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Mark D. Marini, Secretary
Department of Public Utilities
One South Station, 5th Floor
Boston, MA 02110

RE: D.P.U. 15-120 Petition of Massachusetts Electric Company and Nantucket Electric Company d/b/a National Grid for approval by the Department of Public Utilities of their Grid Modernization Plan

D.P.U. 15-121 Petition of Fitchburg Gas and Electric Light Company d/b/a Unitil for approval by the Department of Public Utilities of its Grid Modernization Plan

D.P.U. 15-122 Petition of NSTAR Electric Company and Western Massachusetts Electric Company, each d/b/a Eversource Energy, for approval by the Department of Public Utilities of their Grid Modernization Plan

Dear Secretary Marini:

Harvard Law School's Emmett Environmental Law and Policy Clinic (the "Clinic") respectfully submits these comments in the Department of Public Utilities ("DPU") dockets 15-120, 15-121 and 15-122, regarding petitions from National Grid, Unitil and Eversource Energy for approval of proposed grid modernization plans (the "Proceedings"). These Proceedings are one of several DPU proceedings and legislative initiatives that will influence the future structure of electricity systems and markets in Massachusetts. These developments have the potential to promote valuable innovation in the electric sector that will benefit consumers and the environment, including by advancing the DPU's vision of a modern grid that is cleaner, more efficient and more reliable, and that empowers customers to manage and reduce their energy costs.

At the same time, because transitions to new energy systems tend to come with new costs,[1] decisions about the electric system raise fundamental questions about how to balance innovation with costs to individuals, particularly individuals who are less able to participate in or benefit from innovation. In this vein, and drawing on its experience working on distributed generation, grid modernization and energy justice issues for several years, the Clinic recommends reviewing

[1] *See e.g., id.* at 25-26 ("the pricing to recover the costs of the integrated system will need to evolve to recognize the changing nature of the connecting customer.")

the grid modernization proposals in these Proceedings from an energy justice perspective. This approach encompasses considerations beyond the direct size of low-income rate discounts, including, for example, seeking to provide equitable distribution of and access to benefits from the energy system.

In addition, the Clinic encourages the DPU to review the grid modernization plans with an eye to creating opportunities for the development and integration of virtual power plants, which, as discussed below, are a natural evolution of the modernization of Massachusetts' electric system and can help achieve the goals of the DPU's Grid Modernization Order. Supporting virtual power plants would promote the deployment of distributed energy resources and send a strong signal that the Commonwealth is a leader in electricity innovation.

I. ENERGY JUSTICE

A. Energy Justice Entails Protecting Consumers from Disproportionate Shares of the Costs to Maintain and Improve Energy Systems and Providing Equitable Distribution of and Access to Benefits from Energy Systems

There is no single definition of energy justice, but the Clinic submits the following as a starting point for consideration of energy equity issues in DPU proceedings:

> Building on the tenets of environmental justice, which provide that all people have a right to be protected from environmental pollution and to live in and enjoy a clean and healthful environment, energy justice is based on the principle that all people should have a reliable source of energy, protection from a disproportionate share of costs or negative impacts/externalities associated with building, operating and maintaining energy generation, transmission and distribution systems, and equitable distribution of and access to benefits from such systems.

Energy justice is an issue that needs to be considered in addition to environmental justice; while the concepts have commonalities, they can differ in the people they seek to protect, the harms they seek to avoid and the strategies they employ to achieve fair results. In the energy context, equity concerns often arise in efforts to "steer[] clear of a collision between the needs of low income households and the imperative of wiser energy policies,"[2] while ensuring that all members of society have access to safe, affordable and sustainable energy, regardless of their income, race, medical status or other condition.[3]

A common proxy for energy equity concerns is the energy burden borne by low-income households. An energy burden is the "percent of annual income a household must spend to buy

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[2] Patty Limerick & Jason L. Hanson, *High Energy Prices & Low-Income America*, CENTER OF THE AMERICAN WEST 3 (2008) http://www.centerwest.org/publications/pdf/eoc.pdf.
[3] Kirsten Jenkins et al., *Energy Justice: A Whole Systems Approach* 75 (2014) https://queenspoliticalreview.files.wordpress.com/2014/10/article-5-energy-justice-a-whole-systems-approach-p74-87.pdf.

utilities (not non-energy service) and all other residential fuels."[4] Energy burdens are higher for low-income households than other households primarily because their income is lower, but also in part because their homes tend to be older and less energy-efficient. The disparity increases when heating costs are considered. A 2008 study estimated that low-income consumers in New England had the highest energy burdens compared to the rest of the country, with nearly 40% of their incomes going to energy costs,[5] and in 2014, the average Massachusetts household earning less than 50% of the federal poverty level spent 42.6% of its income on energy.[6]

Energy burdens can have disempowering and harmful effects on low-income populations. High energy burdens can force consumers to make difficult tradeoffs between paying energy bills and attending to other necessary expenses, such as medical care, rent or groceries. These choices jeopardize health, safety and housing stability. For example:

- A research project on housing challenges among low-income families in Boston found that high energy burdens led to illness and stress (*i.e.* asthma, malnutrition and mental health issues associated with large bills), financial challenges (*i.e.* high utility bills and utility-related debts/arreages that affect the entire household), and housing instability (*i.e.* shutoffs resulting from non-payment and difficulties securing proper housing due to high utility expenses or a history of utility debt).[7] The report found that children in families with high energy burdens are exposed to "nutritional deficiencies, higher risks of burns from non-conventional heating sources, higher risks for cognitive and developmental behavior deficiencies, and increased incidences of carbon monoxide poisoning."[8]

- According to a survey performed by the National Energy Assistance Directors Association in 2005, a significant proportion of households receiving federal energy assistance in the Northeast reported making budget trade-offs due to high energy costs: 73% reported that they reduced expenditures on household necessities because they did not have enough money to pay their energy bills; 20% went without food; 28% went without medical or dental care; and 23% did not make a full rent or mortgage payment at least once.[9]

