Home Energy Efficiency Retrofits and PV Provide Fuel for Our Cars

by James M. Fenton

While retrofitting buildings and homes to make them more energy efficient[1] has always been cost-effective, it is now even more so, given that even utility solar[2] and rooftop solar power[3] is cheaper than electricity made from fossil fuels! So, while we may never see $1 per gallon gasoline again in the U.S., there is a clear route to prosperity represented by driving cars powered by electricity (saved by retrofitting our homes or made locally from utility solar "out of the wall" or by rooftop solar) at an equivalent cost of a dollar per gallon while keeping all the money and jobs at home.

President Obama issued the EV Everywhere Grand Challenge[4] to the nation on March 2012 to produce plug-in electric vehicles that are as affordable for the average American family as today's gasoline-powered vehicles by 2022. In June of 2012, David Danielson, the U.S. DOE Assistant Secretary, referred to the Challenge as a "Big Hairy Audacious Goal."[5] Today the current cost of the battery is $325/kWh (see Fig. 1), while the 2022 battery technology cost target is at $125/kWh.[6] As technology advances, and battery and drivetrain costs continue to drop, plug-in electric vehicle (PEV) sales are expected to keep increasing each year, replacing demand for petroleum with demand for electricity.

This additional demand for electricity can be met by widespread deployment of renewables, such as photovoltaic (PV) solar power. The U.S. DOE SunShot Initiative[7] aims to reduce the total installed cost of residential roof-top solar and utility-scale solar energy systems to an unsubsidized $0.09/kWh and $0.06/kWh, respectively by 2020[8] (with the federal income tax credit today the residential and utility prices are $0.12/kWh and $0.056/kWh, respectively). In June of 2012, Dr. Danielson referred to the SunShot Initiative also as a "Big Hairy Audacious Goal."[5]

Figure 2 shows the U.S. average residential electricity costs from 1990 to 2014 as black dots, with the orange and red curves showing possible bounds for the future price of residential electricity out of the wall up to the year 2025. The dark green curve shows an average residential rooftop PV levelized cost of energy (LCOE) for the U.S. with the 30% ITC and the light green curve shows the unsubsidized LCOE.

While today, energy efficiency retrofits and residential PV systems can power PEVs at the equivalent of $0.42 and $1 per gallon, respectively, there are upfront costs to retrofits and residential PV (in the tens of thousands of dollars). It is interesting that only when we talk about energy efficiency retrofits or more energy efficient electric cars, do we talk about payback and economics when we spend more money upfront. We ask what the payback is on more attic insulation or a more energy efficient air conditioner, but we don't ask what the payback is on the granite counter-top or the big screen TV. In choosing the different options of a particular car, we do not ask what the payback is on leather seats, fancy rims, a bigger engine, or a better sound system. What is the payback of say a Mercedes S550 over a Toyota Corolla? We do not ask these questions when we consider entertainment, luxury, or go on vacations. We do pay money for experiences (hopefully good, or better yet, great experiences) and not ask about payback. This experience is then why people want to put PV on their roof before they carry out cost-effective energy efficiency retrofits. PV is "sexy" while increased insulation is boring. The Tesla Model S in 2013 had sales of ~17,650, which puts Tesla's electric sedan well ahead of its large luxury sedan competitors: Mercedes-Benz S-Class (13,303), BMW 7 Series: (10,932), Lexus LS (10,727), Audi A8 (6,300), or Porsche Panamera (5,421). People who bought the Tesla Model S instead of the other luxury cars did

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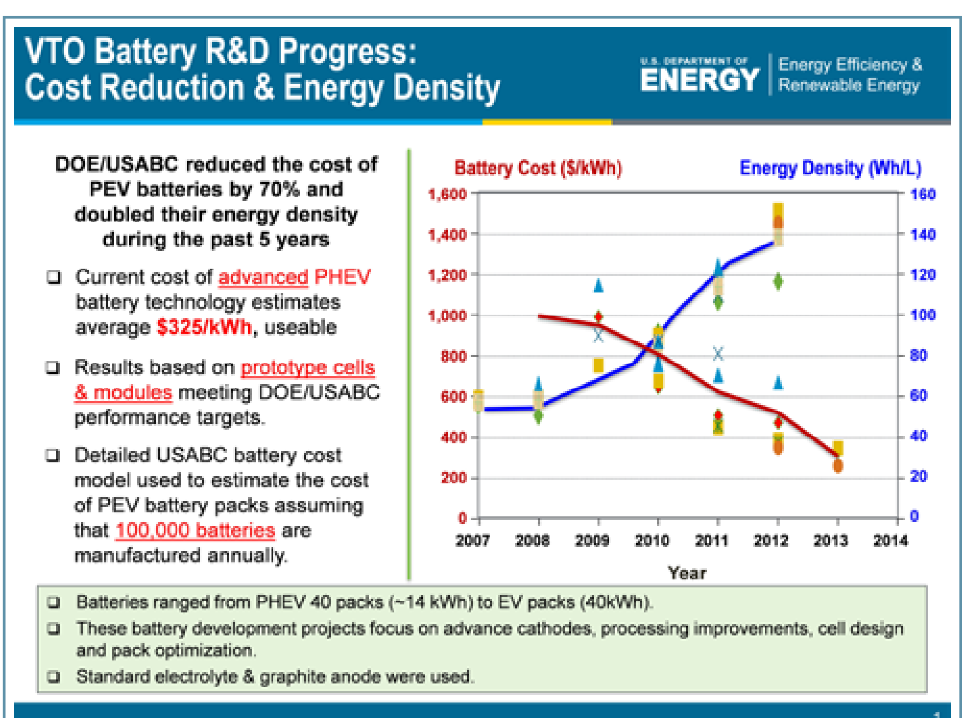

