SHALE GAS ANALYSIS: AN ONLINE EDUCATIONAL RESOURCE

An Interactive Qualifying Project
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ABSTRACT

The goal of our project was to create an interactive online educational resource about sustainability and shale gas to be applied in a curriculum at the Lucerne University of Applied Sciences and Arts. We developed a website using WordPress, conducted interviews with faculty and students to gauge website usability, and developed surveys to investigate social perceptions of shale gas in Europe. The project resulted in the creation of an interactive website that can augment the learning experience at the university.

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CHAPTER 1: INTRODUCTION

Imagine the heating in your home shuts off. Your nation has depleted all fossil fuel reserves and alternative energy technology is not developed. Have you ever wondered where your energy is coming from and how dependent your life is on this energy source? On a global scale, resources have been the driving force for the advancement of many modern technologies, and in turn, energy dependency has been a recurring issue involving foreign trade and affairs. Part of resource dependency is closely related to sustainable development and resource management, and Switzerland is regarded as one of the world's leaders for being environmentally conscious. However, the requirements for a sustainable energy system still elude Switzerland as well as many other countries around the world. Characterizing the requirements of a sustainable energy source raises challenging questions as sustainability relates to complex social, political, energy, and environmental processes. The issue surrounding the sustainable energy debate is complex as it relies on an interdependency between all themes involved, and today, not incorporating these factors together has halted many renewable models. A more coherent discussion and evaluation around energy sustainability needs to be fostered to better understand the complexity around sustainable energy alternatives, and this may lead to more informed energy systems policy decisions.

There are many different alternative energy sources that have been exploited around the world, however, whether these energies are sustainable is still a fierce debate. Recently, shale gas has become a "hot topic" in the search for sustainable energy. As shale gas is being considered by some to be the next viable energy source, several media sources regard it as an environmental nightmare (Dernbach, 2015; Holloway et al., 2013). Shale gas has experienced measurable success in the United States, as decentralized state policies have allowed for drilling to occur in some states; however, other states have banned drilling due to complications with environmental impacts (Boersma, 2012). The states that have allowed drilling have experienced economic benefits, but have suffered from environmental and health related issues in local communities, exposing conflicting interests between gas companies and the public. Despite this disparity of interest, harvesting has lead to a shift in the energy market, as the United States has become the main exporter of shale gas (BP, 2014). As Europe furthers the search for sustainable energies, shale gas has been among the discussed possibilities. All parties involved will need to compare their collective benefits and consequences before shale gas can be analyzed as a sustainable source of energy.

In order to better understand the complexities that shale gas will face as it is debated in Europe, we turn to explore the consequences and benefits of shale gas in the United States, the largest producer of shale gas today. The United States has taken advantage of the economic factors as harvesting shale gas has not only given them their own local supply for energy purposes, but allowed them to export natural gas to make a profit. According to the BP Energy Outlook, the United States accounts for 99% of the world's total shale gas supply and will remain to be the major exporter through 2035 (BP, 2014). Additionally, harvesting has allowed the United States to become an advanced market for chemical production (Loris, 2012). Furthermore, it has allowed the United

States to become not only a net exporter of energy, but also to cut its carbon dioxide emissions by 7.7% in the past decade (Qiang Wang, 2014). Although carbon dioxide emissions are reduced, frequent, accidental releases of natural gas during the harvesting process increases global warming and other pollutants from the harvesting process not only damage the environment, but local communities and workers who may ingest toxic chemicals (Institute of Medicine, 2014). Regardless of negative consequences, shale gas is the fastest growing fuel in the industrial sector, as there is an abundance of supply and it produces 127 kilowatt hours per 1,000 cubic feet (BP, 2014; EIA, 2015). Decentralized policy has allowed shale gas harvesting to flourish in some states in the US, but a determination of whether shale gas provides a sustainable energy source has not been made as the overall benefits and consequences have not been weighed. There is plenty of research that analyze the positive and negative effects of shale gas in the United States, and these reports provide many insights that fit the context of Switzerland and Europe as a whole.

Although many experts are aware of the potential of shale gas, there has been a negative focus on hydraulic fracturing and the process of harvesting shale gas. In part, there is still room for advanced research and the evolution of hydraulic fracturing and horizontal drilling as these are relatively new technologies, but mainly this is because the average person does not know enough about the complex nature of the shale gas debate. With negative events gaining the spotlight and a lack of an in-depth comparison of shale gas impacts in universities, only a fraction of the population that would be affected by shale gas knows about it. A website that presents scientifically backed information about shale gas, including both negative and positive effects, can help the Swiss and all those looking to use shale gas to think more fully about the issue so that they may make an informed decision about the future of their sustainable energy sources.

The goal of this Interactive Qualifying Project was to develop and explore the use of a website that gives students a range of ways to study the impacts of shale gas in the Business Engineering Sustainable Energy Systems department at the Lucerne University of Applied Sciences and Arts - School of Engineering and Architecture (HSLU). The website discusses the concept of sustainability, explores what shale gas is, and presents information on the benefits and consequences of shale gas in the United States in economic, energy, environmental, health, and policy sectors. In implementing the website, the team received feedback on the website usability at the university as well as evaluated current social perceptions of shale gas of European and American students through surveys, polls, forums, and video submissions. The construction of the website was throughout the IQP term and upon our departure from the project center, was passed off to Professor Schulz and Professor West so that they can give the students the tools they need to drill down to the complexity of the shale gas debate.

CHAPTER 2: BACKGROUND

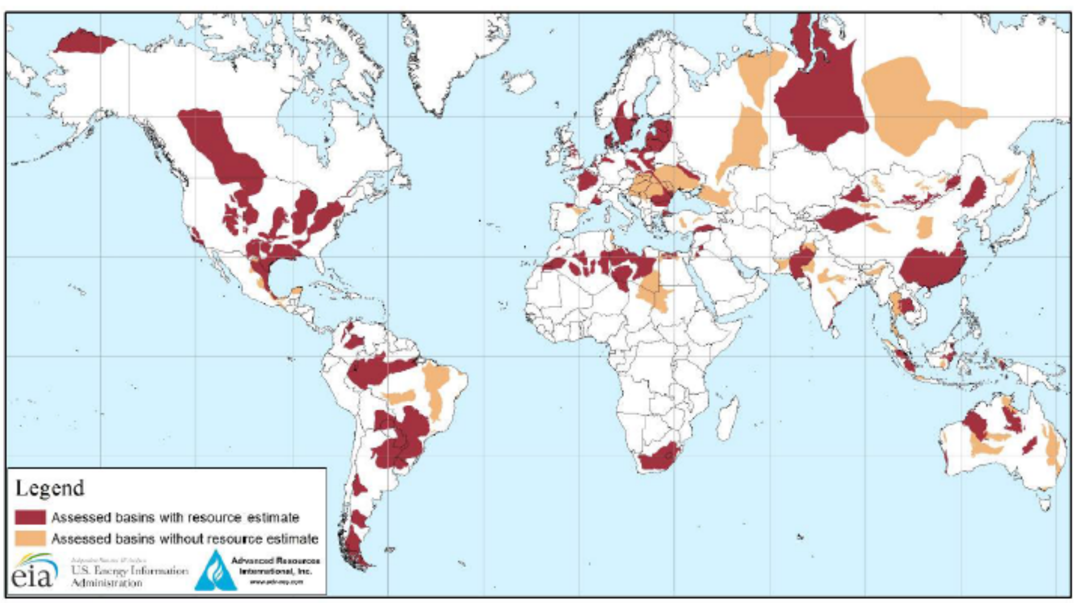
This chapter explores the history of shale gas, focusing mostly in the United States, where there is an abundance of experience and information. We begin with an introduction to what shale gas is, the harvesting process, and policies that are in place to regulate hydraulic fracturing. We then talk about sustainability and what it means to have a sustainable resource, asking whether or not shale gas really presents an opportunity for a sustainable future. Finally, our background research explores the health, environmental, economic, and energy impacts that shale gas has had in the United States so that we can apply lessons learned there to Switzerland's context.

2.1 The process of harvesting shale gas

2.1.1 Shale gas

Shale gas is formed when magma within the Earth's layers heats up organic matter (the remains of archaic plants and animals) within a depository of fine-grained sedimentary rock. Over a long period of time, the intense heat and tremendous pressure packs together the rock, creating hydrocarbons, the simplest of organic compounds. Shale gas is the gaseous state of these hydrocarbons, trapped within shale rock: "organic matter deposited within the Marcellus Shale was compressed and heated deep within the Earth over geologic time, forming hydrocarbons, including natural gas" (Navarro, 2011). Natural gas is just one kind of fossil fuel, which "occur in each of the three fundamental states of matter: in solid form as coal, in liquid form as oil, and in gaseous form as natural gas" (Considine, 2009). The major hydrocarbon component of shale gas is methane, the simplest of the hydrocarbons.

Figure 1: Map of basins with assessed shale oil and shale gas formations, as of May 2013



Source: U.S. Energy Information Administration (EIA), Technically Recoverable Shale Gas

There are several extractable depositories of shale rock across the world as can be seen in Figure 1, but for the United States, the Marcellus Shale is the largest depository of shale rock on the East coast, stretching along the Appalachian Mountains. Approximately 350 million years ago, during the Devonian age, a shallow inland sea was located where the Appalachian Mountains stand today, and over many millions of years, the inland sea evaporated, silts were deposited along this prehistoric Appalachian Basin, and sedimentary rocks, or shale rock, was formed (Soeder, 2009). The western edge of the sediment deposited in the Marcellus region consists of the finer-grained, organic-rich black shale, with a texture similar to mud (Soeder, 2009). Packed within this shale mud, pockets of shale gas exist and are the aim of the harvesting process. The primary methods involved in the harvesting of shale gas are horizontal drilling and hydraulic fracturing (which are talked about in the following section). What makes shale gas so different from other forms of natural gas is the method of harvesting: the gas is trapped within the shale rock and requires horizontal drilling to reach these deep pockets of gas instead of conventional vertical wells.

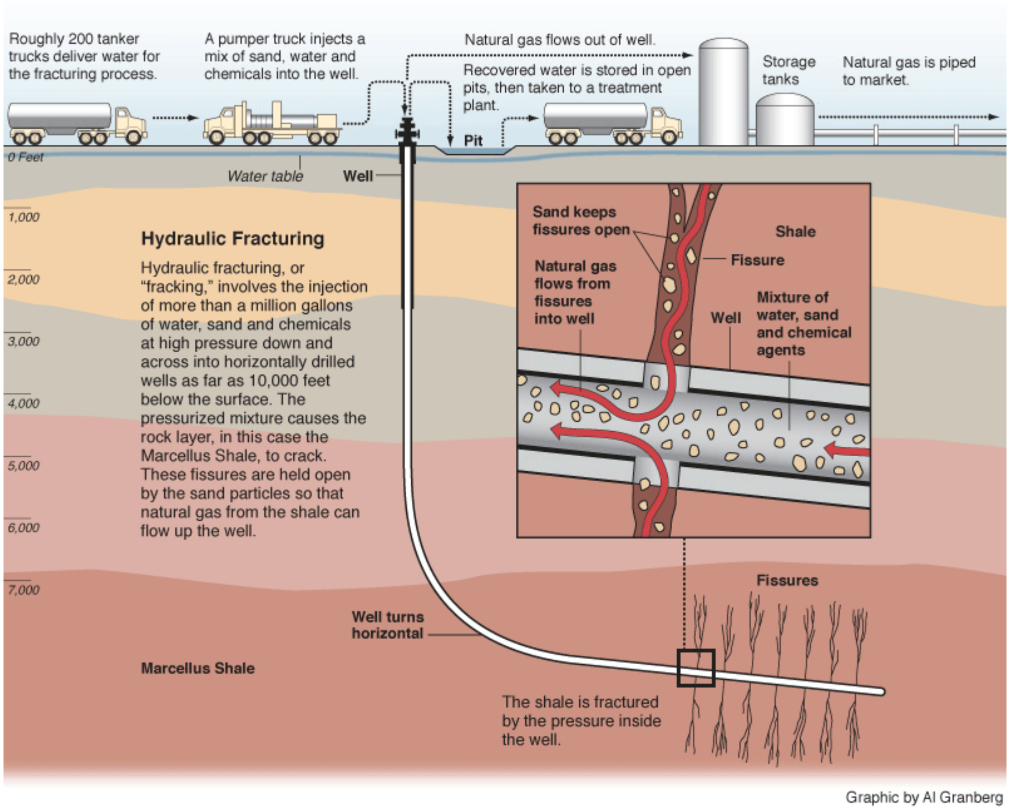
The chemical nature of shale gas makes it a unique fossil fuel. Compared to other fossil fuels, "[shale gas] has the lowest carbon intensity, emitting less CO_2 per unit of energy generated than other fossil fuels, [as well as]…burning cleanly and efficiently, with very few non-carbon emissions" (Considine, 2009). This key difference in addition to the cost of development is what makes this developing natural gas industry a worldwide interest. From a technical point of view, "the high compressibility and low viscosity of natural gas allows high recoveries from conventional reservoirs at relatively low cost" and so enables even the "most unfavorable subsurface environments" to be recovered (Considine, 2009).

Shale gas is an advancing resource, with the "fastest growing source of supply (6.5% p.a.), providing nearly half of the growth in global gas" (BP, 2014). While many shale formations exist, harvesting requires a level of technology that not every country has. With 7,299 trillion cubic feet of recoverable shale gas globally, which is a 10.2% increase from a 2011 report estimate, shale gas has no problem competing with oil and coal in terms of abundance (IEA, 2013). China has the largest amount of recoverable shale gas, followed by Argentina, Algeria, the U.S., and Canada—of which the U.S. leads in recovery, due to its increased state of the art technology. As of 2016, estimates are that North America will produce 99% of the world's shale gas supply, yet because of this developing industry, other countries will likely reach and overtake North America's growth by 2027 (BP, 2014). Slowly but steadily shale gas harvesting and fracking sites are emerging all over Europe, however, there are no shale gas deposits in Switzerland.

2.1.2 Harvesting shale gas

Drilling for fossil fuels is a process that has been going on for the past century. However, the innovative practices of horizontal drilling and hydraulic fracturing are what have allowed for the harvesting of shale gas most recently (Arthur, 2008). Previously, shale gas was thought to be inaccessible and a resource that would not likely be used in power generation due to the nature of methane being trapped in sedimentary shale.

Figure 2: The horizontal fracturing process



Retrieved from (Propublica, 2010)

The process of shale harvesting begins with the construction of the well pad and infrastructure required for the transport of materials, fluids, and the recovered natural gas. Before the well pad is constructed, seismic surveys are employed to generate a three dimensional picture of the shale positioning underground to determine the opportune position of the drilling location (Kargbo, 2010). After computer models are run to determine location and depth of drilling, the well pad can be constructed. A well pad is created by leveling the ground, creating roads, and installing pipelines (Kargbo, 2010). Following construction and moving equipment on site, drilling commences. Several casings are added to the wellbore as the drilling takes place: a conductor casing to stabilize the top, loose layer of sedimentary rock, a surface casing which extends from the ground past the bottom of aquifers in the area to protect against groundwater contamination, and deeper, production casings of cement that will eventually be perforated in the fracturing process (Zoback, 2010).

Drill cuttings and mud that are removed from the ground are brought up to the surface by water, which is also pumped into the wellbore. These drill cuttings and mud are stored, separated, and then trucked off site for waste disposal (Kargbo, 2010). Water is also used to cool the drill bit during this process. A risk that is associated with this initial construction of the well is that "during drilling…there is a slight risk of hitting permeable gas reservoirs … [that] may cause gas blowouts and underground blowouts," causing damage to the wellbore and equipment (Kargbo, 2010). Damage to equipment, personnel, and the wellbore are not the only problems; natural gas is also vented directly to the atmosphere and this causes great environmental concern (discussed below). After the well is drilled, the process shifts gears into the fracturing process that will ultimately yield the harvesting of natural gas. All in all, "a typical horizontal drilled well, using multistage fracturing techniques, costs roughly $3-5 million to complete" (Kargbo, 2010).

Before the fracturing process begins, it is important to note that this process uses thousands of chemicals that stimulate and optimize the recovery of natural gas. All of these chemicals must be produced at off-site chemical facilities and transported to the well. Chemicals, including proppants, acids, biocides, scale inhibitors, and surfactants, are transported via flatbed trucks to the well pad (Kargbo, 2010). Once on site, they are mixed in a blender with water and sand to create the "slickwater" fracturing fluid in preparation for the fracturing process (Arthur, 2008). The fracturing process will use anywhere from 2-10 million gallons of water in the process (Kargbo, 2010).

Once the well is drilled and the chemicals are prepared, "hydraulic fracturing is commonly performed in stages where operators (1) perforate the casing and cement, (2) pump water-based fracturing fluids through the perforation clusters, (3) set a plug, and (4) move up the wellbore" (Kargbo, 2010). The casings are perforated by placing explosive charges in the horizontal part of the well and this creates gaps in the cement where fracturing of the shale will occur (Zoback, 2010). This allows the water, when pumped through the well at extremely high pressures, to "fracture" the shale and create gaps that allows the natural gas to be released back into the well, as Zoback explains: "when the pressure increases to a sufficient level, it causes a hydraulic fracture or 'hydrofracture' to open in the rock, propagating along a plane more or less perpendicular to the path of the wellbore" (Zoback, 2010). Sand is another important ingredient that is added to the fluid because it holds the fissures open after the water pressure decreases, allowing for both natural gas and water to pass freely from the rock to the well.

After the pressure of the well is decreased, the natural gas is processed, compressed, and transported once it flows out of the well to the surface (Zoback, 2010). When the production of natural gas slows or begins to become uneconomical to keep the well open, either the well may be fractured again to stimulate the hydrofractures or permanently closed. If the well is depleted, most states require the well to be plugged from producing layers to the top and bottom of groundwater layers, aiming to prevent any kind of fluid left in the well from seeping through the well casing and contaminating groundwater (Zoback, 2010).

The recycle and treatment of the fracturing fluids is a process that is under intense scrutiny in the news and environmental forums because of the toxic chemicals it contains. Land application facilities or evaporative open pits are the main way the water is treated; the pits allow the water to evaporate and concentrate the chemicals so that less volume needs to be transported and treated at facilities (Zoback, 2010). However, Fountain Quail Water Management in Texas has developed and is currently using 80% recycled fracture fluid as a result of its recycle process (Arthur, 2008).

Recycling of the fluids allows for a reduction in local fresh water required and a reduction of chemicals that need to be transported on site, as well as no lengthy treatment process.

2.1.3 Dangerous working environment associated with harvesting shale gas

There are many health risks associated with shale gas fracturing. The workers on site are exposed to many different chemicals, and without the proper protection, workers can inhale fine particles of silica sand that could damage their health. Air sampling is done at different shale gas fracturing sites and some results show that silica levels are above the Occupational Safety and Health Administration allowable standards: "these exposure levels put workers, particularly sand mover operators and T-belt operators who had the highest levels, at risk of silicosis and the other silica-related conditions of lung cancer, end-stage renal disease, chronic obstructive pulmonary disease, tuberculosis, and connective tissue disease" (Rosenman, 2014).

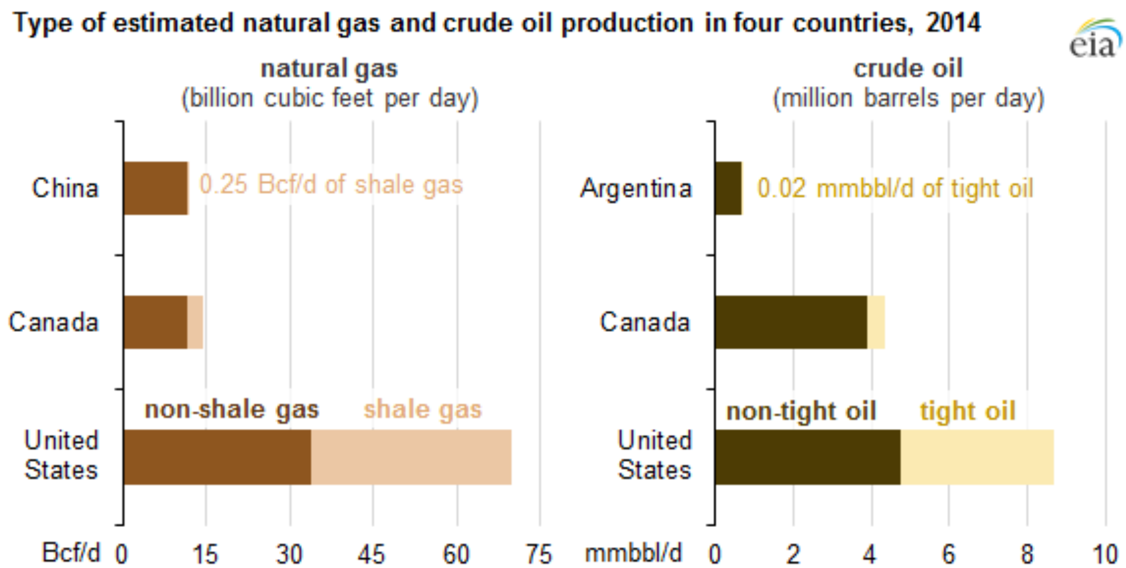
The workers at these hydraulic fracturing sites can also be exposed to poor air quality in the area. The burning of excess natural gas releases toxic chemicals into the air. Also, the use of diesel trucks for transportation can contribute to air pollution. Lastly, many chemicals are used in the hydraulic fracturing process and some can become airborne and affect the air quality. Since most chemicals are not specifically talked about or known by non-workers, the extent of the air pollution is unknown as well as the potential dangers to local communities (which will be discussed in following sections).

As well as air pollution and inhalation of silica sand, workers may also be exposed to chemical spills at hydraulic fracturing sites. Accidental spills may expose workers to different compounds in the fracturing process, which can cause many health risks. Also, some studies indicate that certain flowback operations can release hydrocarbons into the air and workers are being exposed to high levels, leading to the deaths of four workers since 2010 (Snawder, 2014). Although not many workers have been killed in accidental spills, the risks associated with shale gas harvesting are still high.

