

Autonomous Artificial Intelligence in the Electrical

ABOUT



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Introspective Systems

Applied science company specializing in complex systems and energy management products

Research and Development

Fundamental research funded by 4 US Department of Energy (DOE) projects researching and developing electrical grid architectures and AI powered “Transactive Energy” controls.

DE-SC0015754

DE-SC0018819

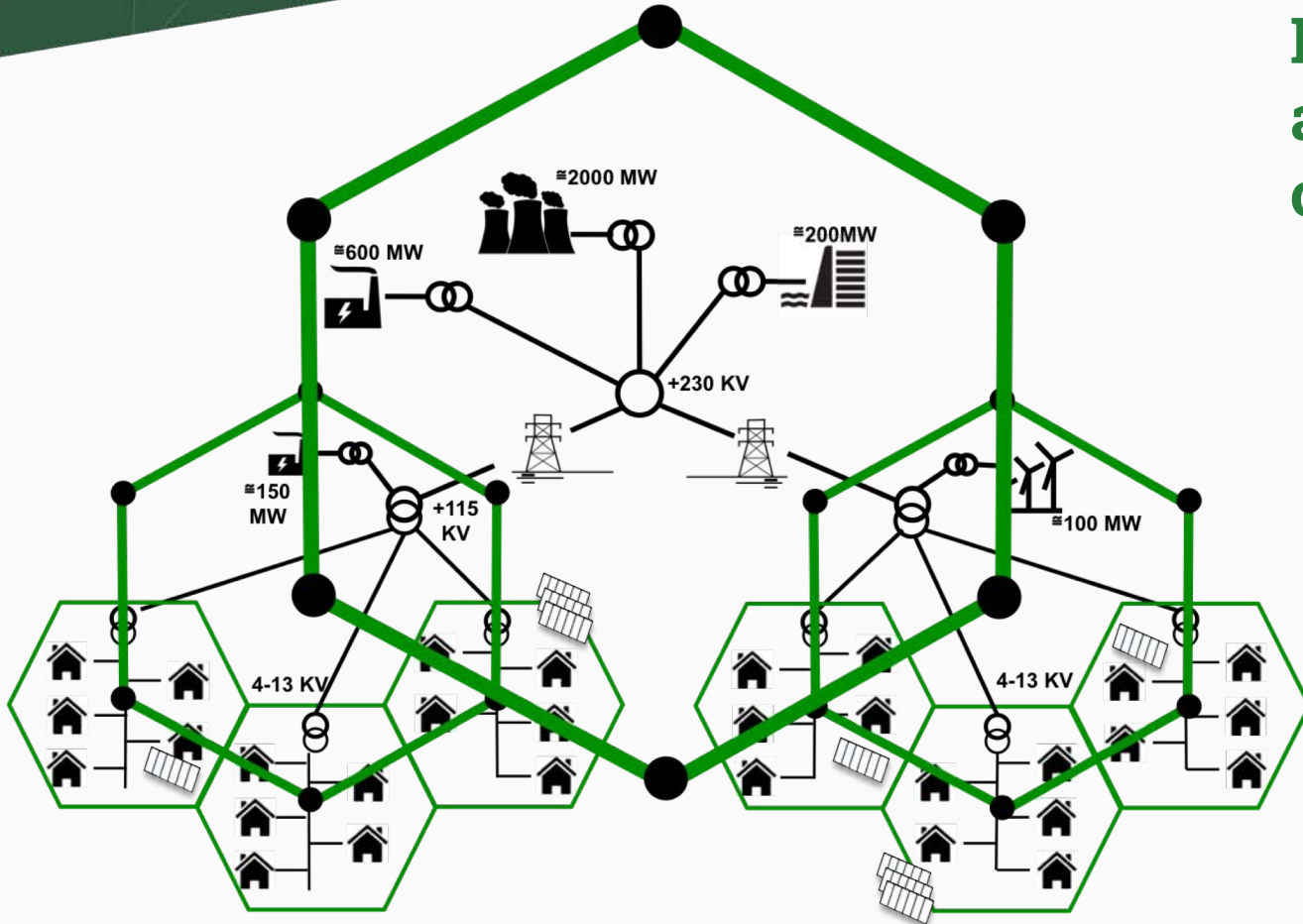
DE-SC0019652

BIRD Energy-9071

IS-Internal Research and Development

FRACTAL OPTIMIZATION

Complexity and the need for Grid Transformation: The explosion of Distributed Energy Resources (DER) and consumer devices are adding to the complexity of managing the grid.



