

A Solar Charged Future

Stephen Heckeroth

Albion CA

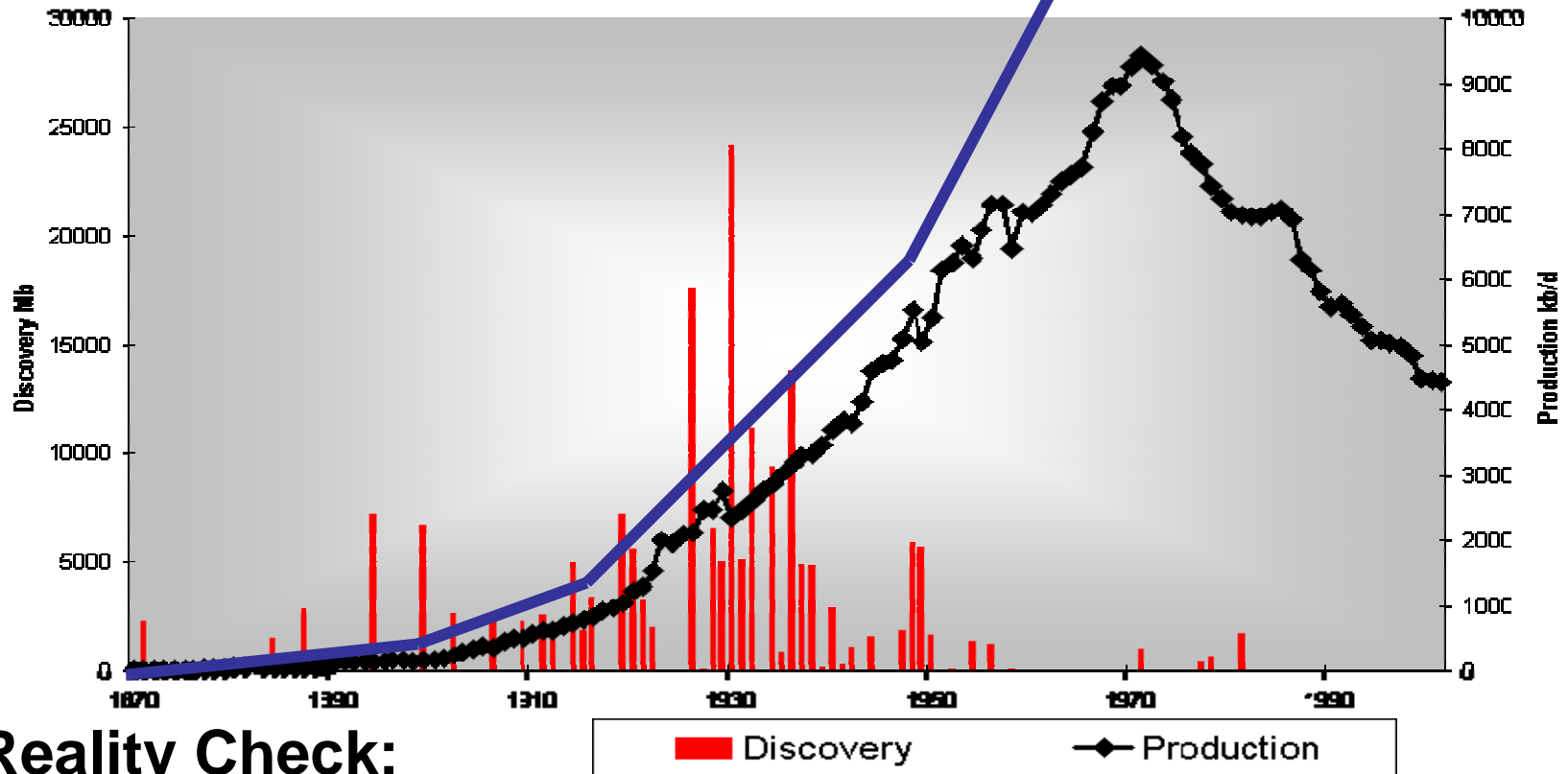
steve@renewables.com

US Over a Barrel

US Oil Discoveries Peaked in 1930
US-48

US Oil Extraction Peaked in 1970

US Oil Consumption
Peaked 2005?

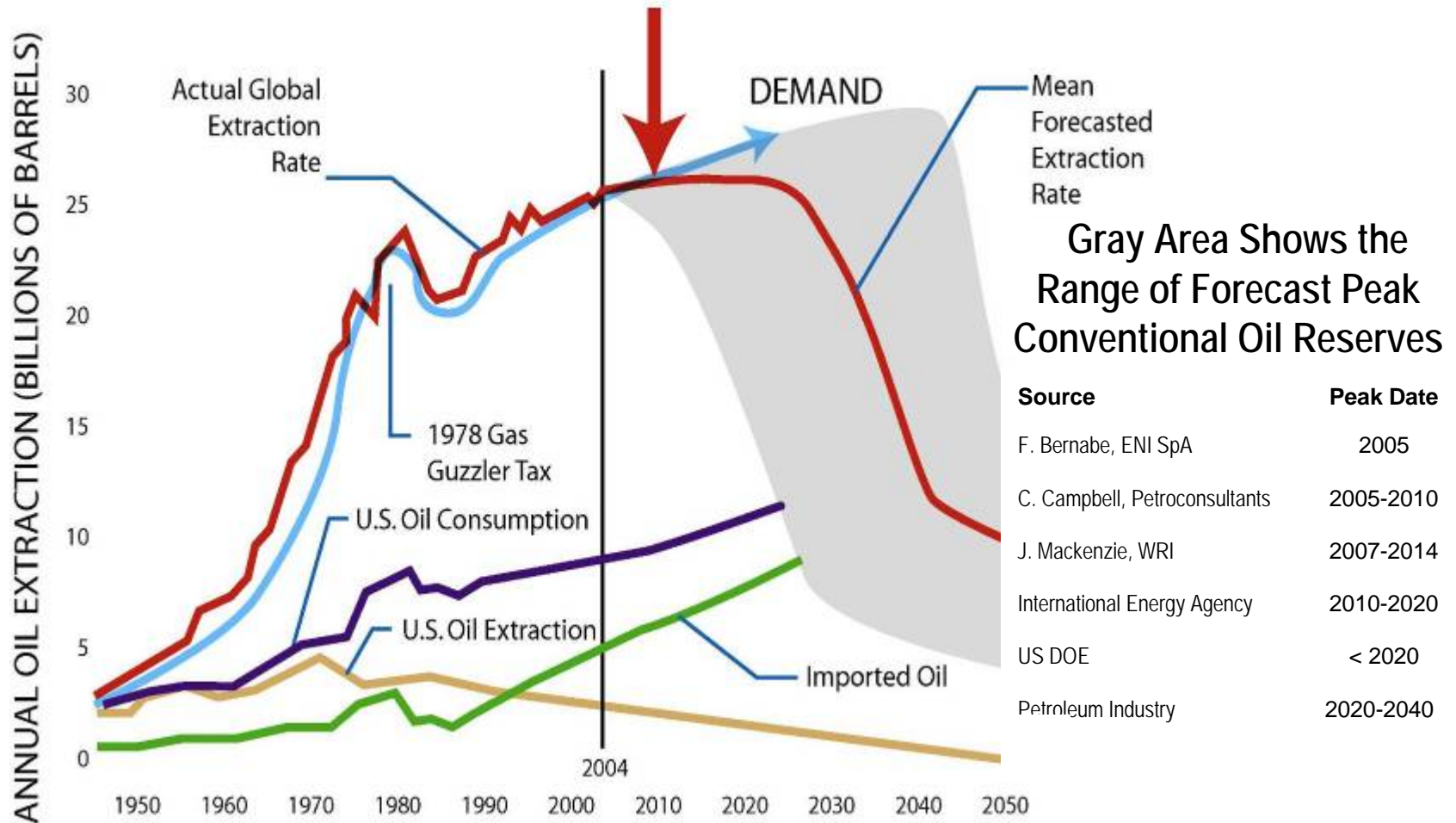


Reality Check:

- This is not a projection it is historical data from the petroleum industry.
- In a more perfect world the US might have noticed a trend around 1955.
- A less than perfect country would have responded to the trend around 1975.
- Ignoring the realities of a finite world puts future generations at risk.
- We are the future generation.

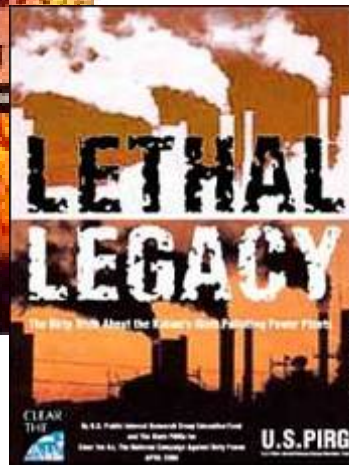
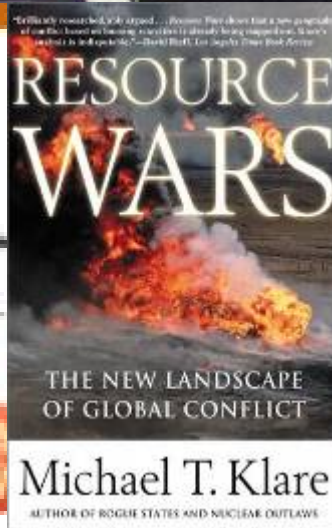
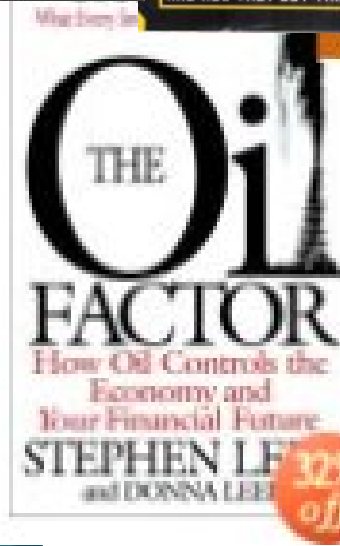
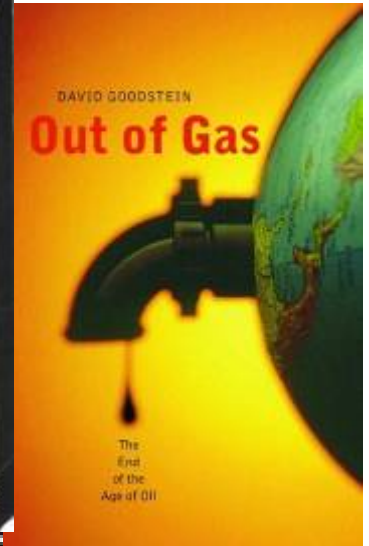
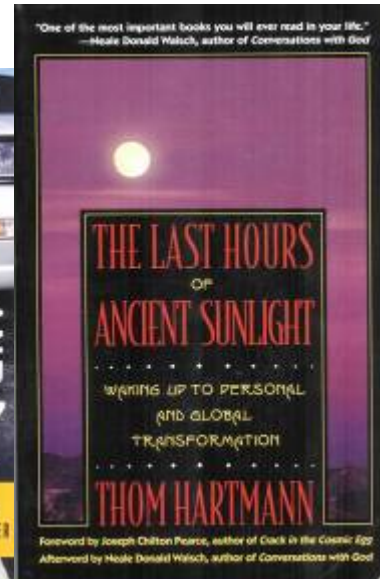
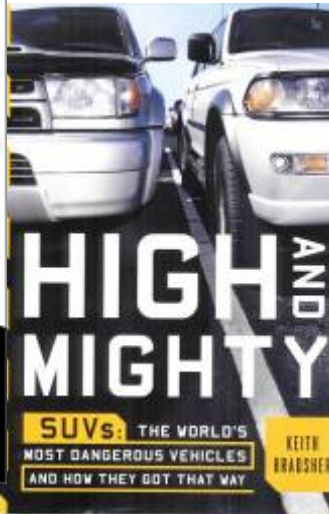
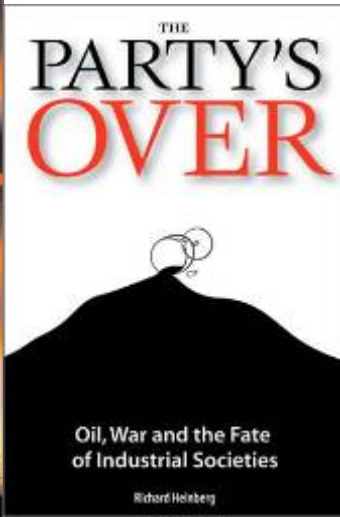
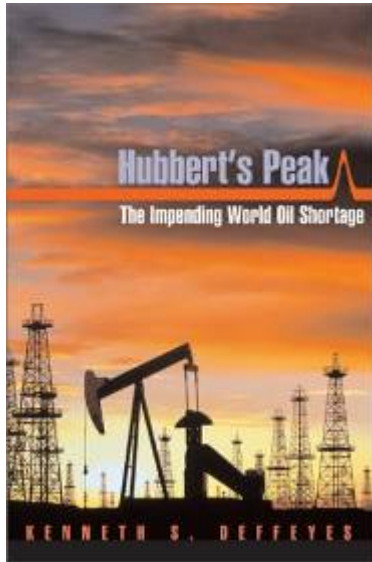
World Peak Oil

CRISIS POINT



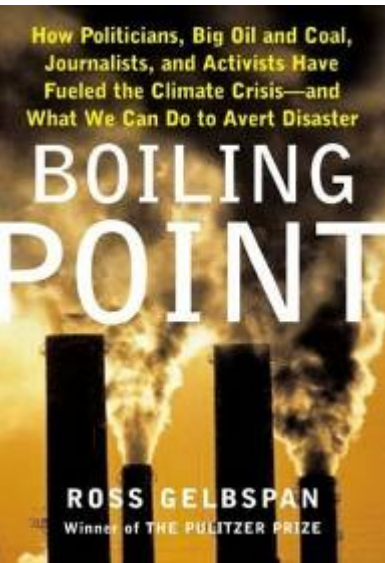
US Oil “production” has been declining at an average of 2%/year since 1980.
 US Oil imports have been increasing at an average of 4%/year since 1980.

A Sense of Urgency



A Call to Action

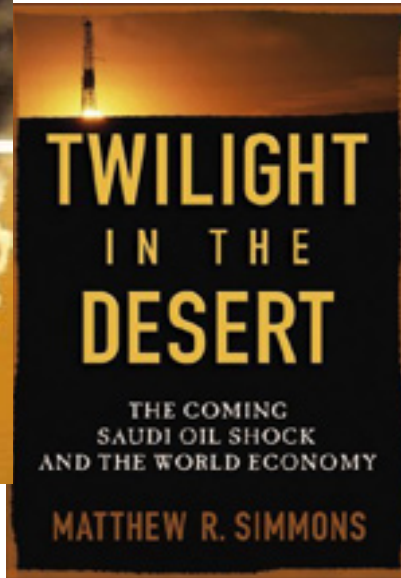
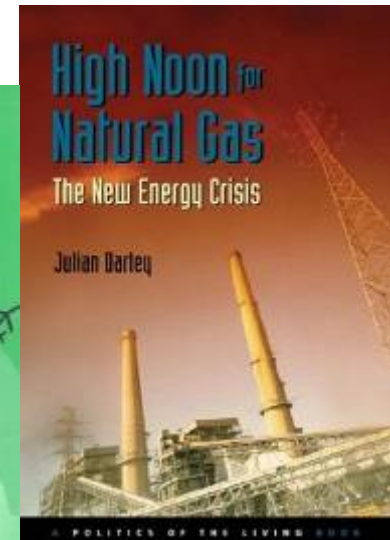
Ross Gelbspan predicts a climate crisis



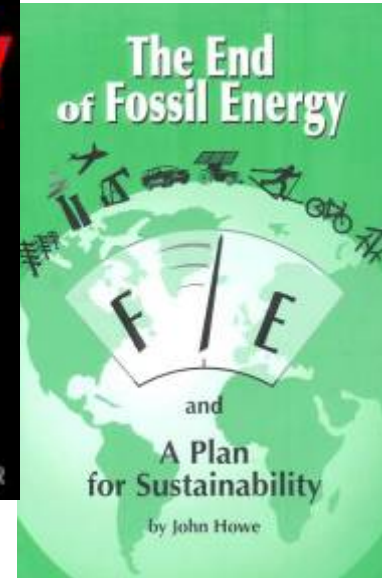
The future will be less about mobility and more about local independence



Natural gas is also in decline in the US



Matthew Simmons, consultant to presidents and the energy industry, thinks world oil extraction has already peaked



John Howe suggests that the best solution is PV on every roof and an EV in every garage

WATCH "RETURN TO TITANIC" ON NATIONAL GEOGRAPHIC CHANNEL, SUNDAY, 9 P.M. ET/PT

NATIONALGEOGRAPHIC.COM/MAGAZINE JUNE 2004

NATIONAL GEOGRAPHIC

THE END OF CHEAP

Oil

The Skittles of Iraq 2
Under Monterey Bay 36
Cliff-Hanging Tombs 56
Sprawl on the Mall? 60
At Home With Flickers 72
ZipUSA: Pawtucket, RI 109
BONUS Tear-out Map of Washington, D.C.