Fig. 1. *Cost reduction of PEV batteries.*

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so for the premium experience. EVs are smoother, quieter and have more torque. So they drive better! The same is true for the retrofitted house with PV on the roof. It is quieter, operates better, provides a healthier environment, and is worth more. That said, it still would be nice to own a net-zero-energy home, own the PV fueling station, have luxurious vehicles, and still pay less than what we paid for our base house and gasoline vehicles.

The upfront costs of plug-in electric vehicles such as the Nissan Leaf and Chevrolet Volt are higher than comparable gasoline fueled cars (Versa and Sentra for the Leaf; and Cruze, Malibu, and Impala for the Volt) even with the $7,500 federal income tax credit (see Table I). On the other hand, the monthly costs of fuel [$0.1188 per kWh and $3.60 ($3.00) per gallon of gasoline] and 2014-advertised 36-month leases have the Nissan Leaf cheaper per month than the Versa (same cost) and Sentra; and the Chevrolet Volt is cheaper per month than the Malibu (same cost) and Impala, but $50 ($65) per month more than the Cruze. Based on 5-year financing at 0% interest, the monthly cost (fuel + financing) for the Nissan Leaf and Sentra are equivalent (at $3.00 per gallon the Sentra is $25 less per month). The Leaf is $70 ($91) more per month than the Versa; and the Chevrolet Volt is cheaper per month (fuel + financing) than the Malibu and Impala, but $40 ($60) per month more than the Cruze.

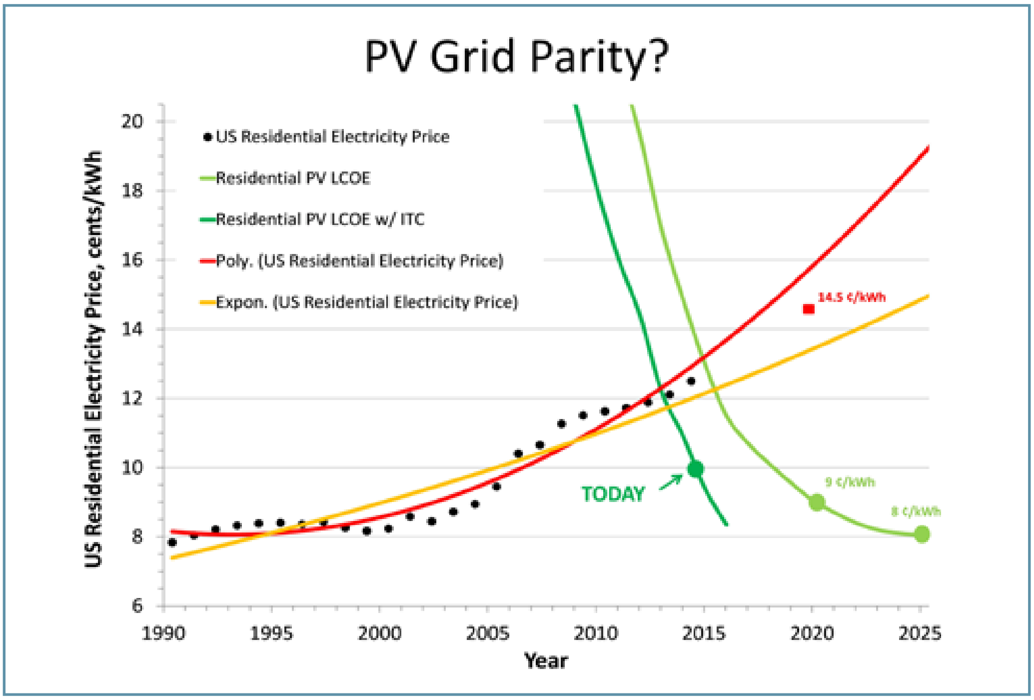

Fig. 2. *U.S. residential electricity cost and residential rooftop PV LCOE cost.*

Table I. Cost of plug-in vehicles compared to gasoline vehicles at $3.60/gal gasoline.

