



TeMIX:

Transactive Energy Market Information Exchange



A Standard Protocol for Transactive Energy in a Smart Grid World

Transactive Energy Workshop

GridWise Architectural Council

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TeMIX Inc.

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- ✓ Expert in electric power markets and decision analysis – consultant to many power industry organizations
- ✓ Founder, CEO, TeMIX Inc. (China) and TeMIX Inc. (US) – Transactive energy services provider
- ✓ Co-Chair, OASIS Energy Market Information Exchange Technical Committee
- ✓ Founder, Vice President, MegaWatt Storage Farms, Inc. – Grid-scale storage project developer
- ✓ Vice-Chair, Board of Governors, California Independent System Operator – California's electric market and grid operator
- ✓ Founder, CEO - Automated Power Exchange, Inc. – wholesale electric power transaction services
- ✓ Board member - US-China Green Energy Council
- ✓ Stanford PhD, Engineering-Economics, U of Washington BS, MS Engineering

OASIS



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TeMIX Inc.

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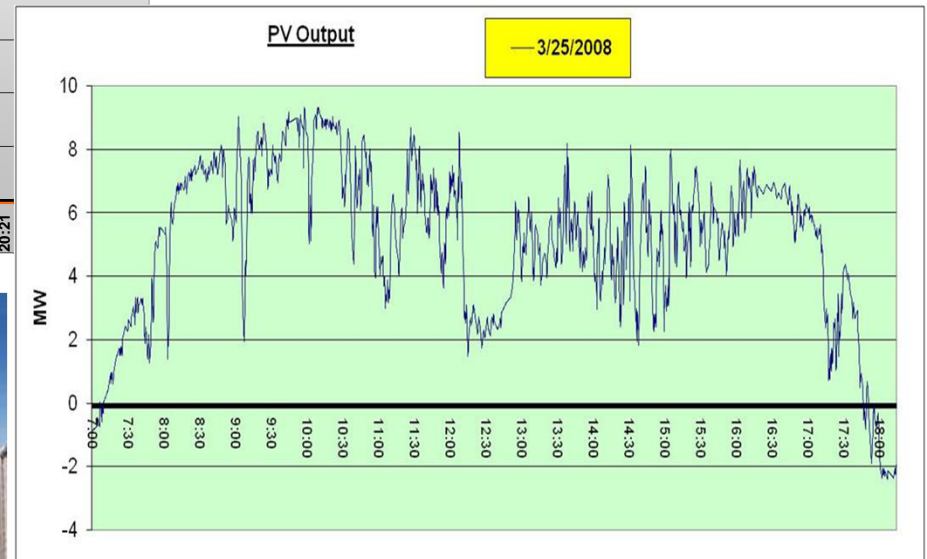
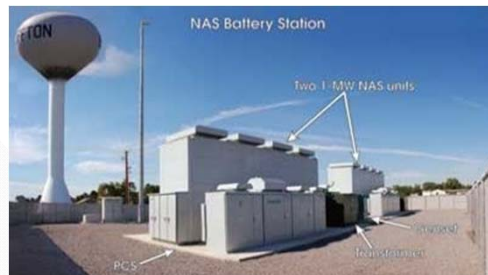
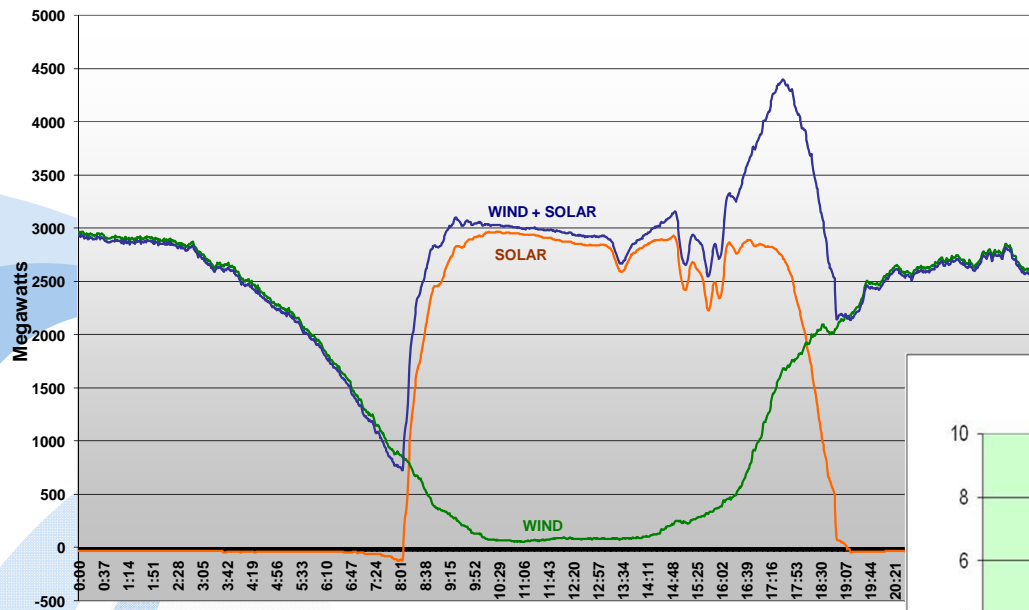


