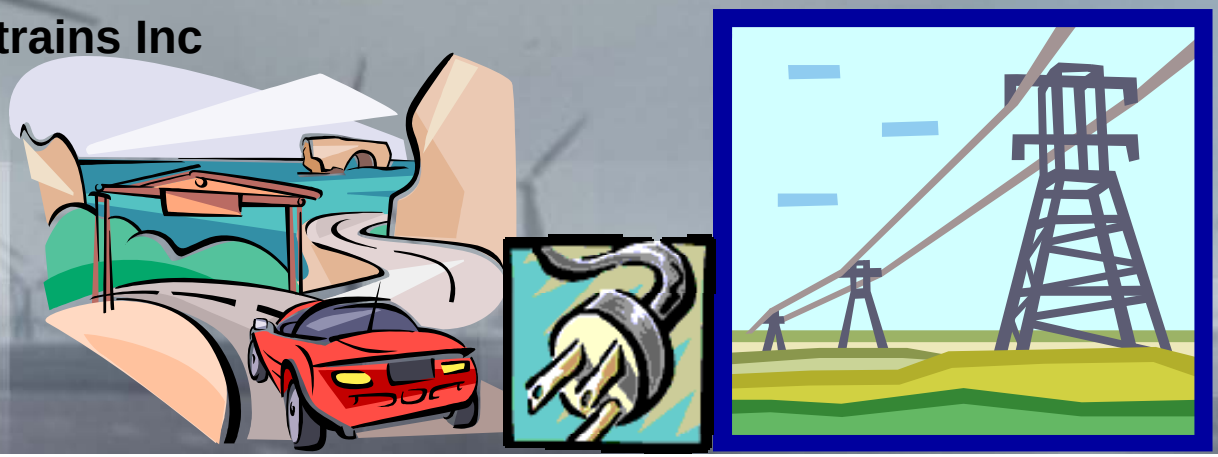
PHEV2007
Where the grid meets the road
Winnipeg Manitoba, November 1,2

The PLUG-IN Highway for
Energy Sustainability of both
Transportation and Stationary use

Prof Andrew A. Frank
University of California, Davis
and
Efficient Drivetrains Inc



The problems facing the World

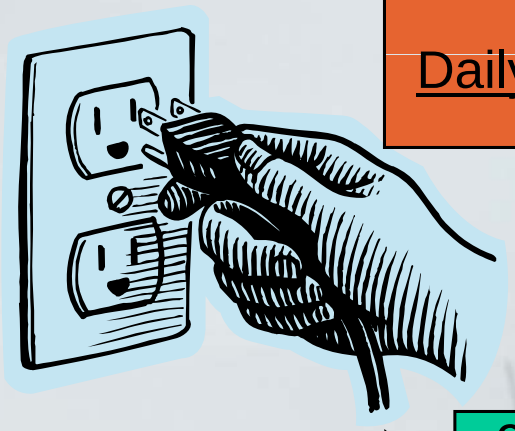
- **Global Peak Oil:--exponential Price Rise—Economic Disruption**
- **Global Warming:--Disappearing Species—Global climate change—Disruption of human lifestyle**
- **How to move toward a sustainable Zero Carbon Society while improving lifestyle and productivity with no change in our energy infrastructure.**

What is the PHEV?

- **A car that will do everything that your current vehicle will do and Much more**
- **A dual energy vehicle using up to 90% electricity from a plug** and **10% liquid fuel—gasoline/bio-fuel**
- **An Energy storage system for leveling the electric system lowering electricity cost**
- **The storage will allow *all*** electric energy **to come from direct Solar and Wind----**

now only 25% can be from solar and wind because of No Storage

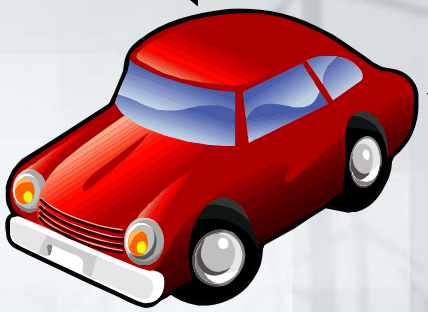
PHEV Energy Infrastructure is the *Existing* Standard 120 volt GFI plugs and gas stations



