

Ec. 177 Old Notes

Ec. 177 Fri, 3/20/81

Last day

Gen. findings.

1. World works best when you reward people for what they do. & charge them for what they get.
Energy problems result from not doing so.

2. Energy problem is a direct result of misdirected activism.

Is an indirect result of some other things that have crept into the system:

a. Bias vs. ec. urban land use.

Vs. cities grow.

Vs. vertical xpts. We tax it.

b. X-subsidy. Result of many forces

- Laziness re pricing schemes

- Spreading rent around. Indirect & partial

approach to "commons". a) Terr. x-sub. to outer land b) Cheap energy, as Canada

- Empire-bldg. by reg. utilities

c. "Anti-pedestrian" mindset. Vehicles as a

way of preempting common space.

social screening device.

d. ~~It~~ Territorialism. A cultural reflex to spread out, grab more res. in pref. to conserve, what we have.

Frank Zeidler's annexations.
Chair Engle's water policy.

Built into the Western European cultural baggage for 1000 years. Conquer frontiers. Only painfully are we adjusting to ~~Mage's~~ Columbus Law (world is round, finite.)

e. Productivity Fallacy.

3. An ec. solution wd.

a. Price energy hi, at marginal replant. cost.

b. Redistribute gains by tax.

c. Begin now to restore cities

d. Restore labor-int. social controls

e. W/ draw subsidies ~~for~~ + rewards for appropriating "frontier" res.

f. Change emphasis to max. res. yields - by costing them properly (e.g., tax system, pref. treatment of land, & expensing early losses from approp.)

The NEW "2-in-1" Garden Way Generator

Your complete home emergency and portable power system.

Each 3000 watt or 5000 watt Garden Way Generator includes all these standard features:

- Rugged, wrap-around protective steel frame
- Exclusive, weatherproof fiberglass cover
- Heavy-duty 12-volt battery for instant starts
- Easy-to-use Frequency Meter to assure generator runs at peak efficiency
- Versatile control panel with multi-purpose outlets, power monitor light and resettable circuit breakers
- Rugged industrial-rated cast iron Kohler engine
- Handy 2-gallon fuel tank

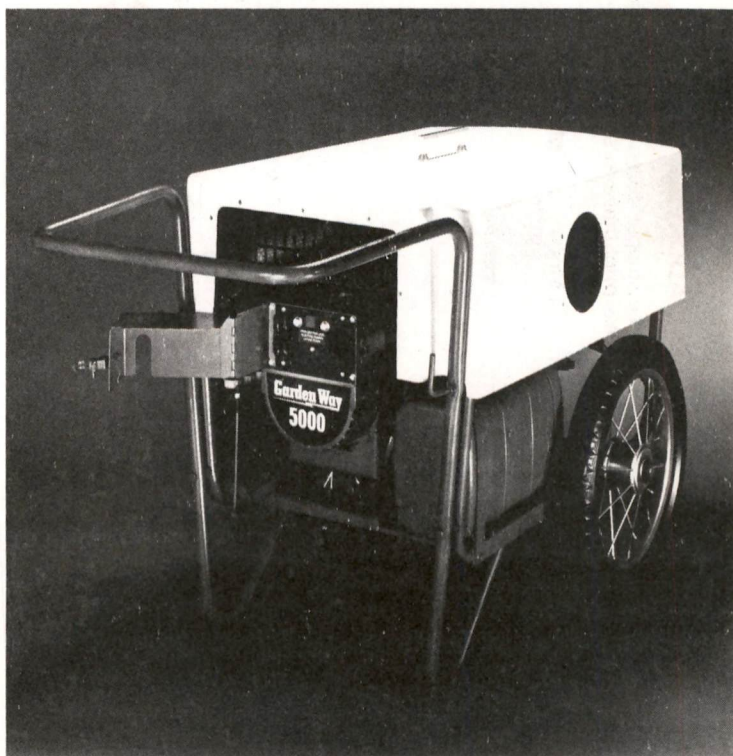
Standard equipment includes complete 100-amp Safety Transfer System



- ① **Transfer Box**
UL-approved inside 100-amp safety transfer box feeds power from generator or outside lines -- but not both at the same time -- for your assurance of safety.
- ② **Outdoor Box**
UL-approved outdoor connection box for quick, easy hook-up of generator during emergencies
- ③ **Power Cord**
10-foot heavy-duty power cord links generator to outdoor connection box.

SPECIAL NOTE regarding Optional 200-amp Safety Transfer System

If your home has 200-amp wiring, you may want the 200-amp Safety Transfer System. It allows direct wiring of more circuits through the generator system. Check with a licensed electrician to see what system you need. System includes 200-amp safety transfer box, (4) outdoor connection box and heavy duty power cord.



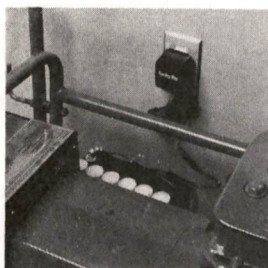
GENERATOR ACCESSORIES

Add these useful accessories for extra convenience



AUXILIARY GAS TANK

Large 6-gallon auxiliary steel gas tank connects directly to generator with easy snap-on connectors. Provides 6 or more hours of emergency or portable power.



BATTERY CHARGER

Plug-in "trickle charger" keeps generator battery at full power without overcharging. Keeps generator always at ready-alert.



POWER FAILURE ALARM

Handy unit plugs into wall outlet; lights and buzzes to alert you during a power failure. Also acts as flashlight until you've started your generator.

GARDEN WAY GENERATORS

Charlotte, Vermont 05445

Phone: (802) 425-2137

2-in-1 GARDEN WAY GENERATOR Order Form

HOW TO ORDER BY MAIL

1. Complete the 4 easy steps on the order form.
2. Enclose the order form and at least 25% payment in the enclosed postpaid envelope. (Note: If you want your Generator as soon as possible, please enclose full payment.)
3. Mail the envelope containing your order and payment to Garden Way Generators, Charlotte, Vermont 05445. We will acknowledge your order and advise you of your shipping date promptly.

**OR, FOR EVEN FASTER SERVICE CALL US...
TOLL-FREE**

800
451-5088 EXT. 112



1. Please complete the 4 easy steps on the order form BEFORE you call, just as if you were going to mail your order. This will help us greatly and also give you a record of what you've ordered.
2. Also, please give us the PRIORITY IDENTIFICATION NUMBER shown above your name on the address label. It will help us to process your order promptly.

