OF NESTING DOLLS AND TROJAN HORSES: A SURVEY OF LEGAL AND POLICY ISSUES ATTENDANT TO VEHICLE-TO-GRID BATTERY ELECTRIC VEHICLES

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INTRODUCTION

Beginning in the late twentieth century, the U.S. auto industry briefly attempted to turn the clock back to the early days of automobile manufacturing by offering (on a very small scale) light duty vehicles powered solely by electricity. The story of how that fad evaporated has been told in print and on celluloid and warrants no retelling here. However, like a phoenix from its ashes, the idea of a domestic fleet of light duty vehicles with electric motors and drive trains instead of internal combustion engines has been reborn, with gusto. Growing concerns about the effects of climate change, legislative decrees to increase the total percentage of renewable energy resources in the domestic fuel portfolio, fears about the volatility of oil prices and the nations that own the resource, and hopes for a "green" economy based on technological innovation and American grit, all have contributed to this resurgence. Moreover, improvements in battery technology coupled with a growing demand for greater fuel efficiency have created the current moment whereby several global auto makers (Chevrolet, Nissan, Tesla, Ford, Fisker, and Toyota) plan to roll out plug-in hybrid electric vehicles (PHEVs) in the immediate future.[1]

Concomitant to the movement toward electric vehicles, smart grid technology[2] has developed and is being implemented via several pilot pro-

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1. Anurag K. Srivastava et al., *The Challenges and Policy Options for Integrating Plug-in Hybrid Electric Vehicles into the Grid*, 23 ELECTRICITY J. 83, 84 (2010).

2. Smart Grid technology is defined as the "use of digital information and controls technology to improve reliability, security, and efficiency of the electric grid . . .[toward] the [d]ynamic optimization of grid operations and resources . . . [and] the [d]eployment and integration of distributed resources and generation, including renewable resources." Proposed Policy Statement and Action Plan, 74 Fed. Reg. 13,152, 13,153 (Mar. 19, 2009).

grams across the country. At the interface between the emerging smart grid and battery electric vehicles (BEVs/PHEVs) stands the concept of vehicle-to-grid (V2G). V2G, (also known as "smart charging" or "mobile energy") refers to the "capability to deliver power from the vehicle to the grid . . . controlled in part by the needs of the electrical system, via a real-time signal."[3] For a grid-enabled vehicle (GEV)[4] to be V2G capable, three things must be present: (1) a power connection to the grid (hence the "GE" in GEV), (2) a control/communication device that allows a grid operator to access the vehicle's battery, and (3) a two-way meter on board the vehicle to measure energy flow in each direction.[5] In other words, V2G is a kind of net metering for an "appliance" that you can drive and that possesses enough electricity storage in its battery to allow the larger grid to take electricity back from it. This begs the (compound) question: How could such a small amount of electricity possibly be beneficial to the huge electrical grid, and why would anyone want to voluntarily deplete the fuel of an electric vehicle?

Those questions will be more thoroughly addressed in subsequent parts of this paper, but for now consider these numbers: (1) a GEV market penetration of about 2% (4,800,000 cars) would store approximately 72 gigawatt-hours (GWh) of electricity, or almost 2% of the daily U.S. residential sector's electricity consumption;[6] (2) studies have projected the value of a V2G GEV that provides ancillary services to the grid at upwards of $3,000 annually.[7] Even without context these statistics reveal the promising potential that underlies the growing excitement surrounding V2G technology, toward the synergistic goals of reducing dependence on fossil fuels, building an economy based on technological savvy and environmental stewardship, and lessening the hemispheric and generational inequity

3. Henrik Lund & Willett Kempton, *Integration of Renewable Energy into the Transport and Electricity Sectors Through V2G*, 36 ENERGY POLICY 3578, 3579 (2008).

4. For the sake of clarity and simplicity, the terms BEV (battery electric vehicle) and PHEV (plugin hybrid electric vehicle) will be subsumed into the broader term GEV (grid-enabled vehicle).

5. Bejamin K. Sovacool & Richard F. Hirsh, *Beyond Batteries: An Examination of the Benefits and Barriers to Plug-in Hybrid Electric Vehicles (PHEVs) and a Vehicle-to-Grid Transition*, 37 ENERGY POLICY 1095, 1103 (2009).

6. A 2% penetration of the 240 million light duty vehicle fleet would be 4.8 million electric vehicles. *See infra* note 24. Assuming an average battery capacity of 15 kWh, 4.8 million electric vehicles could store 72 GWh of electricity. The average residential sector daily electricity consumption in the United States in 2009 was 3.73 terawatt-hours (TWh). Energy Info. Admin., *Short-Term Energy and Winter Fuels Outlook*, DEP'T OF ENERGY, 8, Table 7a (Oct. 13, 2010), http://www.eia.doe.gov/steo/steo_full.pdf. Thus, the 72 GWh of electricity stored by electric vehicles would account for almost 2% of daily U.S. electricity production (72 GWh ÷ 3.73 TWh = 1.93%).

7. Willet Kempton & Jasna Tomic, *Vehicle-to-Grid Power Fundamentals: Calculating Capacity and Net Revenue*, 144 J. POWER SOURCES 268, 273–75 (2005).

that has been the legacy of industrial development over the past two centuries.

Along with the promise of a new, clean economy built upon the "smart" revolution come a host of legal and policy issues to be debated and established before the infant outgrows its trainers. Policy questions include determining how to assimilate V2G into an economy that is sluggish and possibly unprepared for a major reorganization; imagining both *how* the existing electrical grid (which is adequate at best and dilapidated at worst) will be updated to accommodate advanced metering infrastructure (AMI) and *who* will pay for it; deciding what role the federal government will have in the development and establishment of V2G across the country and how the states will cooperate; and planning the implementation of smart grid technology generally—and V2G in particular—simultaneous to the establishment of domestic and international standards of safety and security.

The legal issues surrounding V2G are more nuanced and arcane, but no less important. For instance, how will property rights in electricity change if any individual car owner could become, in effect, an electricity generator supplemental to the grid or primary to his or her home? Coincidentally, how will V2G change the roles of "wires" companies and traditional generators? Is it possible under the few existing state net metering statutes for heretofore non-electricity-based industries to get into the business of electricity generation on account of having lots of parking space?

Because the smart grid exists almost exclusively in small pilot programs in the United States (and because V2G is closer to an abstract concept than a concrete reality), the legal and policy issues briefly discussed above are extrapolations. The purpose of this paper is neither to critically analyze relevant policies, nor to opine on the correctness of the law vis-à-vis V2G. Rather, the paper is a description of the technical concept of V2G, with sections dedicated to its promise (Part I) and potential pitfalls (Part II). The article also intends to introduce the aforementioned policy and legal issues at greater length and perhaps extrapolate just a bit more thereupon (Part III).

I. V2G IS A NESTING DOLL HOUSING THE POWER TO TRANSFORM THE U.S. ELECTRICAL GRID, FUEL MIX, ENVIRONMENT, AND ECONOMY

The first electric automobile built in the United States[8] appeared at nearly the same moment in time that Thomas Edison flipped the switch in the offices of J.P. Morgan, thereby demonstrating the progenitor grid, which would later become Consolidated Edison, the first electric utility.[9] From the grid's inception, coal buried in the Appalachian Mountains fueled the ever-increasing demand for electricity.[10] Then, in the early years of the FDR administration, the Tennessee Valley Authority was built to "jump start the economy and the communities adjoining the Tennessee River," and in so doing became the first renewable electricity generation plant in the United States' energy portfolio.[11] Later, in the wake of the first oil shock (1973), the Carter administration attempted to further diversify the domestic fuel mix by shepherding legislation that fostered the development of wind and solar electricity and co-generation.[12] The result—The Public Utilities Regulatory Policies Act of 1978 (PURPA)[13] —also pioneered *both* the deregulation of the electricity industry that would occur two decades later *and* the concept of selling surplus electricity back to the grid, by mandating that utilities had to purchase excess power from independent power producers (e.g., large factories).[14] Thus, for over a century we have lived with a pervasive, interconnected system to generate, distribute, and consume electricity; we have understood the possibilities of powering our vehicles with fuel other than from decayed fossils; and, for the better part of thirty years, energy policy in the United States has incorporated market behaviors and technological concepts that seem today to be innovations of the present (or near future).

Why has it taken us so long to seriously study the logistical, economic, and environmental effects of a decentralized, responsive, instantaneous electricity generation, transmission, and distribution network? Because until now there has not been a harmonizing agent, something to unify related but diverse policy goals. V2G could serve that function in a near-term

8. *Timeline: History of the Electric Car*, PBS (Oct. 30, 2009), http://www.pbs.org/now/shows/223/electric-car-timeline.html.

9. PHILLIP F. SCHEWE, THE GRID: A JOURNEY THROUGH THE HEART OF OUR ELECTRIFIED WORLD 35–36 (2007).

10. *A Brief History of Coal Use*, U.S. DEP'T OF ENERGY, http://fossil.energy.gov/education/energylessons/coal/coal_history.html (last visited Oct. 15, 2010).

11. SCHEWE, *supra* note 9, at 97.

12. *Id.* at 171–72.

13. Publ. L. No. 95-617, 92 Stat. 3117.

14. SCHEWE, *supra* note 9, at 172.

revolution in domestic energy policy by enhancing the use of renewables (particularly wind), by leveling out the various inefficiencies of the grid, by encouraging proliferation of independent power production and demand response measures, and by catalyzing a needed upgrade in the hardware of the grid and society's relationship to it.

A. Plug-In Hybrid Electric Vehicles (PHEVs, or GEVs)

GEVs have broad appeal for myriad reasons: they emit far less of the standard waste compounds (CO_2, CO, NO_x, SO_2) of an internal combustion engine (ICE), even when powered by coal-fired power plants;[15] they have lower operation and maintenance costs, given the comparative prices of petroleum and electricity and the orders of magnitude fewer parts of an electric motor compared to an ICE;[16] they are quieter and generally less aesthetically obnoxious than conventional vehicles; and they have the potential to offset (or avoid altogether) wealth transfers from petroleum consumers to producers (many of which are hostile to the United States) and the consequent price volatility of oil.[17]

GEVs also possess the potential for even broader appeal as a result of V2G—the kind of allure that makes venture capitalists salivate—by "provid[ing] electricity storage and quick-response electricity generation to the electric grid, . . . complement[ing] or displac[ing] liquid fuel as an energy carrier for a steadily increasing fraction of the vehicle fleet, and . . . optimiz[ing] power transfers between" the electric-fueled fleet and the electricity grid to exploit the compatible needs of each.[18]

1. GEV Specifications and Capabilities

The Department of Energy defines a PHEV as "[a] hybrid vehicle that can be driven in electricity-only or hybrid modes, and [can] be recharged from a standard electrical outlet,"[19] while the Institute of Electrical and

15. *NREL Study Concludes that HEVs and V2G Can Reduce NOx Emissions from Power Generation*, GREEN CAR CONGRESS (Jan. 24, 2009), http://www.greencarcongress.com/2009/01/nrel-study-find.htm; *see also* Ronald E. Minsk et al., *Plugging Cars into the Grid: Why the Government Should Make a Choice*, 30 ENERGY L.J. 317, 362–63 (2009).

16. Minsk et al., *supra* note 15, at 364–65. Up-front costs of GEVs are considerably higher than conventional ICE-powered vehicles, however. *Id.* at 364. Section III.C.1, *infra*, includes a discussion of policy choices involving tax credits, subsidies, warranties, etc.

17. Sovacool & Hirsh, *supra* note 5, at 1097.

18. Willet Kempton & Jasna Tomic, *Vehicle-to-Grid Power Implementation: From Stabilizing the Grid to Supporting Large-Scale Renewable Energy*, 144 J. POWER SOURCES 280, 281 (2005).

19. Srivastava, *supra* note 1, at 83 (citing Press Release, *DOE Announces $30 Million for Plug-in Hybrid Electric Vehicle Projects*, U.S. DEP'T OF ENERGY (June 12, 2008), http://www.energy.gov/news/archives/6337.htm).

Electronics Engineers (IEEE) provides a bit more detail—a PHEV contains at least: (1) a battery storage system of 4kWh (kilowatt-hours) or more; (2) the capability to recharge the battery from an external source; and, (3) the capability to travel at least ten miles in all-electric mode, consuming no combustion fuel.[20] The definitions are important because they describe and establish the essential characteristics of a GEV, which are necessary steps toward the development of markets, drafting of legislation, and establishment of standards for manufacture and operation.

