



page **Part 1 illustrations**

6	<b>1</b> Traditional supply expansion
7	<b>2</b> Distributed generation
11	<b>3</b> 1970 expectation of ever-larger generating units
11	<b>4</b> Ever-larger generating units (all types, all U.S. utilities)
14	<b>5</b> The myth of bigger, better, cheaper
14	<b>6</b> Vanishing economies of scale
15	<b>7</b> Saturating thermal efficiency
16	<b>8</b> Building more coal and nuclear plants made them costlier
17	<b>9</b> The forced-outage trap
18	<b>10</b> Big steam plants age ungracefully
21	<b>11</b> U.S. residential average real price of electricity
22	<b>12</b> Electricity prices have retreated
24	<b>13</b> Maximum and average size of operating units (all types, all U.S. utilities) by year of entry into service
25	<b>14</b> Maximum and average size of new generating units (fossil-fueled steam, all U.S. utilities, five-year rolling average) by year of entry into service
25	<b>15</b> Capacity distribution by date in service (all U.S. utility-owned steam units)
26	<b>16</b> Capacity distribution by date in service (all U.S. utility-owned steam units)
27	<b>17</b> U.S. utility generating capacity commissioned 1920–2007
27	<b>18</b> U.S. utility generating capacity commissioned 1920–2007 (logarithmic scale)
28	<b>19</b> U.S. non-utility generating capacity commissioned 1920–1997
28	<b>20</b> U.S. non-utility generating capacity commissioned 1920–1997 (logarithmic scale)
29	<b>21</b> Market development 1992–94 vs. 1995–97 vs. 1998
31	<b>22</b> Cheaper meant bigger
31	<b>23</b> Bigger isn't always more efficient
32	<b>24</b> The fall and rise of U.S. non-utility generation
36	<b>25</b> Average electricity demand of U.S. residential units, 1997
36	<b>26</b> Average electricity demand of U.S. commercial buildings, 1995
37	<b>27</b> U.S. energy intensity has fallen by 40% since 1975, to once-heretical levels
61	<b>28</b> Peak demand reduction in California, voluntary and program-induced
66	<b>29</b> World crude oil consumption as a function of real price, 1978–2000
72	<b>30</b> Share of U.S. utilities' 1994 capacity by technology and unit size
73	<b>31</b> Distribution of units by unit size (all types, all U.S. utilities, in service 1994)
73	<b>32</b> Distribution of capacity by unit size (all types, all U.S. utilities, in service 1994)

74	<b>33</b> 1995 busbar operating costs vs. capacity factor of U.S. utilities' nonrenewable, non-peaking units > 100 MWe
80	<b>34</b> Seasonal and time-of-use range of PG&E's cost to produce power and deliver it to feeders
81	<b>35</b> Asset utilization varies widely among feeders
81	<b>36</b> Differing feeder asset utilization is exacerbated near peak-load hours
83	<b>37</b> Distribution assets stand idle more than generation assets
83	<b>38</b> Peak power in a high-cost part of the distribution system can incur huge delivery costs
84	<b>39</b> Range of marginal distribution capacity cost for four U.S. utilities, 1994
85	<b>40</b> Area- and time-specific costs are important but not constant
86	<b>41</b> Summer peak demand projections: comparison of annual 10-year forecasts
90	<b>42</b> The brittle grid
93	<b>43</b> A past construction boom may have future echoes

page **Part 2 illustrations**

112	<b>1</b> Electricity's timescales span 15 orders of magnitude
120	<b>2</b> Uncertain demand imposes stringent cost tests on slow-to-build resources
121	<b>3</b> Faster-to-build resources help avoid capacity and price overshoot
122	<b>4</b> Slow, lumpy capacity overshoots demand in three ways
125	<b>5</b> Modular plants reduce need for working capital
126	<b>6</b> Modular resources' early operation increases their present value
127	<b>7</b> Power-plant financial feasibility vs. lead time
128	<b>8</b> Slow construction multiplies its costs
129	<b>9</b> Utility investments are now dominated by the grid
129	<b>10</b> Counting the dynamic nature of demand growth increases the value of short-lead-time plants
130	<b>11</b> Smaller, faster grid-support investments are worth more
136	<b>12</b> Minimizing regret as the uncertain future unfolds
137	<b>13</b> Option value of modular construction
138	<b>14</b> Shorter lead time increases option value
144	<b>15</b> Salvage option value
145	<b>16</b> The random walk of world real crude-oil price, 1881–1995
154	<b>17</b> The importance of risk-adjusted discount rates
155	<b>18</b> Fuel-price risk can dominate comparisons
155	<b>19</b> Effects of discounting avoided costs at risk-adjusted discount rates
156	<b>20</b> Solar and fossil-fuel technologies have opposite cost structures

