HEALTH & ENVIRONMENTAL FUNDERS NETWORK

Green Chemistry: Strategic Opportunities

By: Frank Ackerman

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About this Paper

We asked economist Frank Ackerman to assess our starting points in terms of capacity to make an economic and/or jobs case for transitions towards safer chemicals and materials. He was charged to assess current capacity, tools, and expertise that could help produce sound economic analysis of strategies to shift from toxic chemicals to greener chemicals and materials. He also was asked to flag needs and opportunities for grantmakers to advance this economics-green chemistry work further.

Ackerman's paper, as requested, offers a quick, accessible review of economic models and tools that may prove useful to those interested in evaluating the costs and benefits of a green chemistry-related economic development strategy.

His paper may be even more interesting for some of its analytical points about opportunities to advance the economics case for green chemistry-related economic development. For instance, Ackerman takes aim at the oft-advanced argument that pursuing a "green" economic strategy will cost jobs. He suggests that pursuing green economics strategies purely on a jobs platform may be on similarly questionable ana lytical ground. Drawing on lessons from Europe, Ackerman highlights the potential for making the economics case stronger by assessing societal savings -- in health, hazard management, and other costs – that would result from shifts from hazardous to safer chemicals.

Kathy Sessions
HEFN Coordinator
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About the Author

Frank Ackerman is the Director of the Research and Policy Program at the Global Development and the Environment Institute at Tufts University. He received a Ph.D. in Economics from Harvard University and a B.A. in Mathematics and Economics from Swarthmore College. His current interests include the economics of materials, waste, energy and climate change and their relationship with the environment.

Among Ackerman's many relevant research projects was a report commissioned by the Nordic Council of Ministers (representing the Scandinavian countries) to calculate the expected costs of proposed chemicals policy reform legislation (known as REACH) in the European Union. In the debate over REACH, a German industry federation hired consultants who claimed that REACH would destroy European manufacturing. Ackerman's work for the Nordic Council demonstrated that industry claims of the legislation's costs were exaggerated; his study showed that REACH would raise the cost of chemicals sold in Europe by 1/16 of one percent. The REACH legislation has now been adopted by the European Union and is moving into implementation.

Foreword

HEFN is pleased to offer this paper on “Green Chemistry – Strategic Opportunities” for grantmakers interested in exploring strategies for building a healthier materials base. The paper was commissioned by HEFN for its Catalysts Collaborative, with financial and intellectual support from the Funders Network on Smart Growth and Livable Communities, the Heinz Endowments, the Kendeda Fund, and the Johnson Family Foundation.

This is one of two papers HEFN is releasing that aim to open or advance philanthropic conversations about big questions: What foundation investments could help enable our communities to transition past their current economic dependence on toxic chemicals, products, and processes? How might funders leverage public and private investments in green chemistry capacity to develop safer alternatives? Where are the grantmaking opportunities to align emerging green chemistry innovations with other environmental, health, and equity objectives, such as sustainable economic and workforce development?

If you find this paper of interest, we encourage you to explore other analytical resources related to green chemistry and economic transitions that have been produced by key actors in this emerging field. HEFN has begun to archive particularly interesting resources on our website at www.hefn.org. We also encourage others to share relevant analysis or resources through HEFN’s open-source website, to help build a stronger shared knowledge base about the pathways towards a healthier future.

HEFN wishes to express its deep appreciation to report author Frank Ackerman, to Diane Ives with the Kendeda Fund and Ellen Dorsey with the Heinz Endowments for their intellectual leadership to the Catalysts Collaborative’s work on green chemistry and economic transitions, and to the Heinz Endowments, Kendeda Fund, Johnson Family Foundation, and the Funders Network on Smart Growth and Livable Communities as the joint sponsors of these 2007 papers.

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Introduction

One way to grasp the opportunity and the challenge of green chemistry is to think about the size and economic importance of the chemical industry. There are 100,000 chemicals in common use today, most of which are derived from petroleum and coal. The chemical industry accounts for about 13 percent of world trade. In 2001, the output of the chemical industry worldwide was valued at over $1.60 trillion. In the United States, about one million people are employed in the industry, and it constitutes about one percent of GDP.1

The chemical industry began to take off in the mid- 19th century. Green chemistry is in its infancy, and it is still being defined. The OECD defines green chemistry as: "the design, manufacture, and use of environmentally benign chemical products and processes that prevent pollution, produce less hazardous waste and reduce environmental and human health risks." In particular, the use of renewable feed-stocks is a principle of green chemistry. This principle is a challenge to the chemical industry, as the bulk of its feed-stocks come from petroleum, coal, and natural gas. Thus, simply in terms of scope and scale, the transition to an industry based on the principles of green chemistry is a massive and complex undertaking.

