A New Approach to Strategic Planning in a High Distributed Resource Environment: Distributed Solar as a Case Study

PRESENTED BY

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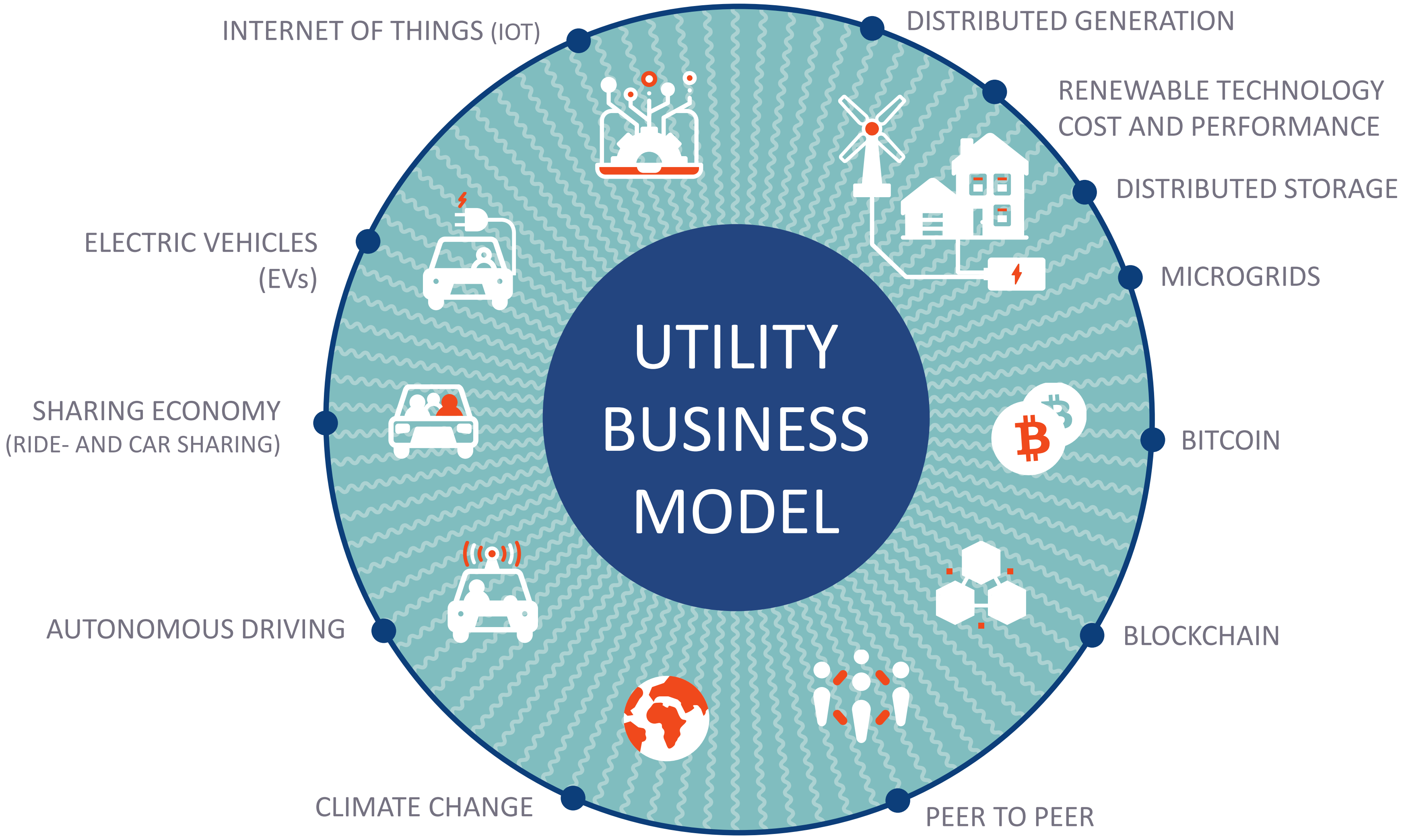
DECEMBER 9, 2020
NEXT-GEN SMART GRID VIRTUAL SUMMIT

THE Brattle GROUP

The utility business model is evolving in the face of emerging disruptions



A new approach to strategic planning is necessary

Traditionally, utility strategic analysis has relied on **scenario modeling**, a largely linear approach that projects key events and models using known relationships:

- In the UoF context, a scenario could involve modeling hypothetical renewable penetration levels (e.g., comparing 5%, 10%, or 20% rooftop solar photovoltaic (PV) penetration by a future date-certain) to assess the impacts on distribution equipment and on utility financials

While scenario-based modeling can provide <u>informative snapshots</u> of possible future outcomes, they <u>ignore important dynamics</u> of exactly how or why a utility might end up in a particular situation

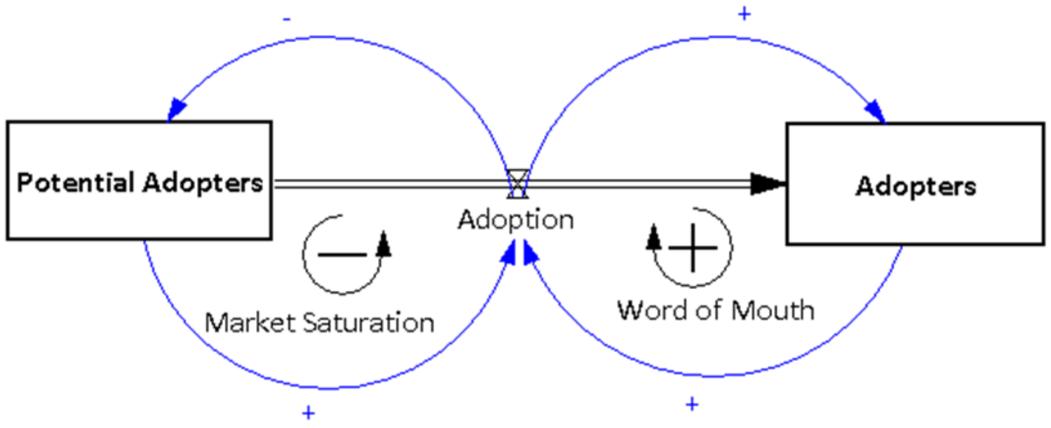
- Scenario-based modeling may overlook important feedbacks and interactions that would make higher or lower DER penetration more likely than the assumed conditions
- They are about "what-if," not "why" or "how"

Therefore, relying solely on scenario modeling approach falls short in UoF related strategic planning, where the path forward is not yet specified, but amenable to proactive management

To address this need, Brattle developed a UoF modelling tool "CRISP" using System Dynamics

A System Dynamics model is essentially an influence diagram in which the relationships are mathematically defined and simulated over time

- Causal loop diagrams represent relationships in a system
- Stocks and flows are used to track movement through a system
- Intuitive equations back up the causal loop diagrams and the stocks and flows



System Dynamics offers an integrated look at what are otherwise detailed but incomplete understandings of parts of the UoF problem(s)

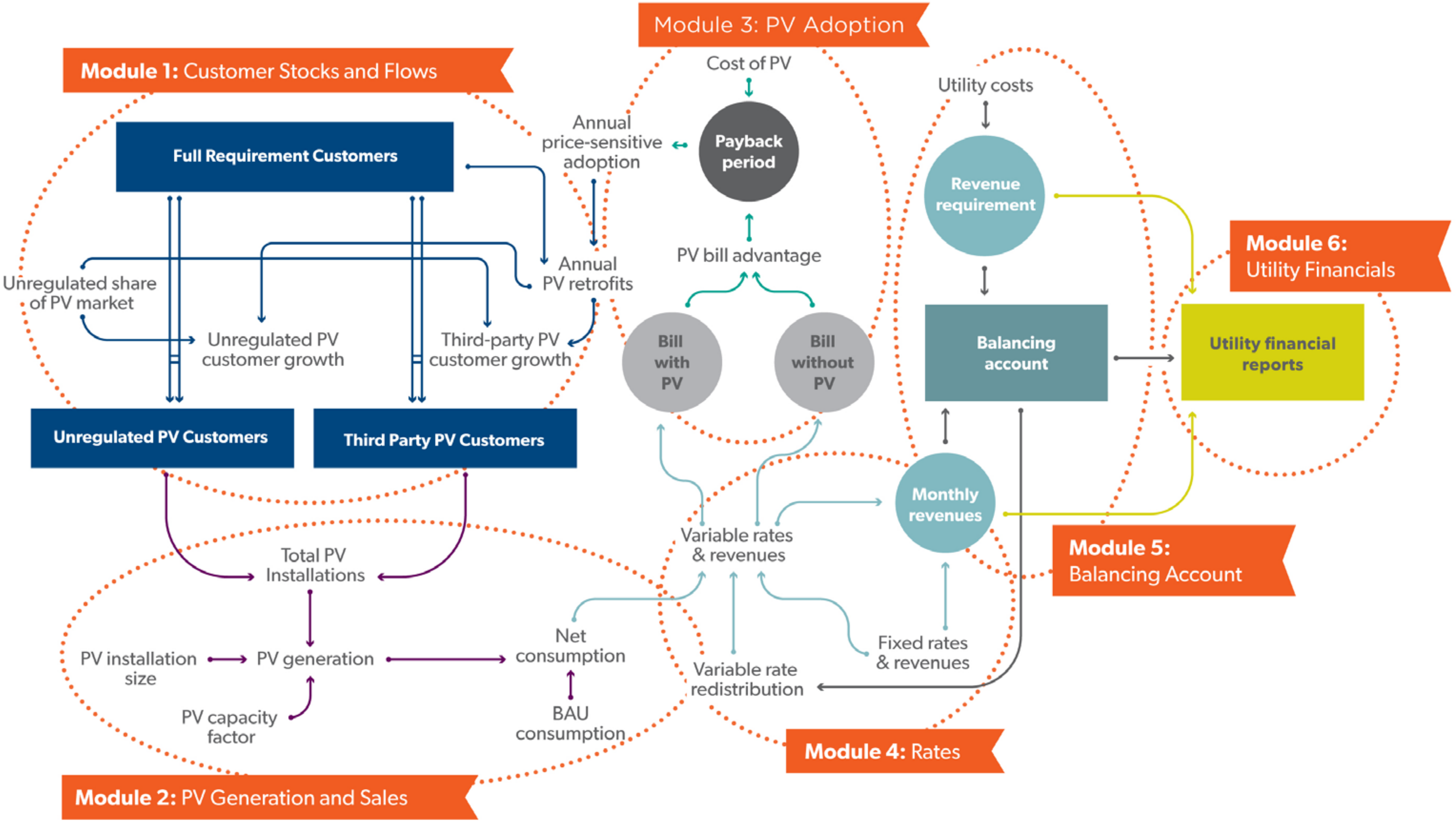
"Alternative outlooks" in System Dynamics are merely projections of how interdependent change factors will evolve and affect each other

