

HERE COMES THE SUN?

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ARIZONA IS DESTINED FOR SOLAR STARDOM, BRINGING NEW JOBS AND OPPORTUNITIES, BUT CONSUMERS STILL HOLD THE KEY TO SOLAR POWER'S FUTURE SUCCESS.

Inside the Unit 2 reactor at Palo Verde Nuclear Generating Station 50 miles west of Phoenix, workers scurry along steel catwalks under a massive concrete dome. Plant operators have throttled back on the Valley's dominant electricity generator so that employees can safely enter and gas it up with a fresh batch of fuel pellets.

The pellets are made of uranium that typically comes from Europe's former eastern bloc, South Africa, Australia, Canada and, on occasion, the Russian military (whenever nuclear disarmament becomes politically popular). Whatever the source, the uranium is then shipped to Kentucky to be enriched (did you think these reactors run on regular unleaded?), then trucked to South Carolina to be packaged inside 1,500-pound vertical cases made of stainless steel.

From there, the fuel assemblies are shipped to nuclear plants throughout the United States about every 18 months. Palo Verde is the largest nuclear plant in the nation – with Unit 1 setting the record for most electricity produced by any nuclear power plant worldwide in 2009, then breaking that record last year with Unit 2's electricity production.

But that's just the fuel process. Tack on miles of pipes, acres of treated sewage, tons of used radioactive fuel mummified in concrete, multiple security checkpoints, one private security force, one public security force (the Maricopa County Sheriff's Office), one private fire department, dozens of pieces of customized industrial equipment, piles and piles of wiring and circuitry, and thousands of nobs, switches, levers, lights, paint and grease, and you have yourself a mighty steam engine – one that produces enough cheap electricity to keep your open-air patio party going strong and prevent the D-backs from dying of heat exhaustion in the dead of summer.

The true art of Palo Verde is how everything is woven together. Yet, for all its marvelous ingenuity, for all its intricacies, its very existence begs serious thought from all of us.

There has to be a better way. Why not use solar power?

Riffing on that thought for a moment, let's take a few more steps. Why not build solar in wasted space like rooftops, parking lots and landfills, which would create hundreds of much-needed jobs? Lure investment and new financing to the Valley? Renovate existing buildings or build entirely new buildings – major capital investments – around the region? Help us declare our energy independence from the rest of the world's increasingly hostile oil-producing countries? Help us cut down on our carbon emissions? Save the planet?

At a time when thoughts are fleeting and political careers end before they truly begin, this chain of thinking has real traction. A recent poll of 600 Arizonans by the Western Clean Energy Campaign found that solar topped the list of most-preferred renewable energy sources,

becoming the most appealing choice over wind or thermal energy with 71 percent of respondents reacting “very favorably.” A recent poll by Salt River Project (SRP) suggests most of their customers are even willing to pay extra for it – despite being polled during the worst economic recession in a generation.

“I think we’re doing a lot, but we’re still behind the curve of where we could be as a state,” says Lori Singleton, manager of sustainability initiatives and technologies at SRP, which provides electricity to about 940,000 customers in the Phoenix-metro area. “I think right now what we’re seeing are all the solar manufacturing firms locating here in Arizona, the demand from our customers continues to grow, and costs are coming down as it relates to the cost of solar. So it feels like there’s this groundswell starting right now to really move us into being more of a leader in solar energy than we are today.”

Yet, for all the hype, there are several factors Phoenicians will have to come to grips with if Arizona is to become a solar star. Maybe it’s best to express them using a prop we can all understand: food.



The turbine room at Palo Verde Nuclear Generating Station Unit 1, which set the record for most electricity produced by any nuclear power plant worldwide in 2009

Solar Energy: It’s in the Oven

Think of your home electricity as a loaf of bread. You’re not always aware what’s actually in the bread (OK, we know there are food labels, but just work with us here); you just see the finished product. You buy it, consume it and go about your day.

The bread has numerous ingredients, and until very recently, they were the cheapest ingredients around. But over the past 10 years, breadheads started realizing that some of the ingredients (i.e., nuclear power and fossil fuels) were actually harmful and problematic, and that the bread wasn’t all it was cracked up to be.

