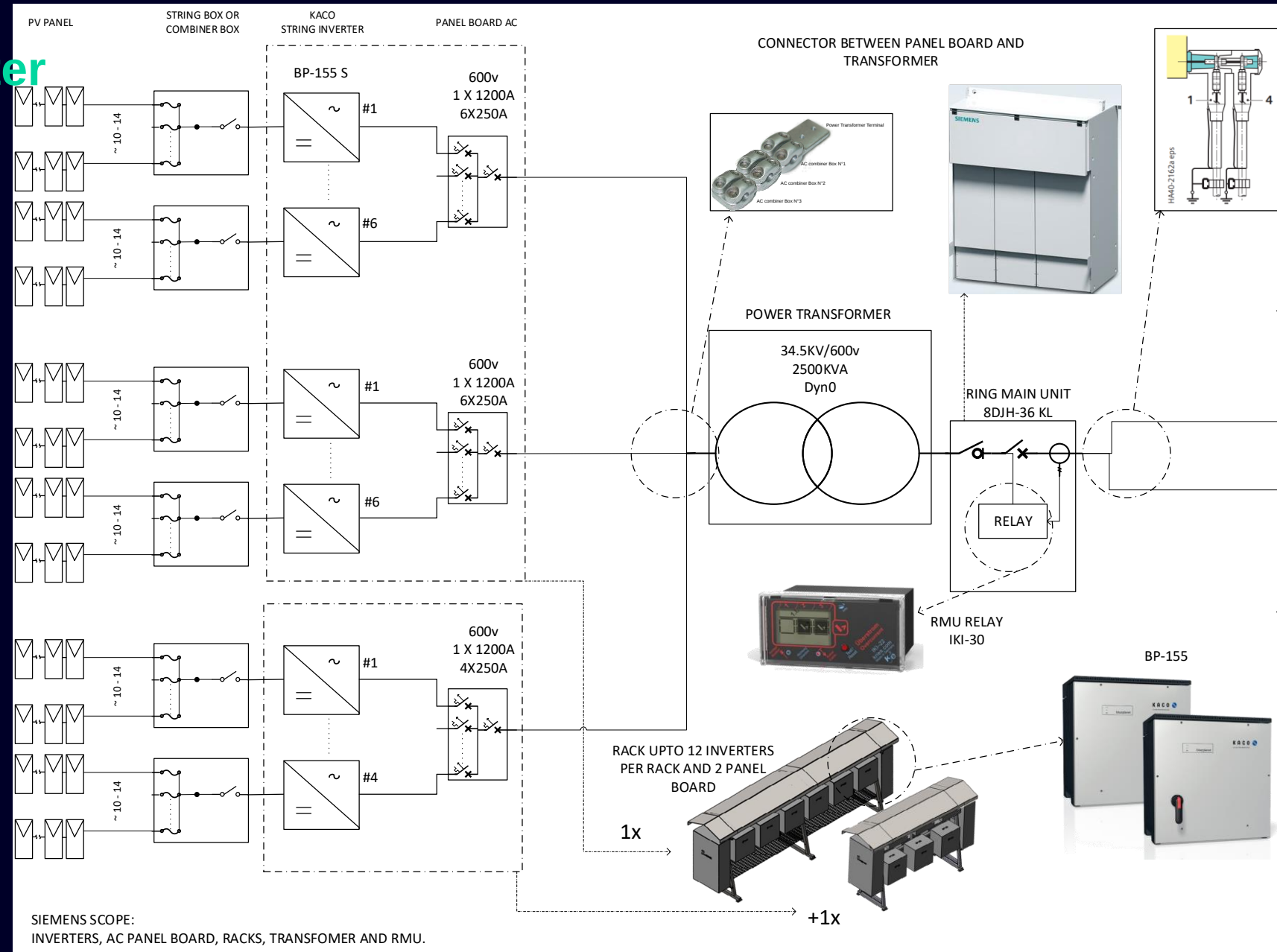
\*on material cost + Direct Labor basis per IRA guidance



