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BEFORE THE ARIZONA CORPORATION COMMISSION

CARL J. KUNASEK
Commissioner - Chairman
JIM IRVIN
Commissioner
WILLIAM A. MUNDELL
Commissioner

DOCUMENT CONTROL

IN THE MATTER OF THE GENERIC) DOCKET NO. E-00000A-99-0205
INVESTIGATION OF THE DEVELOPMENT OF A)
RENEWABLE PORTFOLIO STANDARD AS A) NOTICE OF FILING
POTENTIAL PART OF THE RETAIL ELECTRIC) REBUTTAL TESTIMONY
COMPETITION RULES.)
_____)

Pursuant to the Hearing Division's June 16, 1999, Procedural Order, the Arizona Clean Energy Industries Alliance ("ACEIA") hereby files rebuttal testimony of Robert H. Annan and Robert C. Paladino in the above-captioned docket.

RESPECTFULLY SUBMITTED this 30th day of August, 1999.

MARTINEZ & CURTIS, P.C.

By Paul R. Michaud

Paul R. Michaud
2712 North Seventh Street
Phoenix, Arizona 85006-1090
Attorneys for the Arizona Clean Energy Industries Alliance ("ACEIA").

The original and ten (10) copies of the foregoing are filed this 30th day of August, 1999 with:

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1200 West Washington Street

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AUG 30 1999

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Phoenix, Arizona 85007
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this 30th day of August, 1999 to:**

Service List for Docket No. E-00000A-99-0205

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REBUTTAL TESTIMONY OF ROBERT C. PALADINO

On Behalf of

**ARIZONA CLEAN ENERGY INDUSTRIES ALLIANCE
("ACEIA")**

AUGUST 30, 1999

PREPARED REBUTTAL TESTIMONY OF

ROBERT C. PALADINO

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Q. Please state your name, title and business address.

A. Mr. name is Robert C. Paladino. I am the Executive Vice President of York Research. York Research is a public corporation listed on the NASDAQ exchange with revenues of close to \$1 billion a year. My business address is 280 Park Avenue, New York, NY 10017.

Q. Please state your qualifications to testify in this matter.

A. I am the Executive Vice President for York Research. My responsibilities include project development of cogeneration facilities. I am also the Chairman and President of InnCOGEN, LTD., wholly owned subsidiary of York located in Trinidad. I was formerly the Senior Vice President and General Counsel of NPS Technologies Group, Inc., an engineering/construction firm serving the electric utility industry. I also served as the Director of Fossil Fuels and Assistant to the President of the Edison Electric Institute, a trade association for the electric utility industry. I earned my Bachelor's Degree in Chemical Engineering and Masters Degree in Environmental Engineering from Manhattan College. I received my Law Degree from George Washington University and studied finance at New York University.

Q. Who are you testifying on behalf of in this proceeding and what is the purpose of your testimony?

A. As a representative of York Research, I am testifying on behalf of the Arizona Clean Energy Industries Alliance ("ACEIA"). The purposed of my testimony is to rebut certain testimony

1
2 presented by Edward Z. Fox from Arizona Public Service Company ("APS") recommending
3 a System Benefits Charge ("SBC") mechanism in lieu of the proposed Environmental
4 Portfolio Standard as the means of implementing solar and renewable energy technologies in
5 Arizona.

6
7 **Q. Does York Research intend to invest in solar and renewable technologies in Arizona in**
8 **the event that the Commission approves the proposed Renewable Portfolio Standard?**

9
10 A. Yes. As an independent power producer ("IPP"), York designs, builds, owns and operates
11 conventional and renewable energy power plants. We are looking to Arizona for future
12 projects. York recently commenced operation of a 34 MW wind farm in Texas and we are
13 working on several other similar projects in the Southwest. York has also developed a
14 proprietary solar power system ("SEECOT™) for which patents are pending which it intends
15 to promote in Arizona.

16
17 York has been actively promoting solar power in the state since 1997. York was a member
18 of the Arizona Corporation Commission's ("Commission") solar subcommittee. On
19 numerous occasions, the Company has made written and personal presentations to individual
20 commissioners as well as Staff explaining our SEECOT™ technology. If the Renewable
21 Portfolio Standard is approved by the Commission, York is prepared invest its technology in
22 Arizona and sell solar power generated by the SEECOT™ technology at a price in the 5 to
23 10¢/kWh range depending on the applicable extra credits.
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1
2 **Q. Does York Research agree with APS' proposed SBC based renewable energy program**
3 **in lieu of the proposed Renewable Portfolio Standard?**

4 A. No. APS' proposed SBC mechanism is inadequate and does not provide the level of
5 commitment to solar energy technology York, and other companies, requires to do business
6 in the state. First, APS proposes only a 1 MW a year program to avoid what it perceives as
7 high-risk investment in renewable energy technologies. This is simply is not true. York
8 believes that existing technologies, such as parabolic trough systems, are already proven to be
9 reliable and low -risk investments capable of obtaining financing. For example, the Industrial
10 Solar Technology ("IST") system recently installed at the Federal Correction Institute in
11 Phoenix received close to 100% bank financing. This is typical of the equipment used by
12 York in its SEECOT™ systems.

13
14
15 APS also alleges that if the Commission approves the proposed Renewable Portfolio
16 Standard, this would result in a new round of stranded cost negotiations that would
17 effectively deter long-term commitments. APS believes that the risk of stranded costs
18 together with supply limitations, technology risk, and market uncertainties would likely make
19 current projections of total installed capacity unlikely to be realized and force UDCs and
20 ESPs to take the penalty rather than comply with the Renewable Portfolio Standard. York
21 disagrees with APS' dire predictions. York believes that the a combination of parabolic
22 troughs and PV systems could easily meet the portfolio standard requirements making it very
23 unlikely that any electric provider would choose to take the penalty rather than comply with
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1
2 the Renewable Portfolio Standard. For example, Attachment RCP-1 is a letter from IST that
3 confirms that it is capable of delivering and installing sufficient parabolic trough equipment
4 within an 18-month period to meet the .4% solar content requirement for the entire state.
5 This is the equivalent of 100 MWs or about 240,000 MWhs and assumes a gross power sale
6 of 60 million MWhrs in 2001. Moreover, York is prepared to sign two-year contracts with
7 any UDC or ESP at a cost below the penalty cost. Thereafter, solar power would be
8 available at a price that is comparable to conventional wholesale power. Correspondingly,
9 contracts of longer duration would result in lower cents per kWh cost to a point where a 5-
10 year contract would be in the 5 cent/kWh range. All quoted prices assume a 1.0 extra credit
11 and quantities in the 25,000 to 100,000 MWhs a year range.
12

13
14 Incidentally, this projected cost is in line with NREL's forecast showing that parabolic trough
15 solar power costs are expected to be in the 11 to 12 cents per kWh range in the year 2000,
16 which when the extra credits are applied, would be 4 to 6 cents per kWh. See Attachment
17 RCP-2. While it is York's intention to provide equity and obtain bank financing for these
18 projects, we would entertain offers from any UDCs or ESPs to acquire shares that are
19 currently projected to provide an above average return on investment.
20

21
22 **Q. Does York Research agree with APS' Summary of Impact of Solar Power Proposals in**
23 **its Attachment EZF-4?**
24
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1
2 A. No. York can provide a detailed calculation that shows that the impact of the proposed
3 portfolio standard under the worst case 30¢/kWh scenario would be only \$0.114¢/kWh or
4 \$1.14 per month for 1,000 kWhrs (in year 2001). But since the cost would be more likely in
5 the 5¢/kWh range, the monthly impact for 1,000 kWhrs would only be 1/6th of \$1.14, or
6 only about 19¢ per month. See Attachment RCP-3.

7
8 York believes, however, that the impact on the cost of electricity may in fact be close to zero,
9 or may even result in a slight-savings. This is true because 30% of the requirements can be
10 met with technologies that are even less expensive, and given the extra credits, these
11 technologies would probably be offered in the 2 to 3¢/kWh range (the solar hot water system
12 of the FCI has an operating cost of 6¢/kWh without any extra credits). Also, since it has
13 been shown that at least 1 to 2 percent of ratepayers would voluntarily pay more to receive a
14 higher percentage of solar power, the remaining ratepayers would pay that much less. Last,
15 solar power would be replacing conventional power in the 4 to 5¢/kWh range.
16

17
18 As previously alluded to, York Research has expended considerable effort in promoting solar
19 power for Arizona. The Company is committed to this endeavor which, if successful, would
20 result in a significant new industrial undertaking and the expenditure of millions of dollars,
21 and bring many direct economic and environmental benefits to the state as has been
22 articulated in the testimony of many of the parties to this proceeding including Staff.

23
24 Accordingly, York looks forward to doing business in Arizona if and when the Commission
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approves a Renewable Portfolio Standard.

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4 **Q. Does this conclude your rebuttal testimony?**

5 **A. Yes.**

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REBUTTAL TESTIMONY OF ROBERT H. ANNAN

On Behalf of

**ARIZONA CLEAN ENERGY INDUSTRIES ALLIANCE
("ACEIA")**

AUGUST 30, 1999

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PREPARED REBUTTAL TESTIMONY OF

ROBERT H. ANNAN

A. Please state your name, address and business address.

Q. My name is Robert H. Annan. I am an energy consultant with the Annan- Mooney Group and the lead organizer of the Arizona Clean Energy Industries Alliance. My business address is 6605 East Evening Glow, Scottsdale, Arizona, 85262.

Q. Who are you testifying on behalf of in this proceeding?

A. I am testifying on behalf of the Arizona Clean Energy Industries Alliance.

Q. What is the Arizona Clean Energy Industries Alliance?

A. As explained in my direct testimony, the Arizona Clean Energy Industries Alliance ("ACEIA") is an alliance of local and national companies active in manufacturing, installing and marketing photovoltaic, solar thermal and other solar and renewable energy products and services. Since the time of our original testimony on July 30, 1999, ACEIA has grown from 40 companies to 45 companies. The companies that currently comprise ACEIA include Applied Power Corporation, Arizona Solar Attic Systems, Inc., ASE Americas, Inc., Bechtel, Inc., BP Solarex, Inc., Conservative Energy Systems, Inc., Deluge, Inc., Desert Sun Solar, Inc., Diversified Technical Services, Inc., E V Products, ElectriSol, Ltd., Energia, Inc., Energy Conversion Devices, Entech, Inc., Energy Photovoltaics, Inc., ETA Engineering, First Solar, General Solar, Heliocol Arizona, Inc., Janus II Architects and Planners, Kyocera

1 Solar, NAPV, North Canyon Construction, Pacific West Solar, Photovoltaic Systems
2 Manufacturing, L.L.C., Photovoltaic Resources International, Inc., Progressive Solar,
3 Inc., Science Applications International Company, Southwest WindPower, Inc.,
4 Stirling Energy, SunLight Systems Works, Inc., Sun Earth, Inc., Siemens Solar,
5 SolarBuilt, L.L.C., Solar Wholesale, Solec, Inc., Spire Corp., Sun Systems, Inc.,
6 SunPower of Arizona, The Solar Store, United Solar Systems Corp., Trace
7 Engineering, and York Research Corporation.
8

9
10 **Q. What is the purpose of your rebuttal testimony?**

11 A. The purpose of my rebuttal testimony is to review the testimony presented by the
12 parties to this proceeding in light of the benefit/cost analysis requested by the Hearing
13 Officer in his Procedural Order dated June 16, 1999, in an effort to determine the best
14 way to move forward with a Renewable Portfolio Standard in Arizona. ACEIA
15 believes that a properly implemented Environmental Portfolio Standard, can move
16 Arizona away from its dependence on fuels from outside Arizona and the outflow of
17 dollars that result from this dependence.
18

19
20 The forty-five firms in the ACEIA perform in a highly competitive environment.
21 Using our ingenuity, we link innovative strategies with the values inherent in these
22 new technologies which has led to a 25 percent a year growth. The ESPs and UDCs
23 serving Arizona can experience these same benefits under the proposed Environmental
24 Portfolio Standard.
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By encouraging the use of Arizona's largest domestic energy resource, the Sun, through local manufacturing and installation technologies, and linking this to supports from the states university system and current favorable high- technology business environment, Arizona can become the solar energy production center of the United States, creating new levels of economic development and with it, international solar leadership. This leadership will be hotly challenged by California, Nevada and Texas.