Ken Geiser and Alexander McPherson have underscored the challenges in a green chemistry transition: 2

> The current state of the chemical industry is not conducive to innovation inspired by environmental or health factors. The current efforts to introduce green chemistry or other innovations that conserve resources and reduce waste are slow, piecemeal and often overtly resisted. The chemical industry is a mature, capital intensive, multina tional industry. Process innovation is often risky, expensive and difficult, giving the chemical industry one of the longest new product technology cycles (10-20 years) and new process technology cycles (40-50 years) in all of manufacturing.

Geiser and McPherson's comments underscore some of the challenges in the transition to a green chemical industry. However it comes about, the transition will be long and complex—with many intermediate phases and steps.

Overview of Part I

There is widespread interest in green chemistry-based strategies for local, state, or regional economic development. Does it make economic sense? Can green chemistry contribute to strategies that will succeed in economic development, and above all, in job creation? The answer, in a word, is definitely "yes." But the issues raised by the question are complex, leading to a number of obstacles and opportunities that confront the advocates of the new strategies.

This review of the economics of green chemistry-based development has six sections, making the following points:

1. The threat of overall job loss from environmental improvement is an ancient and discredited myth. Research has repeatedly demonstrated that doing the right thing for the environment creates jobs, many of them in traditional blue-collar occupations. There are only a few reasons why job creation per million dollars of spending varies from one program to the next; none of them suggest that green chemistry is any worse than the alternatives.

2. The calculation of employment impacts may win over some "friendly skeptics," but it does not answer every question about a new program. Federal Reserve micro-management of the economy, as currently practiced, can easily defeat major job creation efforts. There is no way to protect every existing job in an economy of rapid job turnover. Instead, there is a need for transitional assisance, income support, and retraining for those who are displaced.

3. Tools for calculation of employment impacts are readily available; a number of economic models have been used. Many university economists and consultants can perform such studies. In view of the preceding discussion, this is not usually an area where more detailed, in-depth analysis is required.

4. Chemical hazards cause substantial health and environmental damages, providing an additional argument for new, green strategies. Surprisingly large price tags are attached to some of these damages. Campaigns that can highlight the health benefits and the economic savings from green chemistry would be a promising strategy.

5. "Green marketing" is sweeping the business world; while some of it is pure hype, the explosive success of green building products illustrates the potential for new, environmentally defined markets.

6. Economic development in the United States tends to pit communities and states against each other in terms of taxes, regulations, wages, and so on, at enormous human and environmental cost. Philanthropy might want to look at the policies that promote this competition — while at the same time paying careful attention to local resources and capabilities needed to develop realistic, locally appropriate plans. There are many opportunities today for local and immediate work, as evidenced by the existing work in building materials and bio-plastics, that should be pursued.

1. The myth of job losses and how to combat it.

Will doing the right thing for the environment and human health result in massive job loss? This is one of the most persistent wrong ideas in American politics. It apparently lives on, as a challenge that progressives have to answer yet again, despite decades of research supporting the opposite conclusion. Eban Goodstein's book, The Trade-Off Myth, confronts the myth head-on. Documented examples of layoffs with environmental causes are virtually all confined to extractive, resource-based industries such as logging, mining, and fishing, where the industry's primary activity is the direct cause of environmental damages. Such impacts can and should be addressed by adjustment and retraining programs tailored to specific communities and industries. Beyond extractive industries, in manufacturing and elsewhere, environmentally caused layoffs are common threats in business rhetoric, but extraordinarily scarce in reality.

Updates to this analysis can be found in "Prospering With Precaution," a short review of the topic by Frank Ackerman and Rachel Massey[4], written as part of a (successful) effort to win Massachusetts AFL-CIO endorsement of the anti-toxics program of the Alliance for a Healthy Tomorrow; and in "The Unbearable Lightness of Regulatory Costs," a more recent review of the controversy by Frank Ackerman.[5] Until recently, the Bureau of Labor Statistics collected information on the proportion of extended mass layoffs (more than 50 workers out of work for more than a month) related to environmental issues; one out of every thousand extended mass layoffs was related to the environment, while 999 out of every 1000 were not. (That one in a thousand could represent layoffs occurring in extractive industries.)

Independent academic studies have repeatedly confirmed the finding that environmentally preferred strategies create as many, or more, jobs as the old, polluting alternatives. For instance, a UC-Berkeley analysis of employment impacts of alternative sources of electricity, reviewing 13 other studies and creating its own model of employment impacts, offered the following summary of its findings: *A key result emerges from our work: Across a broad range of scenarios, the renewable energy sector generates more jobs than the fossil fuel-based energy sector per unit of energy delivered.*[6]

The Apollo Alliance has developed a political strategy centered on emphasizing the employment benefits of clean energy, smart growth, and energy efficiency. Their detailed calculations show huge potential gains in employment throughout the country, totaling as many as 3 million new jobs. This is not surprising since, as Apollo's website puts it,

Modernizing our extensive energy infrastructure requires building America's capacity to manufacture high tech renewable energy technologies.

New energy technologies like wind turbines and solar panels, once built, will require regular operating and maintenance by skilled workers. These jobs are impossible to outsource.