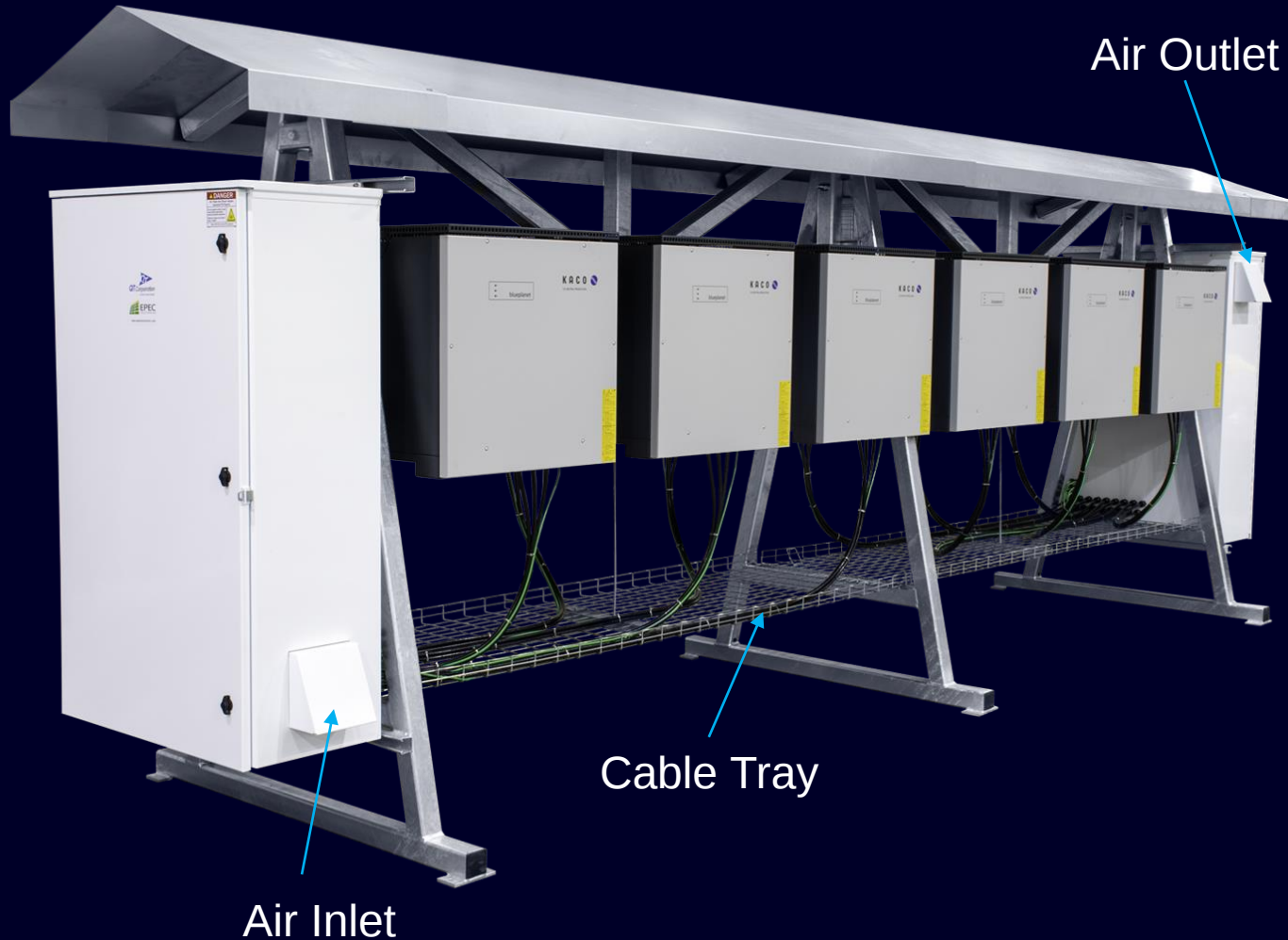
# PV: Virtual central inverter

## Standard Sizes for Rapid Delivery:

- 2.0MW (16x125KW or 13x155KW)
- 2.5MW (20x125KW or 16x155KW)
- 34.5KV Transformer with RMU
- 15KV Class Transformer with RMU
- Other sizes from 1MW to 5MW and custom configurations available upon request



# Inverter Rack: Scalable from 4-12 Inverters



## Inverter Racks

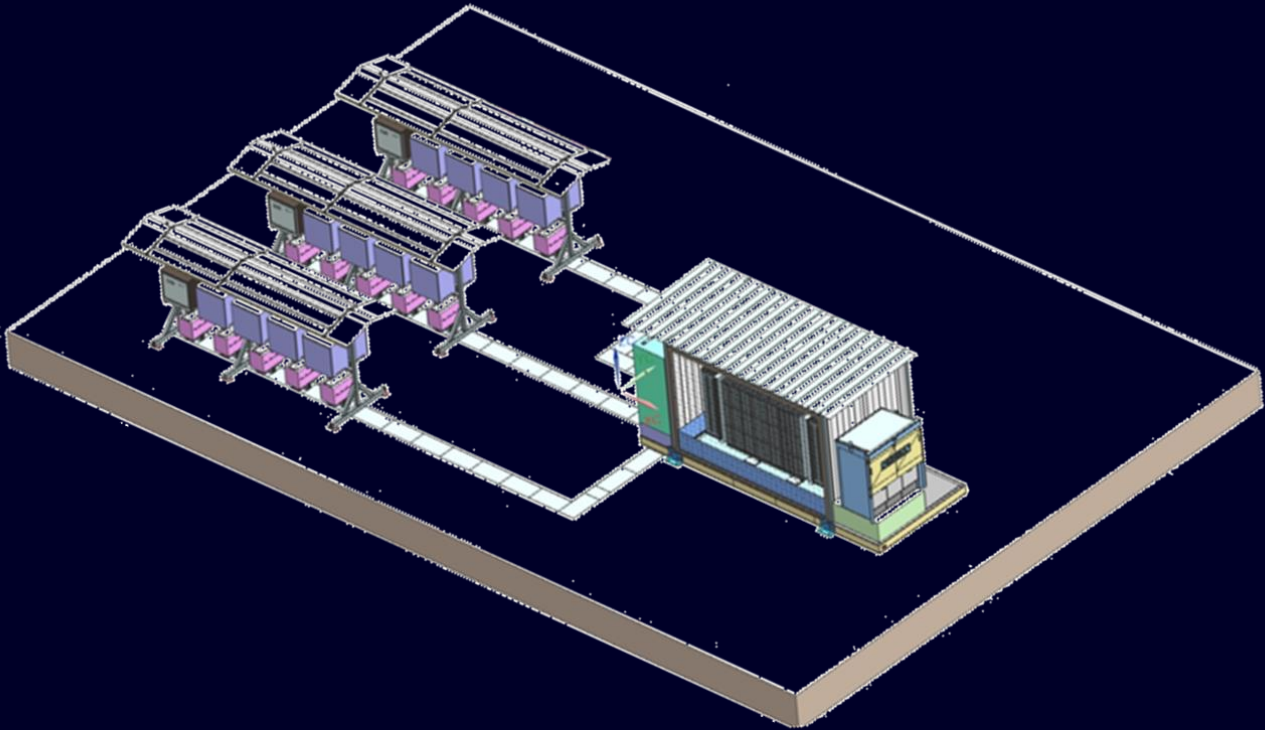
- Pre-assembled from 100% U.S. Steel in North Carolina
- Wire management tray
- Mounting to post, piles or concrete pad
- Integrated roof / shade structure to reduce thermal derating
- Optional Float Controller mounting

