Guide for Virtual Power Plant (VPP) Functional Specification for Alternate and Multi-Source Generation IEEE P2030.14

Overview and update – to 1 June 2024

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IEEE SA STANDARDS ASSOCIATION

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IEEE 2030™ Standards

The IEEE 2030™ Series that apply to the integrated grid & integration of DER:

- **IEEE 2030.7™-2017** – Standard for the Specification of Microgrid Controllers
- **IEEE 2030.8™-2018** – Standard for the Testing of Microgrid Controllers
- **IEEE 2030.11™-2021** – Guide for Distributed Energy Resources Management Systems (DERMS) Functional Specification

Recipient of 2023 IEEE PES Award for Outstanding Working Group for Outstanding Standard or Guide

- **IEEE 2030.4™-2023** – Guide for Control and Automation Installations Applied to the Electric Power Infrastructure
- **IEEE 2030.13™-2024** – Approved Draft Guide for Electric Transportation Fast Charging Station Management System Functional Specification (Approved by IEEE SA Board March 21, 2024; publishing in July 2024)

IEEE 2030™ Standards (under development)

The IEEE 2030™ Series Under Development:

- **IEEE P2030** - Guide for Interoperability of Energy Technology with the Electric Power System (Revision of IEEE 2030™-2011)
- **IEEE P2030.14™** – Draft Guide for Virtual Power Plant Functional Specification for Alternate and Multi-Source Generation

The DOE/Office of Electricity, Microgrid Program initiated and supported the IEEE 2030™ Standards for the integrated grid & integration of DER over the past 12 years and continues to provide leadership.

Related IEEE Standards

- IEEE 1547™- 2018 – IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

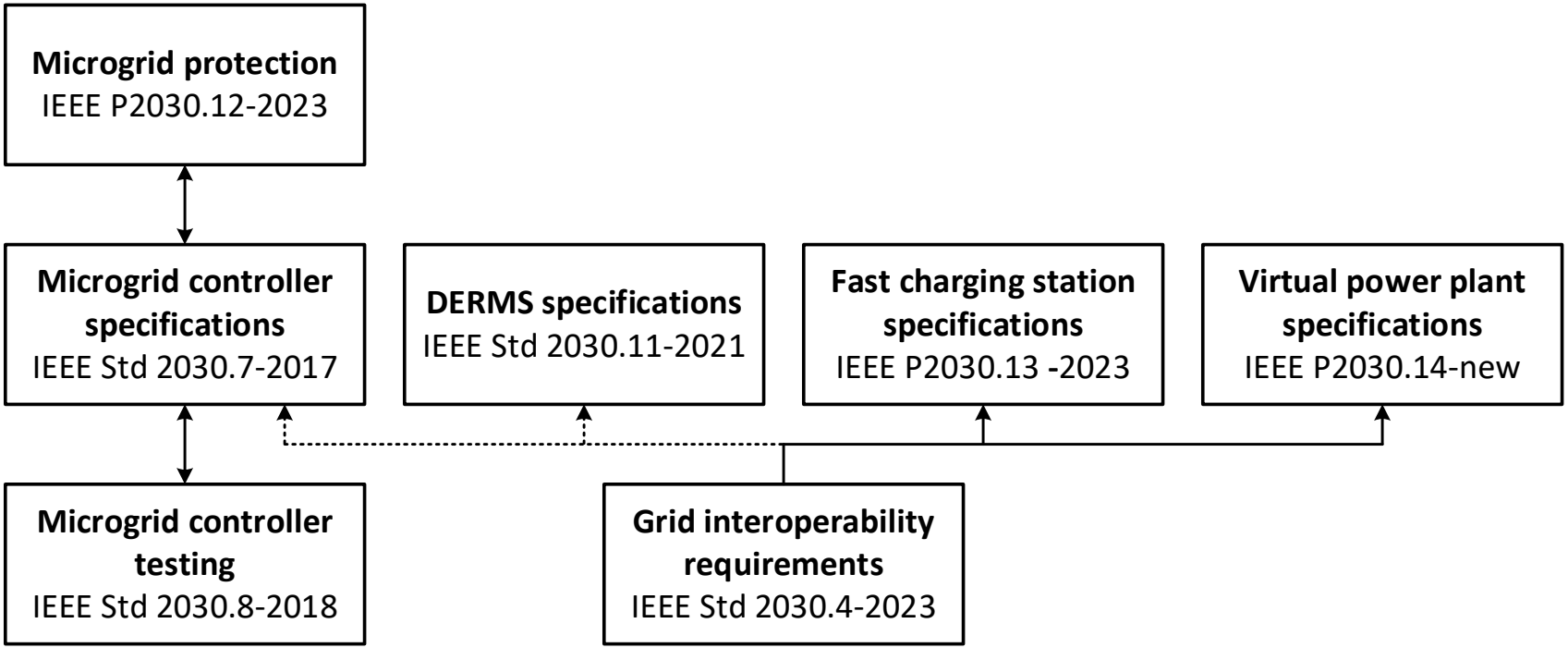
  Covers DER connected to Distribution Systems

