



# “What Energy Future?”

Sustainable lifestyles on a finite planet

## Presentation at CEEM, UNSW

17 September 2010

Kensington, NSW

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## Why this topic?

- ◆ Title of forthcoming book
  - Ted Trainer contributed to book
- ◆ Timely & topical
  - Presented at seminar a year ago
- ◆ Relevant to researchers & scholars

# GENERATING ELECTRICITY

*in a*  
CARBON-  
CONSTRAINED  
WORLD

FEREIDOON  
SIOHANSI



## The closer I looked, the bigger the problem

- ◆ More than decarbonizing electricity generation
- ◆ More than OECD
- ◆ Must be viewed in broader context
  - 9+ billion global population in 2050 with increased aspirations
  - Global resources distributed more equitably



## Pfaffenberger's insight

Must look beyond supply-side options

“As the chapters of this book make clear, **we cannot rely entirely on changes in the supply-side** of the equation to reduce the industry's carbon footprint. Changes in the **demand-side** as well as changes in **energy consumption habits** – and perhaps more profoundly – **lifestyles changes** may ultimately be needed to address the carbon problem.”

## Book's central question

Can we “have our cake & eat it too?”

- ◆ Can we support an “adequate” standard of living for 9+ billion in a “sustainable” fashion on a “finite” planet?
  - What constitutes an “adequate” standard of living?
    - Needs, wants & desires
    - How do we “ration” scarce resources? Price or need?
    - Does our socio-economic system need fine tuning?
  - Define “sustainable”
  - Are basic natural resources “finite” or “infinite”
    - Will technology get us out of the bind -- forever?



## Wrong questions lead to wrong answers

- ◆ Most of the time, the questions are
  - How much more energy we'll need?
  - Where are we going to get it?
  - At what price?
- ◆ Only recently are some people asking
  - About environmental/ecological effects of energy
  - About the longer term sustainability issues
  - And, God forbid, about climate change
- ◆ In my view, these are the wrong questions



## The “right” questions

- ◆ Why do we use so much to begin with?
- ◆ What do we use it for?
- ◆ Is there a way to get far more of what we need using far less energy?

## My personal take

Why? Because it has traditionally been cheap & plentiful

Artificially cheap

Seemingly plentiful

No visible price signal at the time/point of use

What for? For *derived* services

Don't need a gallon of petrol to pick up a gallon of milk

Implications? We *can* do a lot *more* with *far* less

Technology

Incentives

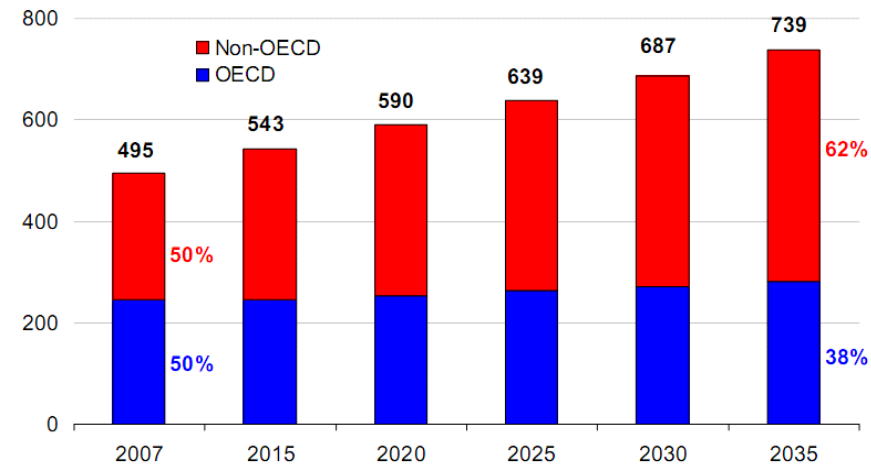
Behavior

## We use a lot, don't we?

- ◆ 200 million barrels of oil equivalent/day
  - 85 million barrels of oil per day
- ◆ According to EIA, by 2035 we will need
  - 49% more energy
  - 87% more electricity
  - 60% more coal
    - 78% of the net increase due to China alone
  - 43% more GHG emissions

