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BEFORE THE ARIZONA CORPORATION COMMISSION

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IN THE MATTER OF THE GENERIC INVESTIGATION OF THE DEVELOPMENT OF A RENEWABLE PORTFOLIO STANDARD AS A POTENTIAL PART OF THE RETAIL ELECTRIC COMPETITION RULES	DOCKET NO. E-00000A-99-205 **NOTICE OF FILING**

Staff of the Arizona Corporation Commission hereby files the testimony of Ray T. Williamson, Acting Director, Utilities Division, Tom Hoff, Clean Power Research and Marshall Goldberg, MRG & Associates in the above-captioned dockets.

RESPECTFULLY SUBMITTED this 30th day of July, 1999.

By: Paul A. Bullis

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DOCKET NO. E-00000A-99-0205

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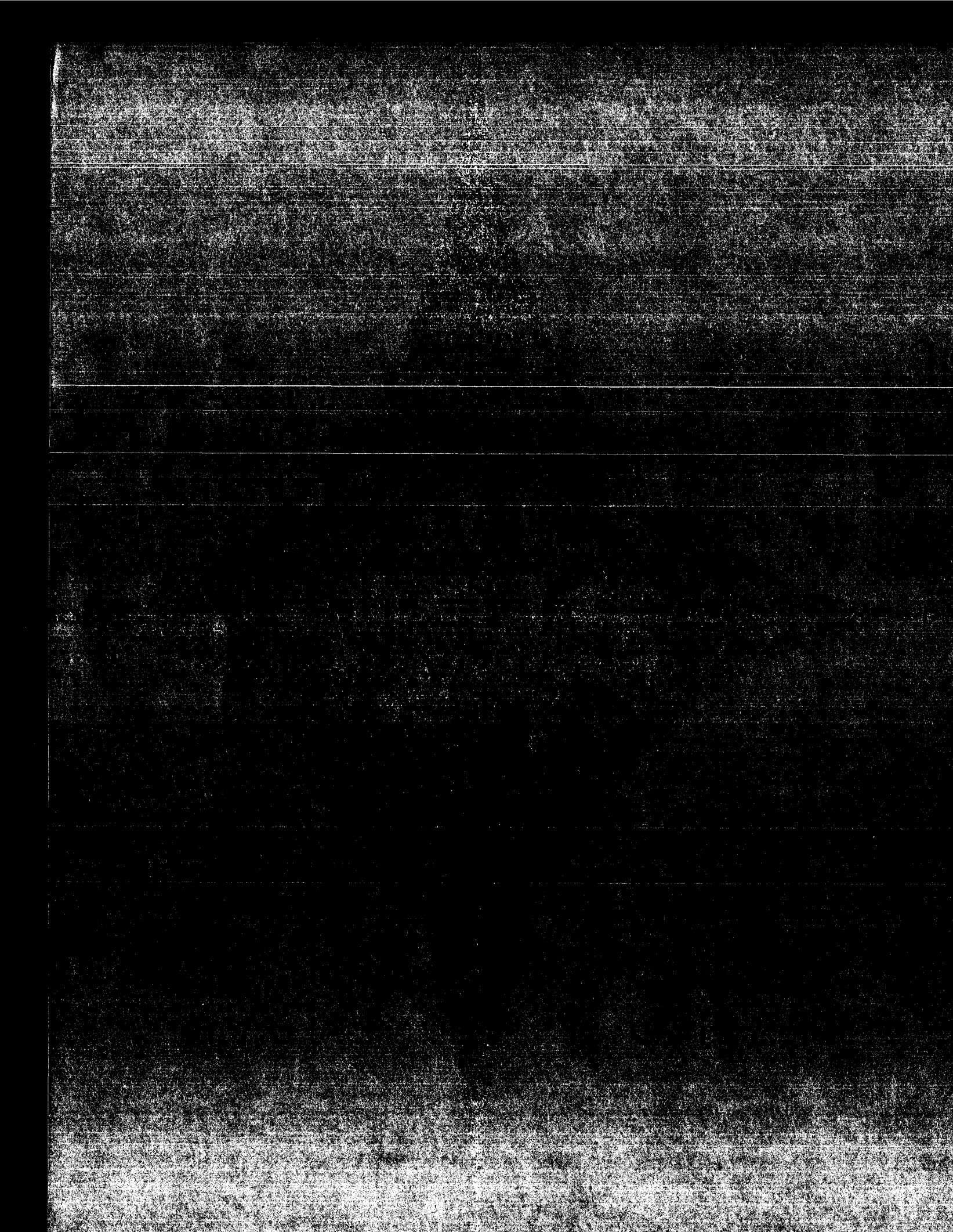

BEFORE THE ARIZONA CORPORATION COMMISSION

CARL J. KUNASEK
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IN THE MATTER OF THE GENERIC INVESTIGATION OF THE DEVELOPMENT OF A RENEWABLE PORTFOLIO STANDARD AS A POTENTIAL PART OF THE RETAIL ELECTRIC COMPETITION RULES	)	DOCKET NO. E-00000A-99-0205

DIRECT

TESTIMONY

OF

RAY T. WILLIAMSON

ACTING DIRECTOR

UTILITIES DIVISION

JULY 30, 1999

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APPENDICES

INTRODUCTION

Q. Please state your name and business address for the record.

A. My name is Ray T. Williamson. My business address is the Arizona Corporation Commission (Commission or ACC), 1200 West Washington, Phoenix, Arizona 85007.

Q. What is your position at the Commission?

A. I am the Acting Director of the Utilities Division at the Commission.

Q. Prior to becoming Acting Director, where were you employed?

A. I have been employed at the Commission since 1992 in various positions, including Economist, Senior Rate Analyst and Chief of Economics and Research.

Q. Please describe the balance of your background and experience.

A. My statement of Professional Qualifications is appended to this testimony as Appendix RTW-1.

Q. What is the purpose of your testimony and that of your consultant witnesses?

A. Our purpose is to help identify the true costs and benefits of incorporating an Environmental Portfolio Standard in the Retail Electric Competition Rules. Mr. Tom Hoff, of Clean Power Research, looked at the economics, costs and benefits of the Portfolio Standard. Marshall Goldberg of MRG & Associates looked at the impact of the Environmental Portfolio Standard on Arizona's economy.

Q. Does the direct testimony submitted today include all of the testimony from Staff and its witnesses?

A. No. There are two items that will need to be addressed in Staff's rebuttal testimony. First, witness Marshall Goldberg's report is marked as "draft." Other commitments for Mr. Goldberg did not allow time for a "clean-up" of the "draft" report by the July 30

deadline. It is anticipated that minor corrections and clarifications will be made in August. Second, Staff hopes to have the results of a survey by the end of August to submit with its rebuttal testimony.

RESPONSES TO HEARING OFFICER'S QUESTIONS

Note that numbered questions respond to question numbers from this docket's Procedural Order, dated June 16, 1999.

Q. 1. A. Should there be an Environmental Portfolio Standard in Arizona and why?

A. Yes. There should be an Environmental Portfolio Standard in Arizona.

The reasons are numerous. We are moving into a new era in the production and sale of electricity in Arizona and much of the nation. The choices that the Affected Utilities and their ESP competitors make about the fuels and technologies they use to produce Arizona's electricity will have a profound impact on Arizona's economy, on Arizona's environment, and on Arizona's ability in the next century to sustain its electricity production, transmission and distribution system.

Today, the fuels that create Arizona's electricity come almost completely from outside Arizona, making Arizona like a third world country that has to export dollars to import the fuels that create its electricity. Although most of the power plants that produce our electricity are located in Arizona, most of the equipment used in those plants is manufactured elsewhere. So, a major part of any dollar spent on electricity in Arizona leaves the Arizona economy to import fuel from other states and to pay for generation equipment that was manufactured elsewhere. This is a drain on the Arizona economy. The proposed Portfolio Standard would encourage local manufacturing of equipment for "environmental portfolio" power plants. It would also encourage the construction of

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those plants in Arizona. The Environmental Portfolio Standard would reverse the Arizona economy's dollar drain that results from today's fossil fuel and nuclear fuel systems.

The Environmental Portfolio Standard will be good for Arizona's environment. There is no question that the burning of fossil fuels is harming the Arizona environment. In addition, it is causing secondary restrictions on growth, limits on automobile emissions, and is creating impacts on daily business operations of a wide variety of companies. By adopting the portfolio standard, Arizona will make a small start in moving toward cleaner electricity technologies that will be the mainstay of 21st century power production.

Finally, the concept of energy availability and security is a compelling reason to move toward local energy resources. Arizona relies primarily on coal, natural gas and uranium to produce most of its electricity. Although these resources seem plentiful in supply today, they are part of finite supply that will begin to shrink in the future. Now is the time to start to develop the new energy sources for the next century, so that as we run out of conventional fuels, they can be replaced by clean, renewable fuels. This clearly is a very long range problem, but starting at .2% of electricity needs is an appropriate beginning for tomorrow's portfolio of environmental generating technologies.

Q. 1. B. What should be the objectives of an Environmental Standard?

A. In my opinion, the objectives should be a modified version of those developed by the Solar Portfolio Standard Subcommittee in the "Final Report of the Subcommittee," dated September 30, 1997 and docketed in the retail electric competition docket. Those objectives were:

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- Encourage the use of solar electric **and environmental** technologies to increase the fuel diversity in the electricity generation mix.

- Increase utility and electric service provider expertise and experience in the procurement, installation, and operation of solar **and environmental** electric systems or in the purchase and transmission of solar **and environmentally-friendly** electricity from other sources.

- Encourage new solar electric **and environmental** technologies as a reasonable percentage of competitive retail electric sales that is significantly less than the annual growth of demand for electricity.

- Encourage the use of modest-sized, distributed solar generators **and environmental technology generators** to reduce the loading on existing transmission lines and also reduce the need to build new, expensive transmission lines as the demand for electricity increases in the future.

- Contribute to the commercialization of solar electric **and environmental** technologies, which will decrease the cost of solar **and environmentally friendly** electricity to Arizona customers in the future.

- Contribute to economic benefits throughout Arizona.

- Encourage environmental benefits.

- Encourage a market-based solar electric **and environmental technology** industry.

- Increase public information/awareness of solar electricity **and environmental technologies**.

- Reach an acceptable cost/benefit point **for solar electric and environmental technologies**.

- Encourage solar resource **and environmental technology** development, rather than payment for non-compliance.

Note that the objective wording has been modified to allow for environmental technologies other than solar electric technologies.

It should be noted that the objectives of the Solar Portfolio Standard Subcommittee were developed by a working group of 57 active participants, representing 40 different organizations. These organizations included utilities, solar and renewable

energy companies, large customers, environmental organizations, residential customer advocates, cities, and various federal and state government agencies.

Q. Who should bear the costs of the Environmental Portfolio Standard and how should those costs be collected?

A. The costs of the portfolio standard should be born by all retail electric customers, since all customers will receive a portion of the electricity produced by the Standard. This is the way that all electric generators in a utility's portfolio of resources have always been paid for: by all customers. The costs should be collected within generation tariffs just as the baseload, intermediate and peaking power plants have their costs collected.

Nobody has ever suggested that certain customers should pay for the nuclear generators, while others pay for coal plants, and finally that a third group should pay for natural gas peaking plants. That does not make sense. Each customer will receive a proportionate share of portfolio generated electricity and will share in the proportional cost of that electricity.

This approach makes sense, because spreading the cost over all customers, reduces the individual customer impacts. If the costs were reserved for only a small group, the individual costs would be much higher and much less in the way of environmental technology purchases would be possible.

Q. 2. Will the proposed new Portfolio Standard meet the desired objectives or would you propose an alternative mechanism?

A. The proposed new Portfolio Standard (see Appendix RTW-4) will meet most of the desired objectives. The one major concern that Staff has is that broadening the Portfolio Standard from solar-only to other technologies will inadvertently force a larger portion of the portfolio to come from outside of Arizona. The reason is simple. Arizona has

abundant solar resources which are just about the best in the nation. However, Arizona is lacking in other renewable energy resources. For instance, most of Arizona is designated as Class 3 or less in wind resources. There are a few Class 4 and 5 locations in the state, but they are not likely to be conducive to economical wind generation. So, if the portfolio includes any wind, it will have to come from other states and will increase loading on transmission lines that are expected to be strained by competition.

As for biomass, the former Arizona Solar Energy Commission in the 1970s or 1980s conducted studies of biomass resources. The studies showed that biomass potential in Arizona was limited. Since the spotted owl became an endangered species, logging in Arizona has decreased significantly and the wood-chip biomass potential has been greatly reduced. So, biomass is not a viable in-state resource.

I personally was involved to two efforts to evaluate geothermal potential in Arizona. One study looked at Yuma County and the other study considered Hot Dry Rock Geothermal potential in eastern Arizona. Neither area was determined to be economically viable for geothermal electricity production.

Most of Arizona's hydropower and low-head hydro resources have already been tapped. Little new hydropower electricity production can be expected.

Landfill gas generation of electricity is one potential candidate for new power plants. In fact, Salt River Project is considering construction of just such a plant.

So, to the extent Arizona can encourage the installation of in-state power plants to meet the objectives, the new proposed Portfolio Standard will work well. To the extent that Arizona adds out-of-state energy sources, the impact on Arizona's economy will be less and we will continue to be a net importer of energy for our electricity generation.

Q. 3. Are you supportive of the proposed Portfolio Standard and, if not, describe any modifications that you would make to the proposed Portfolio Standard (including responses to 6 below) or describe your Company's proposed alternative mechanism.

A. Staff is supportive of the Portfolio Standard as suggested in Commissioner Kunasek's April 8, 1999, letter. The percentages proposed seem to be about right. Up to 10 percent of the Portfolio would be "environmental technologies," with up to 20 percent provided by solar water heating and the remaining 70 percent would be solar electric. This should work well. The 10 percent environmental piece would allow Arizona to use its local landfill gas resources and then import a small amount of other renewables, such as wind, from other states. The solar water heating portion would reduce the need for some conventional fossil-fuel electricity generation. Finally, the solar electricity generation would increase fuel diversity and encourage the development of a solar manufacturing and power plant construction industry in Arizona, with a major impact on Arizona's economy.

Q. 4. If you are proposing an alternative to the proposed Standard, include a detailed description of: (1) technologies to be included; (2) timing; (3) any incentives; (4) cost projection of the alternative over the life of the alternative; (5) impact on customer rates; and (6) all major assumptions for the proposed alternative.

A. Staff is not suggesting an alternative. However, this would be a good place to suggest appropriate technologies. First, in addition to solar electric and solar water heating technologies, Staff believes that two other technologies should be included: wind and local land-fill gas generators. As stated earlier, land-fill gas would be an excellent resource. As far as other renewable resources, wind has been significantly developed over the last 20 years due to California's Standard Offer #4 and PURPA programs. Wind is also one of the lower-cost technologies. Wind generators in neighboring states could export electricity to Arizona with reasonable transmission costs.

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Q. 5. A. Should the Standard be imposed only on sales in the competitive market?

A. No. The Standard, eventually, should be imposed on all retail sales. The original Retail Electric Competition Rules contemplated that, initially, the Solar Portfolio Standard would only apply to "competitive" sales during the four-year phase-in (1999-2002). Then, in 2003, it was to apply to all sales, since that was the year that all customers would be "competitive" customers. By having all customers participate, all customers help to develop the technologies that will be a mainstay of their electricity production in the 21st century.

If we were to only impose the standard on competitive sales (other than in the first two years when the percentage is miniscule), it could create an impediment to competition. In fact, it might really anger potential competitive customers who might see it as a burden for them alone to help clean up our air and environment. The benefits of the Portfolio Standard will accrue to all Arizonan's. Therefore, all should participate, in a small way, in moving to cleaner electricity generation systems.

Q. 5. B. Instead of implementing a Standard as part of the Retail Electric Competition Rules, should the market (the retail consumers themselves) dictate the amount of "green" power to include in competitive energy choices? Should the Commission encourage Energy Service Providers to *offer* programs, instead of mandating rigid targets, allowing the market for such products to develop naturally?

A. No, it would be inappropriate to frame this issue as an either/or choice: either a "green" power choice or a portfolio standard. Staff believes that the Commission should adopt a Portfolio Standard and encourage Affected Utilities and ESPs to offer green power programs as a mechanism to reduce portfolio costs and risks to ESPs and Affected Utilities.

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Since the 1980s, the Commission has been "encouraging" utilities to bring on line some renewable resources. In fact, there are renewable goals in a past Integrated Resource Planning order that have been largely ignored by the utilities. Only APS has attempted any significant renewable development and that effort is primarily due to a minimum spending requirement from the 1996 APS rate case settlement.

In the final analysis, the amounts in the portfolio are small. In the first year, it is only .2% of competitive electricity. This is at a time when demand for electricity in Arizona is increasing by 2 - 3% annually.

By instituting a Portfolio Standard, all customers will contribute a small amount toward developing new energy sources for the next century. By also encouraging "green" power programs (through extra credit incentives), the Commission will allow those who care the most about the environment to pay extra to receive clean power. Such an option is an ideal mix of portfolio and green power concepts.

Q. 5. C. Would it be appropriate to include recovery of costs of renewable systems in a systems benefits charge rather than the general cost/rate structure?

A. Yes, it would be appropriate, but such an approach needs to be carefully crafted. The current "systems benefits charge" that is included in Section 1608 is designed to return to the Affected Utilities the pro-rata share for each customer of certain programs that are already in the utilities' rates. This was designed so that the Affected Utility would not experience a 12 percent shortfall in funding, for instance, if 12 percent of customers chose another electricity generator. So, the money returns to the Affected Utility to conduct programs required by Commission orders.

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For the Environmental Portfolio Standard, a new system benefits charge would have to be developed. This would be difficult, since it is expected that ESPs will be adding customers weekly or monthly, so the system benefits charge would have to change regularly to keep up with new load increases as ESPs attract customers.

Q. 6. A. New Section N allows for "environmentally-friendly renewable electricity technologies" other than solar. Which technologies would be included in this subsection? Would those technologies be available in Arizona or work in Arizona?

A. Landfill gas is appropriate since it is a local energy source and the plant would be installed in Arizona. It is doubtful if much of the landfill gas generation equipment will be manufactured in Arizona. The other recommended technology is wind generator technology. Since Arizona does not have any significant wind potential, the wind generation would probably be in neighboring states.

Q. 6. B. In subsections A and B of the proposed Portfolio Standard, a schedule of portfolio percentages is defined. Is the size of portfolio percentage and timing of increases a reasonable strategy to be included in the competition rules? What alternatives would you propose and why?

A. Yes. The size of the portfolio percentage and timing are reasonable. The percentages are so small that they only reflect a small portion of the annual growth in electricity demand. Arizona's demand for electricity has been growing on the order of 2 - 3% per year. If we assume that the growth is at the lower end, 2%, from 1999 through 2005, demand for electricity will increase by 14.86 percent, but the portfolio will only be 1% of retail sales in 2005. If we assume growth at 3% per year, the increase in demand for electricity will be 22.98 percent higher in 2005, but the portfolio will have only provided less that 1/20th of the new production capacity. Staff does not propose any alternatives.

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Q. 6. C. The proposed Portfolio Standard includes incentives for in-state manufacturing and in-state installation of solar and other environmentally-friendly technologies. Are those incentives appropriate and substantial enough to have a positive impact on Arizona's economy and on Arizona economic development? What alternatives would you propose and why?

A. The incentives are appropriate. If an Affected Utility or ESP were to take advantage of all of the extra credit multipliers in the early years, the result would be a reduction in actual installed renewable/environmental capacity to approximately one-third of that required by the portfolio percentages. This is certainly acceptable, since the result would be a boost to the local Arizona economy, the development of a new and growing industry subsector, and the reduction in electricity dollars leaving Arizona to buy coal, natural gas and uranium for our power plants. A double or triple credit should be a sufficient incentive to encourage early installation, Arizona manufacturing, in-state power plant construction, and the use of various incentive programs such as green pricing and leasing programs.

Staff witness Marshall Goldberg discusses the incentives in his testimony and draft report. He concludes that the incentives provide a very positive impact on Arizona's economy.

Q. 6. D. What long-term benefits will the proposed Portfolio Standard have on the State of Arizona and its residents? Specific terms to be addressed include job creation, maintenance of energy dollars in the local economy, load diversification, and pollution prevention.

A. The first major benefit will be the start of a movement toward a generation portfolio mix that is cleaner than today's power plants. Although a small start, one percent of electricity from "environmentally-friendly" technologies will increase the experience of electricity generators in purchasing, building and operating new, clean generators. The demand for

the technologies will help to spur new innovations in those technologies and encourage the construction of larger manufacturing plants, which will, in turn, take advantage of economies of scale and lower the sales price of equipment. Arizona's Portfolio Standard could do for solar and environmental technologies what California's Standard Offer 4 program did for wind technologies in the 1980s: significantly reduce the delivered cost of renewable electricity.

The second major benefit will be the retention of energy dollars in Arizona's economy. For every dollar not spent on coal, natural gas, or uranium from outside Arizona, there will be a multiplier effect on Arizona's economy. For every dollar spent on solar or environmental technologies manufactured in Arizona, the multiplier will also apply. The extra credit multipliers in the Portfolio Standard will encourage local job creation and the development of a new industry sector for Arizona.

Staff witness Marshall Goldberg discusses the issues of job creation and maintenance of dollars in the local economy in his testimony and draft report. His analysis shows that jobs will increase as a result of the Portfolio Standard and then decline, primarily because the Portfolio Standard will not require significant environmental capacity additions after 2005.