Renewable energy, smart growth and energy efficiency all require construction, sometimes on a very large scale.[7]

Van Jones, head of the Oakland chapter of the Apollo Alliance and the Ella Baker Center, is leading an effort for a Green Job Corps in Oakland and around the country. This effort goes beyond green chemistry, but it is obviously a place to investigate how green chemistry can add to the job creation efforts, and to the protection of human health and the environmental in urban settings.

Protecting the environment is reliably good for employment. How could it be otherwise? Jobs are created by increased spending on almost anything – building schools, building yachts, launching new green chemistry programs, producing weapons to use in Iraq. There are not only the direct jobs created in the new activity itself, but also several categories of indirect jobs that result from the same spending. Workers are employed in industries that supply material inputs to the main activity; when workers spend their wages, they create additional jobs in consumer goods and service industries; and the taxes paid by workers create a small number of government jobs. (These categories are usefully analyzed, and estimated, in publications from the Economic Policy Institute, a valuable source of information on employment issues and impacts in general.[8])

Does it matter what the money is spent on, in terms of job impacts? Yes, at times – but it matters less than most people think. There are only a few ways in which spending a million dollars on option A rather than B can change the number of jobs in the economy.

- One option may involve lower-income workers on average: a million dollars spent on child care creates more jobs than the same money spent on high-tech solutions to environmental (or military or other) problems, because child care workers are paid so little.

- One option may involve more profits, or payments to owners of natural resources; these profits and rents may be saved, or invested in speculative, unproductive pursuits, rather than being spent. If recycling and landfilling of municipal waste would cost the same amount, recycling is likely to create more jobs, because more of the cost of landfill ing goes to land owners.

- One option may involve more imports, and hence "leakage" out of the economy: a million dollars spent on imported oil or imported Danish windmills creates fewer US jobs than a million dollars spent on insulating existing US homes. (On a global level, imported windmills create manufacturing jobs abroad; imported oil involves large payments to land and resource owners, as in the previous point.)

There is a risk of misleading comparisons: if one option is more expensive, it will tend to create more jobs. In the UC-Berkeley study of energy options, cited above, photovoltaics create many more jobs, per unit of electricity, than other options; but at current prices, photovoltaics are also more expensive, per unit of electricity. Even if they create the same number of jobs per million dollars, they will create more jobs per unit of electricity. As this example suggests, the objectives of job creation and cost minimization are frequently at odds with each other: photovoltaics currently create more jobs than other sources of electricity, precisely because they fail to minimize costs in most applications (they become more competitive in remote applications far from the grid).

In short, "if you spend it, the jobs will come." Spending of any kind creates jobs, and aside from the few factors listed here, the same amount of money tends to create the same number of jobs. The myth of massive job loss may rest on a false picture of money spent on the environment being removed from the "real" economy and somehow being thrown away. If conspicuous consumption consists of lighting a cigar with a $100 bill, then no jobs are created (as opposed to spending $100 on luxuries, which employs workers in producing and delivering luxuries). But burning up $100 bills is not an appropriate analogy for any known environmental initiative. Even old-fashioned, end-of-pipe control technologies, now often scorned as less efficient and forward-looking than pollution prevention, are quite good for industrial employment: skilled workers are required to build those controls and bolt them onto the ends of pipes.

To underline what should obvious, the good news here is that the economics of job creation opens the door to a much greater emphasis on the health and safety of the jobs involved and on the environmental implications.

2. Limits of employment-based strategies

It is true that green development and environmental protection can create jobs. This answers the key question asked by one particular type of friendly skeptic: someone who would otherwise like to endorse the project, but is deterred by the imagined threat of massive job loss. Such friendly skeptics do exist in labor unions, and among local politicians concerned about labor issues and community development. Convincing the friendly skeptics may, indeed, justify doing the employment calculations that are described in the next section.

But this target audience for the employment calculation is far from the entire population of critics and skeptics of new initiatives. Questions focused on the employment impacts of a proposal may reflect a belief that the proposal itself is not so important or valuable. After all, as University of California economist Stephen DeCanio points out, if we were convinced that an asteroid was on course to strike the earth a few years from now, no one would be talking about the employment impacts of building the rockets needed to deflect it..[9] Likewise, supporters of the war in Iraq, or the "Global War on Terror," do not defend their proposals for mobilization by pointing to the resulting increases in employment.

The argument from employment benefits is a fickle supporter. Green chemistry creates jobs, but so does "brown chemistry." Jobs are also created by manufacturing metal detectors for use in airports and public buildings, and by replacing weapons and equipment that have been destroyed in Iraq. Such expenditures have the larger appeal, for their supporters, of addressing more dramatic and easily explained priorities; the jobs that are created along the way are a secondary bonus, not a top selling point.