GEV battery storage ranges from 1 to 30 kWh, providing anywhere from 4 to 120 miles per charge, depending on weather conditions.[21] With a standard residential wiring setup of 120 volts, a 15 kWh battery could take up to ten hours to charge, while a 240 volt outlet (for large appliances like washers and dryers) could cut that time by over 75%.[22] The number of light duty vehicles in the United States (e.g, passenger cars, vans, or light trucks) is approximately 240 million.[23] At a 2% penetration rate, the light duty vehicle fleet could provide 72 GW of electricity storage at any given time, or enough electricity to power almost 2.5 million homes for a full day.[24]

2. GEVs Can Provide Ancillary Services to the Grid

Though the metaphor is often employed, electricity is not exactly like water—electrons do not simply sit quietly in place when not in use. The electrical grid is much more like the circulatory system in the human body, requiring a base amount of material at all times, a certain pressure and frequency to move the material through the entire system uniformly in all directions, the capability to create more material on short notice to meet

20. *Id.* (citing IEEE-USA Bd. of Dirs., *Position Statement: Plug-in Electric Hybrid Vehicles*, IEEE (June 15, 2007), http://www.ieeeusa.org/policy/positions/PHEV0607.pdf).

21. Christophe Guille & George Gross, *Design of a Conceptual Framework for the V2G Implementation*, INST. OF ELECTRICAL AND ELECTRONICS ENGINEERS, ENERGY 2030 CONF., 2 (Nov. 17–18, 2008), http://energy.ece.illinois.edu/GROSS/papers/2008 Nov- Design of a Conceptual Framework for the V2G Implementation.pdf; *see also* ELEC. ADVISORY COMM., U.S. DEP'T OF ENERGY, BOTTLING ELECTRICITY: STORAGE AS A STRATEGIC TOOL FOR MANAGING VARIABILITY AND CAPACITY CONCERNS IN THE MODERN GRID 18 (2008), *available at* http://www.oe.energy.gov/DocumentsandMedia/final-energy-storage_12-16-08.pdf.

22. Andreas Dinger et al., *Batteries for Electric Cars: Challenges, Opportunities, and the Outlook to 2020*, BOSTON CONSULTING GROUP, 5 (2010), http://www.bcg.com/documents/file36615.pdf.

23. FED. HIGHWAY ADMIN., U.S. DEP'T OF TRANSP., HIGHWAY STATISTICS, 2005 tbl.MV-1 (2006), *available at* http://www.fhwa.dot.gov/policy/ohim/hs05/pdf/mv1.pdf.

24. The average U.S. household consumed 10.66 MWh of electricity in 2001. *U.S. Household Electricity Report*, ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, tbl.US-1 (July 14, 2005), http://www.eia.doe.gov/emeu/reps/enduse/er01_us_tab1.html. Divide 10.66 MWh by 365 days to get an average daily consumption of 29 kWh per household. A 2% penetration of the 240 million light duty vehicle fleet would be 4.8 million electric vehicles. Assuming an average battery capacity of 15 kWh, 4.8 million electric vehicles could store 72 GWh of electricity, or enough electricity to power about 2.5 million homes for a day (72 GWh ÷ 29 kWh = 2.5 million).

demand (i.e., red/white blood cells when one is ill), and a central command to regulate it all.

Similarly, the electrical grid requires a base amount of material, known as *baseload* power, which is made by the largest, most capital-intensive generation plants.[25] *Peak* power is when pull on the grid and demand for its material is highest (e.g., during a hot summer day when millions of air conditioners operate).[26] *Spinning reserves* is the term for power that is ready at a moment's notice in case of failure somewhere along the grid (akin to a blood transfusion in our circulatory metaphor), and *regulation* is the general term for frequency (measured in hertz (Hz)) and pressure (volts) control.[27] Other than baseload power, these terms represent different markets in the larger electricity market and are known collectively as "ancillary services," comprising between five and ten percent of total electricity cost per year ($12 billion).[28]

In other words, GEVs "can serve as distributed generators—supplements to utility power plants—that provide valuable generation capacity at peak times along with important ancillary services."[29] GEVs have the storage capacity and two-way energy transfer capability to provide these services to regional transmission organizations (RTOs) and independent system operators (ISOs), the central commands of the newly deregulated electricity industry.[30] For instance, when demand for electricity outpaces supply, the frequency and pressure in the grid drop, and vice versa.[31] The RTO or ISO responsible for correcting the imbalance can send a signal to potentially thousands of V2G GEVs proximately connected to the grid, requesting each vehicle either to send electricity to the grid or pull electricity from it.[32] This balancing is known as "regulation up" and "regulation down," respectively, and occurs daily based on minute-by-minute adjustments.[33] In this case, the electricity itself has value along with the contracted service.

Spinning reserves is also a contracted service, but occurs much less frequently (twenty to fifty times per year, more often than you want to have

25. Kempton & Tomic, *supra* note 18, at 282.

26. *Id.*

27. *Id.*

28. Willett Kempton et al., *A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System*, MID-ATLANTIC GRID INTERACTIVE CARS CONSORTIUM, 9 (Nov. 2008), http://www.magicconsortium.org/_Media/test-v2g-in-pjm-jan09.pdf.

29. Sovacool & Hirsh, *supra* note 5, at 1098.

30. Kempton et al., *supra* note 28.

31. *Id.*

32. *Id.*

33. *Id.*

a blood transfusion).[34] Unlike regulation, when spinning reserves are requested, the grid does not need a minor calibration—it needs a major boost, fast. This type of contracted service requires a generator to provide electricity immediately (without having to “ramp up”) and get to full capacity within ten minutes.[35] GEVs are well suited to this service because it involves a quick response but does not require the amount of energy only available from a large power plant.[36]

Together these services increase efficiency and decrease interruptions across the grid. They can also decrease a GEV owner’s annual electricity charges—some estimates average offsets of $1,000 for spinning reserves and $2,800 for regulation, annually.[37]

B. GEVs Will Facilitate the Proliferation of Renewable Energy

The two enduring criticisms of renewable energy generation, particularly wind and solar, have been that (1) the resources do not proximately align with the demand and (2) their occurrence is too erratic for use in electricity generation.[38] In the parlance of the industry, renewables are not easily “deliverable.” Much of the excitement over PURPA involved its mandate that independent power producers (IPPs) be allowed access to transmission lines and have their excess power bought by traditional utilities. Drafters of the Act believed that would open the door for distributed generation and, in turn, create a boom in renewable energy production.[39] But the boom never manifested, and renewable energy generation today remains a small fraction of the total domestic fuel mix, accounting for only 7% of the total energy consumed in the United States.[40] Proponents of V2G argue that the renewable energy industry will finally realize its boom through the introduction of millions of GEVs acting as distributed storage and generation that will interface with the smart grid.[41]

34. *Id.* at 11.

35. *Id.*

36. *Id.* at 12.

37. Srivastava et al., *supra* note 1, at 90 (citing PJM INTERCONNECTIONS, http://www.pjm.com; ELECTRICITY RELIABILITY COUNCIL OF TEXAS, http://www.ercot.com).

38. FRED BOSSELMAN ET AL., ENERGY, ECONOMICS AND THE ENVIRONMENT 838–46 (3d ed. 2010) (citing ARJUN MAKHIJANI, CARBON-FREE AND NUCLEAR-FREE: A ROADMAP FOR U.S. ENERGY POLICY 30–45 (2007)); *see also*, SCHEWE, *supra* note 9, at 197–205.

39. SCHEWE, *supra* note 9, at 172.

40. *Renewable Energy Trends in Consumption and Electricity 2008*, U.S. ENERGY INFO. ADMIN., U.S. DEP’T OF ENERGY, 1 fig.1.1 (Aug. 2010), http://www.eia.doe.gov/cneaf/solar.renewables/page/trends/trends.pdf.

41. Distributed generation is “modular electrical generation and storage . . . strategically sited and operated to supplement central station generation plants and the transmission and distribution . . . grid.” *Distributed Utility Planning: An Introduction to Concepts and Issues*, VT. DEP’T OF PUB. SERV.,

1. Renewables' "Adequacy" and "Variability" Problems Solved

The Federal Energy Regulatory Commission (FERC) notes three primary challenges involving renewable energy: (1) resource adequacy during peak periods or grid disturbances; (2) resource management (i.e., inefficiency, or more supply than demand); and (3) low system inertia (the inability of renewable generators to maintain their motion without the resource).[42] FERC also acknowledges a potential solution to these problems, which sounds very similar to the description of a fleet of GEVs:

> [I]nvestment in large amounts of electricity storage could ultimately address both the resource adequacy and resource management concerns . . . . If a system existed whereby entities could receive a timely signal to temporarily shift their demand from peak to off-peak, and if such load shifts could be controlled by the system operator, then such "dispatchable" demand response could alleviate . . . concerns associated with over-generation.[43]

2. V2G Will Mitigate Deliverability Problems of Renewable Energy

Another significant challenge posed by renewable energy (particularly wind in this case) is the incompatibility of the resource with regards to both timing and location. For instance, wind resources are most temporally concentrated at night and are geographically concentrated in the northern plains of the Midwest and over large water bodies (e.g., the great lakes and the oceans), with high potential in mountainous regions but little-to-no potential in consistently warm areas like the deserts of the Southwest and the marshes of the Southeast.[44] Thus, because the physical distance between supply and demand is so great, the loss of electricity due to the inherent inefficiency of transmission lines makes incorporating renewable energy less economically feasible.

Supporters of V2G posit the technology could resolve this issue in several ways. First, the coincidence of wind energy (at night) with likely GEV recharging patterns (at night) would enhance the energy efficiency and cost effectiveness of wind as a generation resource.[45] Second, by mak-

http://publicservice.vermont.gov/energy/ee_files/dup/dup_ee.htm (last visited Sept. 22, 2010) [hereinafter *Distributed Utility Planning*]; *see also* Lund & Kempton, *supra* note 3, at 3586.

42. Proposed Policy Statement and Action Plan, 74 Fed. Reg. at 13,155; *see also* Lund & Kempton, *supra* note 3, at 3586.

43. Proposed Policy Statement and Action Plan, 74 Fed. Reg. at 13,155; *see also* Sovacool & Hirsh, *supra* note 5, at 1098.

44. *See Wind Resource Potential,* U.S. ENERGY INFO. ADMIN., U.S. DEP'T OF ENERGY, fig.13, http://www.eia.doe.gov/cneaf/solar.renewables/ilands/fig13.html (last modified Apr. 29, 2003).

45. Peter J. Fontaine, *Shortening the Path to Energy Independence: A Policy Agenda to Commercialize Battery-Electric Vehicles*, 21 ELECTRICITY J. 22, 32 (2008).

ing the grid more efficient (via ancillary services), the use of renewable energy in places where those resources do exist becomes more economically competitive relative to other types of generation.[46] Finally, the distribution of potentially millions of storage units (in the form of GEV batteries) much closer to the renewable generation point (e.g., from a solar PV cell on a rooftop down to a garage with a GEV) eliminates the need to access inefficient transmission and/or distribution lines altogether.[47]

3. V2G is Compatible with the Use of Feed-In Tariffs and Renewable Portfolio Standards to Spur Renewable Energy

"A feed-in tariff (FIT) is an energy supply policy that offers a guarantee of payments . . . for the electricity [produced.] . . . [P]ayments are generally awarded as long-term contracts set over a period of 15–20 years."[48] FIT policies have proven successful in Europe at fostering increased deployment of renewable energy projects more cost-efficiently than renewable portfolio standards (RPS), because a FIT offers several incentives, including a guaranteed rate of return on investment (which alleviates normal investment-level risks and, consequently, initial capital costs), an increased likelihood of debt financing (which is cheaper than equity financing), and lower administrative and regulatory barriers on account of the length of the contract terms and the transparent payments.[49] An RPS, on the other hand, is a statutory requirement that electricity retailers include a specific percentage of renewable energy in the total mix of energy sold, toward the twin goals of increasing the implementation of renewable energy (and all the attendant environmental and economic benefits) and leveling the cost gap between renewable energy and traditional fossil-fueled power plants.[50]

The primary difference between RPSs and FITs is the focus of their supply and demand relationships: RPSs mandate a specific percentage of *demand* to be met by renewable energy, while FITs encourage investment in greater renewable *supply* by increasing investor confidence.[51] Therefore, as a type of demand response, V2G (and net metering generally) is more like an RPS than a FIT. Just because the policies fall on opposite sides of

46. BOSSELMAN ET AL., *supra* note 38.

47. *Id.* at 839; *see also Distributed Utility Planning*, *supra* note 41.

