TeMix Transactive Energy and Interoperable Transactive Retail Tariffs

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Transactive Energy (TE) Definition

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- A set of economic and control mechanisms that allows the dynamic balance of supply and demand across the entire electrical infrastructure using value as a key operational parameter.

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- Transactive Energy engages customers and suppliers as participants in decentralized markets for energy transactions that strive towards the three goals of economic efficiency, reliability, and environmental enhancement.

Architecture

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- Centralized, distributed, or a combination of the two

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- Decentralized

There is a difference between distributed control and decentralized control:

- Distributed control is breaking up a centralized control problem in to sub problems, solving each problem separately, and then usually iteratively coordinating the solutions of the sub problems to solve the original centralized control problem.
- Decentralized control starts with a very large set of control problems owned by independent parties that embody all system physics and reliability and policy constraints. Parties engage in mutually beneficial transactions using a variety of peer-to-peer, bilateral, exchange and other matching and clearing mechanisms.

Transaction

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A transaction is simply a negotiated exchange of things. This applies in transactive energy also where it is a communicative activity involving two or more parties that reciprocally affect or influence each other through a formal mechanism in order to reach an agreement. These agreements must not be one time agreements but must be subject to continuous review, and multiple agreements that may take place as frequently as sub-second timing. Rules need to be specified for every transactive system such that interdependent operations on the system are either all completed successfully or all canceled successfully. In other words the transaction is the central mechanism by which transactive energy systems achieve their objectives; by linking multiple individual operations into a single, indivisible transaction, which optimizes the objectives and ensures that all operations in the transaction are completed without error.

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- A transaction is an binding exchange of a quantity of an energy product for currency.
- Two Basic Products
  - Energy delivered at an Interface over an interval of time
  - Transport that moves Energy from one Interface to another over an interval of time
  - Call options on the two products act like capacity and ancillary service products;
  - Environmental certificates products are transacted where not internalized in the Energy product.

Transacting Parties

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Fundamentally, transactive energy involves transacting parties. In most cases these will be automated systems, possibly acting as surrogates for human parties. In some cases humans may be in the loop. A transactive energy mechanism must be explicitly describable by the entities that are parties to transactions. Because a transactive energy system will provide services to various parties, its success in delivering these services will depend in part on the expectations and needs of each group and in part on the qualities of the delivered service. Understanding such criteria is a critical aspect of the monitoring and assessment of an Ultra-Large-Scale system[8].

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- end users owning energy use devices, storage and generation (incl. DER);
- central generation and storage owners
- distribution and transmission grid operators
- Intermediaries – retailers, marketers, exchanges, etc.

Extent

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An implementation of transactive energy <u>technology</u> will typically apply within some geographic, organizational, political, or other measure of extent. A geographic extent, for example, might be within a region and apply across <u>multiple participating entities</u>. An extent may be described organizationally, for example, if an implementation is intended for use within a single utility, building, or campus. Likewise, a transactive <u>technique</u> may apply across political boundaries with different regulatory or policy constraints. Extent may also be considered relative to the topology of an electrical infrastructure including end users. Thus, a transactive technique may apply in transmission, distribution, or both; it may also be useful for managing energy within buildings or by end-users of electrical energy.

