Forward Looking Vision:

Advanced DERs & Demand Flexibility Management

Aloke Gupta
DR Section, Energy Division
May 25, 2021

Agenda

- System Needs
- Opportunity
- Current Approach
- Forward Looking Vision
- Proposed Roadmap
- Discussion

Executive Summary

Policy Objective

Improve demand-side resource management…

- Through more effective demand response (DR) and retail rate structures,
- That leverage opportunities enabled by long term electrification and DER deployment,
- To better address grid issues associated with the growth of renewables, electrification, and DER adoption, and support California's clean energy goals.

Staff Proposal

Jointly pursue reforms of DR programs and Rate structures to Promote *Unified Strategies for Demand (Load) Management and Grid Optimization* to achieve *widespread demand flexibility*.

Anticipated Issues over the Next Decade

Increasing renewables penetration

- Increased curtailment
- Steeper ramps ➔ reliability challenge
- Increased reliance on intermittent, use-limited supply ➔ reliability challenge

Increasing electrification of end uses (buildings, transportation)

- Increased cost of service due to higher load, if unmanaged

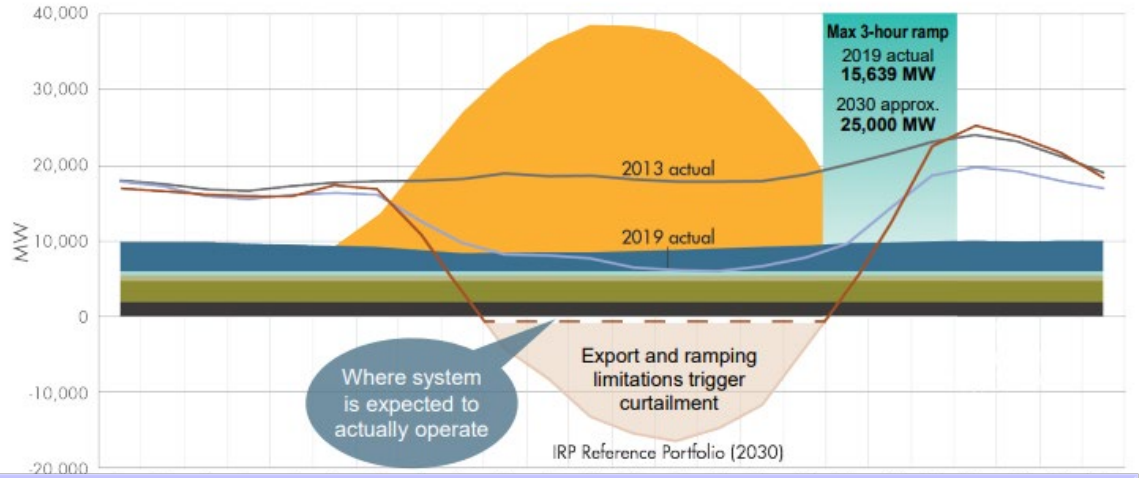
Increasing DER deployment

- Grid instability and increased cost of service, if unmanaged
- Fair compensation and cross-subsidy challenges

2019 IRP* Reference System Plan Implications

System trends by 2030:

- 60% increase in evening ramp
- Substantial increase (15x) in renewables curtailment



IRP analysis:

- DR can be a cost-effective alternative for renewables integration resources
- But highly scalable, low-cost deployment strategies are needed to realize that potential

Graphic from CAISO *"Briefing on Post 2020 Grid Operational Outlook,"* Mark Rothleder, VP, @ CAISO BOG, December 19, 2019

Agenda

- System Needs
- **Opportunity**
- Current Approach
- Forward Looking Vision
- Proposed Roadmap
- Discussion

Opportunity: Proliferation of DERs & Electrification ➔ Demand Flexibility

- **Doubling of rooftop solar** — **20 GW**
- **3.5x growth in BTM storage** — **5.5 GWh storage capacity**
- **Transportation electrification** — **5M EVs ~ 250 GWh aggregate storage capacity**
  - ~ 4.5x utility storage
- **Building decarb** — **Substantial growth of smart, flexible end uses**
  - Smart devices & plugs
  - Smart thermostats/heat pumps,
  - Smart electric (heat pump) water heaters
- **Growth of microgrids and other flexible emerging end uses**

Opportunity or Threat

Agenda

- System Needs
- Opportunity
- Current Approach
- Forward Looking Vision
- Proposed Roadmap
- Discussion

Current Approaches to Achieving DR (Demand Flexibility)

- **Time-Differentiated Rates (Load Modifying DR)**
  - Increasing number of special purpose IOU rates: TOU, CPP, EV, SGIP GHG signal …
  - Increasing number of CCAs & Rates!
  - Lengthy ratemaking process, generally lagging (out of date), sometimes conflicting
  - Administratively complex & confusing to customers, industry

- **Market-Integrated, Incentive-based DR Programs (Supply Side DR)**
  - Multiple programs focused on load shed as resource adequacy
  - Challenges in CAISO market integration, measurement & verification
  - Considering new programs for load shift DR
  - Administratively & technically complex, inefficient, high transaction costs

Current Procurement Options
- IOU DR programs
- IOU LCR DR contracts
- DRAM
- CCA DR contracts

Issues with Market Integrated Pathway (Per Joint Solar/Storage Parties in Resource Adequacy Rulemaking*)

All BTM DERs providing capacity should have the option to forgo market integration, as ***the market-informed pathway is simpler and avoids obstacles impeding DER providers****, such as the following:*

1. Issues surrounding interconnection of exporting resources are eliminated as Rule 21 clearly governs.
2. Complexity and cost associated with market integration and dispatch are also eliminated.
3. Issues associated with visibility at the T&D interface, necessitating communication and visibility of resource performance by both the distribution operator and the CAISO, are eliminated.
4. Concerns associated with double payment for electricity from NEM systems - wholesale market revenue for settled resource export vs. retail bill credits for NEM - are eliminated.
5. Aggregators are better able to dispatch resources to meet specific local needs, rather than rely entirely on system-level CAISO dispatch, which may be inconsistent with local needs.
6. Thorny issue of deliverability to the transmission system is avoided entirely.
7. The only CAISO tariff for Rule 21 connects DERs is PDR, which does not credit energy exported to the grid.

***Joint Solar/Storage Parties Track 4 Proposal, January 28, 2021, at 4. RA Proceeding R.19.11.009 (SUNRUN, CESA, CALSSA, TESLA, CEERT, VOTE SOLAR, AND ENELX)**

Current Approaches to Achieving Demand Flexibility

- **Time-Differentiated Rates (Load Modifying Demand Response [DR])**
  - Increasing number of special purpose IOU rates: TOU, CPP, EV, SGIP GHG signal …
  - Increasing number of CCAs & Rates!
  - Lengthy ratemaking process, generally lagging (out of date), sometimes conflicting
  - Administratively complex & confusing to customers/indus

➔ Complex, inefficient, expensive, confusing
➔ Limited adoption, Difficult to scale
➔ High cost of controls, automation

- **Market-Integrated, Incentive-based DR Programs (**
  - Multiple programs focused on load shed as resource adeq
  - Challenges in CAISO market integration, measurement & verification
  - Considering new programs for load shift DR
  - Administratively & technically complex, inefficient, high transaction costs

- IOU DR programs
- IOU LCR DR contracts
- DRAM
- CCA DR contracts

- **Distribution level DR**
  - Additional localized, temporary rate/incentive tariffs or
  - Incremental DER procurement contracts

Path Forward: Consolidation

Present

Basket of Rates
(cost recovery / allocation, equity)

Basket of Supply-Side Programs
(market integrated)

+ TBD: Load Shift Programs

Distribution Level DR

- ➔ Complex, inefficient, expensive, confusing
- ➔ Difficult to scale, Limited adoption
- ➔ High cost of controls, automation

Future

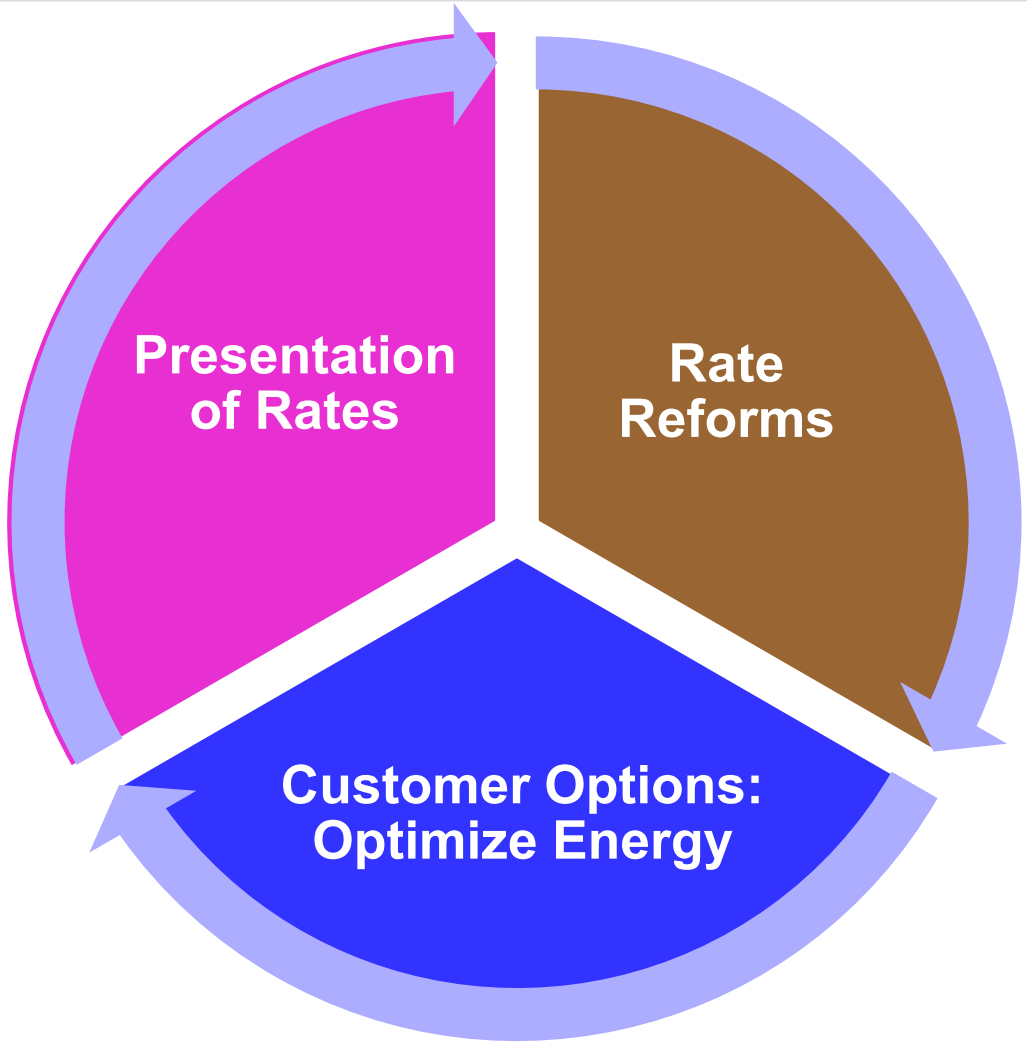
Demand Side: Unified, universal, dynamic, economic (UNIDE) signal

- ➔ Reduced complexity, Single point focus
- ➔ Highly scalable, widespread adoption
- ➔ Reduced cost of controls, automation

Agenda

- System Needs
- Opportunity
- Current Approach
- **Forward Looking Vision**
- Proposed Roadmap
- Discussion

Three Part Vision ➔ UNIDE



Demand-side: unified, universal, dynamic, economic (UNIDE) signal

Goal: Achieve Widespread Demand Flexibility

Leverage significant opportunity resulting from electrification, DER adoption

Challenges

Increasing renewables penetration

- Increased curtailment
- Steeper ramps ➔ reliability challenge
- Increased reliance on intermittent, use-limited supply ➔ reliability challenge

Increasing electrification of end uses (buildings, transportation)

- Increased cost of service due to higher load, if unmanaged

Increasing DER deployment

- Grid instability and increased cost of service, if unmanaged
- Fair compensation and cross-subsidy challenges

Opportunities

➔Enhance renewables integration & reduce emissions

- Reduce curtailment

➔Enhance reliability

- Reduce system ramp
- Intermittent supply balanced by dispatchable demand
- Managed coordination of DER operations