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[4] Meg Power, *The Burden of FY 2008 Residential Energy Bills on Low-Income Consumers*, ECONOMIC OPPORTUNITY STUDIES 2 (Mar. 20, 2008) http://www.opportunitystudies.org/repository/File/energy_affordability/Forecast_Burdens_08.pdf.
[5] *Id*. at 5.
[6] Fisher Cheehan and Colton, *Massachusetts 2014 Home Energy Affordability Gap* 1 (2015) http://www.homeenergyaffordabilitygap.com/downloads/2014_Released_Apr15/ZIP_Archives/2014_Massachusetts.zip.
[7] Diana Hernandez and Stephen Bird, *Energy Burden and the Need for Integrated Low-Income Housing and Energy Policy*, 2 POVERTY & PUBLIC POLICY 4, 11-12 (2010).
[8] *Id*. at 6.
[9] Lauren Smith, Child Health Impact *Assessment of Energy Costs and the Low Income Home Energy Assistance Project*, CHILD HEALTH IMPACT ASSESSMENT WORKING GROUP 2-3 (April 2007) http://www.hiaguide.org/hia/child-health-impact-assessment-energy-costs-and-low-income-home-energy-assistance-program-liheap.

Given these trade-offs, it is not surprising that low-income households tend to be more vulnerable to rising or fluctuating energy prices.[10]

Reducing energy burdens, including through tools like low-income rate discounts and energy efficiency programs, is a critical component of energy justice, but is only one of the objectives of energy justice, which include:

1. Reducing energy burdens on low-income consumers;

2. Avoiding disproportionate distribution of the costs or negative impacts associated with building, operating and maintaining electric generation, transmission and distribution systems;

3. Equitable distribution of and access to real benefits from a modern energy system, including electric generation, transmission and distribution systems; and

4. Ensuring a reliable source of electricity and protecting low-income households, including those on fixed incomes, from price fluctuations.

Thus, an energy justice analysis includes examining whether consumers have equal opportunities to take advantage of energy cost-saving measures, such as solar energy or programmable thermostats. In some instances, low-income households may be interested in taking advantage of new technology but will struggle with the initial investment required to access associated benefits. Policies informed by energy justice principles should account for these initial costs and consider mechanisms that allow low-income consumers to utilize new technologies without increasing their energy burden.

An issue that overlays all of the principles of energy justice is the need for education and outreach. Energy literacy programs are important because the learning curve for understanding and accessing the advantages of an evolving grid can be incredibly steep for any customer, and this is only exacerbated when consumers lack access to information on their energy systems or when they have other needs to prioritize.[11] Greater knowledge can empower consumers to take greater control over their energy usage and become more involved in energy decisions.

B. Consideration of Energy Justice Promotes the Goals of the Commonwealth and is Consistent with DPU Precedent

The Massachusetts Legislature has declared that "electricity service is essential to the health and well-being of all residents of the commonwealth, to public safety, and to orderly and sustainable economic development."[12] Consistent with that finding, the Legislature declared that "affordable electric service should be available to all consumers on reasonable terms and conditions" and

[10] Cara Lampton *et al.*, *Policies for Achieving Energy Justice in Society: Best Practices for Applying Solar Energy Technologies to Low-Income Housing*, CENTER FOR ENERGY AND ENVIRONMENTAL POLICY 3 (December 2010) http://ceep.udel.edu/wp-content/uploads/2013/08/2010_es_READY_AchievingEnergyJusticewithSolar3.pdf.
[11] Hernandez & Bird 6.
[12] 1997 Mass. H.B. 5117, § 1(a).

that "electricity bills for low income residents should remain as affordable as possible."[13] Consideration of energy justice flows directly from these directives, and is reflected in the DPU's mandates.

For example, the DPU is required to pursue issues relevant to energy justice, such as requiring distribution companies to provide discounted rates for low-income users.[14] With respect to decisions or actions regarding rate designs in particular, DPU is directed to consider:

> "[T]he impacts of such actions, including the impact of new financial incentives on the successful development of energy efficiency and on-site generation. Where the scale of on-site generation would have an impact on affordability for low-income customers, a fully compensating adjustment shall be made to the low-income rate discount."[15]

DPU recognizes the important role that it plays "in enforcing laws and regulations of the Commonwealth established to protect and support natural gas and electricity consumers, particularly low-income consumers,"[16] and that low-income consumers may face unique challenges from decisions impacting the energy system.[17] The DPU has also committed to exploring mechanisms "beyond those tools already available (*e.g.* low income discount rate) to insulate low income customers from bill volatility."[18] This is consistent with the Supreme Judicial Court's finding, in the context of upholding different treatment for different classes of customers in ratemaking decisions, that cost of service should not be the only consideration for the DPU. Rather, in determining whether rate classes are justified, DPU should also consider "[t]he nature of the use and the benefit obtained from it, the number of persons who want it for such a use, and the effect of a certain method of determining prices upon the revenues to be obtained by the city, and upon the interests of property holders."[19]

These examples of DPU's consideration of issues relevant to energy justice are illustrative, not exhaustive, but support DPU's consideration of all components of energy justice in its decision-making.

