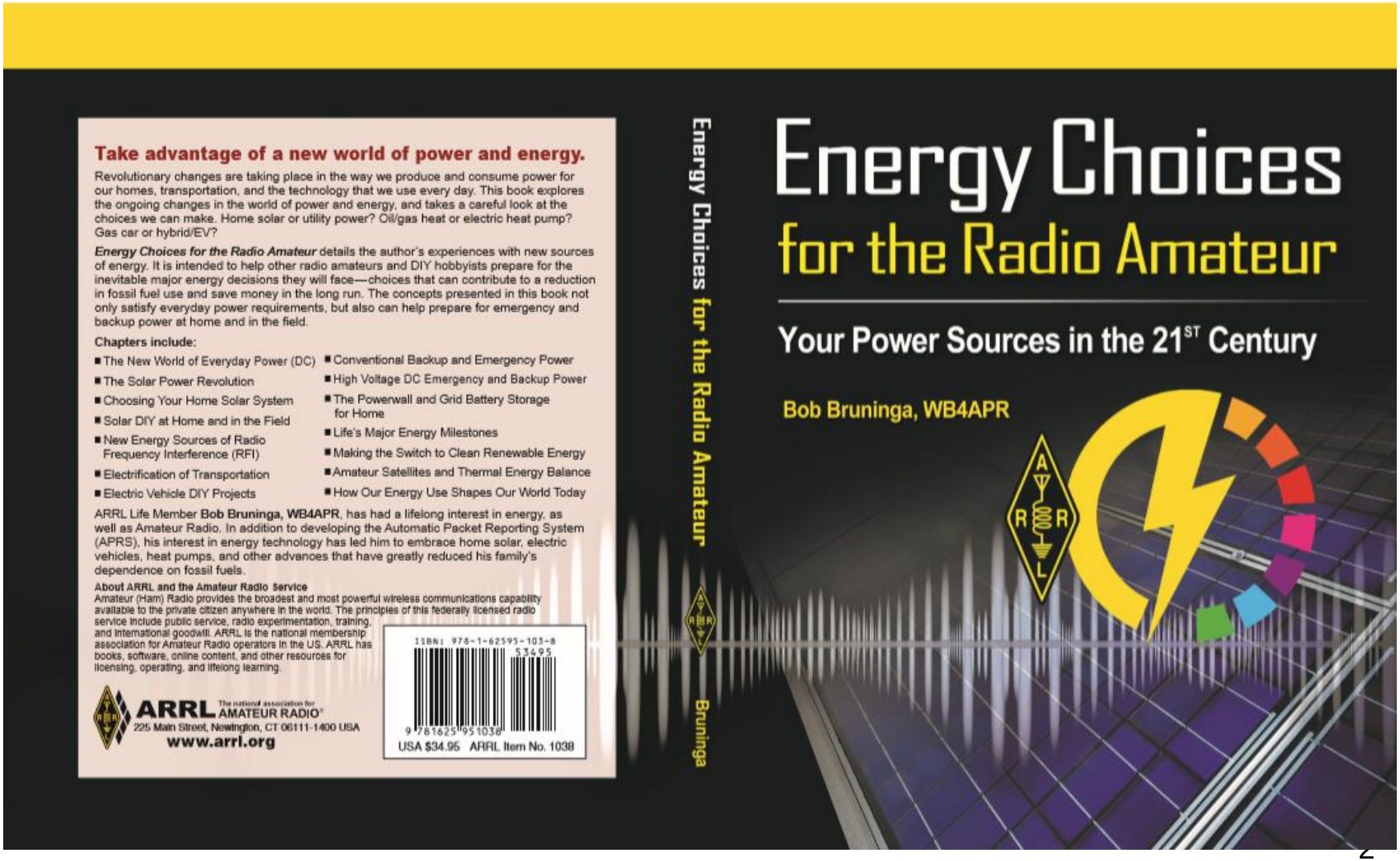
Energy Choices and Emergency power for the Ham

RATPAC

12 Nov 2020

ARRL Book - Power and Energy!



May QST- Power and Energy!

Bob Bruninga, WB4APR, wb4apr@arrl.net

Eclectic Technology

Your Own Microgrid

The popularity and economy of residential solar power has been increasing in large part thanks to *grid-tie* (GT) *inverters* that deliver solar-generated power directly to the home without the need for storage batteries. They do this by maintaining a constant balance between the electricity available from the solar panels and the electricity available from the commercial power grid, switching back and forth as needed.

Three GT Inverter Types

A *string inverter* accommodates up to 14 solar panels in series to a maximum of about 400 V, where lower currents allow common #12 wiring.

Fortunately, SMA Sunny Boy GT string inverters, and possibly others, offer 15 A, 120 V ac *secure power outlets*, as shown in Figure 1. A *grid-down switch* allows power to be redirected to this outlet from an alternative source.

Making a Microgrid for Emergency Power

Solar panels are the obvious alternative if the sun is shining, but at night or on cloudy days, the inverters could still provide ac power to this outlet from a hybrid car or electric vehicle (EV) battery. Hybrids, with their 50 kW generators, can automatically run their engines as needed to meet any long-term power draw. Although EVs don't have generators, their orders-of-magnitude-larger batteries can provide emergency power for days or even a week. Plus, an EV can be recharged from the solar panels during the day and provide both transportation and nighttime electricity almost indefinitely.

This combination of GT-inverter-based solar power and battery storage, provided by a hybrid vehicle or an EV, can be an economical solution for the amateur who wants the benefits of solar power with a secure backup in case commercial power fails — in other words, an independent micro power grid. Of course, this *microgrid* idea only works with string inverters that have secure power outlets and cannot be done with microinverters or optimizers.

Figure 1 — A grid-tie string inverter with a grid-down secure power outlet on the right.

See the author's new book, Energy Choices for the Radio Amateur, *available from your dealer or from the ARRL Store at* **www.arrl.org/shop**.

Six Disruptive Technologies in Energy/Power

1. Universal P.S. 100-240 VAC = 100-330VDC
2. LED Lighting Everywhere
3. Solar Power now cheaper than Coal and gas
4. Hybrids – 50 kW generator in your driveway
5. EV's now Better, Faster, Cleaner, Quieter, Safer, Cheaper to buy, Cheaper to Operate, Cheaper to maintain than average gas car
6. Whole house Battery Backup – Power Wall

- What's in Common? HVDC!

Energy – More than a Hobby!

It can save MONEY!

www.aprs.org/alternative-energy.html

My Background

Energy!

←1965

APRS

1990

Emergency Power and Energy!

Emergency Response depends on Power & Energy!

It's a whole new world of Power

WB4APR (APRS)

Field Day* * *

Satellites

If you want some SERIOUS portable power,

Think EV!

Every hybrid has 50 kW generator

A plug-in EV has from 16 to 85 kWh of Battery Storage!
And can power a house for a week or a month

SERIOUS
Battery power

Leaf
40 kWh

3 year old off-lease used is only $9,000

Bolt = 60 batts

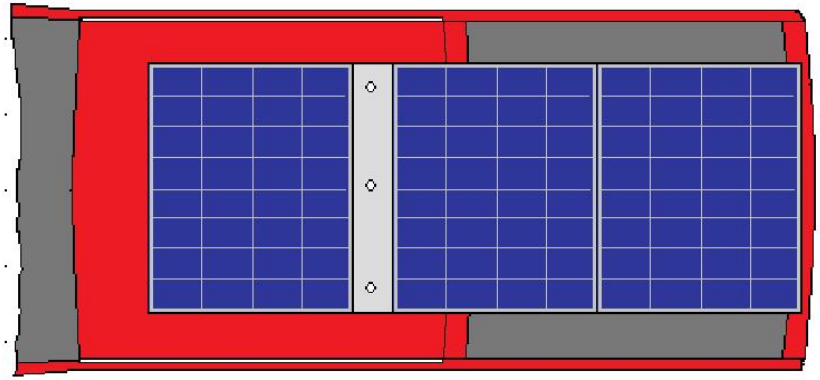
Same as 3 Tesla Power walls costing $21,000

Emergency Power – CQ, October

Back to the Future

FrankenVolt

240 Watts and +5 cuft capacity



240 Watts for portable operations

Gains 30 mi per week

Trunk still opens normally

Total impact on car is 3 pieces of plywood

SERIOUS Generator Power

Plugin Hybrids = 50 kW generator

Plug-in Hybrids have at least 50 kW generators.

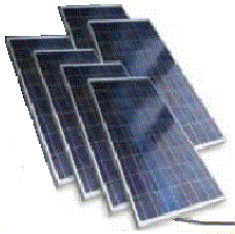
Can power a house for a week or a month

Chrysler Pacifica Minivan

Same as 1 Tesla Power wall costing $7,000 + Generator!

Solar and EVs – The Perfect Marriage

12 Panels ($1200)



Prius

Pacifica Minivan

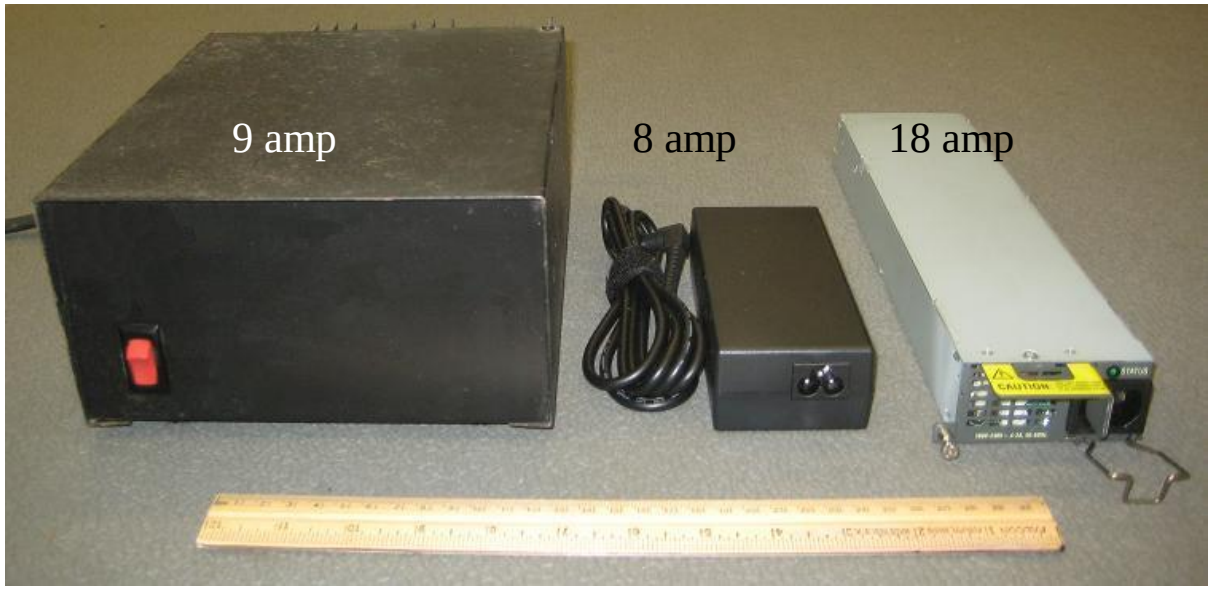
Can fully charge a plugin everyday… FOREVER!

No more $2,000,000,000 per day for overseas oil

No more foreign dependence, no more price fluctuation

No more **oil**, no more insecurity, no more oil wars

It's a new world of Power

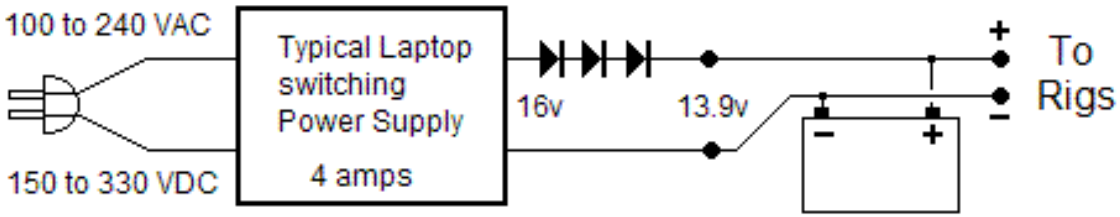


Power Systems have CHANGED!

Switching supply takes up 8% of the space

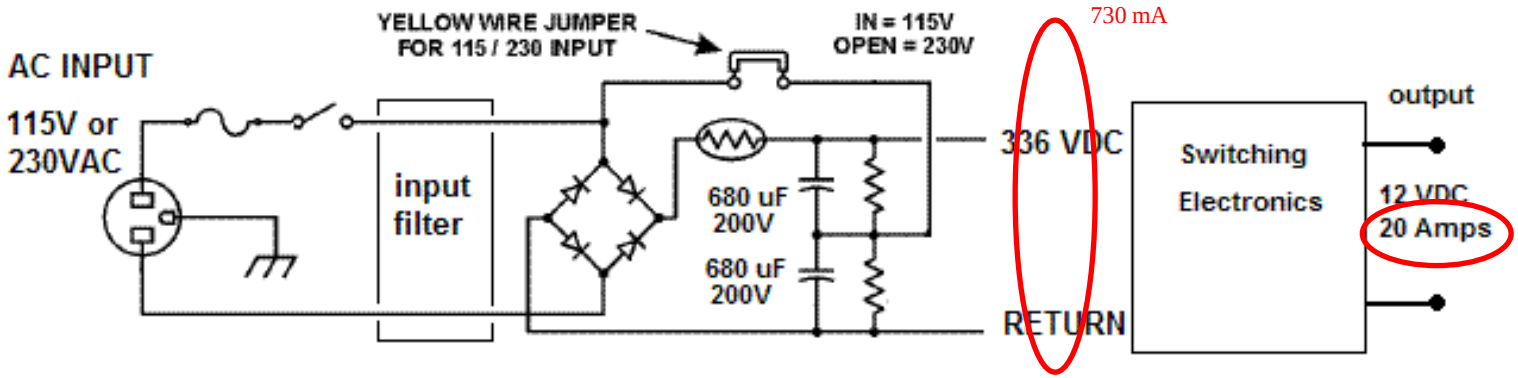
and only 10% of the mass and works **100-240 VAC**

AND **70-330 VDC**



Power Distribution@ 330 VDC

Nearly ALL modern switching supplies will run on VDC



Almost all dual-voltage switching power supplies use this kind of input circuit. The single jumper or 115/230 volt switch converts the supply for use on 115 or 230 volts. On 115 volts AC, the capacitors and diodes act like a 60 Hz Voltage Doubler to give operating voltge of over 300 volts DC to the switching ciruitry.

With the jumper removed, the 220 VAC is simply rectified to directly give the + 300 VDC.
On 220 VDC the switching circuitry will work directly, but probably with only 2/3rds of the overall output capacity.

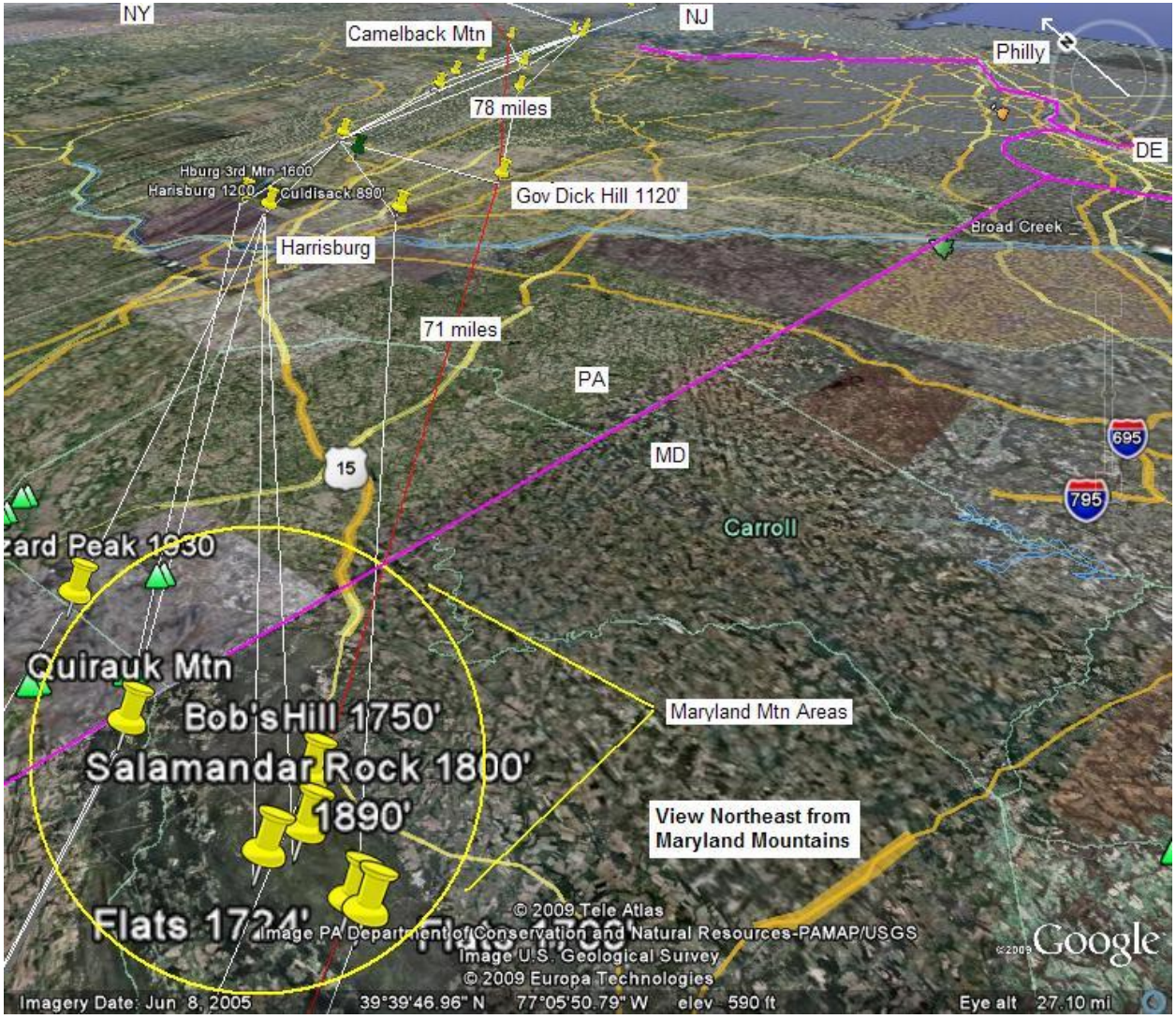
Doubles 120 to 230 VAC

Rectify to 330 VDC for delivery

Eliminate 75% of

Distribution losses

Field Example - Golden Packet Event



2 Laptops, 50W dual band, 2 HT's and APRS – 6 Hours

21 July 2018

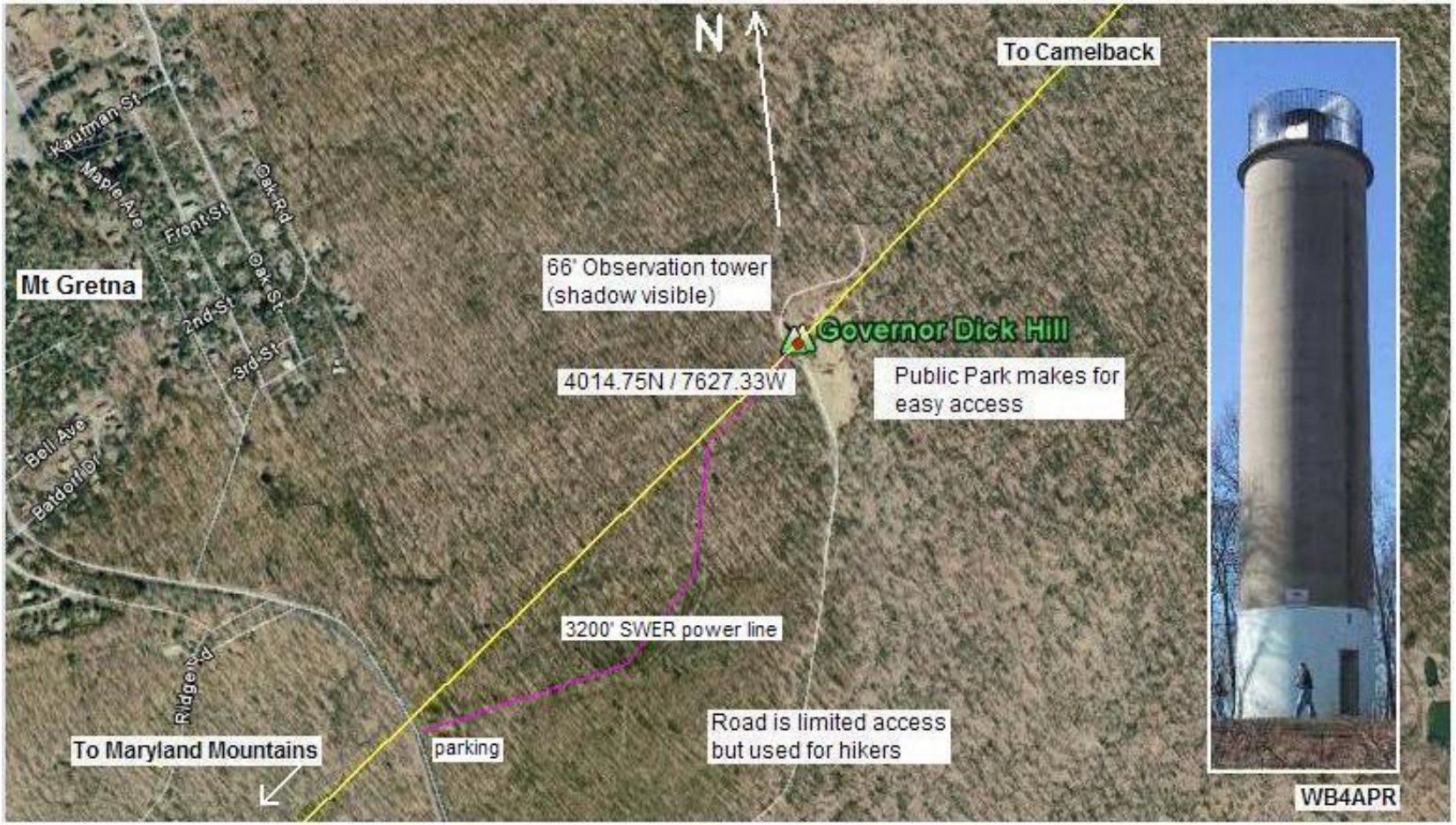
14 Hops

Maine to Georgia!

SUCCESS!

26 July 2014

Example: Power Distribution



Problem: 6 Hr event from Hill top 3200' from car

Power Distribution SWER

Emergency Power: Single Wire Earth Return

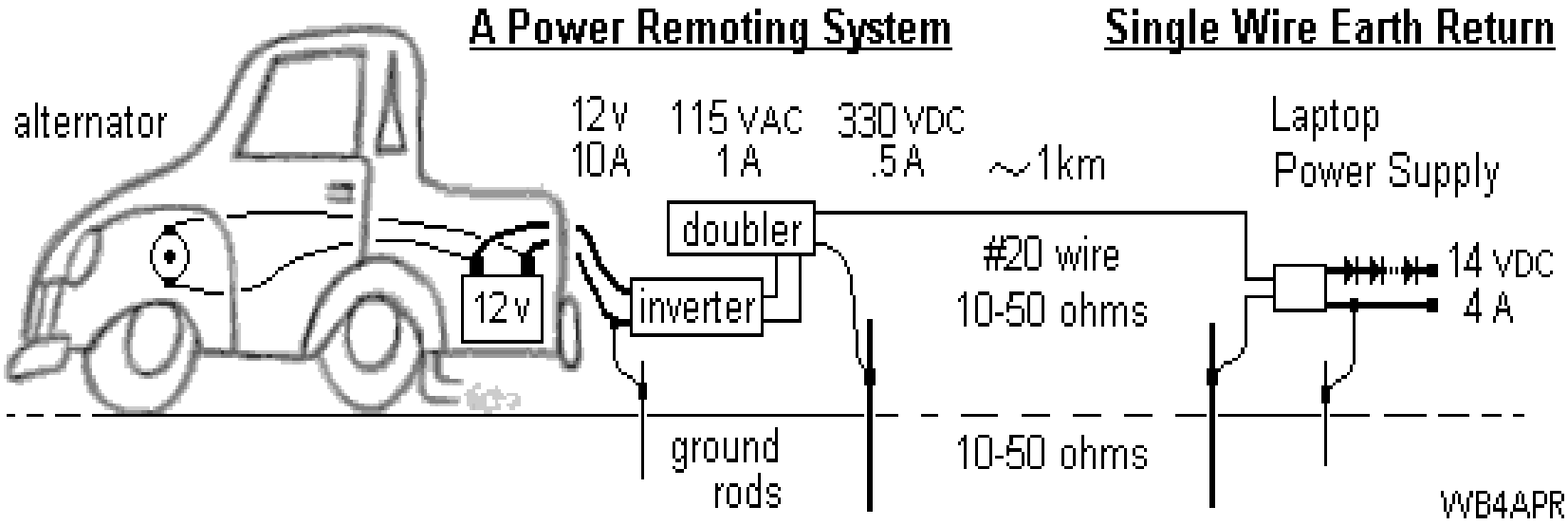
Left to right: 12v Inverter to 115 VAC, Doubler to 330 VDC, 3200' wire, Outlet box, Laptop Power Supply 18v at 4.5 amps.

