Discussion #14: Biofuels

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ELMS Page: https://myelms.umd.edu/courses/1229919


23 October 2017
The Krupp and Horn (KH) book was first published in 2008; the paperback editions are dated 2009 and 2010, but the content is nearly identical to the 2008 edition. In this question and a few to follow, we will examine what has actually happened to solar energy and some of the featured companies, since 2008.

In the KH book, industry research firm Clean Edge makes a prediction of the total installed capacity for solar photovoltaics (PV) in year 2015.

a) What was the prediction?

b) What was the actual installed base in year 2014, the latest year for which an actual installed capacity is given on the wiki page (Link (Links to an external site.)) that has also been assigned? Please use the same units for your reply and comment on whether you think Fred Krupp and Miriam Horn would be pleased with what has actually happened.

a) Clean Edge predicted the solar photovoltaic industry would reach an installed base of 75 gigawatts, supply 0.5% of global electricity, and be worth fifty billion dollars by the year 2015.

b) By the end of 2016, worldwide installed photovoltaic capacity increased to over 300 gigawatts.

   Krupp and Horn would be ecstatic to see the industry they had so much hope in grow so much in such a short period of time.
World *Electricity* Generating Capacity:

**Power**

- **Coal**
- **Gas**
- **Oil**
- **Nuclear**
- **Hydro**
- **Wind**
- **Biomass**
- **Geothermal**
- **Solar**


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World *Electricity* Generating Capacity:

Power

Solar Capacity is:

\[
\frac{300 \text{ GW}}{7800 \text{ GW}} = 0.036 \\
\text{or } \sim 3.6\%
\]

of total global capacity of electricity

Source: [https://www.eia.gov/outlooks/ieo/ieo_tables.cfm](https://www.eia.gov/outlooks/ieo/ieo_tables.cfm)
Capacity Factors for Assorted Energy Systems

Source: DOE and NREL “Transparent Costs Database”
Note: Blue dots represent estimate for the average capacity factor of each technology.

http://www.lightevolution.co.uk/blog/geothermal-visual-capacity-factors-for-assorted-energy-systems/
World Electricity Supply

Solar Supply is:

\[ 300 \text{ GW} \times 0.25 / 7800 \text{ GW} = 0.01 \]

or \( \sim 1\% \)

of total global supply of electricity
PV Efficiency

The size of a standard PV panel used for one of my projects is 62 inches by 37.5 inches and outputs 230 Watts at noon for clear sky conditions.

Area of a panel: 62 inches × 37.5 inches × m² / 1550 inch² = 1.55 m²
PV Efficiency

The size of a standard PV panel used for one of my projects is 62 inches by 37.5 inches and outputs 230 Watts at noon for clear sky conditions.

Area of a panel: 62 inches × 37.5 inches × m² / 1550 inch² = 1.55 m²

Therefore, output of a panel is 233 Watts / (1.55 m²) = 150 W m⁻²
Panel efficiency is $150 \text{ W m}^{-2} / 1370 \text{ W m}^{-2}$ or 11%

In other words, peak output is only 11% of incident solar radiation.

Our capacity factor in Md based on real data has been about 13% over eight years.

Therefore, only $0.11 \times 0.13 = \sim 1.4\%$ of incident noon time sunlight on a clear day has been turned into electricity. Our systems are typical of commercial, rooftop solar PVs.
The KH book gives a numerical value for how much the price per peak watt for solar energy must be, for solar energy to be able to compete with “coal-fired electricity virtually everywhere”. This number appears twice in the reading; also the wiki page provides the same price per peak watt cost for solar energy to achieve economic parity with the grid.

a) what is the price per peak watt for solar energy needed to achieve cost parity with coal

b) according to http://solarcellcentral.com/markets_page.html when was this parity achieved?

c) according to KH, what other additional critical hurdle must be overcome to enable solar-generated electricity to compete with coal-fired electricity virtually everywhere?

a) The price per peak watt for solar energy must fall to $1, for solar energy to be able to compete with “coal-fired electricity virtually everywhere”.

b) According to the link, this parity was achieved shortly after 2010.

c) According to KH, the storage problem is another additional critical hurdle that must be overcome to enable solar-generated electricity to compete with coal-fired electricity virtually everywhere. The storage problem relates to the need for cost-effective storage as the sun does not shine twenty-fours a day or every day of the year in some regions.
The KH book tells the story of three companies: one led by Conrad Burke, one led by Dave Pearce, and the third led by Bill Gross.