2014 Vehicles	Initial Lease Payment	Monthly Lease Payment (36 months)	Purchase Price	Monthly Payment 5 years 0% interest	Electricity (kWh) 11926 miles 5301 city 6625 hgwy	Gasoline (gallons) 11926 miles 5301 city 6625 hgwy	Cost per mile	Total Cost of fuel per year	Total Monthly Cost (Lease)	Total Monthly Cost (Purchase)
Nissan Leaf S	$1,999	$199	$28,890	$357	3618	0	$0.036	$430	$290	$392
Nissan Versa	$1,999	$149	$12,990	$217		337	$0.102	$1,213	$306	$318
Nissan Sentra	$2,399	$149	$17,190	$287		347	$0.105	$1,249	$320	$391
Chevrolet Volt	$2,679	$269	$34,185	$445	3099	72	$0.053	$627	$396	$497
Chevrolet Volt	$2,679	$269	$34,185	$445	4096	0	$0.041	$487	$384	$485
Chevrolet Cruze	$2,359	$159	$19,910	$332		378	$0.114	$1,361	$338	$445
Chevrolet Malibu	$2,569	$189	$22,140	$369		473	$0.143	$1,703	$402	$511
Chevrolet Impala	$2,779	$269	$26,725	$445		466	$0.141	$1,678	$486	$585

By 2022, when the initial cost of the PEV is approximately equal to—or even less than—a gasoline vehicle, inexpensive utility PV-generated electricity can power EVs at less than $0.50 per gallon. Given the expected expansion of both PEV and PV markets over the coming decades, a cost-effective and reliable systems integration of PV, EVs (and their fueling infrastructure), and buildings is needed that offers advantages to homeowners, drivers of PEVs, workplaces, and utilities. As fuel cell vehicles, EVs with fuel cell range extenders, and wireless charging become more prevalent, these technologies must be coordinated with PV installations and the proliferation of battery and/or fuel cell EVs, so as to bring benefits to consumers, employers, and utilities.

In 2012, the U.S. consumed 3,695 TWh of electricity (37% residential, 36% commercial and 27% industrial). There were 127 million residential electricity customers, who consumed on average 903 kWh per month of electricity at 11.88 cents/kWh for an average monthly bill of $107.28.[9] This means U.S. residential customers spend $163.5 B per year for electricity or $0.45 B per day (see Table II). Energy efficiency retrofits can cut the energy use of U.S.

Table II. 127 M U.S. residential electricity customers (paying $0.1188 per kWh in 2012).

	Use (Savings) per year	Bill (Savings) per year	U.S. Use (Savings) per year	U.S. Bill (Savings) $ B per year	U.S. Electric Bill (Savings) $ B per year
Residential Energy (Elec. + Thermal)	Elec.: 10,836 kWh/yr	Elec. ($1,287)+ Thermal ($713) = $2000	Elec: 1,376 TWh/yr	$254	$163.5
Cost Effective Residential Energy Savings	Elec.: 2167 kWh/yr	Elec. ($257)+ Thermal ($143) = $400	Elec: 275 TWh/yr	$51	$33

Table III. U.S. 232 M cars and light trucks (gasoline: $3.60/gal or $3.00/gal; $0.1188 /kWh; 12,000 miles/yr).

	Fuel Efficiency	Vehicle Use per year	U.S. Vehicle Use per year	Bill per year $3.60/gal ($3.00/gal)	U.S. Bill $ B/yr $3.60/gal ($3.00/gal)
Cars (111 M)	24.9 mpg	482 gal/yr	53.6 B gal/yr	$1,735 ($1,446)	$193 B/yr ($161 B/yr)
Light Trucks (121 M)	18.5 mpg	649 gal/yr	78.4 B gal/yr	$2,335 ($1,947)	$282 B/yr ($235 B/yr)
Small Cars (61 M)	30 mpg	400 gal/yr	24.4 B gal/yr	$1,440 ($1,200)	$88 B/yr ($73 B/yr)
EV Cars (61 M)	3 miles/ kWh	4,000 kWh/yr	244 TWh/yr	$475	$29 B/yr

residences by more than 20%,[10] saving 275 TWh per year (7.4% of U.S. electricity) or $33 billion annually on electric bills, reduce greenhouse gas emissions, and create jobs. While there are additional upfront costs to improve an older home or building, or build a new home or office to be highly efficient, these costs are recouped through lower energy bills. On average, families spend about $2,000 per year on energy for their homes—each family could cost-effectively save about $400 each year with energy-saving upgrades. This savings for all the residential customers is then $51 B per year.

In the U.S. there are 111.3 million cars and 120.8 million light trucks (232.1 million total light vehicles) (see Table III). The average fuel economy for the U.S. car fleet (all cars on the road today) and the U.S. light truck fleet (all light trucks on the road today) are 24.9 mpg and 18.5 mpg, respectively. The average U.S. household vehicle travels 12,000 miles per year. At $3.60 per gallon the average car uses $1,735 of gasoline per year, and the light truck uses $2,335 of gasoline per year. In the U.S. then cars and light trucks spend $475.2 B per year or $1.30 B per day on gasoline.