➔Minimize cost of service

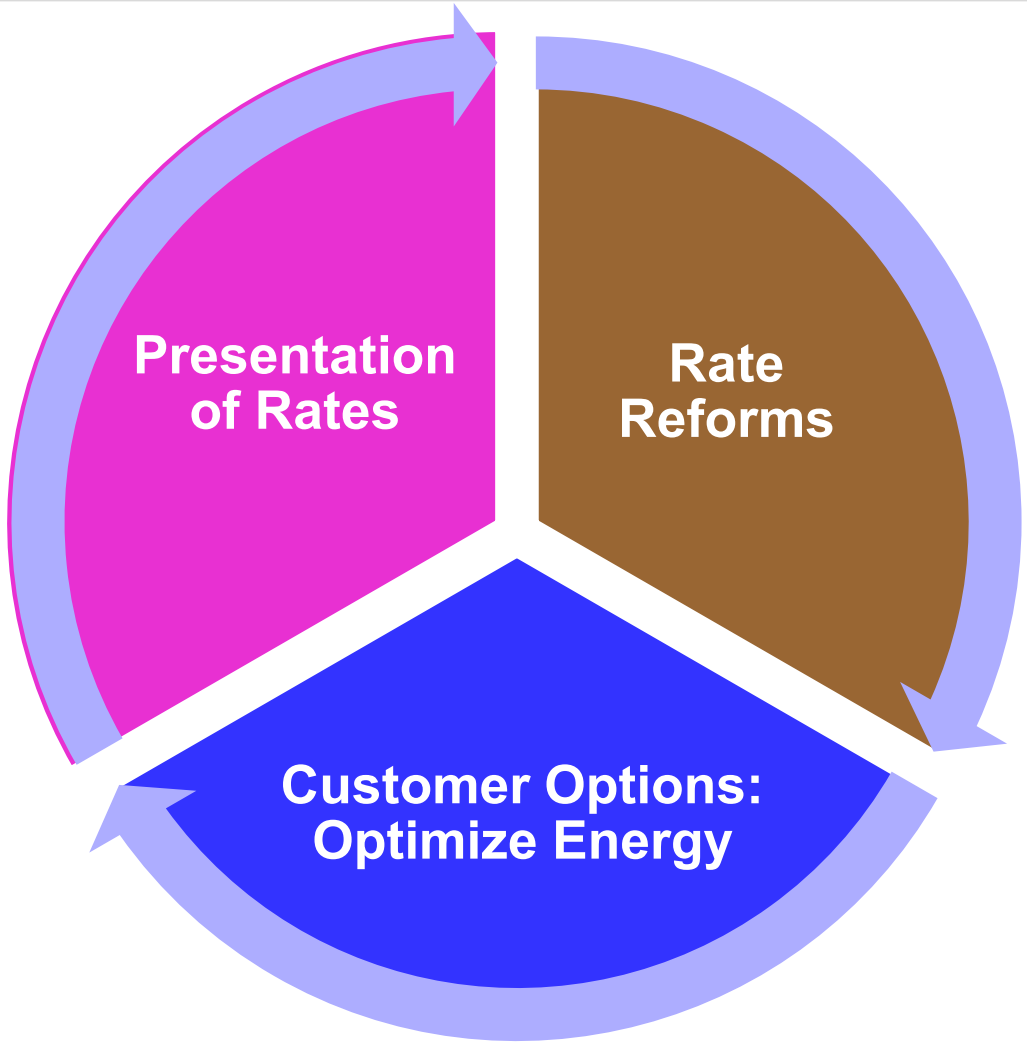
- Managed load growth and DER operations

➔Provide fair compensation of DER services stack

Agenda

- System Needs
- Opportunity
- Current Approach
- Forward Looking Vision
- **Proposed Roadmap**
- Discussion

Three Part Vision ➔ UNIDE



Demand-side: unified, universal, dynamic, economic (UNIDE) signal

Proposed Roadmap

Step 1:

Step 2:

Step 3:

Step 4:

Step 5

Step 6

Demand Side: unified, universal, dynamic, economic (UNIDE) signal

Electricity Price Presentation to Customers (Today)

ENERGY STATEMENT
www.pge.com/MyEnergy

Details of PG&E Electric Delivery Charges

12/19/2019 - 01/17/2020 (30 billing days)

Service For: [redacted]
Service Agree
Rate Schedule: E1 X Residential Service

12/19/2019 – 12/31/2019	Your Tier Usage	1	2	
Tier 1 Allowance	136.50 kWh	(13 days x 10.5 kWh/day)		
Tier 1 Usage	136.500000 kWh	@ $0.22981		$31.37
Tier 2 Usage	137.800000 kWh	@ $0.28920		39.85
Generation Credit				-32.30
Power Charge Indifference Adjustment				7.43
Franchise Fee Surcharge				0.19
San Jose Utility Users' Tax (5.000%)				2.32
San Jose Franchise Surcharge				0.14

01/01/2020 – 01/17/2020	Your Tier Usage	1	2	
Tier 1 Allowance	178.50 kWh	(17 days x 10.5 kWh/day)		
Tier 1 Usage	178.500000 kWh	@ $0.23581		$42.09
Tier 2 Usage	180.200000 kWh	@ $0.29675		53.47
Generation Credit				-42.25
Power Charge Indifference Adjustment				9.72
Franchise Fee Surcharge				0.24
San Jose Utility Users' Tax (5.000%)				3.15
San Jose Franchise Surcharge				0.19

Total PG&E Electric Delivery Charges **$115.61**

2018 Vintaged Power Charge Indifference Adjustment

pge.com

PAY YOUR BILL

REPORT & VIEW ELECTRIC OUTAGES

START OR STOP SERVICE

GET PAYMENT ASSISTANCE

MAKE PAYMENT ARRANGEMENTS

REPORT GAS LEAK OR DOWNED LINE

current electricity price at my

Ad · www.globalenergyinstitute.org/electricity/c...

U.S. Electricity Prices | Cost of Electricity by State |...

Electricity bills too high? You may be paying more than neighboring states. See where your state ranks, and compare it to the...

Join Us | Get Involved | Resource Center

ElectricChoice.com › electricity...

Electricity Rates by State (Updated January 2020) – Electric Choice

STATE	JUNE 20...	JUNE 20...	MOVEM...
Alabama	12.41¢ / ...	12.79¢ / ...	DOWN
Alaska	22.54¢ / ...	22.14¢ / ...	UP
Arizona	13.16¢ / ...	12.65¢ / ...	UP

View 48 more rows

current weather at my locatio

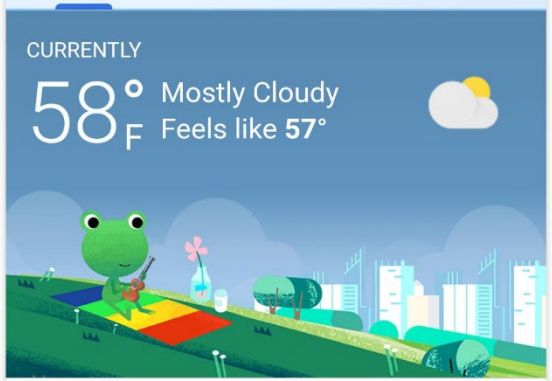
ALL NEWS MAPS VIDEOS IMAGES

Murillo, San Jose, CA

TODAY TOMORROW 10 DAYS

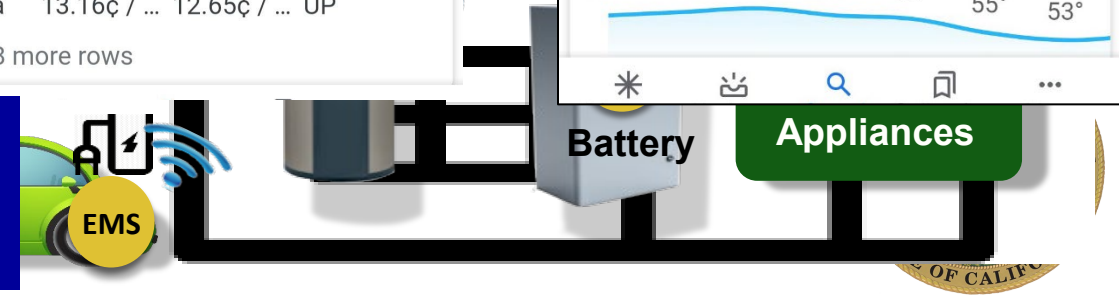
CURRENTLY

58° F Mostly Cloudy
Feels like 57°



Today, February 23
Partly Cloudy
64° 47°

60° 61° 62° 60° 59° 55° 53°



- Practically non-existent information on "current" electricity price
- Price discovery ~ difficult process
- "Manual" EMS configuration in field ➔ expensive

Step 1: Standardized, Universal Access to Electricity Price

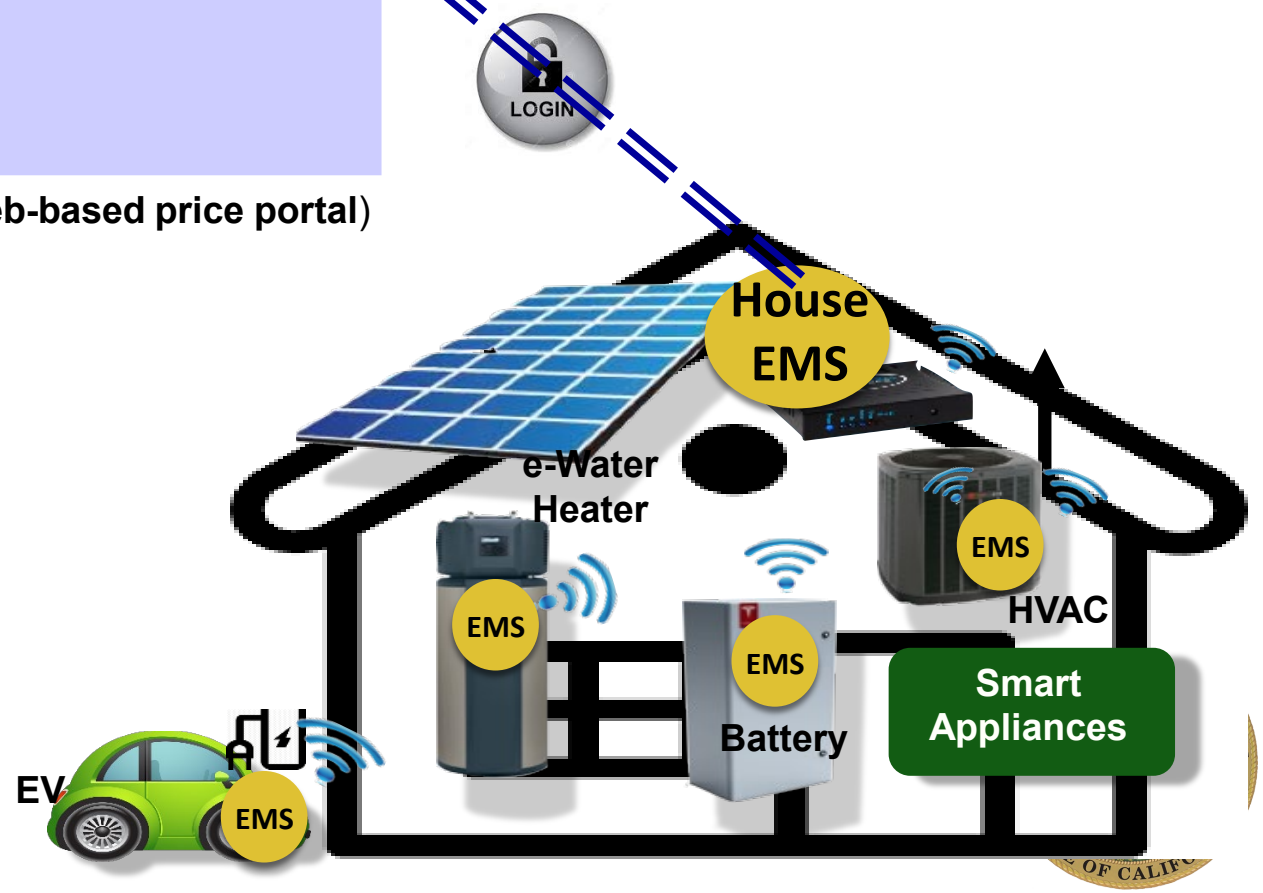
https://MyElectricityPrice.com

John Doe
Address
Account #

← P_{1PM} P_{2PM} P_{3PM} P_{4PM} ….

