BERNSTEIN
SOCIETE GENERALE GROUP

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Americas Energy & Transition

Americas Energy & Transition: The Peaker you can't see - Can VPPs become the MVP in the U.S.?



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Sunrun, Tesla, and Renew Home announced a **framework agreement to deliver up to 16.8 gigawatts (GW) of flexible energy capacity** to hyperscalers and utilities, at a time when the US grid is constrained, and there is a mad scramble for power. We like the idea of VPPs, and while we don't cover TSLA, or RUN, we think VPP adoption can create opportunities for ENPH and GEV.

Virtual Power Plants (VPPs) are aggregated distributed energy resources acting as a flexible energy resource. Distributed energy resources (DERs) are distributed energy assets such as rooftop solar, EV chargers, and smart thermostats.

Electricity markets and the grid have stringent size and reliability requirements for participants in order to maintain the smooth functioning of the system (and avoid issues like blackouts). Since most DERs are relatively small, and comprise flexible resources such as consumer demand response, grid participation is difficult without significant aggregation.

Size and reliability requirements prohibit many resources from being able to participate. Another hindrance is the lack of standardization of access across markets. Currently, access for DERs and VPPs is determined at the utility level in the U.S., which limits participation to smaller markets rather than the broader regional markets served by ISOs and RTOs. Access also varies across the different types of energy markets (wholesale vs. capacity and ancillary services markets), limiting the available revenue streams that VPPs are able to capture.

FERC Order No. 2222 was issued (September 2020) in order to ease and standardize rules around DER and VPP participation in regional energy markets. The order would require ISOs and RTOs to upgrade their systems and establish or clarify rules around DER participation to lower barriers to entry. It would also address participation across different markets, and coordination of participation in existing retail programs.

The U.S. and Europe look remarkably similar when comparing the size and output of their electricity markets. However, Europe is widely understood to have much higher VPP participation than in the U.S. despite having comparable levels of installed VPP capacity. Europe has a higher penetration of renewable power generation capacity than the U.S. This naturally creates greater grid variability and incentivizes greater use of VPPs for load balancing purposes.

Europe also has a larger share of distributed energy resources in the power stack. Comparing rooftop solar capacity (a key DER) with utility scale solar capacity in the two regions, for example, shows that Europe has more installed GW of rooftop solar making up a larger share of overall solar capacity. Additionally, the European Union's Clean Energy package in 2019 formalized a number of mechanisms early on that facilitated VPP participation in electricity markets.

We believe that the continued growth and integration of VPPs into U.S. electricity markets, supported by the implementation of FERC Order No. 2222, could create market

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opportunities for Enphase's product offerings as well as for GEV's electrification business.

BERNSTEIN TICKER TABLE

Ticker	Rating	Cur	26 Jun 2026 Closing Price	Price Target	TTM Rel. Perf.	Cur	Reported EPS 2025A	Reported EPS 2026E	Reported EPS 2027E	Reported P/E (x) 2025A	Reported P/E (x) 2026E	Reported P/E (x) 2027E
BE (Bloom Energy)	M	USD	252.02	276.00	1015.7%	USD	0.82	2.30	4.27	305.9	109.5	59.0
CEG (Constellation Energy)	O	USD	264.02	296.00	(38.1)%	USD	7.40	11.82	12.67	35.7	22.3	20.8
ENPH (Enphase Energy)	M	USD	47.58	56.00	(4.1)%	USD	1.29	0.58	1.22	37.0	81.4	39.1
FRVO (Fervo)	O	USD	32.48	47.00	NA	USD	(0.25)	(0.10)	(0.16)	(130.8)	(331.8)	(206.3)
FSLR (First Solar)	U	USD	239.07	217.00	36.6%	USD	14.21	17.70	22.65	16.8	13.5	10.6
GEV (GE Vernova)	O	USD	1,045.17	1,206.00	80.6%	USD	17.70	25.21	26.05	59.1	41.5	40.1
NEE (NextEra Energy)	O	USD	88.56	107.00	4.4%	USD	3.30	4.30	4.48	26.8	20.6	19.8
ORA (Ormat Technologies)	U	USD	116.12	115.00	17.5%	USD	2.02	2.26	2.48	57.5	51.3	46.7
TE (T1 Energy)	M	USD	8.21	9.00	536.3%	USD	(2.19)	(0.31)	(0.07)	(3.7)	(26.1)	(114.2)
VST (Vistra Corporation)	O	USD	163.49	181.00	(36.7)%	USD	2.18	9.44	11.70	75.1	17.3	14.0
SPX			7,440.43									