2.1.4 Current policies regarding shale gas harvesting in the U.S. and Europe

In the United States, there has been a "shale rush" due to its potential as an energy source and profits. The use of shale gas has lessened the US dependence on imported energy, which has had great influence on foreign policy with regards to energy. With the US as one of four countries to commercially produce natural gas from shale formations, the foreign energy dependence is dwindling, according to the U.S Energy Information Administration. The US and the other three countries that commercially produce gas from shale formations can be seen in Figure 3.

Figure 3: Type of estimated natural gas and crude oil production in four counties, 2014



Retrieved from: U.S. Energy Information Administration

Thirty-one states have shale gas reserves, but there are no federal laws specifically for shale gas within the U.S. Regulation of shale gas harvesting falls under the overall governance of other federal laws on energy, air and water quality, waste management, and chemical contamination (Rabe, 2014). Individual states can also impose their own laws on the shale harvesting practice, and their effectiveness will have lasting implications on the success of shale gas policy.

There are plenty of states in the United States that welcomed the shale gas revolution, as it bolstered their economies (which will be discussed in following sections). This has led to fast tracking the industrial processes to gain profits from the natural gas boom. Only recently, however, have some states begun to tighten up on the regulatory oversight of shale gas. Drilling companies that harvest shale gas in Texas now have to explicitly state what chemicals they use in the process, but the quantity that is used is still undisclosed. Other states such as Colorado have been stricter with the regulations, requiring that both what and how much of a chemical must be disclosed. With stricter laws being enforced in the U.S. and Canada, the move across the Atlantic would be seen as the clear choice for drilling companies, however, the level of freedom that North America has given to shale gas companies is unlikely to be the same in Europe (Boersma, 2012).

The one major law that the federal government has imposed on the shale gas process is the application of the Safe Drinking Water Act. This law ensures that the chemicals used in the drilling process do not affect the ground waters that most drinking water is draw from. Another regulation that affects shale gas harvesting is the Clean Water Act, which helps govern the discharge on the flow back of water from the drilling process. These two federal laws are very important in maintaining environmental purity when looking at the drilling process. Since Europe is generally stricter with all laws, there are a plethora of laws that have implications on the possibility of shale gas harvesting. These laws include: The Drinking Water Directive, the Groundwater Directive, the Water Framework Directive, the Waste Directive, and the Mining Waste Directive (Reins 2011).

Even though no shale gas act exists yet, it has not been from the lack of attempts by the United States government to infuse more laws on shale gas into practice. Laws such as Fracturing Responsibility and Awareness of Chemical Act, Fracturing Regulations are Effective in State Hands (FRESH) Act, Bringing Regulations of Effluence and Stormwater Runoff through Hydraulic Environmental Regulation (FRESHER) Act, and the Bringing Reductions to Energy's Airborne Toxic Health Effect (BREATHE) Act have been proposed, but have never made it through Congress. As of 2014, the legislation in the energy and environmental protection has declined in the past two decades and no real revisions have been made to existing laws for shale gas (Rabe, 2014). This has lead to a decentralized approach in the United States as some states such as Texas, Oklahoma, and Pennsylvania have been early adopters and welcomed the unregulated process of shale gas as a way to economically develop with the creation of jobs and state income. Other states such as New York, Delaware and Vermont have been wary of this decentralized way of governing in regards to shale gas. New Jersey has already passed a law banning the extraction of shale gas, exposing the split opinion on shale gas in terms of policies towards it.

With North American policies more lenient than those in Europe, it will be difficult to promote shale gas harvesting overseas. Poland, which is one of the most excited countries about shale gas, only has six wells drilled and very few companies invested in the process even with large shale formations within its borders. Other European countries, such as the United Kingdom, have already shut down the idea of shale gas by forcing the only drilling company to shut down. Furthermore, the Netherlands and parts of Germany have had such poor public receptions of shale gas, that governmental activities with regards to shale gas have been postponed. However, in recent news, Germany has moved to legalize fracking of shale gas. The spokesmen for shale gas in Europe stated that, "the reality is that Germany needs to ensure security of supply," when talking about shale gas (Neslen, 2015). Also in regards to legal matters, Germany's federal environmental agency (UBA) president, Maria Krautzberger, told the Guardian that, "it is important to have a legal framework for hydraulic fracturing as until now there has been no legislation on the subject" (Neslen, 2015). Conversely in France and Bulgaria, the major technologies required for harvesting have been banned (Boersma, 2012). Inexperience with shale gas has made the European Union hesitant to give as much freedom that shale gas companies experience in North America.

Table 1: A streamlined list of benefits and consequences for the policy section

Benefits	Consequences
• Fewer federal laws makes it easier drilling companies to fast track their production of shale gas • The allowance of shale gas production has lessened the dependence on foreign energy imports for the U.S.	• Fewer federal laws makes it easier for safeguards of environmental laws to be bypassed • Stricter laws in European countries have stalled shale gas production

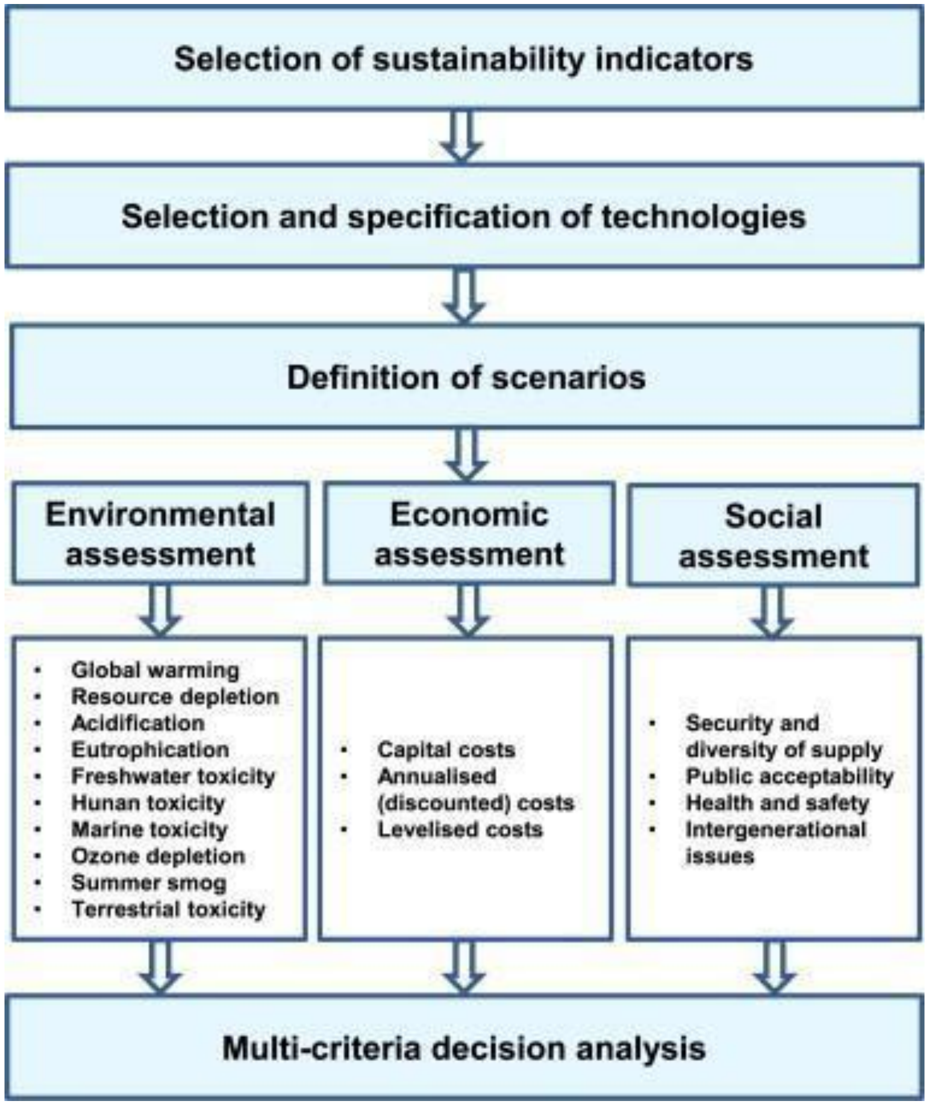
2.2 Shale gas: the search for a sustainable future

2.2.1 What is sustainability?

Sustainability, as it relates to energy, has many definitions and concepts that differ depending on who is describing it. According to Tester's report, "sustainable energy [is] a dynamic harmony between the equitable availability of energy-intensive goods and services and the preservation of the earth for future generations" (Tester, 2005). A very general definition of what sustainable energy is that was taken from the book *Sustainable Energy: Choosing among Options* helps put a context of what sustainability means in regards to energy. Sustainability, in another context, has been related to development. The World Commission on Environment and Development (the Brundtland Commission) in 1987 states that "sustainable development is development that meets the need of the present without compromising the ability of future generation to meet their own needs" (Bärtschi, 2012).

Since sustainability has no concrete definition, the question of what makes energy sustainable is debated frequently. There are general factors that are often reviewed when determining whether or not a particular energy is sustainable. These include, but are not limited to, environmental, economical, and social factors. These three aspects of energy sustainability are the foundation to meeting the global objectives of sustainable development (Santoyo-Castelazo, 2014). A general graphic depicting the sustainability assessment of energy systems is shown in Figure 4.

Figure 4: Sustainability assessment of energy systems flowchart

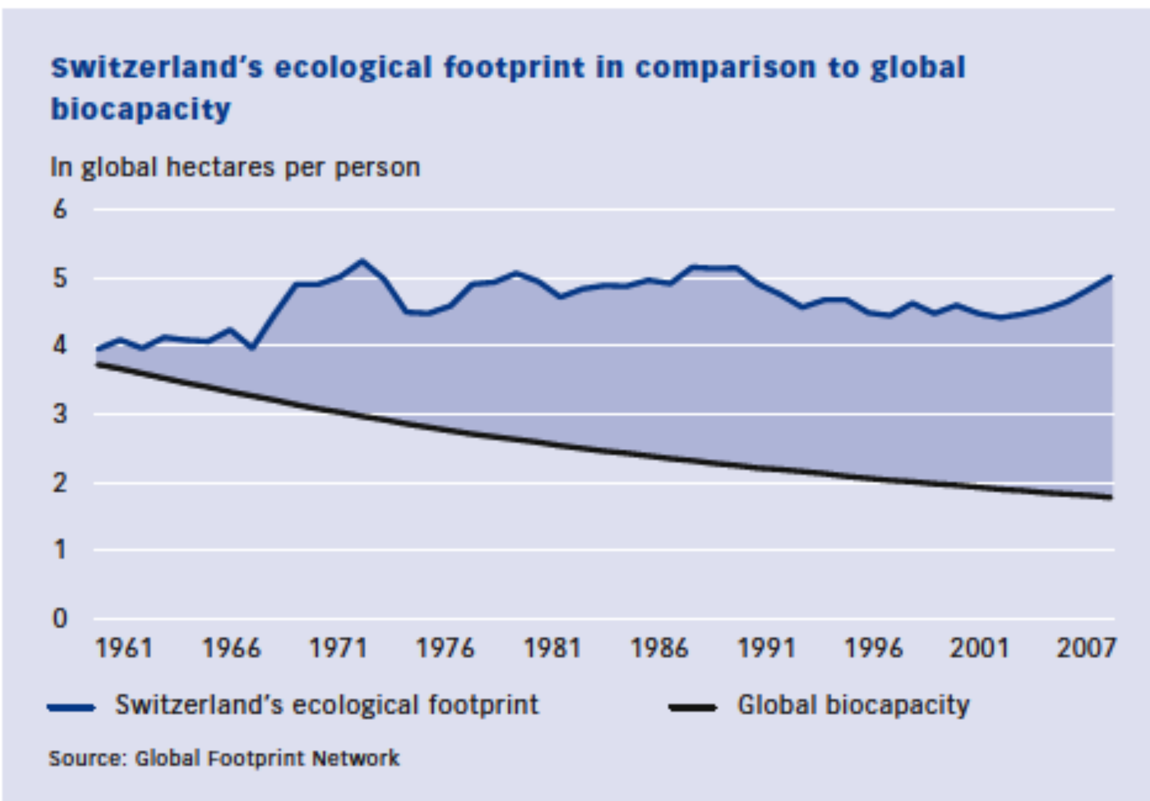


Retrieved from (Santoyo-Castelazo, 2014)

The graphic above is rich with information on how to assess the sustainability of energy systems. To start off, select the sustainability indicators, most of which are selected based on global energy policies. Some sustainability indicators are environmental, economic, and social. Next, a selection and specification of technologies must be made. This means identifying energy technologies that are readily available presently or may become usable in the future. Once technologies have been selected, they must be assessed for their "capacities, efficiencies, capacity factors, lifetimes, emissions to the environment, emission controls, etc." (Santoyo-Castelazo, 2014). Also, these technologies should be assessed for future development that involves looking at the life cycle of the technology. In the case of energy systems, the life cycle of the technology should consider "extraction of fuels and materials, construction and operation of the plants and their eventual decommissioning" (Santoyo-Castelazo, 2014). Lastly, the definition of scenarios should be taken into account. This phase of the analysis of sustainability of energy systems is not about predicting outcomes, but rather is more about providing possible outcomes that will answer the "what if" questions. An example of defining scenarios, would be conceptualizing the implementation of a potential sustainable energy and considering all its outcomes. Something to consider when defining the different scenarios are policy, socio-economic factors such as economic growth, security of supply, climate change, and future technologies development. Figure 4 is an analytical tool that helps run an analysis on sustainable energy. All the previously mentioned indicators and different steps of the graphic can be applied to shale gas.

As Switzerland strives for a more sustainable future, it needs indicators to assess the progress towards sustainability. One international indicator is ecological footprint. This indicator measures a societal resource consumption, which helps measure the rate of success in terms of sustainability. In Figure 5, Switzerland's ecological footprint is measured against global biocapacity.

Figure 5: Switzerland's ecological footprint in comparison to global biocapacity



Retrieved from (Bärtschi, 2012)

The graphic shows that Switzerland "is using about three times the volume of natural resources that is sustainable" (Bärtschi, 2012). This means that Switzerland still has a long way to go to achieve sustainability. See Appendix A, Figure 23 for an in-depth graphic in how Switzerland is trying to achieve sustainability.

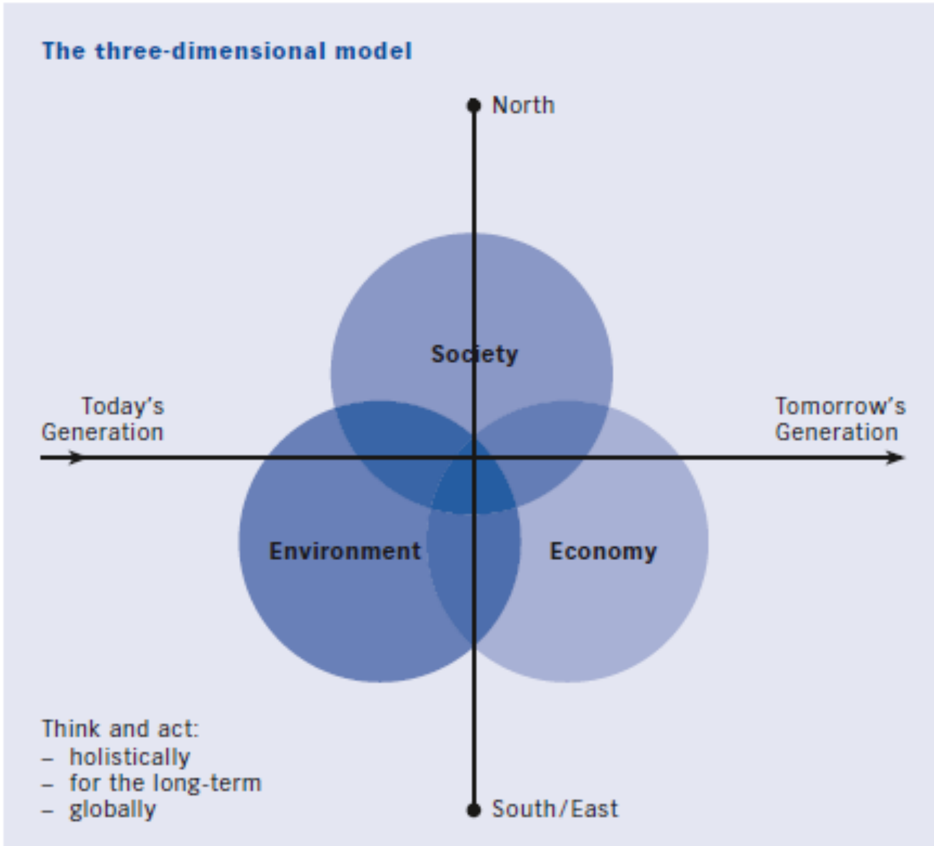
2.2.2 The importance of sustainability

In the 20th century, sustainability became a main issue; scientists began to realize that the population of the earth would increase; yet the resources would diminish exponentially. Naturally, the idea of sustainability has existed for many years; however, with the drawing-up of borders and different nations claiming different resources, the significant change is that now the world has been fully explored and "colonized." Non-renewables were made invaluable and in turn, the race for green energy emerged. Today in Europe, Switzerland is the second most sustainable country as seen in Appendix A, Figure 24, producing much of its energy through hydroelectric energy. Switzerland is becoming one of the most sustainable countries in the world due to "the innovative policies and advanced environmental management practices" placed by the Swiss Federal Council (Gummow, 2014).

Sustainability is of great importance to a country such as Switzerland because of how resource constrained it is. However, this is nothing but advantageous—much of the industrial business that goes around Europe has to travel through Switzerland, in many cases from Germany to other neighboring countries (Shaun West). The Swiss have worked out many business negotiations regarding transportation of goods through its country, and benefit by being strategically placed in such a geopolitical location. Domestically, "thirty-one percent of Switzerland is covered in wood and close to 100k jobs" are due to the timber resource abundance that they have (Gummow, 2014). This a real-time example of how Switzerland is capable of sustainability, even when they have scarce resources, and that sustainability leads to the creation of domestic jobs, instead of giving away work opportunity to foreign countries.

Yet even in the face of successful, local sustainability, Switzerland is feeling the impacts of other countries' lack of sustainability with climate change and global warming. The glaciers in the Alps are rapidly melting and this is negatively affecting the agricultural system that Switzerland relies on (Gummow, 2014). In spite of this, solutions arise for countries similar to Switzerland because of the development of sustainability, and because of how the economy, society, and environmental are interlinked.

Figure 6: Venn diagram of sustainability



Retrieved from (Bärtschi, 2012)

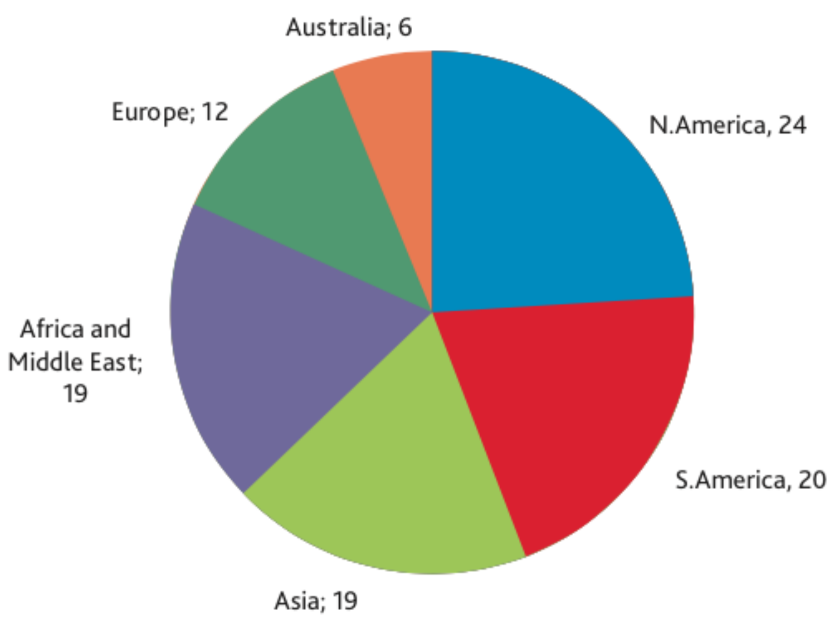
As can be seen in Figure 6, sustainability is often shown in a Venn diagram with circles for the environment, economy, and society (Bärtschi, 2012). This illustrates how each aspect is linked and how an impact on one affects the rest. This is part of what sustainability refers back to; there can be no permanent solution, but instead many alternative solutions each with its own benefits and consequences. The effects that "today's generation" will have on "tomorrow's generation" are the limitations in resources and the need for synthetic alternatives energy resources of which Earth will be exempt (Bärtschi, 2012).

Sustainability, however, is a high-priced ordeal. This makes it difficult to compete against low priced resources such as oil and coal. The balance of having a long-term, yet costly solution versus a cheap, but brief solution is with what many countries struggle. The investment of money is one thing, but the important sacrifice that sustainable options ask for is the time of the consumers: these sustainable alternatives require technology that might not necessarily be in place as of yet or even discovered. On the plus side, the sustainable solution aims to reduce in cost after many years and last for generation. However, in the current day and age, most sustainable proposals remain just that, a proposal. This is inevitable for the time being because countries such as the U.S. have other interests in reducing energy costs for its citizens, even if it means choosing a less-sustainable, less-green option; around the world, the countries that depend on foreign trade are regulated by foreign policy, and so a transition to sustainability is what the countries need. As Switzerland is sustainable, it is still reliant on foreign imports, and so this is a key point in the business model that Switzerland requires: an objective of creating economic independency through its sustainability.

2.2.3 How shale gas may be a sustainable alternative

Shale gas may be a sustainable energy source, but it isn't for every country. Since the formation of shale gas deposits is only evident in certain places around the world and due to differing extraction techniques and costs, the commercial potential varies widely between countries (Brewer, 2014). Figure 7 shows the estimated shares of shale gas resources in different continents, and it is quite evident that what may work in the Americas, may not work as well in Europe, based off of supply.

