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**Energized for  
the Future**

# Introduction



Dear Colleague,

Welcome to the University of Washington Clean Energy Institute's publication, **"Energized for the Future."**

We believe that 2035 will be a crucial year for Washington state energy and power; indeed, two decades from now, the entire energy landscape could be transformed, not just in our state, but globally, too.

That's why this publication brings together some of Washington's leading thinkers on energy.

In the future we plan to expand this publication to include a range of experts; but, in this first installment, please be sure to read:

Maggie Brown, APCO Worldwide Executive Director—**"Our Energy Future in 2035 Depends on New Technologies, Talent, and Mindsets"**

Kevin Klustner, Powerit CEO—**"Game-Changing Clean Technology Is Essential for the Energy Economy of 2035"**

Ronald Litzinger, Edison Energy President—**"Getting the Distributed Grid Ready for the Big Energy Challenges of 2035"**

Rick Luebbe, EnerG2 Co-Founder and CEO—**"Leadership Is an Essential Variable in Washington State's Energy Equation For 2035"**

Daniel Malarkey, 1Energy Systems Vice President of Business Development and Public Policy—**"Transforming the Utility Industry Will Help Smooth the Way to a New Energy Future"**

Gary Shaver, Silicon Energy President—**"Washington State Needs a Long-Term Master Plan to Prepare for the Energy Economy of 2035"**

Jud Virden, Pacific Northwest National Laboratory Associate Laboratory Director for the Energy and Environment Directorate—**"Will the Energy Economy of 2035 Mirror the Energy Economy of 2015?"**

If you'd like to discuss any of the ideas or perspectives in this publication—or where Washington state's energy future is headed as we approach 2035—please be in touch with me.

I look forward to connecting.

Sincerely,

A handwritten signature in black ink, appearing to read "Dan Schwartz".

Daniel Schwartz



# Our Energy Future in 2035 Depends on New Technologies, Talent, and Mindsets

By Maggie Brown  
Executive Director  
APCO Worldwide



The energy economy of 2035 will be driven by incredible advances in technological innovations that promise to radically alter the energy industry as we know it, and will only intensify over time. Technology, combined with Big Data, will lead to energy systems that not only will promote a more diverse resource mix, but will allow end users to both generate and manage a larger share of their own energy. Precise data will provide energy consumers—small and large, residential and commercial—with the information they need to manage their energy demand and usage, resulting in decreased costs and increased performance.

The energy mix in 2035 will continue to be diverse. Oil and gas will not go away, but they will be cleaner and more efficient. Just look to the Middle East, where they're beginning to deploy carbon capture, use and storage technologies for emitting pollutants. Twenty years from now, renewables will increase their market share because of better and more cost-efficient storage technologies, increased energy efficiencies, and more distribution generation and microgrids.

Against this background, I believe the critical piece that fundamentally will impact the design of our energy systems in 2035 is the stress nexus of energy, food and water.

As the world's population continues to grow, demand for these resources will rise exponentially. Rapid population growth in emerging economies will boost demand for agricultural commodities and urbanization will shift patterns of resource generation and consumption. Energy demand will strain finite fossil fuel resources. And water will become more costly as demand outstrips supply. The effects of climate change will magnify the problem by causing severe droughts, shrinking watersheds and altering the global distribution of productive agriculture.

In developed countries especially, cities increasingly will be forced to satisfy—and resolve—the competing needs for energy, water and food, while being centers of economic growth. Cities comprise only 2 percent of the world's land mass, yet emit three-fourths of global carbon emissions. A total “rethink” of how cities—and the energy systems that support them—are built, retrofitted and operated is necessary.

In essence, we'll need the smart home to become the global norm. And we'll need to see a more personalized energy system, with utilities moving away from the 100-year-old centralized, one-size-fits-all, command-and-control distribution model. People should be able to choose the type of energy they use and when they use it.

This means a new model that is distributed, powered by renewables, and supported by next-generation batteries, energy storage and electric vehicles.