48. TOBY COUTURE & KARLYNN CORY, NAT'L RENEWABLE ENERGY LAB., STATE CLEAN ENERGY POLICIES ANALYSIS (SCEPA) PROJECT: AN ANALYSIS OF RENEWABLE ENERGY FEED-IN TARIFFS IN THE UNITED STATES 2 (2009), *available at* http://www.nrel.gov/docs/fy09osti/45551.pdf.

49. *Id.* at 3–4.

50. BOSSELMAN ET AL., *supra* note 38, at 875.

51. KARLYNN CORY ET AL., NAT'L RENEWABLE ENERGY LAB., FEED-IN TARIFF POLICY: DESIGN, IMPLEMENTATION, AND RPS POLICY INTERACTIONS 8–9 (2009), *available at* http://www.nrel.gov/docs/fy09osti/45549.pdf.

the macroeconomic equation does not mean they are incompatible, however. Nor does it mean that the emergence of net metering, the smart grid, and V2G will necessarily cause an either/or choice between them. V2G applications are primarily considered applicable to the home, making a GEV a kind of smart grid super appliance on wheels. Proponents conceive of several types of non-residential V2G applications as well, including commercial charging stations, commercial/industrial fleet parking, and stand-alone multi-level parking structures.[52] Because the purpose of a FIT is to create electricity generation, and conceivably a parking structure could become a generator if tens or hundreds of GEVs brought "outside" power to the structure for delivery, implementing a FIT policy to initiate GEV infrastructure construction is not incompatible. Where the power came from (and to some degree *how* it was generated, as long as it is not generated in the parking structure by burning coal) is of no consequence to the connection between the grid and the structure—only the power transfer matters. Furthermore, a FIT could facilitate the siting of solar panels on that very same parking structure (or commercial/industrial facility rooftop) via a long-term contract between the owner of the panels and the recipient of the electricity (e.g., the facility or its employees' GEVs), and could use V2G ancillary services as a supplementary revenue stream.[53] In the latter scenario, the FIT stimulates the use of solar panels via the guaranteed contract while the V2G provides revenue and flexibility of power delivery or storage.

C. V2G Will Alleviate Strain on the Grid and Could Stimulate Improvements

Experts worry that the domestic electricity infrastructure is aging:

> [We] have taken [the grid] for granted for far too long. As a result, our overburdened grid has begun to fail us more frequently and presents us with substantial risks. Even as demand has skyrocketed, there has been chronic underinvestment in . . . transmission and distribution, . . . limiting grid efficiency and reliability. While hundreds of thousands of high-voltage transmission lines course throughout the United States, only 668 additional miles of interstate transmission have been built since 2000.[54]

52. Kempton & Tomic, *supra* note 18, at 283–84 (several business models have been suggested for V2G applications).

53. Kempton & Tomic, *supra* note 18, at 285; *see also* ELEC. POWER RESEARCH INST., REPORT TO NIST ON THE SMART GRID INTEROPERABILITY STANDARDS ROADMAP 64 (2009), *available at* http://www.nist.gov/smartgrid/upload/InterimSmartGridRoadmapNISTRestructure.pdf.

54. BOSSELMAN ET AL., *supra* note 38, at 988 (quoting U.S. DEP'T OF ENERGY, THE SMART GRID: AN INTRODUCTION (2008), *available at* http://www.oe.energy.gov/DocumentsandMedia/DOE_SG_Book_Single_Pages%281%29.pdf).

It is estimated that disturbances and inefficiencies in the grid cost the economy more than $100 billion annually.[55]

Reliability challenges involve congestion problems (bottlenecking of electrons as a result of unanticipated power flow patterns and/or line disturbances), outsized energy transfers across jurisdictions caused by deregulation, and the plain-old inefficiency of an aging, unidirectional web of copper wires.[56] Here again, proponents of V2G laud its characteristics as an ideal complement to the electrical infrastructure. For example, the ancillary services discussed above serve more than just a revenue-generating function. Currently, regulation (matching power generation with consumption on a minute-by-minute basis) is usually performed by hydroelectric and other power plants in a day-ahead bidding market. Using GEVs for regulation would allow larger load servers (i.e., power plants) to remain quiet and spread the load across (potentially) thousands of connections rather than only a few.[57] Furthermore, by delivering more energy into systems where capacity is maxed out (i.e., urban areas), GEV-supplied power would defer distribution-level upgrades (a not insignificant benefit to overdrawn state and local budgets),[58] or even displace the need for existing regulating power stations.[59]

Critics maintain that adding potentially thousands of small loads to the grid will strain hardware (e.g., transformers, distribution wires, etc.) and outpace supply (leading to brownouts).[60] Proponents counter that, though aging, the existing generation capacity and infrastructure is sufficient to power a "large-scale conversion" to GEVs.[61] Furthermore, if charging during off-peak hours (i.e., during the evening, or over-night), GEVs would actually provide a valuable "leveling" function, whereby the "valleys" of generation (the nadir of demand) are filled to some degree; in essence, the opposite of peak shaving.[62] By leveling out the peaks and valleys, large

55. SCHEWE, *supra* note 9, at 258.

56. Khosrow Moslehi & Ranjit Kuma, *Smart Grid—A Reliability Perspective, in* INNOVATIVE SMART GRID TECHNOLOGIES CONFERENCE (2010), *available at* http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=5434765.

57. *White Paper on V2G*, AC PROPULSION, http://www.acpropulsion.com/acp_v2g_whitepaper.pdf (last visited Oct. 11, 2010).

58. *Id.*

59. Lund & Kempton, *supra* note 3, at 3586.

60. FRANCOISE NEMRY ET AL., INST. FOR PROSPECTIVE TECHNOLOGICAL STUDIES, PLUG-IN HYBRID AND BATTERY-ELECTRIC VEHICLES: STATE OF THE RESEARCH AND DEVELOPMENT AND COMPARATIVE ANALYSIS OF ENERGY AND COST EFFICIENCY 33 (2009), *available at* http://ftp.jrc.es/EURdoc/JRC54699_TN.pdf.

61. Stephen Brown et al., *Electric Vehicles: The Role and Importance of Standards in an Emerging Market*, 38 ENERGY POLICY 3797, 3800 (2010).

62. Minsk et al., *supra* note 15, at 364–65.

generators are able to produce electricity cheaper and more efficiently, and put less strain on the grid during times of max demand.[63]

Potentially straining the existing electrical infrastructure is not all bad, however. Stimulating the beginning of a long-overdue upgrade to an antiquated, unidirectional web of above-ground copper wiring is something V2G proponents actively promote. Supporters also point to the limited market penetration goals (one million cars by 2015 equates to 0.4% market penetration) to assuage fears that the grid will need to be torn down and rebuilt overnight.[64] Forrest Jehlik of the Argonne National Laboratory explains that "[i]f everyone were somehow able to buy a plug-in hybrid tomorrow, that would probably present a problem . . . but given the pace that they are likely to enter the market, we won't face a system-wide failure."[65]

II. V2G IS A TROJAN HORSE, HOSTING A LITANY OF PATHWAYS TO THE DESTRUCTION OF THE U.S. ELECTRICAL GRID, FURTHER DEPENDENCE ON FOSSIL FUELS, AND DESTABILIZATION OF THE ECONOMY

Little more than a decade ago it seemed as though the world might collapse on account of an unanticipated (or ignored) computer glitch. The theory was that the entire world would descend into chaos after the trillions of digital clocks inside the billions of computers controlling the millions of electrical systems around the globe flipped from 99 to 00. The clocks would read 00 as the year 1900 instead of 2000, the computers would freeze up altogether, the electrical system would malfunction and the world would stop.[66] The apocalypse never manifested, and eleven years later the vast majority of the world has forgotten all about "Y2K."[67]

But many of those who worked behind the scenes to prevent Y2K doomsday, including John Koskinen, President Clinton's Y2K czar, and Paul Saffo, director of the Institute for the Future, feel that the threat was

63. *Id.*; *see also* Louise Lerner, *Argonne Helps the Grid Get Smart: Technology, Analysis Can Better Meet America's Needs*, ARGONNE NAT'L LABORATORY (Mar. 25, 2010), http://www.anlgov/Media_Center/News/2010/news100325.html; Sovacool & Hirsh, *supra* note 5, at 1098.

64. Jared Sagoff, *Pulling the Plug on Hybrid Myths: Argonne Tackles Six Myths About Plug-in Hybrid Vehicles*, ARGONNE NAT'L LABORATORY (Nov. 19, 2009), http://www.anl.gov/Media_Center/News/2009/news091119.html.

65. *Id.*

66. *The Surprising Legacy of Y2K: Separating Hype from Reality*, AM. RADIOWORKS, http://americanradioworks.publicradio.org/features/y2k/transa.html (last visited Oct. 9, 2010).

67. *Id.* (David Eddy, the man who coined the term "Y2K," said during the program, "I'd love to do a poll, . . . and just talk to what I would call civilians, and if you ask them, I bet you hard money that most civilians would say, '*oh, y2k, whole thing was a hoax.*'").

real and worry about similar threats to an interconnected world.[68] Both men point to the complexity of the computer network and increasingly sophisticated technology for the proposition that the global community faces another Y2K-like scenario that goes unrecognized.[69] Mr. Saffo worries about an internet malfunction, while Mr. Koskinen speaks plainly of cyber terrorism: "The way to shut down the power system is not to bomb anything. It's actually to hack into the computer controls and shut it down that way."[70]

Concern about V2G centers around the very crux of what makes it so appealing—interconnectedness. Plugging a driveable computer with potentially 30 kWh of electrical energy storage makes the electricity grid more flexible, responsive, and reliable. But that interconnection also makes individuals more dependent upon systems, controllers, hardware and software, and to some degree vice-versa. Furthermore, with major industries ranging from telecommunications to natural gas to finance to healthcare using the public internet as a medium for global communication and system control, potentially adding millions of unsupervised entry points and new network connections only increases our interdependency and vulnerability.[71]

In an ironic twist, some critics of V2G worry less about the abstract possibility of cyber war than the very real environmental costs associated with moving from a petroleum-fueled transportation sector to one fueled by electricity.[72] Additionally, policymakers are concerned that regulations and standards either do not exist or do not suffice to protect consumers, workers, and the general economy from a rapid and wholesale transition.[73]

A. V2G Will Increase the United States' Vulnerabilities to Cyber Terrorism

To understand the argument that V2G will increase the United States' vulnerability to cyber attack, an understanding of the relevant terminology is warranted. *Cyber infrastructure* includes "electronic information and communications systems and services and the information contained

68. *Id.*

69. *Id.*

70. *The Surprising Legacy of Y2K: The Network,* AM. RADIOWORKS, http://americanradioworks.publicradio.org/features/y2k/transc.html (last visited Oct. 9, 2010).

71. RICHARD A. CLARKE & ROBERT K. KNAKE, CYBER WAR: THE NEXT THREAT TO NATIONAL SECURITY AND WHAT TO DO ABOUT IT 100–01 (2010).

72. *Environmental Outlook: Electric Cars*, THE DIANE REHM SHOW, NAT'L PUB. RADIO (July 6, 2010), http://thedianerehmshow.org/shows/2010-07-06/environmental-outlook-electric-cars [hereinafter *Electric Cars*].

73. *See generally* Proposed Policy Statement and Action Plan, 74 Fed. Reg. 13,152.