- Example: higher PV outlook driven by cost declines and increased subsidies
- Enables identification and testing of path dependencies, accelerators, and tipping points
  - Facilitates conversation and visualization of key drivers and assumptions
  - Highlights mechanisms that can alter the rate or direction of change

Benefits of system dynamics based strategic planning

Dynamic Modeling Framework	Visibility into inflection points	Assessment of path dependency	Convergence in internal stakeholder views
• Provides a dynamic modeling framework to explore interdependent aspects of DER technology adoption, utility system planning, and eventually the utility's bottom line	• Explore inflection points, and emphasize the importance of addressing inefficiencies, cross-subsidies early on before they start to compound	• Explore the effects of "path-dependent" decisions through variation in the timing, type, or extent of utility's role in DER development, shifting towards new rate designs, or altering decoupling and cost reallocation mechanisms	• Encourage sharing of information and viewpoints across utility planning groups, and leads to new insights about the planning issues

Example: Model of a distribution utility that is evaluating potential impacts of a proliferation of rooftop PV adoption



The model (developed for a distribution utility) allowed us to study alternative outlooks based on a set of drivers

Starting with the *status quo* outlook, we investigated the impacts of and interactions among the following drivers:

- Rooftop solar adoption
- Default TOU rates
- Alternative regulatory frameworks (i.e. formula rates)
- RPS Policy/wholesale price interactions
- Decoupling (and its impact on rates)

Strategic questions to be answered:

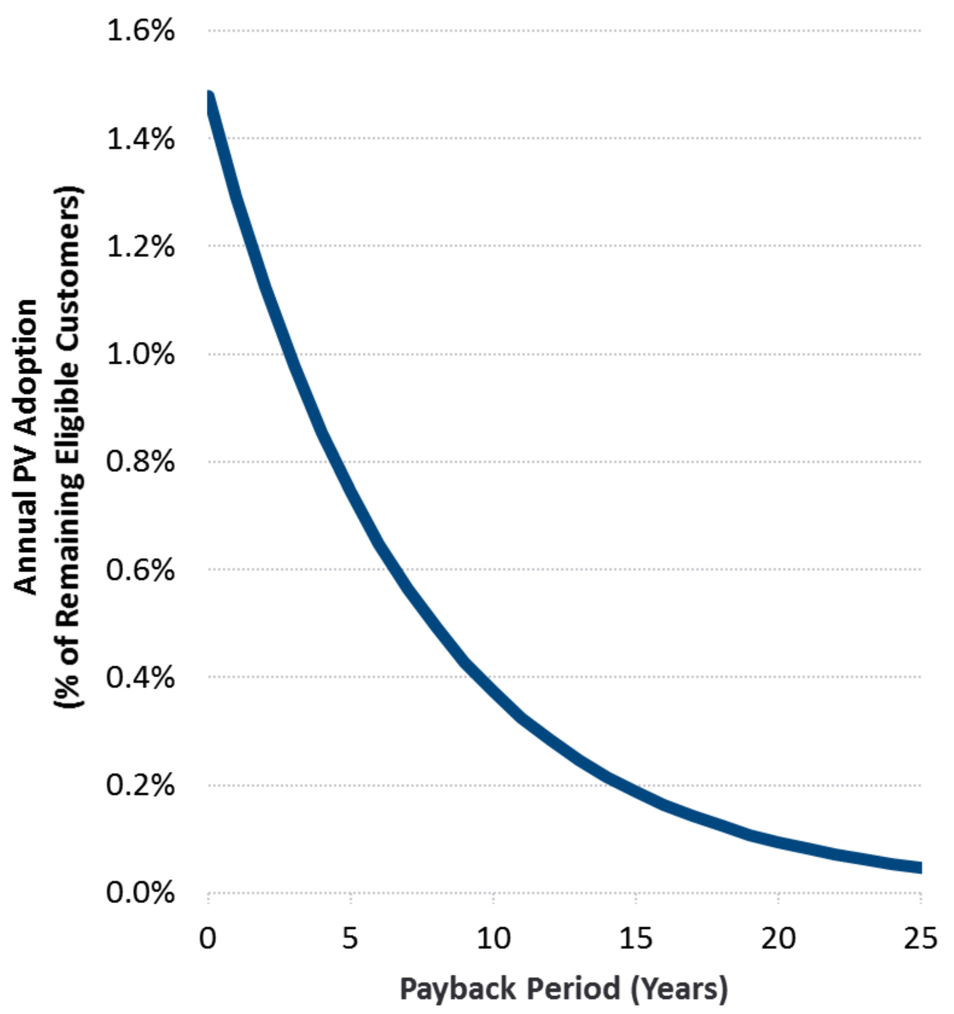
- Do we expect solar adoption to slow and flatten after 2021? What if solar adoption pace continues?
- How would different possibilities of a redesigned NEM tariff change that outlook?
- Could electric vehicle adoption outweigh the negative load impacts of rooftop solar adoption?
- How does a default TOU rate affect solar adoption pace and the potential rate increases?

Model embeds a payback-based solar adoption function

Adoption function is informed by local (and historical) customer preferences given the implied payback period

Base equation for adoption propensity:

- $y = Beta * \ e^{Alpha*x}$
- Beta is propensity to adopt at a given time over entire eligible population, a popularity factor
- Alpha (which is negative) is degree of customers' sensitivity to implied payback period
- Dependent variable (y) is an estimate of the percent of remaining, eligible residential customers that adopted solar in a given year
- X is the calculated payback period, given the technology costs in a given year



CRISP is a platform for refining and implementing utility strategies

RECENT ENGAGEMENT

Brattle used CRISP to examine the potential risk of rooftop PV penetration for the utility's financial performance.

Project served to inform senior management about "death spiral" threat and supported a distribution utility regulatory filing.

RISKS AND OPPORTUNITIES

- EVs
- Rooftop PV
- IoT
- Future of Gas
- …

CRISP

- Adoption Forecasts
- Scenarios
- Risk Assessments
- Financial Performance
- Customer Impacts