C. Proposals in the Grid Modernization Plans Should be Evaluated from an Energy Justice Perspective

Multiple issues in the proposed grid modernization plans could implicate energy justice issues, either directly (*e.g.*, imposing time varying rates) or indirectly (*e.g.*, establishing mechanisms that will support future innovation and opportunities for consumer control of energy costs). DPU

[13] 1997 Mass. H.B. 5117, § 1(a) and 1(n).
[14] M.G.L. ch. 164, § F(4)(i).
[15] M.G.L. ch. 164, § 141.
[16] *See e.g.*, Order Expanding Low-Income Consumer Protections and Assistance, D.P.U. 08-4 (Sept. 15, 2008).
[17] *See e.g.*, Anticipated Policy Framework for Time Varying Rates, D.P.U. 14-04-B (June 12, 2014) ("the Department is mindful of the concerns raised on behalf of low-income customers and others who are unable to shift a significant portion of their consumption due to extraordinary circumstances, such as medical equipment requirements.")
[18] Order Adopting Policy Framework for Time Varying Rates, D.P.U 14-04-C, 11-13 (Nov. 5, 2015).
[19] *Am. Hoechest Corp. v. Dep't of Pub. Utilities,* 379 Mass. 408, 411-12 (1980) (citing *Brand v. Water Comm'rs of Billerica*, 242 Mass. 223, 227 (1922)).

should review the proposals in these Proceedings from an energy justice perspective. A few examples are discussed below.

i. Time Varying Rates

Time varying rates (TVRs) are a critical example of issues in the proposed grid modernization plans that implicate energy justice issues. The impacts of TVRs on low-income consumers are not fully understood, and there will be no answer that applies to all low-income or hardship categories of consumers. Research on the effect of TVRs on low-income consumers is mixed. On the one hand, TVRs potentially allow low-income consumers to save in two ways: (i) low-income customers tend to have flatter load profiles,[20] and therefore will tend to benefit from revenue-neutral TVR programs regardless of their capacity to shift their loads; and (ii) low-income customers who can shift their load will be able to reduce their bills by using less energy during peak periods and more during off-peak periods. At the same time, however, these flat energy usage patterns could be indicative of the fact that some low-income households are already using the least amount of energy possible or have less discretion to shift their energy loads in response to dynamic pricing. Shifting energy use may be particularly difficult for consumers with nontraditional energy use patterns, such as third shift workers who are home during peak energy pricing hours or individuals with medical needs that require a constant supply of electricity.

Striking the right balance between giving low-income consumers access to the benefits of TVRs and protecting them from high peak costs will not be easy. But the DPU should consider innovative strategies to allow those low-income consumers who can benefit from TVRs to do so, while protecting those who would be hurt by TVRs from significant increases in their energy burdens. Simply carving low-income consumers out of TVR programs will likely be too blunt a tool and leave potential benefits on the table.

The DPU should carefully review current research on the energy usage patterns of low-income households in order to determine the effect that TVRs will have on low-income consumers and other vulnerable groups. For example, while pilot programs across the United States that employed dynamic pricing systems demonstrate that “low income customers are responsive to dynamic rates” and “many such customers can benefit even without shifting load,” low-income consumers were generally less responsive in terms of peak shaving than higher-income consumers.[21] Models of TVRs found that in simulations, as opposed to actual pilot projects, between 65 percent and 79 percent of low-income consumers would hypothetically benefit from dynamic pricing even without making changes to their current usage because of their flatter than

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[20] The Edison Foundation, Institute for Electric Efficiency, *The Impact of Dynamic Pricing on Low Income Customers* 7 (2010), http://www.edisonfoundation.net/IEE/Documents/IEE_LowIncomeDynamicPricing_0910.pdf. For example, in the Boston Edison service area in 2014, residential customers on the low-income discount rate had an average daily peak usage about 33% higher than their overall average use, while the standard-rate peak was about 41% higher than that group’s average load. Eversource, *2014 Utility Class Average or Segment Load Shapes*, https://www.eversource.com/Content/docs/default-source/ema---pdfs/2014-load-profile-ema.xls?sfvrsn=2 (providing data for author’s calculations).

[21] Ahmad Faruqui, Sanem Sergici & Jennifer Palmer, *The Impact of Dynamic Pricing on Low-Income Customers*, THE EDISON FOUNDATION & THE INSTITUTE FOR ELECTRIC EFFICIENCY 7 (September 2010) *available at* http://www.edisonfoundation.net/IEE/Documents/IEE_LowIncomeDynamicPricing_0910.pdf.

average load shapes.[22] Importantly, this research also indicated that some low-income consumers would experience sharp cost increases from TVRs.[23]

Whether TVR programs are offered with opt-in or opt-out features could impact low-income consumers. For instance, people who could benefit from TVRs are more likely to participate in the rate program if presented with an opt-out option versus an opt-in decision. A 2010 report by the Edison Foundation and the Institute for Electric Efficiency found that "[p]articipation rates remain particularly low in the opt-in TV[R] programs and the desired system impacts may not be achieved, unless accompanied by aggressive customer outreach."[24] A more recent study by the Department of Energy similarly found that opt-in TVR programs had a participation rate of only 24%, as compared to 93% for opt-out programs.[25] The DPU stated a preference for opt-out TVR programs in order to "maximize customer participation."[26]

At the same time, the DPU and utilities must consider vulnerable customers when evaluating opt-out programs and should provide mechanisms to protect these consumers from significant cost increases; this might include alternatives to the traditional opt-in versus opt-out decision tree for TVRs. For example, the DPU could consider providing exemptions from the opt-out program for particularly vulnerable populations, *e.g.*, individuals dependent on medical equipment that requires electricity, and offer them an opt-in TVR program instead. This would help avoid punishing those who lack the capacity to change their energy usage patterns while still giving low-income consumers the chance of benefitting from TVR pricing. To achieve full realization of potential benefits, such an approach should be accompanied by outreach/education programs that would allow low-income consumers to determine the impact of TVRs on their energy costs. One way of gathering this information would be to conduct pilot projects with "shadow billings" that allow customers to see the impact TVRs would have on their bills before the TVRs are actually applied. This would give consumers an opportunity to test their ability to respond to TVRs. Assuming that the DPU requires installation of smart meters for all consumers, regardless of participation in TVR programs, this type of "shadow" billing could be used by all low-income consumers, not just those in pilot projects.