- IEEE 2800™- 2022 – Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting with Associated Transmission Electric Power Systems

  Covers DER connected to Transmission and Sub-Transmission Systems

  Recipient of the IEEE SA Emerging Technology Award "For development of uniform technical requirements applied to inverter-based generation resources interconnecting with the electric transmission and sub-transmission systems"

VPP scope in relation to existing standards



P2030.14 VPP – history and status

- Project Title: Guide for Virtual Power Plant (VPP) Functional Specification for Alternate and Multi-Source Generation
- Sponsoring: IEEE Power and Energy Society, Transmission and Distribution (PE/T&D) Committee
- PAR Approval: 29 Jun 2023
- Membership: 70 utility, consultants, manufacturers, and software vendors
- Officers: Geza Joos (Chair); Bob Cummings (V-Chair); Jim Reilly (Secretary)
- VPP Working Group Meetings (average attendance ~30)
  - 1 Nov 2023 (NRECA, Arlington, VA); 9th (in person, planned):
  - 18-19 Sept 2024 (EEI, Washington, DC) Planned
  - 6 remote meetings (to date)

VPP – P2030.14 PAR – definition and scope

- VPP – defined as an aggregated resources capable of supplying electrical power to the electric grid and local loads
- Scope – implementation of VPP controller and the basic functional requirements, defining a set of controller core functions
- VPP Controller functions – asset management and dispatch
  - Internal (energy management functions): generation production estimation and scheduling from VPP controlled resources; local load estimation, management and dispatch
  - External (DERMS type functions): provision of grid services (energy, capacity) and ancillary services (voltage and frequency control/support) to electric system (EPS – including distribution, sub-transmission, and transmission)

VPP Tenets

- VPP asset aggregation must be done within a Balancing Authority within a single Interconnection
- VPPs act as go-betweens for DSOs/TSOs and DER assets
  - DSOs/TSOs can use VPPs for command-control
- The VPP may operate in islanded mode as a microgrid, feeding local loads for enhancing energy supply security and resilience
- VPPs can be used for black start functions

