Solar Interconnections

PG&E
Generation Interconnection Services
San Francisco

Courtesy of DOE/NREL
Contact Information

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Generation Interconnection Services
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“PG&E is committed to leading by example when it comes to climate change. That means more than just minimizing the greenhouse gas emissions from our operations. It also means maximizing the opportunity we have to lead efforts to establish responsible policies and programs to address global climate change.”

— Adopted by PG&E Corporation, May 2006
Generation Interconnection Services (GIS)

- Coordinates interconnection activities, including:
  - engineering reviews,
  - metering
  - access issues
  - special facilities
  - customer contracts and administration

- Ensures system is installed as designed and operating according to Rule 21. Issues Permission to Operate (PTO).

- Provides for two types of solar interconnections (Rule 21): NEM (exporting) and non-NEM (non-exporting) options for the customer.
Investing in Renewables and Emerging Technologies

• California’s goal of 33% renewable energy by 2020 is most aggressive renewable energy goal in U.S.

• Since 2002, PG&E has contracted for more than 2,100 MW of renewable energy from wind, solar, geothermal, biomass, and hydro resources.

• We are exploring a number of emerging renewable technologies.

PG&E’s recent agreement with Solel-MSP-1 for 553 megawatts—one of the world’s largest solar commitments—is expected to be fully operational in 2011.
PG&E’s 2008 Electric Delivery Mix

--on average over 50% of the energy PG&E delivers comes from sources that emit almost no carbon dioxide

*These resources are climate neutral and/or renewable
PG&E as a Partner and Solutions Provider

PG&E Portfolio Solution

Reduce Energy Use

Partnership

Education

Outreach

ClimateSmart

Renewable Power Supply
PG&E Customer Solar Installations

• As of Q3 2008 PG&E has over 26,000 customers who have installed solar generation to help them meet their energy needs
  – More than 24,500 residential customers and 1,500 nonresidential customers

• Customers on Net Metering tariffs have installed over 210 MW of solar generation
  – 110 MW by residential customers; 90 MW by nonresidential customers
  – An additional 130 MW has been installed by customers who are not taking advantage of the NEM tariff structure
Annual PG&E Solar Interconnections
Solar Water Heating

**Solar Thermal**
Domestic Hot Water (DHW)
Hot showers, Washers, etc.
120 - 140 degrees all year

Photo courtesy SunEarth
Solar Electricity

Produces electricity year-round

Courtesy of DOE/NREL
Inverters

Changes Direct Current (DC) to Alternating Current (AC)
Inverters & Disconnects

- Range in size from 1 Kw to 225 Kw
- Can easily be connected together, even different models
- A/C Disconnects must be accessible

Source: Darren Bouton
Reliability

• Products tested and approved by CEC
• Long warranties backed by large, stable companies

-- 20 to 25 years on panels
-- 10 years on inverters
-- 10 year labor warranty
Net Energy Metering (NEM)

The utility grid is a two-way street!

Electricity can be “sent back” to the grid by the customer.

• Eliminates the need for batteries.
• Reduces cost and maintenance.
• Ensures a constant supply of electricity.

Source: Andy Black

Source: DOE NREL
Typical System Components

Array

Inverter

Balance of System (BOS)

Source: Darren Bouton
Net Metering

Sell Power to the Utility by Day

Buy Power at Night and Winter

- Exchange at Retail
- Annual Cycle
Reduce Your Energy Bills

Spin Your Meter Slower

- Use the electricity you generate first to reduce electricity you would normally buy from the utility or electric service provider

Spin Your Meter Backwards

- Excess electricity generated goes through your meter and into the grid
- Spins your meter backwards!
- Get credit for “stored” electricity on the grid

Source: Darren Bouton
Net Metering

Average monthly usage
PV system production

kWh/mo

May
“SUMMER”
October
“WINTER”
April

Roll over
The surplus covers the shortfall, and your yearly bill is minimal.
PV system produces less than your yearly usage.

You pay this amount
Net Metering

Average monthly usage
PV system production

PV system produces more than your yearly usage.