NATIONAL GEOGRAPHIC CHANNEL'S MOST AMAZING DISCOVERIES, SEPT. 6-10 AT 9 P.M. ET/PT

NATIONALGEOGRAPHIC.COM/MAGAZINE SEPTEMBER 2004

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GLOBAL WARNING

BULLETINS FROM A WARMER WORLD

The New Face of the American Indian 76 Badgers With Attitude 96
Treasures From a Civil War Wreck 104 ZipUSA: Schooled in Tradition 108
PLUS Supplement Map: Indian Country

WATCH "BAKED SCIENCE" ON NATIONAL GEOGRAPHIC CHANNEL, MONDAYS, 9 P.M. ET/PT

NATIONALGEOGRAPHIC.COM/MAGAZINE AUGUST 2003

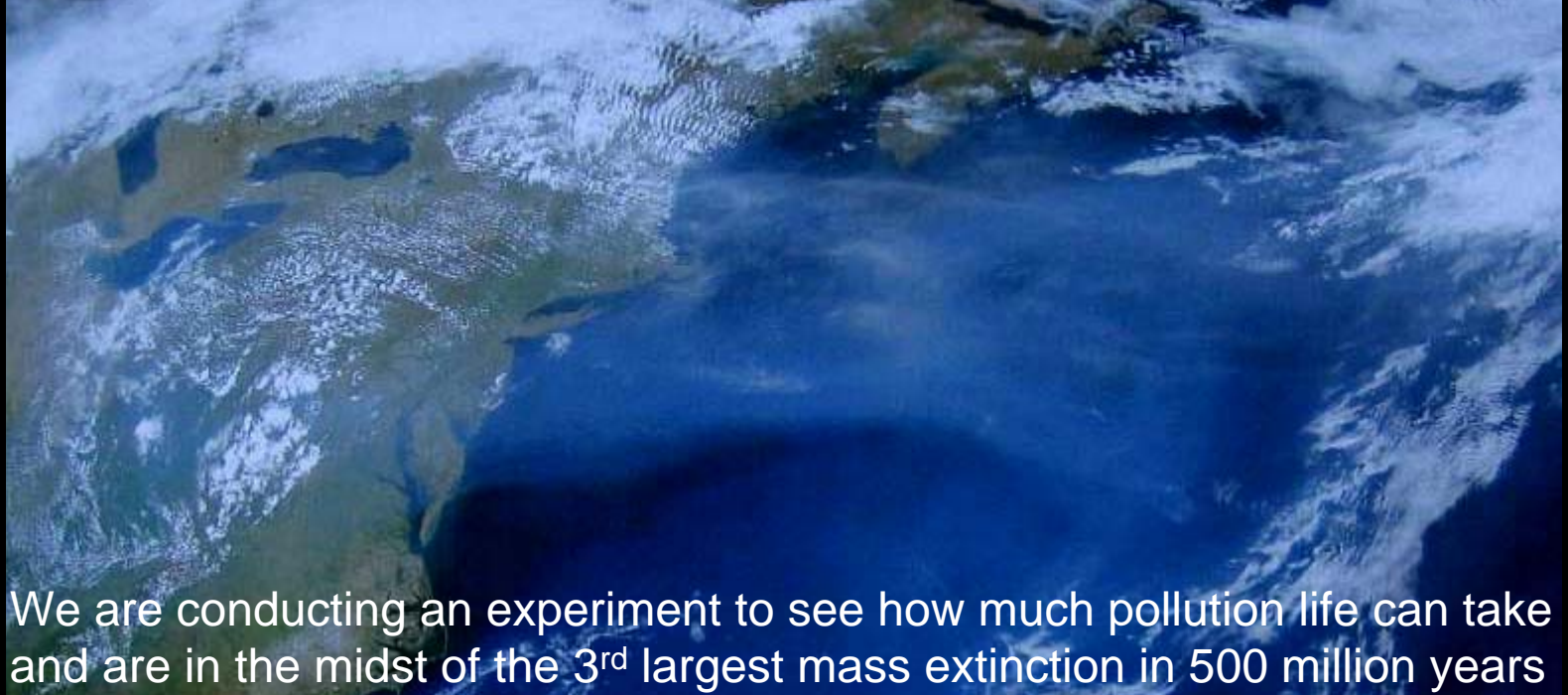
NATIONAL GEOGRAPHIC

After Oil

Powering the Future

THE BOMB—60 Years Later 28
Cave Art Mystery 32 Brazil's Wild Wet 44 Hurricane Warning 72
China Fossil Marvels 88 ZipUSA: Missouri Utopia? 94

Fossil fuel dependence is a double-edged sword of pollution and climate change on one blade and depletion and economic chaos on the other



We are conducting an experiment to see how much pollution life can take and are in the midst of the 3rd largest mass extinction in 500 million years



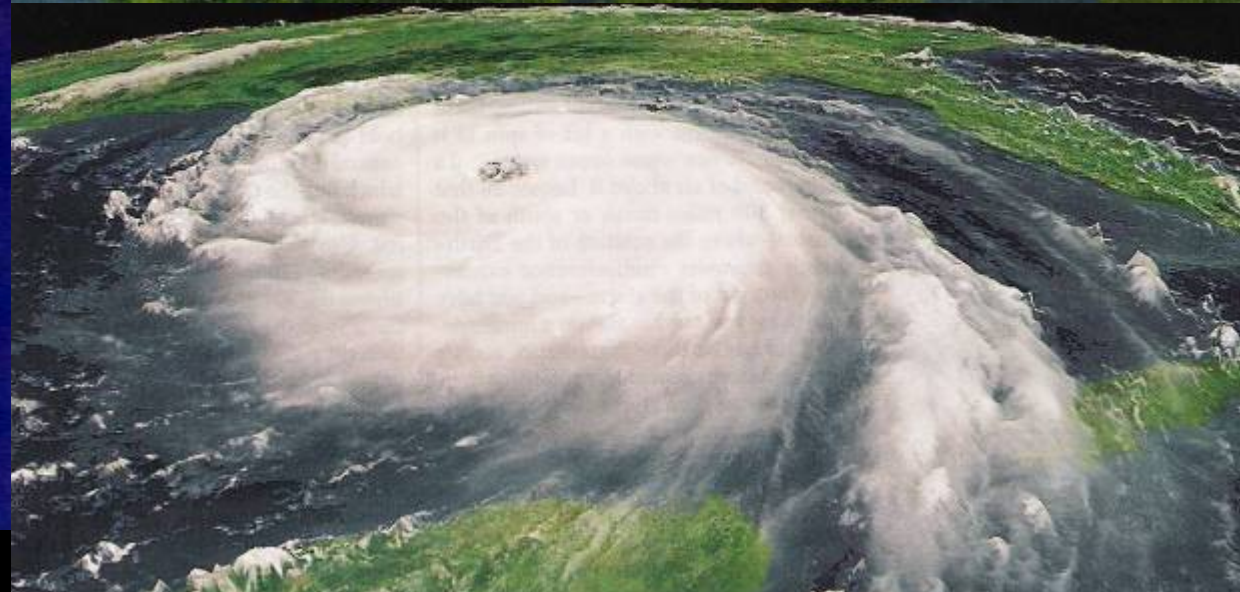
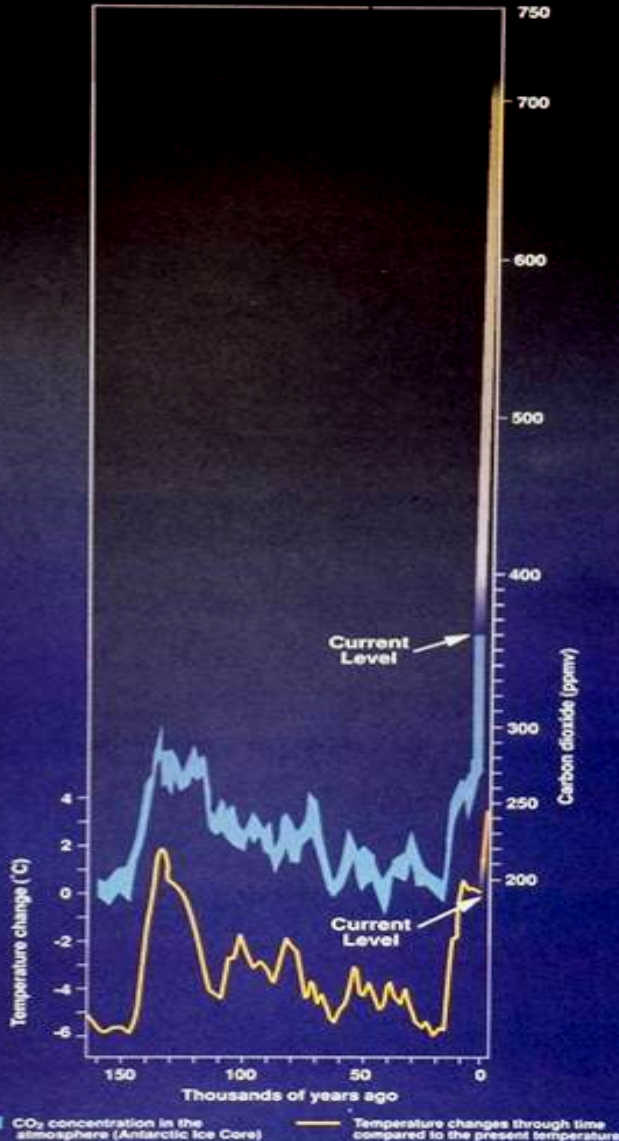
2005



2030 ?

The Global Effects of Increased CO2

Atmospheric Carbon Dioxide Concentration and Temperature Change

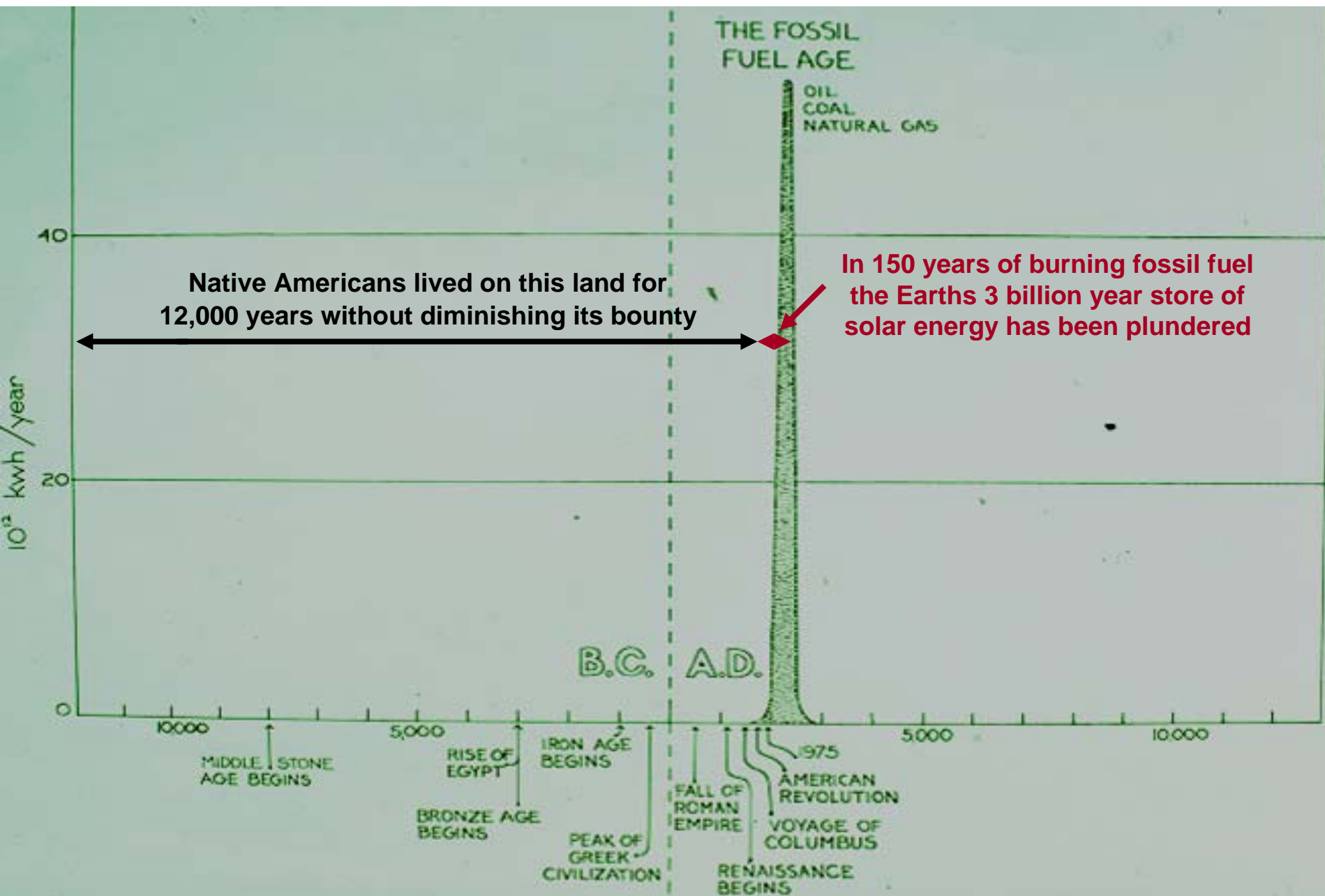




The Local Effects of Increased CO₂



The fossil fuel age on the scale of human history



Our continued existence depends on maintaining the quality of essential resources:

- 1. Air (O_2)**
- 2. Fresh Water (H_2O)**
- 3. Soil (food)**

Humans can survive for about 3 weeks without food, 3 days without water and only 3 minutes without air (O_2)

Oxygen is arguably the most precious resource on Earth

Breathe or Burn



My son, less than an hour old

A baby needs about 400 cubic feet of oxygen to survive the first six months of life

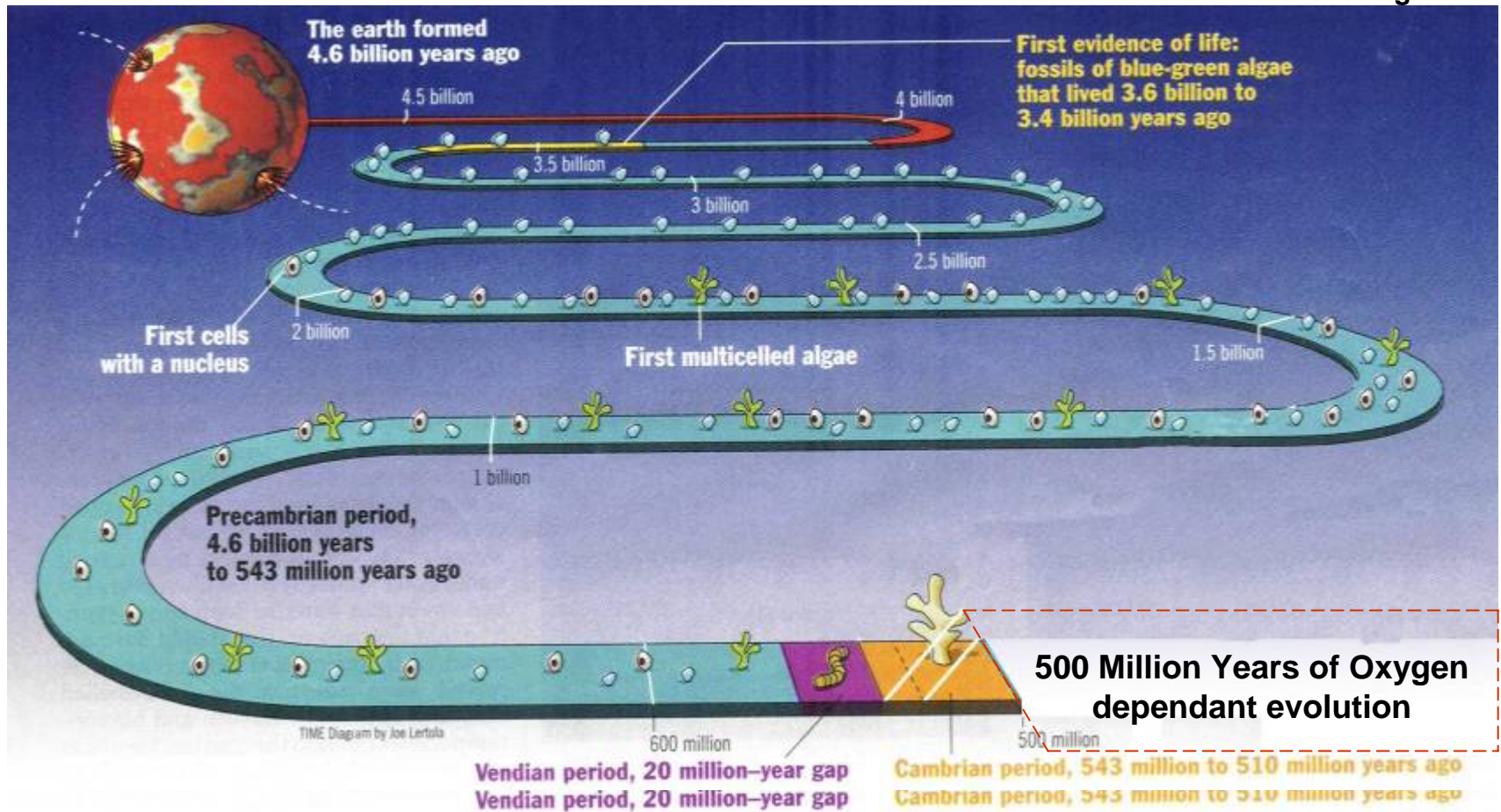


Burning a gallon of gas uses 400 cubic feet of oxygen.