[therein] . . . [which consists of] all hardware and software that process, store, and communicate information."[74] *Cyber security* is the "prevention of damage to, unauthorized use of, exploitation of, and, if needed, the restoration of electronic information and communications systems and services . . . to ensure confidentiality, integrity, and availability."[75] *Cyber terrorism* is "the use of computer network tools to shut down critical national infrastructures (such as energy, transportation, government operations), or to coerce or intimidate a government or civilian population."[76]

These definitions clearly subsume the physical hardware that would comprise a GEV (10–30 kWh Lithium Ion battery, bi-directional energy meter, wireless transmitter), the on-board software necessary to coordinate with an energy provider, and the protection and preservation of the same. By adding to the network (potentially) millions of mobile units that require protection, critics argue we are adding millions of "entry points" that could be exploited.[77] Moreover, adding millions of arguably heterogeneous (given the number of market participants) and complex electrical systems to an already impossibly heterogeneous and complex network of electrical systems (the existing grid and everything attached) exponentially increases the interdependency of the whole, making it more fragile and significantly lowering the disturbance threshold for collapse.[78] Thus, a much smaller—even innocuous—event could cascade into a major catastrophe.[79]

Another security-related concern about the proliferation of V2G technology (and the smart grid generally) is whether international standards will develop in advance of, or even keep pace with, future deployment of GEVs and V2G soft/hardware. FERC notes that this "could be a particular problem where separate groups of interested industry members independently develop and advocate select standards or protocols for . . . [IEEE's] consideration."[80]

74. ELEC. POWER RESEARCH INST., *supra* note 53, at 40 ("Processing includes the creation, access, modification, and destruction of information. Storage includes paper, magnetic, electronic, and all other media types. Communications include sharing and distribution of information.").

75. *Id.*

76. James A. Lewis, *Assessing the Risks of Cyber Terrorism, Cyber War, and Other Cyber Threats*, CENTER FOR STRATEGIC & INT'L STUD., 1 (Dec. 2002), http://csis.org/files/media/csis/pubs/021101_risks_of_cyberterror.pdf.

77. *See id.*

78. Alessandro Vespignani, *The Fragility of Interdependency*, 464 NATURE 984, 984 (Apr. 15, 2010).

79. *Id.* at 985.

80. Proposed Policy Statement and Action Plan, 74 Fed. Reg. 13,152, 13,154 (Mar. 19, 2009).

B. V2G Will Prompt Unsafe and Detrimental Changes to the Economy and Environment

V2G has been characterized as "smart charging," the marriage of the smart grid and a PHEV.[81] Given that neither the smart grid nor battery electrical vehicles is a brand new concept, the concerns about V2G regarding destabilization of the economy and negative environmental impact are not fears about V2G *per se*. Rather, critics point to the detrimental effects of the systemic switch to electricity that V2G could facilitate: increased fossil fuel pollutants from electricity generation plants, increased mining and disposal of rare earth materials and toxic compounds, lack of safety and manufacturing standards for GEV hardware and electricity infrastructure,[82] and dangers associated with increased battery cycling and overuse.[83]

1. V2G Will Exacerbate Fossil Fuel Use and Battery Waste

With the infusion of potentially millions of GEVs over the next decade come concerns about the life cycle costs of (1) switching to electricity as the primary fuel source for the transportation sector (e.g., increased utilization of "dirty" power plants) and (2) manufacturing and disposing of lithium ion battery packs (e.g., mining for the elemental materials that comprise the battery pack and disposal of the same).[84]

Although estimates vary, most studies agree on two aspects of a transportation sector fuel switch to electricity. First, greenhouse gas (GHG) emissions will lower as a result of less petroleum use, even when accounting for GHG increases from electricity generation in coal-fired power plants.[85] Second, volatile organic compounds and other waste gasses (e.g., NO_x, CO_2, CO, SO_2) could increase, depending on the exact fuel mix of the electricity-supplying power plant.[86] Furthermore, the National Academy of Sciences recently reported that GEVs (and hybrids) have higher non-

81. Sovacool & Hirsh, *supra* note 5, at 1096.

82. Brown et al., *supra* note 61, at 3798.

83. Dinger et al., *supra* note 22, at 3.

84. Brown et al., *supra* note 61, at 3801; *see also Report Examines Hidden Health and Environmental Costs of Energy Production and Consumption in U.S.*, NAT'L ACADS. (Oct. 19, 2009), http://www8.nationalacademies.org/onpinews/newsitem.aspx?RecordID=12794 [hereinafter *Report*].

85. Fontaine, *supra* note 45, at 31; *see also* COMM. ON ASSESSMENT OF RES. NEEDS FOR FUEL CELL AND HYDROGEN TECHS., NAT'L RESEARCH COUNCIL, TRANSITIONS TO ALTERNATIVE TRANSPORTATION TECHNOLOGIES—PLUG-IN HYBRID ELECTRIC VEHICLES 30–32 (2010); Minsk et al., *supra* note 15, at 362.

86. Seth Blumsack, *Measuring the Benefits and Costs of Regional Electric Grid Integration*, 28 ENERGY L.J. 147, 179 (2007); *see also* Brown et al., *supra* note 61, at 3801.

climate environmental damages (from resource extraction, water pollution, etc.) than technologies like fuel cells and compressed natural gas.[87]

Furthermor, when the usefulness of a commodity ends, that commodity is either recycled or thrown away; the faster the rate of uselessness, the faster the rate of production for replacement and the larger the stream of waste. The ancillary services that V2G technology would allow a GEV to provide the grid might shorten the life span of the GEV battery. Engineers studying the use of V2G cycling patterns discovered that "V2G modes that are more intermittent in nature" (i.e., peak power, peak shaving) lead to quicker "capacity fade."[88] Thus, V2G could create a battery replacement and recycling challenge for automakers and the communities that will receive the waste, and an existential problem for proponents of the belief that GEVs are an environmental panacea.[89]

2. V2G Will Make GEVs Unsafe, Strain the Grid, and Eliminate Jobs

"Thermal runaway" (spontaneous battery combustion) can occur as the result of over-charging or high discharge rates.[90] The collection of ancillary services that V2G affords to GEV owners engages a battery in a manner that creates a possibility of over-charging and high discharge rates, thus enhancing the potential for thermal runaway in GEVs that provide those services.[91] Further, the proliferation of GEVs on streets and in homes means that in the near-term improperly trained emergency responders may not be capable of protecting themselves, injured persons, or property in cases of traffic accidents and thermal runaway-induced fires.[92]

Another concern about V2G services involves possible GEV-related disturbances on the electrical grid. Some fear that batteries with software and/or hardware problems of similar prevalence to desktop computer "glitches" could create electricity quality issues like excessive current flow, incorrect voltage, and an overall lower quality of power.[93] This concern is made more palpable when coupled with the aforementioned theory that

87. *Report*, *supra* note 84.

88. Scott B. Peterson et al., *Lithium-ion Battery Cell Degradation Resulting from Realistic Vehicle and Vehicle-to-Grid Utilization*, 195 J. POWER SOURCES 2385, 2392 (2010).

89. *See* Linda Gaines, *Lithium Ion Battery Recycling Issues*, ARGONNE NAT'L LABORATORY (May 21, 2009), http://www1.eere.energy.gov/vehiclesandfuels/pdfs/merit_review_2009/propulsion_materials/pmp_05_gaines.pdf; *see also* Brown et al., *supra* note 61, at 3801.

90. Dinger et al., *supra* note 22, at 3.

91. *See generally* Kempton & Tomic, *supra* note 18.

92. Brown et al., *supra* note 61, at 3805.

93. *Id.* at 3803.

greater interdependency could weaken the overall system to the extent that smaller disturbances become potentially catastrophic events.[94]

In addition, a system-wide switch from internal combustion engines to electric motors could have quite an impact on the base services of the automobile industry (i.e., sales, maintenance, and repair)[95] and the interplay between original equipment manufacturers, parts and components manufacturers and suppliers, and dealerships.[96] Mechanics would need to evolve into technicians, car salesmen into something more like cell phone peddlers. Even electric utilities would face a forced evolution away from the traditional top-down, high-leverage contracting position that has been the hallmark of the electricity industry to something closer to a subscription solicitor.[97] Unfortunately, history (and common sense) has shown that vested interests, particularly in the automobile industry, do not take market transitions lightly.[98]

III. POTENTIAL LEGAL AND POLICY ISSUES

Parts I and II introduced the features of vehicle-to-grid technology that proponents espouse will revolutionize the U.S. transportation sector, electrical grid, economy, and environment, and that critics argue will increase our vulnerability to cyber terrorism, strain the electrical grid, weaken our economy, and exacerbate the existing environmental harms of electricity generation.

At the moment, V2G is nothing more than a concept—it exists in the results of abstract models[99] and the goals of inchoate pilot programs.[100] As a result, legal issues arising from the interactions of various stakeholders (e.g., automobile consumers and drivers, automobile parts and components manufacturers, electricity generators, electricity rate-makers, etc.) remain inchoate as well. There exist only suppositions regarding the possible role of law in the development of, and transition to, significant market penetration of grid-enabled vehicles with V2G capability into the domestic automobile fleet. On the other hand, as an emerging technology that excites (and concerns) so many and envisions major implications for the electrical

94. *See supra* Part II.A.

95. Brown et al., *supra* note 61, at 3803; *see also* Fontaine, *supra* note 45, at 30; Sovacool & Hirsh, *supra* note 5, at 1101.

96. Dinger et al., *supra* note 22, at 12.

97. Sovacool & Hirsh, *supra* note 5, at 1101.

98. Fontaine, *supra* note 45, at 30.

99. *See generally* Kempton et al., *supra* note 28.

100. *See, e.g.*, Electric Vehicle Deployment Act of 2010, S. 3442, 111th Cong. § 2 (2010).

status quo, the orbit surrounding V2G is rife with policy issues. The following section introduces a range of legal and policy issues that could become central to V2G development as it moves from theory to actuality.

A. Commerce: Contracting V2G Services and Equipment

GEVs could serve as a means of electricity storage and electricity generation for the electrical grid by providing ancillary services. These services include load leveling, peak shaving, spinning reserves, and frequency regulation, to name a few, and have been shown to generate revenue of as much as $4,000 annually.[101] The GEV owner would contract with the area RTO or ISO to connect the GEV battery as one of a fleet of aggregated vehicles.[102] As Willett Kempton (the foremost researcher in the area of V2G) notes, this could occur in one of several business models, including as an aggregation of individual vehicles.[103] This begs the question, how would an individual contract to provide these services? Mr. Kempton suggests that (1) an existing utility could easily fill this role by becoming, in essence, an electricity provider and quality control supervisor[104] or (2) a third party heretofore wholly unrelated to the electricity industry could become an aggregator of vehicles at its disposal (e.g., a car manufacturer or service provider, a battery manufacturer or battery "swap" supplier, or even a cell phone company).[105]

Different contractual arrangements could arise from different organizations of aggregators. For example, a battery swap company (where a GEV owner effectively leases a battery for a term of years with a warranty to replace it at the end of the term) might offer ancillary services collateral to the lease of a new battery.[106] A car manufacturer, on the other hand, could offer the battery, the ancillary services, and the vehicle as a subscription plan (like a full vehicle lease agreement).[107] Or, a parking facility with distributed generation could offer the sale or lease of spaces for the nominal cost of providing ancillary services while the vehicle is parked. And with each contract type the questions of when a GEV would need to be con-

101. Sovacool & Hirsh, *supra* note 5, at 1098.
102. Kempton & Tomic, *supra* note 18, at 283.
103. *Id.* at 283–84.
104. *Id.*
105. *Id.* at 284.
106. John Addison, *Intelligent Electric Vehicles and Smart Grids*, CLEAN FLEET REPORT (Aug. 20, 2009), http://www.cleanfleetreport.com/electric-vehicles/smart-electric-vehicles-smart-grids/.
107. *Id.*

nected, for how long, and whether the owner would have any control over the vehicle (and the electricity) would also have to be considered.[108]

A precursor to the provision of ancillary services is state legislation prescribing real-time pricing for electricity rates and net metering. For example, Illinois' real time pricing legislation leaves the determination of the real-time rate and the timing (i.e., the hourly rate and day-ahead market price) to the utility.[109] More importantly, net metering legislation explains who is an "eligible customer" and who can be an "electricity provider";[110] it dictates how the metering is billed (e.g., 1:1 kilowatt *credit*, which expires at the end of annualized billing cycle);[111] it mandates who pays for the advanced metering equipment;[112] and it proscribes rate discrimination for net metered customers.[113] It is interesting to note that Delaware, the home state of the aforementioned Mr. Kempton, recently enacted amendatory language to its net metering legislation to include GEVs:

> A retail electric customer having on its premises one or more *grid-integrated electric vehicles* shall be credited in kilowatt-hours (kWh) for energy discharged to the grid from the vehicle's battery at the same kWh rate that customer pays to charge the battery from the grid, as defined in paragraph (e)(1) of this section. . . . Connection and metering of grid integrated vehicles shall be subject to the rules and regulations found in paragraphs (e)(2), (e)(3), and (e)(4) of this section.[114]

108. *See infra* Part III.B.