STRATEGIC POSITIONING

- Aggressively Pursue
- Accommodate
- Wait and See/Go Slow
- Fight
- …

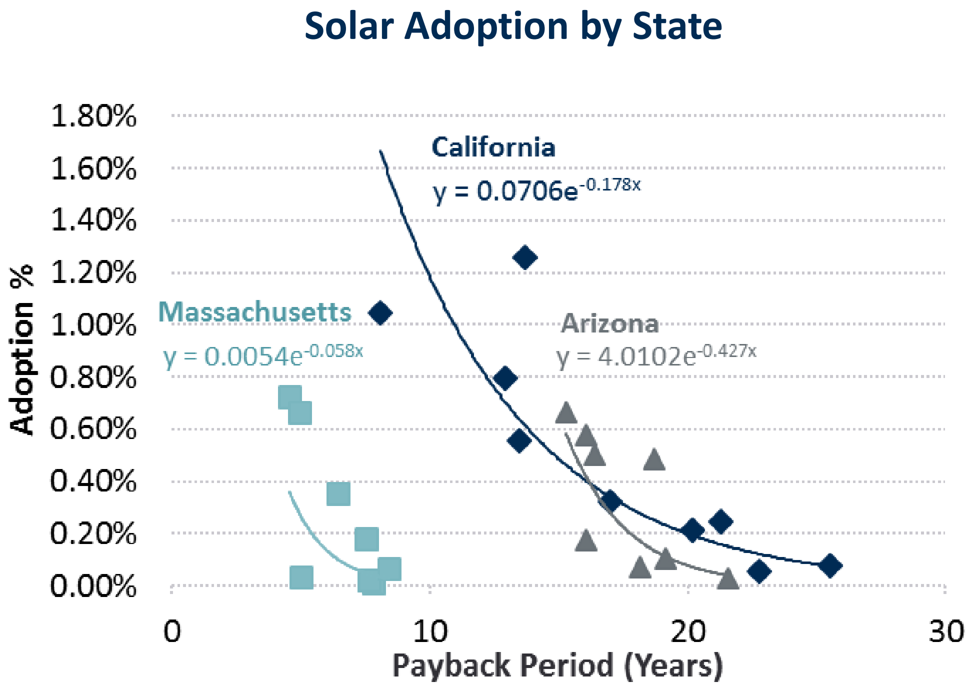
IMPLEMENTATION

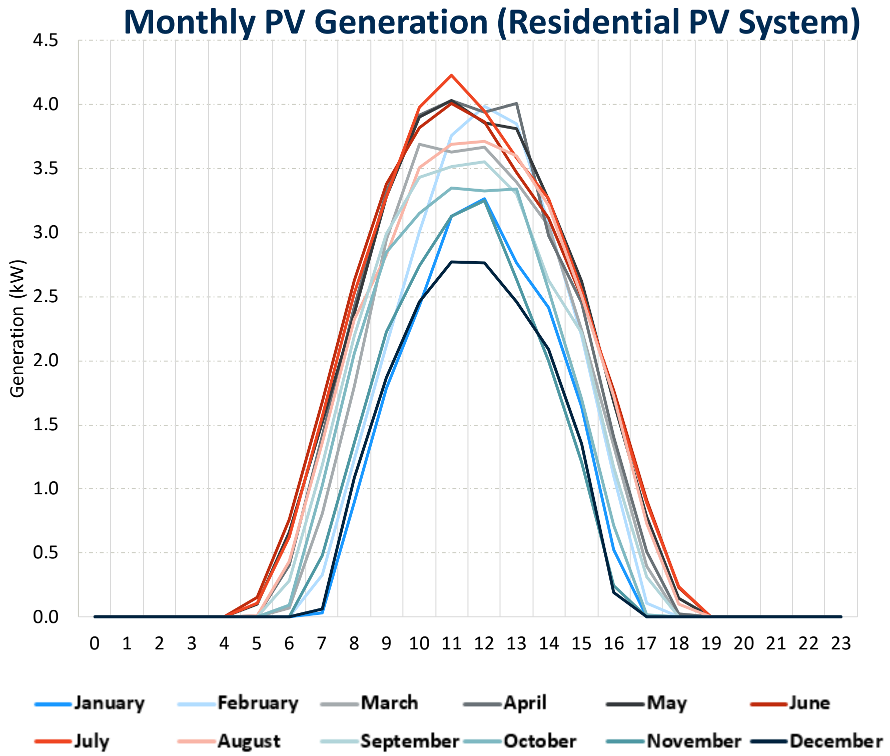
- Load Forecast
- IRP
- Rate Design
- Pilot Programs
- Regulatory Filings
- PBR
- Capex

Payback-based Solar Adoption and Generation (cont'd)

We fit historic data for adoption rate of eligible residential customers and calculated paybacks with exponential equations to derive parameters for adoption function

We incorporate solar array cost projections and monthly generation profiles (module 4) based on typical solar system in a given service territory



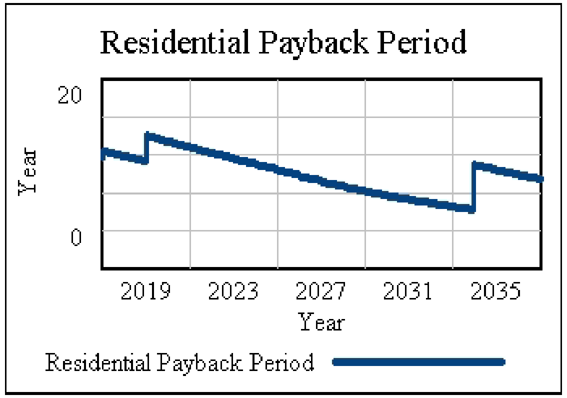


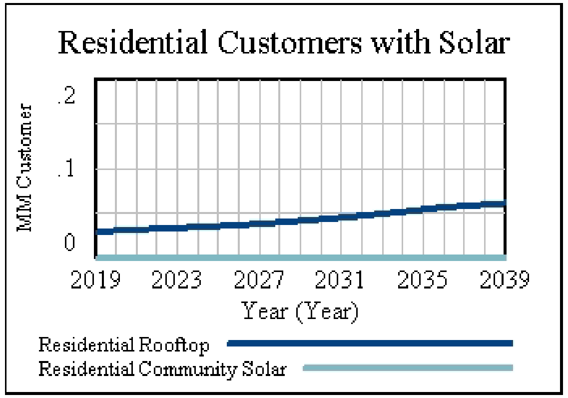
Source: Brattle Analysis of PVWatts

Utility financials and regulatory mechanisms are properly built in the model

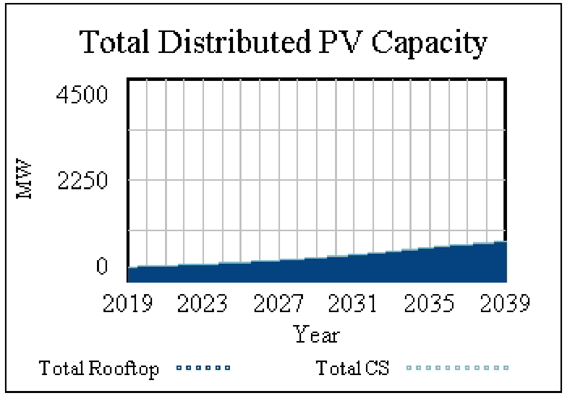
- Important to calibrate the model to reflect the status quo operating mode of the utility
- Primary relationship is cost of service ratemaking based on rate base, O&M, and class allocations to reflect utility's current ratemaking; produces integrated financial statements
  - It is possible to model alternative regulatory frameworks such as formula rates and multi-year rate plans
- Depreciation (tax and book) tracked dynamically in the SD model, e.g., adjusting if capex change or any changes to customer composition, load, rates, or decoupling cost allocations
- System dynamics model solves incrementally (year by year), comparing prior year results with goals to make next-year adjustments (with lags) to affordable capital and O&M to achieve net income targets

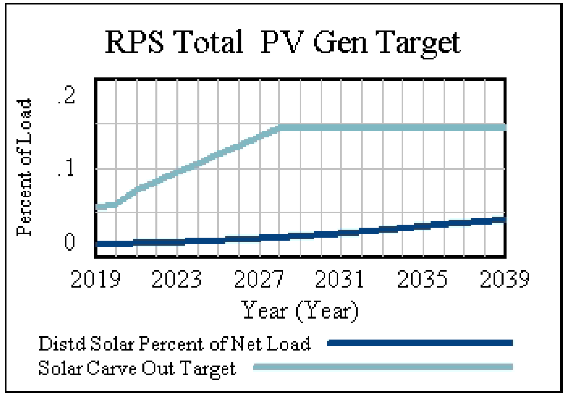
Lower PV Outlook

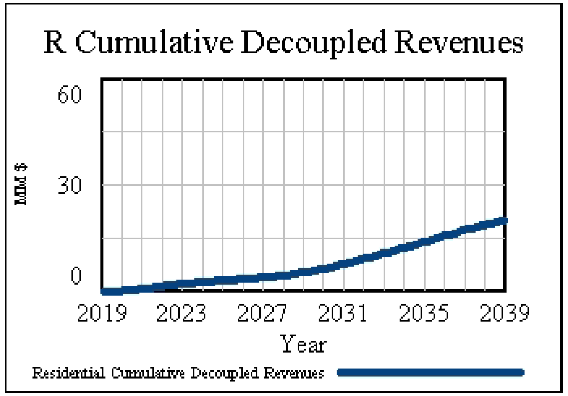


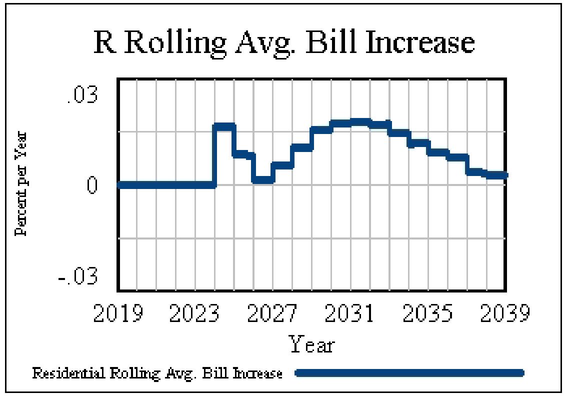


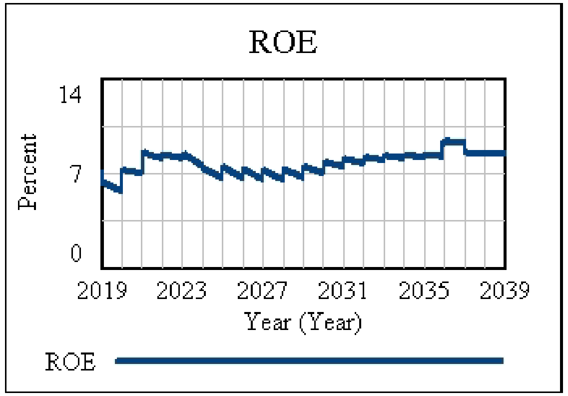
Solar adoption parameters	Base (multi-state avg)
CS	Off
RPS Carve Out	Off
TOU	Off
Formula Rates	Off
NEM Cap (MW)	750

