COMMENTS OF
TeMix Inc.

Energy Storage and Distributed Energy Resources Enhancements Phase 2 Issue Paper

Submitted by	Company	Date Submitted
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TeMix Inc. respectfully submits these comments on the CAISO's Energy Storage and Distributed Energy Resources Phase 2 Issue Paper and related issues http://www.caiso.com/Documents/IssuePaper-EnergyStorageandDistributedEnergyResourcesPhase2.pdf.

TeMix Inc. has previously commented on these issues in formal comments to the CAISO http://www.caiso.com/Documents/TeMixComments-ExpandingMeteringandTelemetryOptions-DraftFinalProposal.pdf and in oral comments before the CASIO Board of Governors on July 16th, 2015. Additionally, TeMix provided comments on the CASIO ESDER Phase 1 Issue Paper and Straw Proposal https://www.caiso.com/Documents/TeMIxComments-EnergyStorageDistributedEnergyResources-IssuePaperStrawProposal.pdf.

TeMix Inc. understands that these issues are complex and that the complexity is magnified by the interactions between wholesale energy / transmission markets, retail energy / distribution transport markets and end customers with behind the meter generation, storage resources and demand responsiveness.

TeMix Inc. complements the CAISO and CPUC on their initiative to hold a joint workshop on May 2-3, 2016 to address multiple use applications and station power and that the CAISO will consider new initiatives and changes to its Phase 2 ESDER Initiative.

Of course the issues to be addressed by the CPUC and CASIO regarding storage and distributed energy resources go well beyond multiple use applications as is recognized by the CAISO and CPUC. At the heart of the issues are retail energy and distribution tariffs that poorly coordinate wholesale operations and investment with distribution operations and investment and end-customer and distribution connected operations and planning.

TOU tariffs with fixed blocks now being considered by the CPUC and real-time pricing tariffs are inadequate for the required wholesale, distribution and retail coordination. Demand response concepts using estimated baselines cannot be trusted for two-way response compensation on the distribution grid and behind-the-customer-meter. Aggregation of storage and distributed resources and demand response for CAISO dispatch is complex, inefficient and inaccurate and is currently unable to coordinate well with distribution operations. Proposals to form a Distribution System Operator (DSO) or an Independent DSO (IDSO) are likely years from fruition, and are complex, expensive and will not address the coordination issues well.

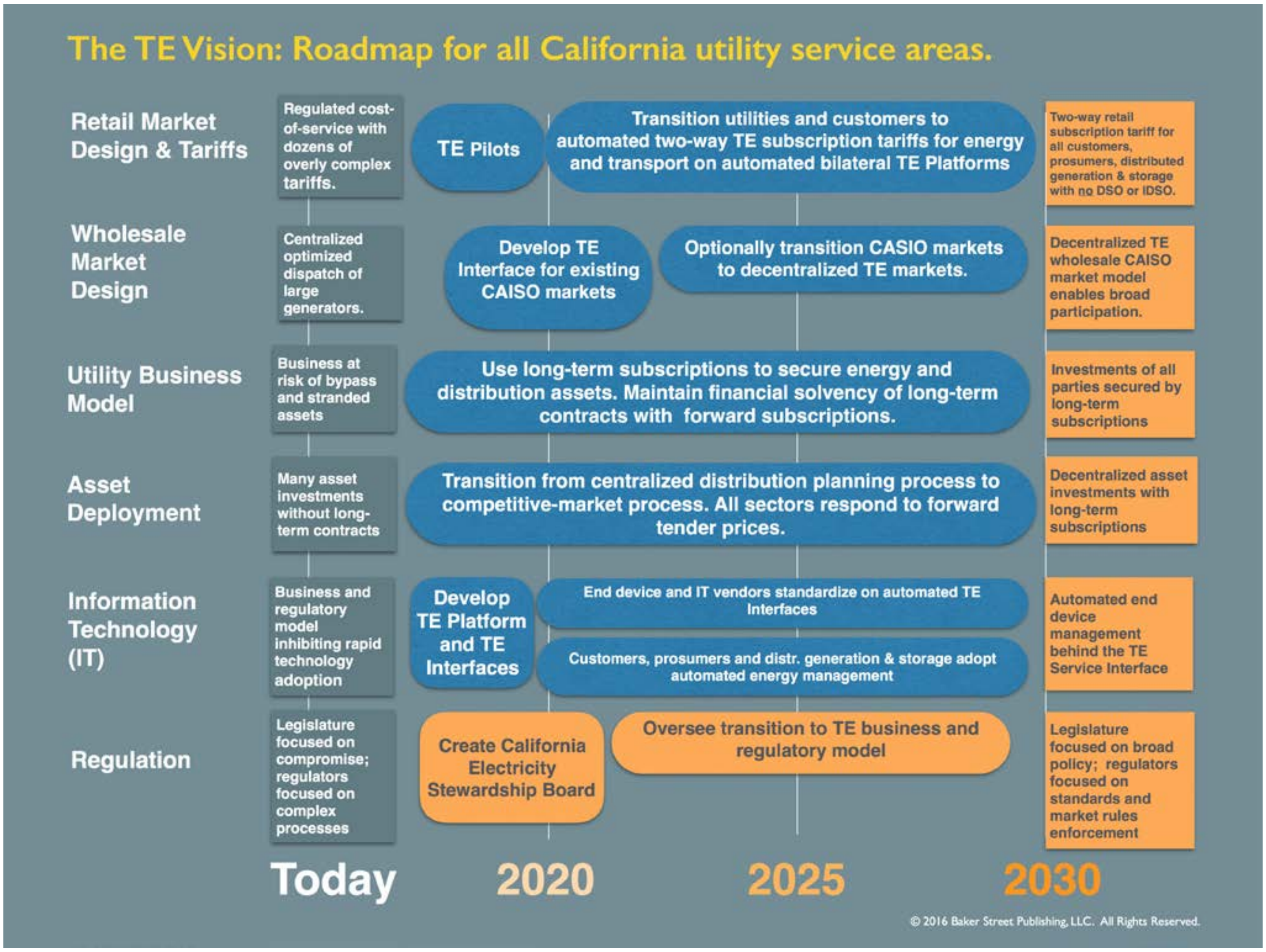
TeMix Inc. respectfully suggests that the CAISO and CPUC have been pursuing an overly complex and unproductive approach to energy storage and distributed energy resources as outlined in the ESDER Phase 1 and Phase 2. The approach is to aggregate and centrally dispatch Energy Storage and Distributed Energy Resources (ESDER). TeMix Inc. suggests that the complexity and time required to implement this approach, especially with consideration of the multiple use issues, will slow the adoption of storage and DER and result in higher costs of integrating high penetrations of renewables and achieving carbon reduction goals as required by California policy.

The CAISO has also commented on the commitments of their staff and limitations on the CAISO resources that can be dedicated in this area. The CPUC also has resource limitations. TeMix Inc. suggests that these resource limits are another reason for the CAISO and CPUC to reconsider their approaches to Phase 2 ESDER and other initiatives.

A Sustainable Electricity Business and Regulatory Model and Roadmap for California Electricity

TeMix Inc. has prepared a transactive energy (TE) vision and roadmap for California that we offer for consideration by the CAISO, CPUC and the stakeholders (See Appendix A) as an alternative to the current approaches.

TeMix Inc. submitted this model and roadmap for California to the SEPA 51st State Project Phase 2 (http://www.sepa51.com/submissions.php) that was held in Denver CO, on April 13, 14 2016. One of the key illustrations in the roadmap document is the roadmap swim lane diagram shown below:



This vision and roadmap outlines a comprehensive and practical roadmap for California that is better, faster, lower cost and less complex than current plans for California. And it can be implemented incrementally without institutional changes such as a creating DSO or ISDO or requiring retail competition and without major changes to CAISO or IOU and POU distribution systems.

The proposal will eliminate the problems of estimated baselines for demand response, storage and distributed generation on the distribution grid that are elements of the ESDER Phase 2 initiative. It will support the multi-use, autonomous dispatch of storage and other distribution connected and behind-the-customer-meter resources while fully coordinating distribution operations and transmission operations.

TeMix Inc. is pleased to offer briefings, answer questions and consider suggestions on this approach to any stakeholder group, CAISO, CPUC or CEC sponsored workshop, and to the CAISO, CPUC and CEC staff and management.

APPENDIX A:

A Roadmap toward a Sustainable Business and Regulatory Model: Transactive Energy
(California Roadmap discussion begins on page

http://www.temix.net/images/51_State_II_20160308_Submission_Narrative_copy_2.pdf

THE 51ST STATE

A Roadmap toward a Sustainable Business and Regulatory Model: Transactive Energy

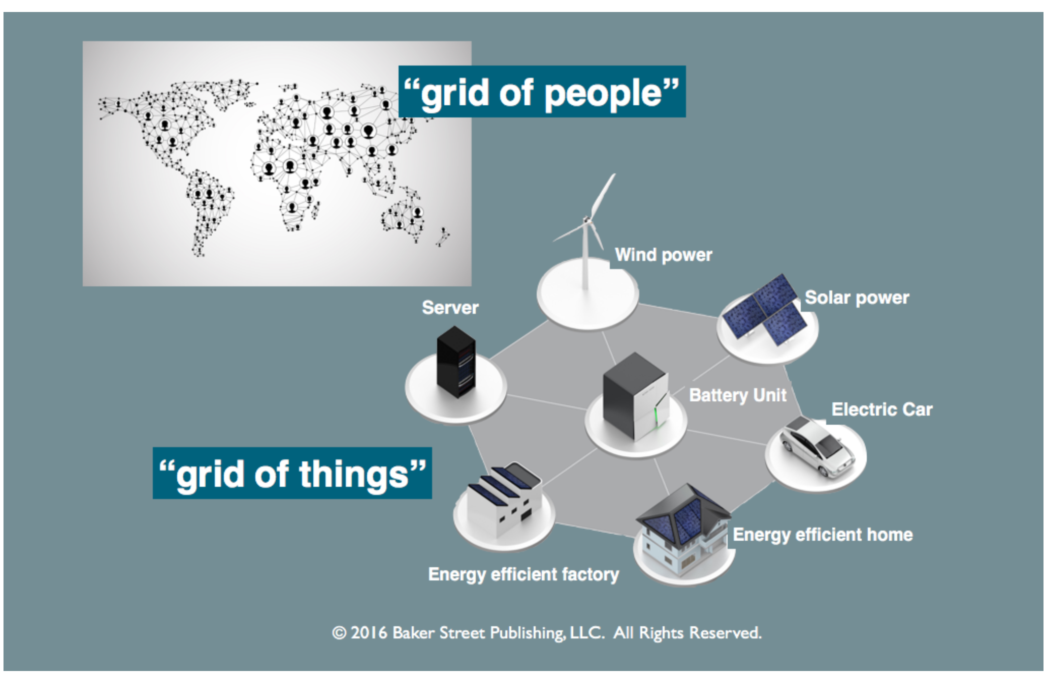
**Submitted by Stephen M. Barrager, Ph.D., Baker Street Publishing, and
Edward G. Cazalet, Ph.D., TeMIx, Inc.**

This submission to the 51st State Project outlines our vision of an electric energy ecosystem where investment and operating decisions are coordinated using fundamental economic principles. We believe the Transactive Energy (TE) business model is more efficient, more fair, and more transparent than the current centrally controlled, resource optimization model.

Industries from airlines to baseball have adopted the transactive business model. It is now feasible and practical for the electric power industry to apply the TE model. This is possible because of the tidal wave of communication and computing technology we are experiencing.

