Q1 2011 Quarterly Report: WilderHill Clean Energy Index®, March 31, 2011

1st Quarter 2011 opened from the Clean Energy Index® (ECO) at 105.50 & closed at 108.92, for a small Q1 gain of +3.2%. For the past 2 years after strong declines 2008 - early 2009, the clean energy ECO Index® tracker (PBW) is up some +40%, the progressive energy WHPRO Index tracker (PUW) is up +119%(!), the global clean energy NEX Index tracker (PBD) is up +45%, and HAUL Index® for global energy efficient transport is up +100%.

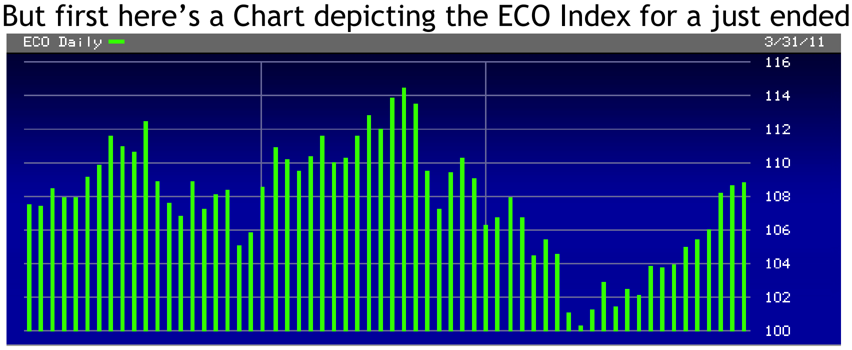
Of significance in Q1 has been deep change in Middle East & Northern Africa, affecting oil. Transport's dependency on oil points to an underlying fragility in our energy portrait — and it's a case to move beyond gas alone in running cars ahead. Greatly impactful in Q1 too was Japan's quake/ tsunami spotlighting weakness in nuclear power, and the risks of a grid relying solely on big, thermal central plants. For this Report we look at the new, resilient, remarkably viable idea of Solar Power & Electric Cars — this attractive, practical and grin-inducing pairing has at last begun to make real economic sense.

For a very first time ever, *affordable* fun to drive Electric Vehicles (EVs) running on photovoltaic (PV) solar to power homes, offices & cars is at the brink of reality — we employ it here! Like a pair of good food+drink, solar+EV matches so well together. At first it should put paid to an old notion that PV+EV is impossible. Distributed solar can even in theory help end dependence on oil harming American security, while creating good jobs, self-reliance, and avoiding our sending $ billions to places that don't much like us.

Start with what is the ever-more-affordable EV. It can grow better still, because many U.S. Utilities are trending away from King Coal. As electric mains grow cleaner by moving from coal, and towards alternate resources including renewables, vehicles clean up too — something ubiquitous rock-oil-burning 'gassers' of today simply are unable to do.

Lower-cost solar that is now at parity with Utility power ever more places, also begins to alter thinking. Elegantly together PV+EV can leverage new rewards. Importantly for example *costs* of the 'sunfuel' running cars + *plus* the costs for much or all of a building's electric power are known and go *lower* over time. After payback there's *free* fuel for cars, plus power for some or all of a building — in essence earning money.

But first here's a Chart depicting the ECO Index for a just ended Q1 2011:



For a past 2 years, 3 trackers: ECO Index is up some +40% in **blue** at middle (PBW), NEX is up +45% in **green**, middle (PBD), WHPRO is up +117% in **red,** top (PUW). A 4th other global clean energy index (not ours) is in **yellow** at bottom for comparison the past 2 years:

The Wilder NASDAQ Global Energy Efficient Transport Index (HAUL) that has no tracker:

Turn now to this fresh idea of 'solar' electric cars; we've found this 'wow' idea already is 100% viable. Our 1st, 2008 electric car performs roughly comparable to a Turbo Porsche. We drive this car 1 some 30-40 miles per day on average. With a range of 200+ miles per charge, it can go much farther than needed and we recharge nightly. Moreover electricity to charge it, 'sunfuel' for this car, is now *free*. We're past payback on solar PV and as our combined solar systems 1 & 2 make on average 72 miles worth of 'fuel' per day, we make more than enough to run car 1 plus electricity for a portion of this building – in Summers we make enough juice for car 1, plus fully either car 2, or this building too.

Our 2nd car also highlights benefits of EVs alone, over oil. Ignore our (free) power from sun a moment: charging this car from the grid costs just 2.7 cents per mile of driving. Gas @ $4/gallon (March 2011) even in a 50 MPG gasser would cost 8 cents per mile of driving. Recharging car 2 nightly on grid averaging 35 miles driving, costs just 95 cents /night – vs $7/day in gas for a more typical 20 MPG gasser. We love independence from oil! If gas prices fell by ½ (!), car 2 on grid is still better. At $20K (after credits) car 2 is an affordable everyday driver. In sum EVs on grid or better yet EVs on sunfuel, may notably chip away at energy fragility. Much is possible – PV+EV so sane – it may soon challenge inertia of a past century and core assumptions about power & fast cars.

EV Costs. Start with EVs: let's take a look at on-ground costs for these emerging cars. We've so far had two full years living with our first electric car, a special 'supercar' 2008 Roadster 2 seater with performance roughly like a Turbo Porsche. This 1st EV had cost $79.5K after credits & rebates. It's lovely and fun, an American-built roadster with a range something just over 200 miles per charge (typically more than we need).

Arriving next month is our more ordinary 2nd electric car, a 4 door sedan that notably cost just under $20K after credits: its appearance is a more an ordinary looking 'econobox'. Far more utilitarian than our 2008 roadster, this 4 door looks & drives like a typical gasser (and so yes, is ho hum slow): we expect shorter range of roughly 70-100 miles per charge. Together they'd cost $100K, or no more than what 2 gassers of similar profiles might be. In fact the 1st car was less (even w/o credits!) than any similar-performing, oily supercar. The $20K 2nd car was a bit more $ than a comparable gasser, think a Versa, although its dashboard is quite advanced. (Tax credits helped lower costs here. Like fat Hummers sold in numbers due to tax benefits, tax policy matters: that said we're not fans of subsidies — we'd like to see ALL subsidies *ended* including those for fossil fuels & nuclear).

Despite these 2 cars costing roughly what comparable gassers might total, they importantly convey advantages making them both far superior choices to 2 gassers. For example our 2008 roadster of the past few years continues to be more fun to drive frankly than any gasser even at twice the price in our opinion. The fact it never needs fuel, or maintenance of gassers makes it even better. Rather like how over time drivers of gassers assume away their limits like so little torque and their being so slow, needing gas stations to refuel (unable to make fuel from sun, wind etc), the key limit here of its lesser 200 mile range for this early version car 1 is something one quickly gets used-to.

For infrequent times we go farther than 200 miles range per charge, we have an old 120K+ miles gasser for that. True in future charging stations will be more common (1,400 coming soon to San Diego) yet today range is an EV restraint. That said for everyday driving we much prefer our car 1 to any gasser: this 2008 is a much more enjoyable ride than a gasser and doesn't have to be slow like say, a typical BMW, an Audi gasser etc. We look forward mightily to our 2nd car next month: while the 4 door is slow as a gasser, its ability to run without oil is compelling and we feel the affordable $20K cost was well worth it.

EVs can include electric bikes too, as in urban settings, hilly places, or where biking is common like Europe & Asia. We have both a 'primitive' 2002, and newer 2009 electric bike. Light-weight & fun with a Li-mn battery, bike #2 is far better technologically & practically speaking, than heavy, early lead-acid battery bike 1. After using obese bike 1 commuting 2002-03, we can say bike 2 is far more desirable: it feels like a regular bike (pedal mode), or is hybrid human/PV-powered with infinitely variable throttle electric assist, or is like a scooter. Costs were $1K for the bike 1 (after a City $0.5K subsidy) — and some $2K for bike #2 (no subsidy there) coming as an EV kit. Having used both, bike #1 is forever now consigned to an obscure garage corner.

In sum car costs were **$79.5K** for a 2008 fast 2-seater Roadster ($92,000 car, minus $7.5K federal tax credit, $5K state cash rebate) — and just under **$20K** for a not-fast, but remarkable for its low purchase price 2011 Sedan ($32,780 MSRP minus $7.5K federal tax credit, minus $5,000 state cash rebate, $1K off by dealer) or nearly $100K for both cars. The two electric bikes were **$1K** for bike 1 (after $0.5K City rebate), **$2K** for bike 2.

Solar PV 1 Costs: On to Solar costs, our PV here was bought as you can imagine in phases. We've found that a good way to bite off expensive items like cars ($79.5K, $20K) or the two solar PV systems here so far, or bikes ($1K, $2K), is take these each on over years one item at a time. Saving enough $ to cover each takes time, plus technologies oft improve as prices come down over time giving more bang for the buck.

In 2003 we installed Phase 1 PV: 3.85 kilowatts (kW) solar on the roof costing us **$15,511.** (From $30,630 our cost was minus then-rebate of near $4/watt subtracted by installer who got rebate directly from the State, a nicer rebate path as the consumer avoids large out of pocket costs: we wrote a check for $18.5K, later subtracting $3K state tax credit from next year's taxes to net out at $15.5K, and so we paid $3.90/watt. There was no Federal solar credit then; conversely early State rebates ended that once-halved PV costs. While we'd prefer to see ALL energy subsidies ended including the more costly breaks for fossil fuels — until EVs/PV are mass-produced in great volume these credits do bring down consumer costs). Solar costs breakdown in 2003 was as follows:

Description	**Quantity**	**Price, Each**	**Price**
185 Watt Sharp Solar panels, NTS5E1U	21	850	$ 17,850
Sharp Sunvista Inverter, 3.5 Kilowatt	1	3,500	$ 3,500
Solarmount Rail Sets	7	157	$ 1,099
Top Mount Clips	7	20	$ 140
Terminal Block 175 Amp, 3 pole	1	36	$ 36
J Box, 10X8X4	1	46	$ 46
2 pole safety Disconnect, 30 Amp	1	66	$ 66
30A RK5 fuse	2	5	$ 10
Safety disconnect, 30 Amp, 600 V	1	165	$ 165
Delta Lightning Arrestor, 440-650 V	2	40	$ 80
Sharp PV Output cable, 50 ft.	4	28	$ 112
	Total of Goods:		$ 23,104
	Sales Tax:		$ 1,675
	Shipping:		$ 151
	Materials Total:		$ 24,930
	Labor:		$ 5,700
	Total Before Rebate:		$ 30,630
	(Minus, California State Solar Rebate)		***$ (12,119)***
	Our Total cash $ Paid at installation		$18,511
	(Minus, CA $3,000 State Tax Credit)		***$ (3,000)***
	Final Cost after Rebates & Deductions		**$ 15,511**

These solar panels have a manufacturer's Warranty of 25 years, but we expect to see much longer life given the past performance of other much older solar panels. We won't be surprised to see our solar producing another 20+ years, or into 2030s! The only item with shorter life is an Inverter. A 1st less-advanced Inverter was expected to have roughly 7 years' life, which indeed proved exactly to be the case. We expect a newer one put in 2010 (costing $2.4K, cost amortized ahead) will have roughly 15 years' life.

In sum we look forward to 20+ years ahead of free electricity from 3.8 kW PV 1, and believe this is a sensible return on investment. One, and now two cars sweetened the deal too by hastening PV payback plus giving us better rides. Next we look at powering the 1st car and some of the building — at times even both — from PV 1 & 2 and so the sun.

Solar Transportation Costs: Long ago we calculated on then-electric rates that in making much of our building's power from solar, we'd reach full payback on $15.5K of PV 1 in roughly 10 years. At the time we'd felt it was a pretty good return on investment and was made possible by 1) PV solar purchase subsidies & 2) the Time of Use (TOU) metering by our local Utility crediting us for surplus daytime power from this building.

We'd since shortened payback to just 8-9 years. Why? What improved PV 1's numbers — accelerating payback and making 3.8 kW free sooner — was our adding in essence a 'solar powered' car. Consider we typically drive here roughly 35 miles per day. Some days it's much more, other days hardly at all, but our average is say 35 miles/day. Driving that elegantly & quickly in electrons-only 2008 car 1, rather than a typical and far-more-costly-to-fuel-per-mile gasser, has made a rather big $ difference. Here's why:

Start with our 35 miles/day. In a gasser comparable to our car that can effortlessly do 0-60 in some 4.0 seconds, we might have spent (March 2011 gas here = $4 gallon) 20 cents/mile for gas. Gas can be less say 15 cents/mile or was more here at $4.50+ three Summers ago, but we'll use $4 gas of this month with oil around $100/barrel WTI.

In a comparable but probably less fun gasser, it's 20 cents per mile = $7/day that we'd have spent on gas. Driving instead our 'suncar 1' we've thus accelerated the time to payback for Phase 1 solar, because gasoline is relatively more $, than is buying the Utility power for this building against which we'd been measuring PV payback.

At $7/day for gasoline over 2 years 2009-2011, we'd have spent say $200/month, about $2,500/year or $5,000 total fueling a comparable gasser. By contrast (ignoring PV that makes power less costly, then free) charging our car 1 regularly from grid at then Off peak rates would have been around 14.5 cents/kWh back in 2009-2011 (less after).

Car 1 getting some 3 miles/kWh from the plug, we'd have spent just under 4.9 cents to drive each mile then using Off peak grid electrons. Calling it 5 cents/mile for our real car vs. 20 cents for a gasser, the smart choice is easy: car 1 saved 15 cents/mile without PV! Were gas half as much (doubtful!) so we paid only $2,500 those 2 years, payback holds: gassers can't compare on per/mile value with EVs. And gas can be far more pricey; in Europe it's over $8/gallon (in 2011) and it can hit even newer highs here in the U.S.

In sum given the favorable PV+EV figures of PV 1, and advantages of added 2.8 kW in PV 2, we expect to add Phase 3 PV to completely cover all power demand.

72 Miles/per Day from Sunfuel: Recall Car 1 brought payback on 3.8 kilowatts of PV 1 to 8-9 years (solar PV system costs) so we've repaid costs for that 2003 system. Certainly the upfront costs were significant. Yet we've recouped the investment. PV 1 now fuels our car 1, plus it is powering part of this building. All 6.5 kW of our PV is enough in Summers to run car 1 + the building/or car 2 and will go on for 20 or more years into the future. Contrast that with paying for traditional Utility electric bills, and gas at the pump. There one can't pay one known sum that covers decades ahead, after which it's free! Instead, costs there vary greatly and usually over time that trend goes one direction, up.

Now if all PV 1 power went to car 1 (like Captain Kirk directing all power to shields), it could fill that plus speed payback: 3.8 kW fills car 1 with juice left for the building. But PV 1 power is up just part of what's consumed total as a mix of electrons — it's all solar when PV 1 & 2 are net surplus in sun — or mixed if cloudy/ some PV — and at night it's zero PV production (offset by TOU 'boost'). We've seen total consumption here overall can be say 2/3 to building + 1/3 to car 1, slowing PV 1 payback a bit. Yet the idea holds: having an EV (or two) assists payback vs. PV for building alone. (Please note that extreme climates elsewhere hit EV miles hard especially if therefore heating or cooling a car so range then drops with present batteries but that isn't an issue here in San Diego).

We look below at how far does combined 6.5 kW of PV 1+2 solar make this first car go? As will be shown we may make roughly 24 kWh on a normal Summer/Fall day so broken down as 24 hours, it is 1 kW per hour, day/night. Able to go 3 miles/kWh, we get from Sunlight 3 miles/hour *free power* for this Roadster. Also a large 'fuel tank' (battery) in this car 1 means that it can also store overnight enough fuel to go 200 miles per charge.

Put another way *24 kWh/Day of free power translates as this car gets 72 Miles from a day of Summer sun*. It can go 72 Miles per Day of Sun (range is 200 miles per overnight charge) were power from all 6.5 KW directed to the car. Of course cloudy or Winter days we make far, far less. So this is an average. Once you have PV and a feeling for what it makes (it only matters if you happen to be interested — you can easily ignore this and go on making solar power), seeing how far you may go on sunlight and it's 72 Miles per Day of Sun (MDS) can be wonderful and feel more intuitively elegant than oily old MPG.

A big battery in our 2008 roadster stores enough onboard to go 200 miles/ per charge, while our $20K car 2 only gets 70+ miles/charge, yet is enough as a 2nd everyday driver.

We expect car 2 (like car 1) to get some 3 miles per kWh. Its battery having only 70+ miles range is offset by its low $20K cost, far more affordable after subsidies than car 1. Indeed if we consider here the $15.5K we paid for PV 1, then in theory car 2 plus PV 1 to run it & very modest parts of a home could total a reasonable $36K. Actual costs vary depending on local credits, but then local petroleum prices & electricity costs vary wildly too. We note PV+EV *after all subsidies* is now in some places beginning to pencil out.

Robustly avoiding imported oil while running cars on local sun are ideas that writ large, could help address America's over-reliance on oil. Plus there's benefits to self-reliance, once an American hallmark it could be so again. Posted next are some images of some ways here we make rooftop power, drive down costs per mile, and add energy efficiency. (One needn't stop there and can even 'squeeze oil from your plate' with organic gardens). Al just ideas, yet they have begun to make sense economically (& ecologically).

