



MicroMarkets and Transactive Energy —A Phased Approach

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Goals

- Show
 - How to use transactive energy and micromarkets to assemble and subdivide microgrids
 - A phased approach for the processes
 - Resilience to failure
- Illustrate dynamic re-configuration
- Contrast Bottom-up and Top-Down Deployment



Background

- Structured Energy—microgrids form a topology, so differences and unions are also microgrids
- Microgrids deliver the business value of smarter grids and collaborative energy
- Micromarkets balance local supply and demand
- OASIS Energy Interoperation and its TEMIX profile connect with (micro)markets
 - Actors are “pre-integrated”—can work together in markets and for DR/Regulation and provide better managed energy by configuration, not re-coding



Microgrids and Energy

- Microgrids address management of energy use, storage, and production
- Energy transactions must include delivery
 - Direct or indirect—see Structured Energy
- Inflows and outflows from each microgrid for analysis and balance
- Differing levels of detail and abstraction
 - Microgrid containment logical consequence



Up and Down a Hierarchy

- Each microgrid has component parts
- Some components can work together to
 - Regulate, store, manage, consume, and provide energy
 - And may themselves be a microgrid
- Think of a tree that reflects inclusion
 - Subdivide to get a lower level
 - Assemble or join to get a higher level



Example: Microgrid Nesting

- Energy flows among microgrids
- Applying structured energy, if there is at least one microgrid nested in the containing one, there must be at least two
 - Example: Philadelphia Navy Yard with shipyard microgrid contained
 - There is at least the complement of the shipyard which is also a microgrid, and may be more
 - Switching and separation with micromarkets to manage supply and demand




How to Subdivide Microgrids

- Given a specific microgrid...
 - Consider the electrical connectivity and locality
 - Consider distribution choke points
 - Consider commonality of participant business goals
 - Ensure communication connectivity
 - Group sets of components together into sub-microgrids, trying to associate consumption with generation/supply and aligning boundaries where possible
 - Establish a market context and a micromarket for actors within each sub-microgrid




Participation and Observations

- One hierarchy for regulation, one for energy, ...
 - So levels won't necessarily be the same
- Subdivisions and assemblies don't need to match
 - Microgrid models, technologies will differ
 - Only integration technology needs to be the same




Example: Navy Base

- Within a Navy facility peers include
 - A ship
 - A house
 - An appliance
- The ship is a microgrid
- The house might be a microgrid
- All three participate via peer agents




Issues with Subdivision

- Boundaries may not be natural
 - Shift as needed
- Energy flows may not be roughly in balance
 - Set different boundaries
- Sufficient micromarket liquidity is important
- Business, ownership, and connectivity boundaries should guide subdivision




How to Assemble Microgrids

- Given a set of microgrids...
 - Group the microgrids with (relatively) balancing inflows and outflows
 - Balance supply and demand with a micromarket scoped to the union
 - Establish a single market context for actors within the assembled microgrid




Duality of Assembly and Subdivision

- The processes are dual, not inverses—the structure may differ
 - An assembled microgrid can be subdivided at the same or different boundaries
 - A subdivided microgrid can be assembled in the same or different ways




Phasing of Operations

- Incremental assembly for a set of microgrids
 - Combine in any order
 - Business and technical considerations apply
 - Consider net energy flows across the set
 - Consider electrical connectivity
 - Focus on commonalities of technology or purpose
 - BACnet on Floor 1 and 2...
 - Coffee pot and toaster on Floor 2 may share a common purpose with Floor 2 and not Floor 1
 - Toaster may not share an agent with Floor 2 BACnet
 - Floor 2 presents as a single, opaque microgrid




Phasing of Operations (2)

- Advantages to incremental change
 - Validate and check each step
 - Easier to try alternate assemblies
- Similar for incremental subdivision
 - Except for liquidity constraints on subdivided markets



Reconfiguration

- Reconfiguration can be
 - Structured—change the tree of microgrids
 - Dynamic—change while operating
 - Resilient—reconfigure in response to failures
- Configuration is easier than recoding
- Market is self-configuring after started
- Consistent environment allows rapid and dynamic reconfiguration as needed
 - For failure resilience and for assembly/subdivision



Needed Technology

- An interoperation approach that supports many markets
 - Flexible participation in multiple markets
 - Flexible change in market participation
 - Regulation capabilities are priced as options
 - Also need timely response and reports
- Service Oriented Architecture
 - Best practices in enterprise quality software
- Adaptable to any end node management system



Energy Interoperation


- Energy Interoperation/OpenADR2/TEMIX
 - Supports regulation, DR and DER
 - Supports markets
- Allow multiple market participation and configuration change
- Conclusion: use Energy Interoperation to provide pre-integration and transactive energy and DR/DER/regulation/projection

Bonus: Energy Interoperation at each actor allows rapid and resilient reconfiguration



An Illustration (2)





Summary

- Use of Energy Interoperation enables
 - Service-Oriented interactions
 - Use of cross-cutting smart grid standards
 - Less specialized programming for services
 - Full transactive energy support at any level
 - Full Regulation, DR, and DER support at any level
 - Clean assembly and subdivision using micromarkets
 - Rapid and resilient configuration & reconfiguration

All within an interoperable standards framework
Using best practices in interoperation



Questions