MegaWatt
Storage Farms, Inc.

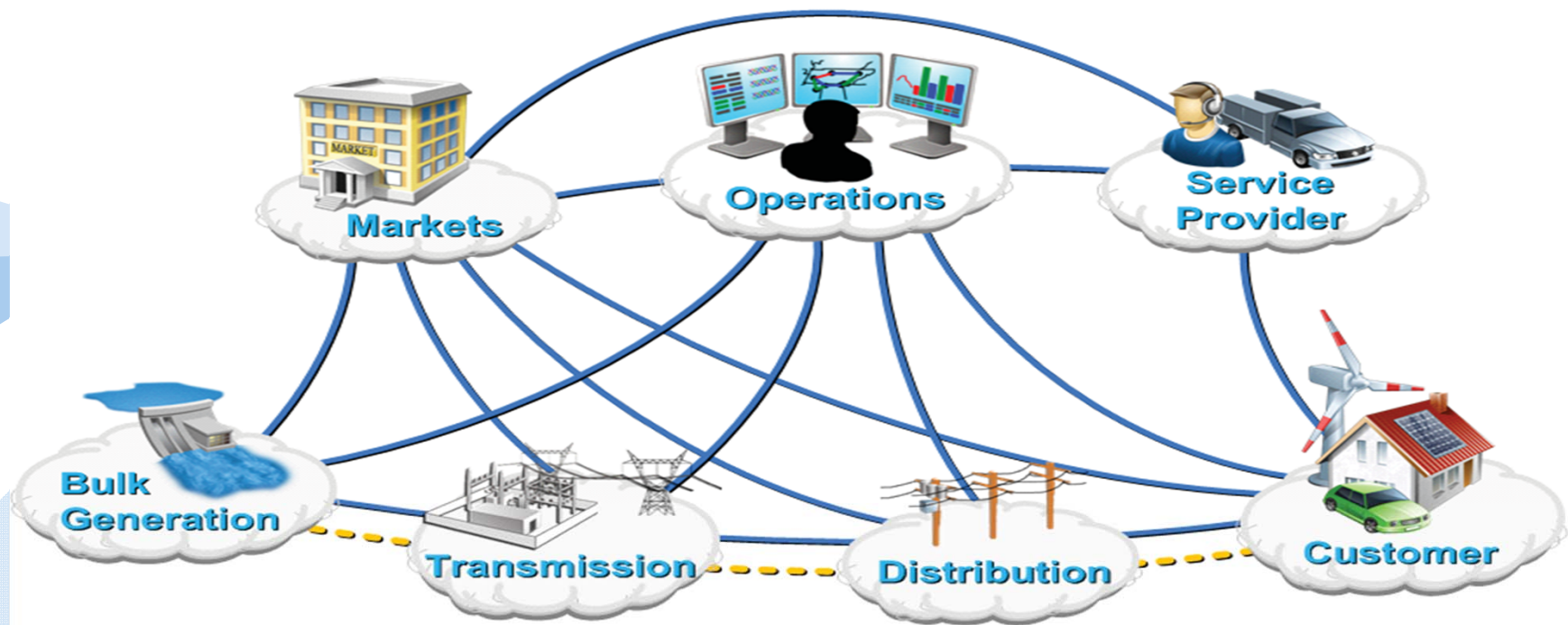


Variable Renewables, Electric Vehicles and Storage need Variable Pricing and Frequent Transactions