Moreover, all job creation, resulting from programs favored by the left or the right, is potentially held hostage by the Federal Reserve and its management of the business cycle. Increasingly, short-run macroeconomic policy is in the hands of the Federal Reserve Board, which sets (low) inflation targets and constantly "fine tunes" the economy to achieve those targets. If, say, the Apollo Alliance program with its 3 million new jobs were somehow enacted from below, the unemployment rate would drop by two full percentage points, threatening inflationary wage increases. The Federal Reserve would undoubtedly respond by raising interest rates in order to slow down economic activity and reduce inflationary pressure. The result might well be layoffs of about 3 million workers, restoring the previous unemployment rate in order to block any wage-price spiral before it started. While important shifts between industries would occur, the net nationwide job creation would, on balance, be close to zero.[10]

There is one more political pitfall regarding employment impacts. It is relatively easy to demonstrate that green chemistry, smart growth, and other environmentally oriented development strategies will (if the Federal Reserve is willing) lead to increases in total employment. In contrast, it is impossible to create a development strategy – or, for that matter, any public policy that is big enough to be worth talking about – that leaves every existing job unchanged. Yet representatives of labor unions (who are understandably anxious about job loss), and others seeking to work with labor, will at times demand guarantees that no existing job will be affected by new initiatives. There is no honest way to comply with this demand; it rests on an unrealistic picture of labor markets.

The overall pace of change in employment is breathtakingly fast: in the month of April 2007, for example, millions of jobs were created and destroyed. The net gain of 300,000 jobs that month came about because there were 4.8 million new hires, and only 4.5 million "separations," a category that includes voluntary quits, layoffs, firings, and retirements. Even in manufacturing, which lost 30,000 jobs that month, there were 350,000 hires and 380,000 separations.[11] If this was a typical month (as it appears to be), then in addition to any net changes in employment, there is ongoing turnover of more than 50 million jobs per year throughout the economy, and more than 4 million in manufacturing. In this context, promises to protect individual jobs from change resemble King Canute's conversation with the waves.

Recognizing the inescapable pace of labor market turnover, it is far more important and relevant to support transitional assistance for those who are displaced, including retraining and income support. Unlike the vain hope of stopping change, protecting those who suffer from change is a plausible (though politically difficult) response to the ever-changing patterns of employment.

There are three implications here:

• Again it may be obvious, but in the context of jobs and economic development, the case has to be made about why the transition to green chemistry is critical for human health and the environment.

• And that case can be localized to the area under discussion: what kinds of jobs, what kinds of chemicals and processes — what are the alternatives? The Lowell Center's "Alternatives Assessment Framework" provides a methodology for such a discussion.

• We need to know more about transitional job assistance and be prepared to integrate questions about such assistance into larger campaigns around green chemistry.

3. Tools for calculating employment impacts

When employment impact calculations are needed, a variety of tools are readily available. These will be most easily applied by a consultant, university economist, or other researcher who is already familiar with such analyses; however, they could in principle be used by anyone who is comfortable with spreadsheet calculations.

The most challenging step in the process often occurs prior to the use of an economic model, in framing the analysis in a manner compatible with the model. By way of analogy, consider the process of doing your income taxes. Many people depend on tax preparation software, or on tax preparation services (which use the same kinds of software), to do the intricate calculations required by the tax code. The difficult part of the process is not installing the software and pushing the "Enter" key (or paying the tax preparation service to push it for you), and then waiting for the computer to calculate your taxes. Rather, it is much harder to gather and prepare the inputs: Which of the checks you wrote last year are charitable contributions? Which of the receipts stuffed in your desk drawer are deductible expenses? And so on.

Similarly, finding and categorizing the data on a new economic development strategy is most of the challenge in analyzing employment impacts. As with income taxes, it helps to know in advance what categories you are going to use – but each case will have unique aspects and problems. It is in this stage of "pre-analysis," i.e. preparing the data for use in a model, where experience with such models and economic expertise may be most needed.[12] Some of the features of the pre-analysis stage will be easier to describe after a look at a few of the leading models.

Most employment impact calculations are based on "input-output" (I-O) models. It is easy to find out how many jobs there are in the auto industry; but how many jobs does the industry indirectly create at its suppliers? To produce cars, auto companies buy rubber tires, steel, paint, and many other supplies, creating jobs and incomes not only in the auto companies themselves, but also in rubber, steel, and paint companies. In turn, rubber companies make purchases from oil refineries; steel companies buy coal; paint companies buy chemicals; and so on. I-O models, developed long ago by Nobel Prize-winning economist Wassily Leontief, follow all of these supply chains throughout the economy, estimating the total employment and incomes created by the purchase of automobiles, or other final goods.

A national I-O model for the US economy is estimated every five years by the Commerce Department's Bureau of Economic Analysis (BEA). The calculations are massive, and results appear only with a long delay: as of mid-2007, the 2002 I-O tables are just beginning to appear; the latest complete set of I-O results describes the US economy as of 1997.[13] However, for many purposes, the geographical area of interest is much smaller than the US as a whole.[14] There are several systems, usually based on the national I-O model, for estimating regional employment and income impacts. If an auto company buys steel from a local producer, but tires from another state, then the regional I-O calculation of auto company impacts would include the indirect employment generated in the nearby steel company, but not in the far-away company that made the tires. (Indirect impacts thus shrink as the region becomes smaller and more suppliers are excluded.) Regional impact models are used by state and local governments, real estate developers, and many others – as well as by advocates of environmental/economic development strategies.