The U.S. budget for 2015 is $1.1 trillion. As described above, U.S. residential customers spend $163.5 billion in electricity (most of which is fossil-fuel based) and spend $475.2 billion on gasoline, or they spend 58% of the budget to power their homes, cars, and light trucks.

If all of the gasoline-fueled small cars in the U.S. were changed to EVs, what would be the gasoline savings and the electricity demand? Small cars (61.0 M) make up 26.3% of the light vehicles. If these small cars get 30 mpg, they use 400 gallons of gasoline per year and at $3.60 ($3.00) per gallon the small car uses $1,440 ($1,200) per year. In the U.S. then small car owners spend $88 B ($73 B) per year on gasoline and use 24.4 B gallons of gasoline per year. The electric car consumes 4000 kWh per year and the electricity costs $475 per year for a U.S. yearly cost of $29 B per year for 244 TWh of residential electricity.

Fig. 3. *Switching all of the U.S.'s small cars to PEVs.*

This means that the 20% energy efficiency cost-effective retrofits to our homes (275 TWh saved per year) let us drive our 61M EV cars (244 TWh consumed per year) for free forever! This also eliminates the consumption of 24.4 B gallons of gasoline at a savings of $88 B per year or 18% of our gasoline use for light vehicles (see Fig. 3). In 2012, U.S. net oil imports provided 40% of the petroleum and other liquids consumed in the United States.[11] Of this imported oil 28% came from the Persian Gulf, and 16% from Africa, which means that 17.6% of U.S. oil comes from the Persian Gulf and Africa. Switching to EV cars then saves all the gasoline used in vehicles in the U.S. that is imported from the Persian Gulf and Africa.

Figure 4 shows that if the U.S. installs utility-scale PV to provide the 244 TWh/yr (6.6% of U.S. electricity) for 61 M EVs, this would be equivalent to 163 GW of PV (assumes a solar irradiance of 1,500 kWh/kW per year). The Q2 2014 utility turnkey fixed-tilt PV system pricing[12] was $1.69 /W. Therefore, with the 30% federal income tax credit, the cost would be $202 B or 2.3 years of gasoline savings. While the first 61 M EVs would be fueled for free through efficiency retrofits, the next 61 M EVs could be fueled by utility-produced PV at 5.6 cent per kWh or the equivalent of $0.47 a gallon.

Many of the nation's more than 116 million homes and almost 80 billion square feet of commercial space were constructed before 1980—prior to the existence of today's efficient products and most equipment standards and building codes. An analytical study carried out under the U.S. Department of Energy Building America Program, "Cost Effectiveness of Home Energy Retrofits in Pre-Code Vintage Homes in the United States,"[13] looked at 1,600 ft^2 homes built in 1975 in 14 cities. The principal objectives were to:

- Determine the opportunities for cost-effective source energy reductions in this large cohort of existing residential building stock as a function of local climate and energy costs.
- Examine how retrofit financing alternatives impact the source energy reductions that are cost-effectively achievable.

A key finding was that the energy efficiency of even older, poorly insulated homes across U.S. climates could be dramatically improved. Moreover, with favorable economics, they can reach performance levels close to zero energy when evaluated on an annual source energy basis.

Findings indicated that retrofit financing alternatives and whether equipment requires replacement had considerable impact on the achievable source energy reduction in this cohort of residential building archetypes. The results that follow: 1) modified this study using a 30-year refinance mortgage at 4.0% interest using full replacement costs;

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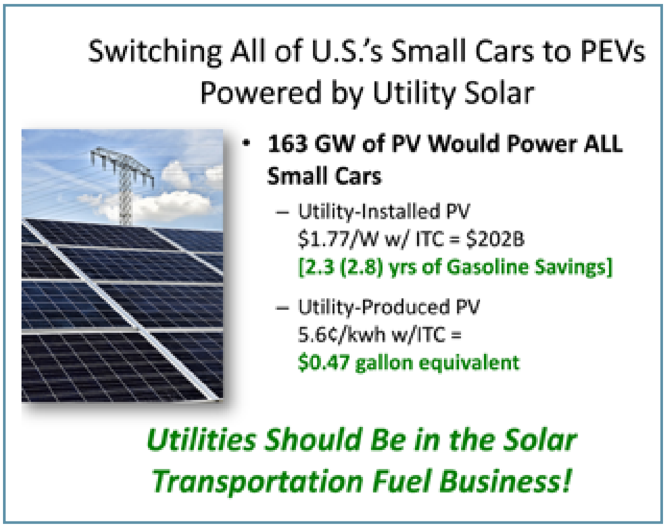

Fig. 4. *Switching all of the U.S.'s small cars to PEVs powered by utility solar.*

Table IV. Retrofitted homes from 14 U.S. cities.