2013 - Wind + Solar
4000 MW Solar and 6000 MW WIND Nameplate Capacity



Smart Grid Interoperation



Tenders, Transactions &
Command Options



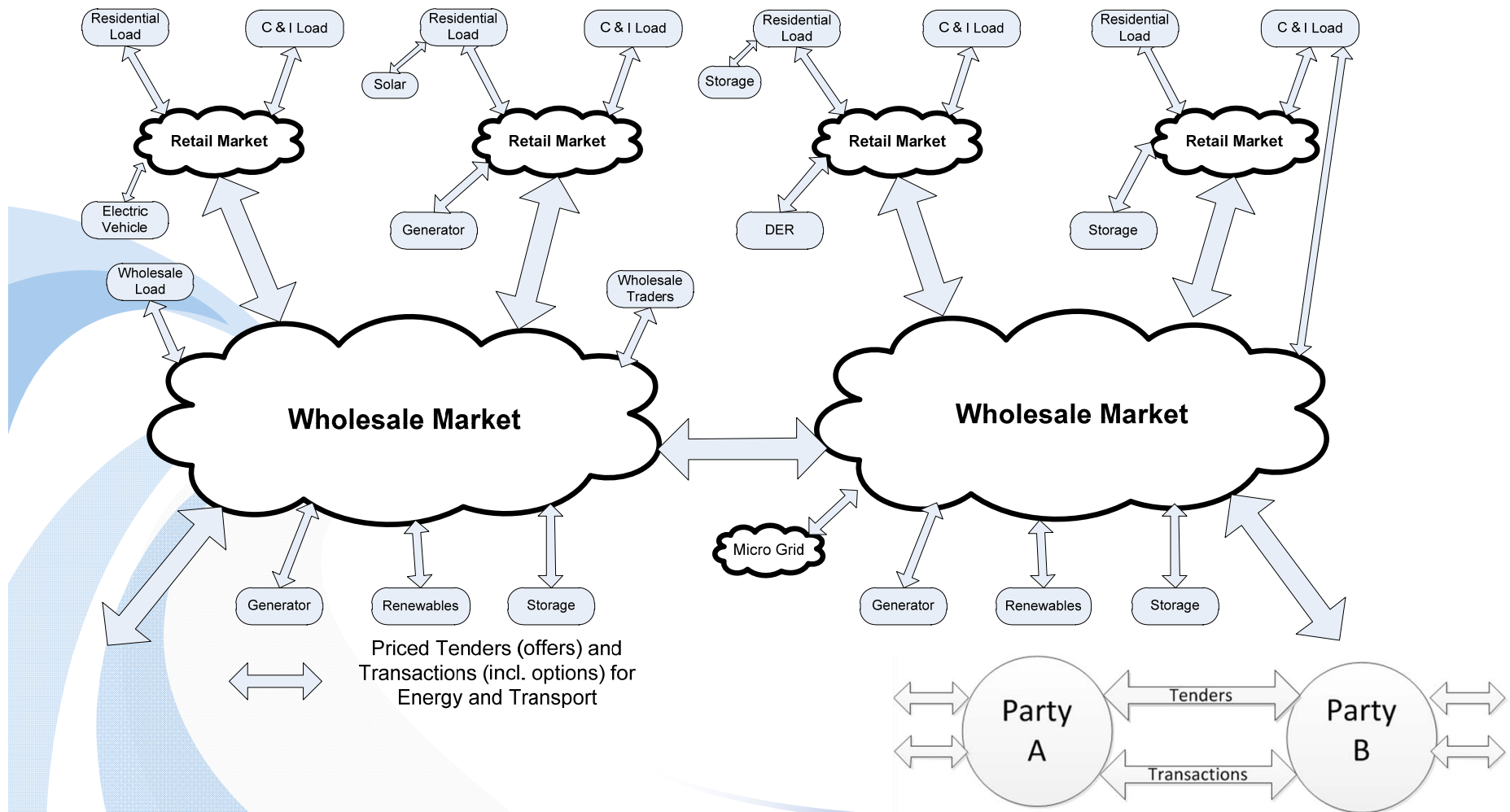
Electricity Flows

Customer



TeMIX Markets and Tariffs

“vision : any party can buy from or sell to any other party”
(subject to regulatory limits)



TeMIX Protocol

- ✓ Internet protocol (TCP/IP)