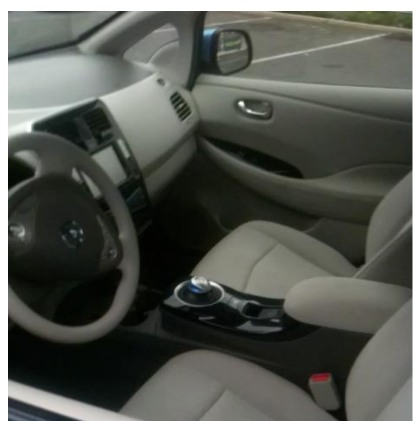
Our 2008 American-designed & built car 1.

EVs run on domestic (solar) power! -.

Interior of car 1, Roadster above.

2011 car 2: 1st test drive, 4 door out on town.

Our Solar Hot Water: tank right/panels bottom.



Car 2 during 1st test drive (above).


After the [rooftop PV] & solar hot water in 2003, we installed foam on our flat rooftop. This white foam reflects sun in Hot Summers helping cool our building, and is an insulator in Winters like snow helping hold in warmth. This is reducing energy use year-round. Moreover it is keeping rain from seeping through the flat roof, a side benefit.

Our 'solar'/hybrid bikes, #2 black, right.

Our PV 2 adds 2.8 kW more, to total 6.5 kW.


Moving off of oil can go beyond just electricity & cars, to squeezing oil out of your food! Instead of lawns — edibles! Growing much food here organically we've found our greens & fruits also taste great; gardening is relaxing too. These add self-reliance and avoid the added-carbon and loss-of-taste in growing food far away and trucking, shipping or flying it many miles to a grocer. Not only is it fun, but also is tasty to be a Locavore!

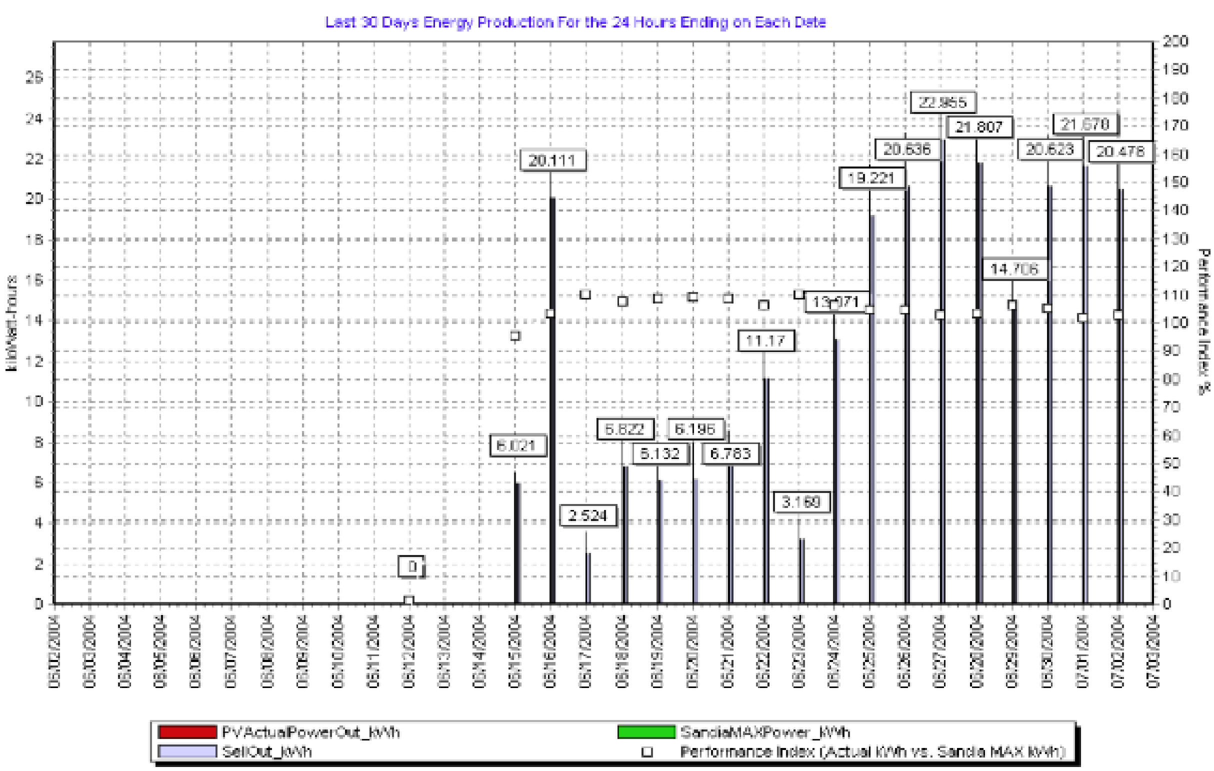
Elegantly Pairing EVs with Solar PV

these data and information below posted are at:
http://www.wildershares.com/pdf/Solar%20Power%20for%20a%20better%20Solution.pdf

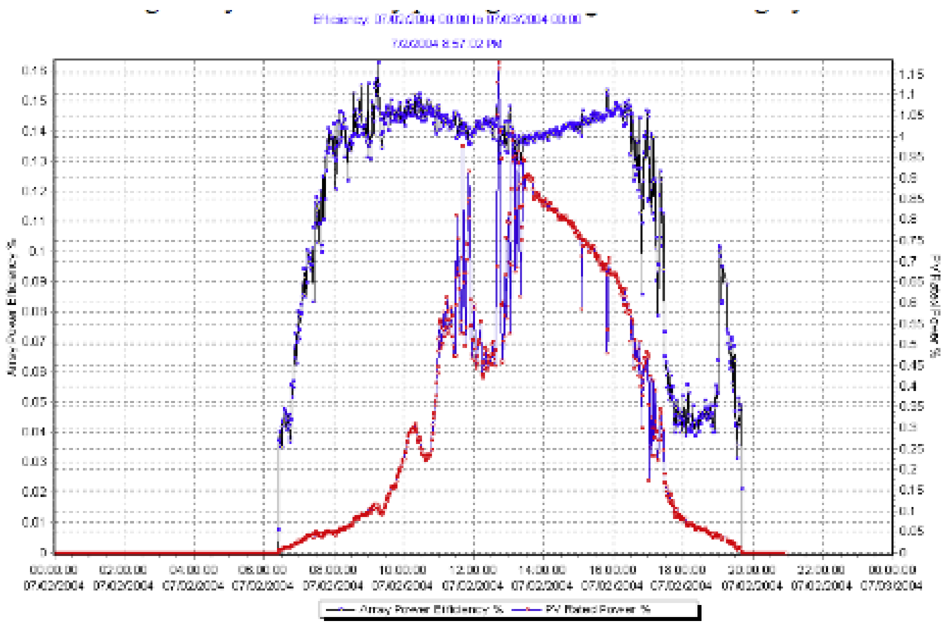
Solar Power for a better Solution

Phase 1 PV: We'd first installed 21 new 185-watt panels (see spec sheet) with then-high 14.2% module efficiency rating to get the most from rooftop space. We 1st chose ***mono***crystalline PV made in USA, at the time (2003) among the most efficient consumer PV (instead of ***multi***crystal PV). Monocrystalline, we'll shorten to 'mono' and it was paired to a 3,500 watt inverter along with a 1st, then 2nd web-based real-time monitoring system in one of the first applications in California although no single aspect of this system was a leap. Monitoring tells us real-time system performance; it's also fun to view.

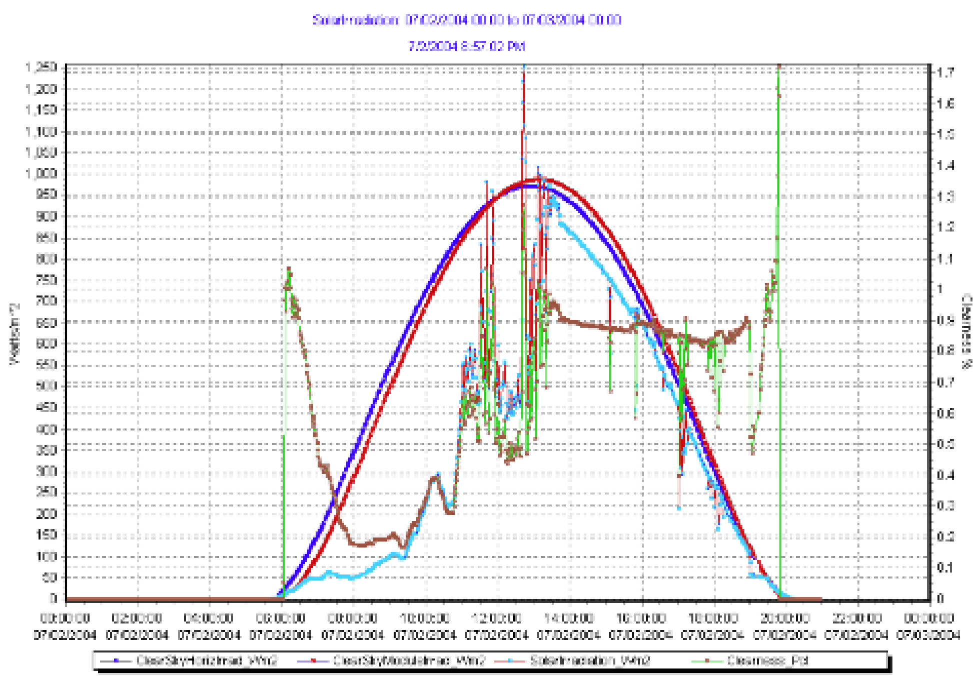
As illustrated by these data below in detailed graphs, panels have delivered efficiencies roughly 5% to 10% over manufacturer rating. Inverter efficiencies are also measurably high. Over long sun hours in Summer/Fall, we generally can make on average around 14 kilowatt/hours (kWh) per day from Phase 1 PV alone. Winter with fewer daylight hours, or cloudy days or anytime with less irradiance (Watts/Meter^2), we make much less:



Daily Energy Output above *for the 3.8 kW PV 1 in June/July 2004. Note daily production varies considerably depending whether it's overcast as seen a 1st week — or sunny a 2nd week. Average is say, near 14 kWh/day in June/July for PV 1. These data were gathered just after a 1st monitoring system was installed and it began readings in mid-June 2004.*



Sample Array Efficiency & Power over a Day, below: *On a sample day roof mono PV 1 @ 14% module Efficiency was seen to outperform and do well 8 am — to 5 pm. While overall Efficiency (in **blue**) maintains a desirably flattened, broad parabola, Power output (in **red**) was more negatively influenced by the passing cloud cover from roughly 11 am — to 1 pm. Cloudy weather can have very sizably impact on PV:*



Solar Irradiance (in green) that Same Day: *Corroborating clouding impacts 11 am — to 1 pm, sunshine drops well under theoretical maximum 1,000 watts/m^2 in same period. For more on Monocrystalline PV1 see our [rooftop performance graph series](#).*

Installation: Phase 1 mono going on rooftop, 2003.

Phase 2: Pleased with the 2003 Phase 1 results, we next installed a competing PV design by adding 24 **multi**crystalline ('multi') PV panels rated 120 watts each. We chose a different, passive inverter design too. Phase 2 alone was rated 2.8 kW, so total ongoing PV capacity for both systems together is some 6.65 kW overall (we'll call it 6.5 kW).

Rooftop space gone and eager to try a new set up, Phase 2 multicrystalline panels were next ground-mounted in 2 rows seen below, at greater inclination angle than roof PV. Ample space also allowed us to optimize ground panels year round, an advantage over roof PV (but ground panels are hindered at times by tree shading if untrimmed).

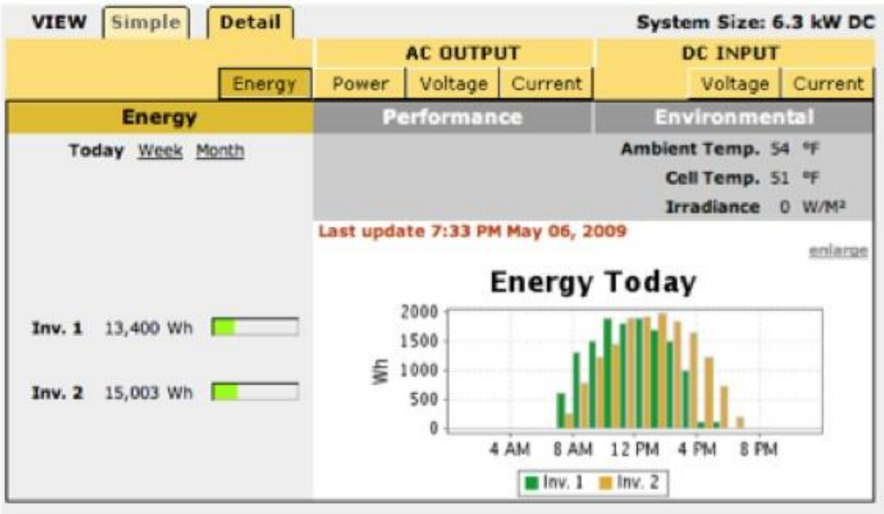
Roughly 6.5 kW of combined solar PV was then right-sized for our own electricity needs, clearly enough power for our 1 building. (There'd been some water pumping at that time, since eliminated — and so it then was easily enough for the building alone).

A lesson learned is we're surprisingly pleased with *multi*crystalline panels of Phase 2. Back in 2002 we'd had slight bias towards getting *mono*crystalline given the higher efficiencies. But in a few short years, *multi* panels narrowed that gap. They can achieve some efficiencies now greater than even the mono PV from just a few years ago.

Multicrystalline 2.8 kW, the Phase 2 is ground-mounted.

Relative performance is seen in a Chart below for a typical Spring day in May. Compare ground-mounted *multi*crystal PV Inverter 1 (**green**) – vs. roof *mono* PV as Inverter 2 (orange) — their output isn't far different. In mornings ground-mount leads; rooftop PV peaks a bit later. While roof mono made 15 kWh, the multi panels came close at 13 kWh. Shading by a tree at times untrimmed, halts output there (**green**) around 4 pm.

Roof panels are regrettably encumbered too by unnecessary disadvantages. They're mounted at flatter angle due to local height rules, favoring late Summer, non-ideal with our limited roof space. Those & other confounding variables conspire to fog the comparison, but a point is we're very pleased with both systems totaling 6.5 kW:



Inverter 1 (ground mount, green) vs Inverter 2 (rooftop, orange): 1-day in May.

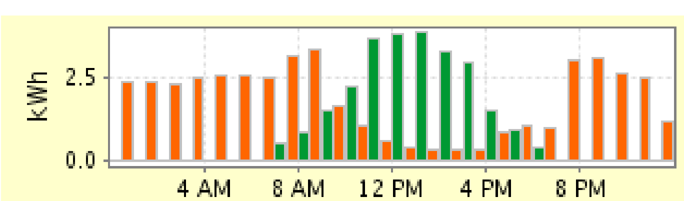
Importantly since inception of solar systems 1 & 2, they're together making about 24 kWh (kilowatt/hours) per day of electricity from all 6.5 kW. That's roughly enough to meet needs of many a small business, or home. Remember 24 kWh per day, it's an amount we think of as "One Sun" and relevant with addition of our first electric car below.

It's also an average. We may make for instance over 24 kWh on longer, typically sunny, non-foggy days Summer & Fall. Conversely on shorter Winter or Spring days, or on any cloudy, rainy or foggy days, the solar production is very, very, very substantially less.

Consider next our billing period is on TOU (Time of Use) & metering a 1-year annual basis — not monthly. So with grid essentially a battery and 1-year billing cycle, we can use greater power in Summer/Fall to offset Winter/Spring shortfalls. As PV in day covers night over 24 hours, surplus Summer & Fall carries Winter & Spring year in, year out.

Practical Knowledge Gained from Adding an Electric Vehicle

Next add our exciting addition of the first 2008 Phase 1 electric car. It's much loved: exceptional, great to drive, quick & lovely. Importantly too it uses our solar PV. We simply plug in and the car dovetails elegantly with solar, in essence a sort of virtual 'solar EV'. We've also gained practical experience in mating PV to EV. Consider first early Chart of energy-made (**green**) vs. initially energy-consumed (**orange**) on a typical May day:



Size & shape of our solar *made* (in **green**) above is predictable — roughly a parabola from around 8 am through 6 pm and this matches (no surprise!) sunshine. These are hours very usefully too a Utility values power most dearly. Of course PV *production* (**green**) didn't change at all when this car 1 was added at one-side of the *PV*+EV equation.