3200' system fits in laptop bag

Not approved by NEC

Power Distribution SWER

Emergency Power: Single Wire Earth Return



Double to 230 VAC at source

Rectify to 330 VDC for delivery

Not approved by NEC

Power Distribution SWER

Type of soil	Earthing resistance		
	Ground electrode depth (meters)		
	3	6	10
Very moist soil, swamplike	10	5	3
Farming, loamy and clay soils	33	17	10
Sandy clay soil	50	25	15
Moist sandy soil	66	33	20
Concrete 1:5	-	-	-
Moist gravel	160	80	48
Dry sandy soil	330	165	100
Dry gravel	330	165	100
Stoney soil	1000	500	300
Rock	-	-	-

http://www.newarkinone.thinkhost.com/brands/promos/Earth_Ground_Resistance.pdf

And 3200' of #22 = 50 ohms

Emergency Power:

Single Wire Earth Return

Not approved by NEC

Power Distribution SWER

Single Wire Earth Return

Not approved by NEC

2 Laptops, 50W dual band, 2 HT's and APRS – 6 Hours

Field-Day Emergency Power

- Adding solar panels to junkyard prius(s)

About 500W of
Field Day solar power

Typical Backup solutions
Generators & Batteries

Generac
Qt03624anax...
$13,734

Generac
GUARDIAN...
$15,414

$7,001

To provide less than $1 of electricity

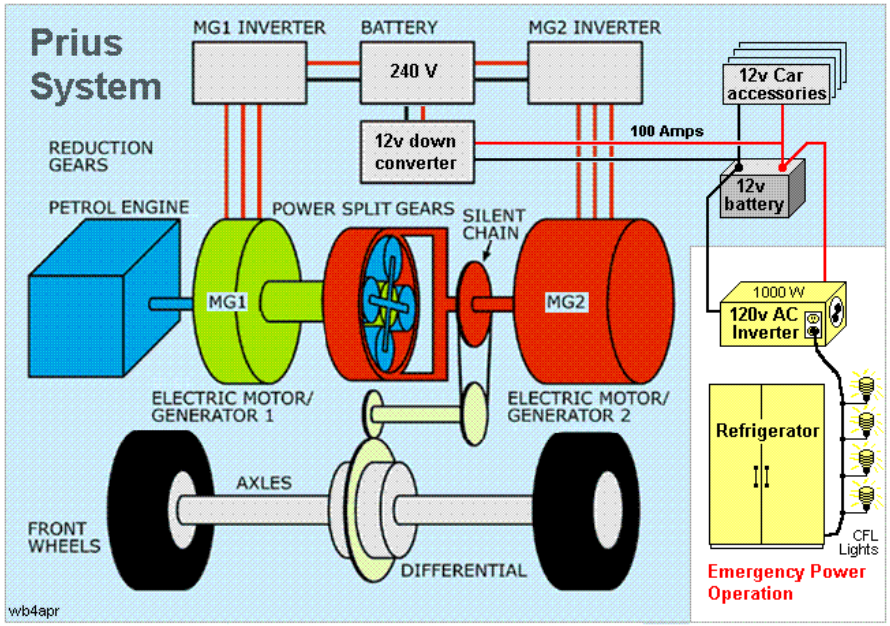
8 hours of 1.2kW house load

Once a year!

www.aprs.org/alternative-energy.html

Every Hybrid has at least a 50 kW generator!

Suitable for about 10kW of continuous field power



Same 5kWh/gal as a good Honda generator
(because it only runs when needed)

Over 60 Hybrids in 2014!

10 kW outlet for 220vDC
And 1 kW outlet for AC

Needs HV or 12v DC inverter

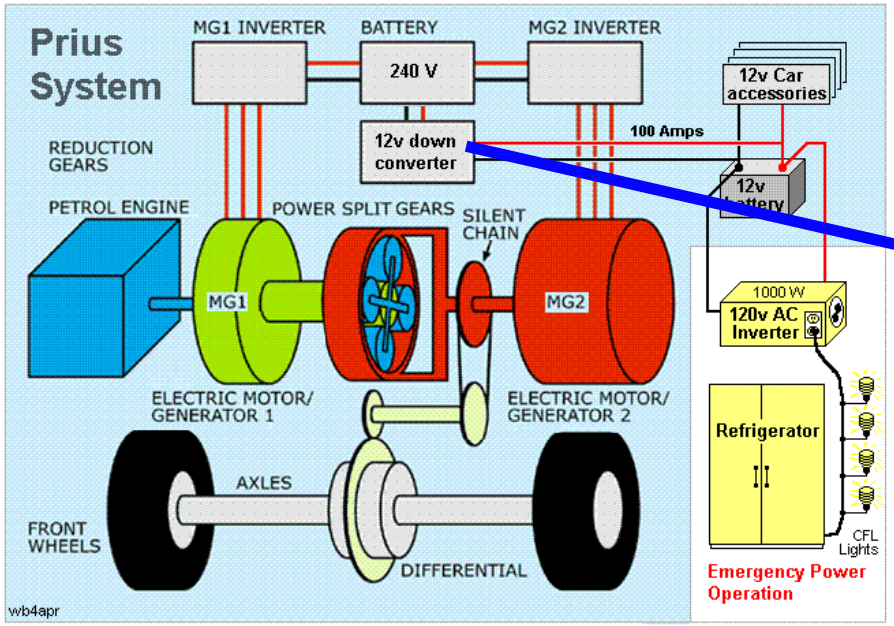
Whole House Prius Backup – 3 kW of 240 VAC

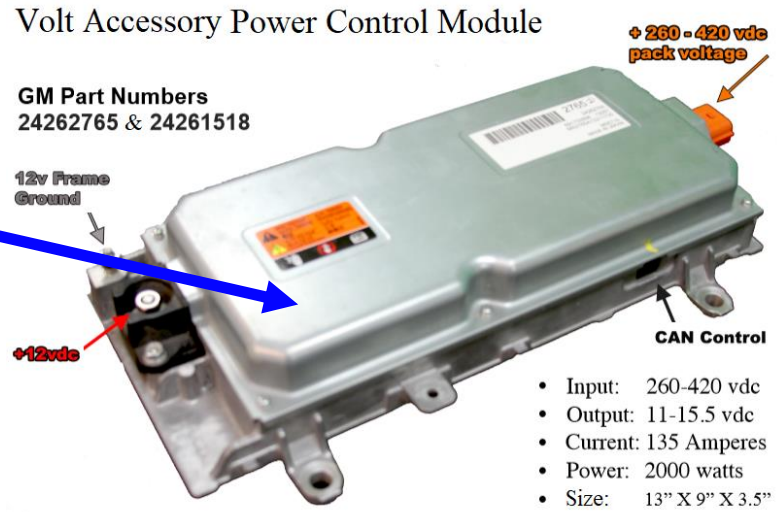
Same 5kWh/gal as a good Honda generator
(because it only runs when needed)

Or 2 kW peak and
800W continuous

Every Hybrid and EV has a KW+ at 12 volts

Suitable for about 10kW of continuous field power





VOLT has 2 kW!

260-420 VDC input
12v @ 135 Amps out
2000w from 12v system

220/330 VDC distribution

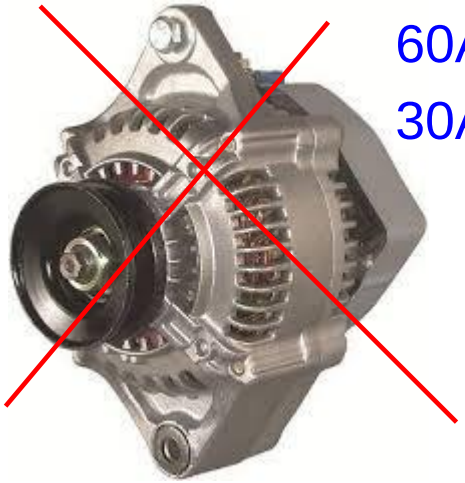
50 kW peak (10 kW average)

Safe, cheap connectors

(Modified to prevent incorrect use.)

Greater distances
At half the current
At twice the power
#18 zip cord (5A) = 1100 watts easily

Gas Cars cannot provide long term House Power



60A alternators only provide
30A at idle (400W average)…”

Can’t do Whole House

Any 12v car can do this

But only with the motor ALWAYS running.

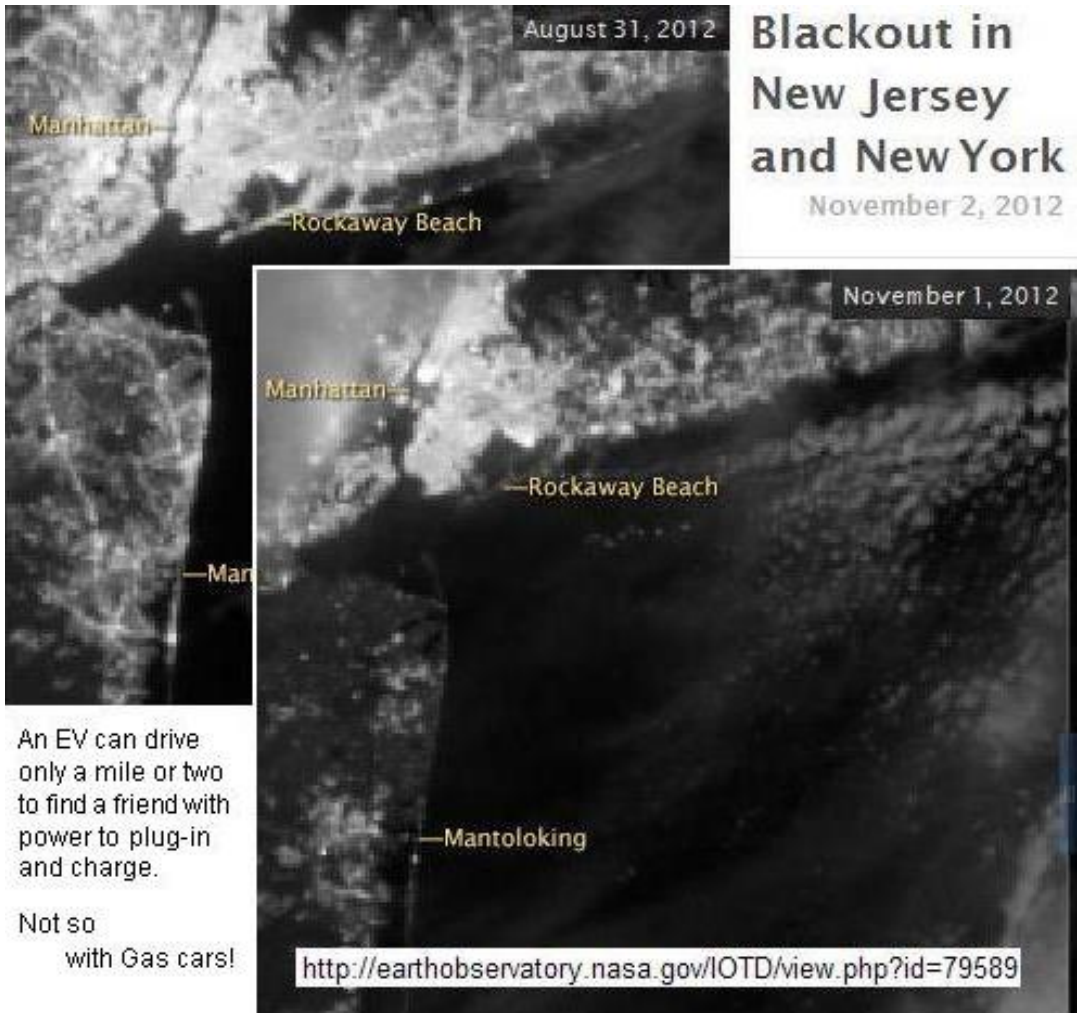
Only Hybrids with auto-motor start/stop can do it continuously.

EVs can power homes during blackouts

Power out?
Power your house
From your Car!

EV's don't wait in gas lines

EVs can power homes during blackouts



Power out at your house?

Go across the street!

All the gas stations have no power and cannot pump gas?

EV's don't wait in gas lines

EV's are now **better, cleaner, faster, quieter, safer,** cheaper to **buy,** cheaper to **operate** and cheaper to **maintain** than **the** v **gas car**

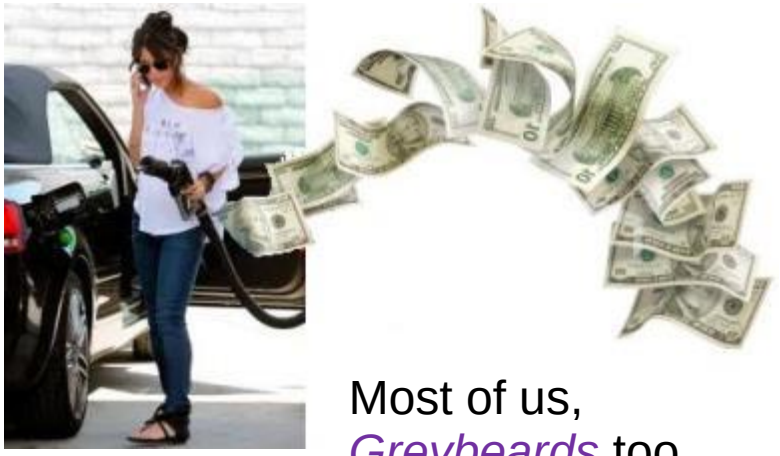
average

- Refuel at home
- Independence fm oil
- No emissions
- 0-60 in 2.3s
- Cost less to buy
- 1/3rd cost of gas
- 1/10 maintenance

My Energy re-awakening 2007

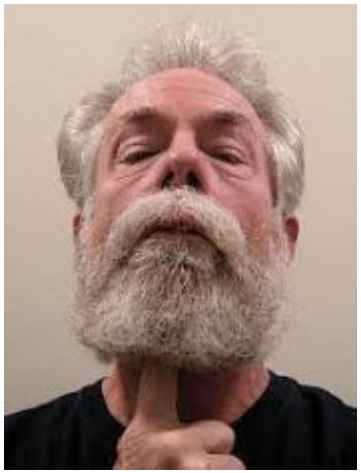
Getting an EV by salvaging junkyard Priuses

Most of what we think we know about EV's is likely wrong and Outdated



Most of us, *Greybeards* too, drive gas cars with gas-tank thinking

- Cost too much!
- Runs on coal from Power Plant (Carbon)
- Range too short
- Useless in power outage
- Planet Impact worse than a Hummer
- No Infrastructure
- Not enough chargers
- Takes too long to charge



95% Energy Driving locally

With Solar or utility-wind, EV driving is 100% renewable

EV charging at ARRL HQ

Solar at ARRL HQ

- Currently spend $8,000 / mo on electricity
- That's $1,000,000 in ten years.

Invest half of that now and have ARRL HQ electricity forever and an extra $100k per year for other projects

This 576 panel array of 277W panels yields 160 kW and should equal an annual 190 MWhr total consumption

Over 62 EV's now on Market!

(in just 8 years!)

500 by 2025!

Half cost less than the average gas car! ($35k)

Half now have ranges over 350 miles

Used from $6k to $12k

Download latest from EVADC.ORG

50% have ranges > 350 miles!

Rng	EV	Cost	Plugin EV/Hybrid model
666	29	$30k	Kia Optima Plug-In
650	27	$30k	Hyundai Sonata PHEV
640	25	**$23k**	Toyota Prius Prime
630	29	**$20k**	Hyundai Ioniq PHEV
610	21	$27k	Ford Fusion Energi
580	33	$33k	Chrysler Pacifica hyb.
580	26	$23k	Kia Niro PHEV
560	24	$93k	Porsche Panamera
540	13	$59k	BMW X5 xDrive40e
480	14	$75k	Porsche Cayenne
460	20	$23k	Ford C-Max Energi
460	8	$62k	Mercedes GLE550e
450	12	$92k	Mercedes S550e
450	18	$48k	Volvo XC60 T8
440	30	$68k	Cadillac CT6 Plug-In
410	8	$44k	Mercedes C350e
410	21	$59k	Volvo S90 T8
380	**53**	$26k	Chevy Volt
380	16	$35k	Audi A3 e-tron
372	16	$48k	BMW 530e
350	22	$42k	BMW 330e
350	19	$60k	Volvo XC90 T8

Rng	EV	Cost	Plugin EV/Hybrid model
340	**47**	$26k	Honda Clarity PHEV
340	14	$86k	BMW 740e xDrive
335	EV	$87k	Tesla 100D
330	14	$143k	BMW i8
310	EV	$37k	Tesla 3 extended range
310	22	$29k	Mitsubishi Outlander
295	EV	$89k	Tesla X 100D
259	EV	$67k	Tesla S 75D
270	12	$33k	MINI Cooper S E Countr
240	37	$123k	Karma Revero
238	EV	$72k	Tesla X 75D
238	EV	$29k	Chevy Bolt
220	EV	**$28k**	Tesla 3 std
180	97	$41k	BMW i3 Range Extender
151	EV	**$22k**	Nissan Leaf
125	EV	$23k	VW e-golf
124	EV	$22k	Hyundai Ioniq Electric
115	EV	$22k	Ford Focus Electric
114	EV	$27k	BMW i3
111	EV	$26k	Kia Soul Electric
89	EV	$26k	Honda Clarity Electric
84	EV	$26k	Fiat 500e

50% cost less than the average $35k gas car

Rng	EV	Cost	Plugin EV/Hybrid model
330	14	$143k	BMW i8
240	37	$123k	Karma Revero
560	24	$93k	Porsche Panamera
450	12	$92k	Mercedes S550e
295	EV	$89k	Tesla X 100D
335	EV	$87k	Tesla 100D
340	14	$86k	BMW 740e xDrive
480	14	$75k	Porsche Cayenne
238	EV	$72k	Tesla X 75D
440	30	$68k	Cadillac CT6 Plug-In
259	EV	$67k	Tesla S 75D
460	8	$62k	Mercedes GLE550e
350	19	$60k	Volvo XC90 T8
410	21	$59k	Volvo S90 T8
540	13	$59k	BMW X5 xDrive40e
450	18	$48k	Volvo XC60 T8
372	16	$48k	BMW 530e
410	8	$44k	Mercedes C350e
350	22	$42k	BMW 330e
180	97	$41k	BMW i3 Range Extender
310	EV	$37k	Tesla 3 extended range

Less than **$35k Avg Gas Car**			
380	16	$35k	Audi A3 e-tron
580	33	$33k	Chrysler Pacifica hyb.
270	12	$33k	MINI Cooper S E Countr
666	29	$30k	Kia Optima Plug-In
650	27	$30k	Hyundai Sonata PHEV
310	22	$29k	Mitsubishi Outlander
238	EV	$29k	Chevy Bolt
220	EV	**$28k**	Tesla 3 std
114	EV	$27k	BMW i3
610	21	$27k	Ford Fusion Energi
380	**53**	$26k	Chevy Volt
340	**47**	$26k	Honda Clarity PHEV
111	EV	$26k	Kia Soul Electric
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115	EV	$22k	Ford Focus Electric
630	29	**$20k**	Hyundai Ioniq PHEV
58	EV	$16k	Smart

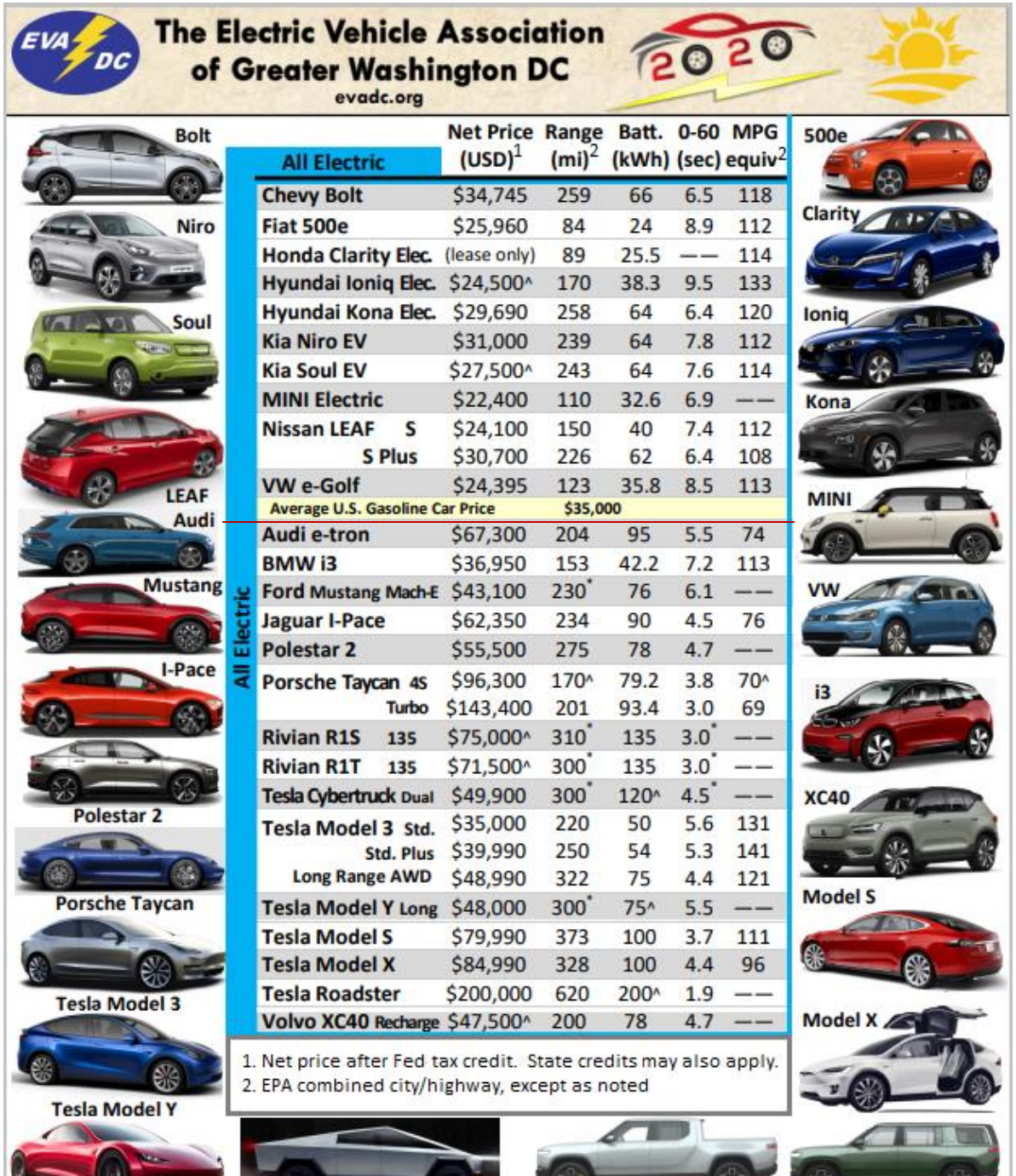
The avg new car stays on the roads for about 18 years before being scrapped.

- A new gas car today will be belching Noxious fumes through 2035
- What will a gas car bought today be worth in 5 years for resale?

at least checkout EVs to meet your driving need

Battery Evs (25 in 2020)

40% cost less than the average Gas car



All Electric	Net Price (USD)[1]	Range (mi)[2]	Batt. (kWh)	0-60 (sec)	MPG equiv[2]
Chevy Bolt	$34,745	259	66	6.5	118
Fiat 500e	$25,960	84	24	8.9	112
Honda Clarity Elec.	(lease only)	89	25.5	——	114
Hyundai Ioniq Elec.	$24,500^	170	38.3	9.5	133
Hyundai Kona Elec.	$29,690	258	64	6.4	120
Kia Niro EV	$31,000	239	64	7.8	112
Kia Soul EV	$27,500^	243	64	7.6	114
MINI Electric	$22,400	110	32.6	6.9	——
Nissan LEAF S	$24,100	150	40	7.4	112
S Plus	$30,700	226	62	6.4	108
VW e-Golf	$24,395	123	35.8	8.5	113
Average U.S. Gasoline Car Price		$35,000			
Audi e-tron	$67,300	204	95	5.5	74
BMW i3	$36,950	153	42.2	7.2	113
Ford Mustang Mach-E	$43,100	230*	76	6.1	——
Jaguar I-Pace	$62,350	234	90	4.5	76
Polestar 2	$55,500	275	78	4.7	——
Porsche Taycan 4S	$96,300	170^	79.2	3.8	70^
Turbo	$143,400	201	93.4	3.0	69
Rivian R1S 135	$75,000^	310*	135	3.0*	——
Rivian R1T 135	$71,500^	300*	135	3.0*	——
Tesla Cybertruck Dual	$49,900	300*	120^	4.5*	——
Tesla Model 3 Std.	$35,000	220	50	5.6	131
Std. Plus	$39,990	250	54	5.3	141
Long Range AWD	$48,990	322	75	4.4	121
Tesla Model Y Long	$48,000	300*	75^	5.5	——
Tesla Model S	$79,990	373	100	3.7	111
Tesla Model X	$84,990	328	100	4.4	96
Tesla Roadster	$200,000	620	200^	1.9	——
Volvo XC40 Recharge	$47,500^	200	78	4.7	——

32 Plugin Hybrid EV's

(38% cost less than avg gas car!)

