Teaching social topics in engineering: The case of energy policy and social goals

Mr. Rylan C. Chong, Purdue University, West Lafayette

Rylan Chong is a master's student in the Information Security Program and affiliated with the Center for Education and Research in Information Assurance and Security (CERIAS) at Purdue University. He has a B.S. in Computer Science from Chaminade University of Honolulu. His research areas include global policy, ethics, information security and assurance, technology adoption, biometrics, education, pharmaceutical supply chain, and energy.

Dr. Dennis R. Depew, Purdue University, West Lafayette

From July, 2002 to June, 2011, Dr. Depew served as the fourth Dean of the College of Technology at Purdue University. He is currently Dean Emeritus and Professor in the College of Technology. He earned his bachelor's and master's degrees from East Tennessee State University before coming to Purdue to pursue the Doctor of Philosophy degree in 1985. He joined the faculty of Purdue's Department of Industrial Technology in 1987 as an assistant professor. During his tenure at Purdue, Dr. Depew served as Head of the Department of Industrial Technology, University Coordinator of Excellence 21, and Assistant Dean of the Graduate School. Prior to becoming Dean of the College of Technology at Purdue, Dr. Depew served as Dean of the College of Applied Sciences at Western Carolina University from 1999-2002. During his days in the classroom, Dr. Depew won or was nominated for numerous teaching awards, including the James G. Dwyer Award presented to the Outstanding Teacher in the College of Technology. He has served as principal investigator or co-principal investigator for over $2 million dollars in external grants to support academic programs and applied research projects in his department and college and serves as a reviewer for programs funded by the National Science Foundation. He is the author of more than 60 technical publications and papers and has served as a technical consultant for Fortune 500 companies on the subject of quality and productivity improvement. The list of companies includes well known names such as Alcoa, Caterpillar, and Subaru-Isuzu. Dr. Depew is also a senior member of the American Society for Quality, the American Association for Engineering Education, and Epsilon Pi Tau Honorary Society.

Dr. Ida B Ngambeki, Purdue University, West Lafayette

Ida Nagmbeki is a Postdoctoral Researcher in the Department of Technology, Leadership and Innovation at Purdue's College of Technology and at Purdue's Global Policy Research Institute. She has a B.S. in Engineering from Smith College and a PhD in Engineering Education from Purdue University. Her research areas include global engineering policy, human-artefact interaction, personality and engineering decision-making, and interest in engineering.

Dr. Melissa Jane Dark, Purdue University

Melissa Dark is W.C. Furnas Professor of Technology in the College of Technology at Purdue University. She serves on the Faculty Leadership Council for Purdue's Global Policy Research Institute, Faculty Director of Purdue's Innovation and Commercialization Center, and Associate Director for the Center for Education and Research in Information Assurance and Security.

Teaching social topics in engineering: The case of energy policy and social goals

Introduction

Engineering professionals are increasingly expected to be mindful of the social implications of their work by virtue of the increasing importance and impact of their role in society. Grasso and Martinelli [8] state there is a growing need for engineers to "think broadly across disciplines and consider the human dimensions that are at the heart of every design challenge" [8]. One of the ways to promote such mindfulness is to introduce engineering students to public policy. A recent 2012 National Research Council of the National Academies (NRCNA) [19] report on science and public policy, suggests that "graduates need a working familiarity with the substance of policy issues and competency to locate, assess, and introduce validated research on those issues" [19]. The report continues, graduates also need an appreciation of "the complexity of the policy world, as well as an understanding of the assumptions underlying divergent policy framings, expert judgments, consensus building techniques, and standard analytic methods and approaches" [19]. The NRCNA [19] report also points out the need for graduates to "recognize the limits of the persuasive power of scientific reasoning" coupled with the realization of the "substantial barriers and cultural resistance to new scientific knowledge" [19] and appreciate the "tradeoffs present in practically all policy" [19].

A study done by Mendoza-Garcia, Ngambeki, Behbehani, Evangelou, Rao, and Cox [17] specifies the areas of public policy with which engineering and technology students should be familiar: a) understand what public policy comprises, how it is developed, and who the major policy actors are; b) understand the historical role of engineers in the public policy arena; c) understand the effect of policy in technological development and vice versa; d) be able to communicate technical knowledge to a lay audience; e) be able to recognize both the technical and non-technical aspects of a situation and weigh these to make decisions; and f) be able to work and communicate competently across disciplines. The authors of this paper suggest that engineering students also need an appreciation of the "public interests" served by public policy. By public interest, we mean the social goals about which there is majority consensus. We turned to and used the work of policy scholar Deborah Stone [28] in our paper, who suggests that "the social goals that dominate most policy discourse include equity, efficiency, security, and liberty" [28].

Teaching public policy could also contribute to the satisfaction of ABET requirements. For example, ABET outcome F - Understanding of professional and ethical responsibility. Outcome F is related to public policy given that the field of public policy is primarily about social structure and the methods used to regulate the processes and activities of human co-existence. ABET outcome H - The broad education necessary to understand the impact of engineering solutions in a global and societal contexts, also has public policy implications. Depending upon interpretation, ABET outcomes E - Ability to identify, formulate, and solve engineering problems and J - Knowledge of contemporary issues, would have societal dimensions that could derive from policy choices, decisions, and priorities.

