THE LEGAL REGIME OF WIDESPREAD PLUG-IN HYBRID ELECTRIC VEHICLE ADOPTION: A VERMONT CASE STUDY

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Synopsis: Now that PHEVs and electric vehicles are available at retail, an on-the-ground legal analysis is necessary to analyze how these vehicles can be integrated into existing legal regimes for the regulation of electricity. Using Vermont as a case study, we identify the key legal issues which must be resolved for widespread fleet penetration of PHEVs to be achieved. These involve integrated resource planning and transmission cost allocation for PHEVs' anticipated cumulative impact on base load and peak electric demand; statewide charging infrastructure development; and integration with the smart grid. Such a legal analysis should be used to inform economic modeling of PHEV fleet penetration both in Vermont and nationwide.

The policy justification for the significant charging infrastructure and smart grid costs related to PHEVs is the reduction of transportation sector greenhouse gas emissions. The relative cleanliness of Vermont's existing energy mix means that PHEVs will reduce greenhouse gases at a higher rate than in more carbon-intensive areas of the United States. However, while PHEVs might play a role in Vermont's low-carbon future, the extent of that role remains in doubt. PHEVs' future role depends in significant part on how this new technology will be integrated into Vermont's pre-existing legal regime for the regulation of electricity. We demonstrate in this article what such an empirical legal analysis should look like, and conclude that continued on-the-ground analysis of the major legal issues confronting the widespread adoption of PHEVs is required.

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I. INTRODUCTION: THE NEED FOR EMPIRICAL LEGAL ANALYSIS

The future of plug-in hybrid electric vehicles (PHEVs) is now. The PHEV Chevrolet Volt and the electric vehicle (EV) Nissan Leaf became commercially available in late 2010.[1] Legal commentators and policymakers have analyzed the potential role PHEVs could play in a low-carbon future.[2] However, the recent rollout of the Volt and the Leaf underscores the need to take this legal analysis to the next empirical level. Such an on-the-ground legal analysis requires that the potential widespread adoption of PHEVs be examined with respect to the legal regime of a specific jurisdiction. Stated differently, expansive PHEV fleet penetration will not be possible unless this new technology is fully integrated into pre-existing and adaptable state legal frameworks for the regulation of electricity. To achieve this empirical understanding, we focus on the state of Vermont.

By examining the interplay between PHEV technology and Vermont's existing regime for the regulation of electricity, we identify the key legal issues which must be resolved for the widespread penetration of PHEVs to occur. Most of these legal issues are not state-specific; they will be encountered by every state in some incarnation. Furthermore, the particular manner by which

1. Mark Clayton, *Nissan's All-Electric Leaf Challenges GM Volt and Toyota Prius*, CHRISTIAN SCI. MONITOR (Mar. 30, 2010), *available at* http://www.csmonitor.com/USA/2010/0330/Nissan-s-all-electric-Leaf-challenges-GM-Volt-and-Toyota-Prius.

2. Ronald Minsk, Sam Ori & Sabrina Howell, *Plugging Cars into the Grid: Why the Government Should Make a Choice*, 30 ENERGY L.J. 317 (2009).

each state incorporates PHEVs into its regulatory framework will help to determine how quickly PHEV technology is adopted nationwide. In this article, we examine a few of the empirical questions which states must consider: 1) whether existing and planned generation infrastructure is sufficient to accommodate the increased electric demand from PHEVs; 2) how federal transmission planning requirements will determine PHEVs' relative contribution to new regional transmission infrastructure costs; 3) whether the costs of local charging station infrastructure will be borne by ratepayers; and 4) what role PHEVs will play in the development and implementation of the smart grid. These and similar questions must be confronted by energy regulators in every state. However, the *manner* by which these questions will be confronted, and the answers to these questions which state regulators will ultimately provide, cannot be generalized. Rather, these issues must be empirically explored. We articulate in this article what this analysis should look like for the state of Vermont.

In section II of this article, we discuss the Leaf and the Volt, examine PHEV technologies and costs, and assess the impact of PHEVs on Vermont's energy infrastructure. Section III of this article investigates PHEVs' potential role in achieving a low-carbon future in Vermont. The role PHEVs will play in that future depends on the cleanliness of the electricity used to power PHEVs, the relative cleanliness of other electric generation technologies, the political interests at stake, and the viability of related public policies. In section IV of this article, we identify the changes to Vermont's regulatory regime necessary for the widespread fleet penetration of PHEVs. These include amendments to utility IRPs, incorporation of PHEV fleet penetration scenarios into smart grid planning, ongoing compliance with federal transmission planning requirements, and the need for the construction of local charging infrastructure. In our conclusion, section V, we argue for continued on-the-ground analysis of the major legal issues confronting the widespread adoption of PHEVs which we have identified in this article.

II. PHEVS AND VERMONT'S GRID INFRASTRUCTURE

A. The Future is Here

1. The Volt

PHEVs are no longer theoretical. At the end of 2010, General Motors released the Chevrolet Volt, a plug-in hybrid electric vehicle which can travel up to 40 miles on a pure electric charge. The Volt is the first commercial PHEV to hit the market; Chevrolet expects it to attract consumers through lowered fuel costs, reduced tailpipe emissions, and the cache of an environmentally sustainable mode of transportation. On a full charge, the Volt's 16 kWh lithium-ion, 400-pound battery pack propels the vehicle 40 miles in an all-electric mode, after which the 1.4 liter, 12-gallon range-extending gasoline engine kicks in. This range-extending gas generator supplies power to an electric motor and allows the vehicle to travel up to an additional 600 miles before refueling.

The Volt's fuel economy varies based on the distance traveled without recharging. A fully charged Volt relies on its electric charge and uses almost no gasoline if it is driven for less than 40 miles.[3] However, the more miles driven after the 40 mile electric charge is depleted, the lower is the Volt's fuel economy. Therefore, the Volt gets up to 230 miles per gallon (mpg) if driven for 51 miles, 70 mpg if driven for 140 miles, and 53 mpg if driven for 640 miles.[4]

More than 75% of the nation commutes 40 miles a day or less.[5] The Volt's 40 mile, all-electric charge could therefore support a significant portion of the nation's basic driving needs. Once the Volt has exceeded the 40 miles supported by its battery pack, the vehicle's gasoline engine powers the electric motor. At that point, the Volt gets up to 50 mpg.[6] If the vehicle is unable to access a recharging station, the Volt runs solely on its gasoline and electric motor engines. Given today's transportation infrastructure, and the lack of public charging stations, Chevrolet hopes that the Volt's combined all-electric and hybrid electric propulsion technology will provide consumers with both convenience and reliability.

The Volt consumes an estimated 2,500 kWh of electricity annually and can be charged through a standard 110V outlet.[7] The battery pack requires eight hours, using an 110V outlet, to be fully charged.[8] If a 240V outlet is used, the Volt only requires three hours to produce a full charge.[9] Even without charging, the Volt is fully operational as a hybrid vehicle. However, if not recharged, the benefits of the Volt's innovative, all-electric technology cannot be fully realized. The cost of charging the Volt's all-electric battery compares favorably to the cost of a gasoline powered vehicle. If the Volt is driven under 40 miles a day and then recharged, powering the Volt at 12 cents per kWh, the average cost to operate the Volt would be less than a dollar a day.[10] The roughly eighty cents it costs to power the Volt for 40 miles in its all-electric range is much cheaper than the $4 cost of running a fuel-efficient, conventional gasoline powered vehicle.[11]

The Volt costs around $40,000.[12] This cost is subsidized in part by the $7,500 tax credit offered by the federal government through the 2009 American

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3. While the Volt's fuel economy when driven for less than 40 miles is considerable, it is not without costs. As discussed below, these costs – both in economic and CO_2 terms – are borne by the electricity sector; they depend upon the underlying cleanliness of the electricity used to charge the battery pack, and on the timing of the charge in relation to peak electric demand.

4. John Voelcker, *How Does the 2011 Chevy Volt Get 230 MPG? By Making Assumptions*, GREEN CAR REPS. (Aug. 11, 2009), http://www.greencarreports.com/blog/1034125_how-does-the-2011-chevy-volt-get-230-mpg-by-making-assumptions.

5. U.S. DEP'T OF TRANSP., BUREAU OF TRANSP. STATISTICS, SOURCE VOL. 3, ISSUE 4 (Oct. 2003), http://www.bts.gov/publications/omnistats/volume_03_issue_04/html/entire.html.

6. Voelcker, *supra* note 4.

7. *2011 Volt, Electric Car*, CHEVROLET, http://www.chevrolet.com/pages/open/default/future/volt.do (last visited Nov. 4, 2010).

8. *Id.*

9. Installation of a 240V outlet requires a particular electrical circuit installation, comparable to that used for a clothes dryer. Such an installation would most likely require an electrician or electrical professional.

10. CHEVROLET, *supra* note 7.

11. Laurence Ulrich, *New York Auto Show: Test Driving the Chevy Volt*, WHEELS: N.Y. TIMES BLOG (Mar. 30, 2010 7:52PM), http://wheels.blogs.nytimes.com/2010/03/30/new-york-auto-show-test-driving-the-chevy-volt-in-new-york/?src=mv.

12. *Id*.

Recovery and Reinvestment Act (ARRA).[13] In addition to this federal tax credit, many state incentives are offered. For example, in California, where the Volt was first released, the state offers up to $5,000 in additional rebates.[14] Vermont currently offers no additional incentives for PHEVs. Chevrolet plans to release 10,000 Volts in the first year of production and has initially only sold vehicles in California; it plans to sell up to 60,000 vehicles the following year.[15]

2. The Leaf

Another alternative vehicle that hit the market in late 2010 is the all-electric Nissan Leaf. The Leaf became available in select markets at the end of 2010; nationwide availability is anticipated in 2011. Initially, the Leaf was offered for sale in Tennessee, Arizona, California, Oregon, and Washington.[16] Powered by an advanced lithium-ion battery, the Leaf travels up to 100 miles on a single charge.

