|  |  |
| --- | --- |
|  | Washington State Chapter180 Nickerson Street, Suite 202Seattle, WA 98109Phone: (206) 378-0114Fax: (206) 378-0034 |

**Comments on Integrated Resource Plan Rulemaking Process**

**Docket UE-161024**

November 2, 2016

Thank you to the Commission for providing an opportunity to improve the IRP process.

State and federal policies clearly call for action on climate change. State reduction requirements are being updated because more emissions reductions are necessary. State policy on Integrated Resource Plans (IRP) requires the Utilities and Transportation Commission (UTC) to determine electric resources through state and federal policies, and specifically carbon dioxide. These obligations are not being met and electric utilities carry a critical *and increasing* role to play.

We agree that the pace of technological change is moving quite quickly in the electric sector, and the existing utilities are struggling to keep up. Some solutions for environmental challenges at reasonable costs may come from home-grown businesses in our state (such as vanadium flow batteries and WA-made solar modules & inverters). The last 18 months have seen two iterations of Tesla’s Powerwall and Powerpack, in addition to a new solar roof idea. Additionally, many utilities are projecting flat load growth for the next decade, yet they must still comply with I-937 and retire fossil fuel plants. It is time to revisit the process and increase our scope.

We have concerns in the following areas:

1. Meeting state and federal climate goals
2. Electric utilities are key to long-term climate solutions
3. Climate change impact on weather predictions & hydro forecasts
4. Lifecycle impacts of natural gas
5. Natural gas risk sharing
6. Deep Energy Efficiency
7. Combined Heat & Power
8. Valuing flexible resources ***and flexible load*** on generation, transmission, distribution, and the California Energy Imbalance Market
9. Big Thinking about Montana Wind
10. Inadequate scope of the IRP process

**Meeting the state and federal climate goals**

Integrated Resource Plans call for a mix of energy supply resources and conservation that will meet current and future needs at the lowest reasonable cost to the utility and its ratepayers.

"Lowest reasonable cost" is further defined as the lowest cost mix of resources determined through a detailed and consistent analysis of a wide range of commercially available sources. At a minimum, this analysis must consider resource cost, market-volatility risks, demand-side resource uncertainties, resource dispatchability, resource effect on system operation, the risks imposed on ratepayers, *public policies regarding resource preference adopted by Washington State or the federal government and the cost of risks associated with environmental effects including emissions of carbon dioxide [emphasis added].*

The federal government and the State of Washington have made clear the need to address climate change. The federal government’s endangerment finding put in place the foundation for the Clean Power Plan which would reduce national electricity sector emissions by an estimated 32 percent below 2005 levels by 2030. The Washington legislature passed 70.235 RCW calling for:



It is now clear that these goals are not sufficient and the Department of Ecology will be providing recommendations to the legislature for deeper reductions. In addition, on July 9, 2013, Governor Inslee called upon the Northwest Power and Conservation Council to identify the “the steepest glide path possible” for climate reductions. Further stating “the final step is decarbonizing our power system”

State and federal policy is clear. We must make every effort to move toward reductions in carbon emissions in the electricity sector. We need to decarbonize our economy by 2050, and the utility sector is the easiest part of the problem to tackle. We also need to ask the utilities to step up to provide nearly all our transportation fuel, as we replace the internal combustion engine with electric motors and batteries. However, these policy goals are not reflected in the IRP process. There is no decarbonization scenario modelled by utilities, nor required by regulators. If we are serious about curbing catastrophic climate change and our nation’s obligations under the Paris climate accord, we must start planning and acting now.

This is where the UTC must regulate utility plans much more tightly. The UTC must require utilities to model scenarios where we decarbonize the electric sector and transportation sector, and consider a day mid-century when natural gas for home heating is no longer an option. ***Natural gas power plants and residential heating via natural gas must eventually become stranded assets.*** Where is this thinking in a 20 year plan? If a utility is allowed to omit that, it is a failure in vision for both the utility and the regulator. We must do better.