State the name of these three companies and for each provide a succinct description of the innovation each company was attempting to place into the market.

The company Innovalight is lead by CEO Conrad Burke, and it's innovation related to the silicon being used for as the semiconductor material for thin films. Innovalight bypassed the supply chain for purified silicon by making its nanosilicon powder from cheap, unpurified silicon. Nanotechnology has made possible a high output of manufacturing. In addition, Innovalight's silicon quantum has seen "multiple exciton generation" meaning that more than one electron could be harvested at a time.

The thin-film competitor Miasole led by former CEO Dave Pearce used a compound semiconductor made up of copper, indium, gallium, and selenium known as CIGS. This translates to savings on expensive semiconductors and on weight. Miasole sought to make solar technology simple enough for your average consumer. For example, panels would be smart enough to tell owners when they need to be cleared of leaves.

Bill Gross, CEO at Energy Innovations sought to innovate the photovoltaic market by focusing on concentrating the sun. Gross believed that concentration is the the cheapest option to innovate as it leverages the scarce supply of purified materials. Energy Innovations designed both the tracking software and much of the hardware responsible for aiming lenses directly at the sun. Coupling the concentrators with high efficiency solar cells has produced big results.
Pick one of the companies for Q3 and, based on your own independent web research, state what has happened to the company since the time the KH book was written.

**DuPont acquired Innovalight in 2011 and today, “DuPont™ Innovalight™ provides innovative silicon inks and licenses proprietary high-efficiency solar cell process technology to solar cell manufacturers which enables an immediate increase in solar cell conversion efficiency for customers”**

Pick one of the companies for Q3 and, based on your own independent web research, state what has happened to the company since the time the KH book was written.

Today, Miasole continues to develop a more lightweight, flexible, thin, and energy efficient solar panel. Since 2008, Miasole has merged with Hanergy and entered strategic partnerships with General Membrane, McElroy Metal, and Inovateus Solar. Recently, Miasole has developed solar cells with 17% efficiency, twice that of previous thin solar technology, and plans to continue being a leader in the fight for viable renewable energy.

Since 2008, Miasolé has been acquired by the privately owned Chinese clean energy company Hanergy. Its production capacity went from 20 megawatts in 2010 to 40 megawatts in 2011, according to the company’s Wiki page; as of 2012, Miasolé’s factory in California had a 150 megawatt capacity. The efficiency of its cells have also grown in the last 3 years, from 15.5% in 2014 to 17% in 2017, according to the company’s website. That number is expected to grow to 17.5% in 2018.

They are now making material for smaller devices, such as phones, and not just large solar panels.
Pick one of the companies for Q3 and, based on your own independent web research, state what has happened to the company since the time the KH book was written.

**Energy Innovations seems to have been out of the news since 2012, because the technology of concentrated solar PV is not yet ready to compete with old fashioned static solar PV on a cost or performance basis**

http://www.ejewel.com/our_companies/show/all/energy_innovations

https://www.greentechmedia.com/articles/read/CPV-Startup-Energy-Innovations-Seeking-Strategic-Acquirer#gs.KC8yNmw
The KH book provides an estimate of how much land would be needed to produce enough electricity to power the entire US from solar photovoltaic technology. This estimate is based on a certain assumption for the efficiency of the solar PV.

a) what is the “length of the square” (KH use the word “side”) that would be needed for the US to get all of its electricity needs from solar PV?

b) what did KH assume about the efficiency of solar PV to arrive at this estimate?

c) what would the “length of the square” (or “side”) be if the efficiency would rise to the highest achieved using a proprietary triple-junction by the Sharp Corporation, that is described on the wiki

a) 100 miles $\times$ 100 miles

b) 10% efficiency

c) The highest efficiency achieved by the Sharp Corporation was 35.8%

To find the new size, we must work with the area of the grid: $100 \text{ miles} \times 100 \text{ miles} = 10,000 \text{ miles}^2$

The new grid, to achieve the same output, needs an area that is $10 / 35.8 = 0.28$ of the original

So new grid is 2800 miles$^2$

To find the length of each side, must take square root of 2800 miles$^2$, which yields 52.9 miles
AT 13b, Q1

Describe in a few sentences the difference in operating principle between solar photovoltaics and solar thermal.