# More and mostly outside OECD

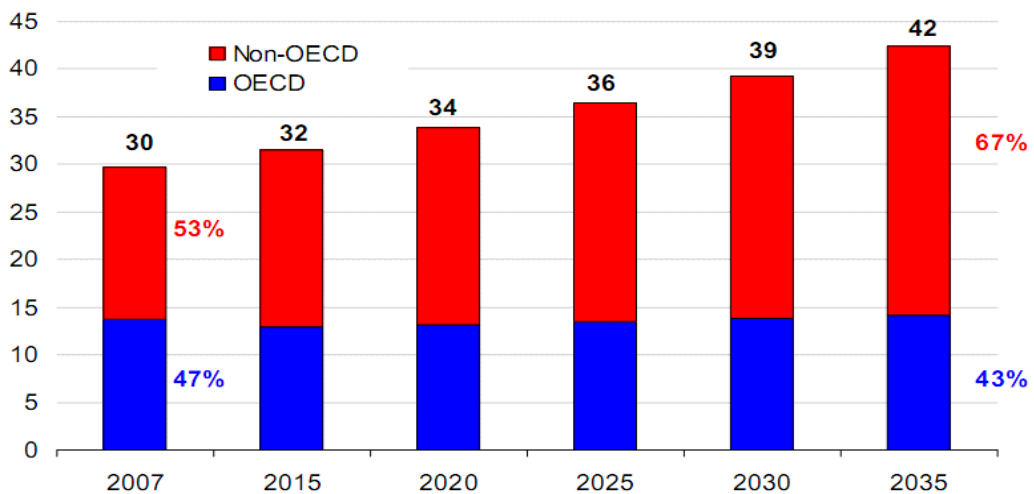
Global energy demand, in quadrillion BTUs



Source: International Energy Outlook 2010, EIA

# More carbon

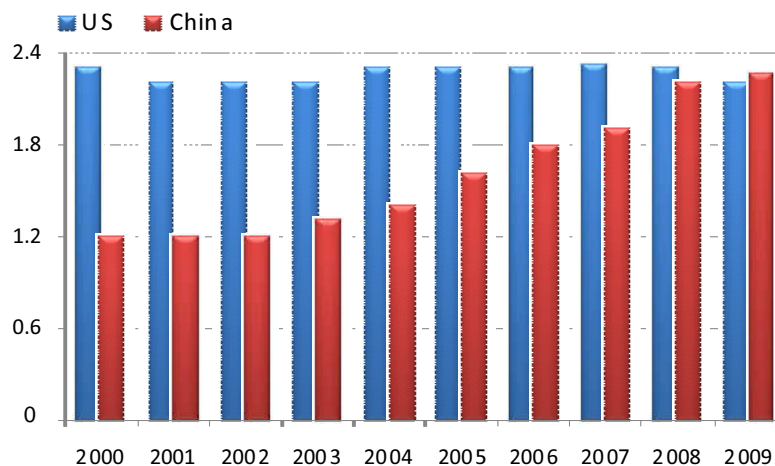
Global energy-related GHG emissions, billion metric tons