Decentralized

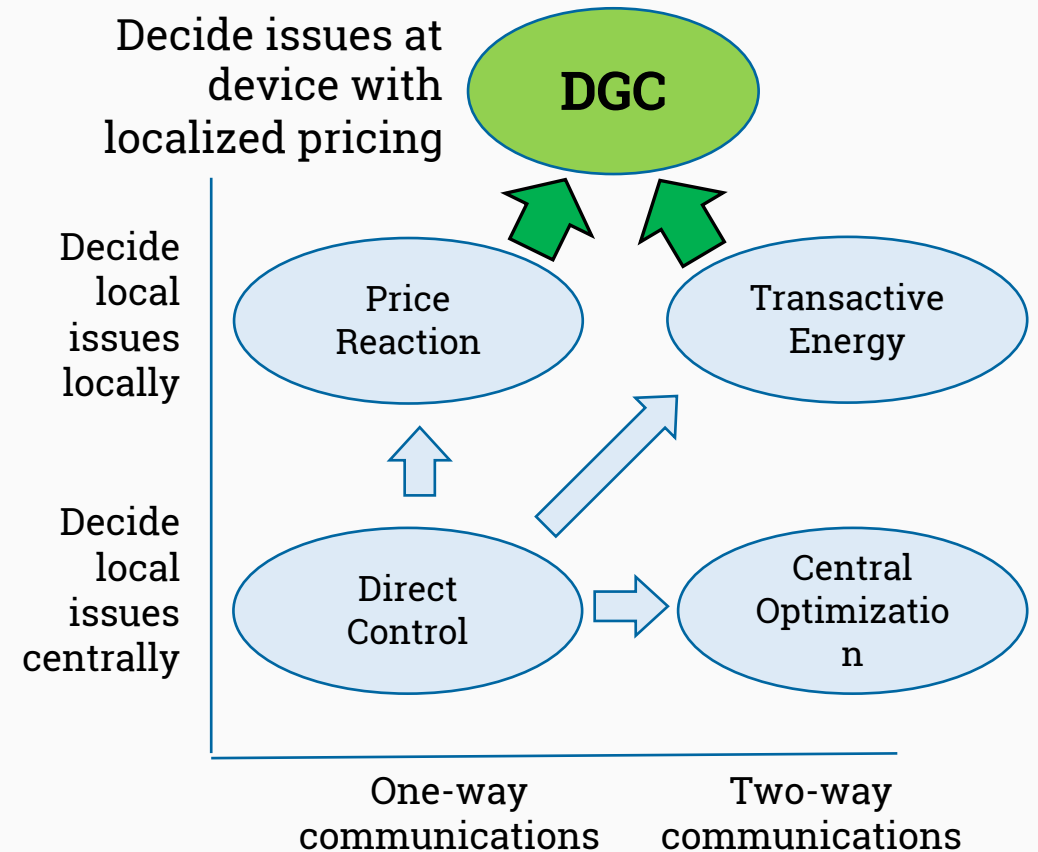
- Biomimetic
- Distributed intelligence
- Adaptive control
- Fractal – sub-optimization

Result

- Self-balancing
- Lowered carbon footprint
- Cyber-secure
- Consumer responsive

- Direct (Top-Down) Control (current method)
- Central Control/Optimization (Some current methods)
- Price Reaction Control
- Transactive Energy (TE) –Two-way (method demonstrated)
- Transactive Energy – One-way market-based
 - Automated devices make decisions at edge
 - Problem sub-optimization
 - Pricing gateways develop real-time localized pricing for display –Downward only (decision making can include power quality)