Figure 7: Estimated shares of shale gas technically recoverable resources (percentage of world total)



Retrieved from U.S. Energy Administration

The challenges of sustainability can be modeled by shale gas, as there is no single overwhelming deciding factor on whether or not shale gas is a sustainable energy. This makes pinpointing shale gas as a sustainable energy not absolute. Even if shale gas proves to be a sustainable energy source, a major challenge that is associated with sustainability is the transitioning local communities into a new model and informing the public (Orr, 2002). Transitioning into sustainability is not an easy task, as it requires strong governance from governments and individuals. Also, as generations change over, views on what is sustainable will inevitably change. The perception of the general public is a strong factor in sustainability.

Sustainability is a difficult topic to understand as well as achieve. In *Assessing sustainability transition in the U.S. electrical power system,* the idea of a sustainable transition of energy is explored (Jiusto et al., 2010). This article does not specifically talk about shale gas, however, the approaches can be adapted to a shale gas model. If the challenges of sustainability are met and overcome, then the benefits of sustainable energy will be implanted into society and the outcomes will be a smooth transition into the new age of sustainability. Whether or not shale gas can be categorized as a sustainable energy is still up for debate, as it provides many benefits but has many drawbacks as well. Many of these benefits and consequences will be discussed in the following sections.

2.3 Impacts of shale gas

2.3.1 Health impacts in regards to communities

In the context of shale gas, a health impact assessment is a key tool to understand how fracturing of shale gas has affected the people around it and what can be done to minimize the health consequences while maximizing benefits. Health impact assessments (HIA) are part of an approach that is aimed towards evaluating the health of a population. A HIA attempts to foresee future health consequences that are both positive and negative. In regards to shale gas, HIAs can be used "to inform decisions by providing a structured process that uses scientific data, professional expertise, and stakeholder input to identify and evaluate the public health consequences of policy and program proposals" (Institute of Medicine, 2014).

Understanding how a health impact assessment works is crucial to determine why one is being performed and how it will effect a current proposal. There are three ways that a health impact assessment tries to determine the future effects of a proposal; (1) forcing decision makers to be aware of how their proposal will affect the health of people, (2), informing decision makers on the specific effect of certain decisions, and (3), to get people that will be directly affected by the proposal involved in the decision making (Joffe, 2005).

Rural communities are candidates for health impact assessments as shale harvesting takes place in many rural communities that are impacted negatively as well as positively. A starting point for using a health impact assessment to determine community health is to determine what health concerns there are in regards to shale gas harvesting. The National Institute for Occupational Safety and Health (NIOSH) has set up the *NIOSH Field Effort to Assess Risks for Chemical Exposures in Oil and Gas Worker* as a way to better assess the type of exposure that workers experience (Institute of Medicine, 2014). The largest health concern that NIOSH found was crystalline silica that is derived from quartz sand. The concern with crystalline silica is that it is known to cause lung disease such as silicosis. Of 111 samples that were pulled from hydraulic fracturing sites, more than 50 percent of them exceeded the Occupational Safety and Health Administration (OSHA) limit for exposure, and 68 percent were above NIOSH limit for exposure.

Communities that shale gas companies inhabit usually pay the price as they fall victim to the boomtown model, which occurs when an industry (in this case, energy), rapidly expands, allowing the community that is harboring the industry to rapidly expand as well. There are considerable economic gains made by the community, however, once the natural resource is depleted, the companies leave and the communities suffer. Besides the emissions from the drilling sites, the increase of traffic especially due to tractor-trailers has made air quality decrease, thus leading to poorer community health.

Furthermore, there is also an increased need for emergency services and health care once a well is in the vicinity: “hydraulic fracturing brings with it increased demands for public services. A 2011 survey of eight Pennsylvania counties found that 911 calls had increased in seven of them, with the number of calls increasing in one county by 49 percent over three years” (Dutzik, 2012). A study done in North Dakota has shown that not only has there been an increase need for emergency services, but also an increase in crimes in the area. They found that “there has been at least a 300% increase in assault and sex crimes over the past year [and] the mayor has attributed the increase in crime to the oil and "natural" gas boom in [the] area” (Dutzik, 2012).

As community vitality is concerned, the economic benefits of shale gas, to the health of a community cannot be overlooked. Since shale gas development spans on both private and state-owned land, there are royalty rates that are paid to the state and private landowners. These rates range between 12.5% and 20% are significant, as signing bonuses have increased the economic wealth of the states such as New York, Pennsylvania, Texas and West Virginia (Nash, 2010). However, even in states that have great approval rates for shale gas development, a study has shown that 57.7 % of the population of those communities have reported that Marcellus shale gas drilling has presented a moderate threat to the environment as well as the public health (Goldstein, 2014). Economic wealth and health compared to public and environmental health is an ongoing debate that has shale gas positively received in some states while negatively viewed in others.

Table 2: A streamlined list of benefits and consequences in the health sector

Benefits	Consequences
• Community growth fostered by economic booms • Diversifying jobs and society	• Boomtown model: where rapid growth is followed by rapid decline • Gutting of infrastructure of the communities • Increase amounts of emergency calls and increased demand for public services.

2.3.2 Environmental impacts

Although shale gas production has substantially increased over the past decade, there has always been doubt about the environmental risks associated with hydraulic fracturing. While some are seeking shale-fracturing expansion, others are seeking a prohibition on drilling while more in-depth environmental studies are completed (Stevens, 2010). Some of the environmental risks associated with hydraulic fracturing are the greenhouse gas footprint, water resources, and natural ecosystems and wildlife.

The chemical composition of shale gas has interested many researchers who are primarily focused on reducing carbon dioxide emissions into the atmosphere. Since shale gas is composed of mostly methane, the chemical combustion produces a substantially smaller amount of carbon dioxide than does burning oil or coal and this shift from coal to natural gas has led to the decrease in carbon dioxide emissions by 430 million tons (a 7.7% decrease) from 2006 to 2011 in the United States (Qiang Wang, 2014). Qiang Wang goes on to suggest that "the replacement of coal by shale gas is a key factor and what happened in the U.S. could very well happen in China and other countries, and could definitely help in reducing CO_2 emissions" (Qiang Wang, 2014).

Reducing carbon dioxide emissions is only a small part in curbing the greenhouse gas effect, however, considering that the greenhouse warming potential (GWP) is just as important. Any gas released into the atmosphere has an effect on the greenhouse gas cycle, and many gases, such as methane, have been studied in an effort to compare their GWP compared to that of carbon dioxide. In fact, carbon dioxide has a relatively low GWP compared to other gases; "methane has a global warming potential (GWP) that is 72-fold greater than carbon dioxide when viewed over a 20-year period" (Qiang Wang, 2014). Increasing the greenhouse gas footprint will lead to an increase in the effects of climate change.

If the methane from shale gas fracturing was harvested with a 100% yield, the greenhouse warming potential would not be an issue. However, Howarth reveals that "3.6% to 7.9% of the methane from shale-gas production escapes to the atmosphere in venting and leaks over the lifetime of a well" (Howarth, 2011). A substantial amount of methane is leaking from the harvesting equipment and this not only causes a direct release of a gas with a greater GWP into the atmosphere, but also a loss of a fossil fuel that is not in infinite supply. In summary regarding the greenhouse gas footprint of shale gas, "a shift from coal to gas would reduce emissions of carbon dioxide, but this shift would slightly accelerate climate change through at least 2050" (Qiang Wang, 2014).

Another significant issue of environmental concern is the extensive reliance on local, site-specific water resources. The fracturing process consumes large volumes of fresh water mixed with sand and chemicals; roughly 2 to 4 million gallons of water are consumed per well (Qiang Wang, 2014). In regions where water may not be an issue, shale gas consumption of water is largely forgotten. However, spreading harvesting operations in Texas and the Midwest need to import massive amounts of water and this takes away from areas that are already in drought. Currently, "the national water requirement may range from 70 to 140 billion gallons…the equivalent to the amount of water consumed by 5 million people" (Qiang Wang, 2014). As the climate continues to change and droughts become more common, large water consumption by shale gas harvesting may no longer be acceptable.

Furthermore, once the water is consumed in the fracturing process, the toxic chemicals used in harvesting techniques may contaminate the soil and surface water. There are at least 650 chemicals that are known or thought to be human carcinogens being used as part of the fracking process; waste fluids must be deemed hazardous and treated appropriately (Qiang Wang, 2014). In many cases, waste fluid is left in evaporation pits to concentrate the chemicals before they are trucked off, saving transportation costs and treatment costs for dealing with a smaller volume of liquid. This temporary storage and transportation of the flow back fluid is a major problem that is under increased scrutiny (Zoback, 2010). Additionally, the fracturing process disrupts many layers of earth and releases heavy metals into the fracking fluid; it has been documented that heavy "…metals including Cu, Cd, Pb, Se, and Zn move through sediments and the food chain to affect aquatic and terrestrial wildlife" (Brittingham, 2014).

While the risk of exposure to chemicals through local groundwater is one that has come under intense media review, "many thousands of feet of rock separate most major gas bearing shale formations in the United States from the base of aquifers that contain drinkable water" and so it is highly unlikely that chemicals and heavy metals will enter local waters through the drilling process (Zoback, 2010). It is also extremely uncommon for an accidental release of toxic chemical waste associated with the fracking process (Brittingham, 2014). However, there have been issues regarding the improper treatment of the chemically contaminated wastewater in the Northeastern United States by using local municipal wastewater treatment plants that were not capable of handling this kind of hazardous waste (Brittingham, 2014).

Environmental impacts of shale gas harvesting also extend to the local ecosystems and wildlife. Ecosystems might be directly affected by the construction of the well pad and infrastructure necessary to operate the gas well. The construction is not considered to be a direct cause of ecosystem mortality, but can cause severe problems if the construction takes place during the breeding season of local wildlife (Brittingham, 2014). Another part of the ecosystem may be disrupted by the habitat fragmentation which develops when "large, contiguous blocks of habitat are broken up into smaller patches," thus splitting wildlife areas (Brittingham, 2014). It has also been suggested that the horizontal fracturing process may lead to seismic events in the region. "Only about three percent of the ~75,000 hydraulic fracturing stages conducted in the United States in 2009 were seismically monitored," leading to a lack of understanding of the seismic risks associated with the process (Zoback, 2010).

Table 3: A streamlined list of benefits and consequences in the environmental sector

Benefits	Consequences
• Reduced carbon dioxide emissions	• Increased greenhouse warming potentials • Accelerated climate change • Large consumption of local water • Potential for local water contamination • Disruption of local ecosystems near drill sites

2.3.3 Economic impacts

Shale gas has many different impacts on the economy; some impacts are good, but others are very costly. Some of the positive impacts on the economy include the creation of jobs as well as the influx of money as the resource is exported to foreign markets. However, negative impacts affect the property value around well dig sites as well as the increase in maintaining local infrastructure and medical services.

A study done in Texas found that the new hydraulic fracturing industry would bring additional jobs for people in the surrounding areas. Here's the job breakdown from the report: "industrial machinery exports: 28,574, chemical exports: 23,787, infrastructure projects: 2,824" (Seifer, 2014). As well as creating job opportunities, shale gas is said to be critical for economic growth, especially in the United States. Natural gas is a large part of the U.S. economy, which means a better form of natural gas extraction could lead to a growth in the economy.

Normally, the natural gas prices in the U.S. shift on a daily basis, but with hydraulic fracturing and the potential for an abundance of shale gas, the natural gas prices could potentially lower. Nicolas Loris of the Heritage Foundation says "the abundance of natural gas makes the United States an attractive place to do business, especially for energy-intensive industries"(Loris, 2012). A new KPMG analysis of the U.S. chemical industry emphasizes that the U.S. has changed to become an advanced market for chemical production due to the new, abundant source of natural gas (Loris, 2012).

Before shale gas, the price of natural gas was closely related to the price of oil because both came from the same place: "A good example of this link between increased oil and gas prices is the market activity seen in 2008, when rising production costs caused oil prices to shift beyond the $100/bbl, which in turn hiked gas prices" (Hughes, 2013). Furthermore, natural gas prices have ranged from $18/ MMBtu in 2003 to around $4 / MMBtu in 2009 (Hughes, 2013). Now that natural gas is being extracted from shale in the earth using hydraulic fracturing and horizontal drilling techniques, oil and gas are no longer linked together in the market. Hughes concludes that "…the increased amount of fracking activity has driven [natural gas] prices consistently below the $5/MMBtu since the beginning of 2010" (Hughes, 2013). This separation between natural gas and oil prices makes natural gas more desirable and provides an economic incentive to those who can supply it.

On the other hand, an increase in gas production leads to the increase in trucks needed to transport the oil and gas from extraction sites. There is a huge increase in heavy truck traffic once shale gas well sites are developed due to the heavy equipment that is used at well sites to level drilling pads. Multiple trucks are used to bring drilling equipment to and from the well site. One study in Texas found that "for all three phases of a gas well—drilling, fracking, and maintenance—approximately 592 one-way truck trips were required per well [and] some individual trucks weighed as much as 80,000 to 100,000 lbs when fully loaded" (Marcellus-Shale, 2015). Another study on trucks used for shale gas fracturing found that "1,184 loaded trucks are necessary to 'bring one gas well into production,' plus 353 loaded trucks per year for maintenance and 997 loaded trucks every five years to re-frack a well" (Dutzik, 2012). To put this in perspective, in number of vehicles, it is equal to about 8 million cars and 2 million service vehicles per year for all of the wells in the whole country (Dutzik, 2012).

Shale gas fracturing also affects property values for landowners; most people will not purchase land next to fracture sites (EcoWatch, 2014). Furthermore, those who have owned land before the natural gas was discovered lose their property investment, illustrated by the "…gentleman who has had 63 acres for sale now for several years. He purchased the property as an investment, and now has three pipelines and an above ground valve. He cannot give this property away. As he reaches retirement age his retirement has been stolen from him"(EcoWatch, 2014). Properties that are near these hydraulic fracturing sites are valued less than before the sites were constructed, shown by a study in Texas that "concluded that houses valued at more than $250,000 and within 1,000 feet of a well site saw their values decrease by 3 to 14 percent" (EcoWatch, 2014).

Table 4: A streamlined list of benefits and consequences in the economic sector

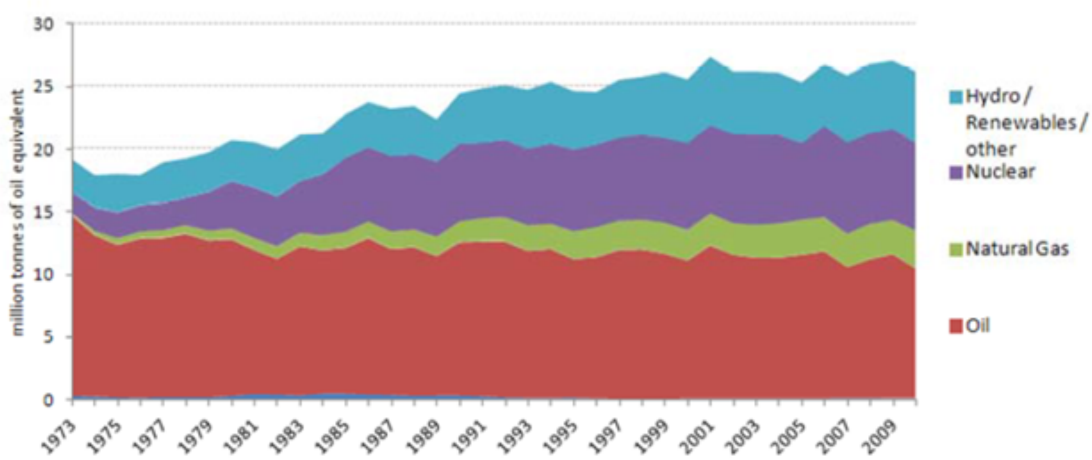
Benefits	Consequences
• Creates job opportunities for people to work at the shale gas harvesting sites • Lower gas prices due to new harvesting of shale gas • Increased energy market and more valuable business partners	• Damage to roads from trucks carrying equipment and gas costs the city a lot of money to fix • Decrease of property values of land near and around hydraulic fracturing sites

2.3.4 Energy impacts

As a clean energy-producing country, Switzerland primarily uses hydroelectric generation for its electricity, but also relies on natural gas as can be seen in Figure 8. In comparison to shale gas, oil has existed as the "dominant energy source" accounting for nearly "40% of [Switzerland's] total primary energy supply (TPES) in 2010" of which they produce none, but rely on imports instead (IEA, 2012). The International Energy Agency (IEA) mandates certain regulations for non-net exporting nations; the organization, which deals with compulsory stockpiling of oil products in Switzerland, is CARBURA, and was established by the Federal Department of Economic Affairs (FDEA) as a response to the IEA's regulation. This is a mandatory process, as Switzerland is reliant on imports for its energy production and distribution, and is an example of Switzerland's attempt on economic interdependency.

The manner in which Switzerland coordinates the storage of its oil supply is that importers must have 4.5 months of motor gasoline, diesel, and heating oils and 3 months of jet fuel in stock; they have a 3-year average share of imports or sales (IEA, 2012). The reason for long-term stockpiling is because in a scenario where a political crisis were to occur, Switzerland would have some resources to work with as an emergency ration until the crisis were to cool down. As it stands, however, Swiss administration forecasts oil imports to decrease by 10% in 2020 and 39% in 2050; furthermore, if Switzerland implements its "New Energy Policy," oil imports decrease by 18% in 2020 and 74% in 2050 (IEA, 2012). Instead, Switzerland's share of natural gas of total primary energy supply stood at 12% in 2010, and similar to the oil, their gas demands are met by pipeline imports (of which was 3.7 billion cubic meters in 2010) and must hold compulsory stocks equivalent to 4.5 months of natural gas consumption (IEA, 2012).

Figure 8: Total primary energy supply



Source: Energy Balances of OECD Countries, IEA

As is stands, the Swiss Federal Council has obliged that in the case of gas supply disruption, their consumers should switch from gas to fuel oil (in which this case study approaches seeking gas to be the alternative, emergency backup resource). In 2012, the demand for natural gas in Switzerland increased 0.8 billion cubic meters, a 27.5% increase, from 2000-2010 primarily consumed by the residential sector (estimated to represent 38% of the country's total gas consumption in 2010), in particular during the winter months (IEA, 2012). Just as importantly, the industry and commercial sectors represented 28% and 24%, respectively, and this can be visualized in Figure 9.

Figure 9: Key natural gas data

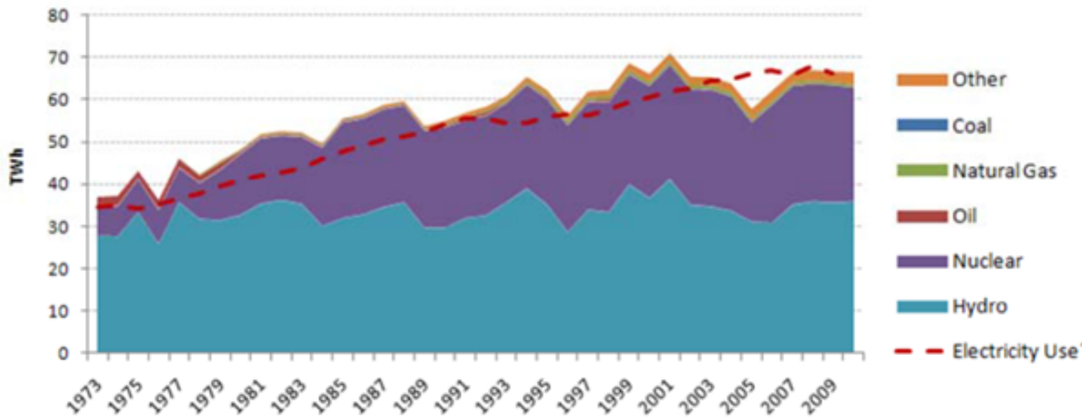
	1985	1990	1995	2000	2005	2009	2010	2011 *
Production (mcm/y)	18	4	-	-	-	-	-	-
Demand (mcm/y)	1 549	1 994	2 682	2 972	3 399	3 295	3 682	3 165
Transformation	*118*	*150*	*230*	*274*	*295*	*236*	*286*	-
Industry	*618*	*710*	*1 029*	*894*	*992*	*1 004*	*1 040*	-
Residential	*525*	*735*	*958*	*1 019*	*1 209*	*1 217*	*1 412*	-
Others	*288*	*399*	*465*	*785*	*903*	*838*	*944*	-
Net imports (mcm/y)	1 531	1 990	2 682	2 972	3 399	3 295	3 682	3 165
Import dependency	*98.8%*	*99.8%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*	*100.0%*
Natural Gas in TPES	*5.6%*	*6.7%*	*8.9%*	*9.5%*	*11.0%*	*9.9%*	*11.5%*	-

** based on monthly data submissions to the IEA.*

Source: Energy Balances of OECD Countries, IEA

By country of origin, the supply sources that Switzerland has are diverse: the Netherlands stood as the largest supplier, 26.6%, followed by Russia at 24%, Norway at 23%, and Germany at 13.1% (IEA, 2012). This is a prudent tactic on Switzerland's part as each of these suppliers has limited connections with each other and therefore in the case of political crises, Switzerland might have a natural gas supply from at least one of aforementioned countries. In the eyes of the Swiss Federal Council, their interests align with having fewer, albeit diverse, suppliers, creating and forming an economic interdependency and thus eliminating a piece from the disadvantages of being an importing country. Through country of contracts, Germany represented 68% of the total imports and was the largest gas supplier; this means that imports were from Germany mainly, yet not all of the gas was harvested there and instead came from different countries.