FOR OFFICE USE ONLY

① CHOOSE THE GENERATOR AND ACCESSORIES YOU WANT

No.	Qty.	Description	Price	Enter Amount
95503		5000 watt Generator with 100 Amp Transfer System	\$1750	
95504		5000 watt Generator with 200 Amp Transfer System	\$1950	
95501		3000 watt Generator with 100 Amp Transfer System	\$1545	
95502		3000 watt Generator with 200 Amp Transfer System	\$1745	
ACCESSORIES				
96301		6-gallon Auxiliary Gas Tank	\$43	
96302		Battery Charger with on-off connectors	\$23	
96303		Power Failure Horn/Light Alarm	\$21	
SUBTOTAL				
CT, NY, GA, VT, & WA residents \$ please add sales tax which apply.				
TOTAL				

Be sure to check the enclosed Bonus Flyer

③ METHODS OF PAYMENT

Please indicate whether you're making a full payment or a down payment now. If this is a charge, give card number and expiration date. We will confirm a shipping date to you promptly. (Make checks payable in U.S. funds to: Garden Way Generators, Charlotte, Vermont 05445.)

FULL PAYMENT:

- ☐ I have enclosed a check or money order
☐ Please charge my bank credit card (see below).
OR

DOWN PAYMENT:

- (at least 25% of the TOTAL ORDER please)
☐ I have enclosed a check or money order for \$ _____
☐ Please charge my bank credit card for \$ _____ (see below)

BALANCE:

- ☐ Bill me for the balance.
☐ Ship C.O.D. for the balance (the trucking company charges an extra \$12-15 for this service).

CREDIT CARD INFORMATION:

☐ VISA



☐ MASTERCARD



CARD NUMBER _____

GOOD THROUGH LAST DAY OF _____

② NAME AND ADDRESS

If Generator is to be shipped to an address different than the one shown below, please print that address here:

SHIP TO: ☐ Mr. ☐ Mrs. ☐ Miss

Name _____

Street _____

City _____

State _____ Zip _____

THE ACTUAL OWNER OF THE GENERATOR WILL BE:

Bill and Ship Generator to:

PRIORITY I.D. NUMBER



GFSJYN H117
M GAFFREY
3040 TYLER ST
RIVERSIDE CA 92503

IMPORTANT NOTICE: This is how we have your name and address in our files. Please make any necessary changes before mailing or phoning in your order.

④ SHIPPING

Shipment will be made motor freight collect. Please give a telephone number where the trucker can reach you, especially from 9AM to 5 PM.

By day: _____
Area Code _____ Number _____

By evening: _____
Area Code _____ Number _____

Please fill in which COUNTY the Generator is to be shipped to:

COUNTY _____

Prices may vary at our Garden Way Living Centers.

5 kW home generator, \$1750 + shipping, Σ ca. 2000

$$\frac{\$2000}{5} = \$400/\text{kW}$$

Looks pretty good, vs. \$3,000/kW LWR cost.

Lovins, Ch. 2

1. Preferred path:
 - a. Effic. use
 - b. Matching quality & scale to end use needs
 - c. Transitional strategy
2. (Why do "we" need to plan energy?
Bes. energy is so much more public than many
pub. goods: p.u., roads, public lands, etc.)
3. Paths are mutually exclusive.
No reasons?
4. Hard path; establishmentarian. Shift to electric.
Coal 180 new 800 MW generators
Oil + gas, frontier
Nuke fission 140 GW nukes
as oil phases out, nukes & coal phase in.
5. Enormous aggr. K needs.
" " pollution
6. Based on assumed lockstep, energy & u.i.
Will double output, while suppressing price.

7. Misc.

$\frac{2}{3}$ fuel use is now direct, i.e. not electric.

Plastics & nitrogen fertilizers use nat. gas feedstock.
Half our oil runs cars

Generation wastes $\frac{2}{3}$ fuel

"Coal conversion" wastes $\frac{1}{3}$.

Fuel industries themselves are large fuel users. E.g.
+ transporting fuel - Dorring.

Ref?

8. Cap. cost

Begin
here

By K-int. he means ~~K/ft~~, ~~in~~ K/kbl, regardless of
value of the kbl. This is rising, but much coal is
still low. Hence, bridge ticks.

K costs for making electric are much higher
than usually acknowledged, bcs. they usually omit
dist. cost.

He unfairly compares delivered costs of electric
and delivered costs of coal, here p. 30, & on p. 134.
This is why he gets coal to make so low cost.

1975 Carter Message, energy program K cost
\$51! (Sanhill; \$6550 + assoc. costs).

But this takes most of the net int. of country!

Long lead time, payback time int., highly inflex —
(or wage-lowering — cf. Ricardo on machinery).

Also untabilizing — cf. TAP line & Ricardo's machine.

Or, Labrador hydro project.

Lovins wrongly identifies net inv. w. discretionary inv. All inv. is discretionary. But we do have other needs.

Too much electrification is big error of Carter program.

9. Utilities have been underpricing b/c of "known" inelasticity.

This is an inflation penalty visited on durable, regulated cap. Customer cause, I o'looked.

10. 1972, FPC ignored both demand elast. and energy cons. in forecasting demand.

(Dave Schwartz story "Eliminate Ec. Rent".)

Cultural clash, consumer oriented U.S. vs.

Blue-eyed Arabs of B.C.

Move on eliminating ec. rent.

11. Tech. fixes, plugging end-use leaks, are more labor-intensive.

(Even here, note cap. bias - must buy a new furnace to get the break, not fix old one.)

12. (As pop. grows, ea. mouth brings 2 hands — but no more land. Labor-int. things will do fine; resource-int. things, poorly. Cap.-int. things depend on K growth, which is slow. Energy is least labor-int.)

Load duration curve. 8760 hrs.

13. Power stations are K-int. How do we know? That's why localities want them. Tax base, no costs. Substations, are clean, too. Same Mater City syndrome. Here is another cap. using bias. Localities zone in cap. to pay tax. Coun. saves cap. — thus lowers tax base

14. Designing Hlgs. for coun. payback time is $1/2$ that of hand test. "so the same cap. cd. be used twice over." p. 34. Here he contradicts other position, (that fast deprec. wld. Δ future cap. requirements.) ~~He~~ The point has 2 parts. Here he sees one; there he sees the other.

15. Cogeneration — electr. as byproduct of process steam. U.S. indy now meets 14% electr. needs this way; could rise to 50%. 1985 — Paul McCracken. (Low rates for big users specifically discourage

thru.

16. Waste heat can also be distrib. in insulated pipes.
(Mihw. used to do this.)

Calls for compact cities. all recycling done.

17. Cogeneration held back by inst. barriers.
But his vague on what there are, p. 35.

18. pp. 35-36. Good list of reforms.

End here Fri.