Source: International Energy Outlook 2010, EIA

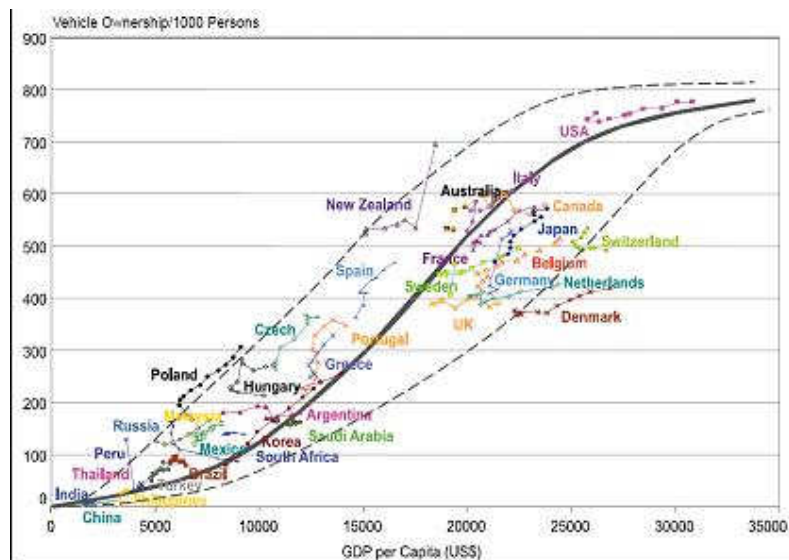
# China matters

Primary energy consumption, billion metric tons of oil equiv



# “You aint seen nothing yet”

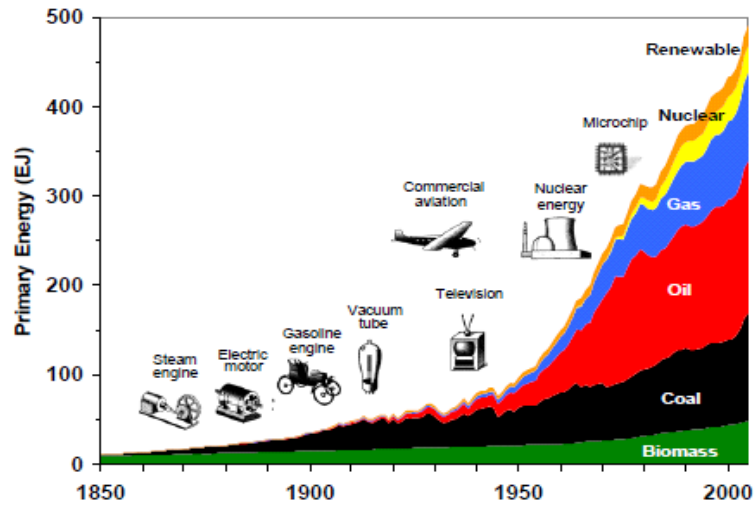
Vehicle ownership per 1,000 person



Source: Prof. J. Goldemberg, IAEE, Rio, June 2010



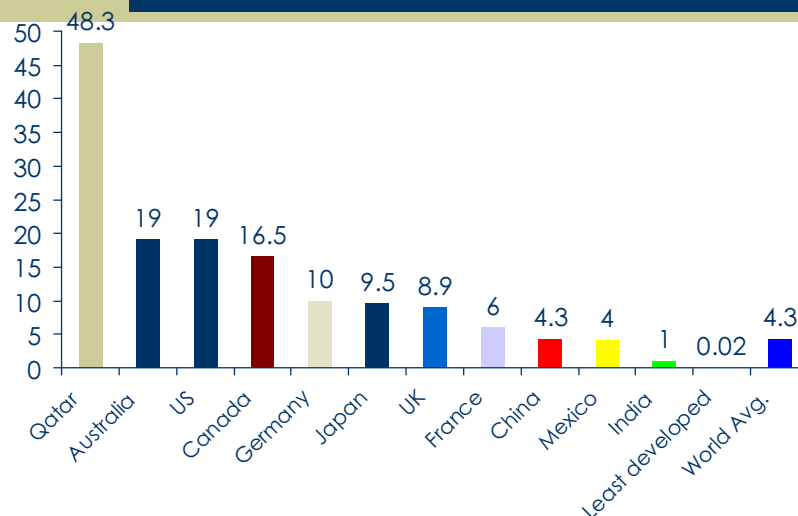
# Why not carry on with BAU?



Source: Prof. J. Goldemberg, IAEE, Rio, June 2010

# Inequitable, unfair, unsustainable

per capita carbon emissions, tons/cap/yr



Source: International Energy Agency

## And why is this?

- ◆ Hopefully by now you are convinced that we do use a lot
- ◆ And maybe, perhaps, possibly, potentially, conceivably, it is not such a great idea to carry on with BAU
- ◆ So the next question is why?