Ford, BMW, VW

Mercedes, Ford, GM

Say, all their cars will be electric in 6-8 years

Plug-in Hybrid Electric	Net Price (USD)[1]	Range (mi)[2]	Batt. (kWh)	0-60 (sec)	MPG equiv[2]
Chrysler Pacifica hyb.	$32,495	32+gas	16	7.4	82
Ford Fusion Plug-In	$30,391	26+gas	9	8.0	103
Honda Clarity PHEV	$25,900	48+gas	17	7.7	110
Hyundai Ioniq PHEV	$21,957	29+gas	8.9	8.9	119
Hyundai Sonata PHEV	$26,481	28+gas	9.8	7.6	99
Kia Niro PHEV	$23,957	26+gas	8.9	9.0	105
Kia Optima Plug-In	$31,171	28+gas	9.8	9.1	101
MINI Cooper S E Countr.	$32,900	17+gas	10	6.7	73
Mitsubishi Outlander	$30,459	22+gas	12	9.2	74
Subaru Crosstek Hyb.	$30,645	17+gas	8.8	8.3	90
Toyota Prius Prime	$23,250	25+gas	8.8	10.5	133
Toyota RAV4 Prime	$29,000^	39*+gas	16^	5.8*	90*
Average U.S. Gasoline Car Price	$35,000				
BMW 330e	$39,164^	30^+gas	12^	5.6	——
BMW 530e	$48,064	21+gas	12	5.9	69
BMW 745e xDrive	$89,714	16+gas	12	4.9	56
BMW i3 Range Extender	$40,800	126+gas	42.2	8.0	100
BMW i8	$141,831	17+gas	11.6	4.2	69
BMW X3 xDrive30e	$42,714^	20*+gas	12^	6.3	——
BMW X5 xDrive45e	$62,500	40^+gas	24	5.5^	56
Karma Revero GT	$127,500	61+gas	28	4.5	70
Land Rover Sport P400e	$71,913	19+gas	13	6.3	42
Mercedes C350e	$45,394	8+gas	6.2	5.8	51
Mercedes GLC350e	$46,190	10+gas	8.7	6.2	56
Mercedes GLE550e	$62,240	8+gas	8.8	5.3	43
Mercedes S560e	$103,750	20+gas	13.5^	4.7	65^
Porsche Cayenne	$74,430	14+gas	14.1	4.7	47
Porsche Panamera	$97,130	14+gas	14.1	4.4	51
Volvo S60 T8	$51,043	22+gas	10.4	4.3	69
Volvo S90 T8	$58,843	21+gas	10.4	4.8	60
Volvo V60 T8	$62,298	22+gas	10.4	4.3	69
Volvo XC60 T8	$49,593	19+gas	10.4	4.9	57
Volvo XC90 T8	$61,998	18+gas	10.4	5.9	55

EV Pickups are Here! (2020)

Rivian -2020

WorkHorse

Via Motors

Ford - 2021

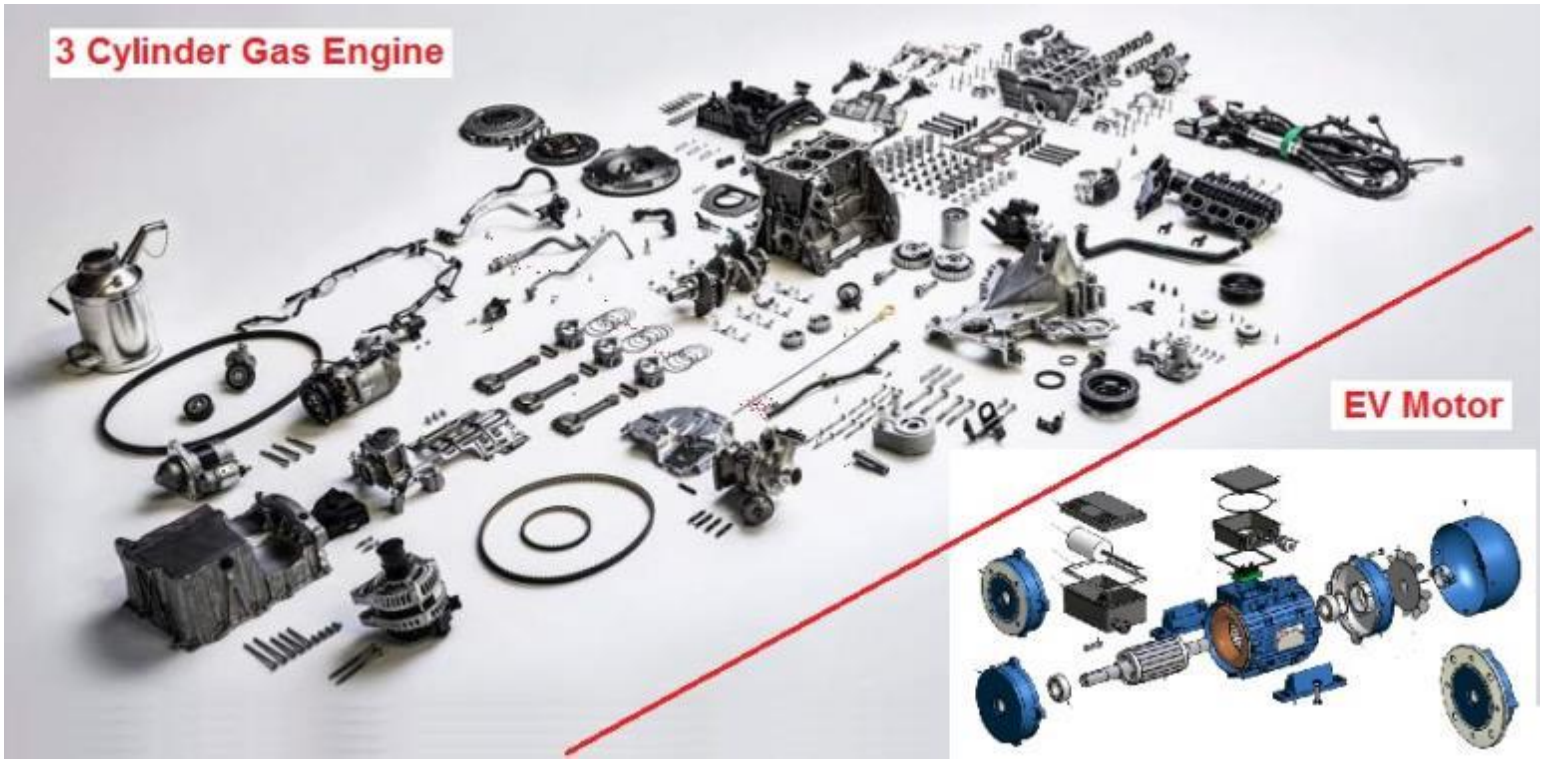
Chevy- 2021

Tesla - 2021

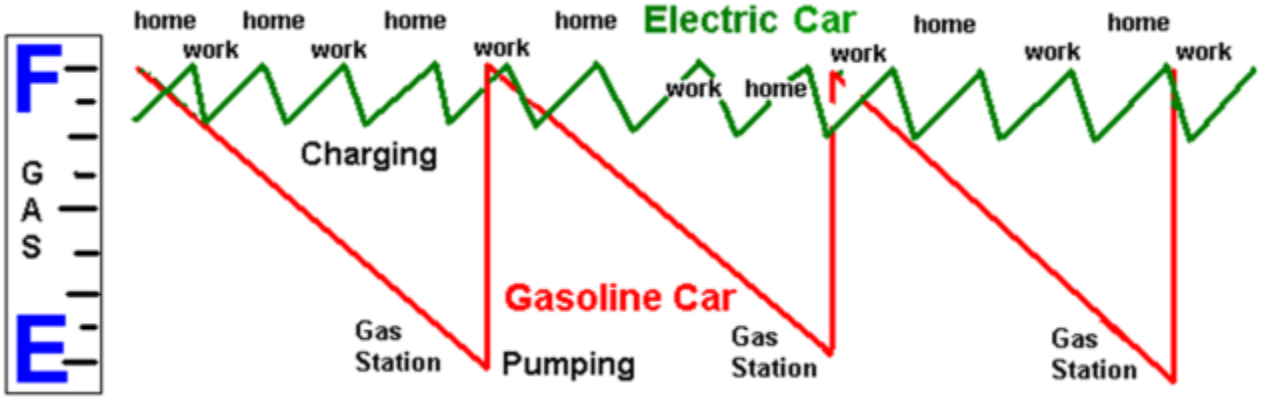
Better Torque, Field Electrical Power

EV engines have Only ONE moving part!

- Electricity about 1/3rd cost of gas
- Maintenance 10% of a gas car



A Battery is not a TANK!



The Complete Paradigm Shift:

Gas cars drive-to-empty, then fill-to-full at Public Stations

EV's charge daily at home and/or at work **while parked**

And are FULLL every morning

Our Legacy experience

Oh the Horror!

People see this

And think $40

Reality with EV's is

20¢/hr

$1 a day

($10 for Tesla 250mi)

Every EV can charge from any 120v outlet

Every EV comes with a 120v charge cord

Exist or $15 each

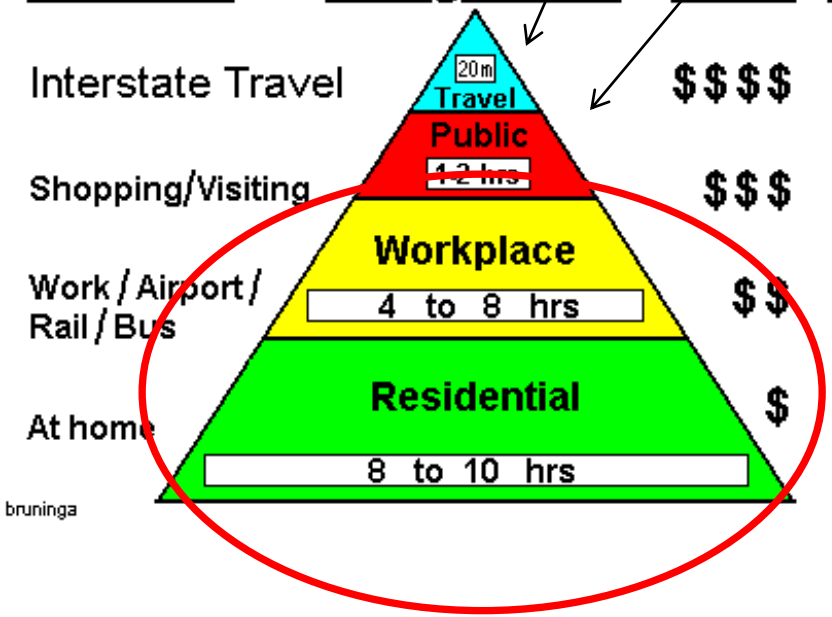
Charging stations for every EV is not sustainable at-work:

$8000 installed

Charge at Home (and at work)

1% of the need

Public Charging is like looking for $10 gas!

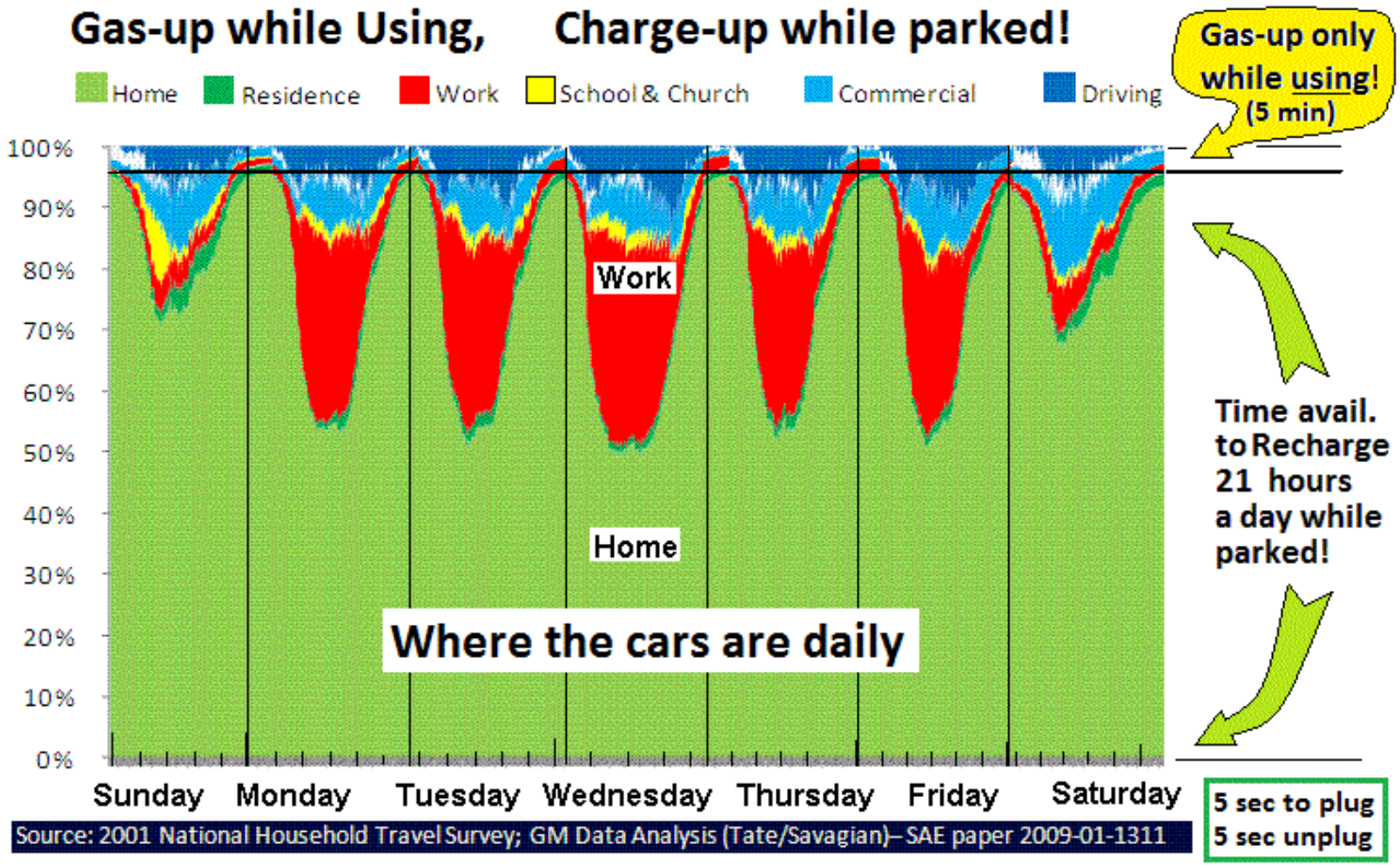


Location	Charge Time	Price	Level	Cost	Driver?	Speed?
Interstate Travel		$$$$	L3	$10,000	Waiting...	20 min
Shopping/Visiting		$$$	L2/3	$2,000	Parked	10 Sec*
Work / Airport / Rail / Bus		$$	L1	$ 25	Parked	10 Sec*
At home		$	L1	$ 25	Sleeping	10 Sec*

* connect/disconnect time

85% of all charging is at home on standard 120v outlets

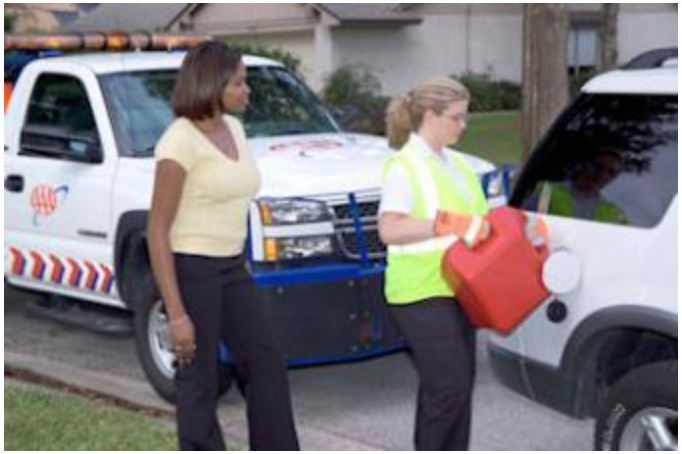
Charging While Parked (21 hrs/day)



Public Charging – only a security blanket

Only Provides comfort & security

… like a spare gas can



85% of all charging is at home

Buying an EV with the idea of public charging, means not understanding EV's and maybe buying the wrong car!

Every Outdoor Outlet should consider a Charging Sign

Charging Load at 120v:

1 Coffee Pot = Level 1 EV charging

115v 12 amps

Employee's pay for coffee mess
and yet get free electricity

SAME = LOAD

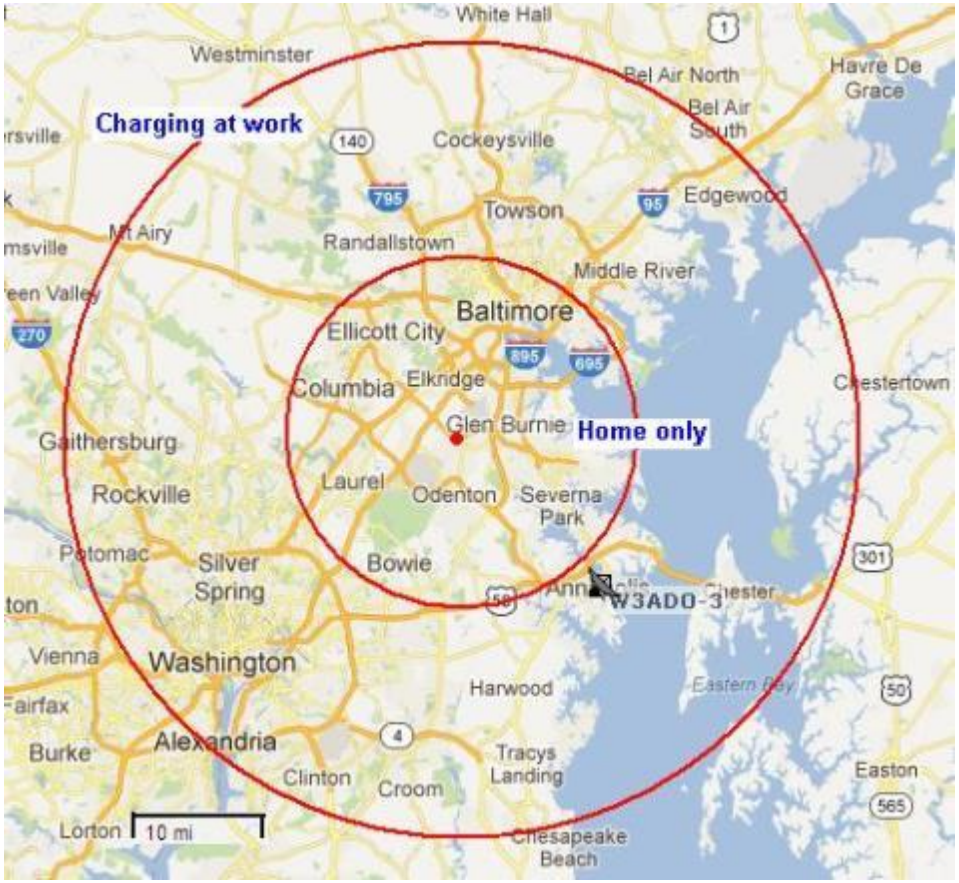
We dont want free electricity, we want to
pay for it, and simply be allowed to plugin!

Pay $20/mo
For 20mi commute

Plug-in at work (double range, quadruple area)

Charge at home only = 16 mi range (chevy Volt)

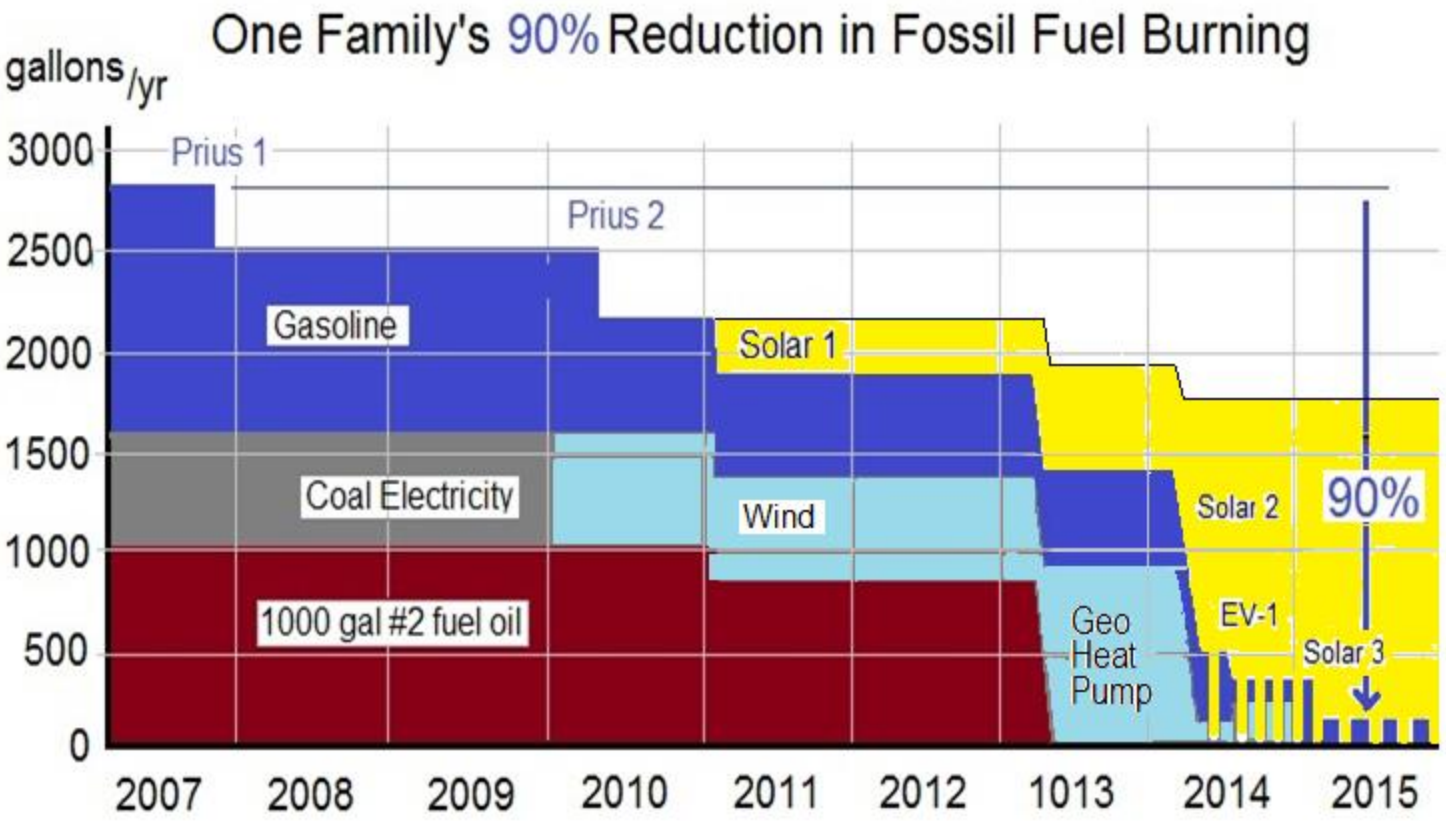
Charge L1 at work/home = 64 mi range



Going Renewable Energy is Easy!

My family went from 3000 gal/year down to 300 gal/year

$500/mo



$8/mo

Help the Environment

And save 50% money!

Go renewables!

AND Save Money too!

Our old house Energy Costs:	BEFORE:
Heating Oil (1000 gal/yr)	$3000/yr
Electricity (10,000 kWh/yr)	$1000/yr
Incandescent Lights	$ 500/yr
Gasoline (15,000 mi/yr 30 mpg)	$1500/yr
Total Annual Energy cost	$6000/yr
AFTER: Heatpump, Solar, LEDs & EV	$ 300/yr?

Help the Environment

And save money!

My Solar re-awakening 2010

3rd Saturday in August 2010 a revelation!

(when I looked afresh at Grid-Tie Solar)

I was so wrong!

- My concept of solar always included batteries:

Grid-tie Revolutionized Solar

- No Batteries!

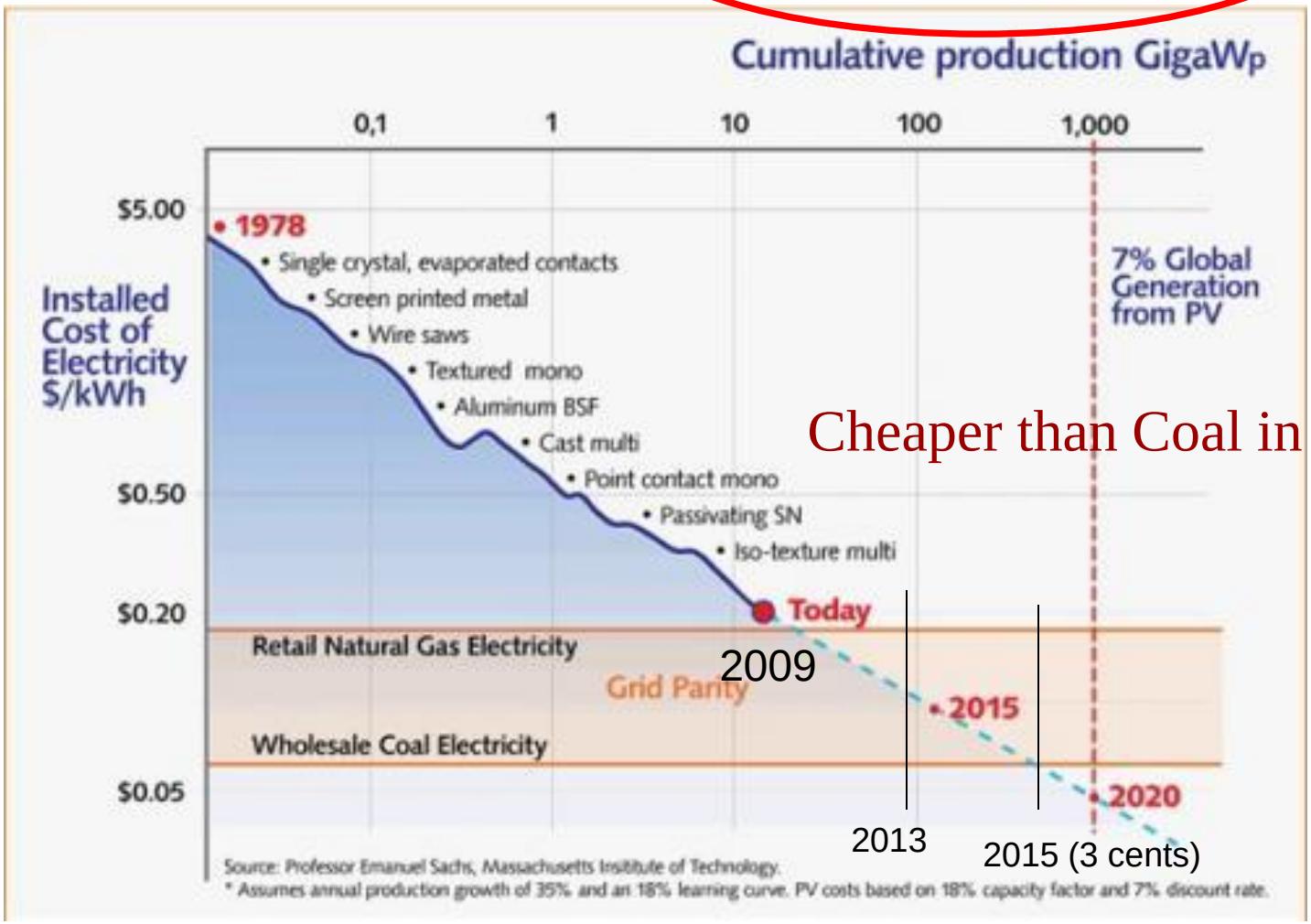
Grid-Tie

Every Watt Produced is valued at full Retail Rates!

ZERO MAINENANCE and storage costs FOR LIFE!

Solar Cost!

Equaled Utility in 2010
Half the Utility in 2013



Cheaper than Coal in 2016!