However, Staff believes that, by 2005, most of the technologies in the Portfolio Standard will become competitively priced technologies. If that is the case, there will be voluntary purchases of these systems by Arizona electricity producers and those in the world-wide energy market. Arizona will be poised to supply Arizona-built systems to this billion dollar world-wide market. Therefore, rather than losing the jobs created by the Portfolio Standard, those jobs will likely become a permanent part of Arizona's economy, exporting clean technologies to other states and countries.

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Q. 6. E. What would the impact be on an average competitive (residential and commercial) customer's monthly bill (assume 1,000 kWh/month usage for residential) of the proposed Portfolio Standard? (Please state assumptions, including technology costs.)

A. Staff's consultant Tom Hoff has prepared a detailed analysis of the impacts of the proposed Environmental Portfolio Standard, including a residential impact example.

I also conducted a simple, "back of the envelop" type of an analysis that simply compares likely portfolio costs with likely competitive electricity prices, for both an average residential customer and average commercial customer.

First, I looked at the impact on an average residential customer. From Tucson Electric's 1998 FERC Form 1, I know that the average cost per kWh for residential customers in 1998 was 9.35 cents. I assumed that a competitor will offer conventional electricity that is 2% cheaper than TEP's previous rate (or 9.163 cents/kWh). I assumed that the customer uses 1,000 kWh per month.

So, in any month in 1999, with a .2% multiplier, the customers pays for 2 kWh of environmental portfolio electricity and 998 kWh of competitive, conventional electricity. I assumed a worst-case scenario, where the portfolio electricity equals the cost of the penalty (30 cents per kWh). Even in this case, the customer is better off this year than last year.

Last year he paid $93.50 per month (1,000 kWh x 9.35 cents/kWh). This year he will pay (including the portfolio costs) a total of $92.05. I continued the analysis through the year 2005.

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In each year, I looked at what the customer paid for a month in the previous year (prior to moving to competition). I compared that number, just as any customer would, to the new competitive bill with a portfolio standard and without a portfolio standard. The results, as shown in Appendix RTW-2, are that in every year (even when the portfolio reaches 1%), the customer pays less than he would have without competition. So the customer is always better off.

Next, I looked at a commercial customer. TEP's FERC Form 1 shows that the average commercial customer paid 10.79 cents per kWh in 1998. I assumed a competitor will offer electricity that is 2% cheaper (10.57 cents/kWh). I assumed that the customer uses 10,000 kWh per month.

In any 1999 month, with a .2% portfolio multiplier, the customer pays for 20 kWh of portfolio electricity and 9,980 kWh of competitive, conventional electricity. If, in 1999, we assume the worst-case scenario of 30 cents per kWh for the portfolio electricity costs, the commercial customer is still better off than he was before competition, so there is a positive impact on the customer's wallet.

My results are shown in Appendix RTW-3. The results are similar to the results for residential customers.

For the commercial customer, last year he paid $1,079 per month without competition. This year, with competition and a portfolio standard, he will pay $18 per month less. His bill will be $1,060.89.

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Q. 6. F. Section 1609.B.2 provides for determination of a cost/benefit point in 2001 prior to an increase in the percentage in 2002. Is it appropriate to determine the cost/benefits point during this proceeding (and the corresponding impact on customers) or in 2001? Should the Commission cap the impact that the Portfolio Standard may have on customers?

A. No, it is not appropriate to determine the cost/benefit point at this time. By setting the date in 2001, it will allow us to experience the anticipated technology cost reductions and industry expansions due to the Portfolio Standard. Then, in 2001, we will have some data with which to consider an appropriate cost/benefit point.

The Commission should not develop an impact cap at this time. Consideration of an impact cap could also be considered in the 2001 cost/benefit proceeding.

Q. 6. G. Section 1609.I of the proposed Portfolio Standard allows for the "banking" or sale of excess solar kWh. This could create a trading program, similar to the EPA's sulfur dioxide trading program. Do you have any suggestions about creating a credit trading or banking program?

A. A credit trading and/or banking program could improve the efficiency of the market for solar or environmental kWh. Such a program could encourage the construction of larger, more-cost effective power plants. The reason is that plant owners could reserve a portion of capacity to sell to those ESPs who were unable to construct enough environmental technology capacity to meet their portfolio requirements.

Staff suggests that, in concert with the concept of deregulation, any credit trading or banking program be developed by the private sector rather than by government agency.

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Q. 6. H. Section 1609.F provides for penalties if ESPs fail to meet the proposed Portfolio Standard. Are there additional provisions needed to require ESPs to issue RFPs or negotiate contracts in a timely fashion rather than merely paying the penalty?

A. Yes, such provisions would be helpful. What we want to avoid is having Affected Utilities and ESPs taking the "path of least resistance" and merely paying the penalty, rather than installing the solar and environmental systems contemplated in the Portfolio Standard.

Q. 7. Should the proposed standard or any alternative that you are proposing apply to Standard Offer Customers in 2001? If yes, should the standard or alternative as applied to Standard Offer be energy driven (kWh) or dollar driven to limit or cap the impact on Standard Offer Customers? What would the impact be on an average residential and commercial customer's monthly bill? (Please state assumptions, including technology costs.) What mechanism should the Commission put in place to recover the costs from Standard Offer Customers?

A. Yes, the Portfolio Standard should apply to all customers in 2001. The Portfolio Standard should be energy driven. Studies by Staff's consultants have shown that the impact of the Portfolio Standard will be minimal on Standard Offer Customers. The point is that electric rates and customer bills will be going down with competition. The projections are that rates will decrease by 1% or more per year due to competition, but the impact of the portfolio will be generally less than 1%, particularly in the early years when the percentage is .5% of electricity sold or less.

PUBLIC SUPPORT OF SOLAR ENERGY

Q. Is there support by the average Arizona citizen for the use of solar energy in Arizona?

A. Yes. Over the years, a number of surveys have been conducted in Arizona to ascertain the level of support for solar energy development and use. One such study, conducted in 1991 by the Arizona Department of Commerce showed that 68 percent of Arizonans

would be willing to pay an additional $2 per year in state taxes to promote solar energy. The same survey showed that 63 percent of those surveyed would be willing to pay an extra $0.35 per month on their utility bills to support solar research and development.

Q. Do you have any recent survey results on public attitude on the development and use of solar energy?

A. Staff does not have any survey results available for submission as direct testimony, but should be able to provide survey results by the end of August as rebuttal testimony.

COSTS AND ASSUMPTIONS USED FOR ANALYSES

Q. What assumptions about costs did you use for analyses?

A. One of the most difficult parts of doing any analysis is to determine costs and assumptions. An analysis of the Solar Portfolio Standard was performed for the Commission in 1997 by Pacific Energy Group, but the costs used then are too old and need updating.

Tom Hoff of Clean Power Research and I surveyed a number of people in the renewable industry to develop cost figures. As can be expected, the cost numbers represent a range of estimates, but they came from very knowledgeable sources.

Wind. Wind cost estimates came from Laurie Jodziewicz of the American Wind Energy Association and Brian Parsons of the National Renewable Energy Laboratory (NREL). The costs range from $800 to $1,000 per kW.

Landfill Gas. The estimate comes from Salt River Project. The cost comes from an actual bid for a proposed project. The costs are $1,411 per kW and O&M cost of $600,000 per year.

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Solar Water Heaters. Cost estimates came from Michael Neary of the Arizona Solar Energy Industries Association. Installed costs for residential solar water heaters range from $2,000 to $2,500. The solar water heater equivalent output estimates, 2,850 kWh per year, came from NREL.

Photovoltaics. The low end estimates ($5,000 per kW) came from Donald Osborne of Sacramento Municipal Utility District (SMUD). The upper end cost estimates ($8,000 per kW) came from Bob Johnson of Strategies Unlimited, a nationally-recognized expert in the photovoltaic industry.

Dish Stirling. Estimates came from Barry Butler of SAIC, one of the major Dish Stirling manufacturers. Based upon volume pricing from Mr. Butler, I constructed a likely scenario for the reduction in costs and ramp-up in units sold. The estimates ranged, over a number of years, from $10,000 per kW down to $2,500 per kW.

Solar Trough. The estimates came from Alphonse Bellac of York Research ($1,000 per kW for the SEECOT type of system) and Ray Dracker of Bechtel Corporation ($1,200 to $2,000 per kW for solar augmentation to a combined cycle generator.)

Mr. Hoff heard estimates of $4,000 to $5,000 per kW from some utility officials. We determined that these numbers must be the old costs related to the kinds of LUZ/SEGS systems installed in California in the 1980s. Since nobody is considering any stand-alone steam cycle SEGS systems, this high number was not used.

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ENVIRONMENTAL IMPERATIVE

Q. Why is it imperative to commence an Environmental Portfolio Standard?

A. The whole discussion of a Portfolio Standard really must come back to the impacts on our environment. It may be forgotten by some, but the effort to move to electric competition in Arizona started in April 1994, barely a month after the publication of the "Report of the Externalities Prioritization Working Group." The interest in externalities waned as it became clear that generation would become competitive and that externalities considerations would not be a high priority for competitive generators.

The cold, hard facts are that competitors will always choose the cheapest generation source in order to compete, whether it is the filthiest source or not. So, the externalities problems will continue to exist and likely will worsen due to free-market forces on competitors.

Therefore, in order to reduce the externality impacts on Arizona of conventional fossil fuel and nuclear generators, the Environmental Portfolio Standard offers the commencement of a movement away from environmentally damaging technologies to those that are clean, non-polluting, and non-destructive to Arizona's habitat or dangerous for Arizona's citizens.

The free market that will drive the new competitive electricity industry is a wonderful thing. It will help reduce Arizona's electricity costs, help the Arizona economy, and offer customers choice of services. However, the free market does a lousy job in controlling environmental pollution and other externalities.

In a free market, electricity generation companies will "externalize," or fail to consider, those impacts we call "externalities." Hence the name. Because the "costs" of externalities do not have to be paid for by the electric generation companies, but by

others, those companies will select the lowest-cost, most cost-effective power plant from their viewpoint. The fact that the plant may impose millions or billions of dollars of costs on others will not be factored in to the power plant selection process. Hence, we see a situation where scrubbers were required to be placed on the Navajo Power Plant at Page, Arizona, because others, upwind from Grand Canyon, failed to consider the externalities of their energy choices.

THE ENVIRONMENTAL PORTFOLIO STANDARD WILL HELP MOVE ARIZONA TO A BETTER, CLEANER ENVIRONMENT, REDUCING EXTERNALITIES, AND OTHER ADVERSE ENVIRONMENTAL AND ECONOMIC IMPACTS.

Q. What are the externalities related to electricity production?

A. The electricity production externalities are:

Cultural Resources	Land Alteration	Nuclear Disaster Plan
Material Damage	Water Quality	Resource Depletion
Water Quantity	Recreation	Acidic Deposition
Aesthetics	Habitat Impacts	Global Climate Change
Releases of Radioactivity	Air Quality	Electric and Magnetic Fields
Cost of Risk Management	Visibility	

Q. What are the human and biological factors that should be considered in relation to electric power plants?

A. The factors are as follows:

- Photochemical Smog
- Visibility Degradation in Pristine and Class 1 Areas
- Physical Modification of Aquatic Habitats
- Physical Modification of Environmentally Sensitive Terrestrial Habitats
- Alteration of Ecosystems
- Degradation of Built and Natural Landscape
- Species Extinction
- Loss of Biological Diversity
- Wet Lands Impact

Q. Why should we be concerned about externalities and human and biological factors related to electricity production?

A. We live in a desert. The desert is a fragile ecosystem. Our production of electricity will have an enormous impact of the environment in which we live and breathe. Take, for example, one externality: water quantity. Conventional electricity generators, with their large, water-intensive cooling towers, use millions of gallons of water each year. We live in a desert and part of our limited valuable water supply is being evaporated away because our utilities chose certain technologies.

Just in the last month, Phoenix has experienced three pollution alerts. If we exceed certain pollution standards one time this summer, tougher federal pollution controls most certainly will be applied to Arizona. Electricity production contributes to this pollution, particularly in the summer during peak power plant operations (June through September).

The health of our citizens is affected every day by the pollutants that our electric generators spew into the air. Just because the power plants stay below minimum pollution requirements does not mean that the cumulative affect does not make people sick. It clearly does.

One way to reduce environmental externalities and human and biological impacts is to start using clean, non-polluting generators. The Environmental Portfolio Standard should be the first step toward a cleaner 21st century.

Q. Does this conclude your direct testimony?

A. Yes, it does.

RAY T. WILLIAMSON

STATEMENT OF PROFESSIONAL QUALIFICATIONS

EDUCATION:

M.B.A. (Finance)	Arizona State University, Tempe, AZ, 1982
M.P.S. (Public Administration)	Western Kentucky University, Bowling Green, KY, 1976
B.S. (Engineering)	U.S. Military Academy, West Point, NY, 1970

PROFESSIONAL DESIGNATIONS:

Certified Energy Manager (CEM), Association of Energy Engineers, 1984

CURRENT PROFESSIONAL ACTIVITIES:

- Chairman, Solar Electricity Division, American Solar Energy Society
- Member, Association of Energy Engineers
- Member, International Association for Energy Economics
- Member, American Solar Energy Society

PAST PROFESSIONAL ACTIVITIES:

- Member, Board of Directors, Solar Rating & Certification Corporation (SRCC), 1988-91; Treasurer, 1989; Secretary, 1990
- Member, Rating Methodology Committee of SRCC, 1981-84
- Member, Arizona Photovoltaic Applications Task Force, 1985-86
- Participant, Arizona Energy Policy & Plan Development, 1989-90
- State Representative, Western Regional Biomass Energy Program, 1988-91
- Member, Arizona Electric Vehicle Task Force, 1991-92
- Member, Executive Committee, Interstate Solar Coordination Council, 1991-92
- Member, Externalities Task Force of the Arizona Corporation Commission, 1992
- Member, Environmental Technology Industry Cluster, Governor's Strategic Partnership for Economic Development (GSPED), 1992
- Member, Executive Committee, Interstate Renewable Energy Council, 1994-95
- Member, National Photovoltaics for Utilities Steering Committee, 1994-95
- Ex Officio Member, Planning Committee, Southwest Regional Transmission Association (SWRTA)

TEAM LEADERSHIP AND COMMITTEE COORDINATION EXPERIENCE:

- Coordinator, Arizona Electric System Reliability and Safety Working Group, 1996-98
- Coordinator, Arizona Photovoltaics for Utilities Cooperative, 1993-present
- Co-founder & Coordinator, Arizona Electric Vehicle Enterprise Network, 1990-92
- Founder & Chairman, Air Quality/Alternative Fuels Task Force of Phoenix Futures Forum, 1990-1992
- Coordinator, Externalities Prioritization Working Group, 1993-4
- Coordinator, Arizona Renewables Working Group, 1994-95
- Leader, Energy Efficiency & Environment Task Force, Retail Electric Competition Working Group, 1994-95

PROFESSIONAL EXPERIENCE:

ARIZONA CORPORATION COMMISSION, PHOENIX, AZ (OCT '92 - PRESENT)

ACTING DIRECTOR, UTILITIES DIVISION, MAR '98-PRESENT:

- Manages the 95-person Utilities Division
- Directly supervises five Section Chiefs, two Supervisors, and an Assistant Director

CHIEF, ECONOMICS AND RESEARCH, JUNE '97 –MAR '98:

- Managed the Economics and Research Section of the Utilities Division
- Supervised a staff of seven professionals
- Read, reviewed, edited, and approved tariffs, special contracts and other Commission Open Meeting items
- Prepared testimony for lawsuits regarding Retail Electric Competition
- Coordinated the Electric System Reliability and Safety Working Group
- Coordinated the Solar Portfolio Standard Subcommittee
- Staffed the Unbundled Services and Standard Offer Working Group
- Staffed the Independent System Operator and Spot Market Development Working Group
- Coordinated the overall Retail Electric Competition effort for the Division
- Wrote, edited, and published the Solar Portfolio Standard Subcommittee's final report
- Co-wrote, edited, and published the Unbundled Services and Standard Offer Working Group's final report
- From 12/15/97-2/6/98 performed duties of Acting Director for four weeks while Director was out of the country

SENIOR RATE ANALYST, MAY '94 - JUNE '97:

- Specialized in electric utility regulation activities and projects, including integrated resource planning, externalities, renewable energy resources, retail electric competition, and electric tariff review and evaluation
- Evaluated and developed recommendations on utility renewable energy plans and projects
- Served as the group leader of the Arizona Photovoltaics for Utilities Cooperative
- Coordinated the activities of the collaborative Renewables Working Group
- Wrote draft Commission rules for externalities and integrated resource planning
- Served as the Task Force Leader of the Energy Efficiency and Environment Task Force in the Retail Electric Competition Working Group
- Helped draft proposed Commission Retail Electric Competition Rules
- Participated as a member of the Planning Committee of the Southwest Regional Transmission Association
- Acted as the Coordinator of Arizona's Electric System Reliability and Safety Working Group

ECONOMIST, OCT '92 - MAY 94:

- Conducted economic and policy analyses of electric and telecommunications utility issues
- Analyzed applications of utilities regarding rate levels, rate design, and service offerings
- Prepared recommendations and testimony on renewable energy, energy conservation, demand-side management, integrated resource planning, special rates and contracts, and tariff filings
- Served as the Coordinator of the Arizona Photovoltaics for Utilities Cooperative
- Served as the Coordinator of the Externalities Prioritization Working Group
- Wrote, edited, and published the Externalities Prioritization Working Group's final report

ARIZONA DEPARTMENT OF COMMERCE, PHOENIX, AZ (JULY '85 - OCT '92)

ENERGY BUSINESS TECHNICAL SPECIALIST in the **ARIZONA ENERGY OFFICE**, MARCH '90 - OCT '92:

- Prepared testimony and testified as an expert witness in the first cycle of the Corporation Commission's Integrated Resource Planning. The testimony resulted in the formation of two Commission Task Forces to consider externalities and sliding-scale hook-up fees.
- Participated in the two-year Arizona Energy Policy and Plan development program
- Founded the collaborative Arizona Photovoltaics for Utilities Cooperative and coordinated its activities

MANAGER of the **ARIZONA SOLAR ENERGY OFFICE**, JULY '87 - MARCH '90:

- Managed the entire solar energy program for the State of Arizona
- Managed the accomplishments of a staff of eight employees and numerous contractors and subcontractors

ENERGY ECONOMIC ANALYST of the **ARIZONA ENERGY OFFICE**, JULY '85 - JUNE '87:

- Prepared various economic analyses, including the impact of the 1986 oil price decline
- Performed utility rate analyses and presented utility bill seminars to school officials and local governments
- Served on the Arizona Photovoltaic Applications Task Force established to evaluate the potential for the use of photovoltaics in Arizona and to make recommendations to the Arizona Corporation Commission

ARIZONA SOLAR ENERGY COMMISSION, PHOENIX, AZ (DEC '80 - JUNE '85)

ASSOCIATE DIRECTOR, FEDERAL PROGRAMS MANAGER, & SOLAR ENGINEERING SPECIALIST:

- Developed strategies and marketing plans to enhance the commercialization of solar energy products
- Was responsible for revising, drafting, staffing, and coordinating work on Commission rules and the public hearings on rules

RAMADA ENERGY SYSTEMS, INC., TEMPE, AZ (JUNE '79 - JULY '80)

MANAGER, MARKETING SERVICES:

- Managed all services and support of the Marketing Department and of the company distribution network
- Established office administration programs, developed standard operating procedures for the Marketing Department, and initiated a comprehensive national inquiry response program
- Developed and implemented advertising, publicity and public awareness plans

SOLARON CORPORATION, DENVER, CO (JULY '76 - JUNE '79)

FEDERAL PROGRAMS ADMINISTRATOR, AUG '78 - JUNE '79:

- Managed all activities of the federal solar grant programs
- Wrote grant applications, assisted applicants with design and grant preparation, follow-up reporting, and assistance on winning grants

ASSISTANT TO THE MANAGER, DISTRIBUTOR SALES, SEP '77 - JUL '78:

- Responsible for the day-to-day activities of the distributor network for Solaron products
- Developed marketing plans for the distributor network
- Assisted distributors in project design, computer simulation, and equipment selection

MARKETING ADMINISTRATOR, JUL '76 - AUG '77:

- Coordinated office administration
- Provided training and grant application preparation assistance to customers in federal grant programs. Sales through these grant programs accounted for 26 percent of all 1977 Solaron sales
- Served as a sales engineer, designing and selling individual systems in areas without distributors and sales to walk-in customers

U.S. ARMY EXPERIENCE: Commissioned Officer from June 1970-January 1976

ADDITIONAL TRAINING:

1984-1993 Arizona State University, College of Business: 36 semester hours of economics courses. This included course work in public utility economics & finance.

1976-1996 Attendance at 110+ seminars, conferences and workshops covering subjects such as: electric industry restructuring, energy conservation, demand-side management, thermal storage, energy economics, financing of energy projects, cogeneration, solar energy, integrated resource planning, solar energy in utilities, environmental concerns, electric vehicles, biomass, and energy-conserving building design.

PUBLICATIONS

Williamson, Ray T. "The Versatile Transparent Polymer Collector." Paper presented at the 1980 Annual Meeting of the International Solar Energy Society, Phoenix, Arizona.

Williamson, Ray T. **Standards for Solar Devices**. Arizona Solar Energy Commission, May 1981.

Williamson, Ray T., Editor. **Information Sources for the Solar Industry**. Arizona Solar Energy Commission, May 1981.

Williamson, Ray T., Editor. **Licensing Solar Contractors in Arizona**. Arizona Solar Energy Commission, May 1981.

Williamson, Ray T., Editor. **Arizona's Solar Laws & Rules**. Arizona Solar Energy Commission, May 1981.