page **Part 2 illustrations (cont.)**

- 
- 165 **21** Gas-coal diversification scarcely reduces financial risk
- 165 **22** Adding renewables can reduce portfolio cost *and* risk
- 166 **23** Costly renewables improve portfolios
- 168 **24** Loadshapes are diverse
- 168 **24a** Measured electricity consumption and estimated production using distributed resources (U.S. residential sector in 1995)
- 169 **25** End-use structure of 1999 California summer-peak-day statewide load
- 169 **26** End-use structure of 1999 California summer-peak-day residential load
- 170 **27** End-use structure of 1999 California summer-peak-day loadshape for the commercial sector, excluding the residual "other" term shown in the statewide total graph
- 170 **28** End-use/sectoral structure of California summer-peak-day industrial, agricultural, and public-service load, excluding the residual "other" term shown in the statewide total graph
- 173 **29** Correlation of wind and electricity demand in England
- 174 **30** PVs well match PG&E's annual load-duration curve...
- 174 **31** ...especially in the top 25 peak-load hours
- 175 **32** Peak-load/PV match in Sacramento
- 175 **33** Peak-load/tracking-PV match in Sacramento
- 175 **34** Tracking PVs prolong late-afternoon output
- 176 **35** West-facing PVs maximize Sacramento capacity credit
- 176 **36** Intermediate azimuth maximizes PVs' economic value to SMUD
- 177 **37** Prospecting for PV sites and mounting types with the highest Planning Area capacity credits
- 178 **38** PVs precool distribution transformers
- 178 **39** PV loss savings are like extra kW
- 179 **40** PV/peak-load match (Figures 2-31–32) remain valid at feeder level
- 183 **41** Technical availability of typical supply technologies. *ca.* 1990
- 184 **42** Isolated systems' units must be very reliable if large
- 185 **43** Multiple small modules dramatically reduce variance of collective availability
- 203 **44** Late-1950s view of reserve margin vs. unit size
- 210 **45** U.S. photovoltaic shipments for general electrical generation
- 210 **46** U.S. photovoltaic shipments by end-use, 1989–1999
- 212 **47** Lost and unaccounted-for U.S. electricity (utility plus nonutility), 1989–2000
- 212 **48** USEIA lost and unaccounted-for electricity vs. cooling-degree days
- 214 **49** U.S. investor-owned utilities' construction expenditures, 1950–2000
- 215 **50** Allocation of U.S. investor-owned utilities' construction expenditures, 1945–2000, excluding nuclear fuel
- 217 **51** U.S. utility plant in service 31 December 1996 (major investor-owned utilities)
- 217 **52** Conventional accounting allocation of the 1996 electric revenues of large investor-owned U.S. electric utilities (average ultimate-customer revenue = \$0.07105/kWh)
- 218 **53** Functional allocation of the 1996 electric revenues of large U.S. investor-owned electric utilities (average ultimate-customer revenue = \$0.07105/kWh)
- 218 **54** Functional allocation (G&A allocated out) of the 1996 electric revenues of large investor-owned U.S. electric utilities
- 218 **55** Where the \$0.07105/kWh of 1996 ultimate-customer revenue to large investor-owned U.S. utilities went
- 223 **56** PV generators' avoided losses are greatest in the peak hours
- 232 **57** Daytime supply's line support *is* worth more
- 233 **58** Distributed resources can offset distribution transformers' unfavorable scale economies
- 238 **59** A little PV capacity goes a long way in relieving substation load
- 239 **60** 1991 substation transformer bank 2 top oil temperature histogram
- 256 **61** EPRI's 1991 view of standalone-PV economics
- 257 **62** A more sophisticated but still incorrect view of standalone-PV economics
- 261 **63** Residential micro-grids represent a huge PV market
- 262 **64** Peaky loadshapes smooth and decrease with aggregation
- 274 **65** Typical design goals of power-conscious computer manufacturers
- 275 **66** Different customers place very different values on electricity supply
- 288 **67** Windpower can enrich farmers and ranchers
- 
- page **Part 3 illustrations**
- 346 **1** Kerman substation-support PV: benefits depend on perspective
- 346 **2** Kerman substation-support PV: distributed benefits raise value by 1.3–3.8×
- 347 **3** The value of the Kerman plant to PG&E (1995 \$)
- 357 **4** Typical utility organizational structure
- 364 **5** California market supply elasticity, summer peak hour (29 June 2000)
- 365 **6** Total savings from 500 MW of distributed resources in the 2000 California power market
- 366 **7** The impact of peak power prices on combustion-turbine profitability (example based on 1999 East Central Area Reliability Council [ECAR] prices)
- 371 **8** Integrated energy services business model
- 372 **9** Capabilities required for energy services businesses