109. 220 ILL. COMP. STAT. 5/16-107(b-5) (2007) ("Each electric utility shall file a tariff or tariffs allowing residential retail customers in the electric utility's service area to elect real-time pricing beginning January 2, 2007. A customer who elects real-time pricing shall remain on such rate for a minimum of 12 months. . . . A tariff . . . shall, at a minimum, describe (i) the methodology for determining the market price of energy to be reflected in the real-time rate *and* (ii) the manner in which customers who elect real-time pricing will be provided with ready access to *hourly* market prices, including, but not limited to, *day-ahead hourly energy prices*.") (emphasis added).

110. *Id.* § 16-107.5(b) ("As used in this Section, (i) 'eligible customer' means a retail customer that owns or operates a solar, wind, or other eligible renewable electrical generating facility with a rated capacity of not more than 2,000 kilowatts that is located on the customer's premises and is intended primarily to offset the customer's own electrical requirements; (ii) 'electricity provider' means an electric utility or alternative retail electric supplier").

111. *Id.* § 16-107.5(d)(2).

112. *Id.* § 16-107.5(c) ("If the eligible customer's existing electric revenue meter does not [measure bi-directional power flow], the electricity provider shall arrange for the local electric utility or a meter service provider to install and maintain a new revenue meter at the electricity provider's expense. . . . For generators with a nameplate rating of 40 kilowatts and below, the costs of installing such equipment shall be paid for by the electricity provider. For generators with a nameplate rating over 40 kilowatts and up to 2,000 kilowatts capacity, the costs of installing such equipment shall be paid for by the customer. Any subsequent revenue meter change necessitated by any eligible customer shall be paid for by the customer.").

113. *Id.* § 16-107.5(e) ("An electricity provider shall provide to net metering customers electric service at non-discriminatory rates that are identical, with respect to rate structure, retail rate components, and any monthly charges, to the rates that the customer would be charged if not a net metering customer.").

114. DEL. CODE. ANN. tit. 26, § 1014(g) (West Supp. 2010) (emphasis added).

The language of the Delaware statute clearly envisions V2G technology and, as an addendum to the state net metering legislation, Delaware is prepared to attempt a market in ancillary services provided by GEVs dispersed throughout the state. While the Illinois statute is not as clear, it arguably could be interpreted broadly enough to include the contracting of services of GEVs. With the foundation therefore laid in at least two states, a market for providing contracted ancillary services can flourish. But what property rights will GEV owners have in their vehicles, batteries, and electricity?

B. Property: What Will V2G Consumers Own?

International expert in energy policy Benjamin Sovacool has noted that V2G technology upsets conventional thinking about the automobile:

> [Under current automobile industry logic,] the *engine* is viewed as the primary commodity; expertise is rooted in combustion, mechanical engineering, and low-cost production; and consumers are seen as preferring performance and comfort to fuel economy. The V2G strategy turns each of these tenets on their head: automobiles become valuable resources; *the energy they produce is a valuable commodity*; expertise is centered on electrochemistry and electronics; and customers are seen as valuing fuel economy and the additional revenue from V2G operations.[115]

Of course, energy has been a commodity since Thomas Edison's endeavors to send it to the offices of J.P. Morgan.[116] For the entirety of the twentieth century, though, electricity as a commodity is something that comes from somewhere most of us have never been—we cannot see it, smell it, or taste it; we do not want to feel it; and hearing it sounds like a hive of insects. In other words, an individual cannot control it, so he tells his children to be wary of it and otherwise does not give it much thought (until it is gone). Mr. Sovacool's point is that the emergence of V2G carries with it the idea that energy in the form of electricity will become a commodity that an individual can control, rather than one that has been tamed.[117] In essence, electricity will become a true form of individual property. Thus, if electricity is to become one of the "bundle of legally protected interests held together by competing and conflicting policy goals,"[118] accessible to an individual and transferrable, policy and law must develop as well.

115. Sovacool & Hirsh, *supra* note 5, at 1101 (citations omitted) (emphasis added).

116. SCHEWE, *supra* note 9, at 35–36.

117. Sovacool & Hirsh, *supra* note 5, at 1101.

118. James Boyle, *A Theory of Law and Information: Copyright, Spleens, Blackmail, and Insider Trading*, 80 CALIF. L. REV. 1413, 1512 (1992).

1. kWh Credits, CO_2 Credits, Rebates

Net metering and distributed generation legislation that allows for the bi-directional flow of electricity and the accumulation of electricity credits gives rise to a new commodity. Both Illinois' and Delaware's net metering statutes talk of "kilowatt-hour credits," "renewable energy credits," and "greenhouse gas credits," and explicitly state the retained ownership of the same by the customer.[119] Thus, this policy question appears to have an answer in Illinois and Delaware: Customers own their energy credits to alienate at their discretion.[120] (Note, however, that Illinois' statute expires accumulated credits at the end of the annualized billing cycle, whereas Delaware's statute provides a mechanism to retire credits and receive a rebate.)[121]

2. Ownership and Use of the GEV

One of the essential attributes of a piece of property is that an owner has the right to use the property in any manner that does not unreasonably interfere with another person's use or enjoyment of his or her property.[122] However, when contracting to use a GEV for ancillary services or even simply to recharge for reuse, a host of restrictions on use is likely. As discussed in sections I.B.1 and I.B.2 above, in order for the grid to handle the anticipated increased load of potentially millions of GEVs, and in order for consumption to coincide with the availability of wind energy, the vast majority of charging must occur during off-peak periods or overnight.[123] In fact, the theoretical design for most ancillary services contracts gives cost benefits to those who charge off-peak or at night and penalizes those who do not.[124] The problem is that studies of initial GEV owners have shown that most owners preferred to charge during the day (peak) and even to leave their cars plugged in all day.[125] Other studies reveal that GEV owners will require an abundance of education and training as to how to operate an electric vehicle to achieve maximum efficiency (e.g., how drive and use

119. DEL. CODE. ANN. tit. 26, § 1014(e)(1); 220 ILL. COMP. STAT 5/16-107.5(g) (note that the Illinois statute includes a provision allowing for an "arms-length agreement" between a credit owner and electricity provider that "sets forth the ownership or title of the credits").

120. The legal question is tougher (and not related to property per se): Is a GEV owner a "generator" for purposes of the net metering statute? *See infra* Part III.

121. DEL. CODE ANN. tit. 26 § 1014(e)(1); 220 ILL. COMP. STAT. 5/16-107.5(d)(2).

122. *Cf.* RESTATEMENT (SECOND) OF TORTS § 821D (1979) (defining private nuisance as "a non-trespassory invasion of another's interest in the private use and enjoyment of land.").

123. Sovacool & Hirsh, *supra* note 5, at 1100.

124. ELEC. ADVISORY COMM., *supra* note 21, at 19–20.

125. Sovacool & Hirsh, *supra* note 5, at 1100.

electricity conservatively and how to use the regenerative braking system).[126] How will generations of Americans, so used to driving aggressively and using their car at a moment's notice, handle such impositions on operation?

A related issue involves a GEV owner's contracted cessation of control over the use of the automobile if providing ancillary services. Some analyses of the issue suggest that the grid controller have the IP address of each contracted vehicle in order to remotely control the recharging of the GEV battery.[127] Mr. Kempton, however, proposes "predictive scheduling" of next-day vehicle use, or setting price or use thresholds that would allow an override of the controller.[128] In either case, some degree of control of the vehicle will be relinquished.

C. Cost

As with any endeavor wherein the expenses of getting started are immediate, yet the supposed benefits will not accrue until some indefinite future point in time, an attempt to transform the domestic transportation sector from a petroleum-based industry to one fueled by electricity will be slowed by the tremendous up-front capital costs.[129] The GEV battery is the primary driver of the vehicle's cost, and the V2G equipment capable of communicating with and charging that battery quickly and safely (in homes, public garages, and public charging stations) drives up the cost of infrastructure.[130] The key policy questions in this arena involve determining who should pay these upfront costs and how much. Should costs be borne by the early adopters who pushed for the technology, or distributed evenly among current and future beneficiaries (i.e., the polity enjoying cleaner air and energy, and future generations)? Should electricity generators be compensated for the stranded costs of equipment they are still paying for that could soon become obsolete? If so, how does one determine which costs are recoverable? What is the best device to catalyze demand and quickly generate the necessary investment capital—a feed-in tariff (as in Europe), a renewable portfolio standard, or tax credits? This section does not attempt to answer these questions; rather, it introduces the complexities and examines existing legislation and proposals that address them.

126. *Id.* at 1099.
127. Srivastava et al., *supra* note 1, at 83.
128. Lund & Kempton, *supra* note 3, at 3582.
129. Dinger et al., *supra* note 22, at 8–9 (estimating the total cost to be $20 billion).
130. Sovacool & Hirsh, *supra* note 5, at 1096.

To appreciate the scope of work to be done to upgrade the domestic infrastructure to serve a sizable market of GEVs, consider the following statistics related to parking: (1) for the approximately 250 million registered vehicles in the United States, there are around 50 million private garages;[131] and, (2) although estimates range from 105 million to 250 million, detailed, categorized information about non-residential off-street spaces (e.g., in garages and ground lots) *does not even exist*.[132] Not only is there a need for a significant amount of electrical infrastructure to be built and maintained over the long term, but a thorough, comprehensive inventory of what infrastructure (and potential resources) already exists must be taken before there is a headlong rush to build new infrastructure, given the likelihood that some (if not all) of what currently stands could be upgraded or modified.[133]

1. Funding the Transition: Taxes, Credits, and FIT Policies

One of the principal themes of this article is that V2G technology could provide the unifying spark that allows the smart grid, electric transportation, and renewable energy to take hold in this country. The electric vehicle is a *sine qua non* of V2G; without it there is no V2G and no revenue from ancillary services. But, although V2G is the nominal subject of this article, it is not the cost prohibitive component of a smart, electrified transportation sector. Rather, proponents and critics agree that fuel cost—the cost of gasoline in an ICE and of electricity and the battery to store it in a GEV—is the key variable to the future success of electric vehicles.[134] For example, a GEV battery—most likely one of five different lithium chemistries[135]—can add as much as $15,000 to the sticker price of an electric vehicle.[136]

In a July 2008 article published in *Electricity Journal*, Peter Fontaine argued that for electric vehicles to overcome initial high cost barriers (by encouraging investment in fast-charging infrastructure), the Internal Revenue Code Sections 30B and 30C needed to be amended to create tax credits for the vehicles themselves and for infrastructure investments.[137] The pas-

131. ELEC. ADVISORY COMM., *supra* note 21, at 18.

132. Estimates vary considerably. *See* Mikhail Chester et al., *Parking Infrastructure: Energy, Emissions, and Automobile Life-Cycle Environmental Accounting*, ENVTL. RES. LETTERS, 2 (July 29, 2010), http://iopscience.iop.org/1748-9326/5/3/034001/pdf/1748-9326_5_3_034001.pdf.

133. ELEC. ADVISORY COMM., *supra* note 21, at 20.

134. *Electric Cars*, *supra* note 72. Note that fuel storage is a nominal cost in an ICE, the price of a ten to twenty gallon aluminum tank.

135. Dinger et al., *supra* note 22, at 3 ex.2.

136. *Id.* at 6.