(standardized, statewide, **web-based price portal**)

1. **Consume @ Current Price**



Step 1: Standardized, Universal Access to Electricity Price

https://MyElectricityPrice.com

John Doe
Address
Account #

← P_{1PM} P_{2PM} P_{3PM} P_{4PM} ....

(standardized, statewide, **web-based price portal**)

1. Consume @ Current Price

Price Machine
(Cloud Platform)

Σ

DO
$P_{Distribution}$

LSE
$P_{Generation}$

6	Investor-Owned Utilities
24 → 50	Community Choice Aggregators
40	Municipal Utilities

LOGIN

Third Party Service Providers (TSPs)

House EMS

e-Water Heater

EMS

HVAC

EMS

EMS

Battery

Smart Appliances

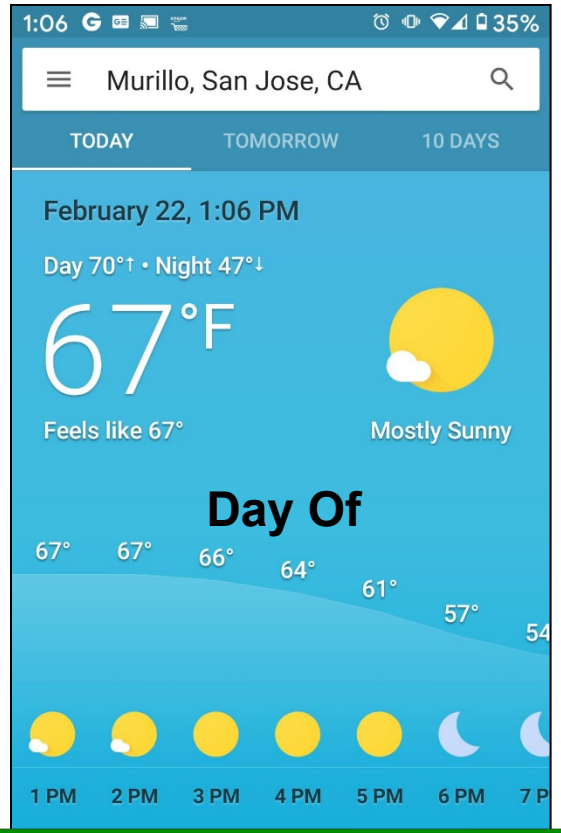
EV

EMS

→ Input at set up

Auto-Configuration of Smart Devices

- **Buy and install smart device**
- **Embedded EMS automatically connects (via internet) to…** https://www.MyElectricityPrice.com
  - Access real-time price time series (hourly, sub-hourly)
  - Day-ahead forecast, hour-ahead forecast
- **Remote upgrade of EMS as needed for changes, new features**



➔ **Enable Scalability, Wide-scale Adoption**

Step 1: Standardized, Universal Access to Current Electricity Prices

1. Provides current, localized, composite electricity price specific to a service territory and customer

2. Accommodates pricing inputs from regulatory entities (DO, LSE)

3. Leverages large “ecosystem” to educate and help customers manage energy and DERs

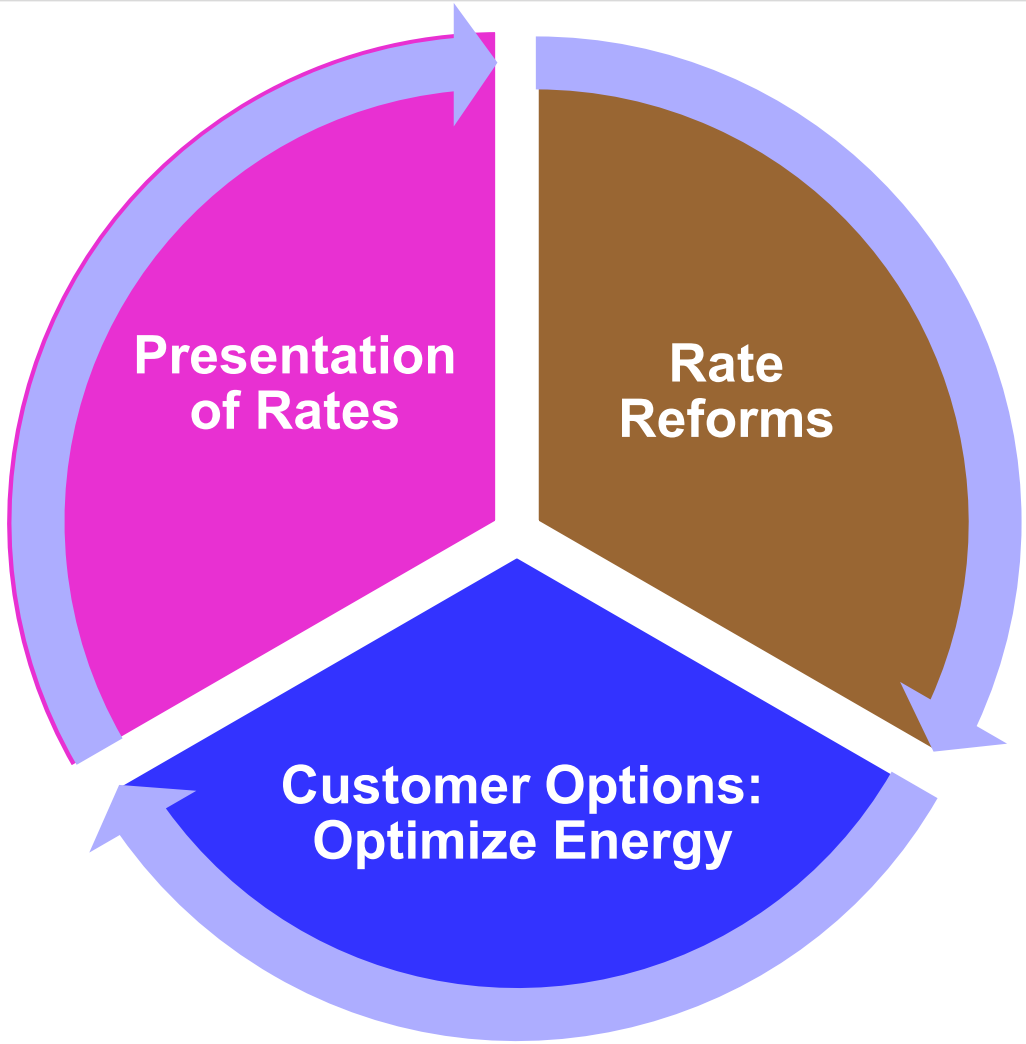
4. Facilitates widespread adoption ← → cost reduction of demand (load) management automation

Proposed Roadmap: Step 1

Step 1: Develop standardized, universal access to current electricity price

Demand Side: unified, universal, dynamic, economic (UNIDE) signal

Three Part Vision → UNIDE



Demand-side: unified, universal, dynamic, economic (UNIDE) signal

- **Staff Proposals**
- **Opt-in!**
- **UNIDE Goal**

Proposed Roadmap: Step 2

Step 1: Develop standardized, universal access to current electricity price

Step 2: Introduce dynamic prices based on real-time, wholesale energy cost *(opt-in)*

Demand Side: unified, universal, dynamic, economic (UNIDE) signal

Step 1: Standardized, Universal Access to Electricity Price

https://MyElectricityPrice.com

John Doe
Address
Account #

← P_{1PM} P_{2PM} P_{3PM} P_{4PM} ....

- Hourly, [15 min, 5 min]
- Next day, 24 x hourly

(standardized, statewide, **web-based price portal**)

1. Consume @ Current Price

Price Machine
(Cloud Platform)
Σ

DO
$P_{Distribution}$

LSE
$P_{Generation}$

California ISO

LMP

Input at set up

Real-time

LOGIN

Third Party Service Providers (TSPs)

House EMS

e-Water Heater

EMS

HVAC

EMS

EMS

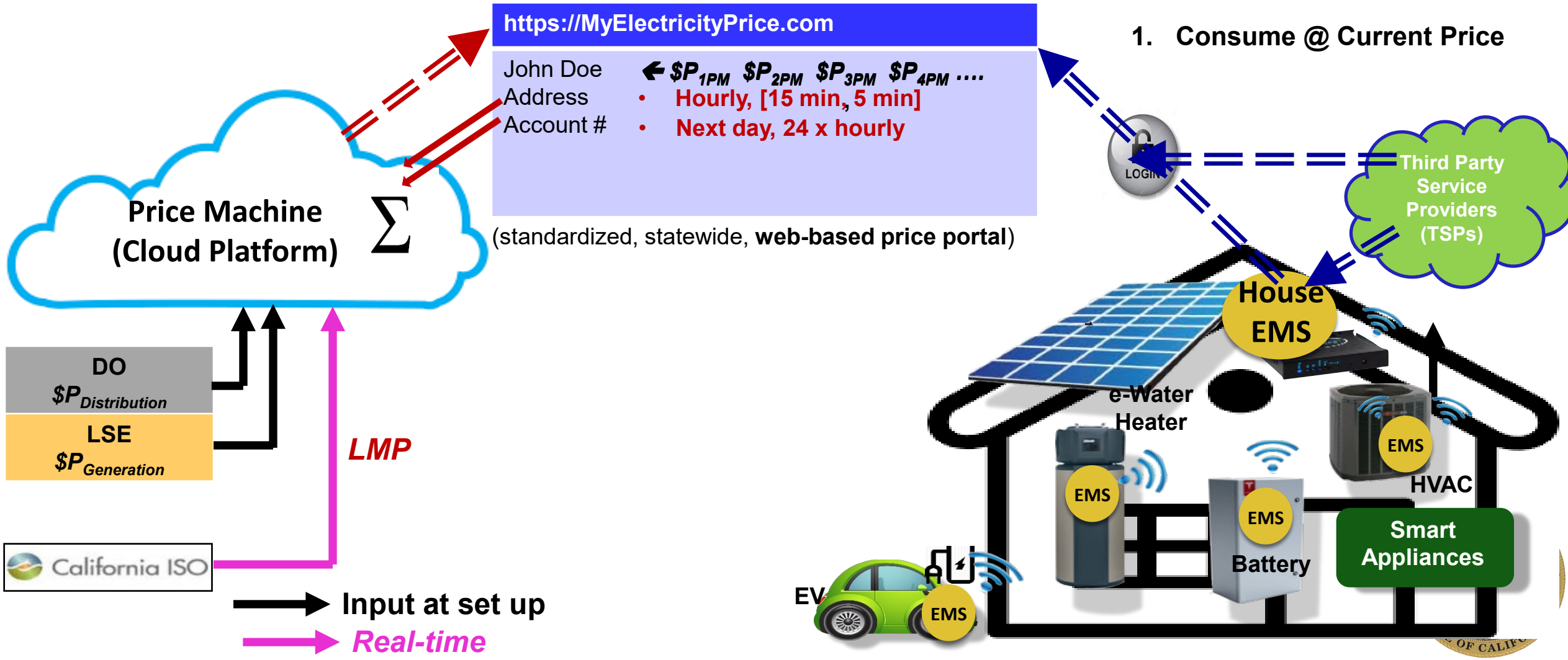
Battery

Smart Appliances

EV

EMS

Step 2: Introduce Dynamic Price per CAISO Wholesale Energy Cost



CAISO Energy Day-Ahead Market (DAM): Price Statistics*

	Units	2018	2020
Weighted average DAM price (WADP)	**¢/kWh**	4.4	3.9
% annual hours below WADP		71.8%	76.4%
% annual hours below 2 x WADP		96.4%	97.5%
# annual hours above 2 x WADP	Hours	315	222
Lowest DAM Price	**¢/kWh**	-1.6	-1.0
# hours below $0	Hours	75	41
Highest DAM Price	**¢/kWh**	93.5	101.9
Highest DAM price to WADP ratio		21.2x	26.2x
Price Range in Top 10% of Net Load	**¢/kWh**	11.8 – 93.5	8.8 – 101.9
# hours responsible for Top 10% of net load	Hours	30	29

*Preliminary estimates – not peer reviewed

Step 2: Real-Time Locational Price Linked to CAISO Markets

1. Reflects CAISO market conditions, encourages load shift or increase
2. Helps reduce curtailment, evening ramp, emissions
3. Helps enhance reliability
4. Helps reduce energy procurement costs (reduces hedging cost)
5. Complements anticipated updates to CEC's Title 20 (Load Management Standards)

Electricity Price Dissected - Energy

Generation	Fixed - generation capacity	Variable - energy
Distribution	Fixed - distribution grid capacity	
Misc	Metering, Billing, Legal, G&A…	
Transmission	Fixed - transmission grid capacity	