Q. Did the parties testify as to Arizona's solar resource base, and did they agree that the proper utilization of this resource can lead to economic and environmental benefits?

A. Yes. Several parties, including, ACEIA, Environmental Intervenors, Grand Canyon Trust, the Grand Canyon Chapter of the Sierra Club, Tucson Electric Power, the City of Tucson, Arizona Public Service and the Commission Staff presented testimony recognizing the states most abundant resource - the Sun. No party took exception to the resource base. However, to some extent, the value of this resource was not widely accepted by some parties. For example, Edward Fox, in his testimony on behalf of Arizona Public Service, reflected a lack of understanding of the value of the states solar resource when he states that “solar generating facilities, although occupying large areas of land relative to the amount of energy generated...”. ACEIA's calculation shows that, assuming that the turbines at Glen Canyon Dam ran at full capacity, covering an area the size of Lake Powell with photovoltaic panels would

1 generate five times more power even assuming a lowered 20 percent capacity factor.
2 Moreover, as stated in my original testimony, the land area could be met by rooftops,
3 windows, parking structures, almost any exposed surface, thereby saving important
4 land resources.
5

6
7 **Q. Is it fair to conclude that there is general agreement among the parties that a**
8 **policy is needed to develop solar energy to fully realize its economic and**
9 **environmental benefits?**

10 A. Yes. Most of the parties agreed that a policy to develop solar energy for the state of
11 Arizona is good public policy.
12

13
14 **Q. What economic and environmental benefits were cited that would flow from such**
15 **a policy?**

16 A. While there are issues as to the extent of the benefits under the proposals to comply
17 with a solar development policy, all of the parties appear to agree that a solar policy
18 would produce environmental and economic benefits. The environmental benefits
19 result primarily in reducing emissions from traditional fossil fuel power plants that
20 now serve Arizona. Economic benefits would flow from in-state manufacturing and
21 installation. Finally, there was general agreement regarding the advantages of
22 developing a diverse set of affordable energy technologies rather than, as Mr. Fox
23 stated "rely on a few sources of energy that are most economical today".
24
25
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1 **Q. Did the parties comment on the need of incentives to promote a solar energy**
2 **development policy?**

3 A. Yes. Most of the parties who provided testimony recognized the benefits of incentives
4 to promote the goal of solar energy development in the state. Many parties, including
5 Staff, Environmental Intervenors, the City of Tucson, as well as ACEIA, favor the
6 kind of incentives for in-state manufacturing and in-state installation of solar, and
7 other environmentally friendly technologies, currently contained in the proposed
8 Renewable Portfolio Standard such as the use of extra credit multipliers. Other
9 parties such as Commonwealth Energy, New West Energy, and APS, although
10 opposed to Commission mandated incentives, also acknowledge the need for
11 economic incentives to promote solar and renewable energy development. The point
12 ACEIA would like to make is that regardless of differing points of view on how to
13 achieve the promotion of solar and renewable energy development, most parties
14 acknowledge the important need to provide incentives to promote this goal.
15
16

17
18 **Q. Assuming that there is general agreement among most of the parties regarding**
19 **the benefits of a policy for solar and other renewable development in Arizona**
20 **along with the need for incentives to promote such a policy, did the parties make**
21 **comment on the appropriate method of implementation?**
22

23 A. Yes. It is interesting to note that the vast majority of the parties recognized the need
24 for an implementation program, whether voluntary or mandated, to facilitate the
25 establishment of solar and renewable technologies in the state. The only point of
26

1 contention was on the correct mechanism for implementation. ACEIA agrees with
2 parties such as the Commission Staff and the City of Tucson who believe that the
3 proposed Renewable Portfolio Standard, which collects costs within generation tariffs,
4 is the best implementation mechanism and should be adopted by the Commission. It
5 is the best mechanism because it is large enough in scope and commitment to allow
6 the solar and renewable industry to make investments in the state.
7

8
9 ACEIA does not agree with the parties such as APS and TEP who recommend that the
10 funding to support a renewable energy program be collected through a System
11 Benefits Charge ("SBC") assessed on all energy consumers in the state by the UDCs,
12 nor some of the other parties who recommend strictly voluntary green pricing
13 programs in lieu of a Commission mandate. The reason for this is that voluntary
14 programs will not achieve the results sought by the Commission's stated objectives.
15 For example, the voluntary program agreements entered into as part of the 1993
16 Integrated Resource Planning docket have fallen woefully short. It appears that
17 instead of the 15MW's supposed to be installed by 2000, the voluntary programs will
18 have actually installed less than 1MW. The reduced programs suggested by the
19 Affected Utility's such as TEP and APS continue this "business as usual" approach.
20 ACEIA would support green marketing efforts as a mechanism to reduce costs within
21 a larger mandated program. Once the Environmental Portfolio Standard is in effect,
22 ACEIA members will offer to assist in establishing viable green market programs.
23
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1 **Q. Did the parties testify as to the benefits of their proposed implementing**
2 **mechanisms?**

3 A. The parties that supported the Renewable Portfolio Standard were strong in their
4 discussion of benefits. The parties that proposed alternative implementing
5 mechanisms had little to say about the benefits that would flow from their respective
6 proposals.
7

8
9 For example, the Environmental Intervenors' testimony includes an exhibit that
10 estimates that maximum compliance including participation by Salt River Project
11 would result in cleaning Arizona's air by 7,000,000 pounds of CO₂, 275,000 pounds
12 of SO₂, and 375,000 lbs. of NO_x each year for the estimated 30 year life of the solar
13 facility. This is equivalent to removing at least 2,000 vehicles from Arizona's roads
14 each year—which may assist in Arizona's compliance with the Clean Air Standard.
15

16
17 In addition, ACEIA, in testimony presented by Mr. Davis, the president of Arizona's
18 leading photovoltaic systems supplier, showed a strong case for the economic benefits
19 that could flow from the proposed Environmental Portfolio Standard. For example, he
20 testified that assuming an average selling price of \$8,500 per kilowatt, 100 Megawatts
21 of solar over a five year period would impact Arizona in the following five ways:
22

- 23 1. Approximately 750 jobs will be supported by the new production in the fifth
24 year.
- 25 2. \$850 million in economic activity will be infused into the Arizona economy.
26

1 3. 74 million of additional payroll into the economy.

2 4. 3.7 million of personal income tax revenue.

3 5. 41,650,000 in sales-tax revenue.

4 Not even included in these figures are the economic multipliers associated with local
5 production of solar technologies. The parties that presented alternative strategies
6 provided no estimates of the economic benefits that would flow from such alternative
7 strategies.
8

9
10 **Q. Did the parties testify as to the cost of the proposed standard?**

11 **A.** Yes. The cost estimates presented fall into three categories: technology costs; the
12 costs of complying with the portfolio standard; and costs to Arizona ratepayers. It
13 appears that there is not a wide enough difference in the cost estimates of the various
14 parties in all three categories to indicate disagreement. ACEIA believes that the cost
15 estimates of Mr. Hoff, who presented testimony on behalf of the Commission Staff,
16 were the most comprehensive and reliable.
17

18
19 Associated with the technology costs were the prospects for cost reductions. ACEIA
20 believes that these estimates are also important because they reflect the potential for
21 improved cost effectiveness. Again, ACEIA believes that Mr. Hoff's work is
22 definitive in this regard. He states that prices will decrease at a real rate of between 5
23 and 6 percent per year which is in general agreement with the capital cost reductions
24 offered by Clifford Cathers representing AEPCO.
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The estimates of the costs to comply with the proposed standard, while they vary, are not enough to be of concern. Mr. Hoff calculated a net cost in present value terms from 1999-2012 and included values to arrive at a range of \$156 million for the optimistic scenario to \$344 million under the pessimistic scenario. Mr. Fox's estimate for APS' compliance of \$254 million appears to have been calculated as a cumulative expensed cost without consideration of values. After accounting for the differences, the two estimates vary by less than 15%, sufficient for purposes of deciding to proceed with the proposed Renewable Portfolio Standard.

Q. The original order placed importance on the cost impact to the average residential ratepayer. Did the parties address this question and was there agreement?

A. Many parties including TEP, City of Tucson, Cyprus, Staff, APS, as well as ACEIA, provided detailed information on the cost impact on the average residential ratepayer. Although the parties used different assumptions making it somewhat difficult to contrast their cost estimates, the bill impact estimates did not seem to vary widely. They ranged from a low of about \$0.80 to around \$4.12.

Moreover, although the possible cost impact of the proposed Renewable Portfolio Standard has received a lot of attention as a possible barrier to the Standard, it is interesting to note that now that the parties have performed their cost analyses, we

1 know that the probable cost impact of a Renewable Portfolio Standard is almost a non-
2 issue in light of the economic and environmental benefits articulated by almost all of
3 the parties.
4

5
6 **Q. Do the costs of the proposed Environmental Portfolio Standard, as presented by**
7 **the parties, justify the implementation of the Standard in Arizona?**

8 A. Yes. As explained above, although the range of costs and calculation methodology
9 differ from a low of 80 cents to an inflated high of \$4.12, ACEIA believes that the cost
10 to implement the proposed Renewable Portfolio Standard are very reasonable,
11 particularly in light that under deregulation the slight extra cost of the proposed
12 Renewable Portfolio Standard is more than offset by the savings ratepayers will
13 experience as a result of competition.
14

15
16 **Q. Do you believe that residential electric consumers would favor an Environmental**
17 **Portfolio Standard?**

18 A. Yes. According to a recently released National Renewable Energy Laboratory
19 ("NREL") report entitled *Willingness to Pay for Electricity from Renewable*
20 *Resources: A Review of Utility Market Research*, residential consumers would favor a
21 policy similar to the proposed Renewable Portfolio Standard. See Attachment RHA-
22 1. This report shows that customers favor renewable electricity sources, but know
23 little about them. It also shows that a majority of residential customers say they are
24 willing to pay more on their electric bills for renewable power in a competitive market
25
26

1 setting. Lastly, the report indicates that customers may be more willing to purchase
2 electricity from utilities that provide renewable power.

3
4 **Q. Are there other reasons why the proposed Renewable Portfolio Standard is the**
5 **best mechanism to implement the solar and renewable energy policy in Arizona?**

6
7 A. Yes. ACEIA believes that the proposed Renewable Portfolio Standard has two
8 overriding advantages compared to the alternative mechanisms proposed. First, the
9 proposed Standard offers a strong commitment to the solar and renewable energy
10 industries which they can use to make substantial investments in the state. Second, the
11 Standard is based on a reliance on market based strategies to contain and control costs.

12
13
14 **Q. How important is the strength of commitment?**

15 A. Very important. The stronger the commitment the greater the response. The market
16 for solar energy products and services created by the Renewable Portfolio Standard is
17 estimated to be between 100 and 150 megawatts over the period 1999 to 2006.