## AC Panelboards

- Assembled in USA
- Forced Air Ventilated NEMA3R painted white to eliminate nuisance breaker tripping
- 1200A or 800A Main Breaker
- 150A or 200A Feeder breakers
- Optional Aux. Power feeder
- Optional Float Controller feeder

# Central vs Virtual Central Inverters

|                                             | Central Inverter                                                                           | Virtual Central           |
|---------------------------------------------|--------------------------------------------------------------------------------------------|---------------------------|
| Block Size                                  | 4.1-4.7MWac                                                                                | 1-5MWac                   |
| Inverter Size                               | 4.1-4.7MWac                                                                                | 125-155KWac               |
| PCS Cost (incl. Xfmr)                       | 5-6c/Wac                                                                                   | 10-12c/Wac                |
| Block Outage (Avg.)                         | 4.3MWac                                                                                    | 125KWac                   |
| Mean Time to Repair (MTTR)                  | 36-48hrs                                                                                   | 3-4hrs                    |
| Inverter Lead Time (Catastrophic Failure)   | 12-16 weeks                                                                                | 48-72hrs                  |
| Field Failure Rate (FFR)                    | <0.5%                                                                                      | <0.5%                     |
| Maintenance Items                           | Fans, filters, pumps, SPDs                                                                 | Fans, SPDs                |
| Annual FFR Yield Loss (100MW Farm)          | \$171<br>4.27MWh                                                                           | \$43<br>1.07MWh           |
| Yield Loss in Event of Catastrophic Failure | \$7,2843<br>1,821MWh                                                                       | \$80<br>1.99MWh           |
| Spare Parts (100MW Farm)                    | IGBTs, fans, filters, pumps, PCB, CCU, HMI, Capacitors, Breakers, Contactors, misc. relays | 2 spare units, fans, SPDs |
| Spare Parts Cost                            | <\$100k                                                                                    | <\$15K                    |



## Virtual Central Advantages

- Block size flexibility for irregular sites
- Cost optimized for larger blocks but not as much of a c/W penalty for irregular or smaller block sizes
- Speed to repair / RMA swap units
- Blocks can be controlled as if they are central inverters with grid interactive features or on a more granular basis
- Reduced spare part requirements
- Low audible noise
- Insurance against catastrophic failure



# Central Inverter Stations

# Central inverter Siemens Gamesa PV 3X Series highlights



## High performance

High efficiency: CEC 99.0%,  
Q at Night



## Ultra-low THD

<1% current distortion  
<3% voltage distortion



## Digitally enabled

Remote monitoring



## High availability

IP 55 outdoor units  
Robust design based on proven wind-  
converter technology  
Liquid cooling 104 °F...140 °F  
(-40 °C...+60 °C) possible

