Vehicle-to-Home Integration to Improve Grid-Interactivity and Resilience

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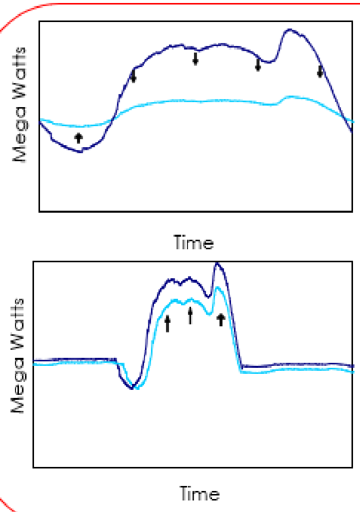
Improve Reliability – Engaging Building Loads/DERs

- The need for adaptable and scalable control solutions is increasing as we are going through **building** and **transportation electrification**.
- There is an immense opportunity for a management system that can **control and coordinate the power use** of these devices

Coordinate Large Number of Building Loads



Reduce Energy Intensity and Increase Energy Efficiency

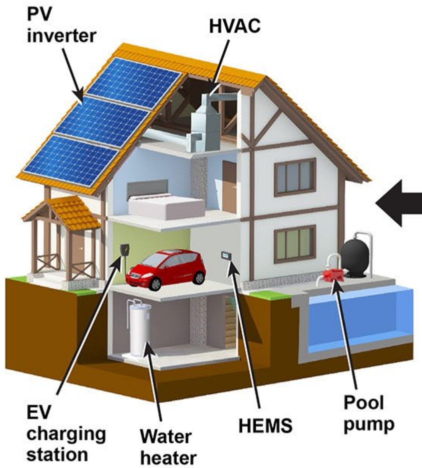
Increase Load Flexibility and Improve Grid Resiliency

Managing to:

KWH

KW

Smart Home + DER



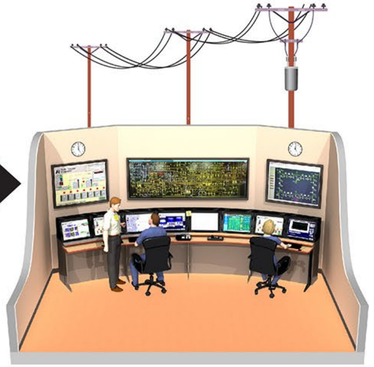
Home Energy Management System Grid Interface

Software controls

Optimized VOLTTRON™ Platform

CTA-2045 device controllers

Utility Demand Management System



Southern Company Smart Neighborhood Initiatives

Understanding tomorrow's home today

Two first-of-a-kind smart home communities at the intersection of energy efficiency, distributed energy resources & buildings-to-grid integration and the traditional utility model

Georgia Power Smart Neighborhood™

- 46 townhomes
- Atlanta, Georgia
- Homeowner owned solar + storage
- Grid integration of solar, storage, HVAC, water heating & EV charging

Alabama Power SMART NEIGHBORHOOD®

- 62 single-family homes
- Birmingham, Alabama
- Utility owned, grid-connected microgrid
  - → 330 kW solar
  - → 680 kWh storage
  - → 400 kW NG generator
- Grid integration of microgrid, water heating & HVAC

Major Research Partners
Electric Power Research Institute and U.S. Department of Energy's Oak Ridge National Laboratory

Key Vendor Partners
LG Chem, Delta, Carrier, ecobee, Rheem, SkyCentrics, Flair, Vivint, Pulte Homes, Signature Homes

Key Results
Homes are 30-40% more efficient
Successful microgrid islanding
New business opportunities deployed

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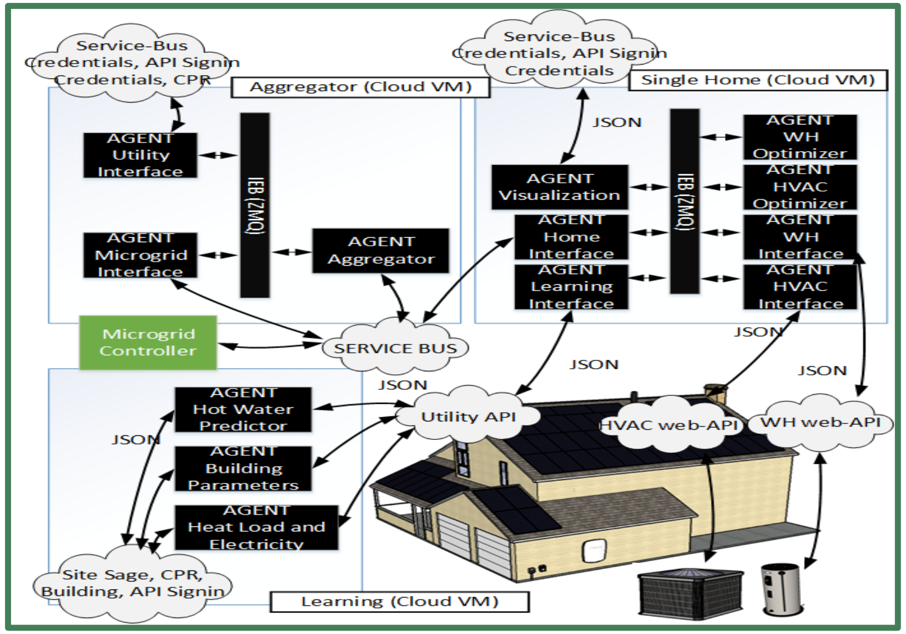
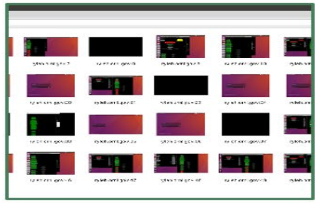
Field Deployment and Validation Approach