**Electric Utilities are Key to Long-Term Climate Solutions**

International, national and state studies provide a pathway for long-term solutions for reducing carbon. The [Deep Decarbonization Pathway Project](http://deepdecarbonization.org/wp-content/uploads/2016/03/DDPP_2015_REPORT.pdf) for the United Nations, the United States, and likely Washington State all depend upon “three pillars of energy system transformation:”[[1]](#footnote-1)

1. Energy efficiency and conservation (across sectors)
2. Decarbonizing electricity and fuels
3. Switching energy end-uses to lower-carbon, and eventually zero-carbon, energy carriers (e.g. electricity, hydrogen, and biofuels)

All three pillars directly affect electricity. For Washington, the 20-year goal for an IRP should be:

1. Meeting all load growth with energy efficiency AND going beyond our current limits on annual energy efficiency achievements
2. Phasing out of coal and gas, and replacing that with renewable energy
3. Moving services – transportation, heating and appliances – to the zero-carbon electricity grid.

No state is better equipped to meet and lead this challenge than Washington State with its existing 75 percent hydropower generation resources. If we cannot lead this transformation, then we are seriously jeopardizing our long-term health and sustainability. The UTC plays a critical role in leading this transformation. As such, IRP and the resource acquisition that follows, must be judged against these fundamental criteria.

**Climate Change Impact**

As pointed out in the Sierra Club comments to the UTC on Puget Sound Energy’s 2015 IRP (Docket UE-141170), the biggest inadequacy with the IRP load forecasts is incorporating climate change into the planning process. Washington State climatologists predict warmer weather, significantly warmer low temperatures, and significant impacts on our hydro cycle. Utilities may be overbuilding capacity substantially for peak winter days that just aren’t so cold. Similarly, they may be over-relying on hydro power from dams, and may be up a dry creek during a low hydro year.

This must be addressed regionally, with good climate modelling data from institutions like the University of Washington and NOAA. Similarly, the BPA has been working on modelling stream flow impacts on the Columbia River hydro system. The variability and updated load forecasts must be included in all utility IRP’s, as appropriate for each region of our state.

To help reduce climate change, the Sierra Club has repeatedly asked the UTC to require utilities to dispatch ***existing resources*** as if they were paying a social cost of carbon. The UTC could do this by requiring utilities to include a carbon price at three points:

1. During the IRP process
2. During dispatch time for existing resources
3. During evaluation of new resources

The carbon price used should be the social cost of carbon, as determined by the US Department of Energy[[2]](#footnote-2). They model a higher cost of carbon than the carbon prices we might pay in regional markets or under I-732. These three changes would ensure we get most of the utility sector benefits of a carbon price, even though no money changes hands. While we may have a real carbon tax in Washington State passed via a ballot initiative by the time of the December workshop, the UTC in their role as an economic regulator charged with environmental responsibility should not overlook this potential policy tool.

**Lifecycle impacts of natural gas**

A very strong body of evidence now demonstrates that lifecycle greenhouse gas impacts of natural gas – from drilling, extraction, transport, redistribution and end-use combustion – are far greater than the very limited accounting of smokestack emissions, now defined under Washington State law as 970 pounds per megawatt hour for combined cycle combustion turbines.

A report[[3]](#footnote-3) by the National Renewable Energy Laboratory concluded:

“While natural gas has low CO 2 emissions upon direct use, methane leakage and long term climate effects lead to the conclusion that increased use of natural gas as a substitute for more carbon intensive fuels will not substantially alter world carbon dioxide concentration projections, and that other zero or low carbon energy sources will be needed to limit GHG concentrations.”

A report[[4]](#footnote-4) by the National Oceanic and Atmospheric Administration found that

“total fossil fuel methane emissions (fossil fuel industry plus natural geological seepage) are not increasing over time, but are 60 to 110 per cent greater than current estimates.”

Some studies indicate that lifecycle GHG emissions may be as bad as coal. Almost all studies indicate that continued use, and any expanded use, of natural gas will not allow us to meet our national climate goals. The same failing results are expected for Washington.

