Economic Incentives for Green Chemistry

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**Abstract:**

The subject of this proposal in Green Chemistry and how economic incentives can lead to the greater implementation of this field in multi-billion-dollar companies around the United States and the world. Organic chemistry research has always been wasteful, and the techniques and field of Green Chemistry can begin to change that dramatically if it was incentivized more. Right now, the government only supplies an award with recognition for employing more sustainable techniques, when tax breaks would encourage this implementation further. With increased incentives from the government and the internal incentives of decreasing costs for the company, it is expected that more of these companies would start employing these techniques. There would also be an increase in centers that just practice Green Chemistry like John Warner’s institute for Green Chemistry. It can be concluded that there would be causation between more governmental economic incentives and more implementation of Green Chemistry.

**Introduction:**

Organic chemistry and organic chemistry research, especially at large companies, are extremely wasteful and harmful to the environment.  The necessity for harsh solvents, high temperatures and dangerous, corrosive chemicals is staggering and the amount of waste used is in the billions of gallons (Information, EPA).  These chemicals have a detrimental effect on the health of every living thing they meet.  However, there is a way to create a more health conscious and environmentally-friendly way to create helpful molecules.  This methodology is defined by twelve principles and has since become a field of its own; the field is known as Green Chemistry.

Green Chemistry was spearheaded by Paul Anastas and John Warner when the Environmental Protection Agency (EPA) decided that the chemical industry needed to start changing in order to create a better and more sustainable field in which to discover.  John Warner has repeatedly said that, since starting work in Green Chemistry and founding an institute in the field, that success and increased efficiency has come from the twelve principles that make up the rules of Green Chemistry.  This leads to the question, though, of why big companies like Amgen and Celgene employ Green Chemistry principles when they already make an absurd profit and have over nine hundred products that they could be working on any given point (News, P&G).

This field has been incentivized by the government, but needs to be further implemented to make chemistry and the running of chemical reactions better.  These incentives have provided many benefits for the field of Green Chemistry as well as the companies implementing the principles.  The largest recognition a company can receive is a prestigious award called the Presidential Green Chemistry Challenge Award.  This award just gives recognition to the company, but the economic incentives are more internal rather than external.  Part of Green Chemistry is the reduction of waste and transferring more starting material to what is being made (Anastas).  Seeing as how there is more material to sell and less need to buy excess material to start the reaction with, internal costs go down and profit, therefore, increases.  However, to get all of these big corporations to transfer to Green Chemistry principles the question must be asked, do more economic incentives increase the use of Green Chemistry in pharmaceutical companies around the country and the world?

**Background/Related Work and Motivation:**

During the current semester, I have been enrolled in an organic chemistry class, which has spurred on the desire to study this field, but John Warner gave a lecture on campus and it was stunning so my interest in Green Chemistry multiplied.  I have been interested in chemistry since I first began to learn about it in high school.  Since taking these classes, the interest to discover more in mechanisms, organic molecular properties and how they affect the human body have become at the forefront of my career plans for the future.

The previous work done in this field has stemmed from the beginning with John Warner.  He discussed many of the success that he has had in the field, beginning with the connections between chemical processes from asphalt to beetles to hair color (Warner, Bioneers).  Warner’s personality, passion, and motivation have accelerated the field and brought it into mainstream news (Clift, GreenBiz).

Green Chemistry in and of itself poses quite a challenge because of the way research has been conducted for so long, changing the way someone goes about doing said research is quite difficult.  However, the success that Warner and others are finding directly stems from Green Chemistry processes and it is incredibly inspiring to see how effective and productive they are being by reducing waste and changing the way reactions are conducted.  The ability to find chemical processes that relate to each other like the aggregation of proteins in Alzheimer’s disease and the aggregation of semiconductors in solar panels allows for progress in discovering a cure and an increase in the use of renewable energy sources, respectively (Warner, Bioneers).  The chemistry community is slowly beginning to realize that molecules do not need to be “slammed together” to get a reaction, but only need the right conditions and correct process to put themselves together at room temperature.

Anastas and Warner came out with a book on Green Chemistry outlining the principles for Green Chemistry and they are as follows: Waste prevention, atom economy, less hazardous chemical synthesis, designing safer chemicals, safer solvents and auxiliaries, design for degradation, real-time pollution prevention, and safer chemistry for accident prevention (Anastas, *Handbook*).  Most of these are pretty self-explanatory, but atom economy simply means that the atoms going into the reaction are becoming product relatively efficiently.  In terms of science and the economy, some are of the opinion that future is tied to science and economics and more economic incentives should increase the implementation of Green Chemistry to secure a better future.

**Methods:**

I plan on doing two different areas of research in order to formulate an answer to my question.  I would like to begin my finding out more on Green Chemistry, its purpose, and its benefits and drawbacks, then I would like to find out how economics functions with the scientific community and how to stimulate Green Chemistry with economics.

To begin, Green Chemistry has been written about and discussed at conferences and studied at institutes specifically designed for work in the field.  More information can be found through videos of these conferences, textbooks, and papers written within the field.  The pharmaceutical industry will be the focus since the largest companies run these reactions quite a bit particularly with substances like acetaminophen, the common painkiller found in Tylenol.

The second aspect of this research comes with economics and incentives for the implementation of Green Chemistry.  What are the economic incentives for implementing these principles in everyday reactions for researchers and for large companies, universities, etc.  particularly with large pharmaceutical companies because they can afford to be wasteful.  Multi-billion dollar companies do not really care about waste because they will make an outstanding profit year in and year out anyway.  However, with how Green Chemistry prevents waste and the need to order less reactants to run reactions, the field allows for less cost overall to a company and this alone should increase profits, making Green Chemistry a viable option for these companies.  The experiment then becomes to increase economic incentives/increase education and awareness about Green Chemistry and see if this causes an increase in the implementation of the techniques and a decrease in pollutants leaving the factory.

**Expected Results:**

I expect to see a direct correlation of Green Chemistry techniques implemented to increased economic incentives. Many companies and laboratories have already been employing these green techniques with great amounts of success.  The results that should be seen is a causation between Green Chemistry techniques being used and governmental economic incentives being given to these specific corporations.

Another possible outcome of this work is more foundations that just research in the field of Green Chemistry since costs would be much lower than the way organic chemistry research is done currently.  The Warner-Babcock Institute for Green Chemistry has already been pioneering the field and creating the future of chemical research so my results could lead to more of these kinds of facilities becoming more prevalent in daily life.

**Conclusion:**

Green Chemistry has massive implications for the future as seen with John Warner’s presentation and the ideas and progress that is already being made within the field.  In terms of economics, green chemistry just makes logical sense because large companies stand to make more money, which is in their own self-interest, and it has the bonus of helping the environment, which is great for public relations.  The only difficult part about implementing green chemistry is the changing of habits that have already been established within certain companies.  Dr. Stephen Heller can corroborate this statement as he has worked for that particular industry and has a doctoral degree in chemistry as well as running his own research group focusing on reaction optimization and development.  Overall, green chemistry is the logical choice for companies to implement and has long term health benefits for the world and is viable as an option right now.  Overall, I expect that with greater incentives, Green Chemistry will become to dominant form of chemical research in the years to come.

**Budget:**

The resources for this particular proposal are travel to Washington D.C. to discuss the politics of this issue with the EPA and possibly people in Congress to see what the viability of a bill like this would be. Round trip airfare and a hotel for a week would cost roughly eight hundred dollars and visitng the Warner-Babcock Institue would also cost roughly the same amount. This whole project would cost roughly 1600 dollars minimum so for safety, 2000 dollars would be a viable amount for this research to be successful.

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