Burning a 7 lb. gallon of gas consumes 14 lbs. of O_2 and produces 21 lbs. of CO_2

How the Earth became the only living planet in the Galaxy

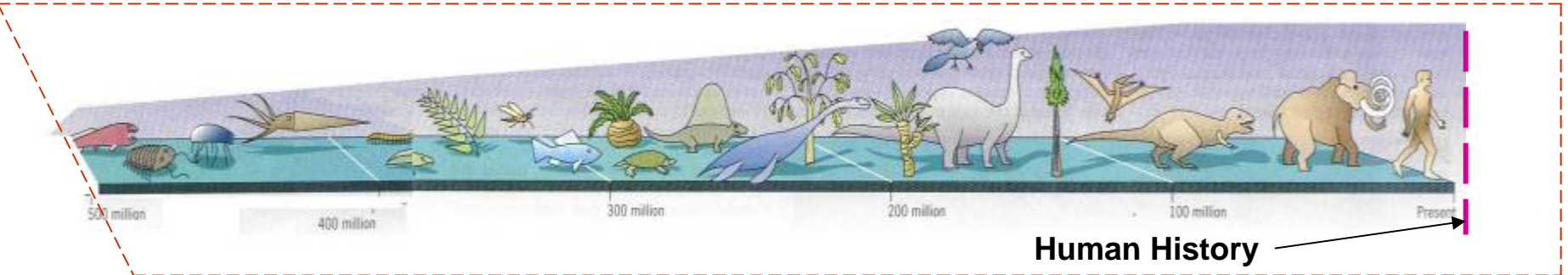
From the December 1995 Issue of *Time* Magazine



Conventional wisdom (and carbon dating) suggests that the earth was formed about **4.6 billion** years ago and about **3.5 billion** years ago the first free oxygen blue-green algae was created when sunlight reacted with CO_2 and H_2O to form C_xH_x (carbohydrates).

It took **3 billion** years of photosynthesis for enough free oxygen to accumulate in the atmosphere to support the first oxygen dependent life. At the same time countless trillions of algae and microscopic aquatic plants lived and died and their bodies covered the ocean floor leaving a legacy of stored solar energy in the form of hydrocarbons.

Over the last **500 million years** these hydrocarbons have been buried by the movement of the earth's crust and subjected to heat and pressure to form the coal, oil and natural gas we know as fossil fuels.



On a scale where **3 billion years** of photosynthesis equals **3 miles**, the **10,000 years** of human history would = **5/8"** and the **200 years** it will take to burn up all the oil would = the **thickness of a piece of paper**.

For every molecule of free oxygen in the air there is a molecule of carbon sequestered in vegetation or the earth's crust.

Burning fossil fuel reverses the 3 billion year process that made life possible and is raising CO₂ concentrations to levels which predate human existence.

Breathe or Burn?

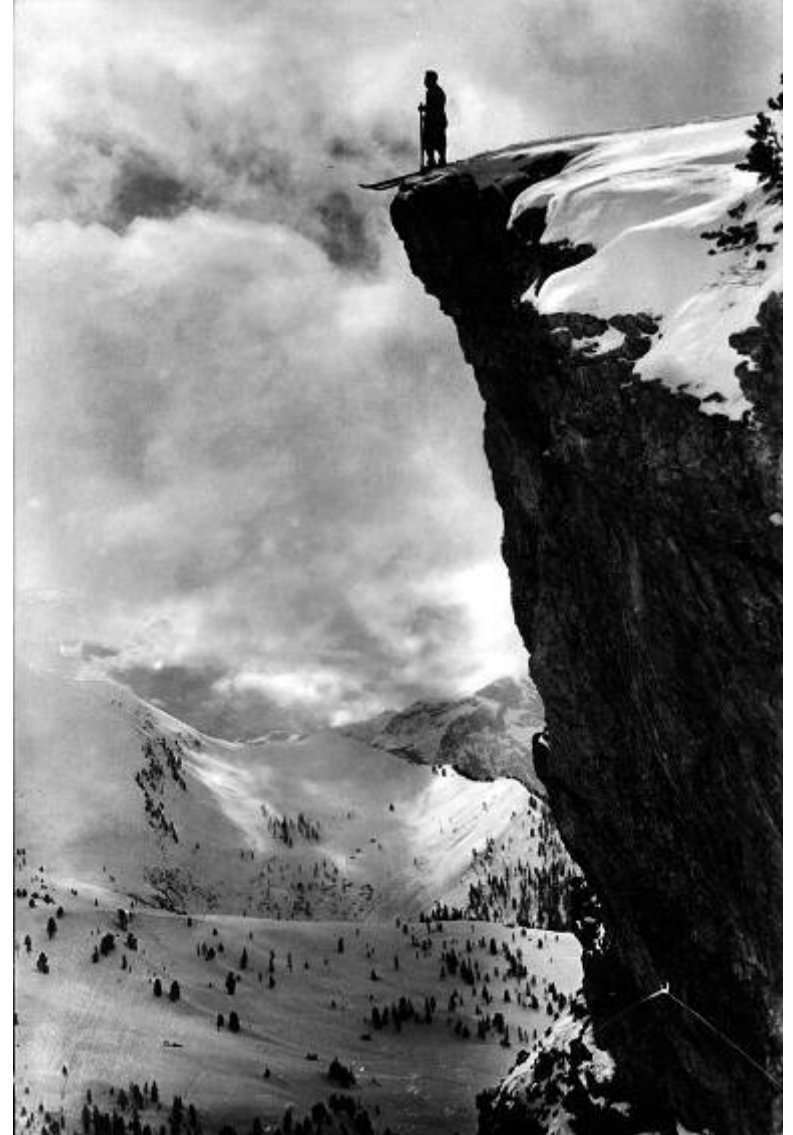
Running out of fossil fuel is a real bummer and presents some interesting challenges.

However turning the Earth into a lifeless planet is like each of us jumping off a cliff and pulling about 6 million unborn people with us not to mention all the other life forms we are pushing to extinction.

The sun is supposed to burn another 5.5 billion years. That's a lot of possible future generations.

It may not be too late if we can move quickly through denial to action.

We are in a great position to set an example for the rest of the world.





40 years of oil left



5,500,000,000 years of sunshine left

99% of motorized transportation is powered by oil

Fuel Efficiency and Climate Change



| Vehicle Type | \$ Gas 50 Mi. /Day | kWh 50 Mi. /Day | \$/Month 50 Mi. /Day | Tons of CO ₂ /Year Tailpipe | +Tons of Upstream CO ₂ /Year* |
|---|----------------------------------|--------------------------------|----------------------------|--|--|
| 10 MPG Gas | 12.50 | 200 | 375.00 | 21 | 27.3 |
| 20 MPG Gas | 6.25 | 100 | 188.00 | 10.5 | 13.6 |
| 30 MPG Gas | 4.17 | 67 | 125.00 | 7 | 9.1 |
| 40 MPG HEV | 3.13 | 50 | 94.00 | 5.2 | 6.8 |
| 50 MPG HEV | 2.50 | 40 | 75.00 | 4.2 | 5.5 |
| 40 MPG PHEV with 25 Mile EV Range | 1.56 for 25 Miles | 10 for 25 Miles | 62.00 | 2.5 | 3 |
| PHEV with 50 Mile EV Range | | 22 | 33.00 | ZERO | .4 |
| EV-1, 120 Mile Range (built & crushed by GM) | | 12 | 18.00 | ZERO | .2 |



For comparison, 20 - 30 kWh/Day are used in the average home 17

The EV-1 was the best commuter car ever built in Detroit but GM made more money selling passenger trucks so...



Now GM is closing 9 manufacturing plants and laying off 30,000 employees because of poor SUV sales. How will GM respond?

As our leaders and industry ignore the approach of Climate Change and “Peak Oil” the resources and wealth to build a renewable energy infrastructure are squandered on gas guzzling passenger trucks.





Toyota Rav4 EV, \$29,000, no gas

Toyota Prius, \$20,000, 50mpg

Efficient Vehicle Solutions Exist



280 mpg tandem by VW 2001



120 miles in one hour on one charge '93



9000 miles per gallon, built by students '05

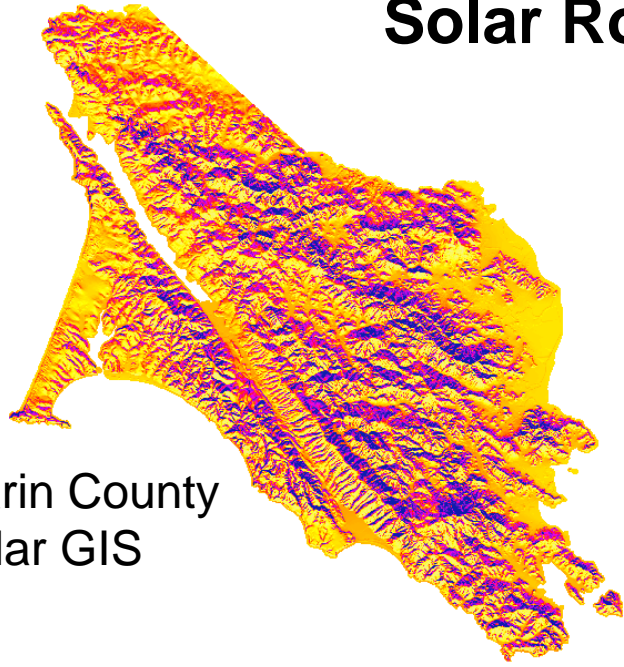
ECD Ovonics H₂ Hybrid EV



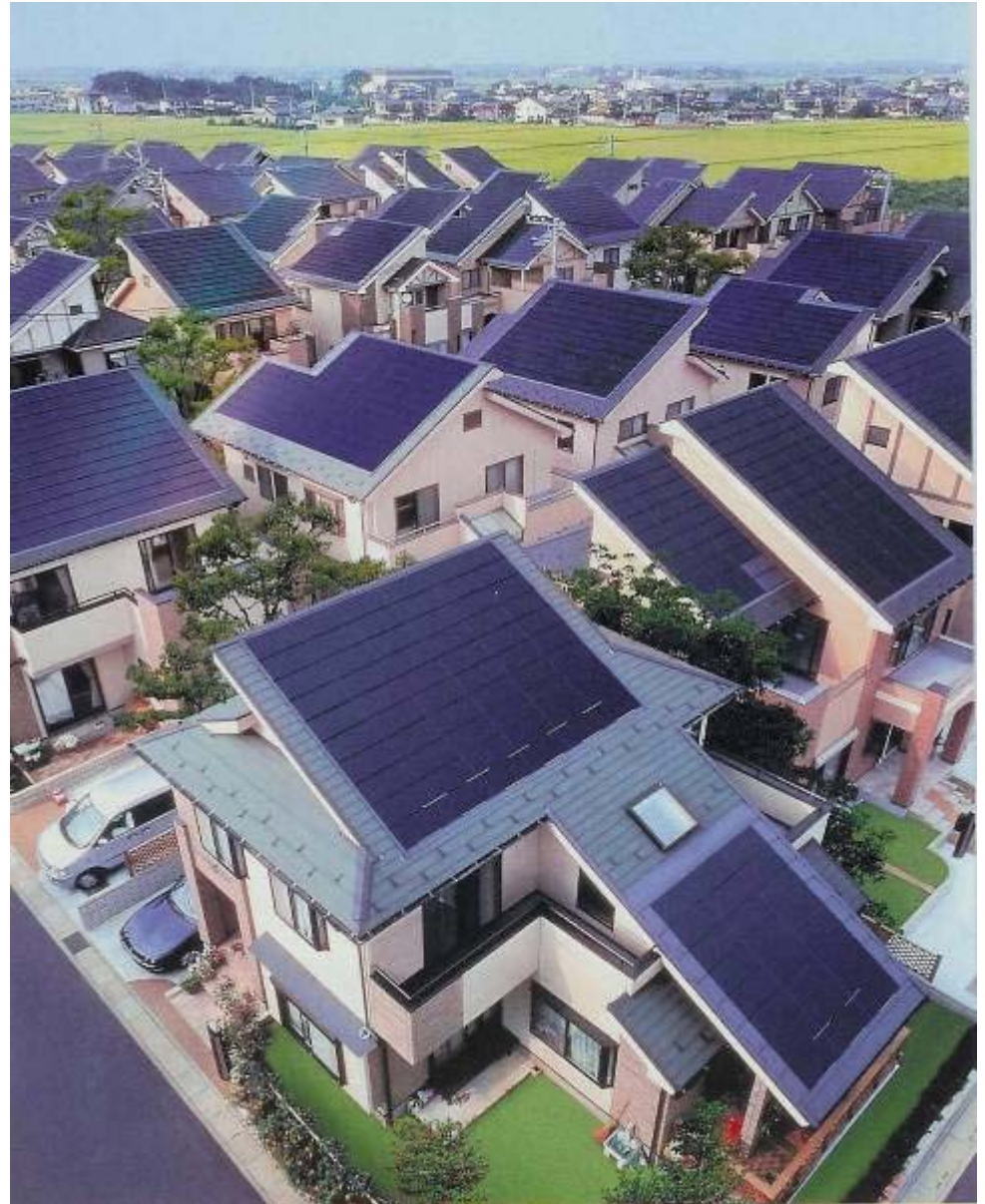
PV portable tent powers an electrolyzer to produce Hydrogen which is stored in Ovonic solid metal hydride to fuel a Hybrid Electric Vehicle with nickel metal hydride batteries

OVONICS@work

Solar Roofs Can Charge Electric Vehicles



Marin County
Solar GIS



PVs Charging EVs



3.5 kW EV Charging Station



10 kW EV Charging Station



30 kW EV Charging Shade Structure



100 kW EV Charging and H₂ Production

Every roof can be a solar charging station



2 kW, CA 1996



4 kW, CA 2001



6.5 kW, CA 1999



2 kW, CA 2003

.3 kW PV on EV minivan roof '89



Electric Van w/ pop-top PV '94



EV conversions '93



Type 34 Karmann Ghia electric conversion



Charging from the sun



Charging at the county offices



Charging while I do my radio show

Electric Porsche Spyder Replica Kit



120 mile range, up to 100 mph



Charging in my shop in Albion



John Schaeffer and Ralph Nader



The crew at our shop in Ft Bragg '94



Built for GNB Battery, Australia



100 mile range

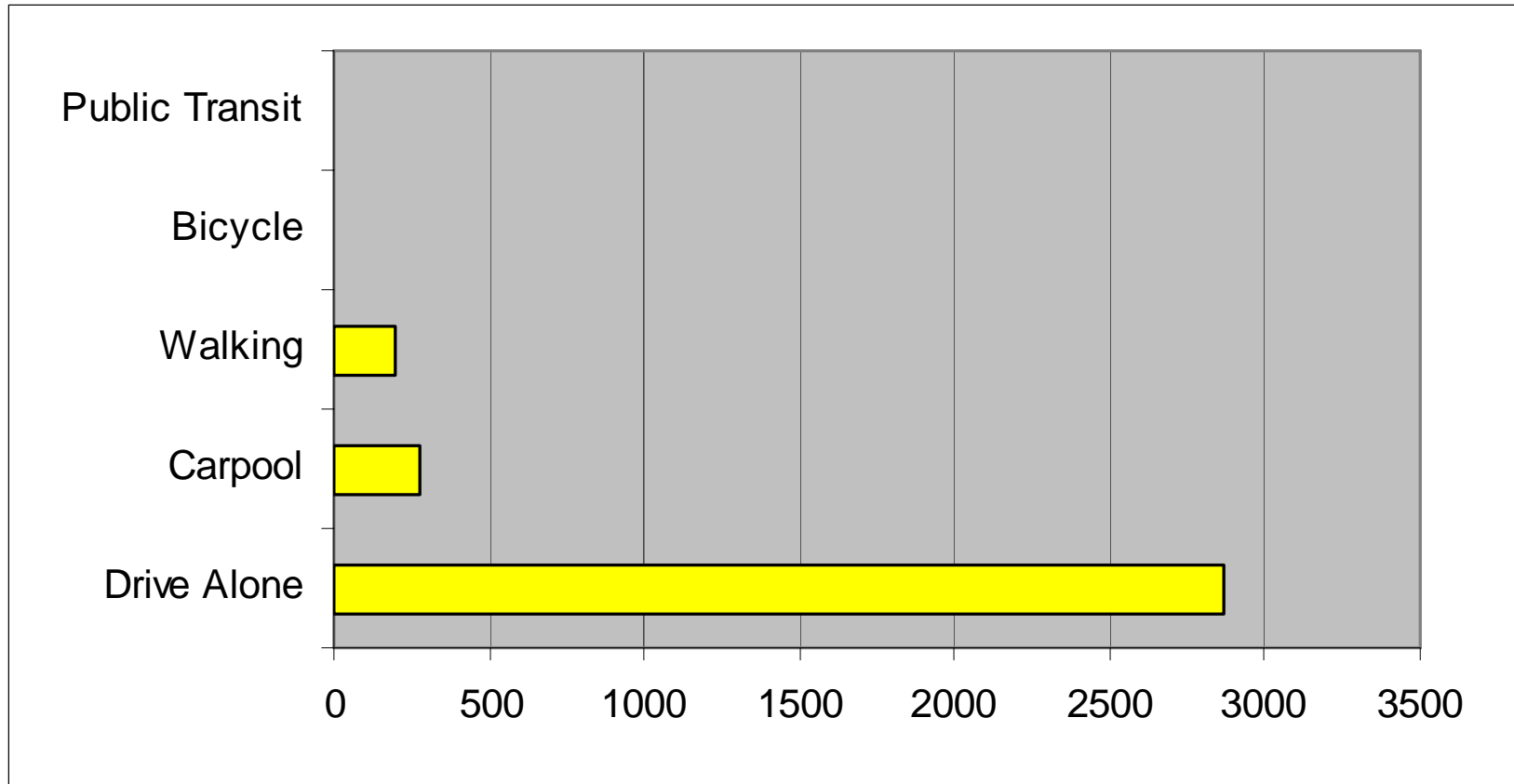


0 – 60 mph in 8 sec.