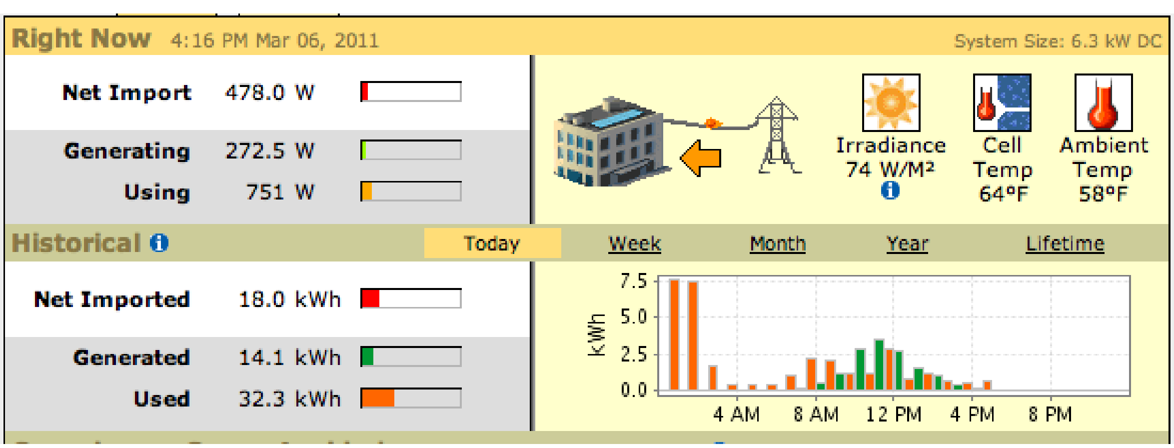
Yet the height & shape of our energy *demand in* **orange** did change once car 1 was added. Those tallish orange bars above here reflect us consuming more than before, though it's 'Off Peak'. Initially as shown above we did not start charging at Midnight (as we do now). Instead because we first tried simple Level 1 charging on a regular 120 volts outlet, we needed all the hours we could get to not charge 8 am -8 pm. This profile above in **orange** thus shows us charging all night starting at 8 pm and going to 8 am the next day in roughly 2.5 kWh tall bars at left / right. We quickly determined that charging at just 120 volts 13 amps Level 1 (L1) was absolutely unworkable since at such slow-rate, we were gaining car range at a ridiculously sluggish 3 miles/ per hour of charging.

That said we did quickly see above how car 1 changed consumption. Adding it suddenly enlarged & shifted energy-use, something to be mindful of in solar & TOU. In June 2009 we moved to our now regular, faster 240 volts, 30 amps Level 2 (L2) charging— so **orange** bars seen below are much taller! Live data: http://wildershares.com/solar.php

Since going to L2 charging, our Chart (below) now usually will show a few tall orange bars gulping down power starting at Midnight, left. It's only a few tall bars as it takes less time to refill typically 30-40 miles of driving that we did a day before. The scale of bars gulping around 7.5 kW each hour now also dwarfs too PV production at less than half that, so the look of this graph in the 2nd row below on right, has changed.

Start this sample day's top row: we see a typical cloudy March at near 4 pm with PV Cell Temp a cool 64 F degrees, not much above air Ambient 58 F degrees indicating little sun is warming panels as confirmed by Irradiance at just 74 W/M^2 or hardly any Sun out. The building alone is then consuming 751 watts, and PV panels are making 272 watts that moment so the grid is Net pushing 478 Watts *into* the building (see the arrow).

Green bar PV production is here dwarfed by 2 hours charging Midnight to 2 am, in tall orange bars at left. After the car briefly used about 15 kWh (15 kWh is right in line with our driving 30-40 miles/day a day before), there's a total 32 kWh so far being consumed as ½ and ½ by both building + car. As that day winds down building consumption goes on so from 1/2 to being maybe some about 2/3rds of the total demand over 24 hours.



To understand how good an EV is, apart from PV making it better, consider that charging at night (Utility Off peak rates) car 1 cost then 14.5 cents per kWh (rate through payback in 2011 — it's now far better than that on car 2). So consuming that 15 kWh Off peak car 1 'cost' only $2.17, not bad for a day's driving a supercar where an equivalent type gasser (20 MPG, $4/gallon in 2011) on gas costs about $7.00! Put another way using the grid-only we'd still save some $5/day. Ignoring PV, we'd spend just 5 cents/mile in fun car 1, rather than 20 cents/mile we'd spend in a gasser saving 15 cents each mile.

Consider next that the large so dear battery in our car 1 holds about 54 kWh. Not only does this car have great acceleration but battery size too, like a large gas tank, gives it very good range although needing much (solar) juice each time it fully charges.

It's important to understand too due to battery cooling and other losses in charging, filling car 1 from empty actually takes about 68 kWh, some 26% more than 54 kWh it holds new. This latter **68 kWh** is a seminal amount to consider, as it quantifies how much truly is needed, we'll use it to determine how far we can go from the power of the sun.

As noted we do EV charging at night (brown electrons) since on TOU it makes most sense — plus it leverages dear value paid us for green power made in day. Before, on car 1, our PV payback calculations in 2003 were based on a domestic rate for solar energy systems from the Utility called DR-SES. For car 1 we'd 1st calculated payback for PV at some 18 cents/kWh to charge car 1 Off peak (later dropped to 14.5 cents). As expected since then an even better 'Super-Off-peak' rate schedule for EVs was rolled out as EV-TOU-2; we switched to it in April 2011: it applies for both car 1 PLUS all building consumption. As we show here the more recent EV-TOU-2 rate is better at 13.7 cents Summers, 13.9 cents Winters that we'll call as 14 cents year-round.

Having PV+EV it's important to consider not just low Off peak rates for car charging, but also most-expensive On Peak rates of Summer & Fall that the PV is credited for. Here the greater the spread the better since we both consume — and 'sell back' power!

For car 1 On Peak DR-SES Summer/Fall was helpfully high, around 30 cents/kWh 11 am-6 pm (weekdays) when PV nicely sent out surplus power for a credit. That was on a DR schedule, rather than newer EV-TOU-2 to which we switched in 2011. Since then and the payback in 2011, the EV-TOU-2, PV surplus is crediting at a bit less, 28.8 cents/kWh in Summer/Fall, the other 6 months of year is semi-on peak @17.8 cents. On the other hand we're charged less for night car 1 charging (and we pay FAR less for car 2, noted below). There's data here on the 2011 EV-TOU, rate levels for Electric Vehicles.

A new requirement for Super off peak is these hours are only from Midnight to 5 am. Yet setting the car's onboard charger to begin at Midnight hasn't been a hindrance or any sacrifice at all; we'd probably do that anyway. We're often asked along these lines, "How long does it take to charge your car"? Frankly it feels like 30 seconds.

With L2 charging 240 volts and around 30 amps, power goes for maybe 1-3 hours middle of the night (cars 1 or 2). But charging *feels like it takes only* about half a minute. We park here in our garage, open a port and plug in a cord — takes less than 30 seconds. Mornings we open that port, remove charge cord — the work is done. So we pay no attention to how 'long' charging takes: starting Midnight is still more than enough time on L2.

Our Phase 1 'solar car' in foreground, 2009. *Same, 2008 model year car here in 2011.*

On the other hand, many lessons are being learned here on real PV+EV limits today. Thus in early experience we'd learned 120V Level 1 charging was ridiculously, impossibly slow. Even charging all hours outside Peak, its battery could only be partly refilled at a slooow rate; car 1 still 'wanted' more time than TOU allowed per night since drawing some 12-15 amps from common 120V outlet on its charger was just too slow.

Switching to Optional L2 charging fixed that. (Car 2 will have an external L2 charger and 400v port on car; charger and installation was free since we're part of a huge EV Project providing benefits in several cities to jumpstart EV adoption. Car 2 charges however onboard at lesser 3.3 kW rate; we'll not be surprised to see it upgraded in future).

L1 charging could be neat as there are ubiquitous wall outlets everywhere, but that 120v just can't meet EV needs. And a simple 120v extension cord warms up (wasted electrons). Picture it as trying to push a large amount of water from a big vat to a jug, size of the tube you use matters. Trying to push much water through a narrow straw (like using a 120V outlet @13a) slows things; using a much wider tube (240V) is far quicker.

In future wiring will matter since fast charging means lots of amps at once. Here today, upgrading at where this EV is habitually parked to a more robust 240V (@30 amps on NEMA 14-50, 4 wire) dramatically shortened charging times. Depleted a car 1 battery can now fill in 'just' some 3-4 hours — rather than 30+. And because we never start a battery from zero, to begin at Midnight has meant we normally finish by say 1 am to 4 am.

A measuring unit we'll use to help explain energy/time is the 'kilowatt/hour', kWh. Elegantly it applies equally to energy *made* by PV — or energy *used* in a building or car; 500 watts in 2 hours, 1,000 watts in 1 hour, or 2,000 watts over 30 minutes all = 1 kWh.

Consider then with initial DR-SES rate to payback 30 cents On Peak (Summer/Fall) for car 1 + building, and 18 cents we'd been paying Off peak year round, each 1 kWh of surplus power we'd *made* On peak was worth 1.6X each kWh *used* Off-peak, for a billing ratio of 30:18. Were *all* 24 kWh made On-peak 11 am-6 pm and leveraged 30:18 Summer/Fall, it's rather akin to producing 41 kWh. *But not all* is made On-peak (Fall/Winters, weekends etc) so we'll call it like supplying say, 30 kWh/day Off-peak.

What next is Range in car 1, wanting 68 kWh (or some 2½ days of strong Summer sun)? Giving an exact range is slippery, regardless of PV. Yes this fast car is impressively rated a 244-mile range, *or* can go 0-60 in 4.0 seconds. Yet it can't go both far, *and* fast.

To explain, sit inside, turn the key and you'll see 3 driving modes; we choose from two. The main default mode is 'Standard' & we almost always use that. A second 'Range' mode allows a bit more battery charge, but also slightly shortens battery life; we sometimes use it if going unusually far — but it slows this EV considerably so is like driving a gasser. (A third Sports mode is for track performance, and we never use that).

Being grin-inducing fast in Standard, yet able to go *much* farther than a 30-40 miles or so we typically drive in a single day, there's no need for us to use anything else, but for an occasional Range mode that slips in if going say 150 miles or so on a single charge.

Now after turning the key in Standard to start, you first see a display of the 'Ideal' range: it may start near say 195 miles (new — battery capacity slowly decreases in time). This is not the EPA rated 244; you'd 'lost range' being able to go fast in Standard. You're also seeing only 80% of the theoretical range partly for battery management. Charging to 90% in Standard prolongs life, with another 10% still left in the reserve not onscreen.

Yet, your likely range is still less. Temporarily you can switch from 'Ideal' to 'Estimated' range, based on how you've driven recently. Estimated range gives a still lower number.

In our experience, 2008 car 1 now a few years old, typically driving to where state of charge shows about ½ 'tank' (½ a charge) left, we've gone approximately 70-75 miles. Extrapolating and being conservative we'd normally expect some 150-miles total range; it may include dipping into 10% Reserve but driving in fast Standard that's so enjoyable.

Sample screen at battery ½ depleted.

So at ½ charge there may be around 70 Estimated miles left, or say 95 miles ideally. Driving mindfully ahead you could easily get greater than 70 miles, nearer to 95 miles on remaining juice if you prefer to slow down a bit — and Range mode would give more.

Forget oily MPG: We're getting 72 Miles per Day of Sunshine, or 72 MDS!

What's real-range in this fast car 1 powered in essence by 3.8 kW, now 6.5 kW PV 1+2 of sunshine? We suggest rephrasing this as: How far can our 6.5 kW solar make this car go? As will be shown we get about 3 miles range per kWh (3 MPK), or 3 miles/sol in this fast car.

So a full 24 kWh/Day, means this car can be driven 72 Miles on each day of sunshine. But numbers used can dramatically impact calculations, given the car is so efficient.

For instance in Range mode you could get near or a bit over 240 miles on a newish battery from 68 kWh of power in. That means going 240 miles on a charge from say 2½ days of Summer sun (TOU using the 30:18 boost, x 2 ½). Or you might get 100+ Miles/Sun if mainly going near 30-50 mph speeds, in Range mode and so 'as slow as a gasser'.

Going the other way, you may get only 15 Miles per Day of Sunshine (15 MDS) or less! Some days it's very cloudy with peak-measured irradiance <100 W/M^2, or under 5 kWh all day. Phase 1 PV at only 2.5 kWh on one June day yields <5 kWh total. Any cloudy, 'May gray'/ June gloom' or Wintry days, etc are less productive: figures go very low that direction.

Consider too energy demanded by car 1 is in addition to meeting building demand. Many days the PV isn't even able to meet building, or EV demands. For EV 'fuel cost' purposes here, we briefly assume away building demand in calculating MDS (yet it exists!).

Solar PV being so changeable, it can DROP TO NEAR ZERO due to clouds, however for simplicity sake we've kept the 1 Sun constant as average. A 2nd variable too is the car 1's *energy expended* while driving and it's keenly influenced by *how*, & *where* we drive.

We estimate average consumption on car 1 is 330 Wh/mile after charging losses. We reckon as follows: on local streets 30-50 mph this EV expends relatively little energy. We often see 250 Wh/mile or less, 1 sol (kWh) from battery before charging losses, thus giving 4 miles. But add in more 60 mph speeds, and we'll expend say 270 Wh/mile (Ex. 1).

Add in faster freeway speeds and consumption rises to say 300 Wh/mile (Ex. 2). We don't drive freeways much but with it, and/or good strong fun acceleration, costs at battery can swiftly go above 0.300 sol/mi, and wind resistance grows mainly at higher speeds.

Example 1, 0.270 kWh/mile typically spent in 30-50 mph stop & go traffic.

Example 2, add some highway miles and we can spend say, 0.301 kWh/mile or more.

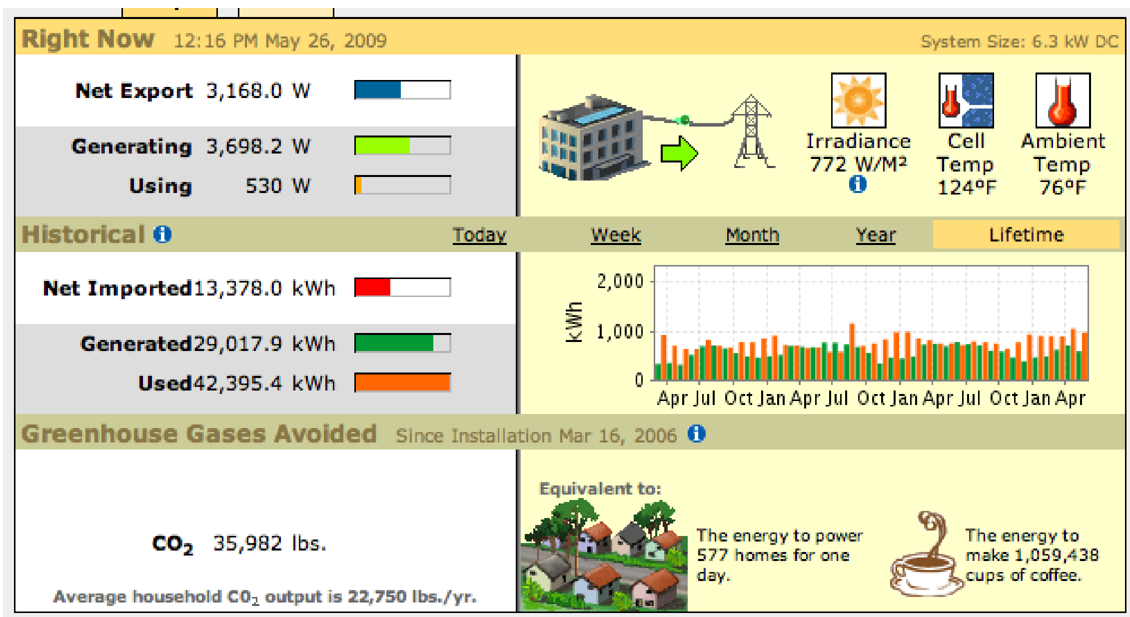
Fast acceleration, or 80+mph speeds push to 350+Wh/m, so speed is a big variable. In sum our own driving mix is mostly local, probably near/under 280 wh/mile overall: subtract a bit for being in Range at times, we likely see a bit under 270 wh/mile average. 270 and adding 26% charging loss takes us to 0.330 kWh/mi so we get roughly 3 miles/kWh (MPK), or spending 1/3 of a kW/h to go each mile in car #1. Car 1 manufacturer data are here.

Generating our own power had made us more aware of building demand. Similarly, an eye to car demand behind a wheel too, yields noticeably more range in an EV. One could just forget speed penalty, but sometimes to drive car 1 (or 2) for range is fun too. For instance we hardly use the brakes in driving, since just lifting off the accelerator with its regenerative braking slows this car nicely down, while making electrons to boot.

So just lift off the ‘gas’ and this car 1 slows itself, particularly at higher speeds as inertia briefly reaches in to put say some 30 kW ‘back in tank’. This creates a smoother more satisfying ride and makes you even more aware how archaic gassers can be, heating their brakes to arrest momentum while putting zero fuel back in tank for the effort!

Since you’ve spent those electrons getting moving in a first place, to recapture some by regenerative braking is an item bought & paid for already — you’re just being smart.

Back to PV/EV nexus we’d estimated PV payback period and with that reached, the solar costs under our belt, we’re seeing those numbers were about right. Total Phase 1 PV had cost us $15,511 (California subsidies in 2003 nicely cut the price paid in half). Since 2003 and based on live data from a 2nd monitoring system since March 2006, a back-of-envelope review shows adding a car (and high costs of gas) hastened matters. We reached payback for Phase 1 solar we reckon in 2011. Aided by solar now covering our transport as well as the ever-Higher Utility rates and gas prices, both have helped much!