18
19 The companies in the ACEIA are faced with making decisions to expand capacity and
20 build new plants that put into practice improvements over prior generation of
21 technology. The decisions involve capital requirements up to \$50 million and a rate of
22 return that may take 10 to 15 years to realize. Building these plants is high risk and
23 large markets with a high degree of certainty help minimize this risk. Accordingly,
24 the industry is watching closely the actions by states to attract manufacturing and in-
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1 state business as part of their restructuring efforts. Moreover, the largest markets and
2 those that have the greatest degree of sustainability will attract firms that will, in turn,
3 make a long-term commitment to the community and to the state's economy.
4

5
6 ACEIA has attached letters from three firms indicating their interest in the Arizona
7 commitment as set forth in the Environmental Portfolio Standard. Attachment RHA-2
8 is a letter from Mr. Roger G. Little, President of Spire, regarding his recent formation
9 of a full-service photovoltaic module manufacturing and systems
10 integration/installation business in Chicago due to a joint commitment by the City of
11 Chicago, the State of Illinois and Commonwealth Edison. In this letter, Mr. Little
12 states his intention to pursue a similar opportunity in Arizona in the event that the state
13 approves a Renewable Portfolio Standard. If Spire locates in Arizona, Mr. Little states
14 his commitment to develop the market well beyond that created by the Standard thus
15 ensuring the business' success.
16

17
18 In Attachment RHA-3, Dr. Walter J. Hesse, Chief Executive Officer of ENTECH
19 states that he has plans to expand production and already has the approval of
20 ENTECH's Board of Directors to move the production operation to Arizona if the
21 market capacity so warrants. During the plant expansion period, ENTECH intends to
22 increase its staff to a minimum of 230 people. It is expected that sales in 2004 would
23 exceed \$94 million. Dr. Hesse's discussion of the investment risk and his strategy for
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1 minimizing this risk matches the attributes of Arizona's business climate and the
2 attractiveness of the market generated by the portfolio standard.

3
4 PVI, a photovoltaic manufacturer, has stated that if a Renewable Portfolio Standard is
5 adopted in Arizona, the Company would almost certainly plan to locate a new
6 production facility in Arizona rather than other options. PVI would require an initial
7 semi-skilled workforce of at least 50 persons, increasing the workforce as future
8 capacity increases. It is expected that the plant would have estimated annual revenues
9 in the \$50 million range. Dr. Chris Sherring, President of PVI, has written a letter to
10 ACEIA in this regard. This letter, however, did not arrive in time for this testimony.
11 Accordingly, ACEIA reserves the right to include the letter as an Attachment to this
12 testimony at a later date.
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15

16 **Q. Is the solar industry capable of meeting such a commitment?**

17 A. Yes. Besides the positive responses from Mr. Little, Dr. Hesse, and Dr. Sherring,
18 please refer to the letter by Mr. E. Kenneth May attached to Mr. Paladino's rebuttal
19 testimony. In this letter Mr. May states that based on the performance of Industrial
20 Solar Technology's parabolic trough system at the Federal Correctional Institution in
21 Phoenix, he can deliver and install a quantity of collectors in Arizona within 18
22 months of receipt of purchase orders and financing sufficient to satisfy a 100MW
23 requirement.
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1 In addition, NREL has an ongoing program to support the improvement of
2 photovoltaic manufacturing processes. According to Dr. Ed Witt, the NREL manager
3 of this program, the ten manufacturers participating in the program had a combined
4 manufacturing capacity in 1992 of about 13 megawatts. By 1998, this had grown to
5 73 megawatts. By 2001 he expects these companies to exceed 220 megawatts of
6 capacity and 500 megawatts by the year 2004. The impact of this expansion on cost
7 reduction is shown in Attachment RHA-4.
8

9
10 **Q. Please explain what you mean when you say the proposed Renewable Portfolio**
11 **Standard is market based?**

12
13 A. As a market based mechanism, instead of promising the certainty under regulated
14 markets, it provides a level playing field between ESPs and UDCs. All of the players
15 must meet the same requirement under the same conditions. It is then up to each
16 individual company, whether an ESP or a UDC to attract customers with innovative
17 strategies to keep costs down, and create market niches to control them.
18

19 **Q. Can you provide the Commission with examples of market based strategies.**

20
21 A. Mr. Don Osborn, Manager of PV and Distributed Technologies Department, SMUD,
22 provided an excellent example in his direct testimony. First, SMUD had a goal to
23 have install 25,000 solar systems by 2010. The current program, in compliance with
24 California's restructuring rules, markets photovoltaic rooftop systems to customers
25 with net metering and cost buy-down ranging from \$2.50 to \$3.00 a watt, with the
26

1 customer bearing the remaining cost equal to retail competitive rates. Instead of
2 buying megawatts required, SMUD leveraged its funds and accomplished much more.
3 The success of this SMUD's program is obvious. Costs have come down by more
4 than 35 percent. A PV factory with 7 to 10 MWyr capacity will begin production soon
5 providing 100 to 200 jobs. The momentum created by SMUD's program has made an
6 impact. Last month the utilities serving Santa Clara and Palo Alto initiated similar
7 programs. At the same time Siemens Solar announced the introduction of pre-
8 engineered solar kits that will reduce the costs of installation creating new
9 opportunities for electrical contractors to profitably sell and install new rooftop
10 systems.
11
12

13
14 **Q. Can this same kind of innovation apply to larger systems where financing is**
15 **critical?**

16 A. Mr. Paladino's rebuttal testimony on behalf ACEIA, states that his company, York
17 Research, is prepared to sign two-year power contracts at a cost less than the penalty
18 cost, with pricing falling in subsequent years to prices comparable to conventional
19 wholesale power. The higher prices for the first two years could be further mitigated
20 with green pricing programs and sales to other providers who need the power to meet
21 the Renewable Portfolio Standard.
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Q. Are the rural electric cooperatives placed at a disadvantage under the proposed standard?

A. No. The proposed Renewable Portfolio Standard offers the rural electric cooperative particularly attractive opportunities. It is estimated that there are 15,000 unelectrified homes in rural Arizona, particularly on Native American lands. Most of these homes are too far from the grid for economical connection. The portfolio standard would provide the cooperatives an opportunity to serve these homes at the lowest possible cost, while taking advantage of further cost reductions through the tradable credit programs authorized by the Renewable Portfolio Standard.

Q. Do you propose any changes to the proposed Renewable Portfolio Standard to make it even stronger and more effective while mitigating the concerns expressed by those opposed to the standard?

A. Yes. After review of the concerns expressed by the other parties, ACEIA proposes six improvements. First, ACEIA proposes to smooth the implementation percentage curve from .4% in 2001, .5% in 2002, and .6% in 2003 to .2% in 2001, .4% in 2002, and .6% in 2003. All other years remain unchanged. Smoothing the curve will alleviate APS' concern regarding ramp up, reduces the \$4.12 consumer cost impact estimate in 2001, and provides for a more sustainable implementation effort without changing the end-objective.

1 Second, ACEIA proposes that the UDCs be allowed to recover the costs of
2 implementation through rate changes, if required. This change levels the playing field
3 between the ESPs and the UDCs.
4

5 Third, ACEIA proposes that the wording of the cost/benefit review point be
6 strengthened to indicate the Commission's intention to continue the portfolio standard
7 through to its 2012 end point. Strengthening this provision will help the industry
8 obtain long term financing needed to develop projects. It also sends a message that
9 the Commission does not favor a strategy that would encourage paying the penalty
10 because the portfolio standard could be revoked in 2001. We are very concerned about
11 the life of the standard and want to avoid setting up a situation where UDCs and ESPs
12 pay the penalty and work to overturn the standard without giving it a chance to work.
13
14

15
16 Fourth, the provision allowing net metering contained in the original order needs to be
17 reinstated to facilitate distributed systems.
18

19 Fifth, the standard should clearly allow for privately financed systems.
20

21
22 Finally, ACEIA recommends that a portion of the \$300 million earmarked for
23 consumer education be earmarked for programs dealing with the Environmental
24 Portfolio Standard.
25
26

1 **Q. How does Arizona's proposed Renewable Portfolio Standard compare with other**
2 **states that are implementing a renewables development policy in conjunction**
3 **with electricity restructuring?**

4 A. Every state in the process of restructuring its electricity system is faced with the
5 challenge of designing a new system that will produce the advantages of competition
6 without sacrificing the public good. I would like to highlight California, Nevada and
7 Texas. California has a four-year systems benefit charge implementing mechanism.
8 The fund currently totals over \$500 million. A state agency, the California Energy
9 Commission has the responsibility of administering the fund. After a four-year
10 stakeholder process, the Commission established four different programs eligible for
11 an identified amount of funding. All of the programs were leveraged type of
12 programs. It has created an immense response from the industry yet there are
13 concerns over centralized control. The administration of such 'central control'
14 programs must be carefully structured to insure impartiality, fairness and avoid
15 conflicts of interest by utilities.

16
17
18
19 Nevada has a portfolio standard favoring solar. While the state is still setting up the
20 rules, the Standard with its 118MW market by 2010, has already created a strong
21 industry response. Specifically, on August 4, 1999, Composite Power announced their
22 plans to develop a green energy project 110 miles northwest of Las Vegas. The first
23 phase calls for 50 - 150 MWs of wind and solar. The partners are many of the same
24 firms interested in doing business in Arizona. Texas recently passed a very
25
26

1 aggressive portfolio standard that calls for 2,880 MW of renewables by the year 2009.
2 Regulations to implement this program are currently under development.
3

4 **Q. In the final analysis, is the Environmental Portfolio Standard the correct**
5 **mechanism to implement a solar and renewable policy in Arizona?**
6

7 A. Yes. Acquiring capital investment and financial support has always been a critical
8 hurdle to the commercialization of new and innovative technologies, particularly
9 energy technologies. Research and development support from utilities and the federal
10 government have made important contributions to accelerating this commercialization
11 process, however support is narrowly focused and funding limited. The energy sector
12 continues to discount the long-term environmental and economic consequences of
13 energy investments and focuses instead on short-term returns. These failures of the
14 marketplace necessitate a partnership between these markets and public policy for
15 solar technologies to reach full commercialization. The proposed Renewable Portfolio
16 Standard provides this partnership. It is the result of a consensus process and has
17 measurable goals and a review point. Speaking for the forty-five firms in the alliance
18 the proposed Renewable Portfolio Standard will cause factories to be built, local
19 businesses will expand, solar power costs will come down, and jobs will be created.
20 Energy fuel sources will be diversified. The energy system will become even more
21 reliable and the environment will be cleaner. Arizona customers will be satisfied. We
22 must not let this window of opportunity close.
23
24
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26

1 Q. Does this conclude your testimony?

2 A. Yes.

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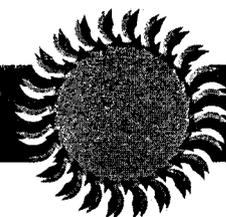
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NREL/TP.550.26148

July 1999

TOPICAL ISSUES BRIEF



Willingness to Pay for Electricity from Renewable Resources: A Review of Utility Market Research

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National Renewable Energy Laboratory
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Abstract

As competition in the electric utility industry becomes more widespread, utilities are becoming concerned about actions they can take to help ensure the loyalty of their customers. National polls have, for 20 years, found majority preferences for renewable energy over other energy sources. This issue brief compiles and analyzes recent market research conducted by utility companies on customer interest in, and willingness to pay for, electricity from renewable sources. Increasingly, market research is documenting in utility service territories the same widespread preference for renewables that has been found in national polls for the past 20 years.

Findings in this review show that:

- Customers favor renewable sources of electricity but may know little about them. Percentages favorable toward renewables increase when customers are educated about options. Solar and wind are the most favored sources of electricity generation.
- Majorities of 52% to 95% of residential customers say they are willing to pay at least a modest amount more per month on their electric bills for power from renewable sources. Deliberative polls show that willingness to pay increases when customers are educated about utility energy options.
- Willingness to pay follows a predictable pattern with an average majority of 70% willing to pay at least \$5 per month more for electricity from renewable sources, 38% willing to pay at least \$10 per month more, and 21% willing to pay at least \$15 per month more. It is likely that any utility market survey asking residential customers about willingness to pay more for renewable energy will exhibit a similar pattern of results.
- A limited amount of data suggest that customers may be even more likely to pay more for electricity from renewable sources in a competitive market setting. That is, customers may respond in greater numbers when the choice is between forgoing rate decreases— as would be expected in competitive markets—than when faced with paying more, as is the case with utility green-pricing programs.
- Customers may view with favor and remain loyal to utilities that provide power from renewable sources.

