Institutional Analysis of Information about Algae Bio-crude Innovation by Sapphire Energy, Inc.,

Part 1: Static Analysis
Collective Action:
This case focuses on information provision by Sapphire Energy that is therefore a part of the innovation feedback system. This information is a public good because this is the information that is available for collective action. Innovation information primarily exists in other forms such as private goods and club goods, but this information cannot be used to inform our common future. It is the provision of this public good that is the subject of analysis because it provides insight into the sustainability of the future. Sapphire Energy is a company that is producing crude oil from algae. The information used in this case study came from Sapphire Energy's web page or was linked from there. Each piece of information was categorized using the SES variables of Ostrom 2007 and is available here.

This CPR report was entered in 2013 by Madeline Tyson at Arizona State University.

Background on Energy Information Commons and Sapphire Energy:
The project of defining a sustainable energy future is one that is riddled with uncertainty and discord. The conversation about sustainable energy is often coopted into one of several discussions. Three of the most popular can be briefly described as: How to get energy to the "have nots" of the world, national security and energy independence, and climate change. Once we move into the energy innovation sphere the conversation quickly gets steered towards funding research and development. A conversation, which is not often pursued, is how does the type and rights to information produced impact our ability to choose and create more opportunity and equity in the future. Choices about our energy future is a commons in which the choices are theoretically endless, but the closer we get to what was once the future, the more constrained we become by what we understand to be possible.

Innovations change the boundaries of what is possible and in doing so completely change the way we do things. History is often seen through the lens of how technologies helped different groups rise over others, but technologies can also cause societal collapse when they are not governed well, such as happened in the Kembong fishery in this database. The fact that we cannot predict or model innovation suggests that we cannot begin to study those technologies of the future. However, what we can study is the information that an innovation system creates. The information we get about a new innovation is feedback. Choices will be made on this feedback, technologies will get funding on this feedback, public opinion will be formed and economies created. Perhaps one of the most important feedbacks is price. But it is not the only important piece of information. People also care a great deal about their future safety and well-being. They care about the robustness of the future, and the information that is generated and provided, is indicative of how and who is choosing the future, and how it will cope with

stresses that are outside the scope of the innovative company. It is this type of information that is useful in making other infrastructure provision choices such as education, laws, and roads that might be needed to support this technology, that is investigated here.

Sapphire Energy grows algae using the best practices from industrial agriculture. It feeds the algae carbon dioxide, nitrogen and phosphorus and grows it in open ponds. After harvesting it and removing a large portion of the water it converts it to crude oil by heating it at high temperatures and pressures using natural gas. This crude oil is then available for refining using existing technology. This process is easily implemented into the existing infrastructure and is cost competitive with existing crude oil. The technology is proven and Sapphire Energy is now in the scale up phase.

1.1 Commons Dilemma/Collective Action:

The commons dilemma is the provision of information that can facilitate a robust and viable society that uses algae based crude oil as the foundation of a social ecological system. This information is a public good because it is this information, which will be used for directing decisions about the future. Information is a good with unusual properties because there is very little control over its replication and use after releasing it, and businesses often fear that they loose their strategic edge if they provide too much. The business and research arms of Sapphire Energy Inc., are undoubtedly thinking strategically about many aspects of robustness but have stated that many factors are outside of their "scope". (Xiaowei et al 2013) In fact, in analyzing the data that is available from them, it appears that the only part of their practice that is being designed with robustness in mind is the process of making crude oil, but even the inputs to the process raise many concerns about the robustness of the innovation overall, and could benefit from external companies or agents working to solve these problems.

While it is logical that they are focused on the aspect of technology, as it is a primary part of their value, it says very little about how successful they will be. Companies that produce nonrenewable crude oil, for example, wouldn't have been nearly as successful if it was not for their lobbying efforts that give them enormous subsidies. (Without subsidies Sapphire has estimated that gas would sell for around $26/gallon) (cite website). Everything from the inputs, to the resource users, to the governance, public infrastructure and byproducts has been deemed to be outside of their scope, yet in looking to understand how outside agents can contribute to solving these problems, very little information exists that suggests that Sapphire Energy is encouraging collective action, problem solving, or a conversation about what is a desirable future and how external actors can become a part of their system. Creating this capacity will require, as a first step, information that does more than display success. Information could be produced on lessons learned and what hasn't worked, what type of vulnerabilities exist, how sensitive to different conditions the system is, and how the greater society can deal with, provide and benefit from them. The questions shown in figure 1 below describe

areas where information based conversations with future users would make the system more sustainable.