We are driven toward the TE business model by technology and our need to radically reduce our use of carbon-based energy. The model will increase efficiency and spur innovation across the entire electric energy ecosystem.

As we will show, the TE vision simplifies tariffs, lowers transaction and IT costs, and better aligns incentives with social goals. Other current industry initiatives share the same goals, but take a more complex, costly and centralized path. The TE vision can be implemented faster and at lower cost.



The TE Vision for the Future 51st State

It is helpful to think of two electricity "grids." The "grid of things" and the "grid of people." Our primary focus in this paper is on the “grid of people”. However, before focusing on people we will discuss the “the grid of things” to establish the context.

By the year 2030 the "grid of things" will be different from our current grid in the following important ways:

- Solar generation will be virtually everywhere: distributed in homes, commercial buildings, parking lots, community solar parks and in large solar farms on the transmission grid. By 2030 many grids will have so much solar installed that without further adaptation midday generation will greatly exceed midday usage.

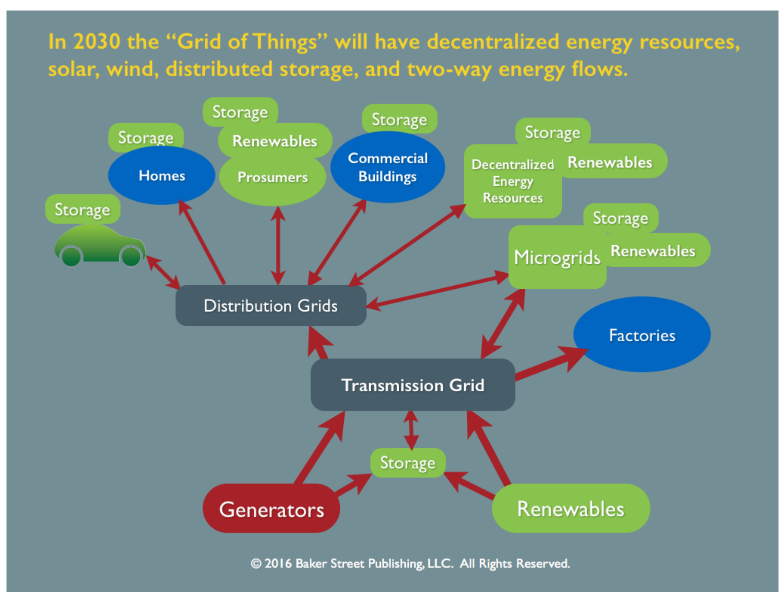
- Energy storage will also be everywhere: Some of the storage will be electrical, some will be thermal.

- Other renewables especially wind, geothermal, hydro, will play an important role.

- Homes, buildings and industry will be much more efficient and highly electrified to reduce fossil fuel use and GHG emissions and energy use will be automatically managed.

- Large numbers of electric vehicles will be capable of both managed charging from the grid and discharging back to the grid.

- Communications, computing, and sensor technology will be ubiquitous, powerful and low cost and increasingly secure. Billions of devices comprising the “internet of things” will be interconnected. Electric energy will be just one of the products that these devices will consume, produce, store and manage.



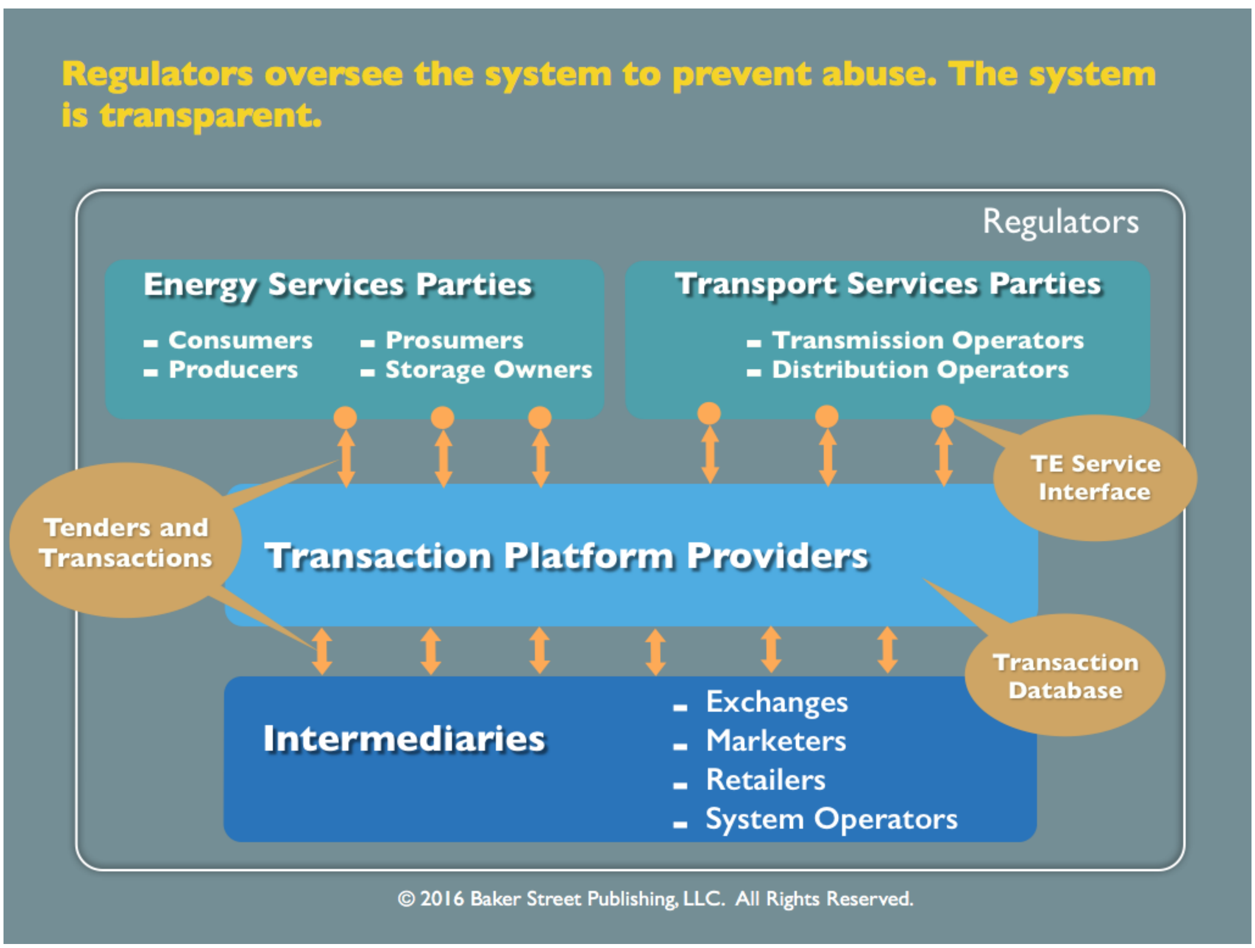
- Energy will flow from the transmission grid to customers. It will also flow from prosumers and distributed PV and storage back to the grid and between customers.

The "Grid of People"

People manage the grid's evolution and operation for their benefit. The "grid of things" serves the "grid of people."

Together the people and the grid form an ecosystem that must be designed so that each party can make decisions in their own self-interest in a way that honors the physics of the grid and the environmental and policy decisions. The policy decisions are made by the people through their governments and regulators.

The people are the parties shown in the figure below. At the top of the figure are shown the Energy Service Parties (ESPs) and Transport Service Parties (TSPs). ESPs include electricity producers, consumers, prosumers, and storage owners. TSPs include Transmission Operators (TOs) and Distribution Operators (DOs). The TSPs will buy and sell transport products to move energy from location to location. The ESPs will buy and sell energy at the locations of their facilities or at another location by using a transport product to move the energy.



Sales and purchases will be executed using Transactive Energy (TE) Platforms hosted by Transaction Platform Providers (TPPs) as shown in the middle of the figure. Parties can make and receive intentions (tenders) to buy and sell energy and transport products with each other on the Transaction platforms. Transactions will be communicated and recorded here. Importantly this platform does not optimize the dispatch of the grid or any grid devices. In our TE Vision only the ESPs and TSPs carry out optimal planning and operation of their facilities and devices, primarily in response to posted forward tenders to buy or sell energy and transport.

With this approach there is no need for an “ISO for the distribution grid” such as a distribution system operator (DSO) or an independent DSO (IDSO).

A set of Intermediaries will help the "grid of people" and the "grid of things" to work together. The intermediaries include: market makers, marketers, retailers, and system operators.

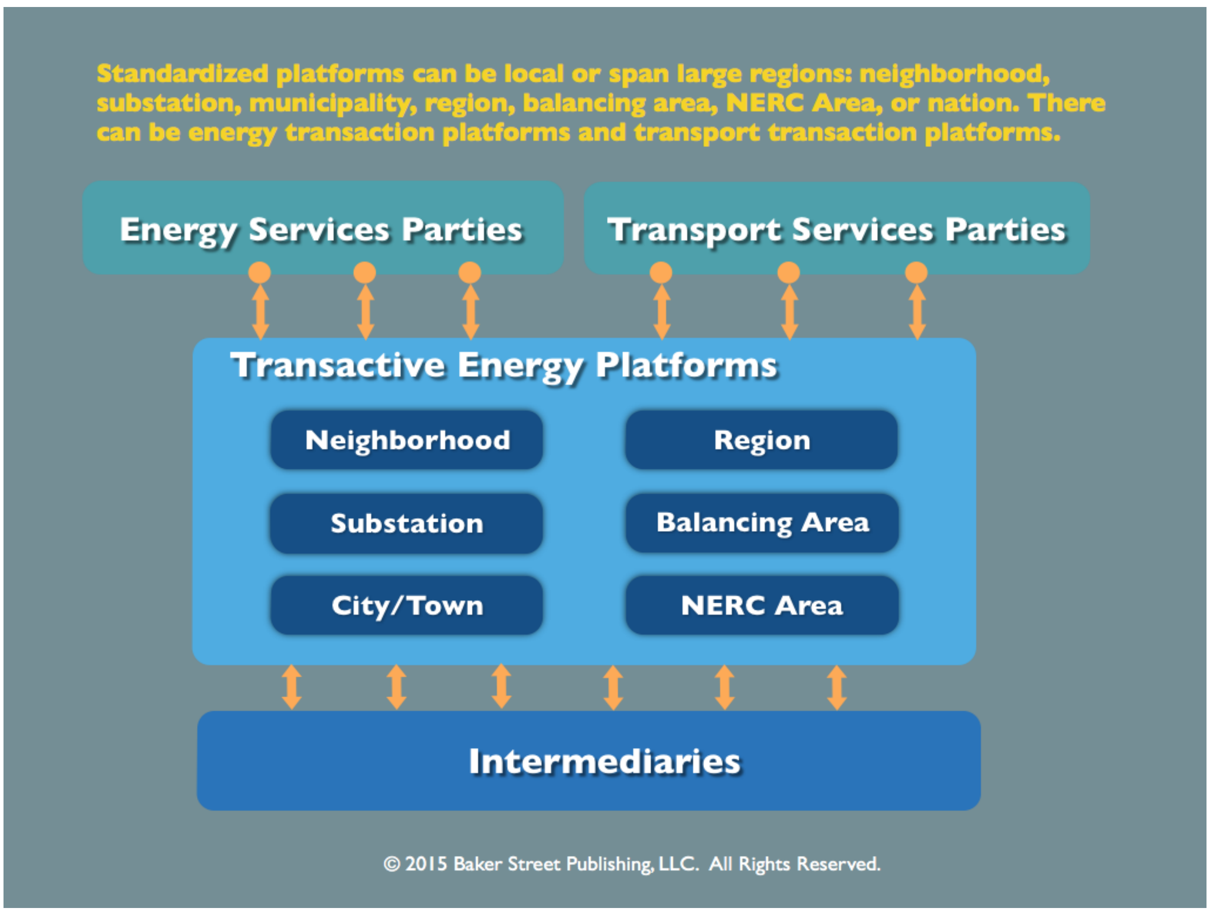
For example, automated market makers will use a TE Platform to frequently post small, priced, forward buy and sell tenders for energy at locations and transport between locations. ESPs and TSPs will take these tenders and other information and self-dispatch their own systems and devices while accepting some tenders to create incremental binding forward transactions among the parties.

