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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

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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

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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

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Up and Down a Hierarchy

- Each microgrid has component parts
- Some components can work together to
  - Regulate, store, manage, consume, and provide energy
  - And are themselves a microgrid
- Subdivide to get a lower level
- Assemble or join to get a higher level

Example 1: Microgrid Nesting

- Energy flows among microgrids at the same level
- 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
  - Switching and separation with micromarkets to manage supply and demand

How to Subdivide Microgrids

- Given a specific microgrid…
  - Consider the electrical connectivity
  - Consider commonality of 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

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 required
- Business and ownership 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
  - 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
- Consistent environment allows rapid and dynamic reconfiguration as needed
  - For failure resilience and for assembly/subdivision

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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

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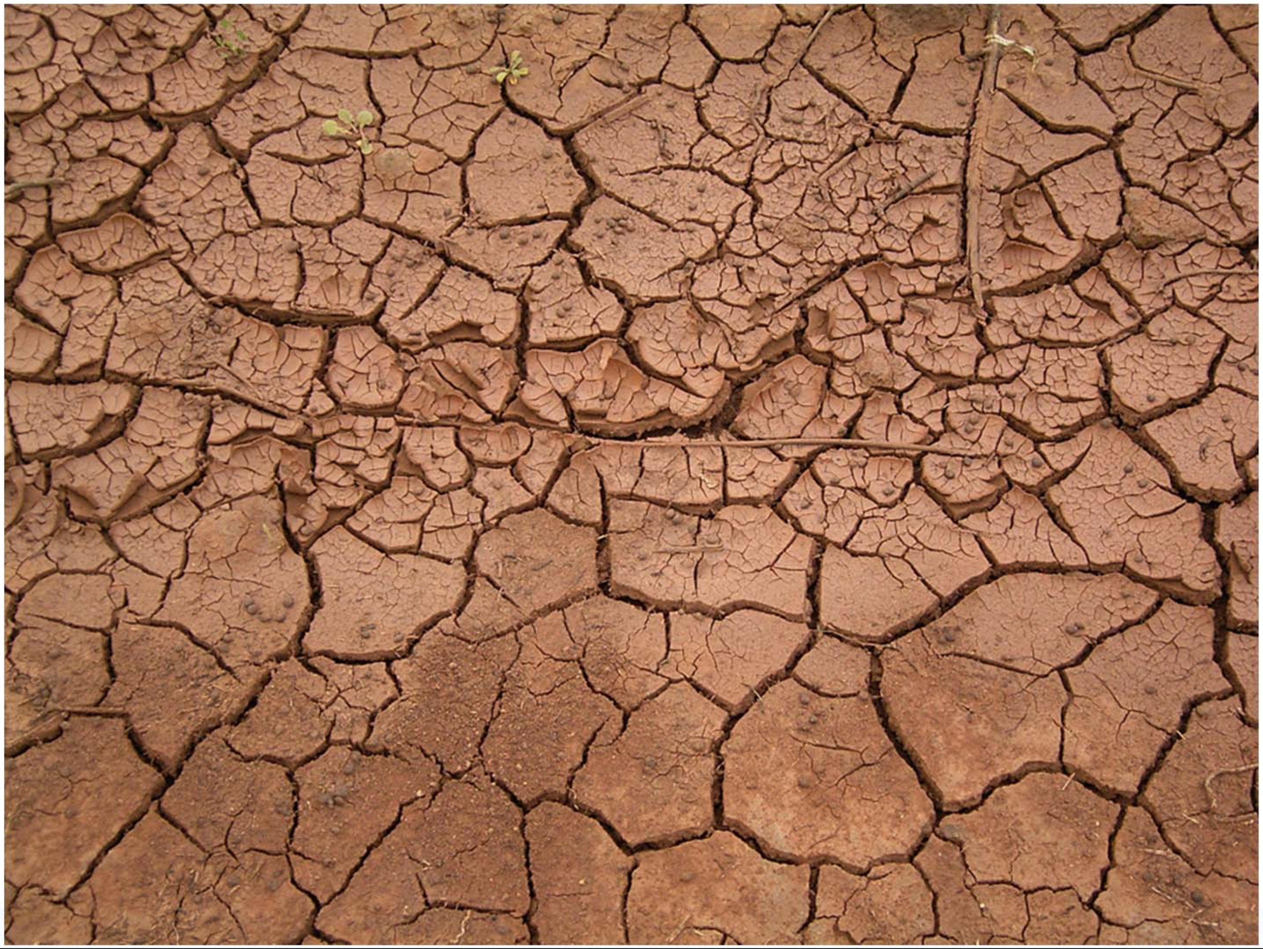
An Illustration (2)



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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

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Questions