*29,000 kWh **generated** & measured in May 2009 (top left), since a 2nd monitoring system was installed. For that sample May 2009 sunny On-peak moment, Irradiance is a sunny 772 W/M², our PV is making 3,698 Watts, **demand** that moment is 530 Watts and 3,167 Watts is being exported. These exported Watts are valuable compared to high costs of gasoline! Put in an EV leveraging at Off peak rates, it accelerates time to PV payback.*

In all, we’re interestingly no longer talking about *whether* PV+EV is feasible. Instead we figure how long it took to get payback on PV for building and car. Later on it will be how much may it cost to meet 100%, all demand with new cars too on a 3rd phase of PV.

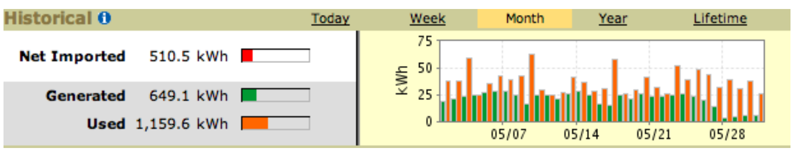
Finally we haven’t missed gas stations and prefer driving this solar car. It’s been said the stone-age didn’t end because we ran out of stones … elegant solar PV+EV feels like a solution at hand, while oil & grid dependence seems increasingly shaky. Local solar power for this building, and for fueling our stronger-America cars seems compelling.

So combination PV+EV works, but there's clearly limits on both sides of the "+".

While pairing PV+EV is viable we've also found practical limits on both sides of the "+". Most obvious is limited range of EV batteries today — and upfront costs of PV too. Becoming accustomed to an EV reduces range anxiety greatly but is a real topic on current batteries (freezing/ very hot climates, not here, zap range). Unsubsidized PV+EV purchase prices are still too high; the technology holds promise, but cost is a huge hurdle.

A point too is any EV is very thirsty; we're suddenly consuming much more power than before when running just a building. Rather than PV meeting 100% of a smaller demand before, now our demand pie is bigger. About 1/3 of the greater need is going on average to car 1, some 2/3 is going into the building. That car nicely hastens payback, true, but also creates a case for more solar (if you want to get power for an EV via a distributed energy system, or to be sure you could just use grid power only).

How well did 6.5 kW of our PV cope with building demand, plus car 1 on previous DR rates? Over a cloudy May month demand from building & EV was 1,160 sol (kWh) — yet in that overcast month the PV made only 650 sol. That sounds a huge shortfall, but TOU leveraged at 30:18 had almost covered it. But for 4 socked-in foggy days month-end below those DR Utility rates at 30:18, would have covered all the combined demand.



650 kWh PV in May becomes like 1,000 sol due to TOU--almost matching 1,160 used.

Clearly not enough watts were made directly head to head by Phase 1 + 2 Solar PV to cover building and car 1 fully, over the year. That said a TOU boost was critical and meant 650 sol created in a month On-peak, were rather like 1,000 sol Off-peak, just short of running building & car 1 together. It's actually more complicated, given some building demand (not car) is also On-peak etc, but this is the basic story. Of 1,160 sol used in a sample May, the building needed 810 sol or some 70% of total, and the 2008 Roadster, our first EV had needed another 350 sol or 30% (including its charging losses).

Car 1 used 279 kWh over May, 350 after losses. Note 57 kWh of regen. added range.

In sum if our building needs 25 sol/day average mostly Off-peak, solar making 24 sol/day almost covers it straight — and does so easily on TOU boost meaning it's like making 30+ sol/day. But add car 1 … driving can add demand for say 12 kWh/day (all Off-peak at least) so we need say 37 sol/day (25+12), or 2/3 to building and 1/3 car falling somewhat short on virtual 30 kWh/day made with older TOU. In Summers we may make enough — other times not. *Yet none of this matters exactly since 6.5 kW can be added to! Indeed we hope to add Phase 3 solar for more PV to take care of it all.*

Car 2 Costs Less than a Gasser To Drive, even On-Grid Without the Advantages of PV

Recall our 2nd car was a 2011 4-door sedan for just under $20K. Pricier than a comparable gasser (it's like a $16.8K Versa), credits meant we paid far less than its steep $32.8K MSRP. That said no gasser comes close to its low driving cost of under 3 cents per mile, even if on grid without solar PV. Indeed it costs under $3 to 'fill the tank'! (Costs per mile as an EV could go down to zero via solar, but we'll ignore all PV here for car 2).

Let's explain our car 2 since it is on a separate TOU rate schedule for this 2011 car, not the EV-TOU-2 that we're using for solar car 1 and this building. Because the local Utility (like many) wants to learn how customers may react to differing On and Off peak rates, they've created an Experimental EV (EPEV) rate of 3 scenarios. To participate in these newest EPEV rates one must be in an EV Project (we are) but that's extraordinarily simple to do and the Project exists in a few cities in the U.S.

One of three ratios is randomly assigned local EV drivers. Given 3 possibilities, we'll post immediately below a Middle ratio, the experimental rate M for illustration:

RATES

Description – EPEV-M	UDC Total (See Chart Below)		EECC Rate		DWR-BC Rate		Total Rate	
Minimum Bill ($/day)	0.170							
Energy Charges ($/kWh)								
On-Peak – Summer	0.14092	I	0.14687	R	0.00505	R	0.29284	R
Off-Peak – Summer	0.12162	I	0.05751	R	0.00505	R	0.18418	R
Super Off-Peak – Summer	0.03596	I	0.03545	R	0.00505	R	0.07646	R
On-Peak – Winter	0.17831	I	0.06571	R	0.00505	R	0.24907	I
Off-Peak – Winter	0.10134	I	0.05965	R	0.00505	R	0.16604	I
Super Off-Peak - Winter	0.03983	I	0.03732	R	0.00505	R	0.08220	I

Before one gets excited seeing above On peak 29.2 cents EPEV-M or better yet EPEV-H High On-peak Summer rates of 38 & 34 cents per kWh thus hoping to 'sell' solar back at 38 cents, it's important to note EPEV rates are isolated from PV. You can't sell power back to the Utility at EPEV rates. Instead they help the Utility understand if customers will still charge at very high On-peak rates (we won't) vs. far better Off-peak (we will).

So just look at the Super Off-Peak: 7.6 cents (Summer), 8.2 cents (Winter) we'll call 8.0 cents year-round. Car 2 on the grid getting 3 miles/kWh thus costs us just 2.7 cents/ mile … or only *95 cents for 35 miles per day!* Gas by contrast ($4/gallon) even in an ultra-high 50 MPG gasser is 8 cents/mile, or $2.80/day. Were gas half(!) or $2 gallon, car 2 is still less $ than a 50 MPG gasser. A typical 20 MPG gasser at today's gas is 20 cents/mile, $7/day vs our 95 cents/night. So a 20 MPG gasser costs $7/day, 7X what car 2 costs. For just a laugh a 12 MPG Hummer is around 10X the cost to drive our car, per mile!

Forget solar and this $20K utilitarian sedan is still better for us on EPEV-M than any gasser. Its limited 70-100 mile range works fine as a 2nd car, and like millions in the U.S. we're not in a freezing climate hitting range. We ordinarily go an average 35 miles/day and have an old remnant gasser (125K+ miles on its clock) for occasional long distances. Plus its cost of 95 cents/night, beats $7 costs in a 20 MPG gasser! Lastly all EV owners we know are excited; not only are the cars grin-inducing but there is also patriotism, national strength and independence to moving off oil. And in California electrons at night are ever more green (red, white & blue) as it quickly moves towards 33% renewables.

Subsidies (from which PV & EV Can be Weaned), + Other Factors that Made it Possible:

Some fundamental circumstances made EV+PV viable here already. They do not all apply in all places or situations, but are notable and 1st is **gas @ $4/gallon** in California. Yes, our gas is pricier here than much of U.S.; the $2,500- $3,000/year helps make EVs plausible. Were gas under $1 gallon like decades ago, there'd be no EVs now. So yes an EV's ride is better, but why put up with range limits if gas were just $1? If an obese gasser gets 15 MPG on $1 gas, just slap in a 30-gallon tank: manufacturers would still merrily supply endless SUVs. It's what they know. Yet gas ahead at $2+, or say $3 or more *nationwide* may become a new normal. Indeed the U.S. DOE expects gas *across the U.S.* to average $3,235 in 2011, up 28% over last year. We don't expect a return to gas under $2 long term and if that's right, EVs could begin to make new sense inter/nationally.

Next consider the **electric costs here.** Were our State's power still coming from big coal burning plants with few pollution controls, at 5 cents kWh that kills the solar PV part. Yes, dirt(y) cheap coal could run EVs at low cost yet that also destroys elegant advantages naturally making EVs better — and it drags them nearer pollution levels of gassers. Coal in EVs makes pollution from mining, & combustion due to Mercury, SOX, NOX, particulates etc. Here in California it's not such an issue since this State like others is quickly moving to new energy. We also enjoy **the U.S. Southwest's sun for PV,** and a benign climate **in the South & West for EVs.** That said even cool, cloudy Germany is way ahead on PV.

Cleaner surroundings have meant higher retail electric costs — and our **On peak** high rates made PV+EV viable too. Though costly upfront at $3.90/watt, the fixed $15.5K for PV was increasingly sensible vs. rising grid electric bills. Recall too we got **Federal tax credits** of $7.500X2 for cars 1 & 2 (because we pay taxes), and **State subsidies** in purchasing PV+EVs. True, far larger Federal subsidies go to oil & nuclear, so these here help level a playing field but fossil/nuclear industries are not excited to denote their own corporate welfare, something they've long required (and will do so for a long time to come).

PV+EV subsidies by contrast more visibly go at purchase to the end-consumers, typically in $ thousands or a significant dollar amount or percent vital for any purchaser. By contrast large taxpayer subsidies for oil and nuclear power go quietly to fewer recipients often in very big amounts. Not say $20K or $30K/each like incentives for PV/EV, they can instead be in hundreds of $ millions per project and add up to many $ billions or more for older industries facing inherent supply risks, or waste problems etc.

Little discussed are subsidies for oil & nuclear. Imagine if oil firms footed the huge bill to protect many strategic oil transit chokepoints like Straits of Hormuz from ongoing threats, a bill that's now paid by governments (e.g. us taxpayers). Cheap oil depends on it. Subsidies distort, and vast indirect ones for fossil fuels or nuclear all the more so.

Likewise nuclear power couldn't function without the enormous subsidies paid to it. After 50 years of commercial operations, that industry is still propped up. Imagine a proposed nuclear plant trying to line up much needed capital without guarantees by government like the Price-Anderson Nuclear Industries Indemnity Act that has Federal agencies (we taxpayers) covering liabilities for nuclear accidents over $12 billion. Yes 'hidden subsidies' may go just to a few large recipients only, not to end-buyers, yet are terrifically distorting nonetheless. Corporate welfare to aid oil & nuclear are just different kinds of subsidies — and much of it (unlike for PV/EV) really can't go away.

PV+EV by contrast is arguably a better solution ahead, *and can be weaned from subsidies.* Particularly after 2011 nuclear accidents in Japan, clean energy appears wiser today. Thinking about a quake/tsunami/nuclear tragedy in Japan it was likely right in the Q1 2005 ECO Report to emphasize nuclear's "radioactive fuel security/terrorism concerns, waste dilemma, and the fact one catastrophe might render billions of dollars of capacity into costly liabilities", and "how far removed costly nuclear plants are from distributed wind or solar generation that's easily made renewably". PV & EVs neither create, nor face inherent ongoing risk and they needn't be propped up long term.

Arguably the PV+EV subsidies may even end sooner than for oil & nuclear. That said we also observe credits etc received mattered greatly when we got our own solar PV & EV. Recall key numbers. We're making roughly 24 kWh/day from 6.5 kW and 60% of it is 3.8 kW from PV 1, so some 14.5 kW/day comes from the system that cost us $15.5K, or $3.90/watt *after key* credits. Now if we look at feeding our building only for years and ignore the no-gasoline part (no car 1), then most of 14.5 kWh/day on DR-SES On peak rates around 30 cents/kWh meant PV 1 makes $4.35 worth of power per day from sun. Over a month it was paying us back $130.00, and each year it paid us back $1,500 in needed building power that was not bought from the Utility.

Making roughly $1,500/year on PV 1, we'd approximately have hit payback after 10 years. *But* as we stress PV 1 cost 'only' $15.5K *after* a State subsidy near $4/watt, plus tax credit that together cut our costs in half. *Had we paid $30K* or $7.80/watt for PV 1, it would instead have taken us a far longer very undesirable 20+ years to reach paypack!!

20 years is clearly uneconomic, so subsidies for 3.8 kW mattered mightily. We don't consider the 2000's DR-SES rates just over 30 cents/kWh a subsidy though, since On peak power in San Diego actually has a much higher value; that's capitalism. Pricing more for (scarcer) daytime power, and less for the surplus (cheap) power at Midnight is a reflection of free markets (although much skewed by Utilities) and so it makes sense here. In sum, the greatly reduced prices when buying the PV and the EVs were significant.

Costs matter too in daily fueling terms. If PV 1 is regarded as 1st to car 1, & it gets 3 miles /kWh (MPK), then our suncar could go 45 miles/day on 14.k hWh 'solarjuice'. As could go each day more miles than we drive on average, there's enough to power car 1 all day with a modest amount (thanks TOU) left over for this building from just 3.8 kW.

Paying us roughly $7/day in car 1's avoided gas @35 miles/day plus about another $1.50/day for building's electricity on surplus PV 1, gives us $8.50/day, $250/month, or roughly $3,000/year by using PV+EV. That's better than a $1,500/year payback we'd estimated for building alone. Given car 1 drives better too than *any* comparable gasser (even without subsidies) we feel PV+EV makes a compelling case. Note too subsidies here may one day be eliminated, as PV may be in future well <$1/watt and EVs far cheaper one day (unlike unending problems with and so the subsidies for, oil & nuclear).

In sum 2 years of enjoyable driving hastened PV payback – we now have *free* power for our car plus for much of our building. Just by driving fun car 1 we had needed only 8-9 years to hit PV payback. We're now enjoying many free miles in car 1. We also love our $20K, 2nd car 2 with low costs of 2.7 cents/mile, or 95 cents/day, far better than *any* rock-oil gasser. We hope these rough back of envelope calculations are broadly informative about the costs, benefits, limits, joys and potential payback of PV-EV.

A Look Ahead:

PV+EV technologies are yet in infancy so leaps forward may be reasonably expected. Yes, our first 2 cars already seem already advanced compared to 'modern' rock-oil gassers (which benefit from a century of technological focus), but it is only the beginning.

State of art in PV is but a few decades old (few years, really) and much will come. Modern batteries (today Li-ion… tomorrow…?) are even newer. As an EV is like a big battery surrounded by wheels, its main limit is the battery. Today's batteries are still basic given EVs were vetted a century ago. But after being ignored the first few have proven wrong conventional wisdom that all EVs must be slow as golf carts, with a 20 mile range and look like a bizarre science fair project. Myths shattered, a battery race is on.

We love high-speed high performance cars. Consider then our 2008 car 1, maybe a first production modern EV and just out of the starting gate is comparable to the following famous super-gassers already -- while it also cost less any single one of these (!): the Aston Martin DBS; Corvette Z06; Ferrari California; Ford GT; Lamborghini Gallardo; Mercedes SL63 AMG; Porsche 911 Carrera GTS. Our car 1 at $92K before credits was in that sense a comparative deal! Plus uniquely our car can get (much) faster as batteries improve and 1,000 pound battery is replaced by a lighter one. Good luck to any gasser above getting faster, or better over time, or to be sure, in running on sunlight!

A century ago the buyers of gassers were made aware that its fuel was toxic, flammable, it needed gears (stick, now automatic) due to inefficient engines and frequent maintenance etc was mandatory. All that still holds for every gasser today, yet the public has over time pretty much assumed those and many other gasser limits away.

Recall gasser limits. The fuel is a toxic liquid, impossible to drill or refine on your own. Yes it is energy dense, but its finite, most of each gallon is from elsewhere and often distant places that hate us, while that (slow) gasser can't move 10 feet without it. And you have NO control over how much you'll pay at a gas pump for it. Basing our nation's transportation needs on such liquid & on gassers also harms American security.

There are limits to EVs too, just different ones. Batteries in particular should be better understood so there's no surprises. Take an EPA rated 244-mile range in car 1: if you're willing to drive this superb car slow as a gasser (Range mode), note speed (it's most efficient around 30-60 mph) and are OK impacting battery life by 100% fills — then you can get 244 miles on today's battery chemistry. That just needs to be understood.

Moreover passage of time makes all worse with EV batteries, since they age. State of art unbranded commodity batteries with 2008 technology in original car 1 decline by cycling, and calendar-aging, so performance degrades without mercy. This applies too to a 54 kWh figure (we've seen figures of 54 and 55 kWh, so use 54 here), and freezing temps harm range. But not to paint an overly pessimistic picture, a first battery in the Roadster is up to snuff with long-term warranty (like car 2) giving us 100,000 miles peace of mind.