Figure 10: Electric generation, by fuel source



Source: Energy Balances of OECD Countries, IEA

Shale gas has yet to become a major energy source in Switzerland, but stands to be reliable in terms of energy aspects. As seen in Figure 10, nuclear energy follows hydropower as the second largest energy source in generating electricity in Switzerland, yet the Swiss Federal Council and parliament have decided to "phase out nuclear power by the end of the operating life of the reactors," expected to be between 2019 and 2034 (IEA, 2012). Reasons for this decision relates to the Fukushima incident in Japan, where three of the six nuclear reactors resulted in a meltdown after an earthquake and a 15-m tsunami hit the plant. The possibility for a meltdown mixed with fears of fallout has convinced the Swiss to use alternative energy sources. For this reason, as well as the introduction of two potential plans, the "Up to now" and the "New Energy Policy," the Swiss government has decided that these precautions and measures could prevent human-induced disasters. In the long-term, the government plans to implement new technologies for a clean and sustainable energy resource. The main difference between the "Up to now" and "New Energy Policy" plans is rather straightforward: the "New Energy Policy" requires new technologies and instruments, whereas the "Up to now" keeps the level of sustainability and technology constant.

Table 5: A streamlined list of benefits and consequences in the energy sector

Benefits	Consequences
• Replaces Nuclear Energy, a potentially disastrous resource • Possibility to create new, sustainable technologies	• Creates dependency on foreign industries • Shale gas is still not widely accepted as an alternative in Switzerland.

2.4 Business Engineering Sustainable Energy Systems at HSLU

2.4.1 Professors Uwe Schulz and Shaun West

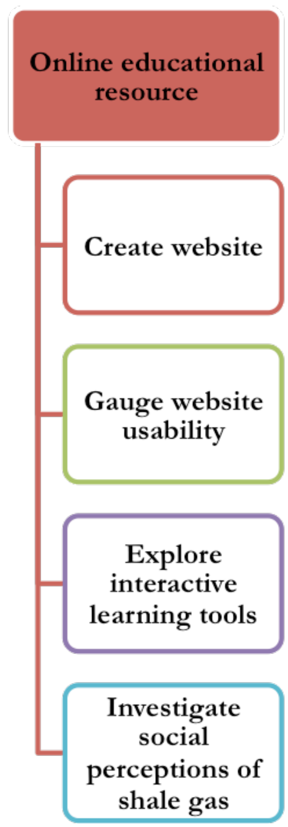
Uwe Schulz is the program director for Business Engineering and Sustainable Energy Systems at the Lucerne University of Applied Sciences. He received his Ph.D. in energy and process engineering from the University of Essen, Germany and has focused on project management in marketing and business development. He is also a managing director at UWE SAN GmbH, a firm focused on quality and environmental project management. Professor Schulz has conducted research that focuses on business models that drive sustainable advancement and is interested in the model that may carry shale gas to the front lines of the energy market.

Shaun West is a professor at the Lucerne University of Applied Sciences/HSLU and gives lectures in the field of business engineering. An alumnus of Imperial College, Professor West has unique insight into the energy sector, energy markets, and energy equipment and services. He has worked at a variety of different workplaces, such as AEA Technology/ETSU, National Power, GE Energy Services, and Sulzer. He has worked with the latest gas turbine technology, implemented risk management techniques for power plants, and was involved in project acquisition and process discipline. He began to lead research at HSLU and is involved in ongoing projects regarding energy sustainability and service innovation.

CHAPTER 3: METHODOLOGY

Mission Statement: The goal of this project was to create an online educational resource that is an information and news platform for students to learn about sustainability, shale gas, and how shale gas has already influenced economic, energy, environmental, health, and political sectors across the world, specifically in the United States. Part of the development of the website was investigating its usability at HSLU through interviews and surveys of students and professors as well as exploring new ways for an educational curriculum to be taught through an online medium. Our hope is that the website will be used in the Business Engineering Sustainable Energy Systems department at HSLU as part of a lecture sequence into the study of the complexities behind the shale gas debate. The information we collected regarding website usability in the classroom can be applied to any class that is trying to implement a website as part of the class curriculum.

Figure 11: Project flowchart

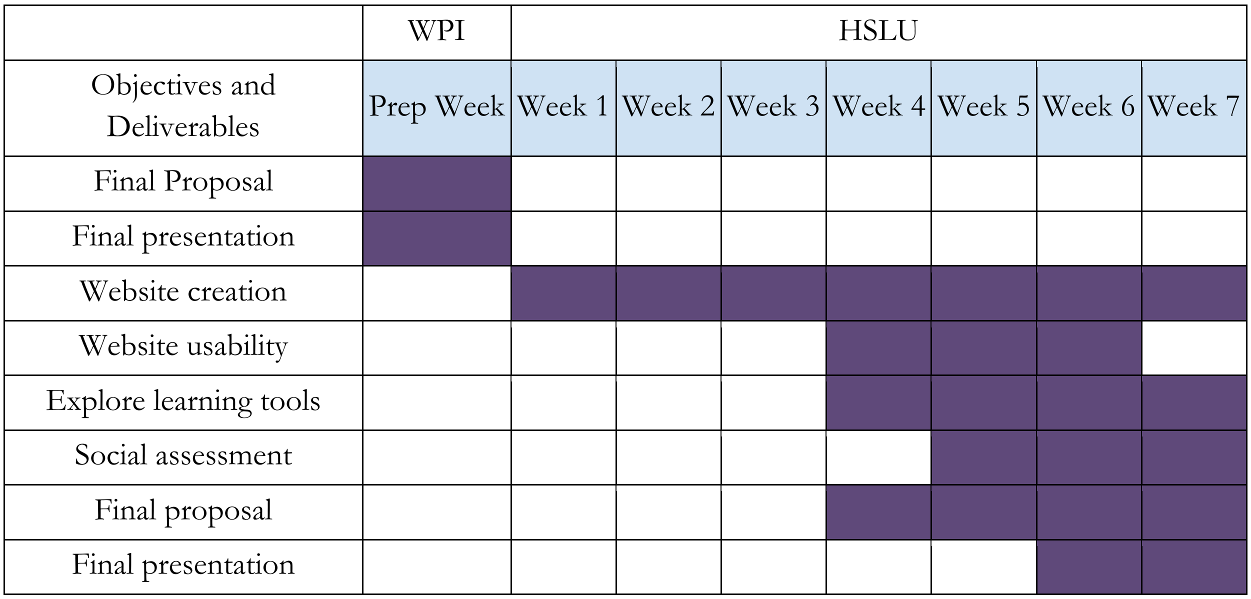


The process to complete this goal can be summarized by our objectives, which are:

1. Create a website that can be used as an educational tool
2. Gauge website usability
3. Explore interactive learning tools to augment learning modules in place at HSLU
4. Investigate social perceptions of shale gas

The relative timeline at which these goals as well as project related requirements were completed can be seen in Figure 12.

Figure 12: Project timeline



3.1 Stakeholder analysis

In creating a website for the Lucerne University of Applied Sciences and Arts - School of Engineering and Architecture, it was important to identify the stakeholders and audiences of our website. We determined early on that there were two types of audiences and stakeholders, direct and indirect. As can be seen in Figure 13, direct audiences include our sponsors and university students for whom the website was developed. Indirect audiences and stakeholders include everyone else who, although they have a stake in the shale gas debate, will not directly be affected by viewing the website. We hope that the website expands outside of the Lucerne University to include the general public, and this would increase the direct audience of our project.

Figure 13: Audiences and stakeholders

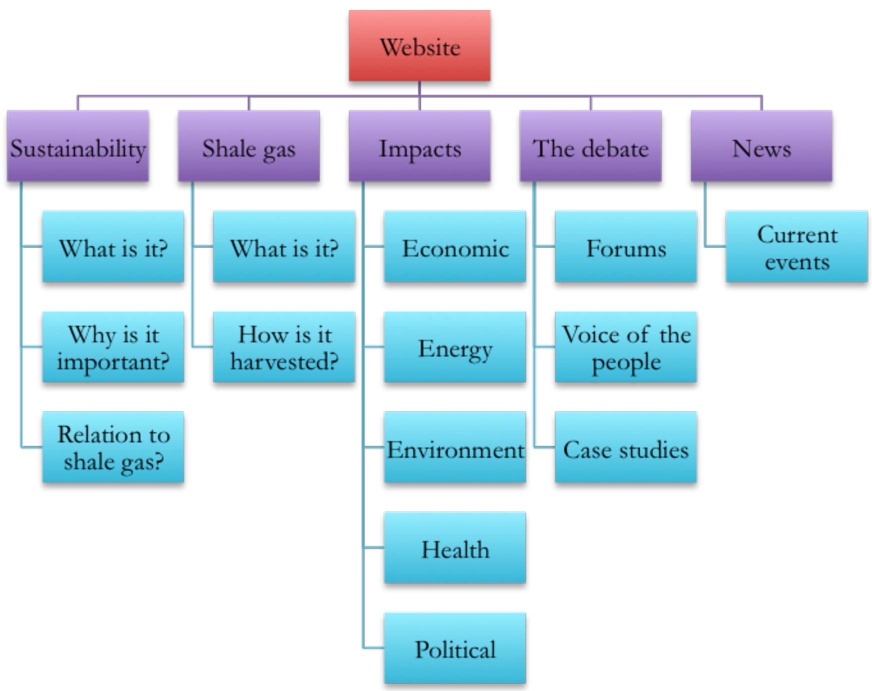
Direct	**Professors Schulz and West**	Stakeholders educating other citizens of Switzerland on the business and sustainability of shale gas.
	University Students	Stakeholders with the opportunity to decide Switzerland's future energy source.
Indirect	**Global Students**	Stakeholders whose diverse backgrounds will lead them into spreading what they learned about shale gas and sustainability around the world.
	Swiss Residents	Stakeholders being impacted by the energy sources and with the vote of accepting or denying Shale Gas as an option.
	Environmental Organizations	Stakeholders involved with analyzing and advising against resources that would harm the environment.
	Industrial Agencies	Stakeholders who manage and conduct business relations regarding Shale Gas supply and demand.
	United States	Stakeholder currently leading the Shale Gas industry.
	Foreign Exporters*	Stakeholders involved with the production and exports of Shale Gas
	Polticians/ Government Officials	Stakeholders with the power of influencing Shale Gas as a potential energy alternative.
	Business/ Energy Corps.	Stakeholders affected by the approval or rejection of Shale Gas in terms of economic impacts.
	European Union/United Nations	Stakeholders involved with overseeing foreign trade of resources between European countries.

These indirect audiences have very different interests associated with production, consumption, regulation, living near, etc. to shale gas. It was tough to gauge their stakes in the website as they have very different interests, and so we have listed them all as indirect, not in any order of ranking.

3.2 Create a website that can be used as an educational tool

We gave the Lucerne University of Applied Sciences and Arts' Business Engineering Sustainable Energy Systems department a website that they can use to study sustainability as it relates to shale gas. While the website was initially supposed to be a small part of an educational model, it evolved to become the main educational tool and deliverable to the sponsors and university. The website is an online database that students can draw information from and contribute to, as well as post assignments as part of the curriculum on shale gas and sustainability. The layout of the website can be seen in Figure 14. The three key areas that serve as the core information of the website are sustainability, shale gas, and its impacts. The debate section of the website is a place for students to voice their own opinions, contribute to the shale gas discussion, post videos, and view relevant case studies to their in-class discussions.

Figure 14: Website layout and design



<u>3.2.1 Framing a website for students at HSLU</u>

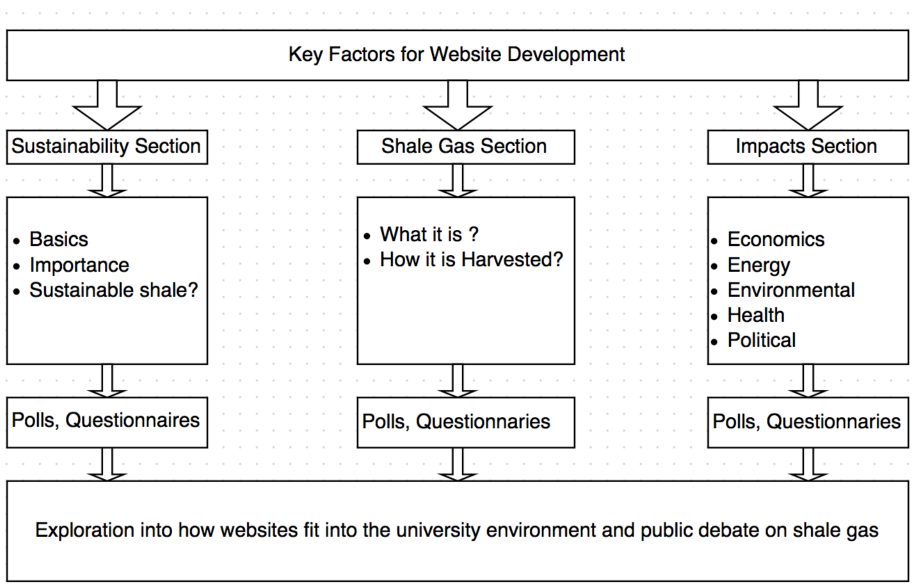
In order to create the website, we spoke to Professor West and determined that WordPress, a web page editor, should be used. Students and faculty have used WordPress-based websites in the past so they are familiar with its functionality. Also, the website development was able to be passed on to the Professors after we left in May 2015 to keep it an updated resource for their classes. Identifying which pages are pivotal in understanding the complexities of the shale gas debate was the next step in framing the website towards students at the university, and this will be discussed in the following section.

This objective was completed in the early and middle stages of our project. We received regular feedback from our sponsors, advisors, and select students about the website. The edited website, created using the feedback, was the final deliverable of our project, and was our final presentation to our sponsors and anyone else that was involved.

3.2.2 Adapting an analytical model into a website

As discussed above, we selected three key areas as part of website development to explore based off of a decision-support framework developed by Santoyo-Castelazo as seen in Figure 4. Instead of selecting sustainability specific indicators as Santoyo-Castelazo did, we selected areas that are crucial to gain an understanding of the complex debate around shale gas as an energy resource; these areas are sustainability, shale gas, and its impacts. Understanding these three key areas will give students the ability to comprehend the current shale gas debate, as well as contribute to the discussion of whether shale gas is a sustainable option for Europe. This updated graphic, that is at the core of our website, can be seen in Figure 15.

Figure 15: Analytical flow chart for the creation of a website



Adapted from Santoyo-Castelazo, 2014

3.2.3 Website pages

Following the adapted analytical tool previously mentioned, the website pages were developed in such a way to funnel students from the informative pages relating to sustainability, shale gas, and the impacts of shale gas into an interactive discussion page. The content also increases in technical detail as the website progresses through sustainability to the impacts pages. It was our goal to make a website that was interactive such that students do not lose interest, but also that we could analyze their social perceptions and understanding of the topics presented. We employed the use of images, videos, polls, questionnaires, and surveys on various website pages to make the overall website experience more interactive (which will be discussed below).

Pulling largely from our background and references, the early development stages of the website focused on what sustainability and shale gas are. The sustainability sections form the basic foundation for understanding the complexity of whether shale gas will meet the three key pillars of sustainability: the environment, economy, and society. Defining sustainability early on also helps make sure everyone is on the same page for the open discussions later on. Understanding what shale gas is and how it is harvested is crucial in discussing the positive and negative effects, and ultimately, deciding if shale gas is a viable sustainable option.

Additionally, the website contains pages for each of the following impacts of shale gas: economics, energy, environment, health, and policies. These sections are more technical than those previously as they focus on the direct effects so far from harvesting shale gas and form many of the points of contention in the current shale gas debate. Although these pages will be fixed and have no actively changing content, they will need to be updated as more research and data is presented in countries that harvest shale gas.

A page that will not be static and will update automatically every day is the news feed page. This is an additional resource that we added to the website to help readers formulate opinions of shale gas. This page incorporates news from several prominent sources such as *The Guardian*, *The New York Times*, *U.S. Energy Information Administration*, *National Gas Intelligence*, and many more. Since the political scene is constantly shifting, keeping a tab on current events will help analyze the policies of Switzerland, Europe, and the United States relating to shale gas.

After developing these major sections, we then moved towards evaluating the complexities behind supporting or rejecting shale gas as a sustainable option. Here, we let students participate in online discussions and voice their own perspectives of shale gas. This page serves as a place where readers can share their opinions through forums and video discussions as well as a place where we can analyze their understanding of the complex issues through assignments as part of the class curriculum. Additionally, there is a page for professors and lecturers to add case studies that they deem relevant for in-class discussion.

3.3 Gauge website usability

The website serves as a supplement to the curricula of the different lecture modules at Lucerne University of Applied Sciences and Arts. In the same aspect that students give feedback to their professor on how they can improve classroom interaction and lectures, the students can assist with their input on website practicality. To make sure that our online educational tool is feasible, usage of surveys and other interactive activities were prepared for students at HSLU in order to gauge how useful the website is as an educational tool. Defining feasibility, practicality, and usability as it refers to cyber resources is as challenging as creating a textbook for students in a classroom. Instead of catering to one certain aspect of a website, we aimed for our website to become a dynamic, developing resource for students to add input on the theme of sustainability and shale gas after our IQP was completed.

3.3.1 Interviews

Interviewing of our sponsors as well as other faculty members produced pertinent advice on how to structure the website. The generalized interview plan can be seen in Table 6. The interview focused on what characteristics of the website they envision being most useful and engaging for the students. As there are no secondary websites being used in the classroom at HSLU at the moment, it was important to find out what kind of features would be on the website and how the website would be used to supplement the normal classroom experience.

Table 6: Key interview guidelines

1	Opening- Explain purpose of the interview
2	Ground rules of the interview
3	Background information questions
4	Ask for opinions on project concepts, goals and objectives
5	Ask for key informant's experience with the project or any related fields
6	Ask for opinions on logistical methods on achieving goals and objectives
7	Ask for recommendations or other resources that might benefit the project
8	Conclude interview, thank participants for their time and knowledge

Adapted from: Agency for Healthcare Research and Quality

A sample interview form for professors and assistants can be seen in Appendix B: Figure 25. After receiving feedback from professors and assistants, the website was updated to incorporate their recommendations so that the website can be better implemented into the classroom.

3.3.2 Student surveys through the website

In addition to interviews with faculty, we surveyed students on the feasibility of navigation through the website as well as to determine if the content is easily understandable. We emailed the link the website to students in the department as their classes are spoken in English and the content of the website is related to their fields of study. Additionally, we contacted the International Student Office at the University and sent an email to international students as well.

The student surveys were on the website and asked students to navigate through the pages, learn some of the material, and then fill out on a survey what they thought about their experience. The survey questions can be seen in Appendix B: Figure 26. As part of the website feedback, we had a place for students to leave their contact information if they were interested in talking to us more about their experience. We have extended this beyond just students at HSLU to also include WPI students.

3.3.3 Student interactions

In addition to website surveying, we table-sat outside one of the common areas where students hang out in between classes in order to interact with them and get some more feedback about the website. It was very difficult for us to engage with the students in the short intervals between their classes. The language barrier also posed challenges, as there are only a fraction of the students who speak English at the university. The student surveys on the website, although less personal, were used as the main part of website feedback.

3.3.4 Swiss company and organization feedback

In order to expand the field of feedback we were receiving, we reached out to energy and environmental companies and organizations in Switzerland. We sent emails to seven companies that have stakes in the environmental and energy sectors, with an introduction of our project as well as ourselves, asking for feedback on the usability of the website in educating the general population about sustainability and shale gas.

3.4 Explore interactive learning tools to augment learning modules in place at HSLU

This objective was created to expand the role of the website in the curriculum at HSLU. Pulling ideas from interviews with professors and faculty members at the university, we learned about what kind of teaching styles are employed in the university teaching modules; we attended several classes and witnessed teaching styles first hand, and looked to expand what they already have in place. We discovered interactive teaching tools through WordPress, as well as pulled from our own experiences as students in the development of an interactive website.

3.4.1 Interactive learning tools

Since a website has never been used to augment a class discussions at HSLU, it was important to make the experience enjoyable, as well as provide the same interactive atmosphere. From the beginning of website development, we knew we would incorporate relevant graphics and videos on individual pages to make the content more interesting in order to hook the reader. We did not want the pages to feel as if the user was reading through a textbook, but rather a resource with a multitude of options to learn the material. Another way to engage the reader is through polls and questionnaires, which we discovered by perusing the widget and add-on pages of WordPress. This not only engages the reader in the discussion of the content presented, but is also a way for professors to gauge the user's understanding and opinions on the material. These help to foster an atmosphere of discussion for the "Forums" and "Voice of the people" pages on the website, which are additional interactive tools to foster understanding of the shale gas debate.

3.4.2 Student questions and assignments

Professor Schulz and Professor West mentioned many times during our discussions that they would be interested in having sample questions, assignments, and activities for the study of shale gas and sustainability. We created questions that linked together topics throughout the website and encouraged students to voice their opinions on shale gas as well as tested their knowledge of the material for grading purposes. The activities are more involved and encourage students to interact with each other, either in class or on the website.

3.5 Analyze social perceptions of shale gas in Europe

This objective was to explore the social preconceptions that exist today in Switzerland as they relate to shale gas and sustainability. The methods and sample questions within this objective were developed through discussions with our sponsors and advisors, pre-testing with a few students, and a refining of our methods as we moved forward. The students at the Lucerne University represent a diverse population that can provide a wide view of opinions on shale gas and sustainability. A large number of international students as well as those pursuing undergraduate and advanced degrees attend the university.

3.5.1 Student surveys, polls, and questionnaires

The main way we analyzed social perceptions was from the online survey questions that we posted to the website. Students were able to take these short surveys directly on the website which gave us an easy way to view their thoughts. There were two different surveys that we made: a pre- and post-survey. The pre- survey was a short survey that the students took before they entered the website. This gave us a baseline for what the students knew about sustainability and shale gas before they looked at the website. The post- survey was taken by the students after they were done reading the website to test their knowledge about sustainability and shale gas once again; this showed how much the students learned from the website. Additionally, polls and questionnaires are on individual website pages to gauge student understanding and opinions relating to the topics presented.

