2020

Aging Pipeline Infrastructure in the United States: How do a changing policy mix, issues of energy justice, and social media communication impact future risk analysis?

Brent Burns

AGING PIPELINE INFRASTRUCTURE IN THE UNITED STATES: HOW DO A CHANGING POLICY MIX, ISSUES OF ENERGY JUSTICE, AND SOCIAL MEDIA COMMUNICATION IMPACT FUTURE RISK ANALYSIS?

By

Brent J. Burns

A DISSERTATION

Submitted in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

In Environmental and Energy Policy

MICHIGAN TECHNOLOGICAL UNIVERSITY

2020

This dissertation has been approved in partial fulfillment of the requirements for the Degree of DOCTOR OF PHILOSOPHY in Environmental and Energy Policy.

Department of Social Sciences

Dissertation Advisor:	*Dr. Adam Wellstead*
Committee Member:	*Dr. Chelsea Schelly*
Committee Member:	*Dr. Mark Rouleau*
Committee Member:	*Dr. Kalim Shah*
Department Chair:	*Dr. Hugh Gorman*

Table of Contents

List of figures

List of tables

Preface

The following chapters will be submitted to journals in the near future:

Chapter 2, *Using a policy mix approach to understand how changing policy goals and politics affect legacy policy regimes,* will be submitted to *Energy Policy.*

Chapter 3, *Advancing the state of energy justice research using deterministic approaches in search of causality,* will be submitted to *Energy Research and Social Science.*

Chapter 4, *Why is the Enbridge Line 5 pipeline crossing at the Straits of Mackinac on the agenda? Using Twitter data to display open policy windows and how they are impacted by reinforcing spirals in social media*, will be submitted to the *Policy Studies Journal.*

Acknowledgements

I would like to take this opportunity to acknowledge and thank my committee members. I thank Adam Wellstead (Social Sciences) who served as my advisor and committee members: Chelsea Schelly (Social Sciences) and Mark Rouleau (Social Sciences). A special thanks to the external member, Kalim Shah, who participated in my dissertation defense.

I also thank my colleagues at Michigan Technological University who have supported me along the process, with special thanks to direct supervisors Jim Baker, Jason Carter, and Kathy Halvorsen. I thank them for their support in both approving tuition and allowing flexibility to achieve the many milestones along the path.

A special thanks to my good friend Michael McEntee for assisting in programming and navigating the Twitter API used in Chapter 4.

Thanks to all those who helped review drafts along the way including my colleague Pete Larsen.

Special thanks to my parents, Bernie and Terry Burns, for not only reviewing dissertation drafts, but more importantly for providing me with the lifelong work ethic, dedication, and motivation to pursue whatever my dreams may be.

Lastly, I would like to thank my family, Catherine, Brad, and Lexi, for their patience and encouragement throughout this long journey.

Abstract

Over two and a half million miles of pipeline cross the United States today, half of which is over fifty years old and thus was designed, located, and debated without today's modern environmental policies in place. Aging pipeline infrastructure, such as the (infamous in Michigan) Enbridge Line 5 pipeline underwater crossing at Michigan's Straits of Mackinac, has undergone increased public scrutiny and risk analysis this past decade. This has led to the potential for policy changes in the historically stable energy services institution associated with pipeline infrastructure regulation. While policy process literature generally describes how policy changes over time, it is missing research on how new goals and new technology, such as energy justice and social media, impact agenda setting and decisions when added to the policy mix. This dissertation first investigates the evolving federal pipeline regime policy goals through an advanced policy mix analysis. Next, it argues that energy justice research can be advanced through deterministic approaches and analyses. Last, this dissertation uses a social network analysis to explain why aging pipelines are on today's policy agenda through. By understanding how the pipeline policy mix has changed over time, including through the addition of modern topics such as energy justice and modern technologies such as social media, policy and decision makers can improve prioritization of risk analysis for aging pipeline infrastructure.

1 Aging Pipeline Infrastructure Risk Analysis: How Changing Pipeline Policy Goals, Energy Justice, and Agenda Setting Impact Risk Analysis

1.1 Policy Change for Aging Pipeline Infrastructure

The purpose of this dissertation is to advance the scholarly field of policy science within the energy policy discipline, focusing on aging infrastructure. The three empirical chapters will accomplish this goal through 1) conducting a detailed policy mix analysis of the United States oil and gas pipeline policy regime goals, 2) describing how to use energy justice principles with deterministic approaches, and 3) demonstrating the impact of modern social media and actors influencing the agenda setting process. Chapter two reviews U.S. federal public laws governing pipeline policy, categorizing and analyzing the changing policy goals over the past several decades. Chapter three introduces the emerging field of energy justice and its principle components to the broader policy process literature, describing how deterministic approaches could further causal analysis for case-study based research. Chapter four uses the multiple streams approach within agenda setting literature to assess an open policy window for a specific aging pipeline case-study and provides a social network analysis investigating how social media and its broader group of individual and organizational actors impact policy windows. The final chapter summarizes findings and describes how each chapter ties together by addressing impacts of policy change on aging infrastructure risk analysis.

Historical institutionalism, or comparing the structures, rules, and operations that have developed over decades of path dependence and stability (Thelen, 1999; Pierson, 2000), provides the overarching framework for the dissertation. The historical institutionalist framework looks at the path dependence and increasing returns of structures and processes over time and, is a good method to analyze problems that span decades. This approach can find sequences and conjunctures over time that can help inform why today's policy regime is the way it is (Pierson and Skocpol, 2002).

1.2 Current Risks of Aging Pipeline Infrastructure

Despite gains in more representative and fair processes for development of new pipelines and other infrastructure, nearly half of the over two and a half million miles of major pipelines operating throughout the United States are over fifty years old, designed and located with limited consideration of broader environmental and sustainability concerns (Dreyfus and Ingram, 1976, p246). Significant local, regional, and transnational attention has recently been brought to one aging pipeline in particular, which passes through an environmentally sensitive area. Built in 1953, Enbridge's Line 5 crosses a five-mile span of open Great Lakes water in the Straits of Mackinac, the seaway that separates Michigan's Upper and Lower Peninsulas. In 2016, the State of Michigan commissioned Risk Analysis of Enbridge Line 5, highlighting a broadening list of actors concerned with

the safety and stability of aging pipeline infrastructure (Michigan Petroleum Pipelines, 2018). In order to ensure safe operations of pipelines and consistent supply of affordable and reliable energy, there needs to be a systematic approach to identifying aging pipelines that need immediate additional risk analysis.

Enbridge's Line 5 is just one of thousands of miles of pipeline designed and constructed before significant national environmental and pipeline policy regulations were created. The first federal pipeline policy legislation was not created until the Natural Gas Pipeline Acts of 1968 and 1979 (liquids added). Additional regulations came with the Environmental Protection Agency, established in 1970, requiring environmental impact statements for development projects and clean air and water legislation (Dunlap and Mertig, 2014). Modern society has increased their expectations of corporate environmental responsibility and sustainable development (Rondinelli and Berry, 2000). However, these aging infrastructure systems were not built overnight; the network of pipelines was constructed over decades of layered regulations, mergers, and changing policies. These policy regimes, or "persistence of fundamental policy components over fairly long periods of time" (Howlett et al., 2009, 86), consist of unique combinations of policy instruments, or policy mixes (Lehmann, 2012). Early goals of the policy regime consisted of 1) safe transportation and infrastructure (Natural Gas Pipeline Safety Act, 1968), and 2) strategic economic benefits, based on privately owned energy systems (Shleifer, 1998).