Daily use

G2V &
V2G

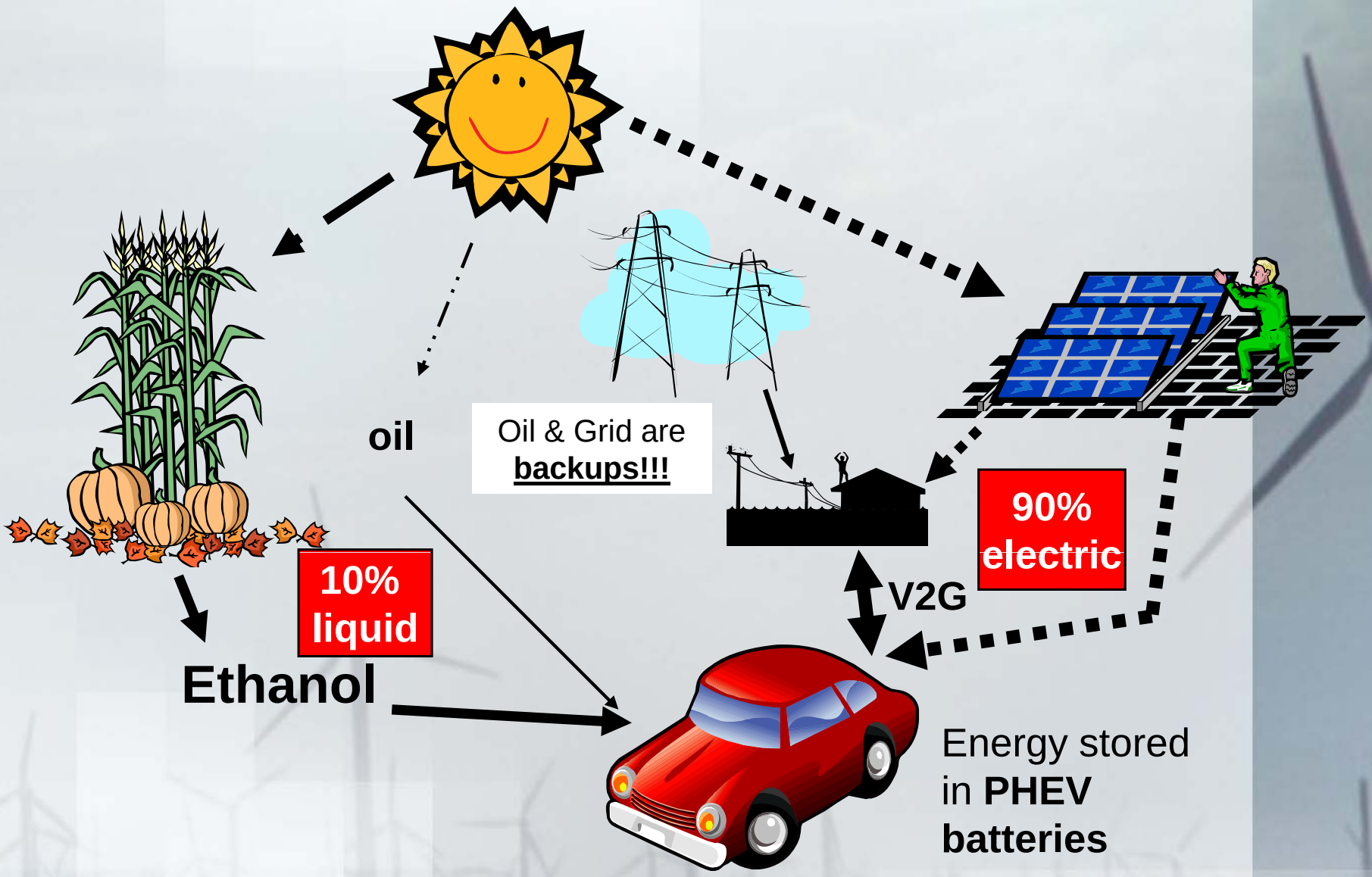
90% of energy



10% of energy

4 times/year use

The PHEV Energy Loop



EDI/AAF

Don’t step back in technology When we move forward to Energy Sustainability

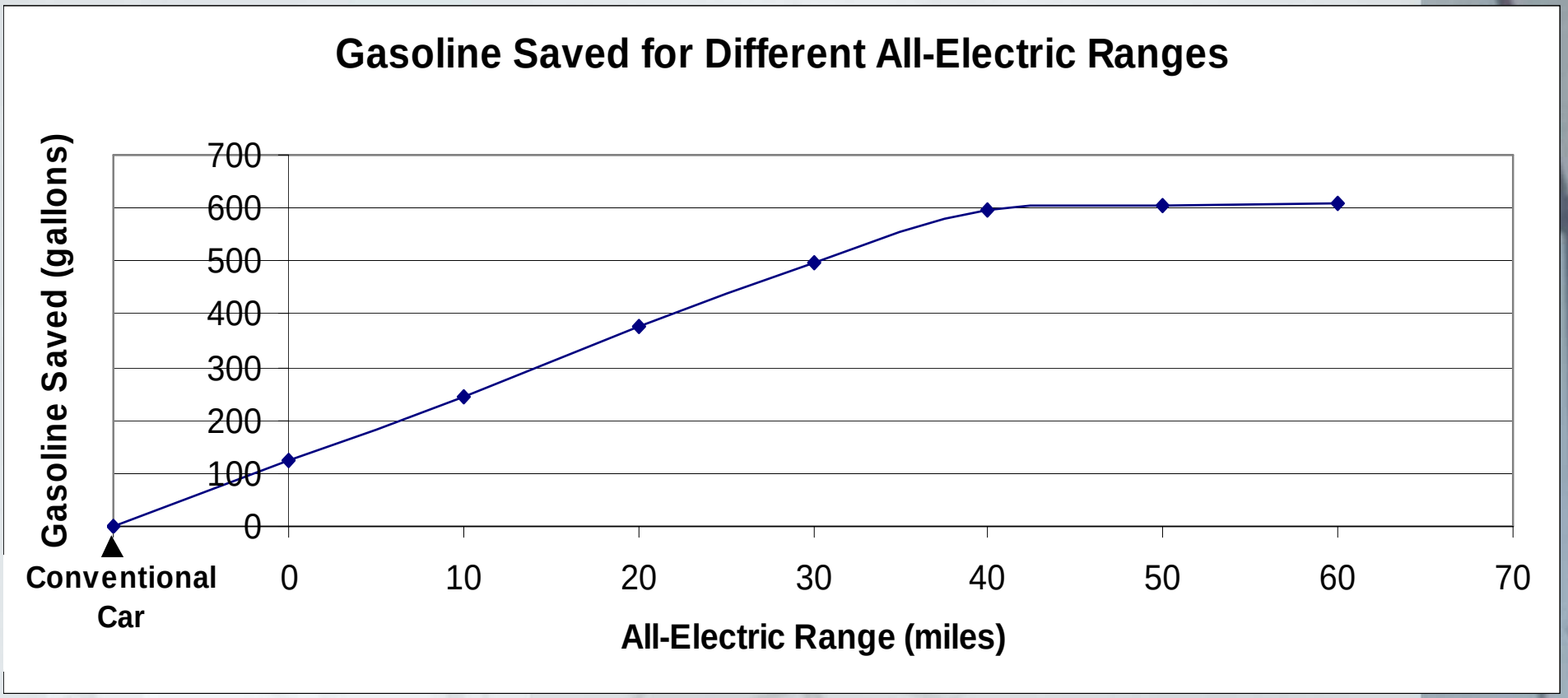
These technologies are **not** sustainable with today’s population!!