Both solar photovoltaics and solar thermal power sources use the energy from sunlight to generate usable electrical power. In photovoltaics, the photons from sunlight displace electrons between n and p type semiconductors, causing electricity to flow along a circuit. However, solar thermal uses sunlight to heat and evaporate a liquid, with the resulting steam turning a turbine, similar to conventional power plants.
The KH book notes “a key advantage of solar thermal over solar PV”. What is this key advantage and how, possibly, might this key advantage play a role in overcoming a major shortcoming of renewable energy.

The advantage identified is that solar thermal converts and stores the energy as heat instead of electricity. This method is cheaper to store than storing electricity, and the heat can be used to run the generators for more hours of the day and during cloudy periods when the collectors are not able to adequately harness the sun's energy. This addresses the major shortcoming of renewable energy sources like wind and solar by allowing the power plants to continue to generate electricity even when the power source, in this case the sun, is largely unavailable.
AT 13b, Q5
Pick one of the three companies, stated above, and describe what has happened to that company since the 2007 publication of the KH book. Alternatively, you can summarize the present state of affairs of Himin Solar Energy group, which is mentioned briefly on page 46. FYI, two of these are success stories, one is a failure, and the last is a bit of a sordid affair (i.e., company survived a legal mess).


[Image of Ivanpah Solar Power Facility]

AT 13b, Q5

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**Acciona Energy North America** has been successful since the 2007 publication of the KH book. Beginning in Spain, this company now produces green energy in more than 30 countries on 5 of the continents. Also, not only does the company work on renewable energy, but they also work on infrastructure, supplying clean water to people all around the world, and providing services that are affordable and accessible to everyone. The company has grown to include more than 30,000 employees.
HONR 229L: Climate Change: Science, Economics, and Governance

AT 13b, Q5

Pick one of the three companies, stated above, and describe what has happened to that company since the 2007 publication of the KH book. Alternatively, you can summarize the present state of affairs of Himin Solar Energy group, which is mentioned briefly on page 46. FYI, two of these are success stories, one is a failure, and the last is a bit of a sordid affair (i.e., company survived a legal mess).

Himin Solar Energy Group is a solar heating and solar power group based in Dezhou, China, the same city which houses China's Solar City. In the years just after Earth: The Sequel was written, Himin showed enough promise to attract a $100 million investment from Goldman Sachs. However, in 2012 their IPO was cancelled amidst a scandal in the Shandong province of China, where it was suspected that the governor illegally granted Himin with large parcels of land at only a third of the market rate. However, they have apparently survived the scandal and are still listed as a company on Bloomberg's website. Himin Solar Energy Group has built world's largest solar powered hotel.

http://sightbywalk.blogspot.com/2010/05/worlds-largest-solar-powered-hotel.html
Every year...

➢ U.S. vehicles pump .................tons of carbon dioxide into the atmosphere

➢ The U.S. uses .................... gallons of gasoline and .................... gallons of diesel fuel.
Every year...

- U.S. vehicles pump 1.3 billion tons of carbon dioxide into the atmosphere

- The U.S. uses ................. gallons of gasoline and ................. gallons of diesel fuel.
Every year...

- U.S. vehicles pump **1.3 billion tons** of carbon dioxide into the atmosphere.
- The U.S. uses **140 billion gallons** of gasoline and **40 billion gallons** of diesel fuel.
Which is a more efficient energy source?

- Solar Radiation
- Biofuels
Which is a more efficient energy source?