Electricity Price Dissected - Capacity

Generation	Fixed - generation capacity	Variable - energy
Distribution	Fixed - distribution grid capacity	
Misc	Metering, Billing, Legal, G&A…	
Transmission	Fixed - transmission grid capacity	

Proposed Roadmap: Step 3

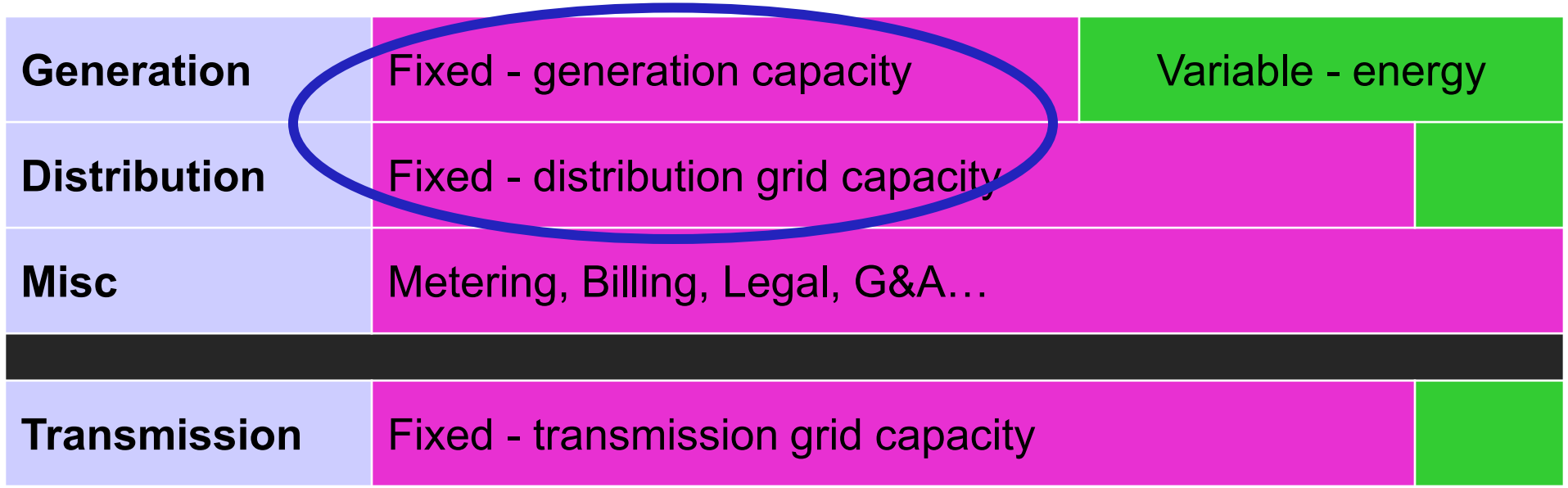
Step 1: Develop standardized, universal access to current electricity price

Step 2: Introduce dynamic prices based on real-time, wholesale energy cost ***(opt-in)***

Step 3: Modify prices per real-time, localized grid conditions *(opt-in)*

Demand Side: unified, universal, dynamic, economic (UNIDE) signal

Electricity Price Dissected - Capacity

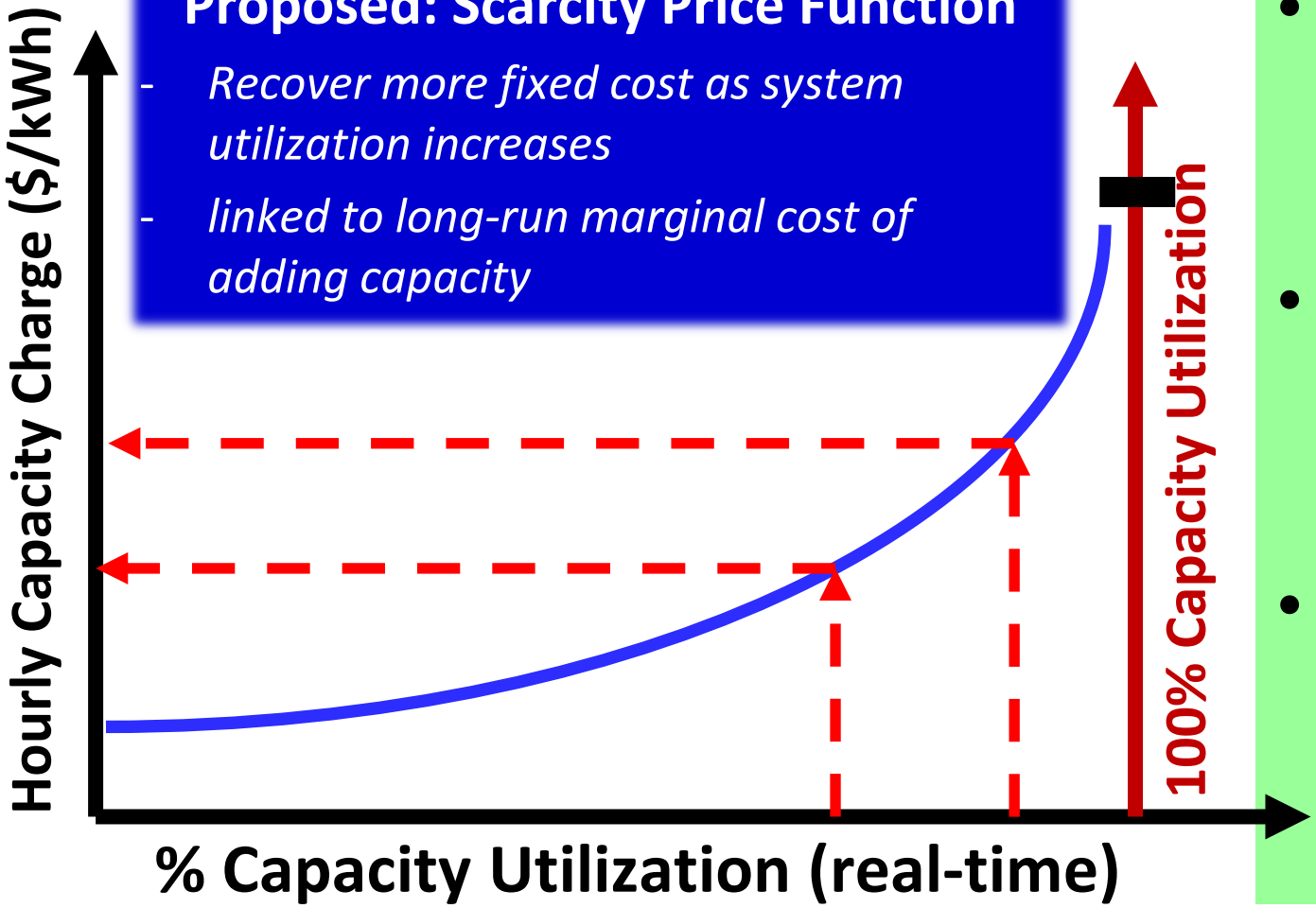


1. **Composite and component prices must be time-dependent, volumetric: $/kWh**
   - Not based on capacity: $/kW (such as, monthly demand charges)
   - Not based on historical consumption (such as, stepped tiers)
2. **Recover more fixed cost when system utilization is higher**
   - aka “scarcity price function”

Step 3: Fixed Cost Recovery - Options

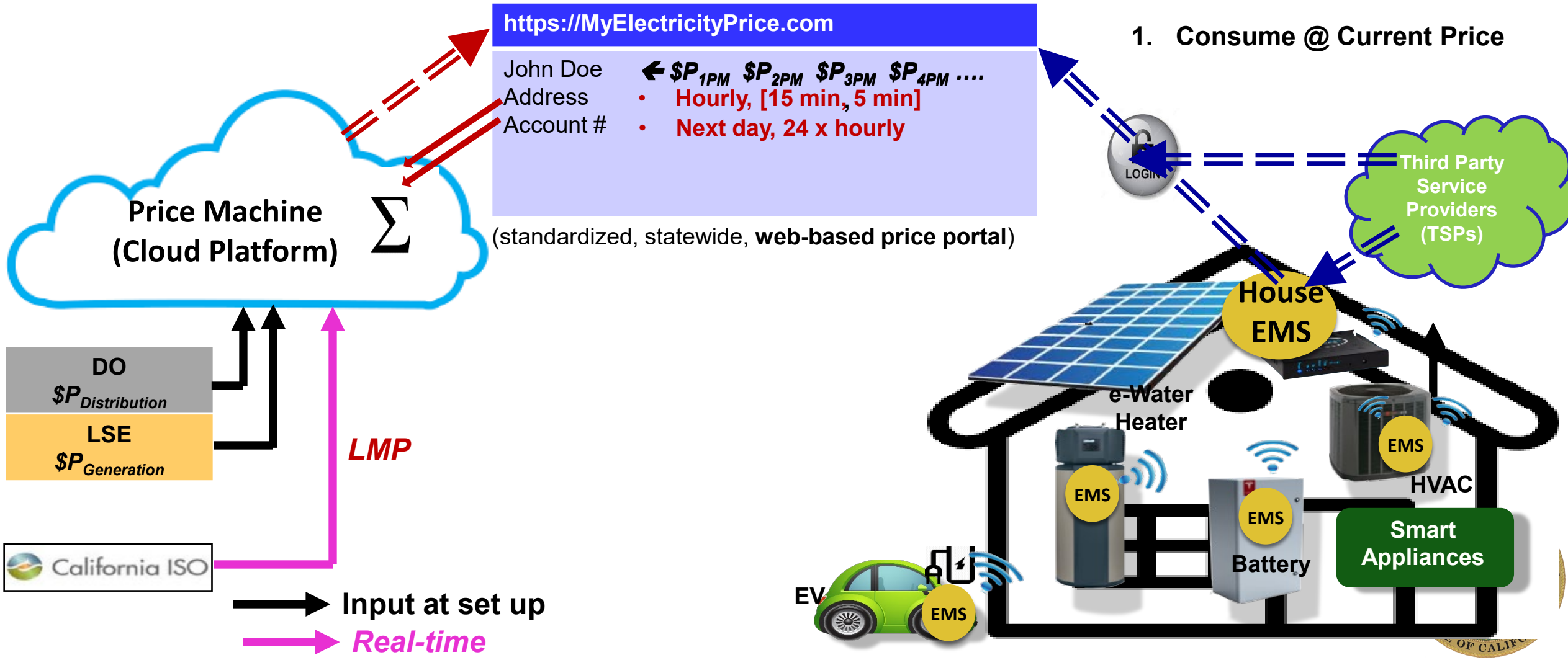
Proposed: Scarcity Price Function

- *Recover more fixed cost as system utilization increases*
- *linked to long-run marginal cost of adding capacity*



- **Current approaches**
  - ***Non-Residential***: Non-coincident demand charge based on *customer's* peak load
  - ***Residential***: Constant volumetric charge
- **Issues with current design**
  - Encourages non-economic behavior
  - No signal to reduce high coincident peaks
  - Increase in cost of service with higher load
- **Fixed Capacity Constraints**
  - Distribution capacity
  - Generation capacity (Resource Adequacy)
  - Ramping capacity (Flex Resource Adequacy)

Step 2: Introduce Dynamic Price per CAISO Wholesale Energy Cost



Step 3: Modulate Electricity Price Per Local Grid Conditions

https://MyElectricityPrice.com

John Doe
Address
Account #

← P_{1PM} P_{2PM} P_{3PM} P_{4PM} ….