Now, finish Ch. 2

→ ~~18~~ Lovins in WSJ.

- ~~19. Soft measures~~
- ~~1) Renewable~~
 - ~~2) Diverse~~
 - ~~3) Flexible, low tech., accessible~~
 - ~~4) Small scale, scattered.~~
 - ~~5) Matched in quality to end use needs.~~

18. Proposed "reforms". (Some are already routine.)
 Inverted rate structures. Coming.

$L.R. M.C. = P$

Non-subsidy

Life-cycle costing.

Including assoc. costs

" " " "

19. Declining use as a goal.

Ceiling of 100 quads. then taper off.

In his talk here, he showed a sharp decline in forecasts by others.

Coal as bridge fuel.

20. Defines soft.

Renewable, diverse, flexible, low technology, (accessible), close to point of use, small, approp. quality.

21. Uses of energy -

Uses of Energy

Heat, at pt. of end use	58%	
Temp $> 100^{\circ}\text{C}$		23
" $< 100^{\circ}\text{C}$		35

Mech. motion	38%
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Vehicles	31
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Pipelines	3	N.B.
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Indl, elect. motors	4
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Lighting, electronics, telecom., electro-
metallurgy, electro-chem., arc welding,
elect. motors in home appliances + rlys.,
etc that require elect.

4%
<hr/>
100.

So $4 + 4 = 8\%$ end uses require elect.

But 13% of uses use it.

Consumes 29% of our fossil fuels.

These data are organized differently from
Dovring's. Dovring emphasizes xptn., & its backward
linkages, but xptn. consumes 45% all energy in U.S.
usual fig. is 26% all energy & $\frac{1}{2}$ all oil. ~~He adds~~
This is direct use only. He adds energy used in extracting,
refining fuel; mfg, delivering cars; etc.
Lorvin focuses on what he knows best.

22. In refuting use of electr. for low-grade uses, he shifts from ~~the~~ econ. to inelegant. A problem - he shifts grounds a lot.

23. $\frac{1}{2}$ the electr. bill is distn. + oil. pooling principle.

OK, but this has a purpose, to Δ LF; also, to save on ~~the~~ distn. fuel widely, - in fact, this is major part of econ. of scale. There may be several generation in one place, parallel.

His point wd. be stronger & more coherent if he noted that the rising share of fuel in costs changes the priorities, tips the balance re what to save.

Hi load factor loses relative importance now bec:

- a. Decades of sprawl have inflated distn. cost
- b. Hi fuel cost reduces relative importance of low LF. i.e., can use more K now, to save fuel: sober.

But this runs into another problem. K is getting costly, too.

✓ So he's ~~making the problem~~ leading us down the wrong path, finally, toward a rural village society. Is failing to address the central problem, i.e. we have thrown away our cities.

Cities are places where people cluster to pool resources:

central power plants, mass transit, xptn. terminals, etc. Cities, if compact, are resource-consuming.

- The basic problem is our settlement pattern. Must face this. He not only misses this, he gets it backwards. He accepts, p. 55, the settlement pattern, wants to accommodate (also)
24. Large units, when they fail, cause black outs. Do do small ones. An ex. of scale is that big ones can afford spinning reserve. Grandfather's old home generator. You can buy one today, \$2,000 or so.
25. Big systems, long lead times, mis-timed demand forecasts, are major indirect causes of scale. Doubtful point. Smaller units, less pooling, more errors. E.g. grandfather's family dropped from 10 to 2, to 0, same generator.
26. The motive power in U.S. cars = 40x that in U.S. generating plants. There is excess capacity!
27. ~~The~~ The cost/kW of the car is 1/10 that of the central plants (regarding motive capacity only.) ~~Now~~ If so, let all have home generators! But look at cost! Cost/kW-hr of home generation cfs. much less favorably bcs. of low LF

it. He sees cities imposing costs on politically
weaker agrarians! "rural agrarians"! !

But on p. 58, he shifts again, sets it right.
Blames settlement patterns for traffic.

I wish I cd. promise he wd. be penalized
for shifting. But Keynes, Schelling, Gov. Brown,
FDR, etc. show that consistency is not the
quality of great politicians.

He's ~~not~~ evidently jiggled other things, too,
 but he backs away from advocating home generator.

28. Small generators cheaper but mass-produced,
 Ecs. of scale at one remove.

But he contradicts self by saying then you can
 enter this market incrementally.

29. Distribute RMS + Syn. City
 CIA vs. mass system.

CIA, but of excess capacity, has low MC, encourages overuse. (over)

30. Soft technologies.

1. Solar.

a. Active

b. Passive. Clearly desirable, new bldgs.

2. Bio conversion.

Mechanot. (polluting)

Bio mass.

Distilling. 10-14 x present alcohol volume, produce

$\frac{1}{3}$ gasoline, equivalent now used.

3. Wind hydraulic.

4. ~~Heat storage~~ Energy storage is cheap if decentralized.
 Store as hot water, rocks.

Compressed air. - use to operate machinery.

With a flat rate or inverted rate utility, you are
paying for cap. cost in the regul. rate of cap. vs.
mass to emit, e.g.

11

Distributing compressed air or hot water in pipes is cheaper than dist. electric.

Biomass stores energy.

31. Transitional tech.

1. Coal.

Supercritical gas extraction

Flash hydrogenation

" pyrolysis

Fluid-bed boilers.

All use coal cleanly.

Fluidized bed. Can be sealed down, used as furnace.

32. Cap. rationing a problem, utilities borrow easier than individuals.

Maybe. They used to, anyway.

33. Energy sectors are "incompatible" b/c they compete for cap.

We may be falling into a cap. trap.

True warnings. But how do we save capital?

Lovins, Ch. 8

Comparative Cap. Costs. Role of Electrification

p. 134.

1. New fossil fuels	\$3,000 / bbl/d	Enthalpy
2. Arch. & mech. leak plugging	5,000	
3. N. Sea Oil	10,000	
4. Heat recovery	15,000	
5. Bio conversions	20,000	
6. Frontier oil/gas	25,000.	
7a. Coal-fired fluidized bed gas turbine, w. delivery	30,000	
7b. Pyrolysis, munic. wastes	30,000	
8a. Solar space heat	70,000	
8b. Syngas	70,000	
9. Coal electric w. scrubbers	170,000	
10. Wind - electric	200,000	
11. Nuke, LWR	300,000	

Conclusions:

1. Big electr. techn. too costly.
2. Improved end-use efficiency gives highest return.
3. Soft techn. is becoming competitive, "arguably".
4. Depends on end use. Fit supply to end use.

2

Dominant end use is space htg. or other low Temp. heat.
Solar cheaper than nuke.

