



Physic Ventures Sustainable Living Investment Strategy 2011 Update

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At Physic Ventures, we define our Sustainable Living investment practice as the technologies, products, and services that enable consumers to apply the principles of Sustainability to their consumption of materials, energy, food, water, and transportation.

This white paper describes the different sectors of Sustainable Living that Physic invests in. It also discusses the cross-sector themes in business models, technology and consumer behavior which unify these different sectors. For each sector we analyze recent technological developments, markets trends, and regulatory drivers that influence our investment decisions within each of these sectors.

This paper also describes the Sustainable Living companies in our current portfolio and how these companies align with the sectors, themes, and trends discussed above.

1 Introduction

Within the Physic Ventures Sustainable Living investment practice we look at five sectors:

- Energy
- Materials
- Water
- Food and Agriculture
- Transportation

There are a number of investment themes which span each of these sectors. The three themes that we are currently tracking are:

- Consumer engagement, participation, and transparency

- Resource efficiency; often referred to as Reduce, ReUse, Recycle and ReCommerce
- Enabling Science and Technology

Each of these investment sectors and cross-sector themes are discussed in more depth in the rest of this paper.

The table at the beginning of the next page represents these sectors and themes as a matrix which shows how the current Physic Ventures Sustainable Living portfolio investments map onto these sectors and themes.



| Theme \ Sector | Energy | Materials | Water | Food/Ag | Transportation |
|---|-----------|-------------------------------------|-------------------------|-----------------|----------------|
| Consumer engagement, participation and Transparency | EnergyHub | gazelle GoodGuide RECYCLEBANK | WaterSmart | GoodGuide | |
| Resource Efficiency | EnergyHub | gazelle RECYCLEBANK | WaterSmart | | Impinj |
| Enabling Science and Technology | | NOVOMER | PIONETICS HALOSOURCE | Chromatin, Inc. | |

2 Sustainable Living Investment Sectors

2.1 Materials and Chemicals

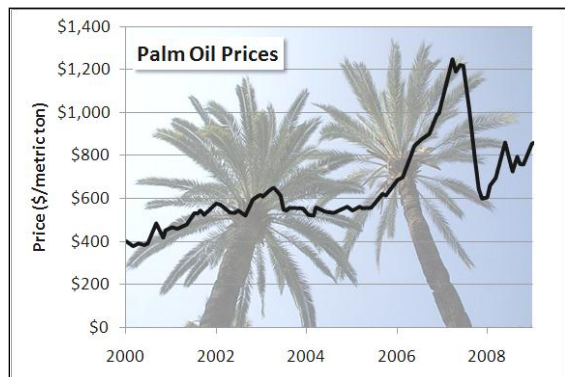
Over the last decade a confluence of factors has led to rapid innovation in the sustainable production of commodity and specialty chemicals and materials. These factors include:

- (i) A wave of technical innovation in synthetic biology, nanotechnology and catalyst development
- (ii) Increasing prices and increasing price volatility of commodities, and oil, in particular (e.g. see palm oil chart)
- (iii) Increased regulatory pressure on carbon emissions and a drive towards more sustainable business practices

Physic Ventures currently works closely with two global Consumer Packaged Goods (CPG) companies to connect our sustainable materials investment practice with their long term

strategies. These two companies, Unilever and PepsiCo, have recently released ambitious sustainable sourcing plans for the chemicals and materials used in their products.

The Unilever Sustainable Living plan can be accessed [here](#). The PepsiCo Performance with a Purpose plan can be accessed [here](#).



Recent Trends in Palm Oil Prices



These plans are indicative of similar initiatives at most global multinationals that are rapidly switching from petroleum based feedstocks to sustainable alternatives. Given these trends, we anticipate that demand for sustainable materials and chemicals will grow rapidly in the next few years creating huge opportunities for producers of these materials.