Williamson, Ray T., Editor. **Arizona's Solar Energy Tax Credits**. Arizona Solar Energy Commission, May 1981. "Standards for Solar Collectors." Arizona Solar Energy Commission, March 1982.

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Williamson, Ray T., Doran Dalton and Robert Robin. "The Hopi Foundation's Solar Electric Enterprise: A Model for Renewable Industry Development in Developing Nations." Paper presented at the 1991 Solar Word Congress. **Proceedings of the Biennial Congress of the International Solar Energy Society**, Denver, Colorado, 19-23 August 1991.

Williamson, Ray T., Peter Eckert, Tom Lepley, and Frank Mancini. "Testing and Evaluation of a Mobile Photovoltaic/Genset Hybrid System." Paper presented at the 22nd IEEE Photovoltaic Specialist Conference. **Proceedings of the 22nd Institute of Electrical and Electronics Engineers, Inc. Photovoltaic Specialists Conference**, Las Vegas, Nevada, 7-11 October 1991.

Williamson, Ray T., Editor/Co-author, and Robert Hammond, Frank Mancini, and James Arwood. "The Solar Electric Option (Instead of Power Line Extension)." A 16-page brochure published by the Arizona Corporation Commission and the Arizona Department of Commerce. Phoenix, Arizona, August 1993.

Williamson, Ray T., Co-author, and Staff of Economics & Research Section, Arizona Corporation Commission. "Staff Report on Resource Planning." Arizona Corporation Commission, September 1993.

Williamson, Ray T. "Staff Report on Arizona Public Service Company's Carol Spring Mountain Project," (DocketNo. U-1345-94-335), Arizona Corporation Commission, October 1994.

Williamson, Ray T., and Robert Gray. "Staff Report on Arizona Public Service Company's Photovoltaic Applications and Systems Development Program," (Docket No. U-1345-95-323), Arizona Corporation Commission, August 1995.

Williamson, Ray T., Co-author, and Staff of Economics & Research Section, Arizona Corporation Commission. "The Electric Industry In Arizona: Staff Report on Resource Planning." Arizona Corporation Commission, October 1996.

Williamson, Ray T., David Berry, and Kim Clark of Economics & Research Section, Arizona Corporation Commission. "Staff Discussion of the Proposed Rule on Electric Industry Restructuring," (Docket No. U-0000-94-165), Arizona Corporation Commission, October 1996.

Williamson, Ray T., "Incorporating Solar in a Restructured Electric Utility Industry," **Proceedings of the 1997 Annual Conference of the American Solar Energy Society**, Washington, D.C., 25-30 April 1997.

Williamson, Ray T. and David Berry, "Solar Power and Retail Electric Competition in Arizona," **Solar Today**, Vol. 11, No. 2, March/April 1997.

Williamson, Ray T. "Designing an Effective Solar Portfolio Standard," **Proceedings of the SOLAR '98 Conference**, American Solar Energy Society, Albuquerque, N.M., 13-18 June 1998.

Williamson, Ray T. and Howard Wenger, "Solar Portfolio Standard Analysis," **Proceedings of the SOLAR '98 Conference**, American Solar Energy Society, Albuquerque, N.M., 13-18 June 1998.

Competitive Residential Customer Impacts of Portfolio Standard (TEP Territory)

	Previous Year Bill	Bill W/EPS	Bill W/O EPS
1999	$93.50[1]	$92.05	$91.63
2000	$92.56[4]	$90.15	$89.79
2001	$91.63[4]	$88.45	$88.00
2002	$91.63	$86.56	$86.24
2003	$91.63	$84.72	$84.51
2004	$91.63	$82.96	$82.82
2005	$91.63	$81.25	$81.16

Assumptions

1. Previous year bill based on TEP's 1998 FERC Form 1.

2. Customer uses 1,000 kWh per month.

3. Competitive tariffs drop by 2% per year to meet competitive price pressures.

4. TEP has two annual 1% rate reductions per the proposed settlement in 1999 and 2000 and then rates are frozen until 2008.

5. Costs of Portfolio electricity (cents/kWh):

1999	30¢
2000	27¢
2001	20¢
2002	15¢
2003	12¢
2004	10¢
2005	9¢

			Cust. price		1999
Competitive tariff			$0.09163		
Portfolio Cost			$0.300	eps1r	
Cust. elec. use:	1,000	kwh			
% kwh by EPS:	0.002				
% kwh by conv.:	0.998				
Cost of EPS kwh:	2	kwh times	0.30	=	$0.60
Cost of conv. kwh:	998	kwh times	0.09163	=	$91.45
		Monthly bill TOTAL		=	$92.05
		Av. cost per kwh:		=	$0.0920
Previous A.U. price	$ 0.09350	Bill w/o competition		=	$ 93.50
Price red. w/EPS:	1.554 %			=	$ 1.45
Price red. w/o EPS:	2.000 %			=	$ 1.87

			Cust. price		2000
Competitive tariff			$0.08979		
Portfolio Cost			$0.270	eps2r	
Cust. elec. use:	1,000	kwh			
% kwh by EPS:	0.002				
% kwh by conv.:	0.998				
Cost of EPS kwh:	2	kwh times	0.270	=	$0.54
Cost of conv. kwh:	998	kwh times	0.08979	=	$89.61
		Monthly bill TOTAL		=	$90.15
		Av. cost per kwh:		=	$0.0902
Previous A.U. price	$ 0.09256	Bill w/o competition		=	$ 92.56
Price red. w/EPS:	2.603 %			=	$ 2.41
Price red. w/o EPS:	2.993 %			=	$ 2.77

			Cust. price			2001
Competitive tariff			$0.08800			
Portfolio Cost			$0.200			eps3r
Cust. elec. use:	1,000	kwh				
% kwh by EPS:	0.004					
% kwh by conv.:	0.996					
Cost of EPS kwh:	4	kwh times	0.200	=		$0.80
Cost of conv. kwh:	996	kwh times	0.08800	=		$87.65
		Monthly bill TOTAL		=		$88.45
		Av. cost per kwh:		=		$0.0884
Previous A.U. price	$ 0.09163		Bill w/o competition	=	$	91.63
Price red. w/EPS:	3.473	%		=	$	3.18
Price red. w/o EPS:	3.962	%		=	$	3.63

			Cust. price			2002
Competitive tariff			$0.08624			
Portfolio Cost			$0.150			eps4r
Cust. elec. use:	1,000	kwh				
% kwh by EPS:	0.005					
% kwh by conv.:	0.995					
Cost of EPS kwh:	5	kwh times	0.150	=		$0.75
Cost of conv. kwh:	995	kwh times	0.08624	=		$85.81
		Monthly bill TOTAL		=		$86.56
		Av. cost per kwh:		=		$0.0866
Previous A.U. price	$ 0.09163		Bill w/o competition	=	$	91.63
Price red. w/EPS:	5.534	%		=	$	5.07
Price red. w/o EPS:	5.882	%		=	$	5.39

			Cust. price		2003
Competitive tariff			$0.08451		
Portfolio Cost			$0.120		eps5r
Cust. elec. use:	1,000	kwh			
% kwh by EPS:	0.006				
% kwh by conv.:	0.994				
Cost of EPS kwh:	6	kwh times	0.120	=	$0.72
Cost of conv. kwh:	994	kwh times	0.08451	=	$84.00
		Monthly bill TOTAL		=	$84.72
		Av. cost per kwh:		=	$0.0847
Previous A.U. price	$ 0.09163		Bill w/o competition	=	$ 91.63
Price red. w/EPS:	7.538 %			=	$ 6.91
Price red. w/o EPS:	7.770 %			=	$ 7.12

			Cust. price		2004
Competitive tariff			$0.08282		
Portfolio Cost			$0.100		eps6r
Cust. elec. use:	1,000	kwh			
% kwh by EPS:	0.008				
% kwh by conv.:	0.992				
Cost of EPS kwh:	8	kwh times	0.100	=	$0.80
Cost of conv. kwh:	992	kwh times	0.08282	=	$82.16
		Monthly bill TOTAL		=	$82.96
		Av. cost per kwh:		=	$0.0830
Previous A.U. price	$ 0.09163		Bill w/o competition	=	$ 91.63
Price red. w/EPS:	9.465 %			=	$ 8.67
Price red. w/o EPS:	9.615 %			=	$ 8.81

			Cust. price		2005
Competitive tariff			$0.08116		
Portfolio Cost			$0.090		eps7r
Cust. elec. use:	1,000	kwh			
% kwh by EPS:	0.010				
% kwh by conv.:	0.990				
Cost of EPS kwh:	10	kwh time	0.090	=	$0.90
Cost of conv. kwh:	990	kwh time	0.08116	=	$80.35
		Monthly bill TOTAL		=	$81.25
		Av. cost per kwh:		=	$0.0812
Previous A.U. price	$ 0.09163	Bill w/o competitio		=	$ 91.63
Price red. w/EPS:	11.330 %			=	$ 10.38
Price red. w/o EPS:	11.426 %			=	$ 10.47

Competitive Commercial Customer Impacts of Portfolio Standard (TEP Territory)

	Previous Year Bill	Bill W/EPS	Bill W/O EPS
1999	$1,079[1]	$1,060.89	$1,057
2000	$1,068[4]	$1,038.33	$1,035
2001	$1,057[4]	$1,018.94	$1,015
2002	$1,057	$996.53	$994
2003	$1,057	$975.36	$974
2004	$1,057	$955.36	$955
2005	$1,057	$935.64	$936

Assumptions

1. Previous year bill based on TEP's 1998 FERC Form 1.
2. Customer uses 10,000 kWh per month.
3. Competitive tariffs drop by 2% per year to meet competitive price pressures.
4. TEP has two annual 1% rate reductions per the proposed settlement in 1999 and 2000 and then rates are frozen until 2008.
5. Costs of Portfolio electricity (cents/kWh):

1999	30¢
2000	27¢
2001	20¢
2002	15¢
2003	12¢
2004	10¢
2005	9¢

			Cust. price		1999
Competitive tariff			$0.10570		
Portfolio Cost			$0.300		eps1c
Cust. elec. use:	10,000	kwh			
% kwh by EPS:	0.002				
% kwh by conv.:	0.998				
Cost of EPS kwh:	20	kwh times	0.30	=	$6.00
Cost of conv. kwh:	9,980	kwh times	0.10570	=	$1,054.89
		Monthly bill TOTAL		=	$1,060.89
		Av. cost per kwh:		=	$0.1061
Previous A.U. price	$ 0.10790	Bill w/o competition		=	$ 1,079.00
Price red. w/EPS:	1.679 %			=	$ 18.11
Price red. w/o EPS:	2.039 %			=	$ 22.00

			Cust. price		2000
Competitive tariff			$0.10350		
Portfolio Cost			$0.270		eps2c
Cust. elec. use:	10,000	kwh			
% kwh by EPS:	0.002				
% kwh by conv.:	0.998				
Cost of EPS kwh:	20	kwh times	0.27	=	$5.40
Cost of conv. kwh:	9,980	kwh times	0.10350	=	$1,032.93
		Monthly bill TOTAL		=	$1,038.33
		Av. cost per kwh:		=	$0.1038
Previous A.U. price	$ 0.10680	Bill w/o competition		=	$ 1,068.00
Price red. w/EPS:	2.778 %			=	$ 29.67
Price red. w/o EPS:	3.090 %			=	$ 33.00

				Cust. price		2001
Competitive tariff				$0.10150		
Portfolio Cost				$0.200		eps3c
Cust. elec. use:	10,000	kwh				
% kwh by EPS:	0.004					
% kwh by conv.:	0.996					
Cost of EPS kwh:	40	kwh times	0.20	=		$8.00
Cost of conv. kwh:	9,960	kwh times	0.10150	=		$1,010.94
		Monthly bill	TOTAL	=		$1,018.94
		Av. cost per kwh:		=		$0.1019
Previous A.U. price	$ 0.10570	Bill w/o competition		=		$ 1,057.00
Price red. w/EPS:	3.601 %			=		$ 38.06
Price red. w/o EPS:	3.974 %			=		$ 42.00

				Cust. price		2002
Competitive tariff				$0.09940		
Portfolio Cost				$0.150		eps4c
Cust. elec. use:	10,000	kwh				
% kwh by EPS:	0.005					
% kwh by conv.:	0.995					
Cost of EPS kwh:	50	kwh times	0.15	=		$7.50
Cost of conv. kwh:	9,950	kwh times	0.09940	=		$989.03
		Monthly bill	TOTAL	=		$996.53
		Av. cost per kwh:		=		$0.0997
Previous A.U. price	$ 0.10570	Bill w/o competition		=		$ 1,057.00
Price red. w/EPS:	5.721 %			=		$ 60.47
Price red. w/o EPS:	5.960 %			=		$ 63.00

				Cust. price		**2003**
Competitive tariff				$0.09740		
Portfolio Cost				$0.120		eps5c
Cust. elec. use:		10,000	kwh			
% kwh by EPS:		0.006				
% kwh by conv.:		0.994				
Cost of EPS kwh:		60	kwh times	0.12	=	$7.20
Cost of conv. kwh:		9,940	kwh times	0.09740	=	$968.16
			Monthly bill TOTAL		=	$975.36
			Av. cost per kwh:		=	$0.0975
Previous A.U. price	$	0.10570	Bill w/o competition		=	$ 1,057.00
Price red. w/EPS:		7.724	%		=	$ 81.64
Price red. w/o EPS:		7.852	%		=	$ 83.00

				Cust. price		**2004**
Competitive tariff				$0.09550		
Portfolio Cost				$0.100		eps6c
Cust. elec. use:		10,000	kwh			
% kwh by EPS:		0.008				
% kwh by conv.:		0.992				
Cost of EPS kwh:		80	kwh times	0.10	=	$8.00
Cost of conv. kwh:		9,920	kwh times	0.09550	=	$947.36
			Monthly bill TOTAL		=	$955.36
			Av. cost per kwh:		=	$0.0955
Previous A.U. price	$	0.10570	Bill w/o competition		=	$ 1,057.00
Price red. w/EPS:		9.616	%		=	$ 101.64
Price red. w/o EPS:		9.650	%		=	$ 102.00

			Cust. price		2005
Competitive tariff			$0.09360		
Portfolio Cost			$0.090		eps7c
Cust. elec. use:	10,000	kwh			
% kwh by EPS:	0.010				
% kwh by conv.:	0.990				
Cost of EPS kwh:	100	kwh times	0.09	=	$9.00
Cost of conv. kwh:	9,900	kwh times	0.09360	=	$926.64
		Monthly bill TOTAL		=	$935.64
		Av. cost per kwh:		=	$0.0936
Previous A.U. price	$ 0.10570	Bill w/o competition		=	$ 1,057.00
Price red. w/EPS:	11.482 %			=	$ 121.36
Price red. w/o EPS:	11.447 %			=	$ 121.00

TITLE 14. PUBLIC SERVICE CORPORATIONS; CORPORATIONS AND ASSOCIATIONS; SECURITIES REGULATION

CHAPTER 2. CORPORATION COMMISSION – FIXED UTILITIES

ARTICLE 16. RETAIL ELECTRIC COMPETITION

(As adopted in Decision No. 61272, December 11, 1998, with proposed language from the April 8, 1999, Kunasek letter.)

R14-2-1609. Solar and Environmentally-Friendly Portfolio Standard

A. Starting on January 1, 1999, any Electric Service Provider selling electricity or aggregating customers for the purpose of selling electricity under the provisions of this Article must derive at least .2% of the total retail energy sold competitively from new solar energy resources, whether that solar energy is purchased or generated by the seller. Solar resources include photovoltaic resources and solar thermal resources that generate electricity. New solar resources are those installed on or after January 1, 1997.

B. The portfolio percentage shall increase after December 31, 2000.

1. Starting January 1, 2001, the portfolio percentage shall increase annually and shall be set according to the following schedule:

YEAR	PORTFOLIO PERCENTAGE
2001	.4%
2002	.5%
2003	.6%
2004	.8%
2005-2012	1.0%

2. The Commission would continue the annual increase in the portfolio percentage after December 31, 2002 only if the cost of solar electricity has declined to a Commission-approved cost/benefit point. The Director, Utilities Division shall establish, not later than January 1, 2001, a Solar Electricity Cost Evaluation Working Group to make recommendations to the Commission of an acceptable solar electricity cost/benefit point or solar kWh cost impact cap that the Commission could use as a criteria for the decision to continue the increase in the portfolio percentage. The recommendations of the Working Group shall be presented to the Commission not later than December 31, 2001.

C. The solar portfolio requirement shall only apply to competitive retail electricity in the years 1999 and 2000 and shall apply to all retail electricity in the years 2001 and thereafter.

D. Electric Service Providers shall be eligible for a number of extra credit multipliers that may be used to meet the solar portfolio standard requirements:

1. Early Installation Extra Credit Multiplier: For new solar electric systems installed and operating prior to December 31, 2003, Electric Service Providers would qualify for multiple extra credits for kWh produced for 5 years following operational start-up of the solar electric system. The 5-year extra credit would vary depending upon the year in which the system started up, as follows:

YEAR	EXTRA CREDIT MULTIPLIER
1997	.5
1998	.5
1999	.5
2000	.4
2001	.3
2002	.2
2003	.1

The Early Installation Extra Credit Multiplier would end in 2003.

2. Solar Economic Development Extra Credit Multipliers: There are 2 equal parts to this multiplier, an in-state installation credit and an in-state content multiplier.

   a. In-State Power Plant Installation Extra Credit Multiplier: Solar electric power plants installed in Arizona shall receive a .5 extra credit multiplier.

   b. In-State Manufacturing and Installation Content Extra Credit Multiplier: Solar electric power plants shall receive up to a .5 extra credit multiplier related to the manufacturing and installation content that comes from Arizona. The percentage of Arizona content of the total installed plant cost shall be multiplied by .5 to determine the appropriate extra credit multiplier. So, for instance, if a solar installation included 80% Arizona content, the resulting extra credit multiplier would be .4 (which is .8 X .5).

3. Distributed Solar Electric Generator and Solar Incentive Program Extra Credit Multiplier: Any distributed solar electric generator that meets more than one of the eligibility conditions will be limited to only one .5 extra credit multiplier from this subsection. Appropriate meters will be attached to each solar electric generator and read at least once annually to verify solar performance.

a. Solar electric generators installed at or on the customer premises in Arizona. Eligible customer premises locations will include both grid-connected and remote, non-grid-connected locations. In order for Electric Service Providers to claim an extra credit multiplier, the Electric Service Provider must have contributed at least 10% of the total installed cost or have financed at least 80% of the total installed cost.

b. Solar electric generators located in Arizona that are included in any Electric Service Provider's Green Pricing program.

c. Solar electric generators located in Arizona that are included in any Electric Service Provider's Net Metering or Net Billing program.

d. Solar electric generators located in Arizona that are included in any Electric Service Provider's solar leasing program.

e. All Green Pricing, Net Metering, Net Billing, and Solar Leasing programs must have been reviewed and approved by the Director, Utilities Division in order for the Electric Service Provider to accrue extra credit multipliers from this subsection.

4. All multipliers are additive, allowing a maximum combined extra credit multiplier of 2.0 in years 1997-2003, for equipment installed and manufactured in Arizona and either installed at customer premises or participating in approved solar incentive programs. So, if an Electric Service Provider qualifies for a 2.0 extra credit multiplier and it produces 1 solar kWh, the Electric Service Provider would get credit for 3 solar kWh (1 produced plus 2 extra credit).

E. Electric Service Providers selling electricity under the provisions of this Article shall provide reports on sales and solar power as required in this Article, clearly demonstrating the output of solar resources, the installation date of solar resources, and the transmission of energy from those solar resources to Arizona consumers. The Commission may conduct necessary monitoring to ensure the accuracy of these data.

F. If an Electric Service Provider selling electricity under the provisions of this Article fails to meet the requirement in R14-2-1609(A) or (B) in any year, the Commission shall impose a penalty on that Electric Service Provider that the Electric Service Provider pay an amount equal to 30¢ per kWh to the Solar Electric Fund for deficiencies in the provision of solar electricity. This Solar Electric Fund will be established and utilized to purchase solar electric generators or solar electricity in the following calendar year for the use by public entities in Arizona such as schools, cities, counties, or state agencies. Title to any equipment purchased

by the Solar Electric Fund will be transferred to the public entity. In addition, if the provision of solar energy is consistently deficient, the Commission may void an Electric Service Provider's contracts negotiated under this Article.

1. The Director, Utilities Division shall establish a Solar Electric Fund in 1999 to receive deficiency payments and finance solar electricity projects.
2. The Director, Utilities Division shall select an independent administrator for the selection of projects to be financed by the Solar Electric Fund. A portion of the Solar Electric Fund shall be used for administration of the Fund and a designated portion of the Fund will be set aside for ongoing operation and maintenance of projects financed by the Fund.

G. Photovoltaic or solar thermal electric resources that are located on the consumer's premises shall count toward the solar portfolio standard applicable to the current Electric Service Provider serving that consumer.

H. Any solar electric generators installed by an Affected Utility to meet the solar portfolio standard shall be counted toward meeting renewable resource goals for Affected Utilities established in Decision No. 58643.

I. Any Electric Service Provider or independent solar electric generator that produces or purchases any solar kWh in excess of its annual portfolio requirements may save or bank those excess solar kWh for use or sale in future years. Any eligible solar kWh produced subject to this rule may be sold or traded to any Electric Service Provider that is subject to this rule. Appropriate documentation, subject to Commission review, shall be given to the purchasing entity and shall be referenced in the reports of the Electric Service Provider that is using the purchased kWh to meet its portfolio requirements.

