

SMART WIRES

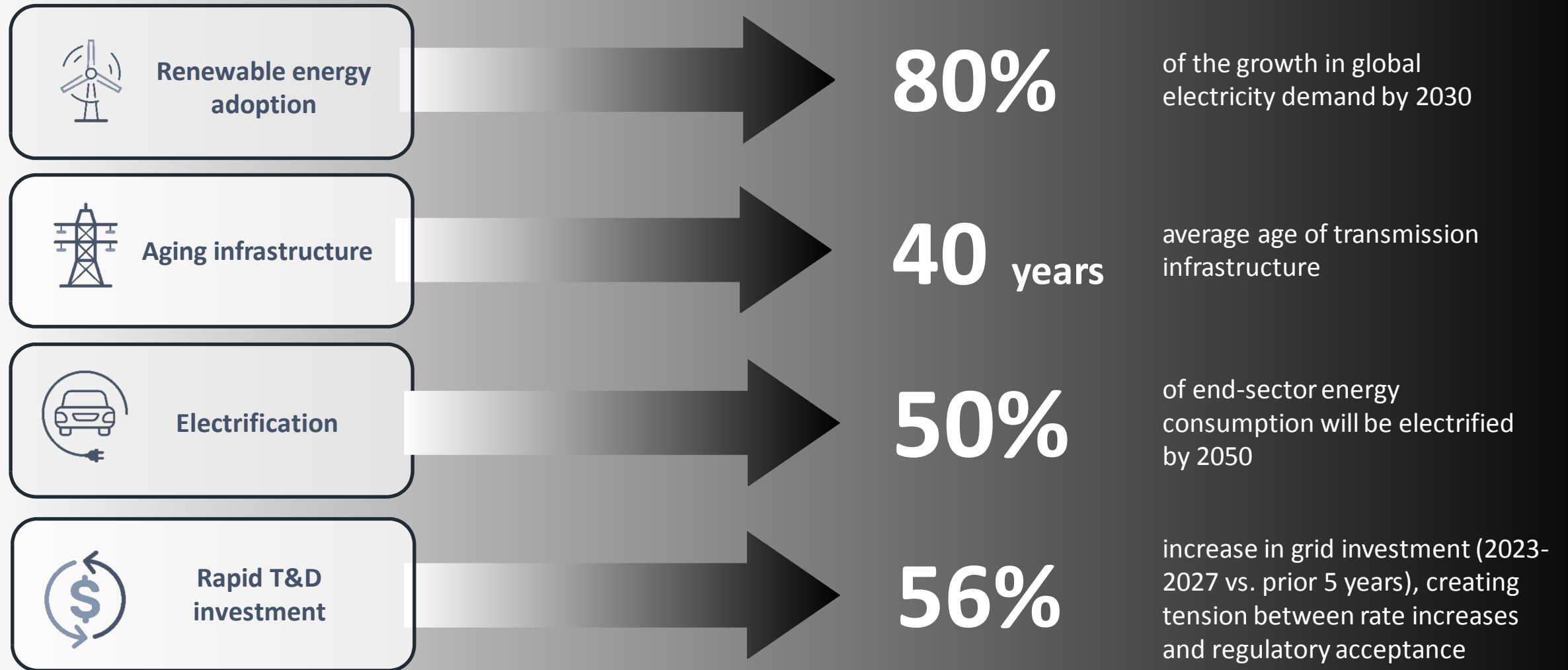
REIMAGINE THE GRID

Reimagining the grid for net zero

April 2024 | VSPC Meeting



The grid of the future: transition, disruption, uncertainty



Sources: IAE, Marsh McLennan, IEA, HIS Market



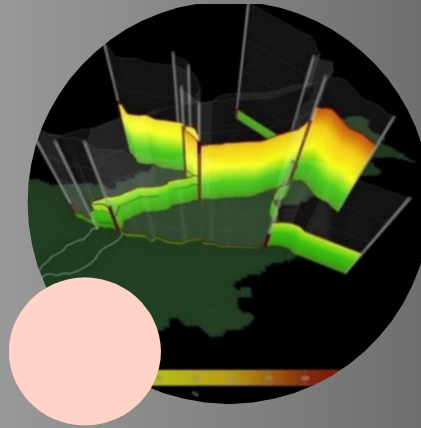
Smart Wires products & services

Patented technology coupled with analytics services



SmartValve™

Low-cost, modular, mobile, flexible, scalable, controllable products spanning the full range of transmission ratings