At Physic Ventures we are particularly interested in sustainable materials and chemicals which can address the following applications:

2.1.1 Packaging

Consumer goods packaging is one of the largest applications of materials. It is an application undergoing rapid innovation and moves towards sustainability. In particular, we are tracking:

- The development of biodegradable and compostable packing
- The development of packaging plastics, such as PET produced from bio-based feedstocks, rather than traditional petroleum feedstocks
- Packaging applications that can be used to sequester carbon dioxide

2.1.2 Personal Care and Food Products

We are currently reviewing a number of technologies for sustainably producing the ingredients in personal care and food and beverage applications.

An area of particular interest is the production of oils that can be used in personal care or food applications. We have recently reviewed a number of algae technologies for these applications. These algae production technologies can be grouped into 3 categories;

growing algae in open ponds, growing algae in Photo Bioreactors, and heterotrophic fermentation.



Figure: A Photo Bioreactor growing algae

We are also interested in sustainable approaches to producing flavors and fragrances that can be used in the production of personal care and food/beverage applications. Synthetic biology approaches are providing routes to producing these specialty chemicals via lower cost routes than synthetic chemistry and from bio-based feedstocks.

2.1.3 Sustainable Building Materials

In the last two years, there have been a number of high profile investments in the green construction materials space. Many of these companies have enjoyed considerable success despite a severe downturn in the housing construction industry. This success correlates with recent data showing that the green building subsector of the construction industry has proved to be more recession resistant than the industry as a whole.

Despite our bullish outlook for the green construction industry, Physic Ventures has not yet made an investment in this sector. This is mostly due to the size of investment required and the B2B business models on which the sector is focused. These industrial B2B models fall outside of the core investment thesis of



Physic Ventures, which is focused on bringing emerging technologies to consumer markets. However, as the market for green construction continues to develop we anticipate more investment opportunities, focused on direct-to-consumer channels, will emerge that are closer to Physic's investment scope.

2.2 Energy

In the sustainable energy sector, the big story in recent years has been the emergence of demand management and energy efficiency as a growth sector. Prior to 2008, most venture capital energy investments focused on renewable sources of energy supply, such as solar, wind, and biofuels. In the last few years, there has been a growing recognition that energy efficiency and demand reduction is the low hanging fruit in the energy sector. In the recent quarter Energy Efficiency was the subsector of CleanTech with the largest number of investments.¹

The Smart Grid has been identified as one of the key enabling technologies for implementing demand reduction in the energy sector. In addition to our investment in [EnergyHub](#), Physic has reviewed numerous investment opportunities in the consumer facing smart grid sector. The sector is now somewhat crowded and it's likely that there will be consolidation over the next two years. While we believe that the consumer facing end of the Smart Grid remains an attractive market, it is unlikely that Physic will make additional investments in this sector as we believe it will be difficult for new entrants to catch up with the technology and partnerships already developed by existing companies, such as EnergyHub.

2.2.1 Lighting

Another area of energy efficiency that we continue to track closely is energy efficient lighting. Within the lighting sector we have seen several exciting technology developments at companies such as [BridgeLux](#), as well as promising new lighting control systems at companies such as [Adura](#) and [Redwood Systems](#). These companies are delivering solutions that provide significant cost reductions and/or improvements in performance.

Currently, most of these companies are targeting the commercial and industrial lighting sector. While this is a large and attractive market, it falls outside the core Physic investment thesis. In the future, we predict that some of these low energy lighting technologies and control systems will begin to migrate from the commercial and industrial market to the consumer market. At this point they may provide attractive investment opportunities for Physic.

2.2.2 Residential Energy Efficiency

Another interesting development in residential energy efficiency sector is the emergence of consumer-facing green auditing, and energy efficiency companies. We have been impressed by a number of companies including [OPower](#), [ReCurve](#), and [EarthAid](#). These companies are all developing solutions to enable homeowners to improve the energy efficiency and air quality of their homes. These are capital efficient companies with the potential for rapid scalability. This is an investment sector that Physic believes will remain attractive.

¹ According to [The Cleantech Group](#), in Q1 2010 there were 39 venture capital energy efficiency investments, followed by 27 transportation and 27 solar investments.