1.3 Policy Change

The core of this dissertation is centered on principles of policy change. Policy change is described by many different policy theories, most of which focus on policy subsystems, or as described by Michael Howlett et al. (2009), the group of actors and institutions within a particular policy issue or sector. Policy change is corelated with the agenda setting phase of the policy process. The word "change" as defined by Merriam-Webster is "to make different; to undergo transformation, transition, or substitution, to give a different position, course, or direction to" (Change, n.d.). Paul Sabatier and Hank Jenkins-Smith's (1993) Advocacy Coalition Framework (ACF) described the process of policy change in terms of policy learning. This theory states that true policy change occurs over a long period of time as it is difficult to change core beliefs within coalitions. Advocacy coalitions involve a subset of actors within a policy subsystem. This type of structure can be witnessed within the pipeline policy regime, where there are two opposing sides to a long-standing debate (pro-pipeline vs. anti-pipeline). The pro-pipeline coalition is grounded in government and business interests to produce and distribute energy in the form of natural gas and oil at a higher volume, faster rate, and lower price to industrial and consumer customers. The anti-pipeline coalition is grounded in political or community-based groups focused on protecting the immediately impacted environment from development and degradation and the longer term environmental and climate implications of fossil fuel consumption. Both sides have made progress in growing their coalitions' positions, however U.S. aging energy infrastructure fits the theory of Pierson and Skocpol's (2002) path dependence and increasing returns,

highlighting the central element where "the costs of switching from one alternative to another will…increase markedly over time" (p. 251). Therefore, the pro-pipeline coalition, the incumbent, has the advantage when it comes to the direction of policy change. Margaret Levi (1977) further elaborates on this theory by stating "the entrenchments of certain institutional arrangements obstruct an easy reversal of the initial choice" (p. 28).

Another policy process theory grounded in the subsystem level is Frank Baumgartner and Bryan Jones's (1993) Punctuated Equilibrium Theory (PET), which argues that policy stability or stasis is followed by "bursts of change" or punctuations. PET describes the pipeline policy regime and how change occurs more comprehensively than ACF. This dissertation will describe how industrial accidents such as oil spills or pipeline leaks create a spike in interest in pipeline policy. In addition to accidents, the pipeline policy regime has experienced "build up" effects as described by PET, such as the environmental movement of the 1970s leading to pipeline policy reform and the more recent alternative energy movement leading to significant restraint of new large pipeline development. This dissertation will describe instances in which policy change has occurred in "bursts" as well as the long and slow process of "policy learning" over long periods of time as described with ACF.

John Kingdon and James Thurber's (1984) Multiple Streams Approach (MSA) fits the pipeline policy regime better than either PET and ACF due to its unique definition of policy windows and their impact on agenda setting. MSA states that radical policy change only happens when problem, policy, and politics all align in a "policy window." These policy windows were captured in Baumgartner's PET study, describing the bursts of policy change, however MSA describes the how the "burst" came about through the alignment of the problem, policy, and politics. The problem, policy, and politics model aligns with this dissertation's model of describing how specific policy goals have changed with time and evolved into new goals as the problem and politics change. The change occurs in the policy window when all three align and have "policy entrepreneurs," or actors that lead the reform and capitalize on the change opportunity.

Table 1.1 Policy change within policy process theories

Policy Process Theory	Policy Change Description	Fit within the Pipeline Policy Regime
Advocacy Coalition Framework	Over long period of time	Pro-pipeline and anti-pipeline coalitions, incumbent maintains control of policy change
Punctuated Equilibrium Theory (PET)	Bursts of change	Oil spills and leaks create change, buildup of environmental efforts lead to change
Multiple Streams Approach (MSA)	Policy Windows	Active problem, policy, and politics

1.4 Aging Pipeline Infrastructure Problem

Aging energy infrastructure across the globe is seeing increased scrutiny and divestment from society and policy makers to justify their existence in today's new era of environmental, energy, and climate justice (Fouquet and Johansson, 2008; Sine and David, 2003). Energy system companies, specifically pipeline companies, are being asked for increased risk analysis on aging infrastructure to ensure not only safe operations but also institute today's policy standards on projects built decades, and in some cases, a century in the past (Wang and Duncan, 2014; Clausard, 2006; Kishawy and Gabbar, 2010; Stastny, 2010). The problem is in the United States alone, there is over two and a half million miles of pipelines, half of which are over fifty years old (Greoger, 2012) with each mile designed, built, and maintained on a patchwork of local, state, and federal policies equally as old.

This dissertation will further address the energy policy problem of pipeline infrastructure by investigating three areas of policy scholarship: 1) identifying changing policy goals within the pipeline policy mix, 2) seeking causal mechanisms through deterministic approaches and energy justice principles, and 3) determining how reinforcing spirals in social media extend the policy window for agenda setting. While new infrastructure projects have implemented modern policy mixes to achieve safety and affordability, aging infrastructure was constructed with the rules and regulations in place at the time of installation. The layered policy mix managing aging infrastructure has adapted to modern standards, however this does not change original siting locations or construction methods and does not include comprehensive decommissioning strategies (Doyle et al., 2008).

One challenge in bringing about change to the current pipeline regime is the that oil and gas pipelines in particular have a strong policy regime, which is defined by Peter May and Ashley Jochim (2013) as having a shared sense of purpose, reinforce political commitments, focus on relevant policy goals, and engage a supportive constituency.

These actions are supported by the increasing returns from high capital investment costs spread out over long periods of time. Economies of scale incentivize large pipelines, further supporting their continued existence to keep energy prices low (Rui et al., 2011). The sunk costs of infrastructure investment make it more challenging to transform energy production to more sustainable and renewable fuels and to decommission aging pipelines. Cost challenges are well documented in the application of the Clean Air Act and regulations surrounding emissions from aging power plants or pollution controls from manufacturing operations (Hower, et. al., 1999). Despite the economic argument to maintain pipelines to keep energy prices low by leveraging the sunken costs of depreciated infrastructure, the risk of catastrophic pipeline failure has driven the recent debate over rerouting or closing.

Most studies analyzing aging infrastructure have focused on economic analysis and life cycle costs (Brown and Willis, 2006) or technical practices to extend life of systems (Dominelli, Rao, and Kundur, 2006). A study by A.M. Fowler et al. (2014), focused on decommissioning of offshore oil and gas infrastructure, however this study also mainly focused on the technical options to decommissioning, not the policy process problems and issues. By not including policy analysis, these studies aren't addressing the important topics of why risk analysis is happening today when pipelines have had seemingly the same risks for decades.

This dissertation will add to energy policy literature by studying the how increasing concerns with aging pipelines have impacted policy change within the pipeline policy regime. Oil and natural gas will remain a significant proportion of the world's energy system for decades to come (Karatayev et al. 2019), therefore aging pipelines will continue to remain a significant part of the U.S. energy system, noting that currently natural gas and petroleum account for 31.8 and 28 percent, respectively of U.S. energy production (EIA, 2019). With such a significant reliance of natural gas and petroleum energy in the U.S., further research of policy change within the pipeline policy regime can provide valuable insights to scholars and policy makers. A detailed policy mix analysis on this important energy infrastructure system is missing from the literature and is needed to create a baseline for future policy studies in this field.