The Nissan Leaf's lithium-ion (Li-ion) battery has a total storage capacity of 24 kWh and delivers a maximum of 90 kW to the electric motor.[17] In order to charge the Leaf's battery, consumers must install a 240-volt/20amp charger that is hard-wired directly to a circuit in their homes.[18] Full battery recharge takes eight hours. However, Nissan hopes that high-powered public charging stations, detectable by an on-board navigation system, will be installed at gas stations, malls, and similar locations.[19] These stations would use a three-phase, 50 kW "fast charger" to provide an 80% charge in thirty minutes.[20] The cost of these fast chargers is projected to be around $45,000 each.[21] Nissan states that it is working with government and the private sector to develop a public charging infrastructure similar to that available for gas-powered automobiles.[22] The development of such a widespread electric vehicle charging infrastructure would provide convenience, alleviate "range anxiety," and encourage the adoption of electric powered vehicles.

At current electricity rates, it costs consumers about $3 to fully charge a Leaf battery pack. The Leaf is priced at $32,780. However, like the Volt, federal tax credits reduce the cost by $7,500, resulting in a price of $25,280. Some states have additional incentives: California and Georgia offer a $5,000 tax credit, Colorado provides up to a $6,000 tax credit, and Oregon has a $1,500 tax

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13. 26 U.S.C. § 30D (2010). The amount of the tax credit is $2,500 plus $417 for each kilowatt hour of traction battery capacity in excess of 4 kilowatt hours.

14. CAL. HEALTH & SAFETY CODE §§ 39600, 39601 & 44271 (West 2010) (Cal. Assemb. B. 118, California Alternative and Renewable Fuel, Vehicle Technology, Clean Air, and Carbon Reduction Act of 2007).

15. CHEVROLET, *supra* note 7.

16. G. Chambers Williams, III, *Nissan Clips Price of Its All-Electric Leaf*, S.F. CHRON. (Apr. 4, 2010), http://www.sfgate.com/cgi-bin/blogs/topdown/detail?entry_id=60559&type=autos.

17. Jon Vandervelde, *2011 Nissan LEAF: Battery*, *ALL ELEC. CARS* (Aug. 2, 2009), http://www.allcarselectric.com/blog/1033848_2011-nissan-leaf-batteries.

18. *Nissan LEAF, Electric Car*, NISSAN USA, http://www.nissanusa.com/leaf-electric-car/details.jsp#/details (last visited Nov. 4, 2010).

19. *Id*.

20. Vandervelde, *supra* note 17.

21. *Id*.

22. NISSAN USA, *supra* note 18.

incentive.[23] Nissan also offers a lease option at $349 per month for thirty-six months with a $1,999 initial payment.[24] As discussed above, consumers are required to install a 240V charger in their homes, adding an additional $2,200 to the cost of owning and operating a Leaf.[25] There is, however, an additional federal tax credit that covers half of this cost.[26]

We have prepared the following Table to summarize the respective characteristics of the Volt and the Leaf:

Table 1. Comparison of the Chevrolet Volt and Nissan Leaf

	Vehicle Type	**Power Source**	**Outlet Required**	**Charging Time**	**All-Electric Range (AER)**	**Total Distance**	**Fuel Costs**	**Vehicle Cost***
Chevrolet Volt	PHEV	Battery Pack, Gasoline Engine, Electric Motor	110V (standard) or 240V	8 hours with 110V; 3 hours with 240V	40 miles	640 miles	Less than $1/day on all-electric; 300 miles on 1.4L gasoline tank	$40,000
Nissan Leaf	EV	Battery Pack	240V	8 hours with 240V; potential for 'quick charge' fill-ups	100 miles	100 miles	$3/fill up	$32,780

* Vehicle cost before tax credits and incentives

The Chevrolet Volt and the Nissan Leaf represent one possible transportation future. Now that PHEVs and EVs are commercially available, it remains to be seen whether they will ultimately achieve significant market penetration. This will depend, in part, on how PHEVs and EVs will be integrated into existing legal regimes for the regulation of electricity. Although both the Volt and the Leaf entered the marketplace in late 2010, this article

23. *See generally* Cal. Assemb. B. 118, 2007 Cal. Stat., Chapter 750; GA. CODE ANN. § 48-7-40.16 (West 2010); COLO. REV. STAT. § 39-33-10 to 39-33-10 (2011); OR. REV. STAT. §§ 316.116, 469.160-469.180, 801.37.

24. NISSAN USA, *supra* note 18.

25. *Id*. Charging stations will also be made available for lease customers; this increases monthly costs to $400.

26. Energy Improvement and Extension Act, Pub. L. No. 110-343, 122 Stat. 3765, § 30D (2008). The American Recovery and Reinvestment Act of 2009 amended § 30D in certain material respects, effective for vehicles acquired after December 31, 2009. 26 U.S.C. § 30D (2009).

primarily focuses on PHEV technology because a purely electric vehicle requires an extensive infrastructure to supply recharging. Before that more extensive infrastructure is in place, the infrastructure necessary to support PHEVs would first have to be established. Thus, the legal issues we present with respect to the necessary legal framework for widespread fleet penetration of PHEVs in Vermont would be applicable to EVs in a more extreme form.

B. PHEV Technology and Costs

1. Battery Technology

PHEVs combine the technologies of a conventional hybrid electric vehicle (HEV), which utilizes an internal combustion engine and an electric motor, with the all-electric technology of an electric battery pack. A PHEV is charged directly from the grid; it stores the energy in an on-vehicle battery, which powers the vehicle during driving. Once the battery is depleted, the vehicle transitions to the gasoline-powered internal combustion engine and electric motor.[27] The PHEV differs from a traditional hybrid vehicle by its all-electric driving range (AER), which is powered solely by the battery pack and does not rely on the gasoline and electric motors.[28]

PHEV batteries allow the vehicle to travel a particular distance on pure electric power. This AER, which depends on battery size, varies amongst different PHEV models.[29] A vehicle that is driven within its AER is in its charge-depleting state; once the vehicle has depleted its battery storage, it transitions to the charge-sustaining mode of operation and functions similarly to the propulsion of a traditional HEV.[30] A PHEV-10 can travel 10 miles in its charge-depleting state before it transitions to the charge-sustaining mode. Similarly, a PHEV-40, such as the Chevrolet Volt, has an AER of 40 miles.[31] A PHEV-10 requires 2.0 kWh of battery energy to meet its 10 mile AER, while a PHEV-40 requires 8.0 kWh[32] of battery energy to fuel its 40 mile AER before its transition to charge-sustaining mode.[33]

Battery charging requirements correspond to battery size and AER capability. A 110-volt AC/15 amp circuit is sufficient to charge a 1.4 kW load battery; a 110-volt AC/20 amp circuit will charge a 2 kW load battery; and a 240

27. ELECTRIC POWER RESEARCH INST. & NATURAL RES. DEF. COUNCIL, ENVIRONMENTAL ASSESSMENT OF PLUG-IN HYBRID ELECTRIC VEHICLES, VOLUME 1: NATIONWIDE GREENHOUSE GAS EMISSIONS (2007), http://my.epri.com/ (Search "Environmental Assessment of Plug-In Hybrid Electric Vehicles, Volume 1").

28. NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD., COMM. ON ASSESSMENT OF RES. NEEDS FOR FUEL CELL AND HYDROGEN TECH., TRANSITIONS TO ALTERNATIVE TRANSPORTATION TECHNOLOGIES — PLUG-IN HYBRID ELECTRIC VEHICLES (2010), http://www.nap.edu/openbook.php?record_id=12826&page=R1 [hereinafter *NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD.*].

29. *Id*. A fully charged PHEV battery would not allow for regenerative breaking. A fully discharged battery (0% charge) would potentially cause serious damage to the vehicle's performance. Therefore, it is likely that early PHEV models will only allow up to 80%, and discharge to 30%.

30. *Id*.

31. *Id*. With a longer AER, the vehicle propulsion mechanism operates differently where the engine only charges the battery, and the electric motor provides all the propulsion for the vehicle.

32. Although the Chevrolet Volt has a 16 kW-sized battery pack, it takes 8 kWh to travel 40 miles and then transitions to the vehicle's charge-sustaining operation mode.

33. *NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD.*, *supra* note 28.

volt/20 amp circuit will charge a 6 kW load battery. It is anticipated that most PHEVs, like the Chevrolet Volt, will be charged using a standard 110V outlet.[34] However, the Nissan Leaf requires a 240V charger, which necessitates the installation of a circuit similar to that required for clothes dryers.[35] Charging time for a PHEV-20 is expected to range from 3.9 to 8.2 hours, depending on the vehicle's size.[36] Meanwhile, the PHEV-40 Volt will take eight hours to charge on a 110V outlet and as little as three hours on a 240V charge.[37] The Nissan Leaf will take eight hours to charge on a 240V station, albeit the charging time will be shorter if the infrastructure for public, high-powered charging stations is developed.[38]

Battery technology is an integral factor to the technological feasibility and cost-effectiveness of PHEVs.[39] The optimal battery for PHEV deployment is the Li-ion battery, which has more than twice the energy density and about three times the power density of the nickel-metal-hydride battery used in most contemporary HEVs.[40] This greater energy and power density reduce the size and weight of the PHEV and thereby enhance the vehicle's fuel economy.[41] However, while Li-ion batteries improve energy storage and promise higher efficiency,[42] this technology also presents a major impediment to integrating PHEVs into the marketplace: Li-ion batteries have yet to be developed and produced at a reasonable cost.[43]

2. Cost and Consumer Demand

Due primarily to battery cost, PHEVs are expected to be significantly more expensive than conventional or hybrid vehicles.[44] In a recent study, the National Academies of Science (NAS) characterized the potential for technology improvements to markedly reduce the cost of Li-ion batteries as minimal.[45] According to the NAS study, a PHEV-40 is estimated to cost up to $18,000 more than the conventional vehicle equivalent, while a PHEV-10 is expected to cost up to an additional $6,300.[46] Increased manufacturing costs are anticipated to cause even greater consumer price increases.[47] The NAS therefore concludes

34. ARGONNE NAT'L LAB., U.S. DEP'T OF ENERGY LAB., PHEV TECHNOLOGY ANALYSIS AT ARGONNE (2008), *available at* http://www.transportation.anl.gov/pdfs/HV/548.pdf [hereinafter *ARGONNE NAT'L LAB*].