Petroleum Displacement

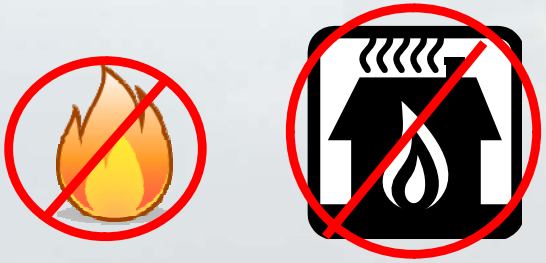
- **PHEV with XX mile electric range is called PHEVXX**
- **PHEV 20 will displace about 50% gasoline**
- **A PHEV 60 uses up to 90% electricity from the grid** or personal **Solar or Wind**
- **Petroleum displacement can begin today** without any change **in our energy infrastructure**

Gasoline displaced by the average PHEV car driving 12,000 miles a year.

The average car uses 750 gallons of gasoline a year.



CO_2 and Global Warming caused by Combustion of Fossil Fuel----Oil & Coal



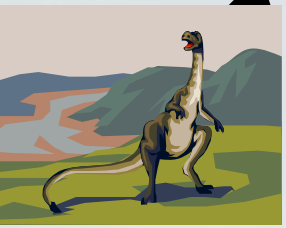
- All energy comes from the Sun-- It is only a Matter **CYCLE TIME, CT**

- Solar, Wind, Tidal CT=1 day but **Intermittent**

3 Energy cycle times

i

1



CO2

500 million year loop

oil

Conventional car
Fossil combustion

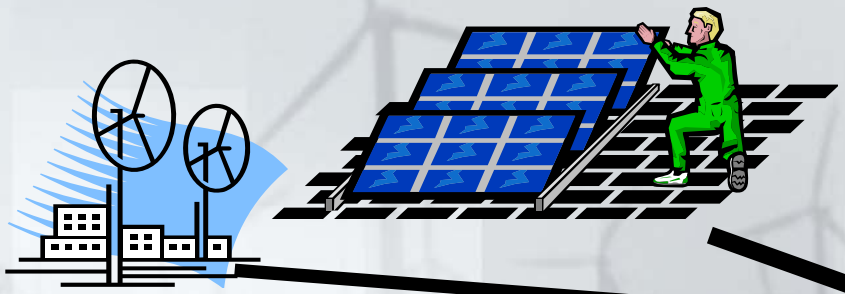
2

CO2

1 to 50 year loop

Ethanol, Bio-Diesel

3



PHEV One day Solar & Wind loop (90%)