City	State	Climate Zone	1600 ft² 1 story home built in 1975	$/kWh	$/therm	Base House Electricity Use, kWh/yr	Electric Bill, Base House	Retrofit House w/o PV Use, kWh/yr	Solar Irrad. Wh/W per yr	PV to make Zero Energy (kW)
Miami	Florida	1	SOG-CMU-HP	$0.1144	$1.844	17,651	$168	7,720	1,527	5.05
Houston	Texas	2	SOG-Frm-HP	$0.1160	$1.115	17,613	$170	10,612	1,431	7.41
Atlanta	Georgia	3	Crwl-Frm-HP	$0.1007	$1.564	18,245	$153	10,479	1,527	6.86
Los Angeles	California	3	Crwl-Frm-GF	$0.1475	$1.023	6,225	$77	4,091	1,685	2.43
Seattle	Washington	4	Crwl-Frm-HP	$0.0804	$1.262	19,476	$130	11,367	1,164	9.77
Seattle (no PV)	Washington	4	Crwl-Frm-HP	$0.0804	$1.262	19,476	$130	11,367		
Phoenix	Arizona	2	SOG-Frm-HP	$0.1097	$1.636	20,619	$188	10,732	1,875	5.72
Minneapolis	Minnesota	6	Bsmt-Frm-GF	$0.1059	$0.903	7,338	$65	5,215	1,369	3.81
Detroit	Michigan	5	Bsmt-Frm-GF	$0.1246	$1.167	7,472	$78	4,996	1,218	4.10
New York	New York	4	Crwl-Frm-GF	$0.1874	$1.448	8,364	$131	5,133	1,394	3.68
Ft. Worth	Texas	3	Crwl-Frm-HP	$0.1160	$1.115	20,048	$194	6,683	1,451	4.60
San Francisco	California	3	Crwl-Frm-GF	$0.1475	$1.023	6,386	$78	4,155	1,875	2.22
Denver	Colorado	5	Bsmt-Frm-GF	$0.1104	$0.838	7,208	$66	5,175	1,618	3.20
Baltimore	Maryland	4	Crwl-Frm-GF	$0.1432	$1.283	8,749	$104	5,563	1,403	3.96
St. Louis	Missouri	4	Crwl-Frm-GF	$0.0908	$1.202	9,450	$72	6,705	1,439	4.66
U.S.		Avg		$0.1154	$1.174					

2) corrected for the decrease in price of PV from 2012 to today's price of $3.73 W installed; 3) retrofitted the 14 homes to a net-zero electric home; and then 4) added the PV needed to provide the electricity for a Nissan Leaf or Chevrolet Volt driven ~12,000 miles per year.

Table IV shows the 14-city home locations along with Seattle (no PV), their climate zone, a brief description of the home, electricity and thermal energy costs, the base house electricity use the monthly electric bill, the retrofit house electricity use, solar irradiance, and the amount of PV to make the house a net-zero electric house.

Figure 5 shows the monthly payments for each of the 15 retrofitted houses under three scenarios (cost effective efficiency retrofits, cost effective efficiency retrofits with PV to make the home a zero-electric house, and PV added to the zero-electric house to power the PEV) less the cost of the monthly electric and natural gas bill for the base house. The purple bars show the monthly payments of the retrofits plus the remaining electric and natural gas bills less the monthly electric and natural gas bill for the base house. In all cases, except for Seattle, the retrofits resulted in monthly savings (i.e., an immediate payback). Seattle has very low electric rates (~ 8 ¢/kWh, renewable hydroelectric), and, as the rates rise over time, the greater than