What about the world's rural areas? Many are served today by unreliable, costly and dirty energy—if they have electricity at all. The beauty of distributed generation is that these areas will not need to model the developed world with its costly and inflexible grid network. They can leapfrog into the future with off-grid solutions powered by cleaner, less costly renewable solutions. Think telecommunications, when we saw parts of the developing world skip expensive land-line infrastructure and jump a generation to cell phone technology. Parts of Africa and South America are already powered by 100 percent off-the-grid renewables.

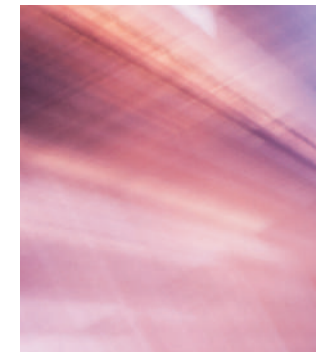
Here in Washington state, increasing research and development and public-private innovation are central to our energy economy in 2035. A good model is the Washington Clean Energy Fund. We also must continue to invest in our unique research and higher education institutions. From UW's Clean Energy Institute to WSU's bioenergy research to WWU's four-year undergraduate program in new energy leadership, the emerging generation of leaders in this space is inspiring.

Stable policies and regulations, nationally and globally as well as statewide, are fundamental to advancing the research and innovation that will make Washington state competitive in the new energy economy. Effective communications has a role to play here. Decision makers need to understand the economic opportunities that will accrue to Washington state as an energy leader—and what's at stake if we are not—and key influentials need to be kept informed so they can hold decision makers accountable for their actions.

Lastly, any discussion about the energy economy of 2035 must avoid talking about winners and losers. If we really want to get there, and get there in the right way, let's focus on the economic opportunities a new energy economy can create. This is something millennials understand. Let's convince everyone else.

If we continue to invest in new technologies, nourish the profound intellectual capital in Washington and beyond, and develop new ways of looking at how we deliver and consume energy, then a bright energy future is ahead for us all.

**Maggie Brown** is an Executive Director at APCO Worldwide and manages the Seattle office. She also leads APCO's global Energy & Clean Technology practice. Her background combines a decade of experience as a professional journalist with 30 years as a public affairs, communication and media relations consultant. She serves on the Executive Committee of the Washington Clean Technology Alliance; is a member of the University of Washington Clean Energy Institute Advisory Council; and is on the Leadership Council of the American Council on Renewable Energy (ACORE).



# Focusing on Game-Changing Clean Technology Is Essential for the Energy Economy of 2035

By **Kevin Klustner**  
CEO  
Powerit Solutions



Our future energy portfolio in 2035 will come from a wide variety of sources. The core of the energy mix will be much more diverse than oil, gas and coal. Renewables will comprise a significant portion of supply. And, over the next 20 years, battery/storage technology and scale will drive pricing of storage down to an economically feasible price point. This affordable pricing process will be similar to what solar has undergone over the past 15 years.

I also believe that local, on-site electricity production will become an increasingly material part of the supply chain. This will replace what we frequently see today—produce it here, deliver it there and then accept the inefficiencies and losses that occur from long-range electricity distribution.

There will still be plenty of challenges in the energy economy of 2035, however.

One of the biggest issues will be rationalizing the production/delivery infrastructure. Coal- and oil-fired power plants will need to be decommissioned and taken off-line in an orderly manner. At the same time, utility-grade and coal renewables will increase in importance—as will storage. This will dramatically impact the business models of the ISO's and utilities—disrupting their profitability and their ability to deliver dividend checks. It may even make some utilities economically unviable.

But I also look at significant opportunities as 2035 approaches.

Huge strides have already been made when it comes to renewables and energy efficiency.

The cost of solar and wind have come down to the point where they are economically viable.

Battery/storage will follow the same cost/MW arc over the next 10 years. And there is a tremendous amount of innovation going on in terms of using less energy—demand management, for example; electric cars replacing carbon-based cars; and self-sufficient, facility-based microgrids.

The biggest opportunity, from my perspective, is thinking about supply and demand in concert, and as an ecosystem. This means using renewables to replace fossil fuels and state-of-the-art techniques to optimize demand.