ii. Installation of Advanced Metering Functionality (i.e., Smart Meters)

Regardless of whether TVRs are offered through an opt-in or opt-out program, or with carved out exceptions, low-income consumers should still be able to meaningfully access smart meter technology. Smart meters could bring about benefits for low-income consumers independent of the role they play in TVR implementation; timely information about energy usage has been shown to help in energy efficiency efforts even for consumers that are not subject to TVRs.[27] By being able to monitor and understand their own energy usage patterns, low-income consumers

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[22] *Id*.
[23] *Id.* at 8.
[24] *Id*. at 13.
[25] Dept. of Energy, *Interim Report on Customer Acceptance, Retention, and Response to Time-Based Rates from the Consumer Behavior Studies* 24 (2015) (noting that retention rates for both types of programs were "roughly the same.") https://www/smartgrid.gov/files/CBS_interim_program_impact_report_FINAL_pdf.
[26] DPU 12-76-B, Order 48 (June 12, 2014)
[27] DSRG Coalition, *Smart Meters, Demand Response & Low-Income Customers* 2 (July 2007) http://www.eesi.org/files/drsg_low_income_111308.pdf at 2

can become more energy efficient, which could in turn decrease their energy costs. Access to smart meters might also help low-income consumers make informed energy investments; data from smart meters can provide customers with "detailed and personalized products and services that encourage greater efficiency and demand response."[28]

If the installation of smart meters is tied to decisions about participating in TVR programs, then questions arise as to who makes the opt-out/opt-in decision, and if it is an opt-in program, who pays for the meters. For example, in a rental property, is the opt-in/opt-out decision made by the landlord or the individual tenants? Will landlords be required to install sub-meters? If an opt-in TVR program charges participants for the smart meters, will tenants or landlords pay for the meters? If the tenant pays for the smart meter installation, what happens to the smart meter when the tenant moves? Would the cost of a meter prohibit participation by low-income consumers and, if so, could the cost be paid over-time through savings in energy bills? Consideration of tenants' is relevant from an energy justice perspective because low-income consumers are less likely to be homeowners but still deserve to have some control over the deployment and use of smart meters for their homes. The DPU should consider the impact that decisions about smart meter deployment will have on individuals who rent, rather than own, their homes.

iii. Customer Education Programs

The proposals under review in these Proceedings include education programs to help explain the grid modernization plan and its benefits to consumers. The DPU should evaluate these programs through an energy justice lens to ensure that the benefits of the grid modernization plans are well presented to all of the Commonwealth's consumers, especially low-income consumers. Eversource's proposed outreach and education plan, for example, includes outreach to community organizations and community energy managers. This specific attention to community organizations is important and should factor in energy justice concerns by, for example, including advocacy groups whose work promotes energy justice, environmental justice and low-income consumer protections in the network of community organizations that assist with outreach to low-income consumers.

Potential outreach and education programs could include providing reliable translations of documents, conducting outreach with local community centers and religious institutions, and emphasizing youth education on energy issues in schools. Programs like these could be good inroads to reaching low-income consumers to help them access energy benefits and take advantage of energy efficient options. Qualitative evidence shows that respondents make "smart, careful energy decisions" when exposed to consumer outreach and education programs.[29] The DPU should consider options for comprehensive outreach and education for low-income consumers when reviewing all of the grid modernization proposals.

Given the high energy burden borne by the Commonwealth's most vulnerable populations, the DPU should include a thorough energy justice analysis in its review in these Proceedings to

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[28] Minnesota Public Utilities Commission, *Staff Report on Grid Modernization* 26-27 (March 2016) https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentid=%7BE04F7495-01E6-49EA-965E-21E8F0DD2D2A%7D&documentTitle=20163-119406-01.

[29] Hernandez and Bird 19.

avoid exacerbating energy burdens and to ensure equitable distribution of and access to benefits from the energy system across all residential consumers.

II. VIRTUAL POWER PLANTS

Virtual Power Plants ("VPPs") can help the DPU achieve its vision of a modern grid that is cleaner, more efficient and more reliable than today's grid and that empowers customers to manage and reduce their energy costs.[30] VPPs help achieve this vision by (i) using renewable energy sources or using fossil fuels more efficiency and (ii) lowering technical and financial barriers to the deployment of Distributed Energy Resources ("DERs"), which in turn avoids costly investments or upgrades to existing electric distribution systems. VPPs can also advance the goals that DPU outlined in its Grid Modernization Order.[31]

VPP technology is rapidly developing and commercially available today; its deployment should not be delayed. The DPU should ensure that grid modernization investments, including in advanced metering and control systems deployed by the distribution companies, support the operation of VPPs. The DPU should also require distribution companies to take steps that would facilitate testing and integration of pilot VPP systems as part of their Research, Development and Deployment Plans and Short Term Investment Plans.

A. Virtual Power Plants Promote the Use of Distributed Energy Resources and Provide a Range of Energy and Environmental Benefits

Virtual power plants are systems that operate, through ownership or by contract, multiple smaller-scale distributed energy resources as a single resource in energy markets. VPPs coordinate, through the use of advanced software, metering and communication technologies, the exchange of energy services, including electricity, heating and cooling, between DERs and consumer energy loads.[32]

The exchange of electricity in a VPP would take place over existing distribution company distribution lines. A VPP would sell electricity produced by DERs to retail customers directly, at negotiated rates, thereby providing a financial incentive for DER deployment as the negotiated rate would likely be closer to the retail than wholesale rate.[33] A VPP and its customers would pay the distribution company for the use of its distribution lines, but such payment should be at a special VPP rate that is lower than the normal distribution rate to reflect the fact that VPPs only use local distribution lines, not the full distribution system.