O - Outperform, M - Market-Perform, U - Underperform, NR - Not Rated, CS - Coverage Suspended

BE estimate is Adjusted EPS; NEE estimate is Reported EPS Adjusted EPS; BE valuation is Adjusted P/E (x);

Source: Bloomberg, Bernstein estimates and analysis.

INVESTMENT IMPLICATIONS

We believe that the growth and further integration of VPPs into U.S. electricity markets, with the continued implementation of FERC Order No. 2222, could create market opportunities for Enphase's product offerings as well as for GEV's electrification business. We rate GEV Outperform with a price target of $1,206/sh. We rate ENPH Market-Perform with a price target of $56/sh.

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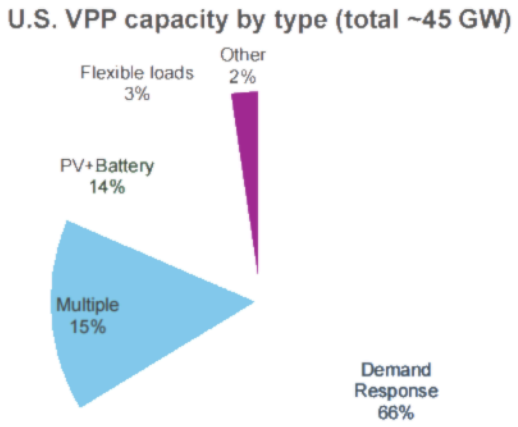
DETAILS

WHAT IS A VPP?

Virtual Power Plants (VPPs) are software-coordinated networks of distributed energy resources that act collectively as flexible energy resources. Distributed energy resources include rooftop solar, EV chargers, and smart thermostats. DERs tend to be much smaller than power plants and traditional grid connected resources - a typical rooftop solar system consisting of 20 400W panels would have a capacity of ~8kW. An EV charger on average is rated at ~7kW. Utility scale power plants in the U.S. have an average capacity of ~50MW and go up to 1.5GW in nameplate capacity. Due to their small size, in order for DERs to be able to participate effectively in electricity markets alongside large power plants, they get aggregated into VPPs (through cloud platforms, for example). The aggregator acts as the direct participant in energy markets.

Most existing VPP capacity in the U.S. falls under demand response programs where consumers manage their energy use in response to signaled grid conditions and incentives, in order to balance electricity supply and demand.