While there is an increased need to teach public policy issues in the engineering

curriculum, curricular innovations in this area are still in their infancy. There are several possible methods for integrating policy topics into the engineering curriculum [21]. The purpose of this paper is to present an example of a way in which a policy discussion can be integrated into an engineering classroom. The case study discussed here is envisioned as a module, but the topic could be expanded to encompass a full course using other case studies.

The module outlined in this paper considers four major social goals (i.e., equity, efficiency, security and liberty) prevalent in the policy world and the implications of their pursuit on energy policy. The interplay of the social goals and energy policy is illustrated using the career of Samuel Insull who was a founding member of General Electric and who is credited with creating integrated power grids in the United States. The module is intended to help engineering students understand the policy context of this major technical achievement in the energy sector and its implications for the current and future energy industry. This particular module uses a case study to achieve this goal. The paper discusses the process of creating and teaching this kind of topic. Specifically, the authors will use this module as an example to discuss choosing a topic, providing a framework for your students, choosing the appropriate scope, and selecting an appropriate case study to illustrate the topic and service the outcomes. Additionally, the authors will discuss more specific concerns such as responding to your students and how to connect the case study to current events. In order to provide a clear example, the authors go into great detail about the topic covered and the case study used in this module. This has the additional benefit of providing instructors interested in social goals and energy with content they can use in their own classrooms.

Choosing a topic

Choosing a topic is an important first step. In this context, the topic refers to the specific area of study and the concepts that will be addressed in the course. When choosing a topic, instructors should keep in mind the desired outcomes of the learning experience. For example, is the goal to understand what public policy comprises, how it is developed, and/or identify the major policy actors. It is important that the topic selected illustrates the connection between public policy and the pertinent technical topic. The topic should therefore be relevant to students and demonstrate a direct relation to the technical material. For example, the authors of this paper have chosen energy policy as the topic. Not only is it related to the current discussions of renewable energy technologies, energy is an essential human resource that has been increasing in consumption and demand over the years. Many students will be familiar with at least some of the social and policy discussions around energy from various media sources.

The role energy plays in our society and the issue of fossil fuels coupled with the struggle to develop solutions to the energy shortage and pollution problems (e.g., alternative energy), provides an excellent setting for the discussion of social issues, such as equity, efficiency, security and liberty in the context of energy technologies. Several authors, Bartlett [1,2,3], Connolly [5], Hoel and Kverndokk [10], Markham [13], Smulders [27], and World Health Organization [30] believe that if the rate of energy production and consumption continues to increase, it will lead to fossil fuels being depleted, human caused climate and environmental challenges, health problems, blackouts, and energy sustainability issues. These issues are detrimental and affect national security, cause inefficiencies, limit equal accessibility, and impinge on individual liberties. This topic also illustrates the complexities and contradictions in both the scientific evidence and the

policy positions. For instance, while many see renewable energy as necessary others, such as the Massachusetts Institute of Technology [14], believe "today's grid meets today's requirements" [14] and that the United States may not be ready for renewable energy. Therefore, questions remain as to whether United States energy policies: a) complement the renewable energy movement; b) meet our social goals; and c) are moving in the right direction. These questions should be deliberated and informed by the experts in the field, especially with regard to decisions to enact public policies to address the social issues and to advance technology and innovation.

Provide a framework

After choosing a topic, it is vital to outline a clear framework. By framework, we mean the basic structure underlying a system. In relation to policy, it can be thought as a set of principles that govern the social schema under discussion. Given the extent of social issues that can be discussed relating to any policy decision, a framework serves the dual purposes of limiting the extent of the discussion to give it a focus, and providing students with a scaffold to structure their understanding. It is especially important that the selected framework be apparent, because social subjects are often amorphous and therefore open to misinterpretation and misrepresentation. Clear understanding at this stage also provides support for those students more comfortable with quantitative analyses to transition to more subjective discussions.

The theoretical framework the authors adopted for thinking about the case study is based on the work of Stone's [28] four social goals, equity, efficiency, security and liberty. Stone [28] noted that the social goals are not simply objectives; these "goals" are justifications for policy, for action and for inaction, as well as criteria or standards against which programs are evaluated. Broadly conceived, the social goals should not be taken to be attainable states or endpoints. Instead, they are concepts or values that are subject to multiple interpretations and perpetually in a state of creation. We expand on each of these social goals here to lay a foundation for examining the context of 30 years of energy policy and the case of Samuel Insull.

Equity

Equity as a social goal focuses on matters of distribution. The three important dimensions to consider are the recipients, the item being distributed, and the process for deciding and carrying out who gets what. What is distributed can range from tangible items, such as land, to less tangible but still physical items, such as utilities. And yet, other issues of equity and distribution also include highly intangible items such as rights (e.g., voting rights, rights to free speech, privacy rights) and opportunities (e.g., access to education, employment). Stone [28] identifies equity challenges as follows.