35. CHEVROLET, *supra* note 7.

36. OAK RIDGE NAT'L LAB., POTENTIAL IMPACTS OF PLUG-IN HYBRID ELECTRIC VEHICLES ON REGIONAL POWER GENERATION (2008), *available at* http://www.ornl.gov/info/ornlreview/v41_1_08/regional_phev_analysis.pdf [hereinafter *OAK RIDGE NAT'L LAB.*].

37. NISSAN USA, *supra* note 18.

38. Williams, III, *supra* note 16.

39. *NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD.*, *supra* note 28.

40. *Id.*

41. *Id.*

42. *OAK RIDGE NAT'L LAB.*, *supra* note 36.

43. *NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD.*, *supra* note 28, at 3.

44. *ARGONNE NAT'L LAB.*, *supra* note 34.

45. "Li-ion batteries based on similar technology are already being produced in great numbers and are well along their learning curves. The steep early drop in cost often experienced with new technologies is not likely." *NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD.*, *supra* note 28, at 1.

46. *Id*. at 4.

47. *Id.*

that PHEV-10s will not be cost-competitive with conventional vehicles until 2030, while PHEV-40s – such as the Volt – will not be cost-competitive until 2040.[48]

Despite the NAS' findings, future technological, economic, and political developments might substantially reduce the cost of PHEVs relative to conventional automobiles. The NAS estimates that the cost of Li-ion batteries will decline by 35% by 2020 - even though it foresees no breakthroughs in battery technology.[49] Moreover, the NAS' conclusion that PHEV-40s will not be cost-competitive with conventional vehicles until 2040 assumes gasoline prices at $4 per gallon or less.[50] Global market forces and political developments in the next decade, such as further EPA regulation of greenhouse gas emissions, could increase gasoline prices significantly above that level.[51] Transportation costs already constitute over 15% of annual income in northeast households.[52] A severe spike in gasoline prices, to well beyond $4 per gallon, would therefore make PHEVs far more attractive to Vermont consumers.

Before federal tax incentives, the Chevrolet Volt costs around $40,000,[53] and the Nissan Leaf costs $32,780.[54] The American Recovery and Reinvestment Act of 2009 provides a $7,500 tax credit for the purchase of a qualified plug-in electric drive vehicle, thereby reducing the price of the Volt and the Leaf to $32,500 and $25,280, respectively.[55] Vermont does not provide any tax incentives to further reduce these costs,[56] but some states, like California, offer up to $5,000 in additional incentives.[57]

Although PHEVs cost more to purchase than similar conventional vehicles, their operating costs are significantly lower. PHEVs cost about three cents a mile to fuel when driven within AER, and about thirteen cents a mile when using the gasoline and electric motors; this results in an average combined cost between six to eight cents per mile.[58] The operating costs of the Volt and the

48. *Id*.

49. *Id.*

50. *Id*.

51. The ongoing severe recession, the prevalence of relatively low gasoline prices, and the outcome of the 2010 mid-term elections make it extremely unlikely that Congress will enact legislation instituting a national cap-and-trade carbon regime, or "carbon tax," for the next several years. Should President Obama be re-elected in 2012, however, EPA's potential issuance of regulations implementing its December 2009 Endangerment Finding on CO_2 – coupled with increased pressures on fuel prices from an anticipated economic recovery – could itself serve to make PHEVs more cost-effective than at present. Final Rulemaking, Endangerment and Cause or Contribute Findings for Greenhouse Gases Under Section 202(a) of the Clean Air Act, 74 Fed. Reg. 66496 (2009) (to be codified at 40 C.F.R. ch. 1).

52. U.S. BUREAU OF LABOR STATISTICS, 2009 CONSUMER EXPENDITURE SURVEY, tbl.2, *available at* http://www.bls.gov/cex/2009/share/region.pdf.

53. Ulrich, *supra* note 11.

54. NISSAN USA, *supra* note 18.

55. 26 U.S.C. § 30D (2010) (Qualified Plug-In Electric Vehicle Credit).

56. *Vermont Incentives and Laws*, U.S. DEP'T OF ENERGY, ALTERNATIVE FUELS & ADVANCED VEHICLES DATA CENTER, http://www.afdc.energy.gov/afdc/laws/state_summary/VT (last visited Nov. 4, 2010).

57. Cal. Assemb. B. 118, 2007 Cal. Stat., Chapter 750.

58. This assumes a $2.77 per gallon cost at 21 miles per gallon, and a cost of $.08/kWh at 2.8 miles/kWh electricity. NAT'L RENEWABLE ENERGY LAB., TACKLING CLIMATE CHANGE IN THE U.S.: POTENTIAL CARBON EMISSIONS REDUCTIONS FROM PLUG-IN HYBRID ELECTRIC VEHICLES BY 2030, 72 (2007), http://ases.org/images/stories/file/ASES/climate_change.pdf [hereinafter *NAT'L RENEWABLE ENERGY LAB.*].

Leaf can be compared to a conventional vehicle, such as the Toyota Corolla. Factoring in sales price and gasoline costs, the Leaf becomes cost-competitive with the Corolla after 150,000 miles, and the Volt becomes cost-competitive after 200,000 miles.[59]

Cost-effectiveness from the standpoint of individual consumers depends on their amount of vehicle miles traveled (VMT). One-half of vehicles nationwide are driven less than 20 miles per day; the AER from even a relatively small battery pack might therefore be sufficient to meet most consumers' needs.[60] However, this holds less true in Vermont. In 2008, Vermont's average annual VMT was 12,379 - a daily average VMT of 34 miles.[61] Vermont's 34 mile average daily VMT is the seventh highest in the country.[62] Moreover, Vermont's average VMT is expected to increase further in the long-term.[63]

Vermont's relatively high average VMT has the potential to deter Vermont residents from purchasing a PHEV. Round-trip commutes that exceed 40 miles would necessitate driving beyond AER. While PHEVs' range-extending gasoline and motor engine system would still ensure fuel economy, this might not be sufficient for many Vermont consumers to overcome the high price tag associated with PHEVs. The lack of existing charging station infrastructure might also deter consumers otherwise motivated to purchase a PHEV for environmental reasons.

3. Storage Potential

The limits of PHEV battery range and the costs of PHEVs discussed above do not factor in a significant benefit that PHEVs could provide Vermont's grid: the ability to store electric energy and complement the intermittent power of renewable energy sources such as wind.[64] The electric grid must constantly balance supply and demand by "maintaining system voltages and frequency within acceptable limits."[65] This necessity for a relatively constant supply of electricity cannot be met by wind farms or solar developments alone; wind and sunlight are too inherently variable for predetermined levels of energy to be

59. This comparison assumes that the Leaf charges for less than $3, and that gas costs about $3 per gallon. The Corolla's gas mileage is 30.5 mpg and its price is $15,450. Daniel Indiviglio, *Will Nissan Leaf Chevy's Volt in the Dust?*, ATLANTIC, Mar. 30, 2010, *available at* http://www.theatlantic.com/business/archive/2010/03/will-nissan-leaf-chevys-volt-in-the-dust/38210/.

60. NAT'L RENEWABLE ENERGY LAB., GOLDEN, COLO., A PRELIMINARY ASSESSMENT OF THE IMPACT OF PLUG-IN HYBRID ELECTRIC VEHICLES ON WIND ENERGY MARKETS (2006), *available at* http://www.nrel.gov/docs/fy06osti/39729.pdf.

61. *Highway Vehicle-Miles Traveled (2006)*, U.S. BUREAU OF TRANSP. STATISTICS, http://www.bts.gov/publications/state_transportation_statistics/state_transportation_statistics_2006/html/table_05_03.html.

62. VT. DEP'T OF TRANSP., LONG RANGE TRANSPORTATION BUSINESS PLAN (2009), *available at* http://vtplan.rsginc.com/docs/LRTBP_final_March_2009.pdf; PAT S. HU & TIMOTHY R. REUSCHER, U.S. FEDERAL HIGHWAY ADMIN., NATIONAL HOUSEHOLD TRAVEL SURVEY: SUMMARY OF TRAVEL TRENDS (2001), *available at* http://nhts.ornl.gov/2001/pub/STT.pdf.

63. *VMT Growth Factors (%) by County: Vermont (2000)*, EPA, http://www.epa.gov/ttn/naaqs/ozone/areas/vmt/vmtvtgf.htm.