The incremental transactions will modify the forward schedules for energy and transport for the use of the grid and its devices and systems.

The TE Platforms will give regulators the tools to standardize products, interfaces, and party roles and to oversee the system and prevent abuse. The system will be transparent. Information about all transactions will be available on the TE Platforms to authorized parties.

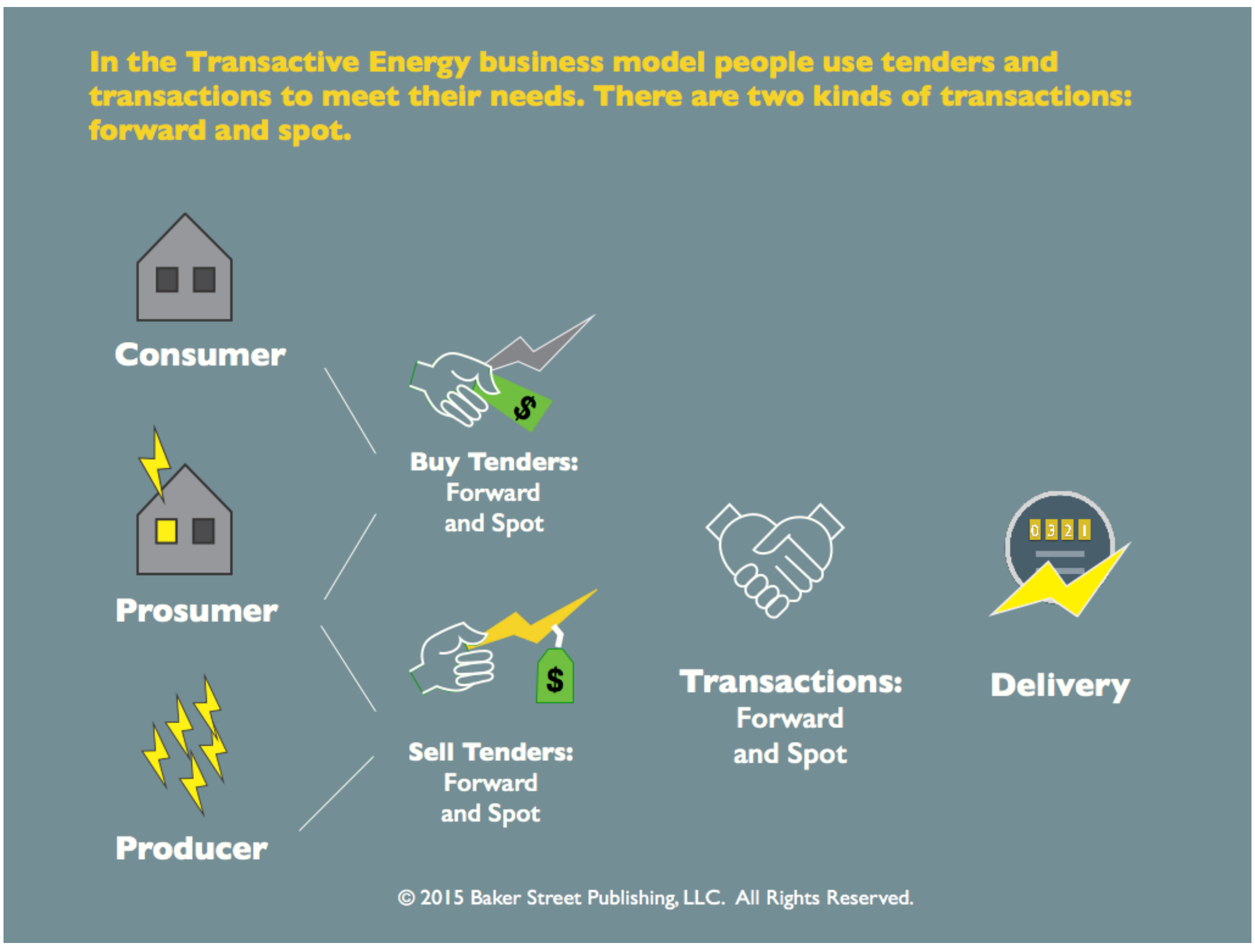
Standardized TE Platforms can be local or interact over large regions: neighborhood, substation, municipality, region, balancing area, NERC Area, or nationally. They are scaleable.

TE Platforms may be dedicated to classes of transactions and operated by different entities. For example, there can be energy only Platforms at the substation level that do yearly, monthly, daily, hourly, and sub-hourly transactions of energy. Other TE Platforms may be for transport only products between for yearly, monthly, daily, hourly, and sub-hourly deliveries on specific distribution feeders.



The transaction process is diagrammed below. There are buy tenders and sell tenders. There are two kinds of transactions: forward and spot. Examples of forward transactions are long-term purchase contracts or subscriptions for service. Spot transactions are used to fill the gap between forecasted and actual needs and supplies or to adjust positions from previous transactions.

Delivery is measured by interval meters at the locations for energy use and supply at all types of facilities on the grid. For each interval the meter will measure the actual delivery which can be compared to the net delivery for all transactions for that facility in the same intervals. Where there is a difference an additional spot 'balancing transaction' is created.



The Transactive Energy (TE) business model embodies four "big" ideas

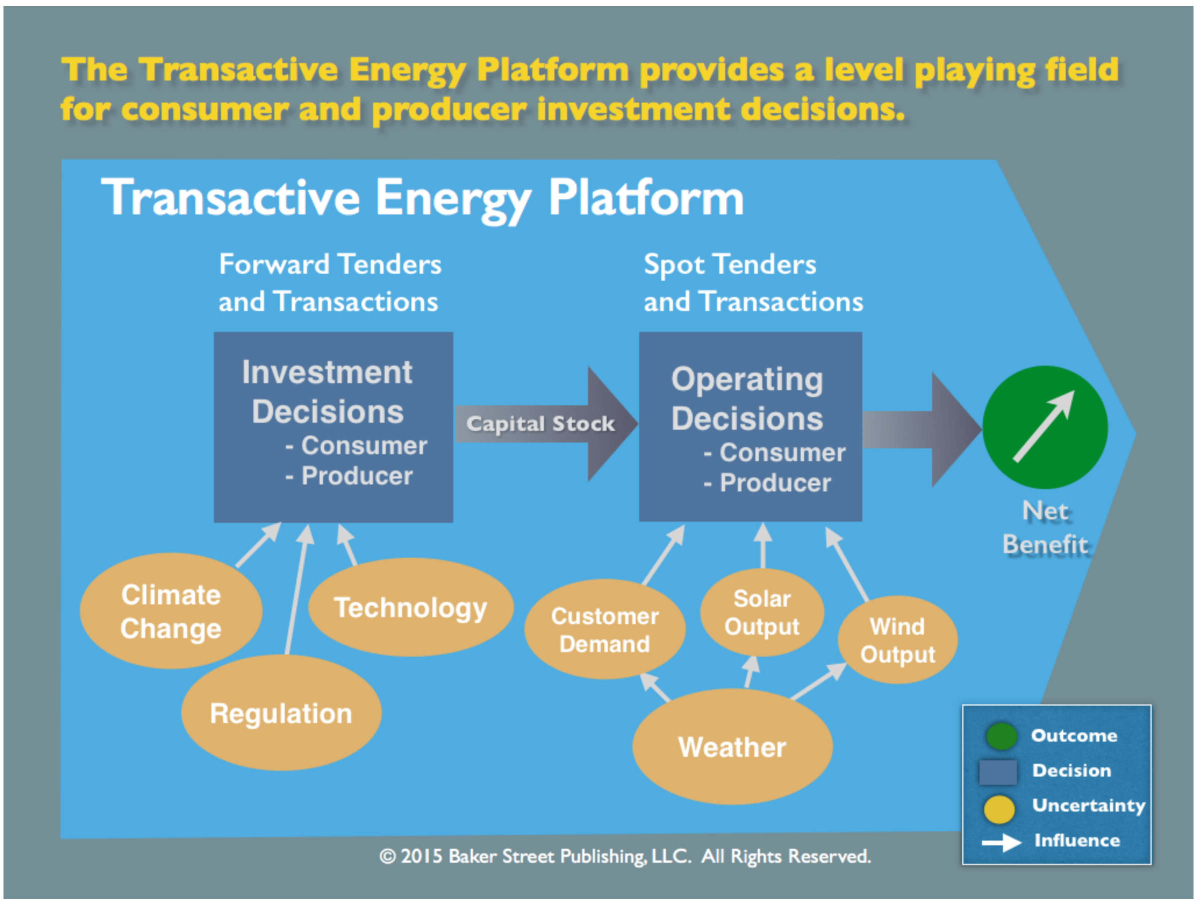
The "Big" ideas are the following:

1) There are two products: energy and transport,

2) Forward transactions are used to coordinate investment decisions and manage risk,

3) Spot transactions are used to coordinate operating decisions, and

4) All parties act autonomously.



