Creating the Dynamic Grid

How controlling the flow of electrons changes nearly everything

December 2014

A Challenging Environment

"Texas wind generation has produced a **transmission system that is underutilized**"
San Antonio Business Journal

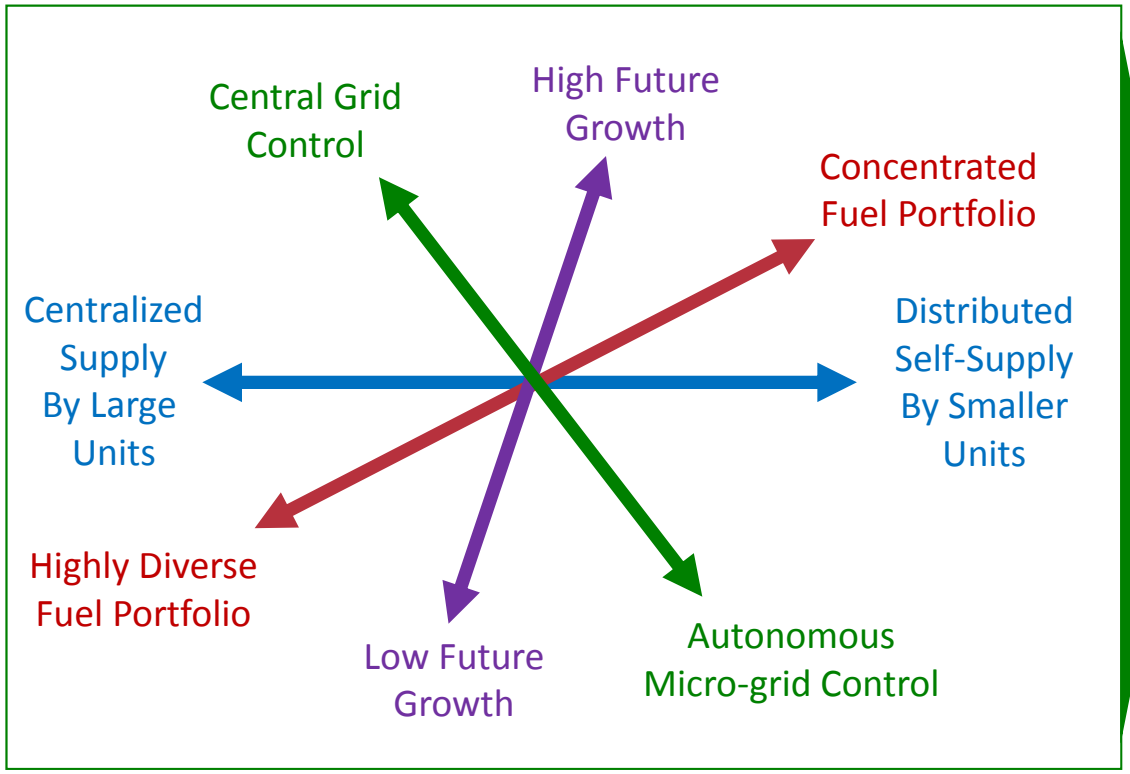
Challenging Environment to Build New Transmission

Triple-digit heat on Monday will strain the electric grid. Photo courtesy SDG&E

Extreme Weather Strains Grid Operations

EPA's Clean Power Plan:
"Texas grid operator says EPA plan raises reliability questions" E&E reporter

Uncertainty: What Lies Ahead?



From Terry Boston's August 2014 CIGRE presentation

What Our Clients Tell Us:

- AEP CEO: EPA carbon rules may cause 'cascading outages' on the grid
  Load flow studies reveal problems with the EPA's 2020 cornerstone assumptions
- The future changes in generation and load are increasingly difficult to forecast, introducing much uncertainty in transmission need
- Unrealistic expectations around restoration of service after extreme weather events
- It is becoming more difficult to manage the stress level of the transmission team

Smart Wire Grid's Solution

A Revolutionary, Low-cost Approach to Power Control that:

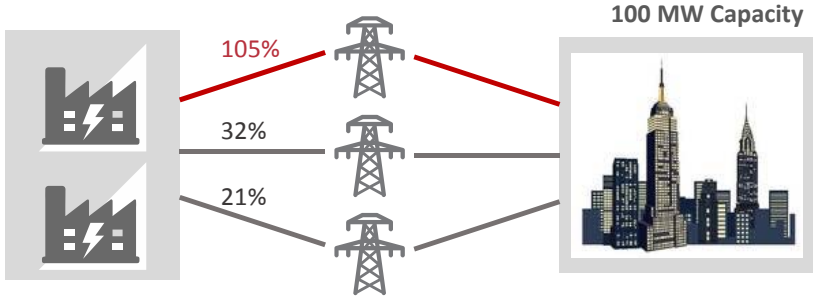
Hardens power grid

Lowers capital needs

Provides system flexibility and a smarter transmission grid

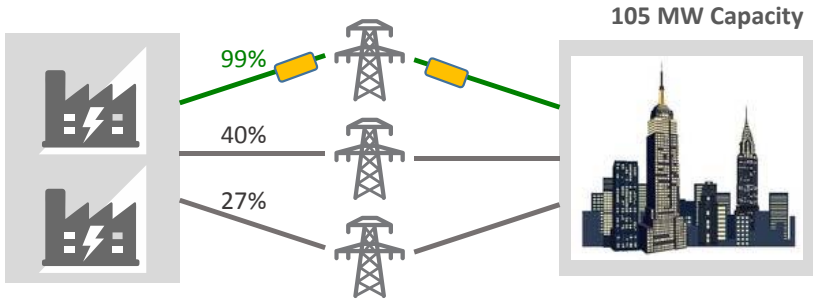
Before SWG

Simplified planning scenario predicts future overload



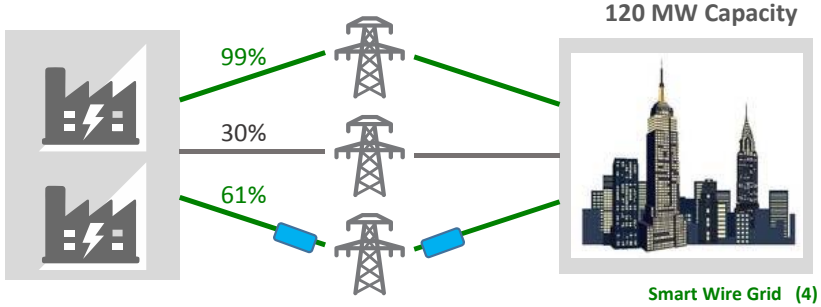
With SWG's PowerLine Guardian

Power is pushed to alternate lines with spare capacity, resolving overload

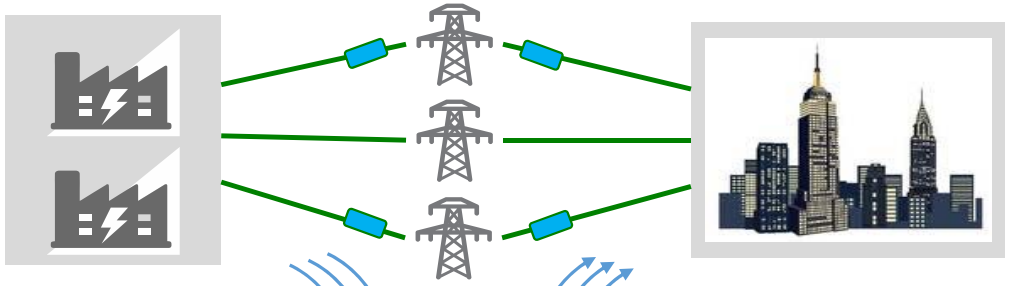


With SWG's Router Technology

Power is pulled onto lines with spare capacity, resolving overload



Creating A Flexible, Resilient Grid: The Power of SWG



Sense

- Conductor Temperature
- Line Current
- Conductor Vibration
- Real time Fault Location
- Conductor Angle

Respond

- Push power
- Pull power

Benefit Areas:

- ☑ Renewable Integration
- ☑ Capital Efficiency
- ☑ Generation Changes
- ☑ Resiliency
- ☑ Compliance / Operational Risk
- ☑ Economic Dispatch
- ☑ Construction Flexibility
- ☑ Loop Flow
- ☑ Image

Plant Retirement Support Case Study

- A customer recently came to us after learning of an imminent closure of a thermal electric power plant.
- With a scarce timeline their options were limited and less than ideal.