The UTC must find a way to incorporate these climate risks into its evaluation of IRPs and related resource acquisition. This should begin with the UTC establishing some common metrics for methane’s impact such as being 28 times more powerful than carbon dioxide with a 100-year global warming potential as defined by the International Panel on Climate Change’s Fifth Annual Report (AR5).

**Ratepayer risks of investments in new natural gas plants**

Electric utilities’ shareholders traditionally earn 7.5 to 7.7 percent profit on capital investments. Ratepayers traditionally pay the majority of operational costs.

In the current 2017 IRP stakeholder process, Puget Sound Energy has identified the greatest cost risks from natural gas investments to be increasing prices on carbon and fuel which are mostly borne by the ratepayer. Deep decarbonization indicates the need to move beyond natural gas. National studies show greater lifecycle carbon risks from natural gas than previously estimated. Governor Inslee has called for decarbonizing the power system. King County’s (half of PSE’s service territory) Strategic Climate Action Plan has called for limiting investments in new natural gas plants. The Northwest Power and Conservation Council’s 7th Power Plan found that almost no possibility that the region will need any new natural gas plants in the next 10 years.

It no longer serves ratepayers interests to allow utilities to profit from new natural gas plants if national, regional, state and local studies and policies show they are not needed or wanted. This is especially true if the climate impacts have been woefully under-represented. And it is fundamentally unfair that utilities’ shareholders make all the profits while ratepayers bear most the risks.

The UTC should establish a new rule that utilities’ shareholders must assume most, if not all, of any increases in carbon or fuel prices once a new natural gas plant is permitted for construction. This will assure that shareholders don’t reap all the profits while ratepayers bear the risks. Conversely, utilities could forego the profits and ratepayers could then more reasonably share the operational risks. But shareholders should not be able to have both ways. If shareholders earn high profits for facilities that are not wanted or needed, then they must assume the associated financial risks.

**Aligning with NW Power and Conservation Council findings**

The NPCC 7th Power Plan once again demonstrates the incredible power of energy efficiency’s ability to meet load growth. The new findings demonstrate the power of demand response to meet peak load hours, which is the stated reason from much of the proposed build of natural gas peaker plants. And as stated above, under almost all scenarios, no new natural gas plants are needed for the next 10 years.

Utilities have responded by saying that the regional results do not necessarily apply to the individual utility. Unfortunately, this thinking leads the four largest private utilities in the Northwest to collectively propose nearly 3,000 megawatts of new natural gas plants over the next 10 years.

While there may be some legitimacy for this collective failure of utilities to act more cooperatively to help ensure the results from the NPCC, they must then demonstrate how they as an individual utility will establish a pathway to achieve this much-needed collective outcome. This starts with such initial efforts as Puget Sound Energy joining the Energy Imbalance Market. This is a laudable first step and much more is needed. If a Regional Transmission Organization or Independent System Operator is not likely in the next five years, then utilities must find other avenues to overcome the balkanization from their independent Balancing Authorities.

**Deep Energy Efficiency**

The Energy Independence Act (I-937) requires electric utilities to follow the methodologies established by the Northwest Power and Conservation Council to capture all cost-effective energy efficiency. This measure-by-measure approach misses critical opportunities to capture additional cost-effective energy efficiency by doing holistic, whole-building approaches for new and existing buildings. This methodology should not preclude utilities from demonstrating through pilot projects the ability to achieve much greater energy efficiencies through a whole building approach.

According to the Pacific Northwest National Laboratory’s (PNNL) “Advanced Energy Retrofit Guides” published in 2011, many existing buildings can achieve over 50% energy efficiency savings with deep retrofits. Recent case studies in the Northwest done by the New Buildings Institute (sponsored by the Northwest Energy Efficiency Alliance) have shown deep energy retrofit savings ranging from 29 to 66 percent.