64. NAT'L RENEWABLE ENERGY LAB., *supra* note 58.

65. N. AM. ELECTRIC RELIABILITY CORP. (NERC), ACCOMMODATING HIGH LEVELS OF VARIABLE GENERATION 3 (2009), *available at* http://www.nerc.com/files/IVGTF_Report_041609.pdf.

supplied to the grid at a specified time.[66] Accordingly, the successful widespread implementation of electric power storage technology is a prerequisite for a significant proportion of electric demand in Vermont to be satisfied by wind and solar power.[67] PHEVs are one of several available commercial technologies by which this electric power storage could be achieved.[68]

Bi-directional energy flow would allow Vermont consumers, through "net metering," to offset their electricity use by feeding excess generation capacity back to the grid.[69] Residents would draw power from plug-in batteries during times of peak electric demand, and sell power to the grid during times when wind and other intermittent power resources produce less energy. PHEVs could also serve as a mechanism for the storage of non-renewable energy. By storing non-renewable energy, PHEVs could effectively increase existing transmission capacity.[70] PHEVs would become more cost-effective for consumers if sufficient compensation was provided for storing energy and improving the overall reliability of the grid.[71]

4. Costs of Charging

While PHEV owners might someday sell electricity back to the grid during times of peak demand, there exists a costly alternative: PHEV owners could simply charge their cars during times of peak energy demand. A traditional peak demand period is the afternoon and early evening hours between four and seven PM, when many offices remain open but many workers have already returned home and turned on lights and air conditioning units. A logical time for PHEV owners to recharge their battery pack would be upon their return home from work. Such charging of PHEVs at times of peak energy demand would increase the costs of electricity for all Vermont consumers, regardless of whether they owned a PHEV. Higher-cost "peaker" units would need to be utilized to meet the increased peak-time demand, and distribution utilities would recover these inflated generation costs from Vermont ratepayers.

If most PHEVs were charged at night, there would be little effect on peak electric demand.[72] Thus, incentivized time-of-day rates could be instituted to encourage the overnight charging of PHEVs. Overnight charging could also improve the load curve for electric utilities by reducing the number of times that

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66. ELEC. ADVISORY COMM., DEP'T OF ENERGY, KEEPING THE LIGHTS ON IN A NEW WORLD 12-13 (2009), *available at* http://www.oe.energy.gov/DocumentsandMedia/adequacy_report_01-09-09.pdf.

67. ELEC. ADVISORY COMM., DEP'T OF ENERGY, BOTTLING ELECTRICITY: STORAGE AS A STRATEGIC TOOL FOR MANAGING VARIABILITY AND CAPACITY CONCERNS IN THE MODERN GRID 6 (2009), *available at* http://www.oe.energy.gov/DocumentsandMedia/final-energy-storage_12-16-08.pdf.

68. Other electric storage technologies include hydro-power, substation battery storage, and neighborhood-based community energy storage. Brad Roberts, *Taking Grid Energy Storage to the Edge*, POWERGRID INT'L, May 12, 2010, http://www.renewableenergyworld.com/rea/news/article/2010/05/taking-grid-energy-storage-to-the-edge.

69. VT. ADMIN. CODE 18-1-17:5.102(H) (2010).

70. ELEC. ADVISORY COMM., *supra* note 67.

71. *NAT'L RENEWABLE ENERGY LAB.*, *supra* note 58.

72. *NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD.*, *supra* note 28.

a generation plant has to shut down and restart.[73] This would have the added benefit of reducing utility dispatch costs.[74]

Some distribution utilities have already begun to implement electric vehicle charging incentives. In California, each of the major municipal and private utilities - the Los Angeles Department of Water and Power (LADWP), Southern California Edison (SCE), San Diego Gas and Electric (SDG&E), and Pacific Gas & Electric (PG&E) - has recently instituted rate reductions for the overnight charging of electric vehicles.[75] LADWP offers a 2.5 cent per kWh discount for PHEV charging at night or on weekends.[76] SCE offers reduced rates for electric vehicle charging during "super off-peak" hours, that is, between 12AM and 6AM.[77] Meanwhile, SDG&E's "super off-peak" rate for PHEV charging, between 12AM and 5AM, is fourteen cents per kWh - just over one-half of the peak, 12PM–6PM rate of twenty-seven cents per kWh.[78] California's largest utility, PG&E, offers two options for reducing electric rates if PHEVs are charged between 12AM and 7AM: billing through a single meter that measures all household energy use, or billing through a second meter that is solely dedicated to measuring the energy use of PHEVs.[79]

5. Cost Arguments Against PHEVs

The NAS study concludes that "[s]ubsidies of tens to hundreds of billions of dollars will be needed for [PHEVs to] transition to cost-effectiveness."[80] PHEV detractors can reasonably posit the question: Is it worth it? Stated differently, should the considerable federal and state government subsidies necessary for a PHEV-40 to be cost-effective by 2040 be better spent on other carbon mitigation measures that would have a more immediate impact? Related, are PHEVs' incremental CO_2 benefit[81] vis-à-vis traditional hybrid vehicles sufficient to warrant this investment, including, as discussed below, the

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73. *NAT'L RENEWABLE ENERGY LAB.*, *supra* note 58.

74. *OAK RIDGE NAT'L LAB.*, supra note 36.

75. *Residential Electric Vehicle Services*, L.A. DEP'T OF WATER AND POWER, http://www.ladwp.com/ladwp/cms/ladwp002056.jsp (last visited Nov. 4, 2010); *Residential Rates, Electric Vehicles*, S. CAL. EDISON, http://www.sce.com/residential/rates/electric-vehicles.htm (last visited Nov. 4, 2010); *Clean Air Transportation Program*, PAC. GAS & ELECTRIC, http://www.pge.com/about/environment/pge/cleanair/ (last visited Nov. 4, 2010); *The Cost of Charging Your Electric Vehicle*, SAN DIEGO GAS & ELECTRIC, http://www.sdge.com/environment/cleantransportation/evRates.shtml (last visited Nov. 4, 2010).

76. L.A. DEP'T OF WATER AND POWER, *supra* note 75.

77. S. CAL. EDISON, *supra* note 75.

78. SAN DIEGO GAS & ELECTRIC, *supra* note 75.

79. PAC. GAS & ELECTRIC, *supra* note 75.

80. *NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD.*, *supra* note 28, at 4.

81. This article is focused on the role PHEVs might play in a low-carbon future. However, irrespective of PHEVs future role in mitigating carbon emissions, PHEV use provides an immediate social and economic benefit from the reduction of criteria pollutants from mobile source emissions. Nationally, mobile sources account for 82% of CO, 56% of NOx, 45% of VOC, 20% of PM_{10} , and 30% of $PM_{2.5}$ emissions. NAT'L RESEARCH COUNCIL OF THE NAT'L ACAD., COMM. ON STATE PRACTICES IN SETTING MOBILE SOURCE EMISSIONS STANDARDS, STATE AND FEDERAL STANDARDS FOR MOBILE-SOURCE EMISSIONS 35 (2006), http://www.nap.edu/openbook.php?record_id=11586&page=35. The National Academies has estimated that criteria air pollutants emitted by vehicles and power plants cause $120 billion in annual health-related costs. Chattanooga Times Free Press, *Heavy Cost of Air Pollution*, ALLBUS., Nov. 3, 2009, *available at* http://www.allbusiness.com/environment-natural-resources/pollution-environmental/13374811-1.html.

investment in local charging infrastructure that widespread PHEV fleet penetration will require?

There is simply no easy answer to this question. Indeed, the answer in part depends upon the degree of fleet penetration that PHEVs will achieve; this depends, in turn, on the premium that consumers will be willing to pay for these vehicles before they do become cost-competitive in relation to conventional vehicles. To be sure, if consumers are unwilling to pay this premium, even with generous federal tax incentives, then PHEV fleet penetration will not be achieved and PHEVs will not play a substantial role in the mitigation of carbon emissions.

We argue, however, that a question positing whether PHEVs *or* some other carbon mitigation mechanism should be used to most cost-effectively lessen greenhouse gas emissions is a fallacious one. Rather, the question is what *portfolio* of carbon mitigation options should be used to combat global warming. Within the transportation sector, there are two policy options: either lessen greenhouse gas emissions from automobiles, or create the conditions for a less automobile dependent society. We believe that both of these policy options in the transportation sector need to be pursued to combat global warming. However, the viability of PHEVs as a policy option for carbon mitigation depends on the underlying cleanliness of the electricity that is used to charge battery packs. Thus, with the caveat that policy measures must concomitantly be enacted to make electric generation less carbon-intensive, we believe that PHEVs belong within the portfolio of options that policymakers must now utilize to combat global warming.

C. Impact on Vermont Energy Infrastructure

1. Generation Capacity

PHEVs increase electric demand by displacing gasoline with electricity as a power source. The Chevrolet Volt, a PHEV-40, will require about 2,500 kWh of electricity consumption annually;[82] this is equivalent to the annual energy consumption of a household air conditioning unit, a water heater, or two refrigerators.[83] Nationwide, if one million PHEVs charged simultaneously, it would utilize only 16% of the country's generating capacity.[84] In Vermont, total per capita energy consumption is 76,491 kWh,[85] and the state's aggregate capacity is 1,127 MW.[86] According to the Vermont Energy Plan, Vermont's annual load factor was 70% in 2007 – the culmination of a thirty-five year trend of improving load factor.[87] Thus, Vermont has sufficient short-term generation

82. *Electric Cars - How Much Does It Cost Per Charge?*, SCI. AM., Mar. 13, 2009, *available at* http://www.scientificamerican.com/article.cfm?id=electric-cars-cost-per-charge.

83. U.S. ENERGY INFO. ADMIN., *End-Use Consumption of Electricity 2001*, *available at* http://www.eia.doe.gov/emeu/recs/recs2001/enduse2001/enduse2001.html (last updated Apr. 20, 2009).