VPPs further lower technical and financial barriers to DER deployment by:

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[30] Investigation by the Department of Public Utilities on its own Motion into Modernization of the Electric Grid, D.P.U. 12-76-B, 1 (June 12, 2014).
[31] *Id.* at 8.
[32] The DERs utilized in VPPs can, *inter alia*, include solar power, natural gas fired combined heat and power units, electric batteries and thermal batteries.
[33] Retail sales of electricity by a VPP at or near retail rates would not implicate federal jurisdiction. The Federal Power Act gives the Federal Energy Regulatory Commission jurisdiction over sales of electricity at wholesale, 16 U.S.C. § 824 (b)(1), which is defined to be the sale of electric energy to any person for resale. 16 U.S.C. § 824 (d). A VPP would not sell electricity for the purpose of resale.

- Aggregating the energy services that DERs provide so that they appear to the grid as a single entity, thus allowing DERs to reach a sufficient scale that the per unit electricity capital cost is minimized; and

- Dispatching combined DERs collectively so that VPPs respond to a single control signal from the distribution utility and/or Independent System Operator ("ISO") and thereby participate in the forward capacity and demand response markets, and provide ancillary services, such as frequency regulation.

Figure 1 presents a graphical depiction of the functions performed by VPPs.

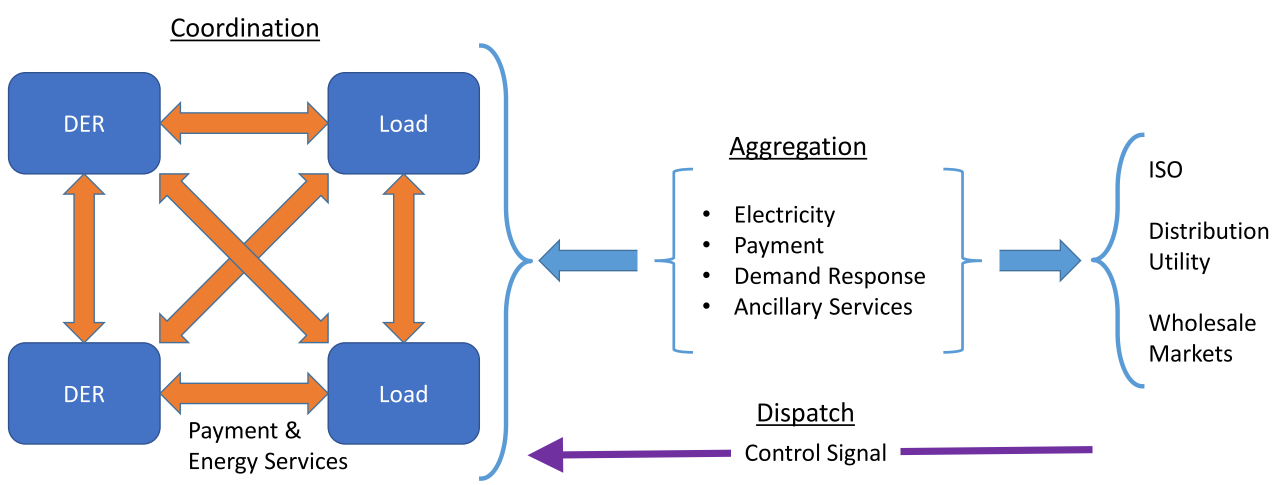

Figure 1. A graphical depiction of the three functions performed by a virtual power plant: coordination, aggregation and dispatch.

VPPs provide additional benefits, such as:

- Promoting Massachusetts' goals of reducing greenhouse gas ("GHG") emissions, which include reducing emissions 25% by 2020 and 80% by 2050,[34] by increasing the amount of electricity produced by renewable sources and combined heat and power generating units;

- Reducing the need for additional infrastructure for the generation and distribution of electricity. For example, the New England ISO has posited that "today's higher prices also indicate the need for additional gas infrastructure *or investment in alternative sources of energy* to offset the demand for natural gas."[35] Generating power closer to

[34] Massachusetts Global Warming Solutions Act, 2008 Mass. Laws ch. 298.
[35] *2015 Regional Electricity Outlook*, ISO NEW ENGLAND, at 22 (2015) (emphasis added), available at http://www.iso-ne.com/static-assets/documents/2015/02/2015_reo.pdf.

loads can reduce the need for expensive infrastructure investments, thereby lowering rates for ratepayers in general;[36] and

- Improving the resiliency and reliability of the grid, consistent with DPU's grid modernization initiatives, by deploying additional DERs onto distribution systems without costly investments and upgrades to such systems.[37]

VPPs are not a hypothetical concept; they are being demonstrated in real-world commercial operation today, especially in Europe, and large industrial conglomerates are offering VPP enabling technology. For example: (i) in 2013 the Dutch island of Ameland started construction of a VPP using 6 megawatts ("MW") of solar photovoltaics and 45 fuel-cell-based micro combined heat and power ("CHPS") units;[38] (ii) since 2012, a municipal utility in Munich, Germany, has operated a 20 MW VPP consisting of six CHP plants, five hydropower plants, and a windfarm;[39] and (iii) a 42 MW VPP, powered by wind, bio-mass and a fleet of electric cars, is serving 2000 households on the Danish island of Bornholm.[40] A recent example in the United States is Con Edison's proposal to build a VPP demonstration project, utilizing aggregated distributed solar and storage assets in homes in New York, as part of the New York Public Service Commission's Reforming the Energy Vision (REV) proceedings.[41]

In addition, commercial solutions for VPPs are now available. For example, Siemens offers a commercial cloud-based web service for municipal utilities to manage their residents' DERs as a VPP,[42] while Bosch offers what it calls a "turnkey software platform" to operate VPPs more broadly.[43] General Electric recently spun-out a company, called "Current," that will provide hardware and software solutions to companies seeking to become "active grid participants" and

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[36] *See e.g.*, Order Adopting Regulatory Policy Framework and Implementation Plan, New York Public Service Commission Case 14-M-0101, 20 (Feb. 26, 2015) ("While much of the aging infrastructure will need to be replaced ... DER can reduce near term needs in targeted areas and long term needs throughout the system.")