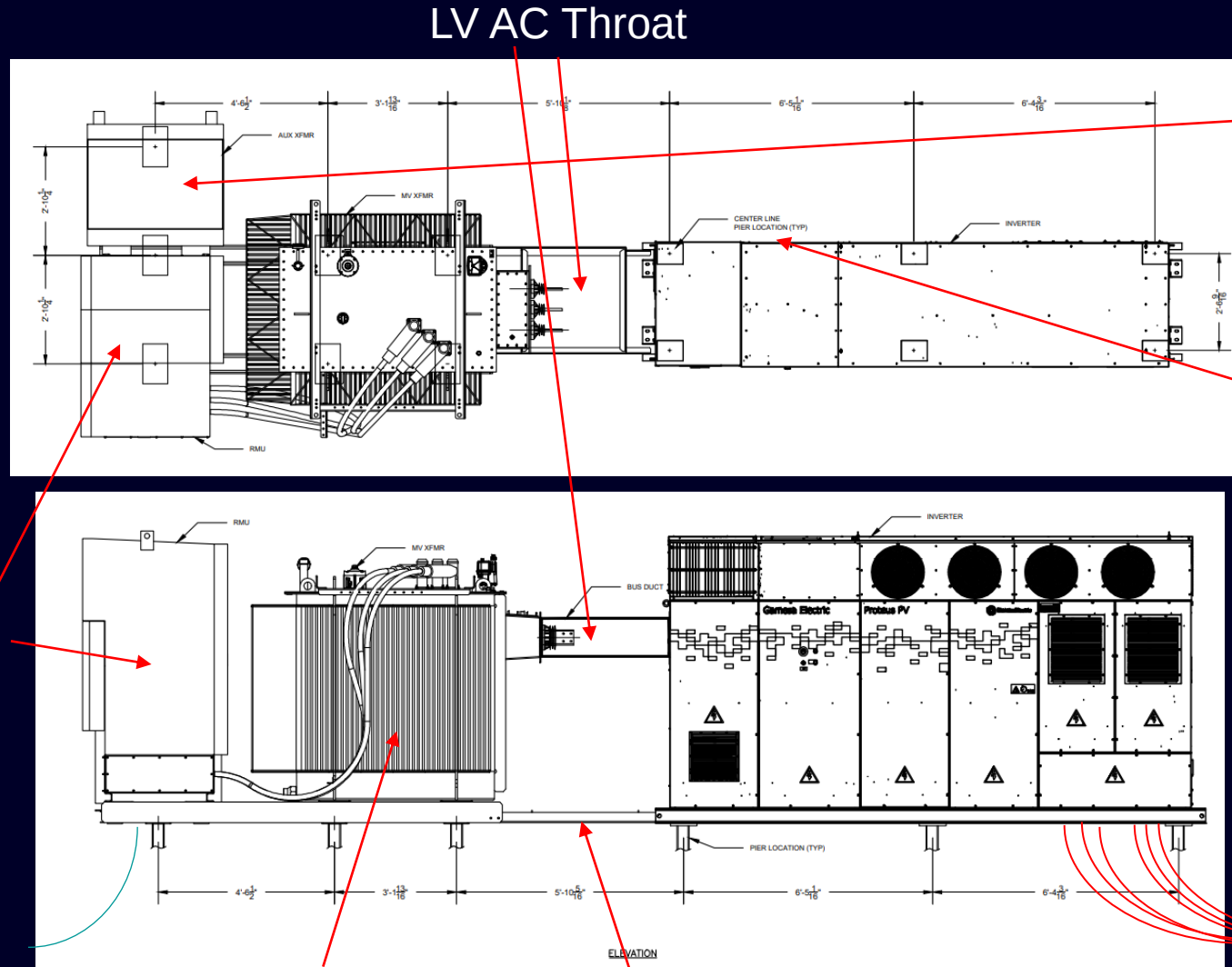


## Design friendly

DC/AC ratios up to 200%  
Suitable for weak grids with SCR down to 1.62  
Up to 24 +/- monitored dc fuses  
Up to 500 A dc fuses



# PV Inverter Integrated Layout (4.1-4.7MWac)



- Aux Power Station up to 55KVA possible (can be field installed) includes distribution breakers for Aux loads
- Provision for mounting rails on back of inverter for any other auxiliary panels (SCADA, Tracker control, etc) to max. 100kg

MV Cabling  
(loop feed)

Transformer  
to MV

Mechanical Linkage (Inverter  
to Transformer Skid)