The survey questions for the pre- and post- surveys can be seen in Appendix B: Figure 27 and 28. The survey questions were created towards the end of the term, only after the website had been fully created. We acknowledge that the survey questions were not fully developed as we were rushed for time and wanted to investigate some social perceptions while we were in Switzerland. The questions could have used some more work and feedback before implementing them on the website, but they did bring in some very baseline information which will be discussed in the Results section.

3.5.2 Focus groups

We originally thought that selecting a convenience sample of students and faculty from the Lucerne University as a focus group would be not only feasible, but a good way to engage with local students and faculty. To view a sample focus group interview form that we had planned on using, see Appendix B: Figure 30. According to Krueger, a focus group is a way to understand how and why people think, and "participants are selected because they have certain characteristics in common that relate to the [overall] topic" (Krueger, 2009). The use of a focus group was never implemented during our work at the Lucerne University as both faculty and students were very busy, but also due to language barriers. We ended up relying more heavily on the pre- and post- surveys than we anticipated as these ended up being the majority of our feedback.

CHAPTER 4: RESULTS AND RECOMMENDATIONS

This chapter documents the process of creating the website, including information on how it was developed through WordPress and how professor and student feedback was incorporated into the overall design. Our project was an experiment of sorts to explore if and how a website could be created and implemented as a platform for education in a university on a complex, evolving issue, and the results from this exploration is also discussed. Additionally, the social perceptions of shale gas in Europe and the United States were investigated. Finally, recommendations were made relating to the creation of the website as well as what would have been done differently to make the process more smooth and successful. If you would like to visit the website, it can be viewed at dokumenton.com/shale-gas, but for the purpose of the report, we have included pictures to document individual pages.

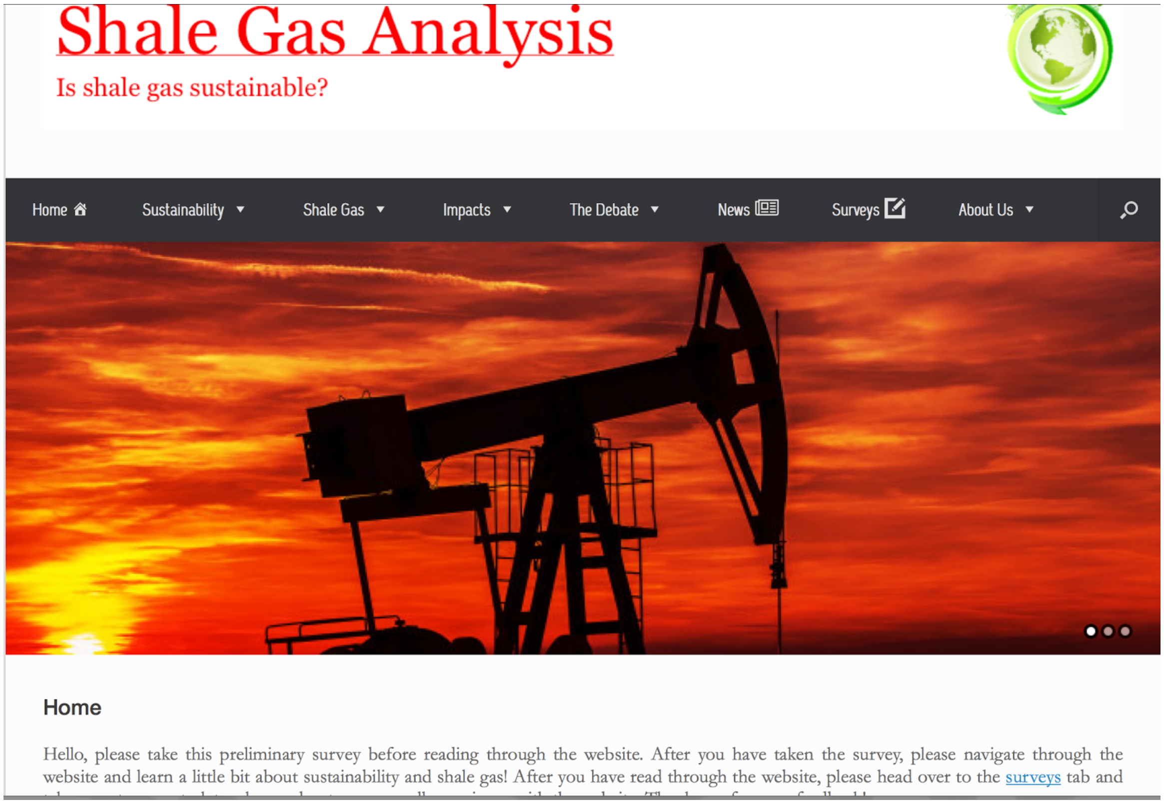
4.1 Website formation

From the conception of our project in Worcester during our prep-term, a website was just an extra deliverable and only a minor portion of our proposed education model. Now, however, the abstract idea of an online education platform became the concrete end-goal of our project. Professors Schulz and West suggested that we use WordPress as a tool in developing the website. WordPress is an open-source blogging tool based on plugins and a template system in which an administrator can edit and publish pages easily and from any location that has access to the Internet. One of the reasons why this was the suggested option is because Lucerne University already had licenses with Dokumenton, a web hosting server that uses WordPress, which allowed for a feasible and time efficient production of a website.

4.1.1 Website theme and title

Beginning with our website design, we first decided on a theme that represented shale gas—dark and carbonite-colored. However, this was before we decided to make the website more interactive and not just static with only research content. We decided to change the theme to white and red, where these colors represent both the Swiss as well as the WPI school colors. Additionally, these colors call attention to and guide the reader to the main message of our page: *Shale Gas Analysis, how sustainable is shale gas?* However, we decided to alter the colors of the theme one last time. We went back and retrieved the dark theme but only applied it to our drop down menu. A darker color indicates a more serious overtone, but delivers a focal attraction to the set menu, which is the key to navigation within our website. We also brought back the idea of a logo, with the title and subtitle implanted on it as well as a green Earth symbol to indicate a general motif of the preservation of nature. As a last modification to the theme, we chose to thin out and "modernize" it with a sleeker menu, as well as a thinner script. A picture of the website theme, title, and navigation menu can be seen in Figure 16.

Figure 16: Website theme, title, and navigation menu

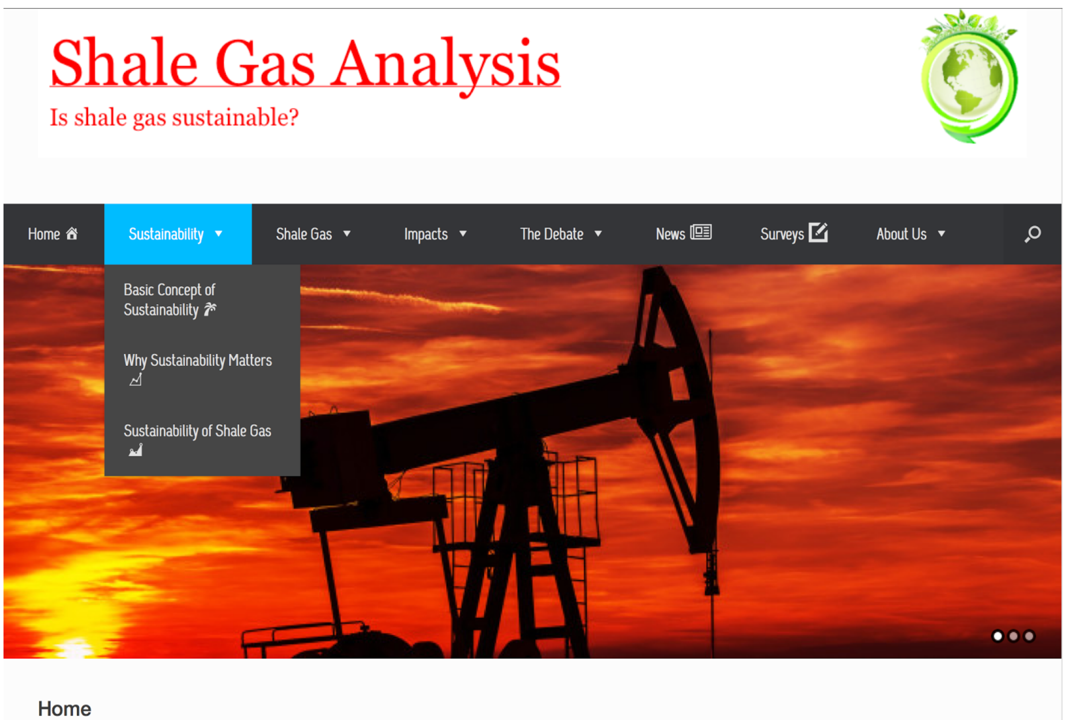


The title was selected through a trial and error system of filtering through many different ideas, from extreme points of bias to more thought provoking. This title was ultimately selected because it puts forth an undertone that this website will shed light on the topic of sustainability and shale gas to incite online discussions and comments on the complexities of the current day situation. The subtitle is just as important as the main title. Our decision to phrase the subtitle as a question eliminates an affirmed opinion that we either support or reject shale gas and instead allows the reader to generate his own thoughts as he progresses through the website. Our question of *How sustainable is shale gas?* was simple and straight to the point—it asked and ses the mood to allow the reader to develop thoughts regarding the entire topic. Yet, we still decided to modify the subtitle once more, albeit very little, but with much weight behind our decision. The subtitle was changed to a direct question of *Is shale gas sustainable?* in order to provoke the reader into thinking about the larger question right away. We devised this with the thought that the reader might not know what sustainability entails, or simply if the reader has heard of shale gas before, and this way they can utilize the website fully to understand these concepts.

4.1.2 Website design, layout, and pages

Underneath the title and subtitle, we developed a navigation menu containing the different categories and pages of our website. The menu is a drop-down box style, where all the pages are listed vertically; each category is also a page to introduce the sub-pages underneath it. The drop down navigation menu can be seen in Figure 17. The categories are: Home, Sustainability, Shale Gas, Impacts, The Debate, News, Surveys, and About Us. Each of these category names were carefully thought out as they needed to represent clearly what each section of the website entails. We also had a sidebar that listed the categories and subcategories of the pages that we had on the website for another visual overview of the available content. However, the sidebar kept interfering with the content of the pages as well as the surveys and polls we posted for feedback, and therefore, we decided to remove it entirely. This opened up the website and seemed to breathe air into the otherwise suffocating pages we once had. This also resolved certain issues that only mobile devices such as tablets and smartphones had; the sidebar would overlap onto the content of the pages and interfere with navigation throughout.

Figure 17: Website navigation menu



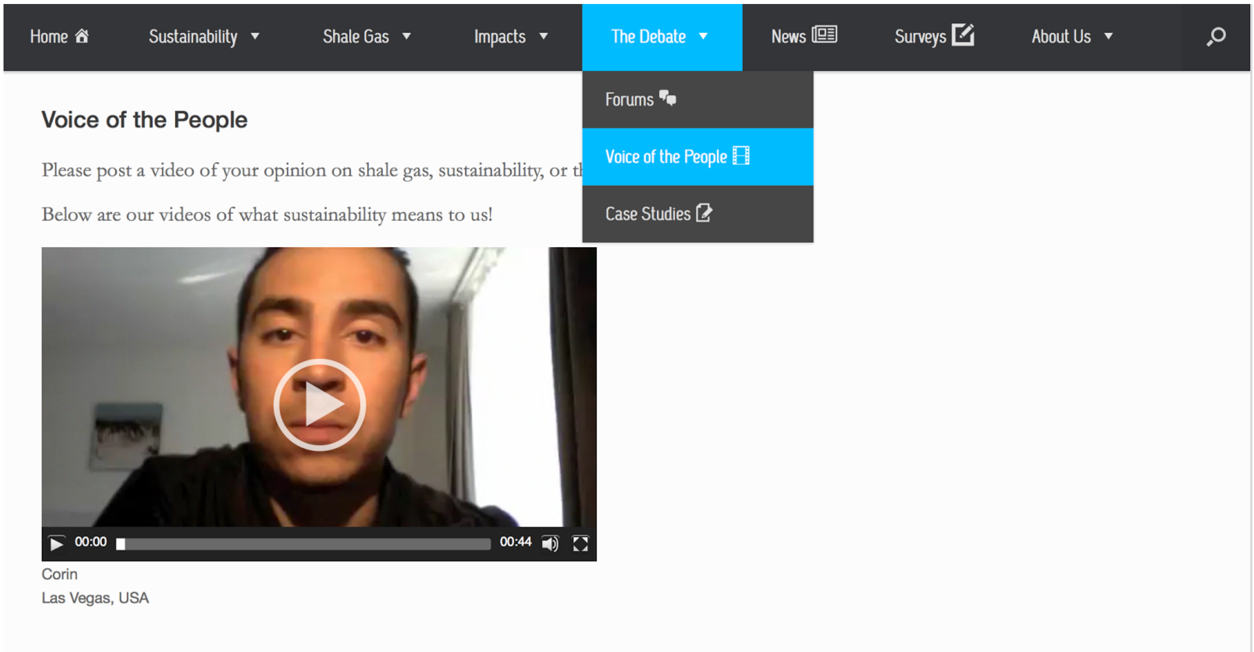
For our homepage, we developed multiple versions and thought about how the homepage should be formatted. In the very beginning, we decided that a dynamic webpage that semi-automatically uploaded recent posts was the central focus. However, we changed to a static page and decided to introduce ourselves and place our mission statement of the project, but we soon realized that our personal background was not the foremost goal in creating the website. We have since updated it by introducing the website content within, while posting a preliminary survey that students can take to gauge their idea on the theme of sustainability and shale gas. We also introduced the idea of an image slider that serves the purpose of introducing photos and images that have to do with shale gas. Towards the end of the homepage, we placed a construction outline of which pages have been completed and which ones are still in progress. This was used as a tool to indicate to the readers which sections were still being worked on during our development stages.

We have three separate categories for our main content and research on Sustainability, Shale Gas, and Impacts. The *Sustainability* page introduces the main three subtopics of the "Basic Concept of Sustainability," "Why Sustainability Matters," and "Sustainability of Shale Gas." Each individual sub-category's focus is as clear as the titles indicate. The sub-pages of *Shale Gas* are simply "What is Shale Gas" and "How is Shale Gas Harvested," covering all bases on the background of shale gas. The *Impacts* sub-pages are more in depth analyses of shale gas. The sub-pages are "Economic Implications," "Energy Outlook," "Environmental Effects," "Health Risks," and "The Politics of Shale Gas," where the majority of arguments and perspectives originate and are used in opposing sides of the shale gas debate.

This leads into the creation of the next section of the website, *The Debate*. Here, we introduce the concept of a forum-styled interaction between the readers. We have three sub-pages: "Forum," "Voice of the people," and "Case studies." The *Debate* page starts out with a poll asking whether the reader has a certain stance on shale gas. Once the reader has developed opinions and thoughts on the matter, we set up the "Forum" as a medium where the readers can post different topics on the forum section of this page and post questions to the Q&A section of the page. We placed ground rules on the top thread of the forums to let users know what was appropriate for submissions.

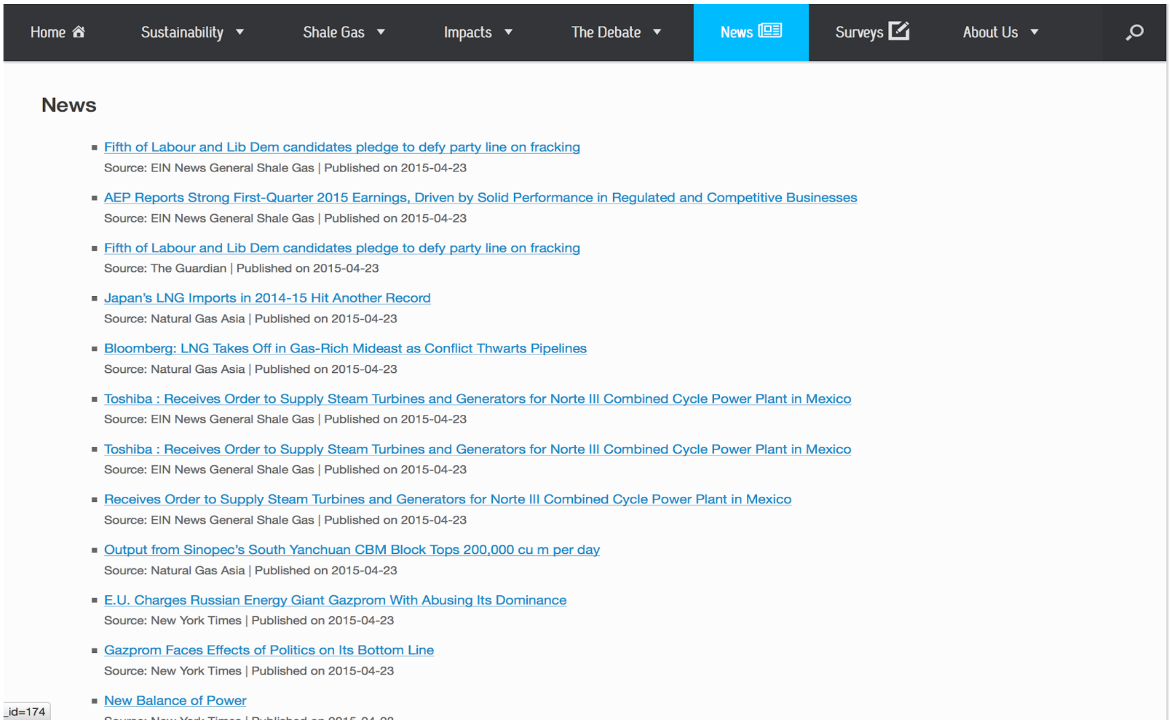
Then, for the "Voice of the people" page, we introduced a method of allowing readers to make an opinion for anyone on the site to hear—through videos submission of themselves discussing what shale gas or sustainability means to them. Respondents could be global experts or just local students voicing their opinions. All submitted material would be reviewed and approved for publishing on the page by administrators of the website. We submitted and posted videos of ourselves giving thoughts on what sustainability means to each of us, as a means of getting readers comfortable with the website, the topic, and even with us. A picture of the "Voice of the People" page can be seen in Figure 18. This is as close as we could get to the readers while introducing our own opinionated thoughts, which we strayed from doing when we actually analyzed the research on shale gas and sustainability that we then incorporated as content for our website.

Figure 18: Website video submissions



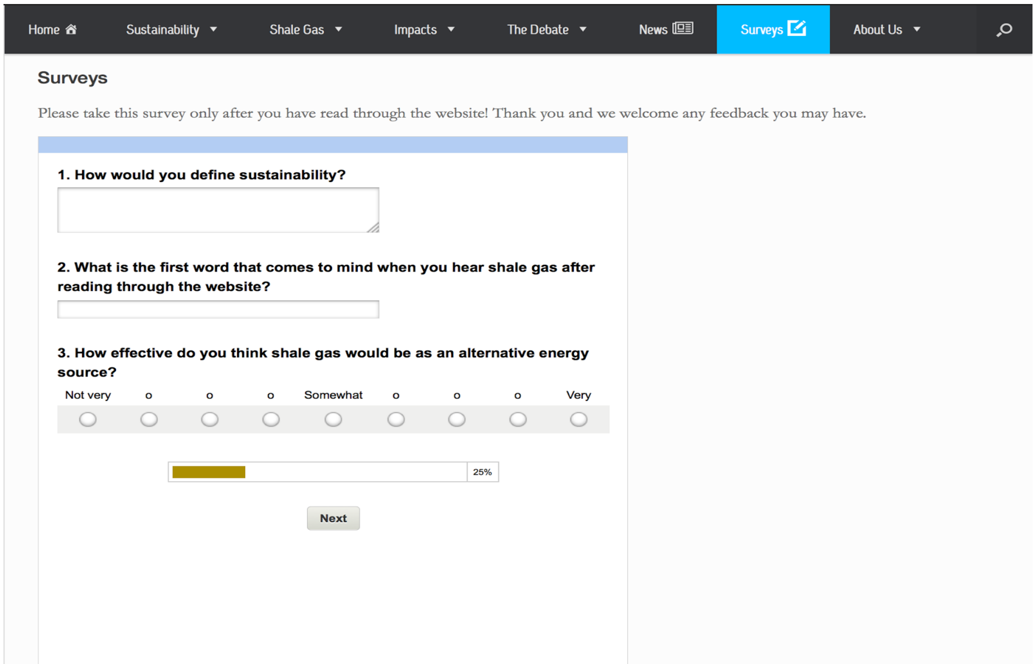
The next engaging page is the *News* section where we have an aggregated RSS feed posting the latest news regarding shale gas and sustainability from a variety of sources. The news page can be seen in Figure 19. We selected *The Guardian*, *U.S. Energy Information Administration (EIA)*, *National Gas Intelligence (NGI)*, *EIN News General Shale Gas*, *European Commision Energy News*, *Shale Gas Information Platform*, *Natural Gas Asia*, and *The New York Times*. Each has a different perspective on shale gas and are from different places around the world, supplying a multitude of views to supply the readers with information. The readers can then go back to *The Debate* page and insert their own thoughts in relevant discussions.

Figure 19: Website news page



We introduced the concept of the *Survey* page towards the middle of our website development stages in order to complete one of our objectives in our methodology. The surveys page can be seen in Figure 20. We gained feedback through surveys and polls on whether the website was feasible and easy to navigate. We considered placing all of our surveys and polls under this section; however, it became clear that these were necessary to individual pages. Instead, we placed a post-website survey, which was to be taken only if the readers went through the entirety of the website content, as the questions were designed to be tougher than the preliminary survey on the homepage. From the post-survey, we gauged the reader's perspective after the user went through our website. We also included daily quizzes as well as polls to continue engaging the reader with the topics and impacts of our website on individual pages. The surveys, polls, and questionnaires will be talked about more fully in the following sections.

Figure 20: Website surveys page



In wrapping up our website, we developed an "About Us" section where we introduce the purpose of this page, how we are related to this project, and our affiliation with Lucerne University. We have two subsections for this section, "Contact Us" and "References," in which we present our email addresses as contact points for the readers and then present all of our annotated citations in a bibliography format. Also, we implemented a search bar feature in the upper right corner of the menu as a method of easy access to specific information. Then at the bottom of each page, before the comment section that exists on every page, we added a print/PDF feature that allows for the page to be saved for offline usage as well as a social networking feature in which our website can be shared via Facebook and Twitter.