(Why then can utilities go for nukes?
X - subsidy among technologies. Drive this home!
Lovins' essential truth.)

WSJ articles

Lovins Ch. 7

Soft Technologies

No Air
No Combustion
Distillation 1.

Fast conversion processes, applied to coal
Pyrolysis (organic decomp. caused by heat)
Hydrogenation (-treat w. hydrogen)

Do not get coal hot enough, low enough to
make tars (corrosive, carcinogenic).

No cost info.

Leaching 2.

Supercritical gas extraction, at 100 bar
Decomposes coal, feeds of diff. quality.
Small scale.

Used in Eng. indy. some.

Total
Combustion 3.

Fluidized bed. KS 33.4 / MWh / day '76.
Granular coal, burned in very compact, small scale
furnaces. 8.8 kW (c), very small
350 kW at Oak Ridge

Use for cogeneration: ind^{process} "steam" + ~~co~~ elect^{ic}.

(Cogeneration pushed by J. Willey; by PUC policy
now. Not mentioned by SCE.)

4. Wind

Burton, 2.35 ¢/kW-h (cf. SCE est.)[‡]

Modern data are for wind-electric only.

Direct applications are better: heat pumps, compressing air, etc. (a good battery wd. do more than anything, for low potential, scattered uses.)

(Old farm windmills, Aeromotor, cheap!)

2500/kW(e) sent out, at 30% LF

Lovins eliminates distr. costs by assuming an existing grid, p. 123; and 4% ~~the~~ line losses!
Bends assumptions too much!

5. Wave power (handily decentralized)

6. Small hydro.

[‡] Lovins LF = 50%, much too high!

7. Hydraulic air compressor, or troupe.

8. Geothermal

No costs given, but recommends direct ~~to~~ transport of hot water, rather than generating electric. Cites one run of 100 mi. in Italy at 98.5% eff.!

9. Bio conversion of crop residues, & man. waste
Vague, but cites numerous lit.

No mention of burning wood, hog fuel, sawdust
(Bonds assumes his way again. No dist. cost)
~~Bio + Chem.~~

Bacterial

Enzymatic

Anaerobic digestion

Pyrolysis

10. Solar heat

a "l.c. inc pricing philosophy", as in 3.2,
is vaguely cited.

\$70,000/bbl.-day, 1985, space ltr.

Ex. 171

1. Line losses, effect on costs.

s = produ. at source

d = delivered production

p = percent line loss

c = cost

$$\frac{c}{d} = \frac{c}{s(1-p)} = \frac{c}{s} \times \frac{1}{1-p} \quad (1)$$

The % cost increase due to line losses:

$$\frac{c/d}{c/s} - 1 = \frac{1}{1-p} - 1 = \frac{p}{1-p} \quad (2)$$

The % cost increase relative to % line losses:

$$\frac{p}{1-p} \div p = \frac{1}{1-p} \quad (3)$$

Some Values

p	$1/(1-p)$	p	$1/(1-p)$
.10	1.11	.50	2.00
.30	1.43	.70	3.33
.40	1.67	.90	10.00

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Ass. Ch. 2, 4, 5
Lectures. Ch. 3

1. Pans prediction techniques
a. Extrapolating, exponentially.
~~Also~~ ~~Other~~

Ruling out price rationing

- assuming Δ scale eff. w/o asking where they came from.
- overlooking Δ distrib. cost
- opposing Δp on principle
- assuming inelast. demand

LP models, ~~must~~ fixed if we enough variables to be interesting, are unstable

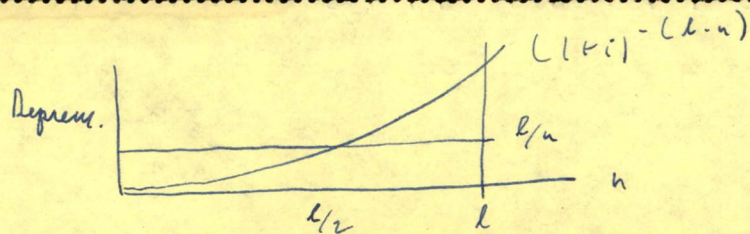
b. Abstracts from judgement + goals

2. Prefers scenarios to projections.
3. Prefers looking way ahead, then working backwards.
4. Wants to look ahead 50 yrs. but that is lifetime of a major energy facility today. He means carcass life. He makes several errors here, re life.

a. Cap. turns over much faster than carcass life. That is when you recover very last unit of cap. As a general rule, payback pd. = K/O .



(Re macro, better review this re land, where payback pd = ∞ , but $K/O = 15$ or so.) (How about apprais land?)



W. SL deprecn., recover cap. in $\frac{1}{2}$ of $\underline{l}$.

b. Says cc. lives have been dropping steeply in recent yrs. on cars, bldgs., ind. plants. No evidence. ~~a half-truth at best.~~ Maybe true, but has K:O for whole cc. been dropping? Frontier oil is more cap. using. So is irrig. ag. Measures are imperfect, so you can hear everything.

e.g. re housing:

- tract houses are tacky, but they now require infrastructure worth more than they are, & long lasting

- new resid. come from even tackier places.

c. Says short lives call for more cap. to replace. Wrong. Cap. forces its own replant. as it wears out. CCA does this.

In a consumer society, lives wd. be longer. Many believe this, but probly less than half true. And refutes his general criticism of hard technology, as being too cap. intensive.

5. Role of Econ. Cheap shots, poorly thought out
p. 67

Wrongly says e.c.s. treats cost of res. in situ as zero. In fact, bidders pay; & they treat deple. as a MC — that's why they hold back for higher prices.

Says replant cost is inf.. Discuss.

Says we treat fossil capt. (found) as income. Wrong? He seems to ~~to~~ refer, however, to discounting deple. But if we didn't, produ. wd. stop 100%.

(Some say we shd. use lower i . But then we deny cap. to other things, & sell U.S. land to foreigners, at hi i .)

6. p. 68 Uses cap. intensity as a signal (of scarcity?)

- K is increasingly the dominant cost
- K is an "engineering no." & unfused.
- escalation of costs can be handled systematically
- soft tech. requires no fuel, so if it's K is same, Σ costs is less.

It all adds up to saying conventional fuels are underpriced. He dumps this on "e.c.s.", not on than politics. cf. Mead.

7. Cost comparisons shd. give some solar due credit for obviating dist. cost.

He has his own way of saying this. Cf. end-use functions rather than ~~the~~ fuel costs; or "delivered function" rather than "delivered fuel".

He claims this is seldom done today. I doubt this. E.g., he notes gas furnace eff. is $1/1.3$ to $1/1.7$.