Step 1: Replace energy production and meet capacity requirements

1. Import more power
2. Keep open another plant that was scheduled to close
3. Run peaker plant at higher capacity factors (as baseload)
4. Cut exports
5. Increased demand response

Step 2: Enable delivery

1. Add transmission capacity: New line construction & reconductoring
2. Re-rating: Raise the towers, dynamic line rating
3. Open a line (weakens grid but may provide Band-Aid)
4. Radializing network topology (losing a line involves losing load, but in a controlled/constrained area)
5. New or expanded RAS/SPS that will shed load

Preferred solutions Preferred tools

Evaluation of Alternatives

#	Power Replacement Option	Reason / Mitigation	Lead Time	Viable?	W/SWG?
1	Extend the life of Plant R	Requires reconductoring of overloaded 115 kV lines	3 years	🔴	🟢
2	Extend the life of Plant T	Emissions limits	N/A	🔴	🔴
3	Extend the life of Plant Q + import more power from North	Plant Q provides necessary voltage support, requires upgrades, provides expensive power	1 year	🟢	🟢 (SWG not required for viability)
4	Extend the life of Plant S	Legal battles with unwilling owner	Unknown	🔴	🔴
5	Run Peaker M at higher CF + import more power from South	Peaker M provides expensive power. Will require RAS. Increased runtime creates concerns for plant dependability	Immediate	🟢	🟢 (SWG eliminates RAS, reduces peaker dependency)
6	Run Peaker N at higher CF	Emissions limits, requires reconductoring of overloaded 230 kV lines	3 years	🔴	🔴
7	Import more power from East	Requires reconductoring of 230 kV line that has clearance issues (no planned outages possible)	6 years	🔴	🟢
8	Import more power from North	Unlikely to secure power and transmission contracts	3 years	🔴	🔴
9	Import more power from West	Insufficient transfer capability	10 years	🔴	🔴

Viable Alternatives

SWG solves downstream problems, increasing the number of viable solutions

#	Power Replacement Option	Reason / Mitigation	Capital Cost Estimate (w/o SWG)	Capital Cost Estimate (w/SWG)	PVRR Estimate (w/o SWG)	PVRR Estimate (w/SWG)	Additional Value
1	Extend the life of Plant R	Requires reconductoring of overloaded 115 kV lines	N/A	$106 MM		$206MM	• Plant R is in an attractive location and a viable next best alternative when avoiding reconductoring with SWG
3	Extend the life of Plant Q + import more power from North	Plant Q provides necessary voltage support, requires upgrades, provides expensive power	$200 MM	N/A	$350MM	N/A	• Uncertainty surrounding ability to obtain permit for upgrades • May be challenging to secure experienced plant operators
5	Run Peaker M at higher CF + import more power from South	Peaker M provides expensive power. Will require RAS. Increased runtime creates concerns for plant dependability	$5 MM	$11 MM	$350MM	$250MM	• Reliability risk of running the peaker beyond design capacity factor • Political risk associated with increased pollution and emissions violations
7	Import more power from East	Requires reconductoring of 230 kV line that has clearance issues (no planned outages possible)	N/A	$10 MM		$110MM	• Easiest solution to implement • Highest confidence in execution • Fewest additional planning issues to resolve

Smart Wire Grid Partners & Customers

SWG technology was developed by utilities and is quickly gaining credibility in an industry that relies on demonstrated reliability

Customers

"The great aspect of the DSR is that it affords us a fast, flexible and economical solution to rebuilding or reconductoring a transmission line." – Chase Battaglio, PM Southern Company

Partners

- Smart Wire products were incubated at NEETRAC, the **R&D & testing facility for large USA utilities**. Its members serve >60+% of all US load.
- A NEETRAC **utility user group** generated the product requirements.
- **ARPA-E** award winner.

