

# CHEMICAL ENGINEERING CAREERS: OLD, NEW, EMERGING

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# OUTLINE

- Some thoughts about the world that relate to chemical engineering
  - It is a great time to be a chemical engineer!
- It is 15 months to graduation, what do you need to do to make the most of it!

# ACTUALLY, IT IS A GREAT TIME TO BE A JUNIOR!

CBE 20260  
Spring 2012  
Test #2  
2/16/2011

## 1. Treatment of process steam (35 points)

Process steam is generally available in different pressures and temperatures (e.g., as shown in this diagram) both because there are different needs for different uses and because it is always desirable to operate a boiler system in the most energy efficient way possible. This figure is an example of a system, which is using some of the steam in turbines for generation of electricity (the “Ts”) or for driving a specific large process device, like a compressor. Note that it does not show a common case where some of streams are may be re-fed into the boiler and the possibility that a stream is extracted at temperature and pressure much below the “VHP” steam which is a 10 MPa and 660C.

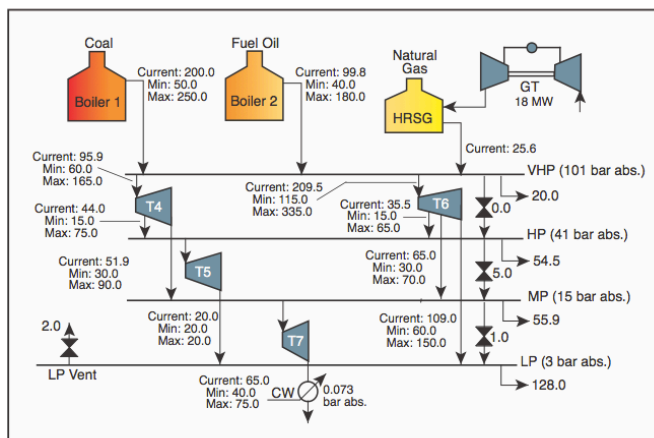


Figure 1. A typical site utility system for a CPI facility.

This problem will address some applications of process steam.

## 3. Steam train: 300 PSI, 650 F (25 points)

The Union Pacific Railroad has always been known for having some of the biggest, heaviest and most powerful locomotives. This was the case during the steam era and for a while during the diesel era until diesel electric locomotives became completely standardized.



One of most powerful late era steam locomotives was the Union Pacific 9000 series (and the longest rigid frame, non-articulated locomotive ever built). These could provide a tractive force of more than 96,000 lb. (430,000) Newtons. This force, at low speed, is comparable to modern diesel-electric locomotives.


The 9000 had 3 driving pistons. One on each side and one under the middle of the locomotive. These had dimensions 27 in. (diameter) and 32 in. stroke. The pressure in the boiler was about 220 PSI. The thermal efficiency of these could have been something close to 10%, (compared to a modern diesel electric which is about 30%).

We would like to analyze these to see if we can get some idea how they work and where the 10% comes from.

# GREAT NEWS AT NOTRE DAME!

- Professor Joan Brennecke has been elected to the National Academy of Engineering!
- Highest general award an engineer can earn!



A woman with long brown hair is speaking at a wooden podium. The podium features a black sign with the text "NATIONAL ACADEMY OF SCIENCES" in gold. A green plant is visible behind the podium. The background is a plain, light-colored wall.

NATIONAL  
ACADEMY  
OF SCIENCES

# GOOD NEWS

- As of a couple of weeks ago, all but a few of the class of 2012 Notre Dame chemical engineers who were looking for a regular job, had some options!