Seattle City Council has provided a good example of how such results can be achieved in a systematic approach. The City’s adoption of their new Building Energy Transparency and Building Tune-Up ordinances demonstrate that a utility can systematically ensure it is addressing each and every building starting with the largest buildings first[[5]](#footnote-5) [[6]](#footnote-6).

Seattle City Light and the Energy Trust of Oregon have commenced three pay-for-performance building pilots. These pilot buildings are previous participants in measure-based utility incentive programs. Using this pay-for-performance model, these buildings are achieving significant additional whole-building savings of 15 to 20 percent. Moreover, the incentive structure in this pay-for-performance approach ensures that the utility pays only for actual savings achieved at the meter and rewards building owners for operations-based efficiency that persists over time. Pay-for-performance models offer PSE the opportunity to work with its customers in a whole-building approach that “marbles” together new equipment replacements with best practices operational savings and occupant behavior changes. This approach can deliver savings well beyond those achieved in a measure-based program approach.

The Metered Energy Efficiency Transaction Structure (MEETS) is another successful model, tested at the Bullitt Center. Though the Bullitt Center was a new building, MEETS benefits include deep energy efficiency without utility incentives; avoiding the utility ‘death spiral’; allowing building owners to profit from energy efficiency; and can lower rates for all utility customers. For instance, using PSE’s 9.75 cent/kWh rate for commercial customers, a building owner with a 20-year MEETS transaction could reduce energy use by 500,000 kWh/year and provide a building owner or investor with a 20-year stream of reliable payments with a net present value of more than $745,000. At the same time, the MEETS transaction would require no utility incentives and would contribute more than $100,000 to the utility and its customers. In addition, a utility would not “lose the energy units” in the system which traditionally put upward pressure on rates. Finally, MEETS is structured in such a way that the utility could (if desired and approved by regulators) provide the necessary capital for deep retrofits. This opens the possibility of exploring a new way to provide a regulated rate of return for utilities. See detailed information on MEETS here: <http://www.meetscoalition.org/in-the-news/>

The Emerald Cities Seattle RENEW program[[7]](#footnote-7) is another holistic approach that is demonstrating early success. The RENEW program supports deep energy and water conservation in affordable multi‐family housing for the benefit of the building owners and tenants. The program targets over 200 buildings in the City of Seattle and additional buildings in the metro region as the program develops. RENEW educates affordable housing building owners on efficiency opportunities through a complete portfolio analysis, setting the stage for a comprehensive approach to efficiency. The program provides a building retrofit coach, supporting benchmarking, assessments, project development, financing and monitoring and verification. The program will work with the entire portfolio of each building owner and bundle projects in lots of 4-6 buildings in order to gain operational efficiencies.

A common characteristic of these successful programs is the payback period. For some pay-for-performance projects the building owners immediately receive the energy savings for three-year pilot programs. The MEETS approach takes a longer time frame but achieves greater savings. And because MEETS allows a simple mechanism for outside investors to invest, building owners can see immediate investments in their buildings at no cost to them, with immediate revenue sharing under the MEETS power purchase agreement structure. Other innovations include third-party financing and on-bill repayment per the RENEW program.

The UTC should strongly encourage utilities to issue Requests for Proposals to demonstrate deep energy efficiency projects. RFPs can call for cost-effective metrics as long as the payback period can accommodate larger capital and operating expenses.

**Combined Heat & Power**

The IRP process regulates electricity and natural gas, but overlooks effects of their use – heat. Tightly integrating heat into long term planning can greatly change how the electrical system is designed. For example, Amazon is sending waste heat from a datacenter in downtown Seattle to an adjacent building to supply a large portion of its winter heating needs. District heating systems can take a waste product and use it to offset electric or natural gas consumption. In Germany, power-to-heat will do a large part of load balancing[[8]](#footnote-8).

This is in contrast to the 2015 PSE IRP which takes a passive approach to CHP -- they will "include a process to aggregate smaller kinds of resources, such as distributed resources, combined heat and power."  This is an under-examined resource.