- ✓ standard, high volume, high speed, data transfers

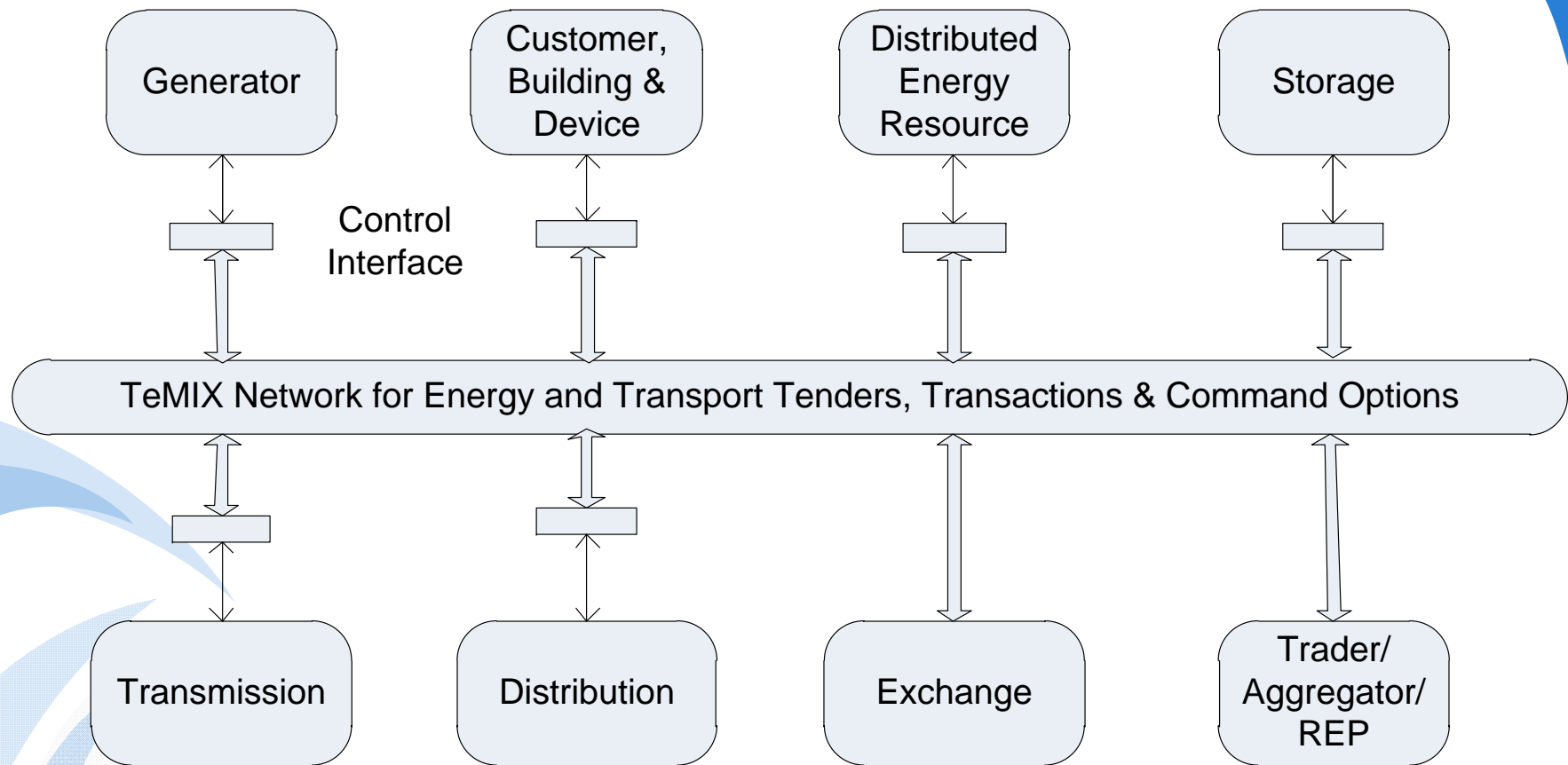
- ✓ FIX protocol

- ✓ standard, high volume, high speed, financial transactions

- ✓ TeMIX protocol (US standard)

- ✓ standard, high volume, high speed, electricity transactions

TeMIX.net



all parties interact using the same two-way messages
communicating
priced tenders (offers), transactions & options
for “Energy” and “Transport” products

Retail “Tariff” Alternatives

- ✓ Flat or TOU Full-Requirements Prices + Demand Response (DR)
- ✓ Tiered Full-Requirements Prices + DR
- ✓ Dynamic Real-Time Full-Requirements Prices
- ✓ TeMIX Subscriptions and Balancing
 - ✓ Subscription : Simple forward block of power at a known forward price.
 - ✓ Balancing : Metered difference credited or debited at variable price.

TeMIX Automated Subscriptions

- ✓ Customer (automatically) subscribes to blocks of power at tendered, forward prices in a plan chosen by and tailored to each customer.
- ✓ Customers automatically receive additional fixed, forward price, buy and sell subscription tenders as conditions change.
- ✓ Smart devices automatically shift usage to save money for customers
- ✓ Any metered balance + or – is charged at a variable price.
- ✓ Price cap options for blocks of power also available.

“While aggregators have a useful transitional role, in the long run, the smart grid must facilitate transactions with residential and commercial customers at low cost.”