SUMO

State-of-the-art Dynamic Line Rating software that identifies spare grid capacity above static limits



Analytics

Advanced software and modeling to develop solutions for generation, load connections and transmission owners

Harnessing the power and adaptability of silicon and software to deliver enhanced, accelerated, and value-added solutions





SmartValve™

Advanced power flow
control

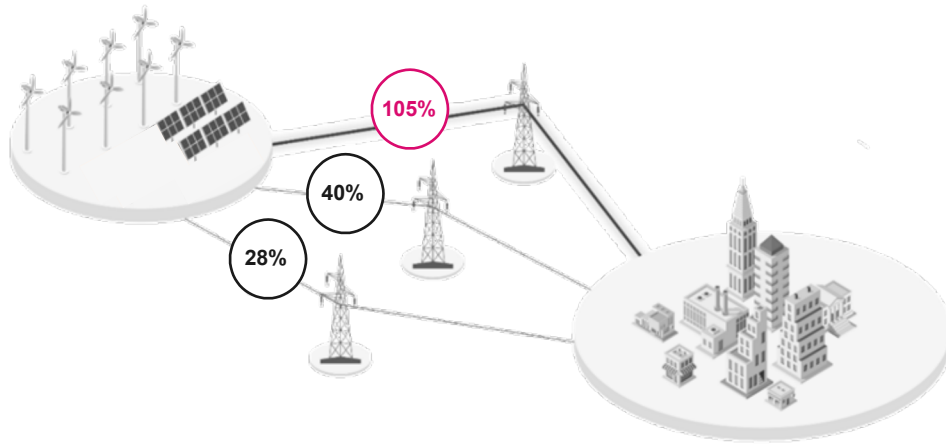
Flexible and scalable
installations

Quick to deliver and
deploy



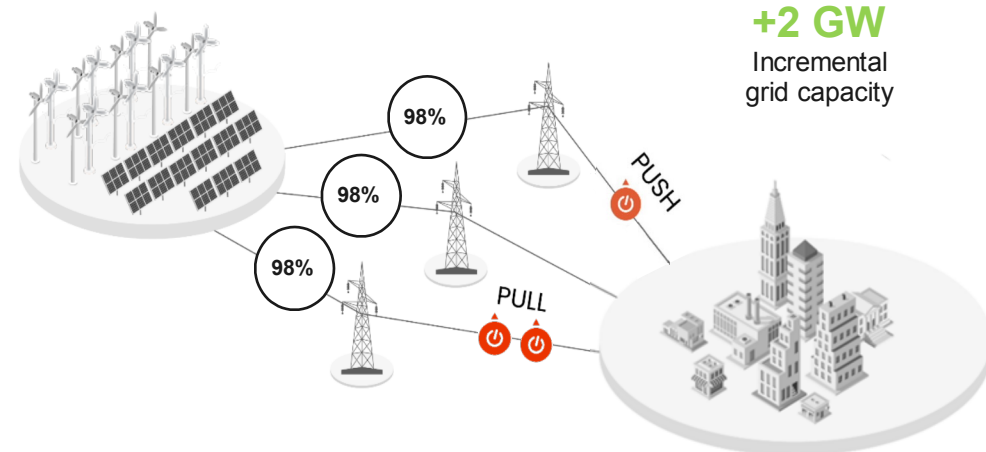
Advanced power flow control unlocks capacity on existing grid

Before Smart Wires



- x Renewable proliferation is bottlenecked by the electric grid
- x Transmission is subject to the path of least resistance
- x Once one line exceeds capacity, the line path is curtailed, even if incremental capacity exists on adjacent lines

After Smart Wires



 Smart Wires' SmartValve™

- ✓ Reducing renewables curtailment
- ✓ Reduced need for new expensive transmission lines
- ✓ Reducing long and growing interconnection queues
- ✓ Reduced operational grid challenges



2.1 GVAR, 670+ devices delivered across the world

North America

NY in commissioning at 345 kV
DoE push for advanced power flow control



Colombia

68 devices delivered in 12 circuits at 110 and 220 kV.

