OUR CARBON FREE ENERGY FUTURE

BY CARL E. SCHODER

A Path to a Carbon Free Energy Future

Don’t look down and dig, dig dig;

Look up to the sky for solar energy ,nitrogen and water

ENERGY DEMAND

Table 1: Primary Energy Consumption, Source: Reference (1)
Note: consumption units changed from Million tonnes oil equivalent to Terawatts, a true energy unit.

12 countries with annual consumption over 2200 Terawatts per year	2007 Primary Energy Consumption	2008 Primary Energy Consumption	Change, 2008 over 2007	2008 Share of total	2008 Per Capita Consumption	Population Source: Reference (2)
Country	Terawatt hours per year	Terawatt hours per year	Percent	Percent	Megawatts per person per year	Population in Millions
USA	27,655	26,944	**-2.8%**	20.4%	88.49	304.5
China	21,832	23,470	**7.2%**	17.7%	**17.72**	1,324.7
Russian Federation	7,966	8,023	0.4%	6.1%	56.54	141.9
Japan	6,045	5,947	**-1.9%**	4.5%	46.57	127.7
India	4,795	5,078	**5.6%**	3.8%	**4.42**	1,149.3
Canada	3,822	3,865	0.9%	2.9%	116.07	33.3
Germany	3,625	3,646	0.3%	2.8%	44.36	82.2
France	2,987	3,022	0.9%	2.3%	48.75	62.0
South Korea	2,762	2,814	1.6%	2.1%	57.90	48.6
Brazil	2,583	2,673	**3.2%**	2.0%	**13.70**	195.1
United Kingdom	2,517	2,480	**-1.7%**	1.9%	40.46	61.3
Iran	2,208	2,251	1.7%	1.7%	31.18	72.2
Top 12 Consumers	86,588	87,963	1.6%	66.4%	24.91	3,530.6
TOTAL WORLD	130,144	132,376	1.4%	100.0%	19.74	6,705.0

(1) http://www.bp.com/statisicalreview
(2) www.prb.org/pdf08/08WPDS_Eng.pdf

ENERGY SUPPLY

- Thermodynamic Laws

- Remember the ***first law of thermodynamics***; the amount of energy in the universe is a fixed quantity.
- Whenever one type of energy is converted into another type of energy, some of the source energy is lost as waste heat or friction (entropy) as demanded by ***the second law of thermodynamics***.

SOLAR ENERGY

- Solar energy, however, is different; it is constantly being generated and radiated into the universe.
- Any solar energy that we do not use becomes wasted light and heat energy (entropy) dispersed into the empty void of space. A sort of dark, dispersed, weak energy, which is unavailable for use.

- A basic source of energy is ***fusion energy***. In fact, fusion energy is the primary source of all energy in the universe. Our sun is a fusion energy source, as are all of the billions of suns in the universe. Our sun is a large, reliable source of fusion energy, which has been producing reliable energy for several billion years and is estimated to have a remaining life of more than 8 billion years.

- ***All we need is an infrastructure to collect and utilize the already ample solar energy that we receive daily from the sun***.

Solar facts

Solar Constant, the power level of solar radiation received by the earth is 1.367 KW per square Meter.