(Gas line losses, wd. be mainly fuel used to move the gas. What %?)

8. Ecs. is tdy to ~~guard~~ ^{guard} ~~social~~ other things. By ecs. he seems to mean engg. narrowly conceived. The other things are:

- ecology

- peace

This tells us much re Lovins. Has become a cult figure, by stressing these 2 points, ~~the~~ which depend on gut perceptions that do not need to be intellectualized. He does enough engg. + ecs. to ~~challenge~~ challenge us, but fails to follow through.

5-
9. Paranoia.

"Ultimate condemnation" is to be used.

Actually, human ecology is stronger weapon,
re Congress pork barreling.

10. Even the hi-cost energy costs vary by less
than human energy, so we will still use it at
much higher prices.

He seems to go from this to saying we
shd. go to solar immediately, or at least be rid of
everything that threatens our survival.

Loring, ch. 6

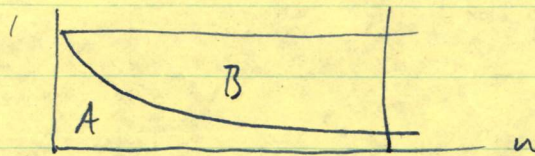
Cap. costs, hand taken.

1. Show how to combine cap. + running costs.
2. Show how big r is ~~in~~ as share of costs.

<u>n</u>	<u>cr.f. @ 10%</u>	<u>.10/crf</u>
1	1.10	.091
2	.58	.174
3	.40	.249
4	.32	.317
5	.26	.379
10	.16	.614
7	.21	.481
15	.13	.761
20	.12	.851
30	.11	.943
100	.10	.99
50	.1009	.991

Above is strictly true only in year 1.
It overstates share of int. over time

3. Better move of int. in TC:



$$TP = A + B$$

$$PV = A$$

$$Int = B$$

$$A + B = n$$

$$\frac{Int}{TP} = \frac{B}{A+B} = \frac{n - PV}{n} = 1 - \frac{PV}{n}$$

<u>n</u>	<u>@ 10% PV</u>	<u>PV/n</u>	<u>$1 - \frac{PV}{n}$</u>
1	.91	.91	.09
2	1.74	.87	.13
3	2.49	.83	.17
4	3.17	.79	.21
5			.24
7			.30
10			.39
15			.49
20			.57
30			.69
50	9.91	.20	.80

4. Cap. intensity means the front costs are hi cfd. to running costs; and that payback is slow.

So, int. becomes hi share of TC.

5. There is an array of alternative technologies, differing in cap. intensity. Hi i.v. tells us to prefer those of lower cap. int.

6. Common measure of cap. cost: \$/kW

"Opt." scale at 1.1 GW = ~~1100 kW~~ 1.1 m kW
= 1,100 MW

- 7.
- | | | |
|----------------------------------|---------------------|-------------------------------|
| a) Direct Constr., LWR | \$ 418/kW | (1974 III \$) |
| b) Indirect or Owner Cost, + 40% | + 167 69 | = \$585/kW |
| c) Xmas circuit, 140 mi (see 8) | + 420 | } x 1.25 = 1005 kW |
| d) Nuclear fuel cycle facilities | + 61 | |
| e) Initial reactor core | + 100 | = 1166 |
| | | ca. 1548 |

Then, ~~now~~ divide by cap. factor . 0.58

Subtr. Xmas line losses, of 10%

\$3152/kW(e) delivered

8. X in su. estimate. Controversial, compressed. How do it?

a. "Modal split" means the % carried on lines of different voltage.

Load carried in su. is MVA, Megavolt-amperes, a measure of power, related to MW by a "power factor".

b. Est. is much higher than Brookhaven. why?
"Internal acctg. procedures that reduce apparent v. loads + cost of money."

9. Extra glossary

1 watt = 1 volt-ampere

= 1 joule/second

1 volt, applied vs. resistance of 1 ohm, gives 1 amp.

1 amp-hour = 3600 coulombs

1 amp-second = 1 coulomb

Joule, a unit of work = .737 ... foot-lbs.

Volt is like power drop. A given stream ^{flow} has ~~flow~~ energy & drop.

But volts & amps are mutually convertible.

Cons. of energy, $A_1 \cdot V_1 = A_2 \cdot V_2$

Energy is work / time, as watt = joule / second

$$\frac{\text{Voltage}}{\text{Resistance}} = \text{Current}$$

$$\frac{1 \text{ V}}{1 \Omega} = 1 \text{ Amp.}$$

Current $\times$ Voltage = Energy

Amps $\times$ Volts = Watts

? but Amps = $\frac{\text{Volts}}{\text{ohms}}$, so Watts = $\frac{(\text{Volts})^2}{\Omega}$

6

$$k = 10^3 \quad dk = 10^1$$

$$M = 10^6 \text{ (In U.S. eng. lit., } M = 10^3; \text{ } MM = 10^6 \text{)}$$

$$G = 10^9 \text{ (Tera)}$$

$$\frac{G}{T} = \frac{10^9}{10^{12}} = 10^{-3}$$

$$q = \text{quad} = 10^{15} \text{ BTU} = 26 \text{ M T oil}$$

$$1 \text{ bbl/d} = 67.1 \text{ kW (t)}$$

$$\frac{1 \times 10^9 \text{ W}}{67.1 \times 10^3 \text{ W}} = \frac{10^6}{67.1} = 14,903 \text{ bbl/d to fuel one}$$

LWR (opt. scale) substitute. i.e., the "avoided cost" of one LWR is ca. 15k bbl/d v \$40/b

$$= \$600 \text{ k/d} = \$219 \text{ M/yr. in oil cost alone.}$$

More gnrly, the oil cost of one thermal kW is

$$\frac{1}{67.1} \times P/b \approx \frac{40}{67.1} = 60 \text{¢ / day}$$

$$1 \text{ kW-h} = 3.6 \cdot 10^6 \text{ J} = 3.6 \text{ MJ}$$

$$= 3413 \text{ BTU}$$

$$= 1.341 \text{ hp-h}$$

$$1 \text{ Mega joule, MJ} = .278 \text{ kW-h (t)}$$

Note that $\text{Work} = \text{energy} \times \text{time} : \text{MJ} = \text{v kW-h}$
 $\text{energy} = \text{work} / \text{time} : W = J/s$

U.S. primary energy use, '73, was 75×10^{15} Btu

T has 2 meanings:

Tera, 10^{12}

Ton, metric =

~~to~~ 1000 kg or Mg

2204.6 lb.