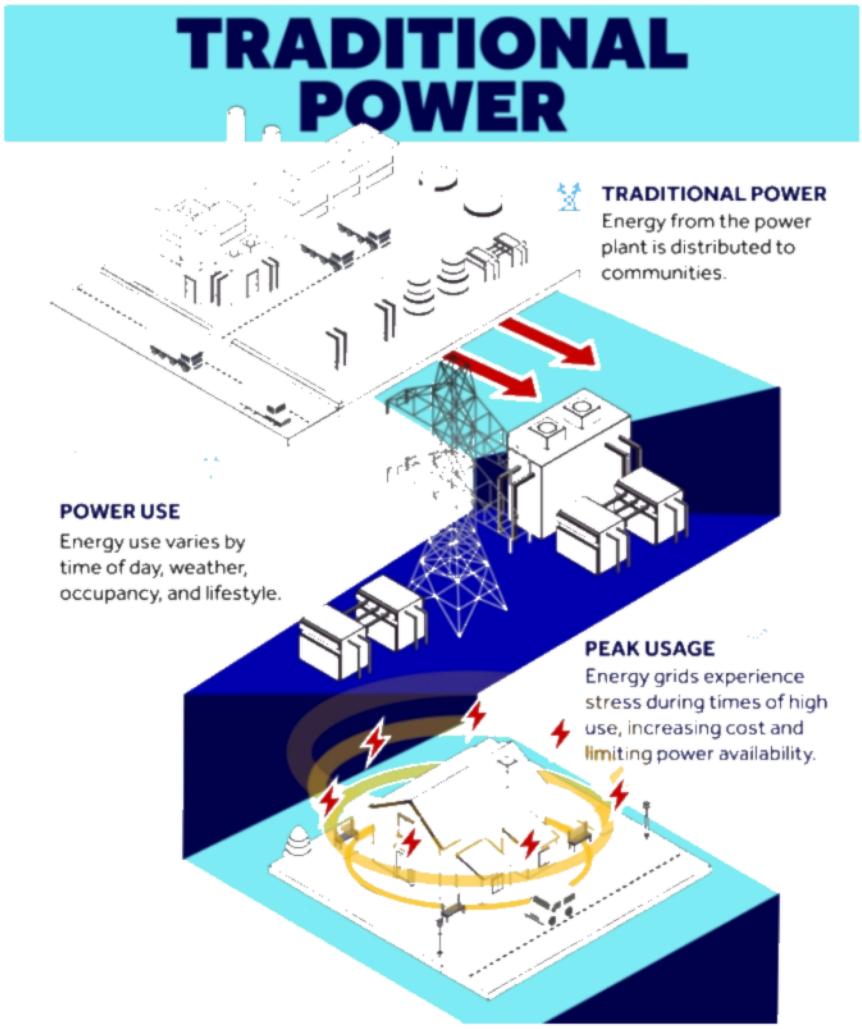
EXHIBIT 1: **LBNL estimates ~45GW of VPP capacity in the U.S. - the majority of which falls under demand response programs**



Source: LBNL, Bernstein analysis

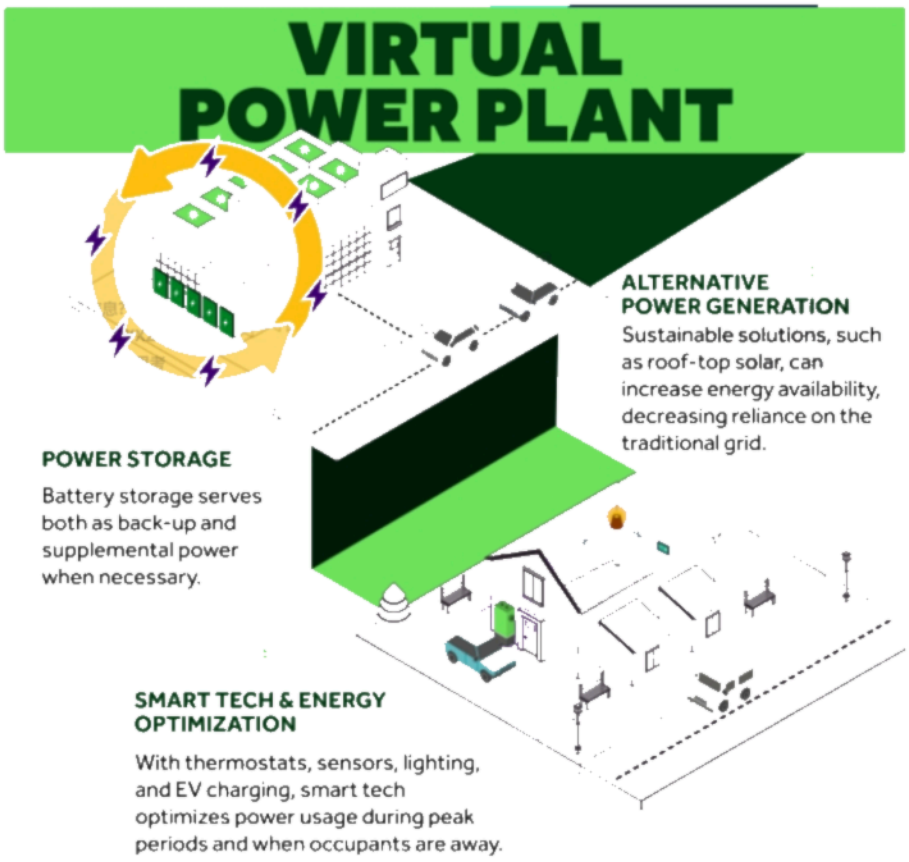
The difference between a traditional power plant and a VPP explained in pictures:

EXHIBIT 2: **Traditional Power Plant**



Source: NRG.com

EXHIBIT 3: **A Virtual Power Plant**



Source: NRG.com

WHY ARE VPPS IMPORTANT

VPPs (including demand response) can act as key reliability resources, balancing demand and easing system stress during peak hours. This helps avoid the cost of adding new, expensive capacity to serve high peak demand (which might otherwise go underutilized) and lowers the risk of blackouts.

Over time, VPPs could replace some of the role currently played by peaker plants, which can ramp quickly but are relatively emissions-intensive. As renewable penetration increases, VPPs can optimize excess generation and aggregate distributed resources into a dispatchable virtual power plant. Current battery durations are often insufficient to absorb all excess renewable generation, and hence as we add more variable power, VPPs can optimize power usage across regions. By leveraging existing distributed resources, VPPs can **free up transmission capacity** and ease distribution congestion, **extend grid headroom** and improve reliability, and potentially **lower household energy bills** and (sometimes) offer direct payments to participants as an incentive to sign up.

MARKET PARTICIPATION OF VIRTUAL POWER PLANTS

Size and reliability requirements - Electricity markets and the grid have stringent size and reliability requirements for participants in order to maintain the smooth functioning of the system (and avoid issues like blackouts). Since most DERs are relatively small, and comprise flexible resources such as consumer demand response, grid participation is difficult without significant aggregation. Size and reliability requirements prohibit many resources from being able to participate.

Lack of standardization - Another hindrance is the lack of standardization of access across markets. Currently, access for DERs and VPPs is determined at the utility level in the U.S. which limits access for VPPs to smaller markets rather than the regional markets served by ISOs and RTOs. Access also varies across the different types of energy markets (wholesale vs. capacity and ancillary services markets), limiting the available revenue streams that VPPs are able to capture.

FERC Order No. 2222 was issued to ease and standardize rules around DER and VPP participation in regional energy markets. The order would require ISOs and RTOs to upgrade their systems and establish or clarify rules around DER participation to lower barriers to entry. It would also address participation across different markets, and coordination of participation in existing retail programs.

EXHIBIT 4: **FERC Order No. 2222 aims to ease and standardize rules around market participation of DERs/ VPPs**

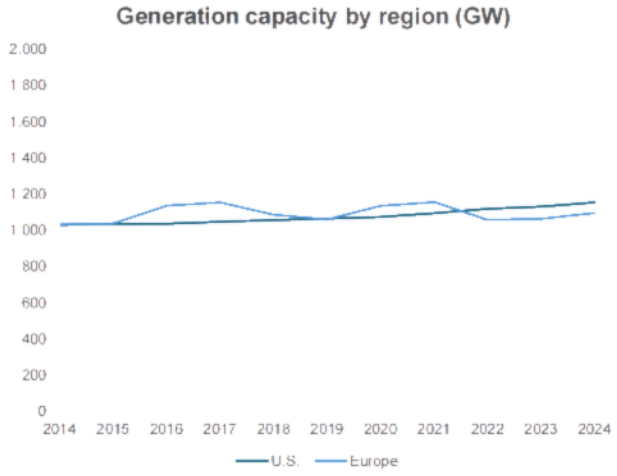
ISO/ RTO	Proposed Implementation Timeline
CAISO	Completed as of 11/24
NYISO	Full implementation slated by YE 2026
ISO-NE	Energy and ancillary services markets: 11/01/2026 Capacity Markets: In time for Forward Capacity Auction 19
SPP	2Q 2030
PJM	Energy and ancillary services markets: 02/01/2028 Capacity Markets: 02/01/2027
MISO	Phase 1: 06/01/2027 Phase 2: 06/01/2029

