Time Dependent Valuation (TDV)
2013 Base Standards

California Energy Commission
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Snuffer Price
Amber Mahone
+ San Francisco-based consulting firm since 1989
+ Deep expertise in electricity sector
+ Experienced in linking technical-economic analysis to policy decision-making and public process
+ E3 worked on the 2005 and 2008 Title 24 TDVs
Agenda

+ Overview and Purpose
+ Key Changes in 2013 TDVs
+ Results Compared to 2008
+ Methodology
  • Electricity TDVs
  • Natural gas TDVs
  • Propane TDVs
Purpose & Principles of TDV

+ Purpose

• Create a metric to value energy efficiency based on *when* energy savings occur, reflecting the variations over time in the cost of energy production and delivery.

+ Principles

• Rational and repeatable methods
• Based on hourly (or monthly) cost of energy, scaled to rates
• Seamless integration within Title 24 compliance methods
• Climate zone sensitive
Key changes to 2013 TDVs Compared to 2008

+ Updates to all data inputs using recent public data
  - Natural gas, CO2 price, retail rate forecasts
  - Wholesale electricity market price shapes
  - Avoided cost of transmission and distribution (T&D)
  - Avoided cost of capacity & ancillary services (A/S)

+ Methodology improvements
  - Statewide weather files correlated with hourly load shapes
  - Inclusion of the impacts of AB 32 Scoping Plan policies
  - Improved capacity cost methodology
  - Standardized treatment of avoided costs across utility service territories
2013 TDVs timeframe for economic analysis is 2011 – 2040

- Timeframe was developed prior to decision to release new standard in 2013
- Analysis period could be updated to begin in 2013, but would have little impact on the results and would slow-down the standards process

All Net Present Value TDV costs are reported in 2011 year dollars

2013 TDVs are reported in the 2009 Calendar-year format and correspond to 2009 typical weather year files
2013 TDVs show strong correlation between temperature and TDVs.
2008 TDVs show correlation between temperature and TDVs, but not as strong as 2013 correlation.
Correlation of Statewide Weather with 2013 TDVs

CTZ 1

CTZ 2

CTZ 3

CTZ 4
### 2013 TDVs Reflect Current State Policies and Trends

<table>
<thead>
<tr>
<th>Input</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail rate escalation</td>
<td>Consistent with the E3/CARB 33% RES Calculator impacts through 2020 (higher than 2008 TDV forecast)</td>
</tr>
<tr>
<td>CO2 price</td>
<td>Synapse Consulting “Mid” forecast (higher than 2008 TDV forecast)</td>
</tr>
<tr>
<td>CO2 price policy</td>
<td>Assume future CO2 value is used to offset any impacts to retail rates. CO2 prices only affect the electricity market price shape, not price level.</td>
</tr>
<tr>
<td>Renewable Electricity Standard (RES)</td>
<td>Assume California meets a 33% RES by 2020. This affects retail rates and the market price shape of electricity based on “High Wind” case from CEC’s “Electricity System Implications of 33 Percent Renewables” Study.</td>
</tr>
<tr>
<td>Other Policies</td>
<td>EE, Solar PV, CHP consistent with the AB 32 Scoping Plan goals and once-through cooling power plant regulations</td>
</tr>
</tbody>
</table>
2013 TDV Comparison to 2008 – Non-Res (15-yr)

Climate Zone 2

Higher peaks
Average TDVs ~10% higher
2013 TDV Comparison to 2008 – Res (30-yr)

Climate Zone 2

Higher peaks
Average TDVs ~50% higher
Methodology
Three Basic Steps

1. Develop hourly 15-year and 30-year forecasts of avoided cost of energy
   - Residential and Nonresidential Electricity Costs
   - Residential and Nonresidential Natural Gas Costs
   - Residential and Nonresidential Propane Costs

2. Calculate net present value (NPV) of cost stream

3. Convert NPV costs ($/unit energy) into TDV energy factors (kWh/kBtu for electricity)
## Step 1: Calculate Hourly Avoided Cost of Energy

<table>
<thead>
<tr>
<th>Component</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td><strong>Generation Energy</strong></td>
<td>Estimate of hourly wholesale value of energy measured at the point of wholesale energy transaction</td>
</tr>
<tr>
<td><strong>System Capacity</strong></td>
<td>The costs of building new generation capacity to meet system peak loads</td>
</tr>
<tr>
<td><strong>Ancillary Services</strong></td>
<td>The marginal costs of providing system operations and reserves for electricity grid reliability</td>
</tr>
<tr>
<td><strong>T&amp;D Capacity</strong></td>
<td>The costs of expanding transmission and distribution capacity to meet peak loads</td>
</tr>
<tr>
<td><strong>Greenhouse Gas Emissions</strong></td>
<td>The cost of carbon dioxide emissions (CO2) associated with the marginal electricity generation resource</td>
</tr>
<tr>
<td><strong>Retail Rate Adjuster</strong></td>
<td>TDV values are scaled to level equivalent to residential and nonresidential retail rate levels</td>
</tr>
</tbody>
</table>
Step 2: Net Present Value of TDVs

- Net Present Value = value in current year dollars of a future stream of costs/benefits

- Energy efficiency measure lifetime is:
  - Residential: 30 years
  - Nonresidential: 30 years or 15 years

- The value of future energy savings is “discounted” to present dollars using a societal discount rate
  - 3% real discount rate (at 2% inflation = 5% nominal)
Step 3: Converting TDV Dollars to TDV Energy Factors

+ NPV costs ($/kWh) are converted to TDV energy factors (kWh/Btu) for two reasons:
  
  2. TDV energy units make it less likely to mistake TDV savings for the actual dollar savings that any single building owner might realize from implementing the standard.