You lose this amount

kWh/mo

May

October

April

“SUMMER”

“You lose this amount”

“WINTER”
## Time of Use Rates

### Residential "E6" Time-of-Use Pricing Periods

<table>
<thead>
<tr>
<th>Time</th>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
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</thead>
<tbody>
<tr>
<td>Midnight - 6am</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
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<tr>
<td>6am - 10am</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
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<tr>
<td>10am - 1pm</td>
<td>Off-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Off-Peak</td>
</tr>
<tr>
<td>1pm - 7pm</td>
<td>Off-Peak</td>
<td>Peak</td>
<td>Peak</td>
<td>Peak</td>
<td>Peak</td>
<td>Peak</td>
<td>Off-Peak</td>
</tr>
<tr>
<td>7pm - 9pm</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
<td>Part-Peak</td>
</tr>
<tr>
<td>9pm - Midnight</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
<td>Off-Peak</td>
</tr>
</tbody>
</table>

- Peak rates in Summer Afternoons 29¢/kWh + tier surcharges
- Part-Peak rates: 14¢/kWh + tiers
- Off-Peak rates (Nights & Weekends) 8.5-10¢/kWh + tiers
PV Orientation

For tilted roof:

- North
- West
- Good
- Very good
- OK
- East
- Not good

24
Pacific Energy Center San Francisco
E-6 summer rates (May – October)
Time of Use Rates

Typical summer production
Time of Use Rates

Summer pattern (May – October)
Buying low and selling high adds value.
Change in Utility Billing

- Two bills, gas & electric
- Yearly billing cycle for electricity
- Fixed minimum electric charge reflected on gas (blue) bill
Change in Utility Billing

WE DELIVER ENERGY.™
Energy Statement

Account Number: 1698917713-0
Bill Date: 04/30/2008
Amount Due: No Payment Due

PETE SHOEMAKER
361 KEITH AVE
PACIFICA CA 94044-3137

210.6970
No payment is due. Please retain bill for your records. Thank you.

ACCOUNT SUMMARY

<table>
<thead>
<tr>
<th>Service</th>
<th>Service Dates</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>03/29/2008 To 04/29/2008</td>
<td>$71.79</td>
</tr>
<tr>
<td>Electric</td>
<td>03/29/2008 To 04/29/2008</td>
<td>5.96</td>
</tr>
<tr>
<td>Gas PPP Surcharge</td>
<td>03/29/2008 To 04/29/2008</td>
<td>2.94</td>
</tr>
<tr>
<td>Utility Users' Tax</td>
<td></td>
<td>5.05</td>
</tr>
<tr>
<td>ClimateSmart Amount</td>
<td></td>
<td>3.49</td>
</tr>
</tbody>
</table>

TOTAL CURRENT CHARGES = $88.58

Previous Balance = $88.75
04/14 Payment - Thank You = $88.75

Account Balance = $88.58
APS To Be Applied 05/14 = $88.03
TOTAL AMOUNT DUE = $0.00

Minimum electric hookup charge

PG&E
BOX 997900
SACRAMENTO CA
95811-7900
Change in Utility Billing

Pacific Energy Center San Francisco

PACIFIC GAS AND ELECTRIC COMPANY
NET ENERGY METERING ELECTRIC STATEMENT
THIS IS NOT A BILL
Service Dates: March 28, 2008 to April 29, 2008
True-up period from Oct 2007 to Sep 2008

SHOEMAKER, PETE
351 KEITH AVE
PACIFICA, CA. 94044

Rate Schedule: E W7TB NEMS
Account ID: 1698917713
Service ID: 1698917532

TOTAL CURRENT MONTH'S BILLED AMOUNT: $6.71*

*This amount is the minimum you must pay this month and is reflected on your regular monthly blue bill, in addition to the energy charges that you may pay monthly or at the end of the true-up period shown below. It includes the following components: Distribution $5.39, Public Purpose Programs $0.15, Generation $0.42, Utility User Tax $0.39 and Climate Smart Amount $0.36.