J. Solar portfolio standard requirements shall be calculated on an annual basis, based upon electricity sold during the calendar year.

K. An Electric Service Provider shall be entitled to receive a partial credit against the solar portfolio requirement if the Electric Service Provider or its affiliate owns or makes a significant investment in any solar electric manufacturing plant that is located in Arizona. The credit will be equal to the amount of the nameplate capacity of the solar electric generators produced in Arizona and sold in a calendar year times 2,190 hours (approximating a 25% capacity factor).

1. The credit against the portfolio requirement shall be limited to the following percentages of the total portfolio requirement:

1999	Maximum of 50 % of the portfolio requirement
2000	Maximum of 50 % of the portfolio requirement

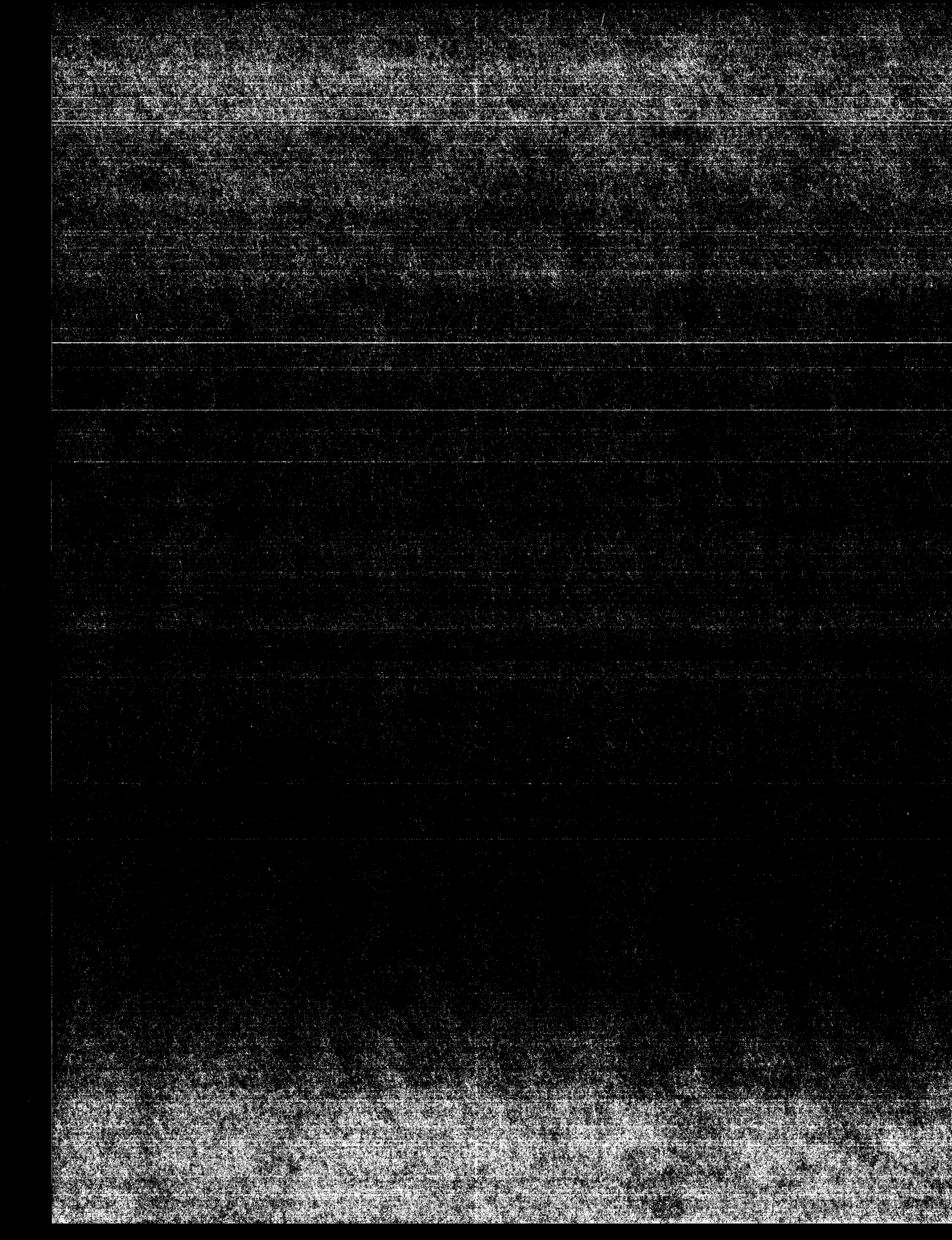
2001	Maximum of 25 % of the portfolio requirement
2002	Maximum of 25 % of the portfolio requirement
2003 and on	Maximum of 20 % of the portfolio requirement

2. No extra credit multipliers will be allowed for this credit. In order to avoid double-counting of the same equipment, solar electric generators that are used by other Electric Service Providers to meet their Arizona solar portfolio requirements will not be allowable for credits under this Section for the manufacturer/Electric Service Provider to meet its portfolio requirements.

L. The Director, Utilities Division shall develop appropriate safety, durability, reliability, and performance standards necessary for solar generating equipment to qualify for the solar portfolio standard. Standards requirements will apply only to facilities constructed or acquired after the standards are publicly issued.

M. An Electric Service Provider shall be entitled to meet up to 20% of the portfolio requirement with solar water heating systems purchased by the Electric Service Provider for use by its customers, or purchased by its customers and paid for by the Electric Service Provider through bill credits or other similar mechanisms. The solar water heaters must replace or supplement the use of electric water heaters for residential, commercial, or industrial water heating purposes. For the purposes of this rule, solar water heaters will be credited with 1 kWh of electricity produced for each 3,415 British Thermal Units of heat produced by the solar water heater. Solar water heating systems shall be eligible for Early Installation Extra Credit Multipliers as defined in R14-2-1609 D.1 and Solar Economic Development Extra Credit Multipliers as defined in R14-2-1609 D.2.

N. An Electric Service Provider shall be entitled to meet up to 10% of the portfolio requirement with electricity produced by environmentally-friendly renewable electricity technologies approved by the Commission after a hearing. Systems using such technologies shall be eligible for Early Installation Extra Credit Multipliers as defined in R14-2-1609 D.1 and Solar Economic Development Extra Credit Multipliers as defined in R14-2-1609 D.2.



BEFORE THE ARIZONA CORPORATION COMMISSION

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

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

DIRECT

TESTIMONY

OF

THOMAS E. HOFF, PH.D.

CONSULTANT

CLEAN POWER RESEARCH
NAPA, CALIFORNIA

JULY 30, 1999

TABLE OF CONTENTS

SCHEDULES

INTRODUCTION

Q. Please state your name and business address for the record.

A. My name is Thomas E. Hoff. My business address is Clean Power Research, 10 Glen Court, Napa, California, 94558.

Q. Please state your business affiliation.

A. I am a principal consultant with Clean Power Research, a firm that designs analytical methods to evaluate the economics of clean energy investments and builds software programs based on these methods.

Q. Please describe your background and experience.

A. I have researched and published extensively over the past 15 years about the economics of applications for photovoltaics (PV) and other renewable energy technologies. These applications include micro-grids, distributed generation, customer-sited PV, and central station PV. I have performed the economic evaluations from the perspectives of investor-owned utilities, municipal utilities, rural electric co-ops, and residential and commercial customers. In the past, I have worked for Pacific Gas and Electric Company and Pacific Energy Group. I have a Ph.D. in Engineering-Economic Systems from Stanford University's School of Engineering. My abbreviated resume is appended to this testimony as Schedule TEH-1.

Q. What is the purpose of your testimony?

A. I am under contract to the Utilities Division of the Arizona Corporation Commission to evaluate the costs and ratepayer impacts of the proposed Portfolio Standard. This testimony is a summary of my findings. The detailed report is appended to this testimony as Schedule TEH-2.

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Q. Please describe the mix of technologies used to satisfy the proposed Portfolio Standard.

A. I assumed that the portfolio requirements will be satisfied as follows. Five percent (5%) will come from wind plants. Five percent (5%) will come from landfill gas plants. Twenty percent (20%) will come from solar water heating systems. Thirty-five percent (35%) will come from distributed solar electric technologies, including photovoltaic (PV) and/or solar dish technologies. Thirty-five percent (35%) will come from central station solar troughs.

Q. Who will own and operate the plants?

A. I assumed that all of the plants will be owned and operated by the Electric Service Providers (ESPs) except for the solar water heating systems. The solar water heating systems will be owned and operated by residential customers.

Q. How did you perform the analysis to evaluate the costs and impact on rates of the proposed Portfolio Standard?

A. I constructed an optimistic scenario and a pessimistic scenario to perform the analysis. This provides the Commission with a range of what the proposed Portfolio Standard would cost. The optimistic scenario represents a high use of the extra credit multipliers and low estimates of the technology costs. The pessimistic scenario represents a moderate use of the extra credit multipliers and high estimates of the technology costs.

Q. What are your assumptions in the optimistic scenario for the ESP-owned plants?

A. Sixty percent (60%) of the wind plants are manufactured in Arizona, none are located in Arizona, none are used in distributed applications, and they cost $800 per kW. None of the landfill gas plants are manufactured in Arizona, all are located in Arizona, none are used in distributed applications, and they cost $1,411 per kW. Sixty percent (60%) of the distributed solar electric plants are manufactured in Arizona, all are located in Arizona, all are used in distributed applications, and they cost $5,000 per kW. Sixty percent (60%)

of the central station solar electric plants are manufactured in Arizona, sixty percent (60%) are located in Arizona, none are used in distributed applications, and they cost $1,000 per kW.

Q. What are your assumptions in the optimistic scenario for the solar water heating systems?

A. Sixty percent (60%) of the solar water heating systems are manufactured in Arizona, all are located in Arizona, all are distributed, and they cost $2,000 per system. The ESP costs are a $500 rebate per system and half of the lost revenue (the other half is saved in not having to generate and deliver the power). Customers will pay $1,000 per system after receiving a $500 state tax credit and the $500 ESP rebate. This will give customers about a four-year simple payback for the systems.

Q. What is the net cost of the proposed Portfolio Standard in the optimistic scenario?

A. The net cost in present value terms from 1999-2012 is estimated to be $156 Million in the optimistic scenario. This assumes that all of the proposed Portfolio Standard's costs and benefits are recovered by 2012.

Q. What are your assumptions in the pessimistic scenario for the ESP-owned plants?

A. None of the wind plants are manufactured in Arizona, none are located in Arizona, none are used in distributed applications, and they cost $1,000 per kW. None of the landfill gas plants are manufactured in Arizona, all are located in Arizona, none are used in distributed applications, and they cost $1,411 per kW. Thirty percent (30%) of the distributed solar electric plants are manufactured in Arizona, all are located in Arizona, all are used in distributed applications, and they cost $8,000 per kW. Thirty percent (30%) of the central station solar electric plants are manufactured in Arizona, none are located in Arizona, none are used in distributed applications, and they cost $2,500 per kW.

. . .

Q. What are your assumptions in the pessimistic scenario for the solar water heating systems?

A. Thirty percent (30%) of the solar water heating systems are manufactured in Arizona, all are located in Arizona, all are distributed, and they cost $2,500 per system. The ESP costs are an $875 rebate and half of the lost revenue (the other half is saved in not having to generate and deliver the power). Customers will pay $1,000 per system after receiving a $625 state tax credit and the $875 ESP rebate. This will give customers about a four-year simple payback for the systems.

Q. What is the net cost of the proposed Portfolio Standard in the pessimistic scenario?

A. The net cost in present value terms from 1999-2012 is estimated to be $344 million in the pessimistic scenario. This assumes that all of the proposed Portfolio Standard's costs and benefits are recovered by 2012.

Q. One concern utilities may have with the proposed Portfolio Standard is the potential for stranded costs if the Portfolio Standard is altered in the future. Is there a way to mitigate this concern?

A. Utilities can mitigate the stranded cost risk by giving customers financial incentives to install solar technologies and then to expense these costs as they occur. The optimistic and pessimistic scenarios were altered as follows to evaluate the cost of this approach. It was assumed that customers own all of the solar investments (i.e., 90 percent of the portfolio) and that all of the solar electric investments are distributed (i.e., there are no central station solar plants). That is, twenty percent (20%) of the portfolio comes from customer-owned water heating systems and seventy percent (70%) of the portfolio comes from customer-owned distributed solar electric systems. It was then assumed that, in order to make the investment cost-effective from the consumer's perspective, ESPs would need to buy down the cost of the system by $1,500 per kW in the optimistic scenario or $4,500 per kW in the pessimistic scenario. Both scenarios account for the lost revenue.

When combined with the 25 percent state tax credit, this reduces the system cost from $5,000 per kW (optimistic scenario) or $8,000 per kW (pessimistic scenario) to $2,625 per kW. Customer-owned systems at this cost can be economically integrated into the cost of new and existing homes.

Q. What is the net cost of the proposed Portfolio Standard for these customer-ownership scenarios?

A. After accounting for the buy down cost and the lost revenue, the net cost in present value terms from 1999-2012 is estimated to range from a low of $155 million in the optimistic scenario to a high of $343 million in the pessimistic scenario. That is, the net costs for the customer-ownership scenarios are almost identical to the net costs of the corresponding ESP-ownership scenarios.

Q. What would the impact be on an average residential customer's monthly bill?

A. The impact of the proposed Portfolio Standard on bills over time depends upon the regulatory treatment of the portfolio cost. To illustrate what the impact would be, assume that the cost of the portfolio is spread out proportional to rates from 1999 to 2012. An average residential customer's monthly bill in the first year would be $90.00 with no competition, $89.20 with competition and the portfolio standard in the pessimistic scenario, $88.66 with competition and the portfolio standard in the optimistic scenario, and $88.20 with competition and no portfolio standard. That is, customer bills would decline compared to no competition, even with the portfolio standard; they simply would not decline as much as with competition and no portfolio standard. All bills in the competitive cases would then decline 2 percent per year in subsequent years. For example, in the next year, a customer's bill would decline $1.78 (optimistic scenario), $1.78 (pessimistic scenario), and $1.76 (no portfolio standard).

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. . .

Q. Does this conclude your direct testimony?

A. Yes, it does.

Resume: Thomas E. Hoff, Ph.D.

EDUCATION

- ***Stanford University***, Ph.D. Engineering-Economic Systems
- ***Washington University***, M.S. Technology and Human Affairs, summa cum laude
- ***California Lutheran College***, B.S. Mathematics/Computer Science, summa cum laude

PROFESSIONAL EXPERIENCE

1998-Present: **Principal**, Clean Power Research, Napa, CA

Key Accomplishments:

- Developed Clean Power Estimator™, an Internet-based economic evaluation tool for customer-owned PV, solar hot water heating, wind, and energy efficiency investments; the program is currently in use by PV vendors, utilities, and public organizations in California, Arizona, Florida, and Iowa
- Identified a potential market of 1,000 MW for PV in rural electric cooperatives in the US over the next decade

1993-1998: **Principal**, Pacific Energy Group, Walnut Creek, CA

Key Accomplishments:

- Assessed the feasibility of micro-grids
- Quantified the economic value of distributed resources under uncertainty
- Developed a risk management approach to integrate renewable energy technologies into the electric utility network
- Evaluated the technical and economic performance of the world's first utility application of a renewable distributed generation resource
- Conducted workshops and presented technical results to industry professionals

1987-1993: **Consultant**, Pacific Gas & Electric Co, San Ramon and San Francisco, CA

Key Accomplishments:

- Identified economic issues associated with utility-connected renewable energy systems
- Wrote and delivered technical conference and internal company presentations.
- Developed techniques to: compute the energy and generation capacity value of non-dispatchable resources; determine the value of photovoltaics as a demand-side management option; evaluate the world's first utility application of a renewable distributed generation resource

1984-1987: **Engineer**, Pacific Gas & Electric Co, San Ramon, CA

Key Accomplishments:

- Determined the technical potential of photovoltaics to Pacific Gas and Electric Company
- Designed projects to assess long-term photovoltaic module performance and evaluate large and small photovoltaic system performance

Evaluation of a Renewable Portfolio Standard in Arizona

July 28, 1999

Performed for:

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Director, Utilities Division
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CLEAN POWER
RESEARCH

Introduction

The Arizona Corporation Commission (Commission) adopted the Retail Electric Competition Rules in December 1996 (A.A.C R14-2-1601 et seq.). These Rules included the Solar Portfolio Standard (R14-2-1609). A Subcommittee was formed that made recommendations regarding the details of the Solar Portfolio Standard (SPS). Staff incorporated most of the Subcommittee recommendations into proposed rule amendments and those changes were approved by the Commission on August 10 and December 11, 1998.

On February 5, 1999, the Hearing Division of the Arizona Corporation Commission docketed a proposed order to amend the Retail Electric Competition Rules. Included in that proposed order was the recommendation to eliminate the Solar Portfolio Standard in its entirety.

On April 8, 1999, Commissioner Carl Kunasek sent a letter to Commissioners Jim Irvin and Tony West with a proposal to consider a modification of the Solar Portfolio Standard. The letter suggested that questions be developed and that a hearing process be commenced to consider "costs and ratepayer impacts" of such a portfolio as well as other issues. A docket was opened to consider an environmental portfolio standard.

Objective

The objective of this report is to evaluate the costs and ratepayer impacts of the proposed Portfolio Standard.

The proposed Portfolio Standard is described in detail in [2]. The proposed Portfolio Standard is an energy-based standard. It requires that a certain amount of energy come from renewable power sources. The most notable aspects of this standard are that: (1) the portfolio percentage increases over time as shown in Table 1; and (2) there are several extra credit multipliers;[1] the multipliers reduce the actual amount of electricity required to satisfy the portfolio percentage.

Table 1. Portfolio Percentages.

	Competitively Sold Electricity	Portfolio Percent of Competitively Sold Electricity	Portfolio Percent of Total Electricity
1999	20%	0.20%	0.04%
2000	20%	0.20%	0.04%
2001	50%	0.40%	0.20%
2002	50%	0.50%	0.25%
2003	100%	0.60%	0.60%
2004	100%	0.80%	0.80%
>2005	100%	1.00%	1.00%

[1] Early Installation Extra Credit Multiplier, Solar Economic Development Extra Credit Multipliers (In-State Power and In-State Manufacturing), and Distributed Solar Electric Generator and Solar Incentive Program Extra Credit Multiplier.

Factors Affecting Portfolio Standard Costs

The objective of this work is to evaluate the costs of implementing the proposed Portfolio Standard. Below is a list of factors that affect the cost. The numbers in parentheses are the assumptions used in this work.

- Technology cost and cost changes over time (varies)
- Technology capacity factor (varies)
- Technology O&M cost (varies)
- Renewable power value (varies)
- Technology life (varies)
- Renewable power value changes over time (2%/yr decline)
- Portfolio rules (as established)
- Real discount rate (10%)
- Current electric sales in Arizona (51.6 Billion kWh)
- Electric sales growth in Arizona (3%/yr)
- Current electricity price in Arizona ($.080/kWh)
- Current average residential electricity price in Arizona ($.090/kWh)
- Price decline of electricity in Arizona (2%/yr)

An Excel spreadsheet was constructed to evaluate the effect of these various inputs on portfolio cost. Assumptions for two scenarios were developed.

Two Scenarios

1. **Optimistic**: high extra credit, low cost scenario (Table 2)
2. **Pessimistic**: low extra credit, high cost scenario (Table 3)

Optimistic Scenario

Table 2. Optimistic Scenario (High Extra Credit,[2] Low Cost)

Technology	Portfolio Percent	Manufactured In State	Located In State	Distributed
Wind	5%	60%	0%	0%
Landfill Gas (Environmental)	5%	0%	100%	0%
Solar Water Heating[3]	20%	60%	100%	100%
Solar Electric (Distributed)	35%	60%	100%	100%
Solar Electric (Central Station)	35%	60%	60%	0%

Technology	Cost	Cost Reduction	Capacity Factor	Power Value[4]	Life
Wind	$800/kW[5]	3%/yr.	35%	$0.015/kWh	25 yrs.
Landfill Gas (Environmental)	$1,411/kW[6]	3%/yr.	90%	$0.015/kWh	25 yrs.
Solar Water Heating	$500/kW[7]	5%/yr.	33%[8]	($0.045/kWh)[7]	20 yrs.
Solar Electric (Distributed)	$5,000/kW[9]	5%/yr.	25%	$0.045/kWh	25 yrs.
Solar Electric (Central Station)	$1,000/kW[10]	5%/yr.	25%	$0.015/kWh	25 yrs.

[2] The investment scenarios were specified by Ray Williamson.

[3] It is assumed that all of the solar water heating units are customer-owned and operated.

[4] Power value is the power value minus the O&M cost for all investments except for the solar water heating. Power value for solar water heating is the power value minus the lost revenue (it is a negative number).

[5] Estimate of the cost of a wind plant from Brian Parsons, National Renewable Energy Laboratory. Capacity factor is for a wind plant located in California. Phone conversation on July 13, 1999.

[6] Cost estimate from Ray Williamson. Phone conversation on July 12, 1999.

[7] The estimated cost in the optimistic case for solar water heating systems is $2,000. Assume that the consumer owns and operates the system. The cost to the consumer after the 25% Arizona tax credit is $1,500. The consumer will save about $260 per year with the solar hot water heating system ($0.09/kWh * 8,760 hours/year * 33% capacity factor). Suppose that a consumer will buy the system if it has less than a 4-year simple payback. The ESP could provide a consumer with a $500 rebate for the consumer to make a purchase ($1,500 - $500 = $1,000; $1,000/($260/yr) = 3.8 years). There are two costs to the ESP: (1) the $500 rebate and (2) the lost revenue minus the savings associated with not having to provide consumers with power (assumed to be $0.045/kWh). The estimated cost of the solar water heating system is from Ray Williamson.