ECONOMY | FEBRUARY 17, 2012

## Share of Workers in Scientific Fields Shrinks

- *Analysis of Census Finds 4.9% in 2010, Down From 5.3% a Decade Earlier; Decline Is First Recorded in Labor Force Since 1950*

[Article](#)

[Video](#)

[Comments \(22\)](#)

# BAD NEWS

- You will have to make choices!
  - a pick of industry is not immediately irreversible
    - But at some point it will be harder to switch
- The issues are not just economic or confined to topics you find interesting

# GROWING AREAS FOR CHEMICAL ENGINEERS

- Healthcare
  - Issues: Cost, Availability, Cures for many afflictions
  - Genome sequencing has not yet paid off
  - “Science” has also not paid off
  - Engineers have not even had a shot at the problems yet.... you will
    - Obesity is a systems engineering problem it needs an engineering solution





Bob Langer, MIT,  
Brain cancer “patch”, skin  
replacement, tissue engineering for  
heart, liver



Adam Heller, U Texas  
glucose monitoring technologies  
that will generalize to other  
diseases



Mark Davis,  
Caltech  
Totally synthetic construct  
for gene delivery!

# ENERGY

- Chemical engineers are involved in all energy technologies ...we are enabling for most
- Interested?... How do you choose?
  - Soundness of technology
  - Sustainability
  - Other social/political reasons

# ENERGY: FRAC-GAS

## NEWS

### Business

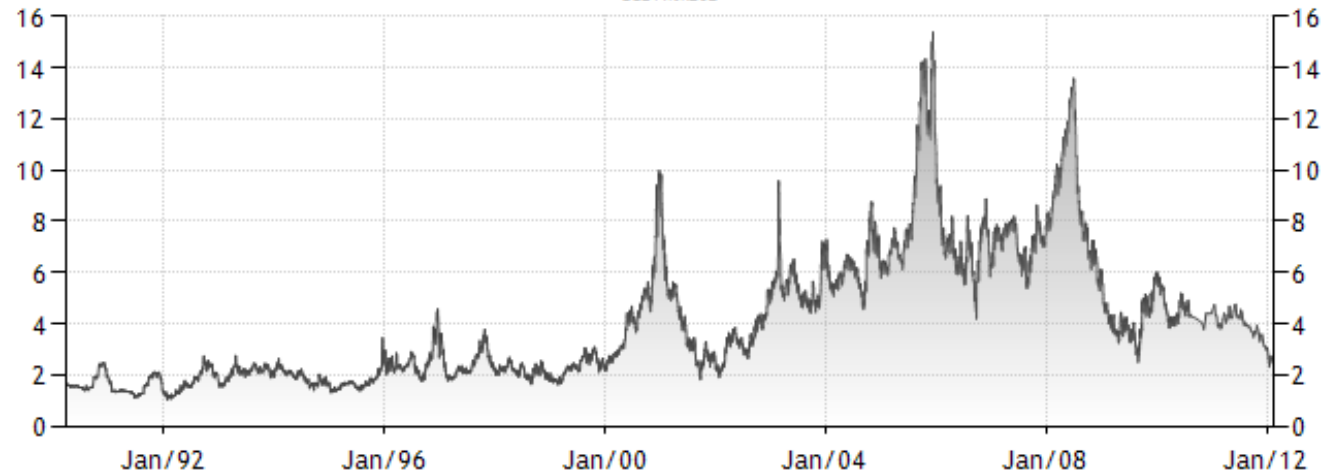
#### Natural Gas Boom Energizing The Chemical Industry



A Shell-owned ethylene cracker plant on Pulau Bukom,

Published: February 13, 2012  
by Jeff Brady

NATURAL GAS  
USD/MMBtu



SOURCE: WWW.TRADINGECONOMICS.COM | NYMEX

TOP STORIES IN Business

Google's iPhone Tracking



New Rich Fuel Luxury Boom

BUSINESS | DECEMBER 27, 2011

# Shale-Gas Boom Spurs Race

States Vie for New Chemical Factories—and Jobs—Powered by Lower Energy

Article

Stock Quotes

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By JAMES R. HAGERTY

The boom in low-cost natural gas obtained from shale is driving that use gas for fuel or as a raw material, setting off a race by st factories and the jobs they create.