They started reading the label. They wanted fresher ingredients that made the bread more organic and nutritional (i.e., renewable energy from the sun, the wind, the earth and water sources). In short, they were sick of the starchy, white, processed stuff you can pick up for a buck; they wanted the good, all-natural stuff that was going to help them grow up big and strong without polluting their bodies.

And they were willing to pay extra for it – even drive out of their way for it. (We’re talking to you, Whole Foods.)

Now think of your local utility company as the bakery. After making the bread for decades, the baker notices this new trend with passing interest – until the health department steps in. The breadheads decide who gets to manage the health department, and they’re demanding an answer to this frumpy, lumpy loaf.

Health officials, a.k.a. the Arizona Corporation Commission, decide the bakery must offer a certain amount of high-quality, organic bread to its customers. And the bakery is only given so much time to find the right mix of ingredients so it can make enough bread to satisfy this new demand without hurting its business model. If the bakery does not comply, the health department will punish its business.

Congratulations. You’ve just graduated from Energy 101.

Thanks to the Great Bread War, Arizona is now on the cusp of doing something truly incredible. It turns out we have a nearly unlimited supply of a single bread ingredient – solar power – that will not only make a healthier loaf but also sprout tons of new opportunities for workers who will harvest and gather that ingredient for the state’s biggest bakeries.

However, this isn't like making cupcakes in an E-Z bake oven. All consumers – not just the breadheads – will end up paying substantially more than they're used to so that the bakeries can offer this new loaf to everyone. Gathering this new ingredient will be expensive at first but become incrementally cheaper with each passing harvest (a season that lasts for more than 300 days per year, based on Arizona sunshine) and as new technology makes the bakery more efficient.

One reason for the up-front expense is the equipment involved. Most of the tools used to gather the solar ingredient are only operating at full capacity about 20 percent of the time. This means the bakery must buy more of the solar ingredient elsewhere to keep the same amount of bread available for everyone – and meet the demands set by the health department. And after sundown, the ingredient can't be harvested or stored in a silo until work begins the following morning. But this new, healthier bread is still in the oven. We can smell it, but the perfect loaf still faces several challenges.

Rising Costs

Have you read your electric bill lately? Take a close look at the line-item charges that comprise the balance. Prices next to items that use terms such as "Environmental Programs Cost Adjustment Factor" or "Green Energy Premium" could increase substantially every year in the coming decade as utility companies rush to meet a state requirement that they obtain at least 15 percent of their electricity from renewable sources by 2025.

The public has called for green energy and energy independence (the perfect loaf), and utility companies (bakeries) are responding with new programs – and new charges. Customers could bemoan these costs, but they should also consider the bigger picture without solar power, says Steven Gotfried, a renewable energy spokesman for Arizona Public Service Company (APS), which provides electricity to more than 1.1 million customers in the Phoenix-metro area. That alternative could include energy sources that are environmentally unfriendly and subject to wild jumps in prices or costly new regulations, such as uranium, coal or natural gas.

"Bills are going up if you want more solar, but what are you getting in return? You're getting more of a levelized [energy source]. Your bill will be more stable," Gotfried says. "You are also hedging against future regulatory actions and a tax on carbon. So how much does that cost? How does that fit in the equation? Solar is climate-friendly, so that fits in the equation as well. It's just not the price that you're paying. There's also the value you're receiving for it or the cost of not doing it."

The bakers at both of the Valley's major utility companies, APS and SRP, are now calculating just how high the increases are expected to be in order to help them buy into enough projects to meet the Arizona Corporation Commission's 2025 goal. And this is critically important because it will determine how many projects are built, how many jobs are created and whether Arizona could ever harness its blessed sunshine to export power outside of state boundaries, turning the state into the Southwest's Middle East.

A recent survey by SRP offers a glimpse into what could become the new normal for our electric bills. In February, the utility asked 423 of its customers how much more they would be comfortable paying each month to support renewable energy programs. The average SRP residential customer currently pays \$133 per month for electricity, including about \$4.50 to support environmental programs.