Dynamic Grid Control

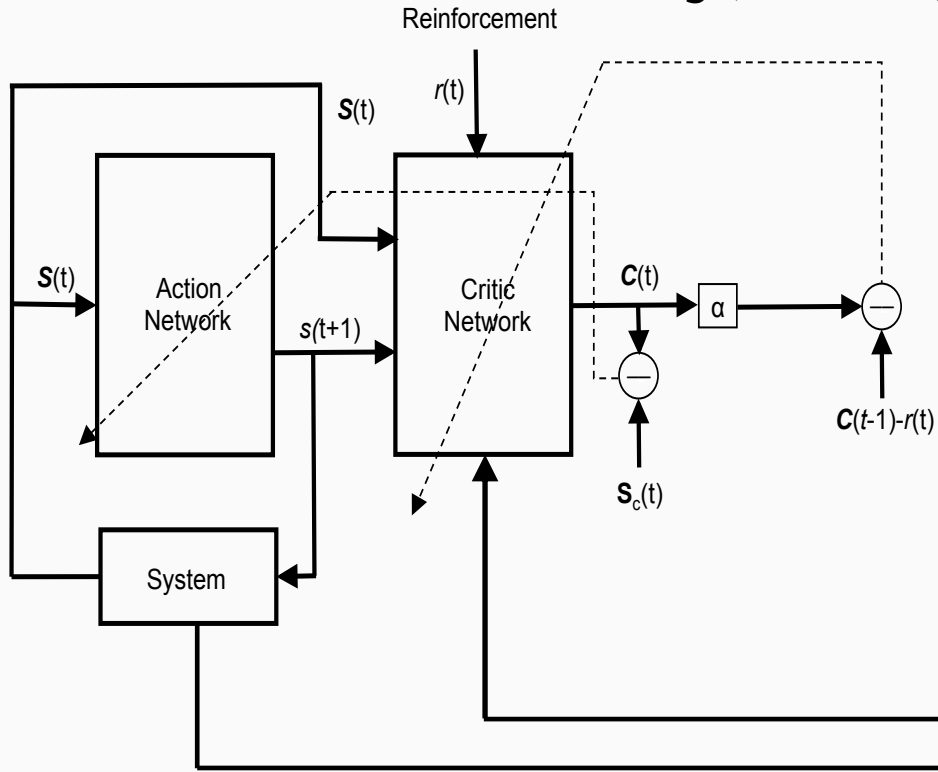


Adapted From: IEEE Power and Energy Magazine
 Volume: 14 Issue 3, A Society of Devices: Integrating Intelligent Distributed Resources with Transactive Energy, Koen Kok and Steve Widergren

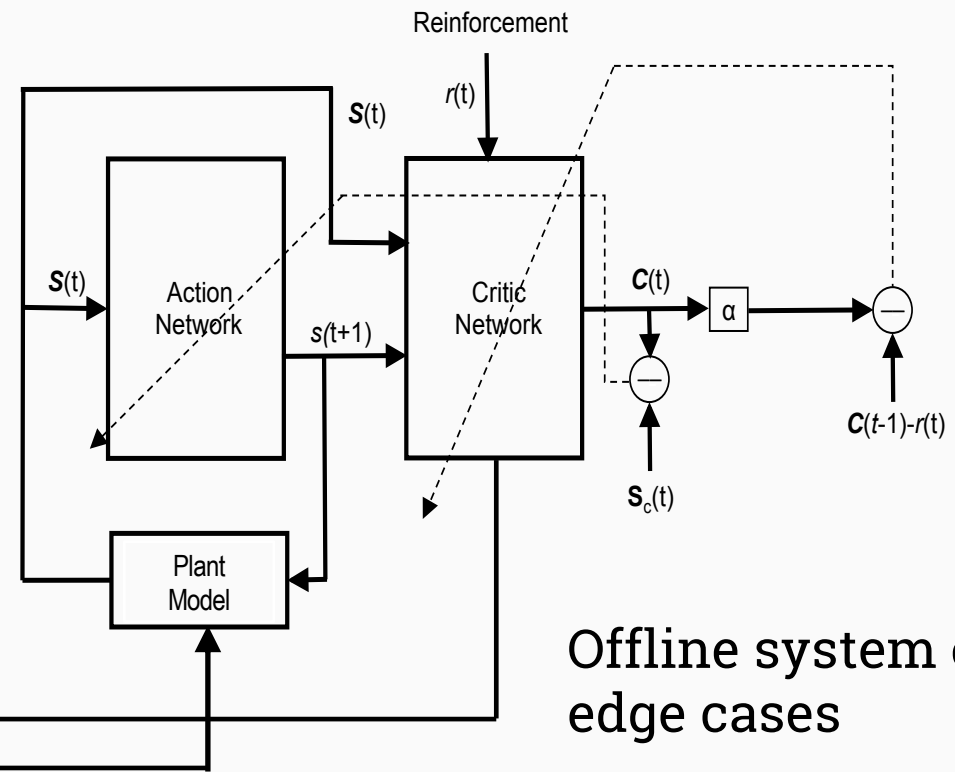
ONLINE/OFFLINE LEARNING

This form of ADP allows for temporal consistency and allows the system to evolve as needed