Enlarge Image

Daymon Gardner for The Wall Street Journal

Ethylene cracker at Dow Chemical plant in Hahnville, La.

advantage of the plentiful new gas supplies.

RLD

New “Steel in the ground”, Surprising!

Shale-gas production is spurring construction of plants that make chemicals, plastics, fertilizer, steel and other products. A report issued earlier this month by PricewaterhouseCoopers LLC estimated that such investments could create a million U.S. manufacturing jobs over the next 15 years.

West Virginia is vying with Pennsylvania and Ohio to attract an ethylene plant that [Royal Dutch Shell PLC](#) said it plans to build in the Appalachian region to take

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## Shale-Gas Boom Spurs Chilean Methanol Plant's Move to U.S.

January 18, 2012, 7:25 PM EST

Recommend Tweet 41 Share 13 +1 0 E-mail Print

By Jack Kaskey

(Updates with number of jobs created in fifth paragraph.)

Jan. 18 (Bloomberg) -- Methanex Corp., the world's biggest methanol maker, plans to dismantle an idled Chilean factory and ship it to Louisiana where it will be reassembled to capitalize on the lowest U.S. natural-gas prices in almost a decade.

MORE FR

Huntsman Capacity Drop

Harry Win Citigroup Mover

Deere Falls U.S. Farm

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## Huntsman May Relocate Capacity to U.S. After Gas-Price Drop

February 16, 2012, 7:59 PM EST

Recommend Tweet 5 Share 1 +1 0 E-mail Print

By Jack Kaskey

(Updates with closing share price in ninth paragraph.)

Feb. 16 (Bloomberg) -- Huntsman Corp., the world's biggest maker of textile dyes, plans to expand chemical production in the U.S. and may relocate some capacity from other countries to take advantage of a drop in domestic natural-gas prices.

MORE FROM BUSINESSWEEK

Gas Well Inspections to Be Required After Fracking, Salazar Says

EOG Channels Enron Roots While Outperforming Chesapeake: Energy

China Shale Delay to Boost LNG Imports in Boon for Exxon: Energy

# EFFECT ON OTHER INDUSTRIES

## Marcellus Shale gas drilling industry creates demand for cars in economically stagnant areas

Published: Thursday, February 16, 2012, 8:11 PM



By **IVEY DEJESUS**, The Patriot-News

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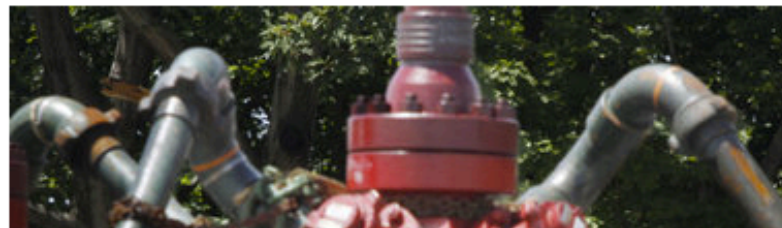
+1 0

Print

A bellwether of the economy, the auto industry has seen its ups and downs.

Analysts are pointing to a strong year, but for a select number of car dealerships, 2012 is poised to deliver a bonanza in sales.

Across the rural swaths of northern and western Pennsylvania, the **Marcellus Shale gas drilling industry** has created a robust demand for cars — especially trucks — from dealers that typically serve economically stagnant towns and counties.



# WIND PROBLEMS

Chicago Tribune  
**BUSINESS**

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## End of tax credit a blow for wind power industry

### Up to 37,000 jobs, many in Illinois, could be lost as projects are halted or abandoned

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By **Julie Wernau**, Chicago Tribune reporter  
*February 17, 2012*

The wind power industry is predicting massive layoffs and stalled or abandoned projects after a deal to renew a tax credit failed Thursday in Washington.