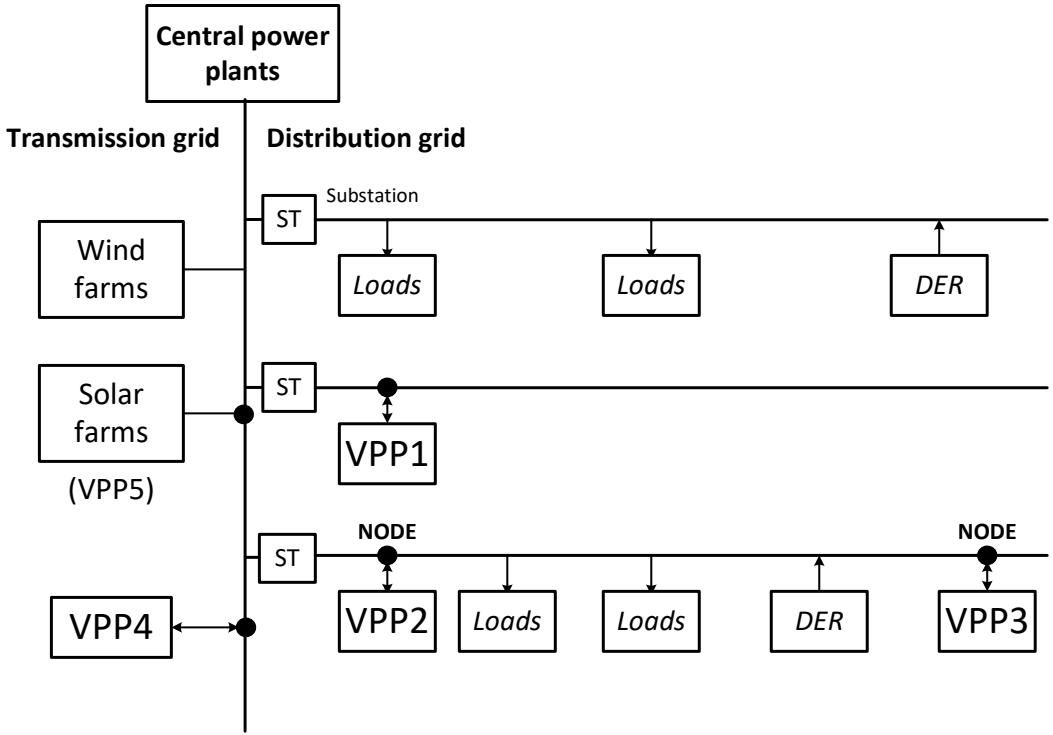
VPP Tenets

- VPP assets can consist of **controllable**:
  - Distributed energy resources such as wind, solar, energy storage systems, controllable demand, etc.
  - Can also include resources such as combined heat and power (CHP) units and the newer microreactors and small modular reactor (SMR) technologies
  - Can include microgrids reflected as single assets
  - Uncontrolled assets can only be aggregated for providing energy – like run-of-river hydro

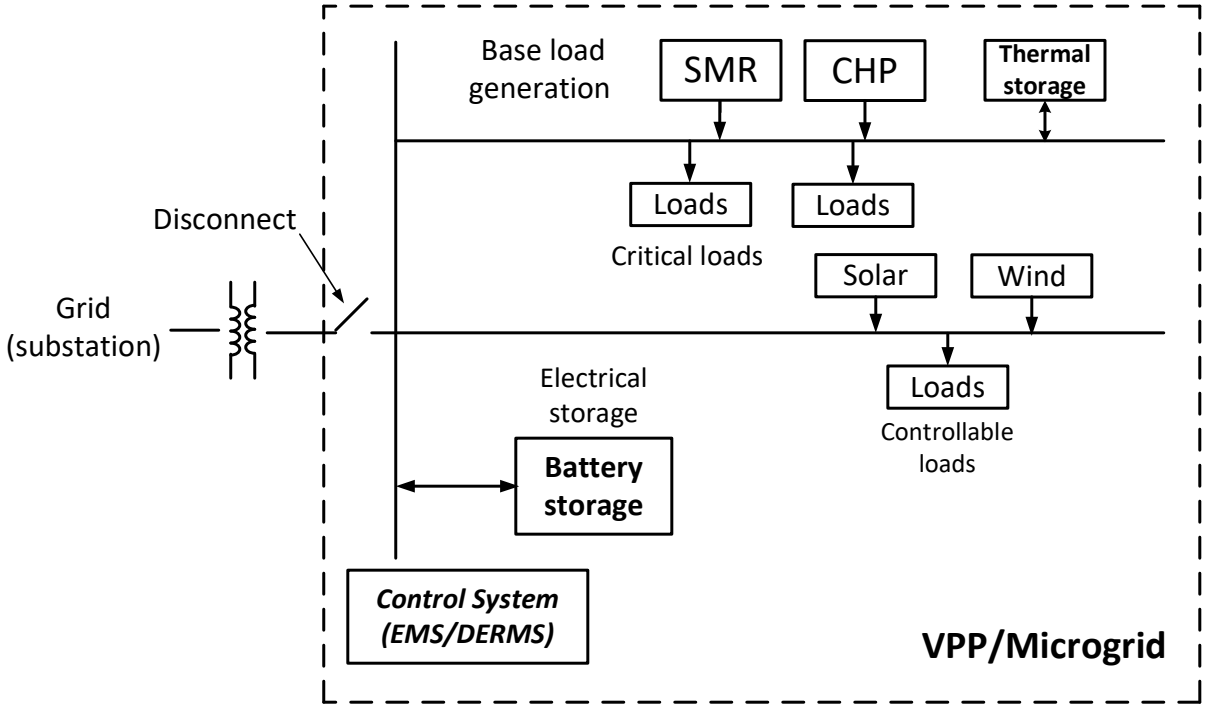
VPP Tenets

- VPP nodal injection/aggregation – constraints/requirements
  - VPP elements must be aggregated to “Nodes” for proper analysis of impacts of their injections at that point on the system
  - Nodes are to be defined by the distribution or transmission system operator to provide adequate information for proper analyses, and ensure adherence to system constraints on voltage, flows, and stability at those locations
  - Nodal constraints – Must meet all distribution and transmission system security constraints such as current injection capacity, voltage constraints (impact of injection), power injection capacity (impact on voltage)
  - Meeting flexibility expectations in managing the interconnected grid
  - Nodal aggregation considerations – economics associated with node location