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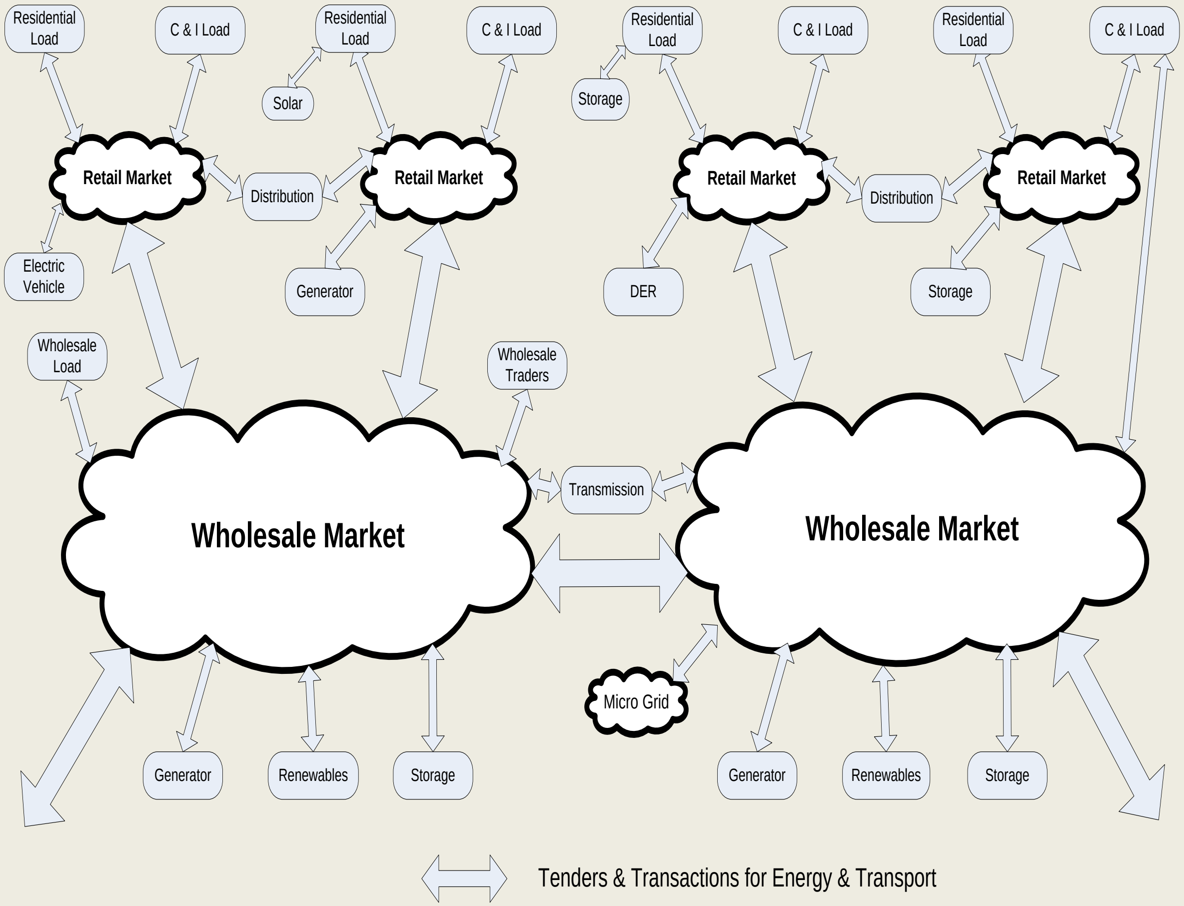

~~Value Discovery Mechanism~~

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A value discovery mechanism is a means of establishing the economic or engineering value (such as profit or performance) that is associated with a transaction. The value discovery mechanism is a key element of value-driven multi-objective optimization. Value realization may take place through a variety of approaches including an organized market, procurement, tariff, an over-the-counter bilateral contract, or a customer's or other entity's self-optimization analysis. Value discovery mechanisms should include considerations of economic incentive compatibility and acceptable behavior.