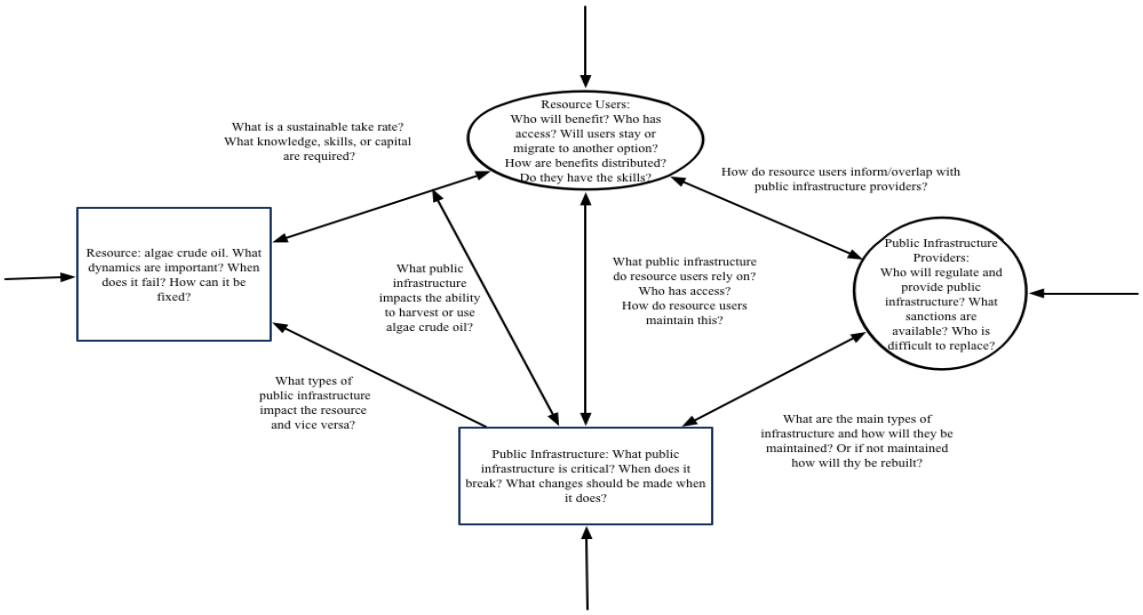

Figure 1 Information Areas for Robust Innovation Decision Making

Figure 1 above shows categorizes of feedback that pertain to the robustness of the future algae based SES. Feedback responds to and asks questions to understand how sustainable an innovation might be. Since Sapphire Energy has declared that their business scope is encapsulated solely in the resource box of Figure 1, it is especially important that information be created about all the other categories, which Sapphire Energy relies upon outside agents to create and maintain. The external arrows represent external shocks to the system. These present questions such as: how would an earthquake or climate change impact the system? What critical inputs are needed that might undergo shocks? What kind of external factors might cause people to migrate away? The ability to access, contribute, extract, remove, manage, exclude, and alienate information in response to these questions, and those presented in the figure is an indication of the type of informed engagement that produces outcomes and actionable knowledge.

After analyzing the information system produced by Sapphire a few things are clear. The first and potentially most important finding is that there is no ability to contribute, nor any rules available for how one can contribute, respond, or gain more information. This renders the information un-actionable and an ineffective feedback system at best. Secondly, there is almost no negative information (about what can or has gone wrong) available, and there are therefore no solutions (or lessons learned) to problems available. Thirdly, several types of information are being adamantly non-disclosed, such as the locations of the scale up sites and what strains are being used. Fourth, the subject of how will benefits will be re-distributed is non-existent, although Sapphire Energy has been the beneficiary of many infrastructure provisions such as roads,