84. *NAT'L RENEWABLE ENERGY LAB.*, *supra* note 58.

85. U.S. ENERGY INFO. ADMIN., *Vermont Energy Profile*, *available at* http://www.eia.gov/cfapps/state/state_energy_profiles.cfm?sid=VT (last updated Jan. 20 2011).

86. U.S. ENERGY INFO. ADMIN., *Vermont Electricity Profile*, *available at* http://www.eia.gov/cneaf/electricity/st_profiles/vermont.html (last updated Mar. 2010).

87. VT. DEP'T OF PUB. SERV., VERMONT COMPREHENSIVE ENERGY PLAN 2009, at II-21, *available at* http://www.publicservice.vt.gov/planning/CEP%20%20WEB%20DRAFT%20FINAL%206-4-08.pdf.

capacity to accommodate the 2,500 kWh increase in energy demand that each Volt creates. However, the existence of sufficient short-term capacity does not detract from the need for long-term PHEV demand to be integrated into Vermont's legal framework for the regulation of electricity. In New England, PHEVs will cause an estimated 2% increase in electric demand by 2020, and a 4.7% demand increase by 2030.[88] A nearly 5% increase in electric demand from this one variable alone, PHEVs, will have a significant impact on utility integrated resource planning. Moreover, the cumulative impact of this 5% increase in electric demand must be considered in concert with all other factors before sufficient future generation capacity can be ensured.

2. Federal Transmission Planning Requirements

Vermont is part of the FERC-regulated New England Independent System Operator (ISO-NE) transmission grid.[89] ISO-NE estimates Vermont's compound annual energy growth rate to be 0.9% between 2009 and 2018 - the same as New England as a whole.[90] To fulfill its FERC-issued mandate of ensuring sufficient transmission capacity to meet this future demand, ISO-NE annually updates its regional transmission plan. ISO-NE's 2009 plan identifies three transmission load pockets of concern within Vermont: northwestern Vermont, southern Vermont, and the interstate region that includes Vermont's southeastern border.[91] In northwestern Vermont, where the Burlington metropolitan area is located, transmission upgrades are under construction pursuant to the Northwest Vermont Reliability Project; this includes a new 36 mile, 345 kV line and a 28 mile, 115 kV line.[92] Meanwhile, the possibilities for improving east-west transmission within southern Vermont are under study, and transmission upgrades were recently completed in the Monadnock region of southeastern Vermont, New Hampshire, and Massachusetts.[93]

The vast majority of transmission lines within Vermont are owned by the Vermont Electric Power Company (VELCO) which, in turn, is owned by the state's major utilities. VELCO's most recent transmission plan, released in 2009, states that "Vermont's peak electric demand will grow by 24 percent from 2008 to 2028, representing an annualized growth rate of 1.1 percent."[94] The 4.7% increase in electric demand that PHEVs will cause by 2030 therefore represents a relatively small proportion of the overall demand increase forecast for that period.[95] VELCO has identified six possible transmission line projects that could help meet the predicted 24% increase in electric demand; two of these

88. The base load generation in 2020 will increase from 149 TWh to 152 TWh with expected PHEV demand, creating the 2% increase; the base load generation in 2030 will increase from an expected 162 TWh to 169 TWh with increased demand from PHEVs, totaling a 4.7% increase. *OAK RIDGE NAT'L LAB.*, *supra* note 36.

89. *ISO New England Inc.*, 106 F.E.R.C. ¶ 61,280 at PP 3, 10 (2004).

90. ISO NEW ENGLAND INC., 2009 REGIONAL SYSTEM PLAN 28, tbls.3-4 (2009), *available at* http://www.iso-ne.com/trans/rsp/2009/rsp09_final.pdf.

91. *Id*. at 131-32.

92. *Id*.

93. *Id*.

94. VT. ELEC. POWER CO., 2009 VT. LONG-RANGE TRANSMISSION PLAN 1 (2009), *available at* http://www.velco.com/LongRange/Documents/2009planlinked.pdf.

95. *OAK RIDGE NAT'L LAB.*, *supra* note 36, at 44.

involve new lines, and four involve line upgrades.[96] To be sure, none of these potential projects are directly attributable to the increased electric demand caused by PHEVs. Nonetheless, PHEVs will make a cumulative contribution to the need for up to $900 million in total transmission upgrade costs.[97]

3. Transmission Cost Allocation Within ISO-NE

Vermont ratepayers will likely be responsible for only a portion of the costs of transmission infrastructure upgrades within the state.[98] A significant proportion of these costs could be borne by ratepayers throughout the six-state ISO-NE service area. The FERC's Order 890 mandates that Open Access Transmission Tariffs (OATTs) comply with the following three cost allocation principles for transmission investment: fair assignment of costs, adequate incentive for new construction, and support from regional and state authorities.[99] Consistent with these criteria, the ISO-NE OATT "socializes costs for regional upgrades" and assigns costs to project beneficiaries for "elective upgrades."[100] As ISO-NE describes its cost allocation methodology, only transmission upgrades necessary to ensure the "continued reliability of the regional system" are recoverable through pro rata regional rates.[101] The costs of "local benefit upgrades," in contrast, are "directly allocated to the local beneficiaries."[102] Thus, ISO-NE has a "hybrid" cost allocation mechanism.[103]

ISO-NE's regional planning process (Regional Transmission Expansion Project or RTEP) identifies regional transmission upgrades the costs of which are recoverable throughout the territory of the RTO. If the RTEP determines that future transmission upgrades will be necessary to ensure the "reliability of the regional system," then ratepayers from all New England states will be responsible for the pro rata share of these costs.[104] In that instance, Vermont ratepayers will only pay the proportion of those costs which is commensurate with the state's relatively small electricity demand. Alternately, the RTEP may ultimately determine that a portion of the future transmission investment within Vermont, in part necessitated by PHEVs, qualifies as a "local benefit upgrade," the costs of which must be borne by Vermont ratepayers.[105]

ISO-NE's cost allocation mechanism is only applicable to transmission rates under its OATT. Thus, RTEP does not apply when transmission upgrades

96. VT. ELEC. POWER CO., *supra* note 94, at 2, fig.1-1 (2009), *available at* http://www.velco.com/LongRange/Documents/2009planlinked.pdf.

97. *Id*.

98. To the extent that VELCO and/or the Vermont investor owned utilities (IOUs) incur costs for transmission upgrades (by themselves constructing the upgrades, wrapping the costs into a bilateral power purchase agreement, or directly paying a merchant transmission entity), they will recover their costs through bundled rates that will ultimately be reflected on the bills of Vermont ratepayers.

99. Order No. 890, *Preventing Undue Discrimination and Preference in Transmission Service*, F.E.R.C. STATS. & REGS. ¶ 31,241 (2007), 72 Fed. Reg. 12,266 (2007) (to be codified at 18 C.F.R. pts. 35 & 37).

100. *ISO New England Inc.*, 123 F.E.R.C. ¶ 61,161 at P 90 (2008).

101. *ISO New England Inc*., Docket No. OA08-58-000, Transmittal Letter at 33 (Dec. 7, 2007).

102. *Id*.

103. As distinguished from PJM's imposition of regional cost recovery for localized transmission upgrades, which the Seventh Circuit recently examined in *Illinois v. FERC*, 576 F.3d 470 (2009).

104. *ISO New England Inc*., Docket No. OA08-58-000, Transmittal Letter at 33.

105. *Id*.

are self-financed pursuant to a bilateral (or trilateral) contract. In *Northeast Utilities v. FERC*, the generator, Hydro-Quebec, agreed to construct a transmission line in Canada from the proceeds of a power purchase agreement it entered into with two New England IOUs; these IOUs agreed, in turn, to construct the United States portion of the transmission line.[106] The FERC held the transaction to be exempt from the requirements of Order 890 on grounds that "participant funding of a transmission facility with priority rights" is non-discriminatory.[107] Following *Northeast Utilities*, should a transaction for a participant-funded transmission line that passes through Vermont not involve Vermont IOUs, Vermont ratepayers will not bear ultimate responsibility for these construction costs.

A merchant transmission facility denotes the construction and ownership of a transmission line by a third party, the capacity from which is sold at market-based rates.[108] Developers of a merchant transmission project "assume all the market risk of a project and have no captive customers."[109] Although unlikely, a merchant transmission project could be proposed within Vermont; such a project may or may not be for the benefit of transmitting energy to Vermont end-use customers. To the extent that Vermont end-users are benefitted, Vermont IOUs will pass on the market-based transmission costs to ratepayers, which will ultimately appear on customer bills as bundled rates. However, to the extent that the merchant transmission facility does not serve Vermont customers, the merchant owner will ultimately be compensated for its construction costs by ratepayers in other states.

III. THE POLICY OF PHEVS

A. *PHEVs and the Cleanliness of Electricity Used*

The major policy justification for a transition to PHEVs is the reduction of greenhouse gas (GHG) emissions from the transportation sector, thereby alleviating the threat of global climate change. Simply displacing GHG emissions from the transportation to the electricity sector, however, does not achieve this policy goal. We know that PHEVs will cause increased GHG emissions in the electricity sector; that increase can only be justified if there is a correspondingly much greater decrease in transportation sector GHG emissions.

Within the transportation sector nationwide, the reduction in greenhouse gases that will be precipitated by PHEVs is significant: for each mile driven on electricity rather than gasoline, carbon dioxide emissions are reduced by an average of 42%.[110] However, while PHEVs emit considerably less GHGs on the road, the electricity needed for battery charging is itself a significant source of GHGs. A PHEV's greenhouse gas emissions depend on the underlying cleanliness of the electricity that is used to charge the battery pack. If a PHEV's battery charge relies on electricity generated from carbon-rich fossil fuels, then

106. *Ne. Util. Serv. Co.*, 127 F.E.R.C. ¶ 61,179 (2009).