Acknowledgments

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Willingness to Pay for Electricity from Renewable Sources: A Review of Utility Market Research

Approach

This issue brief compiles and analyzes recent market research conducted by utility companies on customer interest in and willingness to pay for electricity from renewable sources. The National Renewable Energy Laboratory (NREL) has obtained the results of market research studies on green pricing from several electric utility companies. To honor the proprietary nature of the data, identities of the utilities conducting the studies have not been provided. The data come from 14 different surveys conducted in 12 utility service territories in five Western/Southwestern states. Most of the data were collected in 1995 through 1997. In addition, the study incorporates results from a 1997 Electric Power Research Institute (EPRI) study (EPRI 1997).

The analysis focuses on the results from quantitative surveys rather than on focus group findings, since quantitative data collection was often built on focus group results and took the focus group findings further to enable generalizations about entire populations. Use of survey data makes the comparison of results among studies more straightforward.

In addition, the analysis was limited only to data from surveys that appeared to meet "best practice." Data were collected for utility companies by professional market research firms. The surveys used scientific procedures to sample utility customers, and results had estimated margins of error of $\pm 5\%$ or better. In addition, only questions that were, in our opinion, of high quality, relatively objective, and unbiased were included. Because the questions themselves are considered proprietary, they are not included here.

The studies provided far more information than could be reviewed in this short paper; therefore, the analytical focus was limited

to three topics of widespread interest to the utility industry. These were: (1) attitudes toward and knowledge of renewables, (2) customer interest in paying more for electricity from renewable sources (including stated willingness to pay more for electricity from renewable sources and preferences for paying for renewables in the rate base versus on a voluntary basis), and (3) consumer attitudes toward utility companies as suppliers of power from renewable sources. Of these three topics, most of the questions asked were about willingness to pay for electricity from renewable sources. For purposes of this synthesis, findings from questions on like topics, although not worded identically, are grouped together.

This paper presents a summary of key findings; detailed data are presented in the appendixes. The aggregation of utility market research data on willingness to pay is discussed. We also include some related findings from other recently reported market research.

Key Findings

Attitudes toward Renewables. Many surveys have documented, both nationally and locally, the longstanding preference among U.S. adults and electricity customers for renewable energy over other energy sources. Utility market surveys asking about attitudes toward renewables found the same strong preferences for renewable energy to produce electricity when compared with other energy sources, as has been documented in national poll data (Farhar 1993, 1996). Data detailing these findings are reported in Appendix A.

Knowledge of Renewables. Although consumers are favorable toward renewables, they may not know very much about renewable energy technologies. Utility findings on consumer favorability toward and knowledge of renewables are sparse. Most of the utility

surveys reviewed did not query customers on their familiarity with renewable energy technologies. Customers, as a whole, are likely to be relatively unfamiliar with green power and are unlikely to know anyone who has participated in a green-power program. The few data that do exist suggest that participants in green-pricing programs tend to be more informed than customers in general, and that solar and wind are the best known renewable energy technologies. Appendix A presents the detailed findings.

Stated Likelihood of Voluntarily Paying for Electricity from Renewable Sources. The data reviewed suggest that approximately half or more of respondents surveyed state that they are “somewhat likely” or “very likely” to voluntarily pay more for electricity from renewable sources when price is not mentioned. A sizable minority of samples (~ 45%) tend to indicate that they would be unlikely to voluntarily pay anything more for electricity from renewable sources, when the question is asked in this way.¹ Two samples of commercial customers also expressed likelihood of paying a limited amount more for renewable power. Appendix B presents the data.

Stated Willingness to Pay More for Renewable Electricity by Residential Customers. Across the surveys reviewed, majorities of respondents say they are willing to pay at least a modest amount more per month on their electric bills for power from renewable

¹When survey questions take a form similar to: “If paying for renewable electricity were offered on a voluntary basis, how likely would you be to pay more money on a monthly basis to get some or all of your electricity from renewables?”, and no dollar amount is given, sizable minorities tend to respond that they are unlikely to pay more. However, when survey questions take a form similar to: “How much more would you choose to pay on your electric bill each month to ensure that some or all of your electricity comes from renewable sources?”, and dollar amounts are given—usually \$1, \$2, \$3, \$5, and so on—only about 25% of respondents indicate they are unwilling to pay anything more when they see the modest amounts involved.

sources. The sizes of these majorities range from 52% to 95% of total residential customer samples without exposure to special educational programs. Percentages increase when customers receive more information. Appendix B presents the detailed information.

An Aggregated Residential Customer Willingness-to-Pay Curve. The similarities in findings on willingness to pay (WTP) for electricity from renewable sources is striking, and a means was sought to describe this observed pattern. A best-fit curve was developed for a scatterplot of the averaged value of incremental amounts per month residential respondents stated that they are willing to pay for various forms of electricity from renewable sources (Figure 1).² The curve is based only on responses from residential customers. It includes 95 data points from 12 survey questions.³

Figure 1 presents data on the percentages of survey respondents indicating they are willing to pay nothing more and those willing to pay increasing amounts more. As would be expected, the percentage of those willing to pay more drops off as the price increases. An average of 70% are likely to state

²The curve represents an exponential fit to the data. This “best-fit” curve (in terms of maximizing R^2) was obtained using nonlinear regression with the Y-intercept set at 100%. The scatter of response values around the average values depicted in the curve is most likely a function of variation in question wording, question placement, and the dollar values used in response categories.

³Data on WTP for grid-tied rooftop photovoltaic (PV) systems were omitted because the amounts involved are much higher than the amounts mentioned in most surveys on green-pricing programs. Bimonthly dollar amounts were halved to make them comparable to the monthly dollar amounts used in most questions. Only “pre” data from deliberative polls were included so that data would be comparable with that from random samples of utility customers. Also, some WTP questions were broad in nature and did not include questions on varying pricing structures.

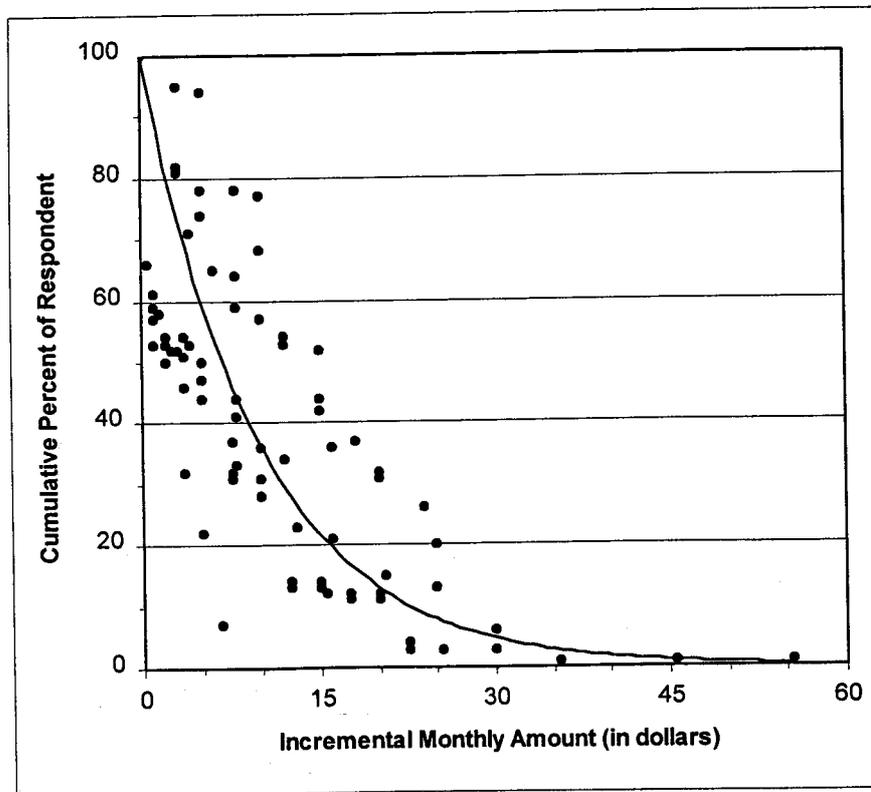
that they will pay at least \$5 per month more. An average of 38% of customers are likely to state they will pay at least \$10 more. An average of 21% are likely to state that they would pay \$15 per month more.

Although these figures represent an important market potential, they should not be construed as the proportion of residential customers who will actually sign up for a green-power product offering at inception. In addition, this curve could change over time as the population gains more experience with green-power programs.

Given the coverage of the research, it is likely that any utility market survey asking

residential customers about WTP for power from renewable sources will obtain results similar to those represented by the curve. Development of a curve on actual participation in green-pricing programs must await the collection of systematic data on participation rates over time.

Preferences for Rate Basing versus Green Pricing. Virtually all questions in this review focused exclusively on a utility green-pricing option. The one question addressing customer preference for distributing the costs of new renewables development across the entire customer population showed that customers strongly preferred "rate basing." Detailed information is presented in Appendix B.



The equation for the curve is:

$$Y = 100e^{-.104 * M}$$

where Y = cumulative percentage of respondents, and M = \$ more per month.

$$R^2 = .76$$

**Figure 1. Aggregated Willingness-to-Pay Curve
(Residential Customers)**

Willingness to Pay for Power from Renewables in Competitive Markets. Two questions asked utility customers about their willingness to forgo price decreases in competitive utility markets to pay for electricity from renewable sources. The few data available show that even higher majorities of customers may be willing to forgo price decreases to pay for environmentally friendly electricity than are willing to voluntarily pay more on their electric bills. Appendix C presents detailed data.

Attitudes toward Utilities. Most residential customers in these samples rate their utilities favorably. Majorities of utility customers want their utility companies to develop new renewable sources of electricity. Findings suggest that those most satisfied with their utility company are also most supportive of adding new renewables to the power mix. Also, participants in green-pricing programs are significantly more loyal to their utility company than are other customers. Detailed findings are presented in Appendix D.

National Poll Data and Other Recent Market Research Findings

Findings from the utility market research synthesized here are consistent with other reported research, including national poll data and company-specific market research. Some examples of these findings are briefly provided below.

Attitudes toward and Knowledge of Renewables. In a review of market research on renewables and conservation in the Pacific Northwest, Ferguson (1999) found that strong majorities of electricity customers in the Northwest support renewable energy. Ferguson concluded that Northwest consumers view conservation and renewables as being environmentally important.

Consumers continue to select renewables over other energy sources in response to questions asking for their preferences among conventional and renewable energy options. For

example, a 1998 poll of Colorado homeowners found that the electricity sources perceived as least environmentally threatening—solar and wind—are also the most preferred (Farhar and Coburn 1999a). In addition to their environmental benefits, solar and wind are preferred over other electricity sources for other positive attributes, such as safety, economic benefits, self-reliance, and diversity of the U.S. energy supply. Similar findings from a national sample are reported in Farhar and Houston (1996).

A 1997 Portland General Electric study found 41% of residential customers selecting solar over all other energy sources to meet the future electric needs of the region (cited in Ferguson 1999). These findings are consistent with results from national polls (Farhar 1996).

Combined results of surveys of probability samples from four Midwestern states showed that 90% of customers believe their utilities should use solar and 85% believe they should use wind to produce power (Tarnai and Moore 1998). Eighty-nine percent favored more use of renewables.