Source: FERC, Bernstein analysis

WHY EUROPE LEADS

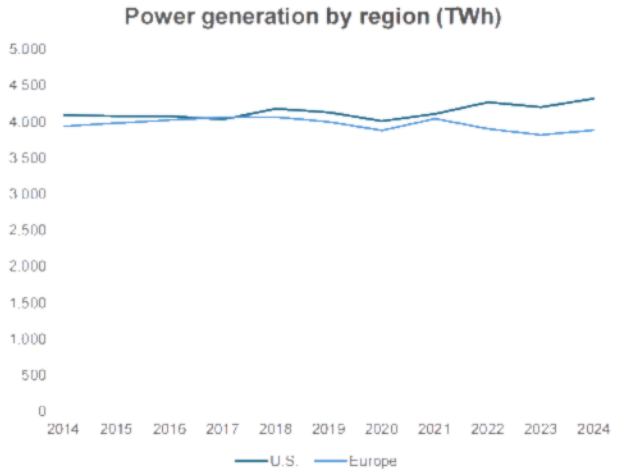
The U.S. and Europe look remarkably similar when comparing the size and output of their electricity markets. However, Europe is widely understood to have much higher VPP participation than in the U.S. despite having comparable levels of installed VPP capacity.

EXHIBIT 5: **The U.S. and Europe have similar installed generation capacity**



Source: EIA, ENTSO-E, Bernstein analysis

EXHIBIT 6: **The two regions also have similar electricity output**

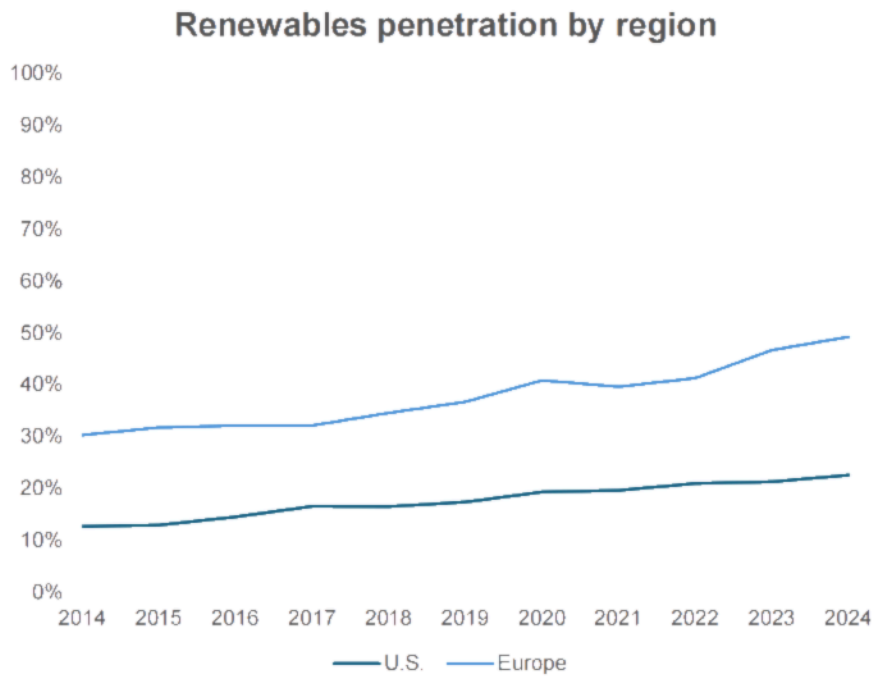


Source: EIA, Statistical review of world energy, Bernstein analysis

Higher share of renewable and DER capacity

One reason is that Europe has a higher penetration of renewable power generation capacity than the U.S. This naturally creates greater grid variability and incentivizes greater use of VPPs for load balancing purposes.