Solar Radiation or Biofuels
Advantages for Biofuel Start-ups

➢ Challenges for energy titans:
  ○ 50% of the world’s oil reserves are state controlled

➢ Rapidly changing technologies
Disadvantages of Biofuels

➢ Intensive water use
➢ Increased demand for coal for biofuel production
➢ Reduced food production
➢ Deforestation
➢ Draining and burning of peatlands
➢ Monocropping
Do you consider biofuels renewable?
“The UN predicts the global demand for both food and fuel will ............... by mid-century...”
“The UN predicts the global demand for both food and fuel will \textcolor{green}{double} by mid-century…”
Food or Fuel?
Thermochemical vs Microbiological
Thermochemical vs Microbiological

Catalysts, heat, and pressure are used to break down biomass into sugars, cellulosic fibers, and lignin. Enzymes and microorganisms convert biomass into a desirable product, such as ethanol. (more widely used)
Biofuel Crops

- Less than 1/100 as efficient as the most efficient solar cell

  - GWI = 36 & 8 BTU/1 BTU

  - GWI = 76 & 1.3 BTU/1 BTU

  - GWI = 4 & 36 BTU/1 BTU
Biofuel Crops

➢ **Switchgrass** - Less than 1/100 as efficient as the most efficient solar cell
  - GWI = 36 & 8 BTU/1 BTU

➢ **Sugar** -
  - GWI = 76 & 1.3 BTU/1 BTU

➢ **Corn** -
  - GWI = 4 & 36 BTU/1 BTU

➢ **Cellulose** -
  - Less than 1/100 as efficient as the most efficient solar cell
Cumulative avoided emissions per hectare over 30 years compared with the carbon sequestered by changing cropland to forest and the loss of carbon to the atmosphere by conversion of forest to cropland.
In terms of sustainability, which effort seems better: ethanol from corn or ethanol from sugar?
In terms of sustainability, which effort seems better: ethanol from corn or ethanol from sugar?

Ethanol derived from sugar seems more sustainable because it has nearly half the global warming impact of corn and produces 8 BTUs for every BTU put in.
Corn Ethanol Flaws

➢ Requires immense amounts of energy to separate 10% ethanol from 90% fermentation steep.

➢ Miscible with water, therefore needs to be transported in trucks rather than by pipeline.
Biofuels in the United States

➢ All of the U.S.’s soy crop would only meet 6% of diesel demand

➢ 200 million acres of switchgrass would need to be planted to replace 30% of gasoline consumed in the U.S. (half of U.S. cropland)

➢ Corn-based ethanol makes up 90% of U.S. biofuel production

➢ Corn ethanol to fill one 25-gallon tank = corn to feed one person for a year

➢ The U.S. spends $7 billion a year on ethanol
Why is jet fuel particularly hard to make from biomass?
Why is jet fuel particularly hard to make from biomass?

Jet fuel requires a high energy density and low freezing point to be viable for air travel.
Cellulose

➢ Organic compound found in tree bark and cobs
➢ Crystalline structure makes it difficult to dismantle
➢ Enzymes able to dismantle cellulose are more expensive
➢ Hemicellulose is amorphous and therefore easier to break down
Distilling Fuel from Agricultural Waste

1. Sources of cellulose include all the plant materials we can’t eat: corn stalks, grasses, husks, wood, shrubs, squeezed-out sugar cane, etc.

2. Delivered to the biorefinery, these plant materials are pumped full of liquid and “exploded” with pressure and heat to burst apart the fibers.

3. Enzymes or microorganisms are added to break the long chains of cellulose into their component sugars.

4. Yeast or bacteria ferment the sugars into a brew.

5. The brew is distilled into ethanol. At some refineries, the required heat comes from burning the remaining plant residues.

6. The ethanol is mixed in small percentages with gasoline or trucked to special ethanol pumps at gas stations.

Cellulose is the most difficult kind of biomass to turn into liquid fuel (one method is shown here). But it may also be the best kind, dramatically reducing carbon dioxide emissions, ecosystem damage, and competition with the food supply.
How can biofuels be fostered by the government?
Why are researchers in the U.S. focusing on restoring perennial grasses to the Great Plains?
Perennial Grasses

➢ Improve soil structure
➢ Improve water filtration
➢ Improve soil fertility

➢ Provide habitat for grassland species
➢ Can be harvested multiple times a year
➢ Do not displace food production
Algae doubles its mass in a few....
Algae doubles its mass in a few...