The 1998 Colorado homeowners survey found that although most respondents were favorable toward grid-tied photovoltaics (PV) (with 59% giving it high favorability ratings), only 10% were familiar with it. Male respondents and those in higher-income households tended to be more familiar with grid-tied PV than others, but they were still not very familiar (Farhar and Coburn 1999b).

Willingness to Pay More for Electricity from Renewable Sources. Farhar and Houston (1996) reported that 57% to 80% of national poll samples said they were willing to pay more for electricity produced in a cleaner way or from sources less harmful to the environment. The 1998 survey of Colorado homeowners found that, when asked specific amounts, 76% of respondents indicated a willingness to pay at least \$1 per month more for electricity from renewable sources (Farhar and Coburn 1999a).

Combined data from the poll of adults in four Midwestern states (Tarnai and Moore 1998) showed that 72% indicated they are "very willing" or "somewhat willing" to pay more for renewables. The modal amounts respondents were willing to pay were \$5 per month (30%) and \$10 per month (28%).

Rate Basing versus Green Pricing.

The Colorado homeowners survey shows broad-based support for renewables development even if it costs more (Farhar and Coburn 1999a). Homeowners prefer to see the costs of developing renewables shared broadly, either through federal subsidies for electricity generation using renewables or through modest increases in electric rates.

Ferguson (1999) reported that Seattle City Light customers preferred that the cost of renewables should be put in everyone's rates, rather than through green-pricing programs in which customers can choose to participate, a result also obtained by other Northwest utility market research.

The surveys of four midwestern states (Tarnai and Moore 1998) found that 30% preferred that everyone's electric rates should be increased to pay for renewables, 29% preferred voluntary choice, and 19% preferred that the federal government pay additional costs. Twenty percent proposed some other way.

Attitudes toward Utility Companies as Suppliers of Electricity from Renewable Sources. Ferguson (1999) found that consumers consistently report they are more likely to identify with utilities that support environmentally sound management practices.

The Colorado survey of homeowners found that widespread support exists for utilities to develop renewables as part of their electricity-generating mix (Farhar and Coburn 1999a). Colorado utilities seem to have a relatively good reputation with their customers. Most homeowners want their utilities to do more to invest in the development of renewable sources of electricity.

Conclusions

- Customers favor renewable energy sources but tend to know very little about them.
- Utility market research studies show customer preference for renewable sources of electricity along with majority willingness to pay an incremental amount more for it. Across the studies examined, majorities of 52% to 95% said they were willing to pay at least a modest amount more per month on their electric bills for power from renewable sources. Deliberative polls show that customer WTP increases when customers are educated about utility energy options.
- Across all studies, customer WTP follows a predictable pattern. An average of 70% stated WTP at least \$5 per month for electricity from renewable sources. The percentages decline as the amount per month increases. An average of 38% of customers say they are willing to pay at least \$10 per month more, and 21% say they are willing to pay at least \$15 per month more for power from renewable sources. It is likely that any utility market survey asking residential electricity customers about WTP for renewables will exhibit a similar pattern of results.
- Proprietary utility market research findings track closely with findings from similar questions from national polls and market research in the public domain.
- A limited amount of data show that customers are just as likely to pay more for renewable energy in a competitive market setting. In fact, customers may respond in greater numbers when the choice is between forgoing rate decreases in order to receive renewable energy in competitive markets than when faced with paying more for this option, as is the case in utility green-pricing programs.

- Although most studies focused on residential customers, there is limited evidence that some business customers will pay more for green power. These data, coupled with actual market experience with businesses voluntarily choosing green power options—such as Toyota, Patagonia, and the New Belgium Brewing Company—suggest that business customers could be an important market segment for renewables. Business customers might be interested in knowing about the extent of interest in electricity from renewable sources among residential customers, because this interest could translate into consumer approval for businesses that purchase electricity from renewable sources.
- Although almost all of the surveys focused exclusively on a utility green-pricing type of option, the fact that large majorities of respondents are willing to pay at least a small, incremental amount for renewable energy suggests a potential willingness to accept slightly higher rates in order to capture the public benefits of greater renewable energy use.
- Customer attitudes are more favorable toward utilities that include renewables in their electricity generation mix. However, the evidence is insufficient to determine whether customers who trust their utilities more are more willing than others to sign up for green-power programs.

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Note: Utility studies are not identified because of the proprietary nature of the questions and findings.

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Appendix A: Data on Attitudes toward and Knowledge of Renewables

Attitudes toward Renewables

Utility market surveys asking about attitudes toward renewables found the same strong preferences for renewable energy to produce electricity when compared with other energy sources, as has been documented in national poll data (Farhar 1993, 1996).

Table A-1 shows the results from a question asking customers about their favorability or opposition toward various energy resources, assuming that they had a choice as to the source of their electrical energy.

Another question resulted in a similar pattern of preferences when it asked whether residential and commercial customers want their utility to use a variety of energy sources. Customers strongly support their utility's use of new renewables, defined as electricity generated by solar, wind, geothermal, and landfill gas sources. Of residential customers, 88% say their utility should include new renewables as one of their sources of electricity. Support for hydropower is similarly high. A majority supports the use of natural gas to generate electricity, while fewer support nuclear power and coal. Table A-2 shows the results.

Table A-2. Preferences among Fuel Sources for Use by Utility as One Source of Electricity

	Residential %	Commercial %
New renewables	88	89
Hydropower	85	91
Natural gas	55	64
Nuclear	39	52
Coal	14	22

More evidence for this pattern of preferring renewable sources came from a question asking customers about their preferences for purchasing electricity from coal, nuclear, natural gas, or wind and solar. Findings show that 41% say they would choose electricity from wind and solar, 35% from natural gas, 9% from nuclear energy, and 5% from coal; 10% don't know.

Table A-1. Preferences among Energy Resources

Energy Resource	Somewhat or strongly favor %	Somewhat or strongly oppose %	Don't know %	Totals
Solar	93	5	2	100
Wind	91	9	--	100
Natural gas	83	11	6	100
Geothermal	71	13	16	100
Landfill gas	64	18	18	100
Forest waste	59	29	12	100
Nuclear	31	63	6	100
Coal	24	69	7	100

Another question asked respondents about favorability toward specific renewable energy sources and also about their top three choices for their utility company to develop. Overwhelming majorities choose wind, PV on homes, geothermal, and PV on schools, and a majority also choose biomass energy. Among the top three choices for development, wind is preferred by two-thirds, followed by PV on homes (64%), and geothermal (63%). PV on public buildings is preferred by a 58% majority. Biomass is selected as a top three choice by 26%. Table A-3 shows the findings.

Table A-3. Favorability toward Various Renewables Options

Renewable resource	Percent 'Very favorable'	Percent choosing in top 3 preferred renewable energy choices
PV on public building	69	58
Geothermal	64	63
Wind	61	69
PV on homes	60	64
Biomass	32	26

Results from another question show favorability toward the idea of utility investment in renewable energy among the customer groups surveyed. On a 1-10 scale, where 1 is low and 10 is high favorability, the mean score for participants in a green-power program is 9.1 and, for all other customers, 6.3.

Findings show that, among customer groups surveyed, most agree that their utility company should provide power from sources that minimize negative environmental impacts (mean scores ranging from 7.7 to 9.2 on a 1-10 scale). Similarly, most agree that the utility should protect the environment as much as possible while producing and distributing power (mean scores ranging from 8.2 to 8.6 on a 1-10 scale).

Knowledge of Renewables

Only a few of the utility surveys reviewed included questions on awareness and knowledge of renewables. One question showed that commercial customers are slightly more aware of electricity from renewable energy sources than residential customers. The most well-known new renewable energy sources are solar and wind power, of which most customers are aware. Landfill gas and geothermal sources have the lowest awareness levels (between half and three-quarters aware). Not surprisingly, almost all commercial and residential customers have heard of hydropower. Another question produced results showing that, although 84% have heard of using solar panels to produce electricity, lack of knowledge is commonly cited as a reason for not installing them.

Another question was asked of a sample of subscribers to a green-power program, interested nonsubscribers (those who had inquired about the program, but did not subscribe), and other utility customers. Three-quarters of subscribers, 53% of interested nonsubscribers, and 37% of other customers say they are familiar with the term "green energy." Despite the program having been in existence for 1½ years, 21% of subscribers, 45% of interested nonsubscribers, and 61% of other customers are not familiar with the term "green energy." This particular survey found that knowledge about wind power and green energy is significantly greater among program subscribers than among the other two groups.

Appendix B: Data on Customer Interest in Paying More for Electricity from Renewable Sources

Stated Likelihood of Paying More for Renewables

Many residential and commercial customers respond that they are likely to pay more for renewables. In one study, 54% of residential customers say they are “very likely” or “somewhat likely” to pay more on their monthly electric bill for electricity from renewable sources; 45% say they are unlikely to do so (Table B-1).

Table B-1. Likelihood of Paying More in Monthly Bill to Support Energy Generated from Renewable Resources

Response	%
Very likely	13
Somewhat likely	41
Not likely	45
Unsure	1
Total	100

Another question asked about purchasing a residential, grid-tied PV system. When asked directly how likely they would be to purchase a PV system if the cost of the loan payment plus their new, reduced electric bill combined would remain the same, 21% of customers say they are “very likely” to purchase a PV system, 42% say they are “somewhat likely,” 33% say they are “not likely” to do so, and 4% don’t know.

In response to a different question, 38% say they would be likely to purchase a PV system if their monthly bill were higher than it currently is. Table B-2 shows the responses.

Results from another question asked of both residential and commercial customers indicate that the likelihood of voluntarily paying

Table B-2. Likelihood of PV System Purchase with Higher or the Same Monthly Electric Bill

Response	
Yes	38
No, but would if bill remained the same	32
No, but would purchase at lower price	12
Would not purchase at all	6
Unsure	12
Total	100

more for electricity from renewable sources is relatively high. Two-thirds of residential customers and 61% of commercial customers say they are at least somewhat likely to pay more for electricity from renewable energy sources on a voluntary basis. Table B-3 shows the stated likelihood among both residential and commercial customers.

In response to another question, both residential and commercial customers (62% and 65%, respectively) agree that using new renewable energy is “the responsible thing to do for the future, even if it costs more now.” Far fewer residential and commercial customers

Table B-3. Likelihood of Voluntarily Paying More for Electricity from Renewable Sources

Response	Residential %	Commercial %
Very likely	16	21
Somewhat likely	51	40
Not very likely	17	21
Not at all likely	14	14
Don't know	3	3
Total	101 ^a	99 ^a

^aPercentages do not add to 100 due to rounding.

(29% and 27%, respectively) think that maintaining current rates as long as possible is important, even if it means using fossil fuels.

Although commercial and industrial customers were rarely included in the utility market research reviewed, available data provide modest evidence that at least some of these customers might be interested in power from renewable sources. In one study, a majority (53%) of industrial respondents say they are unwilling to pay a higher price for “greener” electricity resources.¹ However, 41% say they are willing to pay 5% or more for greener electricity resources, and 6% say they are willing to pay more than 10% more.

A question from another study showed that 62% of commercial customers are willing to pay at least \$1 more every other month for electricity from renewable sources; 57% are willing to pay at least \$3 more; and 52% are willing to pay at least \$5 more every other month. However, only 11% are willing to pay more than \$10 more every other month. Thirty-eight percent of respondents to this question are unwilling to pay anything more (Figure B-1).

Although not numerous, these results—along with anecdotal evidence about large businesses such as Toyota, Patagonia, and New Belgium Brewing Company selecting a green-power option in a competitive market—suggest that commercial, and possibly industrial, customers are worth further investigation as a potential green-power market segment. In addition, these customers would probably be interested in information on the extent of interest in electricity from renewable sources among residential customers. This interest could

¹The survey included respondents from 13 different SIC codes, including printing and publishing, electronic and other equipment, and other manufacturing. However, only 17 respondents answered this question on renewable sources of electricity.