VPP deployment – possible nodal connections



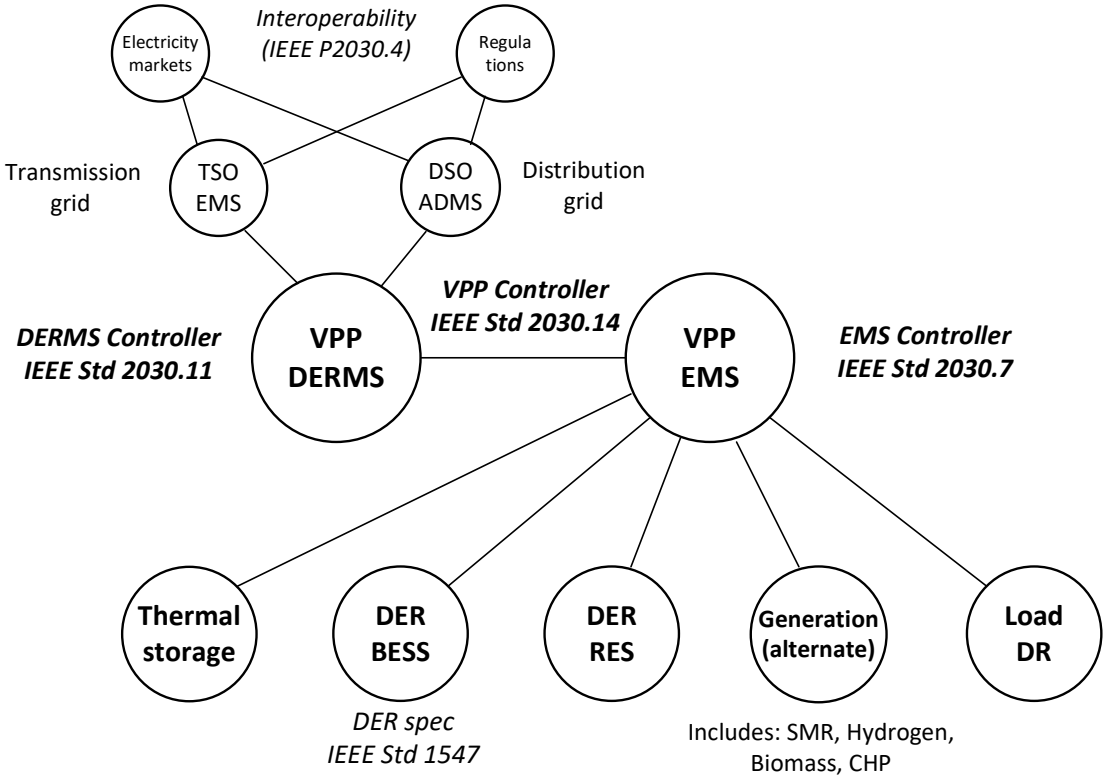
VPP configured as a microgrid



Relation VPP – DERMS – microgrids

- VPP relation to DERMS (DER management systems) and microgrids
  - VPP (P2030.14) – a managed aggregation of assets and resources forming an electric power plant capable of providing continuous power and energy using directly controlled assets including DER (renewables, storage and demand response) and dispatchable generation (CHP, SMR, other resources)
  - DERMS (IEEE Std 2030.11-2021) – a software platform aggregating assets and resources, DER, storage and generation, for the provision of grid services at the request of the DSO (distribution) and/or TSO (transmission)
  - Microgrid (IEEE Std 2030.7-2017) – a group of interconnected loads and DER with clearly defined electrical boundaries that acts as a single controllable entity that can operate in both grid-connected or island modes

VPP controller functional specification



VPP service provision feasibility limitations

- VPP must obey the laws of physics, including feasibility of P & Q injection
- Balancing P injection variations taken into account for service provisions
- VPP directly controls its assets, not the DSO and TSO
- Locational considerations – voltage control at a given node, frequency response and control at the system level
- Injection of P & Q within the reliability constraints of T&D system
- VPP operation within security constrained economic dispatch framework
- VPP meeting the interconnection requirements (rules, grid codes)
- VPP may require forecasting capabilities for the provision of services

Potential VPP benefits/impacts on the BPS

- Business and economics related benefits (Level 3 of interoperability)
  - VPP/DERMS for the provision of grid services (IEEE Std 2030.11): utilities, aggregation software vendors, market participants
  - VPP/microgrid for resilience: utilities, resilient communities
  - VPP/generation for the provision of energy/capacity: power plant developers, owners and operators, aggregation software vendors, utilities, distribution/transmission system operators
- General stakeholder benefits of using P2030.14
  - Establishing a base functional specification for proposals, design and deployment of different VPP configurations, defining a common terminology

Current P2030.14 Activities

- Preparing matrix of responsibilities between VPPs, DSOs, TSOs, and DER assets
- Drafting Guideline – conference calls throughout summer
- Next Meeting 18-19 September 2024 at EEI in DC
  - Working meeting to consolidate draft elements

Questions?