+ TDVs are converted to energy units using standardized factors based on cost of natural gas (same factors as used in 2005 and 2008, adjusted for inflation)

<table>
<thead>
<tr>
<th>TDV Conversion Factors NPV 2011$/kBtu (All Energy Types)</th>
<th>NPV (30-year)</th>
<th>NPV (15-year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low-Rise Residential</td>
<td>$0.1732</td>
<td>n.a.</td>
</tr>
<tr>
<td>Nonresidential &amp; High-rise Residential</td>
<td>$0.1540</td>
<td>$0.0890</td>
</tr>
</tbody>
</table>
Electricity TDV Methodology
Components of TDV values vary by climate zone. In 2013 TDVs, statewide averages of costs are used instead of utility-specific costs in ALL cases except line losses & market price shapes:

<table>
<thead>
<tr>
<th>Climate Zone</th>
<th>Majority IOU Territory</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEC Zone 1</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>CEC Zone 2</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>CEC Zone 3</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>CEC Zone 4</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>CEC Zone 5</td>
<td>SCE</td>
</tr>
<tr>
<td>CEC Zone 6</td>
<td>SCE</td>
</tr>
<tr>
<td>CEC Zone 7</td>
<td>SDG&amp;E*</td>
</tr>
<tr>
<td>CEC Zone 8</td>
<td>SCE</td>
</tr>
<tr>
<td>CEC Zone 9</td>
<td>SCE</td>
</tr>
<tr>
<td>CEC Zone 10</td>
<td>SCE</td>
</tr>
<tr>
<td>CEC Zone 11</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>CEC Zone 12</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>CEC Zone 13</td>
<td>PG&amp;E</td>
</tr>
<tr>
<td>CEC Zone 14</td>
<td>SCE</td>
</tr>
<tr>
<td>CEC Zone 15</td>
<td>SCE</td>
</tr>
<tr>
<td>CEC Zone 16</td>
<td>PG&amp;E</td>
</tr>
</tbody>
</table>

* CZ7 uses SCE market price shape
### More Details: Components of Avoided Cost of Electricity

<table>
<thead>
<tr>
<th>Component</th>
<th>Basis of Annual Forecast</th>
<th>Basis of Hourly Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Generation Energy</strong></td>
<td>Combination of market forwards through 2014 and a long-run forecast of California gas prices through 2040</td>
<td>Energy Commission production simulation dispatch model results using 2012 and 2020 test years</td>
</tr>
<tr>
<td><strong>System Capacity</strong></td>
<td>Fixed costs of a new simple-cycle combustion turbine, less net revenue from energy and AS markets</td>
<td>Hourly allocation factors calculated as a proxy for rLOLP based on loads from production simulation dispatch model results</td>
</tr>
<tr>
<td><strong>Ancillary Services</strong></td>
<td>Scales with the value of energy</td>
<td>Directly linked with energy shape</td>
</tr>
<tr>
<td><strong>T&amp;D Capacity</strong></td>
<td>Survey of investor owned utility transmission and distribution deferral values from recent general rate cases</td>
<td>Hourly allocation factors calculated using hourly temperature data</td>
</tr>
<tr>
<td><strong>Greenhouse Gas Emissions</strong></td>
<td>Synapse Mid-Level carbon forecast developed for use in electricity sector IRPs</td>
<td>Directly linked with energy shape based on implied heat rate of marginal generation, with bounds on the maximum and minimum hourly value</td>
</tr>
</tbody>
</table>
Correlation of Temperature to Price

- Hourly market prices are developed using the CEC’s production simulation dispatch model.
- E3 developed 18 new load shapes by CA region for use in the dispatch model which are correlated with Title 24 typical weather year data.
- This ensures that TDV market prices are correlated with Title 24 weather files.
- E3 used statistical analysis and regression techniques with historical hourly temperatures, historical hourly loads and Title 24 typical weather year data to generate regional “typical” load shapes.
Regression analysis approach accounts for:

- Weather effect
  - dry bulb temperature, dew point temperature
  - cooling and heating degree hours, 3-day lagged cooling and heating degree days
- Time-of-use effect (hour, day, month, holidays)
- Skewness of load data (hourly distribution has long tail)
- Peak loads (secondary regression captures peak hours for temps above 75°F)
- Load growth (data are normalized for peak load)
**Correlation of Temperature to Price: Example Result**

Statistical correlation between hourly historical loads and hourly historical weather produces robust results.