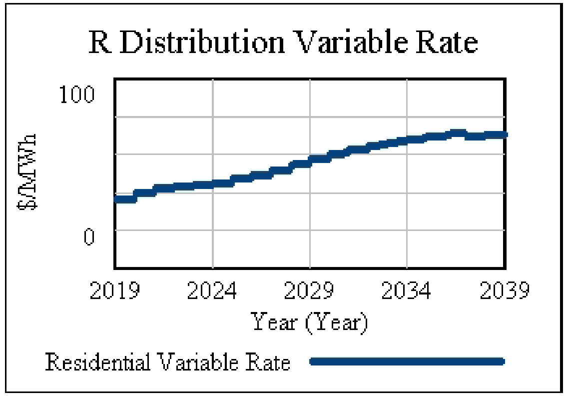




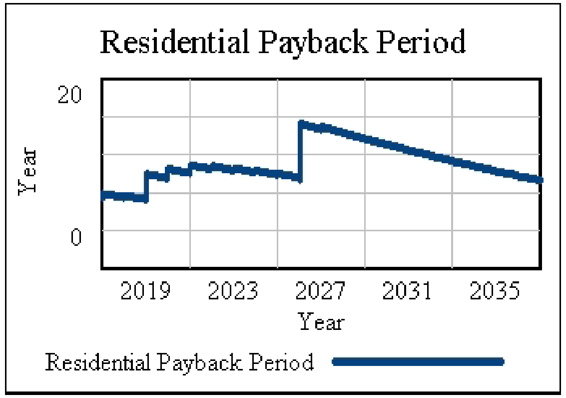


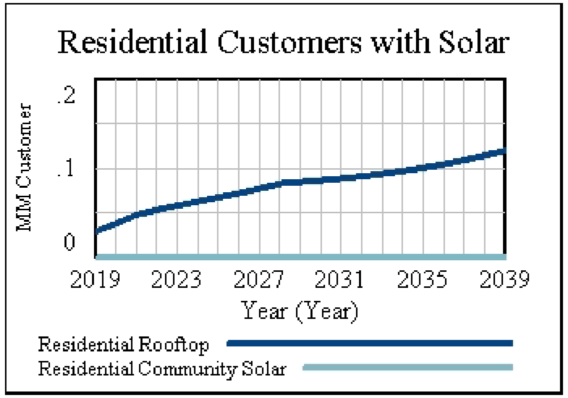




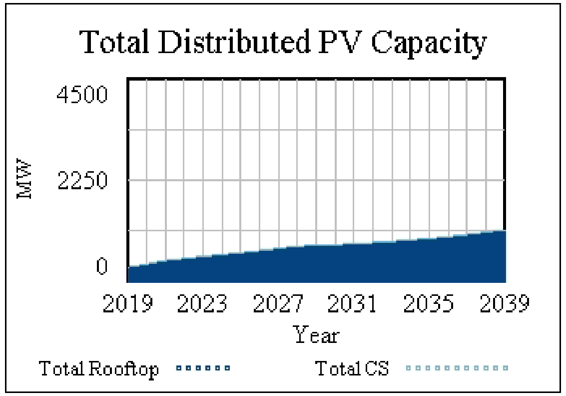


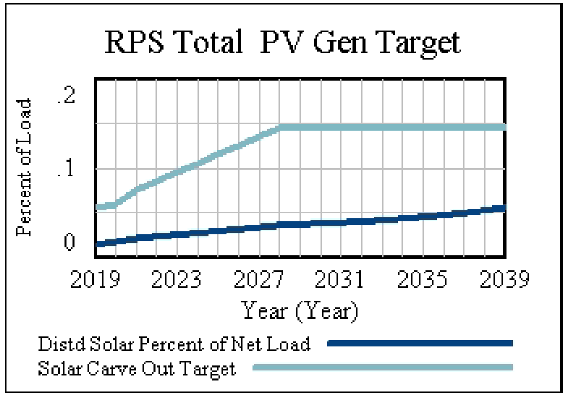
Higher PV Outlook

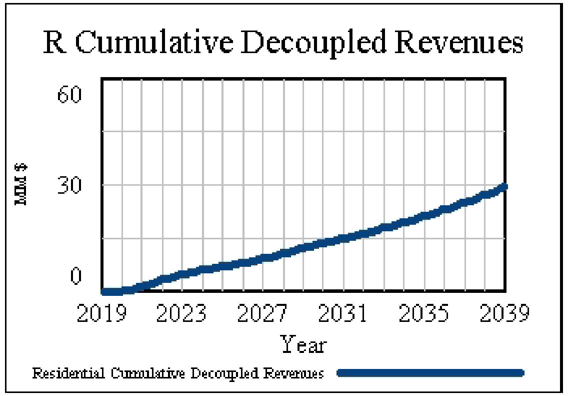


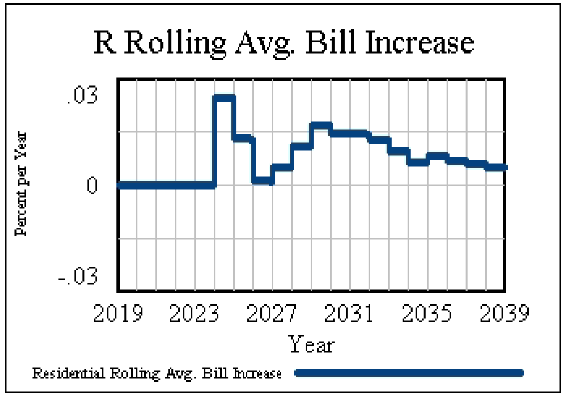


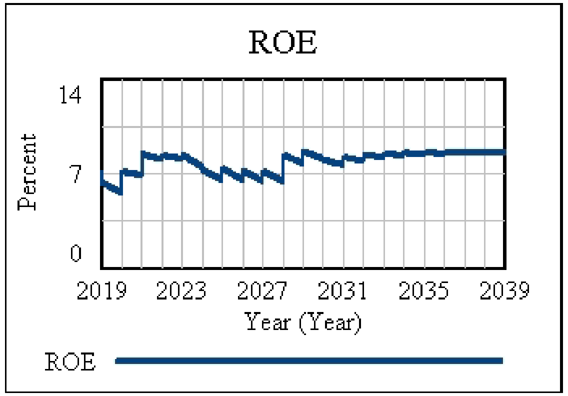
Solar adoption parameters	Utility specific parameters
CS	Off
RPS Carve Out	On
TOU	Off
Formula Rates	Off
NEM Cap (MW)	750
PV Cost Reduction (%/year)	4%
State Grant	$1,000
% Rooftop Eligible	35%