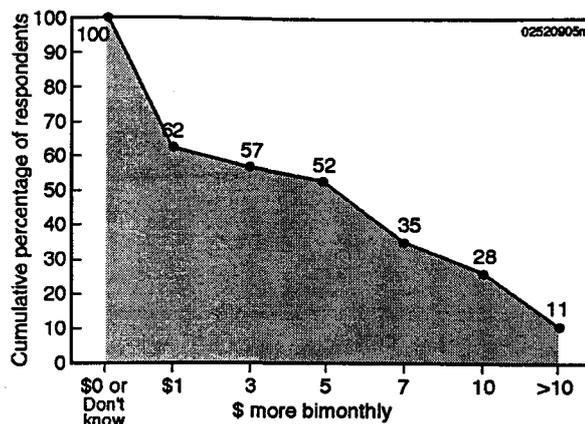


Figure B-1. Incremental Bimonthly Amounts Commercial Customers Are Voluntarily Willing to Pay for Electricity from Renewable Sources^{2,3}

translate into a higher public approval of companies purchasing power from renewable energy sources.

²There was insufficient information to determine the percentage responding \$0 and the percentage responding “Don’t know.”

³Where data on WTP for electricity from renewable sources are presented, the percentages of respondents willing to pay higher amounts is added to the percentage willing to pay lower amounts to show a cumulative percentage of respondents willing to pay at least a stated amount. This is based on the assumption that those willing to pay a higher amount—say, \$25 a month more—would be willing to pay lower amounts—say, \$10 a month more—for power from renewable energy sources.

Figure B-1 and many of the charts that follow display WTP responses as cumulative percentages. For example, in Figure B-1, 62% of respondents indicate that they would be willing to pay at least \$1 bimonthly for electricity from renewable sources. The cumulative curve is drawn to 100% at 0% to indicate that, in this case, some additional number of respondents that answered “zero” may have, if asked, been willing pay some amount between zero and \$1.

Stated Willingness to Pay More for Electricity from Renewable Sources by Residential Customers

No matter how the question was phrased, a large percentage of residential customers—in all surveys a majority—stated that they are willing to pay at least something more on their electricity bills for electricity from renewable sources. Among most of the surveys analyzed here, majorities of respondents are willing to pay at least \$5 a month more for power from renewable energy sources.

In response to one question, 57% say they are willing to pay 5% or more for environmentally sound electricity, and 15% say they are willing to pay 10% or more. Stated WTP varied by income but did not vary by electricity consumption. If a rebate were offered, 70% say they would be willing to pay for more environmentally friendly electricity sources.

Another result shows that respondents tend to support the option of paying “green rates.” On the whole, respondents say they would “somewhat favor” paying a premium of 5% for electricity generated from renewable resources. On a four-point scale, where 1 represents “strongly favor” and 4 “strongly oppose,” the mean value is 1.83. The average favorability toward paying a 20% premium is in the ambivalent range (mean = 2.36).

Response to another question shows that two-thirds of residential customers state that they are willing to pay at least \$1 more every other month for electricity from renewable sources; 58% are willing to pay \$3 every other month; and 52% are willing to pay at least \$5 every other month. Seven percent said they are willing to pay more than \$10 more every two months for electricity from renewable energy sources (Figure B-2).

Another question asked respondents whether they favor increasing their electric bill by \$1 a month so that solar and wind power would be produced in their area. Three-quarters of

respondents say they favor such an increase; 21% oppose it; 2% are mixed; and 2% don't know.

Response to a different question shows that 95% of individuals in the sample say they are willing to pay at least \$3 more per month on their electric bills for electricity from renewable sources (Figure B-3).

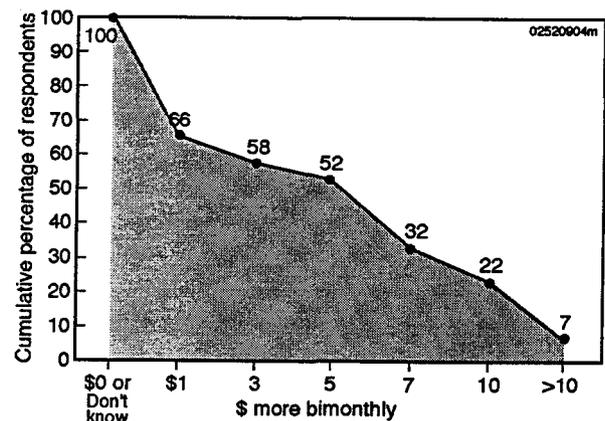


Figure B-2. Incremental Bimonthly Amounts Respondents Are Voluntarily Willing to Pay to Support New Renewable Energy⁴

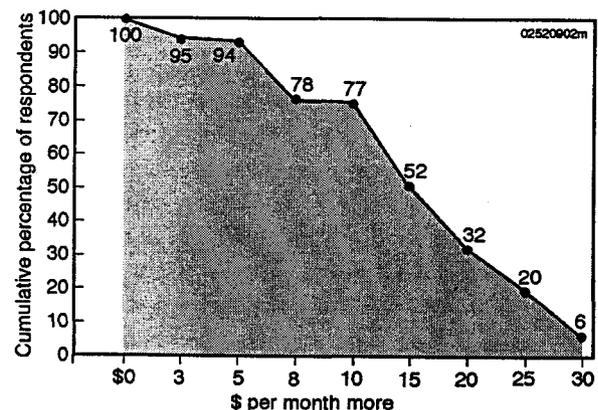
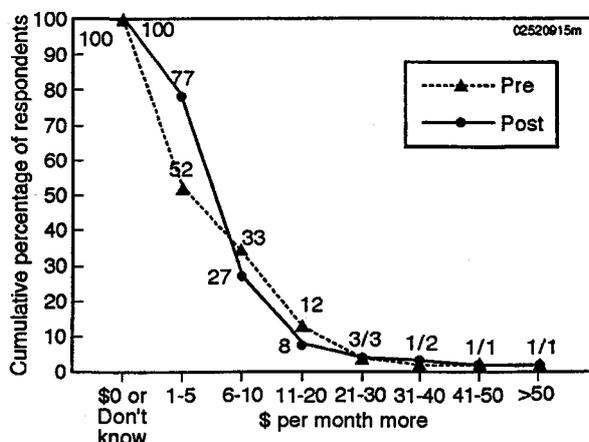


Figure B-3. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Electricity from Renewable Sources

⁴There was insufficient information to determine the percentage responding \$0 and the percentage responding “Don't know.”

Three surveys looked at customer WTP through an innovative polling technique called “deliberative polling.” Using this technique, a sample of electricity customers comes together and completes a questionnaire prior to spending a weekend discussing electricity issues. The customers receive relatively unbiased presentations by energy experts and participate in facilitated discussions, termed a “deliberation.” The sample then completes an identical questionnaire at the end of the weekend.

A question in one such deliberative poll questionnaire asked about WTP for electricity generation using wind and solar power. Prior to participating in deliberation, 52% of respondents said they would be willing to pay \$1-\$5 more per month for solar and wind power. After the deliberation, 77% said they would be willing to pay that amount. The percentage unwilling to pay anything dropped from 38% prior to deliberation to 18% afterwards. The percentage of respondents willing to pay more than \$20 a month more did not appear to change as a result of the deliberation. Clearly, exposure to more information about electricity issues increased participants’ WTP modest amounts for power from renewable energy sources (Figure B-4).



Pre: \$0 = 38% Don't know = 10%
 Post: \$0 = 17% Don't know = 6%

Figure B-4. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Solar and Wind Power before and after Deliberation on Electricity Issues

Similar questions were asked in other deliberative polls, each of which used the same data collection instrument. On average, prior to deliberation, 56% of the combined customer samples say that they would pay at least \$1 a month more for electricity generation using technologies such as wind and solar, and approximately one-third say that they would pay at least \$10 a month more. After deliberation, the percentage willing to pay at least \$1 a month more increased to 85%, while the percentage willing to pay at least \$10 a month more remained at almost one-third. (Figure B-5 shows the averaged percentages for the three surveys.)

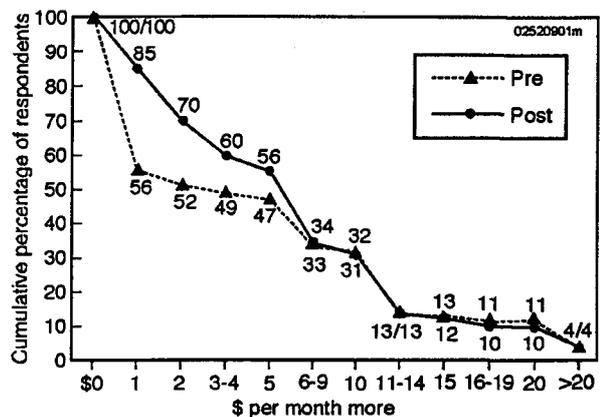
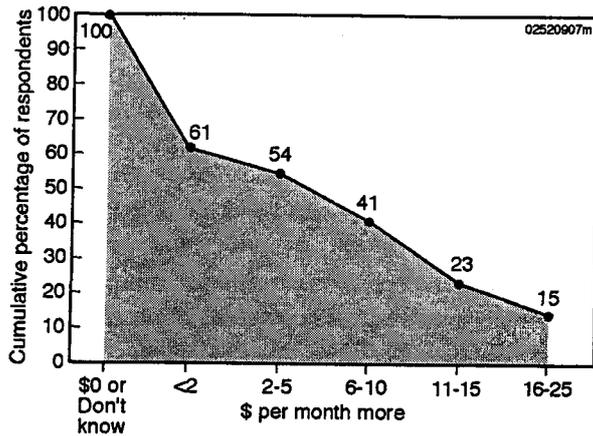


Figure B-5. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Electricity Generation from Renewables (Averaged Data from Three Surveys before and after Deliberation)

Specific Renewable Sources

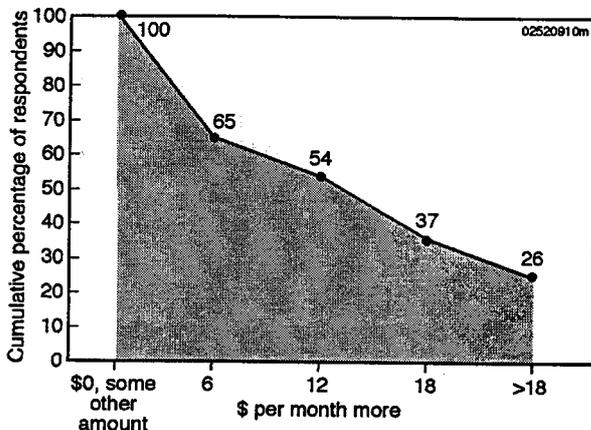
For specific renewable resources, responses follow a pattern similar to that generated from electricity from renewable energy sources in general. In response to one question, 61% of respondents say they are willing to pay up to \$2 per month more for solar, wind, and geothermal development; 54% say they would pay from \$2 to \$5 per month more; and 15% say they would pay from \$15 to \$25 per month more. Twenty-eight percent say they are unwilling to pay more (Figure B-6). These results represent the general trend pertaining to all renewables.



\$0 = 28%; Don't know = 11%

Figure B-6. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Solar, Wind, and Geothermal Development

Wind Power. Another question asked specifically about wind power. Sixty-five percent say they are willing to pay at least \$6 per month more, and 26% say they would pay more than \$18 a month more on their electricity bills for wind power (Figure B-7).