107. *Id*. at P 27.

108. *Id*. at P 41.

109. *Id*.

110. NAT'L RENEWABLE ENERGY LAB., *supra* note 58.

that must be taken into account in calculating the PHEV's actual GHG emissions.

Vermont relies on relatively clean electricity. Although Vermont obtains its electricity from throughout the New England grid, the Vermont Yankee nuclear plant and the Hydro-Quebec facility alone would be sufficient to meet two-thirds of Vermont's energy demand.[111] Indeed, Vermont is one of only two states in the United States without a coal-fired power plant.[112] Vermont also has 74 MW in renewable generation from small generators,[113] known as qualifying facilities under the 1978 federal Public Utilities Regulatory Act (PURPA).[114] Vermont's small generators include hydroelectric facilities and a large wood-fired facility; each accounts for nearly one half of Vermont's total generation capacity from PURPA qualifying facilities.[115] Accordingly, because much of Vermont's electric generation derives from low-carbon sources, PHEVs will reduce greenhouse gas emissions at a higher rate in Vermont than in regions with more carbon-intensive sources of energy generation.

Moreover, independent of the cleanliness of the underlying electricity used, PHEVs use energy more efficiently than conventional automobiles. A traditional internal combustion gasoline engine is only about 20% efficient, that is, only 20% of the energy in gasoline actually powers the wheels.[116] In contrast, electric motors are 75% efficient.[117] Thus, in comparison with conventional automobiles, more PHEV miles are driven for each unit of emissions that is released into the atmosphere. Fuel-cycle analysis, which includes energy generation, transmission, and distribution, likewise demonstrates that electric vehicles are more energy efficient than gasoline-powered vehicles.[118]

B. Vermont's Energy Mix

The role PHEVs will play in Vermont's low-carbon energy future cannot be determined in a vacuum; it will depend on the interdependent "mix" of mobile and non-mobile energy sources needed to meet electric demand, to secure the transportation needs of Vermonters, and to obtain a drastic reduction in GHG emissions. This is not a zero-sum game: an increase in wind energy development within Vermont will not necessarily decrease Vermont's reliance on imports from fossil-fueled generation facilities throughout New England.

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111. VT. DEP'T OF PUB. SERV., *supra* note 87, at 111-39.

112. U.S. ENERGY INFO. ADMIN., *supra* note 85. The other state is Rhode Island.

113. VT. PUB. SERV. BD., BIENNIAL REPORT TO THE VERMONT GENERAL ASSEMBLY PURSUANT TO 30 V.S.A. § 8004(F), at 10 (2007), *available at* http://www.leg.state.vt.us/reports/2008ExternalReports/228645.pdf; 16 U.S.C. § 2601-2645 (2006).

114. Under PURPA, a qualifying facility can be either: (1) a small power production facility of 80 MW or less whose primary energy source must be biomass, waste, renewable resources, geothermal resources, or any combination of these fuel sources; or (2) a cogeneration facility which generates both electricity and another form of thermal energy in a manner more efficient than the independent production of each. 18 C.F.R. §§ 292.203, 292.204 & 292.205 (2010).

115. VT. DEP'T OF PUB. SERV., 2005 VERMONT ELECTRIC PLAN 2-9, *available at* http://publicservice.vermont.gov/pub/state-plans/state-plan-electric2005.pdf.

116. *Electric Vehicles*, U.S. DEP'T OF ENERGY, http://www.fueleconomy.gov (last visited Nov. 4, 2010).

117. *Id*.

118. *ARGONNE NAT'L LAB.*, *supra* note 34.

Similarly, a massive investment in home energy efficiency might mean a reduction in the demand for solar renewable technologies, not just fossil-fuels.[119]

Vermont now relies on Vermont Yankee and Hydro Quebec for two-thirds of its energy supply.[120] That will soon change. At present, it seems unlikely that the Vermont Legislature will vote to renew Vermont Yankee's nuclear license beyond 2012.[121] Meanwhile, a new power purchase agreement between Vermont's two IOUs and Hydro Quebec is under negotiation. The term sheet provides for the purchase of only 225 MW - a one-quarter reduction from the previous power purchase agreement.[122] These relatively low-carbon electric generation sources will need to be replaced during a planning horizon in which Vermont's energy demand is forecast to increase 24% by 2028.[123]

C. An Assessment of the Interests at Stake

1. Regulated Utilities

The increase in electric demand that PHEVs will cause is advantageous for regulated utilities. IOUs will more fully utilize their existing generation capacity and may even build additional generation capacity - increasing their rate base - to meet the increased energy demand. Furthermore, PHEVs may facilitate the implementation of a smart grid, which itself represents a massive capital investment that Vermont's distribution utilities will ultimately recover from ratepayers.

2. Renewable Energy Generators

Renewable generators will also benefit from Vermont's widespread adoption of PHEVs because increased electric demand will require that more renewable generation be built. In 2005, Vermont enacted legislation to promote renewable energy in the state.[124] The Sustainably Priced Energy Development Program (SPEED) provides standard price offers to any qualifying in-state renewable energy producer.[125] Thus, a legal infrastructure is already in place to encourage the construction of renewable generation resources to meet the increased electric demand that PHEVs will create. Moreover, because the storage capability of PHEVs could facilitate the integration of intermittent renewable resources into the grid, renewable energy interest groups are

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119. Although Vermont's least-cost integrated planning framework prioritizes energy efficiency, it has no loading order prioritizing renewable over non-renewable generation. VT. STAT. ANN. tit. 30, § 218c (2010). This is distinct from California, which has the following loading order: conservation and energy efficiency, renewables and distributed generation, and central station fossil-fueled generation. STATE OF CAL., 2003 ENERGY ACTION PLAN 4, *available at* http://docs.cpuc.ca.gov/word_pdf/REPORT/28715.pdf.

120. VT. DEP'T OF PUB. SERV., *supra* note 87, at III-39.

121. Matthew L. Wald, *Vermont Senate Votes to Close Nuclear Plant*, N.Y. TIMES, Feb. 24, 2010, http://www.nytimes.com/2010/02/25/us/25nuke.html.

122. CENT. VT. PUB. SERV., *Governor, Premier Announce Preliminary Vermont-Hydro-Québec Agreement*, MARKETWIRE (Mar. 11, 2010), http://www.marketwire.com/press-release/Governor-Premier-Announce-Preliminary-Vermont-Hydro-Quebec-Agreement-NYSE-cv-1130472.htm.

123. VT. ELEC. POWER CO., *supra* note 94, at 1.

124. VT. STAT. ANN. tit. 30, §§ 8001-8005 (2010).

125. *Id.* § 8005.

supportive of PHEV technology.[126] For instance, the American Wind Energy Association argues that PHEVs will improve the flexibility of the grid and provide a vital electric storage function.[127] Wind energy advocates also support widespread PHEV adoption because overnight PHEV charging provides a natural complement to wind energy production, which peaks at night.[128]

3. Consumers

Consumers who can afford the substantial up-front investment of purchasing a PHEV will substantially reduce their fuel costs. Thus, to the extent that there is a future spike in fuel prices, consumer demand for PHEVs can be expected to increase. Meanwhile, PHEV owners and prospective purchasers will want a public charging infrastructure to be in place at the earliest opportunity, while other consumers may be loathe to subsidize these costs. In a low carbon future, the social cost of PHEVs will necessarily be weighed against the opportunity cost of aggregate social investment in energy efficiency measures and other renewable technologies.

4. Gasoline Station Owners

Gasoline station owners will be impacted by PHEVs. PHEVs lessen the need for conventional, gas-powered automobiles; this is not in the gas station owner's long-term interest. However, to the extent that gasoline stations become co-existent with public charging facilities, gas station owners can be expected to derive at least some benefit from PHEVs. Nonetheless, because electricity at charging stations is anticipated to be much cheaper than gasoline, these charging stations are not anticipated to be as profitable as gas pumps. Moreover, the capital cost of charging stations can be high: a rapid charging station that provides 50 kW of electricity to charge the Leaf battery to 80% capacity will cost $45,000 per unit.[129] A gas station owner will likely insist that the cost of such a unit be paid for by the vehicle manufacturer or the electric utility.

IV. REGULATORY REQUIREMENTS FOR WIDESPREAD FLEET PENETRATION

In this section, we address the regulatory requirements necessary for the potential widespread fleet penetration of PHEVs to be integrated into Vermont's existing legal regime. First, we discuss the incorporation of PHEVs into Vermont utilities' integrated resource plans. Second, we examine smart grid developments in Vermont and how Vermont's existing net metering regulations provide a readily adaptable framework for regulating PHEVs. Third, we discuss the local charging infrastructure necessary to support widespread PHEV use, and the need for determining whether this infrastructure cost will be borne by ratepayers. In the conclusion to this section, we argue for the Vermont Public Service Board to initiate several proceedings to immediately address several empirical legal issues precipitated by PHEVs.

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126. *Smart Grid Policy*, 128 F.E.R.C. ¶ 61,060 at P 86 (2009).

127. *Id.*

128. Robert Gramlich & Michael Goggin, *The Ability of Current U.S. Electric Industry Structure and Transmission Rules to Accommodate High Wind Energy Penetration*, AM. WIND ENERGY ASS'N, 4 (2008), *available at* http://www.awea.org/_cs_upload/documents/issues/5983_1.pdf.