1.5 Chapter 2 Overview

Chapter 2, *Using a policy mixes approach to understand how changing policy goals and politics affect legacy policy regimes*, analyzes the pipeline regime policy mix of complex long-term pattern of policy development and layering. Through systematically determining what the modern U.S. pipeline policy regime goals are and how their policy mix has changed over time, policymakers can better address the future policy needed to achieve modern expectations for aging infrastructure and their associated risks. This study adds to the policy mix literature providing a detailed case study analysis showing how this historical approach can be used to determine policy mix goals and how they change over time. Policy mix studies tend to be limited to examining instrument interactions (Rogge and Reichardt, 2016); however, this enhanced policy mix analysis

will combine policy goals, instrument mix, and political impact to derive a more thorough analysis than any single study. This study uses the Comparative Agenda's Project (The Policy Agendas Project, 2017) to find all federal public laws impacting pipeline policy. Additional data and full document texts are provided by GovInfo.gov (2019) and HeinOnline (2019) as data sources for all U.S. federal documents from 1995 through today. Documents were filtered with the keywords "pipeline safety" in their title, which appropriately narrows content to policy regarding the operations and regulations of the federal pipeline energy system. Broader 'pipeline' searchers included regional specific pipeline regulations which are not the focus of this study. Keyword and phrases for hypothesized policy goals within Safe Transportation and Infrastructure, Environmental Impact, and Economic Benefits were summarized for each federal pipeline policy public law. Policy instrument analysis, adapting Alexandra Lesnikowski et al.'s (2019) approach, was then used to determine substantive and procedural instruments and governing typology of each instrument. They were then compared to changing policy goals to discover significant correlations and trends. Finally, political impacts of each public law were analyzed for significant correlations to both policy goals and instrument mixes over time. This is the first study to use these three policy mix techniques in one case study over time and the first to analyze critical aging infrastructure. With nearly sixty percent of U.S. electric energy supplied by this network of pipelines (EIA, 2019), it is important to understand policy change within the pipeline policy regime goals, the instrument balance within the policy mix, and changing political characteristics and their alignment to goals. This chapter intends to be a journal article submitted to *Energy Policy*.

1.6 Chapter 3 Overview

Chapter 3, *Advancing the state of energy justice research using deterministic approaches in search of causality*, analyzes the emerging field of energy justice and provides suggestions on improving energy justice research through use of deterministic approaches. Core principles of energy justice include "providing all individuals, across all areas, with safe, affordable and sustainable energy" (Heffron and McCauley, 2014, p. 437), which correlates seamlessly with the previously presented pipeline policy goals of "safe transportation and infrastructure," "environmental impact," and "economic benefits." There have been many probabilistic empirical studies within environmental justice as shown in William Bowen's (2002) review as well as Pamela Davidson's (2003) assessment of analytical methods used in the literature. Energy justice research, while a newer field compared to environmental justice, relies upon similar principles of procedural and distributive justice, along with statistical methods within empirical research to date, as described by Kristen Jenkins et al. (2016). In both fields, statistical description of these issues has not widely attempted further causal analysis and testing of causal mechanisms, both of which are needed to address root causes. Further examination of energy justice methods can help answer the question how to find causal mechanisms within energy policy analysis. This chapter first presents the case for using deterministic approaches (including QCA, process tracing, and counterfactual analysis) to seek casual

analysis and causal mechanisms. Next, this chapter empirically categorizes current methods used for recent energy justice literature. This chapter concludes by addressing specific energy justice studies and providing a framework for research design changes to better employ deterministic methods, leading to improved causal analysis. This chapter intends to be a journal article submitted to *Energy Research and Social Science*.

1.7 Chapter 4 Overview

Chapter 4, *Why is the Enbridge Line 5 pipeline crossing at Mackinaw on the agenda? Using Twitter data to display open policy windows and how they are impacted by reinforcing spirals in social media*, adds to the policy process literature on agenda setting originated by Kingdon and Thurber's (1984) "multiple streams" theory, which Thomas Birkland's (1998) expanded through theorizing "focusing events," by combining their theories with social media agenda setting influence. A focusing event is a sudden and uncommon event causing harm to a geographic region with effects beyond said region (Birkland, 1998). In parallel, communication literature scholars Maxwell McCombs and Donald Shaw's (1972) proposed that the media agenda sets the public agenda. Multiple communication studies measuring agenda setting with social media show their distinct impacts to the public agenda (Drezner and Farrell, 2004; Meraz, 2009). Social media has a "reinforcing spiral" impact, as shown by Michael Slater (2007) in his study on media selectivity and its impact on social behavior. This chapter applies both policy and communication literature to aging pipeline infrastructure, provide further insights to why the Enbridge Line 5 policy window is still open. There have been multiple oil spill disasters in the past, such as the Exxon Valdez in 1989 and Santa Barbara 1969 to note a few (Piatt et al., 1990; Molotch, 1970). However, it wasn't until more recent disasters such as the 2010 BP Deepwater Horizon Gulf Oil Spill and 2010 Enbridge Line 6B pipeline spill in Kalamazoo MI, focused attention on aging pipeline safety and integrity. Enbridge Line 5 underneath the Straits of Mackinac has been used as a 'poster child' for this issue. A new variable in agenda setting between the 1970-1990s and today is the introduction of social media and unique "reinforcing spirals" (Slater, 2007).

Knowing that aging energy infrastructure (i.e. Enbridge Line 5) has been vulnerable to environmental changes and aging since construction and has only increased vulnerability when infrastructure passes its designed lifespan (Paskal, 2009), what makes the past ten years of attention on this particular aging pipeline so special? This chapter tests the hypothesis that reinforcing spirals in media extend the window of opportunity for agenda setting following a focusing event. This newly sustained agenda pressure in pipeline policy is increasing calls for risk analysis of what once were relatively unnoticed pipeline routes. A social network analysis helps visualize the individuals and organizations within the policy network and determine how they are grouped. Understanding how these issues rise on the agenda can help policymakers prioritize the aging infrastructure projects that need the greatest attention. Acknowledging this bias is important when making technical decisions on prioritizing aging infrastructure modernization and fixes. This study adds to both policy process and media communication literatures by determining if reinforcing

spirals lengthen the window of opportunity in agenda setting. This chapter intends to be a journal article submitted to *Policy Studies Journal*.

1.8 Chapter 5 Overview

Chapter 5, *Conclusions and Directions for Future Research* summarizes the primary problems confronting aging pipeline infrastructure as well as each chapters' results for their respective research questions. This chapter provides an overview of policy implications for aging pipeline infrastructure and describes how each chapter addresses those implications through scholarly contributions and recommendations for policymakers. Lastly, this chapter summarizes future research directions for the respective fields of policy research related to aging pipeline infrastructure and expanding into other policy regimes.

There are multiple contributions to scholarship within this dissertation. Chapter 2 contributes to both the broader policy process literature and specific energy policy literature by creating an advanced policy mix analysis method by combining policy goals, instruments, and politics over a long period of time. Chapter 3 contributes to both the energy justice literature and the comparative policy literature by providing a roadmap for scholars to use within their research design if seeking causal analysis via deterministic approaches. Chapter 4 contributes to both policy process literature and communication literature by developing an approach which uses social media to assess open policy windows through Kingdon's multiple streams approach along with creating a social network analysis to assess the existence of reinforcing spirals around a policy topic.