[8] It is estimated that each solar water heater will have an energy output of 2,850 kWh/year.

[9] According to Don Osborne, Manager of Photovoltaics and Distributed Generation at the Sacramento Municipal Utility District, SMUD currently has a 10 MW, 5 year contract for PV systems. The installed cost (includes installation, utility costs, etc.) is currently $5,000/kW and will decrease to $3,000/kW by the year 2002. Phone conversation on June 4, 1999.

[10] This is the cost of a Solar Energy Enhanced Combustion Turbine system. Solar energy generated steam is used to enhance the output of a simple cycle or combined cycle power plant by cooling the intake air (which generates more power) and/or steam augmentation. Letter dated July 12, 1999 from Alphonse H. Bellac, York Research Corporation.

Pessimistic Scenario

Table 3. Pessimistic Scenario (Low Extra Credit, High Cost)

Technology	Portfolio Percent	Manufactured In State	Located In State	Distributed
Wind	5%	0%	0%	0%
Landfill Gas (Environmental)	5%	0%	100%	0%
Solar Water Heating	20%	30%	100%	100%
Solar Electric (Distributed)	35%	30%	100%	100%
Solar Electric (Central Station)	35%	30%	0%	0%

Technology	Cost	Cost Reduction	Capacity Factor	Power Value[4]	Life
Wind	$1,000/kW[5]	3%/yr.	35%	$0.015/kWh	25 yrs.
Landfill Gas (Environmental)	$1,411/kW[6]	3%/yr.	90%	$0.015/kWh	25 yrs.
Solar Water Heating	$875/kW[11]	5%/yr.	33%	($0.045/kWh)[11]	20 yrs.
Solar Electric (Distributed)	$8,000/kW[12]	5%/yr.	25%	$0.045/kWh	25 yrs.
Solar Electric (Central Station)	$2,500/kW[13]	5%/yr.	25%	$0.015/kWh	25 yrs.

[11] The estimated cost in the pessimistic case for solar water heating systems is $2,500. Assume that the consumer owns and operates the system. The cost to the consumer after the 25% Arizona tax credit is $1,875. The consumer will save about $260 per year with the solar hot water heating system ($0.09/kWh * 8,760 hours/year * 33% capacity factor). Suppose that a consumer will buy the system if it has less than a 4-year simple payback. The ESP could provide a consumer with an $875 rebate for the consumer to make a purchase ($1,875 - $875 = $1,000; $1,000/($260/yr) = 3.8 years). There are two costs to the ESP: (1) the $875 rebate and (2) the lost revenue minus the savings associated with not having to provide consumers with power (assumed to be $0.045/kWh). The estimated cost of the solar water heating system is from Ray Williamson.

[12] Bob Johnson, Strategies Unlimited, estimates that PV costs range between $7,000 and $8,000 per kW with prices decreasing at a real rate of between 5 and 6 percent. Phone conversation on July 13, 1999.

[13] Cost estimate from Ray Williamson. Phone conversation on July 26, 1999.

Possibly the most important criticism of the proposed Portfolio Standard is that there is the potential for stranded costs for the ESPs if the proposed Portfolio Standard is altered in the future. In order to address these concerns, two additional scenarios were constructed: optimistic (customer-ownership) and pessimistic (customer-ownership) scenarios.

The optimistic and pessimistic (customer-ownership) scenarios are identical to the optimistic and pessimistic scenarios except that:
(1) customers own all of the solar investments; and
(2) all of the solar electric investments are distributed (no central station solar electric)

Optimistic (Customer-Ownership) Scenario

Table 4. Optimistic (Customer-Ownership) Scenario (High Extra Credit, Low Cost)

Technology	Portfolio Percent	Manufactured In State	Located In State	Distributed
Wind	5%	60%	0%	0%
Landfill Gas (Environmental)	5%	0%	100%	0%
Solar Water Heating	20%	60%	100%	100%
Solar Electric (Distributed)	70%	60%	100%	100%
Solar Electric (Central Station)	None			

Technology	Cost	Cost Reduction	Capacity Factor	Power Value	Life
Wind	$800/kW[5]	3%/yr.	35%	$0.015/kWh	25 yrs.
Landfill Gas (Environmental)	$1,411/kW[6]	3%/yr.	90%	$0.015/kWh	25 yrs.
Solar Water Heating	$500/kW[7]	5%/yr.	33%	($0.045/kWh)[7]	20 yrs.
Solar Electric (Distributed)	$1,500/kW[14]	5%/yr.	25%	($0.045/kWh)[14]	25 yrs.

[14] It is assumed in this case that all of the solar electric is distributed and is customer-owned. The distributed solar systems cost $5,000 per kW as in the optimistic case. Rather than the ESP owning the systems, however, the ESPs buy down the system cost by $1,500 per kW. This reduces the capital cost from $5,000 per kW to $3,500 per kW. The customers also get a 25 percent state tax credit. This reduces the system cost to $2,625 per kW. Use of the Clean Power Estimator software program suggests that such a system could be profitably integrated into the cost of a new home and the consumer see a reduction in their total costs. Note that such a program would be similar to SMUD's. The full cost of a PV system for a SMUD customer is $5,070/kW. SMUD buys down the cost of the system for its consumers by $2,700/kW so that the cost to the consumer is $2,340/kW (http://www.smud.org/home/pv_pioneer/FAQs.html).

There are two costs to the ESP: (1) the $1,500 buy down and (2) the lost revenue minus the savings associated with not having to provide consumers with power (assumed to be $0.045/kWh).

Pessimistic (Customer-Ownership) Scenario

Table 5. Pessimistic (Customer-Ownership) Scenario (Low Extra Credit, High Cost)

Technology	Portfolio Percent	Manufactured In State	Located In State	Distributed
Wind	5%	0%	0%	0%
Landfill Gas (Environmental)	5%	0%	100%	0%
Solar Water Heating	20%	30%	100%	100%
Solar Electric (Distributed)	70%	30%	100%	100%
Solar Electric (Central Station)	None			

Technology	Cost	Cost Reduction	Capacity Factor	Power Value[4]	Life
Wind	$1,000/kW[5]	3%/yr.	35%	$0.015/kWh	25 yrs.
Landfill Gas (Environmental)	$1,411/kW[6]	3%/yr.	90%	$0.015/kWh	25 yrs.
Solar Water Heating	$875/kW[11]	5%/yr.	33%	($0.045/kWh)[11]	20 yrs.
Solar Electric (Distributed)	$4,500/kW[15]	5%/yr.	25%	($0.045/kWh)[15]	25 yrs.

[15] It is assumed in this case that all of the solar electric is distributed and is customer-owned. The distributed solar systems cost $8,000 per kW as in the pessimistic case. Rather than the ESP owning the systems, however, the ESPs buy down the system cost by $4,500 per kW (this might be the highest buy down given by any single entity in the nation). This reduces the capital cost from $8,000 per kW to $3,500 per kW. The customers also get a 25 percent state tax credit. This reduces the system cost to $2,625 per kW. Use of the Clean Power Estimator software program suggests that such a system could be profitably integrated into the cost of a new home and the consumer see a reduction in their total costs. There are two costs to the ESP: (1) the $4,500 buy down and (2) the lost revenue minus the savings associated with not having to provide consumers with power (assumed to be $0.045/kWh).

Results

Table 6 presents the costs and rate effects for the optimistic and pessimistic scenarios. The table suggests that the net cost ranges from $156 Million (optimistic scenario) to $344 Million (pessimistic scenario) for a rate increase of between 0.52 percent and 1.14 percent between 1999 and 2012.

The table shows that the optimistic and pessimistic customer-ownership scenarios have almost the same net cost as the corresponding optimistic and pessimistic scenarios.

As shown in Figure 1, more than 300 Million kWh of renewable electricity will be generated within 7 years as a result of this investment.

Table 6. Results

	Cost (Pres. Value)	Benefits (Pres. Value)[16]	Net Cost (Pres. Value)	Rate Increase
Optimistic	$184 M	$28 M	***$156 M***	***0.52%***
Pessimistic	$378 M	$34 M	***$344 M***	***1.14%***
Optimistic (Customer-Ownership)	$93 M	($62) M	***$155 M***	***0.52%***
Pessimistic (Customer-Ownership)	$277 M	($66) M	***$343 M***	***1.14%***

The actual rate changes will depend upon the regulatory treatment of the portfolio cost. One way to cover the cost of the portfolio is to have most of the rate increase occur immediately. Given that rates decline 2 percent per year under competition, an average residential customer's monthly bill in the first year would be:

- $90.00 with no competition
- $89.20 with competition and the proposed Portfolio Standard (pessimistic scenario)
- $88.66 with competition and the proposed Portfolio Standard (optimistic scenario); and
- $88.20 with competition and no Portfolio Standard

Bills then decline at 2 percent per year in subsequent years (Figure 2 and Table 7).

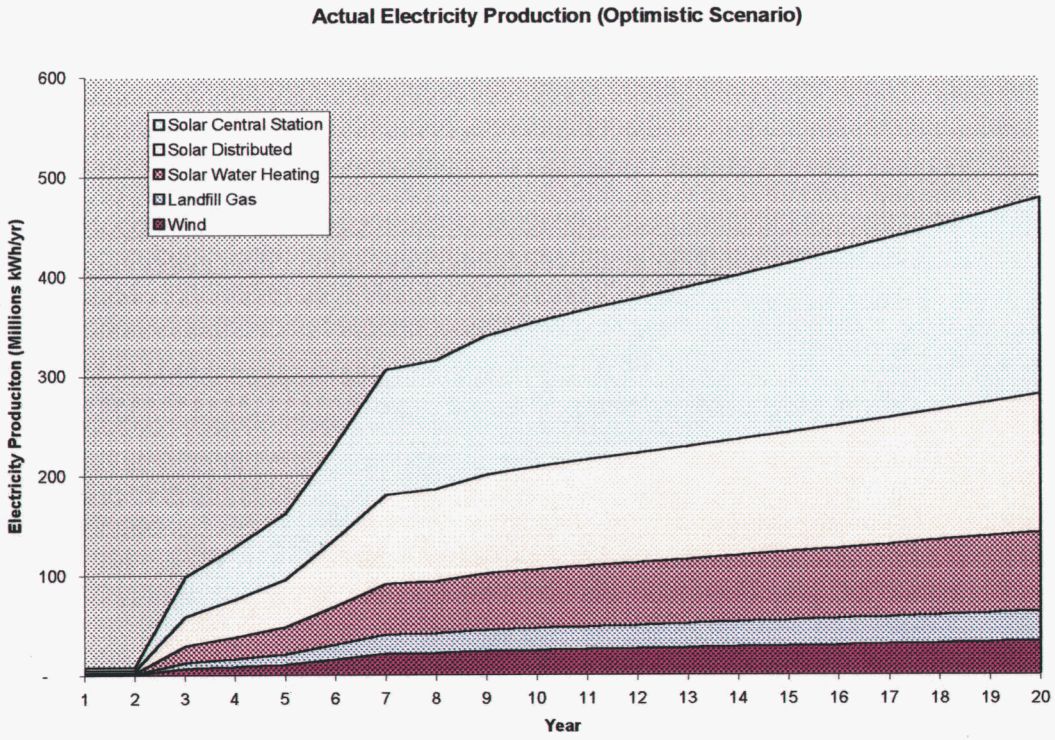
Alternatively, the portfolio costs could be treated as expenses in each year that they are incurred. In this case, an average residential customer's monthly bill in the first year would be:

- $90.00 with no competition
- $88.54 with competition and the proposed Portfolio Standard (pessimistic scenario)
- $88.37 with competition and the proposed Portfolio Standard (optimistic scenario); and
- $88.20 with competition and no Portfolio Standard

The effect on rates in future years varies (Figure 3 and Table 8).

[16] The benefits are negative in the both customer-ownership scenarios because the customers own almost all of the solar and the benefits to the ESP are then negative in the form of lost revenue.

Figure 1. Electricity production for optimistic and pessimistic scenarios.



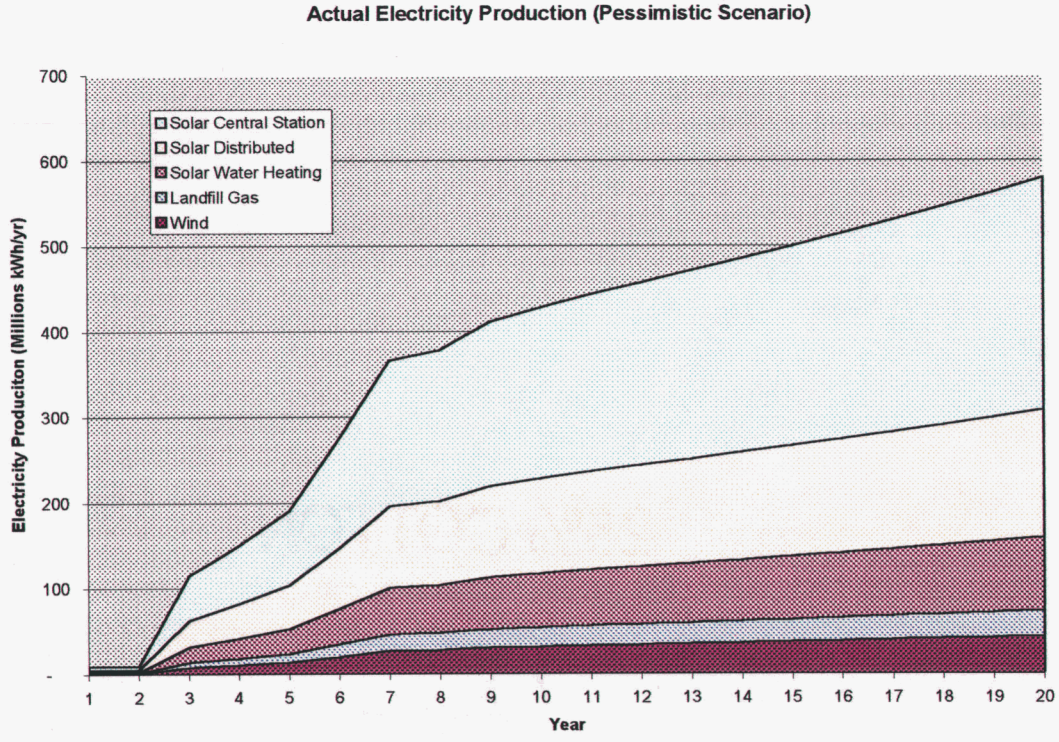
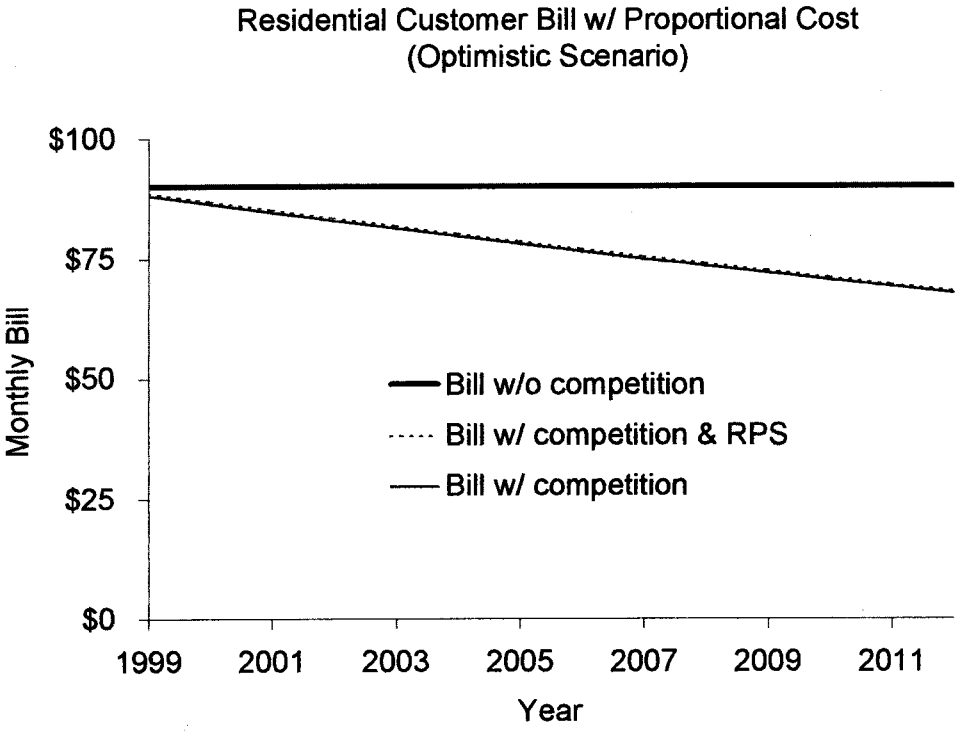


Figure 2. Monthly bill for average residential customer (proportional recovery of portfolio cost).



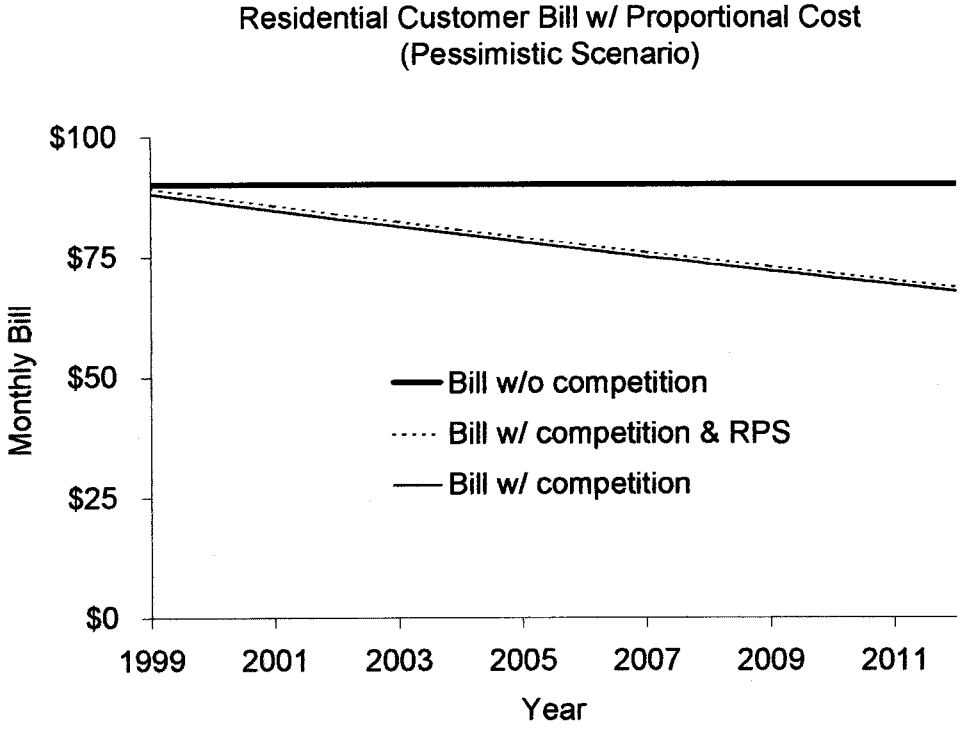
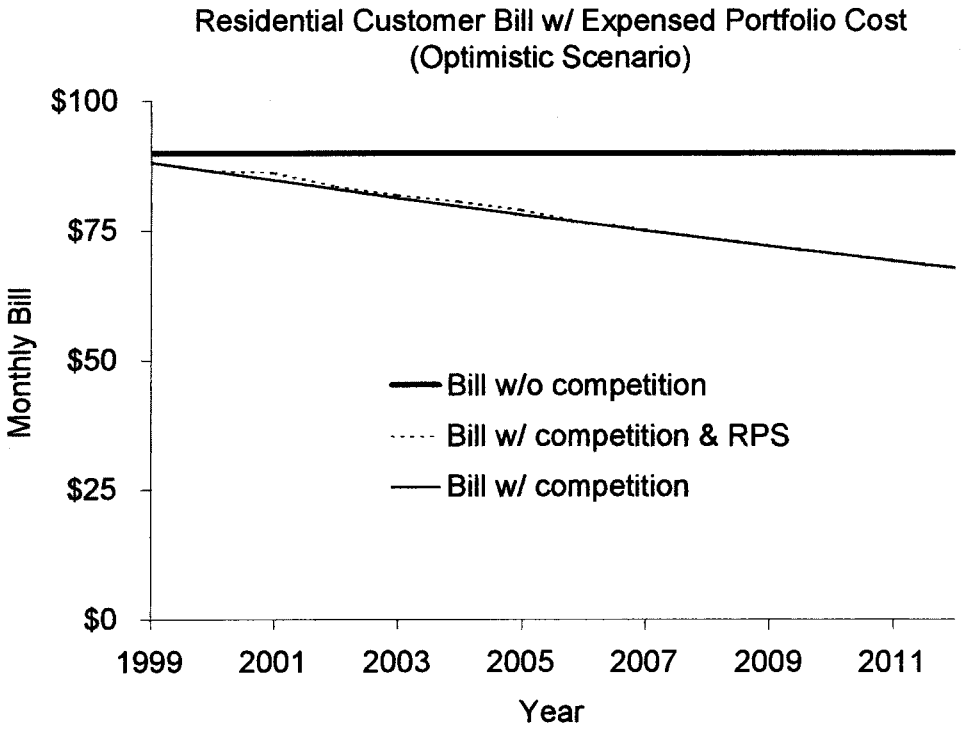


Table 7. Monthly bill for average residential customer (proportional recovery of portfolio cost).