[37] *See e.g.*, Investigation by the Department of Public Utilities on its own Motion into Modernization of the Electric Grid, D.P.U. 12-76-B, 10 (June 12, 2014) ("A modernized grid will facilitate the reduction of peak demand by allowing retail customers to respond to price signals . . . and reduc[e] the need for new generation, transmission, and distribution investments.")

[38] David Appleyard, "Dutch VPP Using Solar PV and Fuel Cell Tech - Renewable Energy World," November 14, 2013, http://www.renewableenergyworld.com/articles/2013/11/dutch-vpp-uses-pv-and-fuel-cell-hybrid.html.

[39] 07/01/2012 | Sonal Patel, "The Rise of the Virtual Power Plant," *POWER Magazine*, http://www.powermag.com/the-rise-of-the-virtual-power-plant/. Siemens, "Stadtwerke München and Siemens Jointly Start up Virtual Power Plant," ctc_xhtml_presshome, http://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2012/infrastructure-cities/smart-grid/icsg201204017.htm.

[40] Jean Kumagai, "Virtual Power Plants, Real Power," *Spectrum, IEEE* 49, no. 3 (2012): 13–14; "EcoGrid EU," http://www.eu-ecogrid.net/ecogrid-eu.; Jean Kumagai, "The Smartest, Greenest Grid," April 29, 2013, http://spectrum.ieee.org/energy/the-smarter-grid/the-smartest-greenest-grid.

[41] ConEdison, *REV Demonstration Project Implementation Plan Clean Virtual Power Plant* (Nov. 20, 2015), available at http://www3.dps.ny.gov/W/PSCWeb.nsf/All/B2D9D834B0D307C685257F3F006FF1D9?OpenDocument.

[42] "Siemens Offers Cloud-Based Web Service for Virtual Power Plants," http://www.siemens.com/press/en/pressrelease/?press=/en/pressrelease/2014/infrastructure-cities/smart-grid/icsg201402046.htm&content[]=ICSG&content[]=EM&content[]=EMSG. (Feb 10, 2014).

[43] Bosch, "Optimizing the Grid and Energy Trading," https://www.bosch-si.com/solutions/energy-management/virtual-power-plant/virtual-power-plant-manager-software.html.

that could be used to build and operate VPPs.[44] Likewise, Encorp offers a virtual power plant software solution.[45]

B. Virtual Power Plants Can Connect to Distribution Systems under Current Laws and Policies

VPPs generate or otherwise procure electricity but do not own or operate distribution facilities; thus they need to use the existing distribution lines owned by distribution companies. Under the Massachusetts Electric Industry Restructuring Act of 1997, the DPU is "authorized and directed to require electric companies to accommodate retail access to generation services and choice of suppliers by retail customers."[46] This law grants retail customers the right to procure electricity services from their choice of suppliers, whether it is the default service provider or a competitive supplier. This right to customer choice only makes sense if generators and competitive suppliers have access to the distribution company's distribution lines.

The DPU has so interpreted the statutory mandate. Per DPU's regulations, distribution companies must "establish *non-discriminatory* Interconnection Standards that govern the connection of Generation Facilities to its Distribution Facilities."[47] Interconnection standards must "ensure that all Generation Facilities have fair access on reasonable terms to the Company's Distribution Facilities."[48] The DPU has implemented this regulation by, *inter alia*, promulgating a model interconnection tariff for distributed generation, also known as the "Standards for Interconnection of Distributed Generation."[49] In addition, the DPU approved Terms and Conditions between distribution companies and competitive suppliers that require the distribution companies to give licensed competitive suppliers access to distribution company lines.[50]

i. Virtual Power Plants Could Connect to Distribution Systems as Generators

In the event that a VPP owns or leases DERs directly, the VPP would qualify under Massachusetts law as a "generation company," a "generation facility," and a provider of "generation services" so that the VPP would have rights as a generator to use a distribution company's distribution lines. (Owners of DERs that are aggregated by a VPP could similarly connect to distribution systems.) A "generation company" is defined as "a company engaged in the business of producing, manufacturing or generating electricity or related services or products, including but not limited to, renewable energy generation attributes for retail sale to the

[44] Katherine Tweed, "GE Launches $1B Energy Services Company, Current," October 7, 2015, http://www.greentechmedia.com/articles/read/ge-launches-1b-energy-services-company-current.
[45] Encorp, "Virtual Power Plants," http://www.encorp.com/VPP.pdf.
[46] Mass. Gen. Laws Ann. ch. 164, § 1A (West).
[47] 220 CMR 11.04(4) (emphasis added).
[48] *Id*.
[49] The most recent Model Interconnection Tariff was issued by Investigation by the Department of Public Utilities on its own Motion into Distributed Generation Interconnection, Order on the Model Interconnection Tariff, D.P.U. 11-75-G (May 4, 2015).
[50] *See e.g.*, Massachusetts Electric Company & Nantucket Electric Company, Terms and Conditions for Competitive Suppliers, M.D.P.U. No. 1201.1 (May 1, 2014).

public."[51] A "generation facility" is defined as "a plant or equipment used to produce, manufacture or otherwise generate electricity and which is not a transmission facility."[52] A "generation service" is defined as "the provision of generation and related services to a customer."[53] All three of these definitions would encompass a VPP.

ii. Virtual Power Plants Could Connect to Distribution Systems as Competitive Suppliers