**SCE 2007 Predicted vs. Actual – Summer Peak Week**

- **Predicted**
- **Actual**

**Day**

**System Load (GWh)**

0 - 25
Hourly Electricity Avoided Cost – One Week

Climate Zone 2

Hourly Levelized Avoided Cost ($/MWh)

- T&D
- Capacity
- Emissions
- Ancillary Services
- Losses
- Energy
- Retail Adjust

Sun 7/5 Mon 7/6 Tue 7/7 Wed 7/8 Thu 7/9 Fri 7/10 Sat 7/11
Hourly Electricity Avoided Costs – One Year

Climate Zone 2

![Chart showing hourly electricity avoided costs for Climate Zone 2 over one year. The chart includes different cost components such as T&D, Capacity, Emissions, Ancillary Services, Losses, Energy, and Retail Adjustment. The costs are displayed on a vertical scale from $0 to $2,000 per MWh, and the horizontal scale represents chronological hours from January to December.]
+ Capacity costs are allocated based on hourly loads

Climate Zone 2
Allocation of T&D Capacity Value

T&D costs allocated based on hourly temperatures

Climate Zone 2
CO2 Price Forecast

![Graph showing CO2 Price Forecast from 2011 to 2039. The graph includes three lines:
- Synapse High Forecast, a dashed red line.
- Synapse Mid Forecast, a solid blue line.
- Synapse Low Forecast, a dotted green line.]

Energy + Environmental Economics
Derivation of Hourly Emissions Rates for CO2 Cost Allocation
Natural Gas and Propane
TDVs
Monthly Natural Gas Avoided Costs

Avoided Cost of Natural Gas ($/therm)

- Jan
- Feb
- Mar
- Apr
- May
- Jun
- Jul
- Aug
- Sep
- Oct
- Nov
- Dec

T&D
Emissions
Commodity Cost
Retail Adjustment
Time Dependent Valuation (TDV)
Proposed 2013 Reach Standards

California Energy Commission
November 16, 2010

Snuller Price
Purpose of Developing Reach TDVs

- Create more aggressive Title 24 standards for optional adoption by local jurisdictions and/or building designers

The Policy Context

Proposed Reach I Standard

Proposed Reach II Standard

Discussion
State law (AB 32) requires emissions to reach 1990 levels by 2020

California buildings represent over 20% of statewide GHG emissions

Building standards are an important component of California’s strategy to reduce greenhouse gases
The Long-term Challenge: >90% Decarbonization of the Entire Economy

California Greenhouse Gas Emissions

BAU 2050
875 MtCO₂

>90% Decarbonization of the system

California Executive Order: 80% reduction below 1990 levels by 2050 = 85 MtCO₂
Energy Efficiency is a Critical for Deep Reductions in Greenhouse Gas Emissions

Carbon Reductions in California
Conceptual Design of Proposed Reach Standards

+ **Base TDV: “Current Policy”**

+ **Reach I: “A Carbon Constrained World”**
  - Reflects a greater societal emphasis on achieving greenhouse gas reductions, consistent with a goal of reducing GHG emissions 80% below 1990 levels by 2050.
  - **Economics are based on ‘equal sharing’ of costs to reduce carbon with future generations**

+ **Reach II: “Zero-Net Energy Ready Buildings”**
  - Reflects a commitment to taking responsibility for solutions to the greenhouse gas problem in this generation, rather than sharing the burden with future generations by building zero-net energy ready buildings – everything but the self-generation
**Two Proposed Changes: Reach I A Carbon Constrained World**

1. **Higher CO2 Emissions Price, layered on top of retail rate adjustment**
   - Base TDVs use a “market price forecast” for CO2 prices
     - Increases from $14/ton to $57/ton (in real 2010$)
   - Reach I TDVs would use a “societal value” on CO2 reductions
     - $73/ton each year (in real 2010$)

2. **Lower discount rate – 0% real discount rate**
   - Base TDVs use a 3% real societal discount rate
   - Reach I TDVs would use a 0% real discount rate: Values the future equally with the present
Comparing Base TDVs to Reach I

Reach I TDVs ~20% higher impacts on average
Reach II: Zero-Net Energy Ready Buildings

+ Principle is to include all energy efficiency measures needed for a ZNE building, EXCEPT for self-generation
  - Self-generation can be added at discretion of the builder
  - Cost-effectiveness of solar electric options is being evaluated at Commission

+ Goal: identify the suite of measures that would lead to a ‘least-cost’ path to a ZNE building

+ In practical terms, this means designing high-performance buildings that include a suite of energy efficiency measures that cost less than rooftop solar PV (~$0.28/kWh, depending on assumptions and installation)
Implementing Reach I & Reach II

- There are a number of possible implementation paths which Commission can decide between.

- Prescriptive and ACM approaches could be the same as those used for the base standard, except...
  - For Reach I use higher Reach I TDV values
  - For Reach II use cost of self-generation

- Implications are being evaluated, considering for example...
  - Interactive effects between measures, integration of passive features, and data availability on higher cost EE measures

- Your thoughts and feedback are requested!
Thank You

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