1.9 References

Baumgartner, F. R., & Jones, B. D. (1993). *Agendas and instability in American politics*. University of Chicago Press.

Birkland, T. A. (1998). Focusing events, mobilization, and agenda setting. *Journal of public policy*, *18*(1), 53-74.

Bowen, W. (2002). An analytical review of environmental justice research: what do we really know?. *Environmental management*, 29(1), 3-15.

Brown, R. E., & Willis, H. L. (2006). The economics of aging infrastructure. *IEEE Power and Energy Magazine*, *4*(3), 36-43.

Change. (n.d.). In *Merriam-Webster online dictionary*. Retrieved August 12, 2019, from http://www.merriam-webster.com/dictionary/change

Clausard, C. (2006). Pipeline integrity management strategy for aging offshore pipelines. *MACAW Engineering Limited, UK*, *15*.

Davidson, P. R. (2003). Risky business? Relying on empirical studies to assess environmental justice. *Our backyard: A quest for environmental justice*, 83-103.

Dominelli, N., Rao, A., & Kundur, P. (2006). Life extension and condition assessment: techniques for an aging utility infrastructure. *IEEE Power and Energy Magazine*, *4*(3), 24-35.

Doyle, M. W., Stanley, E. H., Havlick, D. G., Kaiser, M. J., Steinbach, G., Graf, W. L., ... & Riggsbee, J. A. (2008). Aging infrastructure and ecosystem restoration. *Science*, *319*(5861), 286-287.

Dreyfus, D. A., & Ingram, H. M. (1976). The National Environmental Policy Act: a view of intent and practice. *Nat. Resources J.*, *16*, 243.

Drezner, D. W., & Farrell, H. (2004). Web of influence. *Foreign policy*, 32-41.

Dunlap, R. E., & Mertig, A. G. (Eds.). (2014). *American environmentalism: The US environmental movement, 1970-1990*. Taylor & Francis.

EIA. (2019) US Energy Facts Explained. March 13, 2019 https://www.eia.gov/energyexplained/?page=us_energy_home.

Fouquet, D., & Johansson, T. B. (2008). European renewable energy policy at crossroads—Focus on electricity support mechanisms. *Energy policy*, *36*(11), 4079-4092.

Fowler, A. M., Macreadie, P. I., Jones, D. O. B., & Booth, D. J. (2014). A multi-criteria decision approach to decommissioning of offshore oil and gas infrastructure. *Ocean & coastal management*, *87*, 20-29.

Govinfo.gov. (2019) Discover U.S. Government Information. https://www.govinfo.gov/.

Groeger, Lena. (2012, November 15). Pipeline Safety Tracker. *ProPublica*.

Heffron, R. J., & McCauley, D. (2014). Achieving sustainable supply chains through energy justice. *Applied Energy*, *123*, 435-437.

HeinOnline.org. (2019). Databases. U.S. Federal Legislative History. Retrieved December 19, 2019. https://heinonline.org/HOL/Page?handle=hein.leghis/ngps0001&id=501&collection=leghis&index=

Hower, J. C., Robl, T. L., & Thomas, G. A. (1999). Changes in the quality of coal combustion by-products produced by Kentucky power plants, 1978 to 1997: consequences of Clean Air Act directives. *Fuel*, *78*(6), 701-712.

Howlett, M., Ramesh, M., & Perl, A. (1995). *Studying public policy: Policy cycles and policy subsystems* (Vol. 3). Oxford: Oxford university press.

Jenkins, K., McCauley, D., Heffron, R., Stephan, H., & Rehner, R. (2016). Energy justice: a conceptual review. *Energy Research & Social Science*, 11, 174-182.

Karatayev, M., Movkebayeva, G., & Bimagambetova, Z. (2019). Increasing Utilisation of Renewable Energy Sources: Comparative Analysis of Scenarios Until 2050. In *Energy Security* (pp. 37-68). Palgrave Macmillan, Cham.

Kingdon, J. W., & Thurber, J. A. (1984). *Agendas, alternatives, and public policies* (Vol. 45, pp. 165-169). Boston: Little, Brown.

Kishawy, H. A., & Gabbar, H. A. (2010). Review of pipeline integrity management practices. *International Journal of Pressure Vessels and Piping*, *87*(7), 373-380.

Lehmann, P. (2012). Justifying a policy mix for pollution control: a review of economic literature. *Journal of Economic Surveys*, *26*(1), 71-97.

Lesnikowski, A., Ford, J. D., Biesbroek, R., & Berrang-Ford, L. (2019). A policy mixes approach to conceptualizing and measuring climate change adaptation policy. *Climatic Change*, 1-23.

Levi, M. (1997). A model, a method, and a map: Rational choice in comparative and historical analysis. *Comparative politics: Rationality, culture, and structure*, *28*, 78.

May, P. J., & Jochim, A. E. (2013). Policy regime perspectives: Policies, politics, and governing. *Policy Studies Journal*, 41(3), 426-452.

Meraz, S. (2009). Is there an elite hold? Traditional media to social media agenda setting influence in blog networks. *Journal of computer-mediated communication, 14*(3), 682-707.

McCauley, D. A., Heffron, R. J., Stephan, H., & Jenkins, K. (2013). Advancing energy justice: the triumvirate of tenets. *International Energy Law Review*, *32*(3), 107-110.

McCombs, M. E., & Shaw, D. L. (1972). The agenda-setting function of mass media. *Public opinion quarterly*, *36*(2), 176-187.

Michigan Petroleum Pipelines. (2018). Resources and Reports. *Risk Analysis for the Straits Pipelines*. October 2018. https://mipetroleumpipelines.com/document/risk-analysis-straits-pipelines

Molotch, H. (1970). Oil in Santa Barbara and power in America. *Sociological Inquiry*, *40*(1), 131-144.

Natural Gas Pipeline Safety Act of 1968. Public Law 90-481. *An Act to authorize the Secretary of Transportation to prescribed safety standards for the transportation*

of natural and other gas by pipeline, and for other purposes. United States Government. August, 12, 1968.

Paskal, C. (2009). The vulnerability of energy infrastructure to environmental change. *London: Chatham House*.

Piatt, J. F., Lensink, C. J., Butler, W., Kendziorek, M., & Nysewander, D. R. (1990). Immediate impact of the'Exxon Valdez'oil spill on marine birds. *The Auk*, *107*(2), 387-397.

Pierson, P. (2000). Increasing returns, path dependence, and the study of politics. *American political science review*, *94*(2), 251-267.

Pierson, P., & Skocpol, T. (2002). Historical institutionalism in contemporary political science. *Political science: The state of the discipline*, *3*(1), 1-32.

Rogge, K. S., & Reichardt, K. (2016). Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Research Policy*, *45*(8), 1620-1635.

Rondinelli, D. A., & Berry, M. A. (2000). Environmental citizenship in multinational corporations: social responsibility and sustainable development. *European Management Journal*, *18*(1), 70-84.

Rui, Z., Metz, P. A., Reynolds, D. B., Chen, G., & Zhou, X. (2011). Historical pipeline construction cost analysis. *International Journal of Oil, Gas and Coal Technology*, *4*(3), 244-263.

Sabatier, P. A., & Jenkins-Smith, H. C. (1993). *Policy change and learning: An advocacy coalition approach*. Westview Pr.

Shleifer, A. (1998). State versus private ownership. *Journal of economic perspectives, 12*(4), 133-150.