90%

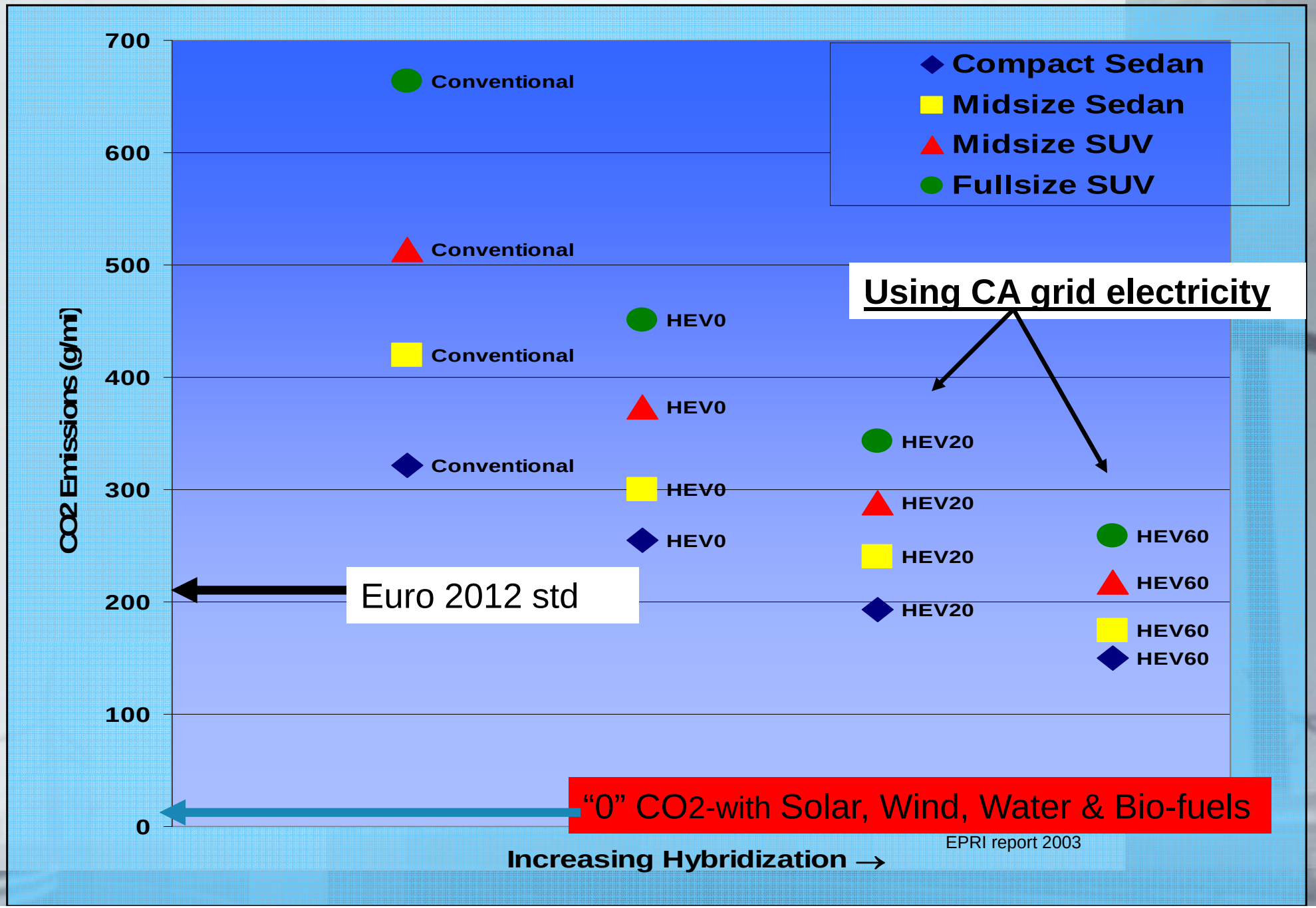
10%

PHEV = *no fossil fuel now!*

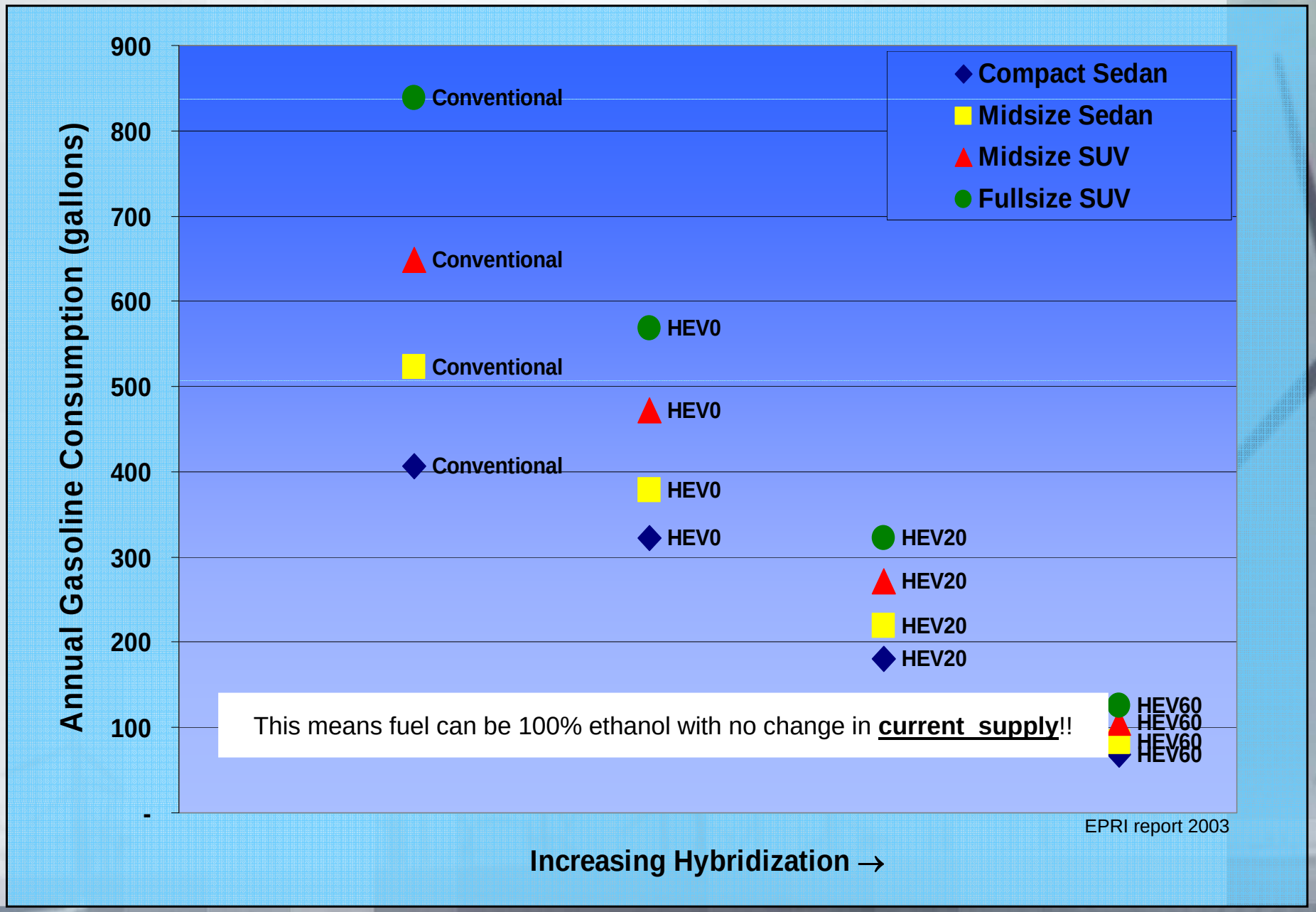
EDI/AAF

Greenhouse Gas Emissions for all light duty cars & trucks– Grid+Gasoline.