Challenges arise when determining recipients, that is who gets something [28]. Equity implies that the *recipients* of the item being distributed should get "equal amounts". The definition of membership challenge is deciding who those recipients are. Rank based justifications for distribution contend the overriding premise in rank based distribution is that "there are *relevant* internal divisions for distribution" [28]. The challenge is what criteria to use to create the divisions; should the item being distributed be based on accomplishment, experience, opportunity, comparable worth, or something else? For example, a group-based claim for distribution would argue that regardless of individual accomplishments, experience, opportunity,

etc.; particular groups (and all members of that group) have a "higher claim" to be recipients than other groups. The argument is often based on historical deprivations. Assuming agreement can be reached on the criteria, how to go about fair and full evaluation of the criteria is another challenge that learners need to appreciate in understanding the complexity of the policy world.

Another important aspect of the social goal of equity arises in considering the item to be distributed [28]. First are the boundaries of the item itself. To take the items being distributed and include them in a larger system (time and space) enlarges the boundaries, and influences the arguments about what is being distributed. Take for example, the issue of distributing electricity access to rural communities. The boundaries on this issue can range from access to academic opportunities, improvements and/or creations of newer innovations, to access to economic opportunities and/or improved medical care, where these arguments are made either in the context of present day inequalities or put in the context of historical and ongoing inequalities faced by citizens in rural communities. Another challenge stems from the relative value of the item to individuals. The policy debate that arises is grounded in how much relative value will be derived from the individual(s) receiving the item(s). Sticky questions often arise as to whether a particular group needs one item more than another (e.g., access to potable water versus access to broadband) or whether a particular group of individuals will "realize the value" of the particular item (e.g., why provide broadband when the literacy rates are low). The last dimension of equity focuses on the of the fairness process(es) of distribution [28]. Often societies are willing to accept unequal outcomes when we perceive that the process to distribute items were "free from bias". Primary methods for "fair" processes include competitions, lotteries, adjudication, bargaining, voting, and the like.

In addition to having students understand these various challenges of who gets what and how, they should understand that equity issues are usually either end-result focused or process focused, and how this view affects perceptions of what would be better policy outcomes. According to Stone [28], those who ascribe to an end-result world view of distributional justice tend to be more "likely to favor redistribution" [28] policies. The logic is as follows. If society has adequate means to "correctly define recipients and items" [28] to be distributed, then when items are not correctly distributed, redistribution offers correction. In contrast, a worldview that focuses on fair processes for determining distributions, when faced with an inequitable distribution would focus on modifying the process as opposed to the outcome. For example, "if the rule of the game in marketplace competition gives an unfair advantage to very large firms" [28], those who view fair processes as most essential to equity would advocate policies that "limit the behavior of large firms" [28] (e.g., antitrust laws, such as Public Utility Holding Company Act of 1935), while those who view issues of recipients and items as most essential to equity would favor policies focused on redistribution (e.g., taking resources from large firms and giving them to small firms).

Efficiency

The social goal of efficiency is to get "the most output from a given input" [28]. Efficiency does not suggest what the outcome or benefit *should* be, only that it is desirable to arrive there efficiently; efficient choices are ones that provide more "benefit for the same cost" [28] or the same benefit for less cost. In much the same vein as other social goals, while people can agree that

arriving *there* efficiently is worthwhile, the challenges are in negotiating where *there* is, determining who bears the burden of the costs, who enjoys the benefits, how to measure costs and benefits, and whether to count opportunity costs and if so, how [28]. Generally speaking, voluntary exchange, which is the underlying premise of the market, is viewed as being efficient. Markets are inefficient under conditions of "imperfect competition, imperfect information, externalities, and collective goods" [28]. Students should understand these concepts and be able to identify their presence in relevant policy matters.

Security

The social goal of security is concerned with what types of needs a government "should attempt to meet, and how the burdens of making security a collective responsibility should be distributed" [28]. While most people agree that society should help individuals in need, intense conflict arises over differentiating needs from wants and how to create a system that encourages self-sufficiency in the face of distribution according to need. Policy issues of need can range from how much food, defense, welfare, subsidy, tax, energy, etc. Security issues often extend beyond counting "how much," this is because matters of need (be it need of food, welfare, energy or defense) have symbolic significance tied to social status. Because need has symbolic dimensions of social status, it is often (though not always) relative and "fundamentally linked to issues of privilege, power, membership and mobility" [28]. Relative need is need compared to others and often defines one's place in a distribution (see equity). According to Stone [28] individuals and communities "generally try to protect their internal social structure as well as their sheer existence" [28], making relative need the more salient policy criterion because relative need is the standard that allows them to do that (protect their internal social structure).

Some needs can be classified as instrumental in that we need them "not for direct satisfaction but for what they allow us to do" [28]. Government protection is often justified on the basis of instrumental need. For example, a university may make the case that the state should invest millions of dollars in a new building on the basis that it will enhance the knowledge and skills of students and ultimately enhance labor force in the given state, perhaps positioning the state to secure a major employer and thereby also impacting employment.

Another way of conceptualizing needs that plays out in policy debates and actions is in terms of the relational [28]. Because humans are social animals, we require and thrive on "community, solidarity, a sense of belonging, dignity, respect, self-esteem, honor, friendship and love" [28]. Regarding policy, the debate often centers on the extent to which government should focus on either the needs of people as individuals and/or the people's relational needs, and how it should do so.