1.102 short ton

.984 long ton (Eng. 1 ton = 2240 lb
= 1.12 short ton)

Btu = 1055 J

$2.93 \times 10^{-4} \text{ kW-h (t)}$

252 gcal (gram-calorie)

gcal = 4.186 J

hp = 550 ft-lbs/sec.

1 kW = 1.341 hp, so 1 hp = .75 kW

Ec. 177. Mon., 3/2/81

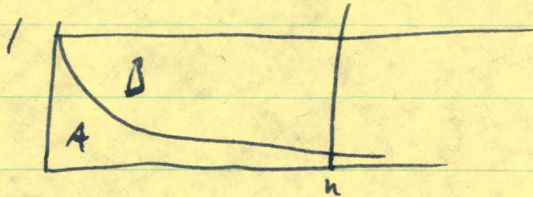
0. Fair airline indy.

1. Grosvenor Main

Shake out, longer lead time,

If Exxon worried, all must be.

2. Int. & deprec.



a. $\sum \text{int} = B$

b. In yr. 1, $\text{int} = b_n$

Payback = a_n

Stg. F and deprec. used by reg. utils.

a level emit.

c. "Payback time" - not simple.

3. 6/10 rule, etc.

0. Execut. Committee mts. "Life has been one long one."
1. Energy forum. Tim Lynch
No title: large Apocrypha.
2. Grunglass, bible defects + TMI
3. Restructuring pks lots
15,000 / space?

Cty. Won't force the issue. But will tax people to subsidize parking.

4. Aug. 3 next.

5. Alt. energy. Many small solutions = one big one.

$$a = \pi r^2$$

$$r^2 = \frac{a}{\pi}$$

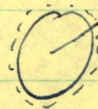
$$r = \frac{a^{\frac{1}{2}}}{\pi^{\frac{1}{2}}}$$

$$\frac{dr}{da} = \pi^{-\frac{1}{2}} \cdot \frac{1}{2} a^{-\frac{1}{2}} = \frac{1}{\pi^{\frac{1}{2}} 2 a^{\frac{1}{2}}}$$

$$\frac{da}{dr} = 2\pi r = 2\pi \cdot \pi^{-\frac{1}{2}} a^{\frac{1}{2}} = 2\pi^{\frac{1}{2}} a^{\frac{1}{2}}$$

Steps

1. $a = \pi r^2$



2. $\frac{da}{dr} = 2\pi r$

3. $\frac{dr}{da} = \frac{1}{2\pi r}$

4. By calc. rule,

~~all~~ $r = a^{\frac{1}{2}} \pi^{-\frac{1}{2}}$

$$\frac{dr}{da} = \pi^{-\frac{1}{2}} \cdot \frac{1}{2} a^{-\frac{1}{2}} = \pi^{-\frac{1}{2}} \cdot \frac{1}{2} \pi^{-\frac{1}{2}} r^{-1}$$

$$= \frac{1}{\pi 2 r} \quad \underline{Q.E.D.}$$

Ec. 111. Fri., 2/27

1. all know diff. betw. miles + mph, or speed.
Work resembles miles
Energy " speed.

Distance consumes work - in gals
Speed " energy - in hp

2. Hi volts resembles Fly
Low " " local alley or cul-de-sac.

3. p. 2, ~~Transmission~~ dists.

4. $kWh/d = 67.1 kW$
 $1 kW = 1.341 hp$
 $kWh/d = 67.1 \times 1.341 hp \approx 90 hp$

5. Lewis says $kWh/d = 67.1 kW(t)$
Convert to $2.5¢/kWh(t)$
Cf. SCC costs.

$$\begin{array}{r} 1.34 \\ 67 \\ \hline 938 \\ 804 \\ \hline 84.78 \end{array}$$

6. Why can't society save on K by
subbing energy feedstocks for K?

7. What 2 things does cap. intensity mean?

2
8. Why are utilities & energy cos. ~~so~~ insulated from higher r?

B.C. Hydro, 5-7% costs are interest —
at 3%!

Bonus on Trilateral Comm.

~~Fire~~ Wells.

9. How est. share of int. in cap. costs.

a. Life-cycle

b. Year by year.

10. Wells as optional vdy.

Lowins on Cost, Capital

1.1 GW nuclear plant, kW R

1976 \$

Why such a big jump

Direct Contr.

$418 + \text{infl. } \frac{\$761}{418} / \text{kW}$

(1974 II \$)

Indirect, @ 40%

167

Xmas, 140 mi $69 + \frac{1}{4} = 86$

Astr. eq. $420 + \frac{1}{4} = 525$

Nuclear fuel cycle fac. $61 + \frac{1}{4} = 76$

Initial reactor core

100

1548 or 1717

Divide by $\frac{.55}{.58}$ for \$/kW (c) "sent out".

2815 or 3121

+ line losses, 12% $\neq$ = 3152 or 3496

Has omitted land (site & r.o.w.); reserve margin; police; fed. & d; future waste mgmt.

Bus. & dead-times in ordering & constr., the price indices are important. Room for lots of fudge. Lowins "1976" is for '76 "ordering". This could well look forward to 1984 price level.

†

Losses are 10.7%, but this adds more than 10.7% to cost per delivered. E.g., suppose losses were 90%.

More factors -

Infln. after '76

Real infln after '76

Energy used by operating the fuel cycle itself: 6-8%.

Before above factors, cost comes to \$21,500 / bbl-day
"delivered into hallway"

He says \$3150 / kW = 21,500 / bbl-day

"Bbl-day" clearly means bbl / d. $67.1 \times 3150 = 211,500$

(Thus, it costs \$21,500 / cap. to save 365 bbl/yr.

$10\% \times 211,500 = \$21,150$ int. cost

$365 \times \$40/\text{bbl} = \$14,600$.

Gas turbines are less cap.-int., tho more costly in fuel.

Coal, Cap cost is \$355 / kW (c), 1974

+ + +

comes to 1370 / kW (c) '76

+ then 2416 / kW (c)

~~20~~ ¹ copy Type. pls. + 20 copies by 11 AM Fri.
M. 4.

Study Topics for students in Energy Econ.,
suggested by Sara Hoffman. Energy Coordinator, City of Riverside.

National Consumer Cooperative Bank - How can it be used for energy?

Attitudes of Lenders Toward Financing Solar (Passive + Active)

1980 Mortgage Bond Law

State and Federal Solar Tax Credits

State Conservation Tax Credits

National Solar Bank

Energy Redevelopment Agency - Is it a viable concept?

Peak Demand - Effect on Cost of Electricity - Riverside

Riverside's Energy Dollars - Where do they Go? (inside or outside Riverside)

What is the cost threshold for installing solar?