**Flexible Resources and Flexible Load**

The UTC’s IRP rulemaking notice raised some intelligent questions about energy storage and flexibility; IRP modelling on a 1 hour basis doesn’t make sense when the CAISO EIM is trading power on a 15 minute basis or even a 5 minute basis. Therefore, we support the UTC’s recommendation to focus more on a 10 year time horizon for dispatch. Additionally a transparent price for avoided costs must be established, as it is very difficult to model what a replacement should compete with. Would a resource like a battery have to compete with a natural gas peaker plant? Or is the flexibility brought by that resource, coupled with frequency regulation and other aspects, not captured in the price of the peaker? What about transmission and distribution grid impacts, where a battery can be collocated with load, either at the substation level, incorporated into a microgrid, or on the customer side of the meter? The IRP process does not provide a good mechanism for incorporating these costs. While some costs may be captured today, it is far from clear which ones are or aren’t.

The thinking needs to be broadened. It is easy to think about flexible generation in the form of a fast-ramping peaker plant, or flexible energy storage like batteries or appropriately-sited pumped hydro projects. But technologies like the smart grid open the door to new opportunities.

The simplest example that encapsulates the basic economics is the BPA’s project to do smart hot water heaters. Here is a residential load that can be shifted throughout the day. The load must be served, but it can be shaped to correspond with the utility’s needs. And by shifting the load earlier before the morning peak or by delaying it until later in the night, this can reduce a utility’s peak capacity needs. But beyond offsetting generation, it opens the door to energy arbitrage (both within the state and with California), potentially lower distribution costs by reducing peak demand on individual feeders, and potentially offsetting new transmission construction[[9]](#footnote-9). The value of this is significant.

Now consider electric vehicles. A similarly skilled smart grid operator can control EV charging and shift it throughout the day for the same benefits. Given that EV’s can draw substantially more power than any other residential load (consider 6 kW for an electric clothes dryer vs. 20 kW for a Tesla with the High Power Wall Charger), there may be more opportunity for substantial improvements. But the economics can be modelled and thoroughly explored based on an already-existing BPA pilot project. Sharing this knowledge with all utilities may help let EV charging keep rates low, independent of whether time-of-use rates are implemented.

There are already three companies building the capabilities to enter this market. A fourth company decided flexible EV charging was a lesser opportunity, and decided to turn a fleet of Nissan Leafs into a frequency regulation resource, and is selling that as a service into the EIM. Are utilities prepared for third party aggregators to turn a network of consumer devices into resources for load shaping, demand response, and ancillary services like frequency regulation? Are they happy to bundle these together and sell them into the EIM? Utilities clearly play a role in ensuring a vibrant, dynamic energy market. Everyone benefits when solutions may come at the speed of cloud computing services and phone apps, but we must ensure that innovators don’t run into organizations and regulations that aren’t prepared to keep up or provide good access to a market.

We encourage utility investment in protocols like OpenADR to ensure the right smart grid technologies can be developed.

**Big Thinking about Montana Wind**

We are excited by the possibility of Montana wind, and in other Rocky Mountain states. In the short term, there are some possible projects well-aligned with the existing transmission line from Colstrip to the BPA grid. These wind farms would likely provide substantially more power and be better correlated with PSE’s winter peak demand in energy than existing WA wind resources. This is very encouraging, and we are glad PSE took suggestions to include Montana wind in their IRP starting a few years ago.

However, there may be a truly national opportunity here that even organizations like the BPA are overlooking. Consider the creation of a Rocky Mountain Wind Authority, similar in scope & function to the Tennessee Valley Authority and Bonneville Power Administration. They could establish a north-south power transmission corridor from Montana to Texas, then provide east-west transmission capacity from the Rockies to Seattle, San Francisco and potentially as far as Chicago or St. Louis (in addition to ERCOT). Using high voltage DC lines, this transmission could be done with minimal loss. We think the nation should start looking at that opportunity over the next 20 years. Clearly this isn’t within the scope of an individual IRP. But there is no room within the existing utility planning process to truly think big or come up with an expansive solution, and seemingly no appropriate regional or national forum. Instead, IRP participants fight over 2% and 5% numbers in various locations to get just a little more conservation each year. It’s not the right level of thinking to build the decarbonized energy grid our nation needs for 2050.