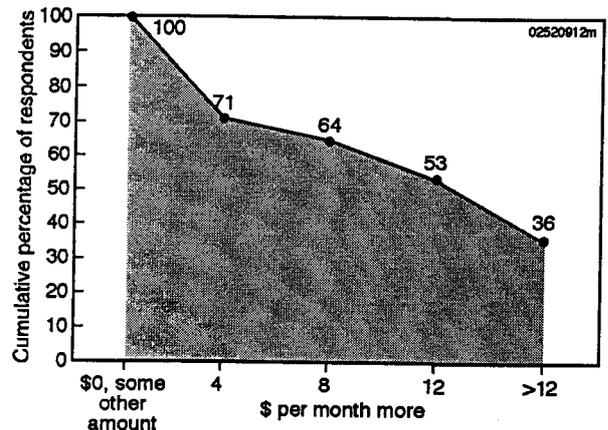


\$0 = 31%; Some other amount = 4%

Figure B-7. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Wind Power

Geothermal Electricity. Another question examined WTP for geothermal electricity.

Although 27% are unwilling to pay anything more, 71% say they are willing to pay at least \$4 a month more for geothermal electricity. Thirty-six percent are willing to pay more than \$12 a month more (Figure B-8).

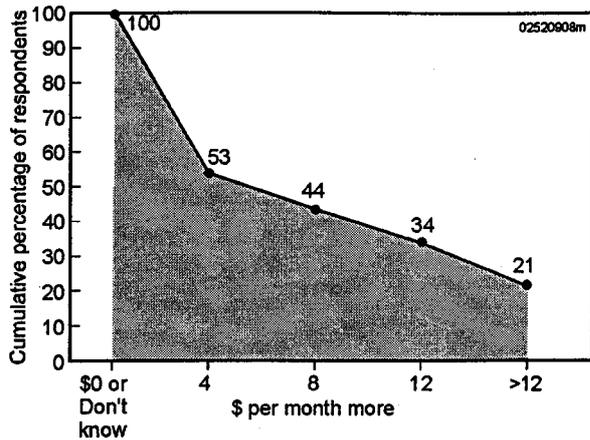


\$0 = 27%; Some other amount = 2%

Figure B-8. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Geothermal Electricity

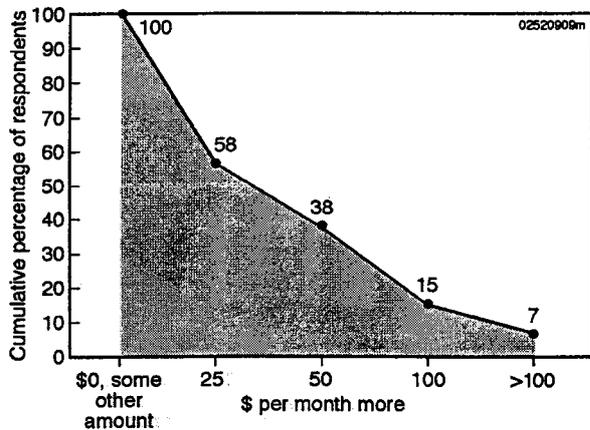
Biomass Electricity. Another question examined WTP for biomass electricity. A majority of 53% are willing to pay at least \$4 per month for electricity from biomass; 21% say they would pay more than \$12 a month more. However, 45% say they are unwilling to pay anything more for biomass electricity, the highest percentage unwilling to pay among the surveys in this body of findings (Figure B-9).

Rooftop PV Systems. One question asked customers about WTP for a PV system at their home that they would own and that would reduce the amount of purchased power. Nearly 60% of respondents say they would be willing to pay at least \$25 per month for such a PV system; 38% say they would be willing to pay at least \$50 more; and 15% say they would be willing to pay at least \$100 a month more for a PV system at their homes (Figure B-10).



\$0 = 45%; Don't know = 2%

Figure B-9. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Electricity from Biomass



\$0 = 35%; Some other amount = 7%

Figure B-10. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Home-Based Rooftop PV System

In response to another question, respondents indicate a preference for rooftop PV systems that supply all of their electricity needs. Of those answering a question about whether they prefer a system supplying 50% or 100% of their electricity needs, 53% say they prefer the larger system and 26% say they prefer the smaller one; 21% don't know.

Regarding financing for the PV system, 46% say they prefer a long-term loan, 36% a short-term loan, and 18% are unsure.

Survey data were also collected from a general residential customer sample, and using the same instrument, from existing contributors to a green-pricing program, asking how much respondents would be willing to pay in a combined electric bill for a PV system installed on their roof that they would own. Most respondents in the general sample (82%) are willing to pay *as much as* \$3 per month more for such a system, although it was not possible to discern how many people said "nothing more" because the data were not shown separately for that response. Eighty-two percent say they are willing to pay *at least* \$3 a month more for a PV system. Nearly one-third say they would be willing to pay \$20 per month more, and 13% say they are willing to pay \$25 per month more. Participants in a green-pricing program are likely to indicate even higher amounts, with 93% stating they are willing to pay at least \$3 more on their electric bill for a rooftop PV system they would own (Figure B-11).

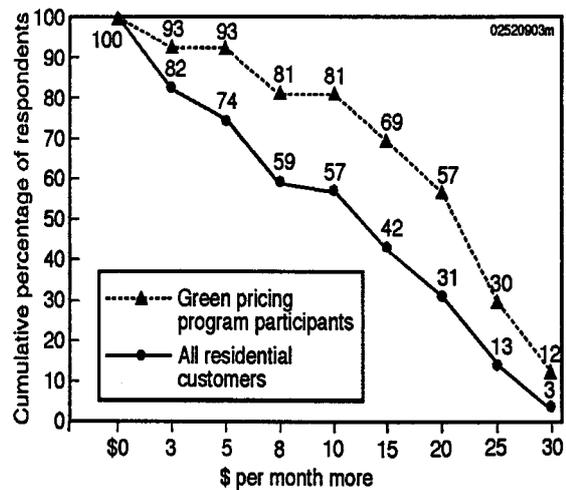


Figure B-11. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay on Electric Bills for a Rooftop PV System

Solar-for-Schools Program. A survey question measured WTP for a PV power system at a local school. A sizable majority (81%) of utility customers in the sample say they are willing to pay at least \$3 per month more for a PV-for-schools program; 78% say they are willing to pay at least \$5 per month more; 68% say they would pay at least \$10 per month more; and 44% say they would pay even more (Figure B-12).

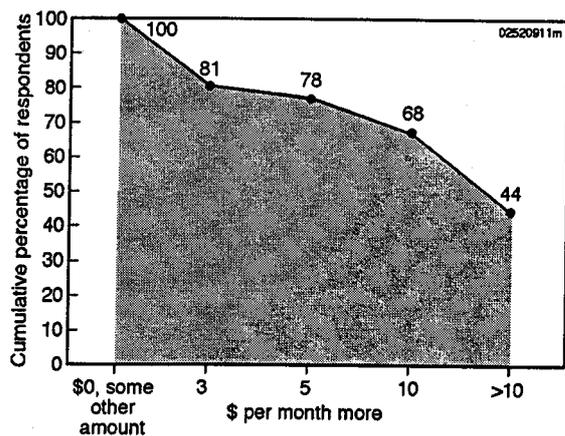


Figure B-12. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for a Solar-for-Schools Program

Preferences for Rate Basing versus Green Pricing

Only one question addressed the rate-basing versus green-pricing issue. The results showed strong support for spreading the costs of new renewables across the entire customer base. When given a choice, respondents asked this question agreed, by nearly four to one, that all households and businesses that can afford it should help pay for renewable power, as opposed to only voluntary purchasers. Seventy-four percent of the respondents in the residential sample and 80% of the commercial customer sample favored spreading the cost over the rate base. All the other questions included in this review focused exclusively on a utility green-pricing option.

Appendix C: Data on Willingness to Pay for Power from Renewable Sources in a Competitive Market

Strong majorities of respondents nationwide also say that they are willing to choose electricity from renewable sources if their electric bills remain the same (EPRI 1997). Another way of measuring WTP is to ask customers to choose between two offers for electric service, one comparable to what customers are receiving already except that it is 5%, 10%, and 15% lower in price, and one that ensures a supply of power from renewable sources at the price they are currently paying (EPRI 1997). In these scenarios, customers would be forgoing rate decreases to choose electricity from renewable energy sources.

Eighty-four percent of respondents nationwide say they would be willing to forgo a 5% discount in electricity prices to select power from renewable sources. Three-quarters (76%) say they would be willing to forgo a 10% discount in order to select electricity from renewable sources, and 71% say they would be willing to forgo a 15% discount to purchase electricity from renewable sources (Figure C-1). These figures are higher than the usual range of WTP for power from renewable sources. This method may represent a less “painful” way of choosing power from renewable sources by allowing customers to opt for a slightly lower bill than they otherwise would have. This pattern of response may be more representative of a competitive market situation.

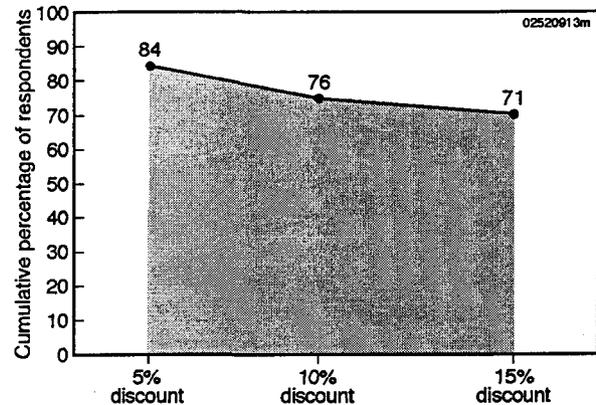


Figure C-1. Willingness to Pay for Electricity from Renewable Sources by Forgoing Different Price Discounts

Customers were asked about their interest in subscribing to different mixes (from 10% to 100%) of “environmentally friendly” electricity. Interest was assessed for different levels of power from renewable sources at price increases ranging from 5% to 25%. More than three-quarters of respondents say they are willing to pay at least a 5% premium to obtain all of their electricity from green sources, while one-third say they would pay a 25% increment. The pattern of responses, illustrated in Figure C-2, bears a similarity to the WTP curves discussed in the previous section.

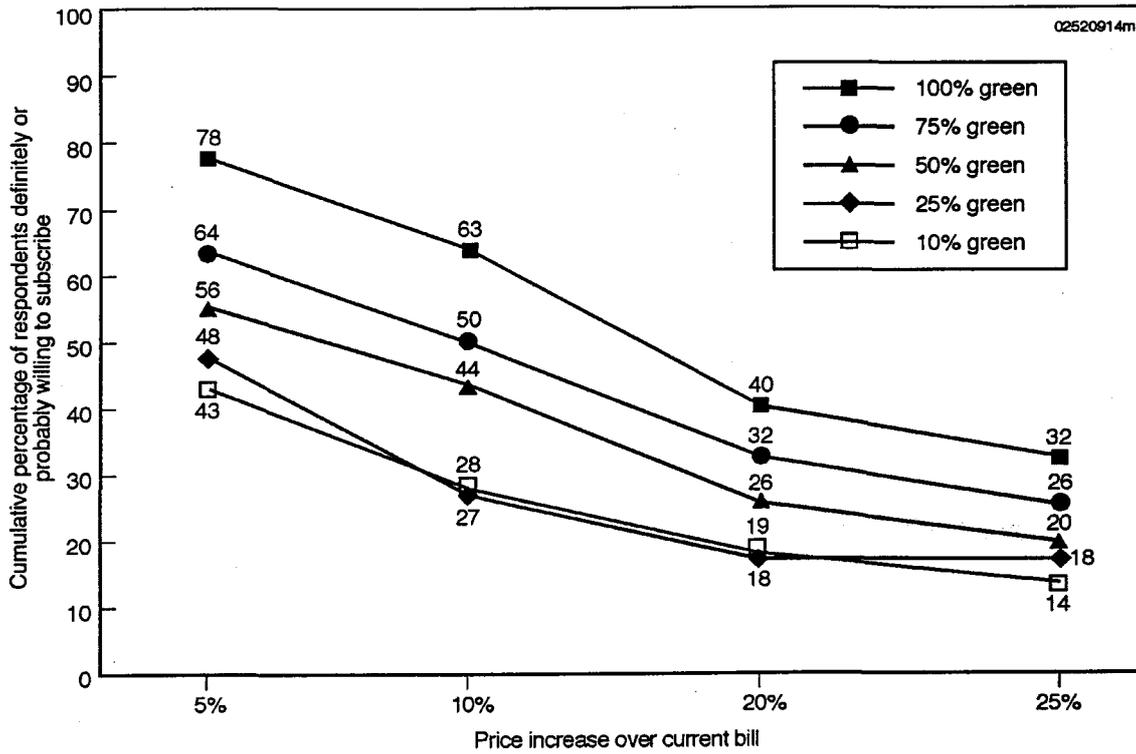


Figure C-2. Willingness to Subscribe to Product with Different Levels of Environmentally Friendly Electricity at Various Price Increases

Appendix D: Data on Consumer Attitudes toward Utilities

A few of the surveys explored customers' attitudes toward utilities relative to the use of renewables to generate electricity. Although they do not constitute a strong pattern, the findings suggest that customers will look more favorably upon, and would be willing to purchase electricity from, a utility providing power from renewable sources.