Liberty

The concept of liberty in public policy concerns matters of choices and activities of individuals and groups in society and when a government can legitimately interfere with those choices and activities [28]. Liberty has been defined negatively and positively. Using the negative definition, liberty is an inherent attribute of individuals; to provide liberty "is to do nothing, that is to refrain" [28] from interference. However, because individual actions can cause harm to others,

in effect, compromising their individual liberty, some interference is usually necessary. Using this definition of liberty, policy matters become issues of how to balance the protection of individual liberty with the prevention of harm to others. The crux of this view is on which harms to prevent, the nature of those harms, and the nature of prevention. Harms can be classified as physical, material, amenity effects, emotional or psychological harms, and spiritual and moral harms [28].

Positive liberty, in contrast, focuses on actions that individuals should take to protect the social order itself [28]. For example, a driver will be disciplined for going through a red light, even if no one was hurt [28]. While the requirement to stop for the red light interferes with the driver's liberty, such restriction is necessary to maintain the social order. In much the same way that harms are the crux of negative liberty, positive liberty too is concerned with what harms to prevent. Structural harms relates to the "ability of a community to function" [28]. Accumulative harms are harms that result not from the action of one or a small number of people, but from the action of many people, for example, littering. Issues of liberty do not arise from the actions of individuals alone. Collectives such as corporations, trade unions, associations, and churches, to name a few, can have significant impact on individuals and communities. Because the power of collectives is almost always greater than the power of individuals, the potential harms from collectives are magnified [28]. That being the case, curtailing the actions of these collectives ought to be a pressing priority. The reality is that often times "we allow all kinds of harms to occur in the name of the free market" [28].

Students should be familiar with the concepts of negative and positive liberty and be able to identify when these perspectives are being invoked in policy stances and decisions. Furthermore, we suggest that students ought to see how the various social goals complete and conflict. Stone [28] notes the tensions between liberty and efficiency, "we allow all kinds of harms to occur in the name of the free market" [28]. By using the Stone framework, we hope to make these tensions manifest and perceivable.

Determine your scope

In addition to providing a framework for the students, it is also important to have an idea of the scope within which the topic and case study will be discussed. The scope is the extent of the subject matter deemed relevant. Scope is necessary for a case study to delimit the breadth and depth of discussion given the expanse of the framework. Without a defined scope, the subject matter may quickly get out of hand and lose purpose. For example, discussions of energy policy could range from the first commercial use of energy around 1000 BC to predictions of the impact of current energy use 200 years into the future. Scope may be determined and defined in several ways, such as over a specific time period, over a certain geographical area, some combination of time and geography, impacts on a specific population, the usage of a specific technology, or the extent of a particular law. As there are many examples, we will provide two:

1. One method for delimiting scope is around a particular actor(s), which aligns to the instructional goal of studying major policy actors. An example would be Franklin Roosevelt whose education in "the field of utility economics and regulation began at the turn of the century with course work at Harvard College and Columbia Law School" [7]. In

1933 and the period of the Great Depression, Franklin Roosevelt became the 32nd President of the United States. During his 1932 campaign, he was very vocal against the electric industry for "exploiting ratepayers and slowing national economic development through monopoly pricing practices, facilitated by ineffective state-level regulation" [7]. To address these problems, Franklin Roosevelt was known for the "first 100 days in office," because of his New Deal reform. According to Emmons [7] research on the New Deal, this policy "helped to reduce monopoly profits and lower electric rates without impairing the ability of investors in utility operating companies to earn returns" [7]. Emmons [7] pondered if the New Deal goals could have been achieved overtime without the New Deal policy. The scope in this case would therefore be Franklin Roosevelt's impact on the energy industry through the New Deal.

2. A discussion may focus on a particular piece of legislation or on a set of policies enacted over time collectively, such as the Rivers and Harbors Appropriation Act of 1899, General Dam Act of 1906, and the Federal Water Power Act of 1920. The Rivers and Harbors Appropriation Act of 1899 was enacted to grant federal government power over navigable waters by making it illegal to "dam navigable steams without a license (or permit) from Congress" [16]. The General Dam Act of 1906 distributed power to the Chief of Engineering and the Secretary of War to approve hydroelectric projects [16]. According to McFarland [16] and Pierce [24], both of these laws were not appropriate and suppressed the advancement and the development of hydroelectric power, because it was meant to protect navigable streams from development. It was not until 1920 that the first energy law came about, which was the Federal Water Power Act of 1920 that promoted hydroelectric development. The scope here is the discussion of the stunting of hydroelectric power in the US because of a particular set of laws.

Our case study uses both an actor and a set of legislations to delineate our scope. Specifically, we focus on energy legislation passed between 1880 and 1935 and key actors whose innovations in technology and efforts towards energy adoption and diffusion resulted in these laws. We largely focus on Samuel Insull and his pursuit for energy equity, efficiency, security and liberty.