Incremental 1.2 GW of transfer capacity in total



Australia

3 installations on 3 x 330 kV interregional circuits, unlocking over 185 MW capacity

Generating \$190M in project savings



Europe

+100 devices at 7 x 275 and 400 kV circuits

Over 2 GW of transfer capacity increase saving £387M to consumers.



The SmartValve difference

WORLD ECONOMIC FORUM

TOP 3 TRANSMISSION
GRID INNOVATIONS

2010-2020

"Accelerating the Energy Transition"



- **Patented award-winning technology:** transformerless, modular Static Synchronous Series Compensator (m-SSSC) that employs VSC technology
- **Real-time control:** injects a controllable voltage that is independent of the line current, allowing the series reactance produced by the device to be varied (manually or automatically) in real-time
- **Modular design:** enables flexible, scalable and movable deployments that minimize use of substation space. No considerable EMFs
- **Multiple network applications:** power flow control and dynamic services including improving voltage stability and transient stability
- **High reliability:** no single point of failure ensures high reliability and redundancy
- **Proven at scale:** multiple large-scale deployments across the world, delivering GWs of extra capacity on the existing grid



Core values offered to customers and protected with IP

Scalable / modular



- Fix problem of any size
- Right-size solution to need over time

Mobile



- Easy, fast transport

Generic protection



- Faster installations
- Cost savings

Redeployable



- Maximize SmartValve utilization
- Manage uncertainty

Power electronics



- Size and weight benefit
- Cost savings

Connectivity



- Coordinate SmartValves across the grid



Unlocking capacity quicker than alternative options in the U.K.



2-year

lead-time

2 GW

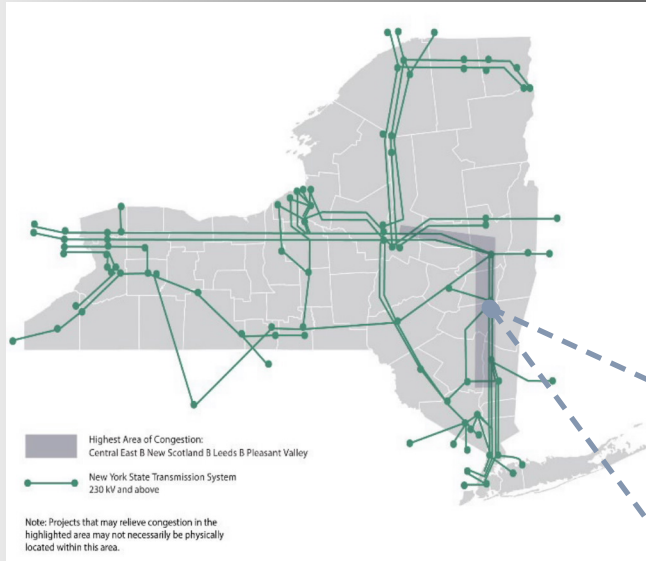
extra capacity unlocked
on the existing network

2.5x

higher NPV than alternate
solutions



Regional Deployment for Renewable Integration



Pilot project installed in 2019, with large-scale project undergoing commissioning in 2024



Central Hudson and Smart Wires have been collaborating over several years, starting with a pilot project in 2019 to gain operational experience with SmartValve, and then a large project to accelerate renewable integration which is undergoing commissioning in 2024:

- Increases capacity on the existing grid to **unlock 185 MW** for faster integration of renewables
- Delivers approx. **\$10M in savings** compared to using the alternative solution (Fixed Series Capacitor), and provides **additional system benefits**
- Deployment design optimized to **use minimal substation space** with limited on-site works required (25% smaller footprint than the alternative FSC solution)
- **Scalable over time** to ensure the full deliverability of several renewable generation and other network projects as the system needs change
- **Supports achieving New York's target 70%** of electricity from renewable sources by 2030