ENERGY CHARGES/CREDITS

Current Month Energy Charge or Credit (-) $8.46

Cumulative Energy Charges or Credits (-) for the current true-up period:
This Cumulative Energy Charge does not reflect any payment you may have made.

You have the option to pay your energy charges either monthly or at the end of your true-up period.

ANY UNPAID ENERGY CHARGES WILL BE DUE AT THE END OF YOUR TRUE-UP PERIOD (Sep 2008)
Change in Utility Billing

PV electric bill: usage history

<table>
<thead>
<tr>
<th>BILING MONTH</th>
<th>BILL TO DATE</th>
<th>SUMMER ON</th>
<th>SUMMER OFF</th>
<th>WINTER ON</th>
<th>WINTER OFF</th>
<th>TOTAL ENERGY</th>
<th>TOTAL CHARGES / CREDITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAY 2008</td>
<td>04/25/08</td>
<td>-83</td>
<td>225</td>
<td>-33</td>
<td>285</td>
<td>147</td>
<td>$8.46</td>
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<tr>
<td>APR 2008</td>
<td>05/28/08</td>
<td>-19</td>
<td>389</td>
<td>-33</td>
<td>252</td>
<td>229</td>
<td>$17.93</td>
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<tr>
<td>MAR 2008</td>
<td>02/28/08</td>
<td>-49</td>
<td>434</td>
<td>-19</td>
<td>300</td>
<td>280</td>
<td>$32.40</td>
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<tr>
<td>FEB 2008</td>
<td>01/29/08</td>
<td></td>
<td>51</td>
<td>-49</td>
<td>363</td>
<td>483</td>
<td>$50.79</td>
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<tr>
<td>JAN 2008</td>
<td>12/31/07</td>
<td></td>
<td>63</td>
<td></td>
<td>416</td>
<td>364</td>
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<td>DEC 2007</td>
<td>11/25/07</td>
<td>0</td>
<td>23</td>
<td></td>
<td>333</td>
<td>364</td>
<td>$28.27</td>
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<tr>
<td>NOV 2007</td>
<td>10/29/07</td>
<td>-53</td>
<td>249</td>
<td></td>
<td>333</td>
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<td>OCT 2007</td>
<td>10/01/07</td>
<td>-77</td>
<td>272</td>
<td></td>
<td>195</td>
<td></td>
<td>$2.03</td>
</tr>
</tbody>
</table>

**Energy Charges/Credits (-) include all energy related amounts and taxes.**
Change in Utility Billing

Yearly “trueup” example

- Yearly usage total $170.20
- Already paid the fixed amount of $6.71 per month for 12 months, total of $80.52
- Amount owed is $170.20 – $80.52 = $89.68
3rd Driver: Federal Tax Incentives

- **Federal Tax Credit**
  - 30% of net cost (PV and Solar Hot Water)
  - No cap for residential
  - No cap for commercial
  - January 1, 2008 thru December 31, 2016

- **Tax Incentives for Businesses**
  - Accelerated Depreciation (first 5 years)
4th Driver: California Solar Initiative (CSI)

*Helps people buy solar electric systems.*

**Official Goal:**
To transform the solar market in California through declining subsidies, so that after 10 years it no longer needs subsidies.
5th Driver: Power Purchase Agreements (PPA)

Enables people to go solar without having to buy the PV system.

• 3rd party purchases, owns, and operates the system.
• Their investors take tax incentives
• They bill clients just as a utility does
• Ideal for schools, gov’t buildings, non-profits (churches, etc.)
Sized to Meet Needs