More specifically, if I had to choose the three most important things that we need to do to get ready for the energy economy of 2035, they would be:

- Improved grid reliability and infrastructure that allows participants to bring local energy onto the grid and sell excess energy back into the grid. This will provide a platform for market-based, buy-sell programs to balance the grid.
- Increasing innovation around storage that allows for utility-grade and local-grade storage to become economically viable.
- Improved transparency on energy costs, energy utilization by location and load within any location across utilities. Transparency is essential to develop optimized delivery, demand response participation and grid stabilization.

Looking at Washington state's energy future, my company is currently working on local microgrid management and optimization that allows a facility to balance demand management, real-time pricing, demand response and the supply of local generation. This is important as we approach 2035 because it enables customers to automatically optimize energy consumption against the price of electricity coming off the grid versus the availability of stored energy and renewables and the buffer that's available from reducing loads in real time.

What we're doing is just scratching the surface. I think our state also needs to push forward with the current administration's efforts around a carbon-reduction tax. The proposal clearly isn't comprehensive, but it's a start—especially if we're looking thoughtfully at the energy economy of 2035.

We also need more joint initiatives between university research and local companies that can commercialize and publicize game-changing clean energy technologies, products and services. And I think an alliance/industry group (like the Open ADR Alliance, for instance) that represents all the research organizations and private companies that are focused on innovative energy is important to advance clean technology and elevate the state to a leadership position in the field.

There's absolutely no reason that this can't happen. Washington state has world-class academic institutions and research organizations, a well-educated work force, deep understanding of IT and technology, and a population that's tuned into, and supportive of, a more energy efficient world.

All of this will make a vast difference come 2035.

**Kevin Klustner** is CEO of Powerit Solutions, a Seattle-based international clean technology company that sets the demand management standard. Powerit's Spira DM™ technology links industrial facilities with the smart grid, so customers can control energy use for savings and sustainability. Klustner's prior executive positions include serving Verdiem Corporation as president and CEO; Coastal Environmental Systems as managing director; Sightward Inc. as president and CEO; and WRQ as COO and VP of sales and marketing. He launched his career at Hewlett-Packard in strategic planning and product management.



# Getting the Distributed Grid Ready for the Big Energy Challenges of 2035

By **Ronald L. Litzinger**  
President  
Edison Energy



Predicting the future in the energy business is difficult for five years, let alone 20 years. That said, we feel the “better bet” is a future energy system that will be a lot more distributed as compared to the largely centralized grid of today. There will be much more generation and storage at the individual customer level. Power will flow in both directions—to and from the grid—not just in one direction. As a result, we will need much more sophisticated digital controls, using monitoring and protection systems that will operate much smarter than the largely electro-mechanical devices of today.

While we believe this is where things are heading, a fully centralized grid isn’t going away anytime soon. Instead, it will gradually become more distributed, facilitating choices for customers in the process.

The biggest delivery challenge will be upgrading the distributed grid, or network, for two-way power flows. This won’t be like the one-direction radial systems that we currently have, so we will need to adapt, and it will be complex. A lot of intelligent control systems will be needed.

The major production challenge will be bringing down the cost curve for distributed generation and storage technologies. We’ve seen this happening with solar. But going forward, all energy sources will have to compete without subsidies. Storage and fuel cells still have a long way to go on the cost curve. We believe all this will get resolved, though; it’s just a question of when, not if.

So much of what we do in the coming years will be focused on storage—the biggest opportunity in the emerging energy economy. This is the Holy Grail, plain and simple, when you’re looking at how energy systems will work in 2035. So many distributed energy resources are intermittent in their production and as such storage technologies are critical to balancing generation and load in real time.

There’s so much that needs to happen over the next 20 years, but if I had to pick several essential items on my energy economy of the future to-do list, I’d say we absolutely have to have affordable storage, low-cost distributed generation systems, and a plug-and-play smart grid that helps facilitate all these devices working together and meeting customer needs.

At Edison International, we’re working towards this new energy future at both our regulated utility business and our competitive energy businesses.

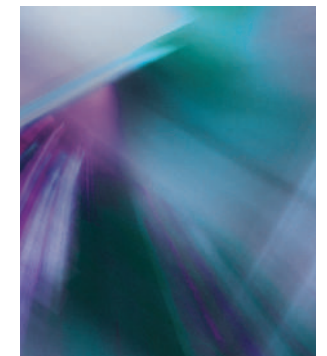
At our utility, Southern California Edison, we’re spending our time and resources on distribution grid readiness. We have to get the grid ready to accommodate California’s new energy policies as well as the steady stream of clean technology breakthroughs.