“A Buyer’s Market” , Constantine Gonatas, Public Utilities Fortnightly, May 11, 2011.

TeMIX Background

- TeMIX is a standards-based information model & protocol for electricity transactions including
 - Forward & real-time transactions
 - Wholesale and retail transactions
 - Transport (transmission and distribution) transactions
- TeMIX is based on and informs three OASIS Technical Committees developing standards under the direction of NIST
 - Energy Interoperation (PAP 09) – TeMIX is a profile – so is OPNADR
 - Energy Market Information Exchange (PAP 03)
 - WS-Calendar (PAP 04)
- TeMIX consumes many web services, security and transport standards and other grid standards such as SEP 1.0, 2.0, CIM etc.

TeMIX Related Links

✓ TeMIX White Paper

<http://www.oasis-open.org/committees/download.php/37954/TeMIX-20100523.pdf>

- ✓ An official white paper of the EMIX Technical Committee

✓ Energy Interop Committee Draft 01

<http://www.oasis-open.org/committees/download.php/40427/energyinterop-1-0-spec-cd-01.pdf> (watch for cd-02)

- ✓ Drawing on TeMIX terminology, Energy Interop integrates TeMIX tenders and transactions with retail tariffs, OpenADR, and ISO/RTO demand response.

✓ Energy Market Information Exchange (eMIX) Technical Committee Draft 02 (in 15-day Public Review)

<http://docs.oasis-open.org/emix/emix/v1.0/csprd02/emix-v1.0-csprd02.pdf>

- ✓ Drawing on TeMIX terminology, EMIX provides the price and product information models consumed by Energy Interop.

✓ WS-Calendar Committee Draft 02 (completed 15-day Public Review)

<http://docs.oasis-open.org/ws-calendar/ws-calendar-spec/v1.0/csprd02/ws-calendar-spec-v1.0-csprd02.pdf>

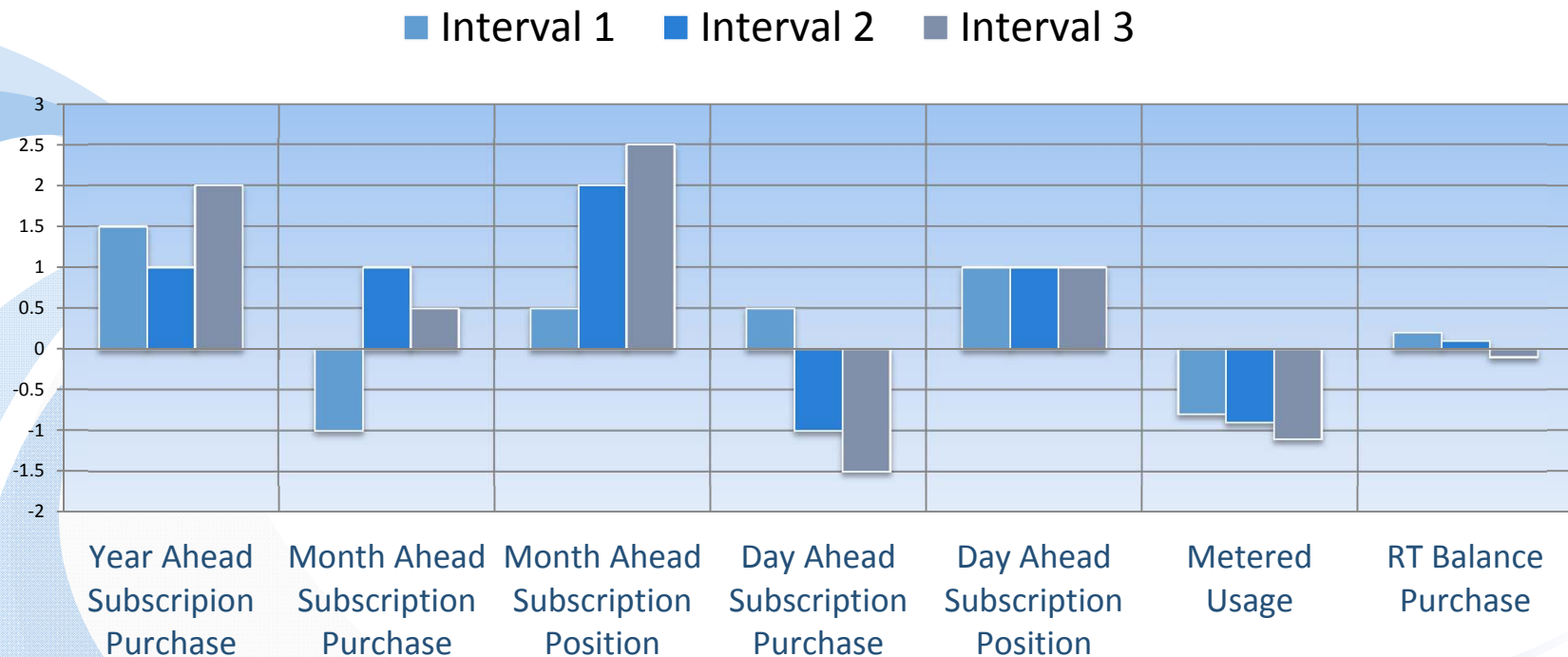
- ✓ Drawing on iCalendar (the standard we use for calendaring) , WS-Calendar provides interoperable sequences of time intervals to support communication of EMIX and Energy Interop information.