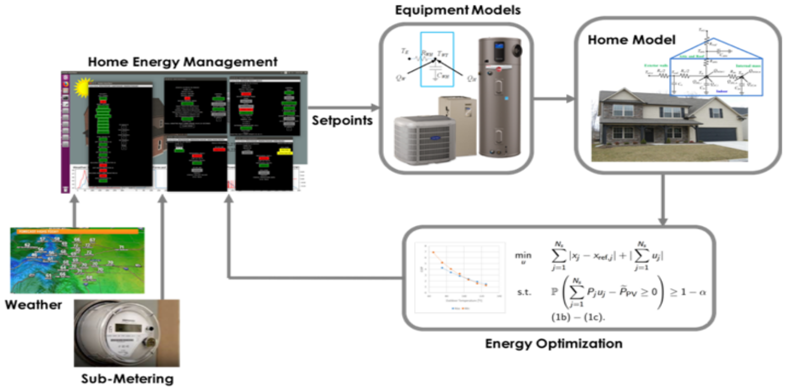


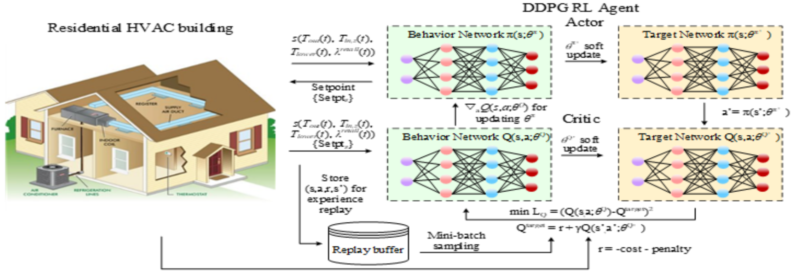
Phased Testing Approach

Laboratory	ORNL Research Home	Field Testing
• Simulation-based Testing • Software as Deployed	• Unoccupied Research Home • Development Testing	• User Acceptance Testing Phase • Community-level deployment

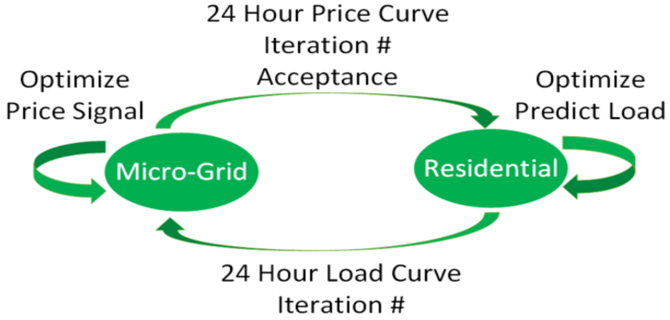


Residential-Level Optimization





Neighborhood-Microgrid Optimization



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Vehicle-to-Home Integration to Improve Grid-Interactivity and Resilience

Percentage of maximum charging capability of the truck (19.2 kW) with respect to the total panel capacity.

Residential Panel Ratings	Charging Percentage of Load (with a safety factor of 20%)
100	80% (100%)
150	53% (67%)
200	40% (50%)
400	20% (25%)

Cost associated to Panel upgrade: (https://www.angi.com/articles/ask-angie-what-does-it-cost-upgrade-200-amps.html)

Panel Amperage	Cost (Panel Only)	Cost (Panel + Install)
100 amps	$100–$200	$800–$1,500
150 amps	$150–$250	$1,300–$1,600
200 amps	$250–$350	$1,300–$2,000
300 amps	$350–$500	$1,800–$3,500
400 amps	$500+	$2,000–$4,000

Use Cases

- Controlling Building loads while charging EV
- Charging EV with Solar and Energy Storage
- EV behaving as an off-grid resource supporting loads (9kW)
- Discharge on-grid from EV
- Coordination of EV, loads, solar, and ES off-grid
- Scale up analysis

Time to charge the F-150 Lightening truck based on different charging rate and battery capacity.