Now Cheaper than wholesale coal!

Falling Prices 10-to-1

Panel

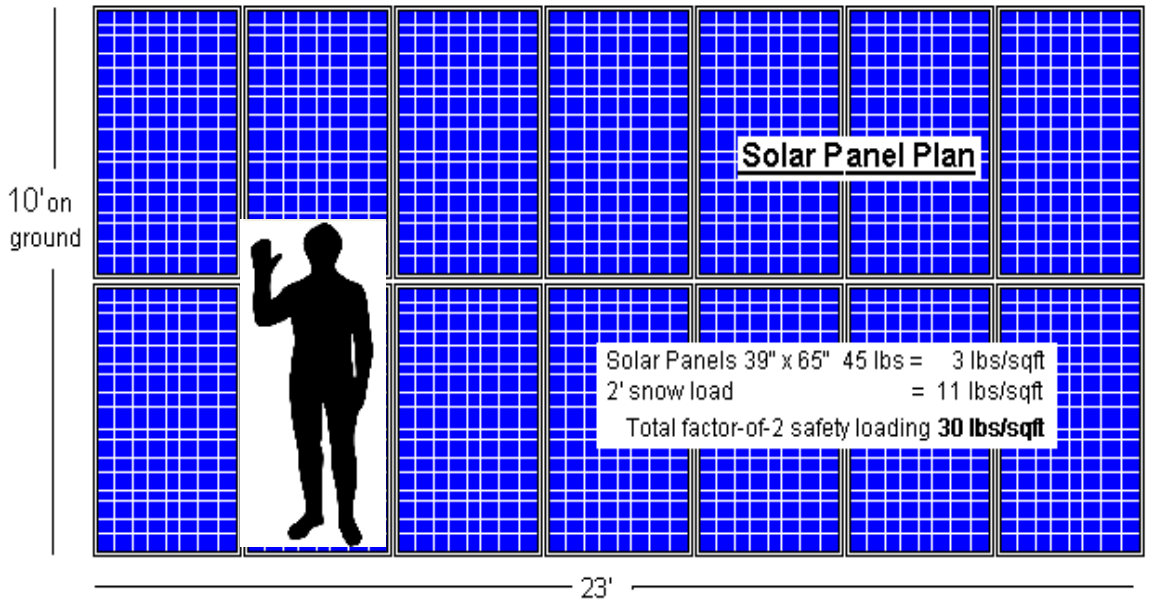
A 3 kW array

200 W

220 W

250 W

(300W)



Array Cost

$15,000 2007

$ 9,000 2010

$ 6,000 2012

$ 3,000 2013

$ 2,000 2014

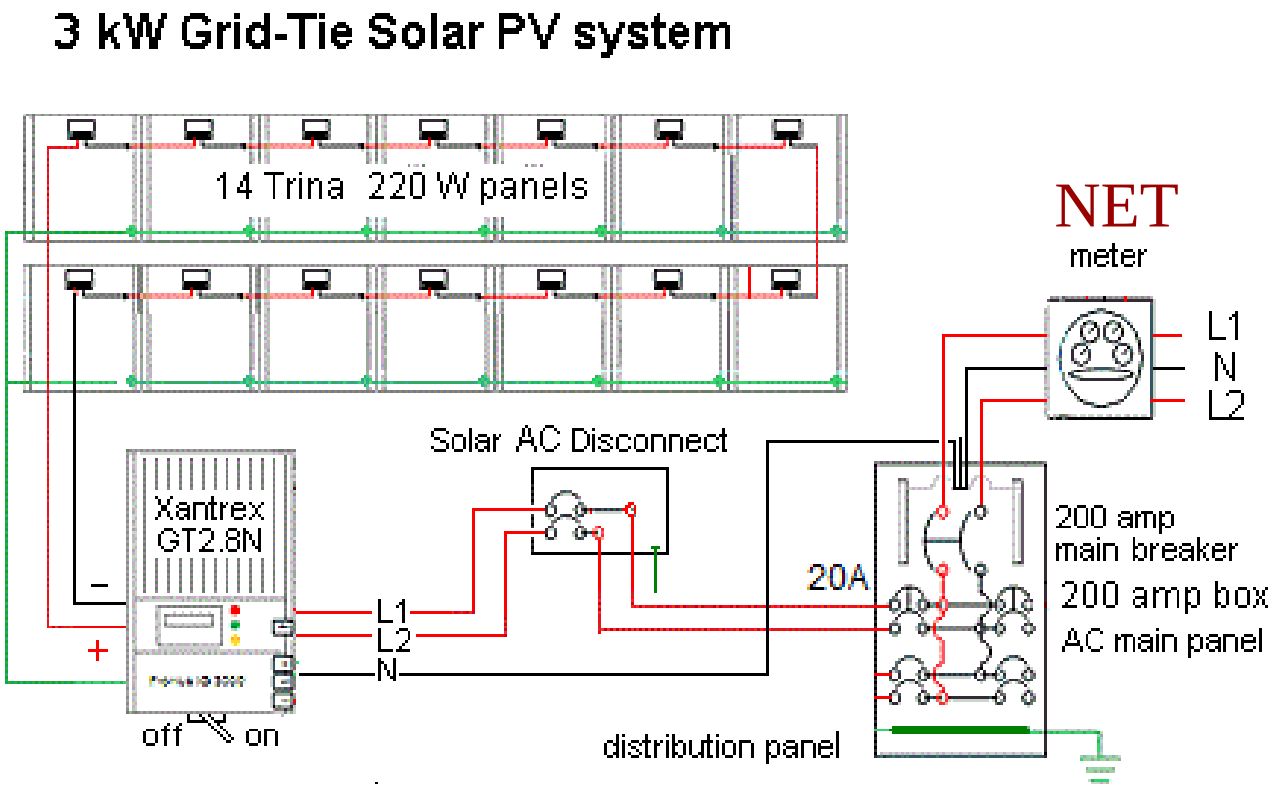
$ 1,500 2015

$5/watt down to 50c/watt* for panels in only 10 years

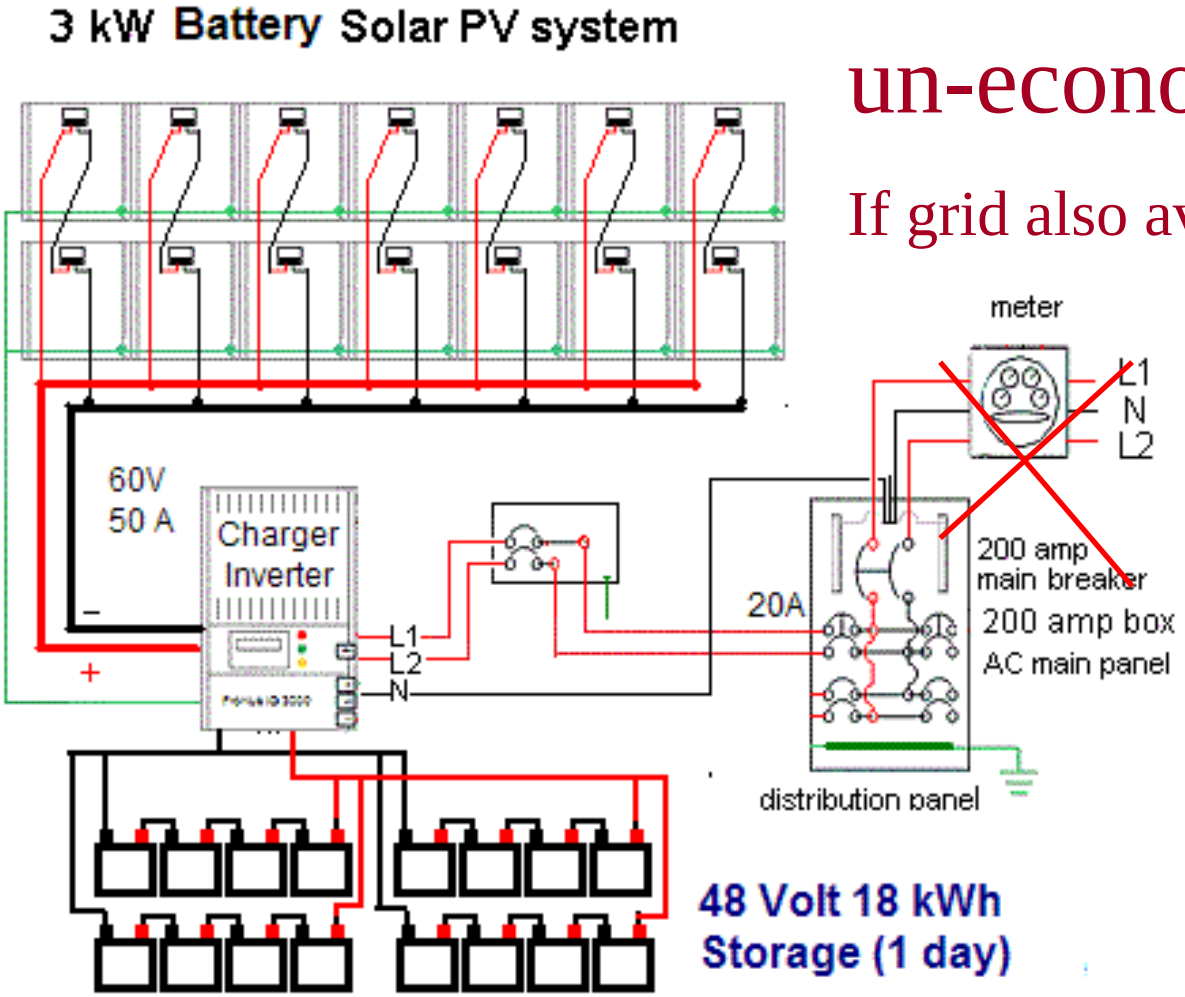
*Contractor cost tho is still about $2.75/w

What is Grid-tie Solar?

As simple as a 20A breaker - L1, L2, N & Ground

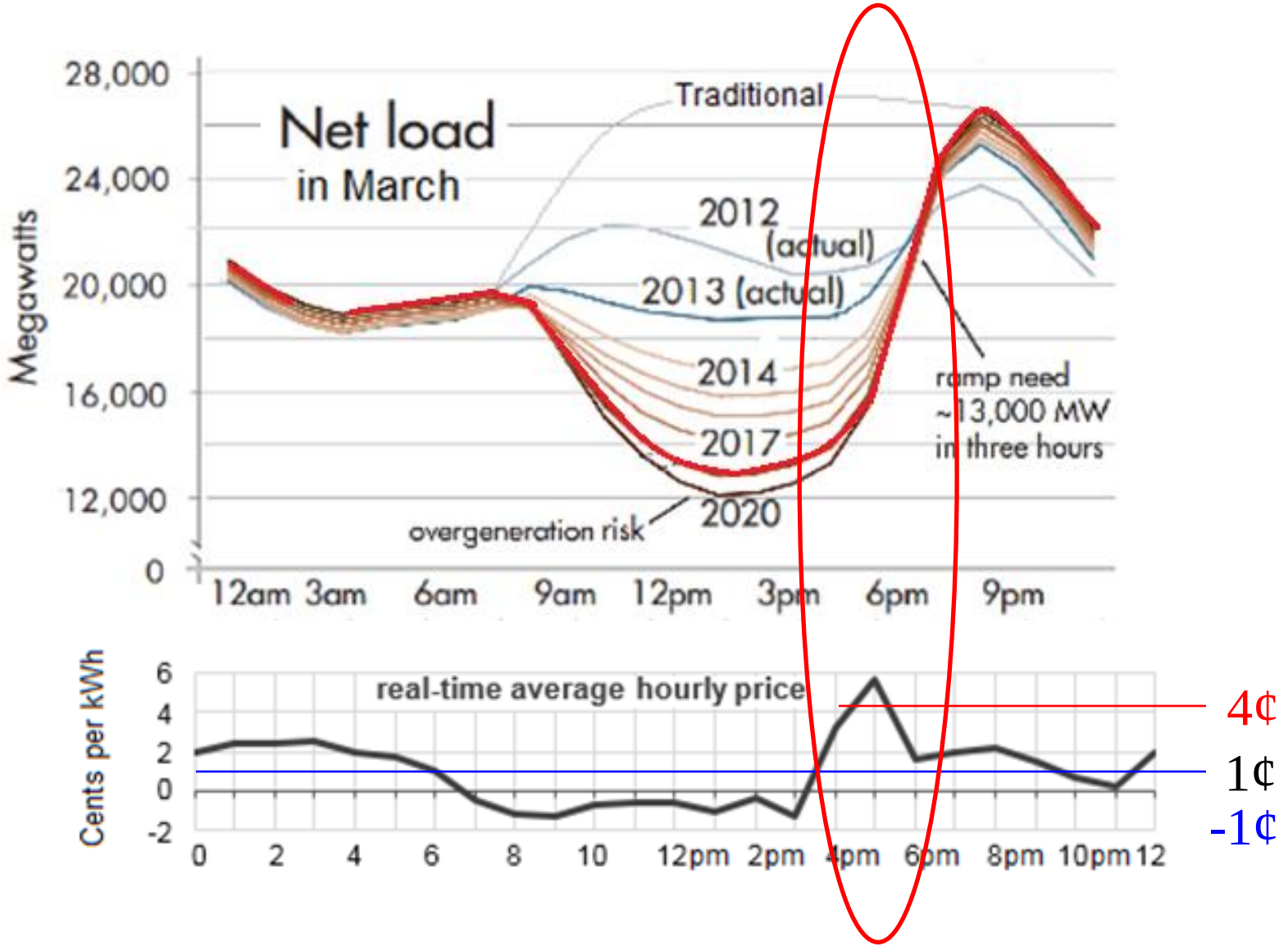


Off-Grid costs 3 times as much



#1 problem: Cannot save the DOUBLE summer power for Winter

Future Value of Home Battery



Grid Solar Power ≠ Emergency Power

- COMPLETELY DIVORCE any thoughts of "emergency power" from Economical power.
- Solar power (grid-tie) is for ECONOMICAL POWER!
- Emergency power has completely different optimal solutions. (Short term and Armageddon)

$400

$10,000

Grid Solar Power IS Economical Power 99.95%

- Grid Tie Solar is not "emergency power"
- For emergency power do what you do now **(4 hrs/yr!)**
  - Candles,
  - Generator,
  - Plug into your Hybrid car or EV
  - A few batteries and $100 inverter, etc
- Emergency power has completely different optimal solutions. (Short term and Armageddon)

Value = 60 cents

$400

$10,000

Grid Solar Power IS Economical Power

- Grid Tie Solar can now include "emergency power"
- Some Grid Inverters come with direct secure power when the grid is down (and sun is up).

SUNNY BOY GRID TIE INVERTER WITH SECURE POWER

$1,099.00 List price $1,925.00

1500W w/o grid

Model: SB3.0-1SP-US-40 (3000 Watt)

Select model:

3000 Watt	3800 Watt	5000 Watt
6000 Watt	7000 Watt	7700 Watt

Even when overcast,

a 5 kW array can produce 500W

Power your house from your EV for a week in power outage

Leaf-to Home:
6 KVA – 24 kWh battery

Prius-to-Home (50 kW gen)

* Currently in Japan only

Power your house from any EV or Hybrid

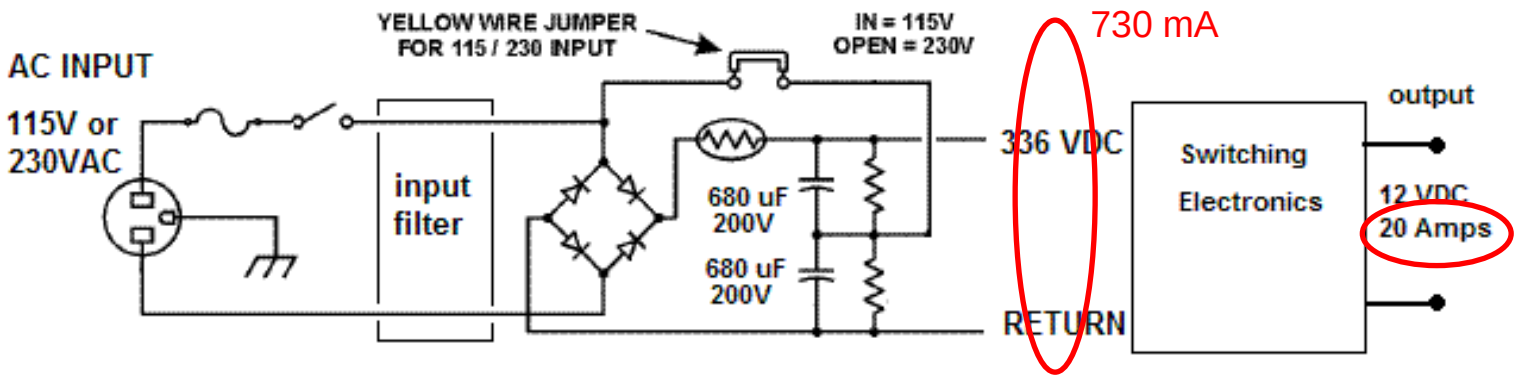
- Your EV, or Plugin-Hybrid is now Emergency Power!

Just a cigarette lighter 120v inverter can power at least 20 LED bulbs in your house.

A larger 1000W inverter clipped to the battery can power all the lights and the refrigerator too!

But all modern equip can run on 330 VDC

Nearly ALL modern switching supplies will run on VDC



Almost all dual-voltage switching power supplies use this kind of input circuit. The single jumper or 115/230 volt switch converts the supply for use on 115 or 230 volts. On 115 volts AC, the capacitors and diodes act like a 60 Hz Voltage Doubler to give operating voltge of over 300 volts DC to the switching ciruitry.

With the jumper removed, the 220 VAC is simply rectified to directly give the + 300 VDC.
On 220 VDC the switching circuitry will work directly, but probably with only 2/3rds of the overall output capacity.

Doubles 120 to 230 VAC

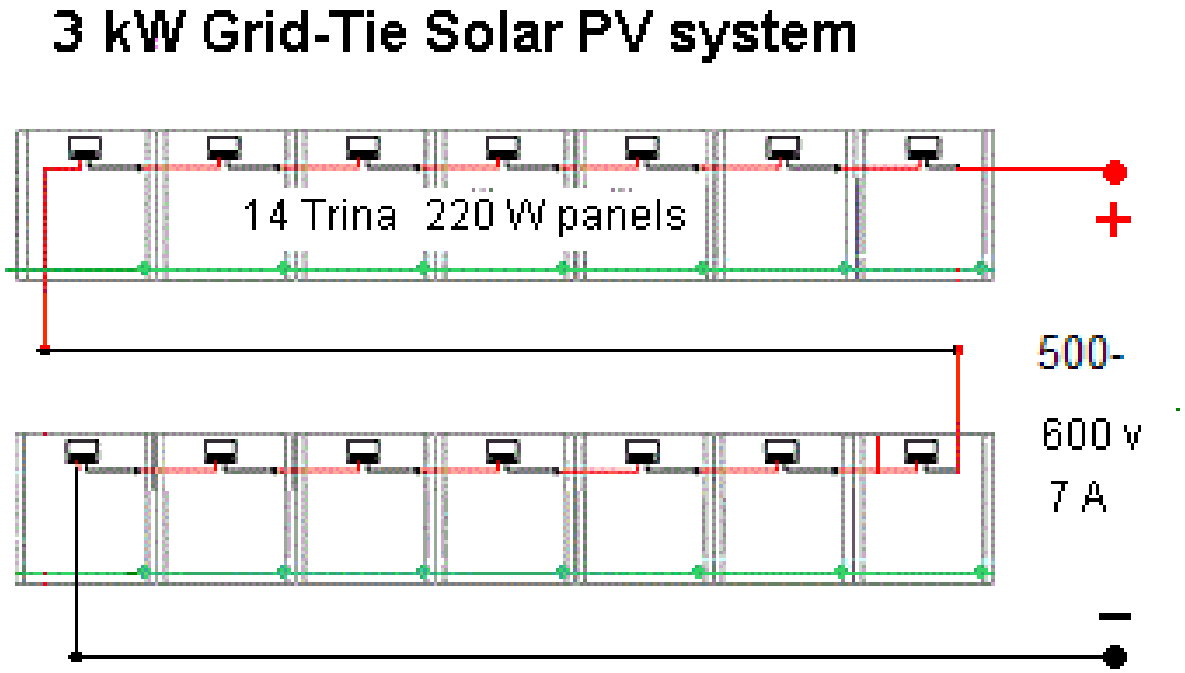
Rectify to 330 VDC for delivery

Eliminate 75% of

Distribution losses

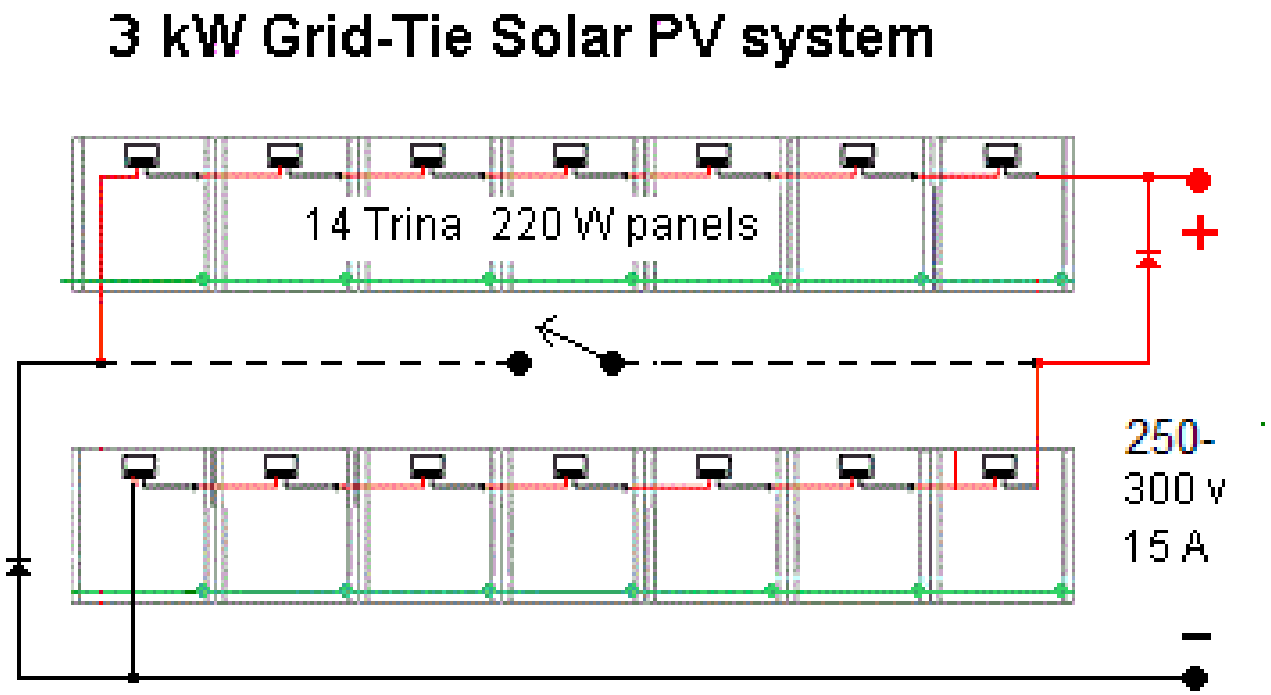
Standard Grid-tie Solar (Series)

500/600V Series to minimize wire loss (7A =4 kW w #14 wire)



DIY backup Solar Power

Emergency Switch to 300 v to power Universal Powered Systems



DIY backup Solar Power

Emergency Switch to 300 v to power Universal Powered Systems

Simple A/C Disconnect

60 amps

600v

Only $6

DIY backup Solar Power

Emergency Switch to 300 v to power Universal Powered Systems

TV, Stereo

PC, internet, laptop

Chargers: Cell

Ham Radio (Switching PS)

Lights (incandescent-series)

Anything with SW/PS

Well pump

Furnace Blower

Appliances

Heaters

A/C

Everything you NEED

#1 DIY backup Power Need

We NEED a 200-500 VDC input – 60 Hz Inverter!

Prius Plug-out-kit:
2, 3 & 5 KVA

200-300VDC Series solar

50 kW generator Hybrid!

Grid-down Solar Power

We NEED a 200-500 VDC input – 60 Hz Inverter!

Leaf-to Home:
6 KVA – 24 kWh battery

Prius-to-Home (50 kW gen)

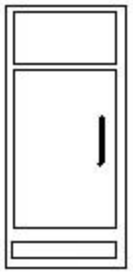
But only in Japan!

Solar Backup Power Ideas

- Even cloudy days = 10% of array power
- Minimum overnight power: Refrigerator & Lights
- 16 Hrs x 250W = 4 kWh
- Four Deep-cycle Car Batteries

$150

$400



And LED bulbs

But BEWARE of Solar RFI!