TeMIX Payload

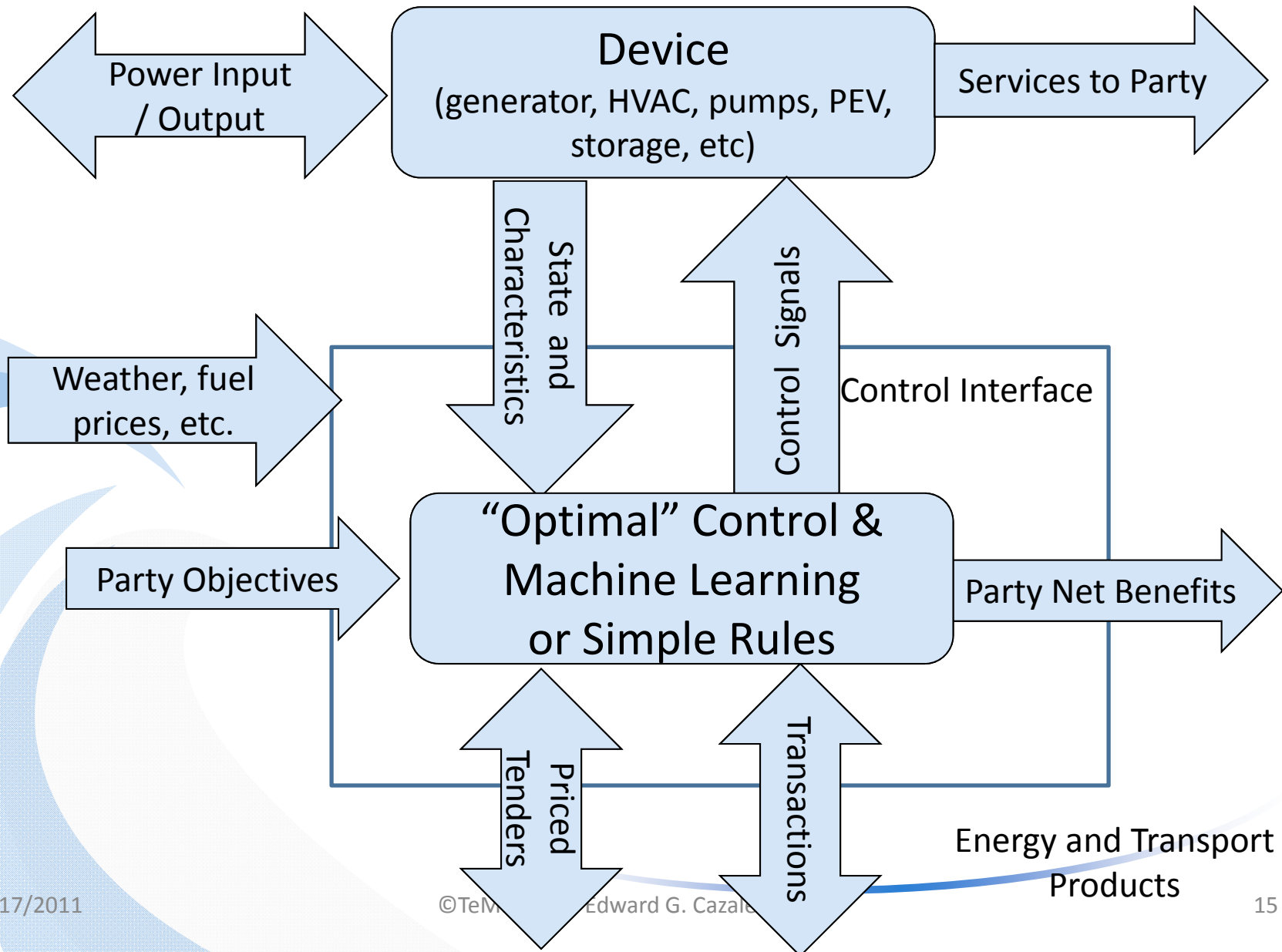
TeMIX Element	Definition
Power Product Type	Enumerated type of Power Product. Used to determine conformance requirements.
EMIX Interface	The EMIX Interface where the transaction occurs. The Interface for a Power Product has one node and the Transport Product has two nodes.
Start Date and Time	When the Interval begins
Duration	The length of time of the Interval
Price	The Unit Energy Price for the interval.
Energy Item	Total Energy (Power * Time), Real, Apparent, or Reactive, in the block purchase
Power Item	Units for the Rate of Delivery of Energy for the Delivery Interval. Includes Power Attributes.
Power Quantity	Rate of Delivery of Energy for the Delivery Interval.
Transactive State	TeMIX Transactive state is conformed to Indication of Interest, Tender, Transaction, Delivery or Publish.
Currency	Currency for the exchange
Side	Indicates which side of the agreement the information originator is on. Buy or Sell
Expires	Date and Time Tender expires. Not present if the Transactive State is anything other than Tender.
Envelope	Warrants : a written assurance that some product or service will be provided or will meet certain specifications".