EV Charging Rates	Time to Charge (20 to 90%)	
	98kWh	131kWh
19.2kW	~ 3.5h	~ 4.8h
15 kW	~4.5h	~6.11h
10 kW	~6.8h	~9.17h
5 kW	~ 13.7h	~ 18.3h

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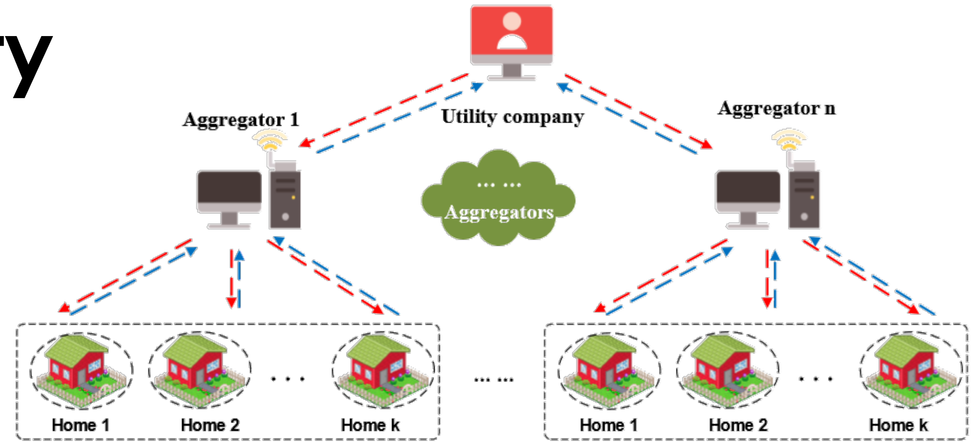
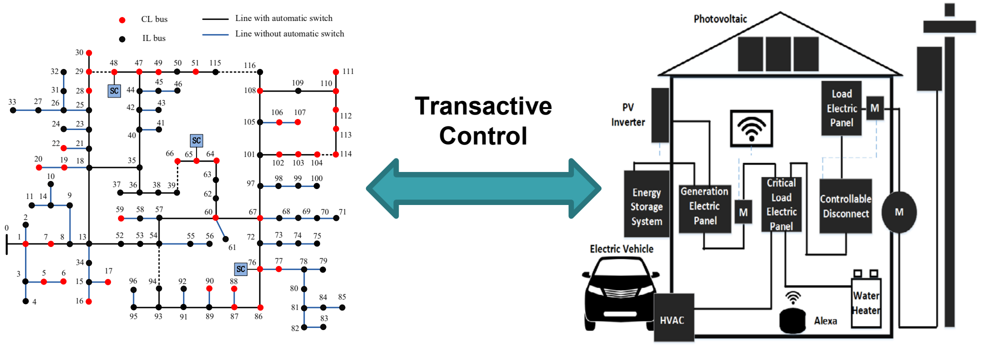
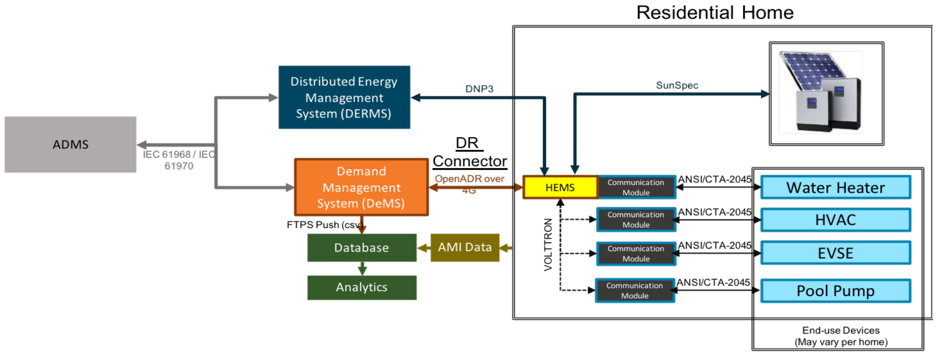
Key Advances to Address Scalability

- **System Integration** – Overlay Architectures
  - Diverse set of requirements in these two domains
  - Integration – System of systems
- **Models -** Online learning-driven models
  - Characterize devices based on available sensor data
  - Forecast energy-use based on disturbances and constraints
- **Controls** - Grid-interactive Building Controls
  - Optimize resources for demand reduction and grid support
  - Coordinated control strategies for a large number of EVs to improve grid-Interactivity and resilience







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Thank you!

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