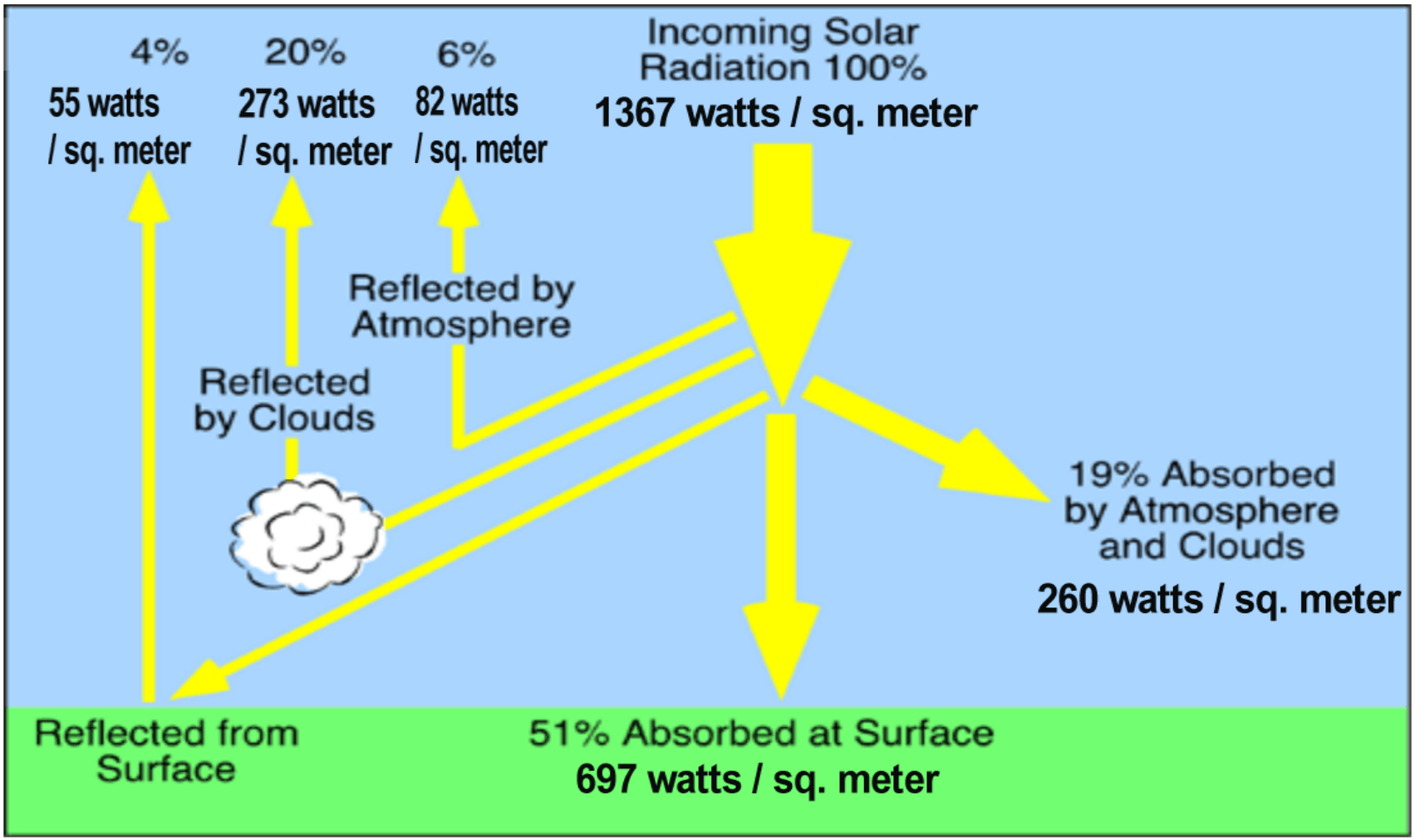
Total TW-hrs of solar energy received per day at the earths surface is over 2 million TW-hrs/day

Total TW-hrs of solar energy per day emitted by sun is over 9 quadrillion TW-hrs/day

2008 USA total primary energy consumption per day was about 74 TW-hrs/day.

2008 world total primary energy consumption per day was about 363 TW-hrs/day.

The “Distribution of Incoming Solar Radiation”



Distribution of incoming Solar Radiation

The Convenient Truth

The convenient truth is that the world does not have an energy shortage; the world only lacks an energy infrastructure capable of using the abundant source of solar energy, which we receive from the sun every day.

The world is on the verge of a major shift in the nature of its energy supply!!!

A new system to make ammonia directly from water and nitrogen has been developed.

When ammonia is consumed as an energy source, water and nitrogen are returned to the atmosphere to be reused over and over again.

No depletion of natural resources results; only the consumption of solar energy, which is wasted if not used.

Solid State Ammonia Synthesis

- The NH3 Fuel Association has learned a lot about the advantages of ammonia as an energy source. The key to an ammonia based fuel system is a newly patented process issued to a small northwest company named “NHTHREE, LLD” which is called the Solid State Ammonia Synthesis process, or SSAS
  .

How much ammonia energy is needed to replace fossil fuels?