Choosing a case study

Along with selecting a framework and providing a scope, the discussion can be further enhanced with the use of a well-chosen case study. The use of case studies has been shown to "increase students' critical thinking and problem-solving skills, higher-order thinking skills, conceptual change, and their motivation to learn" [31]. Yadav, Shaver, and Meckl [31] found that a case study promotes classroom engagement and relevance to real world experiences, helping to connect theory to practical use. A case study can be used to illustrate the relevance of social or policy issues under discussion to technical matters and as a convenient entry point into broader policy discussions. The use of the case study as an example is another way to engage students who may be resistant to discussions of social issues. When choosing a case study, instructors should consider the following:

1. Representativeness – the instructor should consider whether the case under consideration is illustrative of other similar events or processes and how it illuminates them. Depending

on the desired outcomes the selected case should be either highly representative to serve as a reasonable example from which the students can extrapolate; highly illustrate the conditions for or consequences of non-representative action, i.e. highlight an impactful success or failure; or serve as a point of comparison.

2. Salience – the case should illustrate a particularly important event that had or is still has a significant impact.

3. Interest – the case study chosen should be of potential interest to the students, such as its controversial nature, its continuing relevance, its familiarity etc.

4. Clarity – the instructor should select a case, in which the facts are fairly clear and not in dispute, unless the goal is to illustrate the impact of such complexities on the policy process or technology development.

5. Technically relevant – the case in question should include an example of the use of technology or a strong connection to technology use to help students connect technical and policy subjects.

Since the range of breadth and depth of the energy history is so vast, the case study proposed covers the years between 1880 and 1935, highlights a series of legislative pursuits and impacts on the private energy sector, the evolution of the energy product, and the development of the energy industry. This case study will expose students to a portion of energy policy history in the United States and therefore help them understand the development of the current energy policy environment.

Sample Case Study

This section outlines the case study selected for this module. This case study follows a portion of the career of Samuel Insull and the legislation that arose from and in response to his innovations between the years of 1880 and 1935.

According to McDonald [15], "in any political system in which government is by the consent of the governed, utilities are likely to be in politics, partly because of their public character and partly because politicians have found it expedient to make them so" [15], which echoes Stone's [28] social goals of equity, efficiency, security, and liberty. Samuel Insull is an excellent illustration of McDonald's [15] argument and also demonstrates the importance of having policy in the engineering education curriculum. Insull not only had engineering responsibilities, but a political impact as well. To revolutionize and advance the energy industry, Insull strongly believed that there should be regulation and monopolization. In pursuit of this, Insull formed relationships with political leaders, performed political roles, and invoked social goals in the effort to build his energy empire.

Samuel Insull – Background

In 1882, Thomas Edison became the first engineer to revolutionize the energy industry technologically in the United States by establishing a centralized electrical power grid system

with direct current (DC). It allowed 59 customers who paid five dollars per kilowatt hour [14] to gain access to his power grid. While Thomas Edison was a significant actor in the energy industry, it was his secretary, Samuel Insull, who revolutionized the energy industry technologically, politically, and economically. Insull travelled from England in 1880 to New York and worked for Thomas Edison at the Edison Company which later became General Electric. By 1892, Insull had left Edison Company and his vice-president position, to become president of Chicago Edison that was two percent the size of General Electric, had 5000 customers, and an electricity generation of 2800 kilowatts [25]. After his departure from Edison Company, Insull was inspired and motivated by the Great World's Fair, Colombian World Exposition of 1893. "The important lesson was seeing that electricity was used in so many different ways at the fair, that there had to be a way to make electricity universal for street railways, for big machines, for all different kinds of uses" [18].

Need for a regulated monopoly

Insull believed the energy industry should be operated as a regulated monopoly. The primary argument Insull espoused, centered on compelling social contentions of inefficiencies, security challenges, and inequalities. He made two claims, one for the need for regulation and the other for a monopoly. Regulation in this case was based as a function for monopoly. In 1898, at the National Electric Light Association (NELA), Insull who was the president of NELA made a speech on the reasons for such regulation. He proposed that the utilities will need to relinquish some of its liberties to the state, in order to protect the interest of the private utilities, build trust amongst all stakeholders [25], illustrate pricing and profits were reasonable [26], and lower cost [22]. Insull's second claim was for a monopoly on the basis that multiple or redundant utilities were inefficient in lowering cost, new utilities could disrupt incumbent utilities [26], and in the political environment were functioning unethically through bribing and corruption [15].

Since there were no policies to prohibit the regulated monopoly ambition, Insull developed four foundations that enabled a succession of events to increase and secure the capacity of his electricity generation, transmission, and distribution infrastructure to attain two arduous customer markets. The first foundation was giving the states control over operations and customer rates [25]. By 1920, all states had a form of regulatory state agency [22]. Second, tactically and deliberately obtaining particular rights of patents for various technologies; forcing competing companies to go through him for approval [15]. Third, he bought out his utility competitors and large customers (i.e., railways) [18, 25]. Lastly, the regulated monopoly of the energy sector allowed him to remove himself from bribing politicians [15].