Sequences of Forward Additive Subscription Transactions

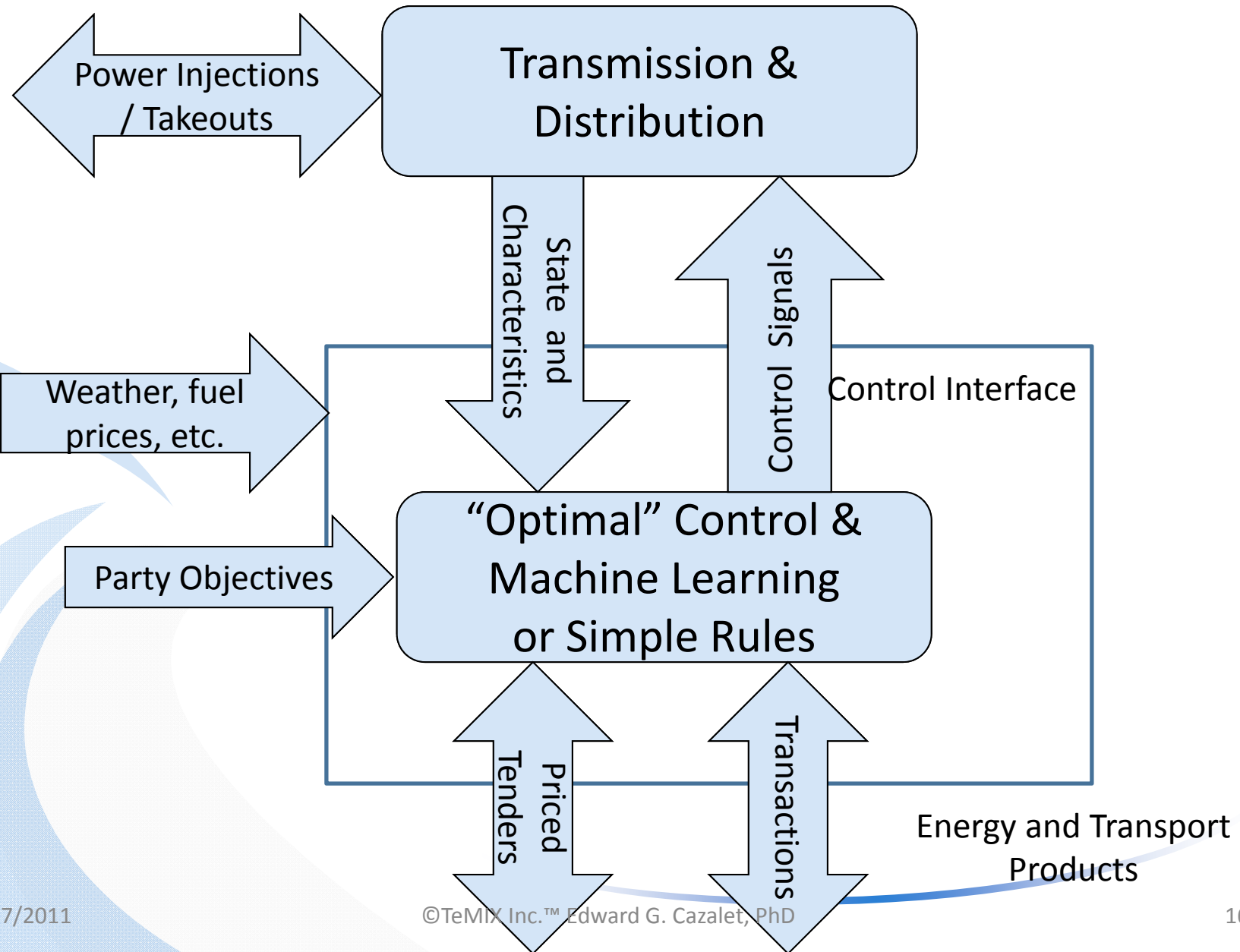
- Additive Power Subscriptions – specified rate of delivery of energy (power) over time and obligation on both parties.
- Position – add and subtract subscriptions purchases and sales.