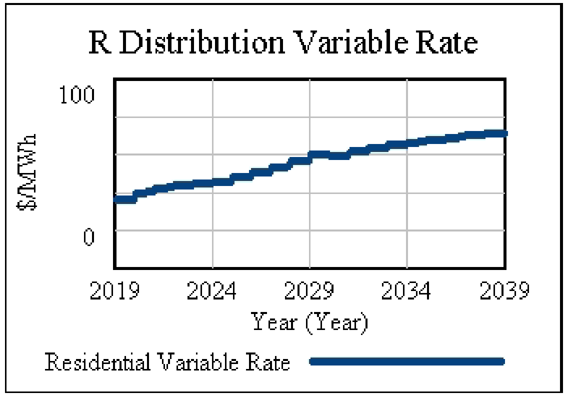




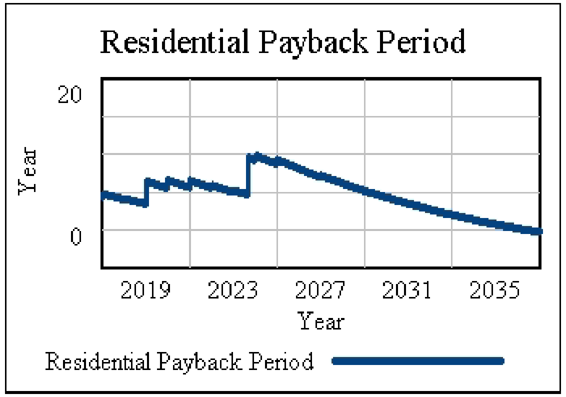


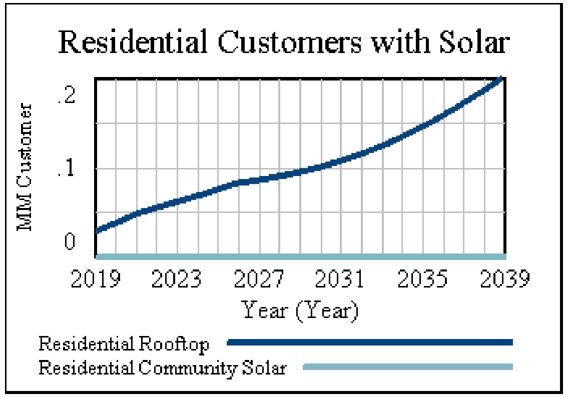




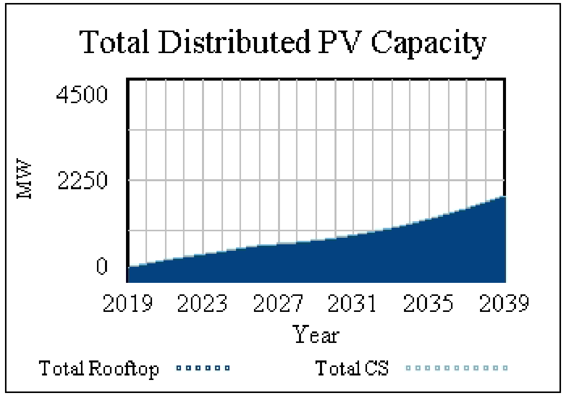


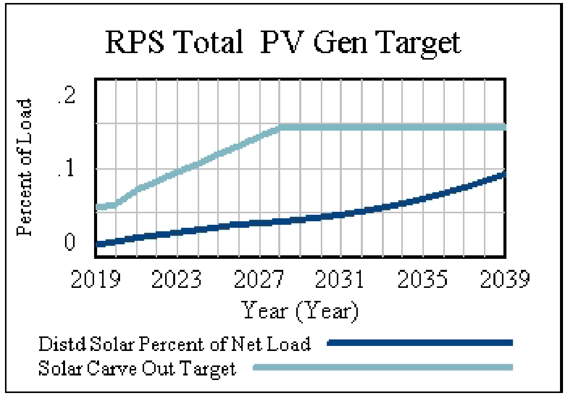
Higher PV Outlook + Cost Declines

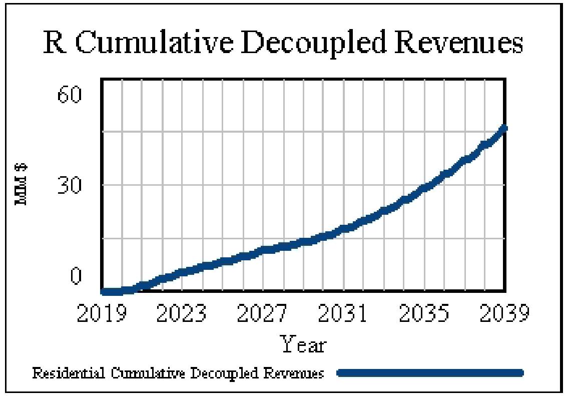


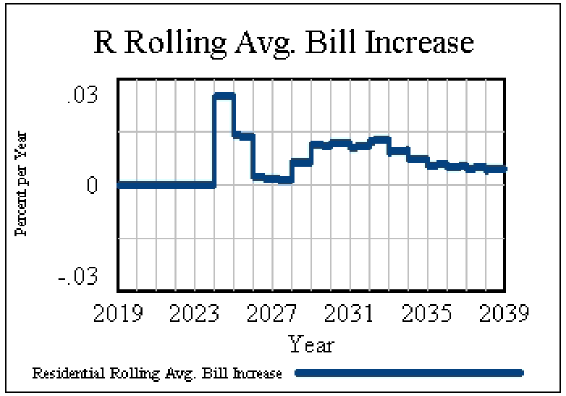


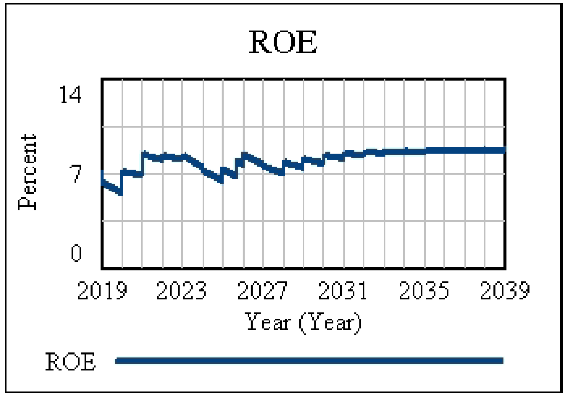
Solar adoption parameters	Utility specific parameters
CS	Off
RPS Carve Out	On
TOU	Off
Formula Rates	Off
NEM Cap (MW)	750
PV Cost Reduction (%/year)	4%
State Grant	$1,000
% Rooftop Eligible	35%

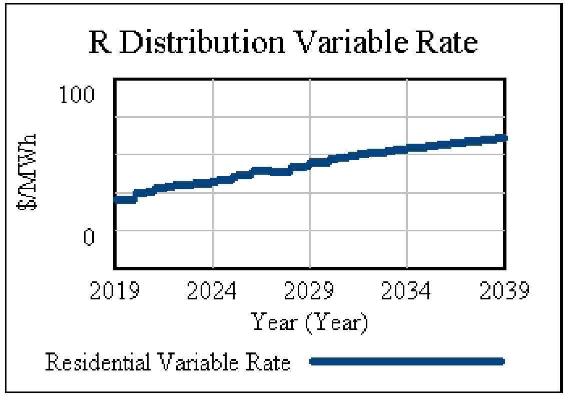




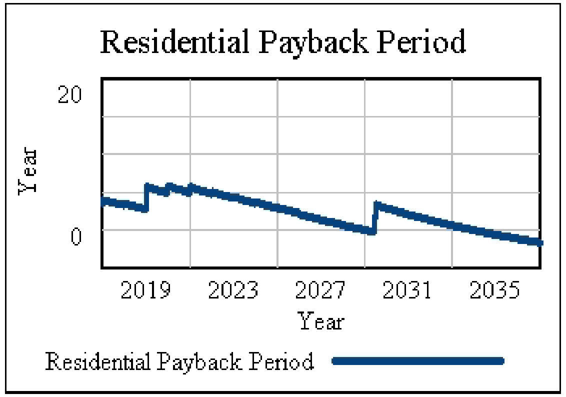


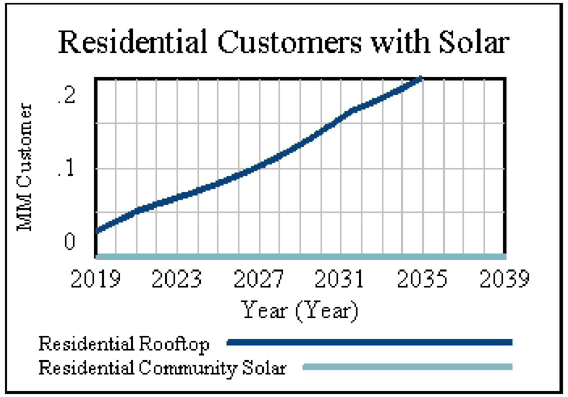




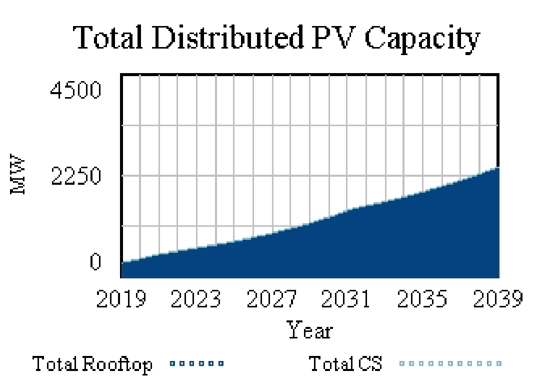


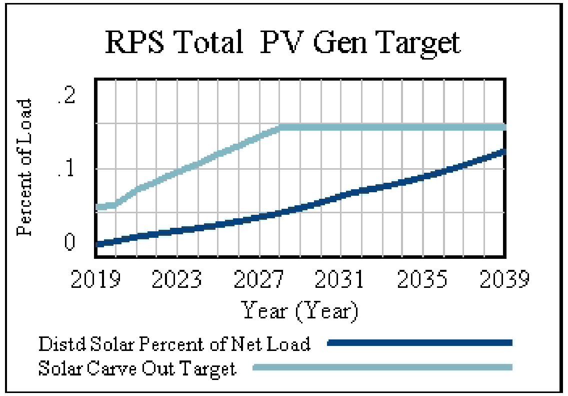
Higher PV Outlook + Cost Declines + Increased Subsidies

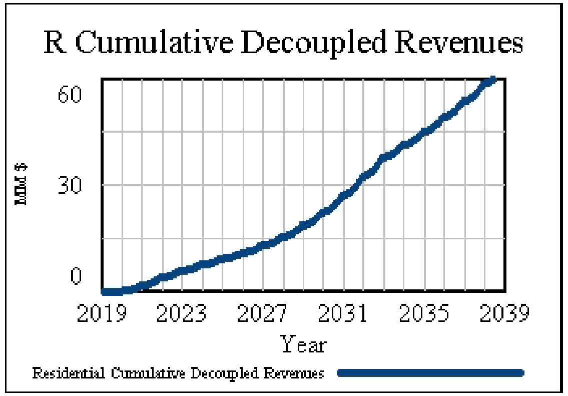


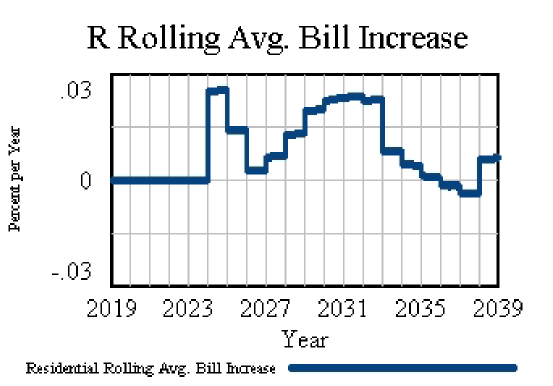


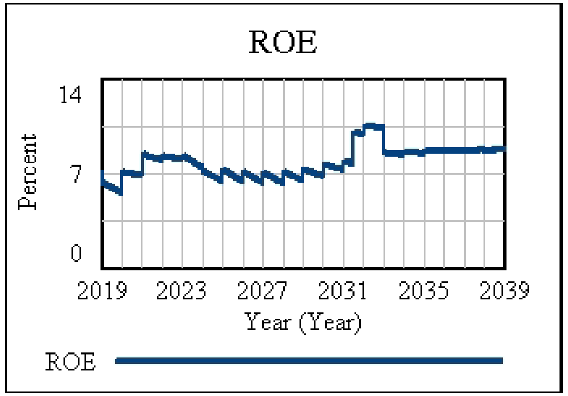
Solar adoption parameters	Utility specific parameters
CS	Off
RPS Carve Out	On
TOU	Off
Formula Rates	Off
NEM Cap (MW)	1500
PV Cost Reduction (%/year)	8%
State Grant	$2,500
% Rooftop Eligible	35%