Improve Chicago Edison inefficiencies

With the four regulated monopoly foundations laid-out, increasing the range of electricity generation, transmission, and distribution insinuates for more efficient technologies. In 1898, Insull had doubled his customers to 10,000 by utilizing both alternate current (AC) and direct current (DC) through an innovation of a rotary converter, maximizing his generator facility space, and outputting 4000 kWh [25]. However, peaking at 4000 kWh was an issue that led to a partnership with General Electric to build the first turbo generator (i.e., powerful steam turbine), which was smaller and produced 5000 kWh per generator than his current generators [18, 25]. Having these engineering improvements allowed Chicago Edison to obtain the transportation

market as customers by generating electricity for the industry and fund electrical charging stations for the vehicles [18].

Insull utility security

In1898, Insull expanded and secured his role in the energy industry to become Commonwealth Edison [25]. He purchased the Commonwealth Electric Company for $50,000, created by John Hopkins and Roger Sullivan who wanted to compete against Samuel Insull's utility company [15]. However, the Commonwealth Electric Company failed to compete, because of Insull's strategic patent ownerships of electrical equipment needed for the sector. The merger was very momentous, because the Chicago Edison patent was on the verge of expiring in 10 years and the Commonwealth Electric Company had a license for 50 years, giving Insull until 1947 to own his utilities company [15]. The 50 years was granted to the Commonwealth Electric Company, because Illinois passed the Allen Law in 1897. The legislation allowed utility companies to be franchised for 50 years [15]. However, in 1898 the Allen Law was annulled [9], which reverted to the older regulation of utility ownership for 20 years. Insull was the only utility company to have a license exceeding 20 years and empowering his monopoly ploy.

Addressing consumer inequality

By 1906, Insull had a customer base of 50,000, "trolleys were electrified, factories increasingly had powered equipment, and electric lights illuminated the streets, train stations, and the better hotels and restaurants" [25]. Up to this point, Insull engaged in the social goal of equality with the aim of universal and affordable electricity for all customers. Two customer markets he desired to provide electricity too were the residential and farming communities. Acquiring both customers would increase his consumer base, which would lower electricity cost and make distribution more efficient. Insull sought the residential market by performing two types of marketing campaigns. The first was to build awareness and educate the public about electricity through a monthly magazine by Electric City [25]. The second campaign was to encourage electricity to be used in a household with a newly developed electric iron that was heavily discounted and competed with the flat iron [25]. He pursued irons, because irons during the 1900's were viewed the way cell phones are viewed today, as necessary technologies.

The rural market was more challenging. According to PBS [18], the challenges were high cost and that farms were not clustered. He resolved the problems by building an estate in Lake County through which he was able to connect and supply electricity to 300 farmers[18]. However, it was not until the enactment of the New Deal and Rural Electrification Act of 1936 by President Franklin Roosevelt that most farms had access to electricity [18]. By 1909, his regulated monopoly vision was serving 100,000 customers and all of the city of Chicago [18]; however, he wanted to expand extensively and further monopolize the energy industry. His company expanded into a holding company in 1912, called Midwest Utilities, generating 208 Megawatts of electricity [23] and had a customer-base of 200,000 [25]. The holding company managed his centralized pyramid scheme he established, which consisted of utilities and other holding companies across 32 states.

Political role that ended his empire

During World War I, Insull was chosen by the governor of Illinois to take charge of the state's war efforts. Insull's prime responsibility was to sell war bonds to finance the war [18]. At the end of the war, President Woodrow Wilson, national leaders, and international leaders praised Insull for being the only utility company that maintained his service cost and his role during the war [25]. He continued selling bonds, but they were utility bonds and stocks. He also broke his principle of distributing contributions to all political candidates that he had maintained since the start of Chicago Edison. Instead he allotted $125,000 to only the Republican candidate [25], a move that eventually fueled his detestation. By 1929, the Great Depression had started and Insull's utilities empire collapsed, bringing down everyone who purchased stocks. In 1932, Franklin Roosevelt's campaign destroyed Insull's representation by calling him "selfish, too driven to profit," [18, 25] "an unethical competitor, the reckless promoter, and Insull monstrosity" [6]. Although there was animosity toward him in the United States, his role in the energy industry as an engineer and political leader were significant. His achievements were recognized by then Prime Minister Stanley Baldwin of Great Britain who offered Insull leadership of the energy commission [25]. However, Insull declined and ended his career in the energy industry.

As a result of the collapse of Insull's empire, President Franklin Roosevelt put into effect a set of legislations consisting of "Securities Act of 1933, the Securities Exchange Act of 1934, the Public Utility Holding Company Act of 1935, the Federal Power Act of 1935, and the legislation creating the Tennessee Valley Authority and Rural Electrification Administration" [9]. The goal of these laws was to strengthen federal power in the energy industry, improve transparency and control of utility practices; provide electricity to all communities; and increase federal control of generation, transmission, and distribution of electricity.

Linking the case study to ABET outcomes

It is important to guide the discussion of the case study to meet the predetermined learning goals, in this case the ABET outcomes. One approach to examine and analyze a case study is with guiding questions. This approach can be used for individual student assignments or as a team project assignment. The authors provide the following list of potential questions for guiding a discussion, evaluation and analysis of the Samuel Insull case study.