4.1.3 Website interface

Navigation through a website is often a defining experience for users. A clear, organized user interface leads to a more enjoyable experience on the website and may be the difference between a one-time user and one that will frequent the website. Since our website will be incorporated into a class as part of the sustainable energies curriculum at Hochschule Luzern, the user interface needs to be smooth, easy to follow, and one that will ultimately encourage frequent users. Although some pages are static and the content will not change, there are some pages that will be updated often, including forums and news pages, and we want students to visit the website regularly to stay up-to-date on the shale gas debate.

Furthermore, website interface is closely related to user engagement with the site. As mentioned above in the methodology, the pages should not be solely text, but have images and videos to hook the reader and make the overall learning experience more interactive. These videos, while very engaging, also provide a wide range of different perspectives from numerous companies, giving the reader a variety of information from different sources. We tried to be unbiased in writing the sections of the website, and the use of videos provided a unique way to expose different perspectives without showing direct support for a particular side in the overarching shale gas debate.

We have had limited time to work on the formation of the website, but we wanted it to be as polished as possible so that it can be implemented in the following semester at the university. While we have tried to make the website as complete as possible, there is always room for improvement and the website development will be handed off to our sponsors upon our departure.

4.2 Website feedback through interviews and surveys

In order to gauge how our website was being perceived, interviews and surveys were conducted. The first people that were interviewed were our sponsors, Professors Schulz and West. Also interviewed was teaching assistant Sebastian Kohl. The purpose of these interviews were to see how the idea of a website would fit into the current curriculum of the school. Also, students were interviewed on the usability of the website through surveys on the website.

4.2.1 Uwe Schulz interview feedback

The general feedback that Professor Uwe Schulz gave us in our interview with him about website implementation was as follows: first, he was very excited at expanding the usual teaching methods to an online platform. He thinks the student will really enjoy a change in teaching styles and although he does not know in which class the website will be used yet, he thinks it will integrate smoothly. Second, he envisions the website as a replacement for a textbook. He would assign reading into shale gas and sustainability through the website instead of a textbook and the interactive parts of the website would make it more enjoyable for the students. Finally, he did not like the idea of having assignments for the students on the website as we had planned, but would rather have them go through the university's own online assignment center. If you would like to see the full interview, a copy is attached in Appendix C: Figure 31.

4.2.2 Shaun West interview feedback

The general feedback that Professor Shaun West gave us in our interview with him about website implementation was as follows: first he is very interested in having a website be a part of his classrooms. Second he does not use a standalone website to augment his teaching module as he just pulls from sites such as youtube to provide external source input. Thirdly, he views the website as more of an online textbook/resource where students can draw information from. Lastly, for full interactions, he would like to see surveys as well as assignments posted to the website. If you would like to see the full interview, a copy is attached in Appendix C: Figure 32.

4.2.3 Sebastian Kohl interview feedback

The general feedback that teaching assistant Sebastian Kohl gave us in our interview with him about website implementation was as follows: first he thinks it would be interesting to have a website being used in a classroom as he never used one when he was a student. Secondly, he believes that our website was laid out very clearly as he could navigate through it easily. Lastly, he voiced his concern about security of student online assignments as there was no login required as well as the unfamiliarity with our website compared to the online platform of Ilias that the university uses to grade students. If you would like to see the full interview, a copy is attached in Appendix C: Figure 33.

4.2.4 Student feedback

To gather feedback on the website from students from the Lucerne University and WPI, we posted a survey about the usability of the website to be completed after navigating through the website. Many of the results were positive, confirming the layout and stylistic elements we incorporated into the website. Many people liked the use of the videos and pictures too. Negative feedback was incorporated into the website as we tried to address many of the issues to make the overall experience more enjoyable. The results from this survey can be seen in Appendix C: Figures 32-35.

As well as surveys to gain feedback about the website, we have also added polls at the end of each individual webpage asking whether or not the student likes or dislikes the page. This will give us a general consensus of the overall impressions about each web page and will be discussed in the following section in more detail.

4.2.5 Swiss company and organization feedback

We emailed 7 different energy and environmental organizations and companies in Switzerland as another way to get feedback about our website. Two organizations, the Swiss Energy Trading (SET) and the Swiss Competence Center for Energy Research Supply of Electricity (SCCER SoE), have replied to our emails saying that they were interested in our project. We supplied them with the link to our website and hopefully gathered feedback through website surveys, polls, and comments, but no more emails were received from either of the organizations. It is worth noting that outside companies and organizations are interested in online educational resources to not promote their cause, but rather to promote a discussion of the issues at stake as well as educate the public about sustainability.

4.3 Explore interactive learning tools to augment learning modules in place at HSLU

4.3.1 Interactive learning tools

In creating the website, we looked for plugins and add-ons through WordPress that would make the website more interactive and provide a better learning experience. As mentioned previously, we employed the use of polls, questionnaires, surveys, videos, pictures, and forums to engage the reader and improve the learning experience. Possibly the most useful tool that we employed was the use of videos.

We employed two types of videos on the website: ones created by third parties providing perspective and professional information on shale gas and sustainability, and then videos created by users of the website to voice their own opinions. The third party videos provide additional content and information to expand on the research that makes up the text portion of the pages. They also supply unique and differeing perspectives to allow the user to understand both sides of the debate. The videos created by the users allow the sharing of perspectives and opinions in the fostering of an online discussion. There is no limit to what these videos can discuss, and we have proposed using videos as an active part of student assignments or activities in the following section.

4.3.2 Student questions, assignments, and activities

Another way to expand the learning tools employed on the website is to add assignments, questions, or activities to be completed by the students in their study of shale gas and sustainability. The Shale Gas team posted several videos of what sustainability means to them as an example of a student activity, but there are many more options to engage the students and make the experience more interactive. We prepared sample activities that could be used in the study of shale gas to supplement the classroom experience or to even be used in class discussion and they can be seen below in Table 7.

Table 7: Example classroom and website activities

1. Tell us what sustainability means to you in a 1-minute video and post online.
2. Respond to the following statement in a 1-minute video and post online: shale gas will be a main energy source in 15 years.
3. Estimation of Swiss energy: in pie chart, estimate what the energy usage is as of 2015 and then in 40 years.
4. Role playing: in groups of 4, take up sides (1 environmentalist, 1 discuss the possible impacts of shale gas well site being implemented in the local community.
5. Role playing: in groups of 4, take up sides (1 representing Switzerland, 1 Russia, 1 Germany, and 1 The United States) and discuss the possible impacts of shale gas well site being implemented in the local community.
6. If your group is a new energy company interested in beginning shale gas harvesting, how would you sell me the idea of shale gas? Why would shale gas need to be implemented in my community?
7. Respond to a graphic in a 1-minute video and post online.

Furthermore, adding questions for homework assignments or to prompt discussion for the classroom could also be implemented. We prepared sample questions that could be used in the classroom or posted to the website to enhance the learning experience and they can be seen in Table 8.

Table 8: Example classroom and website assignments

1. What would be the effect on Switzerland's economy if it began importing shale gas from a EU country? What effect would this have on Russia's economy?
2. What do you think is the biggest benefit of using shale gas?
3. What do you think is the biggest consequence of using shale gas?
4. Why do you think shale gas has had such success in the United States?
5. Does Switzerland's political agenda, as it stands today, have a direct impact on shale gas development in Europe?
6. If shale gas was harvested in other European countries, do you think Switzerland would import it and move away from Russian oil?
7. Why do companies that invest in coal and petroleum harvesting and their image is bad, why do these companies still exist?
8. Would you rather have a short-term, cheap solution that is not sustainable or a long-term, expensive solution that is sustainable, and why?
9. Do you think the image of countries will be affected by the sole importation of shale gas or from the harvesting of shale gas?
10. Why should Switzerland care about the negative impacts of shale gas if it does not directly affect the country, as there are no shale reserves in Switzerland?

4.4 Social perception of shale gas as it relates to sustainability

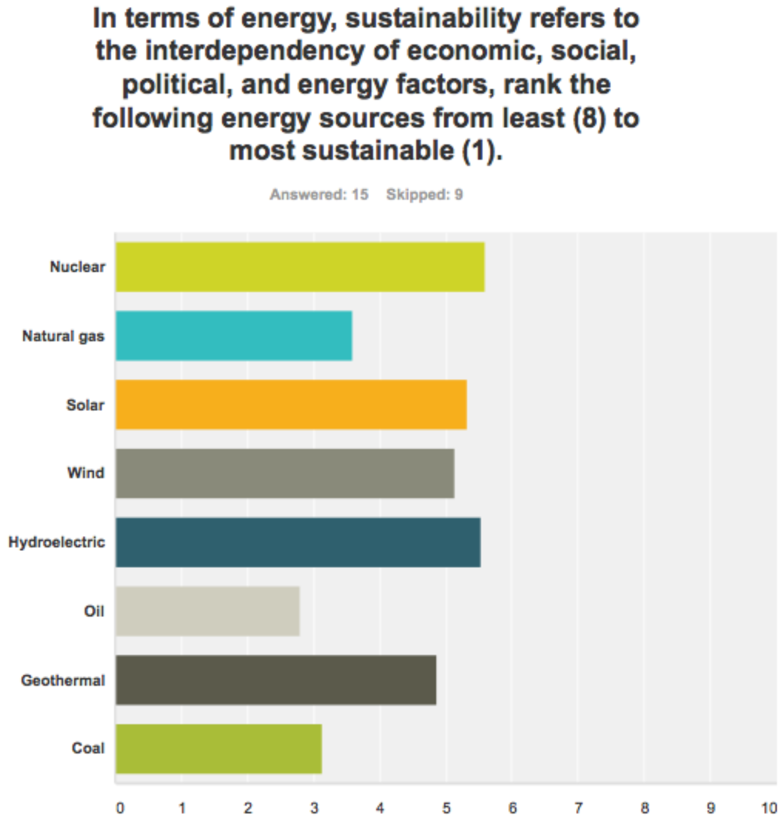
In order to gauge the social perceptions of shale gas, surveys, interviews, polls, videos, as well as a forum were implemented into the website to gather opinions and views. The various numbers of tools ultimately gave users many ways to share their voice on the topic of shale gas and sustainability.

4.4.1 Surveys

The surveys for social perception were broken into two parts, a pre- and a post- survey. The pre-website survey served as a baseline as it targeted what people knew about sustainability and shale gas before they read the website. The post-website served as a follow up as it gauged how much the reader had gained from navigating through the website. As mentioned earlier, the surveys were not completely developed when they were employed on the website. While we admit that they could have used some more work, development, and feedback from advisors and sponsors before they were placed on the website, they did generate useful, albeit very basic, information relating to the social perceptions of sustainability and shale gas.

All results from the surveys can be seen in Appendix C: Figures 38-47, but some of the key findings from the pre- survey are as follows: 1) when asked to rank the general sustainability of eight energy sources (nuclear, natural gas, solar, wind, hydroelectric, oil, geothermal, and coal), the majority of people ranked nuclear power as the most sustainable (Figure 21) and 2) when asked what the first word that comes to mind when shale gas is said, 62.5% of people said 'fracking' while 18.75% of respondents related it to money.

Figure 21: Survey results to pre- survey question #4



We found it particularly interesting that nuclear was ranked higher than all other options; as a team, we ranked hydroelectric or solar as the most sustainable so it is interesting to compare the different perspective here in Europe. It is clear from the results, however, that all the respondents are familiar with the less-sustainable options of coal and oil, with natural gas closely following as a third fossil fuel. Perhaps this suggests that natural gas and shale gas for that matter would not be socially accepted as a sustainable resource in Europe, but future studies into this complex social issue will need to be conducted before this determination can be made.

As the pre- survey was aimed at generating perceptions before users interacted with the website, the post- survey was geared to see if users' opinions changed over the course of using the website. As mentioned before, the surveys were not completely developed, and the post- survey gathered less useful information that the pre- survey, as these questions were more open-ended. The data we had hoped to collect from this post- survey would have been better collected if we had been able to employ a focus group, but with limitations discussed above, we did our best to collect this post- data through the survey. Some of the key findings from the post- survey are as follows: 1) when asked again what word comes to mind after hearing shale gas, only 50% of the respondents still said fracking, 2) when asked if they thought shale gas would be an effective alternative energy source on a lichter scale rating from 1 to 9, the average was a 4.13, indicating that is less than a 50% approval, and 3) 100% of respondents identified that they had shale gas reservoirs in their country of residence.

Again, it is important to note that the surveys were created to gather data on social perceptions, but were not employed to their utmost potential. We will talk about recommendations we have for the use of surveys later on, however, as the project was an experiment into whether or not a website could be used in the classroom, one of those most important pieces of information gathered was not from the surveys, but from using the survey on the pages. It was very easy to create a survey through an online tool such as Survey Monkey or Qualtrics, embed the survey on any page of the website, collect data through the website, and then analyze the data through the online survey tool's own website. With the proper questions and placement on the website, a variety of opinions, perceptions understanding, etc. can be collected and the use of the survey on the website is definitely something that can be used in the future of educational website development.

4.4.2 Polls

Polls were initially used to gather feedback from the website as it was being constructed; these acted like an initial test to gauge how people perceived the web pages. There were two types of polls that were created for the website, each serving different functions. One of the polls was formed to find out opinions of the user on sustainability and shale gas. The other was created to gauge whether or not the user liked the page they were viewing. The result from the opinionated polls about sustainability and shale gas can be seen on the website. They allow users to share their opinions quickly as they are navigating through the website. The results from whether they liked the page or not were generally positive as most users liked the pages we created. These can also been seen at the bottom of most of our pages on the website. We referred to surveys answers for more in-depth feedback on what to improve on the website. As the website gets implemented into classes, these polls will become an ongoing tool for students to use to gather additional feedback. An example of both types of polls can be found in Appendix C: Figures 48 and 49.

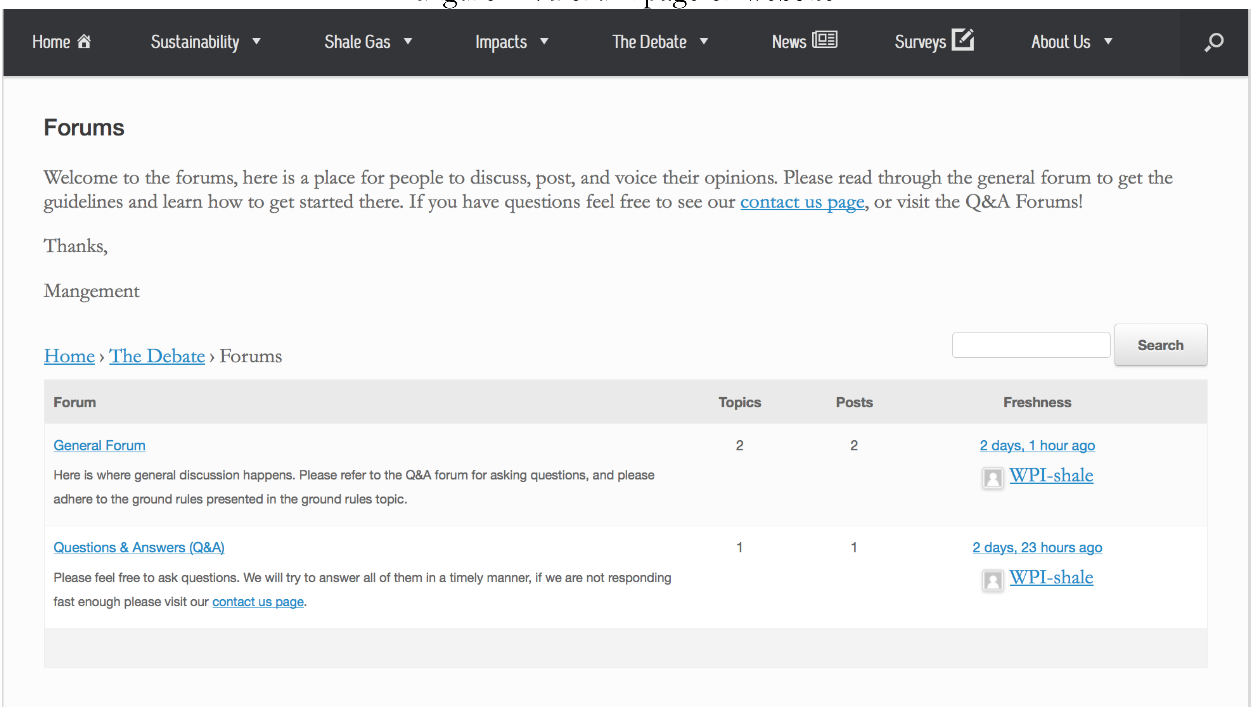
4.4.3 Videos

To truly capture social perceptions, the shale gas team initially created a series of videos. These videos were roughly a minute, showing each member's views on sustainability. These videos served as an example of an activity that could be done using the website for students and professors, as well as a way for the team to voice their own opinions on sustainability after the website construction was completed as seen above in Figure 18: Website video submissions. The results from these uploads were that users of the site uploaded their views via video as well.

4.4.4 Forums

The forums served as an interactive platform for users to engage with the subject of shale gas and sustainability, as well as to give feedback on the website and to connect with the authors and or the users. Some of the notable features from these forums are the discussion threads on shale gas and sustainability as these threads reveal a various view of opinions. Since our time for feedback was limited, the forum never got fully implemented; however, with the website being part of a class, this forum could serve as a valuable tool for students and professors to share and voice their opinions and thoughts. It has the potential to be used as a substitute for in-class discussion and to foster an online community of engagement around certain topics.

Figure 22: Forum page of website



4.5 Recommendations

After the creation of the website and handing it off to our sponsors, our recommendations can be divided into three sections. The first section covers what recommendations we give to Professor Schulz and Professor West at the end of the project relating to the future of the website. The second section covers our recommendations for others working on similar projects in the future. The last section covers what recommendations we wished we would have had beginning the project and lessons that we learnt over the course of IQP.

4.5.1 Future development of the website

In order to keep this website in motion, there are many recommendations that we have for our sponsors to keep things updated and running smoothly. The overall theme of the website will stay the same over time, but some extra additions may need to be added based on the class environment. Initially, the website can be incorporated as is directly into courses at HSLU, yet this is specifically themed towards sustainability and shale gas. Since this is HSLU's first website that could be used in class, they could develop more websites themed towards a specific topic and apply it to different classes. This would be the beginning of a large development where students could easily access information and directly interact with it. As we developed the website, we learned a lot about the complexity of shale gas and sustainability, so in expanding the idea of a website to other classes, we recommend having students build the website as part of a learning process. Not only will the website be created by students for students, but the ones who build the website will have a fun learning experience.

More technical recommendations within the infrastructure of the website include the use of additional plugins. Depending on what the website will be used for, a specific plugin may need to be installed. These plugins help facilitate any and all feature additions within the website. For example, the news feed aggregating plugin allowed for automatic updates of news; this is very useful as it posts news and topics themed towards shale gas and sustainability to the website without needed maintenance from the website develops. Adding a plugin is simple: search for the desired plugin, install it, and activate said plugin.

In order to upload additional content to the website, new pages can be added. These pages can either be stand-alone pages or a sub pages. Different classes at HSLU can upload their own pages to the website if need be; this will allow for numerous usages of the website, as well as collaboration and argumentation between classes. An idea for the future of the Business Engineering Sustainable Energy Systems department is to expand the website to include not just shale gas, but other debated resources for study. Also, static pages with information will need to be updated when relevant research is published. Everything on the website is controlled by plugins and pages, and as long as one understands how to use them, the website can have an unlimited depth and serve a multitude of purposes.

4.5.2 Recommendations for similar IQP projects

For future website creators for an IQP project, here are some recommendations that we have. WordPress is a very easy website creation tool but has many limitations because it is plugin based. If your team has experience building websites, we would suggest building your own website from scratch; for experienced website developers this will give you much more versatility. For our case, HSLU already had many licenses with WordPress, as well as accounts with Dokumenton to host website from their servers, so using WordPress was our most feasible option.

Before going abroad to your IQP, it would be very useful to research WordPress functionality and plugins. This will be very helpful so that you can start creating your website as soon as you arrive at your project center instead of having to take time learning about WordPress and how to use it; we learned this the hard way as we took the first week of our project learning about how to use WordPress.

4.5.3 Recommendations for WPI IQP students

Looking back at our project, there are recommendations that we wish we knew before starting in order to strengthen the final outcome. It would have been more time efficient had we begun the development of our website in ID2050. If this had been the case, we could have created the entire website before we had begun our IQP in Zürich. This would have promoted feedback, and possibly, direct contact with students at HSLU more quickly which would allow for us to begin working on our objective of evaluating social perceptions before even arriving. The first week we arrived in Zürich, we should have dived into HSLU's pool of students. The best way to reach out to these students is to confront them directly and lead with an introduction of who we are, the purpose of our project, as well as who we are working with at their university. This would interest them and give us possible data and feedback on our project and website.

CHAPTER 5: CONCLUSIONS

In closing, the overall experience of the Interactive Qualifying Project (IQP) abroad in Zürich, Switzerland has taught the team skills and techniques that will be carried on even after the project has come to a close. Most importantly, the team learned to adapt to changes on the fly and manage time in order to complete objectives quickly and efficiently. Balancing a wide array of feedback from students, sponsors, advisors, and even from within the team proved to be challenging at times, but in the end, provided a useful learning experience that will closely resemble employee-employee interactions at future places of work. Group teamwork was an integral part in ensuring our success as all members contributed to the development of the website and project as a whole. We would like to thank our advisors, Professor Scott Jiusto and Professor Ruth Smith, for making the experience as painless as possible and providing useful feedback in the development of our project. We would also like to thank our sponsors, Professor Uwe Schulz and Professor Shaun West, for providing the opportunity to work at the Lucerne University of Applied Sciences and Arts – The School of Engineering and Architecture for our IQP and the openness to allow us to design a project as we saw fit.