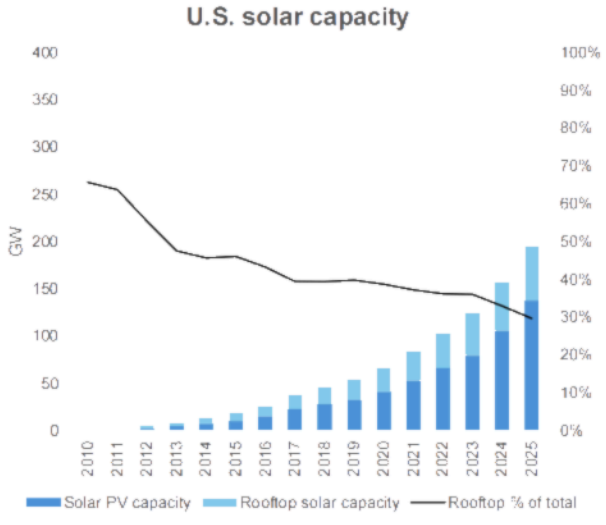
EXHIBIT 7: **Europe has a higher share of power generation from renewables than the U.S. perhaps contributing to more VPP use**



Source: EIA, Statistical Review of World Energy, Bernstein analysis

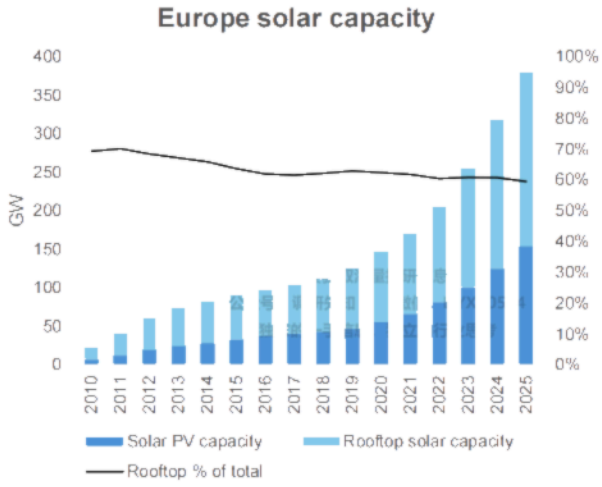
Europe also has a larger share of distributed energy resources in the power stack. Comparing rooftop solar capacity (a key DER) with utility scale solar capacity in the two regions, for example, shows that Europe has more installed GW of rooftop solar making up a larger share of overall solar capacity, as well as a larger share of rooftop solar in overall power generation capacity.