PHEV Solar & Bio-fuel is "0" CO_2 with *full function!!!*



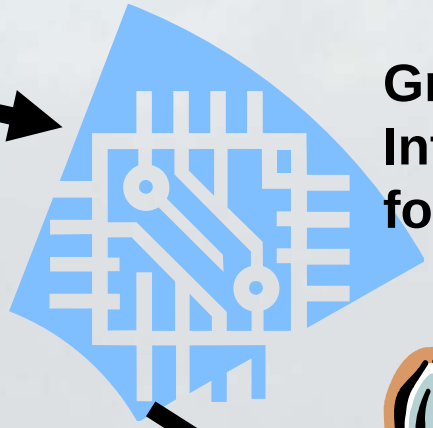
Annual Gasoline Consumption for 12,000 miles of driving- all L/D vehicles



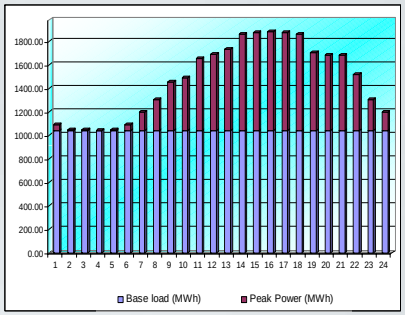
Electric grid Benefits of PHEV's

- **Levels load with only 20% penetration of PHEV's in society—*lower cost electricity* for everyone**
- **Allows grid to move to 100% renewable energy**
- **Allows personal energy independence when homes have private solar and wind.**
- **Electric Utilities should become energy managers for the entire society integrating all energy sources – Public and Private**

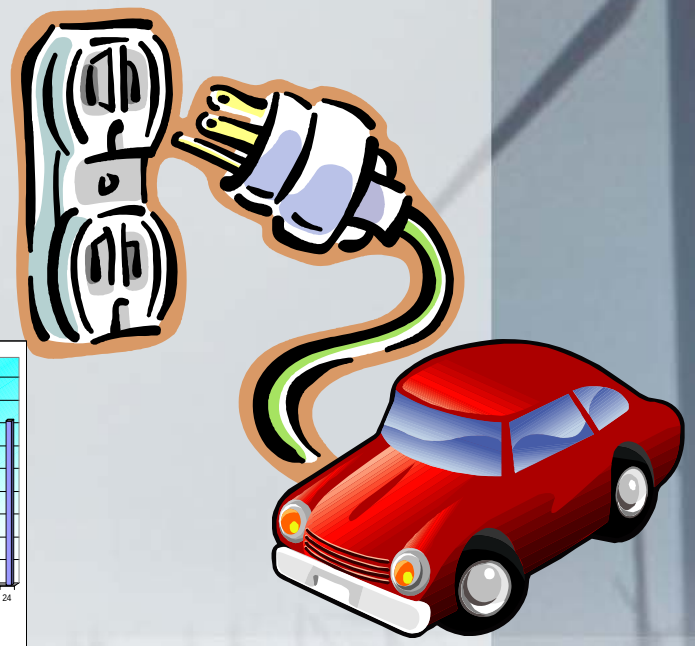
Electric Grid Improvement



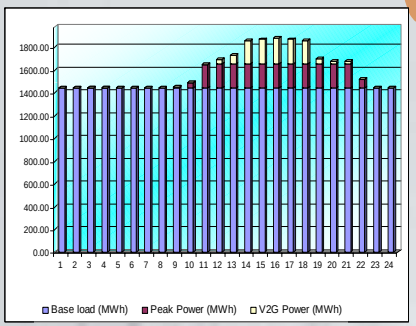
Grid managed Intelligent controller for the PHEV outlets