2.2.3 Energy Storage

Despite recent momentum in the EV sector, the largest technological challenge for electric cars remains the prohibitively high cost of batteries. A lithium ion battery pack, to provide a driving range of 200-300 miles currently costs around \$15,000. Over the 100,000 mile lifetime of the battery, this cost is recouped in fuel savings, but this is a difficult argument to make to consumers who typically don't consider 10 years of fuel costs when selecting which car to buy.

Given the significant need for new battery technologies with increased storage capacity and increased power capacity it is no surprise that there are [numerous technology startups](#) pursuing these goals. Most of the technologies which we review represent incremental improvements to the cathode, anode or electrolyte of conventional lithium ion batteries, these included [ActaCell](#), [Boston Power](#), and [Seeo](#). We continue to review technologies in this sector and, given the significant unmet need, we see this as an attractive investment sector, capable of generating venture level returns.

We are also interested in low cost, sustainable battery technologies that could be implemented in consumer products ranging from consumer electronics to disposable consumer goods with smart packaging. These applications require thin-film batteries, with non-toxic components.

2.3 Water

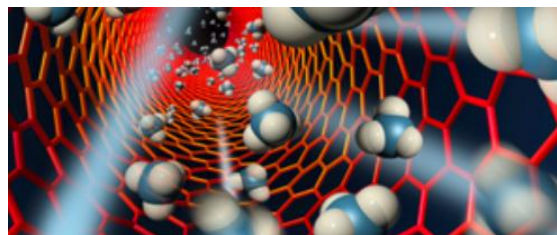


Figure: A carbon nanotube desalination membrane

Water is a sector that is likely to continue generating considerable investment activity due to the increasing scarcity of supply for drinking and agriculture. Our society's current water consumption pattern is unsustainable in a number of ways. Firstly, in the developed world we are consuming more water than is sustainable. In particular, the artificially low, subsidized price of water for irrigation encourages farmers to over water crops or grow water-intensive crops in regions for which they are not suited. This over irrigation is rapidly draining natural aquifers across the US and driving adoption of new technologies.

In addition to unsustainable agricultural practices, the shortage of water in many developed countries, coupled with an increase in urban living is driving demand for alternative ways of producing potable water, such as desalination. While desalination does provide a way to increase the amount of water available for human consumption it does so at a very high cost, as it requires large amounts of energy to extract salt from sea water. Desalination technologies therefore represent an interesting nexus of water and energy.

2.3.1 Water efficiency

Given the finite supply of water on the planet, as demand continues to increase with increasing population, the only viable way to match supply and demand is to implement



more efficient water usage behavior. Our recent investment in WaterSmart is an example of the promising use of digital engagement tools to provide consumers with information on their water consumption and provide suggestions for how to reduce consumption.

2.3.2 Water Purification

We have reviewed a number of water purification technologies in recent years. This is a sector which has witnessed rapid technological innovation with a number of different technologies promising EPA quality water purification and disinfection at costs significantly below that of boiling water. In 2010 one of our original investments in this sector, [Halosource](#), had a successful IPO. We remain interested in making additional investments in this sector.

2.3.3 Desalination

We have reviewed a number of technology solutions for reducing the energy requirements of sea water desalination. In particular, novel membrane technologies that use advancements in nanotechnology to reduce the pressure (and therefore energy) required to force water through a desalination membrane look particularly attractive. Several companies have recently been funded in this sector, including [NanoH2O](#), [NanOasis](#), and [Porifera](#) – a winner at the 2008 [California CleanTech Open](#).

At Physic, we do not see these technologies for low energy, utility scale desalination as falling within the scope of our emerging consumer market Sustainable Living investment thesis. However, we are closely tracking developments in this sector as there is a history of water purification technologies, developed at the industrial scale, migrating into consumer markets as the cost of the technology decreases.

2.4 Sustainable Food and Agriculture

There is a new venture investment sector emerging under the title Sustainable Agriculture, or Agriculture 2.0. Physic has not yet made an investment in this sector, but we are actively reviewing a number of interesting technologies and business models.