Sine, W. D., & David, R. J. (2003). Environmental jolts, institutional change, and the creation of entrepreneurial opportunity in the US electric power industry. *Research Policy*, *32*(2), 185-207.

Slater, M. D. (2007). Reinforcing spirals: The mutual influence of media selectivity and media effects and their impact on individual behavior and social identity. *Communication theory*, *17*(3), 281-303.

Stastny, R. P. (2010). Eye of the storm: Enbridge's Michigan leak and debate over the integrity of North America's sprawling network of aging pipelines. *Oilweek Magazine*, *61*(10), 40-45.

The Policy Agendas Project at the University of Texas at Austin, 2017. *www.comparativeagendas.net*. Accessed August, 2019.

Thelen, K. (1999). Historical institutionalism in comparative politics. *Annual review of political science*, *2*(1), 369-404.

Wang, H., & Duncan, I. J. (2014). Likelihood, causes, and consequences of focused leakage and rupture of US natural gas transmission pipelines. *Journal of loss prevention in the process industries*, *30*, 177-187.

2 Using a policy mix approach to understand how changing policy goals and politics affect legacy policy regimes

Abstract

Legacy energy policy regimes, such as the federal pipeline policy regime, remain strong today despite decades of both political change and evolving policy goals. Policy mix research has ignored studying policy change over long periods of time in such legacy regimes. Using a policy mix approach to address how changing policy goals and layered policy instruments change along with politics will provide insights to these legacy policy regimes strength. This chapter will analyze 17 United States federal pipeline policy laws featuring 316 unique policy instruments between 1968-2016. Results of this analysis suggest a safety goals are consistent, coherent, and congruent with the overall policy mix while environmental and economic goals are less efficient. In addition, no significant political impacts were shown on the policy mix, despite changing federal political majorities. This chapter concludes by discussing the benefits of using this approach to investigate changing policy goals and mixes over time.

Keywords: policy mix analysis, policy goals, policy regime, policy instruments, pipelines

2.1 Introduction

Since the 1950s, the United States pipeline policy mix has increased in complexity, adding layer after layer of policy and regulation as environmental and safety standards develop over time. Florian Kern and Michael Howlett (2009) define policy mixes as "complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years" (p. 395). Understanding policy regime goals and how the policy mix has changed is important in order to determine how and why decisions were made and how they have impacted the policy regime over time. However, policy mix studies have primarily focused on examining instrument interactions (Rogge and Reichardt, 2016) or have been limited to policy processes associated with those studied mixes (Howlett and Rayner, 2007). This limited focus, while informative, does not provide the deeper analysis and assessment whether or not policies are meeting their goals.

This chapter seeks to determine the goals of federal pipeline policy regime's policy and how these goals have changed over time. Peter May and Ashley Jochim (2013) describe policy regimes as "governing arrangements for addressing policy problems" or fundamental policy components over a long period of time (p. 428). The pipeline policy regime, like other regimes, has specific policy goals that are developed to address those problems. Various policy instruments, or the techniques, policies, or programs used to implement specific measures (Howlett, 2005), are created to help achieve policy goals. The American Social Science Research Council understood that "improved

understanding of policy outcomes" needs consideration of "the impact of public policies on the political system's environment and on the system itself" (Ranney, 1968, p.14). The results of various instruments over time occurs through 'layering' or adding policy goals and instruments to existing policy without removing much or any previous policies or instruments (Pierson and Skocpol, 2002). This can lead to "policy incoherence" and 'policy inconsistency,' or competing incompatible goals; these factors undermine the overall goals (Kern and Howlett, 2009).

The U.S. pipeline policy regime is made up of a complex group of subsystems within local, state, and federal levels of government, non-governmental organizations, corporations, and individual citizens, but is primarily driven by the rules and regulations directed by the U.S. Pipeline and Hazardous Materials Safety Administration. This paper will focus solely on federal policy, as federal pipeline policy is responsible for safe, reliable, and environmentally sound operations of the primary pipeline system (PHMSA, 2019).

This chapter has three interrelated goals. First, it seeks to describe the policy strategy and goals within the policy regime. A thorough review of federal policies impacting pipeline operations within the United States will be reviewed, categorized, and analyzed using specific keywords to test the hypothesis for three specific policy goals: safe transportation and infrastructure, economic benefits, and environmental impact. Second, this chapter provides a thorough policy mix analysis, using Alexandra Lesnikowski et al.'s (2019) approach, of federal public laws for pipeline policy, defining substantive and procedural policy instruments into typologies of governing dimensions nodality, authority, organization, and treasure as defined by Christopher Hood (1983). Mixes reflect temporal dynamics, as single policies accumulate over time and develop complex policy environments (Adam et al., 2018; Lesnikowski et al., 2019). Over the past couple decades various forms of federal policies have been layered and stitched together, building a patchwork of safety, codes, and environmental regulations which has led to inefficiencies in achieving their goals. Describing the policy mix over time in terms of typologies of governing dimensions and substantive and procedural instruments will help determine patterns which can be used to increase efficiency, or consistency and coherence in the policy mix. This section also will assess the current nature, or consistency, coherence, and congruence of the federal pipeline policy mix. Lastly, this chapter analyzes the changing political environment has impacted the changing policy goals over time. Politics are directly tied to policy and policy change. Referencing Kingdon and Thurber's (1984) multiple streams approach, the problem, politics, and policy must converge to create a policy window for change. Paul Pierson's (2000) study of increasing returns and path dependence put significant weight in the role of politics with regards to policy change, or in this case, difficulty to change or path dependence. "It is frequently more difficult to reverse course in politics than it would be in economics" (p. 260). In fact, most policies are extremely durable (Rose, 1990). Pierson (1993) also questioned the causal direction that binds policy and politics, stating that "policy choices have political consequences…what needs to be determined is precisely how, when, and where

particular effects are likely to occur" (p. 597). This chapter will seek to determine how politics impacted policies within the pipeline policy regime.

Policy inefficiencies within the pipeline regime are important to address because oil and natural gas provide nearly 60 percent of all electric energy in the U.S. (EIA, 2019) and pipelines are considered the most energy-efficient, safe, environmentally friendly, and economic way to transport hydrocarbons over long distances (Dey, 2004). This complex network of policies is needed to preserve and grow economic stability for nearly every American, at least until there are viable alternatives to the oil and gas economy. Despite pipeline reputations as safe, efficient, and affordable, there have been numerous accidents (da Cunha, 2016), implementation and route debates, and with the Enbridge Line 5 case, in-depth risk analysis. As decades progressed, awareness and concerns over fossil fuel production, transportation, and usage has increased and the policy regime has become more complex.

This in-depth case study of the federal pipeline policies and its policy mix will be the first study to perform a policy mix analysis to aging infrastructure. Aging infrastructure, and the pipeline regime in particular, will provide unique insights to the applicability of policy mix analysis across varying policy regimes. This study will add contributions to the policy mix literature by combining techniques from policy goal definition, policy mix analysis, and political impact over time for one specific policy regime case study. By noting how these goals have changed over time, this combined and enhanced policy mix analysis can become a tool to assess additional policy regimes and how their goals have changed over time, leading policymakers to better adjust policy mixes moving forward.