Perhaps the simplest regional model is BEA's Regional Input-Output System (RIMS II). BEA created the original RIMS in the 1970s, and revised it to create version II in the 1980s. For any county in the US, or group of counties, RIMS II provides multipliers summarizing the results of the I-O calculations. In a BEA sample report, $1 million of purchases of food products machinery from firms in the Kansas City metropolitan area would result in $1.04 million of sales, $307,000 of wages, and 9.9 jobs in industrial machinery production, and $2.07 million of sales, $609,000 of wages, and 24.3 jobs for the metropolitan area economy as a whole. Although the RIMS II multipliers have to be purchased from BEA, they are cheaper than more elaborate models and consultant studies; BEA reports that retrospective comparisons find the results of RIMS II analyses to be within 5-10% of much more sophisticated and expensive studies. RIMS II has reportedly been used by the Pentagon to analyze the effects of military base closings, and by other government agencies analyzing the impacts of nuclear plant construction.

One step more powerful is the widely used IMPLAN model for regional I-O calculations. Originally developed by the US Forest Service in the 1970s, it was transferred to the Minnesota IMPLAN Group (MIG), a firm run by University of Minnesota researchers, who rewrote the model in the 1990s.[15] IMPLAN combines a national technology matrix, from the national I-O model, with regional coefficients describing how much of each industry's demand is satisfied by local suppliers. It can generate the same style of multipliers as RIMS II, but also allows greater flexibility for researchers to modify the model to reflect aspects of the local economy or unusual policy scenarios. According to the IMPLAN website, there are 1500 users of the model, and almost 100 consultants who are available to apply IMPLAN for local analyses.

An even more elaborate regional economic analysis is available from Regional Economic Models, Inc. (REMI), a firm launched by economists from the University of Massachusetts-Amherst.[16] REMI's Policy Insight model provides greater depth than IMPLAN, calculating year-by-year impacts, and modeling price changes and price-induced effects as well as I-O calculations. REMI makes the model available to users, and also does extensive consulting projects applying its models in studies commissioned by users. REMI has numerous public and private sector clients, and its Policy Insight model is used both in the US and other countries.These are by no means the only available tools for economic calculation; others are provided by consultants and university researchers in many areas. One potentially valuable model is the Environmental Input Output - Life Cycle Analysis (EIO-LCA) model, available without charge from Carnegie Mellon University.[17] Although unfortunately lacking in regional calculations, EIO-LCA incorporates environmental coefficients directly into its model, so that it estimates not only the direct and indirect economic consequences of final purchases, but also the emissions and environmental impacts that result from those economic activities. Thus it provides (though only at a national level) consistent estimates of economic benefits and environmental harms from any production process or purchase.

Alternatively, there are tools specifically designed for calculating environmental impacts, which could be applied to the output of any of the economic models described above. A recent, noteworthy entry in this field is EPA's Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI).[18] Released a few years ago with little fanfare, TRACI offers a broad range of impacts (there is, of course, no such thing as "complete" coverage of all environmental impacts) that result from many economic activities, along with environmental modeling of the "fate and transport" of emissions. It does not, however, offer regional calculations, or economic estimates; it provides national average environmental impacts of a given level of economic activity.

The principal challenge in using any of these software tools comes in the "pre-analysis" stage of preparing the input data and asking the right questions. The models do not contain descriptions of every possible commodity and technology; they inevitably aggregate information into a number of standard categories. There is a nearly standard list of roughly 500 industries, based on BEA categories used in the national I-O model and other data; it is rare to see choices other than the industries on this list.

Some questions about local economic development fit these categories and models much better than others. If you want to study the effects of closing, or expanding, an oil refinery, you are in luck: one of the 500-odd standard industries is "petroleum refineries," so the models' built-in calculations will tell you what happens if you increase or decrease local refinery operations. If the technology or employment patterns of your local refinery differ significantly from the national average for the industry, you will need to modify the data or model to reflect that difference; but if you are willing to accept national average refinery data, you are all set.

On the other hand, suppose that you want to study the effects of replacing PVC with non-chlorinated plastics, thereby reducing emissions of dioxins and other carcinogens that are associated with the PVC life cycle. The standard list of industries does not distinguish PVC from other plastics. It does include one industry for plastic resin manufacturing, another for plastic bottles, and another for plastic pipes (as well as others for other plastic products) – but each of these combines data for both PVC and non-chlorinated plastics. In this case, you would need some prior assumptions and analysis of the direct effects of substituting one plastic resin for another, before you could use any of these models. Will the same firms that made PVC products be able to make non-PVC replacements? Will the price of plastic products change due to the switch? Will the employment and income effects, per million dollars, of non-PVC plastic production be the same as the effects of the PVC industry? These questions would have to be answered in a detailed "pre-analysis," before applying any of the standard employment models. The pre-analysis might well determine the outcome of the study, while the contribution of the model itself would be secondary.