On the competitive side of our business, our focus is on delivering low-cost distributed generation and cost-effective energy efficiency and demand response. We continue monitoring storage technology developments. And, we have already completed several combined solar panel and battery storage systems to reduce both energy costs and demand charges for large commercial customers. We do, however, recognize that subsidies are required for these systems today. Planning ahead, we want to remain technology agnostic, so we can continue to package solutions for customers.

I look at Washington state and feel that it should pay close attention to other states like New York, California, Minnesota, Colorado and Massachusetts—they’re all actively engaged in shaping the energy future.

But this is hardly an exclusive club. The energy environment that looms large in 2035 will be complex and challenging, and we’re going to need every great policy, process, program, innovation, idea and initiative that we can lay our hands on in order to keep generating prosperity and productivity for communities everywhere.

**Ronald L. Litzinger** is president of Edison Energy, the competitive businesses arm of Edison International. He is responsible for overseeing a portfolio of competitive subsidiaries and investments in emerging sectors of the electric industry that includes SoCore Energy, Edison Transmission, Edison Energy Solutions, and several minority interests in emerging energy companies. Previously, Litzinger was president of Southern California Edison (SCE), the regulated subsidiary of Edison International and one of the nation’s largest investor-owned electric utilities. From 2008 to 2010, Litzinger was president of Edison Mission Energy (EME), a competitive power generation business of Edison International at the time. Litzinger joined Edison International as an engineer at SCE in 1987. Before joining Edison, he was an engineer for various Texaco subsidiaries. Litzinger is a member of the Visiting Committee at the University of Washington’s College of Engineering. He earned a bachelor’s degree in chemical engineering from the University of Washington and a master’s degree in management from the University of Redlands.





# Leadership Is an Essential Variable in Washington State's Energy Equation For 2035

By Rick Luebbe  
CEO and Co-Founder  
EnerG2



When I look out 20 years, I see a future energy system that is a more distributed and a lot more efficient. The centralized inefficiency problem that we currently wrestle with will be greatly mitigated, and we'll be matching the variability of supply and demand much better. There will likely also be a sophisticated distributed storage component in 2035.

Obviously, we face challenges in getting to this 2035 system. Matching supply and demand, especially with less controllable renewable energy sources, is definitely an area that we need to work on proactively. I also think that the tremendous anticipated growth in generation in developing countries is a huge issue that must be addressed—especially if we want to follow an eco-friendly and lowest-cost path.

There are some solid opportunities here as well.

For example, I think that if we can crack the code on distributed generation, implementing the generation of power in our homes, or on local micro-grids, in a way that is based on renewables, then eco-friendly, distributed generation can become a very real positive solution for vastly improved energy efficiency. It would also enable a much more rapid and eco-friendly path to providing energy capacity to developing economies that is inherently flexible, low capital investment, and faster to implement.

There are a number of things that we have to do, however, to realize our true energy potential by 2035.

First, we need to solve our localized energy storage problem so that it enables distributed generation and allows us to match unpredictable generation with consumption at the local level.

Second, we need to electrify vehicles. We just shouldn't be selling or buying gasoline vehicles in 2035.

With an eye on today—and an eye on the future—my company, EnerG2, is trying to help by developing and manufacturing advanced nano-structured materials for next-generation energy storage breakthroughs.

In terms of Washington state, we have all the capabilities, all the expertise and all the pieces that are needed for the energy future.

But, in my view, we haven't been able to develop true leadership that helps put all these pieces together. Too many people, too many companies and too many organizations are just doing their own thing. We need better coordination. And it may be that we need what I call an "anchor tenant"—or one central entity—to focus in and blend it all together. This "anchor tenant" provides the critical mass required to focus regional technical and manufacturing expertise in specific areas enabling more coordinated and accelerated growth. Boeing and Microsoft are good examples of regional industrial "anchor tenants" for other industries. We need the same approach for energy.