**Inadequate Scope of the IRP Process For Global Problems**

The Sierra Club’s comments to the UTC on PSE’s 2011 IRP detailed our thoughts on the inadequacy of the utility process. Surprisingly, little has changed. We convinced the utility to do a few more Monte Carlo draws and take a first cut at modelling rooftop solar. We got PSE to model a social cost of carbon, but then they threw away the results of that analysis instead of using it to inform their build or dispatch of existing plants, let alone the next IRP. We also secured retirement of Colstrip units 1 & 2, but through a process that could not be resolved through the IRP alone. The renewables picture got brighter but since then fracking has increased fossil fuel availability. But the IRP process is still incomplete. We close by reprinting our concerns verbatim from June 2011, so the Commission can see our objections and measure progress against it.

The IRP process as run by the UTC seems limited in its power & scope and is inadequate to addressing the long-term challenges our world is facing. The overriding factor is cost, but cost doesn’t prepare for the range of potential risks to society. We ask the UTC to pursue longer-term thinking.

The most obvious challenge is catastrophic climate change. While the IRP does allow modeling of carbon costs, that assumes that our federal or state government has the intestinal fortitude necessary to tackle the problem, and to build a binding accord that applies to all developed nations plus China. Success is required for the continuing existence of our species on this planet, with anything approximating today’s lifestyles. We’re not going to replace trillions of dollars of energy infrastructure by squabbling about discount rates to get 2% extra conservation from our utility. We are not on track to addressing this challenge at the global, national, state, or local level. Washington State is blessed with an above-average educated population and a lot of hydropower – if we cannot address this problem in Washington State, the hope for the rest of the planet is quite low. The Utilities & Transportation Commission has the opportunity & responsibility to truly lead the world.

The next major challenge facing the world is energy descent[[10]](#footnote-10). This is the point of maximum extraction for all of our fossil fuels and others relying on finite resources (like uranium). Estimates are that oil extraction appears to have peaked in 2008[[11]](#footnote-11). Natural gas world-wide may peak sometime around 2030[[12]](#footnote-12). Coal may peak as early as 2025, if you look carefully at worldwide coal demand, the quality of coal left in the ground, and the costs of extracting existing reserves[[13]](#footnote-13). And on the nuclear front, uranium extraction may peak around 2035[[14]](#footnote-14), and there may only be about 80 years of uranium left. Beyond the geological limitations, energy demand growth in energy-exporting countries may mean energy available to the world market peaks sooner and contracts at an even faster rate.

The exact years & rate of decline are open to debate, but the long-term shape of the non-renewable energy supply curve available to the human race is not in doubt; at some point, the amount of energy available to our civilization will hit a maximum and begin decreasing annually. This will require replacing the world’s existing $2 trillion fossil fuel extraction infrastructure with renewable sources of energy, huge investments in energy conservation, research to find other novel primary fuel supplies, and a rethink of energy demand.

There are similar problems with availability of food and water for the world, as well as a lack of high quality governments in a significant portion of the world. As all of these problems will be happening in parallel, our ability to cope with changes may be strained to the breaking point. Hopefully this doesn’t lead to war and famine.

The future we want to live in relies on renewable energy for electrical production coupled with biofuels and a complete rethink of our transportation infrastructure. This will require revisiting land use, replacing the car with effective mass transportation, and simply transplanting people in bulk so they don’t need to drive 30 miles a day to get to where they work. We may build huge transmission lines to a North American wind corridor stretching from North Dakota to northern Texas, with connections to the Western power grid and Chicago. Conservation measures will provide perhaps the cheapest route to solving these problems, so that America does not waste half our energy in poorly insulated buildings or in non-efficient equipment, or with gas-guzzling cars.

