



What is a Virtual Power Plant?

Virtual Power Plants (VPPs) are networks of distributed energy resources (DERs), such as smart thermostats, batteries, solar panels, and electric vehicles. VPPs enable these complex systems to precisely and accurately predict grid needs and adjust load and demand accordingly.

First conceptualized in the late 1990s by Dr. Shimon Awerbuch, Virtual Power Plants are coordinated through advanced software platforms to operate as a single, flexible power plant.

The VPP advantage

Electricity systems are under pressure from growing demand, extreme weather, high capital costs, aging infrastructure and the not-in-my-backyard (NIMBY) concerns. Traditional solutions, like physically building new energy infrastructure can also be capital-intensive and slow to deploy due to regulatory barriers.

VPPs allow for flexible electricity resources to be integrated into the grid during peak periods. The resources have the potential to be scaled quickly, rely largely on existing consumer-owned assets, and provide flexibility when and where the grid needs it most.

How do customers participate

VPPs represent a pathway to participate directly in the electricity system consumers can choose to opt-in to from their local utility. Consumers often receive benefits through incentive payments, bill credits, or other forms of monetary compensation. For system operators and utilities, they provide a tool to improve reliability, defer infrastructure investments, and reduce emissions.

How it works

Participation in a VPP starts when homes or businesses sign up eligible energy resources. These devices stay customer owned. These devices remain customer-owned and continue to serve their primary purpose.

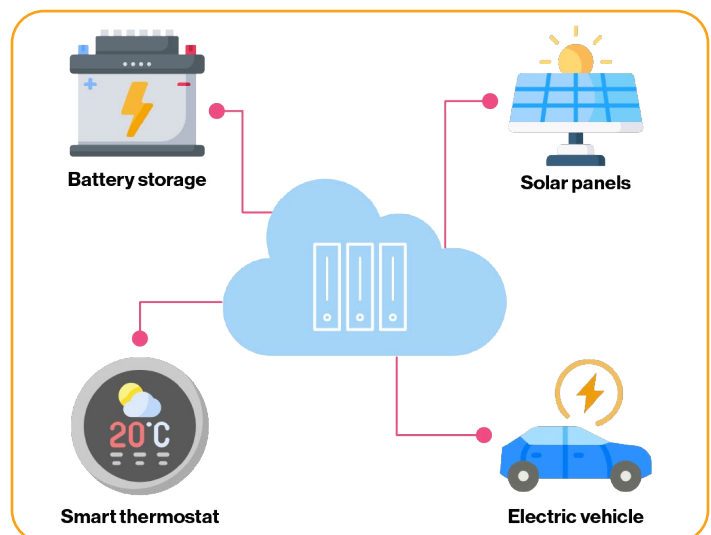
Software platforms aggregate these distributed resources, forecast their availability, and optimize the VPP's response when needed. VPPs operate in coordination with a utility's distributed energy resource management system (DERMS). By working together, these devices enable the VPP to temporarily reduce consumption or dispatch stored energy during peak demand events or system contingencies. The impact of a VPP depends on the specific DERs involved; Table 1 summarizes typical DER activities.

Table 1: DER Activity

DER	Activity
Solar Panel	Power released to the grid during peak demand periods, when coupled with batteries.
Smart Thermostats	Temperatures are increased to decrease electricity demand.
Batteries	Stored electricity released to the grid.

Figure 1 shows the main VPP processes, from connecting customer devices and coordinating through software to ensuring compatibility and responding to events to reduce demand when needed.

Figure 1. VPP Process



International VPPs

Germany

In Germany, VPPs can coordinate thousands of DERs and traditional generation to participate in its energy market by using its software functions (aggregation, DER coordination, and forecasting).



United Kingdom

In the United Kingdom, VPPs use Artificial Intelligence and machine learning algorithms to optimize business and consumer interests.



Australia

In South Australia, coordinated fleets of home batteries have been dispatched during heatwaves and transmission disturbances to provide fast response and peak support to the grid reducing the risk of widespread blackouts.



California

In California, residential solar and storage VPP programs were activated during extreme heat events to discharge energy during critical evening hours, easing stress on the system and helping avoid rolling outages.



These events highlighted how customer-owned resources, when digitally coordinated at scale, can deliver grid-level reliability services traditionally supplied by centralized generation.

The Canadian context

Ontario

Canada's largest VPP program operates in Ontario, where smart thermostats are aggregated to reduce peak demand. In 2024, IESO reported that the maximum demand reduction verified for the program was 101 MW. The program drives enrollment with \$75 prepaid gift cards and \$20 cards for each returning year.



Québec

Hydro-Québec's VPP program cites that nearly 60,000 participants helped reduce electricity demand by 200 MW in the winter of 2024-25.

Canada's growing adoption of electric vehicles presents significant future VPP potential. Transport Canada reported, 192,000 claims from the Incentives for Zero-Emission Vehicles (iZEV) Program from 2024-2025. This represents roughly 9600 MWh of energy, which could be used for a VPP and would have significantly increased grid capacity. However, this program was discontinued in 2025.

While VPPs have seen global success, Canada is still in the early stages of development. Canadian electricity providers are currently piloting their own VPP initiatives, which are expected to ease demand during peak periods.

Risks and challenges

VPPs are not without risk. Their reliance on digital platforms introduces cybersecurity concerns, requiring robust governance and technical safeguards.

Another technical challenge is the diversity of technologies involved. Smart thermostats vary widely in models and software capabilities across manufacturers. Designing a digital platform that can coordinate, aggregate, and accurately forecast the behavior of these devices is highly complex. Addressing interoperability and establishing common system standards will therefore be critical to the successful deployment of VPP solutions. VPP participation often depends on incentive structures, for VPPs and for DER devices, which are subject to change with shifting government and regulatory policy. The strength of a VPP is the ability to scale quickly, however, achieving significant enrollment remains their biggest challenge.

Limitations

VPPs, despite their promise, face significant limitations that complicate their role in modern power systems. Their heavy reliance on distributed, inverter-based resources introduces issues of unpredictability, limited inertia, and asynchronicity. These factors can undermine grid resilience if not carefully managed. VPPs also struggle to integrate into existing markets because regulatory and policy frameworks have not evolved to accommodate their unique operational and economic characteristics.

Furthermore, achieving reliable real-time coordination across thousands of devices requires sophisticated software, standardized communication protocols, and significant investment in monitoring and control systems. While VPPs can complement grid modernization goals, their effectiveness remains contingent on overcoming technical, regulatory, and operational hurdles.

Looking ahead

VPPs are not a replacement for traditional generation or transmission investments, they represent an alternative to reducing costs. As Canada pursues energy security and system reliability, VPPs offer a flexible, scalable, and consumer-inclusive solution.

With thoughtful policy support, strong cybersecurity practices, and continued innovation, VPPs can play a meaningful role in Canada's electricity future by unlocking value from assets already connected to the grid.