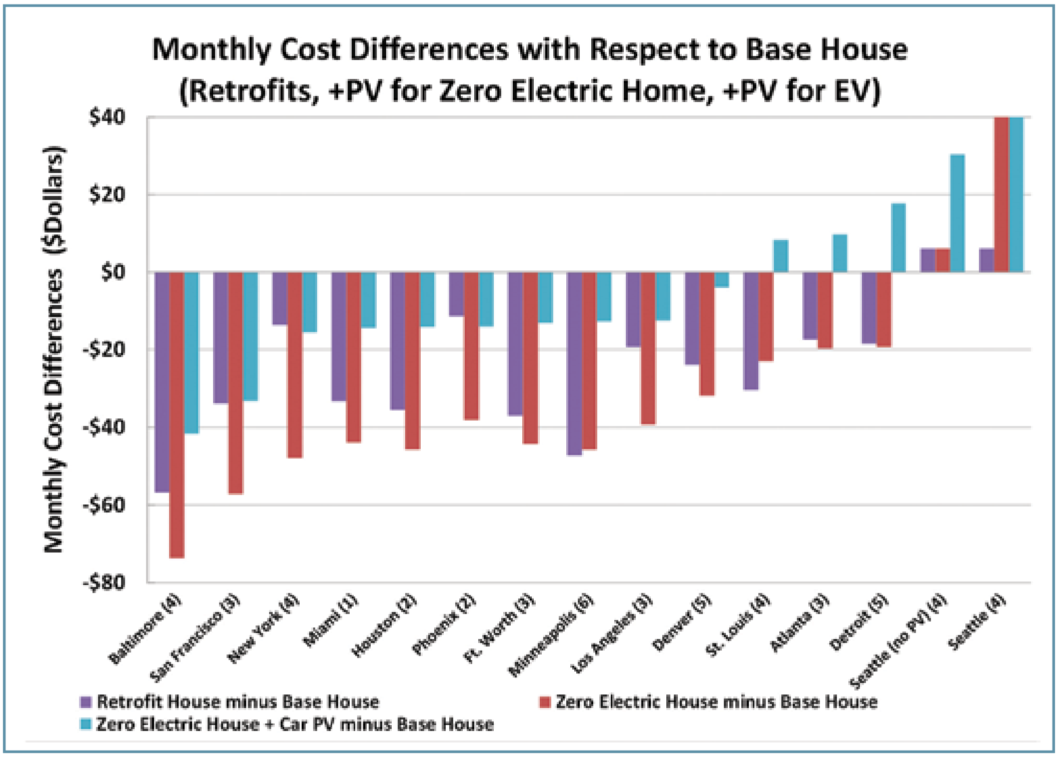

Fig. 5. *Monthly cost differences with respect to base house (retrofits, +PV for zero electric home, +PV for EV).*

8000 kWh/yr saved will show a savings in future years during the 30-year refinance period (see Table IV). Many of the homes in the colder climates had retrofits that saved on the use of thermal energy more than electrical energy. The red bars show the monthly payment for the retrofit and the PV (a net-zero electric home, i.e., no electric bill) less the standard payment for the base house. The cost effectiveness of adding PV to the retrofitted home is a function of the solar irradiance, but, more importantly, the base electric rate. In most cases, except for Seattle and St. Louis (lowest electric rates of the cities considered), the retrofitted zero-electric home results in more savings than the retrofitted home without PV. The blue bars add the monthly payment for installed PV to fuel an EV such as a Nissan Leaf or Chevrolet Volt, so there is then no electric and no gasoline bill (there still may be a natural gas bill for heating). In Baltimore, San Francisco, New York, Miami, Houston, Phoenix, Ft. Worth, Minneapolis, Los Angeles, and Denver, paying for a net-zero electric house retrofit with PV to fuel the Nissan Leaf or Chevrolet Volt for 30 years is cheaper than doing nothing to the house. In St. Louis and Atlanta it would cost only $10 more a month (over status quo) to have a zero-electric home with PV fuel for the car provided for 30 years. Apparently there is a large cost to doing nothing!

Now that we have looked at the monthly costs of electric bills, retrofits and PV, let us add automobiles into the garage of our homes. Based on 5-year financing at 0% interest, the monthly payment of the gasoline-powered cars (gasoline fuel at $3.60 gallon + financing) is independent of the city. For the electric vehicles powered with PV, the city location affects the solar electric fuel costs (30-year refinance mortgage at 4.0% interest). Figure 6 shows the monthly cost differences between a net zero-electric house retrofit with PV for car fuel and a Nissan Leaf parked in the garage relative to a base house monthly electric and natural gas bills with a Versa, Sentra, Cruze, Malibu, or Impala in the garage. The base house with the Versa (purple bars) has the lowest monthly cost for all cities, but the zero-electric house with the PV-powered electric Leaf is cheaper than the base house with the Malibu and Impala for all cities. The zero-electric house with the PV-powered electric Leaf is cheaper than the base house with the Sentra and Cruze in Miami, Houston, Phoenix, Ft. Worth, Seattle (no PV), Atlanta, Los Angeles, and San Francisco.

Along similar lines, Fig. 7 shows the monthly cost differences for the Chevrolet Volt (costs based on all electric miles) parked in the garage of a net-zero electric house retrofit with PV for fuel, relative to the base house monthly electric and natural gas bills with a Versa, Sentra, Cruze, Malibu, or Impala in the garage. The base house with the Versa (purple bars) and Sentra (red bars) have lower monthly cost for all cities, but the zero-electric house with a PV-powered electric Volt is cheaper than the Impala with the base house for all cities. The zero-electric house with a PV-powered electric Volt is cheaper than the base house with