2.4.1 Consumer facing sustainable Ag services

Some of the most interesting sustainable agriculture opportunities that we have reviewed are companies providing services to consumers and businesses that want to purchase sustainable, local, or organic produce. For example, [Local Dirt](#) provides online tools to connect local growers and distributors with farmers markets, restaurants and grocery stores. [Farms Reach](#) also provides an online marketplace for connecting farmers and businesses. These companies have realized that there is an unmet need for the same level of logistics and operations support in the local and sustainable agriculture sector that has been provided by companies such as Sysco in the traditional produce distribution market for decades.

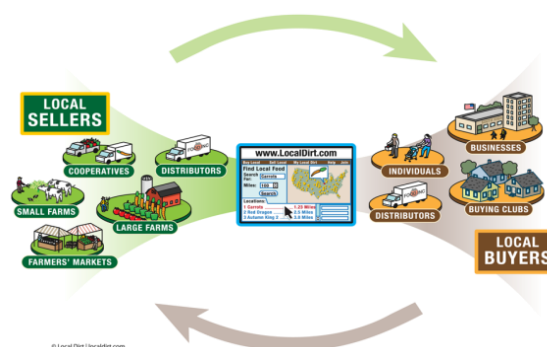


Figure: The Local Dirt Ecosystem



2.4.2 Food safety and supply chain transparency

There are a number of drivers behind the local food movement. One is increased consumer awareness of “Food Miles”. When consumers learn that the produce they are consuming is often transported 1000 miles to reach them, they are typically shocked by the environmental impact of this long range transportation.

Another driver of the local food movement is an increased awareness and concern over food safety. In recent years there have been a number of high profile safety recalls of produce such as spinach and peanut butter. As food supply chains become increasingly convoluted, there is less traceability and therefore less accountability for food safety. A number of companies, such as PurFresh are developing sophisticated food informatics systems to track the progress of food through the supply chain and provide consumers with more information on the origin of their food. Other companies such as FoodLogiQ are incorporating RFID tracking technology into the food supply chain to provide improved tracking capabilities.

2.5 Transportation

During Physic Fund I, we saw a dramatic increase in interest in more sustainable sources of transportation. In particular, the development of electric cars gained momentum in 2008 as oil prices rose and the environmental impact of biofuels, such as ethanol, was challenged.²

² In 2008, Timothy Searchinger and co-workers published an article in Science, entitled "Use of US croplands for Biofuels Increases Greenhouse Gases through Emissions for Land Use or Change." This article concluded that significant carbon emissions result from plowing grassland or forest to plant corn as a feedstock for ethanol. Once these carbon emissions are included in the LCA of first

We anticipate this momentum will continue following the successful IPOs of Tesla and battery maker, A123 Systems. Additional interest in the sector is likely to be generated by the successful launch of the Nissan Leaf, Chevrolet Volt, and several other Electric Vehicles (EV) and Plug-in Hybrid Electric Vehicles (PHEV).



The Nissan Leaf

In addition to electric car technologies, we have also reviewed a number of consumer services for sustainable transportation. Physic Ventures is a big fan of ZipCar and we routinely use this service for renting cars for business travel all over the US. We hope that their successful IPO will stimulate additional investment in this sustainable, alternative transportation sector.



Zimride

We are also reviewing a number of companies developing ride sharing services such as ZimRide, Goose Networks and GreenRide. These companies are using an interesting combination of social networking and mobile

generation (non-cellulosic) ethanol, it is found to have a more negative environmental.



tools to solve the age-old problems with ride sharing and carpooling services which lacked a critical mass of users and an easy way to verify

the identity of the person with whom one is considering sharing a ride.



3 Investment Themes

3.1.1 Consumer Engagement, Participation, and Transparency

One of the leading themes that connects the health and sustainability investment practices at Physic Ventures are products and services that engage consumers and incentivize consumers to adopt behaviors that produce positive impact.

In our consumer directed health investment practice, many of our investments are focused on products and services that incentivize consumers to adopt healthier lifestyles, for example, through diet, exercise, and preventive medicine. In our Sustainable Living practice, some of the consumer behaviors that we're attempting to incentivize are the 4 Rs; Reduce, ReUse, Recycle, and ReCommerce, discussed below.