I. Minutes
II. Hours
III. Months
IV. Years
Algae

➢ Adaptable

➢ Rich in high-energy oil

➢ Rich in carbohydrates for feed or ethanol

➢ Filters air pollutants

➢ “...world’s most efficient converters of carbon dioxide to oxygen and biomass.”
Algae at Redhawk

What do you think went wrong?

What could they do to prevent that problem?

Do you believe there is a future for algae in the energy industry?
In the past, malaria was treated with quinine. However, the pest was becoming resistant so the World Health Organization called for a switch to artemisinin, more expensive and land-intensive drug.

Many citizens of developing nations couldn’t afford the new drug so Amyris developed artemisinic acid-producing yeast strains.
Amyris Biotechnologies Updates

Today, Amyris works with powerful companies such as Johnson & Johnson to develop health and nutrition products, cosmetics, and industrial products such as renewable diesel and jet fuels.
Verenium

Developed a method of converting nonfood material such as woodchips and grass to cellulosic ethanol.

Working with hemicellulose and fermentation organisms to produce fuel competitive with grain ethanol.
Verenium Updates

Acquired by BASF, the largest chemical producer in the world, for over $51 million.
Biofuels at UMD

Rick Kohn, a professor in the Department of Animal and Avian Sciences, and faculty research assistant Seon-Woo Kim discovered a more efficient way to make alternative fuels by isolating bacteria found in a cow’s rumen, or first stomach chamber.
Biofuels Today

Rapid advancements in biofuel technology have reduced cost per gallon from $400,000 to $6 according to the U.S. Department of Energy.

Source: Energy Information Agency (2012)
http://www.eia.gov/totalenergy/data/annual/index.cfm#renewable
Do you think we should invest more into biofuel or focus on the development of other alternative fuel sources?
Biofuels: Last Word

Ross Salawitch
Page 76 states “U.S. vehicle fleet pumps 1.3 billion tons of CO₂ into the atmosphere every year, and $820 million in capital is exported every day for the oil needed to do so:

6,587 \times 0.27 \times 1 \text{ billion} / 1000 \text{ million} = 1.8 \text{ billion tons of CO₂-eq}

https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions
Page 76 states “U.S. vehicle fleet pumps 1.3 billion tons of CO$_2$ into the atmosphere every year, and $820 million in capital is exported every day for the oil needed to do so:

[Table]

<table>
<thead>
<tr>
<th>Import sources</th>
<th>Gross imports</th>
<th>Exports</th>
<th>Net imports</th>
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</thead>
<tbody>
<tr>
<td>Total, all countries</td>
<td>10.06</td>
<td>5.19</td>
<td>4.87</td>
</tr>
<tr>
<td>OPEC countries</td>
<td>3.45 (34%)</td>
<td>0.22</td>
<td>3.23</td>
</tr>
<tr>
<td>Persian Gulf countries</td>
<td>1.76 (18%)</td>
<td>0.02</td>
<td>1.74</td>
</tr>
<tr>
<td><strong>Top five countries</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canada</td>
<td>3.80 (38%)</td>
<td>0.87</td>
<td>2.93</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>1.11 (11%)</td>
<td>0.00</td>
<td>1.10</td>
</tr>
<tr>
<td>Venezuela</td>
<td>0.80 (8%)</td>
<td>0.08</td>
<td>0.72</td>
</tr>
<tr>
<td>Mexico</td>
<td>0.67 (7%)</td>
<td>0.88</td>
<td>-0.21</td>
</tr>
<tr>
<td>Colombia</td>
<td>0.48 (5%)</td>
<td>0.15</td>
<td>0.34</td>
</tr>
</tbody>
</table>

[Links]