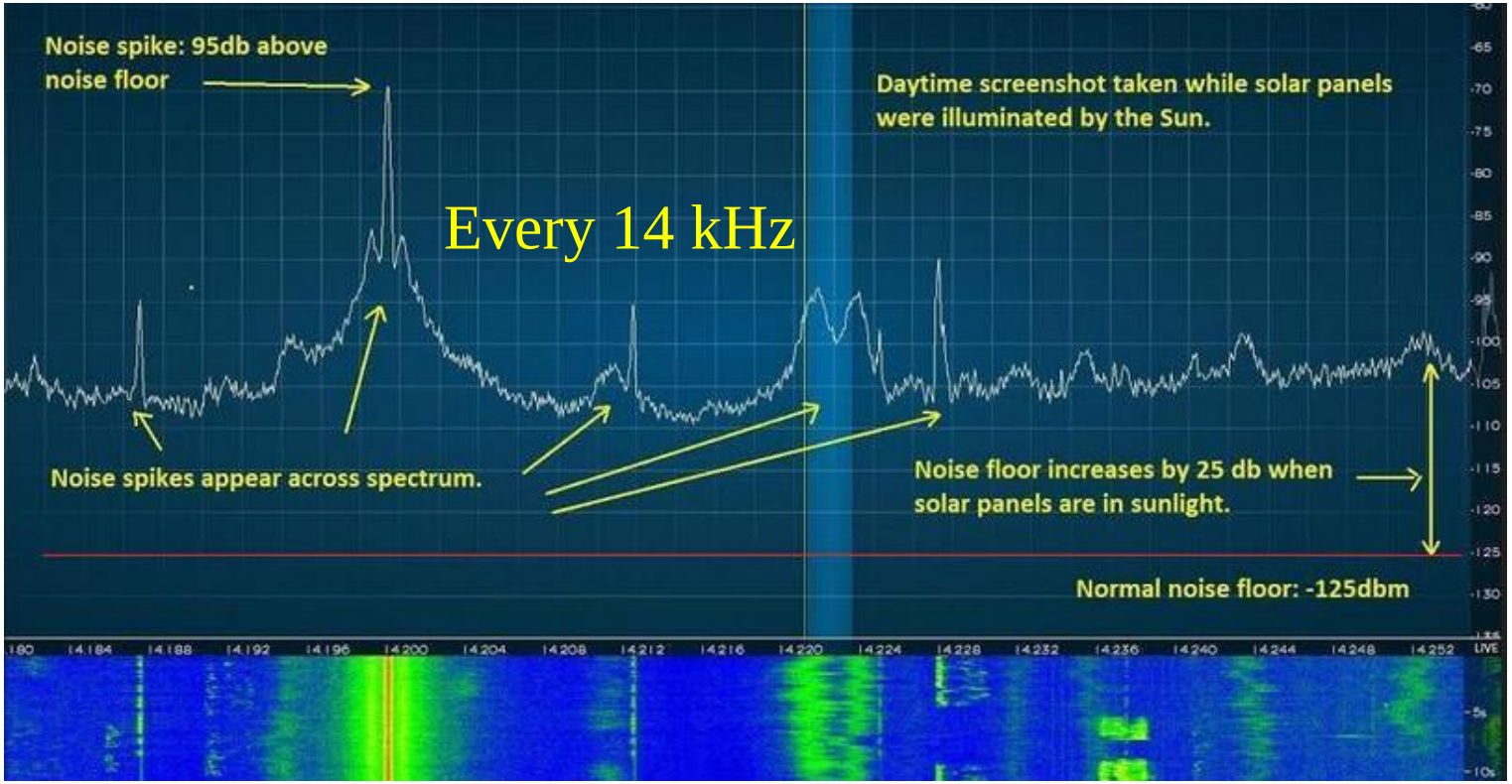
RS!

April 2016 33

Figure 5 — Three bifilar turns of #10 PV wire on Fair-Rite 2631626202 core with MC4 connectors installed.

K1KP's
QST article

BEWARE of Solar RFI!



UNITED STATES COAST GUARD

U.S. Department of Homeland Security

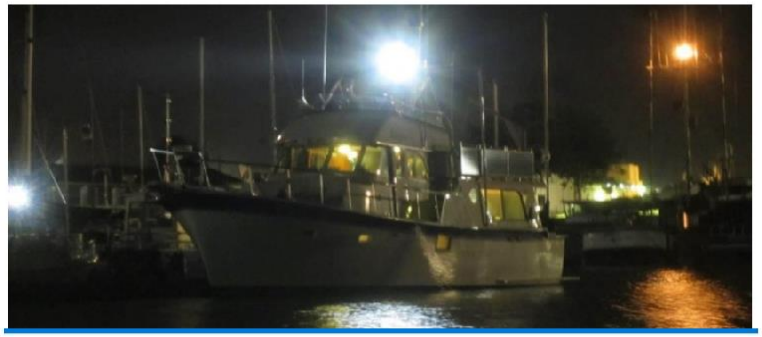
MARINE SAFETY ALERT

Inspections and Compliance Directorate

August 15, 2018 — ***Let us enlighten you about LED lighting!*** — Safety Alert 13-18

Potential interference of VHF-FM Radio and AIS Reception.

Radio frequency interference caused by these LED lamps were found to create potential safety hazards.



Test Procedures:

1. Turn off LED light(s).
2. Tune the VHF radio to a quiet channel
3. Adjust the VHF radio's squelch control until the radio outputs audio noise.
4. Re-adjust the VHF radio's squelch control until the audio noise is quiet
5. Turn on the LED light(s).
6. If the radio does not output audio noise, then the LED lights have not raised the noise floor.

Dead WRONG! It's a Noise-Squelch Dummy

“Optimizers” -Very Difficult to Control!

Figure 6 — The chokes from Figure 2, as well as the twisted wire transmission cables can be seen between two of the aluminum support rails before solar panels were installed.

Especially OPTIMIZERS!
By Solar Edge! ARGH!

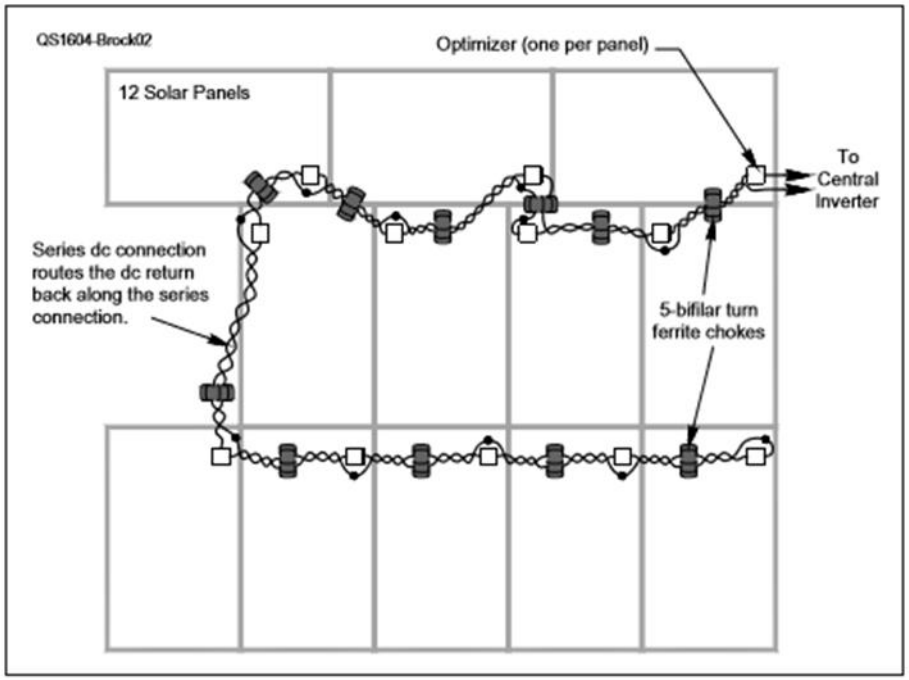
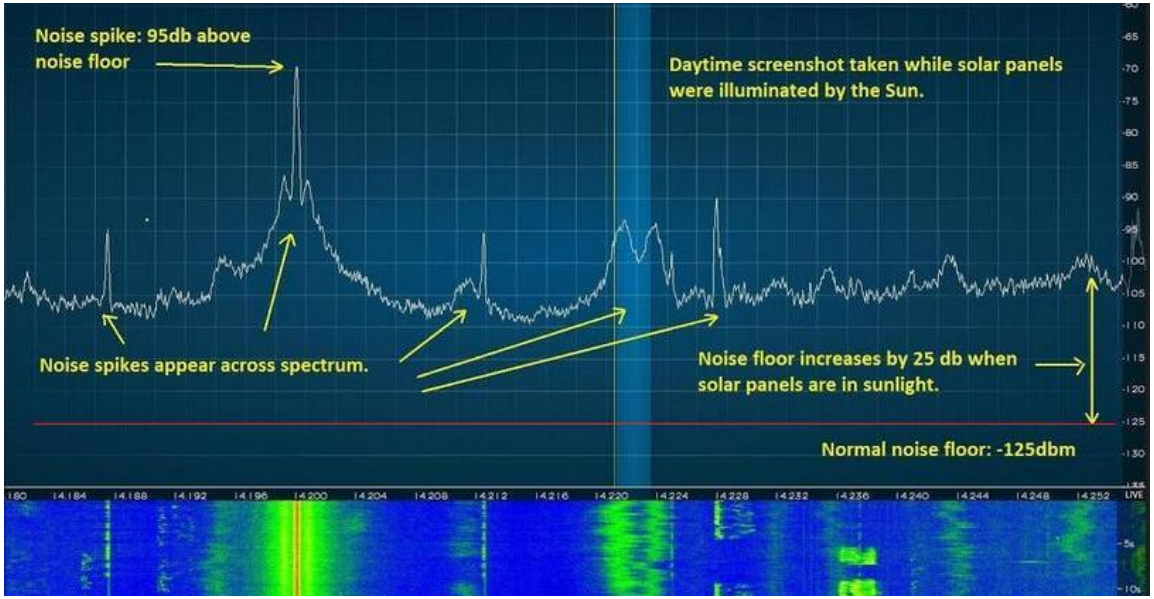


Figure 2 — New wiring configuration shows a closed loop of a twisted pair of conductors, and ferrite beads to suppress common mode currents.

Talk to your neighbor!... NOW



If you wait till you hear it, Its too late!

You've lost HF hobby (Daytime) forever

7,000,000,000 people sharing the Air and Water

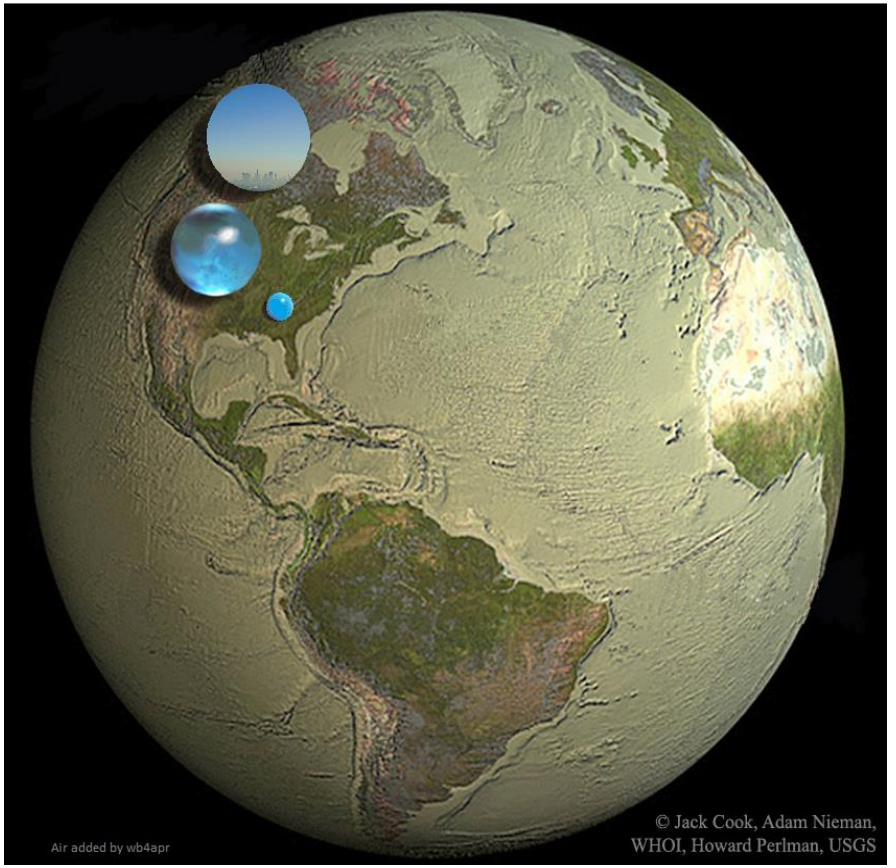
The Clock is ticking

All the Air on Earth

All the Water on Earth

All the fresh water on Earth

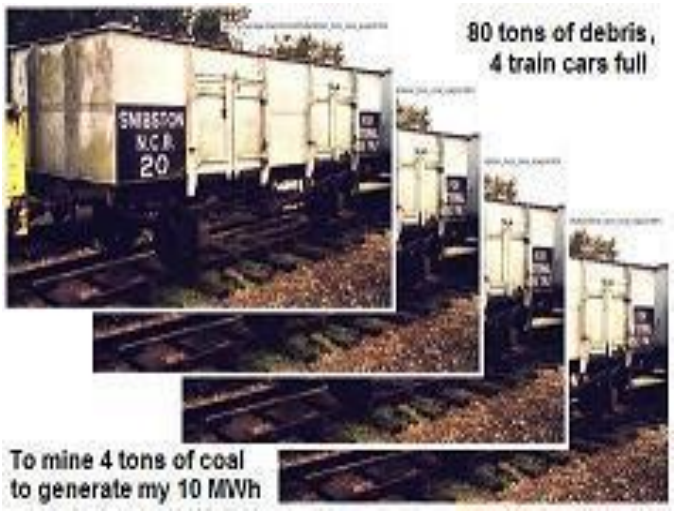
And every cubic foot of air has passed through a combustion engine at least once in the last 200 years



Bob Bruninga, WB4APR

http://aprs.org/AFM-environment.html

Big Picture!



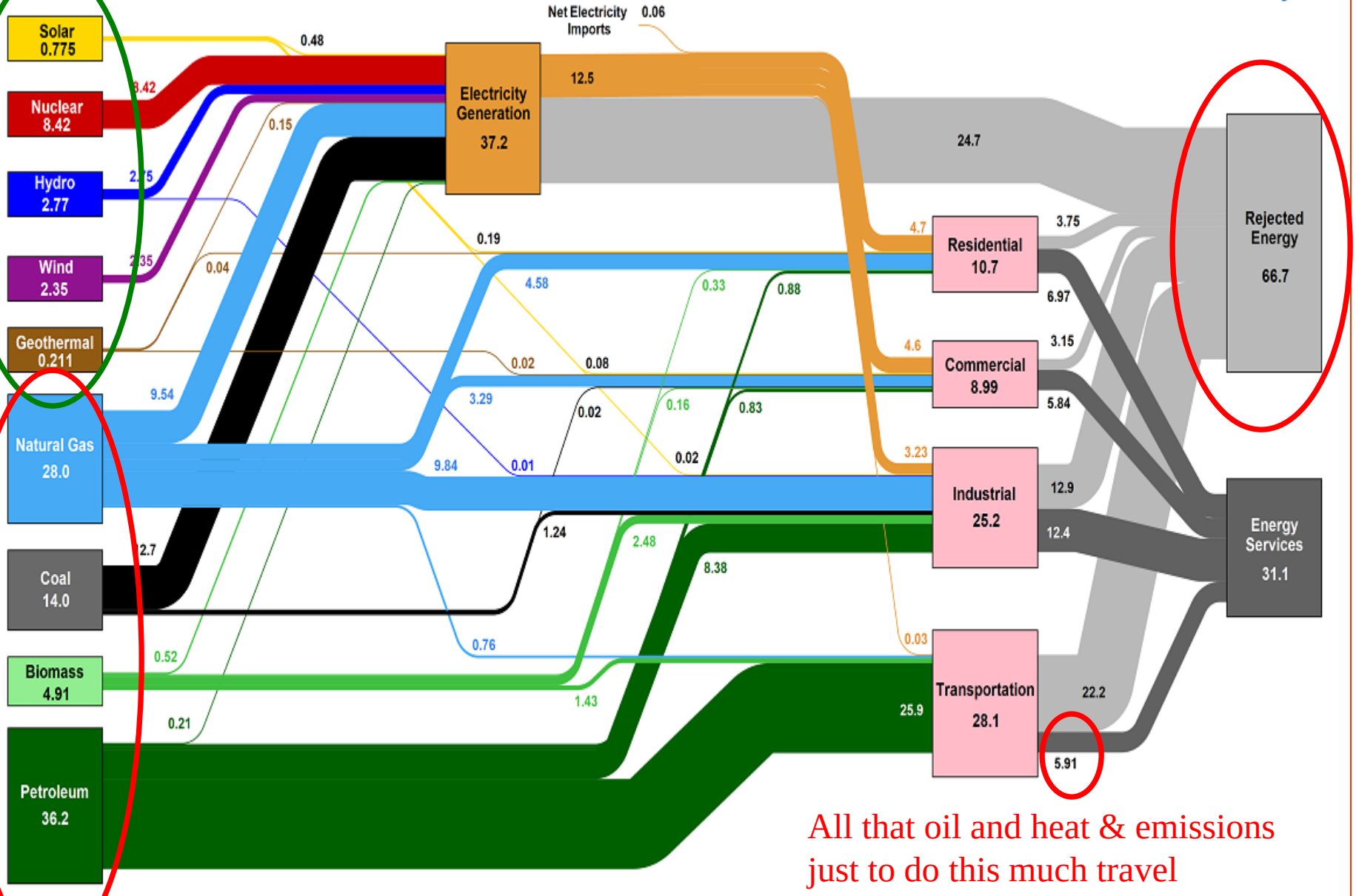
1 House, 1 Year 4 Tons of Coal

Yes, we have 100 years of coal, but there won't be anything left of WV!
Nor clean air to breathe!

Mining for Energy

Estimated U.S. Energy Consumption in 2017: 97.7 Quads

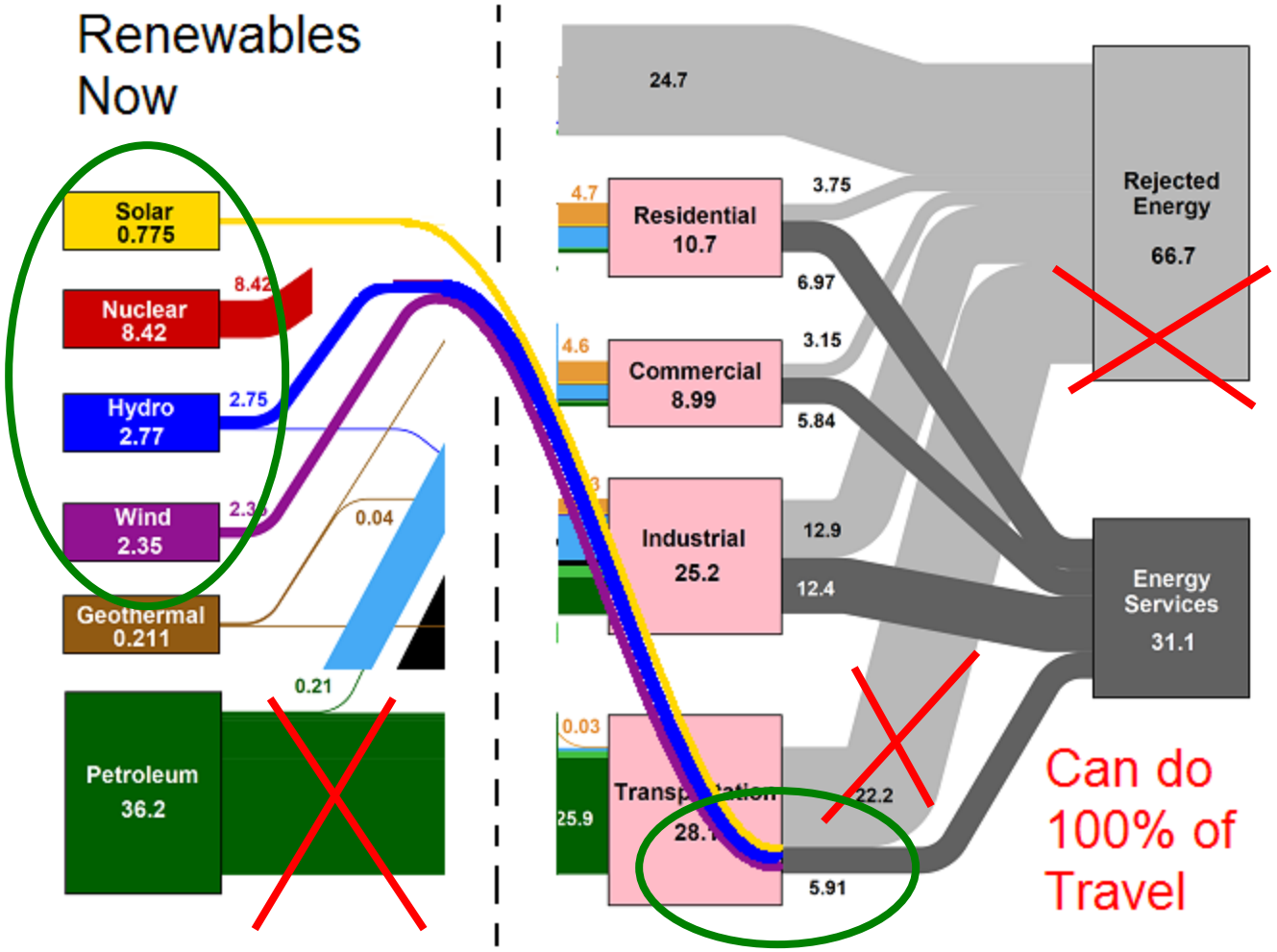
Lawrence Livermore National Laboratory



All that oil and heat & emissions just to do this much travel

Source: LLNL April, 2018. Data is based on DOE/EIA MER (2017). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. This chart was revised in 2017 to reflect changes made in mid-2016 to the Energy Information Administration's analysis methodology and reporting. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector, and 49% for the industrial sector which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Oil - Biggest Polluter is Easiest to Eliminate!



Good news! We all face major Decision points in our lives.

Every 2 years (avg) we face a major **Energy Decision….**

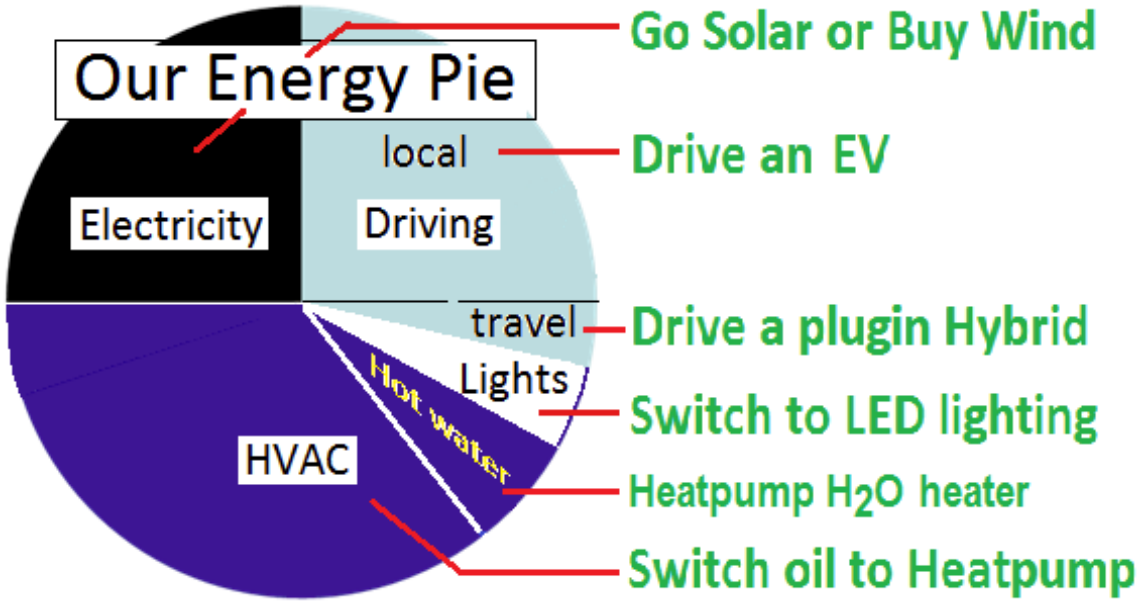
Every 20 years, a new roof
Every 15 years, a new HVAC system
Every 12 years, a new job, a move, retirement
Every 9 years, a new water heater
Every 6 years, a new car
Every 5 years, a new lawnmower
Every 1 year, Energy choice from Utility

Having a prepared mind is essential

A clean energy investment is better in the long run and cheaper too!

Every 2 years you face a major **Energy Decision….**

A prepared mind is essential



A clean energy investment is better in the long run and cheaper too!

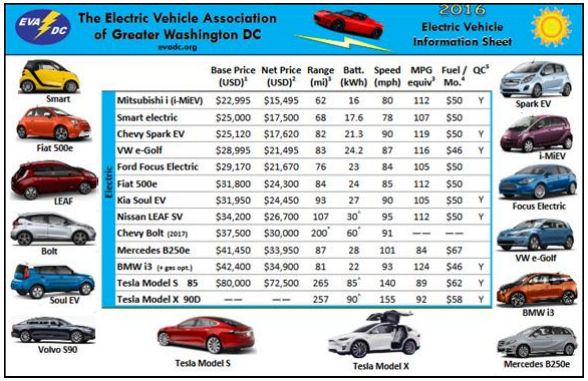
Electric/Solar Transportation Forever!