Numerous new tools have recently been developed to engage consumers, encourage them to participate in creating positive impact, and provide them with transparent information. Most of these tools have been built upon Web 2.0 technology and social media platforms. These new platforms, such as Facebook, Twitter, and Foursquare provide a seamless way for consumers to share information, compare the performance of products they use and monitor the impact of lifestyle choices.

At Physic we are actively investing in both the underlying platform technologies upon which these consumer facing services are being developed and the applications of these tools within different verticals.

3.2 Resource Efficiency: Reduce, Re-Use, Recycle and ReCommerce

As we discussed in the previous section, the advent of digital tools for consumer engagement has opened up a numerous opportunities to empower consumers to adopt behaviors with positive environmental impact. We broadly classify these behaviors as Reduce, ReUse, Recycle, and ReCommerce. These positive impacts can be applied in all the Sustainability sectors that Physic invests in.

Using Gazelle.com to ReCommerce consumer electronics provides consumers with the simplest of incentives – a significant financial reward for trading-in used consumer electronics. It also assures consumers that their used electronics will be disposed of in an environmentally responsible way. If Gazelle are unable to re-sell any consumer electronics sent to them, they will ensure that they are recycled appropriately.

Our investment in [EnergyHub](#) is an example of using information to help consumers reduce their energy consumption. EnergyHub is using the “Prius Effect” to provide consumers with a dashboard for their home which, for the first time, shows homeowners how much electricity each of their appliances is using throughout the day. EnergyHub is currently deploying its systems with utility companies to determine the right amount of information to engage its users and incentivize reduction in energy consumption.

[RecycleBank](#) implements RFID technology to tracks the weight of products that consumers place in their recycling bins. It provides an



online rewards system to incentivize consumers to recycle more. In the pilot cities where they've deployed this technology, Recyclebank saw a dramatic increase in the use of recycling.

WaterSmart has a similar model to EnergyHub in the residential water sector. They provide SaaS tools to water utilities which present water billing data to consumers. By showing customers how much water they are using and putting this usage in the context of average water usage of their neighbors, consumers can learn whether they need to conserve water and receive advice and incentives on how to do so.

3.2.1 Enabling Science and Technology

Enabling science and technology, with intellectual property protected by patents and know-how remains a core investment theme within the Physic Ventures portfolio. Some of the areas that we are particularly focused on include:

- *Materials science*: Developments in materials science in the fields of nanotechnology, biomaterials, and sensors/detectors are enabling many of the investment sectors described above.
- *Computer science*: Computational power continues follows Moore's law, long after most experts predicted it would saturate. Additionally, the growth of cloud based services and the ability to analyze "Big Data" is opening up a myriad of business models and investment opportunities.
- *Biological science*: We are actively tracking developments in genomics, proteomics, diagnostics and synthetic biology.
- *Ag-Tech*: The enabling technology for many new sustainable agriculture opportunities is agricultural technology. Physic is tracking developments in traits and precision agriculture technology.



4 About the Author



Andrew Williamson is a Director at Physic Ventures in San Francisco, CA.

Since joining Physic early in 2007, Andrew has focused on working with

companies that are developing technologies, products and services to enable consumers to adopt more sustainable lifestyles. Among the portfolio company investments managed by Physic Ventures, Andrew is on the boards of [Chromatin](#), [EnergyHub](#), [Gazelle](#), [Impinj](#), [Novomer](#), [RecycleBank](#), and [WaterSmart](#).

Prior to joining Physic Ventures, Andrew spent 10 years leading materials science research and development projects at the Department of Energy's National Renewable Energy Laboratory ([NREL](#)) and Lawrence Livermore National Laboratory ([LLNL](#)). At NREL, Andrew developed computational models for predicting the optoelectronic properties of next generation photovoltaic materials. At LLNL, Andrew was a project leader for computational nanomaterials research. His group's research activities included nanomaterials, hydrogen storage, thermoelectric materials and battery technologies.

Andrew has published over 50 peer reviewed academic articles and 2 patents. He holds a BA and a Ph.D. in Physics from the University of Cambridge and a MBA from the Haas School of Business at the University of California, Berkeley.



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