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APPENDIX A: ADDITIONAL FIGURES

As sustainability continues to perplex societies around the world, Switzerland has begun to assess ways on achieving sustainable developments. Below in figure 15, is Switzerland's criterion for achieving sustainability through sustainable developments.

Figure 23: The 15 sustainability criteria of Sustainable Development Strategy of Switzerland

The 15 sustainability criteria of the Sustainable Development Strategy («Federal Council Criteria»)

Environment	Economy	Society
Preserve natural areas and biodiversity	Safeguard income and employment and increase in line with needs, taking equitable social and spatial distribution into account	Protect and promote the health and security of citizens in the widest sense
Limit the consumption of renewable resources to below the level of regeneration or natural occurrence	At least preserve productive capital, based on social and human capital, and improve its quality	Guarantee education and thus foster the development and identity of the individual
Limit the consumption of non-renewable resources to below the development potential of renewable resources	Improve the competitiveness and innovativeness of the economy	Foster culture and preserve and develop the values of civil society and resources in the sense of social capital
Reduce to safe levels the burden on the natural environment and humanity resulting from emissions or pollutants	Allow market mechanisms (prices) to be the primary drivers of the economy, taking relevant scarcity factors and external costs into account	Guarantee the same rights and legal status for all, in particular equality for men and women, equal opportunities for and the protection of minorities, and the recognition of human rights
Reduce the impact of environmental disasters and only accept risks of accidents where no lasting damage will be created to future generations in the event of a worst-case scenario	Manage public money only in ways that are not at the expense of future generations	Promote both intragenerational and intergenerational solidarity, also globally

Retrieved from (ISDC, 2012

Figure 24: Sustainability ranking

	Iceland	Switzerlan	Costa Rica	Sweden	Norway	Mauritius	France	Austria	Cuba	Colombia
Total Score*	93.5	89.1	86.4	86.0	81.1	80.6	78.2	78.1	78.1	76.8
Environmental Health	**95**	**92**	**82**	**93**	**91**	**84**	**91**	**89**	**84**	**75**
Env. Burden of Disease	91	89	78	87	83	70	83	87	74	63
Air (humans)	97	91	78	97	97	97	97	84	97	90
Water (humans)	100	100	96	100	100	97	100	100	91	82
EcoSystem Vitality	**92**	**86**	**91**	**79**	**72**	**78**	**66**	**67**	**72**	**79**
Air (ecosystem)	38	48	60	59	58	44	42	40	41	48
Water (ecosystem)	96	93	74	96	98	74	80	98	74	69
Biodiversity	69	100	73	61	47	45	67	100	50	83
Forestry	100	100	100	100	100	86	100	100	100	97
Fisheries	66	0	99	67	72	100	88	0	94	89
Agriculture	65	70	91	88	70	93	84	85	83	76
Climate Change	90	74	79	70	66	73	56	50	67	71

Retrieved from: http://carbonpig.com/article/10-most-sustainable-countries-world

APPENDIX B: SAMPLE INTERVIEW AND SURVEY FORMS

Figure 25: Blank key informant interview form

Key Informant Interview Form					
Key Informant Name:	[Enter informant name]				
Position:	[Enter their position]				
Topic of Interview:	[Enter topic of interview]				
Date of Interview:	[Specify date of interview]	Follow Up Interview Required?	Yes	No	Y N
Goals for Interview:	Interviewer:	[Name of Interviewer]			
[Goal/objective of interview]					
Question #1	[Enter question]				
Question #2	[Enter question]				
Question #3	[Enter question]				

Figure 26: Website feedback survey

Website feedback	
Survey Description	To assess website feasibility and usability
Question #1	What did you particularly like about this website?
[Blank textbox]	
Question #2	What did you particularly dislike about this website?
[Blank textbox]	
Question #3	What could be done to improve your overall experience of the website?
[Blank textbox]	
Question #4	Would you recommend this website to a friend? Why or why not?
[Blank textbox]	
Question #5	If you are interested in talking to us more, please leave your name and email.
[Blank textbox]	

Figure 27: Social perceptions blank pre- survey

Intro Student Survey	
Survey Description	To assess social perceptions of shale gas before the user reads through the website
Question #1	On an everyday basis, how environmentally conscious are you?
Not very o o o Somewhat o o o Very	
Question #2	If sustainability is the fine balance between prosperous business and environmental preservation, how sustainable do you think Switzerland is?
Not very o o o Somewhat o o o Very	
Question #3	To supply a country with energy, extraction of energy from raw materials must be performed. How important is preservation of the environment in the harvesting of energy from raw materials?
Not very o o o Somewhat o o o Very	
Question #4	In terms of energy, sustainability refers to the interdependency of economic, social, political, and energy factors, rank the following energy sources from least (8) to most sustainable (1).
Nuclear, natural gas, solar, wind, hydroelectric, oil, geothermal, coal	
Question #5	How familiar are you with shale gas?
Not very o o o Somewhat o o o Very	
Question #6	What is the first word that comes to mind when you hear shale gas?
[Blank textbox]	

Figure 28: Social perceptions blank post- survey

Post Student Survey									
Survey Description	To assess social perceptions of shale gas after the user reads through the website								
Question #1	How would you define sustainability?								
[Blank textbox]									
Question #2	What is the first word that comes to mind when you hear shale gas after reading through the website?								
[Blank textbox]									
Question #3	How effective do you think shale gas would be as an alternative energy source?								
Not very	o	o	o	Somewhat	o	o	o	Very	
Question #4	Is there any shale gas in the country in which you are from?								
Yes or no									
Question #5	If you answered yes above, to what degree has it affected your life?								
Not very	o	o	o	Somewhat	o	o	o	Very	
Question #6	What is the first word that comes to mind when you hear shale gas?								
Not very	o	o	o	Somewhat	o	o	o	Very	

Figure 29: Survey question pool

Pool of Survey Questions	
Question Themes	Questions
Sustainability	· Give a brief statement on what you think sustainability is. · For the following issues, indicate how KNOWLEDGEABLE you feel you are about them as it pertains to sustainability. Rate on a scale of 1-5 where 1 is you don't have any knowledge about this issue and 5 is you are very knowledgeable about this issue. 1 2 3 4 5 Waste 1 2 3 4 5 Safety and Security 1 2 3 4 5 Unemployment 1 2 3 4 5 Resource Consumption 1 2 3 4 5 Education 1 2 3 4 5 Water Use 1 2 3 4 5 Health and Wellness 1 2 3 4 5 Local Business/Local Economy
Shale Gas - specific	· What is the first word that comes into mind when shale gas is mentioned? · Do you have any idea what shale gas is? · Do you know how shale gas is harvested?
Background	· What is your country of origin? · What is your age? · Where is your current residency?
Personal	· What form of heating do you have in your home? · What do you use for fueling your vehicle, if you have any? · How expensive do you think green energy is in comparison to fossil fuels?
Energy – general	· What is the first word that comes into mind when natural gas is mentioned? · What sort of renewable energy resource do you give more preference to: solar, wind, natural gas, nuclear?
Switzerland - specific	· Do you know about any removal of a nuclear power plant? · What do you think is could replace such a massive energy source? · Why do you think Switzerland has a such a negative stance toward shale gas?

Figure 30: Blank focus group interview form

<table>
<tr><td colspan="7">Focus Group Session</td></tr>
<tr><td>Focus Group:</td><td colspan="6">[Enter focus group name]</td></tr>
<tr><td>Number of Attendees</td><td colspan="6">[Enter their position]</td></tr>
<tr><td>Topic of Focus:</td><td colspan="6">[Enter topic of focus]</td></tr>
<tr><td>Length of Interview:</td><td colspan="2">[Specify length of interview]</td><td>Follow Up Interview Required?</td><td>Yes</td><td>No</td><td>Y
N</td></tr>
<tr><td>Date of interview:</td><td colspan="2">Interviewer:</td><td colspan="4">[Name of Interviewer]</td></tr>
<tr><td colspan="2">Goals for Interview:</td><td colspan="5">[Goal/objective of interview]</td></tr>
<tr><td>Question #1</td><td colspan="6">[Enter question]</td></tr>
<tr><td></td><td colspan="6"></td></tr>
<tr><td>Question #2</td><td colspan="6">[Enter question]</td></tr>
<tr><td></td><td colspan="6"></td></tr>
<tr><td>Question #3</td><td colspan="6">[Enter question]</td></tr>
<tr><td></td><td colspan="6"></td></tr>
</table>

APPENDIX C: COMPLETED INTERVIEW AND SURVEY FORMS

Figure 31: Uwe Schulz interview

<table>
<tr><td colspan="4">Key Informant Interview Form</td></tr>
<tr><td>Key Informant Name:</td><td colspan="3">Uwe Schulz</td></tr>
<tr><td>Position:</td><td colspan="3">Program director of Energy Systems</td></tr>
<tr><td>Topic of Interview:</td><td colspan="3">Shale Gas and Sustainability Website</td></tr>
<tr><td>Date of Interview:</td><td>4.3.15</td><td>Follow Up Interview Required?</td><td>no</td></tr>
<tr><td>Goals for Interview:</td><td>Interviewer:</td><td colspan="2">Corin Galati</td></tr>
<tr><td colspan="4">The goal of this interview is to learn about how websites are used at HSLU and how Professor Schulz sees using Shale Gas Analysis website in one of his classes.</td></tr>
<tr><td>Question #1</td><td colspan="3">What classes do you teach at HSLU?</td></tr>
<tr><td colspan="4">Responsible for modules in the B2B class, but moving away from teaching and to project coaching for industrial bachelor thesis.</td></tr>
<tr><td>Question #2</td><td colspan="3">What kind of websites do you use in the classroom?</td></tr>
<tr><td colspan="4">HSLU uses Ilias (similar to blackboard) to manage assignments, readings, and homework submissions.</td></tr>
<tr><td>Question #3</td><td colspan="3">What purpose would this website serve?</td></tr>
<tr><td colspan="4">The website would be a substitute for an assignment reading in literature. Instead, students would be told to visit the website as if it were a required reading and to learn about the topics before arriving to class for the classroom PowerPoint presentations and lectures.</td></tr>
<tr><td>Question #4</td><td colspan="3">Do you think it could be integrated into the class?</td></tr>
<tr><td colspan="4">They are always trying to update teaching modes at the university. Professor Schulz talked about how his teaching styles have changed over the years to accommodate student feedback and preferences and he thinks that a website is the next step in a more interactive learning experience. As each class is required to have a certain number of credit hours, he sees the website as being an out of the classroom experience that prepares students for the in class discussions.</td></tr>
<tr><td>Question #5</td><td colspan="3">Would you want online discussions/assignments?</td></tr>
<tr><td colspan="4">Professor Schulz likes the idea of trying to make the website more engaging for the students, but he doesn’t like the idea of students posting their assignments so everyone can see them. He doesn’t want people to copy/cheat off each other and also doesn’t want people to post incorrect answers. Maybe if we post questions and allow students to think about them before class that would be more</td></tr>
</table>

useful. Also, if there was a spot so that lecturers could post relevant case studies to get students more involved with current day operations.

Figure 32: Shaun West interview

Key Informant Interview Form			
Key Informant Name:	Shaun West		
Position:	Professor in Energy Systems		
Topic of Interview:	Shale Gas and Sustainability Website		
Date of Interview:	4.13.15	Follow Up Interview Required?	No
Goals for Interview:	Interviewer:	Corin Galati	
The goal of this interview is to learn about how websites are used at HSLU and how Professor West sees using Shale Gas Analysis website in one of his classes.			
Question #1	**What classes do you teach at HSLU?**		
Professor West teaches B2M Marketing and Service Innovation.			
Question #2	**What kind of websites do you use in the classroom?**		
Besides Ilias (which he doesn't seem to like much), he doesn't use websites directly in the class. He will use certain sites as resources, but nothing like our website to supplement teaching module.			
Question #3	**What purpose would this website serve?**		
The website would be a substitute for an assignment reading in literature. Professor West really likes the idea of having blogs or chats where students can engage in online discussion. He also likes the idea of posting assignments or tests on the website to gauge student understanding of the material.			
Question #4	**Do you think it could be integrated into the class?**		
Professor West thinks it would be exciting to implement a website like this into a class. He would use it as a textbook that students could leave notes on and do assessments to monitor their learning.			
Question #5	**Do you have any recommendations for us?**		
He wants the surveys to have correct solutions so students will know if they answered the right one. Also, a place where the professors can upload certain case studies or documents would be helpful. Finally, he wants us to get out and start getting feedback from students on the website.			

Figure 33: Sebastian Kohl interview

<table>
<tr><td colspan="4">Key Informant Interview Form</td></tr>
<tr><td>Key Informant Name:</td><td colspan="3">Sebastian Kohl</td></tr>
<tr><td>Position:</td><td colspan="3">Teaching Assistant in Energy Systems</td></tr>
<tr><td>Topic of Interview:</td><td colspan="3">Shale Gas and Sustainability Website</td></tr>
<tr><td>Date of Interview:</td><td>4.13.15</td><td>Follow Up Interview Required?</td><td>No</td></tr>
<tr><td>Goals for Interview:</td><td>Interviewer:</td><td colspan="2">Orland Lamce</td></tr>
<tr><td colspan="4">The goal of this interview is to learn about how websites are used at HSLU and how Sebastian sees using Shale Gas Analysis website in one of the classes he is a teaching assistant for.</td></tr>
<tr><td>Question #1</td><td colspan="3">What classes do you assist at HSLU and what do you do?</td></tr>
<tr><td colspan="4">Sebastian is a teaching assistant for B2B Marketing and Energy Systems. He does not take any classes, but prepares notes, lectures, presentations, and grades assignments for these classes.</td></tr>
<tr><td>Question #2</td><td colspan="3">Have you ever used a website in one of your classes?</td></tr>
<tr><td colspan="4">As a student he did not use any websites as part of a class besides Ilias. He would first go to the library and then use online research platforms to supplement his research, but never use a second party website as a mandatory part of the class curriculum.</td></tr>
<tr><td>Question #3</td><td colspan="3">What do you like about our website and idea for the class?</td></tr>
<tr><td colspan="4">Sebastian thinks the content and interlinks on the website is good. The theme is clear and the content is easy to follow. He thinks that using a website like this would be interesting in the classroom and would really change the education dynamics. He isn’t really sure how posting assignments would work as he is accustomed to using Ilias to grade homework. He is concerned about security risks if there is no student login.</td></tr>
</table>

Figure 34: Survey results to website feedback question #1

What did you particularly like about this website?

Answered: 7 Skipped: 1

Responses (7) | Text Analysis | My Categories

Categorize as... | Filter by Category | Search responses

Showing 7 responses

What is SG and how is it extracted info
4/24/2015 4:20 PM View respondent's answers

It has an organized layout and provides concise and helpful information without being overwhelming.
4/22/2015 10:49 PM View respondent's answers

The diagrams are easy to read and informative
4/22/2015 10:40 PM View respondent's answers

The website is well organized and easy to follow along. I particularly liked the daily thoughts.
4/22/2015 10:24 PM View respondent's answers

The content is good
4/20/2015 12:55 PM View respondent's answers

It attempts to be interactive
4/20/2015 12:49 PM View respondent's answers

Organization is fairly good! There is also an allowance for both sides of the issue, although it is clearly attempting to sway the readers' opinions to the positive for shale gas.

Figure 35: Survey results to website feedback question #2

What did you particularly dislike about this website?

Answered: 7 Skipped: 1

Responses (7) | Text Analysis | My Categories

Categorize as... | Filter by Category | Search responses

Showing 7 responses

the surveys
4/24/2015 4:20 PM View respondent's answers

The header could use a nicer graphic. The format of the home page itself could just benefit from a slight revamp.
4/22/2015 10:49 PM View respondent's answers

Do not know what Vox populi means, videos do not feel natural, intense survey
4/22/2015 10:40 PM View respondent's answers

Nothing
4/22/2015 10:24 PM View respondent's answers

Strange layout, cluttered with "pages" on the righthand side. Strange things happen when you scale the site to different resolutions (navbar goes to two lines, etc).
4/20/2015 12:55 PM View respondent's answers

The layout looks really cluttered Many of the pages have too much going on to be useful I wouldn't know where to look to find specific information about a topic I'd be researching
4/20/2015 12:49 PM View respondent's answers

Figure 36: Survey results to website feedback question #3

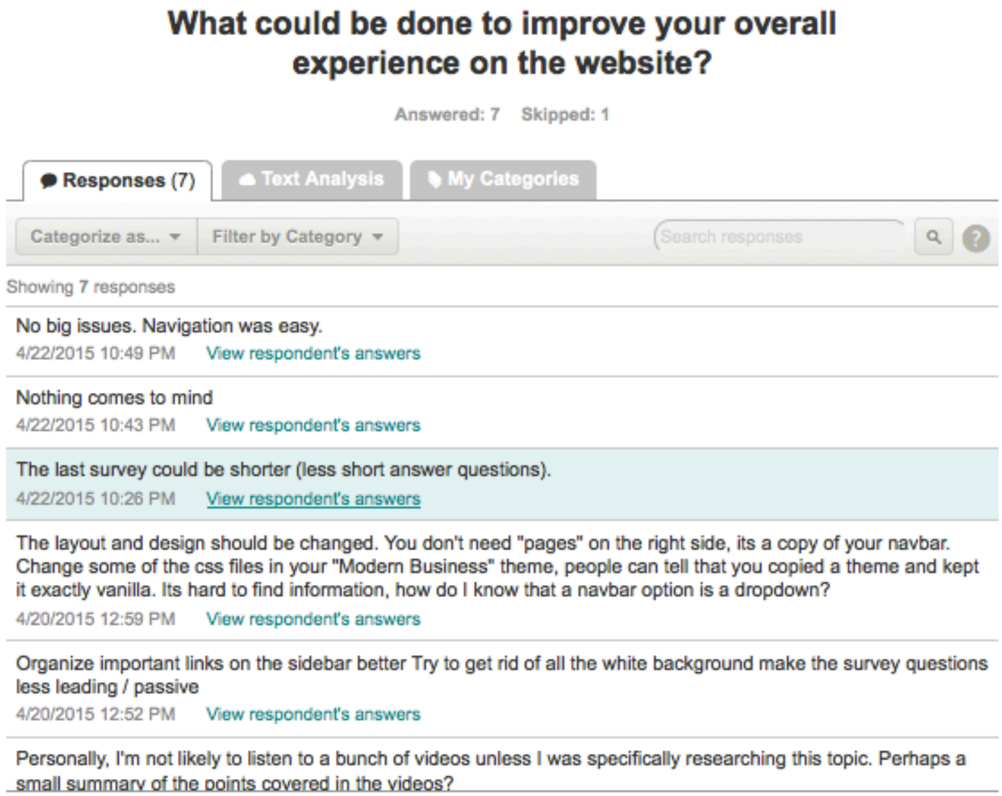


Figure 37: Survey results to website feedback question #4

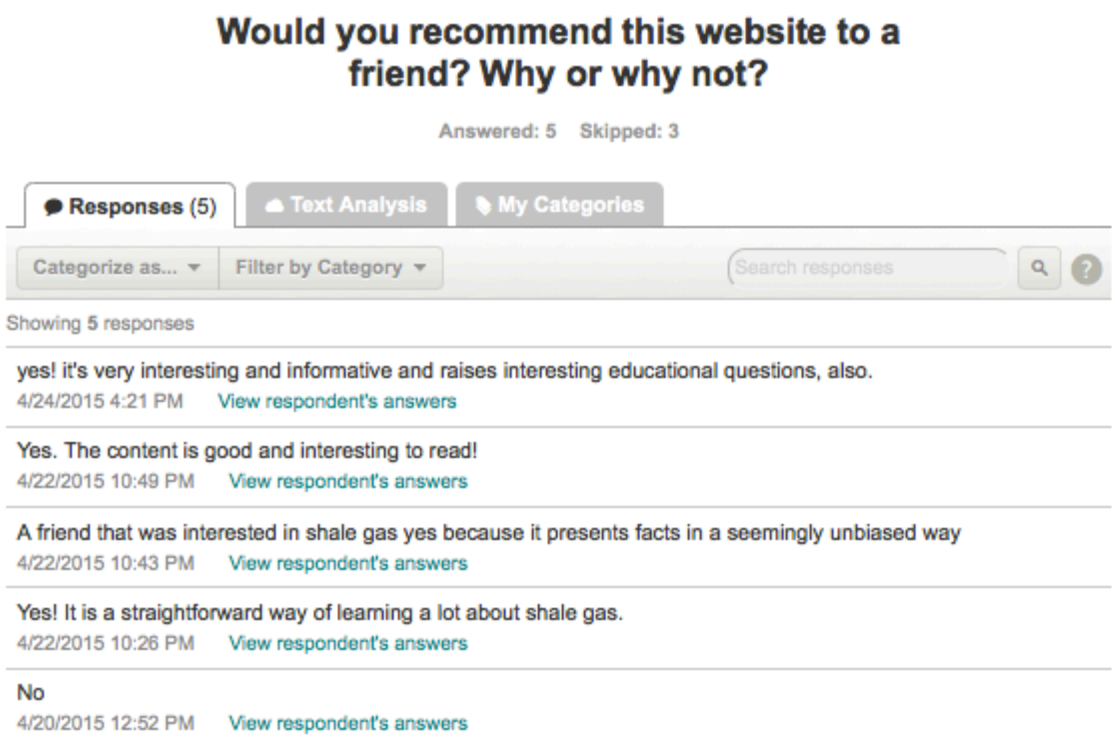
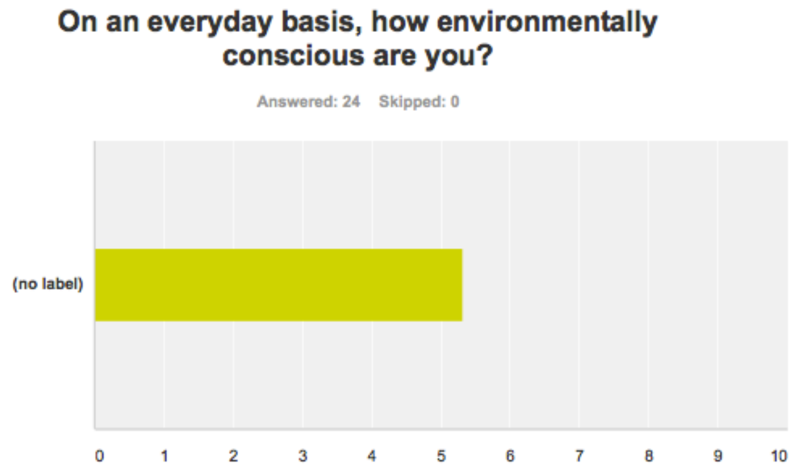
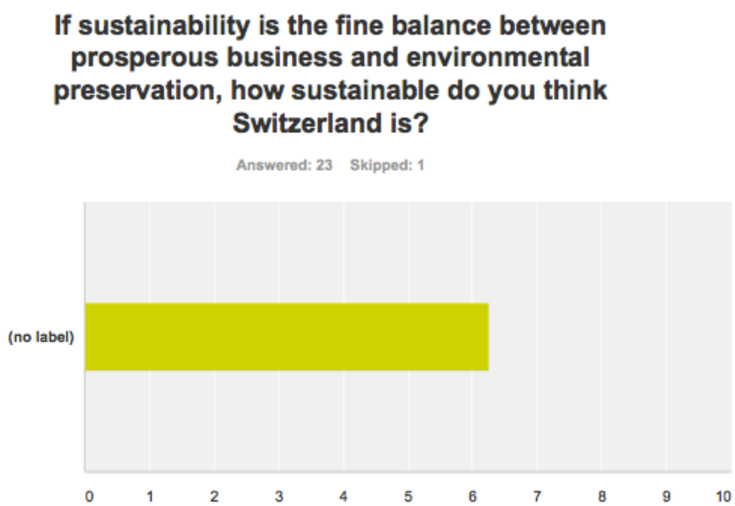