TeMIX Device Control and Interoperation

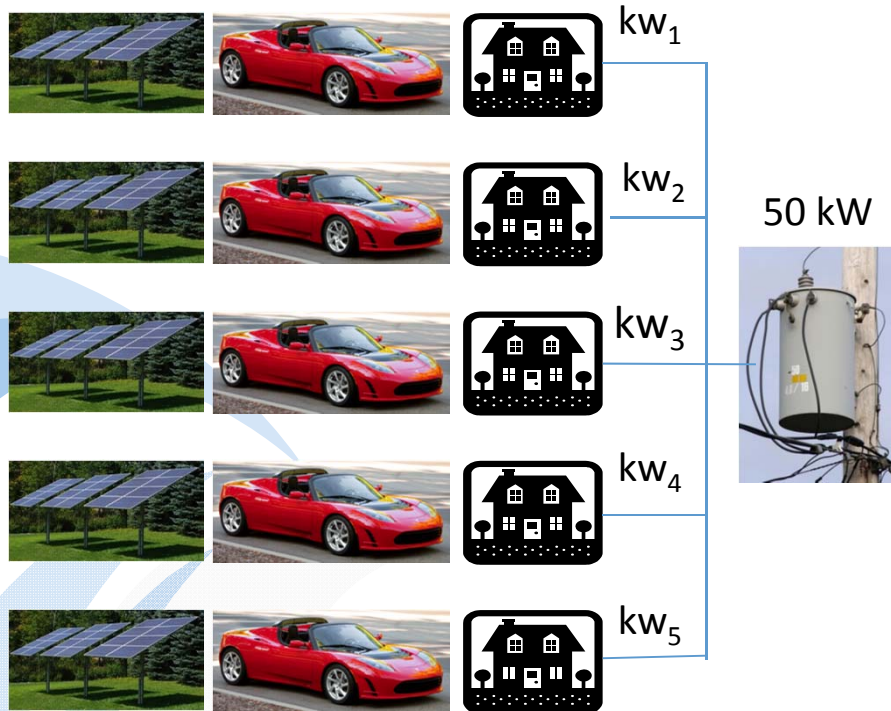


TeMIX Transport Interoperation



TeMIX Distribution Transformer Illustration

17 kW for 4 hours



1. Each home initially “owns” a subscription for 10 kW of Transformer Rights (a TeMIX Transport Product) in each forward interval.
2. Total Delivered Price = Energy Price + Transport Price (\$/kWh).
3. TeMIX Automated Market Maker for the Transformer “continuously” posts and updates forward buy/sell priced Transport “micro-tenders” for subscriptions in each forward interval.
4. Customer’s TeMIX Controllers may accept buy/sell “micro-transactions” for Transport and Energy subscriptions in forward intervals thus changing their “ownership position”.
5. If $\sum kw_i \cong 50 \text{ kW}$ the TeMIX Automated Market Maker adjusts the buy and sell Tender prices up or down to drive the forward usage of Transport to the forward ‘ownership’ by each customer. If $\sum kw_i < 50 \text{ kW}$ then Transport buy/sell prices will be near zero.

TeMIX Needs Partners

- ✓ Utilities : pilot and implement TeMIX retail tariffs.
- ✓ Legislators : grant all customers and companies a choice for TeMIX tariffs.
- ✓ Regulators : hold hearings and implement TeMIX tariffs.
- ✓ ISO / RTOs : support TeMIX tariffs with forward, dynamic wholesale tenders & transactions.
- ✓ NIST / SGIP : integrate TeMIX with other standards.
- ✓ DOE : support TeMIX standards, pilots, and simulations.
- ✓ FERC : support TeMIX standards and tariffs.
- ✓ Companies : develop smart TeMIX devices and services.