The philanthropic community and other relevant decision-makers may want to take some preliminary steps before pursuing this kind of economic modeling in depth: for example, commissioning a introduction/overview to the topic in the context of specific concerns, and providing some inventory of relevant experts and existing materials. Another step would be to start to fill the gap in what we call above the "pre-analysis" stage. As we noted, it may be that this kind of pre-analysis would in fact answer a number of the questions and concerns that are behind the need for an economic analysis.

4. The high costs of toxic chemical exposures

The calculation of employment impacts is not the only economic argument that supports green chemistry alternatives. At least equally important is the high cost of the damages done by toxic chemicals – which are potentially avoidable by introduction of cleaner alternatives.

A cautionary note before turning to the evidence: There is no meaningful way to put a dollar price on the entire range of damages caused by toxic chemicals. The human costs of premature deaths, painful chronic illnesses, and lifetime mental deficits and disabilities resulting from childhood exposures, all transcend monetary calculation. Attempts by economists to "get the prices right" and value every externality quickly become absurd; who among us could name a meaningful price we would pay for avoiding a case of cancer? (In a classic case, involving regulation of arsenic in drinking water in 2000, EPA actually assumed that the value of avoiding a non-fatal bladder cancer was the same as the value of avoiding a case of chronic bronchitis; the value of bronchitis was determined by asking people at a shopping mall whether they would prefer to live in a community with a lower cost of living but a higher rate of bronchitis. Since the bronchitis study was more than 10 years old, the valuation of the disease was carefully adjusted for inflation.) This problem and its implications are explored further in Priceless: On Knowing the Price of Everything and the Value of Nothing, by Frank Ackerman and Lisa Heinzerling (The New Press, 2004).

As a result of this fundamental limitation, it is necessary to look for more meaningful, partial measures of the damages done by toxic chemicals, recognizing that the resulting numbers cannot tell the whole story of the human costs that are involved. One approach is to identify the actual monetary costs of illness, including both direct health care spending, and any losses of income and productivity due to illness. Another method looks at the mandated clean-up costs for past pollutants that are now recognized as harmful.

This section examines two areas of empirical research on the benefits of cleaner chemicals – or alternatively, on the damages that are caused by not using cleaner chemicals. The first concerns the costs of childhood illnesses in the US; the second draws lessons from the extensive European debate about REACH, which involved many estimates of the benefits of safer chemicals.

Costs of preventable childhood illnesses. An important new line of research finds surprisingly large costs for childhood illnesses that are attributable to preventable environmental exposures. A pathbreaking article estimated nationwide costs of $55 billion per year, as of 1997, for childhood cancers, asthma, lead poisoning, and other neurobehavioral disorders that are attributable to environmental factors (excluding individual choices such as diet and smoking).[19] A similar state-level study for Massachusetts, with minor methodological improvements and state-specific data, produced an annual estimate of $1.1 - $1.6 billion per year for the environmentally attributable impacts of the same diseases on Massachusetts children.[20]

Comparable studies have also been done for Minnesota and Washington.[21]

The most innovative, and potentially controversial, aspect of this line of research is the identification of the environmentally attributable fraction (EAF) of each disease. While reports from the World Health Organization and studies by a number of prominent researchers have discussed and estimated EAFs for some time, others maintain that the interaction of environmental and genetic factors is too complex to allow such a clean separation. (Note that this critique is not suggesting that the cautiously developed EAF numbers are too large, but is advocating a different way of thinking about causation.)

The majority of the estimates, in dollar terms, comes from the effects of lead poisoning. In this case, there is widespread agreement that the EAF is 100% - there is no background or purely genetic level of lead poisoning. Moreover, research has identified harms caused by childhood lead exposure at steadily lower levels. Even the weak correlations between blood lead levels, IQ, and future earnings are sufficient to imply measurable lifetime losses for affected children. And because there are so many affected children, the totals are enormous. This finding may mean that lead is the worst pollutant in terms of children's health – or simply that it is the best-studied one. As information continues to emerge about other pollutants that cause long-lasting harm, such as mercury, the total costs of childhood illness attributable to environmental factors may continue to climb.

Benefits of REACH. The European Union's new chemicals policy, REACH, requires registration and testing of all chemicals sold in quantities of 1 ton per year or more. The estimated cost of registering and testing all 30,000 or so affected chemicals will be several billion dollars. In the unusually extensive and thorough debate that raged from the first proposal to the final adoption of REACH (2001-2006), there were of course conservative voices arguing that the costs were prohibitive, and that the EU could not survive this level of regulation.