129. Vandervelde, *supra* note 17.

A. Utility Integrated Resource Planning

All regulated distribution utilities in Vermont are required to implement integrated resource plans (IRPs) for meeting projected energy demand at the "lowest present value life cycle cost."[130] Factoring in both "environmental and economic costs," an IRP must contain a strategy for investing in "energy supply, transmission and distribution capacity, transmission and distribution efficiency, and comprehensive energy efficiency programs."[131]

Once a substantial amount of fleet penetration of PHEVs has occurred in Vermont, utilities will be required to incorporate PHEVs into their energy planning. However, PHEVs have yet to be incorporated into Vermont utility IRPs. Vermont's two largest utilities, Central Vermont Public Service (CVPS) and Green Mountain Power (GMP), submitted their IRPs to the VT PSB in 2007.[132] The IRP of CVPS makes a brief, passing reference to PHEVs - as a possible future "voluntary renewable service offering."[133] Meanwhile, GMP's IRP makes no reference to PHEVs whatsoever.[134]

When the Volt, the Leaf, and other commercially viable PHEVs or EVs become available in the Vermont market, utility IRPs will have to quantify PHEV costs and benefits, including potential benefits to the grid from bi-directional energy flows. PHEVs will not then be examined in isolation, but will be assessed in relation to other renewable technologies and methods of demand side management, including energy efficiency programs. The transmission benefits potentially provided by PHEVs, and the potential for PHEVs to integrate intermittent generation resources into the grid, will weigh in PHEVs favor. But these benefits to the grid from PHEVs will not be possible without Vermont's construction of a smart grid.

B. PHEVs and the Smart Grid

1. The Smart Grid

The Vermont Public Service Board (VT PSB) characterizes the smart grid as involving three components: an advanced metering infrastructure (AMI), customer site automation, and electric grid automation.[135] The VT PSB defines the smart grid as a "concept that embodies an electricity network that uses advanced sensing, communications, and control technologies to generate and

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130. VT. STAT. ANN. tit. 30, § 218c (2010).

131. *Id*.

132. CENT. VT. PUB. SERV. CORP., LEAST COST INTEGRATED RESOURCE PLAN TEXT (2007), *available at* http://www.cvps.com/AboutUs/CVPS2007IRP04-02-07.pdf; GREEN MOUNTAIN POWER, 2007 INTEGRATED RESOURCE PLAN (2007), *available at* http://www.greenmountainpower.com/data/Unsorted/IRP-2007-20243-1.pdf.

133. CENT. VT. PUB. SERV. CORP., *supra* note 132, at 19. The IRP is under review by the VT PSB in Docket No. 7284.

134. GREEN MOUNTAIN POWER, *supra* note 132. GMP's IRP was approved by the VT PSB in *Investigation into Green Mountain Power Corporation's 2007 Integrated Resource Plan*, No. 7319, 2008 Vt. PUC LEXIS 50 (Vt. Pub. Serv. Bd. 2008). GMP will not file its next IRP until April 2011.

135. *Investigation into Vermont Electric Utilities' Use of Smart Metering and Time-Based Rates*, Order Re: Memorandum of Understanding, No. 7307 (Vt. Pub. Serv. Bd. Aug. 3, 2009), at n.1, *available at* http://psb.vermont.gov/sites/psb/files/orders/2009/7307_final_order.pdf.

distribute electricity more effectively, economically and securely."[136] This "concept" of the smart grid is aimed at reducing costs and enhancing reliability for both the utility and the consumer. As the VT PSB explains, the utility will lower operational costs from meter-reading and increase the efficiencies of generation sources.[137] The smart grid is also intended to create demand-response benefits by providing direct price signals to consumers; increasing the reliability of the electricity system; and producing environmental benefits through the encouragement of a shift to lower emission fuel sources.[138]

PHEVs can serve as an integral component of smart grid deployment by providing storage capacity to the grid. This storage capacity can be utilized during times of high-peak demand, when the vehicles are plugged in but not charging. Since most PHEVs will likely be charged overnight during off-peak hours, they will be able to provide electricity back to the grid during high-demand peaks, thereby alleviating the need for utilities to dispatch the more costly and more carbon-intensive "peaker" generation units.[139] Not only will this reduce the overall emissions from electricity generation, but it will incentivize base load generation to become more efficient. With an increased demand for nighttime electricity from overnight PHEV charging, generators will have an incentive to shift from lower efficiency to higher efficiency combined-cycle base load units, thereby producing more electricity with less fuel.[140] Furthermore, the addition of nighttime charging demand decreases the amount of times that generation units must be turned off at night, as demand declines, and started up again in the morning, as demand increases; this levels out the plant's generation and reduces the need for additional energy use from the restarting of generation plants.[141]

Moreover, PHEVs can increase the reliability of the grid by providing a reserve capacity. Depending on the degree of vehicle penetration and on the time of day, PHEVs could offer a substantial amount of available capacity for deployment. PHEVs can also increase the reliability and feasibility of renewable energy resources by mitigating many of the intermittency issues associated with renewable technologies. Thus, even when the electricity from intermittent sources like wind and solar facilities is not needed, it can be harnessed, stored, and employed when necessary to meet demand. Once the smart grid has been developed, the grid operator will be able to determine the capacity of PHEV

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136. *Id.* at 4.

137. *Id.* at 17.

138. *Id.* at 3.

139. The peaking units in Vermont, operationally run through ISO-NE, are generally natural gas units (though it should be noted that sometimes ISO-NE taps into the power from Hydro Quebec). Although natural gas is less carbon-intensive than other conventional fossil fuels, the use of stored electricity in PHEV batteries will still provide, on the whole, a less carbon-intensive resource for electricity as the ISO can rely on electricity already generated rather than having to burn fossil fuels to meet the peak load demand. *Power Generation and Fuel Diversity in New England*, ISO NEW ENGLAND INC. (2005), *available at* http://www.iso-ne.com/pubs/whtpprs/iso_ne_paper.pdf. Moreover, as described above, natural gas units are on average more carbon-intensive than Vermont's existing energy mix: two-thirds of Vermont's energy is derived from hydroelectric and nuclear power. VT. DEP'T OF PUB. SERV., *supra* note 87, at III-39.

140. Keith Parks, Paul Denholm & Tony Markel, *Costs and Emission Associated with Plug-In Hybrid Electric Vehicle Charging in the Xcel Energy Colorado Service Territory*, NAT'L RENEWABLE ENERGY LAB., 17-18 (2007), *available at* http://www.nrel.gov/docs/fy07osti/41410.pdf.

141. *Id.*

storage available for dispatch at any given moment and distribute the reserves accordingly.[142]

2. Smart Grid Funding and Costs

There exist several disparate cost estimates for implementing a smart grid nationwide. These estimates range from $100 billion to $2 trillion, depending on what costs are included.[143] Some of these estimates, for example, incorporate new generation facilities and the corresponding transmission infrastructure needed for interconnection. Other discrepancies in cost estimates result from how the smart grid is envisioned. Despite the enormous differences in cost estimates, one thing is clear: the smart grid will be very expensive. Although the price tag is daunting, successful smart grid development at the state level - and the corresponding establishment of regulatory structures for smart grid implementation - could spur further utility and government investment throughout the United States, ultimately making the smart grid a reality nationwide. Thus, the regulatory structure Vermont establishes for PHEV and smart grid implementation has the potential to serve as a valuable model for subsequent federal and individual state regulation.

The federal government has already mobilized resources to begin funding the smart grid. The Energy Independence and Security Act of 2007 (EISA) amended the PURPA to require states to "consider imposing certain requirements and authorizing certain expenditures" relating to the smart grid.[144] EISA provides $100 million in annual matching funding, through 2012, for state, utility, and consumer investment in smart grid technologies.[145] Pursuant to this legislative directive, and to state agency initiative, utilities have begun to develop a smart grid in Vermont. The state hopes to leverage federal stimulus money to develop a smart grid statewide, connecting almost all Vermont electric consumers through an interconnected transmission and communication system.[146]

The American Recovery and Reinvestment Act of 2009 (ARRA) provides $4.5 billion for electric grid modernization, including $3.5 billion for smart grid investment.[147] ARRA also amends EISA to extend eligibility for smart grid funding to include electric utilities.[148] Two percent of ARRA's $3.5 billion for smart grid investment - a total of $69 million - was awarded to Vermont utilities

142. Jim Lazar, John Joyce & Xavier Baldwin, *Plug-In Hybrid Vehicles, Wind Power, and the Smart Grid*, THE REGULATORY ASSISTANCE PROJECT (2008), *available at* http://www.raponline.org/docs/RAP_Lazar_PHEV-WindAndSmartGrid_2007_12_31.pdf.

143. The American Society of Civil Engineers estimates $1.5 to $2 trillion in investment by 2030; the Brattle Group estimates $1.5 trillion; the Electric Power Research Institute estimates $165 billion; and Secretary of Energy Steven Chu stated that it would only cost upwards of $100 billion to implement the smart grid. Jenny Gold, *Putting a Price on Smart Power*, NPR (Apr. 27, 2009), http://www.npr.org/templates/story/story.php?storyId=103545351.

144. Energy Independence and Security Act, Pub. L. No. 110-140, § 1307(a), 121 Stat. 1492, 1792 (2007).

145. *Id.* § 1304(c)(2).

146. Tom Evslin, *Smart Grid Award*, VERMONT ECONOMIC STIMULUS AND RECOVERY BLOG (Oct. 29, 2009), http://recovery.vermont.gov/blog/smartgridaward.