## Because it is under-priced

Non-market costs *excluding* climate-related

	2005	2030 <sup>1</sup>
<b>Coal</b> <sup>2</sup>	\$62 B, 3.2 ¢/kWh	1.7¢/kWhr
<b>Natural gas</b> <sup>3</sup>	\$740 M, 0.16 ¢/kWh	0.11 ¢/kWh
<b>Cars</b>	\$56 B	

1-Estimated non-climate costs for 2030

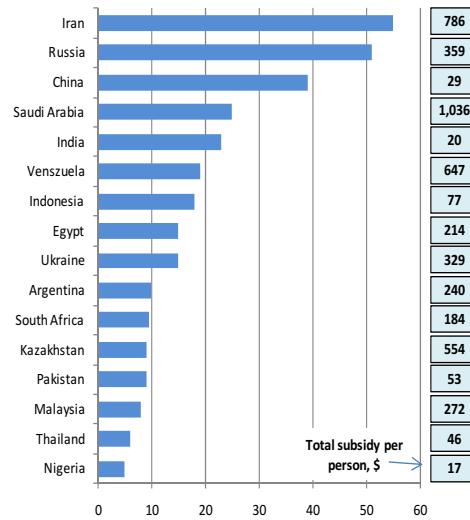
2-Sample of 406 plants accounting for 95% of US coal power generation

3-Sample of 498 plants accounting for 71% of US natural gas generation

Source: *Hidden Costs of Energy: Unpriced Consequences of Energy Production & Use*, NRC, Oct 09, [HTTP://WWW.NAP.EDU](http://www.nap.edu)

# Because it is subsidized

Total & per capita



Source: The Economist 3 Oct 09 based on data from IEA & IMF

# Because it is “institutionalized”

Our habits, our lifestyles, our culture, even our tax codes



## Because of “illusion of plenty”



## Because there is no tank & no pump

Missing price signal has significant implications



# Clueless

- ◆ Consumers today don't know how much they are using
- ◆ Don't know the price
- ◆ Don't know how much it is costing them
- ◆ Get a bill after the fact
  - And even then, most don't understand what happened

# Compare to airline fares

When a seat is sold, all remaining seats are re-priced

travelocity

Home Flights Hotels Cars/Rail Vacation Packages Cruises Last Minute Packages Deals Activities ExperienceFinder

New York, NY to Sydney, Australia  
 Sat, Sep 4, 2010 - Sat, Sep 11, 2010 | 1 Adult  
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Total for **adults** incl. taxes & fees. Add'l fees for **other** adults. **Baggage fees** are not included and may apply.

	American Airlines	Qantas Airways	V Australia	Emirates Airlines	AA Jet
<b>1-Stops Only</b> 57 flights	\$1,530 Total \$1,989	\$1,478 Total \$1,931	\$1,454 Total \$1,912	\$1,720 Total \$1,934	\$1.8 Total \$1.8
<b>All 87 flights</b> displayed below	\$1,530 Total \$1,989	\$1,478 Total \$1,931	\$1,454 Total \$1,912	\$1,720 Total \$1,934	\$1.8 Total \$1.8

Select Flight for Sat, Sep 4

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Airline	Departure Time	Arrival Time	Total Travel Time	Roundtrip Price	In-Flight WiFi
American Airlines Flight 117 / Flight 737 operated by Qantas Airways Flight #18 <a href="#">Flight Details</a> <a href="#">View Seats</a>	1:55pm New York, NY (LPK)	8:25pm Arrive on Mon, Sep 5 Sydney, Australia (SYD)	38hrs 30min - 1-stop Change planes in Los Angeles, CA (LAX) Stop in Auckland, New Zealand (AKL) Change planes in Melbourne, Australia (MEL)	\$1,530 per person Total \$1,989	Select
American Airlines Flight 33 / Flight 738 operated by Qantas Airways <a href="#">Flight Details</a> <a href="#">View Seats</a>	7:45am New York, NY (LPK)	8:30am Arrive on Mon, Sep 5 Sydney, Australia (SYD)	32hrs 45min - 1-stop Change planes in Los Angeles, CA (LAX)	\$1,530 per person Total \$1,989	Select
American Airlines Flight 11 / Flight 738 operated by Qantas Airways <a href="#">Flight Details</a> <a href="#">View Seats</a>	9:00am New York, NY (LPK)	8:30am Arrive on Mon, Sep 5 Sydney, Australia (SYD)	31hrs 30min - 1-stop Change planes in Los Angeles, CA (LAX)	\$1,530 per person Total \$1,989	Select