In the survey, the choices for the possible increase included zero, \$57, \$160 and \$391 per year. Seventy-one percent of the respondents said they were willing to pay \$57 more each year – about \$4.75 more per month – through 2020 to support electricity sources that reduce greenhouse gas emissions. About 43 percent were willing to pay \$160 more each year – about \$13.33 more per month. About 22 percent were willing to pay \$391 more each year – about \$32.50 more per month.

Seventy-one percent said climate change is a serious problem that demands action now. But the largest energy consumers – retail, commercial, agricultural and industrial businesses – expressed concerns about increases at a March meeting hosted by SRP.

Singleton was pleased with the results, even though almost three-fourths of SRP's respondents rejected the maximum increase suggested by the survey – which is the amount SRP projects it will need to support more renewable energy sources for its customers.

"I think we all thought everybody would say zero, because we're hearing from our customers

that they're strapped," Singleton says. "They're losing their houses, losing their jobs."

But one observer says the results raise some serious social questions about Arizona's solar energy future. Jeff Luth, a Scottsdale communications executive who studies renewable energy issues, says the survey's findings show how Arizonans have their priorities mixed up. In a blogpost for Valley Forward, a regional nonprofit that looks at sustainability issues, Luth wrote about how people seem more willing to pay more for personal entertainment than to invest in renewable energy projects, of which solar is the main ingredient for SRP and APS.

"We're paying \$75 a month to have all these channels so we can get Ultimate Fighting on demand. We're paying almost the same amount of money to have these smartphones so we're untethered – and all these other things that are individually important for us as members of whatever society we're in," he says.

"I was just struck by the fact that a household seems to be willing to spend several thousand dollars per year on cable TV and phone service and Internet service and all of these things which are all important in their own way," Luth adds, "but we don't want to spend more than \$57 per year by 2020 to help develop substantially robust sources of clean energy? That's kind of odd."

APS officials are also contacting their customers for feedback. Working with members of Arizona State University's Morrison Institute for Public Policy, the utility also brought in the Sierra Club and other community organizations to teach a small group of its customers the ins and outs of the energy business, Gotfried says. They were asked last fall for their opinions on various energy topics, including solar energy, and then asked again once the sessions were over. The goal was to come up with a curriculum to show the public the advantages and drawbacks of every form of energy, from solar to coal power.

A public report on these sessions had not been released at press time, but the findings will play a large role in determining what APS will eventually charge its customers for more solar energy.

Trade-off: Economic Opportunity

If rising costs are the bad news, here's the good news: All those investments and development subsidies for solar energy are creating potentially thousands of new jobs around the Valley.

In 2006, the Arizona Corporation Commission passed the renewable energy standard that required major utility companies in the state to obtain more electricity from renewable sources. After the real estate bubble popped in late 2007, local officials began scouring the landscape for ways to fill the void left behind by the construction industry.

Since then, tax-credit incentives for residents and businesses to install solar panels have met with generous relocation incentives for businesses and a jobs bill (the subject of *Hot Topics* in our October 2010 issue) from Republican Governor Jan Brewer that makes the Valley labor pool more attractive. Sprinkle that wad of cash we pay in our electric bill into the mix, and suddenly Arizona's new bread starts to rise.

Recent headlines show this strategy is working:

- **Suntech**, the world's largest producer of crystal and silicate cells that go into solar panels, opened a 100,000-square-foot factory in Goodyear in 2010 and should have 150 employees by the end of this year. It's the Chinese company's first U.S. manufacturing facility.
- **Power-One**, the world's second-largest producer of inverters, which convert solar energy into electric current, opened a 120,000-square-foot factory in south Phoenix in January. It will create up to 325 new jobs.
- **Rioglass Solar**, a Spanish company that makes mirrors for certain solar arrays, opened a manufacturing plant in Surprise late last year, creating up to 100 new jobs and \$50 million in capital investment. The company's curved mirrors will be used in the Solana Generating Station, an APS-owned all-solar power plant near Gila Bend that will use the sun's rays to heat molten salt.
- **Gestamp Steel**, a Spanish company that makes the steel frames for solar projects,

announced in February that it will open a 75,000-square-foot plant in Surprise. The new plant will employ 50 people and involve an initial investment of \$10 million. The plant will contribute parts for a major solar-thermal power plant in California's Mojave Desert.