2.1.1 Research Questions and Hypothesis

Question 1: What are the U.S. pipeline policy regime goals and how have they changed over time? First, the "Safe Transportation of Hazardous Materials" is the main activity listed in the policy mission on federal U.S. regulatory body website developing, proposing, and implementing regulatory policy initiatives and regulations governing the safe operation of the nation's hazardous liquid and natural gas pipeline transportation system (PHMSA, 2019), therefore it should be a primary policy goal. Second, 'Economic Benefits' for private companies, or owners and operators of the system, are the foundation for innovation in a capitalist society, seeking to provide profit to shareholders. Economic development has long been tied with energy development (supply-side economics) as energy is used in the production of goods. This is most evident in developing economies, which contribute to 74% of the increase in global energy demand (Sadorsky, 2010). Energy still plays an important role in the U.S. supply chain for all production goods and services (Sari et al., 2008), therefore it will still be a main goal within the U.S. pipeline regime. Lastly, 'Environmental Impact', or environmental protection industrial systems and their surrounding areas has become a priority within the United States in the past few decades. By 1999, nine States in the U.S. had adopted renewable portfolio standards (RPS), a policy instrument designed to increase the proportion of electric energy supplied by renewable energy. By May 2011 that number

had increased to twenty-nine states. Government subsidies have been provided to spark growth in renewable generation. In addition to development subsidies, most state programs require traditional energy suppliers (whom purchase oil and gas from pipelines) to purchase subsidized electricity from alternative energy providers (Schmalensee, 2011). These instruments increase environmental goals while indirectly decreasing focus on economic goals within the pipeline policy regime. A more direct notion to pipeline policy is in Alberta, Canada. A 2009 report from the Government of Alberta proposed six strategies (goals) to pursue regarding oil sands. Five of the six goals reference the environment, health concerns, or sustainable practices, while only one mentioned economic benefit (Gosselin, 2010). The field of environmental economics attempts to inform economists of the environmental policy process, however "the distinction between goals and means has become blurred" (Hahn and Stavins, 1992, p. 467). This is a noticeable change in verbiage from the economically focused policy and goals of the previous fifty years (Percy, 2012). Therefore, environmental policy goals will increase over time compared to other policy goals.

Question 2: What is the current nature of the policy mix within the federal pipeline policy regime? The policy mix will likely be built of multiple 'layering' of various policies contrived by different political and ideological policies of the times in which they were enacted. At times instruments will be 'patching' or 'smart layering' policies to correct or enhance consistency and coherence of the overall policy, striving for better overall policy mix (Wellstead et al., 2016). Consistency, coherence, and congruence are used when describing the nature of a mix. Inconsistency, incoherence, and incongruence leads to misaligned policy mixes (Rayner, Howlett, and Wellstead, 2017).

Question 3: How do changing political environments impact pipeline policy goals and instruments over time? Stability and support of economic benefits could increase regardless of political environment "as an economic sector becomes economically prosperous, it typically also acquires political influence" (Moe, 2010, p. 1732). Also, as the environmental movement grows (years 1970-2010) environmental pipeline policy goals will also grow in quantity. Since the oil-shocks of 1973 and 1978, energy security has been a priority for both political parties in the United States (Bang, 2010). While research and investment has increased, resistance will occur from vested interest groups that benefited from the growth of original economic power from oil and gas. Potential losers have routinely sought to curb innovation (Mokyr, 1992; Mokyr, 1998). The Republican Party emphasizes the economic benefits of expanded domestic oil and natural gas production in contrast to the Democratic Party (Clarke et al., 2016). Therefore, Republican led legislation could lean towards more economic benefits than Democratic led legislation.

2.2 Literature Review

This chapter will review literature from policy regimes, energy policy goals, assessing policy mixes, political impacts on policy goals. Each subsection describes scholarship

related to theory and specific energy policy related content. Content narrowed on oil and gas pipeline policy is reviewed as well.

2.2.1 Policy Regimes

Policy regimes, according to Howlett et al., (2009), are the "phenomenon of the persistence of fundamental policy components over fairly long periods of time" (p.86). This concept can be composed of a single or multiple policy subsystems, or groups of policy actors and institutions organized around an issue. Policy regimes must also not be confused with policy networks, which are more similar to narrower and structured policy subsystems (Howlett et al., 2009). May and Jochim (2013) further describe policy regimes as governing arrangements that depict a particular set of policy strategies. Policy regimes have three distinctive characteristics. 1) *Policy legitimacy*, or acceptance by the governed of policy goals and approach, noting that stronger policy regimes have stronger legitimacy; 2) *Policy coherence*, or the consistency of actions in addressing a set of problems; and 3) *Policy durability*, or sustainability of political commitments over time. The policy regime label can be directly applied to pipeline policy as it spans multiple decades, involves countless actors and institutions, and features elements of policy legitimacy, coherence, and durability within the layering of policy instruments over time.

Carter Wilson (2000) describes policy regimes as 'arrangements of power' and that the policy itself are the goals of the policy regime. Wilson's insights on policy change within a regime supports Charles Lindblom's (1959) theory of incrementalism or Pierson's (2000) increasing returns by stating 'every aspect of the policy regime contributes to long term stability…long-term stable power arrangements mean long periods of incremental policy making" (Wilson, 2000, p.258).

Tim Van Hinte et al. (2007) briefly describes the oil and gas pipeline regime in Canada in a study evaluating major pipeline project processes over the coming decades. While not specifically focusing on the policy regime, this study describes the various actors and institutions involved in the policy process both historically and for the immediate future. This example shows the multiple overlapping regulatory agencies engaged and intertwined with private pipeline operators and socioeconomic analysis from numerous public and private stakeholders. This is a good example of how complex and embedded over time pipeline policy regimes become as they grow in scale and impact.

2.2.2 Energy Policy Goals

According to Andre Roth (2002) public policy is "the existence of a group, consisting of one or several collective objectives considered necessary or desirable, that at least partially, are treated through means and actions by an institution or governmental organization with the purpose of guiding the behavior of individual or collective actors in order to modify a situation or perceived as unsatisfactory or problematic" (p. 27). Martinez Viviana and O.L. Castillo (2019) recognized the primary component of energy policies has been the planning of supply and demand. If the primary mission of energy

policy is energy planning for supply and demand of energy, that leads to a focus on technical and economic policies to steer the balance of supply and demand. This also leads to a lack of policy innovation in environmental protection and other socio-economic factors (Dincer, 1999). An analysis of energy policy and planning documents by Clark Miller and Jennifer Richter (2014) showed that energy policy design focuses almost exclusively on energy technologies with social considerations focusing on economic issues such as energy prices and jobs.

There have been various studies within the energy policy regime set on determining policy goals. Rogge and Reichhardt (2015) refer to policy goals as the set of intended effects or outcomes of policy instruments, because policy instruments are the tools used by policymakers to enact their ideas. Recent energy policy goal studies have been focused on determining renewable energy policy goals as the world is experiencing an energy transition, or new energy source additions coupled with decline in use of established energy sources, from fossil fuels to renewable sources (York and Bell, 2019). The onset of a new energy transition features the setting of new policy goals to accompany the new challenges with the technology and its integration into society. In a 2004 report, the International Energy Agency (IEA) signaled that renewable energy policy goals contribute to the three Es: energy security, environmental protection, and economic development (IEA, 2004).

Muhammad Asif and Tariq Muneer (2007) define energy security as "consistent availability of sufficient energy in various forms at affordable prices" (p. 1401). Although, there is much debate over what truly defines energy security. Some argue that energy independence, or not having to rely on energy imports, fits the best definition of energy security. Others focus on affordable and available supply continuity or maintaining continuous access to reliable and affordable energy (Winzer, 2012). Oil and gas pipeline regimes are one component in the energy system that supports the goals of energy security, in terms of safe transportation and infrastructure that provides consistent, reliable, and affordable energy essentially on demand.