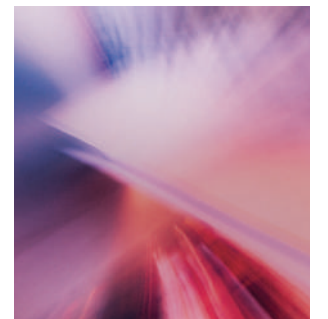
We also need more public-private efforts. And we need to find ways to bring state, local and federal energy initiatives together with private sector support and coordination.

Most importantly, at least from my perspective, Washington state has the right attitude and the right culture as it works its way toward 2035 in the world of energy.

And we have the right players—whether it's the University of Washington, Washington State University, PNNL, Puget Sound Energy, or an assortment of private sector companies—to serve as our "anchor tenant."

My bottom line is that Washington has the promise and potential to be a genuine and innovative leader in the new energy economy of 2035, but we won't be able to realize this extremely important and valuable possibility unless—and until—we coalesce around an institutional or organizational hub that can seamlessly meld and channel our collective efforts.

**Rick Luebbe** is CEO and Co-Founder of EnerG2, a Seattle-based company manufacturing advanced nano-structured materials for next-generation energy storage breakthroughs. Prior to EnerG2, he was CEO and Co-Founder of Hubspan, one of the Web's lasting business-to-business integrators. He has also served as a management consultant with Booz Allen, and he began his career as an Army aviation officer.



# Transforming the Utility Industry Will Help Smooth the Way to a New Energy Future

By Daniel Malarkey  
Vice President of Business Development and Public Policy  
1Energy Systems



What will the energy system look like 20 years from now—in 2035? Well, it will certainly be less carbon intensive, more distributed and more electric.

And my company, 1Energy Systems, is trying to help change today's electric utilities so that they're able to flow into this very different future.

If you think about it, utilities right now are where the telecom companies were in the 1980s. The telcos had a comfortable regulated monopoly, and then a wave of innovation in the form of cellular and internet technology came at them and disrupted their business model. Some adapted and some didn't. That's what we're seeing now in the utilities industry. And how this turns out will have a tremendous impact on the energy economy of 2035.

Following this line of thinking, the biggest energy challenge we now face is in the institutional and regulatory areas, and we need to ask ourselves how quickly these systems can adapt to new clean technology.

I don't want to minimize the clean technology challenges we face in terms of boosting efficiencies and driving down the costs of solar and energy storage, but we won't get the scale of deployment of these new clean energy technologies without changing some of the outdated legal and regulatory frameworks that govern utilities.

In addition to changing the regulatory structure for utilities, we must build support with policy makers to put a price on carbon. More regions and countries are taking this sensible approach and it represents a huge opportunity to reduce carbon emission and advance clean technology.

With the right price signals and regulatory framework, we can zero in on the investments that need to be made in our energy infrastructure and in innovative clean technology solutions. I like the way the University of Washington is already doing more research on new energy materials and advanced photovoltaics. And I'm confident that these breakthroughs will become economically viable alternatives that can successfully compete with fossil fuels.

There are other glimmers of light today as well. Power electronics, for example, hasn't been a hot area for research, but now these departments in universities are

starting to attract some of the best and brightest young minds we've got. This is a very good development for the future of our energy economy.

My company is very attuned to that energy economy of 2035. And that's why we're working to make sure that software enables the electric grid of the future. We envision a key role for software as it helps to manage and optimize the growing number of distributed energy sources. Having said that, we're still trying to figure out how utilities can deploy software using open standards to orchestrate and bring down costs.

We're not the only ones working on the energy future in Washington state. Our higher education institutions are engines of innovation and they're spinning off some great new ideas and technologies that will really matter as we head toward 2035. We need to keep investing in these institutions in order to successfully grapple with the energy issues that await us.

One of the best ways to do this, in my view, is to establish and cultivate ecosystems in Washington state that include research-oriented institutions of higher education, companies and customers.

I absolutely believe that we can move in this direction, because our state has clear competence and expertise in the clean energy sphere; we also have the software chops; and we have the necessary deep scientific resources. Mostly, though, we have people who can really see a clean, green and prosperous 21st century economy.