We expect original batteries to deliver good performance in cars 1 & 2, at least 5 years or say 70,000 miles, guessing we may see roughly say, 70% left after years of use. Very importantly too battery & notably capacitor technologies improve, so it should all get much better as new battery and/or possibly capacitors are placed in ahead.

It feels as if interesting announcements come almost every week. For instance one report showed experimental lithium sulphur with possible high energy density (Nature Materials, 2460). An EV balances power (kW) 'to go fast', with energy density (kW/hr) to go 'far'; new chemistries may improve both (and the key cold weather performance). Or imagine a kind of capacitor/ battery hybrid; Nature reported on an "off-stoichiometry" (reactants/ products in unbalanced reaction) using LiFePO4, lithium iron phosphate.

Yet don't let this obscure a key point: the first 2008 car 1 is already capable at any speed. Without needing battery *unobtainium* (something great if it existed today, but doesn't), this Roadster is today catalyzing action on EVs. Expect to see new electric & hybrid cars emerge in this decade of 2011-2021. ***Now it's all about bringing down costs!***

There will be new concepts. For instance we noted 72 'MDS' in car 1, Miles per Day of Sun a bit like MPG in rock-oil gassers. But unlike oily MPG, MDS is clean, renewable, abundant. Or Car 1 has a big 68 kWh battery a bit like – but not limiting as, a gas tank. EV batteries are getting better/lighter and can extend range as they're replaced, unlike an unchanging fixed gas tank never allowing the gasser to become any lighter, faster & better.

There are inequities too. For instance EV drivers don't pay a gas tax rock-oil drivers must pay as for maintaining roads (46 cents/gallon in California); but that can be fixed by a simple fee on EVs. PV has special benefits too. Unlike say risks of a nuclear meltdown, PV means a SAFE 'nuclear-powered' car and building; here however the nuclear reaction is taking place 93 million miles away. It takes 8 minutes for energy (sunlight) to reach us, but it's continuous so the delay is unnoticed. It's entirely safe, is free, available hours defining daytime, enormously abundant and far more than we need.

All the above for a Roadster quicker than *almost any* gasser, save a few special ones like say quickest Ferraris, or Turbo Porsche. But consider instead of 0-60 mph, one looks at everyday driving enjoyment. Arguably here car 1 beats all gassers. With 100% available torque, quickness & unmatched feel, it's perhaps second to none.

Lastly it is not exceptionally difficult to rough out what an EV might cost you in cents per mile, at your locale if interested. On your Utility's website should be information on rates. Consider for example, for Baltimore Gas & Electric. They have a Time of Use cost schedule showing a nighttime (charging) rate of 9.8 cents per each kWh in Summers (and 9.0 cents in Winters, March 2011) that we'll call 10 cents.

Because early electric cars today go about 3 miles per kWh after charging losses, it means yours may go some 3 miles each kWh used, or 3 MPK. So just divide your Utility's night rate in cents per kWh/ by 3 to get your cost per mile. Look at say Baltimore, an EV there may cost around just 3.3 cents per mile on grid (10 cents kWh / by 3). That's much better than gasser costs, and numbers already appear to pencil out surprisingly well …

Forget oily old MPG. Faster better cars including sun-guzzlers that may use abundant clean sunshine can finally break the bonds of oil, and be a better solution to boot.

Next we'll take a brief look at electric bikes, which are on the horizon, too.

Electric Bikes

At left is early, heavy, primitive Bike #1 (blue); at right is better bike #2.

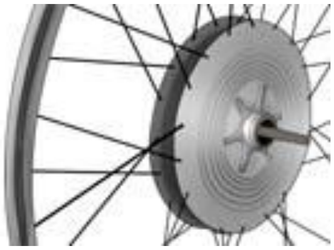
Having commuted for some time over 2002-03 on bike 1, we can say its lead acid battery pack was no fun and made it ponderous, awkward, hard to use and ride. Progressing in late 2000s to a bike 2, it uses a retrofit-style kit that converts an existing bike to hybrid using a far lighter battery pack (gray in middle of frame); this has been far better.

Some specifications on our #2 (above, right) hybrid human pedal/electric bike:

On this 2nd bike, right (in black) above, the rider can choose whether to use strictly their own human-pedal power — or can go variably with a thumb throttle anywhere from zero-electric assistance all the way to full electric power with no pedal effort, even uphill. It is utterly unlike old heavy lead-acid bike 1 (left) that is since only of historical interest.

A newer bike using Li batteries can go up to about 25 mph max on power alone. It can also be set to sense rider effort and assist that by that by a preset 75% assist, 150% assist etc. By running from our solar electricity, it is in a sense 'solar powered'. The console fits over an existing bike frame and allows regenerative braking too. This is a second-generation bike and as we note, far more advanced than a lead-acid battery bike.

Li-Mn Battery:
The battery is key to any EV, and here its using Li-Mn (Lithium-Manganese) cells with good energy density (100-200 Wh/kg). This bike's pack of minor note, uses a different battery chemistry from our first electric car and the results will be of interest. Much lighter than lead acid cells in Phase 1 bike, lighter too than one that might use say Ni-Mh cells, these Li-ion cells are however costly. The battery communicates with motor & console.

350W Motor 

Power is rated 350 W nominal and 700 W peak.
Nominal torque:10 N.m; Maximum torque: 32 N.m
4 power-assist levels: A motor gauge measures rider effort and can boost the assist from electric motor power by 35%, 75%, 150% or 300%, according to selected assist level.
Weight: 8.8 lb

Characteristics: External case is Aluminum
4 regenerating levels: Battery can be recharged while riding downhill or upon braking.

Command Console

Power-Assist controls 4 assistance levels. An analog display for power from battery.
Generation mode controls 4 regenerative settings. Displays energy to battery.
Console includes a multifunctional odometer that displays the following information:
- Current speed, - Tripmeter, - Odometer, - Chronometer, - Average speed,.
The control console includes a battery charge indicator that helps manage battery charge to prevent running out of energy on the return trip. However we are seeing less battery charge than we expected and will watch the battery over years.
Throttle: The throttle allows you to ride like a small scooter using thumb control. This is in addition to proportional power-assist. At full throttle the range is severely limited.

For the electric bikes here, see
http://wildershares.com/pdf/hybridbikespecs.pdf

So much for data for the head. What then does it *feel like,* in the *heart* to adopt EV+PV in one's own life and transport? Personal thoughts about the ride may be of some interest so worth perhaps a moment. We repost personal feelings from years prior to getting our 1st car as we looked forward to a 1st EV eagerly, yet it presented some mystery!

Reprise of a prior posting re: Real-World, First Test Drive of the coming 2008 EV
http://www.teslamotors.com/blog/handing-over-keys-vi-dr-rob-wilder

What Does this Electric Car Initially Feel Like to Drive?? First thoughts:

With pieces already by others on 1st impressions test driving the coming 2008 Roadster, I'll instead focus on some of my own feelings & concerns going into a first — and it turns out rather surprising — test drive. Please excuse the fairly personal nature of this post.

Since sending in a check long ago, I reckon I've 'sort of' owned an early 2008 Roadster sight unseen. But it still was a tremendous leap of faith for the whole family and me to have spent so much on a car that I knew so little about. So when the company asked if I wanted to actually test-drive a near-production car, I jumped at the chance.

First it meant this car itself was probably for real: at least I needn't endure years of ribbing from my wife for buying a non-existent car! Secondly with keys at last in hand, I was curious: what would I feel in my heart and head behind the wheel driving this unique, entirely new electric vehicle (EV)? Can EVs even begin to fulfill the promises?

I'd long been captured by the idea of wrapping a beautiful lightweight car body around thousands of Li-ion cells, with a strong AC motor and regenerative braking. But still it was all merely a thought: could it really come together as a great driving car?? Nobody had pulled it off in production so this Roadster was trying something pretty special. Certainly the world's major automobile manufacturers had ALL given up on EVs long ago as a mass production proposition and their comments about EVs since were derisive.

So there is a rather a lot riding on this coming car. Because I'm passionate about fast cars, emotional feedback was no small matter to me. But before going into the test drive, I'll share the thorny hurdle from when I first came across this car in concept long ago.

I'll admit straight off that the hurdle wasn't that it was electric. Rather it was the price: a quick calculation showed this would be not only the most expensive car I'd ever bought but roughly what I'd spent on all cars before in my life … all put together.

Yet in my gut, I felt an EV if put together in properly disruptive way absolutely *could* yield a car unlike any before. More than anything, that caused me to swallow and send a check … it was how much *better an EV could be,* by integrating right parts and thinking.

But whether this car could deliver when so many failed — still made this a leap of faith.

Mindful this car *might* deliver superior ride, more thrills at speed and be better all-round to boot profoundly changing perceptions — or instead could be the most expensive failure I'd ever known, I was going into this first actual test drive with a lot on my mind.

Walking up to this car, its mid-size and curvy proportions of a supercar stand out yet do not appear extravagant to my eye outside, nor once I first sit at the wheel. Happily it is appealing (it is pretty flashy yes, but) not too showy for my tastes inside or out.

I wanted it to be simply lovely; not over-the-top expensive-looking, nor plain, nor like some awkward science fair project as some EVs have been. I think its styling hits the nail on the head, elegant while singularly different, maintaining a nice sense of balance.

Whew(!) a first key hurdle is cleared. It's beautiful which is essential. It bears semblance to a lithesome Lotus Elise, or Exige though a bit longer wheelbase. However the Elise is evolving in appearance and this a bit larger Roadster seems more timeless to my eye.

Opening the door this doorsill is very high, much too high so it makes getting in a not happy experience for non-limber me. To their credit they lowered even higher(!) doorsills of an Elise and met added side-crash tests, but this doorsill is my biggest complaint on getting in. This clearly is going to be a long time complaint of mine about this car for years to come (but not related to its electric drivetrain, which is what's special)

Turning the key creates a buzzing and whirring but that's not too disconcerting and soon stops. The seats (near-production versions I think) hold one in tightly and I quickly adjust to the feel. Next on putting the car into gear 'D", I see there's creep programmed in so it feels like a gasoline-car (a 'gasser'). I thus lightly brake to prevent inching on ahead.

Next, allowing the car to gently move from the curb, I find steering is pretty stiff at very slow speed: this could take a bit of getting used to compared to power-assisted steering.

OK, deep breath… will this car meet my hopes when I tap the accelerator? I'm worried for example about a cogging feel, or this car may at last give sensation of just a an expensive golf cart. I'm hoping for something from this Roadster better than any EV I've driven. This is the first modern EV of consequence for sale and none heretofore shined.

Remarkably then a surprising feeling of abundance flows as I pull away from the curb even at slow speeds. An abundance of available pulling torque, and horsepower, of silence, of elegant engineering, and careful design is what this car 'is saying' to me.

Steering quickly lightens and my hopes for what an electric car *could be* begin to find basis in reality… so far so good, I begin to feel some feedback now behind the wheel. My apprehensions start to melt away. But I still need to push it, not treat this beast like something I'm glad can actually budge — but rather treat this as a real sports car.

At my first green light, I punch it: what really surprises me is how we pull away quickly with no flat spots in the motor's power, followed by my mouth feeling funny… I then notice I'm actually grinning. This is the 'EV grin' and it is indeed pretty wild.

So despite the conventional wisdom, EVs do not need to be slow like regular gassers.

I think about our solar-powered home: we make some 6.5 kW from sunlight that lands on our roof, so no unrest in the Middle East, nor deepsea drilling nor an oil spill, no terrorism at oil rigs or pipelines or refineries, nor huge nationalized oil interest nor private one can hamper my own drive. With 'my Roadster' (I'm beginning to *really* want this car, to get off oil and make my own fuel!) I should get 200+ MPG… heck, better than 1 million MPG because I *don't need* oil in the first place. I see quite little downside.

It’s now that I notice the speedometer says I’m going faster than I realize. I drive my gassers at high RPMs/low gears, using engine compression to slow that really telegraphs speed changes to driver. Lacking any engine sounds and not always hunting for a gear, I now find driving is a bit like a ‘game’ or Disney ride (remember Rocket Sled?!).

The turbine-like sound whirring behind my ears is relatively quiet. Having a motorcycle as a youth and owning very noisy older gassers today, I thought I might miss the instructive revving sounds of fossil fuels furiously converting into mainly waste heat in classic (read: old) British engines, but I find myself liking this EV silence quite a lot.

It strikes me that my long-term fuel costs should be better too; one expects gasoline to head upwards in cost. Yet for this Roadster, ‘fuel’ costs on solar amazingly enough, drop down to zero. Solar panels sitting silently on our roof pay for themselves in 10 years or even less; we’ve already had them for many years and so reckon in 2011 or so they’ll have paid for themselves — thereafter for decades we get green electron fuel, free.

Imagine that: free fuel from the sun + energy independence and a car faster than say a Porsche Cayman S … wow. It’s been said the stone-age didn’t end because we ran out of stones; combining elegant solar power with EVs just feels like a solution at hand.

Now a sports car needs competent brakes, a car is only as fast as its brakes. So I do a series of fast 0-50-0 stops/starts and detect no fade. Importantly, stopping distance is short, pedal feel excellent and degree of power assist right for me. Next up are ascending curves and chance for 20-50 mph bursts, to push handling closer to where I like to be.

I was convinced before this test drive I’d stay near speed limits, not push matters. Yet I kind of like to throw out rear wheels a bit in my Lotus 7. Mid-range acceleration and handling are my favorites. Tempted, I go into that first curve pushing matters a bit.

I’d note here probably the trait I seek most in any EV, or any gasser is lightness. Adding in lightness creates snowballing benefits like allowing for great handling, and it also makes for a better car. Heaviness has an opposite effect. So I am keenly aware of weight …

To briefly illustrate how far cars today drifted to obesity, if my three+ decades-old 1969 Lotus Super 7 TC weighing about 1,200 lbs was stacked on an identical one, *they both* would weigh *less than* a single Miata, considered among the lightest of modern cars.

Likewise two older classic Mini (Australian Moke) 4 seaters here each weigh about 1,500 lbs apiece. They’re great for family & fun, yet if stacked (as were actually designed to be!) both those would still weigh much less than most single 4-seaters today. And I don’t know how many 4 seater Minis it would take stacked, to equal a single morbidly obese Hummer in weight, but that’s probably worth a laugh. Weight matters.

Thus I’d been encouraged early on to see a high priority put on lowest possible weight, when I first saw the 2008 Roadster’s specs including use of carbon fiber and aluminum. Lightening is an area where mainstream manufacturers of even today’s gassers should turn attention to ahead, given their obese gassers can benefit (although not as much as EVs which are more efficient and weight-sensitive).

With this Roadster starting out having an aluminum extrusion frame and adding in more lightness such as via Li-ion batteries and carbon fiber body, they clearly were being attentive to every pound and this was pretty impactful upon me. So I went into this very first curve attentive to how heavy this near-mass-production Roadster would feel, and how it might handle. With batteries alone adding around 1,000 pounds, I think, truly the pounds being put elsewhere upon this car would be felt and count.

Aiming into my first curve at speed, I first hear a very heavy 'thunk, thunk, thunk' sound at wheels as I drift a bit over 'Botts' dots', those small raised yellow reflective markers in centerline here in California. Maybe it's because the car otherwise is so quiet or the batteries make it (I am guessing several hundred pounds amidships?) heavier than a say roughly 2,000 lb. Exige, that heavy thunking is quite noticeable to me.

As the car continues to drop into this curve, I hit the accelerator at the apex and boy, does the rush of this car make those problems go away! Unlike a gasser one commands loads of torque without ever bogging the engine down or needing to downshift. It's so cool; even though I am heading uphill overall, it seems effortless to hug curves at high cornering limit. It appears so balanced I don't think my passenger sweats our speed.

A fear I'd had driving very early EVs was this one might feel like it needed to be pushed uphill — I now see that's totally unfounded here. And importantly this car I'm driving isn't 'vaporware' like an EV great in concept, but that never comes to fruition. Likewise this battery solution here doesn't require *unobtanium* at all (a substance that's great, if only it existed at a viable cost, but doesn't yet today): it's 100% real.

I don't on this early test drive (of a non-final car) greatly notice the regenerative braking; I imagine it is dialed in not far from the feeling of strong engine compression slowing some high-revving gasser: the difference is that instead of wastefully heating brakes and trying to vent heat, energy captured slowing this EV extends its range. How stupid a gasser now seems, to expend energy uphill but recapture none back down!

[A brief note from 2011 is this regenerative braking on production car 1 now feels very comfortable after two full years. We use it to slow the car in everyday driving by lifting off the accelerator, rather than step on the brake… a slightly different way of driving, one that is more enjoyable and easier. A test drive of the newer 2011 car 2 felt like it has considerably less regeneration, which we'd increase. That said the $20K car 2 is far preferable to us for its cost, over any $20K gasser in the world!]

We take curve after curve and it's a whole lot of fun. As my test drive ends on this nearly-here-2008-production car, I'm surprised to find I now have much less of a 'Zen' attitude about actually getting my Roadster, compared to when I got in at the start of this drive. As others report, my feeling too is one of 'hey, I want this car as soon as I can get it!'