1. When reviewing the Samuel Insull case study from a policy perspective, how do you reconcile Insull's approach and view on regulation and monopoly with Stone's theoretical framework on the social goals of equity, efficiency, security, and liberty? Can you make an effective argument for the benefits of a monopoly in electrical power distribution?

2. Do energy monopolies exist today in some form within the United States and Europe? If they do, how are they similar or dissimilar to Samuel Insull's situation?

3. Would deregulation and market competition in the electrical energy sector have a positive impact on society?

4. President Wilson praised Insull for his work and the success of his utility company. Would Insull's idea and vision for electrical energy and distribution have survived if he had not made political mistakes? Was his ultimate failure a result of a misguided approach to monopolizing the industry or as a result of the Great Depression and a change in political priorities and policy?

5. Draw some comparisons from the Insull case study and a current energy policy challenge in the United States or the European Union (e.g., Keystone Pipeline).

Linking the case study to a modern energy policy event

The collapse of Enron was described as a repeated history by Henderson and Cudahy [9], because of the comparability to the forgotten history of Samuel Insull's rise and fall. After the collapse of Insull's electricity empire, legislations were signed by President Franklin Roosevelt, which included the New Deal, Securities Act of 1933, Securities Exchange Act of 1934, Public Utility Holding Company Act of 1935 (PUHCA), and the Federal Power Act of 1935 to prevent and to protect such an event from happening in the future. The purpose of these laws was to increase governmental power in the electricity industry, create financial transparencies for stakeholders, and dismantle the monopoly chaos that evolved overtime. However, these laws and the story of Insull faded away, permitting a déjà vu moment of history to repeat it-self in 2000.

The fading was due to the rise of environmentalism and the increase of electricity prices that had spawned new innovations and legislation, weakening one of the most powerful laws President Roosevelt signed in the electricity industry, PUHCA. There were two bills passed to address the concerns of the environmental movement and with the objective of reducing rising electricity prices. The first was the Public Utility Regulatory Policy Act of 1978 (PURPA), which supported renewable energy innovation such as rewarding utilities using smaller generators powered by renewable energies such as wind and geothermal [9]. The second was the Energy Policy Act of 1992 (EPAct). Similarly to PURPA, EPAct supported renewable energy innovations, such as providing exemptions for wholesale generators (EWG) that were "cleaner and more efficient than the power plants constructed in earlier decades" [9]. The generator technologies used natural gas as its resource. According to Henderson and Cudahy [9], both of these laws evolved the electricity industry to be competitive and deregulated, removing control of PUHCA.

Enron used PURPA and EPAct to their advantage. Although the approaches were different, the end results were comparable. First, both reached the apex of their business where market control and financial responsibility became confusing. Second, both were vulnerable to and eventually collapsed due to a stock market crash. Lastly, both resulted in new laws to prevent and protect another Insull-Enron incident. In response to the Enron incident, Sarbanes-Oxley Act of 2002 was passed.

Henderson and Cudahy [9] also noted that the lesson of the Insull-Enron repeated history is:

> Not so much that we need to strengthen laws on corporate wrongdoing – is in recognizing that during a financial bubble driven by rapid changes in network industries (e.g., electricity and the internet) regulatory officials will inevitably buckle under political

pressure and (a) fail to issue new rules that might interfere with the financial "hijinks" and (b) fail to vigorously enforce laws already on the books. [9]

Furthermore, Henderson and Cudahy [9] believe the Insull-Enron incident will not be the last and will occur again. Due to the trend of laws being both redistributed and weakened by other laws, new developments in the energy sector outpacing policy oversight, and notable events such as Insull-Enron that inspired the laws being forgotten.

Conclusion and final thoughts

Based on arguments from ABET , the National Research Council[19], Mendoza-Garcia et al. [17], and others, public policy should be included in the engineering curriculum. We recognize that many educators might hesitate to include such topics because of a lack of familiarity with the subject matter, or uncertainty about how it can be connected to technical learning so in this paper we presented an example of how to integrate policy into an engineering classroom using a case study module framed through Stone's [28] four social goals. However, this module is not the sole method; public policy could be integrated using experiential learning activities or through an engineering or technology and public policy course. Future works in this area will continue to address discussions on how much public policy should be part of the engineering curriculum, when it should be included and provide further examples of how it could be added to the engineering curriculum without overburdening students or instructors.

Bibliography

1. Bartlett, A. A. (2004). Thoughts on long-term energy supplies: Scientists and the silent lie. *Physics Today*, *57*(7), 53-55.

2. Bartlett, A. A. (2006). A depletion protocol for non-renewable natural resources: Australia as an example. *Natural Resources Research*, *15*(3), 151-164. doi:10.1007/s11053-006-9018-1.

3. Bartlett, A. (2012). The meaning of sustainability. *Teachers Clearinghouse For Science and Society Education Newsletter*, *31*(1), 1-17.

4. Bergin, D. A. (2010). Influence on classroom interest. *Educational Psychologist*, *34*(2), 87-98.

5. Connolly, D. (2011). *The global energy challenge: A contextual framework* (pp. 1-26). Retrieved from http://www.dconnolly.net/publications.html.