137. Fontaine, *supra* note 45, at 38.

sage of the Energy Improvement and Extension Act of 2008[138] codified Mr. Fontaine's recommendations by creating tax credits for electric drive vehicles and for "alternative fuel vehicle refueling property."[139] The American Recovery and Reinvestment Act of 2009[140] extended them.[141] Several states have also passed legislation to augment these tax credits.[142] Mr. Sovacool, however, argues that further incentives are necessary for greater market penetration.[143]

Earlier this article examined the distinction between a FIT policy and an RPS to stimulate renewable energy generation, and it concluded that a FIT policy is not incompatible with stimulating investment in smart grid infrastructure,[144] the idea being that a FIT policy's long-term guaranteed payment contracts, low administrative costs, and amenability to regulation match with the concerns of smart grid (and V2G) infrastructure private investors. Analysis of the Delaware net metering legislation suggests the state had this in mind: Section 1014(h) allows the state public service commission to "adopt tariffs for regulated electric utilities that are not inconsistent with subsection (g) (net metering for GEVs)," including rate and credit structures that do not conflict with the development of GEVs.[145] It is almost an axiom of the electrical industry that regulated utilities need some kind of assurance of a rate of return (or cost recovery) before they will invest in infrastructure (or new/offsetting generation). A FIT policy designed to stimulate smart grid infrastructure could provide those assurances.[146]

It is also important to consider how to replace the nearly $40 billion[147] in annual revenue derived from taxes on gasoline, which is used to fund state and federal highway infrastructure, to reduce the deficit, and to support federal clean-up of environmental damage (among other things).[148] As this revenue disappears with the increasing use of electricity as fuel, what will replace it? Perhaps the answer can be found in federalism. Because

138. Pub. L. No. 110-343, 122 Stat. 3807.

139. *Id.* §§ 205, 207, 122 Stat. at 3835–40 (to be codified at 26 U.S.C. §§ 24, 30B, 30C, 30D).

140. Pub. L. No. 111-5, 123 Stat. 115.

141. *See Plug-In Electric Vehicle Credit (IRC 30 and IRC 30D)*, INTERNAL REVENUE SERVICE, http://www.irs.gov/businesses/article/0,,id=214841,00.html (last updated Mar. 26, 2010).

142. *See State Incentives*, PLUG IN AMERICA, http://www.pluginamerica.org/incentives.shtm (last visited Oct. 13, 2010).

143. Sovacool & Hirsh, *supra* note 5, at 1099.

144. *See supra* Part II.B.3.

145. DEL. CODE ANN. tit. 26 § 1014(h).

146. ELEC. ADVISORY COMM., *supra* note 21, at 16.

147. *See State and Local Motor Fuel Tax Revenue, Selected Years 1997–2007*, TAX POLICY CENTER (Jan. 13, 2010), http://www.taxpolicycenter.org/taxfacts/displayafact.cfm?Docid=401.

148. Sovacool & Hirsh, *supra* note 5, at 1101.

grid upgrades and regular maintenance involve local and regional siting issues, a tax on the electricity returned to the grid from ancillary services would provide local income for local infrastructure reinvestment and maintenance, reduce federal taxes on all fuels, increase taxes on *locally* generated fuels of all types (ethanol, biodiesel, natural gas), and strictly administer local reinvestment of the revenue. In that way, increased development of locally generated energy could be encouraged (even with a tax) if marketed to consumers as only intended for the benefit of local residents.

2. Cost Recovery of Advanced Metering Infrastructure and Legacy Equipment

> [T]he overall transportation system cost can be reduced by providing rich charging infrastructure rather than compensating for lean infrastructure with additional battery size and range. Beyond the initial cost savings, the far shorter life of a battery versus charging infrastructure ensures that infrastructure will continue to accrue savings over its operating life.[149]

On the other end of the issue of the enormous capital needed to transition to a smart, electricity-based transportation sector is the question of how to pay for the deployment of advanced metering infrastructure (e.g., smart meters and wireless communication devices) and the stranded costs of electricity generation facilities and equipment that cannot be upgraded (legacy equipment). FERC noted in its *Proposed Policy Statement and Action Plan* [for the Smart Grid] that a "key consideration of public utilities in deciding whether to invest in Smart Grid technologies may involve the potential for stranded costs associated with legacy systems that are replaced by Smart Grid equipment."[150]

FERC has taken a leading policy position on cost recovery of the deployment of new electrical infrastructure. To that end, the Commission proposed a rate policy whereby it would "accept single-issue rate filings submitted under [Federal Power Act] section 205 by public utilities to recover costs of Smart Grid deployments."[151] The legal standard for this cost recovery is whether an item or facility is "used and useful in providing [electrical] service."[152] FERC then stated that smart grid equipment (including anything used in a pilot program or demonstration project, as most

149. NEMRY ET AL., *supra* note 60, at 31 (citing KEVINE MORROW ET AL., PLUG-IN HYBRID ELECTRIC VEHICLE CHARGING INFRASTRUCTURE REVIEW (2008), *available at* http://avt.inel.gov/pdf/phev/phevInfrastructureReport08.pdf).

150. Proposed Policy Statement and Action Plan, 74 Fed. Reg. at 13,153.

151. *Id.*

152. Nat'l Elec. Power Co. Mun. Rate Comm. v. Fed. Energy Regulatory Comm'n, 668 F.2d 1327, 1333 (D.C. Cir. 1981).

V2G systems will be initially) is *per se* "used and useful" if several criteria are satisfied: (1) the equipment will not adversely affect the reliability and security of the grid, (2) the equipment will be upgradeable, and (3) the utility will share diagnostic and operational information with the Department of Energy's Smart Grid Clearinghouse.[153]

Thus, if FERC's smart grid plan is any indicator, costs associated with V2G-capable infrastructure would seem to be recoverable by public utilities, which would facilitate development. Illinois' and Delaware's real-time pricing and net metering legislation also allow for cost recovery of AMI, albeit after an electrical utility has fronted the cost of the equipment and installation.[154] Each statute sets a kW threshold up to which the expense of a bi-directional flow meter belongs to a utility and above which the expense belongs to the customer.[155]

On the other hand, recovering the costs of legacy systems (the unidirectional electricity generation equipment of the twentieth century) could prove to be more difficult and might dampen enthusiasm for infrastructure investment. For example, security and reliability standards that would apply to smart grid electricity generation systems may not be easily modifiable to existing systems that are based on unidirectional power flow.[156] FERC's proposed smart grid policy plan for legacy equipment is slightly more onerous than for AMI, insofar as it requires a plan be developed for the staged deployment of upgradable smart grid equipment where technically feasible and cost-effective.[157] Should its proposal be effectuated, the Commission would be wise to define "technical feasibility" and "cost-effectiveness," or risk allowing the judicial branch to define those terms itself.

D. Community

A domestic fleet of hundreds of thousands or millions of GEVs can be considered a kind of subset of distributed generation (DG), insofar as a fleet of GEV batteries could provide electricity to be used very near (or at) the point of origin.[158] V2G is a more modular form of DG—a locality could be served by a couple thousand GEVs connected to the grid rather than by one or two DG facilities (e.g., small ICE generator, micro-turbine,

153. Proposed Policy Statement and Action Plan, 74 Fed. Reg. 13,152, 13,153 (Mar. 19, 2009).
154. DEL. CODE. ANN. tit. 26 § 1014(e)(4); 220 ILL. COMP. STAT. 5 /16-107(b-25).
155. DEL. CODE. ANN. tit. 26 § 1014(e)(4); 220 ILL. COMP. STAT. 5 /16-107(b-25).
156. ELEC. POWER RESEARCH INST., *supra* note 53, at 44.
157. Proposed Policy Statement and Action Plan, 74 Fed. Reg. at 13,160.
158. Lund & Kempton, *supra* note 3, at 3586.

or wind farm) in the same area.[159] Or, as discussed earlier, V2G could facilitate the growth of DG (particularly wind-generated electricity) by providing proximate energy consumption and storage.[160]

What would such a dispersed, micro-modular electrical system do to the conventional relationships between generators, wires companies, and consumers? What problems could arise if a municipality, or even a neighborhood, began to aggregate electricity stored in the batteries of GEV owners within its borders? Would such a scenario alleviate existing problems in the recently deregulated electricity industry (e.g., "seams issues") or exacerbate them?

1. Could Neighborhoods Become Micro-Generators?

The Illinois Power Agency Act[161] is a statute enacted to further the transition to retail competition in Illinois after deregulation "failed to benefit" residential and small commercial customers as hoped.[162] The Act allows for the aggregation of "residential and small commercial retail electrical loads located. . .within the municipality or unincorporated areas of [a] county. . .for the purpose [of soliciting bids and entering] into service agreements to facilitate for those loads the sale and purchase of electricity."[163] The purpose of the Act was to undo the "New Jersey-style auction" that existed (whereby bids were uniform) and create an agency to oversee the bidding process, by "encourag[ing] aggregation by. . .local government, both in the function of purchasing power [and] in terms of building power plants."[164] (The Act was supposed to encourage, for example, the construction of a hydroelectric plant on the Mississippi River to serve the citizens of Quincy, Illinois, and thereby use that electricity to leverage lower rates.)[165] In an electricity market accessible to V2G GEVs, the Act could allow a municipality or county to aggregate the GEVs connected to the grid within the municipality's boundaries and sell that power and the attendant services those batteries collectively provide.

If a unit of local government does not want to get into the power business, is it possible for a large group of well-organized individuals to become a kind of micro-utility, and thereby become a bidder in the auction

159. *See generally* Kempton & Tomic, *supra* note 18.

160. *See supra* Part II.B.2.

161. 20 ILL. COMP. STAT. 3855/1-1 (2010).

162. *Id.* § 1-5.

163. *Id.* § 1-92(a).

164. ILL. H.R., 95th Gen. Assemb., 101st Legis. Day, (July 26, 2007) (statement of Rep. George Scully, Jr.), *available at* http://www.ilga.gov/house/transcripts/htrans95/09500101.pdf.

165. *Id.*

supervised by the Illinois Power Agency? As the law is currently written, the answer is no, because while the definition of an alternative retail electric supplier is broad enough to include such a hypothetical entity,[166] membership in an ISO or RTO in Illinois is limited to "electric utilit[ies] owning or controlling transmission facilities or providing transmission services in Illinois."[167] Thus, alternative retail electric suppliers seem to be locked out at the ISO/RTO level.

But imagine if Illinois law (or any other state) did not proscribe a large group of individuals from forming a micro-generator that could participate in a deregulated market. Mr. Sovacool thinks such a scenario could considerably transform the existing electricity landscape:

> [I]f V2G transition achieves high levels of customer engagement, it may alter the conventional role that utilities play as primary sources of power, . . .[which] could shift investment away from the centralized plants and be seen as competitors to traditional forms of electricity supply, in turn motivating electric utilities to persuade network regulators to impose onerous requirements on interconnecting and operating V2G technology.[168]

2. RTO/ISO Seams Issues

Assuming *arguendo* that a micro-community could become a player in a deregulated state's electricity market, what might that do to the interaction between large generators and RTOs/ISOs, or amongst RTOs and ISOs? (The borders between areas controlled by these entities are called seams.)[169] Seth Blumsack, a postdoctoral research fellow in engineering and public policy, has argued that increasing distributed generation could

166. 220 ILL. COMP. STAT. 5/16-102 ("'*Alternative retail electric supplier*' means every person, cooperative, corporation, municipal corporation, company, association, joint stock company or association, firm, partnership, individual, or other entity, . . . that offers electric power or energy for sale, lease or in exchange for other value received to one or more retail customers, or that engages in the delivery or furnishing of electric power or energy to such retail customers, and shall include, . . . resellers, aggregators and power marketers, *but shall not include* (i) *electric utilities* . . . (ii) *any electric cooperative or municipal system* . . . (iii) a *public utility* that is owned and operated by any public institution of higher education of this State . . . (iv) a *retail customer* to the extent that customer *obtains its electric power and energy from that customer's own cogeneration or self-generation facilities,* (v) an entity that owns, operates, sells, or arranges for the installation of a customer's own cogeneration or self-generation facilities, . . . or (vi) an *industrial or manufacturing customer* that owns its own distribution facilities, to the extent that the customer provides service from that distribution system to a third-party contractor located on the customer's premises that is integrally and predominantly engaged in the customer's industrial or manufacturing process") (emphasis added).

167. *Id.* § 16-126(a), (b).

168. Sovacool & Hirsh, *supra* note 5, at 1101.

169. Blumsack, *supra* note 86, at 179–80.

exacerbate physical "loop flow" problems in the grid and market irregularities across regions.[170]

Loop flow creates congestion as a result of decentralized generation and the long distances of electron travel within the grid.[171] V2G could theoretically lessen this congestion problem by increasing the local consumption of electricity and leveling out demand locally by allowing grid controllers more flexibility to control smaller sections of the grid.[172] This, in turn, could alleviate the market uncertainties that occur as a result of congestion that occurs at the seams between RTOs, ISOs, or each other.