The move is expected to have major ramifications in states such as Illinois, where 13,892 megawatts of planned wind projects — enough to power 3.3 million homes per year — are seeking to be connected to the electric grid. Many of those projects will be abandoned or significantly delayed without federal subsidies.

## AEC Wants Cellulosic Ethanol Requirements Continued

Posted on 16 February 2012 by Andy Eubank

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Several oil industry associations have asked the Environmental Protection Agency to retroactively waive the 2011 cellulosic ethanol requirements under the RFS as no reported volumes of cellulosic ethanol production were reported. The Advanced Ethanol Council believes that waiver should not be issued. In a letter to the EPA, AEC Executive Director Brooke Coleman pointed out that Congress anticipated potential shortfalls in cellulosic ethanol production in the early years and created a mechanism to address such a situation.

Coleman continues, – we are well-aware that the commercialization of cellulosic biofuels is behind the schedule set forth by the federal RFS. However, Congress anticipated the inevitable uncertainties and variability inherent with the commercialization of new technologies and set up a credit waiver system to account for variances from the established schedule for advanced biofuels,

DT

# ETHANOL UNCERTAINTY

## Wood-to-Ethanol: Avoiding a New Biofuel Boondoggle

by Timothy Hurst on February 14, 2012

2 Comments and 17 Reactions

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Once taught that that corn-based ethanol was a cleaner, greener fuel, we soon learned that large-scale production of corn-based ethanol not only had a direct impact on the price of food, life cycle analyses showed that it had a deleterious effect on air quality, water quality and was a net producer of carbon dioxide, the most prevalent heat-trapping greenhouse gas.



So when the federal tax credit for corn-based ethanol expired at the end of 2011, companies began stepping up their efforts to realize one of the holy grails of biofuel: commercial-scale cellulosic ethanol.

## BP: cellulosic ethanol is real, here, and no pixie dust

Jim Lane | February 16, 2012

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In Washington, BP Biofuels North America President Sue Ellerbusch, interviewed in the Biofuel STAT online series produced by the Advanced Biofuels Association, rejected recent headlines describing the industry as “pixie dust” by declaring “the technology works.”

The next ah-ha moment for the industry? “It’s going to be less of an ah-ha and more of an uh-huh, we told you so. We are right on the cusp with this technology.” Over the next five years? “We are building a 36 million gallons facility now. Our next facility will be double the size of that. As we look beyond, we will be looking to see how far we can take that capacity up.

“There are lots of stories because it makes good media to talk about that it’s pixie dust or fairies out there and people have been working on this for ten years and are we going to have it,” Ellerbusch says. “I am here to tell you we do.”



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## RELATED

Impact of Genesis solar project on local desert kit foxes

## FROM THE ARCHIVES

Arizona firm in deal to spread sun power to China  
*September 9, 2009*

Using solar heat to power air conditioning  
*August 20, 2009*

Future cloudy for California solar farm  
*January 13, 2009*

State solar power plans are as big as all outdoors  
*December 3, 2008*

## MORE STORIES ABOUT

Environment  
California

## Problems cast shadows of doubt on solar project

*The unexpected deaths of kit foxes and discovery of ancient human settlements threaten to delay or even cancel a \$1-billion, 250-megawatt installation on federal land in the desert near Blythe.*

February 11, 2012 | By Louis Sahagun, Los Angeles Times

Reporting from Blythe, Calif. -- One of California's showcase solar energy projects, under construction in the desert east of Los Angeles, is being threatened by a deadly outbreak of distemper among kit foxes and the discovery of a prehistoric human settlement on the work site.

The \$1-billion Genesis Solar Energy Project has been expedited by state and federal regulatory agencies that are eager to demonstrate that the nation can build solar plants quickly to ease dependence on fossil fuels and curb global warming.