U.S. federal regulatory and funding support for APFC

Order 2023



Grid Deployment Office



Generator and Transmission Study Process

Mandate that utilities consider Alternative Transmission Technologies during the study process

Alternative Transmission Technologies:

- static synchronous compensators (StatCom)
- static VAR compensators (SVC)
- advanced power flow control devices (APFC)
- transmission switching
- synchronous condensers
- voltage source converters
- advanced conductors
- tower lifting

FACT SHEET
GRID RESILIENCE AND INNOVATION PARTNERSHIPS PROGRAM
 Established by the Bipartisan Infrastructure Law, the U.S. Department of Energy's Grid Deployment Office is administering a historic \$1.5 billion investment into the Grid Resilience and Innovation Partnerships (GRID RIPP) program to enhance grid flexibility, improve the resilience of the power system against growing threats of extreme weather and climate change, and ensure American communities have access to affordable, reliable, clean electricity when and where they need it.

ENHANCING THE CLEAN ENERGY TRANSITION BY ENHANCING GRID STABILITY

Algonquin Power Fund America, Inc. plans to deploy SmartValve, an advanced power flow control technology that quickly solves grid issues by unlocking additional transfer capacity on existing transmission lines. The project aims to increase transmission transfer capacity of the existing grid, resolve stability issues, mitigate the risk of climate impacts, and be replicable at other locations with similar stability limitations in the U.S.

PROJECT DETAILS

- **Project:** Enabling the Clean Energy Transition by Enhancing Grid Stability Using SmartValve Technology
- **Applicant/Selector:** Algonquin Power Fund America, Inc.
- **GIP Program:** Smart Grid Grants (Bipartisan Infrastructure Law, Section 40107)
- **Federal cost share:** \$42,905,918
- **Recipient cost share:** \$42,905,918
- **Project Location:** Illinois and Texas
- **Project type:** Grid Capacity and Renewables Integration

HELPFUL LINKS

- Grid Resilience and Innovation Partnerships Program
- About the Grid Deployment Office

Published October 2023. Fact sheet information is based on project applications at the time of publication and should be considered final.



Addressing barriers to inclusion of APFC in planning and operations

- Collaborated with planning software vendors and utilities to co-develop modular SSSC models for **PowerFactory**, **INTEGRAL** and **Organon**
- Developed **user-defined models** for other planning platforms
- Actively working with other vendors to make modular SSSC models **natively available** in additional platforms.

Models readily available on request for:

- PowerFactory
- INTEGRAL
- Organon
- ASPEN
- MATLAB®/Simulink®
- PSCAD™/EMTDC
- PSLF
- PSS®E
- RSCAD/RTDS
- TSAT
- PowerWorld
- NEPLAN

If you would like to request models for any platform, reach out at info@smartwires.com