12 Panels can fully charge Average American 40 miles daily Forever!

Electric & Gas	Ford C-Max Energi	20+gas
	Ford Fusion Energi	20+gas
	Hyundai Sonata	27+gas
	Audi A3 e-tron	17+gas
	BMW X5 xdrive40e	14+gas
	Volvo XC90 T8	13+gas
	VIA VTRUX (fleet)	40*+gas
	Porsche Cayenne	14+gas
	Mercedes C350e	18*+gas
	Mercedes S550e	12+gas
	Porsche Panamera	15+gas
	BMW i8	14+gas
	Porsche 918 Spyder	12+gas
Electric & Gas	Chevy Volt	53+gas
	Chrysler Pacifica hyb	30*+gas
	Cadillac ELR	40+gas
	VIA VTRUX (fleet)	40*+gas

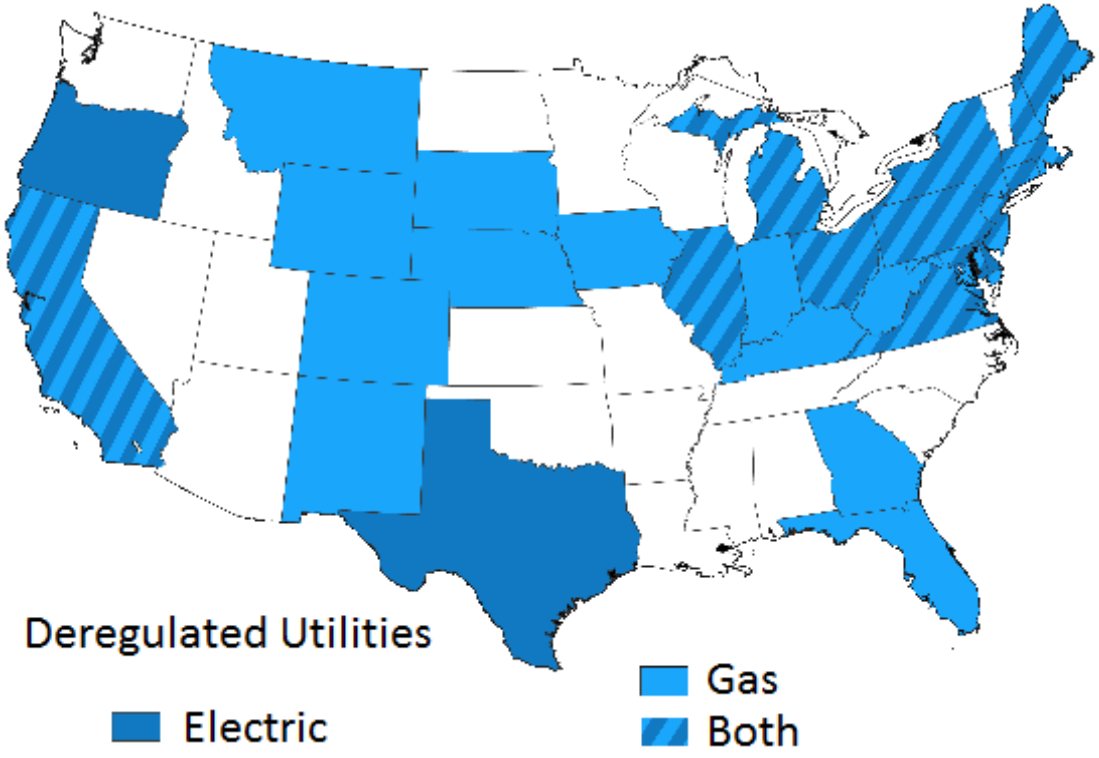
3 kW
$2000

40 mi/day average commuter Forever!



	Base Price (USD)[1]	Net Price (USD)[2]	Range (mi)[3]	Batt. (kWh)	Speed (mph)	MPG equiv[3]	Fuel / Mo.[4]	QC[5]
Mitsubishi i (i-MiEV)	$22,995	$15,495	62	16	80	112	$50	Y
Smart electric	$25,000	$17,500	68	17.6	78	107	$50	
Chevy Spark EV	$25,120	$17,620	82	21.3	90	119	$50	Y
VW e-Golf	$28,995	$21,495	83	24.2	87	116	$46	Y
Ford Focus Electric	$29,170	$21,670	76	23	84	105	$50	
Fiat 500e	$31,800	$24,300	84	24	85	112	$50	
Kia Soul EV	$31,950	$24,450	93	27	90	105	$50	Y
Nissan LEAF SV	$34,200	$26,700	107	30*	95	112	$50	Y
Chevy Bolt (2017)	$37,500	$30,000	200*	60*	91	—	—	
Mercedes B250e	$41,450	$33,950	87	28	101	84	$67	
BMW i3 (+ gas opt.)	$42,400	$34,900	81	22	93	124	$46	Y
Tesla Model S 85	$80,000	$72,500	265	85*	140	89	$62	Y
Tesla Model X 90D	—	—	257	90*	155	92	$58	Y

1st Sign up for Wind!



Sign up via your Utility that offers “choice”

2nd LED Lighting: Save 9 to 1 Energy!

(breakeven in 2 weeks!)

Cost under $2

Save $60 over the life of the bulb!

House with 50 bulbs saves $2500

Now LEDs

Only 3 in 4 households do it!

Yet BGE reports 20% load reduction since 2008!

Across USA, Coal burning is down more than 20%

3rd Go electric on all small engines!

Gas mowers are TEN times more polluting* than a CAR.
Buy one Electric mower for $200 more and reduce toxic emissions as much as spending $10,000 more on an EV

21 in. 56-Volt Lithium-ion Cordless Battery Self Propelled Mower with 7.5Ah Battery and Charger Included

- Delivers the high torque of gas-powered mowers
- 7.5Ah 56-volt battery (shipped separately) and rapid charger
- 60 minutes cut time and 60 minutes charge time

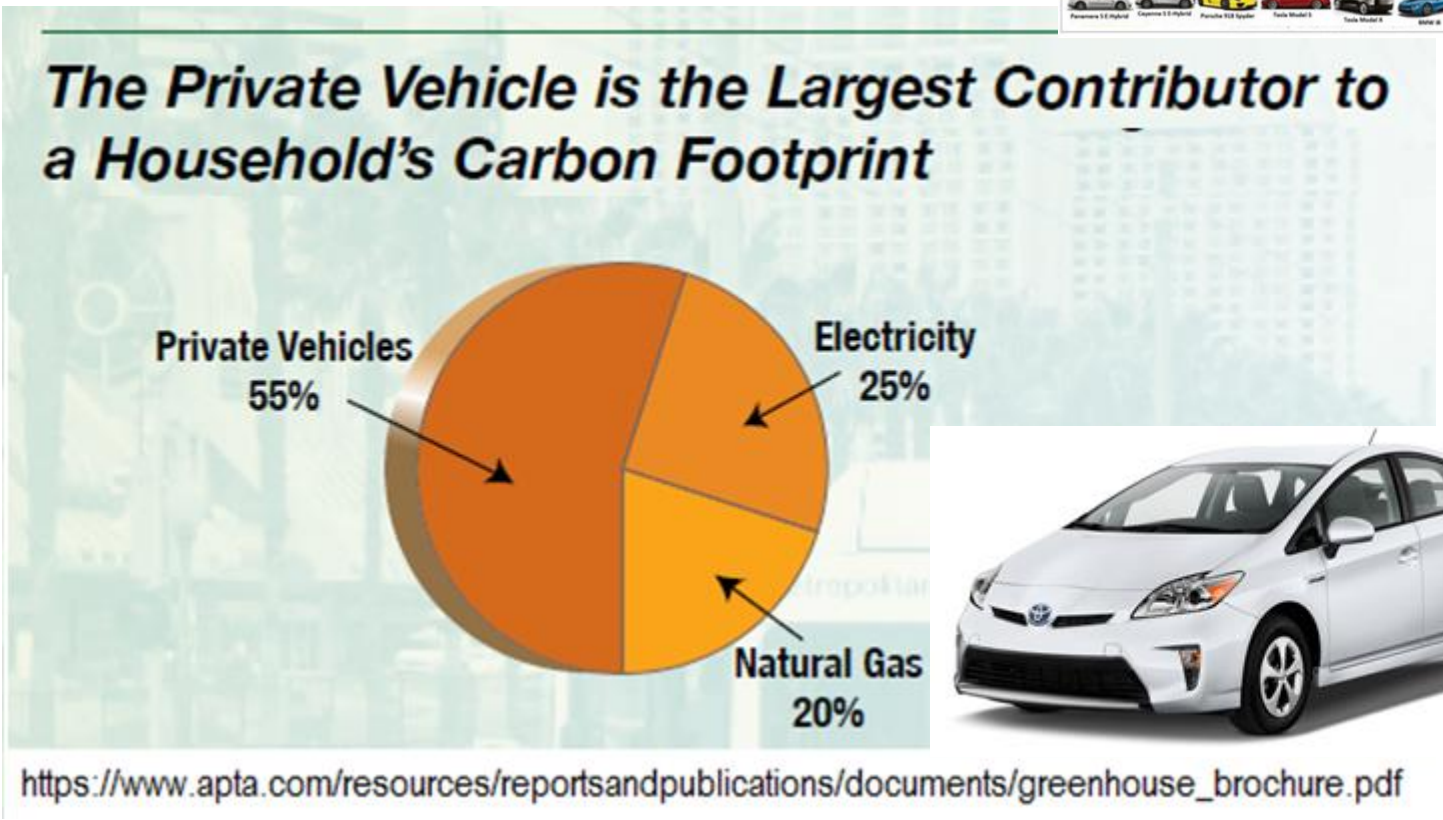
~~$599.00~~ /each $550

6 lb battery

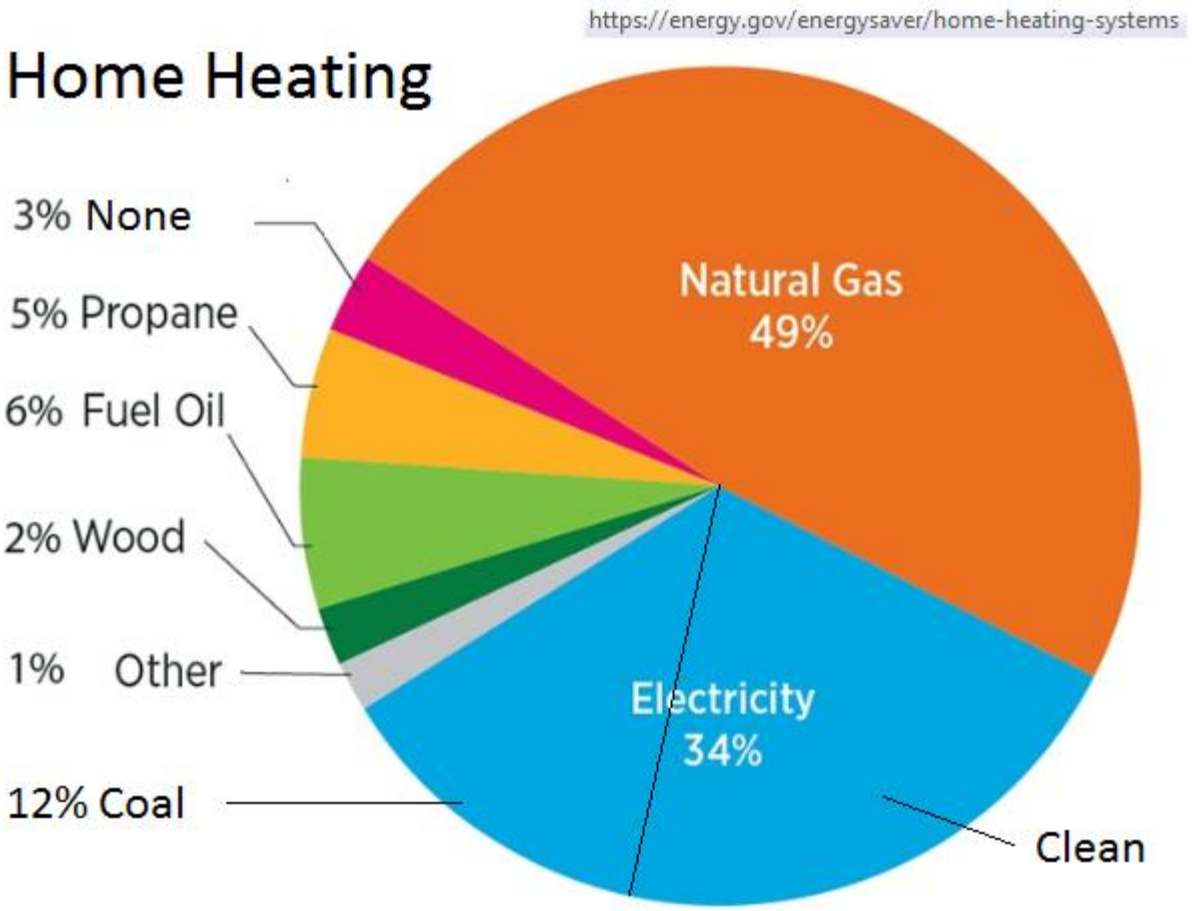
I Love it!

* Toxicity, carcinogens, etc (not carbon)

4th The easiest step – Buy a Plugin



5th The easiest step - Heatpmp



Easy Heatpumps

- Window Units
- Portable Units
- Mini-Split units
- Hot Water Units

Easy DIY - No Ductwork!

And is best of zone heating and cooling!

Ductless Heatpumps Anywhere!

12,000 BTU 1 Ton
Ductless Mini Split Air Conditioner and Heat Pump - 208-230V/60Hz

$1,199.00/bundle

✔ Shipping available

Add To Cart

Never Buy or Replace an AC unit Again!

When that time comes, **buy a bi-directional Heatpump!**
It only costs about 10% more but..

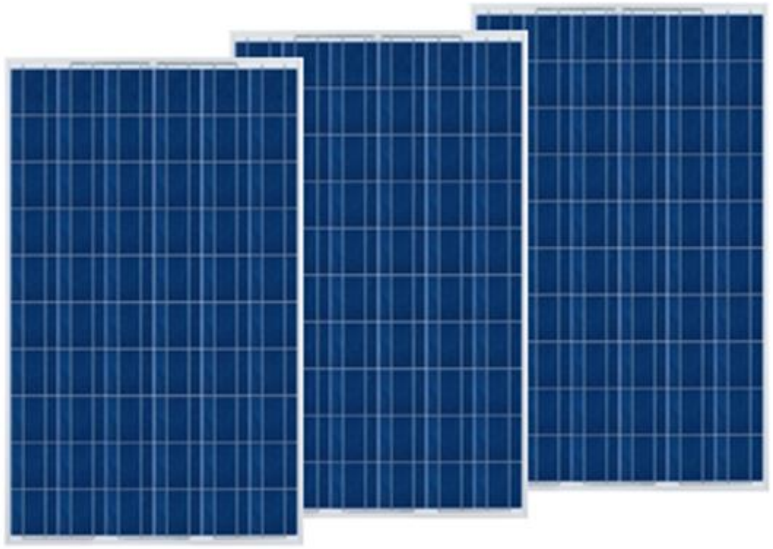
It Cools!
It Dehumidifies

It Heats! (with 1/3rd the cost of Electricity, 1/2 the cost of Oil/Propane)

You can even buy Solar HVAC

Solar Air Conditioner Heat Pump

ACDC12b SOLAR AC
SAVE >90% ON COOLING / HEATING COSTS



ENERGY STAR

c ETL US LISTED Intertek

Or make your own from a new variable speed HVAC

Finish this Sentence:

- There is nothing certain in life except

Death and ….

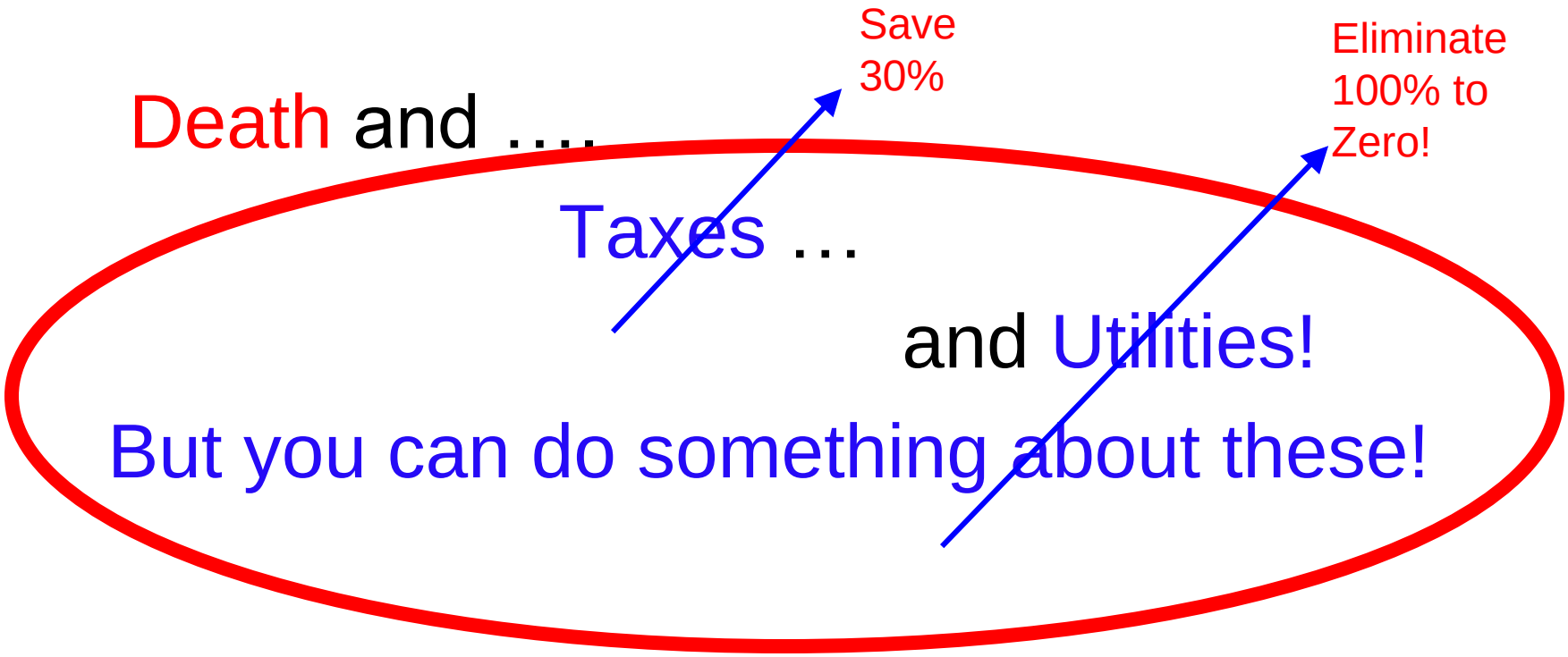
Taxes …

and Utilities!

But you can do something about these!

Finish this Sentence:

- There is nothing certain in life except

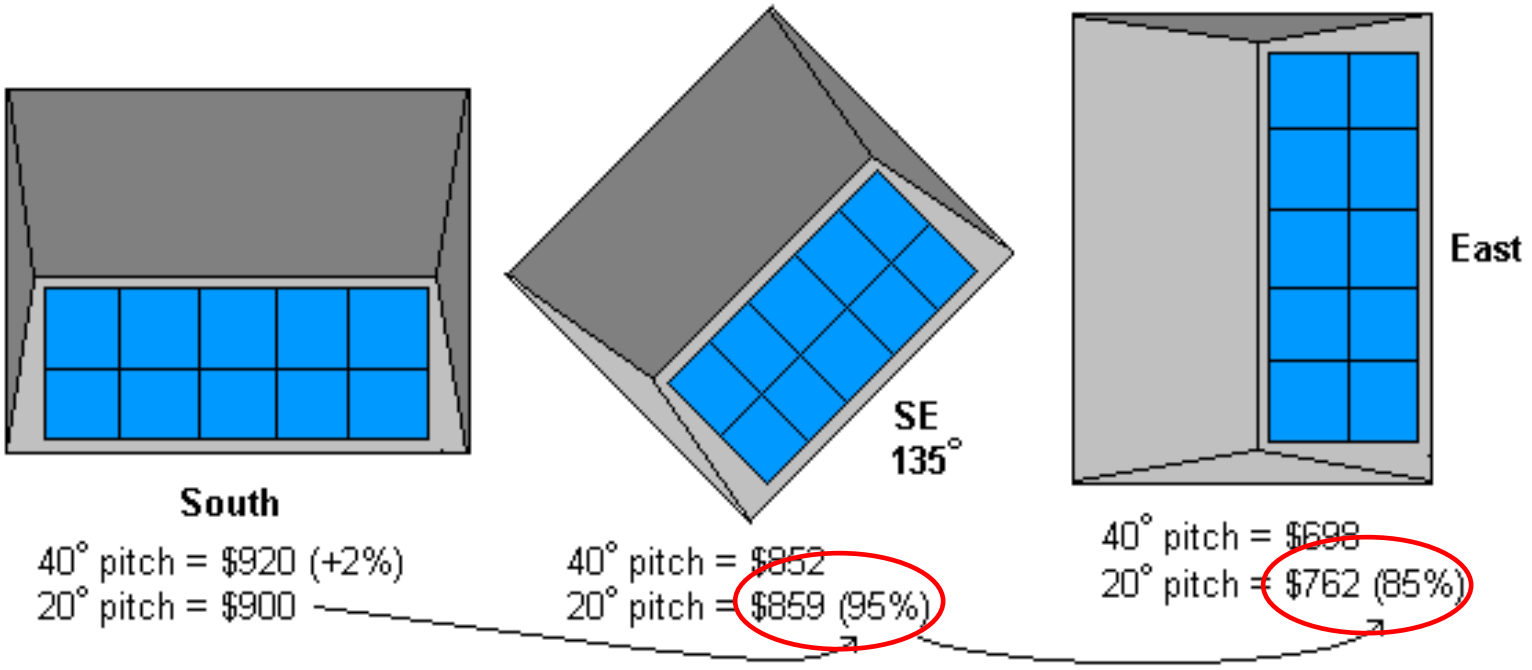


Lets talk Solar!

Direction - not important with Grid-Tie

PVWatts AC Energy & Cost Savings

http://www.nrel.gov/rredc/pvwatts/

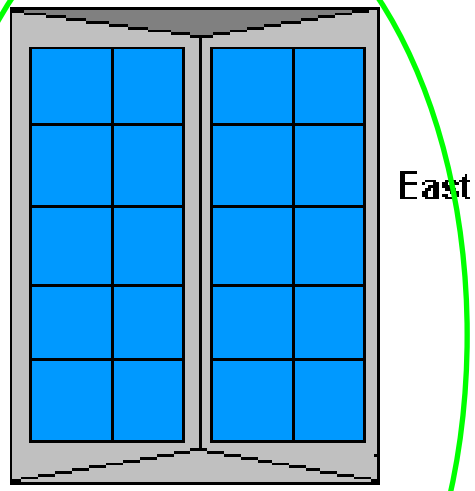


Amazing, even due East, you still get 85% effectiveness!

Direction - less important, More Roof is!

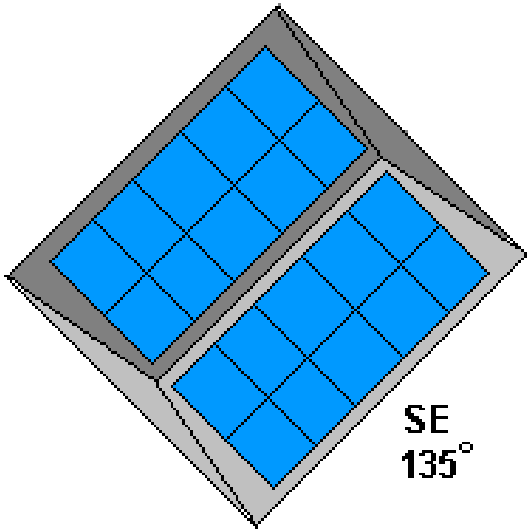
PVWatts AC Energy & Cost Savings

http://www.nrel.gov/rredc/pvwatts/



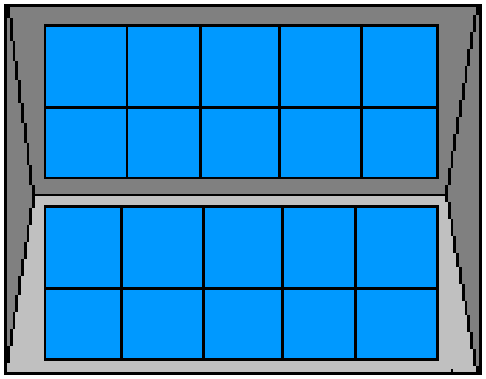
East

20° pitch = $ 762 (85%)
West side + $ 766
Total $1528 (170%)



SE 135°

20° pitch = $ 859 (95%)
NW side + $ 657
Total $1516 (168%)

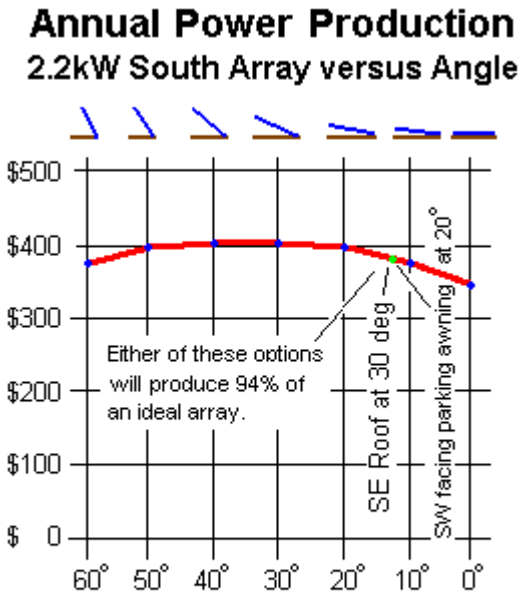


South

20° pitch = $ 900
North side + $ 604
Total $1504

Amazing! Increase power by 60% to 100% on other side!

Tilt Angle not important* with Grid-tie



For annual total power, the tilt angle is not that important. The more important parameter is shade (location)

Tilt angle chosen was 25 deg instead of 35 deg to reduce visibiity (<1% loss)

Any angle from 20º to 50˚ is within 1% of annual total

(*Tilt is absolutely essential for ***winter*** with off-grid)

One of the Biggest problems for Solar is Shade

And easiest to fix

Solar panels can also provide a bit of shade to the roof

A chain saw fixes a lot!

- A 6 kW array reduces carbon as much as 200 trees (2 acres)

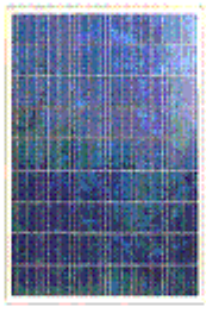
- So give up one if you have to, and…

- Plant a new one just where you want it
- In 20 years it might be over 30’ tall!

8 Trees Eliminate these Pollutants /yr

400 lbs of carbon dioxide
48 lbs of particulates
9 lbs of nitrogen dioxide
6 lbs of sulfur dioxide
2 lb of carbon monoxide

Derived from data on: http://www.coloradotrees.org/benefits.htm



One 220W solar panel Eliminates Per Year:

440 lbs of Carbon Dioxide
57 lbs of Particulates
7 lbs of Sulfer Dioxide
1.4 lbs of Nitrous Oxide
0.4 lbs of Carbon Monoxide
.0012 lbs of Uranium and Thorium
.0000008 oz of Mercury

Derived from http://en.wikipedia.org/wiki/Fossil_fuel_power_plant

Bob Bruninga, WB4APR

Big Picture!