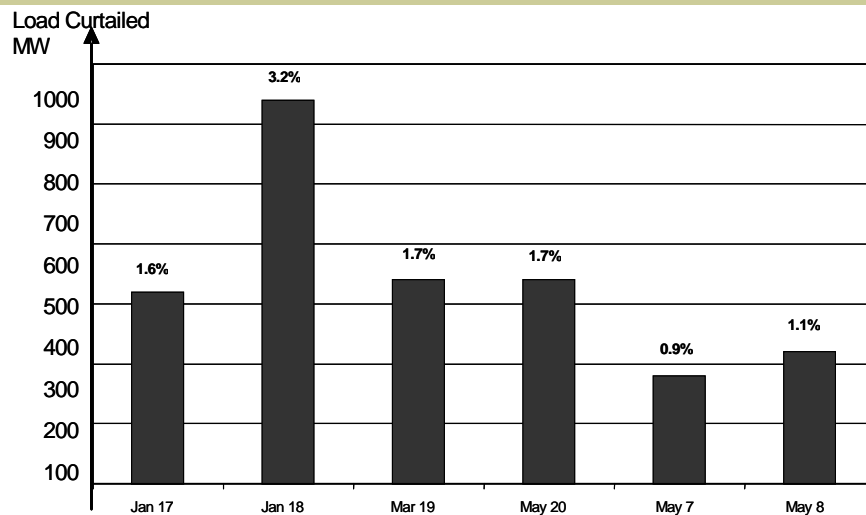
# Dumb pricing, dumb usage

At the height of CA crisis, Idaho farmers were pumping water at peak time to grow potatoes



# California blackouts

CA experienced 6 blackouts during crisis, Jan-May 2001



Source: James L. Sweeney in Electricity Market Reform: An International Perspective, 2006

# Missing price signal

During CA crisis retail consumers did NOT see higher prices

California wholesale electricity prices\*, 1998-2001, monthly means, \$/MWh

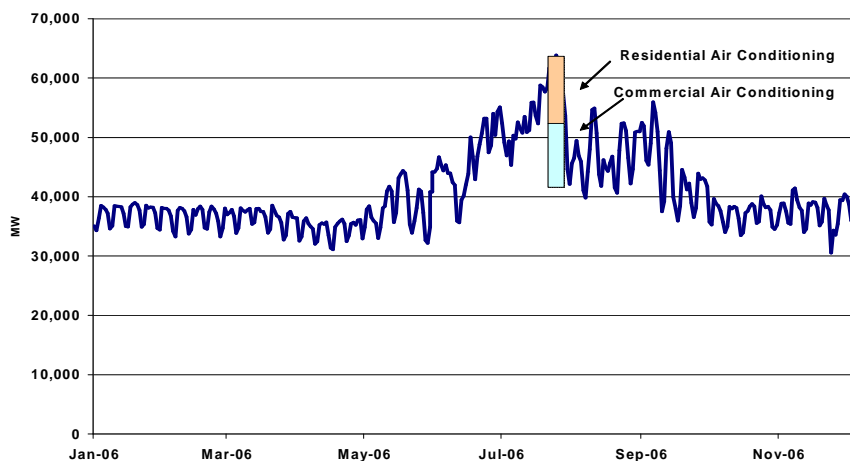
	1998/9	1999/00	2000/1	2001
Apr	23.3	24.7	27.4	265.9
May	12.5	24.7	50.4	239.5
Jun	13.3	25.8	132.4	159.8
Jul	35.6	31.5	115.3	137.8
Aug	43.4	34.7	175.2	120.1
Sep	37.0	35.2	119.6	126.8
Oct	27.3	49.0	103.2	69.4
Nov	26.5	38.3	179.4	74.8
Dec	30.0	30.2	385.6	69.6
Jan	21.6	31.8	272.0	
Feb	19.6	18.8	304.4	
Mar	24.0	29.3	249.0	
Mean	26.2	31.2	176.2	

\* Prices for 98-00 are not strictly comparable to 2001 prices

Source: The History of Electricity Restructuring in California, Blumstein, Friedman and Green, Center for the Study of Energy Markets, Aug 2002

# Why flat rates are flat wrong

CA's summer peaks are aggravated by flat pricing



Source: David Hungerford, CEC

# What do we use energy for?

And why so little of what we use ends up as useful

- ◆ We use energy to derive useful services
  - But we do not charge for the service, but energy
- ◆ And we get little service while using a lot of energy
  - A gallon of gas to pick up a gallon of milk?
- ◆ EPA estimates that 30% of energy used in US commercial sector is “wasted or inefficiently used”
- ◆ Consider everyday things around you
  - Incandescent light bulb
  - IC engine