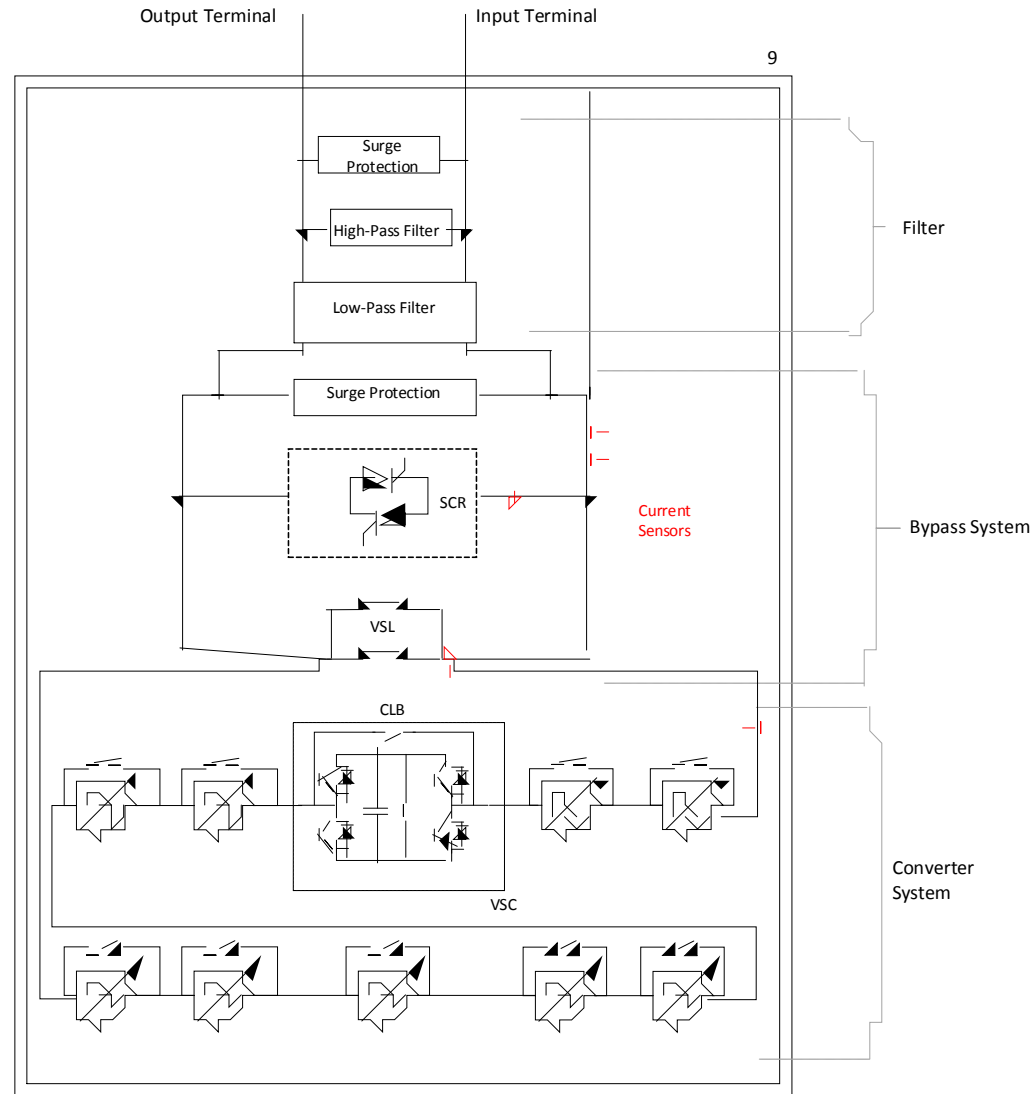


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Appendix



SmartValve single line diagram



SmartValve harvests all power from the line to operate the control and communication circuits and senses line current for control and fault-protection purposes.

Filter Capabilities

- The high-pass filter allows the passage of high frequency transients.
- The low-pass filters allow the power line frequency to enter the SmartValve.

Bypass Capabilities

- The vacuum switch links (VSLs) primarily conduct current during steady-state conditions.
- The silicon-controlled rectifiers (SCRs) primarily conduct current during grid faults (e.g. a fault on the line connected to the SmartValve).