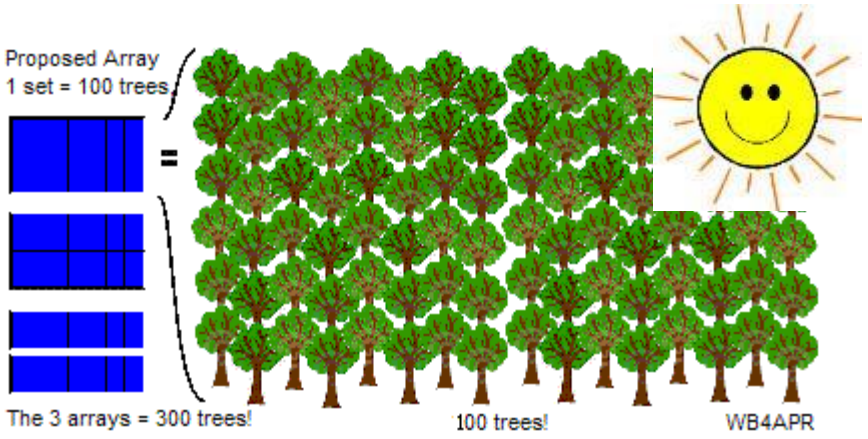
Clean Energy, SOLAR

Carbon Equivalence!

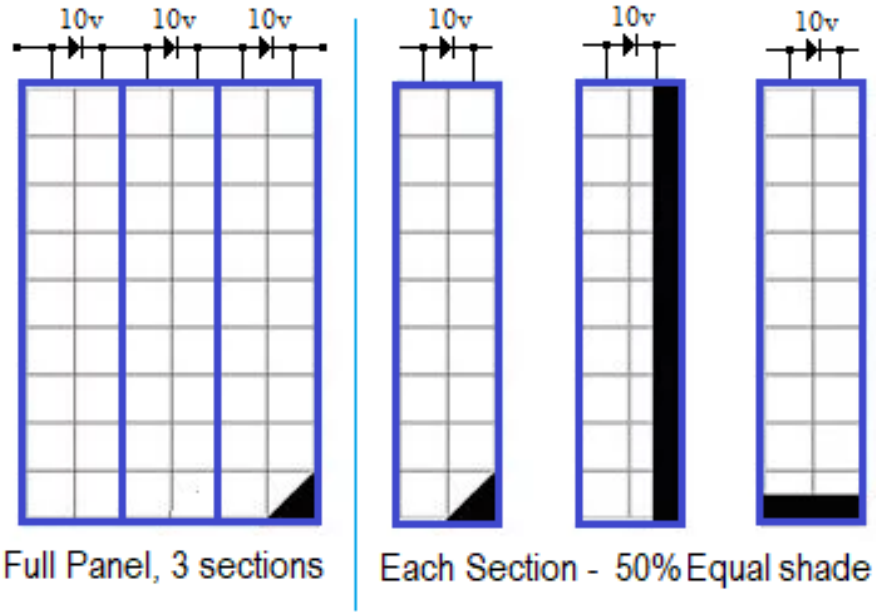
Each Panel = 8 Trees.

Our system = 312 trees!

= **(3 acres of trees)**



Shade on a cell takes out whole section (1/3rd) of panel



Same effect on both String arrays AND Microinverters!

10% or more annual Return on Investment for Life!

- Federal gives 30% tax credit. No limit
- State Grants (was $5000 in 2011, $10(
- County Real Estate Tax credit (was $2500)
- Total Gov't Tax Credits were ~ 40% of investment!

Compare 1% ROI from banks

Compare zip-squat-zero ROI from utility!

When did you hear about solar?

- In 2010, when solar city showed it was cheaper than the utility In Maryland? (9 years ago)
- What did you do about it?
- At $100/mo electric bill, you have thrown away $11,000 to the utility
- And missed over $3300 in Tax credit
- And missed over $2000 in local tax benefits

- Your cost for doing nothing? Nearly $15,000

The Value of $12,000 Savings?

For Someone with a $100/mo elec bill ($1200/yr)

In bank @ 1%
Pay $1200/yr for electricity forever*

Buy 6 kW solar $16k equity
Get back $4000 immediately on taxes (OPM)
Get back $600/yr in SRECs (5 yrs) $3,000
Get $1200 free electricity/year
Get $1000 from state? County? City?

$ 0 Equity left 10 yrs
$ 1200 Earned interest

Own nothing
Continue $1200/yr utility for life
$ 0 after 1 more year 11 yrs

$12,000 System Value
$ 5,000 Tax refund
$ 3,000 SREC's

$20,000 Equity
Avoided $12,000 in electric bills
You own your own Energy system
Net value $32,000* 10 yrs
NO utilities for life!

* Apples and Oranges
your mileage may vary

The Value of $12,000 Savings?

For Someone with a $100/mo elec bill ($1200/yr)

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Get $1200 free electricity/year
Get $1000 from state? County? City?

$ 0 Equity left 11 yrs

$12,000 System Value
$ 5,000 Tax refund
$ 3,000 SREC's
$20,000 Equity

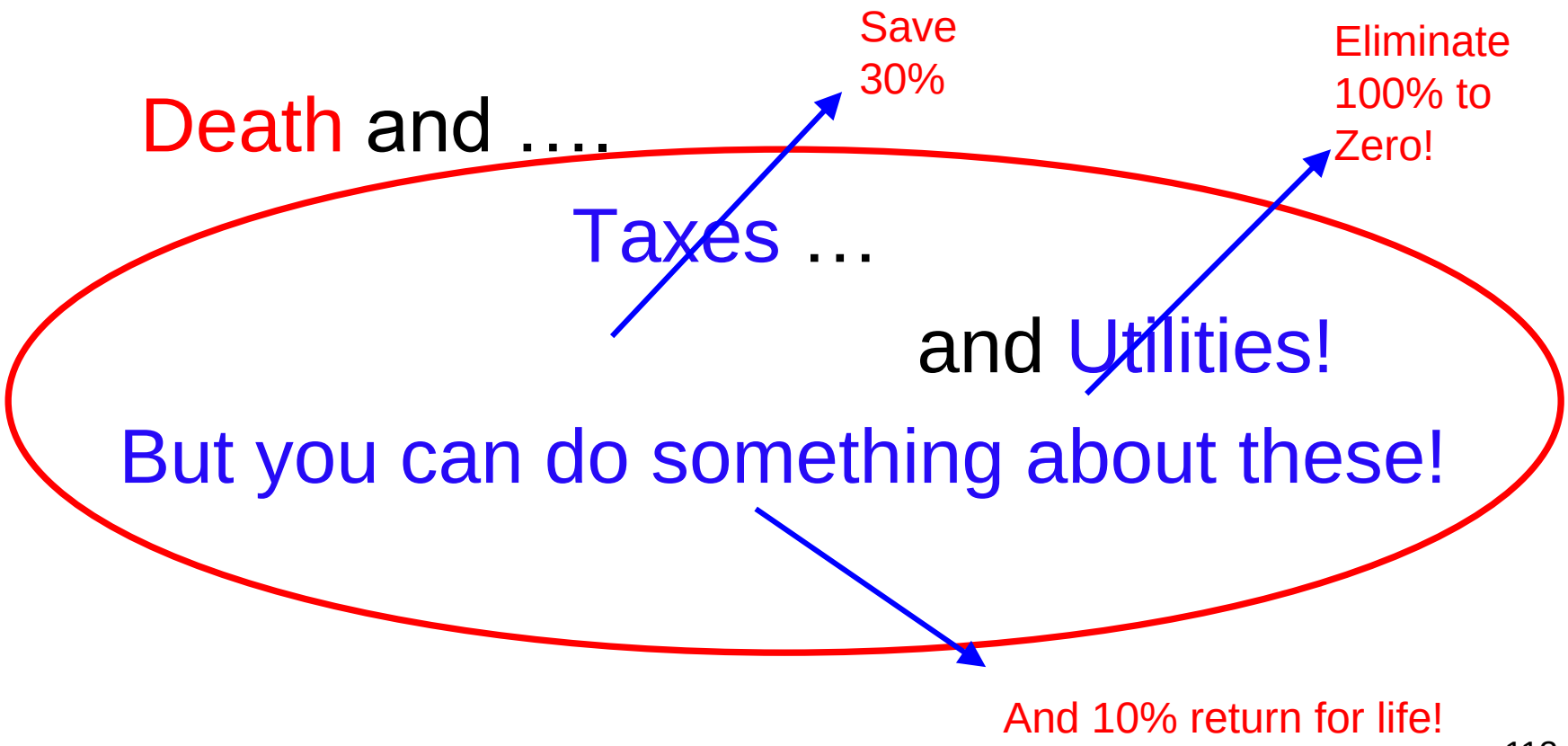
Own nothing
Continue owing $1200/yr utility for life

Avoided $12,000 in electric bills
You own your own Energy system
Net value $32,000* 10 yrs
NO utilities for life!

* Apples and Oranges
your mileage may vary

Remember:

- There is nothing certain in life except



Solar panels better than a pension, says minister

8% - 10%

Energy minister says those approaching retirement should consider putting some of their savings into solar panels to deliver a better financial return than a pension

Greg Barker, the energy minister, said that anyone approaching retirement should consider putting some of their savings into solar panels because they would deliver a better financial return than a pension.

Email

Buy or lease Solar?

Personal Decision based on your situation

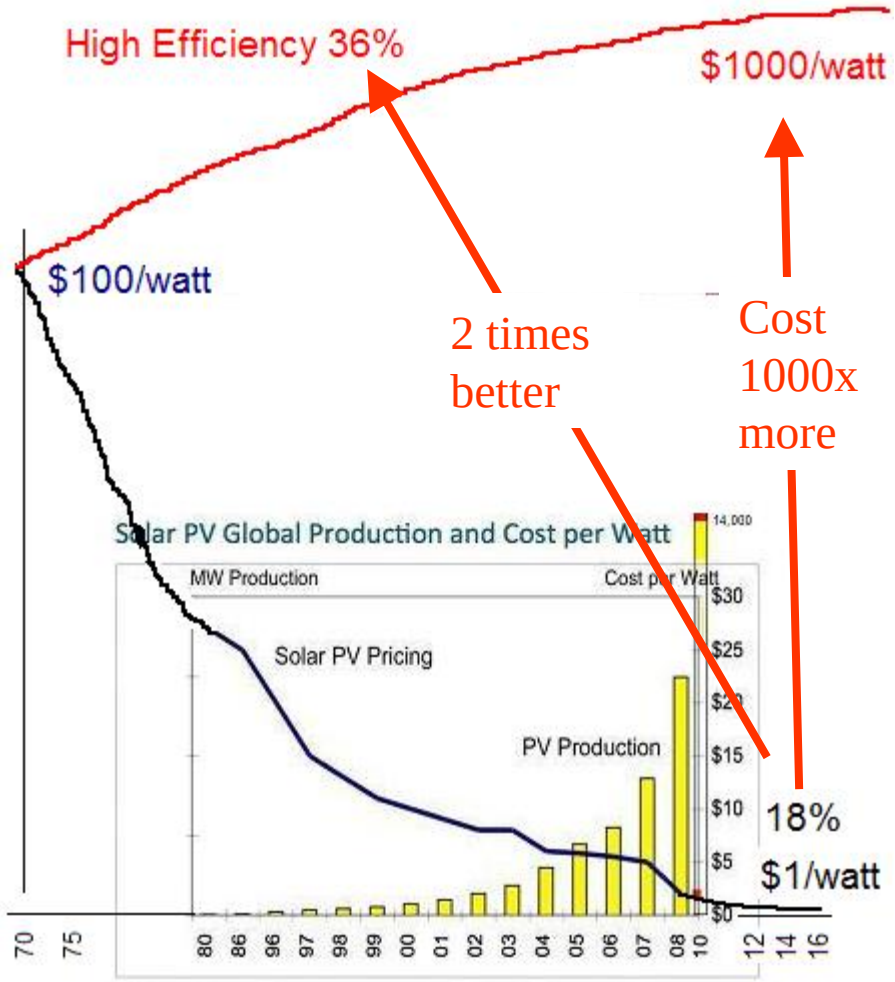
- Do nothing – Pay utility/month Forever (FOSSILS)
- Lease – Pay ~ 15% less for 20 years (**clean**)

- Buy via Loan – about 25% less?
- Buy – From savings – about 50% less?

} You Own!

- Get Three estimates (don't trust me!)

Waiting for Higher Solar Efficiency is a Fools Errand



High efficiency prices ONLY go up since the space industry will pay anything for each additional 1 percent.

Home panel prices only go **down** since homeowners will not buy anything but the cheapest

Rapid Change is happening all around you!

Just in 2008 they were saying the grid cannot handle more than 2% solar/wind

2013 Hawaii hit 40% on a weekend, Germany hit 60%,

2014 Netherlands and Spain hit 100% for a day

2015 many countries hit days of 100% solar wind

2015 **In one year China installed more wind than USA to-date**

2016 Saudi Arabia began largest solar, cheaper than coal

2017 Oil rich Texas hit 100% wind/solar for a day

2017 Denmark was 63% solar & wind for the whole year!

2018 Germany

Now 100% is common!

* Facts are correct, dates are from memory…

The Great Ham DIY Solar Paradox!

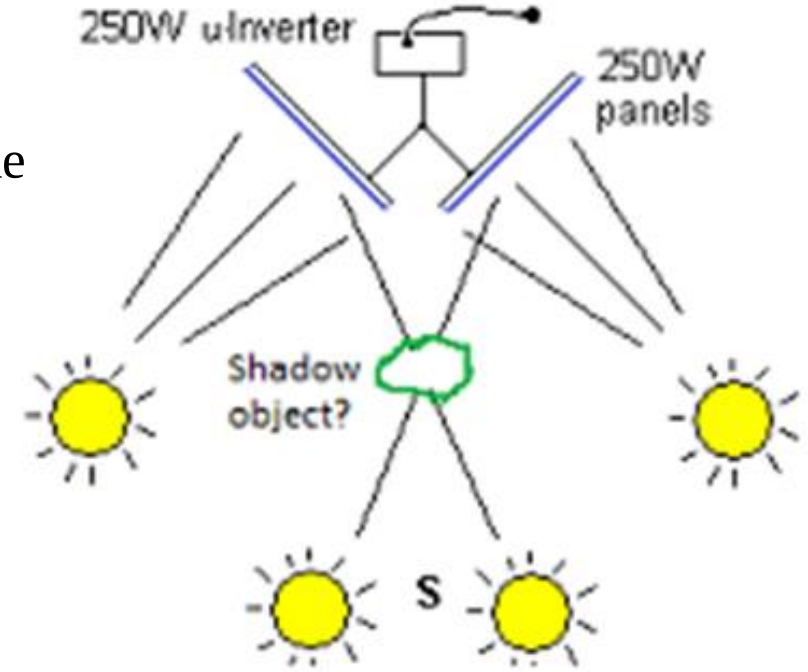
Solar is a Fantastic Investment for the Ham (grid Tie)
But, Solar Grid Tie is impossible DIY:
•Building & Electrical permits, Utility Inspections

DIY Solution:
Contract a small system
Get Net Meter - $2.50/W

Add your panels - $0.30/W
& plugin GT inverters - $0.30/W

Another DIY Tip:
– Double your GT Inverter Power!

- Double panels at 90 degrees
- Parallel to same inverter
- Inverter rating remains the same
- BUT FOR TWICE AS LONG

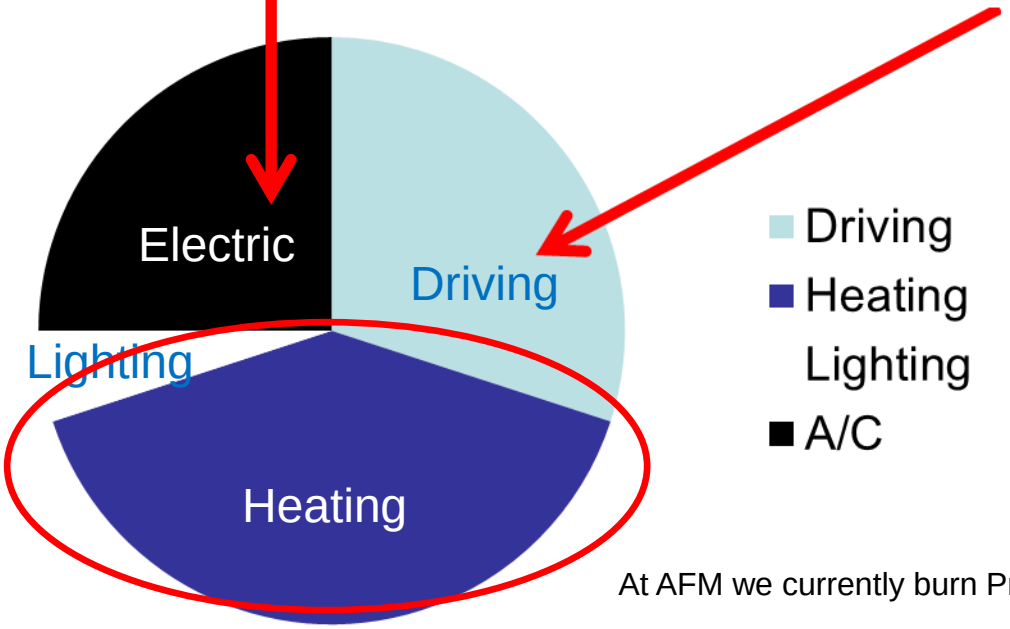


Big Picture!

Burning Fossils for Heat!?

Solar Power for Electricity

Electric Vehicle Support



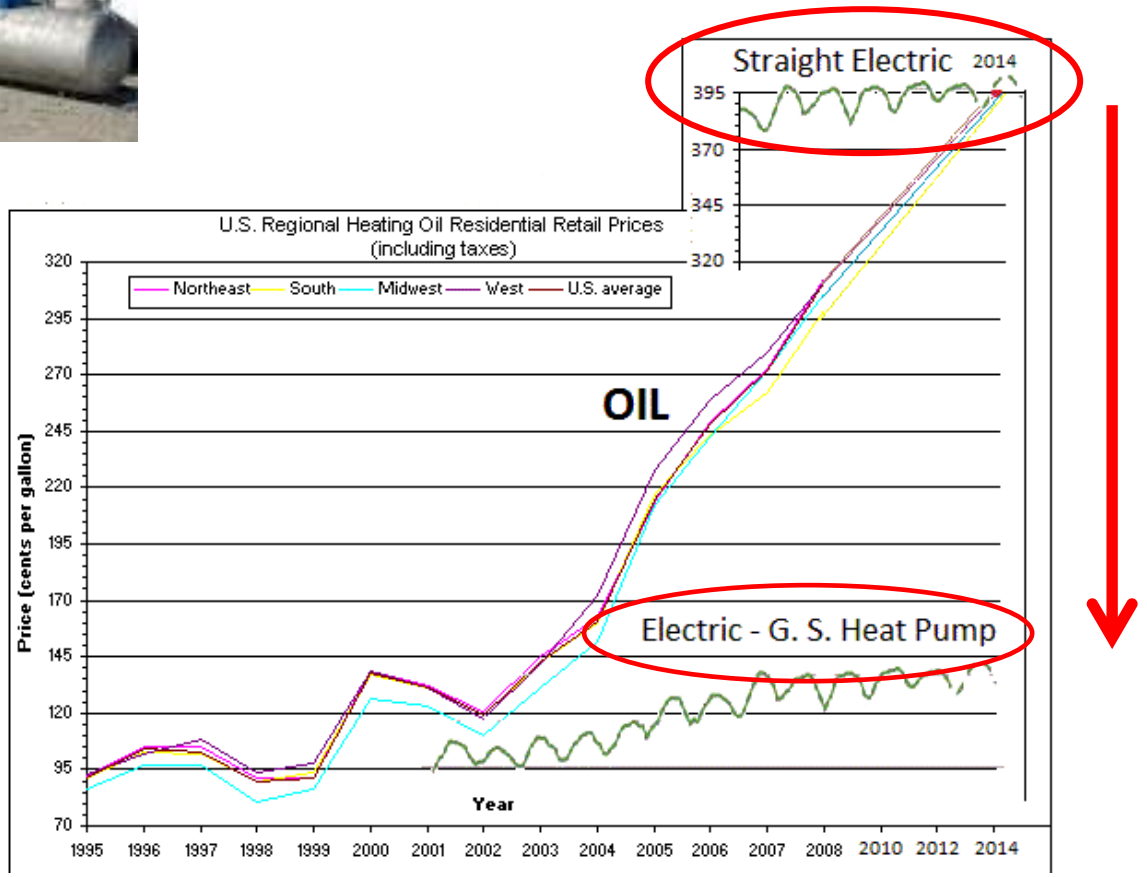
We include EV's because about half of our easily-fixed energy is spent *driving*

At AFM we currently burn Propane for heat

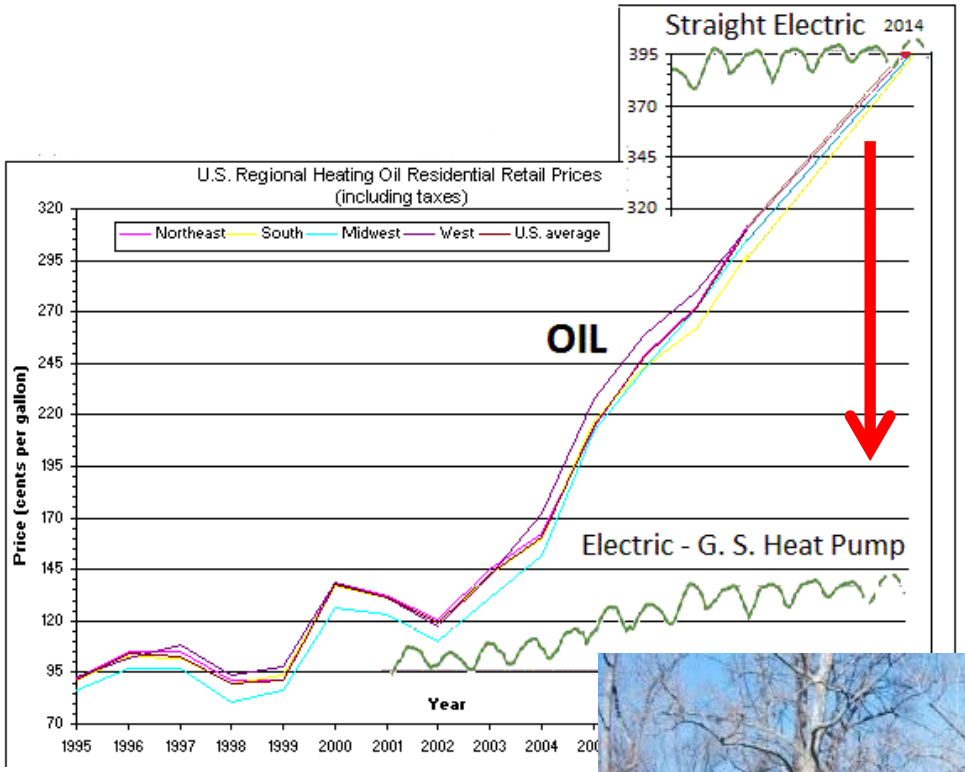
Heating Costs – Oil, Propane…

Actually our biggest Energy cost is our Propane heating.

Switching to Heatpump can save 60% of our energy costs!



Switching from Propane to Heatpump (electric)



Our heating costs went down 60% AND being electric, we replace that with solar free heating for decades!

Never Buy another Air Conditioner Again

When the old AC dies **GET A HEATPUMP** to replace it.!

A Heatpump is same as AC unit but with a reversing valve.

Only adds 10-20% cost but can replace 80% of fossil Heat

When the old furnace dies, GET A HEATPUMP

Heatpumps save 2 or 3-to-1 on Energy costs

AND they can run on 100% fossil free energy!

Window units, Split units, Duct units, etc

Easy Heatpumps

- Window Units
- Portable Units
- Mini-Split units
- Hot Water Units

Ductless Heatpumps Anywhere!

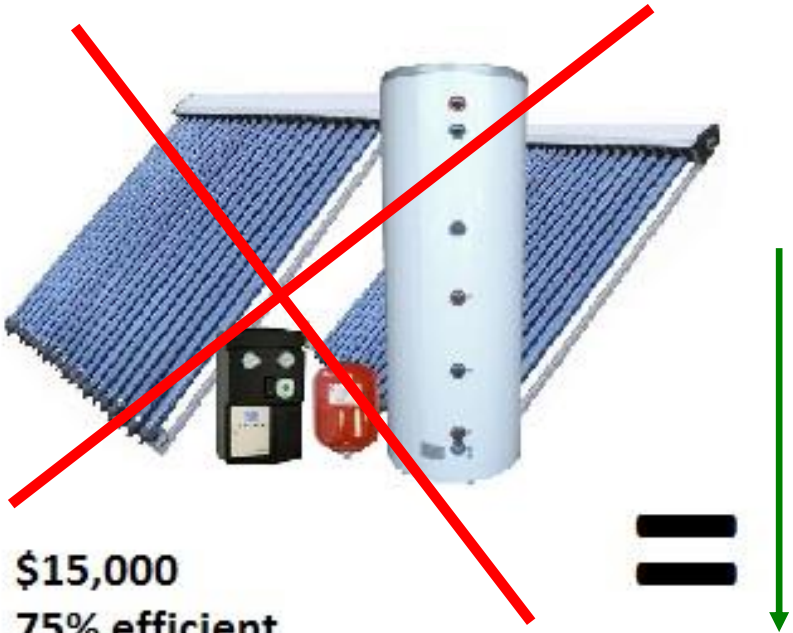
12,000 BTU 1 Ton
Ductless Mini Split Air Conditioner and Heat Pump - 208-230V/60Hz

$1,199.00/bundle

✔ Shipping available

Add To Cart

Solar PV now BETTER than Thermal hot water… !



$15,000
75% efficient
Maintenance

Dead,dead,dead

$5,000
15% efficient

Heatpump
250% efficient

100% hot water not used EVERYDAY
… Excess solar every day is lost

100% of solar energy = full retail value
Independent of how you use it!