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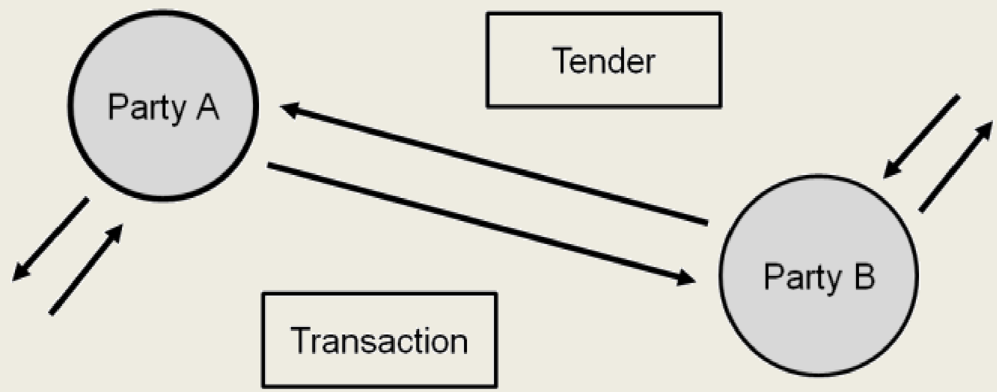
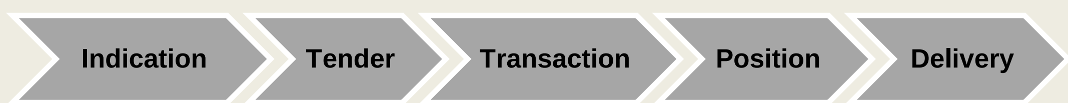
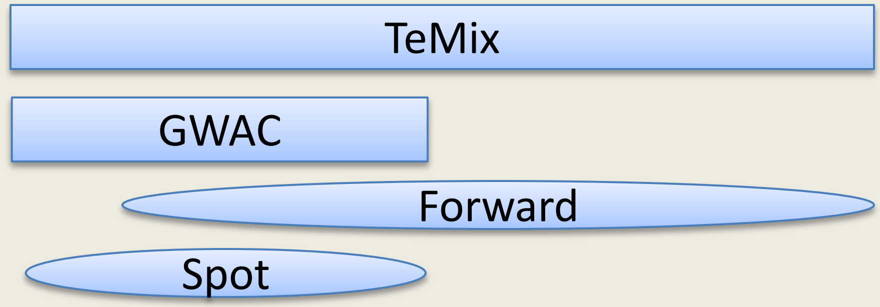
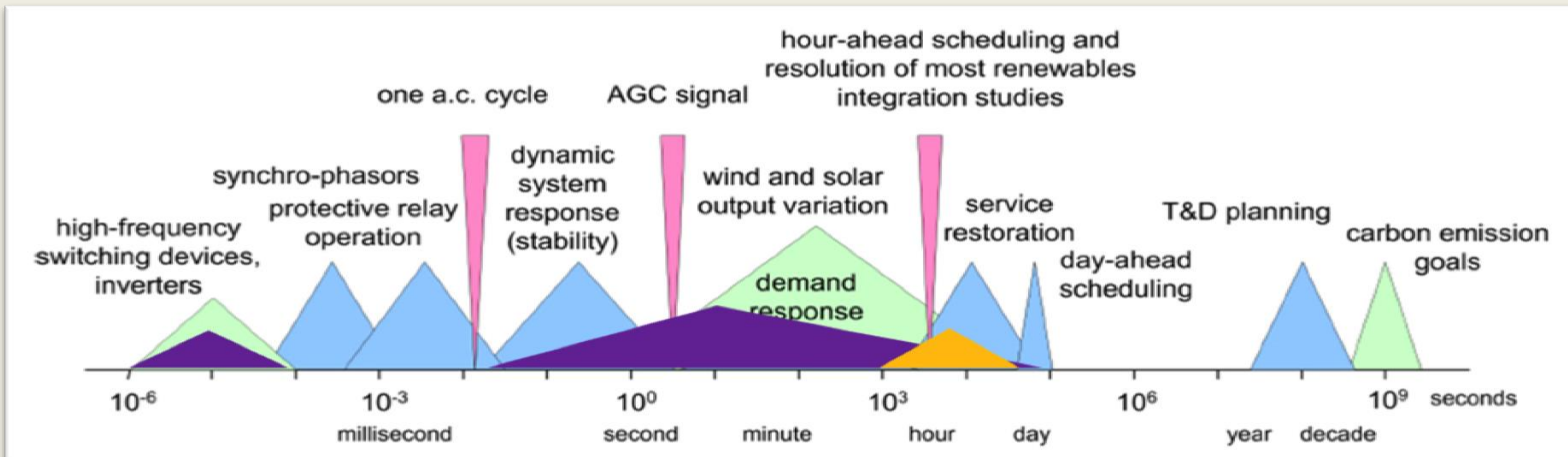