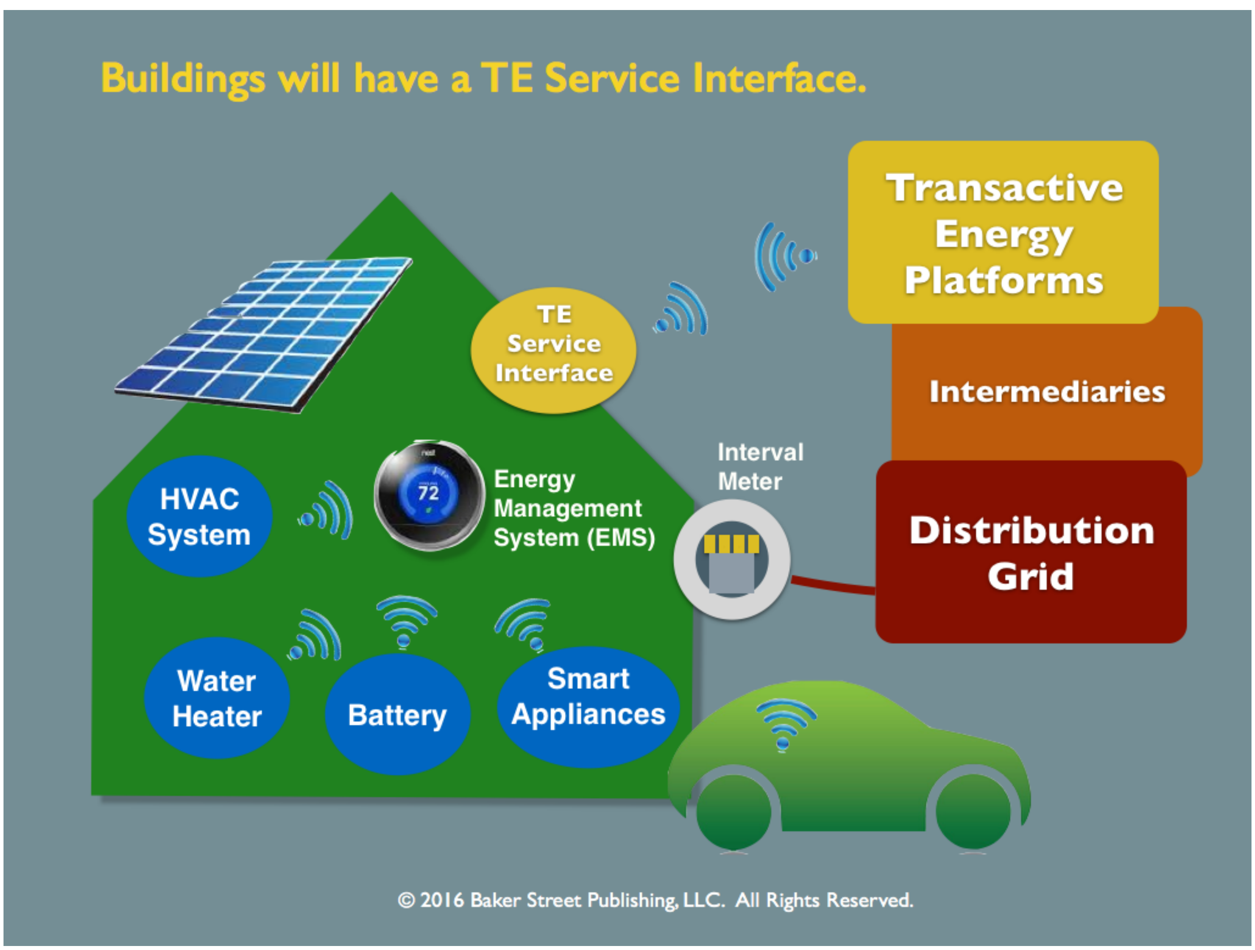
The two basic TE products are energy and transport. Energy is produced and consumed at locations on the grid. Transport of electric energy is provided by the grid which can move energy from one location to another on the grid. TE also supports call and put options on that are more effective ways to transact “capacity” and “ancillary” products.

The two kinds of decisions in the energy ecosystem are: investments and operating are diagramed in the figure above. Investment and operating decisions are made by both producers and consumers.

The TE Platforms provide the level playing field for producer and consumer investment decisions. Central station, distributed, and customer investments are coordinated by forward transactions. The forward transactions enable everyone to manage risk associated with uncertainty in future prices, technology, and weather. Forward transactions coordinate the investments so investment dollars go where they produce the highest net social benefit.

Producer and consumer operating decisions are coordinated by spot transactions. There is no need for "peak" or "time-of-use" pricing, or demand charges. Price signals using tenders to everyone can be time-varying and location dependent.

All parties with devices will interface with the TE Platforms through a TE Service Interface. The interface relationship between a smart building, interval meter, and TE Interface is shown below. All parties can act autonomously to automatically or manually manage their energy devices for their benefit, comfort, cost savings, etc., in response to priced tenders.



For retail customers (including prosumers and distributed generation and storage owners) tenders can be communicated and transacted using a two-way retail subscription tariff. A recent White Paper by the Smart Grid Interoperability Panel [1] explains how a two-way subscription TE tariff for energy and transport can be designed for industrial, commercial and residential customers. The tariff offers customers a combination of subscriptions and spot prices. Subscriptions are simply forward transactions that approximate the typical net usage of a customer in each hour of a year.

Example of how a two-way subscription TE tariff works for a typical retail consumer.

- Based on my typical usage or production, I automatically transact for subscriptions for prescribed quantities of energy and transport in each hour of the year(s) for a fixed monthly payment (subscription.)
  - If I use less than I subscribed for in each hour then I am paid for the difference at spot prices.
  - If I use more than I subscribed for then I pay for the difference at spot prices.
- As my needs change I can automatically buy or sell to modify my subscriptions at the current tendered prices from a Transactive Energy Platform.

This means stable bills for customers and stable revenues for distribution operators and energy suppliers.

Forward subscriptions provide stable long-term bills to customers and stable long-term revenues to distribution operators and energy suppliers while at the same time coordinating efficient operations.

[1] A Model Interoperable Transactive Retail Tariff, A white paper developed by the Smart Grid Interoperability Panel, January 23, 2015, available on the Smart Grid Interoperability Panel website, http://www.sgip.org/publication-retail-tariff

Typically the two-way tariff will allow retail energy services parties to buy and sell energy for delivery at a wholesale/retail grid substation using forward and spot buy and sell transactions.

Separately, a party will also buy and sell the distribution transport on the feeder (line) in either direction between his facility and the local substation. A distribution transport tariff would typically recover more of the costs of transport when the total feeder load is high in either direction.

Summary of the TE Vision

The 51st state's electric energy ecosystem will be the ultimate in efficiency, fairness, and transparency. It will unleash innovation in both the "internet of things" and the "internet of people." How do we get there? And who are the winners and losers?

Ultimately we will all win. This business model is more efficient, more fair, and more transparent than our current cost-of-service, command-and-control model. Transactive Energy is based on sound economic principles. It will stimulate innovation. It will raise efficiency and lower fossil fuel consumption.

- In the near term, **electric utilities** will win if they actively participate in the transition. They have a natural advantage in transmission and distribution. In the long run they will remain as transport service providers. They can provide the local TE Platforms. They can also provide many intermediary services to facilitate transactions and maintain safety and reliability. Their unregulated affiliates can become competitive energy service providers. And most importantly, the long-term subscriptions and other forward transactions can support sustainable business models for utilities.

- The **Solar and Storage industry** value chain will flourish. Everyone will have more choices. Market forces will determine what, where, and when technologies are deployed. Demand will continually shift toward low cost supplies.

- **Solar and Storage Customers** will have more choices and less risk. They will capture more of the benefit of the service they provide to the grid. This will stimulate efficiency and cost reduction. The cost of electricity will go down and we will use less of it.

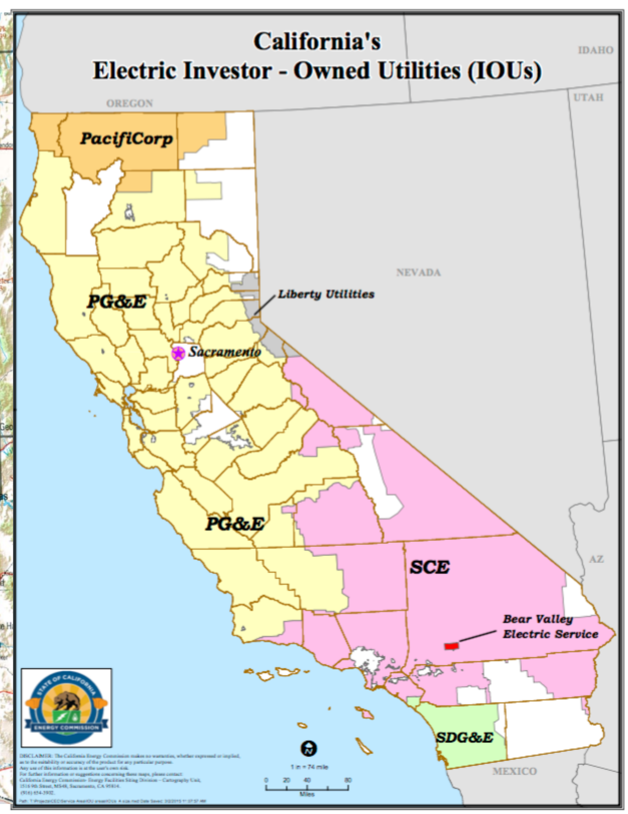
- **Independent power producers** will also have more choices. They will be able to transact long-term and short-term directly with end customers using the TE Platforms.

We now turn to the main objective of Stage II of the SEPA 51st State project. In the following we develop a market transformation roadmap that shows a path to get to TE 2030 vision from today's current state using the following Swim lanes: Retail Market Design, Wholesale Market Design, Utility Business Model, Asset Deployment, Information Technology, and Rates & Regulation.

A Market Transformation Roadmap for California from 2016 to 2030

We choose California to explain how the TE business and regulatory model will be implemented. We start from the state of the California electricity market in 2016. The California market is complex and confusing.

However, as we shall show, the market transformation roadmap we are putting forth is not very sensitive to the current market state or the type of utilities that participate in the transformation. For TE, the roadmap to 2030 will be very similar for all utilities and parties.



The current state of the California electricity market is described using the categories suggested by SEPA as follows:

- **Service Territory** – California is the most populous US State with 39 million people. It contains eight of the nation's most populous cities (Los Angeles, San Diego, San Jose, San Francisco, Fresno, Sacramento, Long Beach, and Oakland.) California electricity demand is mostly residential and commercial.

- **Utility Type** – Three IOUs dominate the California electricity market: Southern California Edison (SCE), Pacific Gas and Electric (PG&E), and San Diego Gas and Electric (SDG&E). Two large public utilities, Los Angeles Department of Water and Power (LADWP) and Sacramento Municipal Utility District (SMUD) serve about 17 percent of the state market. There are several smaller publicly-owned entities and electric cooperatives.

- **DER Penetration** – California is #1 in solar deployment. As of 2016 there is —about 3000 MW of behind the meter solar and about 6000 MW of utility solar.

- **Utility Structure** – The major IOUs and public utilities own distribution and transmission assets. The IOUs' ownership of generation is mostly hydro and nuclear with some thermal plants. Independent Power Producers (IPPs) own the bulk of California thermal generation assets.

- **Wholesale Market** – The California Independent System Operator (CASIO) operates the generation and transmission spot markets and centralized generation dispatch for all of the IOUs. The publicly owned utilities (POUs) participate in CAISO markets but retain control over their transmission and generation. Some POUs have their own balancing authorities and control areas?

- **Retail Market** – Retail competition exists for a portion of the IOU markets such as for large commercial and industrial customer classes. Otherwise the IOU retail market is largely a regulated monopoly franchise overseen by the California Public Utility Commission. In some case Community Choice Aggregators (CCAs) have won the right to service a community's IOU retail customer s while using and paying for the IOU's distribution grid services.

- **Renewable Policy** – California has a Renewable Portfolio Standard (RPS); 33% for 2020; 40% for 2024 and 50% for 2030 (in addition to roof-top solar and large hydro). Some utilities also offer 100% renewables service to retail customers. The driving force is California's Green House Gas (GHG) policy to reduce GHG emissions to 40% of 1990 levels by 2030 and 80% by 2050. Additionally, California has a price on GHG (carbon) under its aggressive cap and trade legislation and programs. The price of carbon is now imbedded in the cost of electricity generation from fossil fuels.

- **NEM Policy** – California IOUs have a very strong Net Energy Metering tariff.