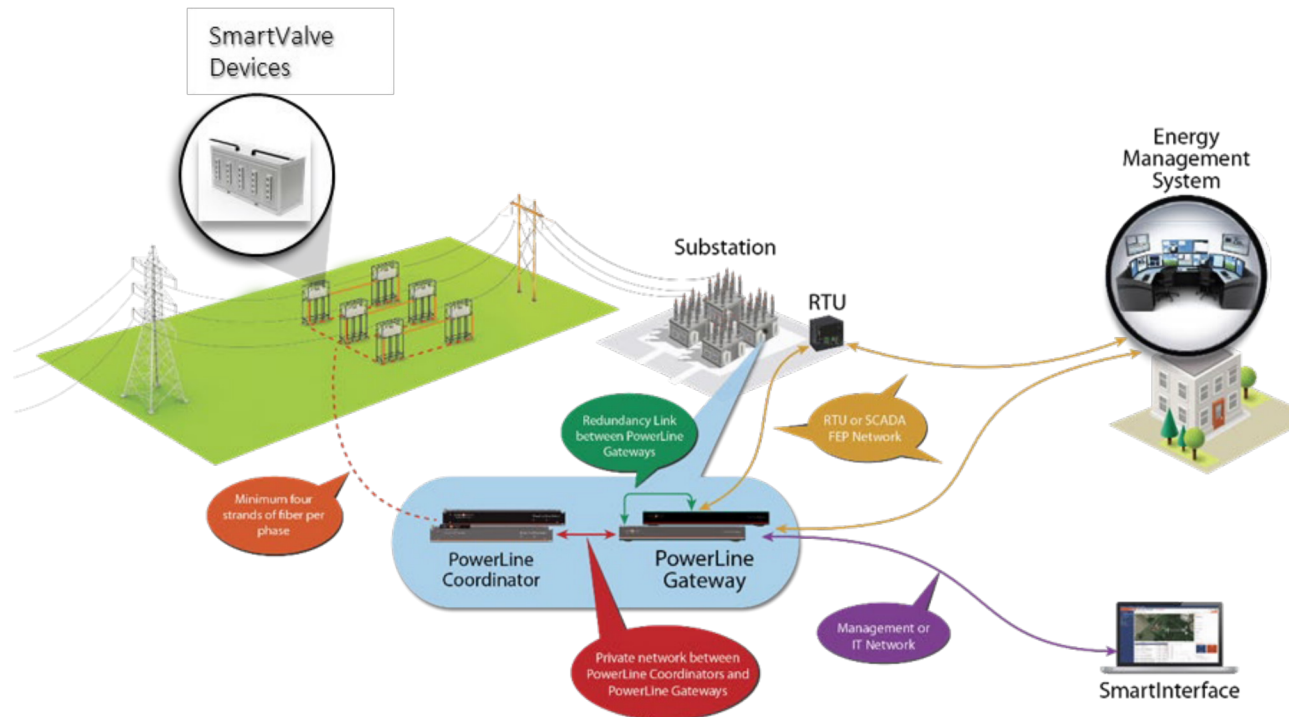
Converter Capabilities

- The core components of each Voltage-Sourced Converter (VSC) are four semiconductor switches and the DC Link capacitor.



End-to-end Communication and Controls System:

A fiber optic link is used to communicate the SmartValve and The Power Line Coordinators.



System Components

- **Smart Wires Field Devices (SWFD)** – SmartValves observe the state of and/or control the power flow the electric power system.
- **Secure Optical Link** – Connection between SWFDs and PowerLine Coordinator. Use Gigabit Ethernet over Multimode Fiber. The fiber optic link supports Smart Wires native command and control protocol, as well as the interphase balancing capabilities.
- **PowerLine Coordinator** – IT/SCADA device in substation or in field. A fiber optic communication device that serves as a communication relay between SWFDs and PowerLine Gateway and manages operation of secure optical link. It communicates with PowerLine Gateway using the Smart Wires Asset Management (SWAM) Protocol.
- **PowerLine Gateway** – IT/SCADA device in substation that serves as an intermediary between SWFDs and the utility EMS. It supports multiple utility communication protocols, including DNP3, IEC 61850, IEC 60870-5-101 and IEC 60870-5-104.
- **SmartInterface** – Windows application used for commissioning, upgrading, monitoring and troubleshooting the solution.
- **Energy Management System (EMS)** – Used by electric utility grid operators to monitor, control, and optimize the performance of the generation, transmission and/or distribution systems.
- **Remote Terminal Unit (RTU)** – Utility provided IT/SCADA device which facilitates communication between EMS and devices in substation.



SmartValve control modes

Flexible and tunable operational regimes



Monitoring

SmartValves are bypassed and can report line current and other telemetry data.



Fixed Reactance

SmartValves are programmed to inject a fixed level of reactance on the line, automatically regulating the injected voltage to account for changes in line current.



Fixed Voltage

SmartValves are injecting and the operator can tell the system what percentage of nominal voltage to inject, up to the system's maximum capacity, on a percentage basis.



Current Control

SmartValves devices can automatically start or stop injecting based on the current flow.

Any of these control modes can be configured with a variety of pre-determined set-points.