- Hourly, [15 min, 5 min]
- Next day, 24 x hourly

(standardized, statewide, **web-based price portal**)

1. Consume @ Current Price

Price Machine
(Cloud Platform)

Σ

LOGIN

Third Party Service Providers (TSPs)

Real-time Grid Conditions
x = Circuit Aggreg Load
y = LSE Aggreg Load
z = LSE Net Load Ramp

DO
$P_{Distribution} = f(x)$

LSE
$P_{RA\ Capacity} = g(y)$

LSE
$P_{Flex\ RA} = h(z)$

California ISO

LMP

House EMS

e-Water Heater

EMS

HVAC

EMS

EMS

Battery

Smart Appliances

EV

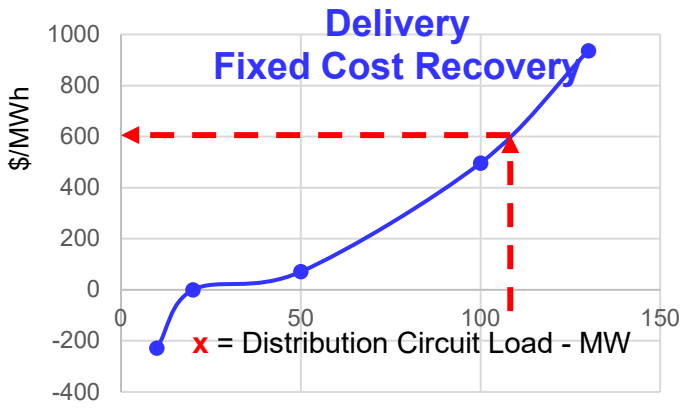
EMS

Input at set up

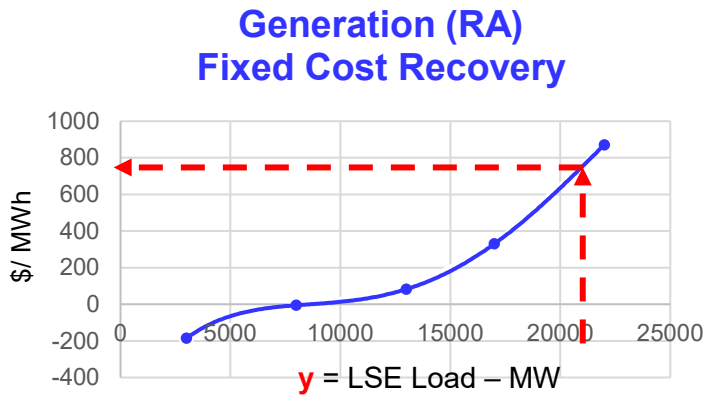
Real-time

Developing a Composite Economic Signal based on Grid Utilization*

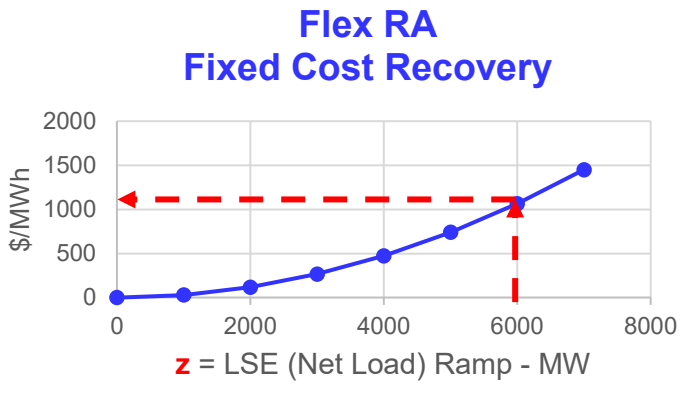
- **Scarcity pricing functions & grid conditions determine Delivery, Generation and Flex prices:**
  - Based on long-run marginal cost of adding new capacity
  - Designed to recover the required annual revenue in the target year



DO: $P_{Distribution} = f(x)$



LSE: $P_{RA Capacity} = g(y)$



LSE: $P_{Flex RA} = h(z)$

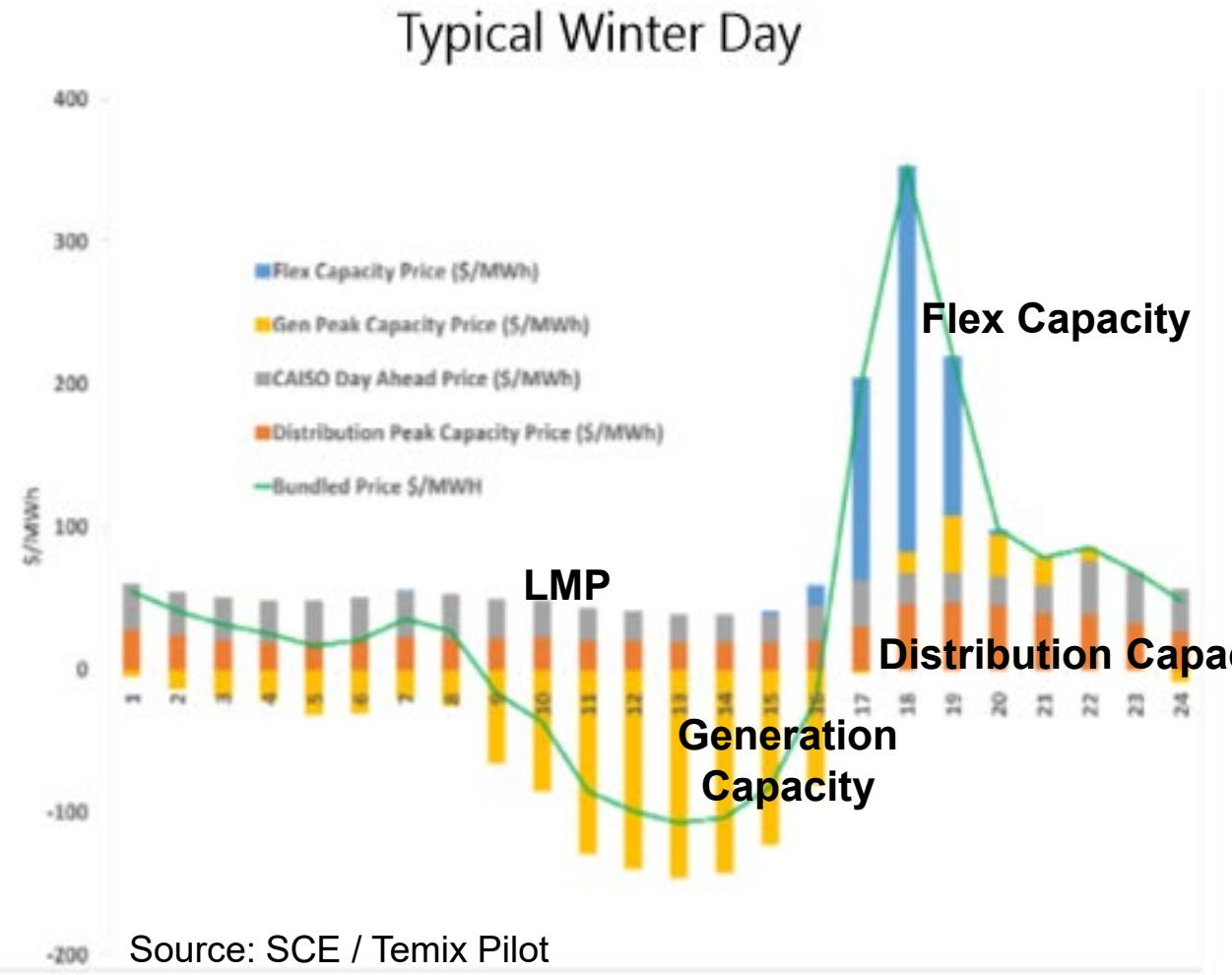
CAISO: Real-time *Locational Marginal Price ($LMP)*

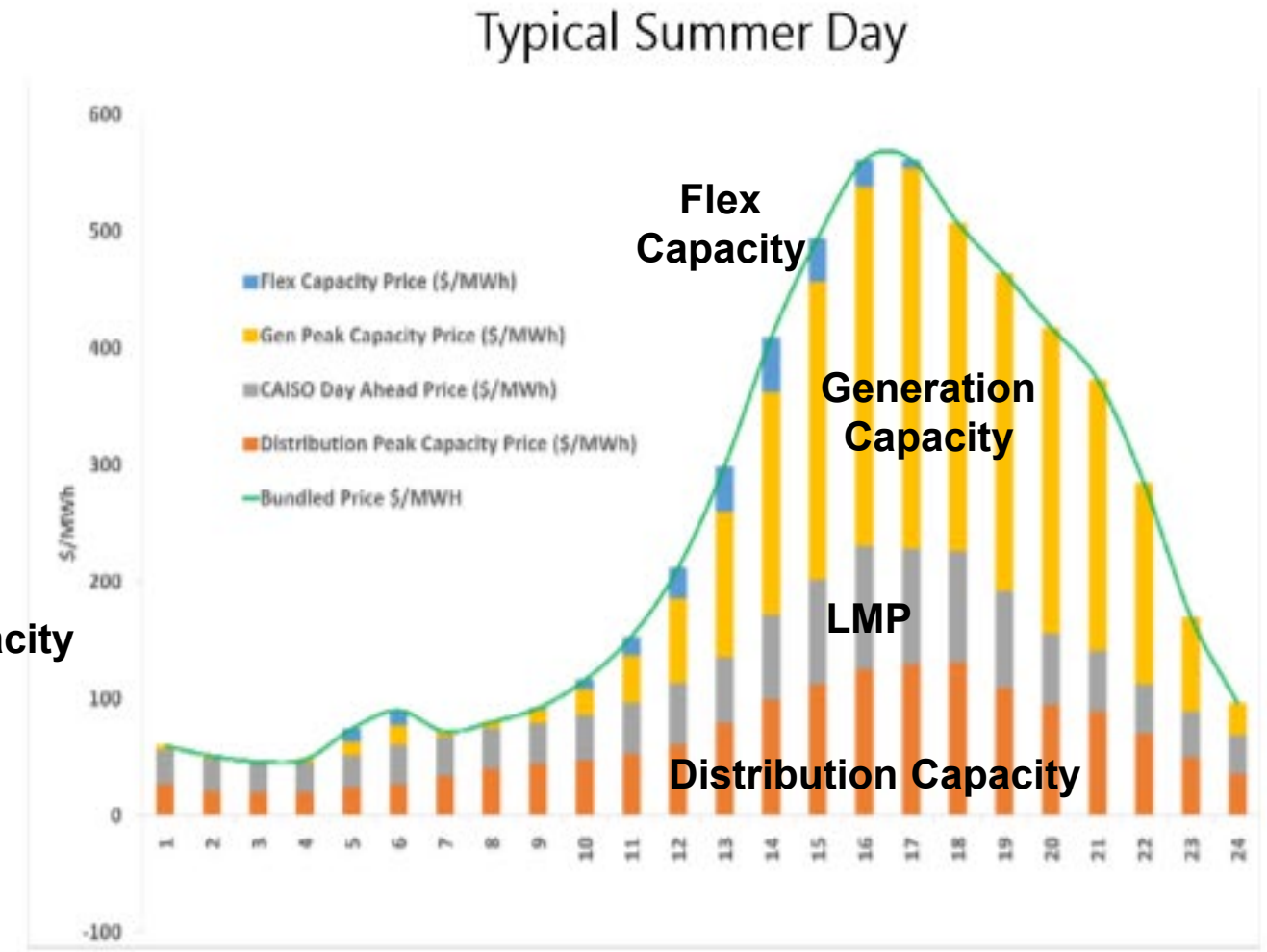
- **Price Machine computes composite spot price = $P_{Distribution} + $P_{RA Capacity} + $P_{Flex RA} + $LMP**
- **Other fixed costs (metering, billing, etc.) included in "base" price**

*Based on design used in SCE/TEMIX EPIC Pilot (2016-2019)