DC PV  
Homerun  
Wiring

**SIEMENS**

# PV Skid Integration Activities

| Action                                                                  | Siemens | EPC | Notes                                                                                                                                                                                                                                                                                          |
|-------------------------------------------------------------------------|---------|-----|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Inverters delivered 4 per container to jobsite                          |         |     | if no level dock available, please advise PjM and we can deliver on flatbed                                                                                                                                                                                                                    |
| Offload Inverters                                                       |         |     | 10,000lb rated forklift with fork extensions required                                                                                                                                                                                                                                          |
| Post/Pile or Pad installation for Inverters                             |         |     | drawing showing locations provided by Siemens                                                                                                                                                                                                                                                  |
| Transformers delivered 2 per container to jobsite                       |         |     | open top container. Note that we are currently evaluating viability of delivering 3 per container.                                                                                                                                                                                             |
| Post/Pile or Pad installation for Transformer/RMU half skid             |         |     | drawing showing locations provided by Siemens                                                                                                                                                                                                                                                  |
| Offload Transformers                                                    |         |     | Crane lift required                                                                                                                                                                                                                                                                            |
| Alignment of Inverters / Transformer on mounting location               |         |     | XFMR skid extension rail that connects the inverter and transformer skid. This ensures proper alignment between inverter and transformer skid                                                                                                                                                  |
| Throat kit delivered to site                                            |         |     |                                                                                                                                                                                                                                                                                                |
| Throat kit installation between inverter and LV side of transformer     |         |     |                                                                                                                                                                                                                                                                                                |
| DC cable terminations, DC grounding cable terminations                  |         |     |                                                                                                                                                                                                                                                                                                |
| MV terminations to RMU (incoming and outgoing)                          |         |     |                                                                                                                                                                                                                                                                                                |
| RMU to Transformer MV connections                                       |         |     | done as part of half skid assembly. Factory connected before shipment                                                                                                                                                                                                                          |
| Equipment grounding connections                                         |         |     | Grounding connections shown in the transformer skid drawings. Connections from MV RMU and Transformer to the ground bar pre-connected in factory. Onsite connection between the Inverter ground to the earthing bar. Connections of all other customer provided equipment to be done by others |
| Delivery of Panelboard/Transformer Auxiliary unit                       |         |     | if purchased by customer                                                                                                                                                                                                                                                                       |
| Installation of Panelboard/Transformer Auxiliary unit                   |         |     | Per VFA, installation of Aux transformer and panelboards are not included. This has to be done by EPC. Once installed, Siemens will provide the wiring between Inverter AC terminals to the input of Aux transformer                                                                           |
| Wiring of Panelboard/Transformer Auxiliary unit to supply from inverter |         |     | if included in Siemens scope, otherwise done by EPC                                                                                                                                                                                                                                            |
| Unistrut on back of Inverter for mounting other auxiliary panels        |         |     | Siemens can include if purchased by customer                                                                                                                                                                                                                                                   |
| Mounting and wiring of other auxiliary panels                           |         |     | eg. SCADA panel, Tracker control panel                                                                                                                                                                                                                                                         |
| Inverter commissioning (including transformer and RMU)                  |         |     |                                                                                                                                                                                                                                                                                                |
| Supply of DC gland plates                                               |         |     | Supplied by Siemens as ship-loose item but installed by EPC (Optional item)                                                                                                                                                                                                                    |
| Installation of DC gland plates                                         |         |     | Supplied by Siemens as ship-loose item but installed by EPC (Optional item)                                                                                                                                                                                                                    |



# Energy Storage Inverter technologies AC Coupled

# Proteus PCS-E Storage System

- Compatible with 1500Vdc battery systems
- Very high efficiency 99%
- High power density up to 5.5MVA @ 1500Vdc
- **THD  $\leq$  0.7%** (IEC 61727 and IEEE 519)
- **High DC short-circuit capacity: 2 x 250kA, 3msec**
- Liquid + air Cooling (Cooldbrid)
- Battery Agnostic
- IEC and UL certified\*
- **Black start and grid forming capability**



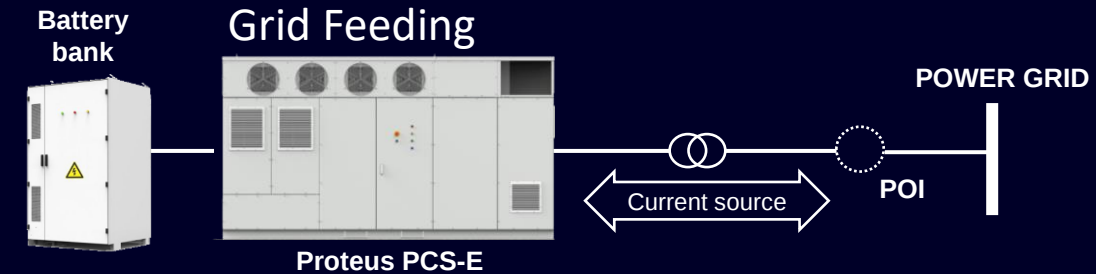
\* UL508, UL1053, UL1741, IEC 60529, IEC 62116, IEC62109, IEC 61683, NEC (2020), IEC 62262