California Energy Milestones

California is a leader in state-led efforts to increase energy efficiency and decrease use of fossil fuel. The state has issued several mandates to support these efforts. See the figure below. The state's utilities have been directed to do the following:

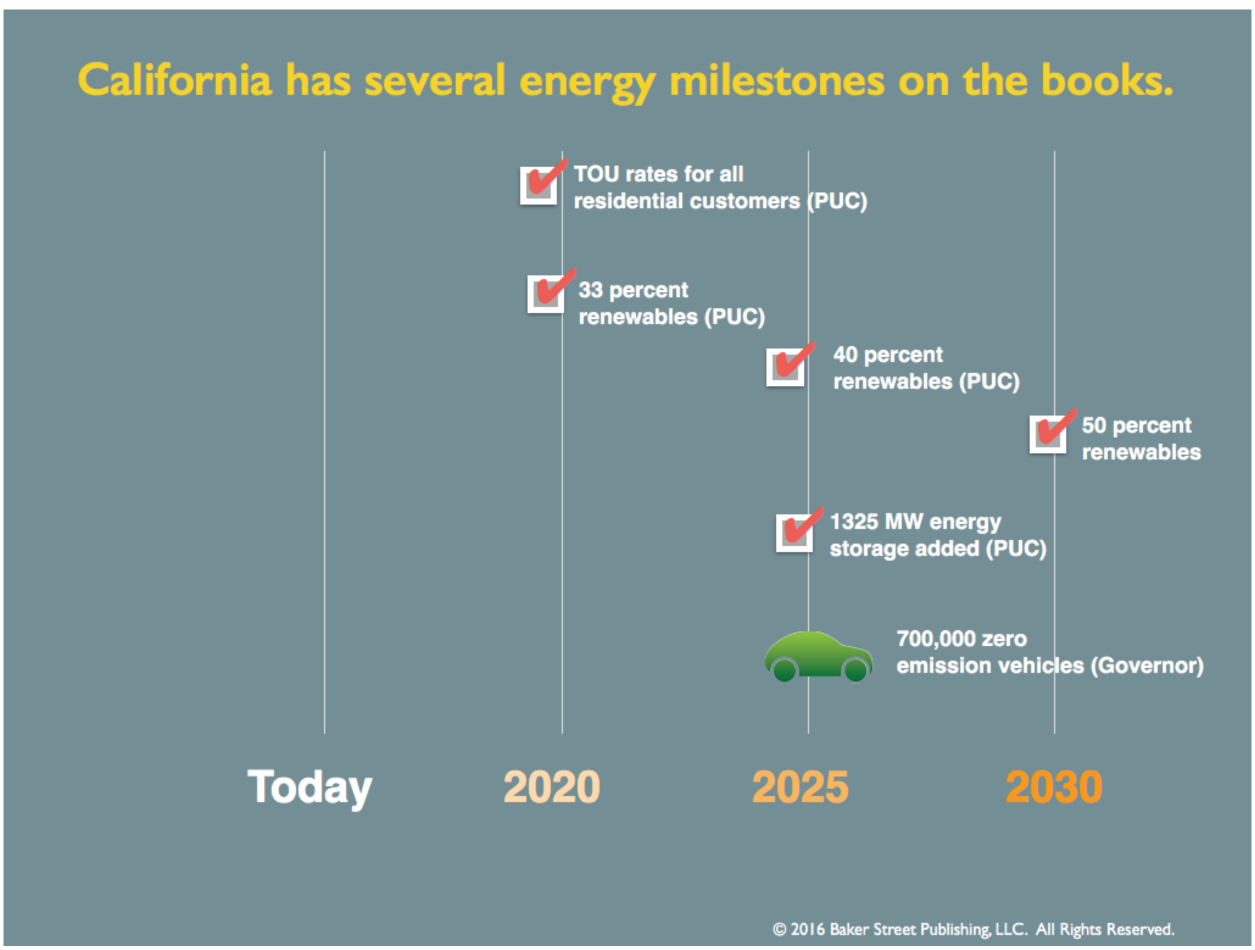
1) Achieve 33 percent of net utility load from renewables by 2020; 40 percent by 2024; and 50 percent by 2030.

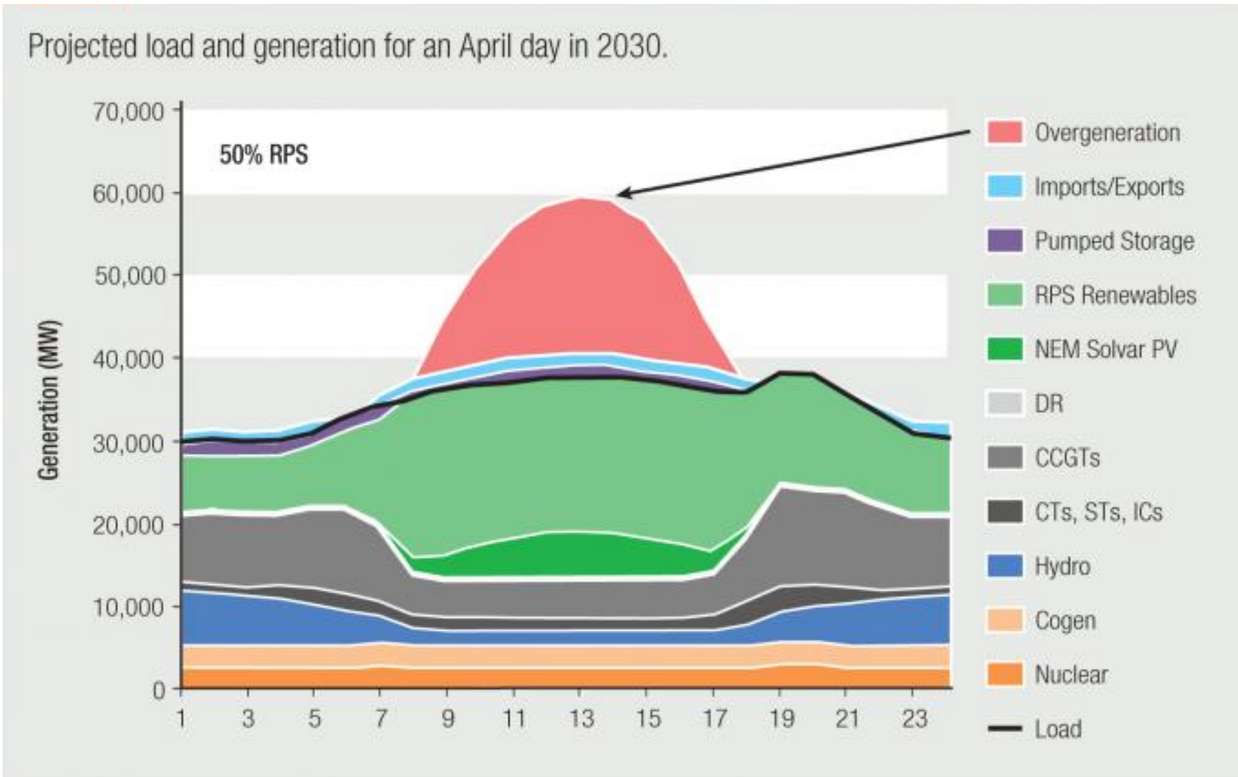
2) Add 1.325 gigawatts of energy storage by 2024.

3) Offer Time of Use (TOU) tariffs for all IOU residential customers beginning in 2019. California has Net Metering rates to encourage prosumers. Several utilities 's are actively upgrading their distribution system to accommodate two-way energy flows on distribution feeder lines.

In addition, the State has a goal of putting 1.5 million zero emission vehicles on the road by 2025. Most these vehicles will be battery based.

The challenges faced by California in achieving its 2030 50% renewables policy goals are illustrated in part by this estimate of about 20,000 MW of midday over generation without mitigation for a spring 2030 day. (See figure below.)