Small is Beautiful



Typical Rural/Suburban Commuter Choices

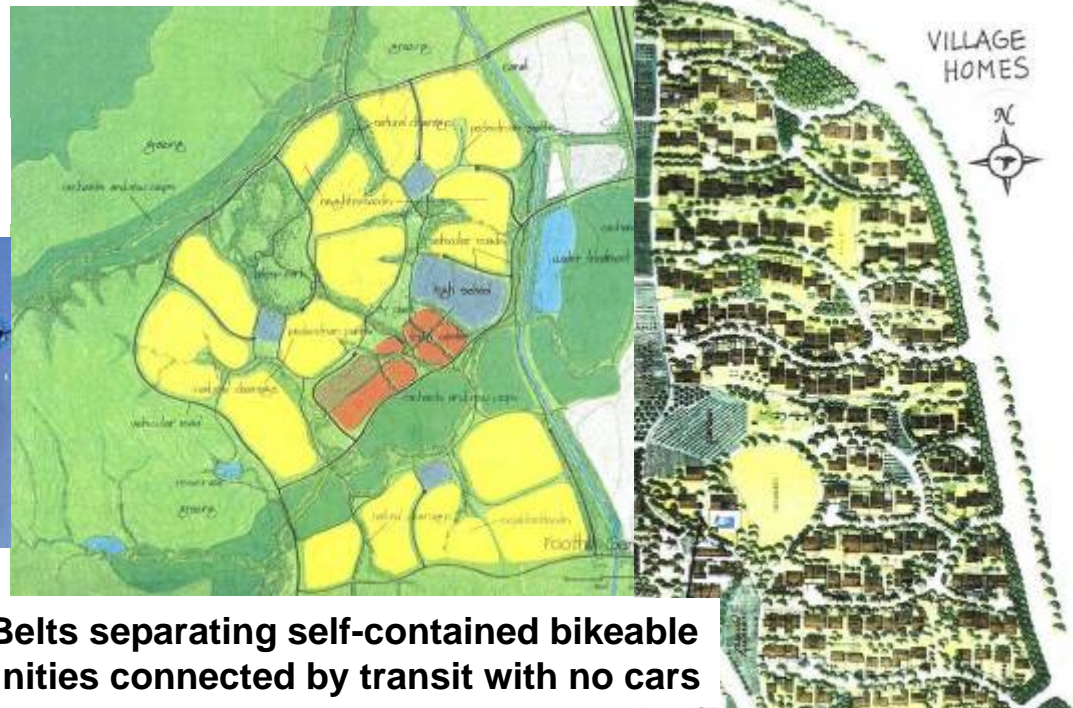


Solution: Plan and build walkable, bicycle friendly, human scale communities surrounded by agricultural green belts connected by transit

Good planning can minimize the need for cars and pavement

Design with Nature

by Ian McHarg



Green Belts separating self-contained bikeable communities connected by transit with no cars



Bike trail through a greenbelt in Germany

No cars in Venice

Bike trail through an orchard in Village homes

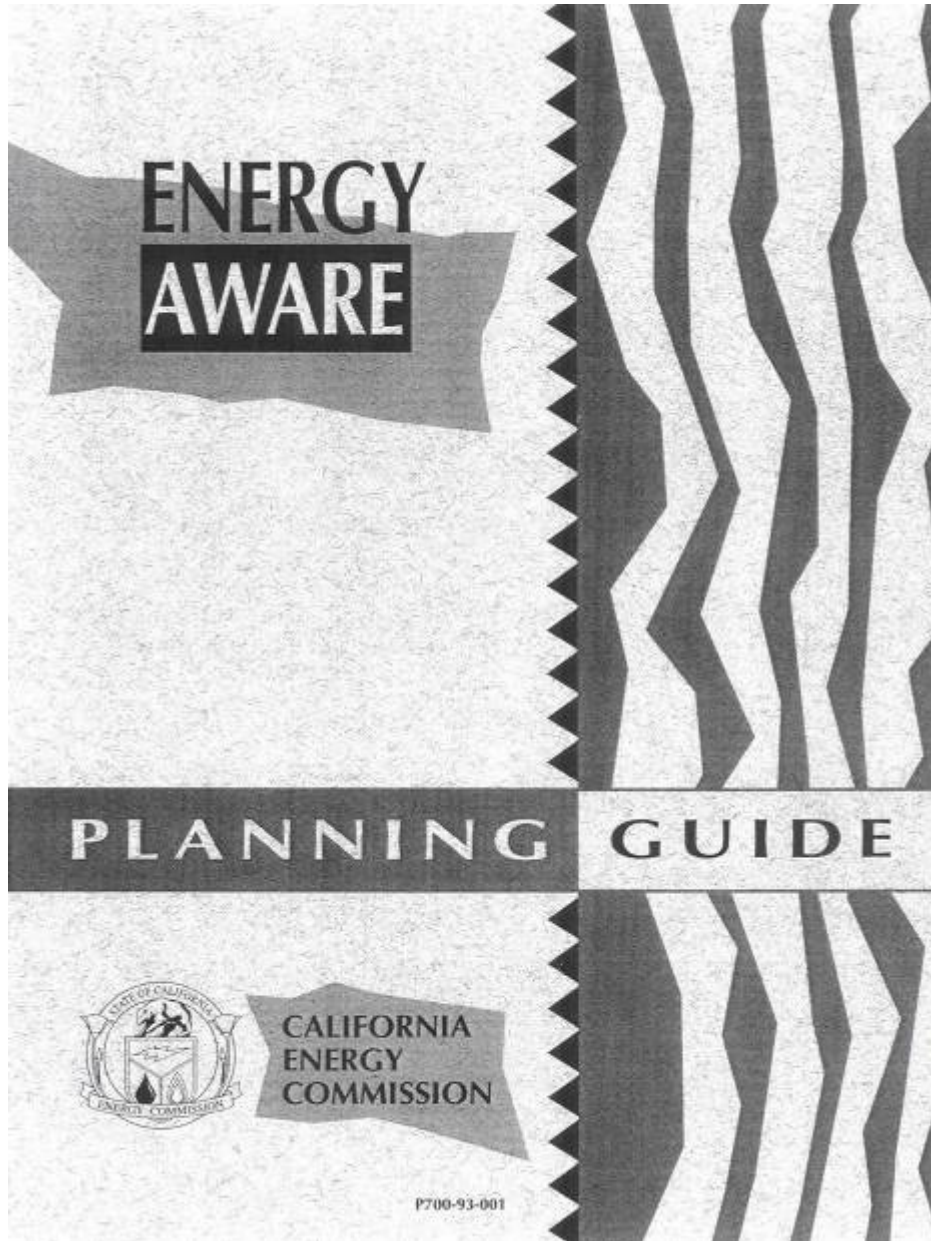
Village Homes built in the 1970s in Davis, California, is still the standard by which other sustainable neighborhood developments can be measured

What makes Village Homes a success



- **Density:** 200 homes and 30 rental units on about 40 acres, leaving 30 acres for Gardens, orchards and common areas, including a community center.
- **Southern Orientation:** Allows full access to solar radiation.
- **Narrow Roads:** Less pavement leaves more land available for other uses and slows down traffic.
- **Bike and Pedestrian Paths:** Makes it more convenient to use our legs and discourages the use of motor vehicles.
- **Natural Drainage:** Allows groundwater recharge
- **Common Areas:** Allows space for gardens, orchards, playing fields,, shops, offices and neighborhood and community gathering places.

Energy Aware Published by the CEC in 1994



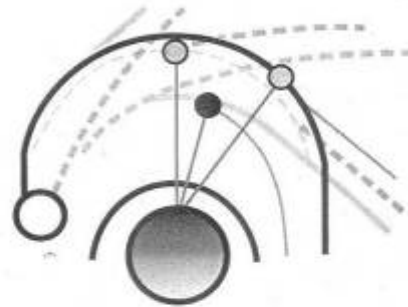
Planning strategies:

1. Mixed use development
2. Density near transit
3. Street trees
4. Pedestrian facilities
5. Bicycle facilities
6. Telecommuting
7. Fleet efficiency

Planning for Community Energy, Economic and Environmental Sustainability, 1996

THE ENERGY YARDSTICK:

Using **PLACE³S**
to Create More
Sustainable Communities



PRODUCED FOR:

Center of Excellence for Sustainable Development
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

Program Partners:

Oregon Department
of Energy



Washington State
Energy Office



California Energy
Commission



Using energy as a yardstick to measure and compare the efficiency of development options makes Informed decisions possible.

Recent developments in GPS and GIS makes this strategy an inexpensive planning tool.

We have the tools to move beyond zero energy homes to zero energy communities

Imagine efficient electric vehicles that could be charged from renewable sources and drive onto a raised rail and safely travel at 180 mph with fuel efficiency equivalent to 280 mpg



Solar charged electric bikes with 20 mile range at 25 mph



Solar powered charging electric bikes



16 bike solar powered charging trailer



Trailer with surfboard rack



Recumbent with 50 mile range

Muscle Power is Best

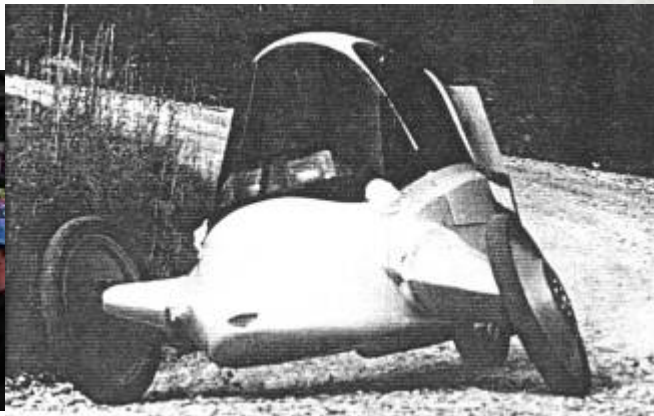


Surviving 'peak oil' and climate change will require that we first acknowledge our addiction then localize our economies and take back our streets from oversized gas guzzling polluters



Transportation Hierarchy

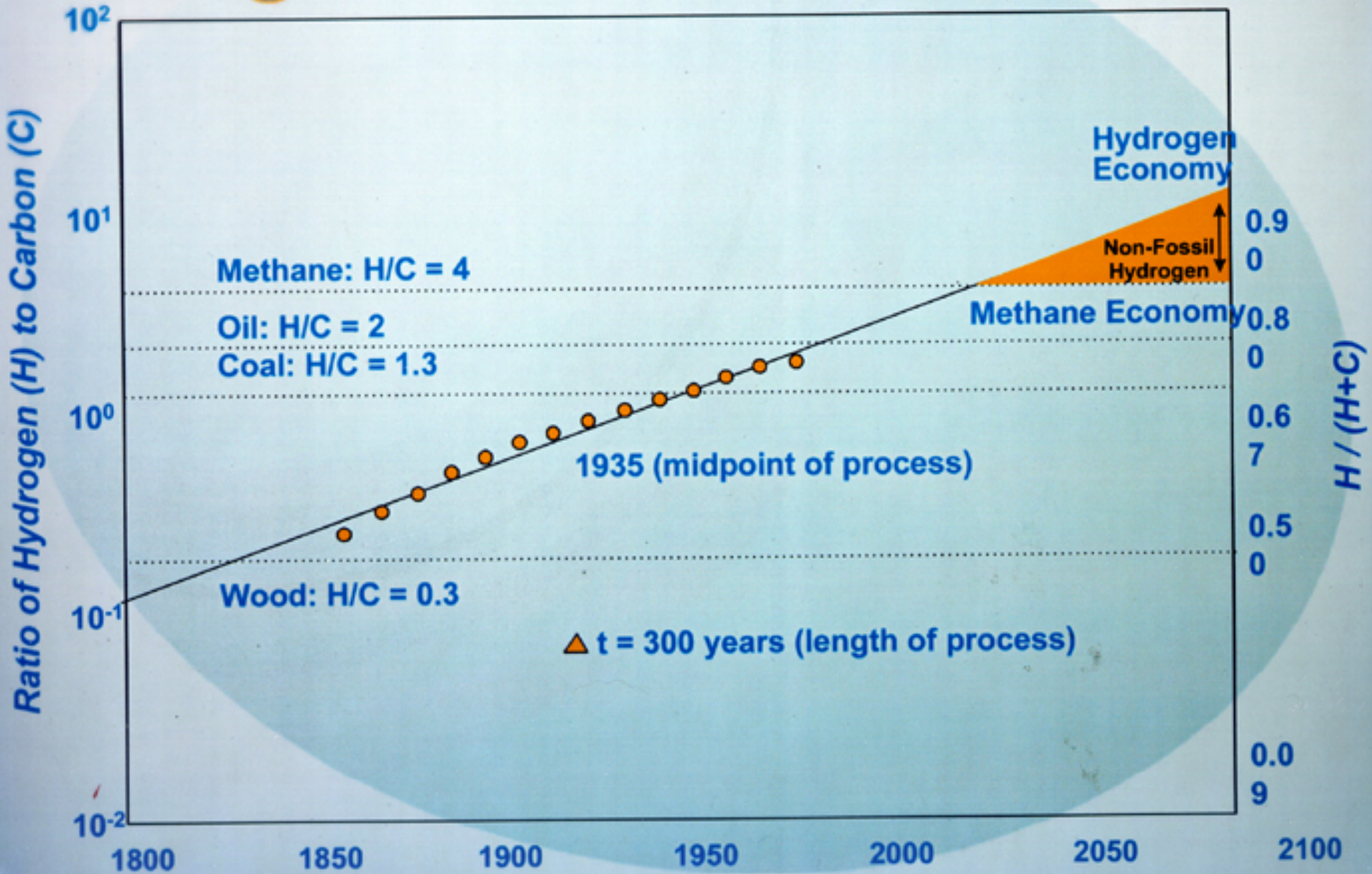
1. Consolidate Trips
2. Walk or Bike
3. Pedal Electric
4. Ultra-light EV
5. Pedal Electric Rail
6. Compact EV
7. Plug-in H₂ Hybrid
8. Biofuel



99% of our transportation \$'s leave the county



Underlying Decarbonisation



The Best Place for a Nuclear Reactor is 93,000,000 Miles Away



Advantages of Solar Energy

Fossil Fuel Dependence



- Finite fuel supply
- Ugly infrastructure
- Polluted air / Climate change
- Extraction site devastation
- Polluted land
- Spills and polluted water
- Energy resource wars
- Susceptible to terrorism

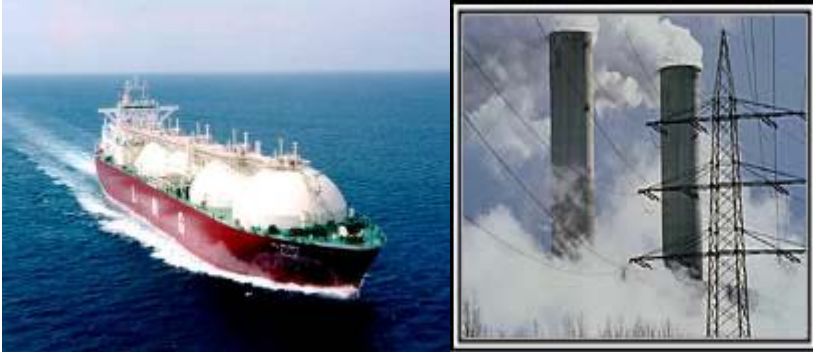
Solar Independence



- Abundant solar energy
- Aesthetically superior
- Clean air / no CO2 emissions
- No extraction sites
- Healthy land
- No water pollution
- Free solar fuel
- National and individual security

Advantages of Distributed Solar Generation

Conventional Power Generation



- Explosive polluting terrorist targets
- Requires fuel from distant sources
- Price Volatility
- Uses land for extraction and power generation
- Difficult permitting process
- Requires security infrastructure
- Requires new transmission and distribution lines
- Power has low value (\$0.03 – \$0.04/kWh)
- Multinational corporate control
- Priority: Short-term profits