intellectual property regulation, university research labs, and financial backing. The non-discussed assumption is, most likely, that these provisions will be returned through eventual taxes on profits and job creation. Fifth, the reliance on phosphorus, nitrogen, carbon dioxide and natural gas to the process presents an enormous and foreseeable stumbling block to which they concede may prove increasingly difficult, but conclude is outside of their scope. This information about the potential resource input constraints however is buried in the fine print of an academic journal article, and as such is not actually available for, but does represent information that should be used as a feedback. In general there is only limited and very general information available about the system. The rest of this paper continues to look at some of the conditions that produced this inadequate provision of usable feedback. The diagram below shows action arena that we will be discussing in the following sections:

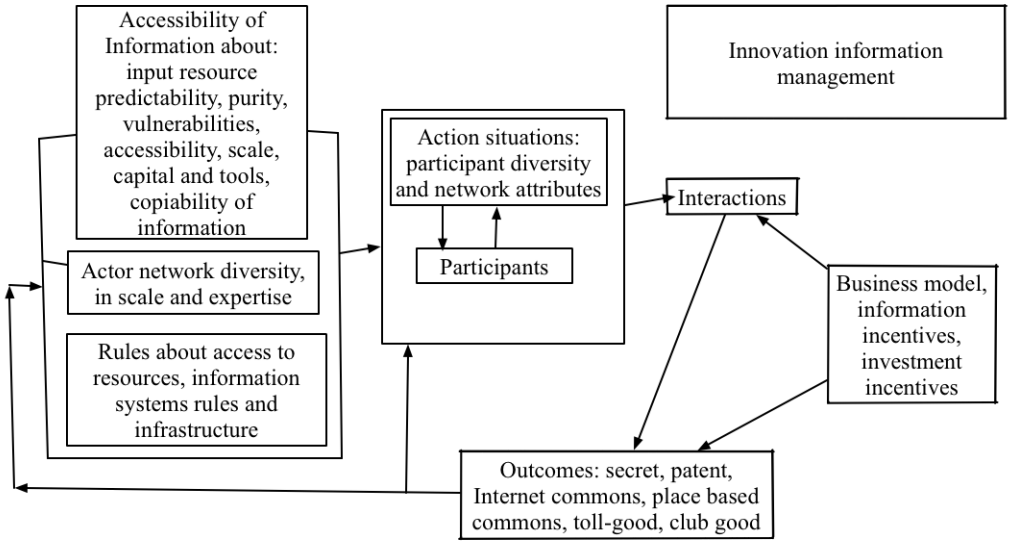

Figure 2 Action Arena for the provision of innovation information

1.2 Biophysical Context (IAD):

The biophysical context of the innovation space plays a major role due to the constraint that information is primarily embodied within the researchers and employees of Sapphire Energy. They have 4 facilities (2 in California and 2 in New Mexico), which are privately owned and operated. As they are in the scaling up stage, the different aspects of the business are fairly separate, and this makes it harder to understand the composite dynamics. Additionally, in the lab space learning continues throughout the process, however much of the learning stays within the individuals that generated it. There is no ability for future users to be a part of the information system at this point. In fact, one of the pieces of information they are withholding from the future users is their potential future

location for the next stage of scale up. They cite the reason for this being that they want to develop their own partnerships before releasing that information.

The biophysical context of the information itself, through the Internet, creates an interesting dynamic because it is easily copied and easily accessible to anyone with a computer. The ability of people to copy has probably increased their desire to gain patent protection and their reliance on trade secrets. Sapphire Energy has over 300 patents acquired or pending, and in published interviews they mention several aspects that they are unwilling to share and prefer to keep as a trade secret. Although it is common practice for many modern businesses to use wikis or other online tools for learning, it does not appear that Sapphire is pursuing this option and they are not looking for feedback or partnerships, which they do not initiate. This may be influenced by their fear of having their ideas and concepts stolen, which is mediated by the physical context of the internet.