147. American Recovery and Reinvestment Act, Pub. L. No. 111-5, 123 Stat. 115, 138, (2009).

148. *Id.* § 143.

to help finance the construction of smart grid communication and transmission infrastructure. This funding of all Vermont utilities, and the commitment utilities have made to match federal grants, marks a significant financial effort in Vermont to begin the development of a statewide smart grid.[149]

3. Net Metering

PHEVs will produce greater societal and environmental benefits in Vermont *if* the smart grid is developed. In order to successfully integrate both PHEVs and the smart grid, however, there must be some consideration of the legal standards needed for the synergistic benefits of PHEVs and the smart grid to be realized. A model and readily adaptable framework for regulating PHEVs is the VT PSB's net metering regulations.[150] These define "net metering" as the calculation of the difference between the amount of electricity that is supplied and the amount that is taken from the grid, by a "net metering system," in a given billing period.[151] A "net metering system," defined by the VT PSB to include renewable generation less than 250 kW in capacity, must be constructed for the purpose of offsetting a consumer's electricity use by feeding excess generation capacity back to the grid.[152]

Although PHEVs will not themselves generate electricity, their batteries' storage potential serves an analogous purpose: they make reserve capacity available to the grid. Similarly, Vermont's existing regulatory structure for "net metering systems" could be adapted to PHEV's storage capacity. This regulatory structure includes filing for a certificate of public good,[153] commensurate monthly rates for consumers in the same rate class irrespective of whether they plug in to the grid,[154] liability insurance requirements,[155] utility monitoring requirements,[156] and reasonable fees for interconnection and utility services.[157] PHEV charging and storage capacity for a smart grid should be under a similar system, with pre-determined agreements for direct load control, passive load control and home communication systems, and Home Area Networks (HAN) which include home displays that indicate charge, storage, and grid demand.[158]

C. Local Infrastructure Requirements

No large-scale network of public PHEV charging stations exists in the United States. Absent such a network, individual PHEV owners will use the electrical power in their residences to charge their cars. Home charging of a PHEV will not be a problem for a homeowner who has an attached garage that is tied into the circuitry of a modern home with 200-amp service; but such an

149. Evslin, *supra* note 146.
150. VT. STAT. ANN. tit. 30, § 219a (2010).
151. *Id.* § 219(a)(2).
152. *Id.* §§ 219(a)(2), (a)(3)(A), (a)(3)(C).
153. *Id.* § 248(a)(1)(B).
154. VT. ADMIN. CODE 18-1-17:5.103 (2010).
155. *Id*. at § 5.111.
156. *Id*. at § 5.113.
157. *Id*. at § 5.106(A)(5).
158. VT. PUB. SERV. BD., *supra* note 135, at 7-8, 11 (findings (C)(17), (C)(18), (C)(2)(29)).

individual represents the decided minority of United States households. City dwellers with no driveway access will need to charge their cars from their on-street parking spaces. Likewise, residents of multi-family dwellings will need to find a way to charge their cars. A network of public charging stations will ultimately need to be established but, as California is now discovering, this presents a host of other, unforeseen legal issues.

The California Public Utilities Commission (CA PUC) initiated a rulemaking proceeding in 2009 as "part of its efforts to ready the electric infrastructure for light-duty passenger plug-in hybrid electric vehicles and battery electric vehicles."[159] The scope of the proceeding includes an investigation as to whether public charging providers must be legally regulated by the CA PUC as utilities; whether approvals for new charging stations should be streamlined; whether electric vehicles should be separately metered; and whether utilities should be allowed to make infrastructure improvements for PHEVs which are recoverable from ratepayers.[160] While the proceeding remains open, the CA PUC is anticipated to issue a decision on some of these issues in February 2011.[161] The Volt and the Leaf are not yet commercially available in Vermont. But these cars will become available in Vermont next year, and the VT PSB will have had little time to learn from the California experience. For that reason, the VT PSB should proactively deal with the numerous infrastructure issues associated with PHEVs now.

D. Vermont Regulatory Issues

The Vermont Legislature must first decide whether, like California, it will offer incentives in addition to the $7,500 federal tax credit for PHEVs. At present, PHEVs are not cost-competitive with conventional automobiles. This does not imply that the subsidy offered can or should make PHEVs equal in price to conventional automobiles, but it does imply that an additional incentive may be necessary to encourage a viable commercial market for PHEVs in Vermont. Related, the VT PSB should initiate a proceeding that investigates the local infrastructure requirements for PHEVs and proactively addresses some of the legal questions that PHEVs will invariably raise. The state's two largest utilities, CVPS and GMP, should be required to address PHEVs in their respective IRPs. An analysis of PHEVs' potential energy storage role should likewise be incorporated into a separate smart grid proceeding, a proceeding that moves beyond smart metering and is aimed at determining whether full-scale smart grid investment will be pursued.

Rate design structures also present a powerful tool that the VT PSB should utilize to regulate PHEV charging and storage on the smart grid. In California, the Public Utilities Commission has approved rate reductions for the overnight charging of electric vehicles for each of the major municipal and private

159. *Order Instituting Rulemaking*, Assigned Commissioner's Scoping Memo, RM-09-08-009 (Cal. Pub. Utils. Comm'n Aug. 20, 2009), at 1, *available at* http://docs.cpuc.ca.gov/efile/RULC/112302.pdf.

160. *Id.* at 3, 6, 10 & 11.

161. *Order Instituting Rulemaking*, Administrative Law Judge's Ruling Requesting Additional Information and Setting Comment Schedule, RM-09-08-009 (Cal. Pub. Utils. Comm'n Oct. 27, 2010), at 1, *available at* http://docs.cpuc.ca.gov/efile/RULINGS/125662.pdf.

utilities.[162] For each regulated utility, the VT PSB should likewise approve rates that incentivize PHEV charging at particular times (i.e., nighttime, off-peak hours) by charging higher daytime rates. The VT PSB should also modify block tariffs[163] so that the increase in electricity use from residential customers charging their vehicles at home, or at public charging facilities, reflects both the marginal cost of the electricity used and the social and economic benefits of electric vehicles.[164] Finally, the VT PSB should adopt a statewide rate design infrastructure; this would prevent a particular utility service area from receiving a favorable rate structure and thereby attracting a disproportionate number of electric vehicle charging customers.[165]

The recommendations set forth in this section can now be summarized:

- The Legislature should enact PHEV tax incentives;
- The PSB should initiate a proceeding on PHEV local infrastructure requirements;
- The PSB should require utility IRPs to address PHEVs;
- The PSB should initiate a smart grid proceeding; and
- The PSB should adopt uniform rates to incentivize off-peak PHEV charging.

V. CONCLUSION: VERMONT'S LOWEST-CARBON FUTURE

The extent of the role PHEVs will play in Vermont's low-carbon future remains in doubt. PHEVs' future role depends on many factors, not the least of which is how widespread PHEV fleet penetration can be integrated into Vermont's pre-existing legal regime for the regulation of energy. The manner by which this is accomplished will help to determine whether PHEVs play an important role in Vermont's low-carbon future. In this article, we have empirically investigated how PHEVs can be integrated into Vermont's regulatory regime.

Irrespective of whether Vermont addresses some or all of the empirical legal issues we have discussed in this article now, at least some of these legal issues will necessarily have to be addressed in the future. If a degree of PHEV

162. *Residential Electric Vehicle Services*, L.A. DEP'T OF WATER & POWER (2011), http://www.ladwp.com/ladwp/cms/ladwp002056.jsp; PAC. GAS & ELECTRIC CO., PEV CHARGING COST EXAMPLE (2011), *available at* http://www.pge.com/includes/docs/pdfs/shared/environment/pge/cleanair/electricdrivevehicles/PEV_rate_options.pdf; *The Cost of Charging Your Electric Vehicle*, SAN DIEGO GAS & ELECTRIC (2011), http://www.sdge.com/environment/cleantransportation/evRates.shtml; *Residential Rate*, S. CAL. EDISON (2011), http://www.sce.com/residential/rates/electric-vehicles.htm.

163. The VT PSB is required to consider the adoption of "inclining block rates" for residential customers. This type of block tariff provides for "an initial block of low-cost power available to all residences," and then for increasing rates as more electricity is consumed. VT. STAT. ANN. tit. 30, § 218(b) (2010). An unmodified inclining block rate structure, based entirely on the amount of electricity consumed, would impose a price penalty on Vermont consumers for the additional electricity required to charge PHEVs.

164. The California Public Utilities Commission is now undergoing consideration of these same issues. *Order Instituting Rulemaking*, Assigned Commissioner's Scoping Memo, RM-09-08-009 (Cal. Pub. Utils. Comm'n Aug. 20, 2009), at 1, *available at* http://docs.cpuc.ca.gov/efile/RULC/112302.pdf.

165. For example, if an IOU was to receive higher rates within its service territory than other IOUs, it would incentivize charging station investment within that territory — while a statewide investment in charging station infrastructure would ultimately be needed.

market penetration is achieved, the VT PSB, and the Vermont Legislature, will be required to decide on PHEVs' role in the development of the smart grid. As federal transmission infrastructure planning evolves, a decision will be made, if only by default, as to whether PHEVs have a role to play in maximizing grid efficiency. Most importantly, should a sufficient critical mass of PHEV owners be established in Vermont, planning for local charging infrastructure must already have commenced. The ratepayer cost, and the consumer expense of PHEVs, may or may not ultimately prevent the occurrence of widespread PHEV fleet penetration in Vermont. But Vermont now has the opportunity to affirmatively address the legal issues that PHEVs will precipitate. Meanwhile, PHEVs should not be allowed to merely stumble into Vermont - or any other state's - regulatory framework. Rather, PHEV technology should be allowed to either fall down or land on its own feet, without first having encountered unnecessary obstacles to its integration into states' existing legal regimes for the regulation of electricity.