Technology

- Strong core licensed **patent coverage** plus additional 11 proprietary filings.
- Integrated into transmission planning software.
- **ISO-9001** certified manufacturing facility.

Advisory Board

Tom Voss, SWG Chairman
Former CEO, Ameren

Miriam Maes
Chairman B.O.D., ELIA Group

Anjan Bose
Regents Professor, WSU
IEEE Fellow

Daniel Dobbeni
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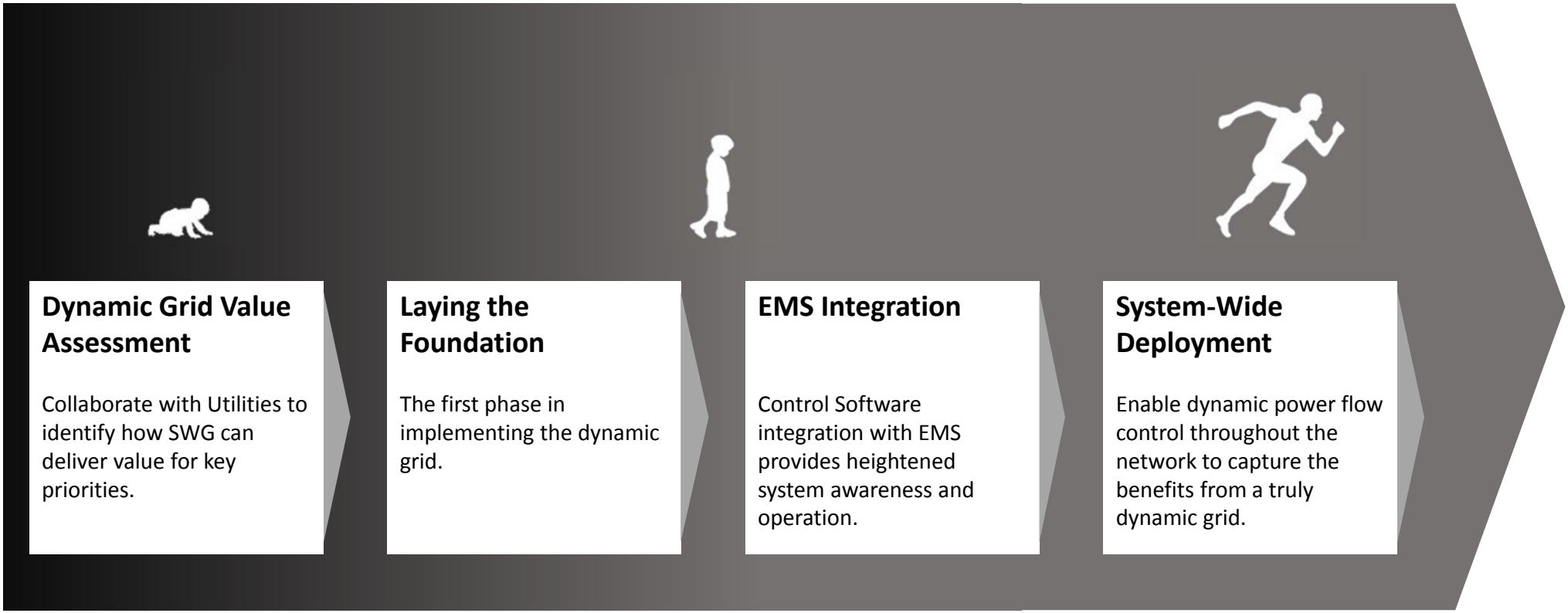
The Path to a Dynamic Grid



Dynamic Grid Value Assessment

Collaborate with Utilities to identify how SWG can deliver value for key priorities.

Laying the Foundation

The first phase in implementing the dynamic grid.

EMS Integration

Control Software integration with EMS provides heightened system awareness and operation.

System-Wide Deployment

Enable dynamic power flow control throughout the network to capture the benefits from a truly dynamic grid.

Additional Information

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