However, Washington State & the Bonneville Power Administration’s current planning processes leave us in a world where we cannot build new transmission to export excess power. As a direct effect, the BPA is curtailing renewable power generation during certain months in high-water years. Wind farms aren’t built because transmission availability is a limiting factor in siting, because no one knows how to pay for the new lines our nation needs. The lack of ability to build transmission wires makes our region look like Emperor Nero fiddling while Rome burns.

The IRP process is not moving us to the world we must construct quickly enough. While the IRP will save ratepayers $80M here or $120M there in the next 10 years, if it does not address catastrophic climate change and Peak Energy, then it has failed. It is time for the UTC to think globally and act locally. If this requires legislative action, the Sierra Club is happy to assist in whatever role we can.

Brian Grunkemeyer

Energy Committee Chair

Washington State Chapter of the Sierra Club

1. Pathways to Deep Decarbonization, <http://deepdecarbonization.org/wp-content/uploads/2016/03/DDPP_2015_REPORT.pdf> [↑](#footnote-ref-1)
2. Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis-Under Executive Order 12866 (Revised July 1015) <https://www.whitehouse.gov/sites/default/files/omb/inforeg/scc-tsd-final-july-2015.pdf> [↑](#footnote-ref-2)
3. A review of water and greenhouse gas impacts of unconventional natural gas development in the United States, NREL <http://www.nrel.gov/docs/fy16osti/62386.pdf> [↑](#footnote-ref-3)
4. Study finds fossil fuel methane emissions greater than previously estimated, NOAA <http://www.noaa.gov/media-release/study-finds-fossil-fuel-methane-emissions-greater-than-previously-estimated> [↑](#footnote-ref-4)
5. Seattle City Ordinance on building benchmarking reports <http://www.seattle.gov/Documents/Departments/OSE/OSE%20Benchmarking%20Amends%20ORD.pdf> [↑](#footnote-ref-5)
6. Seattle City Ordinance requiring building tuneups <http://www.seattle.gov/Documents/Departments/OSE/OSE%20Building%20Tune-Ups%20ORD.pdf> [↑](#footnote-ref-6)
7. Emerald Cities Seattle RENEW program: <http://emeraldcities.org/cities/seattle> [↑](#footnote-ref-7)
8. Batteries will not be the future of grid balancing in Germany, [https://www.greentechmedia.com/articles/read/batteries-will-not-be-the-future-of-grid-balancing-in-germany](https://na01.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.greentechmedia.com%2Farticles%2Fread%2Fbatteries-will-not-be-the-future-of-grid-balancing-in-germany&data=02%7C01%7Cbriangru%40EXCHANGE.MICROSOFT.COM%7Cd49422d22fe34b52b99608d4022e99bb%7C72f988bf86f141af91ab2d7cd011db47%7C1%7C0%7C636135846557891217&sdata=W5nQIcgCFidX5DM4dzw8CBbKM7x6594kTBFKshRE%2B7M%3D&reserved=0) [↑](#footnote-ref-8)
9. Other regions are looking at energy storage benefits:
CAISO: <http://www.transmissionhub.com/articles/2016/04/cal-iso-seeking-input-on-storage-examples-usage-limitations.html>

Maine: <http://www.utilitydive.com/news/maine-turns-to-battery-storage-to-avoid-transmission-investment/400440/> [↑](#footnote-ref-9)
10. Energy Descent: <http://en.wikipedia.org/wiki/Energy_descent> [↑](#footnote-ref-10)
11. Peak Oil <http://en.wikipedia.org/wiki/Peak_oil> [↑](#footnote-ref-11)
12. Peak Natural Gas: <http://en.wikipedia.org/wiki/Peak_gas#World_peak_gas> [↑](#footnote-ref-12)
13. World Peak Coal estimates: <http://en.wikipedia.org/wiki/Peak_coal#World_peak_coal> [↑](#footnote-ref-13)
14. Peak Uranium <http://en.wikipedia.org/wiki/Peak_uranium> [↑](#footnote-ref-14)