Advocates of REACH offered two principal responses. First, a few billion dollars, which will be spread over the first 11 years of REACH implementation (2007-2018), amounts to an inconsequential cost burden, less than 0.1% of chemical industry sales revenue in the same period.[22] Second, the measurable monetary benefits of REACH are likely to be many times the cost. An early study by the European Commission estimated the benefits at more than ten times the cost; an analysis by David Pearce and Phoebe Koundouri, for World Wildlife Fund-UK, offered three different estimates of health benefits of REACH. The lowest of the Pearce-Koundouri estimates, based on health care savings alone, was several times the cost of REACH; their other estimates, based on hypotheses about willingness to pay, were much higher.[23]

Many additional studies have shown that even a very partial accounting of the benefits of cleaner chemicals will outweigh the total costs of REACH. Savings in the costs for sewage systems and wastewater treatment alone will be several times the costs of REACH.[24] A report commissioned by the European Trade Union Confederation estimated that the reduced costs of non-cancer skin and respiratory occupational diseases over the first ten years of REACH would roughly equal the total costs of REACH; savings in later years would be much greater.[25] The costs of cleaning up just one toxic chemical problem from the past - PCBs - will total 15 – 75 billion euros for the EU as a whole, many times the cost of REACH.[26]

In short, Europe's massive move toward greener, safer chemicals could be economically justified by its sewage and wastewater savings alone, or by its non-cancer occupational disease cost savings alone, or by its potential to avoid just one

PCB-style toxic cleanup problem (indeed, even a considerably smaller avoided cleanup cost would make REACH look like a bargain).

Similar arguments could be made about the economic benefits of green chemistry development in the US, highlighting many of the same areas. A recent study of the effects of REACH on US industry demonstrates that compliance with REACH is far more profitable than defiance, and compares it to cases where the US has lost export markets by failing to meet foreign standards.[27]

REACH has gained an undeserved reputation as a potential barrier to innovation in the chemical industry, which might hinder the efforts to create green chemistry alternatives. While industry critics of REACH often made such claims, there is little reason to suspect that desirable innovations will be impeded – particularly in light of the changes made to the original REACH proposal before it was finally adopted.

REACH actually lowers the regulatory burdens on low-volume (under 100 tons/year) new chemicals, compared to the EU rules that were in place before its adoption; most new products will presumably start in this category. REACH provides ample opportunity for appeals for reconsideration by industry, if regulatory restrictions on chemical use appear to cause economic harm; some European environmentalists believe it has compromised too much in this respect. And above all, REACH is primarily burdensome to the use of old, large-volume, potentially hazardous chemicals – the substances that compete with new green chemistry initiatives. By making it harder for the producers of the old, entrenched chemicals to continue business as usual, REACH creates a market opportunity for new, safer alternatives.

Summing up this section, we think that philanthropy might want to invest in developing the economic impacts of REACH-type legislation in the United States. Going further along this track, it is possible to create models and decision-matrices that could be applied at the regional level or within particular sectors that take in account a variety of jobs, health, and environmental impacts of a green chemistry initiative. As we noted, taking into account factors such as sewage and wastewater treatment, the costs of occupational disease, cleanup costs, and related health costs in the general population, can make it clear that REACH-type legislation is cost-effective in given localities or regions in the United States, as well as promoting the case for such legislation in the country as a whole.

5. The potential for green products

Consumers are now inundated with claims that major companies are concerned about the environment and are marketing green products – if not remaking the entire company into an agent of environmental change. It’s not just Ben & Jerry’s any more: General Electric, one of the world’s largest manufacturing companies, now prefers to tell us about its wind turbines and “ecomagination” rather than the nuclear plants, coal plants, and jet engines which it also sells. British Petroleum, one of the largest oil companies on the planet, has tiptoed into renewable energy and tried relabeling itself “Beyond Petroleum” – although it still mainly sells oil, and still has disastrous refinery accidents from time to time.

Yet behind the hype, there is a real transformation of markets for many goods. Organic food is the fastest growing segment of the food industry, with $40 billion in global sales, and supply shortages in North America and Europe. Wind power, after decades of research and development, has become cost-competitive with other sources of electricity (in suitably windy locations), and is growing rapidly.

The example which may be most relevant to green chemistry strategies is the market for green building products, now estimated at more than $22 billion a year in the U.S., and growing at 5% per year.[28] Indeed, the existence of high-priced market research reports on green building materials is powerful indirect evidence of the maturity of the industry (the previous sentence is based on the free on-line summary of such a report). A Harvard Business Review article in 2006 described a number of green buildings recently built by major corporations, concluding that they were no more expensive than traditional buildings if they followed a list of straightforward design principles.[29]

None of the new markets for environmentally preferred products have resulted solely, or primarily, from a “eureka” moment of scientific discovery. Wind power was widely discussed as a promising renewable alternative as long ago as the 1970s energy crises; initially uncompetitive, it received extensive support for research and development, subsidies, and favorable regulatory treatment. But this early US leadership, involving support from both federal and California agencies, lapsed in the 1980s when the politics of the Reagan era and the return of cheap oil made Americans lose interest in energy conservation. Fortunately, public support for wind power was growing in Denmark, Germany, and other European countries, which are now the world leaders in the industry. In short, a good idea with obvious technical potential took 30 years of subsidies to research and development in order to reach the current level of competitiveness in the marketplace.