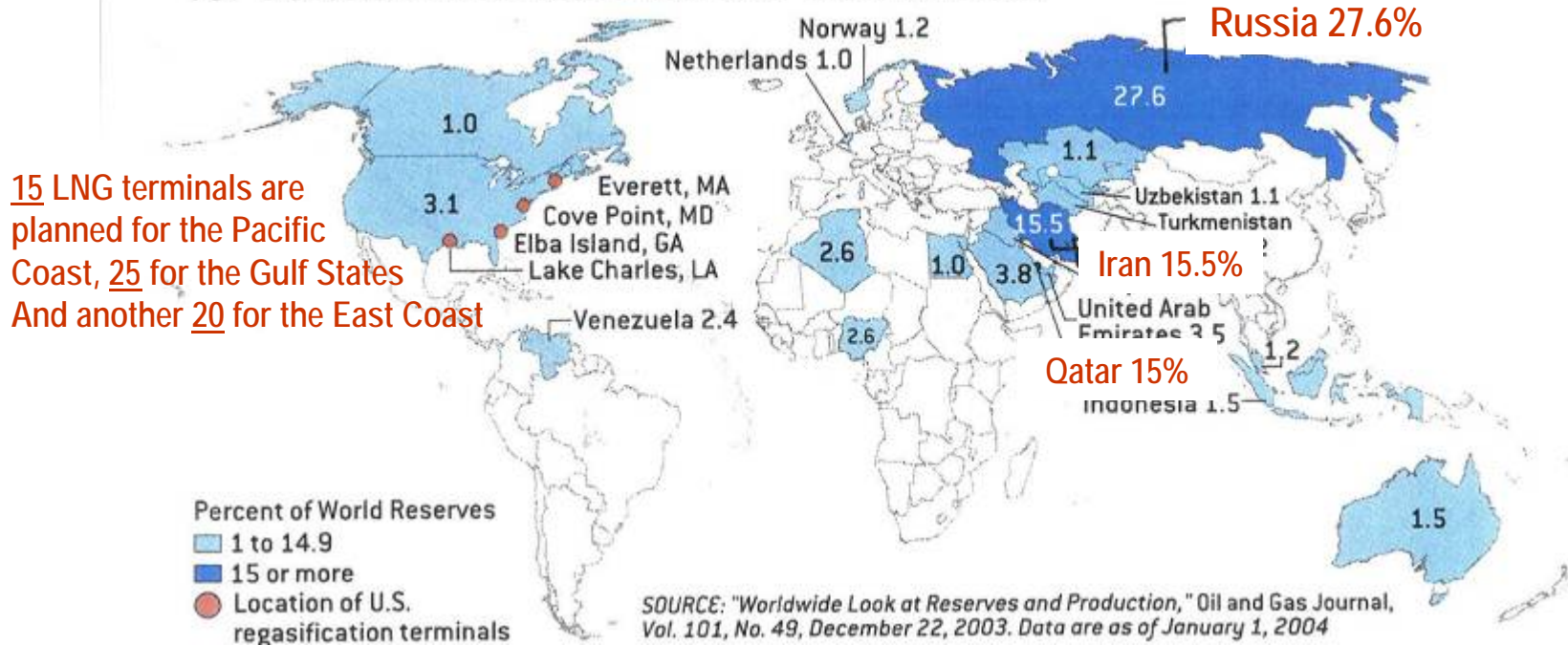
Distributed Solar Generation



- Clean and Secure
- Requires no fuel, only sunshine
- Economic stability
- Uses existing infrastructure
- Easy permitting process
- Cost of roofing can be offset
- Uses existing transmission and distribution lines
- Power has high value (\$0.10 - \$0.30/kWh)
- Time of Use net metering for automatic Peak Power Shaving
- Local control for public good

Who Has Natural Gas

TOP 20 COUNTRIES IN RESERVES OF NATURAL GAS



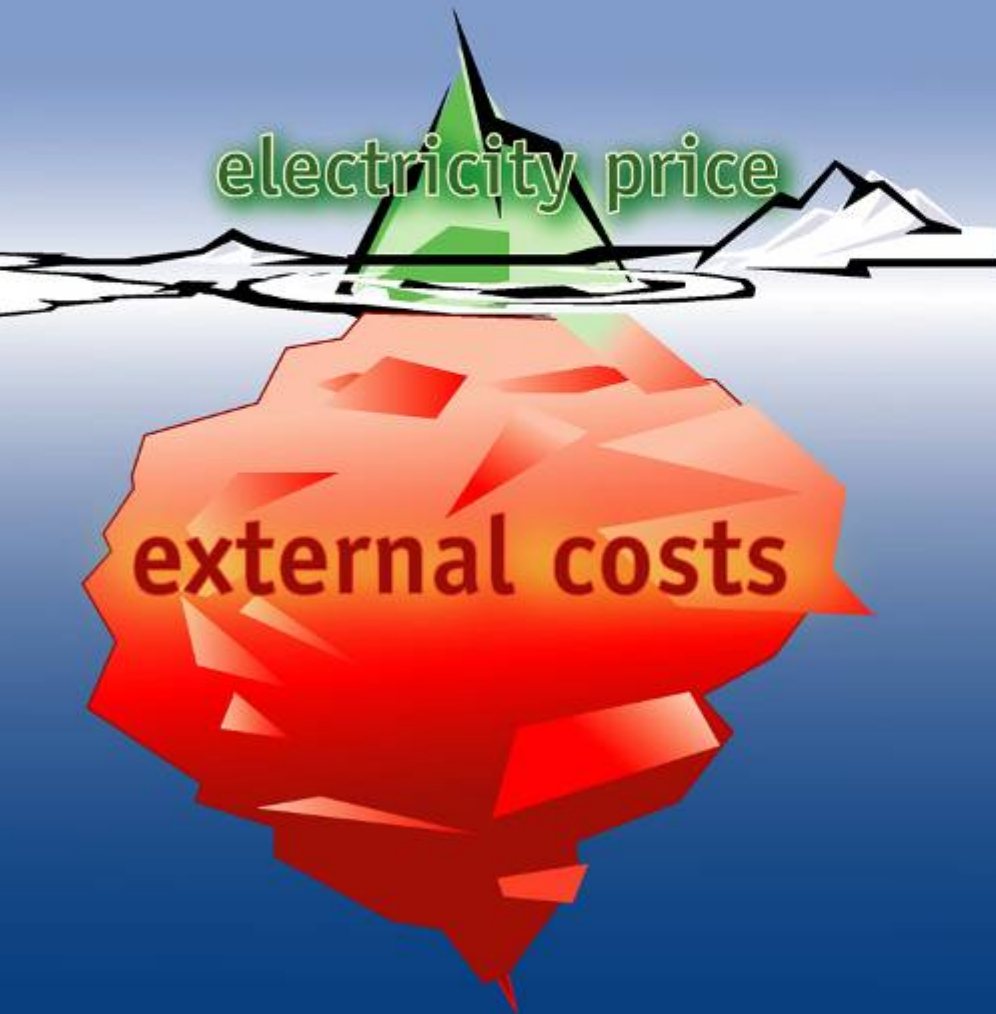
Most of the new generating capacity in California is fueled by natural gas but 85% of the fuel used is imported from outside the state. The proposed Liquefied Natural Gas (LNG) terminals will cost about \$5 billion each. If these terminals are built the cost will be passed on to the ratepayer, US trade deficits will continued to rise and dependence on distant volatile energy supplies will be institutionalized causing another round of resource wars

PRICE OF OUR ENERGY SUPPLY

THE CONVENTIONAL ENERGY PRICE ICEBERG

©

Bundesverband
WindEnergie e.V.



Who pays the bill?

The consumer of electricity

The society

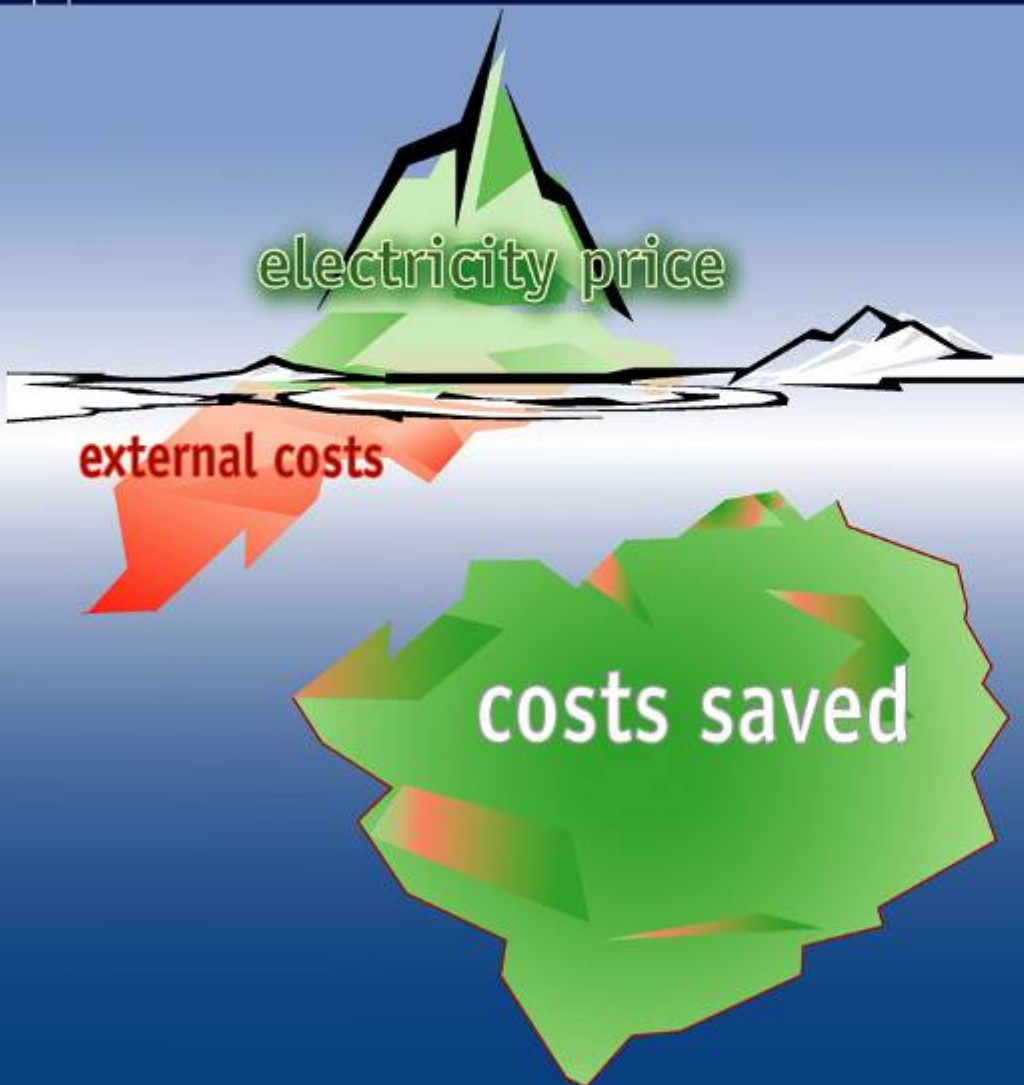
Indirect burden through taxes,
insurance and social security payments.

The state

Increased damage to the environment;
the state pays the political "price" for the
energy supply.

Global loss
of quality of life

PRICE OF OUR ENERGY SUPPLY SAVING COSTS THROUGH RENEWABLE ENERGIES



Who profits?

The consumer of electricity

Electricity consumption at own responsibility, no indirect burden by social security payments.

The state

Relief for state budget and social security institutions. Damage to the environment avoided.

Global gain of quality of life

Through protection of the environment and a decentralized energy supply system.

Advantages of Thin-Film BIPV

Building Applied PV



2 kW crystalline modules installed on racks

- **High embodied energy**
- **100 times more silicon than thin-film**
- **Glass modules can break**
- **High cost per square foot (>\$100)**
- **Racks are expensive**
- **Must be removed to replace roofing**
- **Roof penetrations required**
- **Detract from building's appearance**
- **Modules add excess weight to roof**
- **Electrical cables & conduit are exposed**

Building Integrated PV

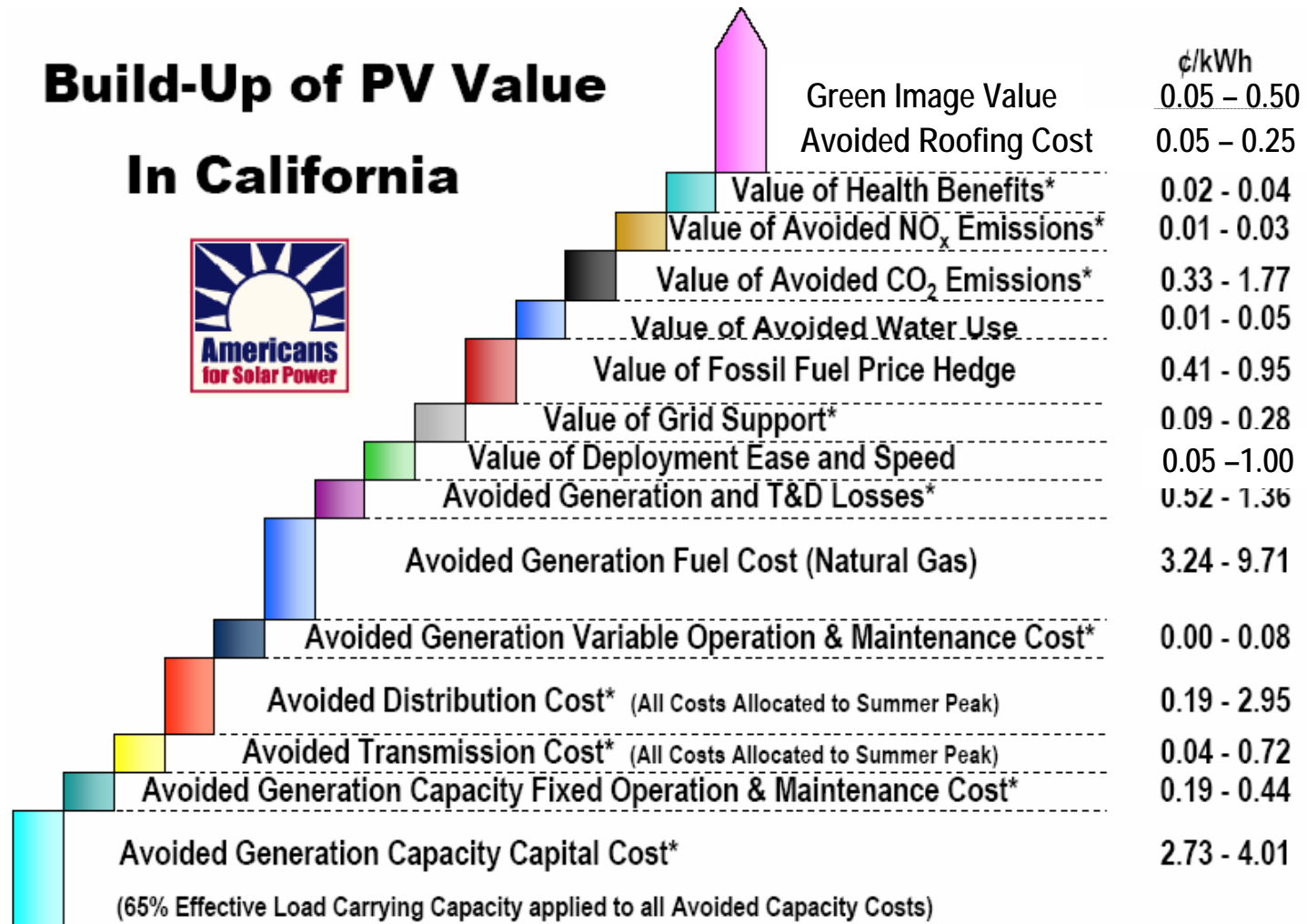


2kW flexible thin-film PV roofing

- **Low embodied energy**
- **100 times less silicon than crystalline**
- **Laminates are vandal resistant**
- **Lower cost per square foot (<\$50)**
- **Avoids the expense of racks**
- **Synchronized roofing and PV installation**
- **No roof penetrations**
- **Laminates are aesthetically superior**
- **Lightweight**
- **Easy to install quick connects hidden and protected under ridge cap**