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https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions

https://www.eia.gov/todayinenergy/detail.php?id=29412

4.87 × 10⁶ barrels / day × $45 / barrel = $ 220 million / day

https://www.eia.gov/todayinenergy/detail.php?id=29412
Updates to Reading

Page 88 mentions the US renewable fuel standard:

[Diagram: Congressional Volume Target for Renewable Fuel]

36 Billion Gallons of Renewable Fuel by 2022

https://www.epa.gov/sites/production/files/2015-09/congressional_volume_target-02_0.png
Updates to Reading

Page 88 mentions the US renewable fuel standard:

Iowa Republicans raise pressure over renewable fuel standard
Grassley suggests holding up Trump nominees to EPA if rules get relaxed

By Ed Tibbetts, Quad City Times
Oct 17, 2017 at 9:02 pm | Print View

Iowa’s top elected Republicans turned up the heat Tuesday on the Trump administration to prevent a rollback of Renewable Fuel Standard requirements, with U.S. Sen. Chuck Grassley suggesting the Senate could bottle up the president’s nominees to the Environmental Protection Agency if the agency doesn’t support agriculture interests in its policy.

Grassley and a handful of other farm state senators met Tuesday with EPA Administrator Scott Pruitt over his agency’s announcement that it might lower advanced biofuel volumes for 2018 and count ethanol exports toward meeting the renewable standard targets.

Updates to Reading

Fill in the blanks: Ethanol from corm

Ethanol is one area in which Senator **Person A** strongly disagrees with his (or her) [Dem or Reb] opponent, Senator **Person B** of **State**. While both presidential candidates emphasize the need for the United States to achieve “energy security” while also slowing down the carbon emissions that are believed to contribute to global warming, they offer sharply different visions of the role that ethanol, which can be made from a variety of organic materials, should play in those efforts.

**Person B** advocates eliminating the multibillion-dollar annual government subsidies that domestic ethanol has long enjoyed. As a free trade advocate, he (or she) also opposes the 54-cent-a-gallon tariff that the United States slaps on imports of ethanol made from sugar cane, which packs more of an energy punch than corn-based ethanol and is cheaper to produce.

... The candidates’ views were tested recently in the Farm Bill approved by Congress that extended the subsidies for corn ethanol, though reducing them slightly, and the tariffs on imported sugar cane ethanol. Because **Persons A and B** were campaigning, neither voted. But **Person B** said that as president he (or she) would veto the bill, while **Person A** praised it.

Ethanol is one area in which Senator Barack Obama strongly disagrees with his (or her) Republican opponent, Senator John McCain of Arizona. While both presidential candidates emphasize the need for the United States to achieve “energy security” while also slowing down the carbon emissions that are believed to contribute to global warming, they offer sharply different visions of the role that ethanol, which can be made from a variety of organic materials, should play in those efforts.

McCain advocates eliminating the multibillion-dollar annual government subsidies that domestic ethanol has long enjoyed. As a free trade advocate, he (or she) also opposes the 54-cent-a-gallon tariff that the United States slaps on imports of ethanol made from sugar cane, which packs more of an energy punch than corn-based ethanol and is cheaper to produce.

... The candidates’ views were tested recently in the Farm Bill approved by Congress that extended the subsidies for corn ethanol, though reducing them slightly, and the tariffs on imported sugar cane ethanol. Because McCain and Obama were campaigning, neither voted. But McCain said that as president he would veto the bill, while Obama praised it.

Updates to Reading

S.918 - E-85 Fuel Utilization and Infrastructure Development Incentives Act of 2005

Senators Barack Obama (D-Illinois) and Jim Talent (R-Missouri) cosponsored the Fuel Utilization and Infrastructure Development Incentive Act of 2005 (Senate Bill 918) that provide a number of incentives designed to increasing the use of high ratio blends of gasoline with a minimum 85 per-cent domestically derived ethanol content (E–85).