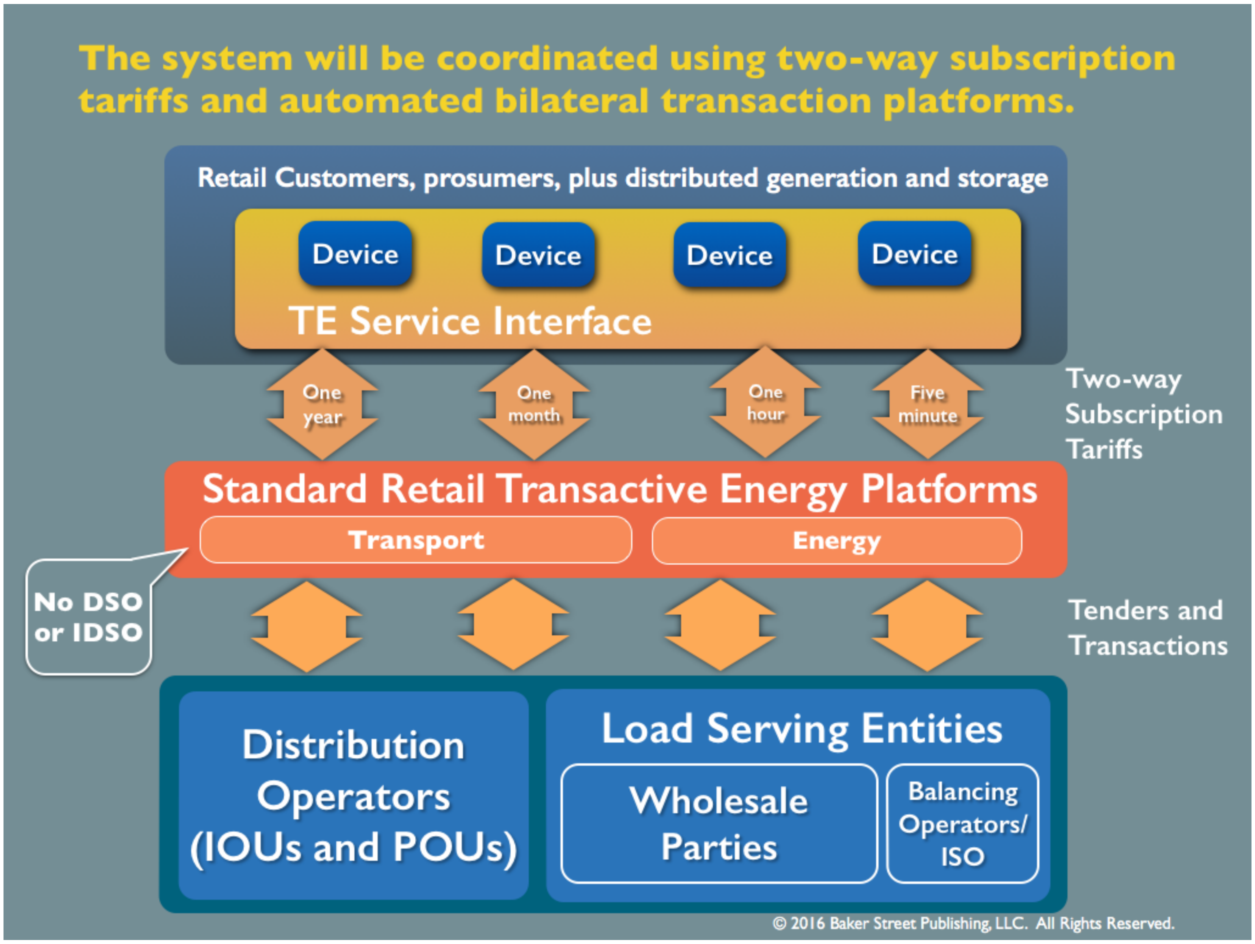




Implementing The TE vision for California in 2030

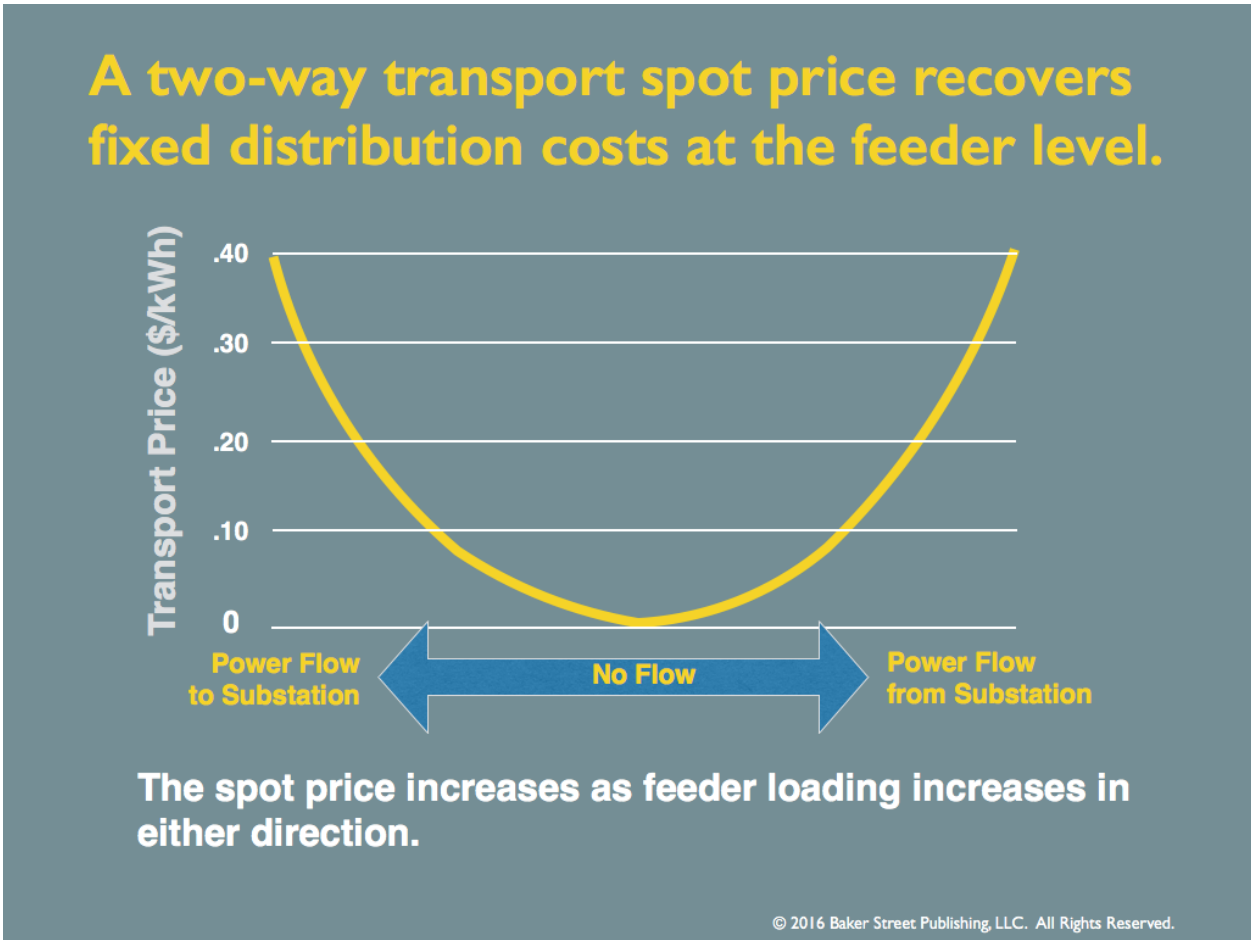
Building on the current California policy initiatives for 2030 and beyond, our TE vision implements the retail market design illustrated in the following figure. The design is hosted on standard retail TE Platforms for energy and distribution transport. These platforms support the two-way retail subscription tariffs we described earlier.

In this approach energy is typically transacted for delivery at the local substation. This is the interface between the distribution and transmission grid. Distribution transport charges are for two-way service between the substation and the TE Service Interface.



The load serving entity (LSE) determines the monthly energy subscription payments for the subscriptions to each TE Service Interface. The energy payments are based on wholesale contracts and forward and future wholesale transactions. The LSE determines the prices of buy and sell tenders to each TE Service Interface based on the balancing operator or CAISO spot market prices and other costs. The LSE also acts as a market maker for energy by posting forward buy and sell tenders for energy to TE Service Interfaces .

The distribution operator (DO) uses a formula that recovers more of the regulated distribution revenue requirements when the distribution feeder between the substation and the TE Interface is more heavily loaded (in either direction) by all TE Interfaces on the distribution feeder. Transport loads or flows are measured on short intervals to account for the volatility in flows that can occur on feeders with solar and EV charging. The same price formula is used for both spot flows and forward (subscribed) flows. The formula is illustrated below:



At the substation level, the DO is both the Transport Service Party (TSP) and the market maker for two-way transport between the customer and the transmission substation. The DO frequently posts buy and sell tenders for transport for forward intervals.

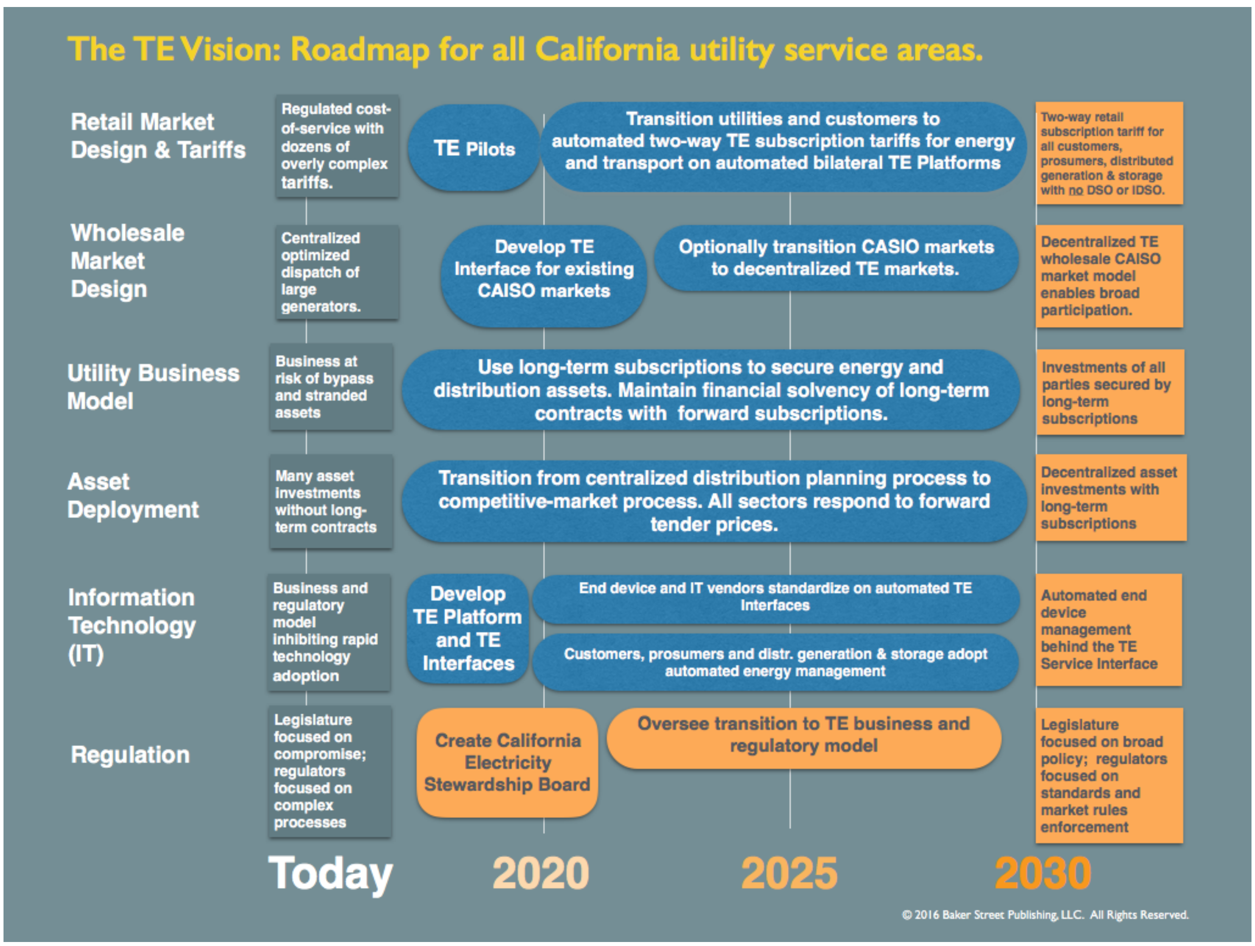
The customer's Energy Management Systems (EMS) at the TE Service Interface makes decisions autonomously to maximize the net benefit to the customer. The EMS makes these decisions based the total of the forward energy and transport tender prices for each forward interval. The EMS will accept portions of these tenders and create forward and spot transactions for energy and transport that modify subscription and previously transacted total positions in each interval.

With this approach very expensive and complex DSO's and/or IDSOs are not necessary or desirable. DSOs perform the roles of both DO and resource dispatch and compute locational prices. Such DSOs would find few retail participants willing to bid using complex supply curves and to be dispatched at distributed locational prices. Most distributed PV is non-dispatchable so it cannot provide flexible resources. Storage does not fit the typical ISO-like dispatch model that is based on supply curves especially when the storage has multiple roles.

Thus, there likely would not be enough liquidity for an effective DSO dispatch. Typically a DSO also aggregates the supply curves of all distributed resources on distribution feeders for each distribution/transmission substation. Such aggregation is complex and approximate.

A California Market Transformation Roadmap

In the following section we describe a California Market Transformation Roadmap using the six “swim lanes” set forth by SEPA in the 51st State Phase II request. The six swim lanes are (1) retail market design and tariffs, (2) wholesale market design, (3) utility business model, (4) asset deployment, (5) IT, and (6) Regulation. For a graphical summary of the Market Transformation Roadmap see the figure below.



Retail Market Design

Our retail market design employs two-way retail subscription tariffs hosted on TE Platforms for energy and distribution transport.

Our retail market roadmap begins with well-designed pilot demonstrations. Although the economic fundamentals embodied in the TE business model are well tested in almost every industry, they have not been applied in all retail customer classes for electricity. (Some electricity marketers and IOUs have offered similar block and index retail tariffs for many years.) Demonstrating the two-way subscription tariffs in California is necessary before the concept will be broadly accepted. Seeing is believing is the mantra, as it should be.

Following the pilots, the standard TE Platforms can be deployed and configured from secure cloud servers over about five years for most California IOU and POU LSEs and DOs and other non-utility LSEs.

The two-way subscription tariffs will be phased in by customer choice and by customer sector, DO, and LSE over about ten years. Initially customers will have the choice to opt-in to the two-way subscription tariff. Soon, large customers and customers with PV and storage or EVs will be defaulted to subscription tariffs. Later, depending on the DO and LSE readiness and regulatory approvals, all but the smallest customers will be defaulted to two-way subscription tariffs, but be able to opt-out to some form of a flat or TOU tariff.

Low income customers can be offered discounted subscriptions but should be able to respond automatically to spot tenders to save more money.

Equity among customers in high cost area or at the end of feeders with higher spot prices can be accounted for in the long-term subscription prices while still allowing all customer to respond to spot tenders.

Customer data on energy use and production behind the meter is owned by the customers. Customers autonomously control their own devices.

Existing net metering, TOU, demand charge and demand response programs will be phased out and replaced by a simpler subscription tariff model for all customers and distributed generation and storage.