# Proteus PCS-E inverters. Working Modes

## Working modes:

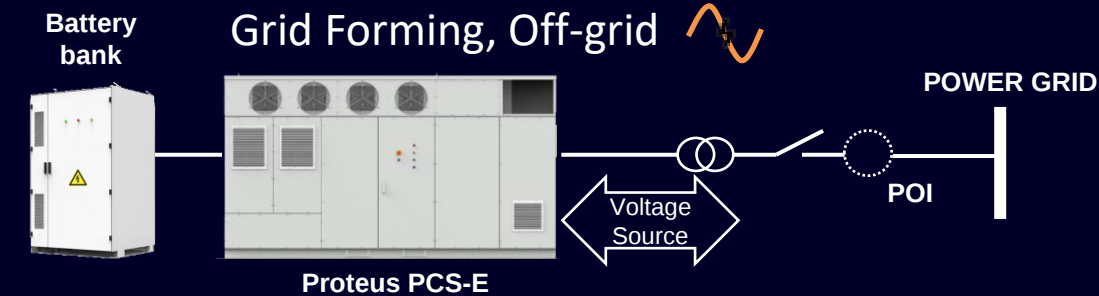
### Grid feeding

- Current source
- Also called grid following



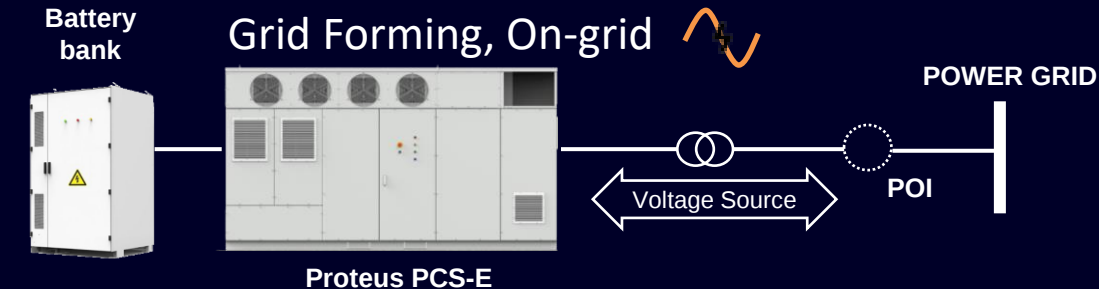
### Grid forming (Off-grid mode)

- Virtual synchronous machine (VSM)
- Voltage source
- Islanded operation, disconnected from the grid
- Black start available



### Grid forming (On-grid mode)

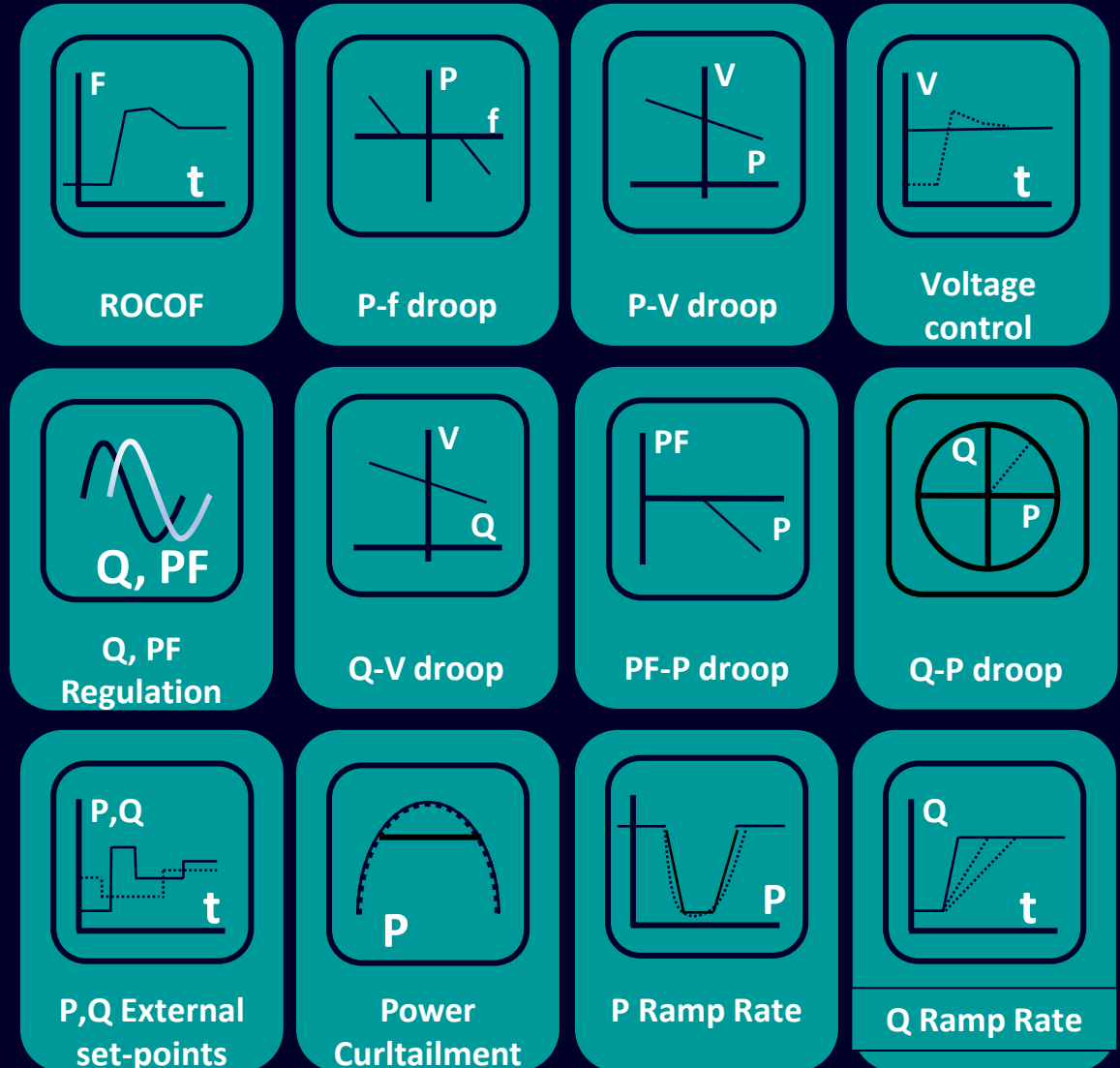
- Virtual synchronous machine (VSM)
- Voltage source
- Operation in parallel with the grid
- Inverters can continue working in case of loss of mains if the consumption of the loads is below the generation capacity