On first getting in for this test drive, a bicyclist had come over and asked what this car was … on reply he said he'd heard these were the most expensive cars ever made! I chuckled (can't afford something like that!) but also groan inside since this 2008 Roadster costs less $ than a German, British or Italian supercar of like performance.

But this is a crux of the matter: this Roadster may pretty radically alter perceptions of electric cars, importantly helping to start an interesting EV (with PV) future.

I thus hope once this 2008 Roadster comes out, a new reality that EVs really can exist (and be good) will stimulate movement by other manufacturers in the U.S. Asia, Europe etc to produce more affordable EVs, and still less costly ones soon after that.

The Roadster's mystique should dissipate as they come out and I look forward to that. But most of all I like the idea that we could all one day be driving a raft of great EV cars, many running on clean energy, and it's 'gassers' that will give us all a chuckle.

Reprising some prior Thoughts on a Coming 2008 Phase 1 EV
http://www.teslamotors.com/blog/powering-tesla-roadster-green-electrons

….
Having an EV plug in at home raises intriguing future possibilities. Potentially, home-owners could arbitrage the difference between very low cost power say 8 cents per kWh at night, when most plant capacity is just sitting idle – and much dearer costs for electricity during the daytime peak at maybe 25+ cents or more per kWh.

It might work like this: an electric car is based around a very big mobile battery. If that car has Vehicle to Grid (V2G) capability, it could also feed power back to the grid.

By charging up at night when juice is cheapest and able to regularly sell back io the grid by V2G if a signal is sent from Utility calling for it, an EV simply sitting there plugged in to the garage can be a money spinner for the home or building owner.

This has benefits for all, since one problem with renewable energy like solar, wind, micro-hydro and the like is that they are each *intermittent* and so ***not firm** sources* – more desirable energy storage created by future EVs might do a lot to advance practical growth of renewable energy globally once batteries improve. However batteries of today are still quite limited by their duty cycles, so this is now just concept.

As batteries improve to thousands of cycles life or are superseded by capacitors, this idea of V2G also can help Utilities also avoid building costly peaker plants, plus better use idle capacity at night. They'd be able to sell more power at night than otherwise, to EVs -- shaving peaks and leveling a total load they're required to supply. If distributed solar generation grows the Utilities may capture new revenue (despite solar power).

While EVs won't have V2G capability for at least several years, it may not be too far off. Today's Li-ion batteries have rather limited cycle life so it wouldn't make sense to hasten demise of those costly batteries for small nightly profit gains (a hardware issue). And communications protocols don't yet exist in the grid (software issue) but as we've seen with for instance personal computers & the internet, change can happened fast.

In sum we expect our coming car 1 may reflect undeniably how when disparate, fast-emerging technologies are put together well, the sum can be greater than the parts. Especially as an EV is combined with solar PV like a coming 2008 car 1, the two may prove this pairing viable and the driving frankly a joy.

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ECO Index for start of Q2 2011: 1 Addition to ECO Index, and No Deletions.
For start of Q2 2011 there was one Addition, & no Deletions. The 1 addition was GEVO in speculative biotech R&D for drop-in isobutanol, a possible renewable biofuel.

Summary

1st Quarter 2011 opened from the Clean Energy Index® (ECO) at 105.50 & closed at 108.92, for a small Q1 gain of +3.2%. For the past 2 years, after strong declines 2008 - early 2009, the clean energy ECO Index® tracker (PBW) is up some +40%, the progressive energy WHPRO Index tracker (PUW) is up +119%(!), the global clean energy NEX Index tracker (PBD) is up +45%, and HAUL Index® for global energy efficient transport is up +100%.

Of significance in Q1 has been deep change in Middle East & Northern Africa, affecting oil. Transport's dependency on oil points to an underlying fragility in our energy portrait — and it's a case to move beyond gas alone in running cars ahead. Greatly impactful in Q1 too was Japan's quake/ tsunami spotlighting weakness in nuclear power, and the risks of a grid relying solely on big, thermal central plants. For this Report we looked at the new, resilient, remarkably viable idea of Solar Power & Electric Cars — this attractive, practical and grin-inducing pairing has at last begun we feel to make economic sense.

There was 1 Addition to, and no Deletions from ECO Index® for start of Q2 2011.

Sincerely,

Dr. Rob Wilder
rwilder@wildershares.com

Appendix I: ECO Index in Q1, 03/15/2011: about 2 weeks before rebalance to start Q2 2011:

Company Name	Symbol	% Weighting
Polypore International	PPO	2.82%
Rubicon Technology	RBCN	2.70%
GT Solar International	SOLR	2.58%
Universal Display	PANL	2.55%
MEMC Electronic	WFR	2.53%
Amerigon	ARGN	2.50%
Sunpower	SPWRA	2.49%
First Solar	FSLR	2.48%
Yingli Green Energy	YGE	2.48%
Trina Solar	TSL	2.48%
SOLA International	SOL	2.38%
Quanta Services	PWR	2.35%
Zoltek Cos	ZOLT	2.31%
Suntech Power Holdings	STP	2.26%
Applied Materials	AMAT	2.25%
Aixtron SE	AIXG	2.25%
Ameresco	AMRC	2.18%
JA Solar Holdings	JASO	2.14%
Amyris	AMRS	2.10%
Advanced Battery Tech	ABAT	2.04%
Sociedad Quimica	SQM	2.04%
Itron	ITRI	2.03%
International Rectifier	IRF	2.03%
STR Holdings	STRI	1.98%
Om Group	OMG	1.95%
Canadian Solar	CSIQ	1.94%
Calpine	CPN	1.92%
FuelCell Energy	FCEL	1.86%
CPFL Energia S.A.	CPL	1.85%
Molycorp	MCP	1.83%
China Ming Yang	MY	1.80%
Maxwell Technologies	MXWL	1.77%
A123	AONE	1.72%
Ormat Technologies	ORA	1.67%
Tesla Motors	TSLA	1.67%
Idacorp	IDA	1.65%
Echelon	ELON	1.65%
Ener1	HEV	1.65%
Cosan	CZZ	1.63%
Power-One	PWER	1.62%
Air Products & Chem	APD	1.58%
American Superconduct.	AMSC	1.57%
Fuel Systems Solutions	FSYS	1.56%
Rare Element Resources	REE	1.54%
Cree	CREE	1.53%
Satcon Technology	SATC	1.44%
Broadwind	BWEN	1.30%
Energy Conversion	ENER	1.09%
Ballard Power	BLDP	0.67%
UQM Technologies	UQM	0.64%
China Wind Systems	CWS	0.48%
Ocean Power Technol.	OPTT	0.45%
Ascent Solar Technol.	ASTI	0.44%
China BAK Battery	CBAK	0.44%
Active Power	ACPW	0.42%
US Geothermal	HTM	0.39%
Comverge	COMV	0.31%

INDEX (ECO) SECTOR & STOCK WEIGHTS FOR THE START OF Q2 2011. 58 STOCKS.
Each stock freely floats according to its share price after rebalance.
*Stocks below $200 million in size at rebalance are banded with a 0.5% weight.

Renewable Energy Harvesting - 23% sector weight (10 stocks @2.05 each; +5 banded stocks)
**Ascent Solar,* ASTI. Solar, early-development stages in thin film CIGS flexible PV.
**Broadwind Energy*, BWEN. Wind, holds firms across supply chain in wind energy.
Canadian Solar, CSIQ. Solar, vertically integrated solar PV manufacturer, China.
China Ming Yang Wind, MY. Wind, large turbine manufacturer is pure play.
**China Wind Systems,* CWS. Wind, makes large forged turbine components.
First Solar, FSLR. Thin film, CdTe solar panels reducing silicon need and costs.
JA Solar, JASO. Solar, China-based sells PV modules in Asia, Europe, U.S., etc.
**Ocean Power Technologies,* OPTT. Wave power, speculative very early-stages.
Ormat, ORA. Geothermal, working too in areas of recovered heat energy.
SunPower, SPWR. Solar, efficient PV panels have all-rear-contact cells.
SunTech Power, STP. Solar, major producer of global PV based in China.
Trina Solar, TSL. Solar, produces ingots, wafers, solar PV modules; China-based.
**U.S. Geothermal,* HTM. Geothermal, site acquisition, PPAs, development-stage.
Yingli Green Energy, YGE. Solar, is vertically integrated PV manufacturer.
Zoltek, ZOLT. Wind, makes carbon fiber for wind blades, product lightening.

Power Delivery & Conservation - 27% sector weight (13 stocks @2.03% each; +1 banded)
Aixtron Aktiengesellschaft, AIXG. Deposition tools, efficient (O)LEDs, displays.
Ameresco, AMRC. Energy saving performance contracts, also in renewables.
Applied Materials, AMAT. PV & semi fabrication, LCD displays, crystalline solar.
**Comverge*, COMV. Demand-side energy management, building smarter grids.
Cree, CREE. LEDs, manufacturer in power-saving lumens, efficient lighting.
Echelon, ELON. Networking, better management of whole energy systems.
GT Solar, SOLR. Solar, PV manufacturing lines with automated fabrication.
Itron, ITRI. Monitoring, advanced energy metering, measurement, management.
MEMC, WFR. Producer of polysilicon used in many crystalline solar PV cells.
Quanta Services, PWR. Infrastructure, modernizing grid and power transmission.
ReneSola, SOL. Wafers, for silicon PV, mono and multicrystalline, China-based.
Rubicon, RBCN. Substrates, used in the production of LEDs for lighting.
STR Holdings, STRI. Encapsulants, broad technology in range of PV panels.
Universal Display, PANL. Organic light emitting diodes, OLED panel displays.

Energy Storage - 17% sector weight (8 stocks @2.00% each; +2 banded stocks)
Active Power, ACPW. Flywheels, uninterruptible power conditioning; non-chemical.
Advanced Battery, ABAT. Batteries, China based maker of Li-ion for diverse uses.
A123 Systems, AONE. Batteries, nanophosphate for EVs, grid, portable power.
**China BAK,* CBAK. Batteries, large China based OEM manufacturer of Li-ion cells.
Ener1, HEV. Batteries, diverse in Li-ion power storage, nanotechnology; fuel cells.
**Energy Conversion,* ENER. Thin film, amorphous flexible PV panels; also batteries.
Maxwell, MXWL. Ultracapacitors, alternative supplement for batteries, hybrids, UPS.
OM Group, OMG. Cobalt and other precursors, producer for Li-Ion batteries, FCs.
Polypore Intl., PPO. Separators, membranes used in Li-ion, Pb-acid battery cells.
Sociedad de Chile, SQM. Lithium, major Li supplier for batteries; also STEG storage.

Energy Conversion - 21% sector weight (10 stocks @2.00% each; +2 banded stocks)
American Superconductor, AMSC. Wind power converters; superconducting HTS.
Amerigon, ARGN. Thermoelectrics, waste heat to power energy conversion.
**Ballard Power,* BLDP. Mid-size fuel cell R&D, FCs potential in transportation.
FuelCell Energy, FCEL. Large fuel cells, stationary high-temp flex-fueled MCFCs.
Fuel Systems Solutions, FSYS. Gaseous fuels, ICEs in cleaner-fueled vehicles.
International Rectifier, IRF. Energy-saving, power conversion and conditioning.
Molycorp, MCP. Rare Earths, strategic elements in NdFeB magnets, wind power.
Power-One, PWER. Power conditioning, inverters & converters for renewables.
Rare Element Resources, REE. Rare Earths, holdings for strategic lanthanides.
Satcon, SATC. Inverters, DC/AC conversion in large utility-scale renewables.
Tesla Motors, TSLA. Electric vehicles, new pure-play in EVs, power systems.
**UQM Technologies,* UQM. Motors, control systems for EVs & hybrid vehicles.

Cleaner Fuels - 7% sector weight (4 stocks @1.75% each)
Air Products & Chemicals, APD. Hydrogen, is a supplier of industrial gases.
Amyris, AMRS. Biotech, speculative R&D on drop-in renewable diesel, jet fuels.
Cosan, CZZ. Biofuels, Brazil-based using sugarcane feedstock, ethanol exporter.
Gevo, GEVO. Biotech, speculative R&D, drop-in isobutanol, renewable biofuels.

Greener Utilities – 5% sector weight (3 stocks @1.66% each)
Calpine, CPN. Geothermal, major North American producer, low-carbon assets.
CPFL Energia S.A, CPL. Hydroelectric, Brazil Utility has larger, smaller hydro.
Idacorp, IDA. Hydroelectric, Utility has sizeable hydroelectric, some small h

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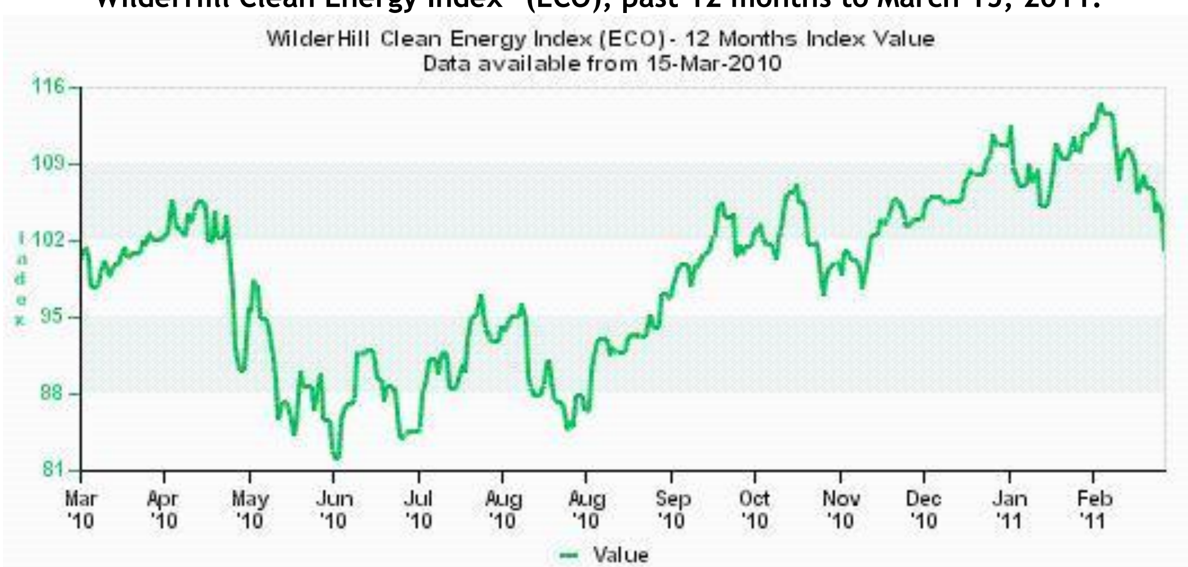
WilderHill Clean Energy Index® (ECO), past 12 months to March 15, 2011:



Appendix III: WHPRO in Q1 2011, 03/15/2011; about 2 weeks before rebalance to start Q2.

Company Name	Symbol	% Weighting
LSB Industries	LXU	2.96%
Chesapeake Energy	CHK	2.69%
Andersons	ANDE	2.52%
Corning	GLW	2.49%
Rockwood Holdings	ROC	2.43%
Mcdermott Intl	MDR	2.40%
EnergySolutions	ES	2.34%
Sasol Ltd.	SSL	2.32%
General Cable	BGC	2.30%
Range Resources	RRC	2.30%
Exide Technologies	XIDE	2.27%
Veeco Instruments	VECO	2.26%
Chicago Bridge & Iron Co NV	CBI	2.25%
Tenneco Automotive	TEN	2.25%
Centrais Elec. Brazil	EBR	2.21%
Owens Corning	OC	2.21%
Southwestern Energy	SWN	2.19%
Johnson Controls	JCI	2.15%
Cooper Industries	CBE	2.15%
Companhia Energetica de Minas	CIG	2.15%
Smith (a.o.)	AOS	2.13%
GrafTech International	GTI	2.09%
EnerSys	ENS	2.09%
Telvent GIT SA	TLVT	2.08%
Eaton	ETN	2.06%
Siemens Ag	SI	2.06%
Hexcel	HXL	2.04%
Regal Beloit	RBC	2.03%
Koninklijke Philips Electron	PHG	2.02%
Questar	STR	2.01%
Emerson Electric	EMR	2.00%
Foster Wheeler.	FWLT	1.99%
Harbin Electric	HRBN	1.93%
Covanta Holding	CVA	1.90%
Methanex	MEOH	1.88%
Elster Group	ELT	1.87%
ESCO Technologies	ESE	1.85%
Clean Energy Fuels	CLNE	1.85%
Energizer Holdings	ENR	1.76%
Tata Motors Ltd	TTM	1.75%
Westport Innovations	WPRT	1.75%
Cameco	CCJ	1.72%
Enersis S.A.	ENI	1.66%
Woodward	WWD	1.62%
EnerNOC	ENOC	1.54%
USEC	USU	1.51%
Denison	DNN	1.49%
Peerless Manufacturing	PMFG	0.48%
Rentech	RTK	0.47%
A-Power Energy	APWR	0.44%
Fuel Tech	FTEK	0.39%
SnartHeat	HEAT	0.38%
Kandi	KNDI	0.32%

Appendix IV: WilderHill Progressive Energy Index (WHPRO) at the Rebalance

Sectors & Stock Weightings: WilderHill Progressive Energy Index (WHPRO) for the start of Q2 2011. 53 stocks.