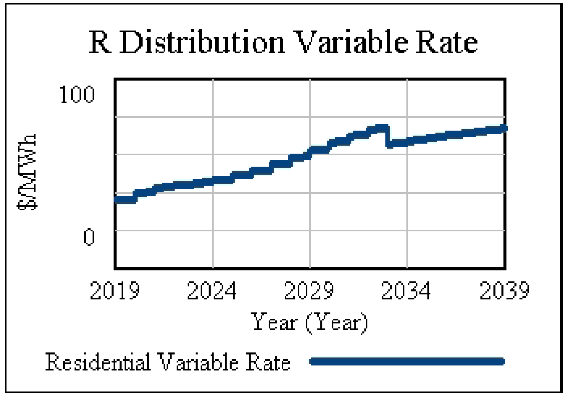






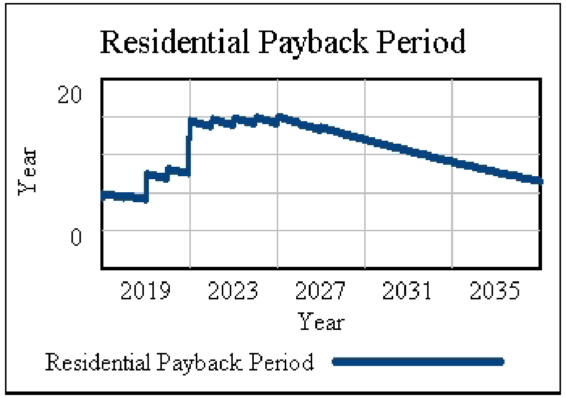


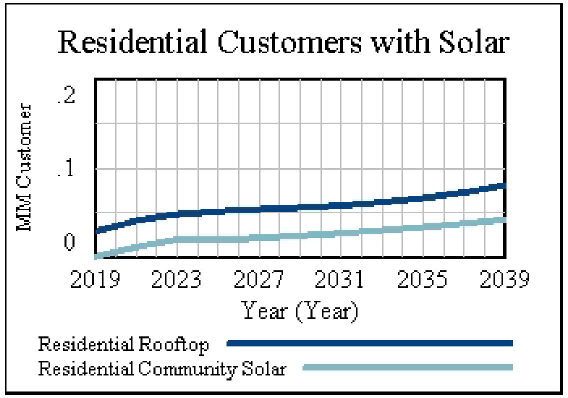


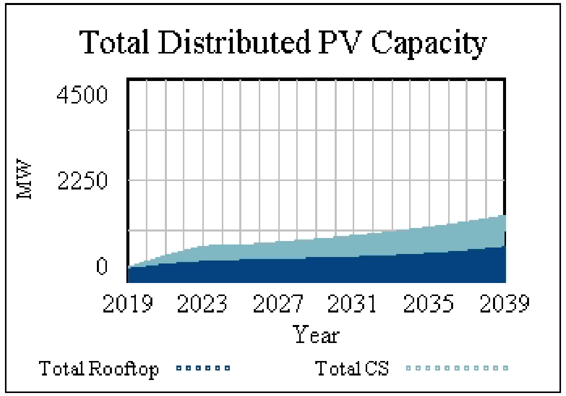


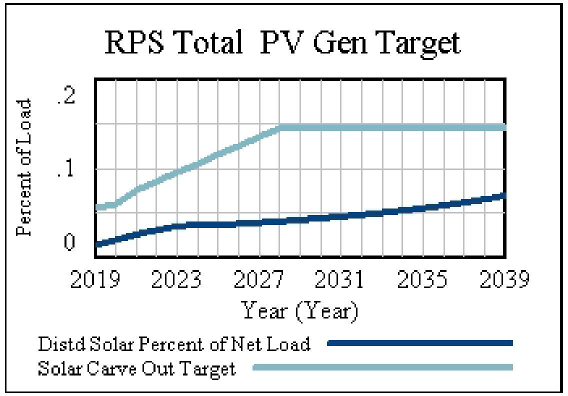
Rooftop + Community Solar

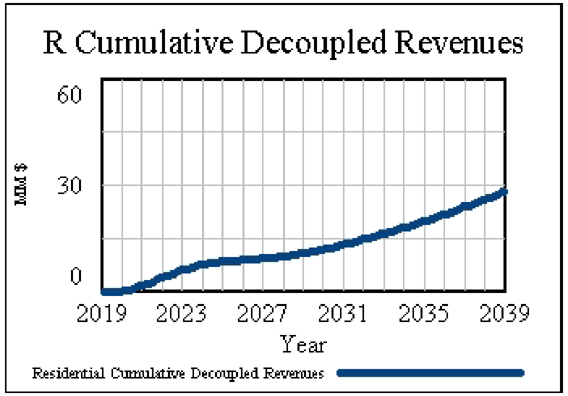
Solar adoption parameters	Utility specific parameters
CS	On
RPS Carve Out	On
TOU	Off
Formula Rates	Off
NEM Cap (MW)	750
PV Cost Reduction (%/year)	4%
State Grant	$1,000
% Rooftop Eligible	35%
CS Developer Offer	Based on Avoidable Market Rates
CS Initial Potential	1000 MW
CS Subscription Rate (%/month	0.85%
% Customers "Opting In"	25%