EPIC Pilot: Composite Hourly Prices

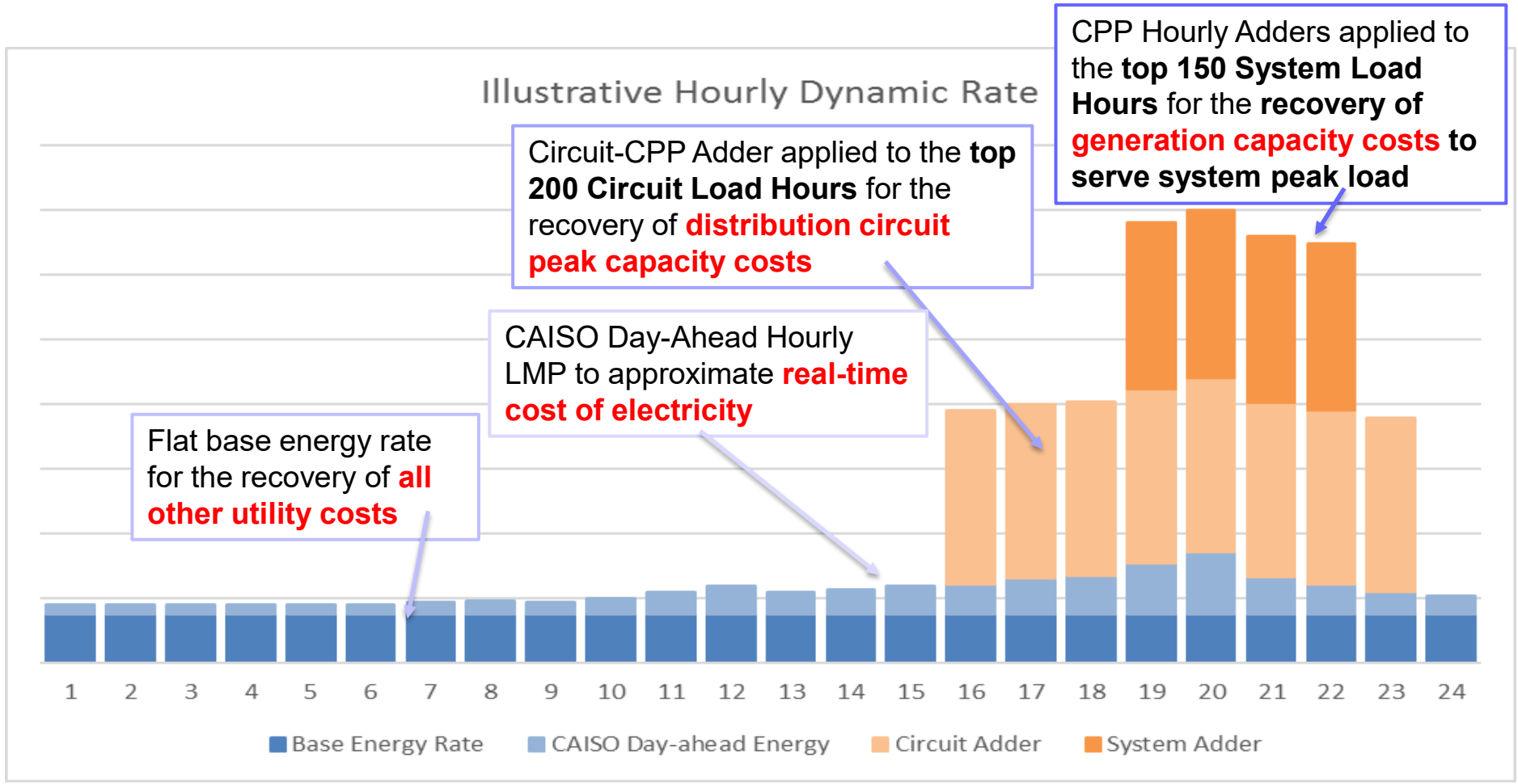
(based on Hourly Capacity Utilization & CAISO LMP)





Source: SCE / Temix Pilot

Alternate Example: SDG&E "Power Your Drive" Rate



System-level CPP *- an energy rate option that provides a "capacity" price signal*

Circuit-level CPP *provides a locational price signal while preserving customer equity by still charging all customers the same price*

Step 3: Rate Reform Objectives via Hourly Capacity Charge

1. **Encourage load shift / increase complementary to grid-based economics - avoid uneconomical arbitrage**
2. **Shift fixed cost recovery burden onto load driving high system utilization and capacity upgrades**
3. **Ensure full recovery of revenue requirements**
4. **Minimize long-term infrastructure upgrades & investment with electrification and related cost of service**
5. **Allow flexible rate design options to reflect policy choices and accommodate:**
   - Different decisions by different regulatory entities
   - Different cost allocations and recovery by customer class
   - More frequent and granular updates to maintain revenue collection on target

Issues with Market Integrated Pathway (Per Joint Solar/Storage Parties in Resource Adequacy Rulemaking*)

All BTM DERs providing capacity should have the option to forgo market integration, as ***the market-informed pathway is simpler and avoids obstacles impeding DER providers****, such as the following:*

1. Issues surrounding interconnection of exporting resources are eliminated as Rule 21 clearly governs.
2. Complexity and cost associated with market integration and dispatch are also eliminated.
3. Issues associated with visibility at the T&D interface, necessitating communication and visibility of resource performance by both the distribution operator and the CAISO, are eliminated.
4. Concerns associated with double payment for electricity from NEM systems - wholesale market revenue for settled resource export vs. retail bill credits for NEM - are eliminated.
5. Aggregators are better able to dispatch resources to meet specific local needs, rather than rely entirely on system-level CAISO dispatch, which may be inconsistent with local needs.
6. Thorny issue of deliverability to the transmission system is avoided entirely.
7. The only CAISO tariff for Rule 21 connects DERs is PDR, which does not credit energy exported to the grid.

***Joint Solar/Storage Parties Track 4 Proposal, January 28, 2021, at 4. RA Proceeding R.19.11.009 (SUNRUN, CESA, CALSSA, TESLA, CEERT, VOTE SOLAR, AND ENELX)**

Proposed Roadmap: Step 4

Step 1: Develop standardized, universal access to current electricity price

Step 2: Introduce dynamic prices based on real-time, wholesale energy cost ***(opt-in)***

Step 3: Modify prices per real-time, localized grid conditions ***(opt-in)***

Step 4: Transition to bi-directional prices

Demand Side: unified, universal, dynamic, economic (UNIDE) signal

Step 4: Transition to Bi-directional Prices

https://MyElectricityPrice.com

John Doe
Address
Account #

← P_{1PM} P_{2PM} P_{3PM} P_{4PM} ….

- Hourly, [15 min, 5 min]
- Next day, 24 x hourly

(standardized, statewide, **web-based price portal**)

1. Consume / Export @ Current Price

Price Machine
(Cloud Platform) Σ

DO
$P_{Distribution} = f(x)$

LSE
$P_{RA\ Capacity} = g(y)$

LSE
$P_{Flex\ RA} = h(z)$

California ISO

LMP

Real-time
Grid Conditions
x = Circuit Aggreg Load
y = LSE Aggreg Load
z = LSE Net Load Ramp

LOGIN

Third Party
Service
Providers
(TSPs)

House
EMS

e-Water
Heater

EMS

HVAC

EMS

EMS

Battery

Smart
Appliances

EV

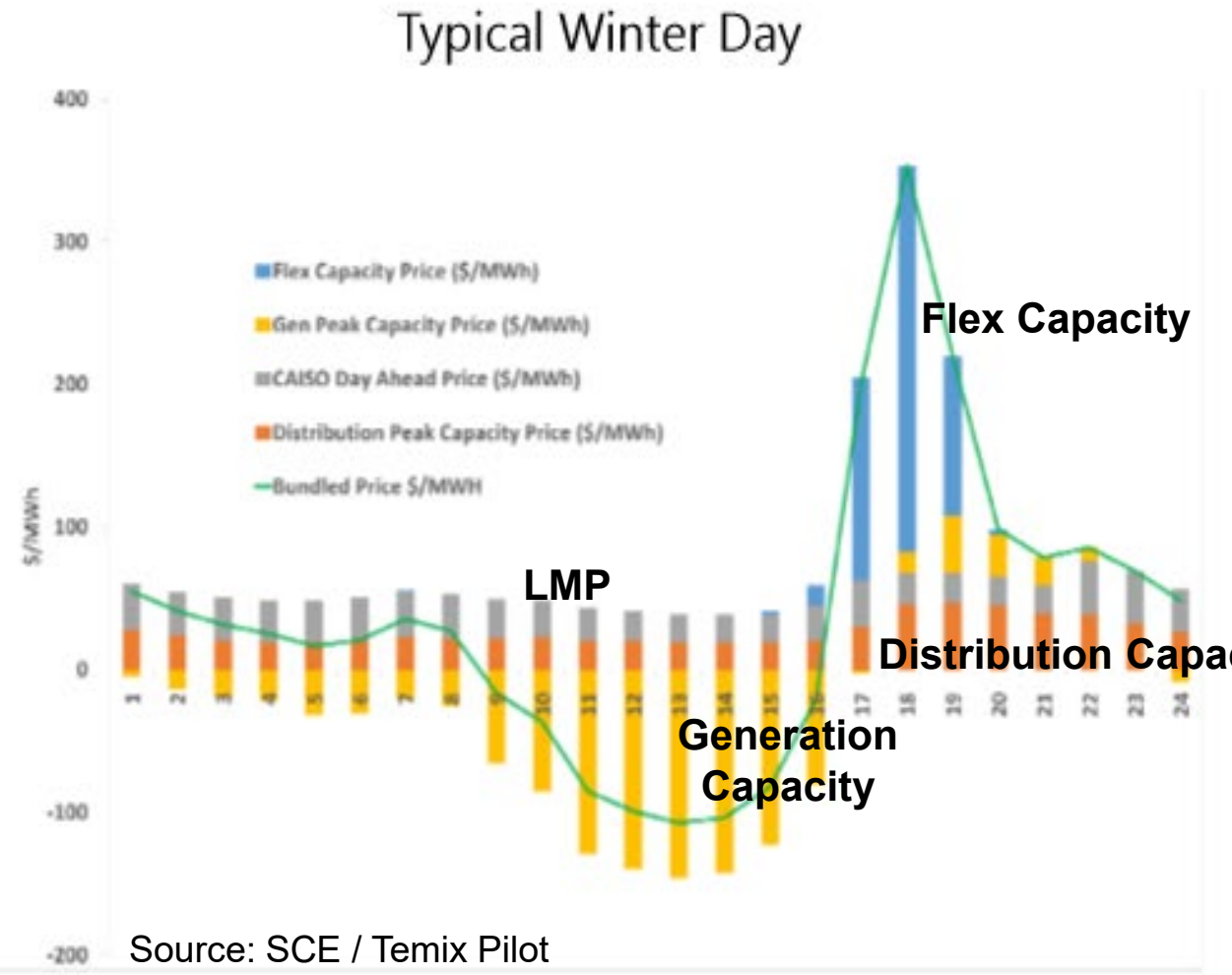
EMS

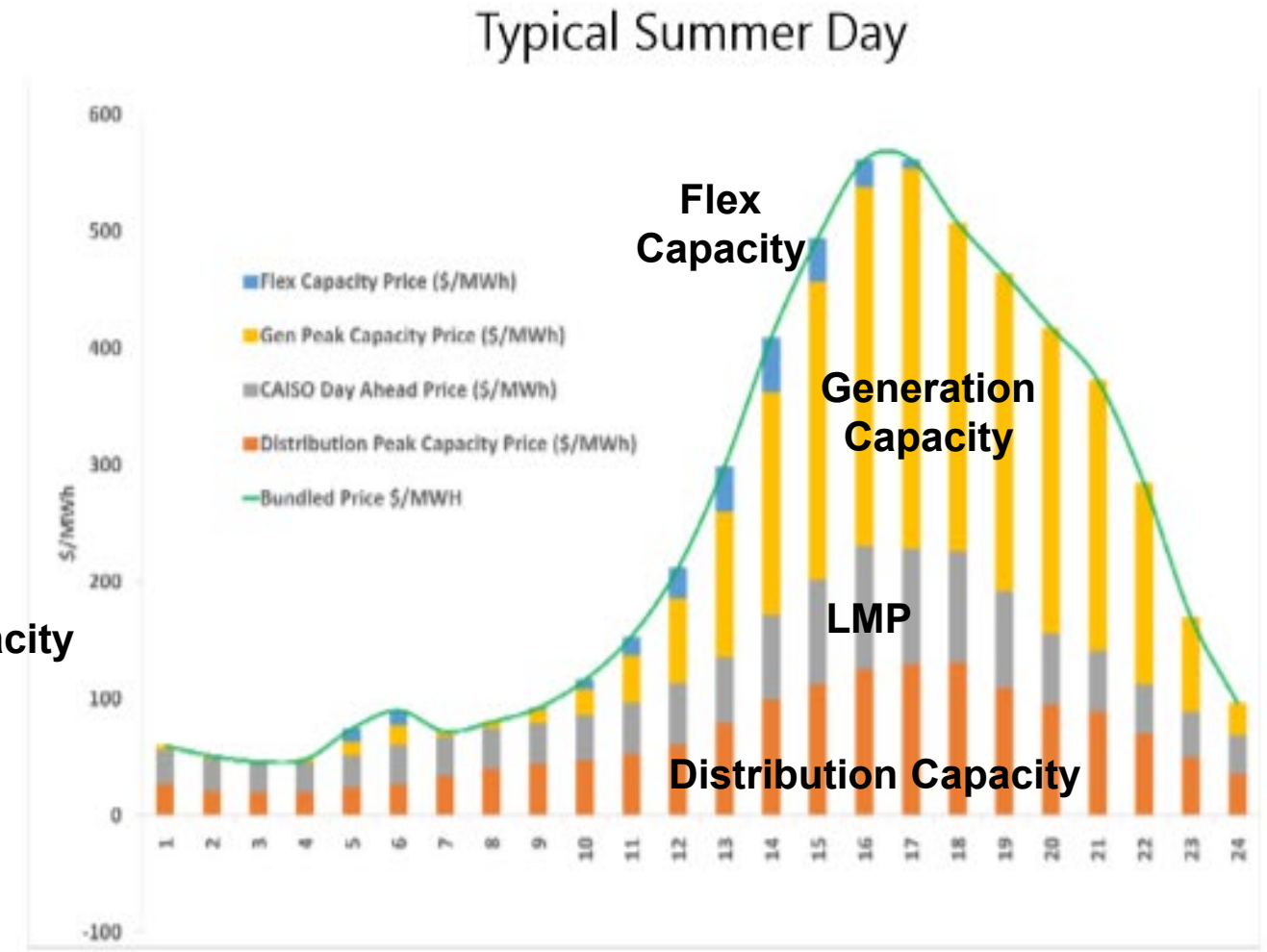
Input at set up

Real-time

EPIC Pilot: Composite Hourly Prices

(based on Hourly Capacity Utilization & CAISO LMP)