**Daniel Malarkey** is Vice President of Business Development and Public Policy for 1Energy Systems, which provides software for grid-connected energy storage systems (ESS) and other electric energy assets. He has over 30 years experience in technology and public policy and recently served as the Deputy Director for the Washington State Department of Commerce, where his duties included management and policy leadership for the state energy office and state broadband office. He has held senior positions at Amazon.com, as an investment banker to local governments, and as an economic and management consultant. He is a frequent speaker on clean technology and economic policy issues.



# Washington State Needs a Long-Term Master Plan to Prepare for the Energy Economy of 2035

By Gary Shaver  
President  
Silicon Energy



The energy system of 2035 will be much distributed in nature with a variety of safe, clean generation technologies and load smoothing technologies like battery storage. The centralized spoke and wheel control system of today will give way to a more dynamic model that can react more quickly and efficiently to the changing needs of the electrical grid and those that connect to it.

Additionally, customers will be able to choose the utility that provides them the best service and product offering. The new utility model will see utilities focusing more on the generation and infrastructure needs of industrial users while taking on more of a service role in upgrading and maintaining the smaller volume needs of the residential market. This market will continue to see reduced energy delivery needs from the utility through a combination of conservation, more efficient appliances, and onsite generation such as smaller photovoltaic (PV) systems sized appropriately to the energy needs of the residence and electric vehicles. As a result, the utility will be able to use smaller, more efficient electric distribution lines that incorporate super conductive technologies to support the residential market. This is quite different from the role of utilities today.

The biggest challenge in all this will be overcoming our present understanding of energy generation and distribution. Generally, we try to fit new concepts and technologies neatly into our preexisting frameworks that have served us well historically. However, this handcuffs the full potential of these emerging disruptive energy technologies. As a result, it will take time and careful planning to intelligently transform our energy infrastructure to match the capabilities of these new technologies and the challenges of these new technologies such as potential vulnerability to cyber attack.

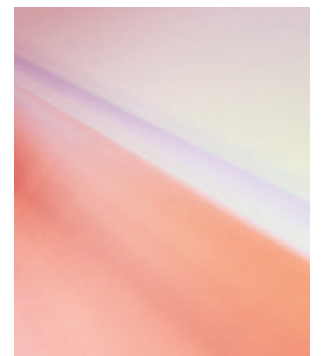
For our part, our company is trying to prepare itself for emerging energy markets by working with technology partners to better integrate our products into our built environment both mechanically and electrically. Presently, there is clearly a strong interest by the public in clean energy, but it is centered primarily on least cost and ROI comparisons against heavily subsidized fossil fuels or just being a lucrative investment that feels good. As a result, the market is flooded with commodity PV modules with little true differentiation; but we're looking well beyond this, to a new market horizon, and to a time when the market can embrace differentiated products.

When I look at Washington state, and how it will embrace the new energy economy of 2035, my first thought is that we need to step back and carefully consider how we want this new energy economy to look. We need to identify the key critical thinkers in energy and recruit them into energy leadership positions within our government to provide vision and guidance for the present and future. In order for us to look forward and prepare for this energy future it is my belief that these critical leaders will need a balanced background in environmental sustainability, economic development, business management, and sustainable technology. One of the key tasks is to prepare our state's governmental agencies for the energy economy that is coming. Another task is to make absolutely certain that our state is doing all that it can to support clean technology innovation here in Washington to create local economic development, support local job creation, and support the critical relationship between manufacturing and institutions of higher learning in the sciences and engineering.

We have the capabilities to achieve this, but we need strong leadership with vision and commitment that can look forward based on the experiences of the past and plan for the future in a world with evolving technologies and challenges.

Washington state has great depth in science and engineering. If fostered, there's no reason to think that we can't succeed on this energy path to 2035. We just have to evaluate what we want to do going forward and then craft a long-term master plan that helps us make this important transition.

**Gary Shaver** is President of Silicon Energy. Located in Washington and Minnesota, Silicon Energy offers customers durable, locally manufactured and environmentally friendly solar PV products. Prior to his current post, Shaver was Operations Manager at Silicon Energy. He is a member of the Climate Solutions Business Partnerships Advisory Council, the University of Washington Clean Energy Institute Advisory Council and the Shoreline Community College Clean Energy Technology & Entrepreneurship Advisory Committee.