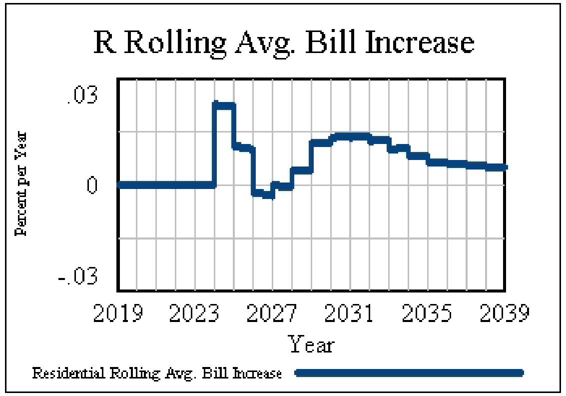


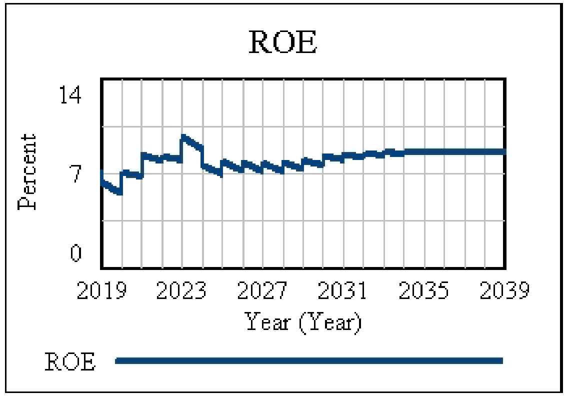


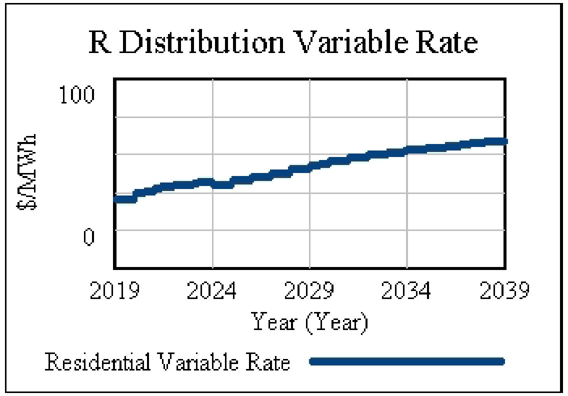






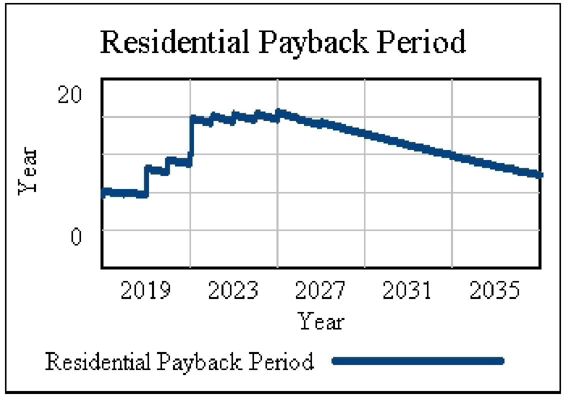


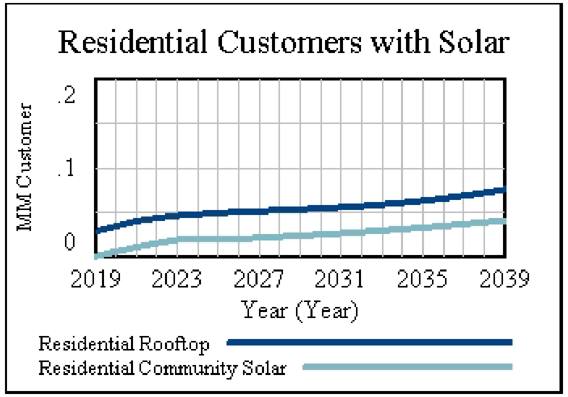


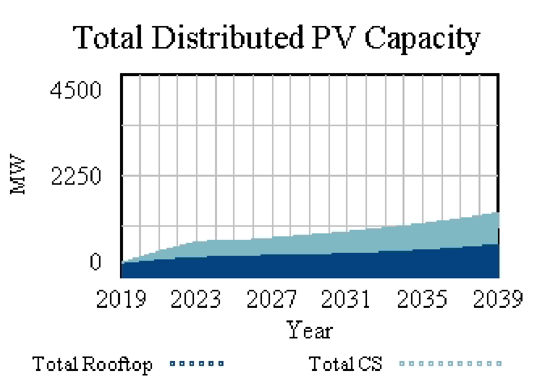


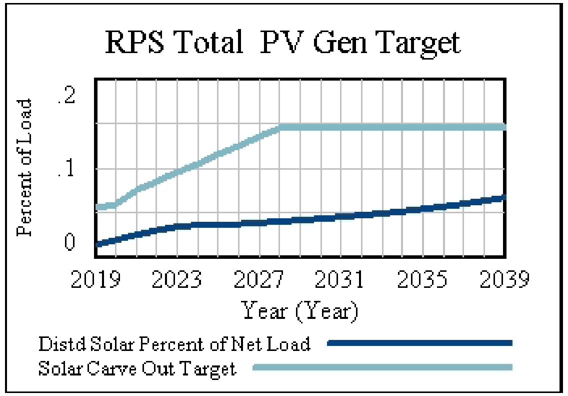
Time-of-Use Rates

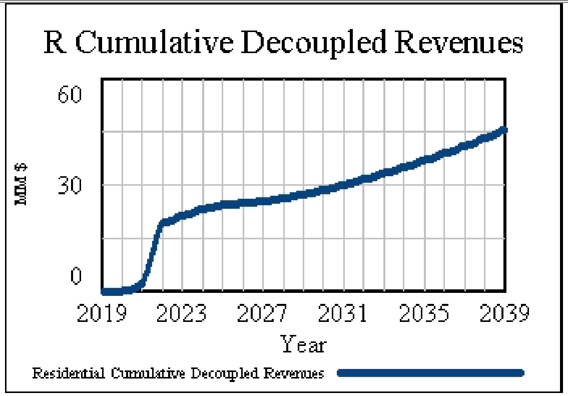
Solar adoption parameters	Utility specific parameters
CS	On
RPS Carve Out	On
TOU	On
Formula Rates	Off
NEM Cap (MW)	750
PV Cost Reduction (%/year)	4%
State Grant	$1,000
% Rooftop Eligible	35%
CS Developer Offer	Based on Avoidable Market Rates
CS Initial Potential	1000 MW
CS Subscription Rate	0.85%
% Customers "Opting In"	25%
TOU Ratio (Energy Supply)	4
TOU Ratio (Distribution)	5.2

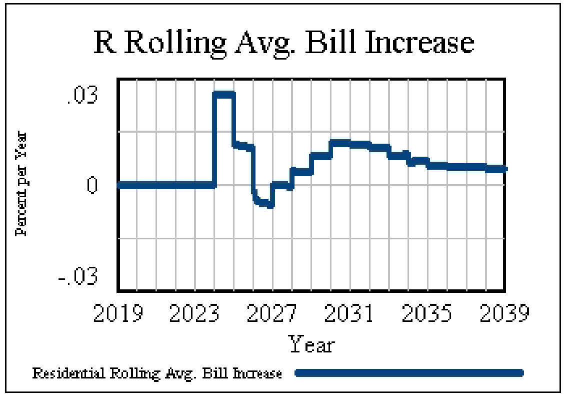


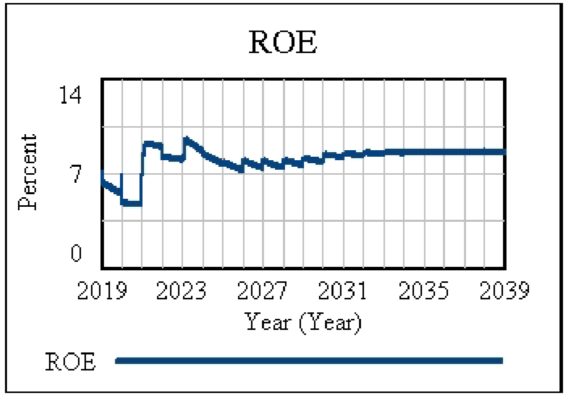


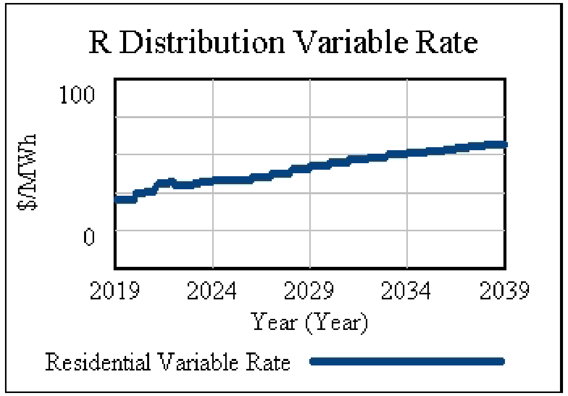






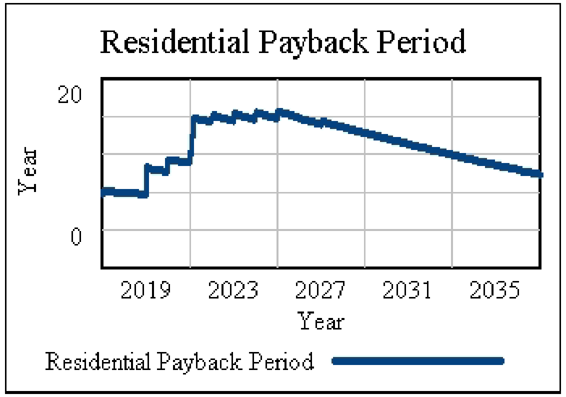


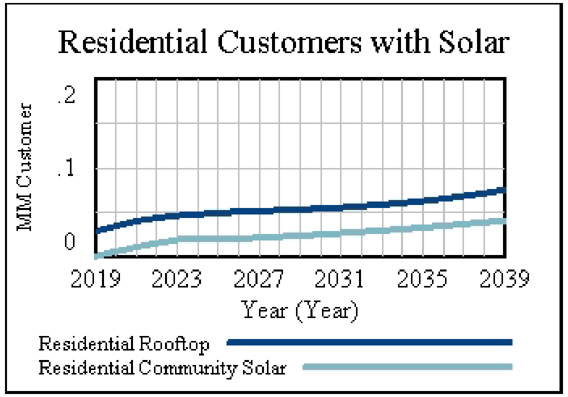


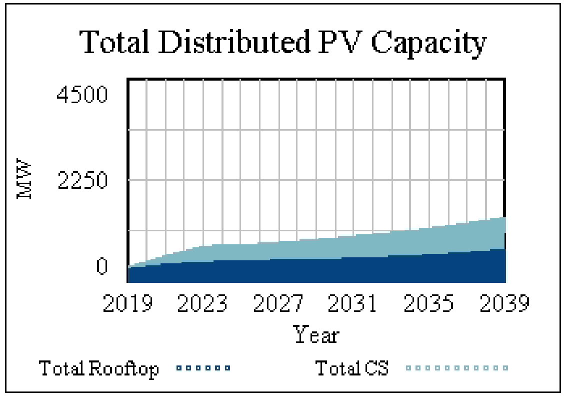


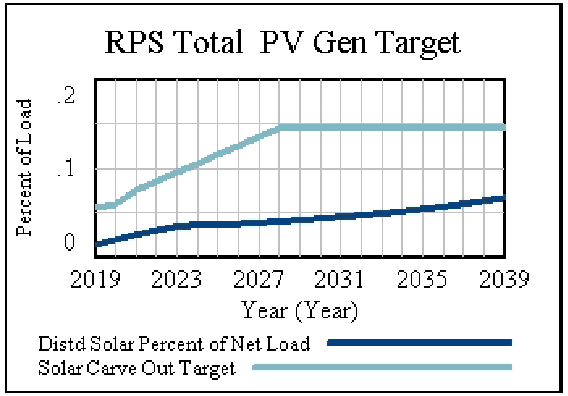
Time-of-Use Rates with High Ratios

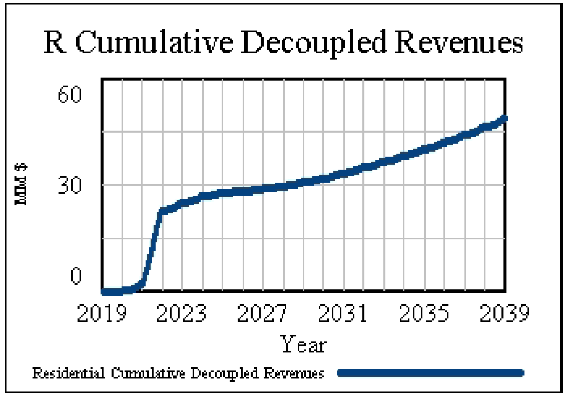
Solar adoption parameters	Utility specific parameters
CS	On
RPS Carve Out	On
TOU	On
Formula Rates	Off
NEM Cap (MW)	750
PV Cost Reduction (%/year)	4%
State Grant	$1,000
% Rooftop Eligible	35%
CS Developer Offer	Based on Avoidable Market Rates
CS Initial Potential	1000 MW
CS Subscription Rate	0.85%
% Customers "Opting In"	25%
TOU Ratio (Energy Supply)	5
TOU Ratio (Distribution)	6.0