Source: SCE / Temix Pilot

Step 4: Simplified Framework for DER Valuation & Operations

1. Easily discoverable, rational, fair, transparent, and predictable economic value

Step 4: Simplified DER Valuation & Operations

1. Easily discoverable, rational, fair, transparent, and predictable economic value

2. Full monetization of DER services to the grid (locational, temporal), including exports to the distribution grid (embedded capacity value)

3. Distributed, economically driven, coordinated, self-dispatch of DERs

4. Enables contracts between DER service providers and LSE or Distribution Operator (based on the embedded capacity value), with dispatch driven by UNIDE

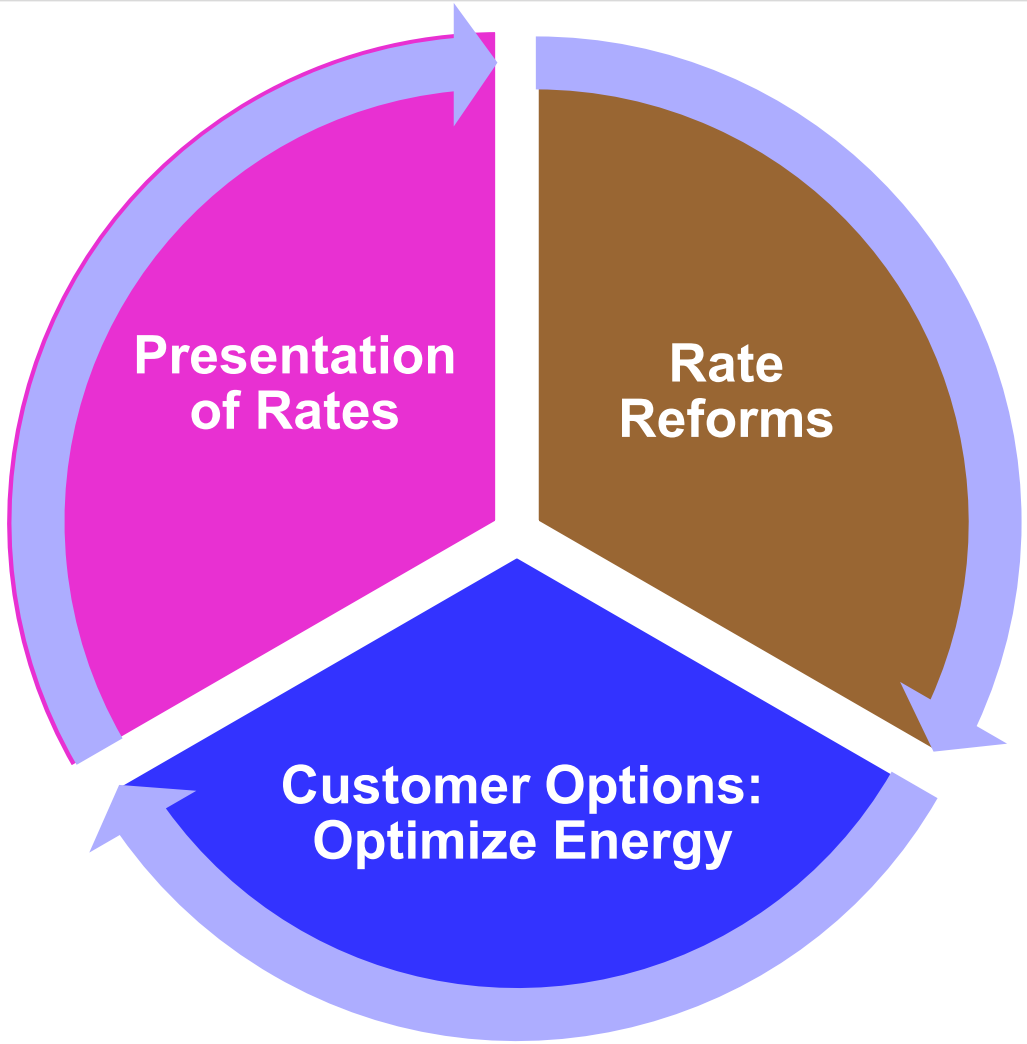
Step 4: Avoided Complexities

1. Avoids complexity and constraints of CAISO market integration
2. Avoids distribution level “command & control” of DER operations
3. Avoids one-off, DER-specific point solutions

4. Avoids counterfactual Measurement requirements (direct metering data)
5. Avoids reliance on Avoided Cost framework for valuation
6. Straightforward integration into the planning & forecast framework

- To do: Streamline, standardize, simplify the Rule 21 export permit process

Three Part Vision ➔ UNIDE



Demand-side: unified, universal, dynamic, economic (UNIDE) signal

Proposed Roadmap: Step 5

Step 1: Develop standardized, universal access to current electricity price

Step 2: Introduce dynamic prices based on real-time, wholesale energy cost ***(opt-in)***

Step 3: Modify prices per real-time, localized grid conditions ***(opt-in)***

Step 4: Transition to bi-directional prices (buy & sell)

Step 5: Offer subscription option

Demand Side: unified, universal, dynamic, economic (UNIDE) signal

Step 5: Offer Subscription Option

https://MyElectricityPrice.com

John Doe
Address
Account #

← P_{1PM} P_{2PM} P_{3PM} P_{4PM} ….

- Hourly, [15 min, 5 min]
- Next day, 24 x hourly

1. ~~Consume / Export @ Current Price~~
2. [Fixed Price Subscriptions]

(standardized, statewide, **web-based price portal**)

Price Machine (Cloud Platform) Σ

LOGIN

Third Party Service Providers (TSPs)

House EMS

Real-time Grid Conditions
x = Circuit Aggreg Load
y = LSE Aggreg Load
z = LSE Net Load Ramp

DO
$P_{Distribution} = f(x)$

LSE
$P_{RA\ Capacity} = g(y)$

LSE
$P_{Flex\ RA} = h(z)$

California ISO

LMP

e-Water Heater

EMS

HVAC

Battery

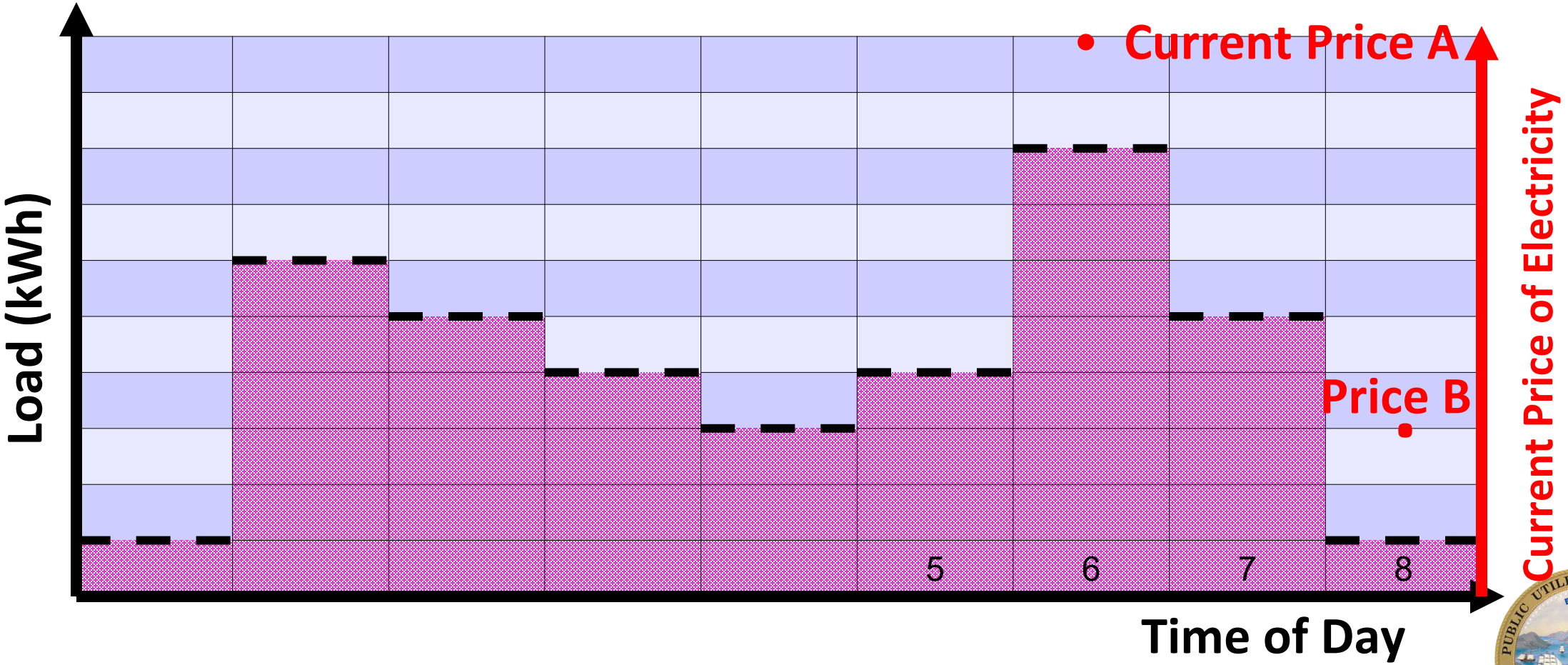
Smart Appliances

EV

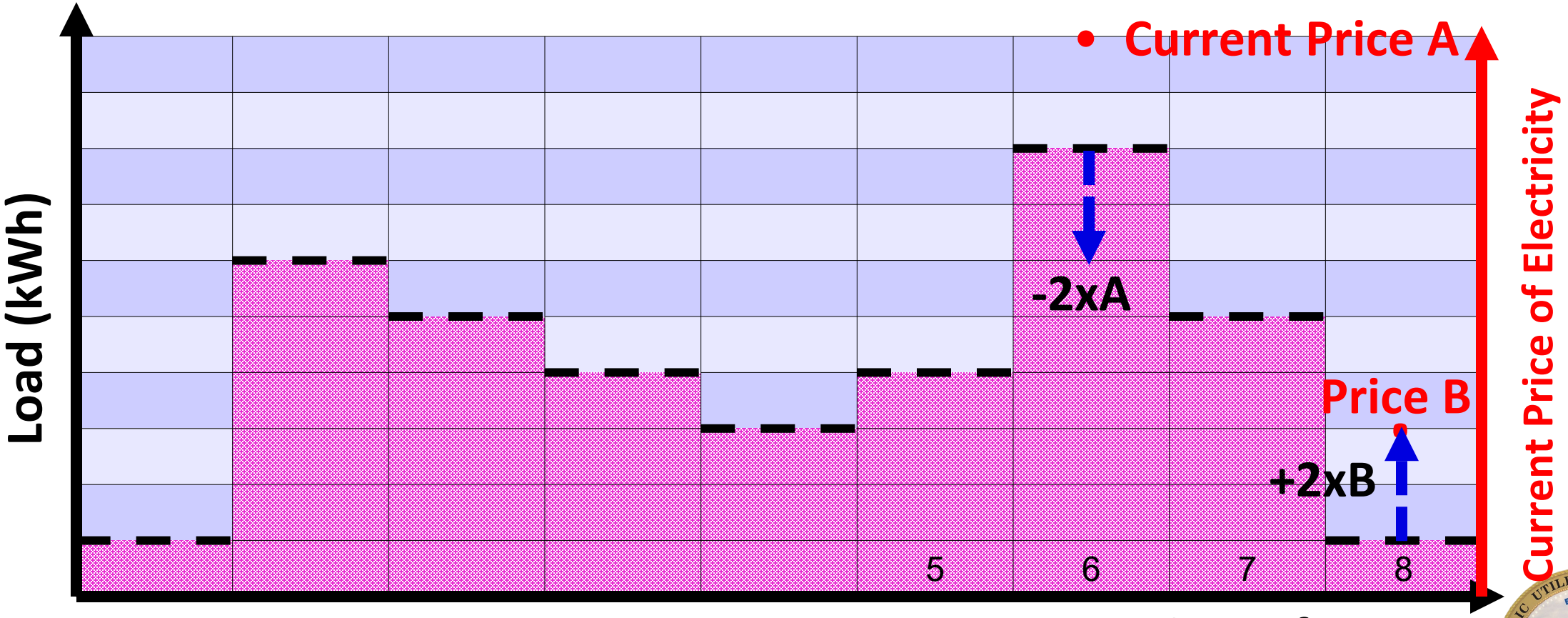
→ Input at set up

→ Real-time

Step 5: Purchase Average Load Shape & Energy Quantity @ Fixed Monthly Price



Step 5: Purchase Average Load Shape & Energy Quantity @ Fixed Monthly Price



➔ Protect bill volatility while still encouraging opportunistic load shift

Benefits of "Shaped Subscription"