As a supplier of retail electricity to retail customers, a VPP would also qualify as a competitive supplier under Massachusetts law, DPU regulations, and Supreme Judicial Court precedent so that a VPP would have rights as a competitive supplier to access a distribution company's distribution lines. A "supplier" is defined by statute as "a supplier of generation service to retail customers."[54] Because a VPP provides generation service to retail customers, it would qualify as a supplier. The DPU takes an even broader view of "competitive supplier," defining that term to cover any entity that is licensed to sell electricity to retail customers other than distribution companies or municipal light companies.[55] The SJC has defined competitive suppliers as "firms that generate or otherwise procure electricity without owning or operating the means to distribute electricity to consumers."[56] Because VPPs generate or procure electricity but do not own or operate the means to distribute electricity, VPPs would meet this definition, and thus could utilize DPU-approved Terms and Conditions between distribution companies and competitive suppliers that require the distribution companies to give licensed competitive suppliers access to distribution company lines.[57]

A VPP's operation as a competitive supplier is consistent with the DPU's Model Terms and Conditions for Competitive Generation Service,[58] which forms the basis for each distribution company's relationship with competitive suppliers. The Terms and Conditions do not preclude exchange of electricity over distribution lines and VPPs can satisfy the licensure requirements for competitive suppliers.[59] Licensure would require a VPP to be a participant in the New England Power Pool ("NEPOOL"),[60] and the NEPOOL Agreement explicitly contemplates distributed generation resources as being NEPOOL participants.[61]

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[51] M.G.L. ch. 164 § 1.
[52] *Id.*
[53] *Id.*
[54] *Id.*
[55] 220 CMR 11.02.
[56] *NSTAR Elec. Co. v. Dep't of Pub. Utilities*, 462 Mass. 381, 383 (2012).
[57] VPPs operating as competitive suppliers would have to comply with consumer protection regulations promulgated by the DPU (220 CMR 11.05) and the Attorney General (940 CMR 19.00).
[58] 220 CMR 11.04 (2)(c) (providing that each distribution company shall file, for Department approval, terms and conditions governing the manner in which Distribution Service is provided to Distribution Customers, and the Terms and Conditions must be consistent with the Model Terms and Conditions for Distribution Service established by the DPU.)
[59] 220 CMR 11.05(2).
[60] 220 CMR 11.05(2)14.
[61] New England Power Pool Second Restated NEPOOL Agreement, § 1.15, available at http://www.nepool.com/uploads/Op-2d_RNA.pdf.

C. Virtual Power Plants Are a Natural Evolution of the Commonwealth's Existing Grid Modernization and Greenhouse Gas Emission Reduction Policies and Advance the Objectives of the DPU's Grid Modernization Order

Massachusetts has long been at the forefront of grid modernization efforts. This leadership has been displayed, *inter alia*, by (1) the Restructuring Act of 1997, which separated generation from distribution and introduced retail competition into electricity markets, and (2) the Commonwealth's long standing policy of encouraging the deployment of DERs. These DER deployment policies are evidenced by, for example: (i) the creation and continued revision of a model distributed generation interconnection agreement;[62] (ii) the Green Communities Act of 2008,[63] which expanded net metering and virtual net metering for some types of DERs; (iii) the DPU's Grid Modernization Order,[64] which ordered distribution companies to develop a plan for integrating DERs; and (iv) the 2012 Energy Bill,[65] which also expanded net metering and ordered the DPU to develop an interconnection timeline for distributed generation facilities.

VPPs also advance the four objectives of the DPU's Grid Modernization Order:[66]

1. Reducing the effects of outages – VPPs promote the deployment of DERs, which can provide electricity in the event of a grid outage.

2. Optimizing demand, including reducing system and customer costs – VPPs optimize demand, including peak loads, by managing the exchange of energy between customers and DERs on distribution circuits and by incorporating storage, both electric and thermal, into the distribution system.

3. Integrating DERs – VPPs lower technical and financial barriers to DERs and thereby promote their deployment.

4. Improving workforce and asset management – VPPs improve asset management by lowering the need for distribution companies to invest in distribution and transmission infrastructure and by providing a means for DERs to communicate with the larger grid as a whole.

As a natural evolution of Massachusetts' efforts to introduce retail competition and encourage distributed generation, VPPs build on existing features of the electric system and should be

[62] The first model distributed interconnection agreement was promulgated by the DPU in 2002. *See* Investigation by the Department of Telecommunications and Energy on its own motion into Distributed Generation, DTE 02-38-B (Feb. 24, 2004). The model agreement was most recently revised in Investigation by the Department of Public Utilities on its own Motion into Distributed Generation Interconnection, Order on the Model Interconnection Tariff, (DPU 11-75-G, May 4, 2015).
[63] An Act Relative to Green Communities, M.G.L. Session Law Ch. 169.
[64] Investigation by the Department of Public Utilities on its own Motion into Modernization of the Electric Grid, D.P.U. 12-76-B, 2 (June 12, 2014).
[65] An Act Relative to Competitively Priced Electricity in the Commonwealth, M.G.L. Session Law Ch. 209, § 49.
[66] Investigation by the Department of Public Utilities on its own Motion into Modernization of the Electric Grid, D.P.U. 12-76-B, 1 (June 12, 2014).

supported by ongoing efforts to modernize the grid, including decisions made in these Proceedings.

D. Grid Modernization Plan Investments Should Facilitate the Deployment of Virtual Power Plants

There may be many synergies between the implementation of VPPs and the distribution companies' short term investment plans for grid modernization efforts. For example, the DPU directed the electric distribution companies to file research, development and deployment plans that focus on the testing, piloting, and deployment of new and emerging technologies to meet the objectives of the Grid Modernization Order. Incorporating VPPs into the grid will require testing and integration of many of the same technologies in which distribution companies will be investing to develop a smarter grid that can support the cost effective interconnection of DERs. Thus, when evaluating the proposed research, development and deployment plans and short term investment plans, the DPU should consider whether the plans will support an eventual wide-scale deployment of VPPs.