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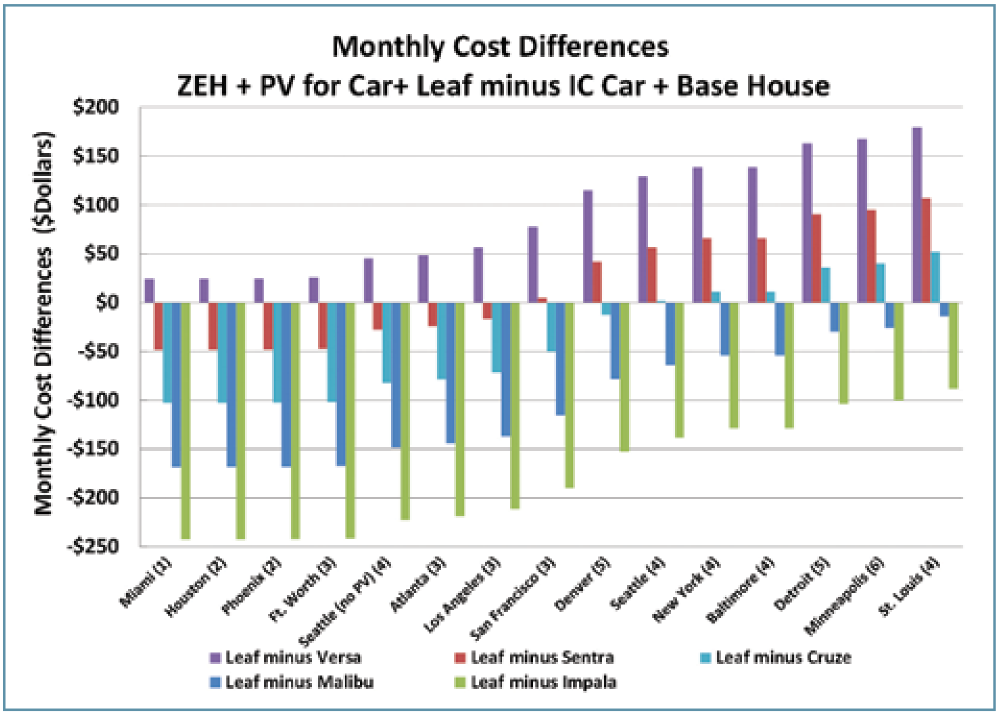

Fig. 6. *Monthly cost differences between a net zero-electric house retrofit with PV for car fuel and a Nissan Leaf parked in the garage relative to a base house monthly electric and natural gas bills with a Versa, Sentra, Cruze, Malibu, or Impala in the garage.*

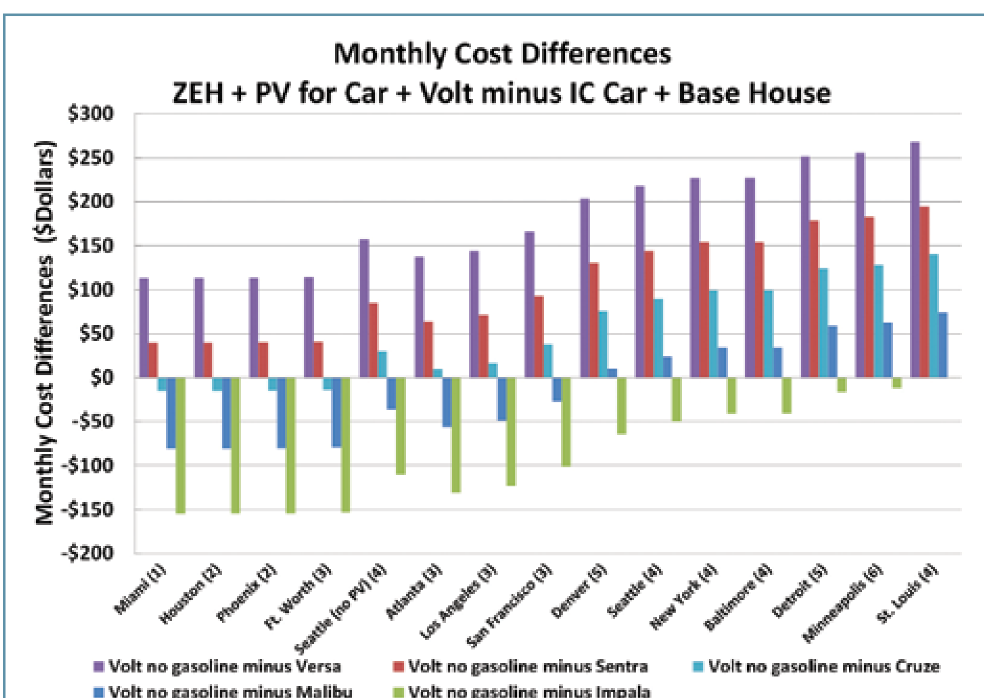

Fig. 7. *Monthly cost differences between a net zero-electric house retrofit with PV for car fuel and a Chevrolet Volt parked in the garage relative to a base house monthly electric and natural gas bills with a Versa, Sentra, Cruze, Malibu or Impala in the garage.*

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the Malibu as well in Miami, Houston, Phoenix, Ft. Worth, Seattle (no PV), Atlanta, Los Angeles, and San Francisco. The zero-electric house with the PV-powered electric Volt is cheaper than the base house with the Cruze in Miami, Houston, Phoenix, and Ft. Worth.