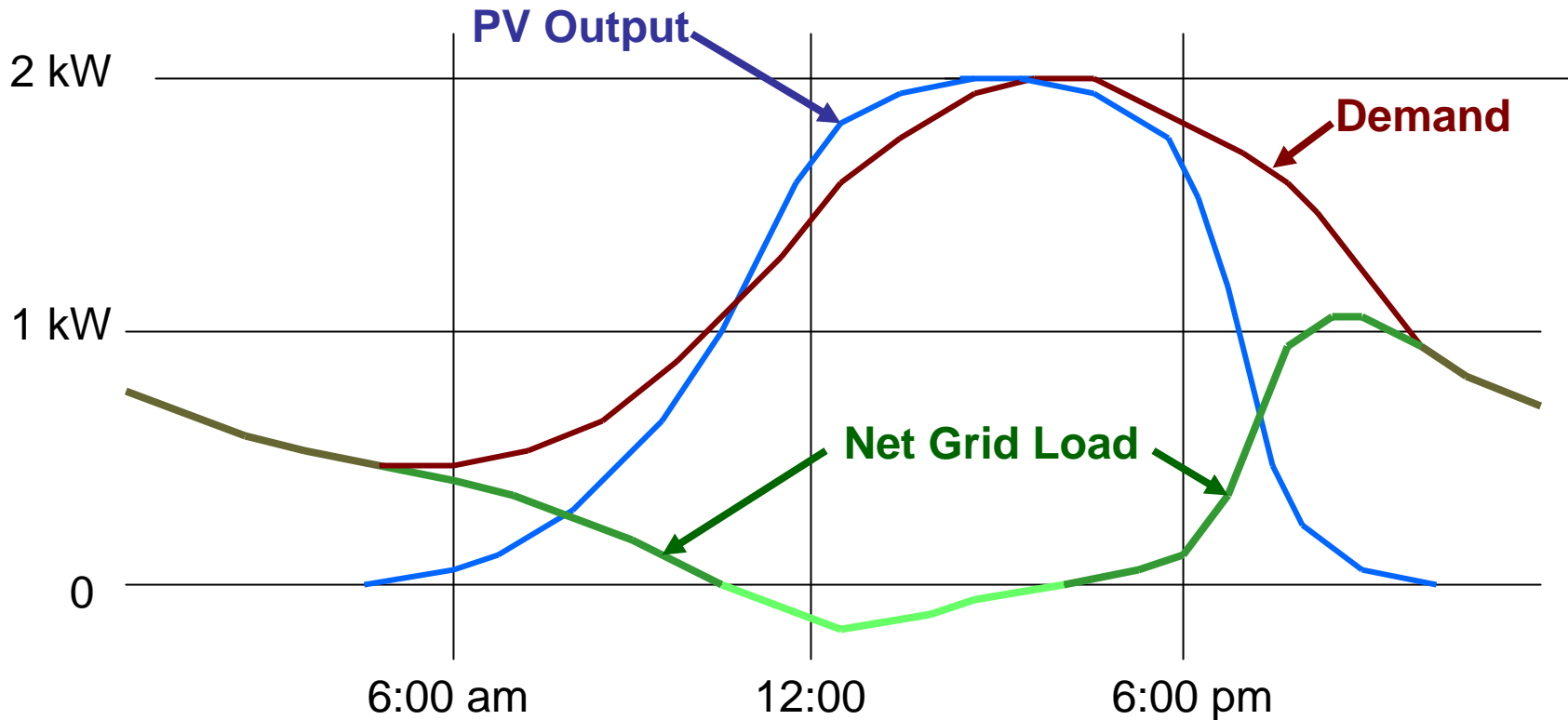
The Real Economic Value of BIPV

Build-Up of PV Value In California



TOTAL ADDED VALUE of BIPV: \$.08 – \$.25 / kWh

Graph of **Net Grid Load** on Home with **2 kW West Facing PV System** and **2 kW Peak Summer Load**



PV performance coincides with peak air conditioning loads

PV Manufacturers are Ready



SHARP



EVERGREEN



UNI-SOLAR
United Solar Ovonic

1 GW/year Total Capacity

Every hour, the sun showers the earth with more power than human beings consume in an entire year



1 MW Power Light, Alameda



340 kW SIT, LA



There is enough roof area with Solar exposure to satisfy all our energy needs

Solar Water Heating in China

FROM 5 - 42 THERMAL GIGAWATTS OF SOLAR WATER HEATING CAPACITY IN 3 YEARS

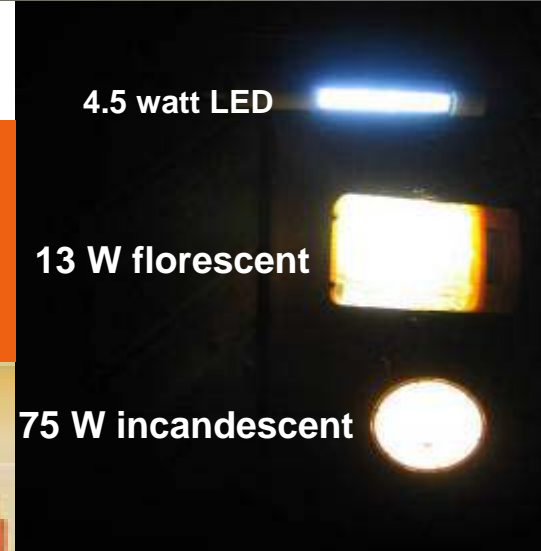


56 GW of wind generation installed worldwide

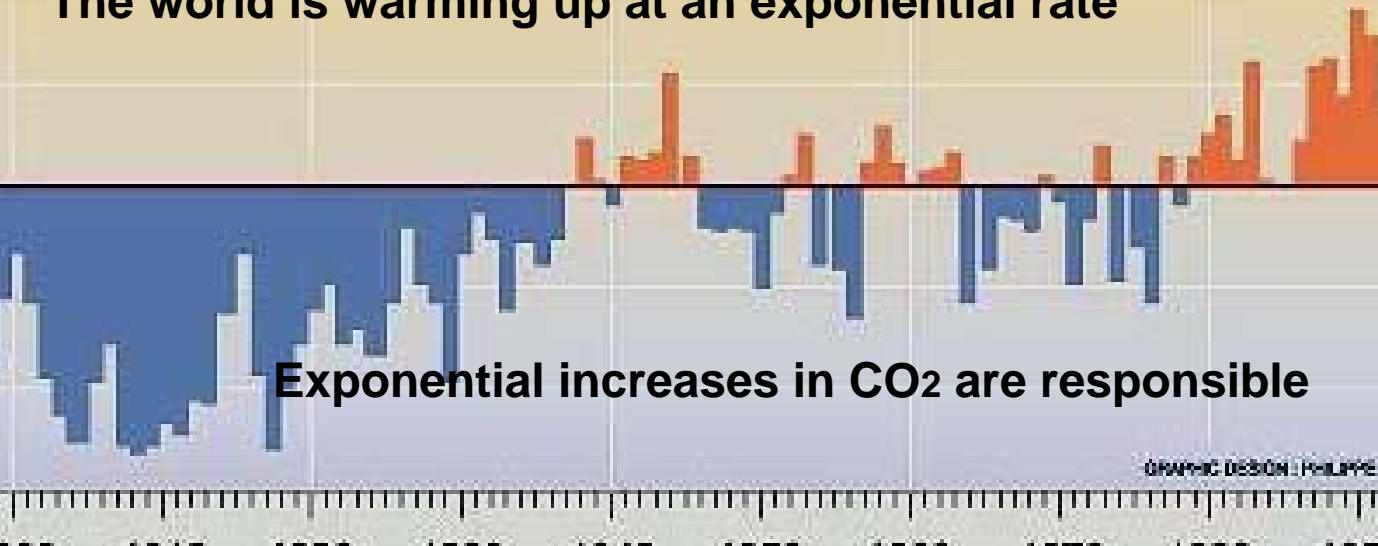


Energy Hierarchy

1. Conservation
2. Efficiency
3. Muscle
4. Zero Emission Renewables
5. Biofuels



The world is warming up at an exponential rate



Fresh Water Hierarchy

1. Gravity Fed Spring

2. Wind or Solar Pumped Well
(must not be pumped faster than the water table is recharged on an annual bases.)

3. Rain Water Catchment
(cistern or pond)

4. Wind or Solar Pumped From Stream or River
(must not be pumped at a rate that will negatively affect aquatic populations.)

98% of water pumping dollars leave the county



Wind was the Primary Pumping Power Before Fossil Fuel



Food Hierarchy

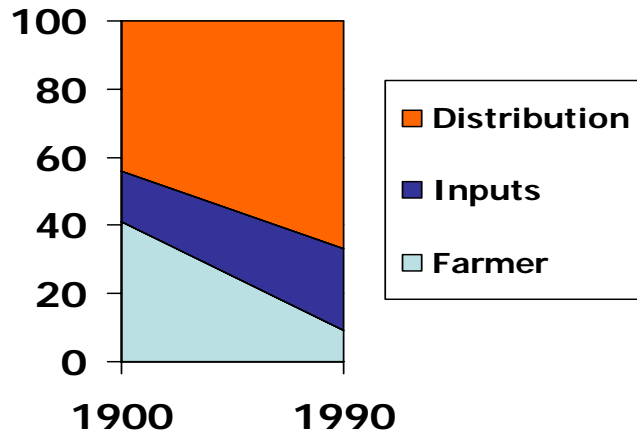
1. Organic Home Garden
And Greenhouses

1. Local Organic Farms
(farmed without fossil fuel)

3. Regional Organic Farms
(farmed without fossil fuel)

4. Fair Trade Import
(farmed without fossil fuel)

Where Food Dollar Goes



My son again, the carrots worked, he's now 6' 7"

South slope gravity irrigation



Solar charged electric tractors can eliminate the need for fossil fuel

Tractors require weight for traction



Batteries provide useful weight for traction



E-tractors Built in my Ft. Bragg shop '94



Built for Ford-New Holland '95



**Onboard inverter for mobile AC power '96
All above are conversions of Yanmar tractors**



**Allis Chalmers' "G" electric conversion '2004
For more info: www.flyingbeet.com/electricg.**



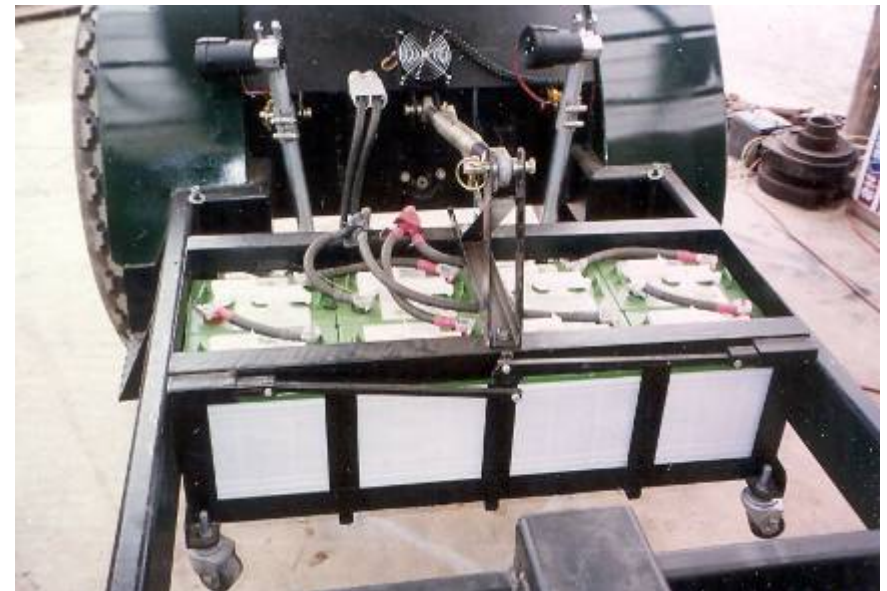
Solar powered Planter/harvester



Movable seat for good visibility



Zero radius steering front and rear 3 pt hitch

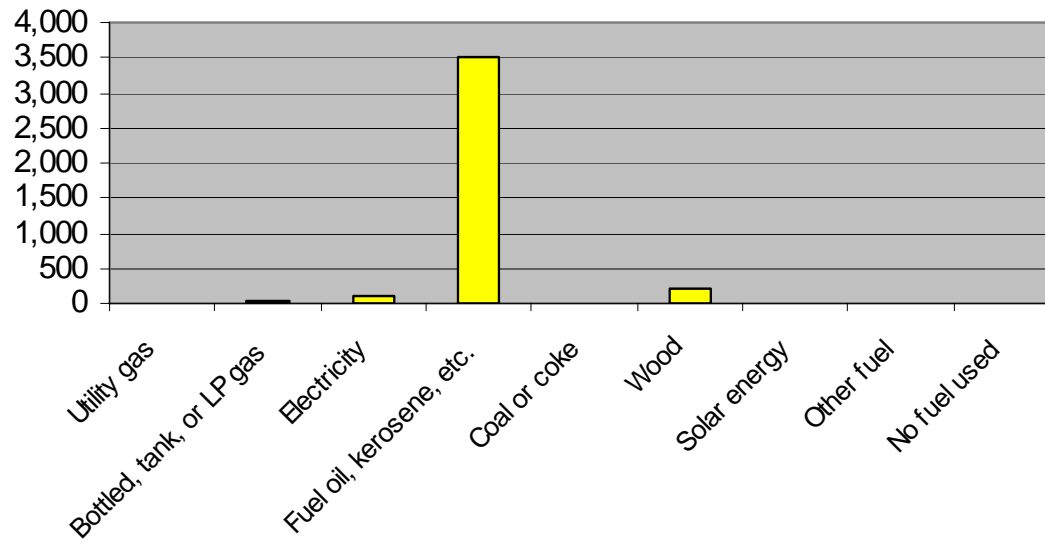


Exchangeable battery packs for continuous operation

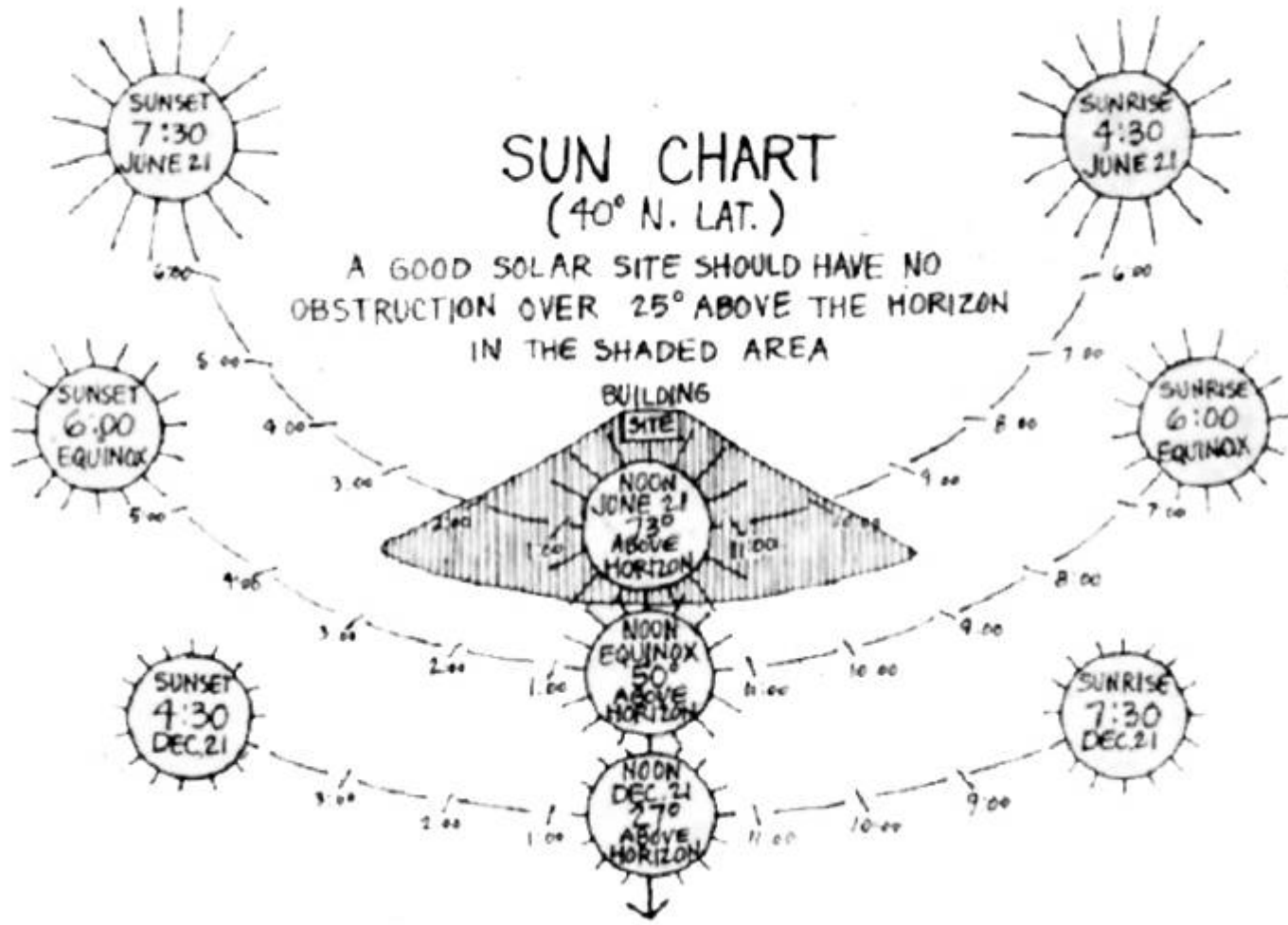
Shelter Hierarchy

1. Passive Solar with On-Site Materials
2. Local/Recycled Materials
(produced without burning fossil fuel)
3. Regional Materials
(produced without burning fossil fuel)
4. Very Efficient/Durable