With the subscription tariff all energy is essentially transacted at wholesale prices (plus other some other costs). The energy spot prices will be highly variable. All two-way distribution transport highly variable spot prices and with stable subscriptions.

In the case of PV on distribution feeders, small amounts of PV will have little effect on these spot prices and the two-way tariff will have similar economics to current net metering. As the penetration of PV increases during mid-day wholesale energy will drop and perhaps be negative. And the same time, the evening wholesale prices are likely to increase after the sun goes down. Also, as the midday reverse flow on the distribution grid increases, the transport price back to the wholesale grid will increase. Together these effects will provide the correct signal to reduce further PV investment and/or to install storage on the feeders. The subscriptions will provide stable revenues to the distribution operator and wholesale energy providers and stable benefits to PV owners.

Wholesale Market Design

Currently, wholesale energy producers and LSEs primarily use forward transactions, e.g., Power Purchase Agreements (PPA's) or resource ownership to serve their retail customers.

The CAISO spot market supports hourly transactions and 5-minute transactions.

Transmission will continue to be owned by transmission owners and made available to the ISO or by open access tariffs.

To implement the TE retail market design no changes to the wholesale markets are necessary.

But the CAISO wholesale spot market will need to evolve to meet the challenges of high renewables and low-carbon in 2030 and beyond. The CAISO was designed to optimally dispatch fossil generators within the transmission network operating constraints. As a result of the optimization, locational prices are calculated at each generation source, at inter ties to other areas, and at distribution/transmission substations.

Increasingly, with high renewables penetration, more storage, and continued transmission investment, most of the costs of wholesale power will be fixed. And with increasing over generation especially from solar there will often be no variable, fossil generation at the margin from which the optimization can calculate locational marginal costs that are meaningful.

The next logical step for the CAISO is to implement standard wholesale TE Platforms for energy at distribution/transmission substations. These platforms would allow the CAISO to frequently post forward buy and sell tenders for hourly and 5 minute intervals. The tenders would be based on the forward prices currently calculated by the CAISO network models and optimization. The tenders would be passed by the LSEs to retail customers and the resulting customer transactions aggregated and submitted to the CAISO TE Platforms. These transactions would be reflected in subsequent CASIO optimizations.

This evolution will continue as the CAISO transitions to use the TE market model for all transactions. Pilot projects to develop and test the necessary interfaces to the CAISO TE Platform should begin immediately.

Forward planning will increasingly be done by customers, commercial distributed generation and storage owners, and the distribution and transmission owners and less by the legislature and regulators.

Utility Business Model

The California IOUs and POUs in the year 2030 will continue to own the regulated distribution operators (DOs). With TE there is no need to create distribution system operators (DSOs) that act like ISOs for the distribution grid. This greatly simplifies the DO business model. The DOs will not be allowed to own or control any generation and storage or to directly control end customer usage, except perhaps under emergency conditions.

The current IOU and POU LSEs will be increasingly challenged by competition from competitive LSEs and customer and third party investment in distributed PV, other distributed generation and storage. Ideally, these LSEs should have no business linkages with any DOs and should be able to compete with competitive LSEs.

The transitions to utility business models with competitive LSEs and regulated DOs can be gradual. It also will be facilitated by the transition to subscription tariffs. Subscription tariffs for DOs are long-term contracts with customers that can support stable revenues for the DO investments and business model. This will help to minimize stranded assets. The sooner utilities transition to long-term, commercial contracts that are acceptable to both the customer and the LSE or DO, the better for all.

Subscription tariffs for LSEs can be unbundled into various classes of fossil, hydro and nuclear generation and storage. Current retail customers would subscribe to a set of these subscriptions. As these resources retire or the underlying wholesale contracts expire the corresponding subscriptions would retire. The LSE would be protected, temporarily from revenue losses until the costs are reduced. Customers would then be free to subscribe from competitive LSEs, buy their own generation and storage, or subscribe to shares of community generation and storage, for example. This gradual transition to more competitive energy will protect the current LSE investments and enable more competition to the benefit of California customers and new, innovative market entrants.

Utilities that want to continue to grow as independent LSEs will find opportunities in new competitive service businesses for electrification and automation of California's buildings, homes and transportation in all California and US service areas.

For example, utility LSEs will continue to be leaders in implementing the smart “Grid of Things.” LSEs will provide customers with advice on energy investments and operations. They will help customers set up Energy Management Systems and configure TE service interface software and hardware.

Asset Deployment

Many visions for the two-way more renewable and distributed grid of the future assume that massive investment and automation of the distribution and transmission grid must precede market transformation. These visions also assume an expensive and complex IDSO must be launched. Finally, the visions assume that a regulated LSE must contract for renewable and storage assets and that most planning is centralized by the IDSO.

Our vision takes a different faster, simpler and less expensive path. First low-cost two-way subscription tariffs enabled on low-cost TE platforms are deployed.

As these tariffs are adopted the deployment of smart end user technology and distributed generation and storage will accelerate. Home and business owners will have the economic information that they need to make sound investment and operating decisions. Third party distributed storage and generation will seek out locations on the distribution grid where they can sell subscriptions to end customers to finance their unregulated investments. Owners will be able to manage investment risk using the same tools big investors use today, i.e., forward transactions.

When the prices for transport distribution feeders and substations reach the point that capacity increases in either or both directions are economic then the customers on those feeders should agree to pay for the increases. They will pay for the increases by purchasing additional distribution transport subscriptions from the DO. The DO will then invest in new transport assets.

Transactive tariffs and on-board Energy Management Systems will lower the cost of operating electric and hybrid vehicles. This should encourage customers to buy more of them and pull California closer to its ZEV goal.

The standard TE tariff and standard TE Service Interfaces will allow distributed assets to slip smoothly into the electricity ecosystem. The standards and transaction protocols are developed, open and free. Wide spread voluntary and mandatory adoption will enable a Plug-and-Play process for any device.

Information Technology (IT)

As with asset deployment the TE vision takes a very different approach to IT software and communication protocols to make the system function.

A real advantage of the TE approach is that it is all about using computing, connection, and communication technology that already exists. The IT challenge is to write and test TE software in the utility environment.

There are two areas for development and testing: transaction platforms and interfaces to the LSE, distribution operator and the customer TE service interfaces.

- **Transaction Platforms**.

From the IT point of view, a Transaction Platform is a database that records tenders and transactions. The Platform also hosts the protocols and application programming interfaces (APIs) to do several tasks:

1. access existing tenders and transactions in the database and create tenders and transactions,
2. compute total schedules for energy delivery and transport use, and
3. compute the associated payments for products among parties

Many markets can be hosted on a platform and many platforms, each operating independently, can be hosted in the Cloud. The software for each is identical. Each market has a configuration data base where parties and locations are registered, locations are defined, products are identified, and time periods are specified.

- **TE service interface hardware/algorithms.**

The best place for the TE Service Interface is at the customer facility so it can manage devices even if connectivity is lost. Today's technology can control from a single box, a 1000 or more devices,e.g., smart appliances, and host the algorithms needed to respond to tenders, create transactions, and access weather application program interfaces (APIs) in the Cloud. The devices can access meter data every few seconds. Everything is kept private except transactions. All communication is internet based. Settlement calculations can eventually be distributed avoiding the need for large back office operations.

The computing and communication technology is ready. The algorithms need to be developed and tested with real two-way transactive tariffs.

- **Load Serving Entity (LSE) Interfaces**

The LSE interfaces posts forward and spot energy tenders and then receive accepted tenders (transaction) from the TE Service Interfaces. These tenders also form the basis for the subscription energy tariffs.

For cost-of-service LSEs the tender prices will be computed based on incremental long- and short-run costs using normal ratemaking processes. Competitive LSEs the tender prices will be set in competition with other LSEs, price responsive load and distributed generation and storage. Market making algorithms will be used by each LSE.

- **Distribution Operator (DO) Interfaces**

The operation of the distribution grid with the TE Vision will increasingly rely on autonomous control of end devices, using PV and storage inverter settings in addition to the two-way prices for distribution service tenders. The DOs need for new back office systems and Distributed Energy Resource Management Systems (DERMS) will be very limited or unnecessary.

The two way prices of distribution service are computed using the price formula described earlier.

Rates & Regulation

Rates (tariffs) using the two-way subscription retail tariff are fundamental to our design for the retail market as discussed previously.

Regulation with the TE business model can be much more focused on enablement of the TE business model, the specification of the roles of the parties, the standardization of the products transacted, the rules for market participation, and the policies for renewables, carbon, electrification, etc.

The competitive, decentralized TE business model promotes efficiency, fairness, and transparency. Once the TE business model is in place, regulatory and policy-making bodies will be able to focus on promoting competition and avoiding economic abuses. The TE forward transactions will greatly reduce the incentives for market manipulation of spot markets and will contribute to reliability.

The TE business model will relieve some planners of an impossible task. The emerging energy ecosystem is becoming too complicated for a centralized planning command-and-control operations. If we continue the path we are on our centralized, command-and-control system will ultimately collapse. It will collapse like many centrally planned economies collapsed. Central planners cannot make efficient investment and operating decisions because they only know costs. They do not know the benefit of energy use or efficiency. The objective of system investments and operations is to maximize net social benefit. This requires both benefit and cost information.

Only producers and customers know the benefit and the cost. Net social benefit will be maximized if customers and producers are to be able to make autonomous decisions within carefully designed TE platforms and transaction rule and carefully designed public policy regarding pricing, standards and restrictions on carbon and other environmental impacts and promotion of competition.

The roadmap for the TE Vision is summarized in the following figure. Today is on the left. The year 2030 is on the right. The activities that will get us to the TE business and regulatory model are in the middle.

The California TE Stewardship Board

The transition to TE will involve change. Change involving many entrenched stakeholders is never easy. Only babies like to be changed.

In the last decade, Californians have discovered a new mechanism for implementing policy changes: the Stewardship Board. A Stewardship Board is empowered to implement policy and monitor changes in parallel with established lines of authority and responsibility. The approach has worked at least twice to implement high visibility, high impact policy.