Responses to one survey question showed that almost everyone wants the utility to develop new renewables to avoid resource depletion (93%) and because it would be good for the environment (91%). Most (84%) disagree with the statement that it makes no difference how their utility gets its electricity, and 83% trust the utility to make good decisions on the selection and development of new power sources.

Results from another survey question showed that a majority of these respondents give a generally favorable rating to their utility (64%). A moderate relationship was found between satisfaction with the utility and support for adding new renewables. Those giving highest approval to their utility most strongly supported the idea of the utility adding new renewables. Both commercial and residential customers follow this pattern.

Also, residential customers who give the highest rating to the utility company's overall performance are more likely to say they are "very willing" to voluntarily pay more for renewables than all other respondents. They also are more likely to trust their utility to make decisions and to care about how their utility gets electricity. This suggests that, among very willing respondents, there is a higher level of trust in the utility company than among others. Residential customers less willing to pay more for renewables are twice as likely to say something negative about the utility company than those who say they would probably or definitely spend

an additional \$5. Negative comments about the utility included high rates and frequent outages.

A different question showed that green-pricing program participants are significantly more likely than customers at large to assign very high importance to having a utility that gets some of its electricity from green sources (mean scores of 9.1 and 7.3, respectively, on a 1-10 scale).

Results from still another question found that green-pricing program participants are significantly more loyal to the utility company than are customers as a whole. Only 3% of green-pricing participants say they *would* switch utility companies, and 17% say they *might* switch, compared with 40% of customers as a whole who say they would (16%) or might (24%) switch. In comparison, 34% of all respondents had switched long-distance telephone companies in the last year.

Three other survey questions explored respondent selection criteria for power providers if there were competition. One of these showed that 9 in 10 customers would choose as their electric company the one who has taken steps to provide more renewable energy resources. A second one showed that 87% of respondents say a "very important" or "somewhat important" factor in choosing their electric provider is a higher percentage of power from renewable sources than from conventional sources. Ninety percent of respondents to the question say that providing 100% renewables is most important while 85% say the same for clean-burning natural gas. When asked which company they would choose (when price is not mentioned), 63% of the respondents say they would choose the company that generates 80% of its power from renewables, 22% say it wouldn't matter, and 7% don't know.

Responses to the third question showed that criteria for selecting a green-power provider centers around price, environmental benefits, and credentials of the provider (including general reputation and specific experience with clean, renewable energy). Responses are summarized in Table D-1.

Table D-1. Importance of Green-Power Provider Attributes

Attributes	%
Is trustworthy/reliable	74
Has experience with clean/renewable energy	64
Experienced/been around a long time	62
Is located in your state	48
Is a company you are familiar with	48
Is a leader in the industry	47
Is your current provider	42



National Renewable Energy Laboratory

1617 Cole Boulevard
Golden, Colorado 80401-3393

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Contract No. DE-AC36-98-10337



27 August 1999

Mr. Robert Annan
6605 East Evening Glow
Scottsdale, AZ 85262

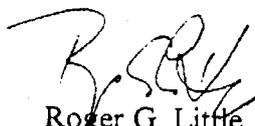
Dear Mr. Annan:

The size of the market for solar energy technologies created by the proposed Environmental Standard would prompt Spire to begin a concerted effort to locate a full service photovoltaic module manufacturing and systems integration/installation business in Arizona. Spire has recently announced the formation of such a business in Chicago, Illinois. Spire was motivated to locate the business in Chicago because of the commitment to develop the PV market demonstrated by the City of Chicago, the State of Illinois, and the major utility in Illinois, Commonwealth Edison.

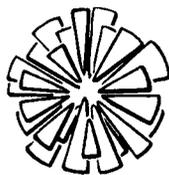
The business in Chicago and the type of business Spire would pursue in Arizona allows Spire to demonstrate the viability of its long-held philosophy of the connection between local economic/business development and the growth of the business' target market. If Spire locates a business in Arizona in response to the Environmental Standard, the intention of Spire would be to develop the PV market well beyond that created by the Standard, thus ensuring the business' success. Additionally, Spire would begin to develop the necessary infrastructure to widely distribute, install, and maintain its products in the marketplace. This illustrates the positive economic cycle that would be engendered by the Standard. If the market is big enough to draw new businesses, to ensure their own survival and to yield a return to their investors, those businesses will leverage the Market created by the Standard to grow sustainable markets that will go beyond the initial market. Those businesses will also ensure that the necessary infrastructure is in place to deliver and service their products. In short, the Standard will set the stage for solar technologies to become a significant contributor to Arizona's energy future.

Sincerely,

Spire Corporation



Roger G. Little
President

**ENTECH, INC.**

Thursday, August 26, 1999
(annan082699.doc)

Mr. Robert H. Annan
6605 East Evening Glow
Scottsdale, AZ 85262
Pho: 480-488-7858
Fax: 480-595-8487

Dear Mr. Annan:

ENTECH is a private corporation that manufactures top-quality solar energy products for the grid-connected and remote power markets. Since ENTECH was formed in 1983, it has been 100% involved in designing, manufacturing, and installing solar photovoltaic systems and solar thermal systems that concentrate sunlight for small and large terrestrial power applications, as well as space power applications. Throughout this period, we have worked closely with the U.S. Department of Energy, Sandia National Laboratories, National Renewable Energy Laboratory, NASA, a host of U.S. electrical utilities, and other users.

ENTECH has developed a business plan to expand production of our solar PV products so that in 2004 we will be producing a minimum of 33 MW per year of PV systems with the capability for 100 MW per year. We have the approval of ENTECH's Board of Directors to move this production operation to Arizona if the market capacity in Arizona so warrants. During this 5-year planned expansion program we would increase our staff to a minimum of 230 people with annual sales greater than \$94 million in 2004.

We believe that only a small amount of resources will be required from outside Arizona under our plan to locate our production facility in the State and to use existing local vendors where possible for all steel and aluminum fabrication, as well as for construction, installation, operation and maintenance. We plan to work with these vendors to increase their capacity if needed. Use of local vendors reduces our risk and insures Arizona content. The only items we plan to initially order from vendors outside of Arizona are the plastic Fresnel lenses and the bare solar cells, which constitute less than 20% of the total installed system price.

Our plan to manufacture, assemble and install the PV power systems in Arizona can be carried out within a schedule whereby a cumulative amount greater than 50 MW's of capacity is installed from 2000 through 2004.

There is investment risk involved in our plan. Our approach to minimizing this risk is to look at the total market available to us, that is: 1) the total on-grid and off-grid market in Arizona, 2) the total market for our product in the southwestern U.S., including the on-grid green power market, as well as the established off-grid market through existing system developers and distributors, and 3) the high-growth market outside of the U.S. that is being addressed under

our licensing program in which we plan to build about 50% of the systems content in Arizona and the balance in the host country.

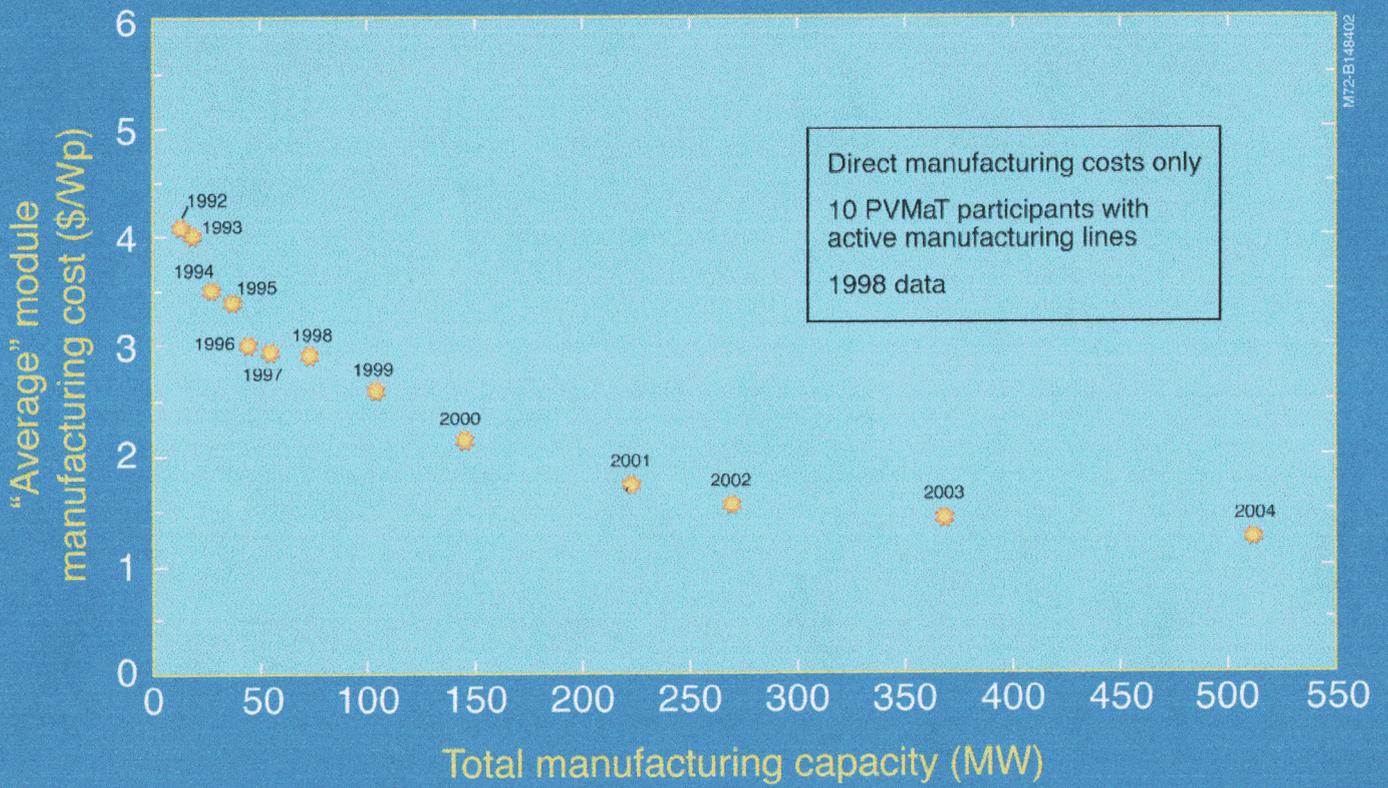
ENTECH is excited about Arizona's Environmental Portfolio Standard and is ready to commit its resources to contribute to the success of the program.

Sincerely,



Dr. Walter J. Hesse
Chief Executive Officer
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PVMaT Manufacturing Cost/Capacity



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