Temporal Variability





TeMix : Asynchronous tender and transaction creation by tender acceptance
Nested, standard intervals such as year, month, day, hour, 15-min, 5 min, 1 min, 4-sec

~~Value Assignment~~

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- Assignment of value is fundamental to value discovery. For sub-elements of a transactive energy mechanism, a means may be needed for assigning value to those objectives that cannot be addressed through a discovery mechanism or for values that do not have a common dimension that can be used for valuation.

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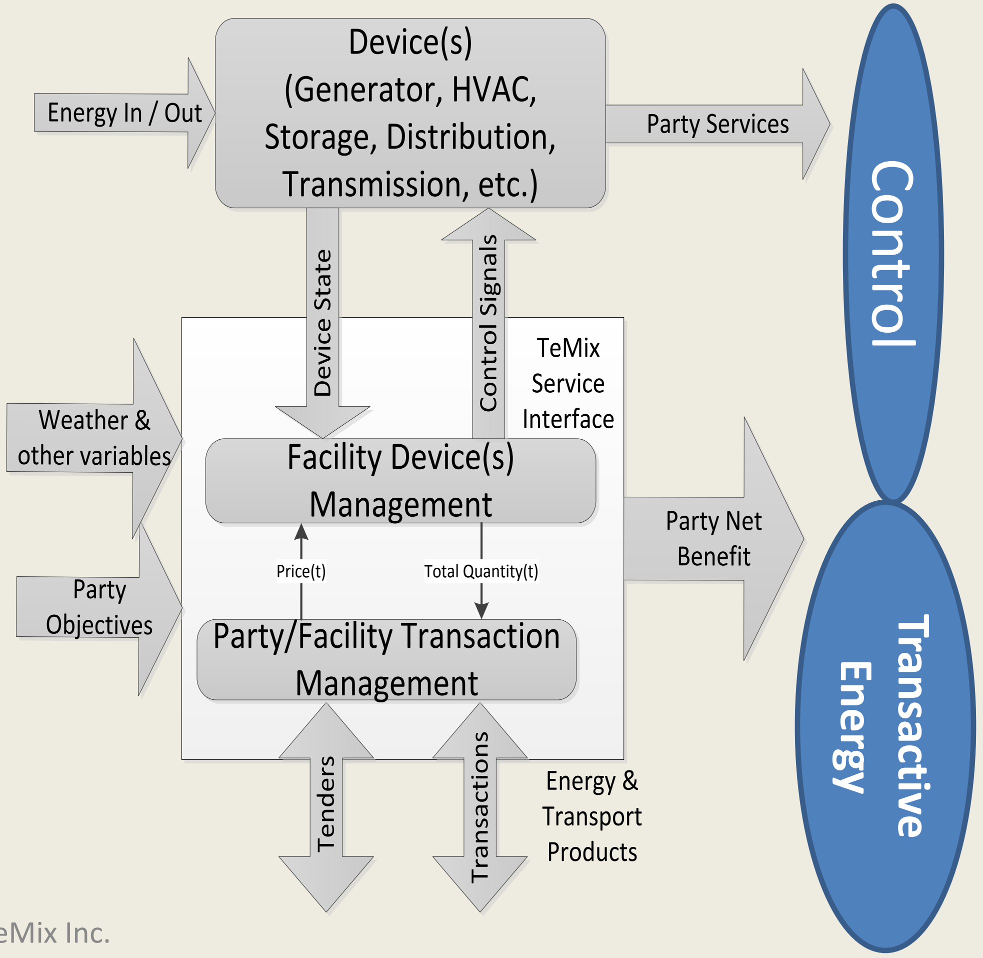