Each stock freely moves according to its share price after the rebalance;
***Banded stocks are those under $400 million in size and weighted at 0.5%.**

Alternative Fuel – 16% Sector Weight (8 stocks @2.00% each)
The Andersons, ANDE. Ethanol producer, corn-based; rail group in fuel transport.
Cameco, CCJ. Uranium fuel, one of largest producers; also does fuel processing.
Chesapeake Energy, CHK. Natural gas, one of larger U.S. independent producers.
Denison Mines, DNN. Uranium fuel, in/outside U.S; decommissions, waste recycling.
Methanex, MEOH. Methanol, liquid fuel can be derived from fossil fuels or organics.
Range Resources, RRC. Natural gas, produces in Appalachian & Gulf Coast regions.
Southwestern Energy, SWN. Natural gas, U.S. producer, also midstream services.
USEC, USU. Uranium fuel, converts ex-Soviet warheads to U.S. nuclear feedstock.

New Energy Activity – 23% Sector weight (11 stocks @2.09% each)
Cooper Industries plc, CBE. Energy efficiency, diverse in new LEDs, grid innovation.
Eaton, ETN. Hybrids, better electric and fluid power in truck & auto applications.
Foster Wheeler, FWLT. Infrastructure, engineering services in WtE, LNG, CCS.
GrafTech, GTI. Graphite, advanced electrodes for power generation, fuel cells.
Hexcel, HXL. Lighter composites, advanced structural reinforcement materials.
Johnson Controls, JCI. Building control, also advanced hybrid vehicle systems.
McDermott, MDR. Infrastructure, reduces coal emissions, constructs WtE facilities.
Owens Corning, OC. Materials lightening, building insulation composite materials.
Rockwood Holdings, ROC. Lithium battery recycling, lithium & cobalt supply.
Siemens AG, SI. Conglomerate, is diversified across energy innovation globally.
Veeco Instruments, VECO. Design, manufactures equipment for LED production.

Better Efficiency – 26% Sector Weight (13 stocks @2.00% each)
A.O. Smith, AOS. Energy efficiency innovations for water heating and monitoring.
Elster Group se, ELT. Metering innovations, power and grid 2-way communications.
Emerson Electric, EMR. Broad work in energy efficiency, storage, lately biofuels.
EnerNOC, ENOC. Demand response energy management, smarter grid efficiency.
Esco Technologies, ESE. Power grid, advances 2-way metering & communications.
General Cable, BGC. Power grid, high voltage transmission cable and wire products
Harbin Electric, **HRBN**. Linear motors for energy efficiency, propulsion, reliability.
Koninklijke Philips Electronics NV, PHG. Efficient LEDs, advanced industrial lighting.
LSB Industries, LXU. Greater energy efficiency in building end-use, heating, cooling.
Regal Beloit, RBC. Energy efficient motors, in commercial, industrial, homes etc.
SemiLEDs Corp. LEDS. Efficient LED light, Taiwan maker of high brightness chips.
Telvent GIT S.A, TLVT. Information technology for smarter grid, transport, energy.
Woodward, WWD. Energy controllers, optimization, industrial turbines in generation.

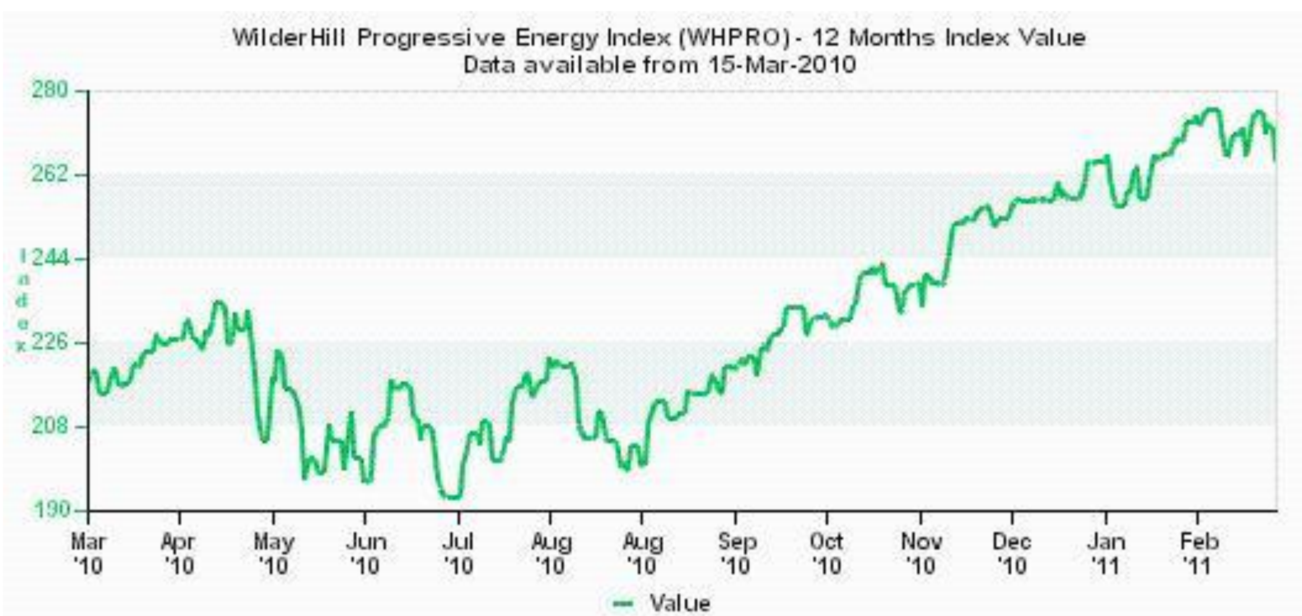
Conversion & Storage – 21% Sector weight (10 stocks @2.05% each+1 banded stock)
Altra Holdings, AIMC. Mechanical power transmission, electro-mechan conversion.
****A-Power***, APWR. Distributed power generation, micro-grid systems; China-based.
Chicago Bridge & Iron, CBI. Nat. gas; also better containment for next-gen nuclear.
Clean Energy Fuels, CLNE. Natural gas fleet vehicles, integration and distribution.
Covanta Holding, CVA. Incineration, converts waste to energy (WtE); conglomerate.

Energizer, ENR. Lithium, NiMH, various new battery and charger technologies.
Energy Solutions, ES. Spent nuclear fuel storage, fuel recycling and management.
EnerSys, ENS. Battery maker, for telecommunications, utilities, motive power.
Exide Technologies, XIDE. Better lead-acid batteries for motive, traction uses.
Tata Motors, TTM. Smaller & 'nano' vehicles, India-based with worldwide sales.
Westport Innovations, WPRT. Enables vehicles' use of natural gas, gaseous fuels.

Emission Reduction – 8% Sector Weight (3 stocks @2.00% each+4 banded stocks)
Corning, GLW. Diverse activity includes emissions reduction, filters, and catalysts.
****Fuel Tech NV***, FTEK. Post-combustion, control systems reducing NOx, pollutants.
****Peerless***, PMFG. Pollution reduction, effluent separation & filtration systems.
****Rentech***, RTK. Gas to liquids, converts synthetic gas from varied sources to fuels.
Sasol Ltd, SSL. Syngas to synthetic fuel; potential CO2 capture/sequestration (CCS).
****SmartHeat***, HEAT. Plate heat exchangers, making use of waste heat; China based.
Tenneco, TEN. Automotive end-of-pipe emissions controls, catalytic converters.

Utility – 6% Sector weight (3 stocks @2.00% each)
Companhia Energetica de Minas Cemig, **CIG**. Brazilian Utility, large hydroelectric.
Centrais Electricas Brasileiras, EBR. Brazilian Utility, large hydro, also nuclear.
Enersis, ***S.A.***, ENI. Chile, Argentina, Peru. Utility, lower-CO2 large hydroelectric.

WH Progressive Energy Index (WHPRO), past 12 months to March 15, 2011:



Appendix V: Rebalance for HAUL Index® for the start of Q2 2011

Wilder NASDAQ Global Energy Efficient Transport Index (HAUL). 38 stocks.

Alternative Vehicles. 10 stocks. 25% Sector weight; stocks @2.50% each.

AONE UQ	*A123 Systems (U.S).* Lithium ion battery maker, uses nanophosphate.
HEV US	*Ener1 (U.S.).* Lithium ion battery maker for electric cars, plug in hybrids.
MXWL US	*Maxwell (U.S.).* Ultracapacitors, can very rapidly store/release power.
PIA IM	*Piaggio & C. SpA (Italy).* Scooters include Vespa, developing hybrids.
SAFT FP	*Saft Groupe SA (France).* Advanced batteries in electric cars, subways.
1211 HK	*BYD (China).* Early production EV batteries, also builds entire EVs.
6674 JP	*GS Yuasa (Japan).* Li-ion batteries, in EV production partnerships.
9921 TT	*Giant (Taiwan).* Bike manufacturer also makes hybrid electric bikes.
051910 KS	*LG Chem (S. Korea).* Larger-format Li-ion cells in production EVs.
006400 KS	*Samsung SDI (S. Korea).* Li-ion cell maker in Korean JV for autos.

Rail & Subway Systems. 9 stocks. 25% Sector weight; stocks @2.77% each.

ALO FP	*Alstom SA (France).* More efficient rail infrastructure, high speed TGV.
BBD/B CN	*Bombardier (Canada).* Builds efficient locomotives, also in light rail.
CNI US	*Canadian National Railway (Canada).* Rail as 3x more efficient than trucks.
CSX US	*CSX Corp (U.S.).* Invests $1 billion in better Tier II locomotives; SmartWay.
NSC US	*Norfolk Southern (U.S.).* Software optimizes rail movement; SmartWay partner.
STS IM	*Ansaldo STS SpA (Italy).* New information technology for subways, rail.
UNP US	*Union Pacific (U.S.).* 3,000 fuel-efficient locomotives add to fleet; SmartWay.
WAB US	*Wabtec (U.S.).* Makes, services control systems in locomotives, subway cars.
7122 JP	*Kinki Sharyo (Japan).* Shinkansen Bullet Train; light mass transit vehicles.

Sea, Land, Air & Intermodal. 9 stocks. 25% Sector weight; stocks @2.77% each.

BOKA NA	*Koninklijke Boskalis NV (Netherlands).* Improving ports for global shipping.
CLNE US	*Clean Energy Fuels (U.S.).* Enables natural gas CNG in fleet buses, trucks.
FGP LN	*FirstGroup plc (U.K.).* Public transportation, in buses, rail and logistics.
MAERSKB	*Maersk A/S (Denmark).* Shipping, globally efficient transport of goods.
OSG US	*Overseas Shipholding (U.S.).* Bulk shipping, VLCCs, diversified LNG, CNG.
SGC LN	*Stagecoach Group plc (Scotland).* Trains, buses, trams, in U.S. and U.K.
TLVT US	*Telvent GiT S.A. (Spain).* Information technology, in transport, traffic, energy.
316 HK	*Orient Overseas Intl. (Hong Kong).* Container shipping and logistics.
7251 JP	*Keihin Corp (Japan).* Control systems for Honda's hybrids, light scooters.

Transport Innovation. 10 stocks. 25% Sector weight; stocks @2.50% each.

BG/ LN	*BG Group (U.K.).* Natural gas, CNG used as transportation fuels.
FSYS US	*Fuel System Solutions (U.S.).* Gaseous fuels, enables natural gas in engines.
KNIN VX	*Kuehne + Nagel AG (Switzerland).* Globally integrated logistics solutions.
PWTN SW	*Panalpina Welttransport AG (Switzerland).* Freight forwarding & logistics.
RS US	*Reliance Steel & Aluminum (U.S.).* Aluminum, used to lighten modern vehicles.
SGL GR	*SGL Carbon AG (Germany).* Advanced carbon composites, lightening.
SQM US	*Sociedad de Chile (Chile).* Lithium, is needed in electric & hybrid batteries.
TSLA UQ	*Tesla Motors (U.S.).* EV mass production, a pure-play BEV global leader.
WBC US	*Wabco (Belgium).* Control systems, better electronic automation in vehicles.
WPRT US	*Westport Innovations (Canada).* New technology advancing gaseous fuels.

Appendix VI: WilderHill New Energy Global Innovation Index (NEX) in Q1 2011.
Data below are from Q1 2011 at close on 3/15/2011,
about 2 weeks Before the Rebalance of NEX to start Q2 2011:

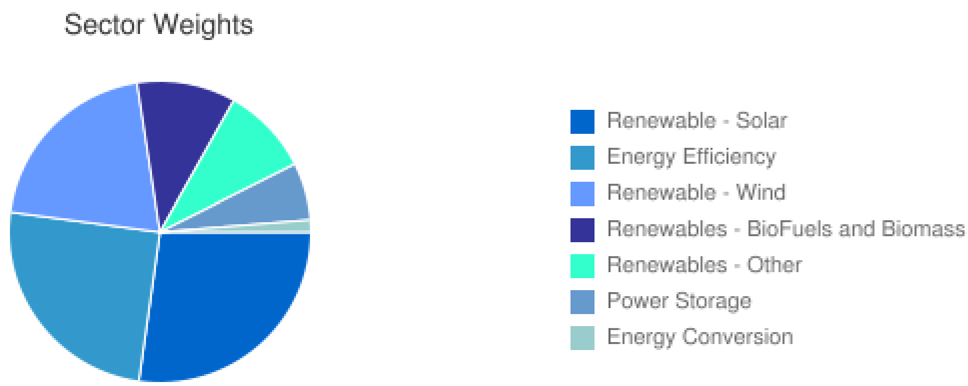
See also for more NEX data: http://www.nex-index.com/Constituents_And_Weightings.php

Name	**Country**	**Currency**	**Weight**	**Sector**
Enel Green Power SpA	IT	EUR	1.96 %	ROH
SolarWorld AG	DE	EUR	1.94 %	RSR
Universal Display Corp.	US	USD	1.87 %	EEF
Acciona S.A.	ES	EUR	1.87 %	RWD
Verbund AG	AT	EUR	1.79 %	ROH
GCL-Poly Energy Holdings Ltd.	HK	HKD	1.74 %	RSR
Energy Development Corp.	PH	PHP	1.72 %	ROH
centrotherm photovoltaics AG	DE	EUR	1.71 %	RSR
Amyris Inc	US	USD	1.70 %	RBB
Abengoa S.A.	ES	EUR	1.70 %	RBB
Seoul Semiconductor Co Ltd	KR	KRW	1.66 %	EEF
A.O. Smith Corp.	US	USD	1.65 %	EEF
International Rectifier Corp.	US	USD	1.61 %	EEF
EPISTAR Corp.	TW	TWD	1.60 %	EEF
Johnson Controls Inc.	US	USD	1.60 %	EEF
Gamesa Corporacion Tecnologica S.A.	ES	EUR	1.58 %	RWD
SMA Solar Technology AG	DE	EUR	1.57 %	RSR
Yingli Green Energy Holding Co. Ltd. ADS	US	USD	1.54 %	RSR
First Solar Inc.	US	USD	1.54 %	RSR
SunPower Corp. Cl A	US	USD	1.53 %	RSR
Trina Solar Ltd. ADS	US	USD	1.52 %	RSR
Iberdrola Renovables S.A.	ES	EUR	1.51 %	RWD
GT Solar International Inc.	US	USD	1.51 %	RSR
EDP Renovaveis S/A	PT	EUR	1.51 %	RWD
MEMC Electronic Materials Inc.	US	USD	1.51 %	RSR
Contact Energy Ltd.	NZ	NZD	1.49 %	ROH
EDF Energies Nouvelles S.A.	FR	EUR	1.47 %	RWD
Vestas Wind Systems A/S	DK	DKK	1.46 %	RWD
Itron Inc.	US	USD	1.45 %	EEF
Renewable Energy Corp. ASA	NO	NOK	1.43 %	RSR
Novozymes A/S Series B	DK	DKK	1.43 %	RBB
Suntech Power Holdings Co. Ltd. ADS	US	USD	1.41 %	RSR
Fortum Oyj	FI	EUR	1.41 %	RBB
Power Integrations Inc.	US	USD	1.41 %	EEF
Rockwool International A/S Series B	DK	DKK	1.40 %	EEF
Meyer Burger Technology AG	CH	CHF	1.39 %	RSR
Tesla Motors Inc.	US	USD	1.37 %	EEF
Kingspan Group PLC	IE	EUR	1.35 %	EEF
Ormat Technologies Inc.	US	USD	1.34 %	ROH
China Longyuan Power Group Corp. Ltd.	HK	HKD	1.33 %	RWD
Covanta Holding Corp.	US	USD	1.31 %	RBB
JA Solar Holdings Co. Ltd. ADS	US	USD	1.31 %	RSR
Cosan S/A Industria e Comercio	BR	BRL	1.30 %	RBB
China WindPower Group Ltd.	HK	HKD	1.28 %	RWD
Power-One Inc.	US	USD	1.28 %	EEF
China High Speed Transmission Equipment	HK	HKD	1.22 %	RWD
Polypore International Inc.	US	USD	1.21 %	PWS
STR Holdings Inc	US	USD	1.18 %	RSR