So, choose forward with clean Energy

Bob Bruninga, WB4APR
Annapolis, MD 21401
http://www.aprs.org/AFM-environment.html
410-293-6417

Summary

You can do something

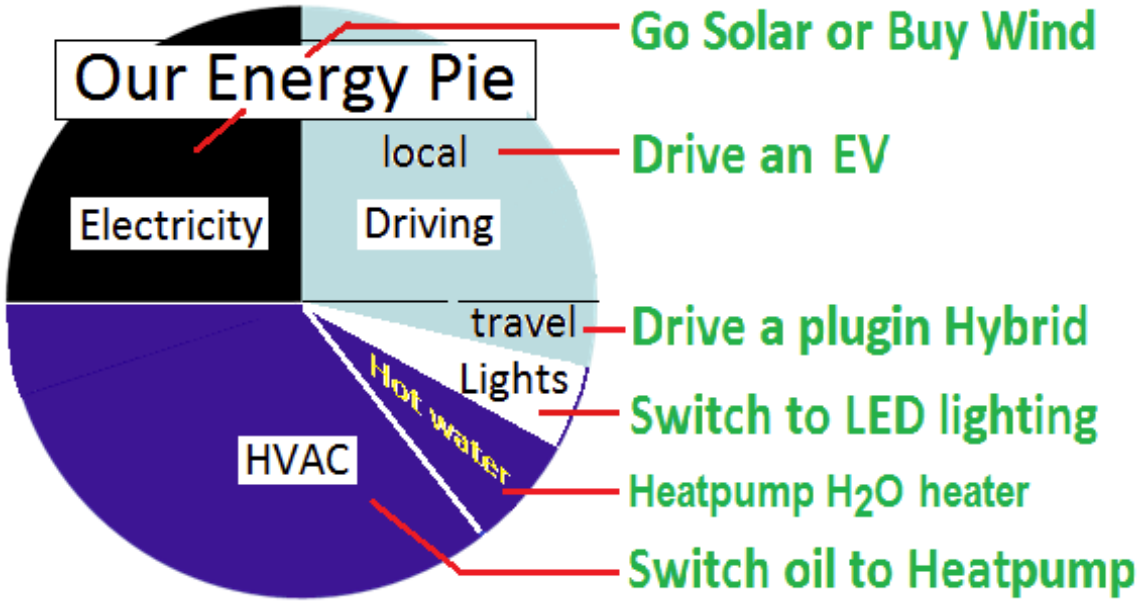
- Pre-think your next personal energy decision.

- If you have sun, solar is best investment ever…
- Everyone* can sign up for WIND power!
- Water heater dies – get a heatpump one
- Heating dies – get a heat pump (and solar)
- AC dies – Get a heatpump
- Car ages – get an EV for commuting
- Put charging signs on outdoor outlets
- Power them for life with Solar! $$$

Its cheaper and cleaner!

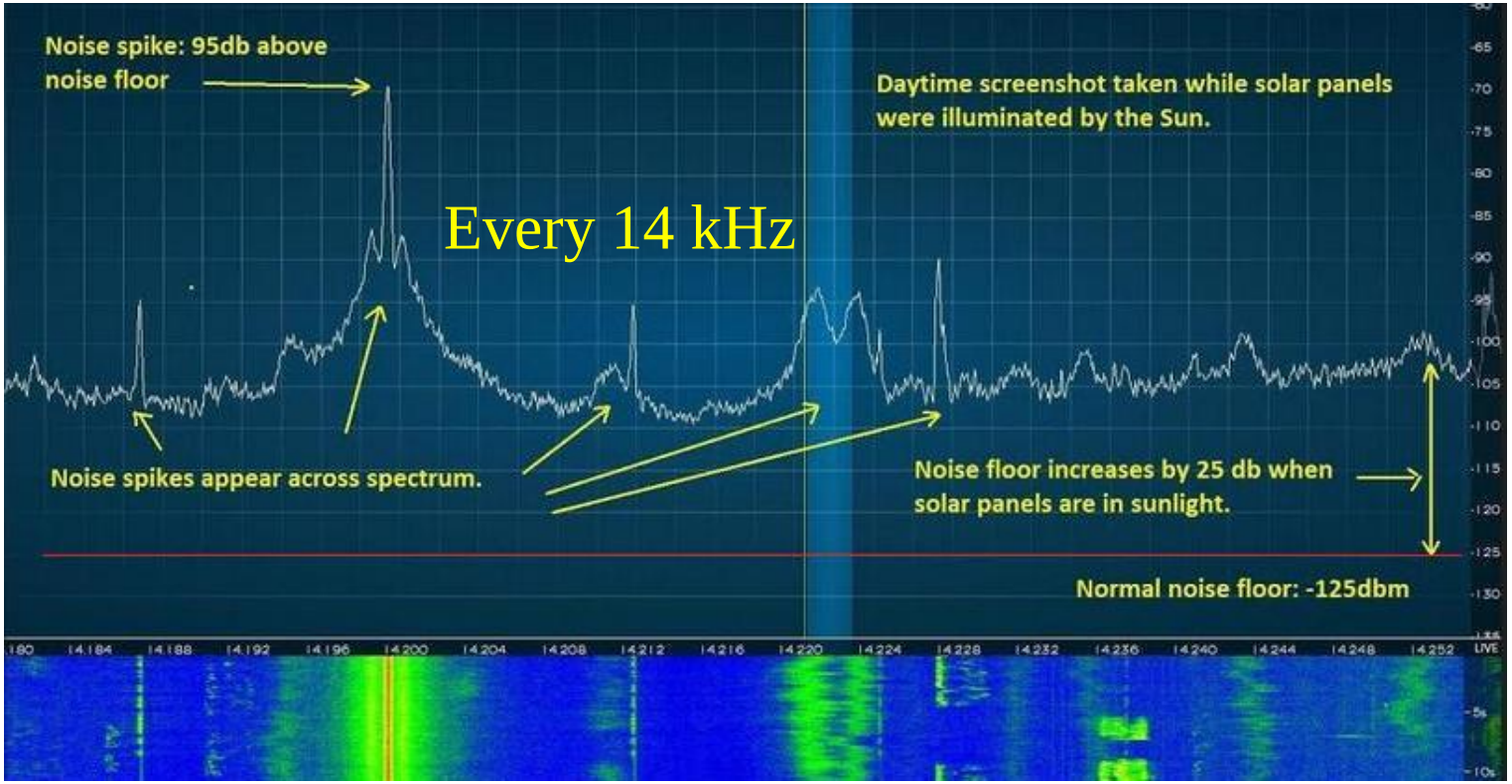
Every 2 years you face a major **Energy Decision….**

A prepared mind is essential



A clean energy investment is better in the long run and cheaper too!

BEWARE of Solar RFI!



Backup slides follow

Who's Talking * * *

OUR PRESENT LIFESTYLE IS NOT SUSTAINABLE!

Are we part of the problem?

Or part of the Solution?

Big Picture!

When is the Payback ???
When is the Breakeven ???

Paying for at-home Garbage Pickup -
was from Day ONE !

Big Picture!

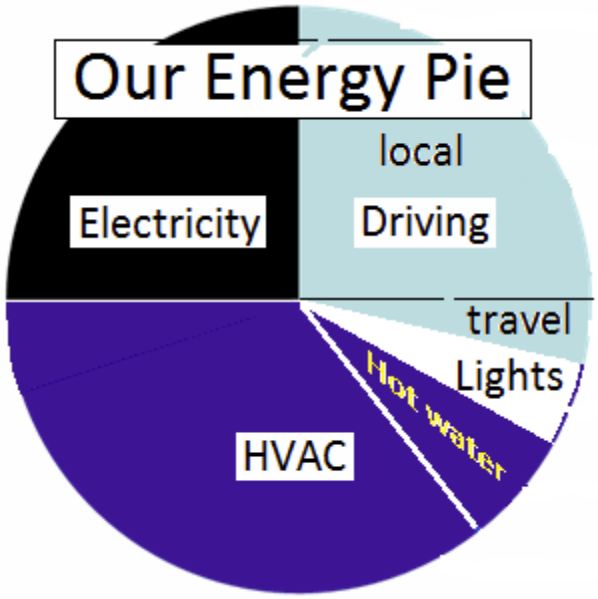
When is the Payback ???
When is the Breakeven ???

Paying for Sewage Plants –
was from Day ONE !

Big Picture!

When is the Payback ???
When is the Breakeven ???

Investing in Solar Power - is from Day ONE !
Because that's when we Stop Beating Mother Nature and stealing from our kids future.



Who, What, When, Why, How

Homeowners can do the most

What? / Who?	Electricity		HVAC		Transportation		
	Wind	Solar	Hot Water	HVAC	Local	Trips	
Rent	✓	✗	✗	✗	✗	✗	Single
Have outlet					PHEV ⇦		
Own	✓ ⇧	✓ Trees ✗	✓	✓	EV + PHEV		Family
					✗	✗	

Power Distribution 330 VDC

Nearly ALL modern switching supplies will run on VDC

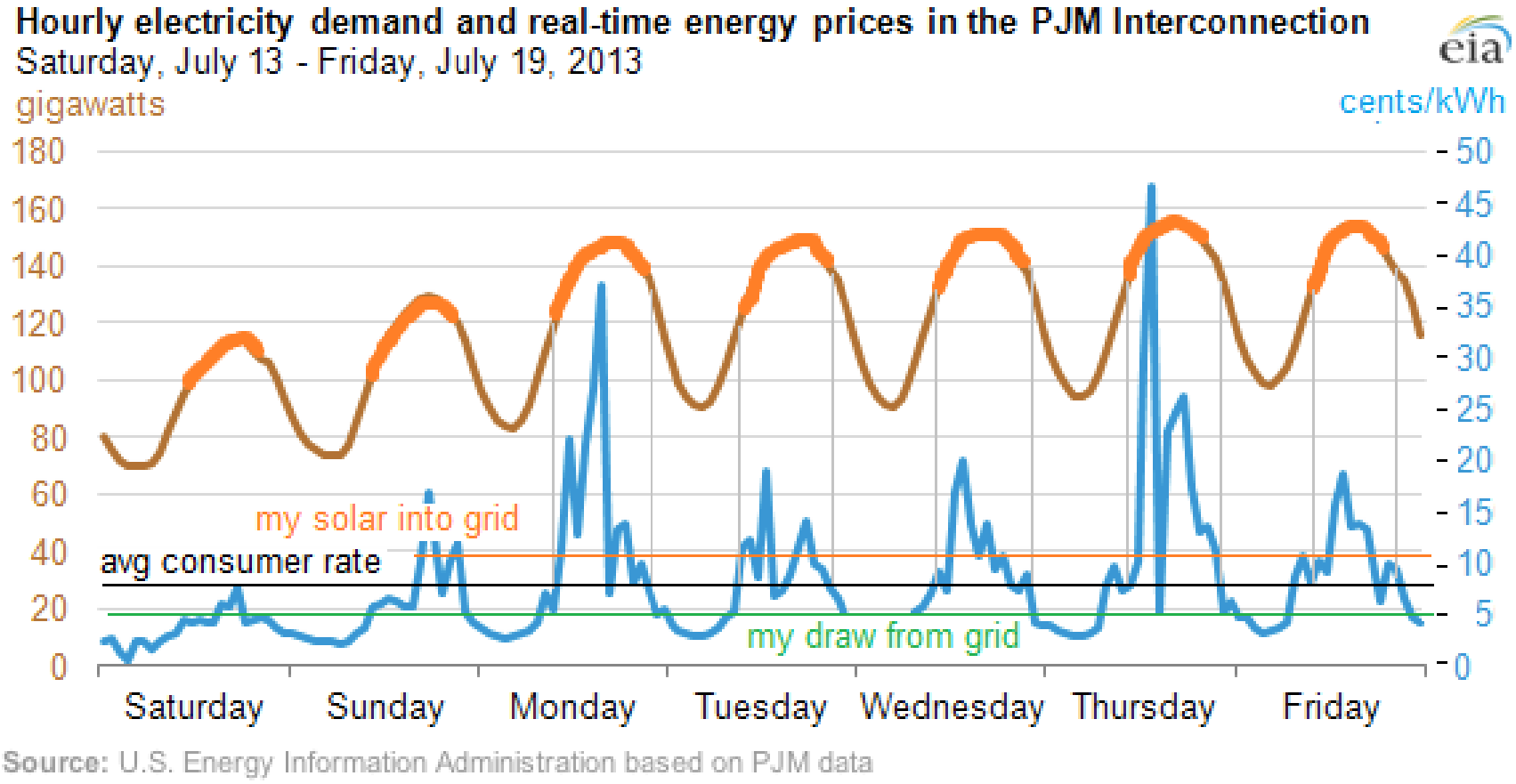
Kenwood 115 VAC only supply

Actually has internal jumper

Eliminate 75% of

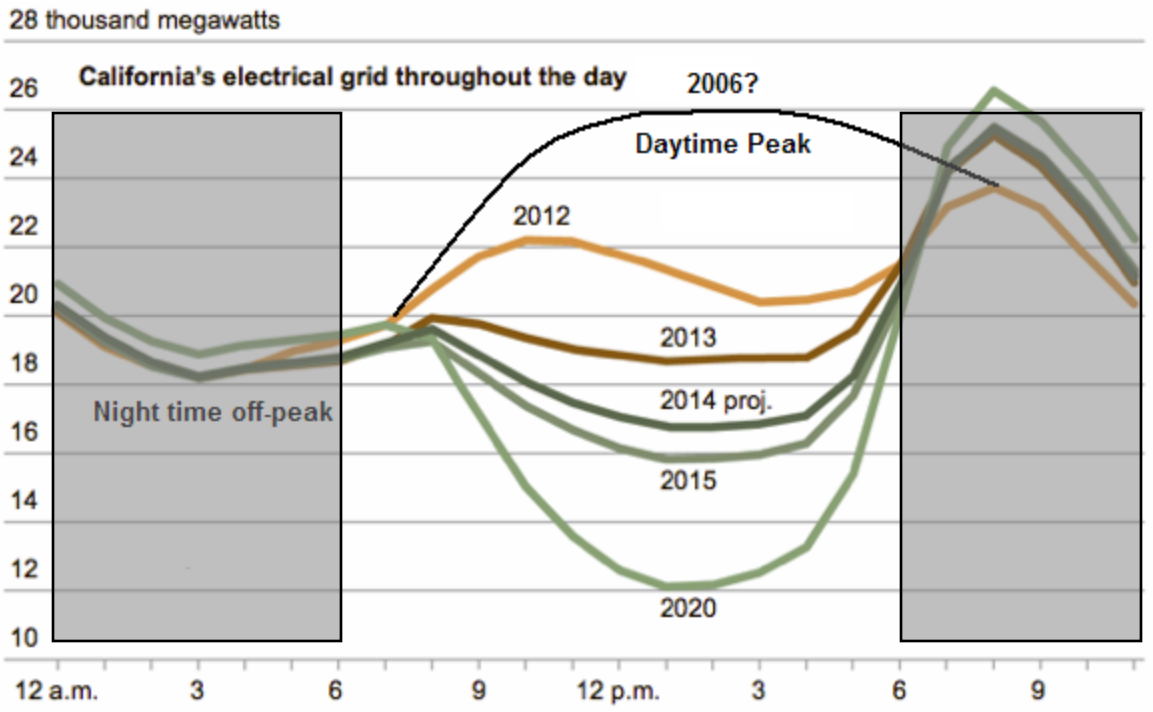
Distribution losses

What is fair in Net Metering?



Rapid Change is happening all around you!

The Duck's Back



Already electricity is cheaper during day than night!
In California.

And that means Charging-at-work!

And Massive opportunity for demand Response

Solar Grid-tie Inverter Types

- String Inverter – simple, efficient, one big box on the wall in the basement/utility room. *RF quiet. easy to replace maintain. Cheapest – less profit for installer.

My three inverters or AFM's one

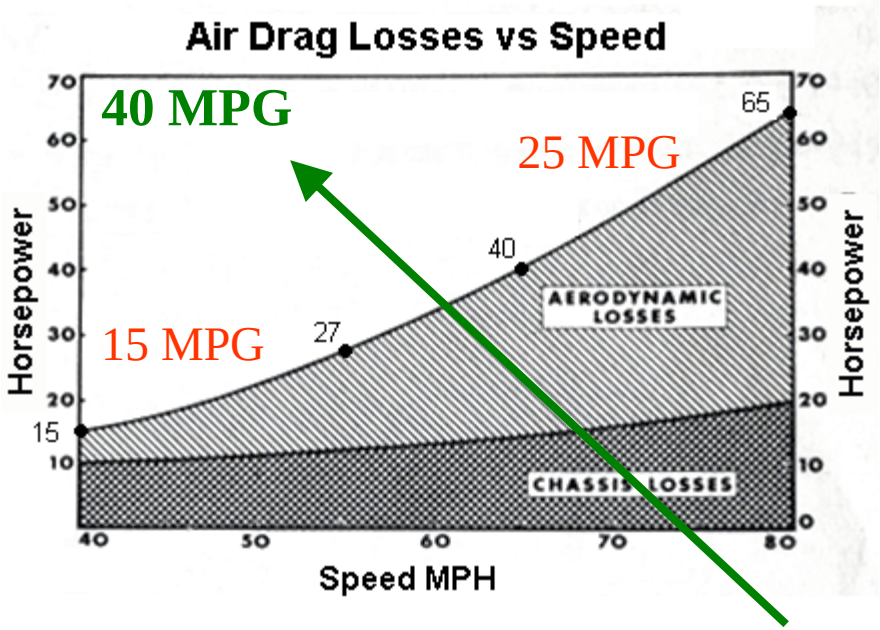
Solar Grid-tie Inverter Types

- Micro Inverters – On every panel.
  - Made sense when panels were $1200 and M.I. was $250.
  - But now panels are $120!
  - Dozens of elex modules on roof (-10F to +160F extremes)
  - Costly to repair/replace!
  - Some brands might Generate RF hash on nearby radios?

- Optimizers – Cheaper but all the same disadvantages and definitely known to be RF noisy.

4th Learn to Drive Efficiently

- Double your range -IN ANY CAR



So why do we get better MPG on the highway?

Duh, it's the brakes!

They burn up energy as heat.

Coast to the next light and save all that energy!!!

Or in a hybrid or an EV, 90% of braking energy is saved

Solar and EVs – The Perfect Marriage

6 Panels ($1200)

Can fully charge a Prius plugin everyday… FOREVER!

No more $2,000,000,000 per day for overseas oil

No more foreign dependence, no more price fluctuation

No more **oil**, no more insecurity, no more oil wars

Over 45 EV's now on Market!

(in just 8 years!)

And now 500 committed to in the next 6 yars

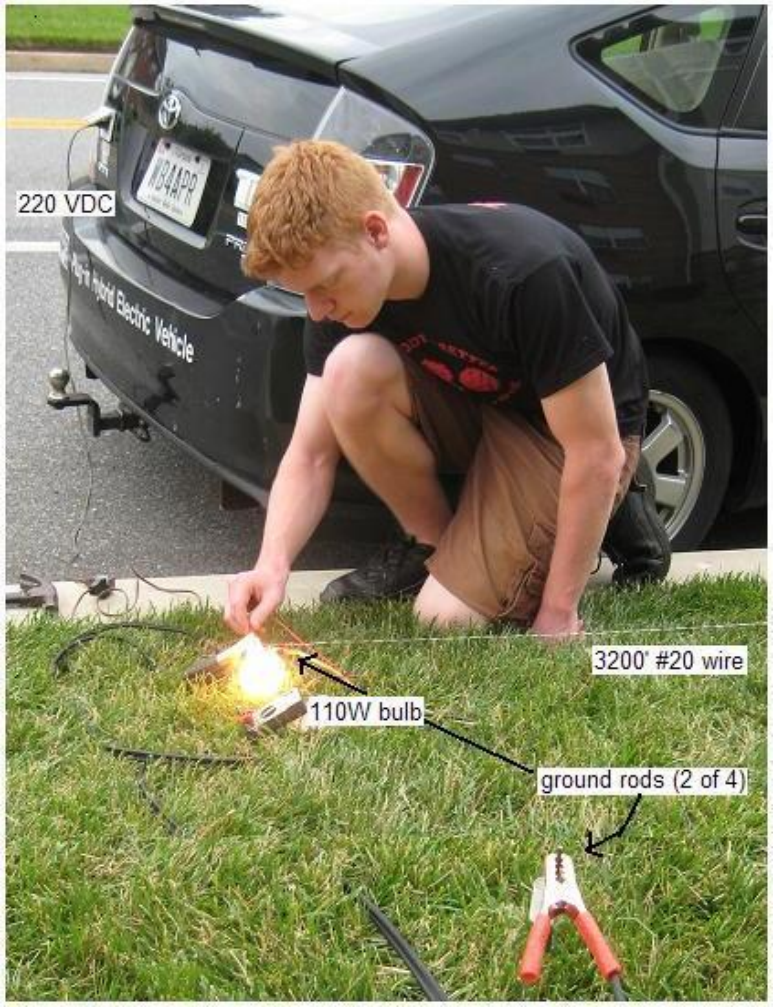
Volvo	ALL models will be electrified by 2019
GM	10 EV models in China by 2020 (2 years from now)
Mercedes Benz	Electric versions of ALL Models by 2022 (4 years)
Ford	More than half will be Electric by 2022 (including F150)
Nissan Group	12 new EV's by 2022
Hyundai	12 new EVs by 2022
BMW	25 Electric models by 2025 (7 years from now)
VW Group	80 EV models by 2025, 16 new plants 3 million/year

All car purchasers today should at least checkout the potential of an EV to meet their driving need

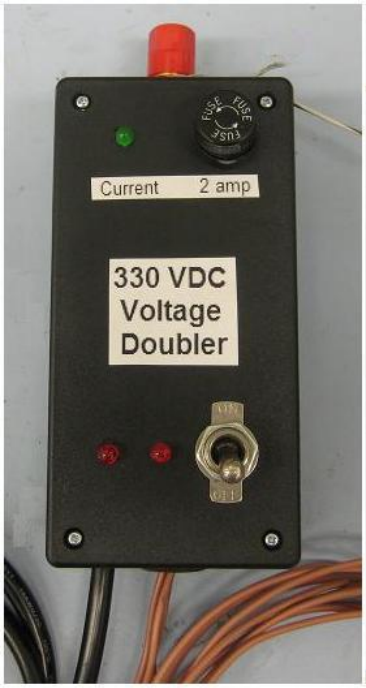
- There is an EV or PHEV replacement for every car model on the market.
- That cost less than the average gas car ($35k) avg new or under $10k used,
- That have any range from 100 to 600 miles (EV, PHEV)
- Go faster, but with less cost to operate and maintain

We cannot keep doing this!

Power Distribution SWER



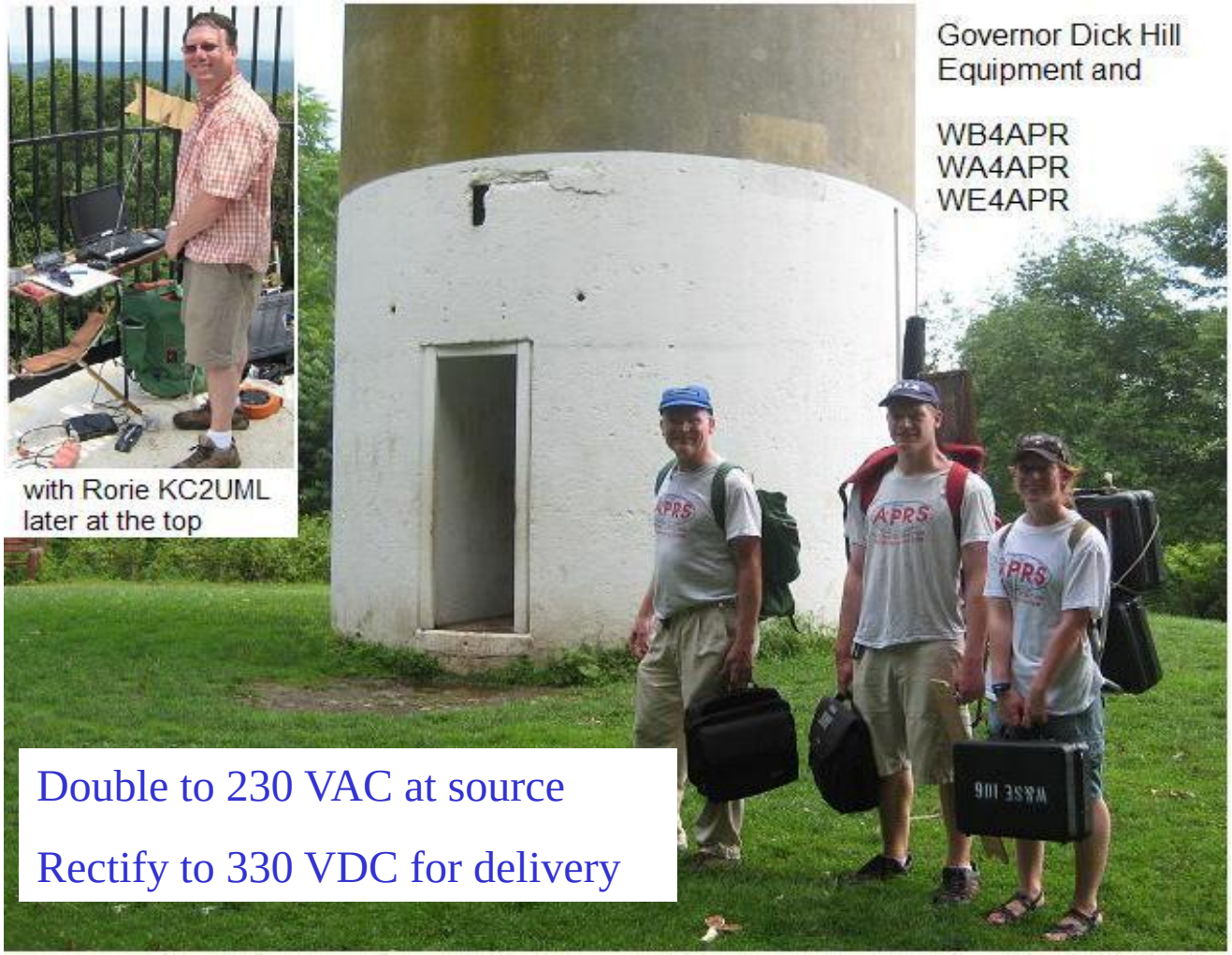
Emergency Power: Use Single Wire Earth Return



Not approved by NEC

Power Distribution SWER

with Rorie KC2UML
later at the top



Double to 230 VAC at source

Rectify to 330 VDC for delivery

Single Wire Earth Return

Not approved by NEC (when grid connected)