E. The Role of the Federal Government in a Possible V2G Transition

Passage of the American Recovery and Reinvestment Act of 2008 (the "stimulus package") and other subsequent large pieces of legislation (e.g., health care reform and financial industry reform) have led to a backlash against "big government" and the emergence of the Tea Party, a caucus within the Republican Party that espouses small government, no deficit spending, and less intrusion from the government.[173] On the other hand, the global oil market is arguably the very definition of market failure, which practically compels government intervention.[174]

1. Investment and Subsidies

In this atmosphere, with the national debt continuously rising[175] and the Congressional Budget Office's budget projections for short term Gross National Product (GNP) decreasing annually,[176] does government investment in a technology that could revolutionize several of the United States' largest industrial sectors make sense? The stimulus package appropriated billions for the "construction of new or upgraded electric power transmission lines and related facilities,"[177] and extended tax credits on GEVs and GEV infrastructure enacted by Energy Improvement and Extension Act of

170. A "loop flow" problem occurs when electricity is generated at a point, then sent out into the grid through innumerable networks of circuits over many miles, before ultimately being consumed at the point of generation, which increases congestion throughout the system. *Id.* at 180.

171. *Id.*

172. *Id.* at 181.

173. *See Non-negotiable Core Beliefs*, TEA PARTY, http://www.teaparty.org/about.php (last visited Oct. 13, 2010).

174. Minsk et al., *supra* note 15, at 355.

175. *See* U.S. DEBT CLOCK, http://www.usdebtclock.org/ (last visited Oct. 13, 2010).

176. Dean Baker, *Has the Congressional Budget Office Joined the Push for Cutting Social Security?*, MRZINE (July 31, 2010), http://mrzine.monthlyreview.org/2010/baker310710.html.

177. American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, § 402, 123 Stat. 115, 141 (to be codified at 42 U.S.C. § 16422a).

2008.[178] Should a government with an historic debt be allocating huge sums for infrastructure? Should the government "choose winners and losers"? Critics say no.[179] Others worry that smart grid and V2G technology might not happen *without* government investment.[180]

Several critics also question why the government is "picking winners and losers" by offering large federal subsidies (in addition to several state subsidies).[181] Proponents respond to that critique on several fronts, noting that the government has invested in "new" and "untested" technologies throughout this country's history (e.g., the telegraph, the railroad, and air travel)[182] and that not long ago, under the control of a different administration, a tax credit of up to $100,000 existed for the purchase of a Hummer SUV.[183]

2. Education and Training, Warranty Corporations

We take new technology for granted quickly in the United States. From the speed in which electricity became an inseparable piece of daily life, to the prevalence of cell phones, Americans take up techno-gadgets rapidly once we feel that they work reliably. What we tend to forget, however, is how much government involvement preceded these times of technological proliferation. As Mr. Sovacool notes, "[b]efore Americans accepted new energy technologies in the past, policymakers and business people first needed to erect significant amounts of infrastructure . . . . As important, the electric utility infrastructure expanded because of supportive legislation."[184] As to GEVs, Mr. Fontaine agrees, noting that "decisive action by the federal government to create a market demand for [GEVs] will enable America to seize [an] opportunity. By nurturing a domestic [GEV] industry, the U.S. can accelerate the deployment of the crucial technology across the globe and restore American automobile technology to a position of leadership."[185]

178. *Id.* §§ 1141–44, 123 Stat. at 326–333 (to be codified at 26 U.S.C. §§ 24, 30, 30B, 30D).

179. Charles Lane, *Unaffordable at Any Speed*, SLATE (July 30, 2010, 9:51 AM), http://www.slate.com/id/2262229/; *see also Electric Cars*, *supra* note 72.

180. Dinger et al., *supra* note 22, at 12.

181. Lane, *supra* note 179; *see also Electric Cars*, *supra* note 72. For a breakdown of federal tax credits for PHEVs, see *Plug-In Electric Vehicle Credit (IRC 30 and IRC 30D)*, *supra* note 140. For state PHEV tax credits, see *State Incentives*, *supra* note 142.

182. Daniel Gross, *A Chevy Volt in Every Pot*, SLATE (Aug. 2, 2010, 2:11 PM), http://www.slate.com/id/2262530/; *see also Electric Cars*, *supra* note 72.

183. *Electric Cars*, *supra* note 72.

184. Sovacool & Hirsh, *supra* note 5, at 1100.

185. Fontaine, *supra* note 45, at 25–26.

If the transition does occur, a significant amount of reeducation and skills training will be necessary to update automobile mechanics, first responders, and EMTs, as well as inspectors and electricians as to the hardware, software, chemistries, and materials that comprise electric vehicles, batteries, smart grid equipment, and higher voltage transmission and distribution lines.[186] Such training and education will mainly take place within the many taxpayer-funded public colleges and universities across the country.

David Sandalow, Assistant Secretary of Energy in the Obama administration, thinks this level of government involvement is necessary and perhaps even insufficient.[187] In his book *Freedom From Oil,* Mr. Sandalow proposes a federal battery guarantee corporation[188] (akin to the Federal Deposit Insurance Corporation) to aid and encourage the purchase of GEVs by spreading the risk of battery failure between manufacturers, the private insurance sector, and the federal government.[189] Mr. Fontaine agrees: "Warranties are a principal means to overcome information imbalance . . . between an informed manufacturer and an uninformed consumer. . . . A federal battery guarantee corporation . . . would help OEMs provide 10-year/150,000 mile battery warranties for the first million [G]EVs."[190]

3. Federalism: What Role for FERC? What Role for the States?

FERC's *raison d'etre* is to ensure fair operation of energy markets by overseeing the making of rates, and to investigate claims of fraud, deceit, or misrepresentation therein.[191] FERC holds primary jurisdiction over "transmission lines which are. . .primary lines transmitting power from the power house or appurtenant works of a project to the point of junction with the distribution system or with the interconnected primary transmission system."[192] The most contentious legal issue related to FERC's jurisdiction has generally been what constitutes transmission lines (FERC possesses jurisdiction) versus what is local distribution (states have jurisdiction). In its Order 888, the Commission established a seven factor test to distinguish between transmission and distribution:

186. Brown et al., *supra* note 61, at 3805.

187. *Electric Cars*, *supra* note 72.

188. DAVID SANDALOW, FREEDOM FROM OIL: HOW THE NEXT PRESIDENT CAN END THE UNITED STATES' OIL ADDICTION 71–72 (2008).

189. Fontaine, *supra* note 45, at 33.

190. *Id.* at 37.

191. 18 C.F.R. § 1c.1–2 (2009).

192. 18 C.F.R. § 2.2.

> (1) Local distribution facilities are normally in close proximity to retail customers.
> (2) Local distribution facilities are primarily radial in character.
> (3) Power flows into local distribution systems; it rarely, if ever, flows out.
> (4) When power enters a local distribution system, it is not reconsigned or transported on to some other market.
> (5) Power entering a local distribution system is consumed in a comparatively restricted geographical area.
> (6) Meters are based at the transmission/local distribution interface to measure flows into the local distribution system.
> (7) Local distribution systems will be of reduced voltage.[193]

The seven factor test works fairly well in an electrical system that flows in one direction because the power is meant to decrease towards an end point. For an electrical grid with smart meters and GEVs, wherein power flows in both directions and voltage decreases to a lesser degree,[194] the seven factor test would not seem to work as well. In fact, it is arguable that four of the seven factors are irrelevant in a smart grid system: power will definitely flow out from a distribution system (factor three); power could be transported to another market for sale or consumption that is not geographically proximate (factors four and five); and local distribution systems may not be of a lesser voltage than local transmission (factor seven).[195] The issue is further muddled by the fact that FERC asserts jurisdiction over unbundled retail transmission but not over bundled retail transmission in order to better regulate the *wholesale* power market, a policy decision the Supreme Court affirmed in *New York v. Federal Energy Regulatory Commission*.[196]

The question for purposes of this article, then, is whether (and how) a smart grid with high incidences of GEVs dispersed throughout the country, most of which are contracting to provide ancillary services and send power back onto the grid, will affect FERC's assertion of jurisdiction. If the Supreme Court's affirmation of the Florida Power Commission's determination that electricity moves so fast as to be in interstate commerce *per se*[197] is to withstand the transition to a smart grid with V2G, FERC could theoretically assert some jurisdiction over when an individual fuels his or her vehicle. As noted earlier, a policy that allows the government to restrict the

193. Promoting Wholesale Competition Through Open Access Non-Discriminatory Transmission Services by Public Utilities; Recovery of Stranded Costs by Public Utilities and Transmitting Utilities, 61 Fed. Reg. 21,540, 21,620 (May 10, 1996) (to be codified at 18 C.F.R. pts. 35, 37, 385).

194. NEMRY ET AL., *supra* note 60, at 29–31.

195. *Id.*

196. 535 U.S. 1, 26 (2002).

197. Fed. Power Comm'n v. Fla. Power and Light Co., 404 U.S. 453, 469 (1972).

single object that is most closely tied to American individuality and independence, the automobile, is a policy sure to meet resistance.[198]

FERC's proposed policy statement on the smart grid acknowledges this tension, noting that:

> [s]pecifications for customer meters [remain] within the jurisdiction of the States, but it is clear that communication and coordination across the interfaces between the utility and its customers can have a significant impact on the bulk power system, particularly as new renewable power and climate policy initiatives introduce the need for more flexibility in the electricity grid, which creates the need for increased reliance on demand response and electricity storage.[199]

What is also clear from this excerpt is the missing language whereby FERC assures the separate states of their continued jurisdiction over local distribution. FERC also recently issued Order Number 719, which mandates fair dealing between traditional supply-side resources (e.g., large power plants) and demand response resources (e.g., GEVs providing ancillary services).[200] Thus, it appears that FERC feels the winds of change and is setting its sails accordingly.

States will not be completely shut out of the electricity regulation game after the GEV transition, however, because of the proximity (both physical and professional) that state regulators have to local concerns related to siting and construction of power infrastructure.[201] Nevertheless, FERC appears to be on the move toward acquiring broader jurisdiction over the entirety of the electrical grid.

F. Global Standards for a Global Marketplace: Cooperation and Anticipation

The automobile was an inextricable part of the history of the United States in the twentieth century and figures to remain such in the twenty-first. But the United States is not the only country that can lay claim to having the automobile play a pivotal role in its current identity and past and future development (e.g., Germany, Japan, China). Industry analysts suggest that the automobile markets in most of the developed world are saturated but that a tremendous potential for growth exists in emerging

198. *See supra* Part III.B.2.

199. Proposed Policy Statement and Action Plan, 74 Fed. Reg. 13,152, 13,158 (Mar. 19, 2009).

200. Wholesale Competition in Regions with Organized Electric Markets, 73 Fed. Reg. 64,100, 64,100 (Oct. 28, 2008); *see also Report of the Renewable Energy and Demand-Side Management Committee*, 30 ENERGY L.J. 273, 296–97 (2009).

201. Cassandra Burke Robertson, *Bringing the Camel into the Tent: State and Federal Power over Electricity Transmission*, 49 CLEV. ST. L. REV. 71, 92 (2001).

economies like those in China, India, and South Africa.[202] However, in order for a worldwide transition to electric vehicles to occur without fragmenting the global market altogether, the international community must concomitantly develop the technology, the manufacturing processes, and the international standards for safety, production, and operation. Such standrds are arguably most important because they ensure compatibility between jurisdictions, which is essential for the proper functioning of existing international automobile and parts markets, and the development of compatible GEV infrastructure.[203]

Scholars and policymakers alike agree that the impact of GEVs on the environment, in regards to public health and safety and to the overall global economy, will depend greatly on the cooperative development of new standards for the manufacture, sale, repair, reuse, and disposal of GEVs, GEV batteries, and the consequent infrastructure to support them.[204] There also appears to be agreement in the literature that some existing electrical standards could be updated to provide a "framework" for a GEV smart grid.[205] Existing frameworks of standards for building codes could also be updated to accommodate an electrified transportation sector, rather than recreated anew.[206] Such updates will have to occur regularly to keep pace with technological improvement.[207]

FERC's policy statement on the development of smart grid standards articulates a few important considerations. First, FERC recognizes that while a transition to a large GEV fleet will not occur overnight, there is a sense of urgency among all stakeholders to develop "at least the minimum communications and interoperability requirements" for GEV charging, in order to support wider acceptance of new technologies and to help increase economies of scale, thereby reducing costs.[208] Second, the Agency argues that "consistency with cyber security and reliability standards" should be a "precondition to. . .adoption of Smart Grid standards."[209]

202. Chithra Gopal, *Global Automobile Industry: Changing with the Times*, OUTSOURCE2INDIA, http://www.outsource2india.com/kpo/site/includes/Global_Automobile_Industry11.pdf (last visited Oct. 12, 2010).