- **SolFocus**, a company based in Mountain View, California, expanded its manufacturing plant in Mesa in April 2009. The plant makes mirrors for concentrated-solar power projects, which capture more of the sun's rays than traditional solar panels.

- **Amonix**, a southern California company that builds concentrated-solar power projects, will build a manufacturing plant in the Phoenix area that will create 167 jobs.

- **First Solar**, Wall Street's solar darling, is expanding from its Tempe headquarters into southeast Mesa, where it plans to invest \$300 million and create 600 jobs by opening a new plant on 135 acres next spring.

Major investments like this drive down the cost of gathering and harvesting the ingredient by attracting talent and new ideas. Researchers at Arizona State University's LightWorks program are looking at new materials that would capture more sunlight than the current solar panels (today's panels gather up to 18 percent of the sun's rays, Singleton says, while the next wave may capture up to 40 percent). Small startups are playing with ways to apply thin-film solar panels to buildings like canvas, turning them into small urban power plants. Singleton says one of the most interesting innovations is the solar roof tile, a dusky-hued version of the tiles that have become an icon of suburban architecture. Bye-bye, solar panels in ugly metal frames.

Other methods that have been used to harvest sunlight elsewhere in the world are finally landing in the U.S. Because traditional solar panels harvest less sunlight in high temperatures, power plants using parabolic troughs to focus the sun's rays on a heating fluid that turns water into steam are entering the marketplace in Arizona and the Southwest. These systems are a breakthrough because they can store the heat that creates the steam after the sun sets. The Solana Generating Station in Gila Bend, for example, will store electricity for up to six hours after sundown, Gotfried says.

However, the storage question is still the Achilles heel of solar energy. Palo Verde Nuclear Generating Station generates up to 4,020 megawatts of electricity, and it stays on 24/7; by comparison, Solana Generating Station, the biggest of the solar power plants, is expected to generate 250 megawatts of electricity from sunup to just after sundown.

While some people have proven that living "off the grid" with solar panels and a shed full of batteries is possible, the storage issue for an entire city using solar power is much more complicated.

Although new technologies are emerging, none of them has exceeded Solana's capabilities or is converting solar energy into electricity after sunset for a major city. This summer, Gotfried says, APS will test a Canadian company's new battery technology at one of its northern Arizona power stations to see if it can store electricity gathered from the sun and release it to the grid on demand. Another company, Salt Lake City-based Ceramtec, is playing with a refrigerator-sized battery that residents who have solar panels on their house can buy for around \$2,000 to store and release electricity for four hours – without the battery getting too hot, becoming too corrosive, or lasting less than 10 years. Popular Mechanics magazine declared it one of the "10 Most Brilliant Innovators of 2009."

Other new technologies are promising better results. EnviroMission, based in Melbourne, Australia, is staking its future on Arizona's solar scene – and that of the Southwest in general – by building giant towers that use a "chimney effect" to create electricity from the sun's rays. They heat enclosed collectors along the ground – much like your garden-variety greenhouse – which pipe hot drafts of air up a 2,400-foot-tall chimney. Inside, the winds turn large turbines. Unlike Solana, the towers use no water and can reliably generate electricity through the entire night and sunless days because they are based on thermal energy, says Chris Davey, president of EnviroMission's U.S. headquarters, which is located in Phoenix's Biltmore area.

Sure, the towers are twice as tall as New York's Empire State Building. But like all things environmental, think of the bigger picture, Davey says. "It is truly the most benign technology out there. Yes, there is a tall chimney, but that's all there is," he says. "I would prefer to live next to that as opposed to some of the other technologies, from an environmental perspective."

EnviroMission's project in La Paz County will create 1,500 construction jobs to build the 200-megawatt power plant, which will supply southern California. It is set to come online at the end of 2014, Davey says, and the company is pursuing other projects near Maricopa County to support customers there.