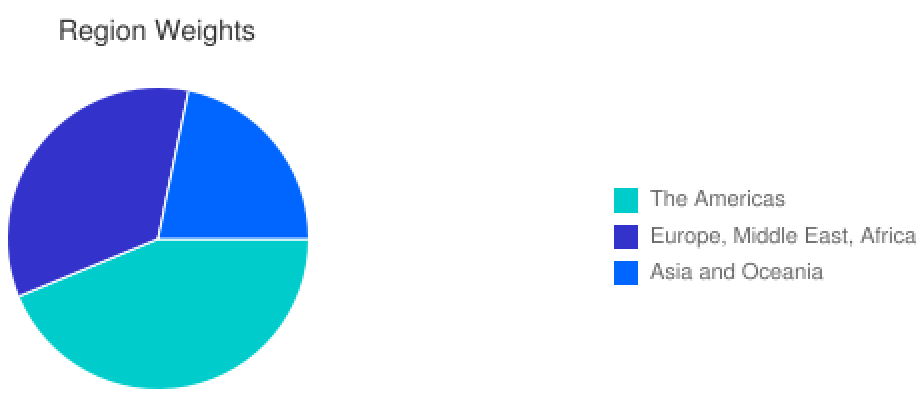
Xinjiang Goldwind Science & Technology	HK	HKD	1.13 %	RWD
China Suntien Green Energy Corp Ltd	HK	HKD	1.12 %	RWD
China Ming Yang Wind Power Group Ltd	US	USD	1.11 %	RWD
Cree Inc.	US	USD	1.10 %	EEF
Trony Solar Holdings Co Ltd	HK	HKD	1.09 %	RSR
Meidensha Corp.	JP	JPY	1.08 %	EEF
American Superconductor Corp.	US	USD	1.01 %	RWD
Saft Groupe S.A.	FR	EUR	0.99 %	PWS
Molycorp Inc	US	USD	0.84 %	PWS
Eaga PLC	GB	GBp	0.77 %	EEF
GS Yuasa Corp.	JP	JPY	0.77 %	PWS
A123 Systems Inc.	US	USD	0.76 %	PWS
BYD Co. Ltd.	HK	HKD	0.73 %	PWS
FuelCell Energy Inc.	US	USD	0.71 %	ECV
LSB Industries Inc	US	USD	0.70 %	ROH
Nordex AG	DE	EUR	0.59 %	RWD
Fuel Systems Solutions Inc.	US	USD	0.58 %	ECV
Aerovironment Inc	US	USD	0.55 %	EEF
Rubicon Technology Inc.	US	USD	0.55 %	EEF
Q-Cells AG	DE	EUR	0.52 %	RSR
Ayen Enerji AS	TR	TRY	0.45 %	ROH
Ameresco Inc	US	USD	0.44 %	EEF
Roth & Rau AG	DE	EUR	0.42 %	RSR
Sechilienne-Sidec	FR	EUR	0.42 %	RBB
Elster Group SE	US	USD	0.42 %	EEF
PV Crystalox Solar PLC	GB	GBp	0.42 %	RSR
Zoltek Cos.	US	USD	0.41 %	RWD
Phoenix Solar AG	DE	EUR	0.40 %	RSR
Zhejiang Yankon Group Co. Ltd. A	CN	CNY	0.39 %	EEF
Taewoong Co. Ltd.	KR	KRW	0.39 %	RWD
China Datang Corp Renewable Power Ltd	HK	HKD	0.38 %	RWD
Solar Millennium AG	DE	EUR	0.37 %	RSR
Neo Solar Power Corp.	TW	TWD	0.36 %	RSR
Sao Martinho S/A Ord	BR	BRL	0.35 %	RBB
Gurit Holding AG	CH	CHF	0.35 %	RWD
Apollo Solar Energy Technology Ltd	HK	HKD	0.35 %	RSR
Praj Industries Ltd.	IN	INR	0.34 %	RBB
Echelon Corp.	US	USD	0.34 %	EEF
EnerNOC Inc.	US	USD	0.34 %	EEF
Brasil Ecodiesel Industria e Comercio de Bio	BR	BRL	0.33 %	RBB
Wasion Group Holdings Ltd.	HK	HKD	0.33 %	EEF
Neo-Neon Holdings Ltd.	HK	HKD	0.31 %	EEF
NPC Inc.	JP	JPY	0.30 %	RSR
Hansen Transmissions International N.V.	GB	GBp	0.29 %	RWD
Takuma Co. Ltd.	JP	JPY	0.28 %	RBB
Advanced Battery Technologies Inc.	US	USD	0.25 %	PWS
Broadwind Energy Inc.	US	USD	0.24 %	RWD
Maxwell Technologies Inc.	US	USD	0.22 %	PWS
Infigen Energy	AU	AUD	0.21 %	RWD
Ener1 Inc.	US	USD	0.20 %	PWS
Energy Conversion Devices Inc.	US	USD	0.18 %	RSR
Tanaka Chemical Corp.	JP	JPY	0.13 %	PWS

Index Sector Information for Tue Mar 15, 2011		
Key	**Sector**	**Weight**
RSR	Solar	27.24 %
EEF	Energy Efficiency	24.87 %
RWD	Wind	20.45 %
RBB	BioFuels and Biomass	10.58 %
ROH	Renewables - Other	9.45 %
PWS	Power Storage	6.11 %
ECV	Energy Conversion	1.29 %

March 15, 2011 at close of markets:



Index Region-of-Listing Information for Tue Mar 15, 2011	
Region	**Weight**
The Americas	43.78 %
Europe, Middle East, Africa	34.48 %
Asia & Oceania	21.74 %



Appendix VII: WilderHill New Energy Global Innovation Index (NEX) to start Q2 2011.

For more on daily data for the dynamic NEX Index components and weights, see,
http://www.nex-index.com/Constituents_And_Weightings.php
http://www.nex-index.com/about_nex.php

NEX Index Components to start Q2 2011. 98 stocks.

The WilderHill New Energy Global Innovation Index (NEX) rebalances quarterly on the last trading day of March, June, September and December.
Calculation Method Modified Equal Weighted
Component Change - Rebalance

Company Name	Country	Currency	Weight	Sector
Contact Energy Ltd	NEW ZEALAND	NZD	1.71%	ROH
Enel Green Power SpA	ITALY	EUR	1.71%	ROH
Energy Development Corp	PHILIPPINES	PHP	1.71%	ROH
Ormat Technologies Inc	UNITED STATES	USD	1.71%	ROH
Verbund AG	AUSTRIA	EUR	1.71%	ROH
Rockwool International A/S	DENMARK	DKK	1.41%	EEF
International Rectifier Corp	UNITED STATES	USD	1.41%	EEF
AO Smith Corp	UNITED STATES	USD	1.41%	EEF
Seoul Semiconductor Co Ltd	SOUTH KOREA	KRW	1.41%	EEF
Johnson Controls Inc	UNITED STATES	USD	1.41%	EEF
Power-One Inc	UNITED STATES	USD	1.41%	EEF
Kingspan Group PLC	IRELAND	EUR	1.41%	EEF
Epistar Corp	TAIWAN	TWD	1.41%	EEF
Meidensha Corp	JAPAN	JPY	1.41%	EEF
Tesla Motors Inc	UNITED STATES	USD	1.41%	EEF
Cree Inc	UNITED STATES	USD	1.41%	EEF
Universal Display Corp	UNITED STATES	USD	1.41%	EEF
Power Integrations Inc	UNITED STATES	USD	1.41%	EEF
Itron Inc	UNITED STATES	USD	1.41%	EEF
First Solar Inc	UNITED STATES	USD	1.41%	RSR
Centrotherm Photovoltaics AG	GERMANY	EUR	1.41%	RSR
STR Holdings Inc	UNITED STATES	USD	1.41%	RSR
JA Solar Holdings Co Ltd	UNITED STATES	USD	1.41%	RSR
Renewable Energy Corp ASA	NORWAY	NOK	1.41%	RSR
GCL-Poly Energy Holdings Ltd	HONG KONG	HKD	1.41%	RSR
Trony Solar Holdings Co Ltd	HONG KONG	HKD	1.41%	RSR
Solarworld AG	GERMANY	EUR	1.41%	RSR
Suntech Power Holdings Co Ltd	UNITED STATES	USD	1.41%	RSR
Meyer Burger Technology AG	SWITZERLAND	CHF	1.41%	RSR
GT Solar International Inc	UNITED STATES	USD	1.41%	RSR
MEMC Electronic Materials Inc	UNITED STATES	USD	1.41%	RSR
SunPower Corp	UNITED STATES	USD	1.41%	RSR
Yingli Green Energy Holding Co Ltd	UNITED STATES	USD	1.41%	RSR
Trina Solar Ltd	UNITED STATES	USD	1.41%	RSR
SMA Solar Technology AG	GERMANY	EUR	1.41%	RSR
EDF Energies Nouvelles SA	FRANCE	EUR	1.34%	RWD
Acciona SA	SPAIN	EUR	1.34%	RWD
Gamesa Corp Tecnologica SA	SPAIN	EUR	1.34%	RWD
EDP Renovaveis SA	PORTUGAL	EUR	1.34%	RWD
China High Speed Transmission	HONG KONG	HKD	1.34%	RWD
Xinjiang Goldwind Science & Technology	HONG KONG	HKD	1.34%	RWD
China Suntien Green Energy Corp Ltd	HONG KONG	HKD	1.34%	RWD
China Datang Corp Renewable Power Co Ltd	HONG KONG	HKD	1.34%	RWD
China WindPower Group Ltd	HONG KONG	HKD	1.34%	RWD
China Longyuan Power Group Corp	HONG KONG	HKD	1.34%	RWD
Iberdrola Renovables SA	SPAIN	EUR	1.34%	RWD
China Ming Yang Wind Power Group Ltd	UNITED STATES	USD	1.34%	RWD
American Superconductor Corp	UNITED STATES	USD	1.34%	RWD
Vestas Wind Systems A/S	DENMARK	DKK	1.34%	RWD

Novozymes A/S	DENMARK	DKK	1.27%	RBB
Abengoa SA	SPAIN	EUR	1.27%	RBB
Amyris Inc	UNITED STATES	USD	1.27%	RBB
Sechilienne-Sidec	FRANCE	EUR	1.27%	RBB
Covanta Holding Corp	UNITED STATES	USD	1.27%	RBB
Cosan SA Industria e Comercio	BRAZIL	BRL	1.27%	RBB
Fortum OYJ	FINLAND	EUR	1.27%	RBB
Molycorp Inc	UNITED STATES	USD	1.13%	PWS
A123 Systems Inc	UNITED STATES	USD	1.13%	PWS
Byd Co Ltd	HONG KONG	HKD	1.13%	PWS
Saft Groupe SA	FRANCE	EUR	1.13%	PWS
GS Yuasa Corp	JAPAN	JPY	1.13%	PWS
Polypore International Inc	UNITED STATES	USD	1.13%	PWS
FuelCell Energy Inc	UNITED STATES	USD	0.75%	ECV
Fuel Systems Solutions Inc	UNITED STATES	USD	0.75%	ECV
LSB Industries Inc	UNITED STATES	USD	0.49%	ROH
Ayen Enerji AS	TURKEY	TRY	0.49%	ROH
Aerovironment Inc	UNITED STATES	USD	0.40%	EEF
Echelon Corp	UNITED STATES	USD	0.40%	EEF
Neo-Neon Holdings Ltd	HONG KONG	HKD	0.40%	EEF
Wasion Group Holdings Ltd	HONG KONG	HKD	0.40%	EEF
Rubicon Technology Inc	UNITED STATES	USD	0.40%	EEF
Zhejiang Yankon Group Co Ltd	CHINA	CNY	0.40%	EEF
Ameresco Inc	UNITED STATES	USD	0.40%	EEF
EnerNOC Inc	UNITED STATES	USD	0.40%	EEF
Elster Group SE	UNITED STATES	USD	0.40%	EEF
NPC Inc/Japan	JAPAN	JPY	0.40%	RSR
Apollo Solar Energy Technology	HONG KONG	HKD	0.40%	RSR
PV Crystalox Solar PLC	UNITED KINGDOM	GBp	0.40%	RSR
Neo Solar Power Corp	TAIWAN	TWD	0.40%	RSR
Q-Cells SE	GERMANY	EUR	0.40%	RSR
Roth & Rau AG	GERMANY	EUR	0.40%	RSR
Solar Millennium AG	GERMANY	EUR	0.40%	RSR
Phoenix Solar AG	GERMANY	EUR	0.40%	RSR
Taewoong Co Ltd	SOUTH KOREA	KRW	0.38%	RWD
Zoltek Cos Inc	UNITED STATES	USD	0.38%	RWD
Nordex SE	GERMANY	EUR	0.38%	RWD
Hansen Transmissions International NV	UNITED KINGDOM	GBp	0.38%	RWD
Broadwind Energy Inc	UNITED STATES	USD	0.38%	RWD
Gurit Holding AG	SWITZERLAND	CHF	0.38%	RWD
Sao Martinho SA	BRAZIL	BRL	0.36%	RBB
Takuma Co Ltd	JAPAN	JPY	0.36%	RBB
Praj Industries Ltd	INDIA	INR	0.36%	RBB
Brasil Ecodiesel Industria e Comercio	BRAZIL	BRL	0.36%	RBB
Gevo Inc	UNITED STATES	USD	0.36%	RBB
Ener1 Inc	UNITED STATES	USD	0.32%	PWS
Tanaka Chemical Corp	JAPAN	JPY	0.32%	PWS
Advanced Battery Technologies Inc	UNITED STATES	USD	0.32%	PWS
Maxwell Technologies Inc	UNITED STATES	USD	0.32%	PWS

1 Addition

Name	**Country**	**Ticker**	**WilderHill New Energy**
Gevo Inc	UNITED STATES	GEVO	RBB

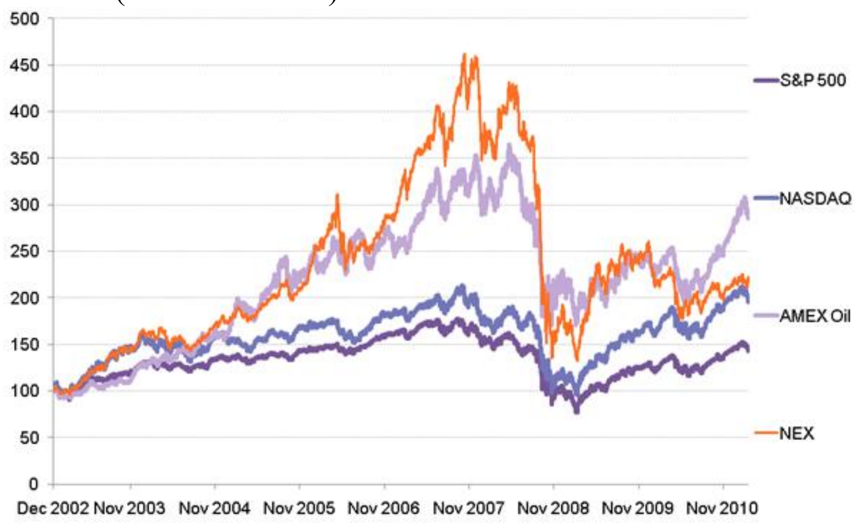
3 Removals

Name	**Country**	**Ticker**	**WilderHill New Energy**
Eaga PLC	UNITED KINGDOM	EAGA	EEF
Energy Conversion Devices Inc	UNITED STATES	ENER	RSR
Infigen Energy	AUSTRALIA	IFN	RWD

Here are links to quotes to the NEX Index available on the web:

NEX Quotes & Data	Ticker	Bigcharts	Bloomberg	Marketwatch	Yahoo	
USD Price Index	**NEX**	51599W10	NEX:IND	NEX	^NEX	
EUR Price Index	NEXEU	26499Z42	NEXEU:IND	NEXEU	^NEXEU	
GBP Price Index	EXBP	26499Z40	NEXBP:IND	NEXBP	^NEXBP	
JPY Price Index	NEXJY	26499Z38	NEXJY:IND	NEXJY	^NEXJY	
USD Total Return Index	NEXUST	26499Z43	NEXUST:IND	NEXUST	^NEXUST	
EUR Total Return Index	NEXEUT	26499Z41	NEXEUT:IND	NEXEUT	^NEXEUT	
GBP Total Return Index	NEXBPT	26499Z39	NEXBPT:IND	NEXBPT	^NEXBPT	
JPY Total Return Index	NEXJYT	26499Z37	NEXJYT:IND	NEXJYT	^NEXJYT	

January 2003-March 2011: the NEX Index (**orange**), AMEX Oil (**purple**), NASDAQ (**blue**), and the S&P500 (**reddish-brown**):



AMEX Oil, Nasdaq and S&P 500 rebased *Source: Bloomberg New Energy Finance*

30 Dec 2002 = 100

(The NEX Index only, is a unique partnership between Bloomberg New Energy Finance based in London, and Josh Landess of First Energy Research LLC based in U.S., and Dr. Rob Wilder of WilderHill Indexes in the U.S.; the NEX is also addressed in prior reports).