203. Brown et al., *supra* note 61, at 3801–02.

204. *Id.* at 3798; *see also* Proposed Policy Statement and Action Plan, 74 Fed. Reg. at 13,154.

205. Proposed Policy Statement and Action Plan, 74 Fed. Reg. at 13,156; *see also* Brown et al., *supra* note 61, at 3798.

206. Brown et al., *supra* note 61, at 3805.

207. *Id.*

208. Proposed Policy Statement and Action Plan, 74 Fed. Reg. at 13,158 (FERC is particularly concerned about "separate groups of interested industry members independently develop[ing] and advocat[ing] select standards or protocols"); *see also* Brown et al., *supra* note 61, at 3803.

209. Proposed Policy Statement and Action Plan, 74 Fed. Reg. at 13,158.

Again, scholars agree on both counts. As to cyber security, Richard Clarke notes the following in his book *Cyber War*:

> [FERC] finally required electric companies to adopt some specific cyber security measures . . . . The companies have until [this year] to comply. Then the Commission [will] begin to inspect some facilities to determine if they are compliant. Unfortunately, President Obama's "Smart Grid" initiative will cause the electric grid to become [less safe].[210]

Safety and environmental standards also belong on FERC's precondition list: "[E]nergy storage systems associated with GEVs will need to have new regulation and standards to assure that interconnection and transfer is done in a manner that is both safe and environmentally sustainable."[211]

G. The Future: Legislation and Speculation

Candidate Barack Obama pledged to create a $7,000 tax credit for the purchase of "advanced vehicles" and to "get 1 million plug-in hybrid cars on the road by 2015."[212] President Obama was not able to claim the tax credit—the Energy Improvement and Extension Act of 2008 incorporated the credit just before the general presidential election[213]—but he did extend the credit by two years in the American Recovery and Reinvestment Act of 2009.[214] Furthermore, according to Mr. Sandalow, Secretary of Energy Steven Chu is "very enthusiastic" about GEVs and has personally directed funding to support research and development of batteries, components, infrastructure, and facilities for manufacture.[215] Clearly the federal government regards GEVs as a viable future industry. To that end, the following sections discuss prospective legislation regarding GEVs and V2G technology and engage in conjecture as to what a future with a high market penetration of GEVs would hold.

1. SB. 3442: Electric Vehicle Deployment Act of 2010

Perhaps the best place to start a discussion about the future possibilities of GEVs in the United States is with a bill introduced by the Senate "to promote the deployment of electric drive vehicles," popularly known as the

210. CLARKE & KNAKE, *supra* note 71.

211. Brown et al., *supra* note 61, at 3805.

212. Barack Obama & Joe Biden, *New Energy for America*, ORGANIZING FOR AM., http://my.barackobama.com/page/content/newenergy_more (last visited Oct. 11, 2010).

213. Emergency Economic Stabilization Act of 2008, Pub. L. No. 110-343, § 205, 122 Stat. 3807, 3835–36 (to be codified at 26 U.S.C. § 30D).

214. American Recovery and Reinvestment Act of 2009, Pub. L. No. 111-5, § 1142, 123 Stat. 115, 326–28 (to be codified at 26 U.S.C. § 30D).

215. *Electric Cars*, *supra* note 72.

Electric Vehicle Deployment Act of 2010,[216] introduced by Senator Byron Dorgan (D-ND) introduced on May 27, 2010. The bill was immediately referred to the Senate Committee on Finance.[217] Highlights of the bill's findings include averments of energy independence and national security, reductions in carbon emissions, and a stated goal of one hundred million plug-in electric drive vehicles deployed by 2030.[218]

The bill addresses nearly all of the substantive issues raised heretofore in this article. The bill establishes a Targeted Electric Drive Vehicle Deployment Communities Program to achieve "significant market penetration" nationally and in the targeted communities,[219] and calls for the "rapid. . .deployment of residential and publicly available charging infrastructure."[220] The bill mandates selection of the targeted communities no later than one year after enactment, which will begin the first phase of deployment, lasting five years.[221] The Targeted Communities Program (TCP) envisions deployment of GEVs and construction of infrastructure concomitant to the development of standards, as it requires "assurances that. . .equipment to be deployed will meet open, non-proprietary standards for [GEVs]. . .that are either—(I) commonly accepted by industry at the time. . .or (II) meet the standards developed by the Director of the National Institute of Standards and Technology."[222] TCP requires applicant communities to submit a plan for making and recovering the cost of "necessary utility and grid upgrades, including . . . information technology upgrades";[223] to submit a description of electric service provider policies, rate-structures, and billing protocols for residential and public charging;[224] and, to submit plans for "anticipating vehicle-to-grid applications that will allow batteries in cars as well as banks of batteries to be used for grid storage, ancillary services provision, and backup power."[225]

Applicant communities can request up to $250 million in grants to fund the implementation of their plans under the TCP.[226] Grant funding is

216. Electric Vehicle Deployment Act of 2010, S. 3442, 111th Cong. (2010) (co-sponsored by Senator Lamar Alexander (R-TN) and Senator Jeff Merkley (D-OR)).

217. *See S. 3442: Electric Vehicle Deployment Act of 2010*, GOVTRACK.US, http://www.govtrack.us/congress/bill.xpd?bill=s111-3442.

218. S. 3442 § 2(7), (8), (9), (11).

219. *Id.* § 5(b)(1)(B), (C).

220. *Id.* § 5(b)(2).

221. *Id.* § 5(a)(1)(C), (D).

222. *Id.* § 5(c)(4)(D)(vi)(I), (II).

223. *Id.* § 5(c)(4)(K).

224. *Id.* § 5(c)(4)(L)(i)(I)(aa).

225. *Id.* § 5(c)(4)(L)(v).

226. *Id.* § 5(d)(2)(A), (B).

subject to a minimum 20% cost-sharing requirement, at the discretion of the Secretary of Energy.[227] The federal funds do not, however, "prohibit the purchaser of a vehicle, equipment, or other property, from retaining sole, permanent title [to the same]."[228] The bill also amends Section 30D of the Internal Revenue Code by adding an extra $2,500 credit (on top of the existing $2,500 credit) for purchasers in accepted communities, and by adding $100,000 to the manufacturer credit.[229]

Finally, the bill also contemplates the electricity industry transformation by amending PURPA[230] to require electric utilities to "develop a plan to support the use of plug-in electric drive vehicles" by investigating potential market penetration in the utility's service area, potential impacts on distribution infrastructure and interstate transmission, and "the role of third parties in providing reliable and economical charging services."[231] The proposed PURPA amendment also requires state regulatory authorities to cooperate with municipal and cooperative utilities in investigation and deployment plans.[232] In total, the bill addresses nearly every issue related to GEVs and V2G;—the only imperfection lies in the amendatory language that allows a utility to apply for a waiver of the aforementioned investigations if it determines that there will be "no meaningful [GEV] penetration" in its service area.[233] Also, the amendments do not mandate that utilities offer time-of-use pricing or ancillary services.[234]

2. PHEV Profiteering

As with any new entrant into the marketplace, entrepreneurs and opportunists alike will surely attempt to game the system to make a profit on GEVs with V2G. Several analysts have already imagined one way that GEV owners might do just that. Very simply, a GEV owner could charge the automobile's battery off-peak, when prices are low, and then resell that energy on the market when prices are high (peak), or even resell to another GEV owner off-market (vehicle-to-vehicle, or V2V).[235] Both scenarios are difficult (if not impossible) currently; few states have completely unbundled retail electricity to the extent that a GEV owner could sell directly

227. *Id.* § 5(d)(2)(C)(i), (iii).
228. *Id.* § 5(d)(2)(C)(vi).
229. *Id.* § 6(a)(2).
230. 16 U.S.C. § 2601 (1978).
231. S. 3442 § 8.
232. *Id.*
233. *Id.*
234. *Id.*
235. ELEC. ADVISORY COMM., *supra* note 21, at 16.

back to the larger market, and V2V is easily imaginable but not yet a feature on GEVs.[236]

3. Smart Phones on Wheels?

Smart phones have quickly taken over the cell phone market, for obvious reasons—a person could conceivably dispense with a desktop or laptop computer altogether given the amount of connectivity they provide. Does it take much creativity to imagine the possibilities of a GEV computer with the processing speed and storage space to execute an individual's every digital command, or to consolidate all the possible functions of a smart grid connected residence?[237] Or, an individual GEV could eventually become a mobile electricity generator, providing backup for homes, other GEVs, and small commercial establishments.[238]

4. Will the Department of Motor Vehicles be the New "Geek Squad™"?

The Geek Squad™, a registered trademark of Best Buy,[239] is an electronics (hardware and software) service provider that has become a sort of short hand for high tech assistance. If V2G is the catalyst that many industry watchers believe it could be, how long will the government wait before it develops its own version of the Geek Squad™, complete with repair, maintenance, registration, and renewal options?

CONCLUSION

The Obama administration's stated goal to put one million grid-enabled vehicles (GEVs) on American roads by 2015 aligns with several policy statements and decisions that have occurred during the first two years of the President's term, including the inclusion of massive spending on electrical infrastructure improvements in the stimulus bill and the FERC smart grid policy proposal. Further, a bill to initiate an extensive GEV pilot program in as many as fifteen U.S. cities in order to study the economic, logistic, and sociologic effects of a transition to an electricity-fueled transportation sector has been introduced on the Senate floor and directed to the Senate Finance Committee. The United States Government is focused on, and invested in, a heavy penetration of GEVs sooner rather than later.

236. ELEC. POWER RESEARCH INST., *supra* note 53, at 64–65.

237. Sovacool & Hirsh, *supra* note 5, at 1096.

238. ELEC. ADVISORY COMM., *supra* note 21, at 21.

239. *See Legal Notice: Owner and Operator of the Geek Squad Web Site*, GEEK SQUAD, http://www.geeksquad.com/faq.aspx?id=813.

One of the principal characteristics of an electrified transportation sector that is likely very appealing to the federal government is the assortment of services that a large fleet of GEVs could provide to the electrical grid as a result of vehicle-to-grid (V2G) electricity transfer technology. V2G allows a GEV battery to transfer power from the vehicle back to the grid, or to take power off of the grid, under the control of an external device or grid operator, which in turn enables the grid operator to perform ancillary grid services without using large power plants.

Proponents of V2G point to this function as the crucial attribute of a large domestic fleet of GEVs that will facilitate the transition to an electrical transportation sector, a more reliable electricity grid, a smarter and more efficient consumer base, and a cleaner and less dependent U.S. economy. Critics challenge that V2G is unproven and unsafe, and will not provide the economic benefits that proponents claim; that adding orders of magnitude new gadgets to the electrical grid creates new entry points for cyber terrorists; that consumers will be unwilling to sacrifice personal autonomy vis-à-vis their automobile; that GEVs could actually increase fossil fuel consumption and its attendant consequences; and that the federal government should neither be picking a technology winner nor investing so actively in the same.

A large GEV fleet also raises several imminent policy questions and legal issues. Questions regarding how to contract for ancillary services and what property rights a GEV owner will have in the vehicle battery and the electricity it stores are primary issues that must be addressed before any realistic attempt to establish a market for ancillary services could occur. Existing electrical infrastructure will also have to be upgraded in many cases to accommodate greater electricity demand from different places and at different hours of the day than has been the custom over the past 100-plus years of electricity transmission and distribution. Who will pay for these upgrades and improvements and, more fundamentally, what effect will an infusion of distributed storage (and generation) have on the deregulated, increasingly fragmented electricity industry?

These questions do not stop at the U.S. border. Several of the largest developed countries—and a few of the most important developing ones—are investing just as heavily (if not more so) in electric drive vehicles. In order to facilitate a smooth transition in the global automotive marketplace, international standards for manufacturing, safety, and disposal must develop along with, and in advance of, V2G technology and GEV market penetration.

V2G has the potential to transform the economy, the electrical grid, domestic energy use, the Internet, and the daily lives of every citizen of the world. The stage is set for the beginning of a transition to an electrified transportation sector. State capital investment has been appropriated in order to encourage the private sector and consumer base to prepare for and eventually accept the transition. A host of legal and policy issues remain to be considered, however, before any rollout could begin.