6. Dick, W. A. (1989). When dans weren't damned: The public power crusade and visions of the good life in the Pacific northwest in the 1930s. *Environmental Review*, *13*(3), 113-153.

7. Emmons III, W. M. (1993). Franklin D. Roosevelt, electric utilities, and the power of competition. *The Journal of Economic History*, *53*(4), 880-907.

8. Grasso, D., and Martinelli, D. (2008). Holistic Engineering: The Dawn of a New Era for the Profession. In G. Madhavan, B. Oakley, & L. Kun (Eds.), Career development in bioengineering and biotechnology. (pp. 303-

307). New York, NY: Springer.

9. Henderson, W. D., & Cudahy, R. D. (2005). From Insull to Enron: Corporate (re)regulation after the rise and fall of two energy icons. *Energy Law Journal*, *26*, 35-110.

10. Hoel, M., & Kverndokk, S. (1996). Depletion of fossil fuels and the impacts of global warming. *Resource and Energy Economics*, *18*(2), 115-136. doi:10.1016/0928-7655(96)00005-X.

11. Linnenbrink, E. A., & Pintrich, P. R. (2003). The role of self-efficacy beliefs in student engagement and learning in the classroom. *Reading & Writing Quarterly*, *19*, 119-137. doi:10.1080/10573560390143076.

12. Manning, J. E. (2011). *Membership of the 112th congress : A profile*. *Information Research* (pp. 1-8).

13. Markham, V. D. (2008). *U.S. population energy and climate change* (pp. 1-28). Retrieved from http://www.cepnet.org/documents/US-Population-Energy-Climate_Change2009.pdf.

14. Massachusetts Institute of Technology. (2011). *The future of the electric grid*. *Electrical Engineering* (pp. 1-268). Retrieved from http://web.mit.edu/mitei/research/studies/documents/electric-grid-2011/Electric_Grid_Full_Report.pdf.

15. McDonald, F. (1958). Samuel Insull and the movement for state utility regulatory commissions. *The Business History*, *32*(3), 241-254.

16. McFarland, C. K. (1966). The federal government and water power, 1901-1913: A legislative study in the nascence of regulation. *Land Economics*, *42*(4), 441-452.

17. Mendoza-Garcia, J., Ngambeki, I., Behbehani, L., Evangelou, D., Rao, S., & Cox, M. (2012). Defining the knowledge and skills that enable engineers to participate in public policy. Paper presented at the annual conference of the American Society for Engineering Education. Retrieved December 18, 2012, from http://www.asee.org/file.../EPP_ASEE_2012_Draft_paper-march-final.pdf.

18. National PBS Broadcast. (2002). Interview with Loyola University Professor Harold Platt for program two: "Electric nation". Retrieved from http://www.pbs.org/greatprojects/interviews/platt.pdf.

19. National Research Council of the National Academies. (2012). *Using science as evidence in public policy* (pp. 1-110).

20. Newmann, F. M. (1989). Student engagement and high school reform. Association for Supervision and Curriculum Development.

21. Ngambeki, I. B., Depew, D. R., Dark, M. J., & Chong, R. C. (2013, June). Approaches to integrating policy into engineering education. Paper presented at the annual conference of the American Society for Engineering Education, Atlanta, GA.

22. Perkins, R. (1998). Electricity deregulation, environmental externalities and the limitations of price. *Boston College Law Review*, *39*(4), 993-1059.

23. Peskoe, A. (2011). A challenge for federalism: Achieving national goals in the electricity industry. *Mo. Envtl. L. & Pol'y Rev*, *18*(2), 210-281.

24. Pierce, H. J. (1916). Federal water-power legislation. Government Printing Office. Retrieved from

http://www.hathitrust.org/access_use#pd-google.

25. Schewe, P. F. (2005). Most electrified city. *Electrical Book* (pp. 64-89). Retrieved from http://www.w2agz.com/Library/Electricity History/Samuel Insull - Pages from ElectricitySep05.pdf.

26. Smith, V. L. (1996). Regulatory reform in the electric power industry. *Regulation*, *1*, 33-46. Retrieved from http://www.cato.org/pubs/regulation/regv19n1/v19n1-3.pdf.

27. Smulders, S. (2004). Non-renewable resources and economic growth: Comparing the classics to new models of endogenous technology and growth. Retrieved from http://www.feem-web.it/ess/ess04/contents/smulders1.pdf.

28. Stone, D. (2002). *Policy paradox: The art of political decision making.* (Rev. ed.). New York, NY: W. W. Norton & Company.

29. Svinicki, M. D., & Dixon, N. M. (1987). The Kolb model modified for classroom activities. *College Teaching*, *35*(4), 141-146.

30. World Health Organization. (2005). *WHO air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide* (pp. 1-20). Retrieved from http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf.

31. Yadav, A., Shaver, G. M., & Meckl, P. (2012). Lessons learned: Implementation the case teaching method in a mechanical engineering course. *Journal of Engineering Education*, 55-69.

32. Zahorik, J. A. (1996). Elementary and secondary teachers' reports of how they make learning interesting. *The Elementary School Journal*, *96*(5), 551-564.