Online Learning (Real-time)



Offline Learning



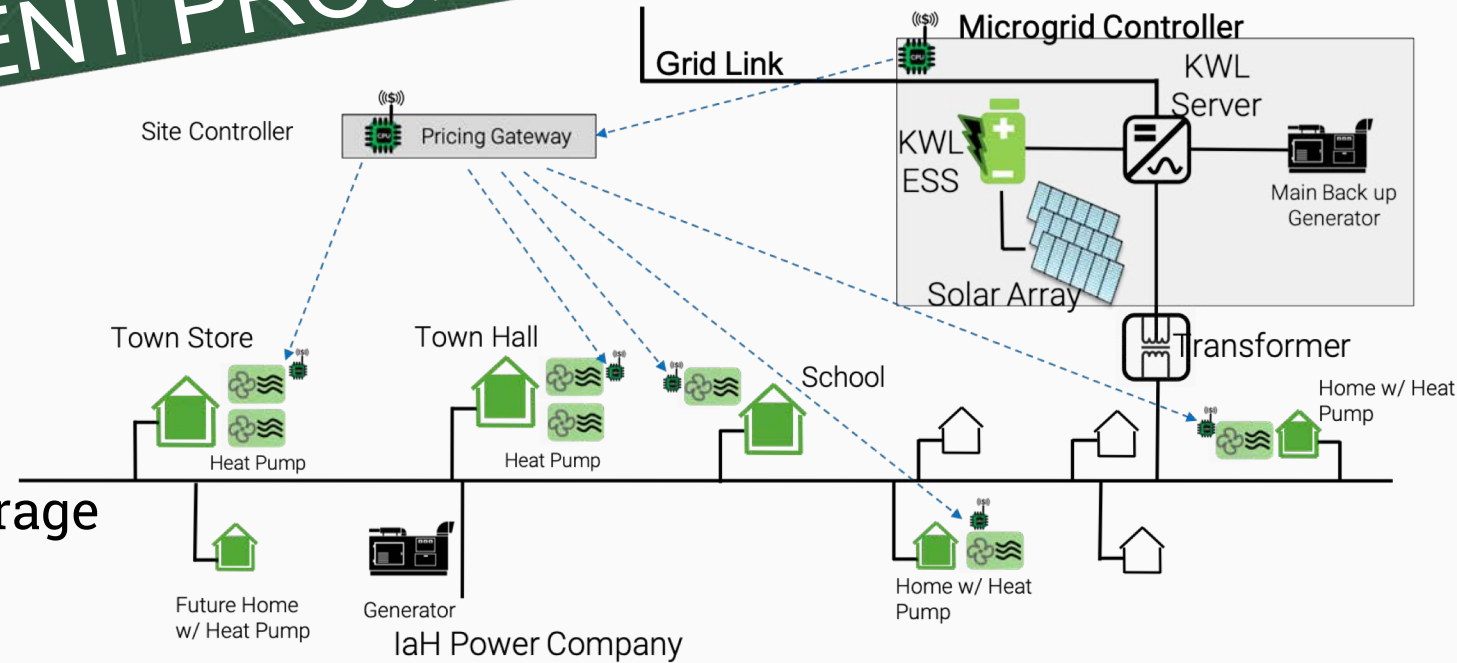
Offline system explores edge cases

This class of algorithms solve the traveling salesman problem

CURRENT PROJECT

Fully Autonomous Utility Microgrid

- Transactive Energy
- 95 kw peak load
- 300 kw Solar and 1MWh Energy Storage
- Three levels of real-time pricing coordinating system balance
- 20 Heat pumps with thermal storage
- 5 to 10 other deferrable loads



		When Power is		Resulting in	
		Consumption	Production	Consumption	Production
Distributed intelligent software gives the system and prosumers the ability to respond to the scarcity and abundance of power	Scarce	↓	↑	↓	↑
	Abundant	↑	↓	↑	↓