~~Alignment of Objectives~~

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A key principle in transactive energy is the continuous alignment of multiple objectives to achieve optimum results as the system operates. This alignment enhances the economic and engineering impacts of the dynamic balance(s) achieved by transactive energy. Note that optimal relates to balancing the entire transactive system, and to achieving an optimum balance necessary to optimize objectives, variables, and constraints. It is important to understand that optimization does not simply add intelligence to existing business processes. It changes business practices.

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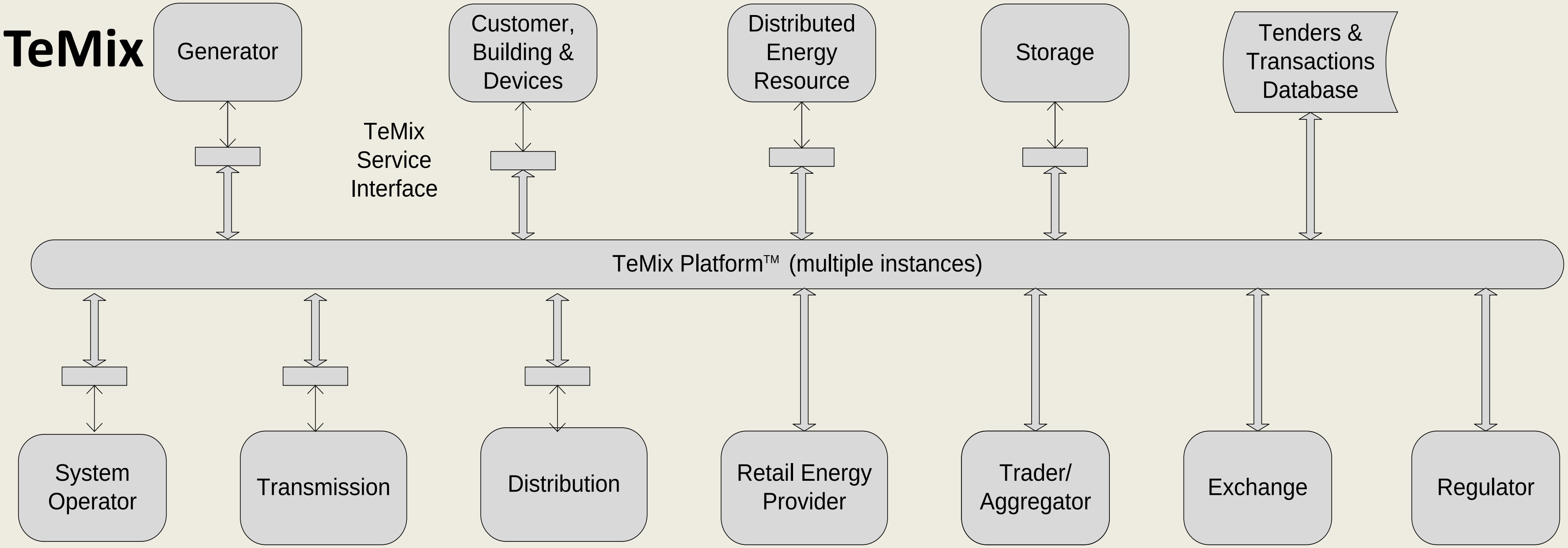

Interoperability

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- Transactions are enabled through the exchange of information between transacting parties. There are two elements to consider here: technical interoperability and cognitive (semantic) interoperability. The systems must be able to connect and exchange information (emphasizing format and syntax), and they have to understand the exchanges in the context that was intended in order to support workflows and constraints. For any given transaction the information exchanged during a transaction must be explicitly identified. Furthermore, one should be able to explain how interoperability has been addressed in support of the information exchanges.