	No Competition	Competition		
		PS (pessimistic)	PS (optimistic)	No PS
1999	$90.00	$89.20	$88.66	$88.20
2000	$90.00	$87.42	$86.88	$86.44
2001	$90.00	$85.67	$85.14	$84.71
2002	$90.00	$83.96	$83.44	$83.01
2003	$90.00	$82.28	$81.77	$81.35
2004	$90.00	$80.63	$80.14	$79.73
2005	$90.00	$79.02	$78.53	$78.13
2006	$90.00	$77.44	$76.96	$76.57
2007	$90.00	$75.89	$75.42	$75.04
2008	$90.00	$74.37	$73.92	$73.54
2009	$90.00	$72.89	$72.44	$72.07
2010	$90.00	$71.43	$70.99	$70.62
2011	$90.00	$70.00	$69.57	$69.21
2012	$90.00	$68.60	$68.18	$67.83

Figure 3. Monthly bill for average residential customer (expensed portfolio cost).



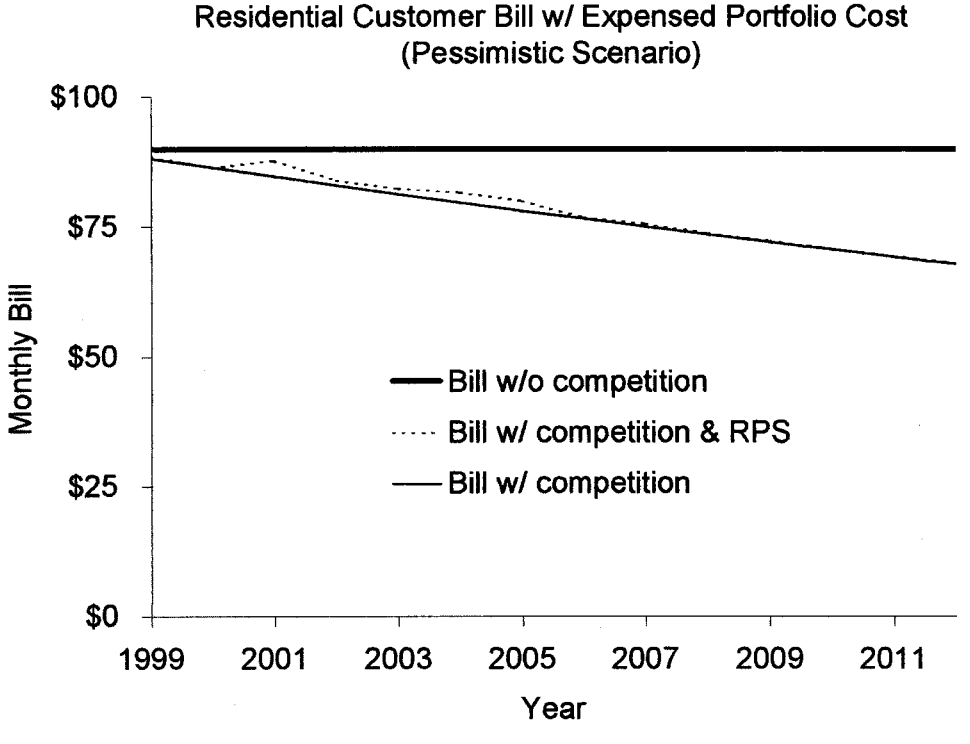


Table 8. Monthly bill for average residential customer (expensed portfolio cost).

	No Competition	Competition		
		PS (pessimistic)	PS (optimistic)	No PS
1999	$90.00	$88.54	$88.37	$88.20
2000	$90.00	$86.44	$86.44	$86.44
2001	$90.00	$87.76	$86.22	$84.71
2002	$90.00	$83.93	$83.45	$83.01
2003	$90.00	$82.29	$81.79	$81.35
2004	$90.00	$81.55	$80.58	$79.73
2005	$90.00	$79.95	$78.98	$78.13
2006	$90.00	$76.72	$76.61	$76.57
2007	$90.00	$75.53	$75.22	$75.04
2008	$90.00	$73.73	$73.60	$73.54
2009	$90.00	$72.22	$72.11	$72.07
2010	$90.00	$70.73	$70.65	$70.62
2011	$90.00	$69.31	$69.23	$69.21
2012	$90.00	$67.92	$67.85	$67.83

Conclusions

The objective of this report was to evaluate the costs and ratepayer impacts of the proposed Portfolio Standard. Results suggest that the proposed Portfolio Standard will have a net present value cost of between $156 Million (optimistic scenario) to $344 Million (pessimistic scenario). Rates are estimated to increase between 0.52 percent (optimistic scenario) and 1.14 percent (pessimistic scenario). The actual rate changes will depend upon the regulatory treatment of the portfolio cost. One way to cover the cost of the portfolio is to have most of the rate increase occur immediately. Given that rates decline 2 percent per year under competition, an average residential customer's monthly bill in the first year would be:

- $90.00 with no competition
- $89.20 with competition and the proposed Portfolio Standard (pessimistic scenario)
- $88.66 with competition and the proposed Portfolio Standard (optimistic scenario); and
- $88.20 with competition and no Portfolio Standard

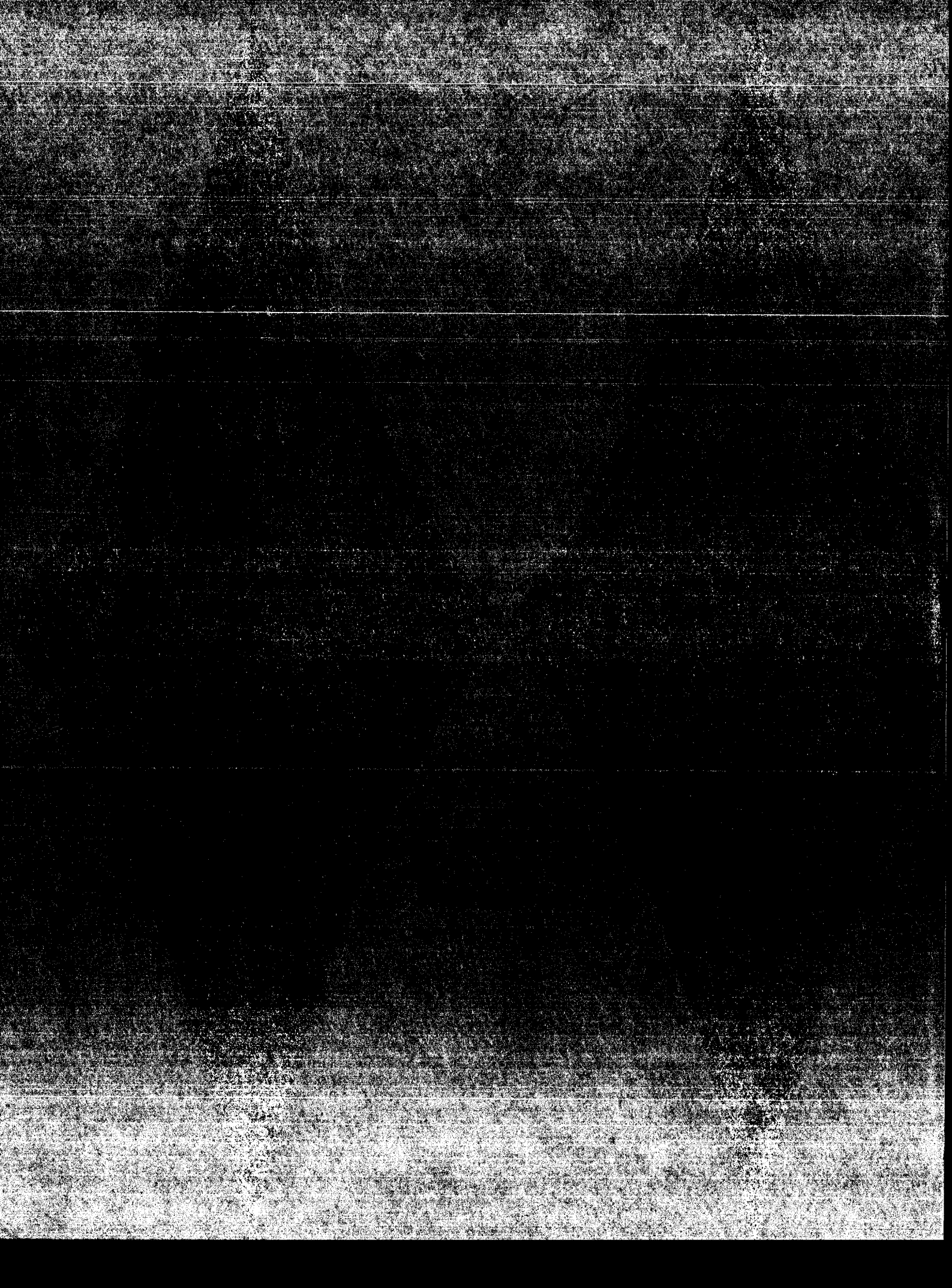
Bills then decline at 2 percent per year in subsequent years.

References

[1] Docket No. E-00000A-99-0205: THE GENERIC INVESTIGATION OF THE DEVELOPMENT OF A RENEWABLE PORTFOLIO STANDARD AS A PORTION OF THE RETAIL ELECTRIC COMPETITION RULES.

[2] TITLE 14. PUBLIC SERVICE CORPORATIONS; CORPORATIONS AND ASSOCIATIONS; SECURITIES REGULATION. CHAPTER 2. CORPORATION COMMISSION - FIXED UTILITIES. ARTICLE 16. RETAIL ELECTRIC COMPETITION (As adopted in Decision No. 61272, December 11, 1998, with proposed language from the April 8, 1999, Kunasek letter).

[3] R. T. Williamson and H. J. Wenger, "Solar Portfolio Standard Analysis", American Solar Energy Society's Solar '98 Conference, Albuquerque, NM., June 1998.



BEFORE THE ARIZONA CORPORATION COMMISSION

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

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

DIRECT

TESTIMONY

OF

MARSHALL R. GOLDBERG

CONSULTANT

MRG & ASSOCIATES
MADISON, WISCONSIN

JULY 30, 1999

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EXHIBITS

POSITION AND QUALIFICATIONS

Q. Please state your name, business and occupation.

A. My name is Marshall R. Goldberg. I am a resource planner and policy analyst employed by my own firm, MRG & Associates. My work includes the application of benefit-cost analytical techniques as they are applied in the energy and natural resource public policy arenas. It also includes the development of models to estimate energy consumption and usage patterns, the use of input-output analysis to evaluate energy programs for their employment impacts, and the application of computer-based decision support tools which are designed to strengthen public policy analysis.

Q. What is your business address?

A. My address is MRG & Associates, 449 Charles Lane, Madison, Wisconsin, 53711.

Q. Please describe your background and qualifications.

A. I founded MRG & Associates in 1991, a firm that specializes in two areas: 1) energy and resource management strategies; and 2) environmental, community and economic development policies. Among our recent and or current clients are the U. S. Department of Energy, the American Council for an Energy-Efficient Economy (ACEEE), the Tellus Institute, the State of Texas Department of Economic Development, the Mississippi Division of Energy, and the Illinois Department of Commerce and Community Affairs.

I have been involved in energy and utility issues for almost eight years. I have also been involved in several resource management initiatives. My recent projects include an economic and employment evaluation for the State of Texas, a report issued by Skip Laitner of Economic Research Associates (ERA) and myself to determine the feasibility of alternative energy-efficiency and renewables investment strategies in the years 1998 through 2010. I also recently completed an employment impact analysis of additional investments in energy efficiency technologies in the State of Illinois. The report was co-

authored with Economic Research Associates and the American Council for an Energy-Efficient Economy (ACEEE) for the Illinois Department of Commerce and Community Affairs.

I have conducted technical workshops for energy office staff in places such as the U. S. Virgin Islands. I have also conducted workshop training sessions to certify contractors to participate in utility incentive programs. I have used the *OPTIONS* software package, a decision support tool that assists community leaders in the identification of energy alternatives that best support local economic development and employment goals. Similarly, I have developed a number of spreadsheet based modeling tools to analyze energy usage for residential and commercial appliances and equipment.

In 1992, I received my masters' degree in community and regional planning from the University of Oregon, Eugene.

Q. Have you testified in regulatory proceedings in the past?

A. No. However, during the last eight years I have assisted Skip Laitner of Economic Research Associates (ERA) in preparing testimony before utility commissions in Virginia, Wisconsin, and Indiana. The subjects ranged from utility rate design and conservation/load management programs to the cost of capital and the appropriate treatment of various expenses.

In July 1992, I assisted Mr. Laitner in preparing his testimony to appear before the Virginia State Corporation Commission to review the application concerning the construction of a transmission line, and to determine whether DSM programs might offset the need for the proposed line. I assisted Mr. Laitner again in September 1992, in preparing his testimony before the Wisconsin Public Service Commission (WPSC). The purpose of that presentation was to establish a formula that could be used to determine

the maximum rebate levels associated with renewable energy technologies. The formula was based on avoided capacity, energy, and environmental costs associated with carbon dioxide and sulfur dioxide emissions.

Finally, in late 1993, I again assisted Mr. Laitner in providing testimony before the Indiana Utility Regulatory Commission. The purpose of that testimony was to establish DSM as a least-cost means of compliance with the new Clean Air Act Amendments. Additional biographical information is provided as Exhibit MRG-1.

PURPOSE OF TESTIMONY

Q. What is the purpose of your testimony in this proceeding?

A. I am appearing on behalf of the Arizona Corporation Commission. I have been asked by the Commission to evaluate the economic impacts associated with the implementation of a proposed Solar Portfolio Standard (SPS) associated with the initiation of retail competition in the State of Arizona. I have done this by reviewing the economic framework of Arizona, the Portfolio Standard itself, and a relevant study examining the link between energy efficiency, renewables, and the job creation process. The study released in July 1997, is titled *Arizona Energy Outlook 2010: Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy*. The study was completed by Economic Research Associates, co-authored by Skip Laitner and myself, and prepared for the National Renewable Energy Laboratory, the Land and Water Fund of the Rockies, and the Arizona State Energy Office, a Division of the Arizona Department of Commerce.

The current analysis builds upon this recent study but utilizes revised estimates of retail sales growth, a larger mix of renewable technologies, and a SPS different from that analyzed previously. The study examines the magnitude of income and employment benefits associated with two possible SPS implementation scenarios. The first, a High

Economic Scenario includes an aggressive scenario to meet the most recent Arizona SPS requirements, taking advantage of numerous extra credit multipliers for installation and manufacturing of renewable resources that generate electricity in Arizona. The second, a Modest Economic Scenario includes a less aggressive scenario to meet the SPS requirements, taking advantage of fewer extra credit multipliers for installation and manufacturing of renewable resources that generate electricity in Arizona.

Q. Have you reviewed documents filed in this proceeding relevant to your testimony in this proceeding?

A. Yes, I have. I have reviewed R14-2-1609, Solar and Environmentally-Friendly Portfolio Standard (previously referred to as the Solar Portfolio Standard), Attachment A, Title 14, Public Service Corporations; Corporations and Associations; Securities Regulation, Chapter 2. Corporation Commission-Fixed Utilities, Article16, Retail Electric competition (as adopted in Decision No. 61272, December 11, 1998, with proposed language from the April 8, 1999, Kunasek letter).

Q. Have you reached any conclusions on the issues you have examined?

A. Yes. My analysis indicates that the use of the extra credit multipliers (as defined in the standard) to encourage early adoption of electricity generating renewables in Arizona, in-state installation of electric generating plants, distributed solar electric generation, and in-state manufacturing will provide significant economic gains within the state. Analysis of the two scenarios indicates the SPS will create significant employment opportunities through 2005, substantial income for state residents, and contribute to gross state product. In general, we see that encouraging in-state production increases local benefits, as does in-state manufacturing. In contrast, initially higher costs for renewable technologies (compared with conventional technologies) tends to decrease local benefits. The net result from modeling each change in spending with appropriate sectoral multipliers results in a generally positive net impact.

At the same time, and equally as important, the SPS could help stimulate a renewables manufacturing industry in Arizona. The new and/or expanded industry can serve both in-state and domestic needs, as well as the needs of the rapidly growing international market. Thus, encouraging existing or new electric service providers entering the Arizona market to install renewable electric generating resources should be thought of as an important economic development opportunity for the state of Arizona. The use of extra credit multipliers specifically targeted toward increasing in-state installation and manufacturing can help offset the use of conventional technologies and the associated air pollution as they boost local employment opportunities.

Q. Can you provide more detail on the scenarios and the results?

A. Building upon the analysis undertaken in my original study, I was asked to analyze the impacts of two different extra credit multiplier scenarios relative to a baseline scenario. The baseline scenario assumes no new renewables are installed in Arizona during the 2000 to 2010 time period. To begin, each of the extra credit scenarios incorporates the same overall mix of renewables to meet the proposed SPS requirements. This mix was provided by Ray Williamson of the Arizona Corporation Commission and adheres to the SPS guidelines. Each meets the requirement by including: 70 percent from solar electric (a mix of photovoltaics- distributed and central, solar trough, and solar dish); 20 percent from solar water heating; and the remaining 10 percent from environmental technologies (a mix of landfill gas and wind). Mr. Williamson also provided estimates for statewide electricity generation requirements through 2010, and cost data for each of the technologies. Mr. Williamson also provided detail on the percentages of electric systems manufactured in Arizona and the percentages of systems installed in Arizona for each of the technologies, in each of the scenarios. This data is contained in the attached report provided as Exhibit MRG-2.

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Q. Can you provide more detail on the results of the scenarios?

A. For the High Economic Scenario, I found that as electric service providers aggressively take advantage of the extra credit use multipliers to reduce the required capacity of renewables they need to install, a total of 170.5 MW of renewables will be installed by 2010 to meet the SPS requirements. To put this in perspective, absent the credits, approximately 299 MW of the same mix of renewables will be required to meet the portfolio standard in 2010. This level (170.5 MW), will require a cumulative investment of just over $500 million (1996$) during the period of 2000 to 2010. Based on these assumptions (and others noted in the report) the High Economic Scenario generates a net increase of approximately 800 job-years of employment for Arizona in 2005. With a large portion of the renewables installed by 2005, and many of the credits continuing during the study period, the number of new renewable electric plants brought on-line to meet the SPS requirement decreases through 2010. The result is a sharp decline in investment combined with slightly higher costs continuing for residents and business (to pay for the plants previously installed). This results in a net loss of 400 job-years by 2010. A job-year refers to a full-time job equivalent for one year. The results are shown in Exhibit MRG-1. The employment totals represent a net increase in jobs, income, and gain in gross state product, that would not otherwise have existed if the SPS and extra credit multipliers were not implemented.

Although not modeled directly in the analysis of this scenario, these potential job losses might easily be offset as Arizona's support for renewables creates a niche market giving in-state electric providers and manufacturers a competitive edge. As interest in renewables increases, the state's generating and manufacturing momentum may continue and provide a competitive edge in providing electricity and renewable technologies to other areas. This potential could increase the number of in-state jobs by as much as two to three times that created by Arizona's SPS production requirement.

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Q. Does the more modest scenario have similar impacts?

A. Yes. The Modest Economic Scenario requires installation of 239 MW of renewables with a cumulative investment through 2010 totaling $725 million (1996$). This level of renewables and investment required is larger than in the High Scenario due to the fact that solar electric providers take advantage of fewer early installation credits and a smaller percentage of in-state installation and manufacturing. Based on these assumptions, and others noted in the report, this scenario generates a net increase of 500 job-years of employment for Arizona in 2005. Similar to the High Scenario, the numbers of jobs drops to a negative 700 job-years by 2010. These results are also shown in Exhibit MRG-2. Once again, these losses may also be offset as momentum for expanding renewables increases in Arizona and elsewhere.

Q. Could we expect similar positive impacts without the extra credit multipliers?

A. Theoretically, yes, if electric service providers step forward and decide to install renewable electric generating plants in Arizona and put a strong emphasis on utilizing and or expanding in-state manufacturing capabilities. However, given the current higher cost of these generating facilities and relatively low rates in the state, the probability of this occurring is low, absent additional incentives.

UNDERSTANDING THE JOB CREATION PROCESS

Q. Let's explore in more detail the employment and economic development implications of renewable opportunities. Can you describe this generally?

A. In general, we can say that as renewable technologies are installed in Arizona, economic efficiency is promoted. This has the positive tendency to create new and more employment opportunities.

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Q. Please explain this point.

A. Employment levels change as expenditures change. Each sector of the economy – whether agriculture and construction, or health and electric utility services – support different levels of employment. This is usually expressed as the number of jobs per million dollars of expenditure. As the level of expenditures are increased or decreased, the level of employment supported by a given sector will rise or fall. I should note that employment is only one measure of economic activity. Two other frequently used measures include changes in regional output (or sales) and changes in labor income in the form of wage and salary compensation.

Q. What tools are used to measure these effects?

A. Analysts employ what are called input-output models to evaluate the total changes in economic activity. Perhaps the best way to understand an input-output model is to think of it as the production recipe of a regional economy. For each sector of an economy, an input-output model lists the regional purchases needed to generate a dollar of sales to consumers, sometimes referred to as final demand. The higher the level of regional purchases made by a given sector or firm, the larger its total multiplier effect. Similarly, the lower the level of locally-purchased goods and services (i.e., the higher the imports), the lower its total multiplier effect. This is true whether we are measuring jobs, earnings, or total output.

Input-output models also reveal the interdependencies within an economy. For instance, traditional utility operations are less dependent on support from other sectors of the Arizona economy than, say, construction or manufacturing activities. As a result, lower revenues for either construction or manufacturing firms will usually have a larger negative impact on the economy than a drop in utility bills.