Figure 38: Survey results to pre- survey question #1



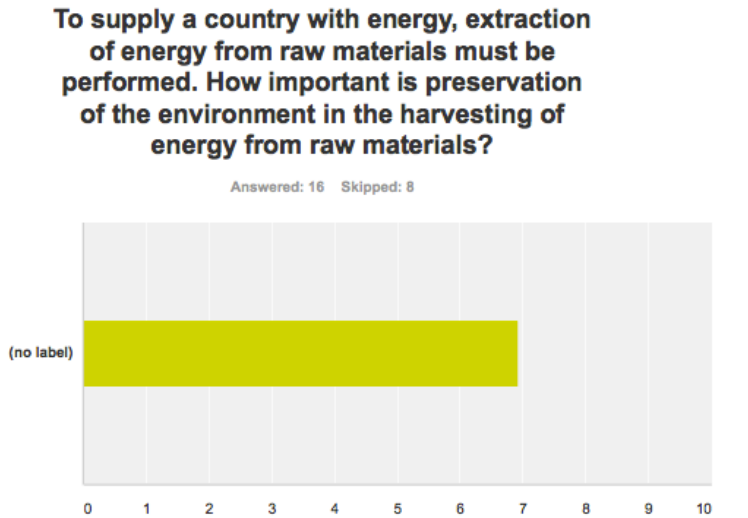
	Not very	o	o	o	Somewhat	o	o	o	Very	Total	Weighted Average
(no label)	8.33% 2	12.50% 3	4.17% 1	0.00% 0	20.83% 5	12.50% 3	29.17% 7	8.33% 2	4.17% 1	24	5.33

Figure 39: Survey results to pre- survey question #2



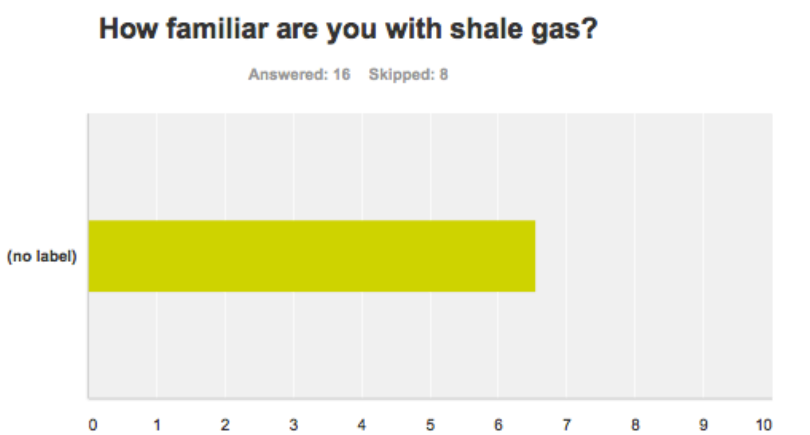
	Not very	o	o	o	Somewhat	o	o	o	Very	Total	Weighted Average
(no label)	4.35% 1	4.35% 1	0.00% 0	0.00% 0	21.74% 5	26.09% 6	17.39% 4	8.70% 2	17.39% 4	23	6.26

Figure 40: Survey results to pre- survey question #3



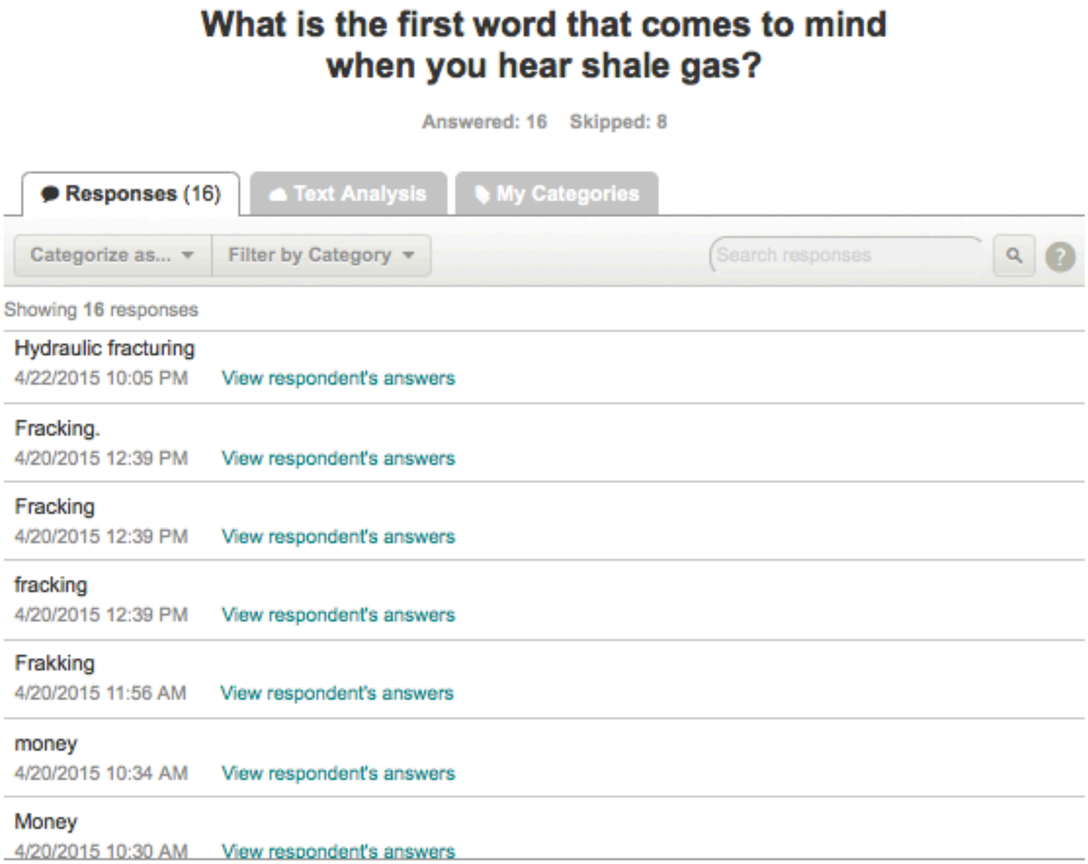
	Not very	o	o	o	Somewhat	o	o	o	Very	Total	Weighted Average
(no label)	6.25% 1	6.25% 1	0.00% 0	0.00% 0	6.25% 1	18.75% 3	6.25% 1	18.75% 3	37.50% 6	16	6.94

Figure 41: Survey results to pre- survey question #5



	Not very	o	o	o	Somewhat	o	o	o	Very	Total	Weighted Average
(no label)	6.25% 1	6.25% 1	0.00% 0	0.00% 0	25.00% 4	0.00% 0	18.75% 3	12.50% 2	31.25% 5	16	6.56

Figure 42: Survey results to pre- survey question #6


What is the first word that comes to mind when you hear shale gas?

Answered: 16 Skipped: 8

Responses (16) | Text Analysis | My Categories

Categorize as... | Filter by Category | Search responses

Showing 16 responses

Hydraulic fracturing
4/22/2015 10:05 PM View respondent's answers

Fracking.
4/20/2015 12:39 PM View respondent's answers

Fracking
4/20/2015 12:39 PM View respondent's answers

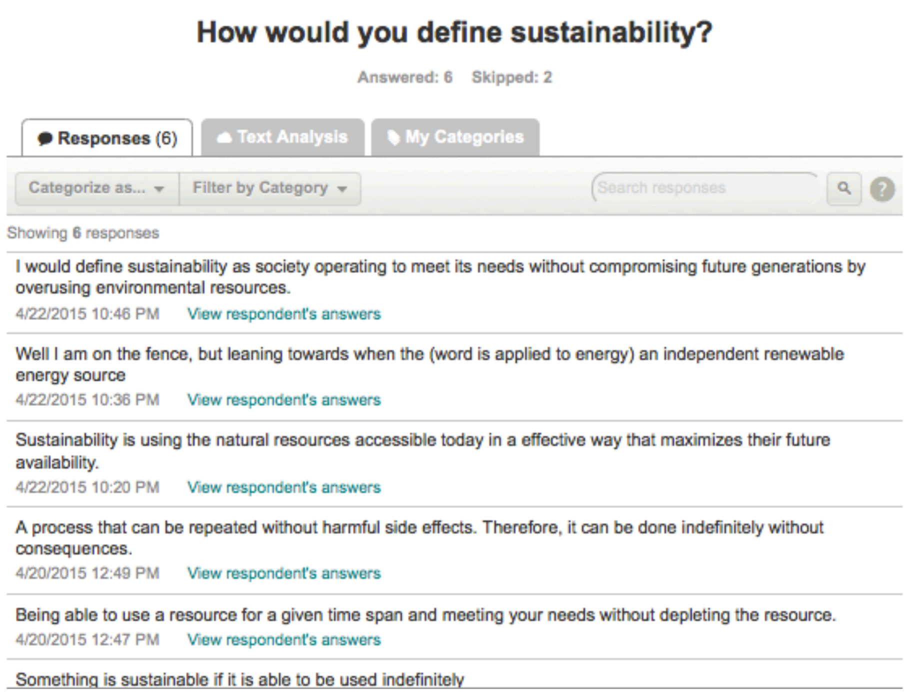
fracking
4/20/2015 12:39 PM View respondent's answers

Frakking
4/20/2015 11:56 AM View respondent's answers

money
4/20/2015 10:34 AM View respondent's answers

Money
4/20/2015 10:30 AM View respondent's answers

Figure 43: Survey results to post- survey question #1


How would you define sustainability?

Answered: 6 Skipped: 2

Responses (6) | Text Analysis | My Categories

Categorize as... | Filter by Category | Search responses

Showing 6 responses

I would define sustainability as society operating to meet its needs without compromising future generations by overusing environmental resources.
4/22/2015 10:46 PM View respondent's answers

Well I am on the fence, but leaning towards when the (word is applied to energy) an independent renewable energy source
4/22/2015 10:36 PM View respondent's answers

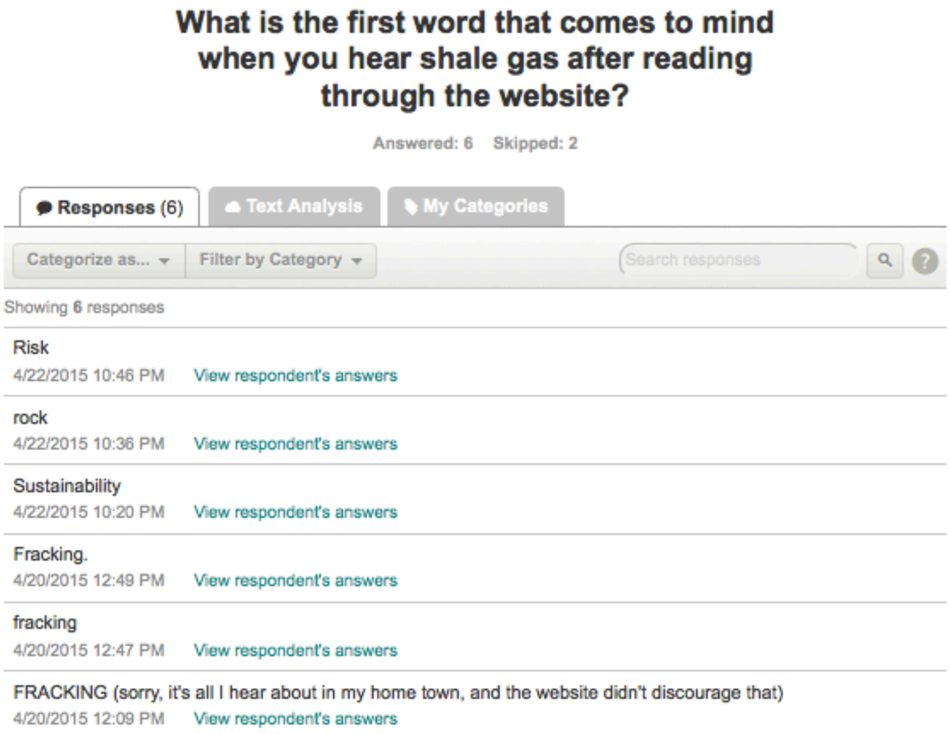
Sustainability is using the natural resources accessible today in a effective way that maximizes their future availability.
4/22/2015 10:20 PM View respondent's answers

A process that can be repeated without harmful side effects. Therefore, it can be done indefinitely without consequences.
4/20/2015 12:49 PM View respondent's answers

Being able to use a resource for a given time span and meeting your needs without depleting the resource.
4/20/2015 12:47 PM View respondent's answers

Something is sustainable if it is able to be used indefinitely

Figure 44: Survey results to post- survey question #2



What is the first word that comes to mind when you hear shale gas after reading through the website?

Answered: 6 Skipped: 2

Responses (6) | Text Analysis | My Categories

Categorize as... | Filter by Category | Search responses

Showing 6 responses

Risk
4/22/2015 10:46 PM View respondent's answers

rock
4/22/2015 10:36 PM View respondent's answers

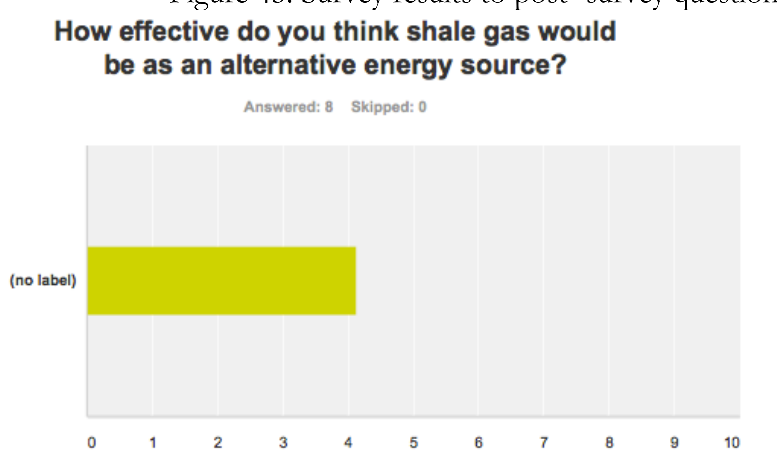
Sustainability
4/22/2015 10:20 PM View respondent's answers

Fracking.
4/20/2015 12:49 PM View respondent's answers

fracking
4/20/2015 12:47 PM View respondent's answers

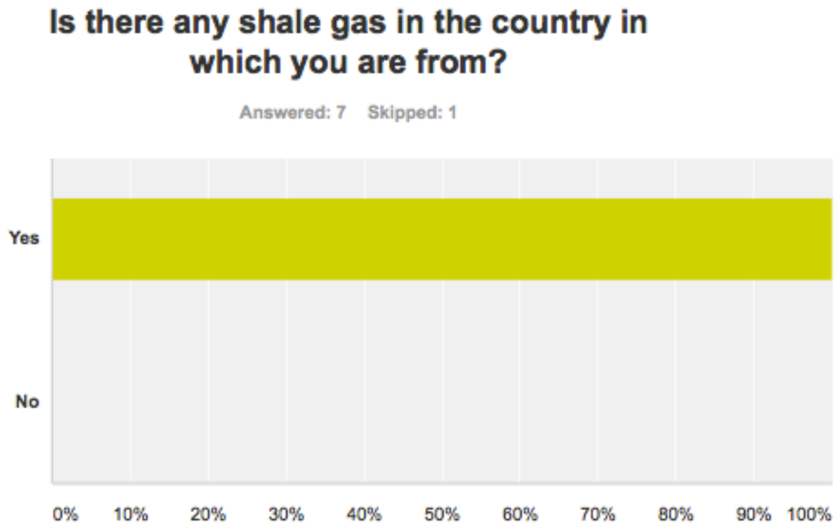
FRACKING (sorry, it's all I hear about in my home town, and the website didn't discourage that)
4/20/2015 12:09 PM View respondent's answers

Figure 45: Survey results to post- survey question #3



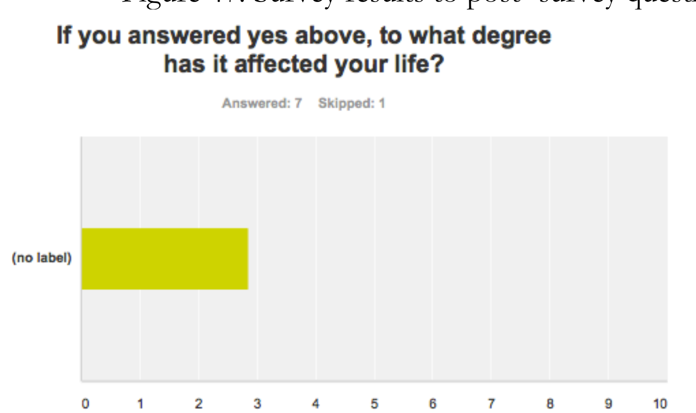
	Not very	o	o	o	Somewhat	o	o	o	Very	Total	Weighted Average
(no label)	12.50% 1	0.00% 0	25.00% 2	25.00% 2	25.00% 2	0.00% 0	0.00% 0	12.50% 1	0.00% 0	8	4.13

Figure 46: Survey results to post- survey question #4



Answer Choices	Responses	
Yes	100.00%	7
No	0.00%	0
Total		7

Figure 47: Survey results to post- survey question #5



	Not very	o	o	o	Somewhat	o	o	o	Very	Total	Weighted Average
(no label)	28.57% 2	14.29% 1	14.29% 1	0.00% 0	28.57% 2	0.00% 0	14.29% 1	0.00% 0	0.00% 0	7	2.86

Figure 48: Opinionated poll

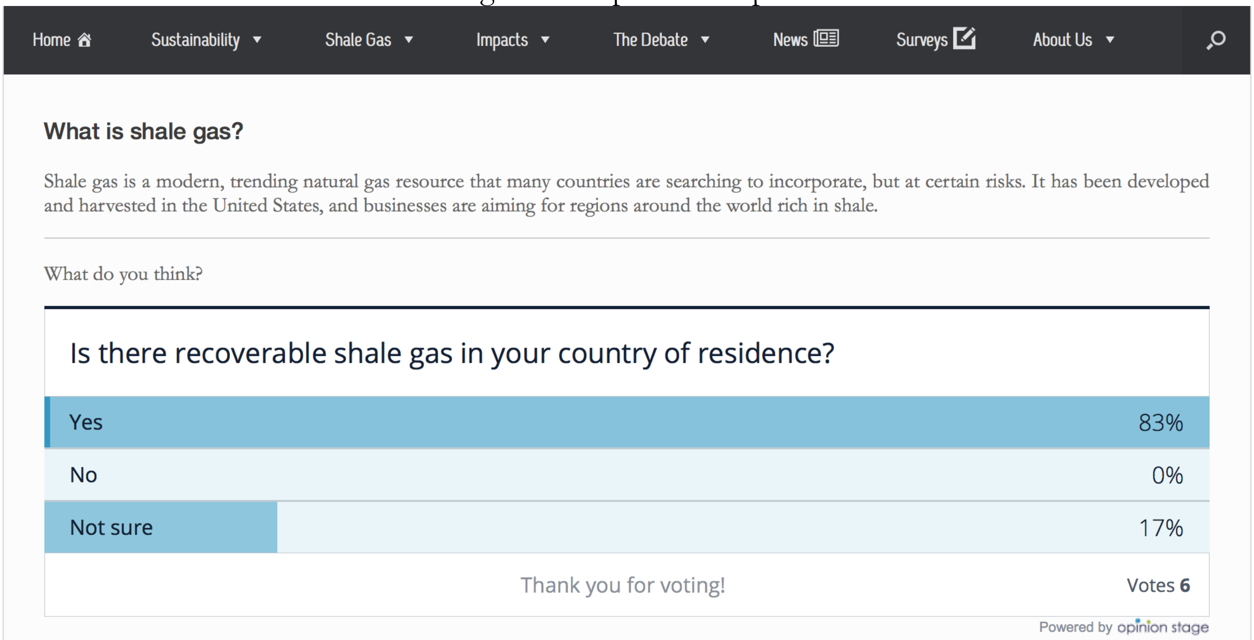


Figure 49: 'Did you like this page?' poll