Source: DOE National Renewable Energy Laboratory
Adaptable Applications

Rooftop

Source: DOE National Renewable Energy Laboratory
Adaptable Applications

Ground Mounted

Source: Pete Shoemaker

Source: DOE National Renewable Energy Laboratory

Courtesy: SPG Energy
State Incentives

- California Solar Initiative (CSI)
  - Goal: 3,000 MW of solar installed “1 Million Solar Roofs”
  - Investment: $3 billion
  - Term: 2007-2016
  - Outcome: Ensure CA leads nation in solar and meet 5% of state’s peak electricity demand with solar
  - Implementation: Via IOUs and Munis, except residential new construction, to be administered by the CEC

www.gosolarcalifornia.ca.gov
Grid-Connected PV Capacity Installed in California
Cumulative

Solar PV: 400+ MW
CA peak: >50,000 MW
(solar 0.4%)
CSI goal: 3,000 MW

Source: California Energy Commission (CEC)
California Solar Initiative (CSI)
The CSI makes PV ...

- **Economical:**
  Gives financial incentives to lower the cost

- **Secure**
  Screens and tests equipment
  Requires long warranties
  Helps screen and check installers

- **Easy**
  Helps installers handle everything
CSI Financial Incentives—two types

**EPBB** (Expected Performance-Based Buydown)

- One-time, up-front payment (rebate)
- Based on expected production
- Only for smaller systems (< 100 kW)

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**PBI** (Performance-based Incentive)

- Ongoing monthly payment for 5 years
- Based on actual production
- Possible for all systems, but required for large ones (> 100 kW)
Package with Energy Efficiency

- Conservation gives best payback
- Many EE rebates available
- Will be required for rebate
- Can handle entire package for client

Source: DOE National Renewable Energy Laboratory
Reduce Electricity Consumption

Look for “negawatts” – Efficiency First

– Lights
  • use the right light for the job, CFLs instead of incandescent lamps

– Heating, Ventilating & Air Conditioning (HVAC)
  • use the most efficient available

– Appliances & office equipment
  • Energy Star

– Building envelope
  • insulation, glazing, cool roofs
Energy Efficiency: First California Energy Resource

Per Capita Electricity Consumption

- US
- California
- Western Europe
PV Installation Process

• STEP 1: Complete an Energy Audit
• STEP 2: Contact and Choose an Installer
  INSTALLER HANDLES THE REST
• STEP 3: Submit Applications for GIS/CSI
• STEP 4: Install System
• STEP 5: Schedule Final Building Inspection
• STEP 6: Schedule Final Utility Inspection
• STEP 7: Claim Your Incentives
Weather: Microclimates

Source: www.sf.solarmap.org
Aesthetics
Sloped Roof Installations

Courtesy: SPG Energy
San Mateo County Forensics Lab
San Mateo, CA  234 kW

Photo Provided by Sharp Electronics Corporation

Courtesy: Sunpower Corporation
Flat Roof Installations
43 kW Gas Station System

Photo Provided by Sharp Electronics Corporation
Western Wine Services Warehouse
Napa, CA  99 kW

Courtesy: SPG Energy
Santa Rita Jail
Dublin, CA  1.18 MW

Courtesy: Sunpower Corporation
Cache Creek Casino Resort
Brooks, CA  307 kW

Courtesy: Schott Solar
Wastewater Treatment Facility
Oroville, CA  520 kW

Courtesy: SPG Energy
Building Integrated Installations

PV Roof Tiles, SUNSLATES™

Courtesy: Atlantis Energy
Where to Go for Tools

- **Pacific Energy Center: Tool Lending Library**
  Phone: 415-973-9945
  Email: pectools@pge.com

- **Pacific Energy Center Web Site:**
  www.pge.com/pec/tll
PV Resources

Go Solar California
- www.gosolarcalifornia.ca.gov

PG&E Solar Program
- www.pge.com/solar

Expected Performance-Based Buydown Calculator
- http://www.csi-epbb.com

California Solar Center (Solar e-Clips)
- www.californiasolarcenter.org/index.html

California Solar Energy Industries Association
- www.calseia.org/index.html

Northern California Solar Energy Association (NCSEA)
- www.norcalsolar.org

US Department of Energy, Solar Energy Technologies Program
- www.eere.energy.gov/solar/photovoltaics.html

Solarbuzz
- www.solarbuzz.com/index.asp