So what can you as a home and car owner do, besides wait until the U.S. chooses to provide financial instruments to retrofit your homes and utilities install solar at large scale? First, you can get a home energy rating analysis of your home's energy efficiency, as per the Home Energy Rating System (HERS) Index.[14] The HERS Index is the nationally recognized scoring system for measuring a home's energy performance. Based on the results, an energy-rated home will receive a HERS Index Score. The HERS Index Score can be described as a sort of miles-per-gallon (MPG) sticker for houses. The comprehensive HERS rating provides a computerized simulation analysis utilizing RESNET Accredited Rating Software to calculate a rating score on the HERS Index. The report will also contain a cost/benefit analysis[15] for the recommended improvements and expected return on investment. You could then refinance your house (4% interest 30 years) and include in the refinance the cost of efficiency improvements, and PV to make the house both a net-zero electric home and provide the electricity for your PEV, all while making money and putting people back to work. Imagine ***no electric or gasoline bills*** for as long as you are in your home!

About the Author

James M. Fenton is the Director of the University of Central Florida's Florida Solar Energy Center (FSEC). The U.S. DOE is currently funding programs at FSEC in: "Building America" energy efficient homes, Photovoltaic Manufacturing, Hot-Humid PV testing of large-scale PV to show bankability, train-the-trainers education for solar installations, programs to decease the soft-costs of PV installation and management of a smart-grid education consortium for power engineering students. The U.S. DOT recently awarded a University Electric Vehicle Transportation Center (EVTC) to FSEC. Prior to joining FSEC, Dr. Fenton spent 20 years as a Chemical Engineering Professor at the University of Connecticut. He received his PhD in Chemical Engineering from the University of Illinois in 1984 and his BS from UCLA in 1979. He is an Electrochemical Society Fellow and received the Research Award of the ECS's Energy Technology Division last May. He may be reached at jfenton@fsec.ucf.edu.

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References

1. "Lazard's Levelized Cost of Energy Analysis—Version 8," http://www.lazard.com/PDF/Levelized%20Cost%20of%20 Energy%20-%20Version%208.0.pdf (accessed Jan. 22, 2015).
2. "Solar Less Than 5¢/kWh In Austin, Texas! (Cheaper Than Natural Gas, Coal, & Nuclear," http://cleantechnica.com/2014/03/13/solar-sold-less-5%C2%A2kwh-austin-texas/ (accessed Jan 22, 2015); "Austin Energy Switches from SunEdison to Recurrent for 5-Cent Solar," http://www.greentechmedia.com/articles/read/Austin-Energy-Switches-From-SunEdison-to-Recurrent-For-5-Cent-Solar (accessed Jan. 22, 2015).
3. Calculated using the System Advisor Model (SAM 2014.1.14) https://sam.nrel.gov/
4. "EV Everywhere Grand Challenge: DOE's 10-Year Vision for Plug-In Electric Vehicles," http://www1.eere.energy.gov/vehiclesandfuels/electric_vehicles/10_year_goal.html (accessed Jan. 22, 2015).
5. "EV-Everywhere Grand Challenge," http://energy.gov/sites/prod/files/2014/02/f8/2-danielson.pdf (accessed Jan. 22, 2015).
6. D. Howell, "USA Hybrid and Electric Vehicles Market and R&D Activity, May 22, 2014," http://www.ens.dk/sites/ens.dk/files/klima-co2/transport/elbiler/IA-HEV_EVI/Konference_22_maj_2014/david_howell_u.s._department_of_energy.pdf (accessed Jan. 22, 2015).
7. SunShot Initiative, http://energy.gov/eere/sunshot/sunshot-initiative (accessed Jan. 22, 2015).
8. R. Garabedian, "A Utility Scale PV Perspective on SunShot Progress and Opportunities," Slide 15, http://energy.gov/sites/prod/files/2014/07/f17/raffi_garabedian_firstsolar_sunshot_progress_2014.pdf (accessed Jan. 22, 2015).
9. "Electricity," http://www.eia.gov/electricity/data/state/ (accessed Jan. 22, 2015).
10. "About the Building Technologies Office," http://energy.gov/eere/buildings/about-building-technologies-office (accessed Jan. 22, 2015).
11. "How Dependent Are We On Foreign Oil?," http://www.eia.gov/energy_in_brief/article/foreign_oil_dependence.cfm (accessed Jan. 22, 2015).
12. "Solar Market Insight Report 2014 Q2," http://www.seia.org/research-resources/solar-market-insight-report-2014-q2 (accessed Jan. 22, 2015).
13. P. Fairy and D. Parker, "Cost Effectiveness of Home Energy Retrofits in Pre-Code Vintage Homes in the United States," http://www.fsec.ucf.edu/en/publications/pdf/FSEC-CR-1939-12.pdf , (accessed Jan. 22, 2015).
14. "What Is the HERS Index?," http://www.resnet.us/hers-index (accessed Jan. 22, 2015).
15. "Energy Rating Benefits," http://www.resnet.us/energy-rating-benefits (accessed Jan. 31, 2015).