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The economic profile data I am using for Arizona in this analysis is based upon the input-output model know as IMPLAN. IMPLAN contains highly detailed information for over 500 different economic sectors.[1]

Q. You have reviewed for us the job impacts of the SPS, but what about overall income impacts within the state?

A. While I am focusing on job creation in this testimony, the income benefits are similarly positive as a result of the SPS renewable expenditures. For example, in the High Economic Scenario a combined total of over $500 million (1996$) is invested in renewables during the period of 2000 through 2010. This level of spending accounts for $10 million in wage and salary compensation and contributes $30 million to the state's GSP in 2010 (both in 1996$).

CONCLUSIONS

Q. What conclusions can you draw from your analysis?

A. If economic development and new job creation are equally appropriate objectives of Arizona's state energy policy, then it is appropriate to consider a Solar Portfolio Standard with extra credit multipliers. This encourages the use of renewable electric generating plants and in-state manufacturing as retail competition emerges. By encouraging substitution of renewables for conventional electricity supply, the SPS and the extra credits should be thought of as an important economic development opportunity within Arizona. Electric service providers are not only providing electricity to residents and businesses, they are also contributing to the larger well-being of the Arizona economy. By the same token, electric providers who fail to participate in early installation of

1. In this study we have adapted the 1994 IMPLAN model (used in the previous study for Arizona). For a more complete description of the IMPLAN model, see, *Micro IMPLAN User's Guide*, Minnesota IMPLAN Group, Stillwater, MN, January 1993. A more complete discussion of input-output models can be found in Ronald E. Miller and Peter D. Blair, Input-Output Analysis: Foundations and Extensions (Englewood Cliffs, NJ: Prentice-Hall, 1985).

renewable electric generation and in-state manufacturing opportunities may be detracting from the state's future economic well-being. They are, in effect, costing the state new, environmentally friendly jobs.

Q. Does this complete your direct testimony?

A. Yes, it does.

RESUME FOR
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PERSONAL INFORMATION

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Profession: Resource Planner and Policy Analyst

Education: Master of Community and Regional Planning from the University of Oregon, Eugene. The degree was awarded in May, 1992.

PRESENT EMPLOYMENT RESPONSIBILITIES

Marshall Goldberg is the principal in the consulting group, MRG & Associates. The firm specializes in energy and resource management strategies, and analyzing environmental, community and economic development policies.

Marshall is a resource planner with a background in energy policy and resource analysis. He has considerable experience designing and coordinating research programs, developing and evaluating policy and economic impact analysis, and designing spreadsheet-based models to evaluate impacts, project costing, energy expenditures and savings for energy efficiency/renewable technologies and programs. His specialties include analyzing resource policies, evaluating demand side management programs, and the economic and environmental impacts associated with energy and resource use for program and policy support.

Since 1991, Marshall has worked with many utilities, government agencies, and non-profit organizations, performing energy and environmental analysis with a strong emphasis on evaluating energy policy, energy efficiency, and economic impacts associated with energy production and consumption. He has been involved in numerous projects analyzing utility, government, and industry programs and policies. These range from assessing the energy needs of low income residents in the Virgin Islands, to the economic benefits associated with renewable and conventional energy generation resources in the Northeast, to an evaluation of the energy, environmental, and economic implications of Maine's energy policies over the last fifteen years.

Marshall has completed projects for numerous clients, including the U.S. Department of Energy, the National Renewable Energy Laboratory, the Minnesota Municipal Utilities Association, the Arizona State Energy Office, the Nevada State Energy Office, the Solar Energy Industries Association, the Southeastern Regional Biomass Energy Program, the Virgin Islands Energy Office, the American Public Power Association, the American Council for an Energy-Efficient Economy (ACEEE), the Union of Concerned Scientists, the Tellus Institute, the Michigan Public Services Commission, and the Missouri Environmental Improvement and Energy Resources Authority, among others.

Marshall helped evaluate sustainable community and economic development strategies in Albuquerque, New Mexico; and evaluated current energy programs, efficiency technologies, renewables, demand side management policies and programs, and associated income and employment impacts, in Colorado, Arizona, Wyoming, Nevada, Pennsylvania, Washington, Ohio, and the Middle Atlantic and Midwestern states, among others.

During the last six years Marshall has assisted the U.S. Virgin Islands Energy Office in analyzing energy and resource management strategies throughout the Territory. Marshall recently completed working as Project Manager with Economic Research Associates to update the *U.S. Virgin Islands Energy Profile*. The project involved analyzing energy use in all sectors of the Virgin Islands, identifying Territorial energy resources, supplies and existing energy programs, evaluating potential environmental and economic impacts associated with energy production, and estimating energy savings associated with future energy consumption trends.

Complementing this work, he facilitated workshops for Energy Office staff to support more comprehensive understanding of economic indicators and energy analysis. This training was used to help facilitate better understanding of electric customer needs and development of legislative policy and program initiatives. Similarly, he provided extensive support for customer education and consumer education efforts.

Currently, Marshall is working on evaluating the impacts of electric utility restructuring in the state of Mississippi. At the same time, Marshall is working on evaluating the impacts from investments in energy efficiency and renewables in the state of Florida.

Prior to forming MRG & Associates Marshall worked as a Research Planner at the University of Oregon, Community Planning Workshop, specializing in economic and environmental research, analysis, and planning. He has also taught Environmental Studies and Environmental Health Planning classes for undergraduate and graduate students. His background also includes directing an environmental affairs program at a community legal information center and coordinating research and public education to assist policy makers in resource policy development and planning efforts. Similarly, Marshall has done extensive work in the solid and hazardous waste management field, helping coordinate countywide management plans and ongoing public information efforts.

RECENT SELECTED PUBLICATIONS

Energy Efficiency and Economic Development in Illinois. A report co-authored with Marty Kushler, Steven Nadel, Skip Laitner, Neal Elliott, and Martin Thomas. Prepared by the American Council for an Energy-Efficient Economy, Washington, DC. for the Illinois Department of Commerce and Community Affairs. December 1998.

Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy for Texas. A report co-authored with Skip Laitner. Prepared for the State of Texas, Department of Economic Development and the Texas Energy Conservation Office, Austin, TX. November 1998.

Arizona Energy Outlook 2010: Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy. A report co-authored with Skip Laitner for the National Renewable Energy Laboratory, the Land and Water Fund of the Rockies, and the Arizona State Energy Office, a Division of the Arizona Department of Commerce. July 1998.

Quantifying Benefits of U.S. Department of Energy Programs, Study Area: Albuquerque/Bernalillo County, New Mexico. A report co-authored with Skip Laitner for the U.S. Department of Energy, Denver Regional Support Office. Golden, CO. August 1997.

Energy: A Major Economic Development Strategy for Nevada, The Case for Aggressively Pursuing Energy Efficiency and Development of Renewable Energy Industries in Nevada. A report co-authored with Skip Laitner for the Nevada State Energy Office, a Division of the Department of Business and Industry, the Corporation for Solar Technology and Renewable Resources, and the National Renewable Energy Laboratory. June 1997.

Energy Efficiency and Economic Development in New York, New Jersey, and Pennsylvania. A report co-authored with Skip Laitner, Steven Nadel, Neal Elliott, John DeCicco, and Robert Mowris. Prepared for the American Council for an Energy-Efficient Economy. Washington, DC. March 1997.

Assessing the U.S. Employment Benefits from Increased Production of U.S. Renewable Energy Technologies, Part 1: Review of Renewable Energy Employment Impact Studies and *Part 2: Multipliers for Exported Products* . Two reports co-authored with Skip Laitner and Anne Polansky (Solar Energy Industries Association). Prepared for the Solar Energy Industries Association. Washington, DC. December 1996.

Regional Energy and Economic Self-Sufficiency Indicators in the Southeastern United States. A report co-authored with Skip Laitner for the Southeastern Regional Biomass Energy Program, Tennessee Valley Authority. Muscle Shoals, AL. May 1996.

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Planning For Success: An Economic Development Guide for Small Communities. A guidebook co-authored with Skip Laitner. Prepared for the American Public Power Association. Washington, DC. March 1996.

"A Model to Analyze the Economic Impacts Associated with Renewable and Conventional Energy Generation Resources in the Northeastern United States." This Model and the subsequent analysis were developed jointly with Skip Laitner for the Union of Concerned Scientists. Cambridge, MA. December 1995.

Energy Efficiency and Economic Development in the Midwest. A report co-authored with Skip Laitner, John DeCicco, Neal Elliot, and Howard Geller. Prepared for the American Council for an Energy-Efficient Economy. Washington, DC. April 1995.

Environment and Jobs: The Employment Impact of Federal Environmental Investments. A report co-authored with Skip Laitner and Michael Sheehan. Prepared for the National Commission for Employment Policy. Washington, DC. April 1995.

U.S. Virgin Islands Energy Profile. A report co-authored with Skip Laitner and Gregory Holmes, both of Economic Research Associates. This report represents a compilation of 8 individual reports written on energy use, production, policies, and economics, for the U.S. Virgin Islands Energy Office. Frederiksted, USVI. December 1994.

Energy Efficiency as an Investment in Ohio's Economic Future. A report co-authored with Skip Laitner, John DeCicco, Neal Elliott, and Howard Geller (all with the American Council for an Energy-Efficient Economy). American Council for an Energy-Efficient Economy. Washington, DC. November 1994.

Assessment of Small Scale Biomass Cogeneration in the State of Michigan. A report co-authored with Skip Laitner and Gregory Holmes. Prepared for the Michigan Biomass Energy Program, Public Service Commission, Michigan Department of Commerce. Lansing, MI. July 1994.

Energy Efficiency and Renewable Energy as An Investment in Pennsylvania's Economic Future. A report co-authored with Skip Laitner (American Council for an Energy-Efficient Economy) for the Campaign For An Environmental Economy. Washington, DC. June 1994.

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Energy and Economic Indicators: A Manual for the U.S. Virgin Islands Energy Office. A guide for the U.S. Virgin Islands Energy Office staff. Christiansted, USVI. November 1993.

Estimating the Environmental Cost of Missouri's 1990 Energy Consumption Patterns. A report co-authored with Skip Laitner (Economic Research Associates) part of a series of studies for the Missouri Environmental Improvements and Energy Resources Authority. Jefferson City, MO. April 1992.

Expanding Energy Savings by Accelerating Market Diffusion of Efficient Technologies: Three Case Studies, a report co-authored with the Center for Applied Research and Economic Research Associates, for the U.S. Department of Energy. Washington, DC. February 1992.

Exhibit MRG-2

DRAFT REPORT

Assessing the Economic Impacts of a Solar Portfolio Standard in Arizona

Prepared for the

Arizona Corporation Commission
Utilities Division

By

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MRG & Associates
449 Charles Lane
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July 1999

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Preface

MRG & Associates is a consulting firm specializing in economic impact analysis and public policy studies, particularly in the energy policy and development arenas. It is based in Madison, Wisconsin. The firm has a long history of evaluating the employment and other macroeconomic benefits of increased investments in energy efficiency and energy technologies.

The findings and recommendations of the economic analysis in this study will provide a wide variety of decision makers with an expanded basis for informed discussion and constructive action about promoting a Solar Portfolio Standard for Arizona.

In presenting the results of this analysis, every effort was made to provide clear and accurate information. Special thanks go to Ray Williamson of the Arizona Corporation Commission, Utilities Division, for his assistance in gathering pertinent technology data and developing the scenarios to model.

However, any opinions, findings, conclusions, or recommendations expressed in the report are those of the authors. They do not necessarily reflect the views of the Arizona Corporation Commission, any of the individuals who provided assistance, or the organizations they represent.

I. Introduction

In 1997, Economic Research Associates completed a study for the state of Arizona analyzing the energy and economic impacts of an alternative energy future. The study, titled *Arizona Energy Outlook 2010: Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy*,[1] provided a sound basis for understanding the significant benefits of increasing investment in energy efficiency and renewable energy technologies in the state. In addition to modeling the benefits of energy efficiency investments throughout the economy, the study modeled a proposed Solar Portfolio Standard for electricity generation being considered at the time.

Now more than two years since much of the analysis took place, population and job growth continues at a rapid pace in Arizona and electric industry restructuring is taking hold. The opportunity to choose an electric service provider is soon to become a reality for many of the state's residents. At the same time, this growth and economic prosperity is shaping a growing demand for electricity. Despite the benefits noted in the previous study, one of Arizona's most significant resources — solar energy — still remains essentially untapped.

Arizona continues to be a prime area for developing the manufacturing capacity to produce its own renewable energy technologies. Yet, with retail electric competition may also come a new Solar Portfolio Standard. The new standard is designed to promote installation of renewable electric generating capacity in Arizona and stimulate a renewables manufacturing industry as well. Arizona is poised to take advantage of the many job and economic development benefits associated with renewables development.

Efforts to accelerate investments in renewable energy technologies can enhance Arizona's air quality, diversify the mix of energy resources available to homes and businesses, and encourage the development of new clean technologies and industries in Arizona. The earlier study suggested that total energy consumption will increase by 35 percent as a result of a rapidly expanding population and a growing economy. It identified an "alternative energy Arizona" which, in the year 2010, pays approximately $1.4 billion (in 1996 dollars) less in energy bills, has 11,100 more jobs, and enjoys a cleaner environment. Arizona ratepayers in 2010 would save approximately $1.4 billion in lower energy costs. The energy efficiency and renewable energy scenario would require a $4.8 billion (in 1996 dollars) cumulative investment in the years 1998 through 2010, including approximately $700 million for electricity generating renewables.

In 2010, renewable electricity generation would account for 15 percent of total electricity consumption. This includes existing hydro resources and a mix of new renewable energy

1. See, Skip Laitner and Marshall Goldberg, *Arizona Energy Outlook 2010: Energy Efficiency and Renewable Energy Technologies as an Economic Development Strategy*, July 1997.

technologies. New renewable technologies (providing 534 million kilowatt-hours) account for 1 percent of total electricity consumption in 2010.

The rise in employment in year 2010, was driven largely by an increase in net energy bill savings. However, the study also found that if Arizona is able to develop a renewables manufacturing industry capable of producing 50 MW by 2010 — to meet in-state renewable electricity generating needs and take advantage of growing export opportunities — the market potential would be $115 million in 2010 and creation of 1,100 new jobs in that year.

A. Purpose of the Report

The purpose of this report is to build upon the previous report to quantify the economic benefits associated with the revised Solar Portfolio Standard now being discussed by Arizona policy makers. The proposed Solar Portfolio Standard is based on a system of extra credits available to electric service providers to install renewable electric plants in Arizona and take advantage of in-state manufacturing capabilities.

With these objectives as a benchmark for the analysis, the study that follows:

(1) Incorporates a mix of renewables to meet the proposed Solar Portfolio Standard;

(2) Develops two possible renewable scenarios for new and existing Arizona electric service providers which will meet the Portfolio requirements;

(3) Reflects the use of extra credit multipliers to encourage a early installation of renewable energy technologies, distributed generation, and in-state manufacturing;

(4) Identifies the level of investments needed to meet the Portfolio objectives of both scenarios — given the baseline projection of future electricity consumption; and finally

(5) Evaluates the economic and employment impacts of the Portfolio scenarios, should the State of Arizona adopt the proposed Standard.

B. Structure of the Report

This report begins with a brief summary of the proposed Solar Portfolio. Section III provides an overview of projected electricity use in Arizona. Section IV is the heart of the report, it utilizes the projection for future electricity use and outlines two Portfolio scenarios for Arizona. The analysis includes investments for the years 2000 through 2010 for each of the technologies in the mix. Section V provides the economic and employment impact analysis of the scenarios. And finally, section VI provides some brief conclusions.

Two caveats are important to note at this point. First, the projection of future electricity use in Arizona is based on an analysis of electricity consumption trends provided by Ray Williamson, Acting Director of the Arizona Corporation Commission, Utilities Division. Second, the scenarios analyzed in this study are not predictions of what will happen, but rather they describe two possible renewable futures for Arizona, given reasonable assumptions about the technologies and efforts to meet the proposed Solar Portfolio Standard requirements.

II. Solar Portfolio Standard

The Solar Portfolio Standard being analyzed here is referenced as R14-2-1609, *Solar and Environmentally-Friendly Portfolio Standard* (previously referred to as the Solar Portfolio Standard), in Attachment A, Title 14. Public Service Corporations; Corporations and Associations; Securities Regulation, Chapter 2. Corporation Commission-Fixed Utilities, Article16, Retail Electric competition (As adopted in Decision No. 61272, December 11, 1998, with proposed language from the April 8, 1999, Kunasek letter.). Provisions used to develop the respective scenarios modeled in this study are summarized below. (*Please note: this is only a partial listing of the Portfolio Standard. For a more comprehensive and detailed description of all provisions contained in the Standard, refer to the Standard directly.*)

1. Starting on January 1, 1999, 0.2 percent of total retail energy sold competitively shall be from new solar energy resources. Solar resources include: photovoltaic resources and solar thermal resources that generate electricity.

2. Starting on January 1, 2001, the portfolio percentage shall increase annually as noted in the following table:

Year	Portfolio Percentage
2001	.4%
2002	.5%
2003	.6%
2004	.8%
2005-2012	1.0%

3. The Portfolio requirements only apply to competitive retail electricity in 1999 and 2000, after that they apply to all retail electricity.

4. Electric service providers are eligible for extra credit multipliers that can be used to meet the Portfolio requirements. All multipliers are additive, with a maximum extra credit multiplier of 2.0 in years 1997-2003. The multiplier is applied to each kWh generated by an electric service provider (e.g., if 1 kWh is generated and there is a 2.0 extra credit available, the provider receives credit for 3 kWh towards their Portfolio requirement). The following credits are available:

   1. Early Installation Extra Credit Multiplier. Electric service providers qualify for multiple extra credits for each kWh produced from new solar electric systems installed and operating prior to December 31, 2003. The credits vary depending upon the year in which the system starts up and run for 5 years following system start-up.

Year	Extra Credit Multiplier
1997	.5
1998	.5
1999	.5
2000	.4
2001	.3
2002	.2
2003	.1

   2. Solar Economic Development Credit Multipliers. Solar electric power plants installed in Arizona receive a .5 extra credit multiplier. Solar electric power plants receive up to a .5 extra credit multiplier related to manufacturing and installation content that comes form Arizona.

   3. Distributed Solar Electric Generator and Solar Incentive Program Extra Credit Multiplier. Solar electric generators installed on customer premises may receive a .5 extra credit multiplier.

13. Electric service providers are entitled to meet up to 20 percent of the portfolio requirement with solar water heating systems purchased by the provider for use by its customers or purchased by customers and paid for by the provider.

14. Electric service providers are entitled to meet up to 10 percent of the portfolio requirement with electricity produced by environmentally-friendly renewable electricity technologies approved by the Commission.

III. State Electricity Use

The following table provides the projected electricity consumption in gigawatt-hours for the years 1999 through 2000[2] and the share of electricity to be met by the renewables as defined in the Solar Portfolio Standard. As the table indicates, electricity consumption is expected to increase from 51,577 gigawatt-hours in 1999 to 71,395 gigawatt-hours in 2010. This represents an annual growth of 3 percent. Similarly, the share of renewables to meet the SPS requirement increases from 21 gigawatt-hours in 1999 to 714 gigawatt-hours in 2010.

Table 1. Projected Electricity Use and SPS Requirements (Gigawatt-hours)

Year	Retail Electric	SPS Requirement	SPS Percentage	SPS Increment
1999	51,577	21	0.04%	21
2000	53,125	21	0.04%	1
2001	54,719	219	0.40%	198
2002	56,360	282	0.50%	63
2003	58,051	348	0.60%	67
2004	59,792	478	0.80%	130
2005	61,586	616	1.00%	138
2006	63,434	634	1.00%	18
2007	65,337	653	1.00%	19
2008	67,297	673	1.00%	20
2009	69,316	693	1.00%	20
2010	71,395	714	1.00%	21

2. This projection was provided by Ray Williamson, Acting Director, Arizona Corporation Commission, Utilities Division, in July 1999.

IV. Solar Portfolio Scenarios

This section of the study describes the two Economic Extra Credit Multiplier scenarios modeled in this study. To develop these scenarios, it was first necessary to determine the share of renewables required of each technology. The following table provides this data based on the split of 70 percent solar electricity, 20 percent solar domestic hot water, and 10 percent environmental technologies.

Table 2. Renewables Share of Portfolio Requirement - Without Credits (in Gigawatt-hours)

		Environmental Technologies	Solar Domestic Hot Water	Solar Electric
Year	SPS Req.	10%	20%	70%
1999	na	na	na	na
2000	21.3	2.1	4.3	14.9
2001	218.9	21.9	43.8	153.2
2002	281.8	28.2	56.4	197.3
2003	348.3	34.8	69.7	243.8
2004	478.3	47.8	95.7	334.8
2005	615.9	61.6	123.2	431.1
2006	634.3	63.4	126.9	444.0
2007	653.4	65.3	130.7	457.4
2008	673.0	67.3	134.6	471.1
2009	693.2	69.3	138.6	485.2
2010	714.0	71.4	142.8	499.8

Once this was determined, these broad technology shares were then allocated to more specific technologies to be incorporated into the scenarios. These include environmental technologies (landfill gas and wind split equally); solar domestic water heating systems, and solar electric allocated based on technology development status (distributed photovoltaic systems, central plant photovoltaic systems, solar trough, and dish stirling). This distribution is provided in the following table.