EXHIBIT 8: **U.S. solar capacity by type**



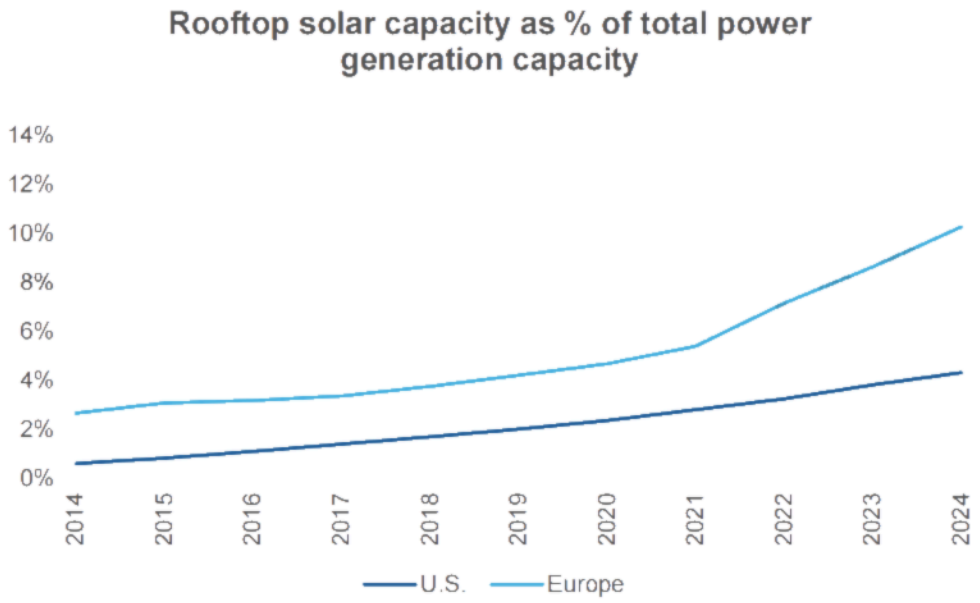
Source: Rystad, Bernstein analysis

EXHIBIT 9: **European solar capacity by type**



Southern, Eastern and Western Europe capacity from Rystad
Source: Rystad, Bernstein analysis

EXHIBIT 10: **Rooftop solar makes up <5% of power generation capacity in the U.S. whereas the share is double in Europe**



Source: Rystad, EIA, ENTSO-E, Bernstein analysis

Market design and policy support

Additionally, the European Union's Clean Energy package in 2019 formalized a number of mechanisms early on that facilitated VPP participation in electricity markets, while the U.S. is still implementing FERC Order No. 2222.

For example, the CEP mandated the creation of a Distribution System Operator Entity to strengthen the network of DSOs that manage the grid at the distribution level, and are therefore critical in coordinating and integrating DERs into the system.

Article 17 of the CEP explicitly called for the fostering of demand response through aggregation, allowing aggregators non-discriminatory participation in all electricity markets. It also provides for final customers to have direct contracts with aggregators, and the exchange of data between all participants.

In order to regulate grid frequency, Europe has centralized balancing markets that coordinate balancing capacity between DSOs and transmission system operators. These markets are coordinated across borders and are highly integrated, with open participation from DERs. The balancing function in the U.S. on the other hand, is less standardized across regions, and does not have a dedicated balancing market. Rather, frequency is maintained in real time markets through ancillary services and price signals. Highly developed and regionally coordinated balancing markets that allow DER participation could be another reason that VPPs are more integrated into electricity markets in Europe.

WHAT PIQUED OUR INTEREST ON THE SUNRUN TESLA RENEW HOME AGREEMENT

We view the Sunrun (not in coverage) Tesla (not in coverage) /Renew Home announcement as an important proof point for VPPs moving into mainstream capacity procurement. While the >16 GW headline is attention-grabbing, the more important point is that companies like Sunrun (not in coverage) are trying to convert its installed base into a grid and data center resource that can be marketed as fast, flexible capacity in constrained regions like PJM and Virginia.

EQUITIES

We believe that the growth and further integration of VPPs into U.S. electricity markets, with the continued implementation of FERC Order No. 2222, could create market opportunities for Enphase's product offerings by incentivizing greater use of rooftop solar, EV chargers and home battery systems. We also believe this could create opportunities for GEV's electrification business, particularly around grid management solutions.

ENPH

Enphase's **IQ Battery 5P** and **Enphase Energy System** are the core products enabling participation in VPPs, which aggregate small-scale distributed energy resources like rooftop solar with behind-the-meter batteries to provide grid services. Enphase's Energy Systems includes IQ Battery 5P and Enphase microinverters, creating a complete home energy system that can be aggregated for VPP operations. It also enables **firming of renewables**, load following, and peak shaving when coordinated with VPP software.

GEV

GE Vernova has **indirect** exposure to VPPs through utility-scale controls, Energy Management Systems (EMS), SCADA, and fleet optimization software embedded in its solar/storage/hybrid offering. GE Vernova's VPP exposure is centered on FLEXIQ, an asset-agnostic EMS/plant-control and fleet-software platform that orchestrates utility-scale solar, storage, and hybrid assets across sites to provide dispatch, optimization, and grid-support functionality.