1.3 Attributes of the Community (IAD)

The community that has rights over information is made up of a variety of people with different backgrounds such as business-oriented people, researchers, lawyers and investors. They also have a network of partners and investors that includes businesses such as Monsanto and Phillips 66. It is not known who within Sapphire is responsible for deciding what information to release. Based on their biographies and comments it is clear that a primary attribute within the community is that they value the importance of energy, and crude oil in our economy and our livelihoods. Their primary goal is to have a cheaper source of crude oil than fossil fuels.

One attribute of the community that clearly affects their information system is their business ethic with regard to performing for shareholders and investors. In several of their documents they have mentioned that maintaining investor confidence is one of their greatest hurdles, and that maintain this confidence requires staying on schedule and on track to achieving their milestones. However, their process and milestone accomplishments clearly rely on many external variables such as for process inputs, trained workers, and infrastructure.

Although there is a clear reliance upon other parts of the system, it appears that there is little value held in concepts of equity, or a fair distribution of benefits in the future outside of shareholders and investors. It appears that there is no consideration for the longevity of those factors that are “outside their control” and as such they are not publically considering support or benefit distribution towards any of the mechanisms which might support those external variables such as roads, pipes, harvesting more diverse inputs such as CO_2, fertilizer or an educated and healthy work force. In smaller scale social ecological systems where the returns from the work are redistributed the users of the system are much more likely to reinvest in the infrastructure that maintains the external functioning of the system. (Anderies et al., 2012).

1.4 Rules in Use

Public infrastructure, monitoring, and enforcement

The public infrastructure is the website which is maintained by Sapphire Energy as it is the primary location for information about the system. Other documents relevant to the company are linked from the webpage.

Rules for digital information commons are associated with different rights than traditional CPR systems. The following rights were put forth by Hess and Ostrom as rights associated with information commons:

1. **Access**	The right to enter a defined physical area and enjoy nonsubtractive benefits.
2. **Contribution**	The right to contribute to the content.
3. **Extraction**	The right to obtain resource units or products of a resource system.
4. **Removal**	The right to remove one's artifacts from the resource.
5. **Management/ Participation**	The right to regulate internal use patterns and transform the resource by making improvements.
6. **Exclusion**	The right to determine who will have access, contribution, extraction, and removal rights and how those rights may be transferred.
7. **Alienation**	The right to sell or lease management and exclusion rights.

Table 2. The bundle of rights in the digital knowledge commons (source: Hess and Ostrom, 2005a, p. 14-15). Number 1 till 4 are operational rights, number 5 till 7 collective choice rights.

Figure 3 From Dedeuwaerdere 2005

The first four rights are individual rights and the last three are collective rights. It is important to realize that there are multiple rights associated with information because they allow us to think about the range of possibilities for rights that exist and which may or may not be provided and how those might be changed to create different ones. Moreover, we can begin to think about how information might affect the future robustness of a complex system. In this case study we found that the Sapphire has only extended the right of access to positive indicators about the system to its future users, Access to positive indicators is unlikely to provide the type of feedback from which future users might contribute to the overall sustainability and robustness of algae crude oil as a social ecological system. Instead the information resource that is available is presented only as series of positive statements that are vague and illusory.

Sapphire is making prolific use of the management and exclusionary rights. In order to contribute to the information system governing this future system you have to gain approval or create your own infrastructure for providing the information. The management team has done many interviews, and keeps them linked from the website The messages and information within these interviews focus on explaining the positive

indicators and milestones that Sapphire is achieving, and do not contribute to any real feedback systems. The rules that would allow for access, contribution, extraction, and removal by future users are simple and enforced through the design of the website such that there is only one rule that is relevant to future users and the enforcement of this rule is bounded by the biophysical context of the website's design: You may access limited information.
The other information rule, which is prescient, is the disclosure requirement of the specification portion of their patents. Due to the exclusionary language used in these documents in which only PHOSITAs (Persons Having Ordinary Skill In The Arts) are expected to be able to understand them, we have not considered them in this analysis, but they should be considered in future analysis.

1.5 Evaluative Criteria and Outcomes:

It was evident in the information that a primary criteria is generating value for its shareholders and investors. The primary metrics for this appear to be, patentable innovations, completion of milestones, and price point calculations. While this process may be cost competitive with crude oil, there is no indication that it will be robust to other types of shocks.

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