Table 3. Technology Share Requirement - Without Extra Credits (in Gigawatt-hours)

Year	Landfill	Wind	DHW	PV-Distrib	PV-Central	Trough	Dish Stirling
1999	na	na	na	na	na	na	na
2000	1.1	1.1	4.3	7.4	7.4	0.0	0.0
2001	10.9	10.9	43.8	16.4	16.4	119.3	1.1
2002	14.1	14.1	56.4	27.4	27.4	140.3	2.2
2003	17.4	17.4	69.7	38.3	38.3	162.8	4.4
2004	23.9	23.9	95.7	54.8	54.8	216.6	8.8
2005	30.8	30.8	123.2	76.7	76.7	251.5	26.3
2006	31.7	31.7	126.9	82.1	82.1	253.5	26.3
2007	32.7	32.7	130.7	87.6	87.6	253.7	28.5
2008	33.6	33.6	134.6	92.0	92.0	254.3	32.9
2009	34.7	34.7	138.6	97.5	97.5	255.3	35.0
2010	35.7	35.7	142.8	104.0	104.0	256.7	35.0

With the necessary shares of the Portfolio requirements allocated, the following criteria for each of the scenarios was used to determine the extra credit multipliers. And then, once applied the resulting megawatts of renewables that would be installed and the investment required. Additional technology data used to estimate capacity required is contained in the Appendix.

High Extra Credit Use Scenario:

Solar Electricity (70% of portfolio)
60% of solar electric systems manufactured in Arizona
80% of solar electric systems installed in Arizona

Solar Water Heating (20% of portfolio)
60% of solar water heating systems manufactured in Arizona
100% of solar water heating systems installed in Arizona

Environmental Technologies (10% of portfolio)
½ of portfolio segment is wind from outside Arizona
½ of portfolio segment is land-fill gas installed in Arizona; none of land-fill equipment manufactured in Arizona

The following table provides the technology share in megawatts required to be installed by electric service providers once the extra credit multipliers are applied.

Table 4. High Extra Credit Scenario
Technology Share - Total Required with Credits
(in Megawatts)

Year	Landfill	Wind	DHW	PV-Distrib	PV-Central	Trough	Dish Stirling	Total
1999	na	na	na	na	na	na	na	na
2000	0.1	0.4	0.6	1.7	1.8	0.0	0.0	4.6
2001	1.1	3.9	6.6	3.3	3.7	34.0	0.3	52.9
2002	1.2	4.2	7.7	5.5	6.1	33.7	0.6	58.9
2003	1.5	5.4	9.6	7.8	8.5	40.1	1.2	74.0
2004	2.1	7.6	13.5	11.3	12.4	55.1	2.4	104.5
2005	2.8	10.1	17.7	16.2	17.8	65.0	7.4	137.1
2006	2.9	10.6	18.4	17.7	19.6	65.6	7.4	142.2
2007	3.3	11.8	19.8	19.2	21.2	72.0	8.1	155.3
2008	3.4	12.2	20.4	20.4	22.6	72.2	9.3	160.5
2009	3.5	12.7	21.1	21.7	24.1	72.8	10.0	165.9
2010	3.6	13.0	21.8	23.2	25.7	73.3	10.0	170.5

The following table provides the investment required by electric service providers to meet the SPS renewable requirements with use of high extra credits. The investment is based on technology cost data contained in the Appendix.

Table 5. High Extra Credit Scenario
Technology Share - Annual Investment
(in Millions of 1996 Dollars)

Year	Landfill	Wind	DHW	PV-Distrib	PV-Central	Trough	Dish Stirling	Total
1999	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2000	$0.14	$0.35	$1.43	$11.73	$13.00	$0.00	$0.00	$26.65
2001	$1.20	$3.06	$12.44	$11.29	$12.25	$71.54	$2.91	$114.69
2002	$0.10	$0.27	$2.29	$14.02	$15.38	($0.75)	$1.89	$33.21
2003	$0.38	$0.96	$3.66	$13.51	$14.83	$12.25	$2.21	$47.79
2004	$0.72	$1.83	$7.00	$20.47	$22.62	$26.94	$4.24	$83.81
2005	$0.76	$1.95	$7.18	$26.72	$29.61	$17.07	$16.30	$99.61
2006	$0.14	$0.35	$1.10	$8.03	$9.10	$0.92	$0.00	$19.63
2007	$0.34	$0.86	$2.09	$7.24	$8.14	$9.94	$1.59	$30.21
2008	$0.11	$0.29	$1.02	$5.59	$6.30	$0.17	$2.99	$16.47
2009	$0.12	$0.32	$0.98	$5.93	$6.62	$0.96	$1.54	$16.46
2010	$0.10	$0.25	$0.84	$6.20	$6.87	$0.54	$0.00	$14.81
Total	$4.11	$10.48	$40.04	$130.73	$144.72	$139.59	$33.67	$503.33

Modest Extra Credit Use Scenario:

Solar Electricity (70% of portfolio)
30% of solar electric systems manufactured in AZ
50% of solar electric systems installed in AZ

Solar Water heating (20% of portfolio)
30% of solar water heating systems manufactured in AZ
100% of solar water heating systems installed in AZ

Environmental Technologies (10% of portfolio)
½ of portfolio segment is wind from outside Arizona
½ of portfolio segment is land-fill gas installed in AZ; none of land-fill equipment manufactured in AZ

The following table provides the technology share in megawatts required to be installed by electric service providers once the extra credit multipliers are applied.

Table 6. Modest Extra Credit Scenario
Technology Share - Total Required
(in Megawatts)

Year	Landfill	Wind	DHW	PV-Distrib	PV-Central	Trough	Dish Stirling	Total
1999	na	na	na	na	na	na	na	na
2000	0.1	0.4	1.0	2.3	3.0	0.0	0.0	6.7
2001	1.1	3.9	10.0	4.4	5.5	47.4	0.4	72.6
2002	1.2	4.2	11.1	7.3	9.2	43.4	0.8	77.1
2003	1.5	5.4	14.1	10.2	12.9	53.0	1.6	98.6
2004	2.1	7.6	20.0	15.1	19.1	73.5	3.2	140.6
2005	2.8	10.1	26.4	21.7	27.8	87.4	10.2	186.4
2006	2.9	10.6	27.5	24.0	31.0	88.2	10.2	194.4
2007	3.3	11.8	30.2	26.1	33.8	100.6	11.2	217.0
2008	3.4	12.2	31.3	27.8	36.2	100.1	13.0	224.0
2009	3.5	12.7	32.4	29.7	38.7	101.4	13.9	232.2
2010	3.6	13.0	33.4	31.7	41.3	101.9	13.9	238.9

The following table provides the investment required by electric service providers to meet the SPS renewable requirements with use of high extra credits. The investment is based on technology cost data contained in the Appendix.

Table 7. Modest Extra Credit Scenario
Technology Investment
(in Millions of 1996 Dollars)

Year	Landfill	Wind	DHW	PV-Distrib	PV-Central	Trough	Dish Stirling	Total
1999	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
2000	$0.14	$0.35	$2.20	$16.03	$20.91	$0.00	$0.00	$39.63
2001	$1.20	$3.06	$18.88	$14.34	$17.09	$99.54	$4.05	$158.15
2002	$0.10	$0.27	$2.29	$18.57	$23.55	($7.98)	$2.40	$39.20
2003	$0.38	$0.96	$5.61	$17.88	$22.50	$18.24	$3.03	$68.60
2004	$0.72	$1.83	$10.61	$27.70	$35.75	$36.99	$5.83	$119.41
2005	$0.76	$1.95	$11.01	$36.52	$47.64	$23.76	$22.68	$144.33
2006	$0.14	$0.35	$1.84	$11.82	$16.66	$1.28	$0.00	$32.08
2007	$0.34	$0.86	$4.15	$10.35	$14.03	$19.20	$2.29	$51.22
2008	$0.11	$0.29	$1.57	$8.08	$11.18	($0.68)	$4.18	$24.73
2009	$0.12	$0.32	$1.59	$8.31	$11.14	$1.72	$2.19	$25.39
2010	$0.10	$0.25	$1.29	$8.48	$11.06	$0.75	$0.00	$21.92
Total	$4.11	$10.48	$61.04	$178.09	$231.50	$192.80	$46.65	$724.67

V. Economic Impact Analysis

With both of the Extra Credit scenarios established, the question now posed by this analysis is: "What are the employment and other macroeconomic benefits for Arizona if either of these scenario were implemented." One tool that can assist in this type of macroeconomic evaluation is referred to as input-output modeling, sometimes called multiplier analysis.

A. Input-Output Analysis

Input-output models initially were developed to trace supply linkages in the economy. For example, they show how purchases of photovoltaic equipment not only benefit photovoltaic cell manufacturers, but also the fabricated metal industries and other businesses supplying inputs to those manufacturers.

The employment that is ultimately generated by expenditures for renewable technologies will depend on the structure of a local economy. States which produce fabricated metal products or have renewables manufacturing, for instance, will likely benefit from expanded installation of locally manufactured wind turbines, solar water heaters, or development of solar electric or other renewable technologies. States without such production will not benefit in the same way.

Different expenditures support a different level of total employment. Table 8, on the next page, compares the total number of jobs in Arizona that are directly and indirectly supported for each one million dollars of expenditures made by consumers and businesses. The employment multipliers are given for key sectors such as agriculture, construction, manufacturing, utility services, wholesale and retail trade, services, and government.[3]

3. In this study, we have adapted the 1994 IMPLAN model for the analysis. See, for example, *Micro IMPLAN User's Guide*, Minnesota IMPLAN Group, Stillwater, MN, January 1993. Table 8 presents what are referred to as Type I multipliers, incorporating the direct and indirect effects of an expenditure. For more information on this point, see, Ronald E. Miller and Peter D. Blair, *Input-Output Analysis: Foundations and Extensions*, Prentice-Hall, Inc., Englewood, NJ, 1985, pages 25-30.

Table 8. Arizona Employment Multipliers for Select Economic Sectors

Sector	Multiplier
Agriculture	19
Other Mining	8
Coal Mining	7
Oil/Gas Mining	5
Construction	16
Food Processing	9
Other Manufacturing	12
Pulp and Paper Mills	9
Oil Refining	3
Stone, Glass, and Clay	11
Primary Metals	6
Metal Durables	9
Motor Vehicles	7
Transportation, Communication, and Utilities	14
Electric Utilities	6
Natural Gas Utilities	4
Wholesale Trade	16
Retail Trade	30
Finance	16
Insurance/Real Estate	7
Services	24
Education	33
Government	30

Source: Adapted from the 1994 IMPLAN database for Arizona. The employment multipliers represent the direct and indirect jobs supported by a one million-dollar expenditure for the goods or services purchased from a given sector

For purposes of this study, a job is defined as sufficient wages to employ one person full-time for one year. Of immediate interest in Table 8 is the relatively large number of jobs supported for each one million dollars spent on construction. In sharp contrast, we see a relatively small number of jobs in utility services. As it turns out, much of the job creation from the development of renewable electric plants is derived by construction and utility jobs which also support spending in other sectors of the economy.

B. Evaluating the Extra Credit Scenarios

The employment analysis for the renewable scenarios is carried out by matching the changes in expenditures brought about by investments in the renewable technologies with their appropriate employment multipliers. There are several modifications to this technique, however.

First, it was assumed that only a portion of the renewable investments are spent within Arizona. These percentages (both for installation and manufacturing) are based on the scenario data noted earlier in Section IV of this report.

The level of locally-installed and locally manufactured (i.e., in Arizona) renewables does matter. To maximize employment within the state, investments should emphasize the use of locally-based businesses, both for installation and manufacturing as much as possible.

Second, an adjustment in the employment impacts was made to account for future changes in labor productivity. As outlined in the Bureau of Labor Statistics *Outlook 1995-2005*, productivity rates are expected to vary widely among sectors. For instance, a 0.1 percent annual productivity gain is projected in the service sectors which will experience a large influx of employment as those sectors become more important to the economy.[4]

To illustrate the impact of productivity gains, let us assume a typical labor productivity increase of one percent per year in manufacturing. This means, for example, that compared to 1999 an one million dollar expenditure in the year 2010 will support only 90 percent of the number of jobs as in 1999.[5]

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4. The productivity trends were calculated by Economic Research Associates using data from the Bureau of Labor Statistics employment projections, *Outlook 1995-2005*, as downloaded from the BLS FTP site <ftp.bls.gov/pub/special.requests/ep>, U.S. Department of Labor, Washington, DC, February 1996.

5. The calculation is $1/(1.01)^{11} * 100$ equals $1/1.116 * 100$, or 90 percent.

Third, for purposes of estimating avoided costs it was assumed that electricity prices decline between 1999 and 2010. This is, in part, to recognize expected trends resulting from deregulation and increased competition, and for consistency with future projections in AEO98.

Fourth, it was assumed that all renewables investments are financed at an average 10 percent interest rate over a 20 year period. To limit the scope of the analysis, however, no parameters were established to account for any changes in interest rates or in labor participation rates — all of which might affect overall spending patterns.

Finally, it should again be noted that the full effects of the renewable investments are not accounted for since the additional sales of renewable technologies by expanding Arizona firms, during the study period and beyond 2010, are not incorporated in the analysis. Nor does the analysis account for any additional sales of renewable generated electricity, lease payments to landowners, taxes paid to local jurisdictions, or environmental benefits such as cleaner air.

To the extent these "co-benefits" are realized in addition to the noted investments, the economic impacts would be amplified beyond those reported here.

C. Macroeconomic Results

The investment data from the renewable scenarios are used to estimate three sets of impacts for 2005, and 2010. For each benchmark year, each change in a sector's spending pattern for a given year — relative to the baseline (i.e., no renewable investments) — was matched to the appropriate sectoral multiplier. These negative and positive changes are summed to generate a net result shown in the tables that follow.

Table 9, on the following page, summarizes the economic impacts of the two Extra Credit scenarios for the benchmark years. It provides the estimated economic benefits of the use of the extra credit to encourage in-state electric generating plants and credits to stimulate the renewable electric manufacturing throughout the state.

Table 9. Impacts of the High and Modest Extra Credit Scenarios

Year	Change in Gross State Product (Million$)	Change in Wage and Salary Compensation (Million$)	Net Jobs Gain (Loss)
High Extra Credit Scenario			
2005	$70	$30	800
2010	$30	$10	(400)
Modest Extra Credit Scenario			
2005	$60	$20	500
2010	$40	$10	(700)

Notes: Dollar figures are in millions of 1996 dollars while employment reflects the actual job total. The calculations are based upon a working analysis by MRG & Associates, July 1999.

The first of the three impacts evaluated here is the net contribution to Gross State Product (GSP) measured in millions of 1996 dollars. In other words, once the gains and losses are sorted out in each scenario, the analysis provides the net benefit of a scenario in terms of the overall economy. The second impact is the net gain to the state's wage and salary compensation, also measured in millions of 1996 dollars. The final category of impact is the contribution to the Arizona employment base as measured by full-time jobs equivalent.

There are a number of different aspects of Table 9 worth noting. The first is that the impacts are largely positive. In both scenarios, wage and salary earnings as well as GSP are strongly positive in both years analyzed, with the High Extra Credit scenario providing somewhat larger benefits. At the same time, employment in Arizona is projected to increase by 500 to 700 jobs above the baseline employment levels in 2005. By 2010, employment drops, causing a loss in jobs despite significant gains in wage and salary compensation and GSP. With a large portion of the renewables installed by 2005, and many of the extra credits continuing during the study period, the number of new renewable electric plants brought on-line to meet the SPS requirement decreases through 2010. The result is a sharp decline in investment combined with

slightly higher costs continuing for residents and business (to pay for the plants previously installed)

As elsewhere it should be noted that the results for the High and Modest scenarios in Table 9 are not intended to be precise forecasts, but rather approximate estimates of overall impact. While the aggregate totals offer reasonable insights into the benefits of the Extra Credits and renewables overall, the impacts are sufficiently small that the results may swing one way or the other depending upon even modest changes in the assumptions.

As might be expected, the electric utilities and construction industries experience the largest gains while services and retail incur overall losses in jobs, compensation, and GSP. But this result must be tempered somewhat as the renewables manufacturing industries and their support industries expand and employ more people from the business services, creating more jobs, and additional spending in the economy. Therefore, the negative employment impacts should not necessarily be seen as job losses; rather they might be more appropriately seen as a redistribution of jobs in the overall economy and future occupational tradeoffs.

Local and state tax revenues associated with these investments (e.g., property taxes) are not included in the impacts, but could be sizeable. In some areas of Arizona, renewable resources can provide a significant boost to the local economy. Tax revenues from electric generating plants can help to fund schools, local hospitals, and county services. If installed on state lands these plants can help support the state as well. In addition to the revenues, plants provide employment during construction and continue to provide permanent jobs. And equally important, if a large percentage of the plant (parts, components, etc.) are manufactured in Arizona, the state will enjoy significantly larger economic gains.

Another prime example of the benefits of renewables as an economic development strategy was the decision two years ago by the Sacramento Municipal Utility District (SMUD) to purchase 10 MW of photovoltaic modules over a five year period. As part of the contracts, SMUD required that the units be manufactured in Sacramento. The winners of the contracts, were each required to locate manufacturing facilities in the Sacramento area. These companies are expected to bring as many as 280 new manufacturing jobs to the Sacramento community.[6]

D. Manufacturing Market Potential

One of the more critical benefits of the SPS Extra Credits in Arizona are the prospects for significantly expanding renewables electricity manufacturing capabilities within the state. As Arizona moves towards increasing its manufacturing capabilities, renewables can provide the state with a new environmentally sound industrial base — providing a significant source of jobs

6. See, "SMUD Board votes to bring ten megawatts of solar power to Sacramento, Renews commitment to renewable energy," SMUD News Release, May 16, 1997.

and income. With growing interest worldwide for renewable energy technologies, international markets will also increase the likelihood of meeting this goal.

Arizona is a prime location for developing new renewables manufacturing facilities and relocation or expansion of existing industries. At the same time, existing industries will have opportunities to meet many of the materials needs associated with renewables technology manufacturing and installation of facilities.

If in-state commitments for renewable generation occur sooner or more rapidly than modeled in the scenario, and Arizona is able to develop the renewables manufacturing industry to meet the technology needs, the expected job gains will take place even sooner. To the extent local industries are able to ramp-up more quickly and momentum continues, the state may enjoy even larger gains.

The magnitude of potential renewable sales and expenditures is shown in a report released last year by the Renewable Energy Marketing Board (REMB) in California. The report notes that the renewable energy industry in California, "...has been growing faster this year than it has in the past 10." The report also states that existing renewable plants supply 11 percent of the state's electricity and represent over $6 billion in private sector investment and over $400 million in annual taxes.[7]

Arizona may be able to expand its market share of the growing domestic and international renewables export markets. If they can, they will share in the benefits (i.e., more jobs and income) from exporting (i.e., sales) renewable technologies manufactured for installation outside of Arizona, including other regions in the United States and international markets.

VI. Conclusion

The use of extra credit multipliers (as defined in the Portfolio Standard) to encourage early adoption of electricity generating renewables in Arizona, in-state installation of electric generating plants, distributed solar electric generation, and in-state manufacturing will provide significant economic gains within the state. Analysis of the two scenarios indicates the SPS will create significant employment opportunities through 2005, substantial income for state residents, and contribute to gross state product. In general, encouraging in-state production increases local benefits, as does in-state manufacturing.

At the same time, and equally as important, the SPS could help stimulate a renewables manufacturing industry in Arizona. The new and/or expanded industry can serve both in-state

7. See, *How Emerging Green Markets Help Respond to Global Climate Change*, Renewable Energy Marketing Board, cited in an November 18, 1998 news article by Business Wire.

and domestic needs, as well as the needs of the rapidly growing international market. Thus, encouraging existing or new electric service providers entering the Arizona market to install renewable electric generating resources should be thought of as an important economic development opportunity for the state of Arizona. The use of extra credit multipliers specifically targeted toward increasing in-state installation and manufacturing can help offset the use of conventional technologies and the associated air pollution as they boost local employment opportunities.

Appendix A

Key Input Data for Scenario Analysis

	Landfill	Wind	DHW	PV-Dist	PV-Cent	Trough	Dish Stirling
Capacity Factor	90%	25%	33%	25%	25%	25%	25%
kWh Output per kW	7,884	2,190	2,850	2,190	2,190	2,190	2,190
O&M Costs (per kWh)	$0.013	0.005	$0.000	$0.004	$0.004	$0.021	$0.021

Note: DHW assumes 2,850 kWh per year

Technology Cost per kW
(1996 Dollars)

Year	Landfill	Wind	DHW	PV-Distrib	PV-Central	Trough	Dish Stirling
1999	$1,314	$932	$2,329	$7,453	$7,453	$2,329	na
2000	$1,275	$904	$2,213	$7,080	$7,080	$2,213	na
2001	$1,237	$877	$2,102	$6,726	$6,726	$2,102	$9,316
2002	$1,200	$850	$1,997	$6,390	$6,390	$1,997	$7,453
2003	$1,164	$825	$1,897	$6,070	$6,070	$1,897	$3,726
2004	$1,129	$800	$1,802	$5,767	$5,767	$1,802	$3,493
2005	$1,095	$776	$1,712	$5,478	$5,478	$1,712	$3,261
2006	$1,062	$753	$1,626	$5,205	$5,205	$1,626	$2,329
2007	$1,030	$730	$1,545	$4,944	$4,944	$1,545	$2,329
2008	$999	$708	$1,468	$4,697	$4,697	$1,468	$2,329
2009	$969	$687	$1,394	$4,462	$4,462	$1,394	$2,329
2010	$940	$666	$1,325	$4,239	$4,239	$1,325	$2,329

Source: Technology cost data for 1999 and annual growth is based on data provided by Ray Williamson, Arizona Corporation Commission in July 1999.