# Will the Energy Economy of 2035 Mirror the Energy Economy of 2015?

By **Dr. Jud W. Virden, Jr.**  
**Associate Laboratory Director for the Energy and Environment Directorate**  
**Pacific Northwest National Laboratory**



My view of the Pacific Northwest's energy economy in 2035 will surprise some people, because, in terms of the energy mix, what we'll see then will be very similar to what we're looking at today. Primarily because it takes a long time to change the energy infrastructure.

That means we'll still be hydro-rich. We'll still be using natural gas. There will be a nuclear component. Wind power will keep growing. Solar will continue to grow, but I believe it will be a smaller contributor than wind, unless there's a carbon tax. I also expect to see slow and steady growth of distributed energy storage.

The central question for the Pacific Northwest in 2035 will be the same as it is today—how do we take advantage of our abundance of clean energy and still keep electricity prices low? We don't want to be like California, which has energy costs that can be two or three times what ours are. We have to move our energy agenda forward and keep costs down.

A related question on the electricity side for 2035 will be similar to what we're asking today—how do we create a state-of-the-art grid with advanced data and predictive analytics, plus controls so we can most efficiently utilize the grid and incorporate clean energy technologies.

This is important, because, in my view, the key to our clean energy future in the 21st century is a highly flexible grid that's operated in real time and that's able to handle all we throw at it. Fortunately, as I look to 2035, we're blessed in the Pacific Northwest with progressive utilities and a community-wide desire to deploy and use clean energy.

The keys, of course, will be embracing next-generation technology over the next 20 years; continuing to view the grid as a holistic energy system; and remaining focused on efficient, cost-effective and effective infrastructure—no matter what.

I also think that we've got to continue to utilize demand response in any conversation about the energy future of 2035. It's definitely part of the equation—especially when you consider how important intermittent renewables are and will continue to be. Loads must participate in a transactional way, including buildings to address peak loads and to reduce additional grid infrastructure costs.

Energy efficiency is another key. It's the fifth fuel and will remain the fifth fuel. Our best analysis tells us that two-thirds of future energy demand could be met,

thanks to energy efficiency. This approach could, without question, keep our region economically competitive and productive as we head toward 2035.

There are still a host of unanswered questions as we look out over the next few decades, however.

One area that we need to think about is transportation. We pay higher than average fuel costs. Personal expenses for transportation (cost of vehicle, maintenance and fuel) are generally much higher than what the cost of the electricity we each use. The transportation sector is also a significant contributor to carbon emissions.

Over the next 20 years gas powered vehicles will continue to get more fuel efficient which reduces emissions. This will be driven by current CAFE standards. Plug-in electric vehicles are available now and I believe their use will continue to grow. It takes 10–15 years for the vehicle fleet to turn over so it may take more than 20 years for all of us to be driving electric vehicles. This will give us time to ensure our grid system can handle a significant number of plug-in vehicles and to develop the new low cost generation that will be needed increase the electricity needed to support the vehicle fleet.

So, in terms of change, here's a summary of what we can expect as 2035 approaches—gradual changes in our energy mix; continued advances in energy efficiency and energy storage, large changes in the way the grid is managed and operated; and even bigger changes if a carbon tax is ever passed and implemented.

**Jud W. Virden, Jr.** is the Associate Laboratory Director for the Energy and Environment Directorate at Pacific Northwest National Laboratory. He leads a team that is focused on delivering science and technology solutions for energy and environmental challenges. During his two decades at PNNL, he has served in many key roles, including technical group manager, program manager, deputy associate laboratory director, director of business operations and director of energy market sectors. As part of his involvement in the strategic direction and growth of PNNL energy programs, he has helped shape national and international public/private technology partnerships to accelerate technology deployment. In 2009, for example, he was assigned to DOE Headquarters to assist in development of U.S.-China technical research priorities. And, in 1994, he served on a two-year assignment in Flint, Mich., working with the United States Council for Automotive Research, where he initiated and developed multiple government/industry advanced vehicle technology development projects.





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