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- Apply OASIS TE Standards
  - OASIS Energy Market Information Exchange (EMIX) for TE Information Model
  - OASIS Energy Interoperation for TE Messaging
  - Standards were developed openly under SGIP PAP oversight; free and open to all; in SGIP Catalog of Standards
  - Examples:
    - CreateTender(P, Q, Side, Interval, Interface, Expiration)
    - GetTender
    - CreateTransaction (Tender, Q)
    - GetTransaction

Stability Assurance

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The stability of grid control and economic mechanisms is required and must be assured. Considerations of control system stability must be included in the formulation of transactive energy techniques and should be demonstrable. Unfortunately, there are no public benchmarks for the control system stability and during numerical optimization minor errors can build on each other, and sometimes spiral out of control. It is important to mitigate optimization instabilities because grid stability may be compromised by poor value optimization techniques. In addition to the need to assure stability from a control systems point of view, stability should also be assured with respect to existing grid stability limits.

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- Primary frequency regulation is a connection requirement
- Transactions between parties are within conservative grid operating constraints and stability margins.
- Transaction stability enhanced by forward transactions, position limits, tender size limits, and near-continuous clearing with operator and regulatory market oversight.

Interoperable Transactive Retail Tariffs

B2G/I2G Joint DEWG of SGIP 2.0

Disruptive challenges threaten the utility business & regulatory model

Utilities are calling for increases in fixed charges in current tariffs – this could accelerate customer self-supply and departures

Interoperable Transactive Retail Tariff Proposal: TE commercial subscriptions at fixed monthly payments plus spot transactions

Example Transactive Retail Tariff

- Subscription:
  - Retailer tenders to each customer a one-year or more subscription for customer’s typical usage by hour
  - Customer accepts subscription or stays on current tariff
- Spot:
  - Customer is *paid* at hourly (or 15-min) spot price for metered usage *below* subscribed KWh and *pays* same price for usage *above* subscribed KWh
  - Customers may receive indicative (non-binding) forward prices to help them save money

Active Use of a Transactive Tariff

- Customer frequently receives forward BUY and SELL hourly tenders for the next 24 hours
- Customer energy management system uses the forward prices of these tenders to
  - automatically reschedule cooling, heating, pumping, storage and PEV charging and discharging and DER dispatch
  - accept buy or sell tenders to create transactions that modify forward subscribed KWh

What is a Transactive Retail Tariff?

- Applies TeMix to the critical retail interface
- Two products: energy & distribution transport
- Tenders and Transactions
  - Forward subscription and spot
  - buy and sell
- Interoperable with
  - all customers, distributed generation, & storage
  - all IOU, public, competitive, & microgrid retailers
  - all distribution service providers
- See " B2G/I2G White Paper on Transactive Retail Tariffs"

Why a Transactive Retail Tariff?

- To support
  - many different customer needs
  - customer automation, self-generation, storage and PV two way flows
- To recover increasing fixed costs
- To manage cost shifting from self-generation
- To reduce the proliferation of special tariffs
- To support efficient investment and operation

Benefits of Transactive Retail Tariffs

- Customer saves money
- Stable customer bills
- Stable retailer and distribution provider revenues
- Forward tenders and transactions with variable prices coordinate decentralized investment & control of all types of usage, generation, storage and distribution service
- Interoperable among IOU, public, and competitive jurisdictions

Proposal for an SGIP 2.0 PAP on “Interoperable Transactive Retail Tariffs

- Engage a broad scope of stakeholders
- Build on existing OASIS / SGIP PAP 9 and PAP 3 TE and other standards
- Identify technical, business and regulatory gaps and any standards needs
- Interface with other efforts
- Facilitate pilot Interoperable Transactive Retail Tariffs