# Proteus PCS-E inverters. Ancillary services

## Ancillary Services\*

- Active power regulation
  - Fast frequency response (FFR)
    - Synthetic inertia (ROCOF)
    - P-f droop (primary frequency response)
  - P-V droop
- Reactive power regulation
  - Voltage, PF, Reactive power control
  - Q-V droop
  - PF-P droop, Q-P droop
- Tracking of external set-points (P,Q):
  - Secondary, tertiary response
  - Curtailment
- Active/Reactive power Ramp rate (Up-Down)



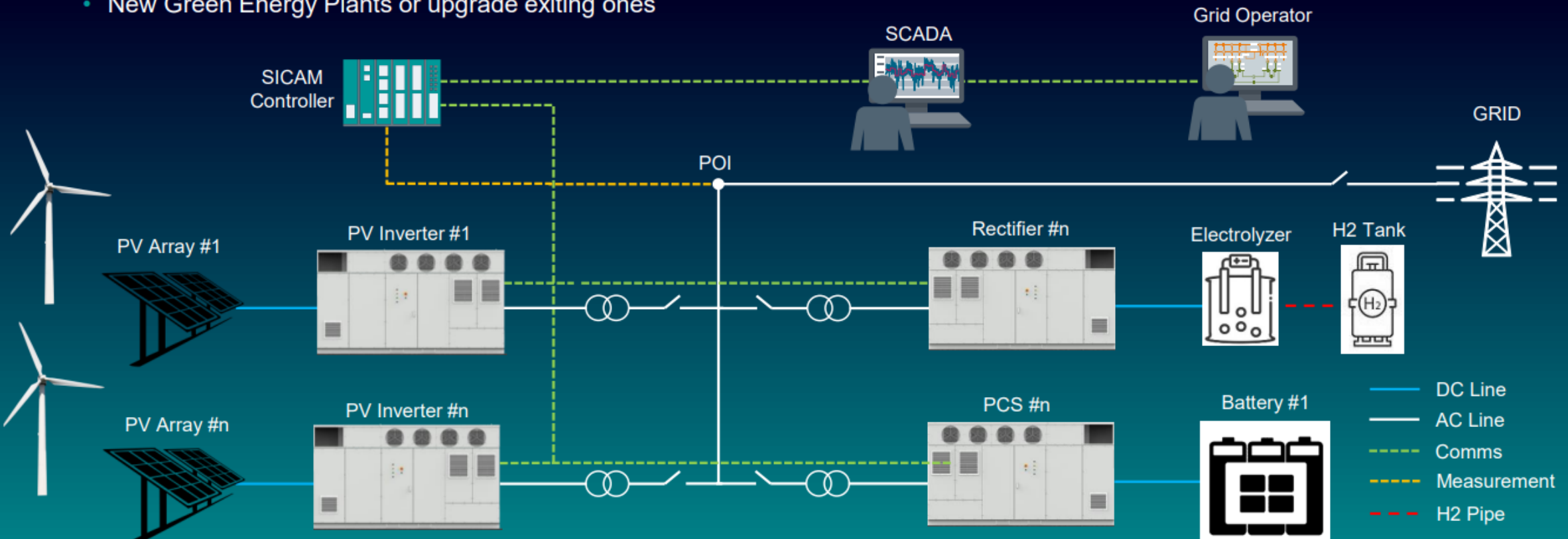
\* Most of these services can be performed either at PCS level or at plant controller level, POD is performed at plant controller level



# Green Hydrogen Inverter technologies

## H2 Rectifiers – Green Hydrogen Generation – Hybrid (Grid / off-Grid)

- AC / DC System
- Hydrogen generation will require inverting and rectifying electric power
  - Grid connection is not required, but possible
  - **Batteries** for grid stabilization would be required for **off-grid operation: Green H2 certified**
  - New Green Energy Plants or upgrade exiting ones