- **Worldwide energy consumption using fossil fuels is about 80% of the total energy demand.**
- **The USA fossil fuel portion is about 84%**
- To convert fossil fuel demand values to ammonia demand values, the following conversion is used:
- Conversion calculation: 1Mtoe, FF/yr. * 0.03968 Quads FF / Mtoe FF / 365 days/yr. * 2.0133 MJ/kg FF /MJ/kg NH^3 * $5.848E^{-05}$ MJ NH^3 / cubic meter NH^3 0.8 to replace fossil fuels only

AMMONIA DEMAND DATA

Ammonia Demand Data using the Solid State Ammonia Synthesis System				
Data for the World & USA	Worldwide, IEA	Worldwide, IEA	USA, EIA	USA, EIA
Type of Energy Demand	Volumetric demand	Gravimetric demand	Volumetric demand	Gravimetric demand
Energy Demand units	Cubic meters of NH3 per day	Mtonnes NH3 per day	Cubic meters of NH3 per day	Mtonnes NH3 per day
Air Separation Unit input, air	95,519,027	65,134,424	29,944,954	20,419,464
Air Separation Unit output, nitrogen	74,585,077	50,859,564	23,382,218	15,944,334
Air Separation Unit output, oxygen	20,933,950	14,274,860	6,562,736	4,475,130
SSAS input, water	59,744,604	40,739,845	18,729,770	12,771,830
SSAS input, nitrogen	74,585,077	50,859,564	23,382,218	15,944,334
Total inputs	134,329,681	91,599,409	42,111,988	28,716,165
SSAS output, NH_3	90,711,825	61,856,394	28,437,910	19,391,811
SSAS output, O_2	43,617,856	29,743,016	13,674,079	9,324,354
Total outputs	134,329,681	91,599,409	42,111,988	28,716,165

Do we have enough fresh water and nitrogen available on a daily basis to meet this demand?

- The total worldwide freshwater abundance is 35,030,000 cubic kilometers, however only 0.3% of the total is readily available as ***surface liquid freshwater***. The available surface liquid freshwater is 105,090 cubic kilometers.
- To supply the worldwide ammonia demand requires about 6.0% of the available surface liquid freshwater.

- To supply the needed nitrogen less than 0.0000000016% of the atmospheric nitrogen.

Energy Storage

- Before we proceed further discussing the future of world energy, it is appropriate to discuss the storage of energy. The energy content of fuels, fossil and renewable, can be compared on both a volume and weight basis. The aviation industry will be interested in both the weight density and the volumetric density; Land based industries will be mostly interested in the volumetric density. Table 3 in the next slide lists the gravimetric and volumetric energy densities for several fuels.

Table 3. Some possible Transportation and energy storage Fuels This table lists only liquid and gas fuels; electric batteries are also an energy storage medium.

Higher Heating Values	Energy Density MJ/kg.	Fuels sorted by BTU / gallon Heat content, BTU / lb.	Fuels sorted by BTU / gallon Heat content, BTU / Gal.	Volumetric Energy Density (BTU per gal) as a Percent of Diesel, low sulfur
Diesel, low sulfur	45.600	19,594	138,490	100.0
Gasoline, conventional	46.500	20,007	124,340	89.8
Reformulated Gasoline (RFG)	45.400	19,530	121,848	88.0
Propane	50.200	21,597	91,420	66.0
Liquefied Petroleum Gas	50.200	21,561	91,410	66.0
Ethanol	29.800	12,832	84,530	61.0
Methanol	22.900	9,838	65,200	45.1
Ammonia, anhydrous (75% H2).	24.644	10,600	60,282	43.5
Lithium Ion Batteries, the most energy dense battery.	0.445	940	4134	2.99
Hydrogen, liquid	139.000	60,619	35,815	25.9
Hydrogen, gas, STP	139.000	59,816	42	<0.001

Cost of Solar energy

The Green Econometrics website says that a five–Kilowatt (KW) solar energy system costs about $45,000.
They also say that $45,000 5KW solar energy system produces about 120,000 KWH of electricity over its lifetime of 20 years, at which the average cost equals $0.38 per KWH.

At a 40 year lifetime: the cost would be $0.19 per KWH.
At a 60 year lifetime: the cost would be $0.125 per KWH. Which is equivalent to grid electricity costs.

Conclusions

- **“Carbon tax” or “resource extraction tax”**
- **There is no free lunch**
- **Rethinking the “Good Life”**

Thank you for your attention

- Any questions??