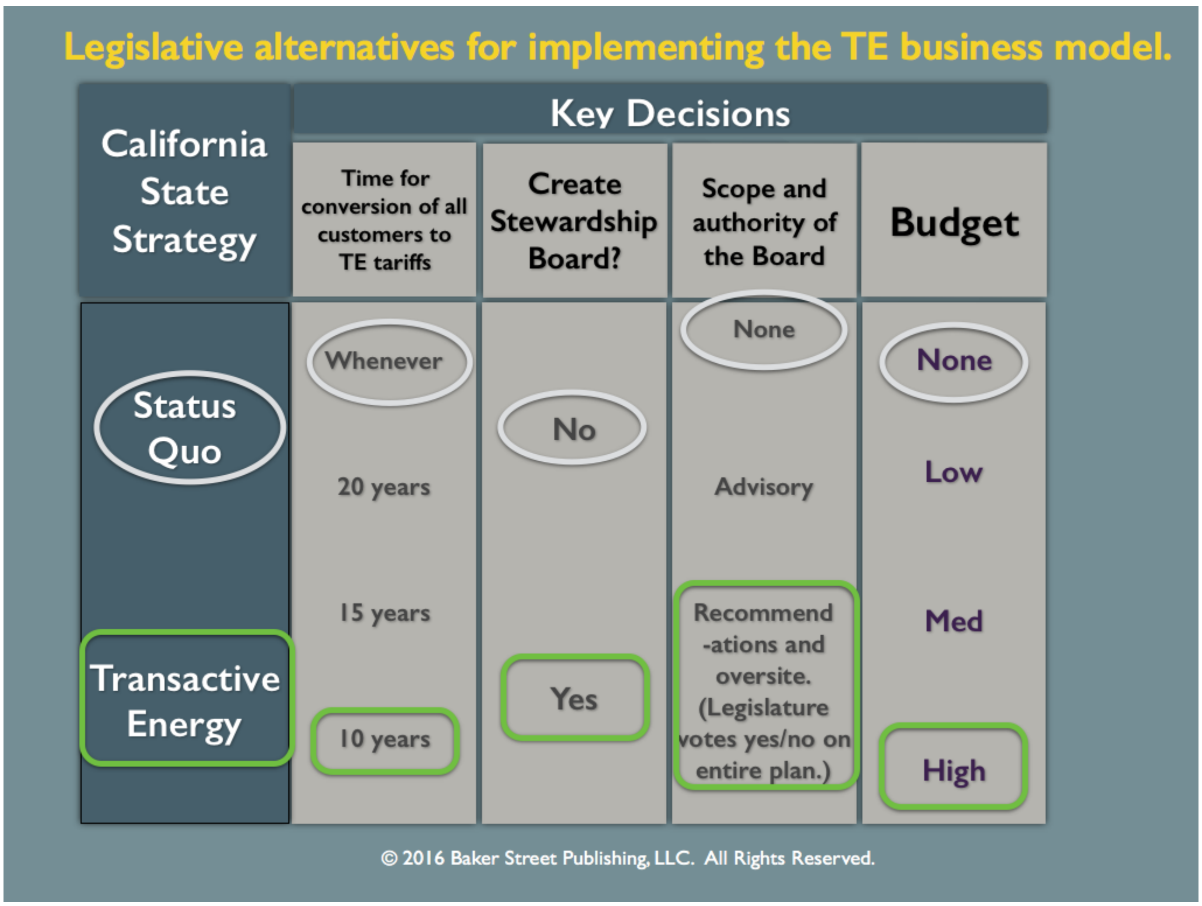
The first application of the Stewardship Board was the Marine Life Protection Act (MLPA). This act directed the California Secretary of Resources to design and implement a network of marine protected areas along the entire coast of California. The Secretary of Natural Resources appointed a Blue Ribbon Task Force to act as the Stewardship Board.

The second application was the redrawing of the voter district lines statewide. This was accomplished by creating the California Citizens Redistricting Commission. Both the

MLPA and voter redistricting were implemented on schedule with massive stakeholder involvement and expert participation.

We believe this approach is appropriate for implementing the TE business model in California. The formation and composition of the Stewardship Board would be directed by the California legislature as in the case of the "Boards" for the MLPA and voter redistricting. Responsibility for implementation of policy ultimately rests with the Governor.

The Stewardship Board could be appointed by the Governor or recruited according to a process set out by the legislature, as in the case of voter redistricting.



The strategy we recommend includes four decisions. The four decisions set deadlines for the conversion of customers to the TE retail tariff; create the Stewardship Board; define the scope of the Board's responsibility, and establish the size of Board's budgets. See the strategy table below. The white ovals in the figure define the "status quo" strategy. The green boxes define the recommended TE strategy.

Timing

When the Marine Life Protection Act (MLPA) was passed in 1999, the California State legislature directed the Department of Fish and Wildlife to design and implement a network of marine reserves along the coast of California. They gave the Department 11 years to make it happen. In 2009 the State took a similar approach with the redesign of the voting districts.

We think the State should take the same approach with Transactive Energy. The legislature should set clear objectives, specify responsibility, and establish a deadline when the transformation should be complete. A deadline for completion would establish the pace of change, milestones, and required budgets.

The California PUC has already mandated that TOU rates be available to all customers by 2019. An automated TE subscription tariff could be implemented in the same time frame. One advantage of the TE tariff is that it can be implemented in parallel with virtually any other tariff structure. Customers can accept it on a voluntary basis. Even with the standard TE tariff there can be support for fixed-price tariffs and low-income discounts.

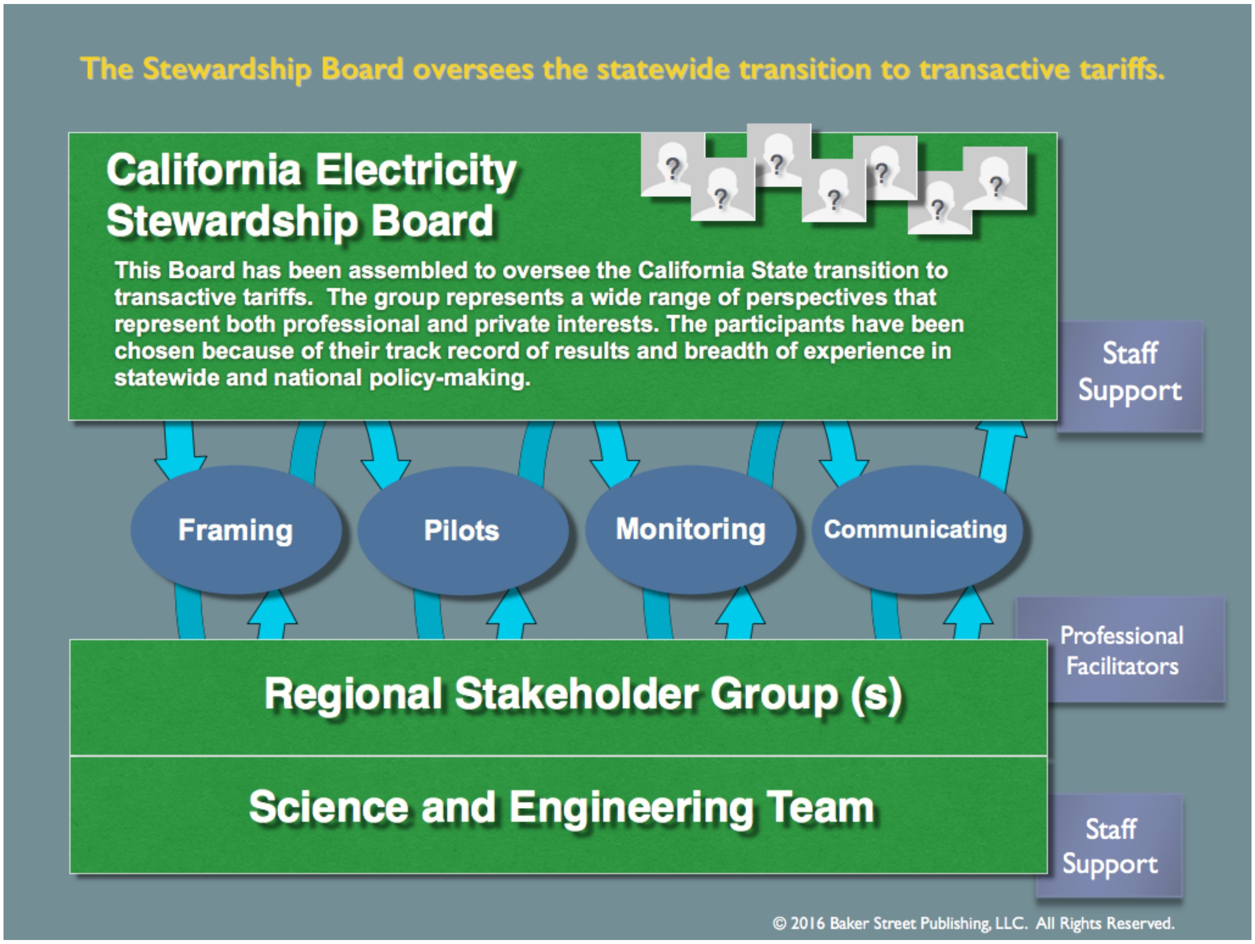
We think the TE model can be widely implemented statewide with adequate funding and stewardship. The sooner the transformation takes place, the sooner the benefits will be realized.

Stewardship Board

Implementation of the MLPA was accomplished by appointing a Blue Ribbon Task Force to make network design recommendations to the State. The Board oversaw a public process that involved many experts and multitudes of stakeholders.

There are two basic alternatives for defining the scope and authority of the Stewardship Board. The first alternative is for the Board to be granted full authority to develop a plan with advice of its technical experts and the input of all parties; to direct its implementation; to monitor the results; and to make adjustments for transition of the utilities and their retail customers to the TE model. The legislature could only reject or accept the entire plan of the Board with an up or down vote and at the same time approve the recommended changes.

Alternatively, the Board plans could be advisory and the legislature could then decide on its implementation. We recommend the first alternative because the politics of energy policy have proven to be extremely challenging and have led to failure as in the case of AB 1890.



Budget

The Stewardship Board will need a budget in order to make and implement decisions. The Board will have a staff of consultants, contractors, and expenses. The Board will monitor projects, facilitate public participation, and support communication activities, and reporting. They may fund pilots and prototype development or recommend the funding by the IOUs and the CPUC.

The direct cost of the Marine Life Protection Act (MLPA) Initiative was about $25 million. The voter redistricting project cost about $7 million. (It was grossly underfunded according to people involved.) Both of these efforts were funded from a combination of public and private sources. The exact budget for TE depends on the mission and timing of the business and regulatory model conversion.

The cost of these efforts should be compared with the cost of the current regulatory process and the cost of missed opportunities if changes are delayed. It is important to note that both the MLPA Initiative and the California statewide voter redistricting are regarded as major policy implementation successes.They were both completed on time.

Summary

For the best possible results, the decision to implement the TE business and regulatory model statewide will have to be made by the California legislature. The pace of the change should be set by the legislation, just as it was with the MLPA and voter redistricting. The legislature also needs to specify mission, makeup, and budget for a Stewardship Board.

The focus of change should be on changing retail tariff structures from legislatively enforced tariffs based on fixed prices to a system of forward subscriptions and spot prices. The legislation should also be clear that the intent is to separate energy and transport services and to facilitate a transition to competitive two-way transactions for energy on transaction platforms overseen by the CPUC and POU boards.

The ultimate goals are lower energy service costs through greater efficiency and lower investment risk by small investors. Less energy use together with the shift to renewables will result in less carbon emissions.

The current energy system is overly complicated and it does not provide customers and decentralized energy developers with the information they need to make investment and operating decisions that are consistent with social goals.

All utilities are concerned with the future viability of their business model. The model is threatened by increasing self-generation by customers and the resulting decrease in revenues from those customers. Customers want reasonable costs of electric service and the right to make their own choices for electricity self-supply or purchased supply. Customers with self-supply want the option to sell their excess supply at fair prices.

The State is passing policies to increase distributed generation, storage, and solar and wind electricity technologies. Successful implementation of these policies requires coordination of operation and investment and contractual obligations among the parties. The TE model offers the promise of resetting the system for everyone's benefit—and sparking statewide innovation.

For more information about this business model see following:

Transactive Energy: A Sustainable Business and Regulatory Model for Electricity, , Stephen Barrager, Ph.D., and Edward Cazalet, Ph.D., 2014 (A digital version of the book is available Amazon and iTunes. A paper version is forthcoming from Public Utility Reports.)

Transactive Energy: A Surreal Vision or a Necessary and Feasible Solution to Grid Problems?, White Paper, California Public Utilities Commission, 2014

Slideshare - Transactive Energy: A Sustainable Business and Regulatory Model for Electricity

Automated Transactive Energy by Edward G. Cazalet, Ph.D., Grid Interop, 2011.

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