Recommend 13

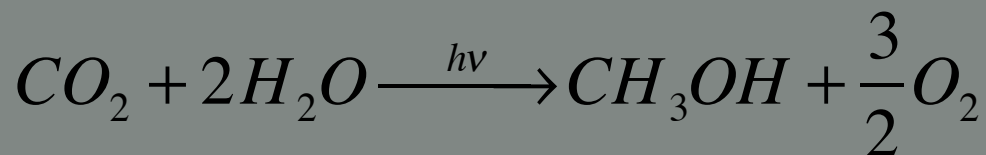
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# ISSUES WITH SOLAR

A noble pursuit, but keep your eyes open!

Solar to liquid fuel



## Germany's sunshine daydream

FEBRUARY 16, 2012 - 4:39PM



Bjørn Lomborg

About the Author



COPENHAGEN – One of the world's biggest green-energy public-policy experiments is coming to a bitter end in Germany, with important lessons for policymakers elsewhere.

Germany once prided itself on being the 'photovoltaic world champion', doling out generous subsidies – totaling more than \$130bn, according to research from Germany's Ruhr University – to citizens to invest in solar energy.

# CHOOSING FIELD OR COMPANY

- Check financial reports of companies
- Look at societal issues
- Decide what is best decision for you

# CHEG '86 ALUMS IN DIFFERENT FIELDS



# SHAWN O'GRADY

- Senior VP, President, Consumer Sales, General Mills
  - 2 years at Air Products
  - Harvard Business School
  - First Marketing (including Wheaties!) then Sales for General Mills
    - Has a basketball court in his basement that is painted in a Notre Dame sports theme!
- “...WHY, do we do it this way?”
- Even as a student, was extremely personable and gregarious -- leading large groups of people was a natural for him

# ROB LUCCHESI

- Exxon/Mobil Downstream Portfolio Manager:
  - PhD in Chemical Engineering from Princeton
  - Career in various positions at Exxon since 1992
  - Responsible for research improve XM's products and profitability
- Was a “top of the class” student -- career has been perfect for him!

# STUDENTS: LOOKING FORWARD...

- If you have an interest in graduate school you should be doing research or you need to start this by summer!
- If you are planning for a job, you need to begin planning for this now
- Also, please don't drop the ball on classes
  - but, most likely technical skills will be more than adequate!
    - polishing could help -- talk to people

# TRANS-TECHNICAL ACCOMPLISHMENTS

- Differentiation from a “resume” standpoint
  - Have you done something that engineers do not typically do -- meaning not associated with curricular engineering
  - Make sure this is prominently displayed on your resume and that you can talk about it.

# TRANS-TECHNICAL SKILLS

- Efficient, enlightened, engaging conversation
  - Your chance at a first and continuing positive conversation
  - You need to know rudimentary principles of economics and finance (since you are an engineer) and have a broad understanding of modern society



# ALUMS FROM 2005/6



Just finishing PhD's at MIT

# SUMMARY

- Despite the current overall economy, it appears that you will have to make choices as you start your careers
  - This may considerations beyond your current scope of knowledge
- You probably should take time to reflect and work on things that could improve the chances of early career success...
  - Quick recall of technical skills
  - Improvement and polishing of informal communication abilities

# (academic) “TASSEL” LIST

- Go with your lab or HW group for breakfast or lunch with one of the faculty
- voluntarily take a deep academic experience e.g., figure out what the 2nd law really means, or what a normal viscous stress is or figure out why infinite domain transport problems have similarity variables naturally arising.
  - we can help!
- Ask a really perceptive question in class, or any question if you have never done it!
- Compliment a faculty member on a particularly good lecture

# TASSEL LIST (CONTINUED)

- Explain (e.g.,) the utility of knowing the consequences of the first law of thermodynamics when, say, making green energy policy at ND, to a non-engineer !
- Read a publication written by one of the faculty members and discuss it with him or her over coffee.
- Attend a department research seminar or a similar seminar in another department
- Develop a fully-informed and well thought position on an important world problem
- Make a constructive suggestion for course improvement on the CIF