Davey says the company changed its focus to Arizona because Australian officials throttled back on their commitment to renewable energy sources. Brewer and the Greater Phoenix Economic Council, meanwhile, were offering attractive financial incentives, a friendlier development climate and publicity on the issue, he says.

"With perception, there is reality. Because there is so much talk about Arizona becoming the solar capital of the world, or the Saudi Arabia of solar, you've got the immediate groundswell of support for the pursuit of these technologies," Davey says.

Another question mark is just how many jobs are being created by all this baking. Singelton says SRP is working with ASU graduate students on a research project that would determine just how many jobs have sprung up as the result of solar power efforts. She says the results should come out in December.

However, not all jobs are created equal. Many of the immediate jobs will be short-term construction jobs to build these solar power and manufacturing facilities – the equipment that harvests and gathers that main ingredient.

For example, one solar power plant could create more than 1,000 jobs for a few years, but after it's complete, the plant only requires about 50 to 100 people to operate it, says Tom Campbell, a Phoenix attorney who specializes in regulatory and renewable energy law for Lewis & Roca and was a legal adviser for Solana Generating Station. That project will generate 1,500 construction jobs up front and 85 high-tech jobs in the longer term.

Campbell estimates there are six to 10 large-scale solar power projects that have been approved by the Arizona Corporation Commission, with another 30 to 50 in the conceptual stage. Many of those projects are held up by issues related to financing – nine-figure loans are hard to come by after the real estate collapse – and infrastructure, such as adequate transmission lines to carry all that sun-powered electricity from outlying areas to the city grid.

Long-term employment, however, will come from manufacturing jobs. These workers will make parts that are included in multiple solar power projects around the country, which means demand will remain more steady, Campbell says.

The key factors going forward, he says, will be continuation of government subsidies for solar power and decisions that will expand transmission capabilities so solar projects can get their product to the market that needs it. The latter must come from members of the Arizona Corporation Commission.

"For us to be the solar capital, you have to be able to sell into California, because that's a huge market," Campbell says. "I think having some certainty for these developers to know they can get their product to market is probably the critical factor. I think approval and development of transmission is the single most important thing [commission members] can do."

Everyone interviewed for this column agrees that solar energy is our energy future. It will be a main ingredient in every loaf of bread. That's because Arizona has harnessed as much hydroelectric power as feasibly possible, and because wind energy – which has also seen a spike in popularity thanks to better technology – is too sporadic to depend on for electricity when Phoenix temperatures top 100 degrees and the Valley's collective air-conditioning units drone on all day.

Nuclear power will be the "baseload" ingredient, which means Palo Verde will be a critical part of the recipe going forward. On April 21, federal officials granted the plant a 20-year extension on its license, meaning it will operate through 2047 – a total lifespan of 60 years.

The Main Ingredient

The turbine room for Palo Verde's Unit 1 nuclear reactor is as spacious as an airplane hangar. Parked inside is a giant turbine assembly installed by General Electric in 1986. It is painted mustard yellow, which looks even more yellow under the fluorescent lights along the cavernous ceiling.

Steel grates in the floor offer a view two stories down into the industrial piping, gauges and electrical equipment guiding steam from the nuclear reaction next door toward the turbine

blades.

The blades turn a driveshaft, and that's it. That's Palo Verde. Every activity on the 4,000-acre property ends here.

The first thing you feel is the heat. Then you feel the steel floor gently vibrating like a tuning fork. Dwayne Carnes, a Palo Verde plant manager who oversaw Unit 2 before he retired earlier this year, walks up to the turbine. He turns to the group, which is wearing hard hats and earplugs for protection, and waves his hand over the generator.

"This is the moneymaker!" Carnes shouts. "The whole thing – the whole plant – to run this!"

On the generator door there's a sailboat-sized porthole that offers a view of a steel shaft spinning at a calm cruising speed of 1,800 rpm. Everyone takes a turn looking at it as it pumps electricity to the Phoenix-metro area and southern California.

A series of dials is perched along the side of the generator. Their needles are quivering – but holding steady.

—Peek inside Palo Verde with an image tour of its grounds and Unit 2 nuclear reactor at phoenixmag.com/extras.