Cost of Installing a Solar Water Heater (include ^{net} cost breakdown)

taking into account

?

WSP
C. J. L.

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Fri, 1/23, Energy

Mon, 1/26

Why not write off
current oil logs for
lease?

Midterm 1.

Qu. Anti-gas guzzler law.
Why inadequate? (cf. Mead vs. Kneese)

2. Mead

- ec. solution simple. Remove govt. So?

- lots of hydrocarbons. Coal, shale.

- Promoting energy cons. & prodn.

the way NTE talks

Shd. favored uses be price-controlled? Homes,
farms, water, military, welfare?

- Supplies are predictable. Yet experts differ!

~~or ~~Adelman~~~~ Why? Bn. of different ec. assumptions.

~~Adelman~~ Adelman used too hi a real i, 10%.

Mead goes to 3% & finds no cartel. Johnson & Kneese
neo-classical error.

Friedman doesn't understand rent. Mead does.

Fr. has to exaggerate the cartel power; Adelman too.

Mead sees rent as holding price above cost.

- Import dependence? Mead favors - to avoid exhausting
domestic reserves.

Domestic sources? Slow down learning rate.
 Mc Donald likes bonus bidding. Mead calls it "purely
 competitive". Blind spot.

Particip. causes "dissip. of ec. rent". What is
 rent? Kuroki royalties for wrong reason (premature
 abandonment)

A. Sum of geom. prog.

$$S = 1 + r + r^2 + \dots + r^{n-1}$$
$$rS = r + r^2 + \dots + r^{n-1} + r^n$$

$$S - rS = 1 - r^n$$

$$S = \frac{1 - r^n}{1 - r}$$

B. Present Value Formula

$$PV = 1 + (1+i)^{-1} + (1+i)^{-2} + \dots + (1+i)^{-n-1}$$

$$S \equiv PV$$

$$r \equiv (1+i)^{-1}$$

$$PV = \frac{1 - (1+i)^{-n}}{1 - (1+i)^{-1}}$$

To simplify, assume first princ. is at end of year.
Multiply thru by r , or $(1+i)^{-1}$

$$PV = \frac{1}{(1+i)} \times \frac{1 - (1+i)^{-n}}{1 - (1+i)^{-1}} = \frac{1 - (1+i)^{-n}}{1+i-1}$$
$$= \frac{1 - (1+i)^{-n}}{i}$$

Mon, 1/26

1. Sara's idea
2. Show ~~to~~ that $\frac{\Delta q}{q} = i$ also max's P.V.
3. On Wed. submit statement of interest
4. Next rds. Chaps 7 + 8

A. Sum of geom. prog.

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Multiply thru by r , or $(1+i)^{-1}$

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$$= \frac{1 - (1+i)^{-n}}{i}$$

More ec. waste:

1. Producing submarginal oil.

Too far; deep; small; hard to find.

Subsidizing prodn.

" " kptn.

Too soon

Infant indy.

Mac grows, instead of net.

Indy. nominations, as trigger.

Leaving on demand, early exploration.
Duplication.

Wed. Jan. 14, 1981

Energy Ec.

1. The conventional ec. model
 2. Lovins' critique, & others.
-

Week #1,2. The ec. model

Ch. 1. Mead. Review of selective bias identification.
Ch. 4. Mc Donald
Ch. 9. Kuense
Ch. 10. Brannon

Topics

Ec. vs. physical waste

Present value

Rent & pricing

Opt. extraction rates — & corresponding opt. prices.

a. ERT plug.

b. Prudhoe Bay models, van Poolen Rpt.

Enthalpy: Q of energy w/o regard to quality
(to which we shd. add locn. & time
as elements of quality.)

Hi entropy is low quality.

Ranking by ^{quality} entropy:

Electr. & mechanical work
hi temp. heat: low temp. heat:

Note fallacy in non-qualitative energy balance analyses.

Ec. 177, Energy, Fri., Jan. 16, '81

1. Opt. recovery time

E/bar of royalty on gross

Relate to the individual unit of oil, the last one is heavily discounted.

Pass out math.

Define depletion

Doubling times.

Give e.g. of how rapid use may reduce ult. recovery; (but more wells may Δ ult. recov.)

- Soviet's large field. Water intrusion
- Flaming gas (this isn't rapid use, but spanning cost of reinjecting gas)

Can we rationalize avoiding ec. waste?

- There are values other than oil in the ground.
Its value is not infinite

- If we do save oil, we finally sell it for money. So money is a fair measure.

- If we delay producing known reserves, we stimulate search & dev't. of new ones

- Slow prodn. makes a more R-int. indy.

2. Opt. beginning time.

3. Loading on vents

Wed., Jan. 21, '81
Ec. 177, Energy

Some aspects of ec. waste.

A. Producing known reserves too slowly

1. Due to M&E reqs.

2. " " proportioning to mkt demand.

Producing $\times$ days per mo. "allowables": ΔK costs

3. Taxes off the top

4. Royalties off the top

5. Max. price control, imposed from outside.

B. Countervailing factors, produce too fast from known reserves

1. Replen. allowance

2. Common pools, open access.

3. Fear of expropriation

Net balance of forces varies, w. time & place.
Too slowly is probably more common problem.

C. Subsidies to exploration.

1. Price upheld by cartels etc.

2. Tax system

3. Bias toward using gains to lessons in gross rather than net terms.

- 2
4. Underestimates of reserves, by mistaking proven reserves ~~for~~ for ultimate reserves.
 5. Distort of mkt. as mechanism for conveying.
 6. ~~For~~ Vertical mkt.
 - By firms
 - By nations

Use as
midterm
gr. } Other aspects of ec. waste

1. Relying on reg. like anti gas-guzzlers.
What is left out.

- a. Energy cost of saving energy - e.g. use of aluminum.
- b. Miles driven
- c. Bldg. more highways, parking lots, etc.
- d. Mkt. of effie. by owner of car
- e. Exports of energy. Coal, #1.

To sort out all this, we need the price system.

Proper prices, in proper degree

Weight other values in the same balance w. energy

So, the cost's position is that the price system promotes energy cons. in optimal efficient way; & crisis caused by interfering with it.

Wd. blame our problem on heritage of subsidies to both S + D.

Re McDonald, Chap. 4

1. Decision rule: Max PV of rent,
p. 46. 2 reasons.
= 3, pure surplus, burdenless tax.

Wants sequential sealed bids.

Acknowledges problem of front-end barrier

Sees joint bidding as solution. Cites unpub. work
by Spence & Erickson.

Stresses problems of royalty bidding, wild bids
Don't consider in royalty w. bonus bid.