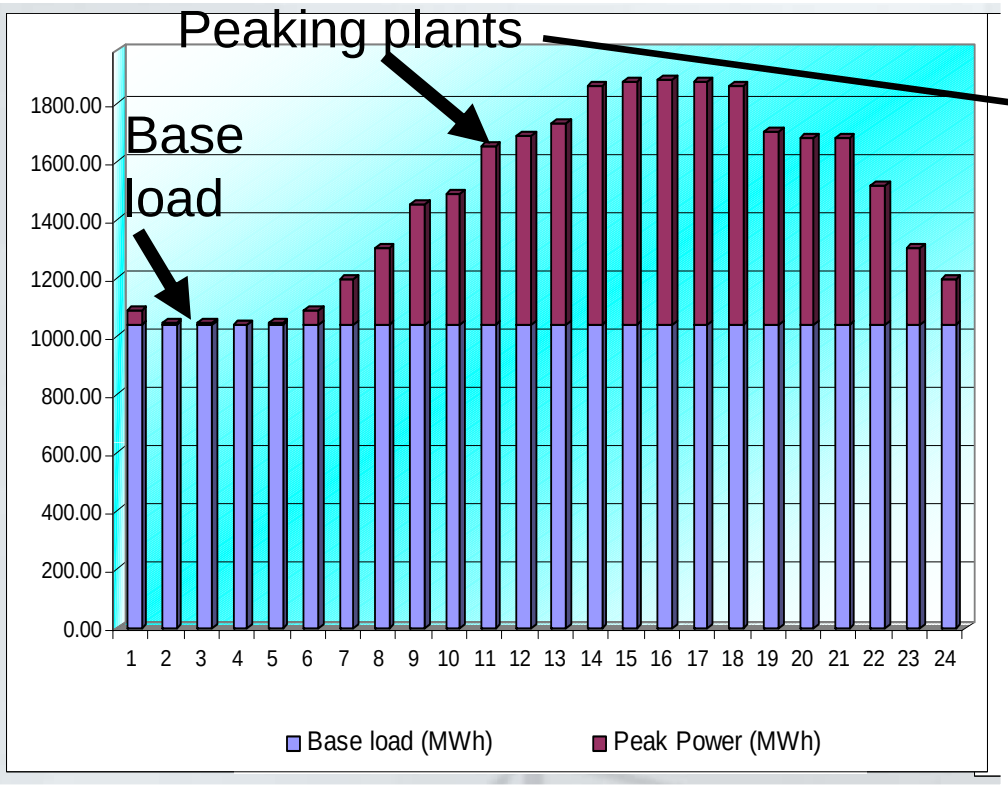
Before intelligent control

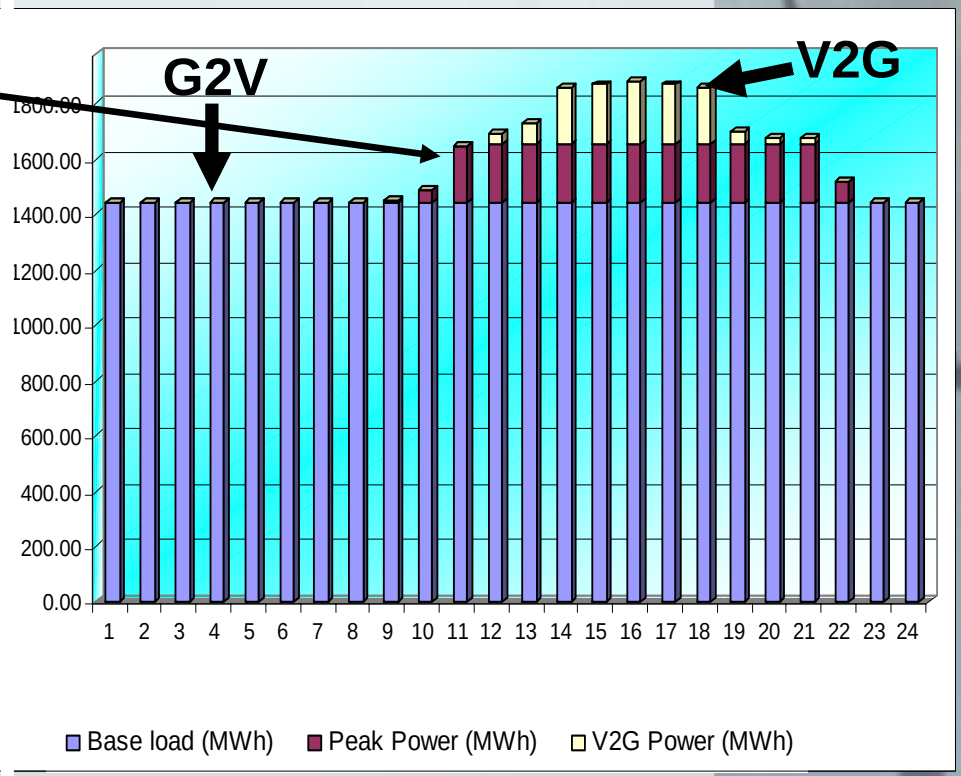


After Intelligent control with PHEV's



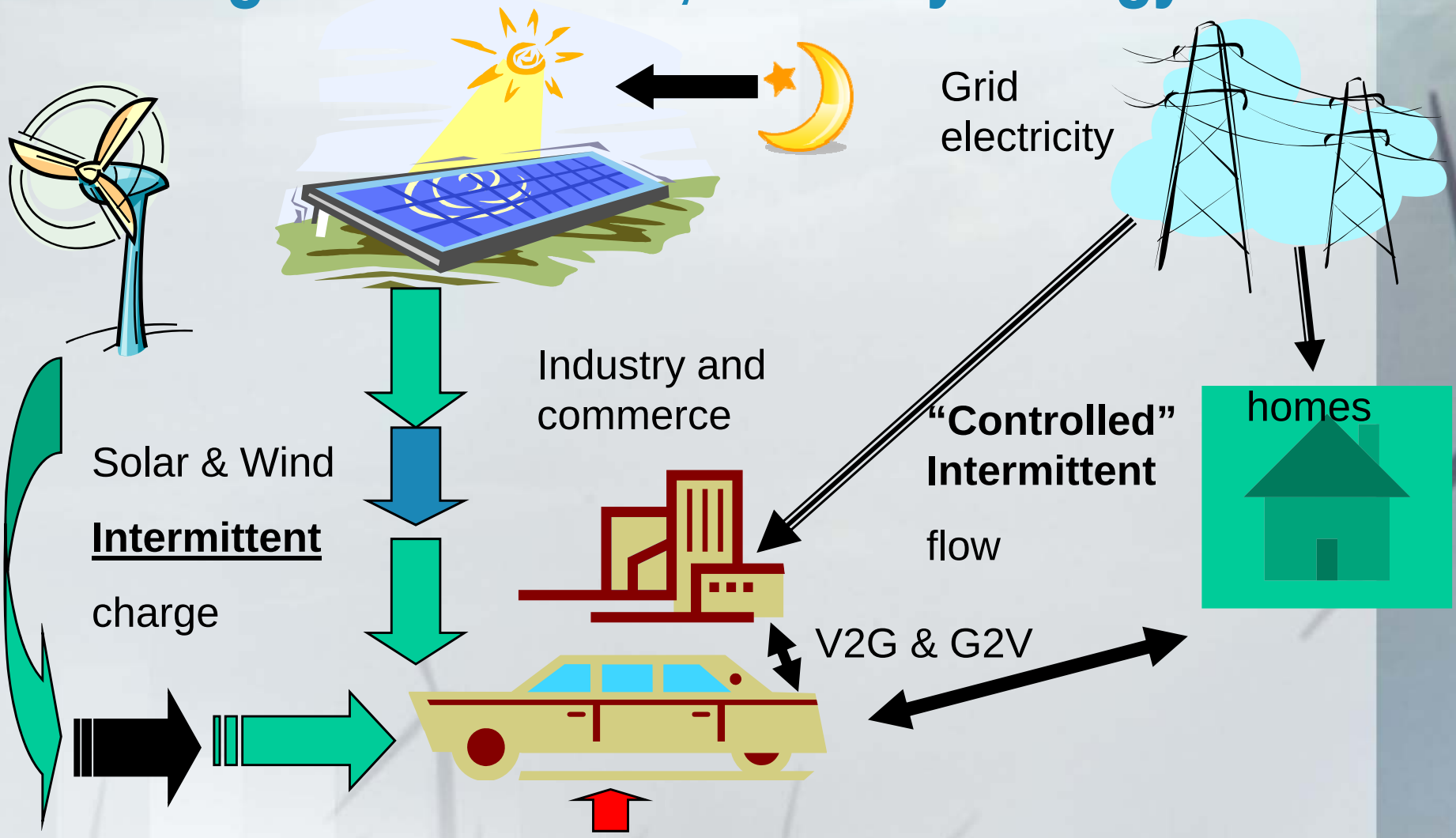
The PHEV can be used to balance the Electric Grid Integrating electric power and transportation energy. With only 20% of the cars PHEV the following results.





Energy available for the grid (V2G)	0	Mwh	Consumption without V2G	35300	Mwh	Total Base load before	24960	Mwh	Total Peak Power before	10340	Mwh
Energy use for recharging vehicles	4	Mwh	Consumption with V2G	37068	Mwh	Total Base load after	34560	Mwh	Total Peak Power after	2508	Mwh
Nb of vehicles	125000	#	Consumption increase	5.01	%	Base load increase	38.46	%	Peak Power decrease	75.74	%

Solar and Wind *integrated* by the PHEV
Electric grid with home, industry energy use



Energy stored in **PHEV** car **Batteries**

All over Society --5gigKwhrs of energy in US!!

EDI/AAF

ovonic solar

Charging Shelters for cars, homes, offices

3.5 kW EV Charging Station

10 kW EV Charging Station

12 kW School Lunch Shelter

30 kW Parking Shade Structure

Wind farms on the sea or Plains with large numbers of PHEV's for temporary Energy storage.

No need for Back Up Electric Power Plants!!

Vehicles constructed at the University of California Davis

- **All vehicles demonstrate that the PHEV Can be designed to weigh no more than the conventional car.**
- **All vehicles designed perform better than current cars and trucks—Mechanically much simpler.**
- **All vehicles obtain 2X fuel economy when using gasoline only.**
- **All vehicle cost increment is less than 20% due to batteries. Payback time less than 4 years.**

New UCDavis PHEV that will run on Sunshine *40mi/day* and a little Ethanol

Can be ZERO gasoline or diesel Now for the avg. driver!!!

Solar charging “Trinity” at GM proving grounds June 2007

60 mile AER PHEVs with CVTs constructed at UCDavis to show technology is here today & Supply Chain for parts already Developed!!

EV1-PHEV
80mi AER, 80mpg

1994 Mercury Sable
60 mi AER, 58 mpg
Automatic mechanical CVT

2000 Suburban
60 mi AER, 28 mpg
New automatic CVT
Being installed

The PHEV will:

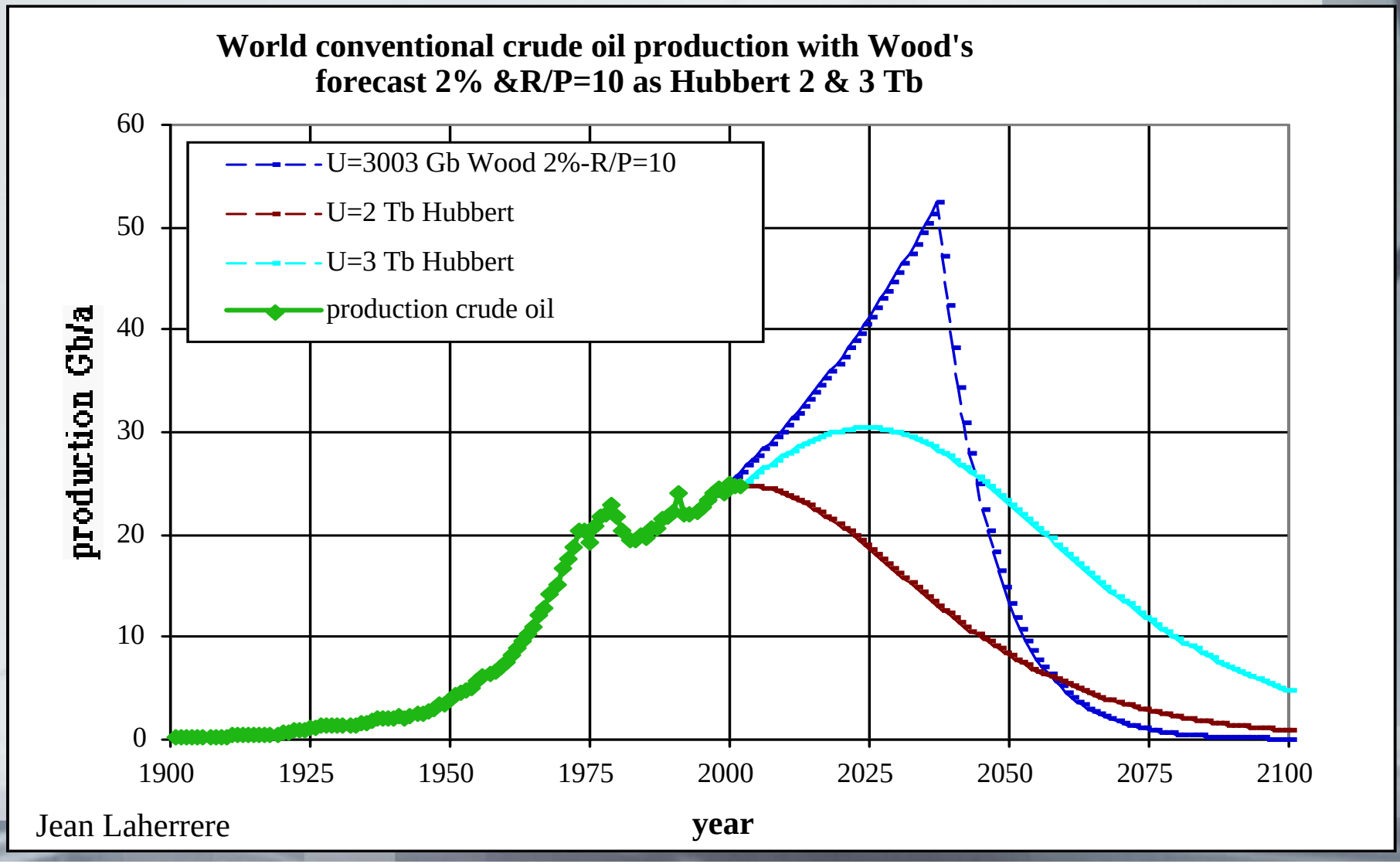
1. **Lower the cost of transportation fuel by 4 now and using Solar & Wind by 10 or so!!—12cents/mi~3cents/mi**
2. **Lower the cost of centrally generated Solar and Wind because there is *no* need for back up power plants! Electricity costs from 10c ➡ 6c/kwhr.**
3. **Provide individuals the ability to be *energy independent* from gasoline and the grid *now*! Energy @ 30C/gal eqvlnt.**
4. **Enables the shift to sustainable Bio-fuels for zero CO_2 with current bio-fuel production**

The PHEV for 50 year solution --- Time line toward ZEV---

Year	% of total vehs-PHEV	PHEV average AER	Nationwide Oil saved from 2007
2010	1%	10 miles	½%
2020	10%	30 miles avg.	5%
2040	80%	60 miles avg.	70% or more

Matches time frame of oil depletion rate.

World Oil reserves
USGS: Techno-Optimism or Mischievous Politics?



Oil and Coal companies --New Business--

- **Have 50 years to find new uses for oil & coal where it is *not* used for combustion.**
- **Already being used for plastics of all sorts.**
- **Combine oil with coal industry to create *new Plastic* building construction materials that are resistant to insects, fire and totally recyclable. Saving forest from harvesting.**
- **Create new processing industries for building materials ie plastic 2X4's.**
- **Plastics can be recycled forever- and *never again burned for energy!!***

Renewable energy companies formed for increased employment

- New wind and solar systems manufacturers and distributors both small (1-10kw) and large (0.1mw-100mw)
- New solar and wind systems that combine heat and electricity
- New recyleable plastic building material companies.
- New companies using the PHEV to Integrate transportation, home & industrial uses of energy

New affluent lifestyle with PHEV's

- **Much Lower cost energy and fuel**
- **More durable society with homes built with materials that can be recycled and renewed every few years.**
- **Improved performance of our society due to better & faster transportation.**
- **Much better air quality--- Practically Zero!**
- **Begin to restore the Planet!!**
- **No sacrifice in lifestyle for the environment because instead of <u>conservation</u> of fossil fuel we are <u>replacing</u> it with proven Solar, Wind and Renewables!!**

Conclusions—The PHEV:

- **Can displace 100% fossil fuel use per vehicle today!! Nationwide oil displacement -one Veh. @ time**
- **Will make grid more efficient.**
- **Will allow the integration of Wind and Solar for** 100% renewable energy use **for all of society and the Human Race.**
- **Can begin *with* our *current* energy infrastructure and move into the sustainable future NOW!!**

Conclusions

- **Need to get PHEVs into mass world wide production as quickly as possible by creating a demand. EDI will attempt to do this.**
- **Liquid fossil fuel is now 3 to 4 times the cost of electricity and Solar driven transportation is 1/3 the cost of fossil fuel transportation and leads to *energy independence--SO Why are we waiting?***

- **Need to convince the world that PHEVs can provide the solution to global warming and oil displacement with an improved lifestyle NOW. We need your help to Promote the PHEV!!**