The three Es can also compete with one another, leading to shifting policy goals between economic development, energy security, and environmental protection. According to Benjamin Sovacool (2009), the primary drive behind the proposed Trans-ASEAN Gas Pipeline (TAGP), a project designed to connect Southeast Asian nations, is economic development. Pipelines are often seen as a catalyst for economic development which creates "spillover" to downstream industries from fossil fuels such as chemicals and fertilizers. Dawn Manley et al. (2013), also agrees that security, environment, and economic concerns are the three main drivers of energy policy, but also elaborated that job creation and GDP growth are key drivers, further emphasizing economic concerns. Pipelines, as a subcomponent of the overall U.S. energy system could have similar priorities within the goals of the broader energy policy system. One example of how policy plans and can lead to determining the policy goals is from a study by Susan Handy (2008) which used keywords and phrase searches within multiple years of regional

transportation plans for metropolitan planning organizations (MPOs) to determine what their goals were and how they changed over time.

2.2.3 Assessing Policy Mixes

Policy mixes, as defined by Kern and Howlett (2009), are "complex arrangements of multiple goals and means which, in many cases, have developed incrementally over many years" (p. 395). One way to improve policy is through analyzing the policy mix of a particular issue. Understanding the complicated and diverse set of policy rationales that have become intertwined over decades of policy layering and incrementalism helps prepare for new and better policy formulation (Rogge et. al., 2017). The layering of policies, or the process when new elements are added to existing elements without abandoning old ones, lead to incoherence among goals and inconsistency with instruments used (Wellstead et. al., 2016). This incoherence and inconsistency lead to inefficient policies.

There are a variety of policy mix approaches, but nearly all utilize key elements including policy instruments, or the techniques, policies, or programs used to implement specific measures (Howlett, 2005); instrument interactions, which could be either positive or negative (Sorrell and Sijm, 2003); and policy strategy, or the policy objectives and the plans to achieve them (Rogge and Reichardt, 2016). Policy instruments in this study are federal public laws that directly impact pipelines. Instrument interactions within this study are the various overlaps (or gaps) covered by the pieces of legislation. The policy strategy focused on in this chapter will study the hypothesized policy goals. "Policy tools are *consistent* when they work together to support a policy goal" (p. 395) and inconsistent or counterproductive if they lead away from achieving said goal. Policy *coherence* refers to "synergistic and systematic policy making and implementation processes contributing – either directly or indirectly – towards the achievement of policy objective" (Rogge and Reichardt, 2016, p. 1626). Figure 2.1 shows the challenges to balance consistency of goals and coherence of goals as the scale of the policy mix increases. *Congruence* is when a mix of instruments supports established goals (Strambo et al., 2015).

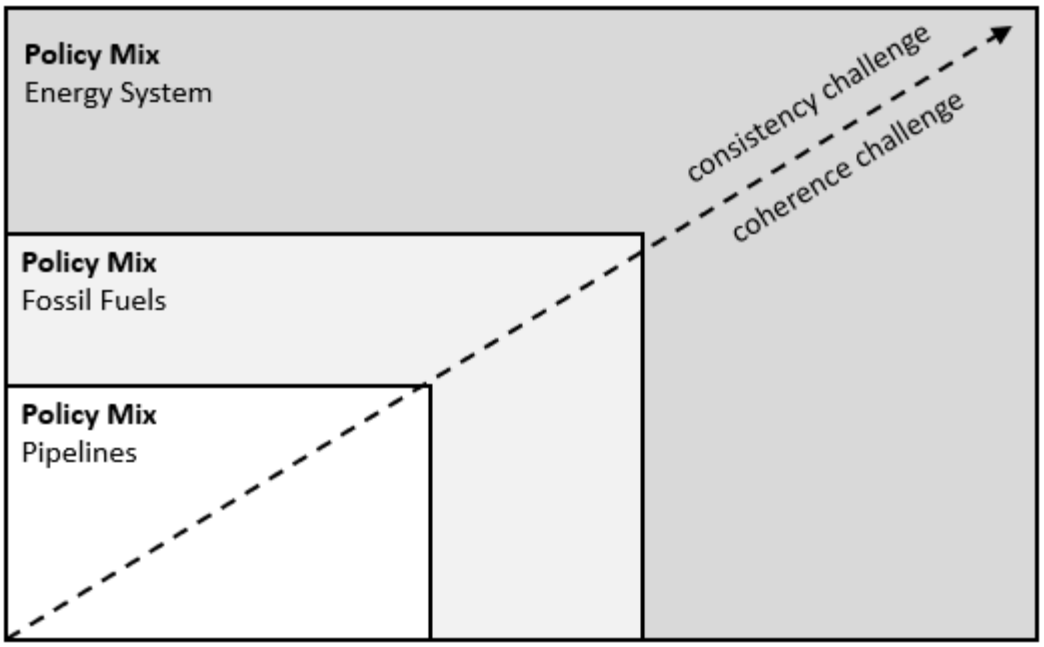


Figure 2.1 Link between policy mix boundaries and consistency/coherence

Adapted from (Rogge and Reichhart, 2016)

While there are no policy mix studies on pipelines or even oil and gas policy regime mixes, there are studies on policy mixes and how to study their efficiencies. Bettina Bahn-Walkowiak and Henning Wilts (2017) study used policy mixes to study goals within a multi-level governance of resource efficiency within European Union nations. They analyzed coherence of resource efficiency among various categories, creating a vertical coherence (level of governance) and a horizontal coherence (each category; education, land use, R&D, etc.). Their conclusions visually represented coherence of many goals in a clear and concise table. Alexandra Purkus et al.'s (2017) study on Germany and European bioenergy policy mixes, describes the lack of prioritization as a challenge for assessing consistency of policy mix. This lack of prioritization can be investigated by using Rogge and Reichardt's (2016) criteria to break down consistency into manageable concepts of policy strategy, instrument mix, and interplay of instrument mix and strategy.

Paul Lehmann (2010) addresses climate policy mix in the German electricity sector through analyzing a case study of its existing policy mix. This chapter recommends that specific policies added to the policy mix such as energy efficiency labelling and low-interest loans (both policy instruments), will help to improve climate policy goals for more renewable energy sources. He notes that certain design features (instruments) impair the overall efficiency of the policy mix. Lehmann's study details a larger variety of policy instruments and their interactions than the proposed pipeline policy mix study. Lehmann focuses only on current policy mix and not a historical institutionalism approach seeking how policy has changed. His study also recommends particular policy

instruments or combinations, compared to the pipeline study goals of determining strength of the policy mix with primary and secondary goals identified.

Jan Rosenow et al.'s (2016) study on *energy efficiency and the policy mix* also takes Lehmann's approach by focusing on a particular current topic (energy efficiency in the European Union (EU) for this case) and analyzing the different instruments and their interactions. She noted while her study analyzed 55 different combinations of policy instrument types, it was unable to incorporate the full complexity of multiple goals. Again, as with both Lehmann and Bahn-Walkowiak, their studies focused on analyzing a policy mix with many different overlapping instruments, all of which are in Europe. While the EU has a somewhat analogous federalist policy landscape to the United States (EU Nations are compared to U.S. States), their approaches to energy policy are different, as is their domestic source of fossil fuels (Mearns, 2016). This extended policy mix analysis will be one of few that have focused on energy policy in the United States and the only one focused on policy change in the pipeline policy regime.