Alts. to ^{high} bonus: ~~hidden~~

1. Royalty
 - Step royalty
 - By volume
 - By costs

2. Profit share.

Deduct running costs. Fairly simple, except "entertainment".

Deduct K costs.

- a. Which costs?

On site only? Not proceeds approach

Exploration?

Pre leasing, seismic
abandoned lease acqui?
Dry holes?

- b. When?

Expense

Deprec. w. time?

" " prodn?

B ~~2~~

c. W or w/o interest?

3. AVC

Tried in Alta.

Reverses "tax" in Ak.

Proposed in Ak.

4. Work commitment.

Singer's thesis, from Fri., Feb. 6
He on Monday, Feb 9

1. Like Mead, denies OPEC is a cartel.

But unlike Mead, doesn't apply competitive model, ~~emphasis on max. rent~~ entirely. Makes Saudi Arabia a swing producer, + the others produce what they will. He includes other Gulf states as ~~the~~ working as joint monopolists w. Saudi.

That wd. be Kuwait, Abu Dhabi, Iraq.

An Arab conspiracy theory. (Venezuela, Nigeria, Indonesia, are just free riding.)

Non-members also free-riding. Mexico, Norway, Russia, Canada, + U.S.

This theory is not as different as sounds. All cartels have a leader, who holds back more than others. Ts. used to, while unregl. states had no provates, expanded: Montana, N.D., Fla., Alaska. (It was a 2-tier cartel: private inside states, enforced by states; private among states harder, but major cos. wd. handle this.)

Singer has a cartel thgy, coupled w. an Arab devil thgy. I'd be leery of the Arab devil thgy. I've lived among devils, ~~at~~ blood-eyed Arabs in BC + Alaska, + they're

2

just plain folks like you & me, out to make a buck, overly hostile to rest of the world, then faulted, but not part of any conspiracy.

2. Arger says control unit police itself.

It's widely believed the 7 sisters do this for OPEC, in return for part of the action.

They ~~use~~ use control over: - Info

- Credit
- Xpert - ships & docks
- Mktg.
- Refining
- Storage

Plus CIA, Kissinger, Brezhnev, etc.

The stuff of which his drama is made. The obvious world police is U.S. govt. Before '73 it worked w. 7 sisters, & old habits die hard.

3. Model presumes rising S curve. (a 3d way of expressing dim. rets) But he misstated it. Left out important link. But made it seem as tho world proceeds along S curve over time. But S curve is simul.

Missing link is rising MC
Same as dim. rets. Reciprocal.

m

To speed output, ^{one incurs} several kinds of costs, which are brakes.

a. ~~Op's~~ Op's, e.g. overtime pay; & pressure

b. K

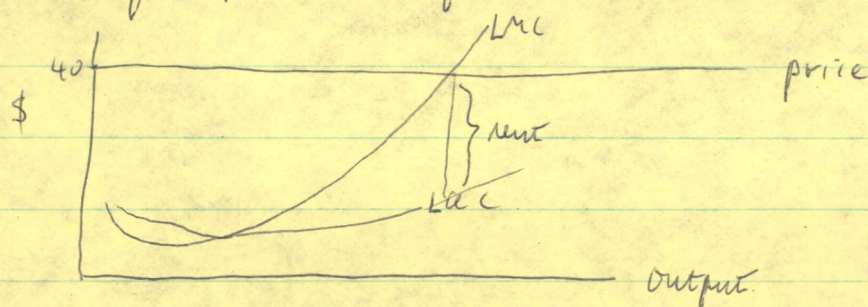
i. On site. Deprem. + interest.

ii. Assoc. costs, offsite infrastructure

c. Depletion charge.

This is what lets an annual statement of decision variables give same result as a lifetime analysis. Depl. like depr., comes from summing whole life of the deprec.

LR in all
but land.
Land fixed



This is why low cost producers' LAC does not determine price; and should not. [Unless they have large short-run low-cost reserves, so large that depln. is negligible. In this case, depln. brake is a sham.]

3 reasons why Saudi's perception of depletion wd. differ from Customers'

1. Low i.r. More assets than can handle.

2. Customers' Devil theory. Saudi's

may not be so sure they have untapped reserves.

4

3. Saudi's desire for permanence.
It's all they have.

If ownership were different, wd. be produced much faster. Raises more fundamental qns., rights of nations to their land, when some lands are much better than others.

Egypt, Phl, Israel, Russia, ~~the~~ U.S., ~~and~~ + America wd. all like to grab it. If Saudi's are smart, they will share w. allies.
Pan-Islamics; U.S.; esp. U.S.

The ~~only~~ way they ~~can~~ share w. U.S. is hold prices below mkt. A more ec. way wd. be to help U.S. get more taxes, by calling a royalty a royalty. But U.S. wd. do this unilaterally, if our Govt. repd. people of U.S. (as vs. 7 sisters.) That much of the problem is ours as much as theirs.

4. Singer's model of Saudi motives is same as mine.
Needs translation.

$$\text{Max } \sum_{t=0}^{\infty} [(P_t - C_w)(D_w - S_{rw})(1+r)^{-t}]$$

I just drew a picture of that.

"Calc. of Variations" & "Opt. Control Thy" are just intimidating words, used to exclude by esoteric obscurity.

5

~~$\sum (P \cdot Q) (1+r)^{-n}$~~ $\sum [P \cdot Q] (1+r)^{-n}$ is more
general form of PVR or DCF;

$$\frac{A}{n} \frac{1 - (1+r)^{-50}}{r}$$

as for C_0 , no discount needed.

as for calc. of variations etc., that just
handles our Moving NPV.

as for calc., is old fashioned way of handling,
this w/o computer. Now, you can write program
on a hand calc.

So, if you've mastered our model, you know
much more than you thought you did.
Don't need to be shown.

5. Price History

2 big jumps in real price

1970-73. Why?

He didn't say.

Mead's reason sounds good. This is
when OPEC govt's, declared independence, asserted

their ownership etc., slowed down prodn. rates.
 Their time horizons were longer.

This is also against a background of rising demand.
 End of import quotas helped.

U.S. support for Israel was a factor.

~~All told~~

These are only pieces. The genius who puts
 them all together has yet to write.

1979-80. Why?

Singer thinks, only a spec. error, price
 will fall.

6. S. thinks demand will sink now, subs.
 coming on stream.

Never said why. Too bad, was most
 important thesis.

Levin

Over compressed, tendentious. His writing strategy is to:

- a) Establish his Technical expertise
- b) Show his susceptible readers
- c) Provoke skeptics to criticize, creating forums for expanding his views.

Clearly, he is less interested in the alt. Technologies themselves than in showing they exist, to buttress his major themes.