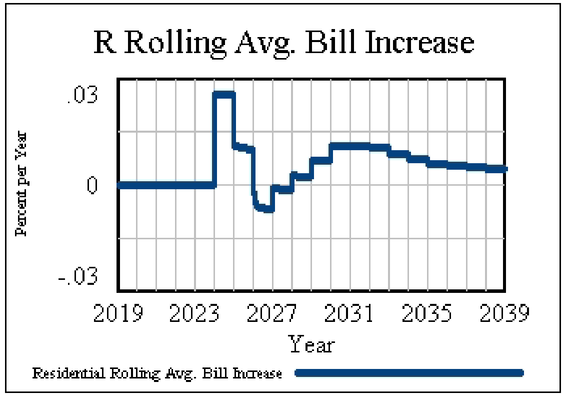


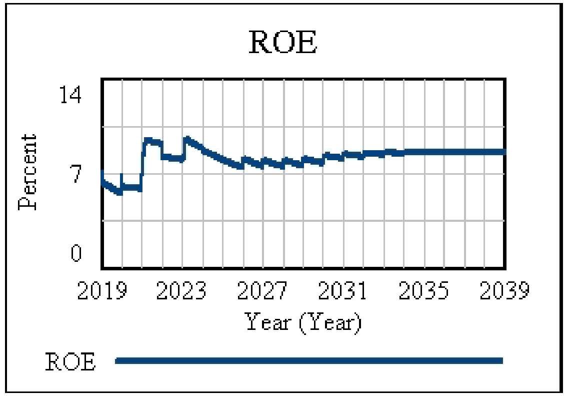


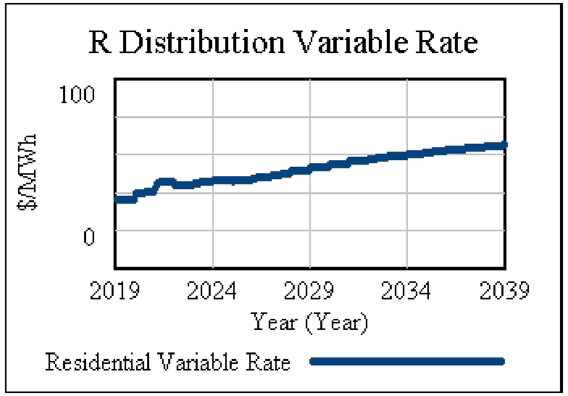






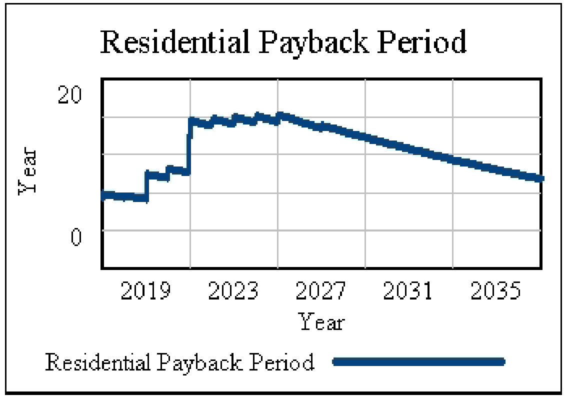


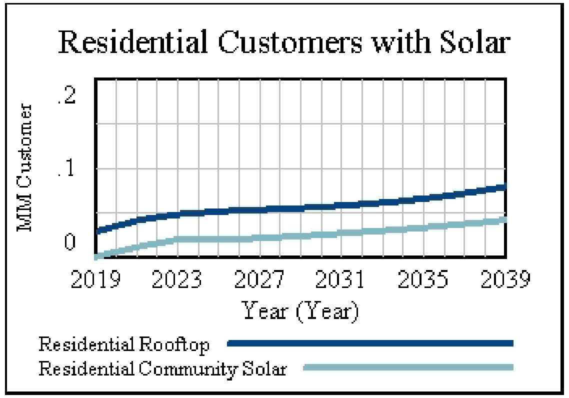


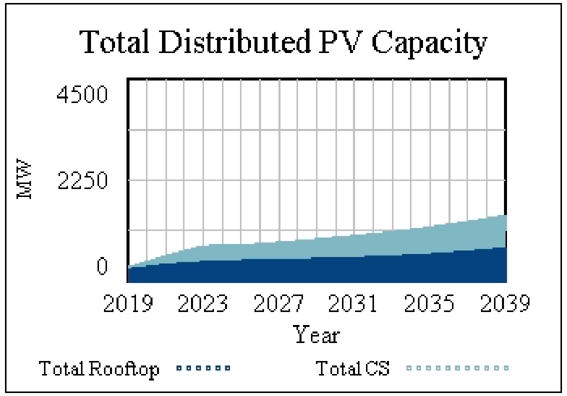


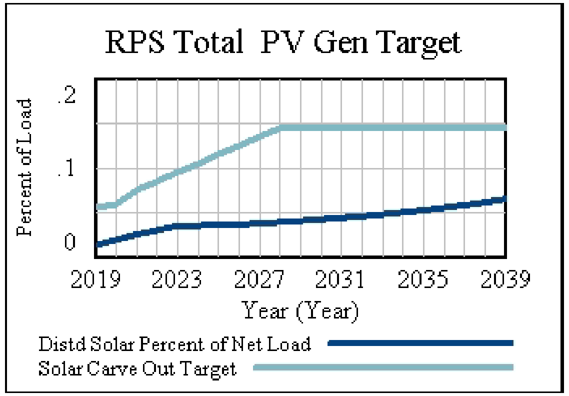
Increased EV Load

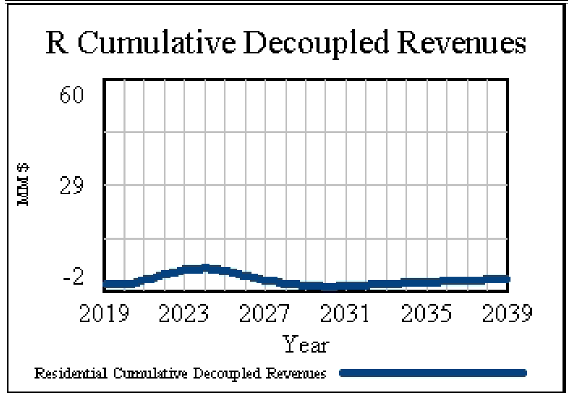
Solar adoption parameters	Utility specific parameters
CS	On
RPS Carve Out	On
TOU	Off
Formula Rates	Off
NEM Cap (MW)	750
PV Cost Reduction (%/year)	4%
State Grant	$1,000
% Rooftop Eligible	35%
CS Developer Offer	Based on Avoidable Market Rates
CS Initial Potential	1000 MW
CS Subscription Rate (%/month	0.85%
% Customers "Opting In"	25%
Scalar on EV Load Forecast	3

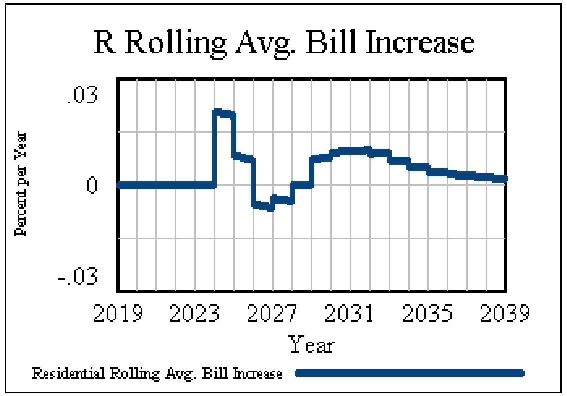


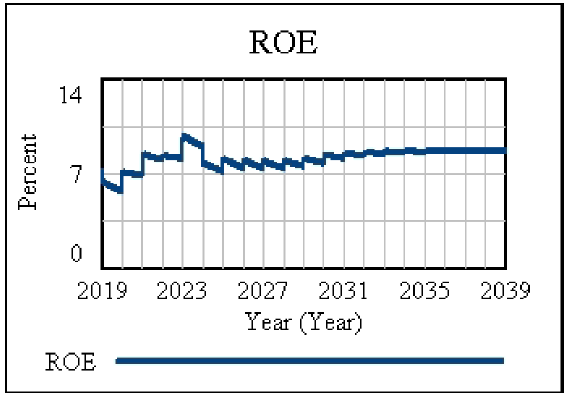


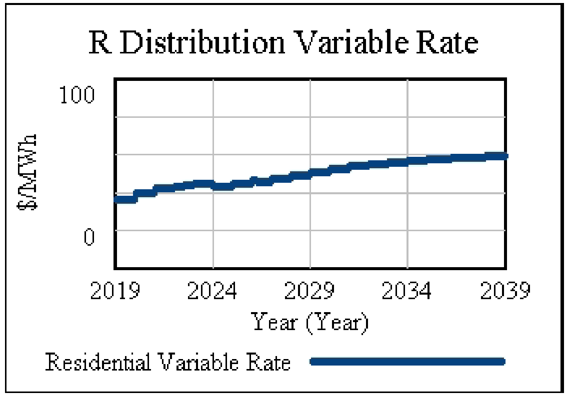












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Dr. Sanem Sergici is a Principal in The Brattle Group's Boston, MA office specializing in program design, evaluation, and big data analytics in the areas of energy efficiency, demand response, smart grid and innovative pricing.

She regularly supports electric utilities, regulators, law firms, and technology firms in their strategic and regulatory questions related to retail rate design and grid modernization investments. Dr. Sergici has been at the forefront of the design and impact analysis of innovative retail pricing, enabling technology, and behavior-based energy efficiency pilots and programs in many states and regions including District of Columbia, Connecticut, Florida, Illinois, Maryland, Michigan, Ontario, CA and New Zealand. She has led numerous studies in these areas that were instrumental in regulatory approvals of Advanced Metering Infrastructure (AMI) investments and smart rate offerings for electricity customers. She has significant expertise in resource planning; economic analysis of distributed energy resources (DERs); their impact on the distribution system operations and assessment of emerging utility business models and regulatory frameworks.

Dr. Sergici is a frequent presenter on these matters and regularly publishes in academic and industry journals. She was recently featured in Public Utility Fortnightly Magazine's "Fortnightly Under 40 2019" list. She received her Ph.D. in Applied Economics from Northeastern University in the fields of applied econometrics and industrial organization. She received her M.A. in Economics from Northeastern University, and B.S. in Economics from Middle East Technical University (METU), Ankara, Turkey.

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