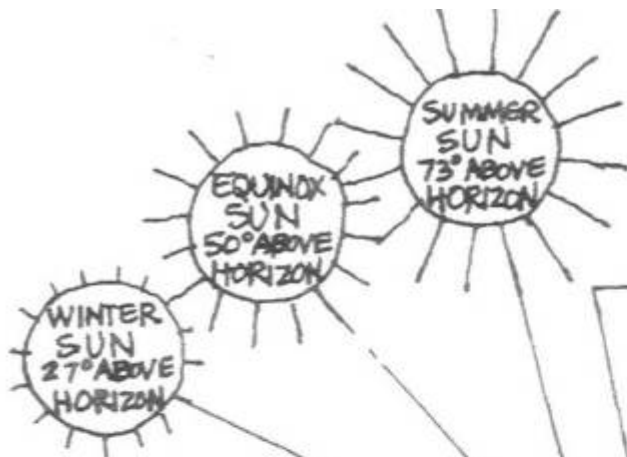
Where Do Our Heating Dollars Go



PASSIVE SOLAR DESIGN



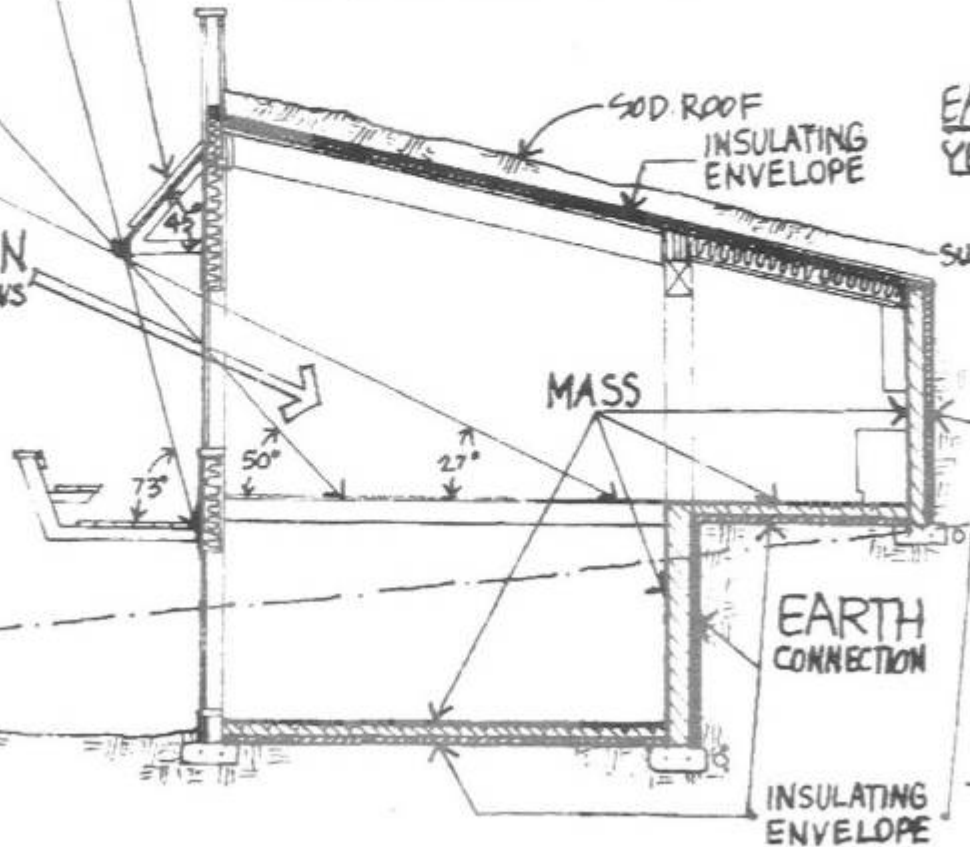




OVERHANG BLOCKS SUMMER SUN AND SUPPORTS PHOTO ELECTRIC PANELS

DIRECT GAIN THROUGH WINDOWS

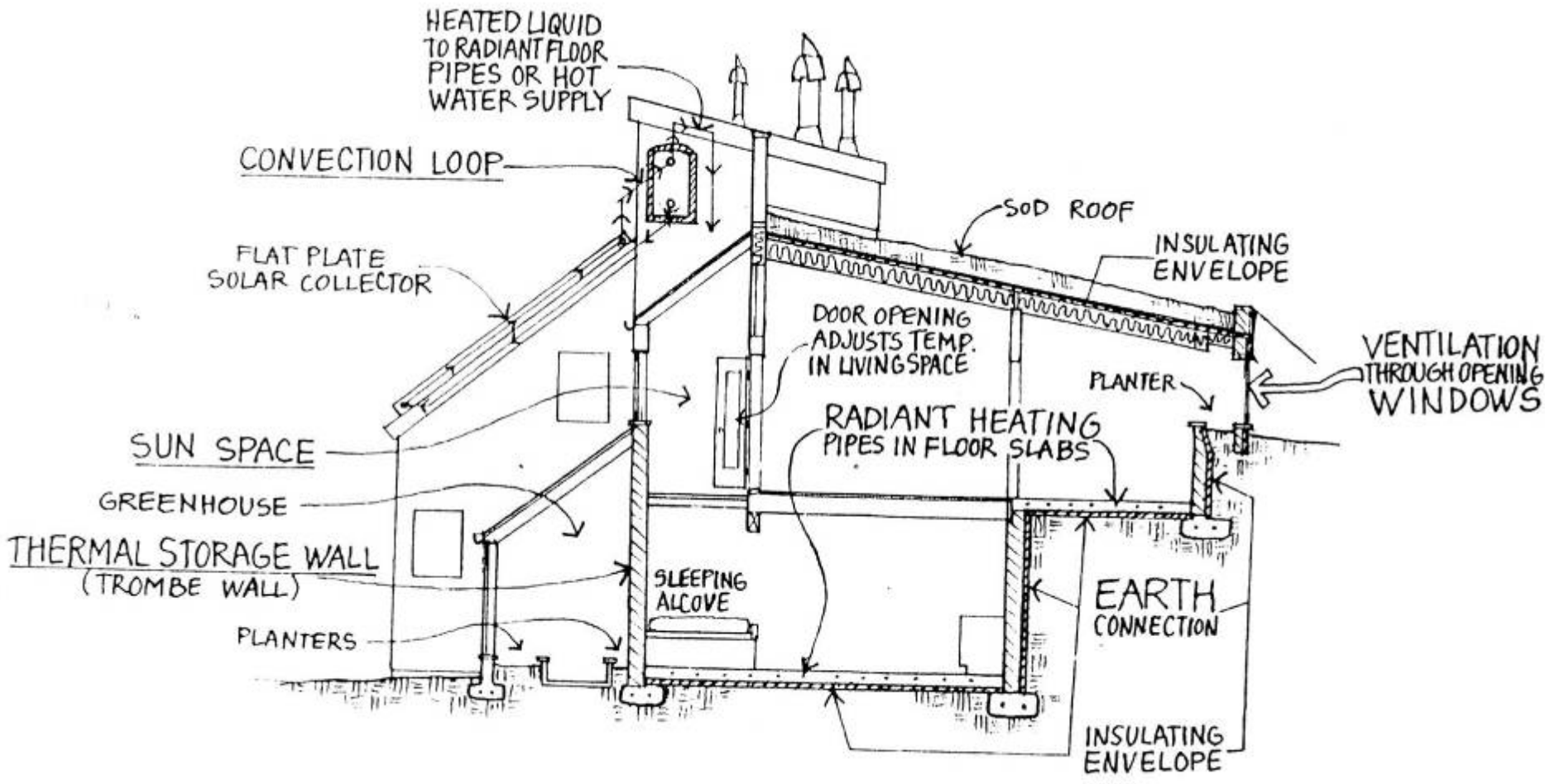
ORIGINAL GRADE



EARTH CONNECTION CHART
YEARLY TEMP. EXTREMES

| | HIGH | LOW | DIFFERENCE |
|---------|------|-----|------------|
| SURFACE | -95° | 30° | 65° |
| -1' | -85° | 35° | 50° |
| -5' | -75° | 45° | 30° |
| -10' | -65° | 52° | 13° |
| -15' | -62° | 56° | 6° |
| -20' | -60° | 58° | 2° |





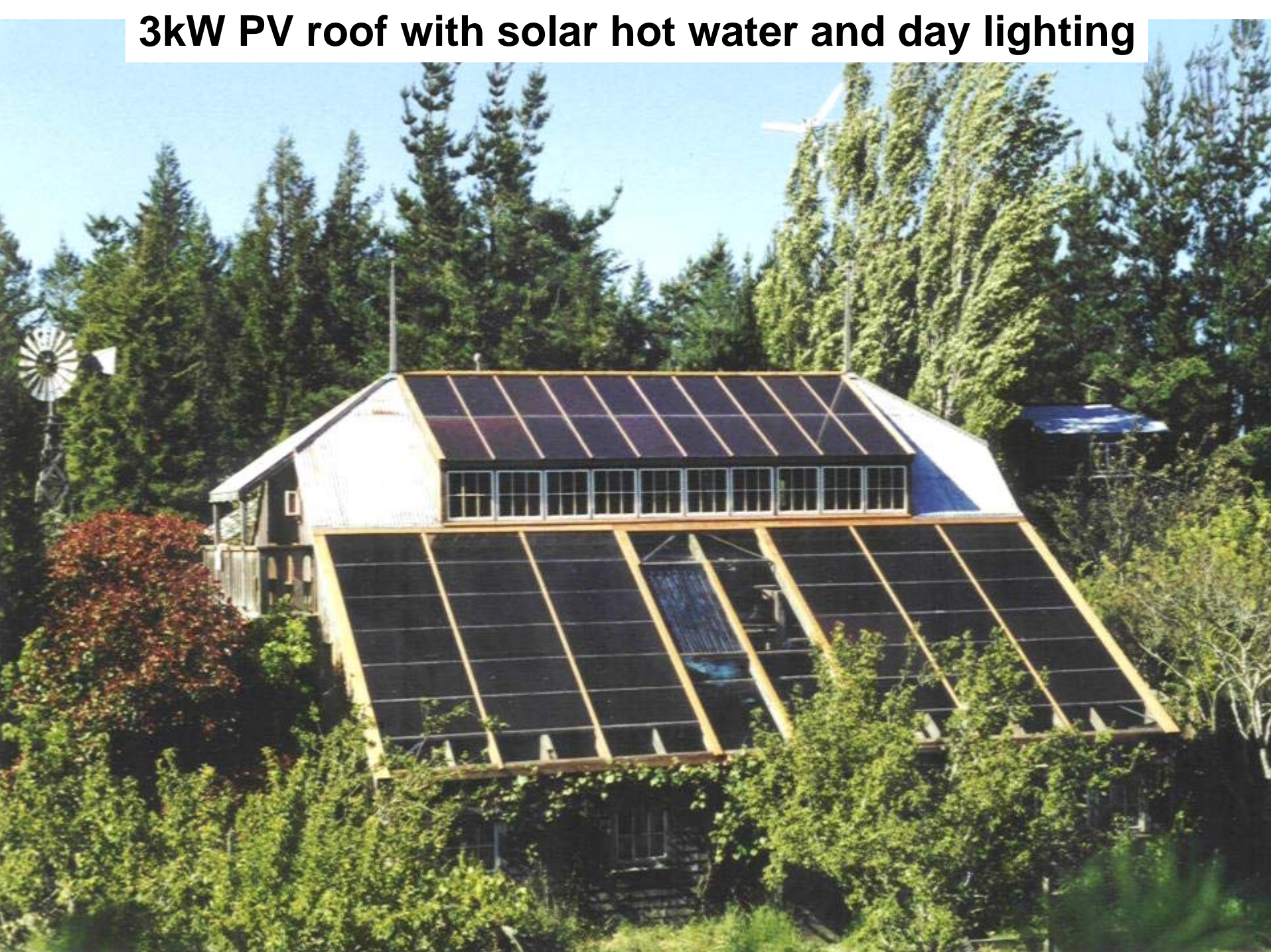
Passive Solar Heat Gain



Homestead built with hand tools & on-site or recycled materials



3kW PV roof with solar hot water and day lighting



Zero Net Energy House

(Boston Edison House, Solar Design Associates)



Zero Net Energy House— even in Maine!

The Lord House—Solar Design Associates
www.solarhouse.com

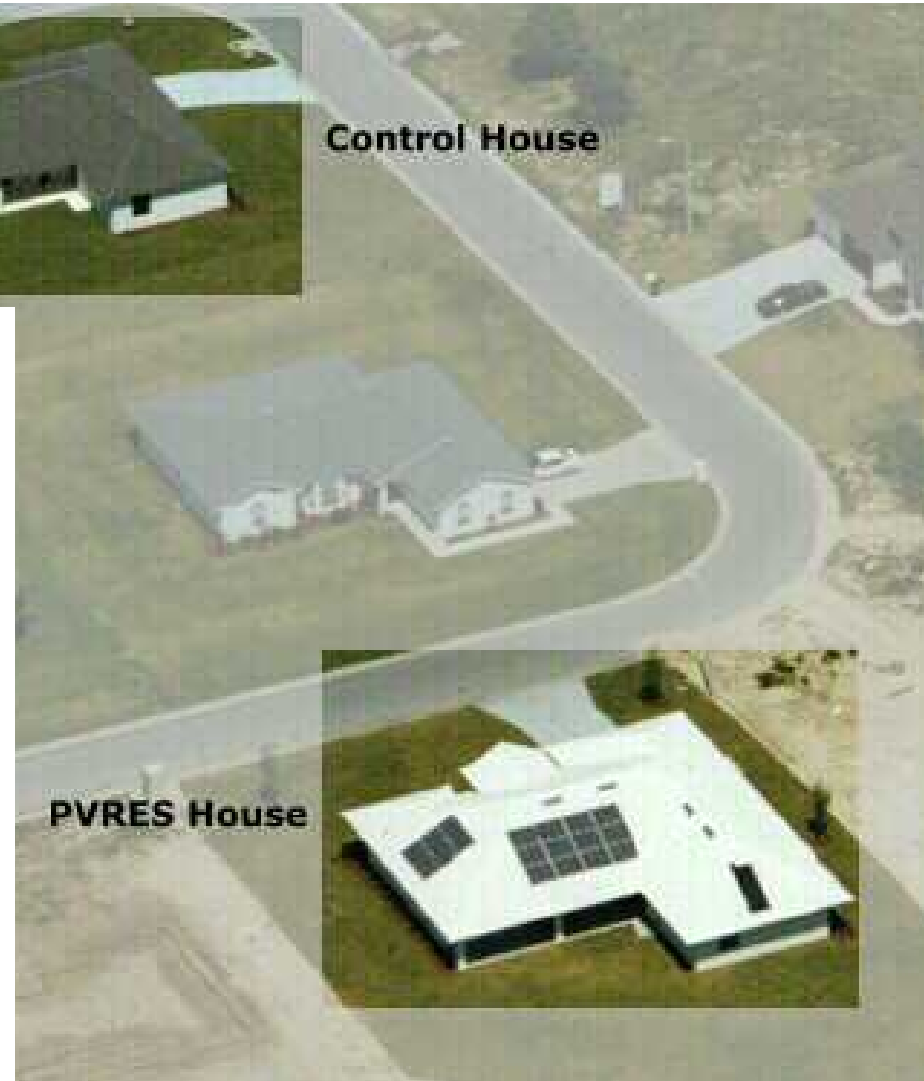


The Lakeland House Project

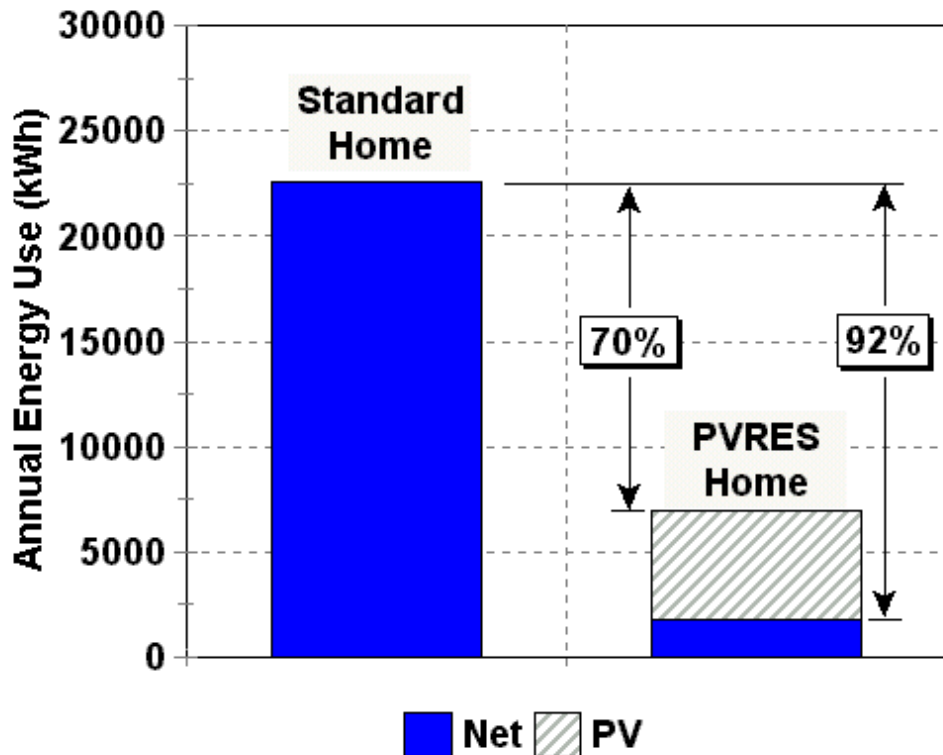
Proving the Benefits of Efficiency, BIPV and Passive Solar Design