Protection

- Protect customers against bill volatility
- Ease customers transition

Flexibility

- Accommodate changed home conditions
- Encourage opportunistic load shift

Predictability

- Stabilize revenue recovery for distribution operators, LSEs

Proposed Roadmap: Step 6

Step 1: Develop standardized, universal access to current electricity price

Step 2: Introduce dynamic prices based on real-time, wholesale energy cost ***(opt-in)***

Step 3: Modify prices per real-time, localized grid conditions ***(opt-in)***

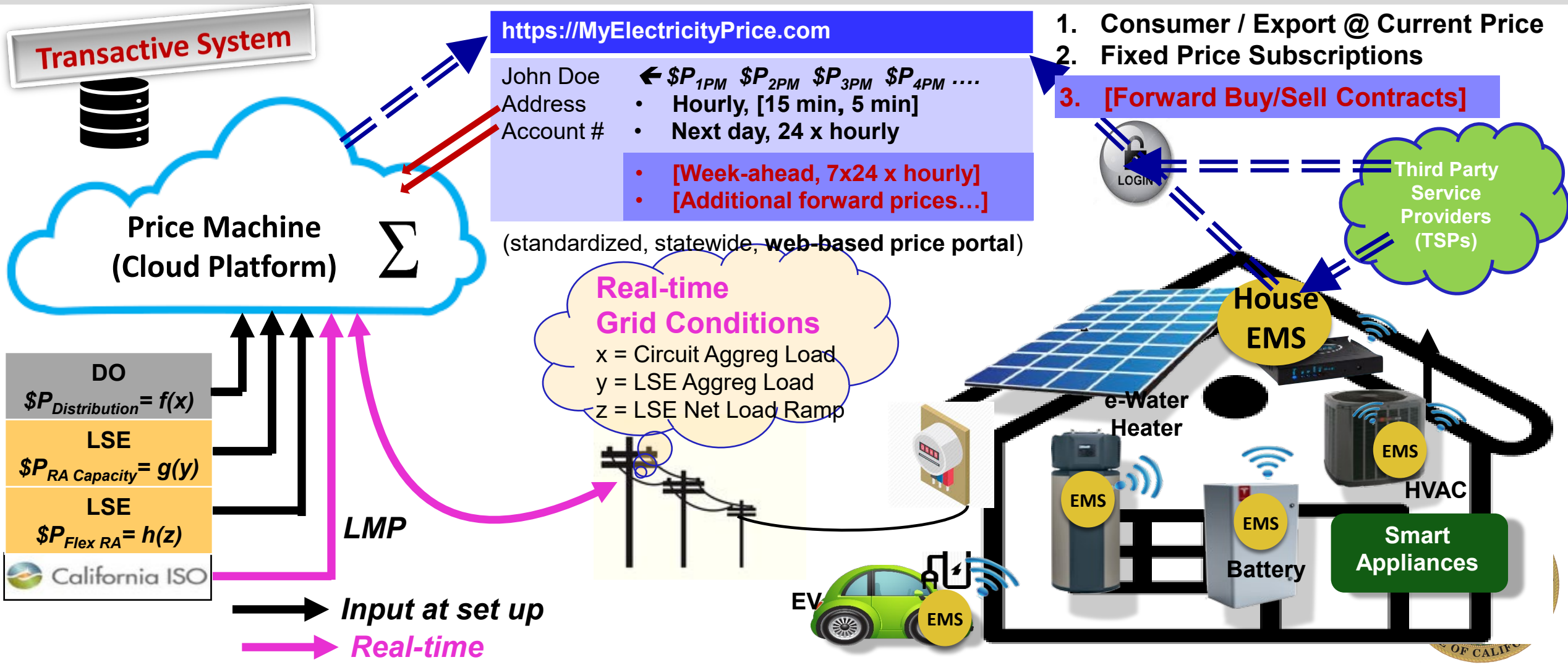
Step 4: Transition to bi-directional prices (buy & sell)

Step 5: Offer subscription option (average load shape & energy quantity)

Step 6: Introduce transactive features (ability to lock in price in advance)

Demand Side: unified, universal, dynamic, economic (UNIDE) signal

Step 6: Introduce Transactive Features



Transactive Features are NOT About…

- Peer to pear trading
- DSO market
- Forcing customers to become market traders
- Forcing customers to deal with price variability
- Blockchain

- Eliminating RA capacity markets
- Obsoleting IOUs or LSEs

➔ Options for customers and devices to optimize energy management

Benefits of Transactive System

LSEs & Distribution Operators

- Improves visibility, planning, operations

CAISO

- More visibility, reduce load forecast error

Customers

- Advanced energy management tools, optimize cost…

Proposed Roadmap - UNIDE

Step 1: Develop standardized, universal access to current electricity price

Step 2: Introduce dynamic prices based on real-time, wholesale energy cost ***(opt-in)***

Step 3: Modify prices per real-time, localized grid conditions ***(opt-in)***

Step 4: Transition to bi-directional prices (buy & sell)

Step 5: Offer subscription option (average load shape & energy quantity)

Step 6: Introduce transactive features (ability to lock in price in advance)

Demand Side: unified, universal, dynamic, economic (UNIDE) signal

Goal: Achieve Widespread Demand Flexibility

Leverage significant opportunity resulting from electrification, DER adoption

Challenges

Increasing renewables penetration

- Increased curtailment
- Steeper ramps ➔ reliability challenge
- Increased reliance on intermittent, use-limited supply ➔ reliability challenge

Increasing electrification of end uses (buildings, transportation)

- Increased cost of service due to higher load, if unmanaged

Increasing DER deployment and adoption

- Grid instability and increased cost of service, if unmanaged
- Fair compensation and cross-subsidy challenges

Opportunities

➔Enhance renewables integration & reduce emissions

- Reduce curtailment

➔Enhance reliability

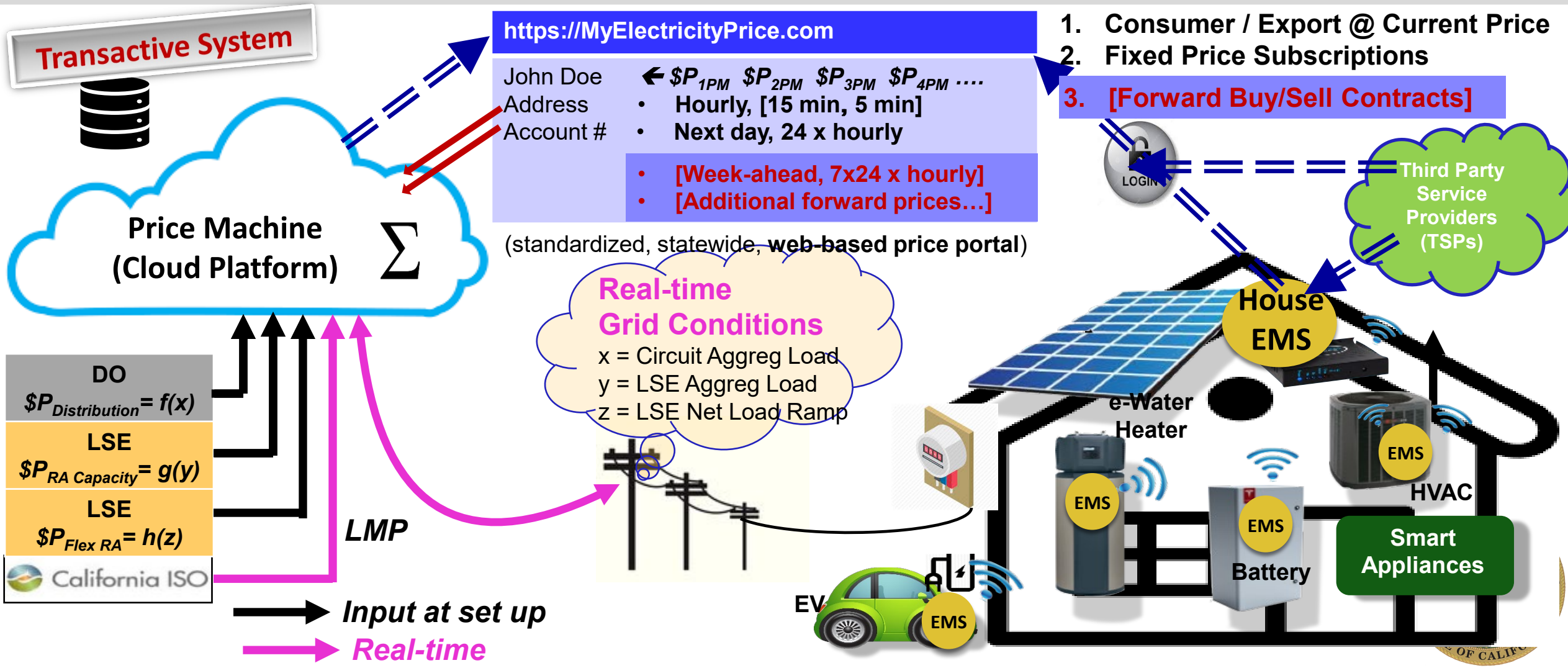
- Reduce system ramp
- Intermittent supply balanced by dispatchable demand
- Managed coordination of DER operations

➔Minimize cost of service

- Managed load growth and DER operations

➔Provide fair compensation of DER services stack

Q & A


Transactive System
Price Machine
(Cloud Platform)
Σ
https://MyElectricityPrice.com
John Doe
Address
Account #
P_{1PM} P_{2PM} P_{3PM} P_{4PM} ….
• Hourly, [15 min, 5 min]
• Next day, 24 x hourly
• [Week-ahead, 7x24 x hourly]
• [Additional forward prices…]
(standardized, statewide, web-based price portal)
1. Consumer / Export @ Current Price
2. Fixed Price Subscriptions
3. [Forward Buy/Sell Contracts]
LOGIN
Third Party Service Providers (TSPs)
Real-time Grid Conditions
x = Circuit Aggreg Load
y = LSE Aggreg Load
z = LSE Net Load Ramp
DO
$P_{Distribution}$ = f(x)
LSE
$P_{RA\ Capacity}$ = g(y)
LSE
$P_{Flex\ RA}$ = h(z)
California ISO
LMP
House EMS
e-Water Heater
EMS
HVAC
Battery
Smart Appliances
EV
Input at set up
Real-time

Discussion / Feedback

1. **Consumer Advocates: CalPA, TURN, CLECA…**
2. **CCAs, NGOs**
3. **Utilities**
4. **DER Industry**
   a. CESA, CALSSA, CEDMC, CalSEIA
   b. DR/DER Service Providers
   c. Transportation
   d. Building Decarb
5. **Consultants / Independents**
6. **Government, Research**

Contacts

Demand Response, Energy Division:

Jean.Lamming@cpuc.ca.gov, Senior Analyst

Andrew.Magie@cpuc.ca.gov, Analyst

Aloke.Gupta@cpuc.ca.gov, Supervisor

Retail Rates, Energy Division:

Parimalram.Madduri@cpuc.ca.gov, Senior Analyst

Masoud.Foudeh@cpuc.ca.gov, Senior Analyst

Paul.Phillips@cpuc.ca.gov, Supervisor