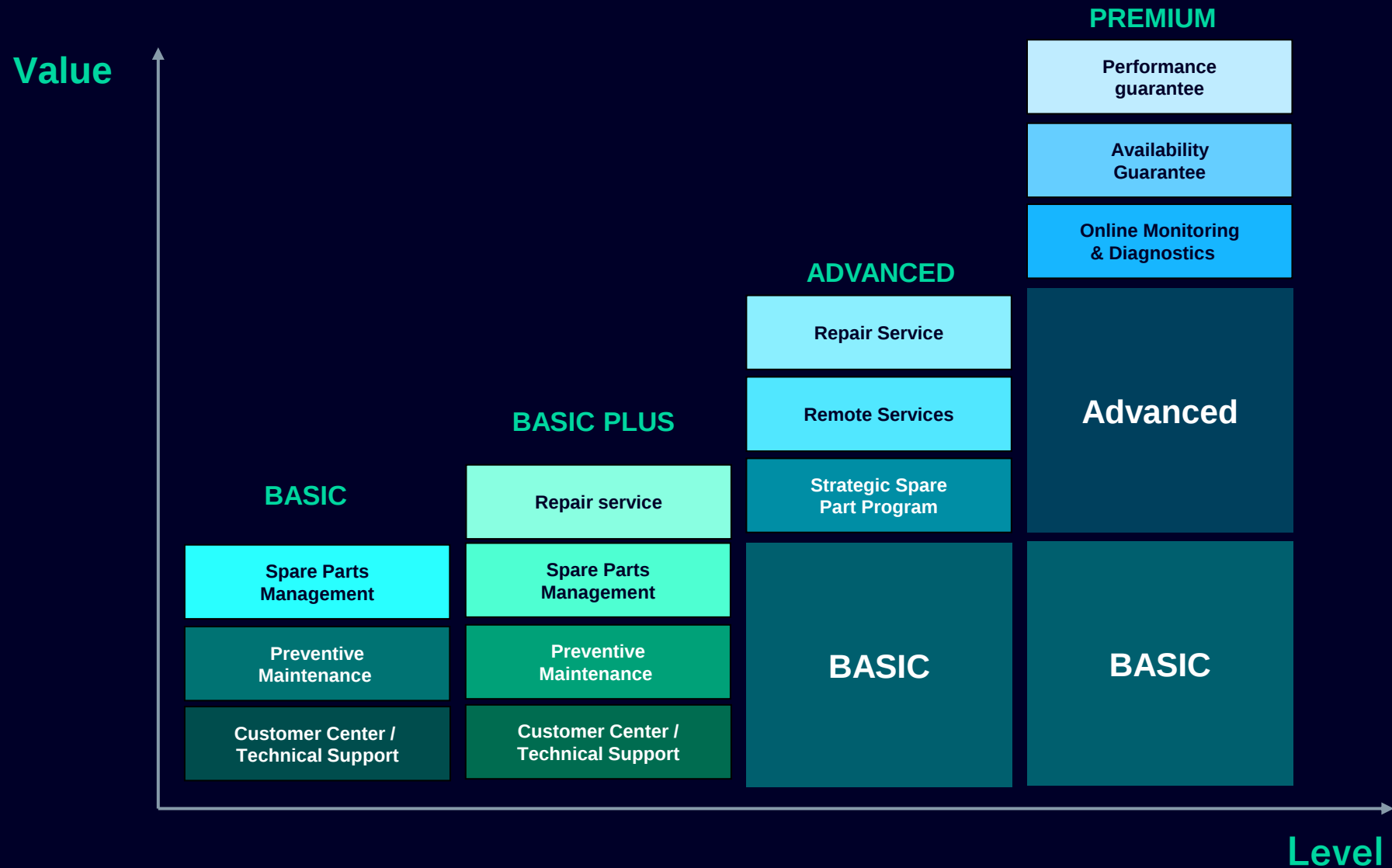




# Ancillary Offers: Field Service and Siemens Financial Services

# Customized Service Packages

Defined according to your individual needs & requirements



# Siemens Financial Services (SFS) Involvement

|                                                    |                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                        |
|----------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Main Products                                      | <ul style="list-style-type: none"> <li>Project Finance</li> <li>Structured Loans (senior secured and/or mezzanine debt)</li> <li>Asset Finance</li> <li>Siemens involvement as supplier/solution provider preferred</li> </ul>                                                                     |                                                                                                                                                                                                        |
| Sectors<br>Social- & Economic-<br>Infra and Energy | <ul style="list-style-type: none"> <li>Renewables (wind/solar)</li> <li>Oil and Gas</li> <li>Power Generation and Transmission</li> <li>Distributed Energy Services / Energy Storage</li> <li>District Heating</li> </ul>                                                                          | <ul style="list-style-type: none"> <li>Healthcare/Education</li> <li>Roads/Ports/Airports</li> <li>Rail/Light Rail</li> <li>Water (DeSal)/ Waste to Energy</li> <li>Justice and Corrections</li> </ul> |
| Volume                                             | <ul style="list-style-type: none"> <li>Debt ticket size from €10 up to €100 million (depending on product); Potential for higher holds for strategic Siemens project</li> <li>Multi currency - Ability to fund in various currencies such as USD, EUR, GBP, SGD, HKD, AUD, NZD etc.</li> </ul>     |                                                                                                                                                                                                        |
| Countries                                          | <ul style="list-style-type: none"> <li>Core lending markets are Australia, South East Asia, Taiwan, Germany, France, United Kingdom, Poland, Netherlands, Spain, Italy, Belgium, Turkey and Middle East.</li> <li>Lending into other countries / regions possible (strategic relevance)</li> </ul> |                                                                                                                                                                                                        |

# I Questions

## **Legal Manufacturer**

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Wendell, North Carolina 27591  
United States of America

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<https://new.siemens.com/us/en/products/energy/topics/photovoltaic-inverters.html>

Order No. SIDS-I10083-00-4AUS  
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