# The car of the future is *electric*

*No emissions & 90% efficient “Fuel-to-wheel”*

## Tesla Roadster

performance with a clean conscience

- 0-60 mph in 3.9 seconds
- 244-mile range
- 2x more efficient than a Prius

[view more images](#)





## How can we get far more with far less?

I was afraid you were going to ask

- ◆ Price it “right”
  - Cost-reflective including externalities
- ◆ Price it “smart”
  - Price based on value of services derived
- ◆ Make price transparent/accessible
  - Google's PowerMeter?
- ◆ Eliminate “illusion of plenty”
  - Install a tank, fuel gauge & fuel pump
- ◆ Promote frugality as a virtue
  - By making consumers aware of the consequences

## Price it “right”

PG&E's SmartRate applies to Air Conditioners

Tier	E-1 ¢/kWh)	SmartRate Peak Period Price
1	11.5	61.5
2	11.7	61.7
3	14.9	64.9
4	21.0	81.0
5	26.7	86.7

## Price it “smart”

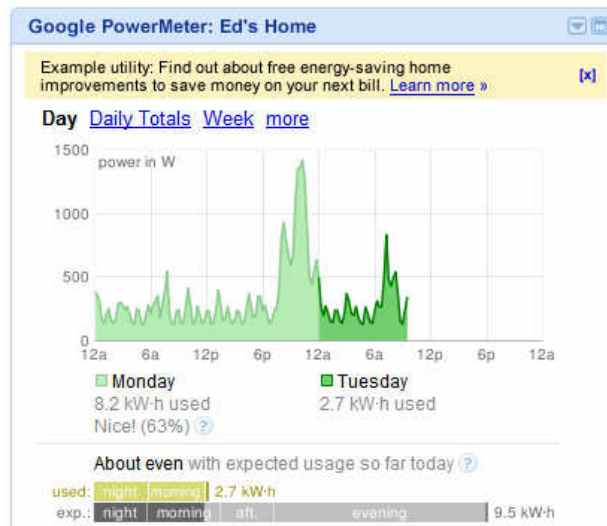
Airlines differentiate every conceivable attribute of service

### ◆ How would we do this?

- Vary fares by class of service
- By date, time & length of travel
- By market & competition in a given route
- How long prior to departure date
- How many empty seats are left on any given flight
- Aisle or window?
- Early boarding
- Extra leg room?
- Checked luggage, carry on, on-board food/drinks
- What’s next: Weight of passenger

## Make it transparent/accessible

“Honey, did you just turn on the oven?”



## Install a tank, a fuel gauge & a pump

- ◆ Install an artificial electricity “tank”
  - Remove the “Illusion of plenty”
- ◆ Provide a “dial”
  - Make it easy to see how much is left in the “tank”
- ◆ Provide a “pump”
  - Force consumer to “filler up” every so often
- ◆ Make it easy to see the bill
  - Provide simple display or access thru Internet?

## Promote frugality

Basic need vs. sinful consumption

Tier	Price cents/kWh <sup>1</sup>	Baseline allowance <sup>2</sup>
Tier 1	11.808	0-100%
Tier 2	13.741	101-130%
Tier 3	23.334	131-200%
Tier 4	26.833	201-300%
Tier 5	30.334	>300%

\* Baseline allowance is determined by applicable climate zone; higher allowances apply to high temperature zones, lower for mild coastal zones

<sup>1</sup> For low-income customers, applicable prices for the first three tiers are 8.533, 10.668 & 18.051 cent/kWh respectively with tier 3 rate applied to all usage above 130% of baseline allowance.

<sup>2</sup> Link to SCE's Baseline Allocation table:

<http://www.sce.com/CustomerService/billing/tiered-rates/baseline-chart-map.htm>

Source: Southern California Edison Company

# How many nozzles in a shower?

<b>Current US law</b>	<b>Luxury 18-nozzle showerhead</b>
<b>3-minute shower</b>	<b>15-minute shower</b>
<b>7.5 gallons</b>	<b>675 gallons</b>