As an example, Eversource proposed upgrading existing electro-mechanical relays with DSCADA-enabled microprocessor-based relays with adaptive protection that will monitor the grid for abnormal power flow, which will support further integration of DERs into the grid.[67] VPPs build on such investments by providing further control and information regarding power flows on distribution circuits. As another example, proposals to deploy energy storage, including to address solar PV intermittency, also parallel what can be accomplished by VPPs.[68] By their nature, VPPs manage the intermittency of solar power and other non-baseload DERs by coordinating the exchange of electricity between DERs, the VPP loads and the grid. VPPs can use storage to help coordinate this exchange, and thus, would be an appropriate partner in pilot studies for storage technologies. There may be opportunities for distribution companies to share the cost of testing and adopting new technologies with commercial VPPs, because many of the functions of VPPs and the technologies proposed in the grid modernization plans overlap. Together, commercial VPPs and distribution companies can support the integration of DERs into the grid.

i. Smart Meters, Advanced Sensing Technology and Distribution Management Systems Should Be Able to Communicate with Each Other Using a Compatible Communication Protocol

A modern grid will require innovative smart meters that can: (i) measure two-way power flow; (ii) measure power flow in real time; and (iii) communicate with each other and with the grid as a whole. Currently, if a VPP seeks to connect to a distribution system, the VPP may request the installation of a meter, at the VPP's expense, but the meter will be selected by the distribution

[67] NSTAR Electric Company and Western Massachusetts Electric Company d/b/a Eversource Energy, Petition for Approval of Grid Modernization Plan, D.P.U. 15-122/15-123, 23.
[68] *Id.* at 56.

company.[69] Meters provided by distribution companies in response to a request from a customer or competitive supplier should, if requested, support the operation of a VPP.

In addition to requiring smart meters, a VPP cannot operate unless the DERs and loads in a VPP can effectively communicate amongst themselves and with the larger grid as a whole. In their grid modernization plans, distribution companies have proposed investments in advanced sensing technology and distribution management systems that also require communication between various elements of the grid's control equipment. However, the effectiveness of this communication may be limited if technology from different vendors "speak" in incompatible languages; this in turn would limit the ability of a VPP to operate on the distribution system. Thus, an investment in grid control equipment that did not provide for effective communication would be a wasted opportunity. Additional investment would likely be required in the future to provide for the communication systems that a modern grid will require.

The DPU can avoid a wasted opportunity and facilitate communication between DERs and the grid by requiring new smart meters, advanced sensing technology and distribution management systems to use a compatible communications protocol. This protocol should be an industry standard and publicly available so that new DERs and other grid technologies can effectively communicate with grid control systems.

The need for such a protocol is widely recognized and other jurisdictions are in the process of developing and implementing such a protocol. For example, California is evaluating appropriate communication standards between the grid and smart inverters, such as Smart Energy Profile 2.0, IEC 61850, and IEC 61970.[70] To avoid duplication, the DPU should consider requiring the distribution companies to adopt communication standards adopted in other jurisdictions.

ii. New Communication Infrastructure Built as Part of a Grid Modernization Plan Should Be Open to VPP Communication

As described above, the operation of a VPP requires communication between DERs, loads and the larger grid. Where distribution companies' propose enhancements in communication infrastructure, such as Eversource's proposal for additional fiber and radio communications, the DPU should require that such infrastructure be constructed so that VPPs, and DERs in general, can have access to the communication infrastructure.

[69] Western Massachusetts Electric Company, Terms and Conditions for Distribution Service, M.D.P.U. No. 1023C, §4A (Jan. 31, 2011); Fitchburg Gas and Electric Light Company, Terms and Conditions for Distribution Service, M.D.P.U. No. 266, §4A (June 1, 2014); Massachusetts Electric Company & Nantucket Electric Company, Terms and Conditions for Distribution Service, M.D.P.U. No. 1192, §4A (Dec. 1, 2010).

[70] See California Public Utilities Commission, *Recommendations for Utility Communications with Distributed Energy Resources* (DER) Systems with Smart Inverters (February 28, 2015), available at http://www.energy.ca.gov/electricity_analysis/rule21/documents/SIWG_Phase_2_Communications_Recommendations_for_CPUC.pdf.

iii. Research, Development and Deployment Plans Should Include Virtual Power Plants or Virtual Power Plant-Related Technologies

Distribution companies' Research Development and Deployment programs should provide at least some level of support for VPPs. Regardless of whether VPPs are widely used in Massachusetts, the underlying features of communication, energy exchange and DER aggregation will likely be prominent features in the grid of the future. Thus, there will be long-term benefits to consumers if distribution companies pursue these features as part of their Research Development and Deployment plans.

Although the proposed grid modernization plans do include some elements of VPP technology, they could be far more ambitious. For example, Eversource proposes establishing a Grid Modernization Test Bed on a distribution feeder or substation to test grid technologies, but could learn more by piloting VPP technologies. Because the underlying technologies for VPPs are well developed, and actually deployed in some contexts around the world, the technology would best be pursued as part of demonstration projects in the Commonwealth. Distribution companies should explore partnering with Universities, municipalities or large corporate consumers in urban environments to pilot VPP technologies, such as DER aggregation, electricity storage and peak load management. Such demonstration projects could include microgrids that use wires owned and operated by distribution companies and technology that is similar, if not the same as, that used in VPPs.

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Thank you for your consideration of these comments. The Clinic appreciates the opportunity to submit these comments and welcomes the opportunity to participate further in efforts to promote energy justice and electric system innovations in Massachusetts. Please direct any follow-up communications to Aladdine Joroff, 617-495-5014 (ajoroff@law.harvard.edu).

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