The market for green building materials has similarly been a long time in the making. Here the technology and choices are more diverse than in the simple example of wind power. Regulation of hazardous substances, development of industry standards, and active advocacy campaigns focused on substitution for particular problem materials, have all played a part. Green building standards first appeared in the UK in 1990; the LEED (Leadership in Energy and Environmental Design) standards for certification of green buildings were adopted by the US Green Building Council (USGBC) in 2000. USGBC is a rapidly growing trade association for the green building industry, with thousands of affiliated organizations and 75 local chapters; its annual exposition and conference draws an attendance of 18,000, many of them architects, builders, and suppliers.

At the same time, more activist groups such as the Healthy Building Network (HBN) have advocated changes in particular materials choices. A successful HBN campaign led to the elimination of arsenic from pressure treated wood. Other campaigns have focused on formaldehyde in building materials – now subject to regulation in California, as well as Europe and Japan – and the use of PVC. The latter has involved a lengthy debate within USGBC, as the plastic industry has maintained that PVC should be considered a “green” material due to its energy saving potential, while HBN and others have argued that PVC’s lifecycle toxicity should rule it out. These and other debates and campaigns have helped to turn green building materials into the successful market opportunity that exists today.

6. The current status of green chemistry economic development

Green products and language are increasingly visible in the world of mainstream marketing. At the same time, the best examples of contemporary green products, like wind power or green building materials, have required decades of hard work, research, advocacy, regulation, and subsidies to achieve their current profitability. In this context, what can be added by a local or regional green chemistry-based economic development strategy? Something that is already clearly profitable under current market conditions is likely to be adopted as part of the “ecomagination" of General Electric or its ilk, or to catch the eye of BP in its visits to the world "beyond petroleum." At the other extreme, something that is currently far from profitability will not be moved into mass production by a modestly funded regional development strategy. What opportunities are available that fall between these poles, where there is clear value added by a plausible regional effort?

One logical answer is to call for massive, long-term support for a new green chemistry strategy. The Heinz Foundation's interest in developing green chemistry-based industries in southwest Pennsylvania is an example: they see a need for involvement in supporting university researchers, start-up companies, and suppliers to create local synergies and new sources of industrial growth. While local research and industrial resources make the strategy plausible, it requires a multi-year, multi-million-dollar commitment. A foundation that has sufficient resources and a focused commitment to a particular local area may want to concentrate its efforts in this manner; others may not be able or willing to follow this path.

Another answer involves discovery of uniquely place-based opportunities that the market has thus far overlooked. The Environmental Health Strategy Center (EHSC) in Maine is promoting the use of the state's potatoes – particularly the large number that are discarded for failure to meet food industry standards – as raw materials in a new bio-based plastics industry. This creative use of a unique local resource might easily have escaped the notice of national and multinational corporations.

In general, however, proposals for bio-based industries should proceed with caution, as conflicting demands will be made on US agricultural land in coming years. The early stages of climate change will diminish agricultural productivity in the tropics, while temporarily raising productivity in high latitudes; thus northern North America will be increasingly important as a source of food for the world's growing population. Meanwhile, short-term farm state politics is currently leading to extreme interest in and support for ethanol and other biofuels (arguably well beyond the level that is environmentally desirable), making rival demands on the same agricultural lands. While Maine's waste potatoes are a unique resource with few competing uses, this does not mean that the Midwest or other farming areas have excess land available for growing new industrial feedstocks.

Foundation-supported initiatives can provide one of the multiple components needed for the success of a green chemistry economic transition. In a thoughtful review of the prospects and requirements for green chemistry in California, Michael Wilson identifies three gaps in current policy: the data gap, the safety gap, and the technology gap. More information is needed about chemicals to inform our choices and uses of them; better regulation is needed to protect worker and consumer safety in the face of known hazards; and incentives and support are needed for the development of green chemistry alternatives.[30] The first two gaps are largely matters of regulation (in which California is noticeably ahead of the federal government and most other states). Without solutions to these problems, private initiatives will face severe limitations. The third gap, involving technical innovation, is an area where both public and private support can be helpful; the current advocacy of green chemistry addresses one important aspect of the third gap.

Green chemistry is at the technological frontier. It is undoubtedly appropriate to emphasize the need for changes in chemistry education and research; the Heinz initiative may include a significant component for support for green chemistry at area universities. With a longer-term focus on redirecting science for the next generation, it would be useful to apply political pressure to NSF and other agencies that play a role in setting research priorities and funding.

The question of the status of biofuels points to broader critical opportunities for foundations: to develop the linkages between green chemistry and economic development within the broader context of ecological thinking, to integrate green chemistry into the development of a sustainable biomaterials economy, and to develop approaches to green chemistry economic development that point to an economy consistent with environmental values, societal and personal health, and community needs.

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