Control House

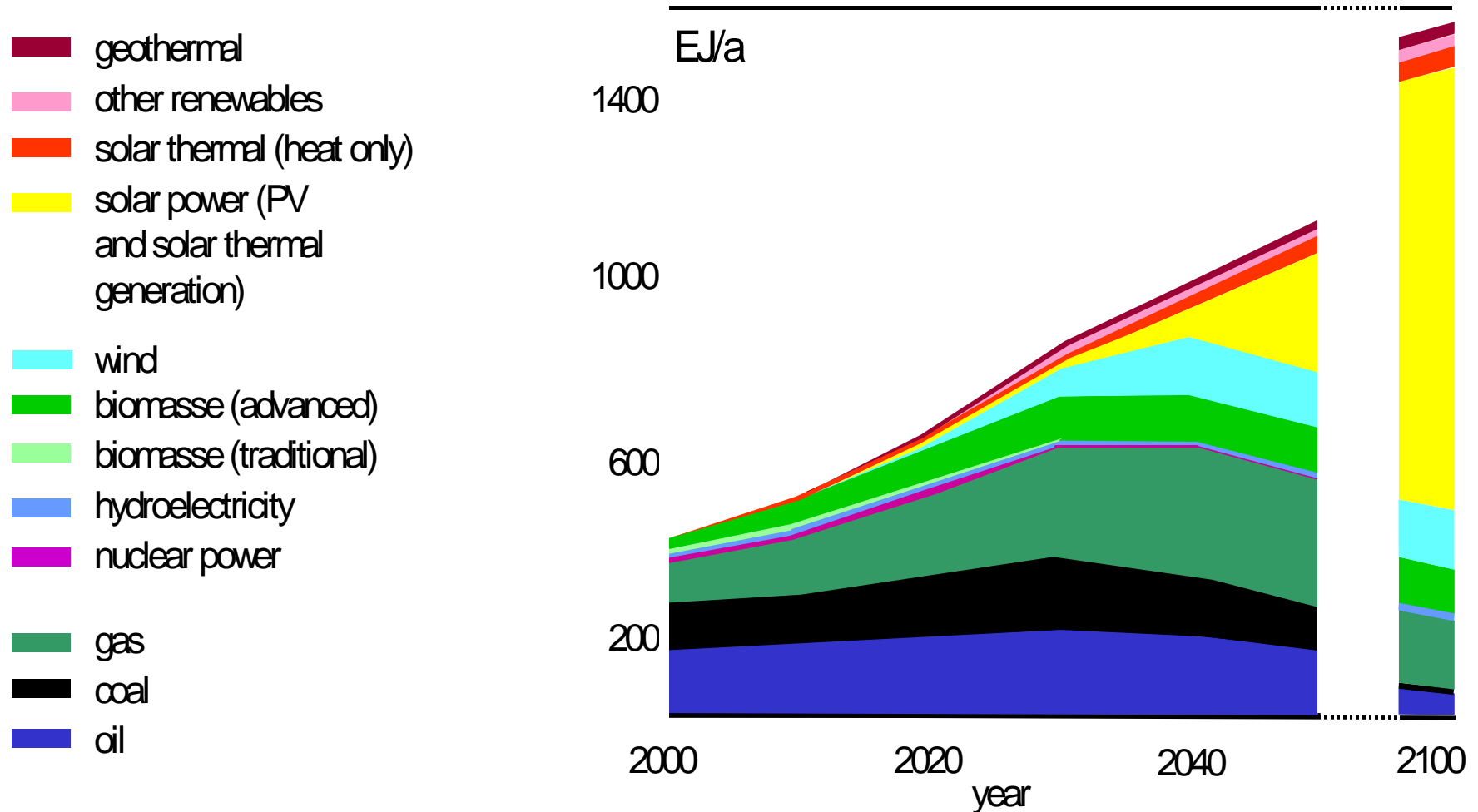


PVRES House



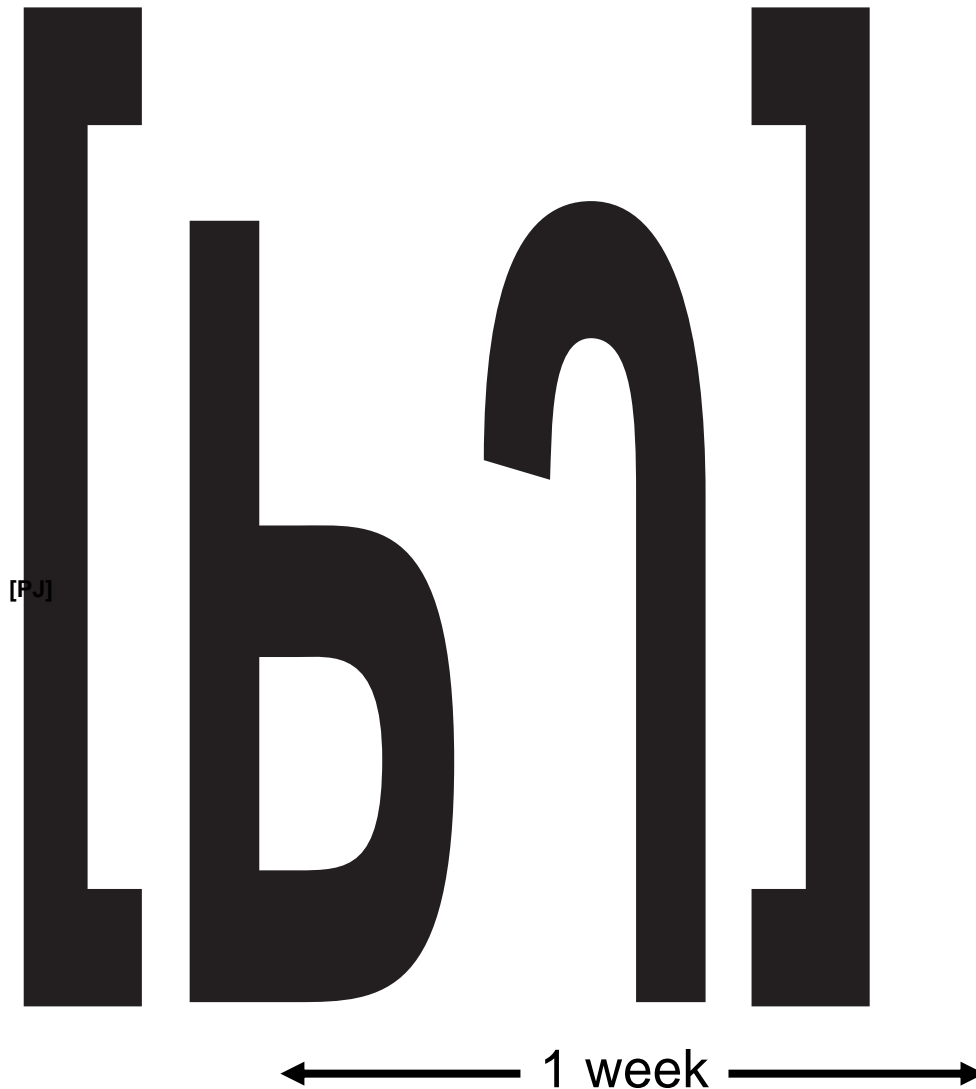
Global primary energy strategy to maintain economic growth

In order to meet the projected demand for solar energy, 500 MW/year manufacturing capacity must be brought online each day for the rest of this century.



Source: German Advisory Council on Global Change, 2003, www.wbgu.de

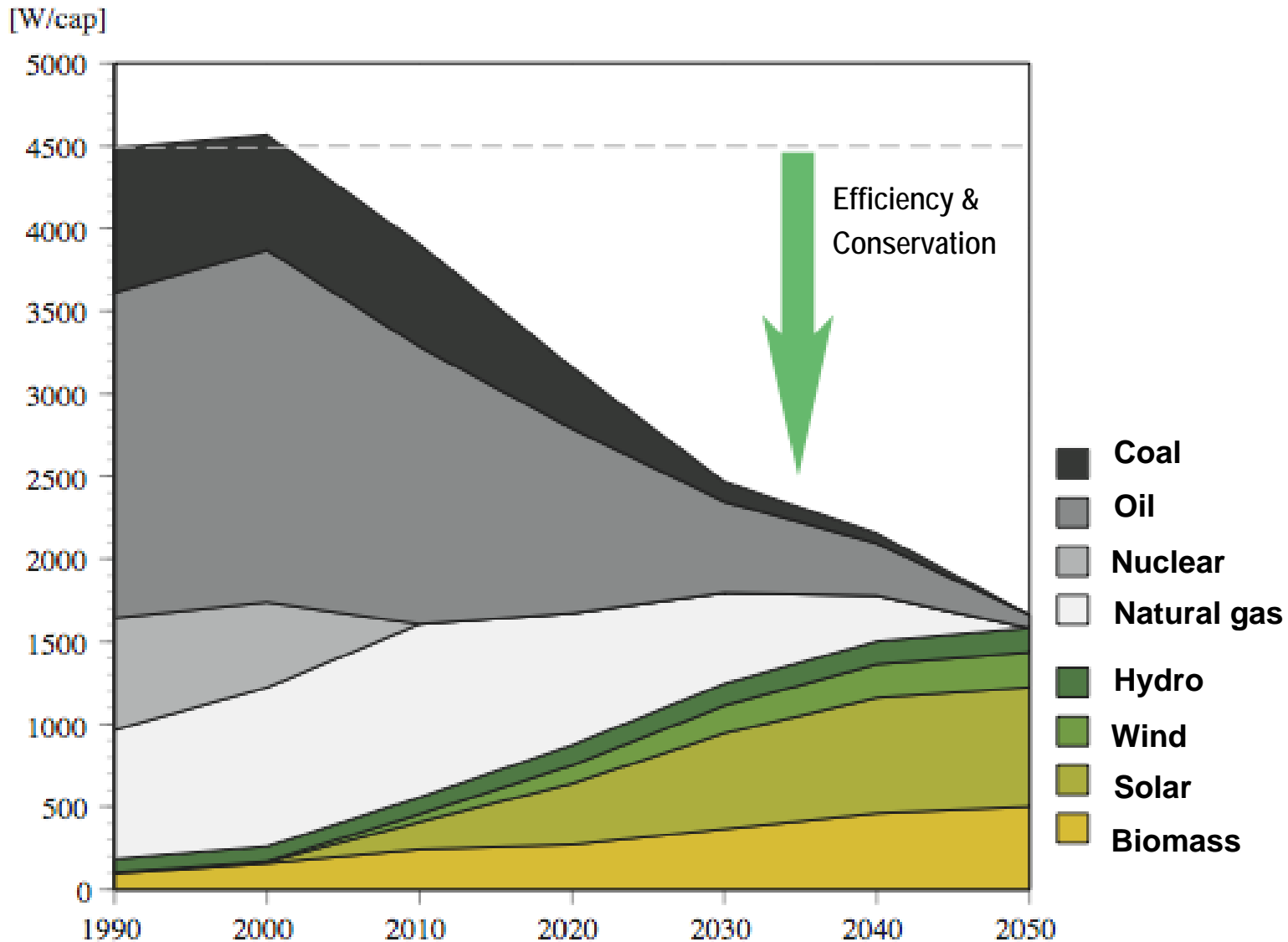
Modeling a Renewable Energy Future



Efficiency & conservation
creates excess capacity
for H₂ production

Source: ERJ,
info@energyrichjapan.info

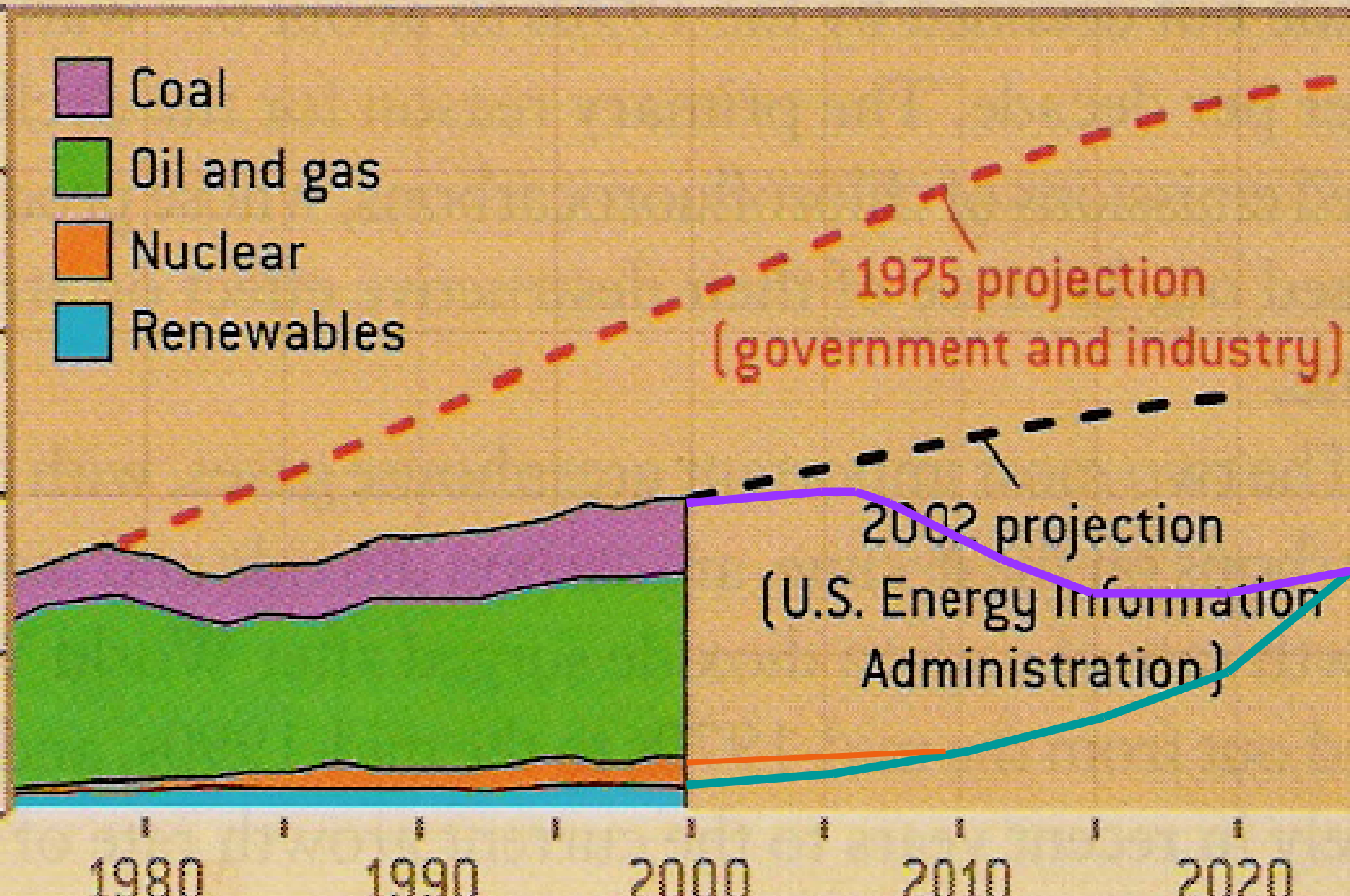
Sustainable Scenario for Europe



Quelle : LTI; H.Lehmann et. al. 1996 und 1998

U.S. ENERGY CONSUMPTION

- Coal
- Oil and gas
- Nuclear
- Renewables



1975 projection
(government and industry)

2002 projection
(U.S. Energy Information Administration)

1980

1990

2000

2010

2020

The human mind has few bounds



Mendocino County General Plan

Elements included

| | # of pgs |
|-----------------------------------|----------|
| I. Land Use | 159 |
| II. Housing | 30 |
| III. Circulation | 109 |
| IV. Safety | 36 |
| V. Seismic Safety | 60 |
| VI. Noise | 83 |
| VII. Recreation | 25 |
| VIII. Open Space and Conservation | 106 |
| IX. Scenic Highways | 24 |
| X. Coastal | > 500 |

What's Missing

| | pgs. in plan |
|-----------------------------|--------------|
| I. Air Quality | 3 |
| II. Energy | 5 |
| III. Water | 9 |
| IV. Agriculture | 10 |
| V. Fisheries | 7 |
| VI. Vegetation and Wildlife | 6 |
| VII. Soils and Minerals | 6 |
| VIII. Green Building | 0 |
| IX. Recycling | 0 |
| X. Localization | 0 |

Buried in the Land Use Element are 2 pages of Energy Policies. The first policy adopted in 1981: Create a county-wide task force to develop a comprehensive Energy Element.

Its time for action

Ways communities can offer support to increase supply and reduce cost of clean renewable energy

- Prepare implementation plan for Community Choice for submittal to California Public Utilities Commission which includes > 40% Renewable Portfolio Standard by 2020.
- Provide incentives for local renewable (PV, solar thermal, wind, etc.) manufacturing capacity and distributed generation by qualifying for government programs or issuing municipal revenue bonds.
- Execute purchasing agreement for XX MW of renewable energy capacity
- “Piggy Back” purchasing agreements with other California Cities and Counties i.e. \$500 million available from GE capital for financing PV on schools.
- Create renewable energy design curriculum and installation training programs in conjunction with schools and trade organizations.
- Support performance based installation incentives and contracts.
- Enact public policy to enforce solar access laws and “Green” construction standards (LEED).
- Demand that the County General Plan respond to the need for locally produced energy from clean renewable sources.

Summary

Energy costs are at an all-time high and a new energy crisis is unfolding.

Pollution is compromising the quality of our lives and making the Earth less habitable.

A clean reliable energy source is essential to maintain our standard of living.

The external and future cost of conventional energy supplies necessitates immediate action to start the transition to clean renewables.

Do No Harm to the Children of all Species for all Time