Obama Camp Closely Linked With Ethanol

By LARRY ROHTER | JUNE 23, 2008

World Energy Supply: units of Energy

In 2014, world obtained ~80% of its energy from combustion of fossil fuels

Residential Biofuels in South Asia: Carbonaceous Aerosol Emissions and Climate Impacts

C. Venkataraman,¹* G. Habib,¹ A. Eiguren-Fernandez,² A. H. Miguel,² S. K. Friedlander³

High concentrations of pollution particles, including “soot” or black carbon, exist over the Indian Ocean, but their sources and geographical origins are not well understood. We measured emissions from the combustion of biofuels, used widely in south Asia for cooking, and found that large amounts of carbonaceous aerosols are emitted per kilogram of fuel burnt. We calculate that biofuel combustion is the largest source of black carbon emissions in India, and we suggest that its control is central to climate change mitigation in the south Asian region.

An analysis of the climate response of soot emissions from fossil fuel and biofuel combustion has suggested that control of soot, in addition to greenhouse gases, is an important measure to slow global warming, especially on short time scales (6, 7). Our results suggest that biofuel combustion could significantly affect atmospheric BC concentrations in the south Asian region. The climate effects of biofuel combustion aerosols have been combined with the effects of open biomass burning in the scientific consensus reports of the Intergovernmental Panel on Climate Change (29). We suggest that biofuel combustion needs to be addressed as a distinct source, and that cleaner cooking technologies not only could yield significant local health and air quality benefits but also could have an important role in climate change mitigation in the south Asian region.
What other deleterious effects might result from Third-World Stove Soot?
What other deleterious effects might result from Third-World Stove Soot?

ENVIRONMENT: Indoor Air Pollution - Silent Killer of Women

By T V Padma

NEW DELHI, Jan 3 (IPS) - Women and young girls coughing and choking as they cook food over traditional stoves that burn wood, leaves or dung is a common sight in poor homes across Asia, Africa and Latin America. But no one notices the deleterious effects.

Over 1.5 million females die prematurely every year by inhaling poisonous fumes as they cook or heat their homes with these organic fuels but catch little attention from governments, policy experts, scientists and medical experts.

Almost three billion people burn traditional fuels indoors for cooking and heating and their numbers are expected to "rise substantially by 2020," John Mitchell, coordinator of the partnership for clean indoor air at the United States Environmental Protection Agency told IPS at an international meeting on better air quality held in Yogyakarta, in December.

Most people in the region rely on firewood for cooking and heating, but this not only destroys the local forest but also causes serious health problems due to indoor air pollution. TNC initiated an alternative energy programme in 2001 to protect the rich biodiversity in northwest Yunan and use energy strategies.

http://ipsnews.net/news.asp?idnews=36052
Electricity from Waste

- Opened in 1984
- Site of old pyrolysis plant
- Burns 2,250 tons of trash per day
- Metals recovered; volume of trash reduced by factor of 10
- Capacity to generate 60 MW of electricity ⇐ ~6% typical nuclear plant
- Heat used for direct steam heating / cooling downtown Baltimore
- One of 16 such plants in the US

http://www.eia.doe.gov/kids/energy.cfm?page=RESCOE_Plan
Updates to Reading

Much of Chapter 5 is devoted to use of algae to scrub CO$_2$ from power plant stacks

Stack gas is an ideal feedstock for photosynthetic algae producing any one of a number of products.

The problem with using stack gas effectively is that it basically requires the use of enclosed photobioreactors to fully utilize the potential of the high concentration of carbon dioxide.

Photobioreactors are expensive to buy, difficult to maintain, and have never commercially succeeded for anything but nutraceuticals [nutritional food supplements]. Over the last ten years I've seen commercial algae photobioreactor designs move first from expensive, sophisticated hard plastic bubble columns all the way to what we're seeing now, which are essentially glorified clear ziploc bags, in the quest for cost reduction. Even so we are still at the stage where no photosynthetic algae play has achieved commercial success for anything but, as I said before, nutraceuticals or food supplements*.

The economics of algae fundamentally depend on being able to monetize the algae in some way - be that through tipping fees for water treatment, selling the algae, processing for oil, biofuels, biochemicals, etc. Even if the objective is to break even, there are significant costs associated with algae growth at a large scale.

Opinion of Josh Velson, expressed as:
https://www.quora.com/What-is-stopping-algae-from-being-used-to-capture-carbon-emissions-from-power-plants