Finally, Alexandra Lesnikowski et al.'s (2019) study uses a policy mix approach to measure climate change adaptation policy. Their method gathers 3328 adaptation policies (6000+ documents) over the dates of 2010 through 2017 from 125 local governments over five different nations. Their approach coded the documents to identify four typologies of governing dimensions as identified by Christopher Hood (1983), which includes: 1) information (nodality), 2) regulation (authority), 3) finance (treasure), and 4) institutional influence (organization). Data collection was acquired by keyword searching for "climate change" within archival local government records. Instruments and their categories were either coded as substantive or procedural, providing a chart which clearly describes where each policy instrument falls. "The dimension of governing logic specifies two distinct approaches that governments can take to implement policy: direct provision of services and services (substantive policy instruments), or indirect efforts to change the beliefs and behavior of actors (procedural policy instruments) (Lesnikowski et al., 2019, p. 6). Table 2.1 shows an adaption of Howlett and Rayner's (2007) taxonomy of pipeline policy instruments.

Table 2.1 Taxonomy of pipeline policy instruments

		Principal Governing Resource			
		Nodality	Authority	Treasure	Organization
Governing Logic	Substantive	Advice; education and training; reports and assessments; monitoring and evaluation	Land use planning regulations; infrastructure performance standards; building and safety regulations; intergovernmental (state/local) mandates	User Charges; grants; subsidies; loans; direct expenditures (e.g., infrastructure spending); demonstration projects	Procurement /expansion of federal government operations; federal government facilities management
	Procedural	Exhortation; public outreach; pipeline safety practice labeling	Agreements between governments and/or non-governmental actors; advisory group creation; public hearings	Research funding; interest group funding	Conferences and workshops; organization reforms

Adapted from Howlett and Rayner (2007) and Lesnikowski et al. (2019)

This chapter will adapt Lesnikowski et al's (2019) approach but instead of focusing on assessing a single topic current policy mix (past seven years of available data) and comparing among different countries, this study seeks to assess decades of a single top policy mix within a single country and compare the time periods to one another. An additional analysis of political overlay will be used to investigate if there are trends in politics that correlate with policy mix changes over time.

2.2.4 Political Impact on Policy Goals

Social and political viewpoints have a direct and indirect impact on policy creating both positive, negative, or a combination of effects (Sheikh et al., 2016). Many factors point to economic conditions impacting policy goals the most for energy, however Carolyn Fischer and Richard Newell (2008), describe how political economy impacts policy goals in their case study analyzing policies for reducing carbon dioxide emissions and promoting renewable energy innovation. Only using economics, in their case economic surplus, while a meaningful metric, it will not reflect full social impacts of the prescribed policy. Sheikh et al. (2016) further describes six identified criteria within the political perspective that effects energy policy; policies, regulation/deregulation of power markets, public/government R&D framework, codes/standards-compliance, perception/position of utilities, and security. These criteria have similarities to policy instruments but are described in a way that fit political insights. For example, within the United States' two-party system, Republicans and Democrats consistently have polarizing points of view on each of the six criteria suggested. Alan Abramowitz and Kyle Saunders (2006) define

political ideology as "a set of beliefs about the role of government that shapes responses to a wide range of specific policy issues" (p. 177) and political polarization is no stranger to energy policy in the United States, including fracking (Clarke et al., 2014), construction of new power plants (Ansolabehere and Konisky, 2009), and proximity to pipelines (Gravelle and Lachapelle, 2015). In summary, politics impacts policy goals and determining how those politics are changing and shaping goals within a particular policy regime, such as the pipeline policy regime, will help address policy making for future goals.

2.3 Background

2.3.1 U.S. Federal Pipeline Policy

There are over two and a half million miles of pipelines throughout the United States energy transportation network, operated by approximately 3,000 companies of varying sizes. An overview of this extensive network can be seen in Figure 2.2. Pipelines transport fuels and petrochemicals that are used in cooking, cleaning, travel, heating, manufacturing, and other daily tasks. The two main materials within the pipeline network are natural gas and petroleum. Natural gas accounts for nearly 25% of the nation's total energy consumption, while petroleum provides nearly 40% (USDOT, 2019; Oliver and Mason, 2018).

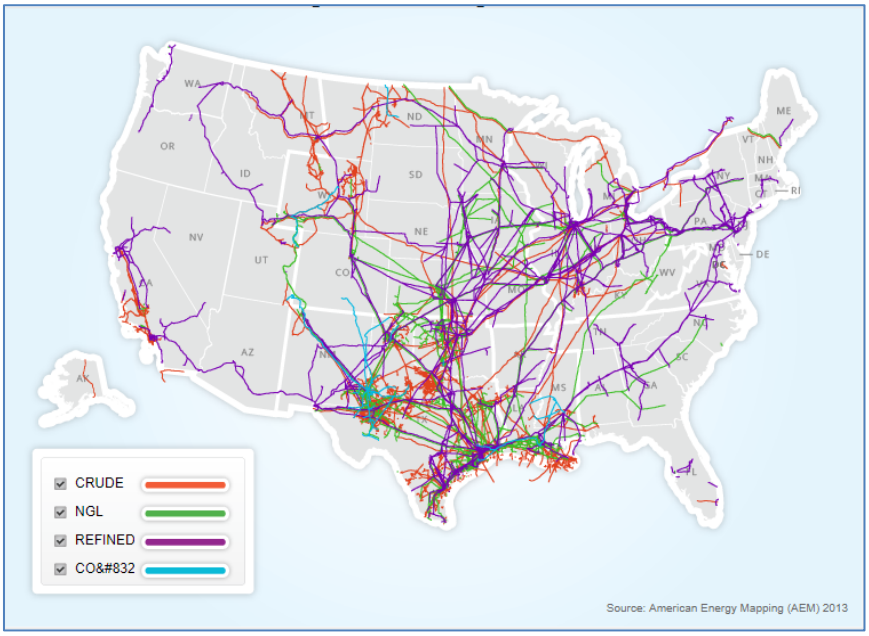


Figure 2.2 Where pipelines are located in the United States

Source: (Pipeline101.org, 2019a)

In order to analyze the national historical policy mix of the pipeline regime, it is important to know its origins and current administrative organizations. Prior to Congress creating the Office of Pipeline Safety (OPS), within the Department of Transportation, there has been little federal oversight of the pipeline safety regulations. Multiple accidents and dissatisfaction of OPS from the USDOT (noting OPS has the lowest implementation rate of National Transportation Safety Board (NTSB) recommendations at 69%), Congress passed the Pipeline Safety Improvement Act of 2002, significantly enhancing regulations on the industry (Parker, 2004). Established in 2004, the Pipelines and Hazardous Materials Safety Administration (PHMSA) is currently responsible for developing, issuing and enforcing safety regulations on the national pipeline network (USDOT, 2019; PHMSA, 2019). Pipeline companies are responsible for the safety of their own pipelines, operating under a series of regulations from construction to operation and maintenance. Both federal and state agencies and inspectors help ensure companies are following the regulations. Most state agencies and individuals are members of the National Association of Pipeline Safety Representatives (NAPSR). State pipeline safety personnel make up more than 75% of the state and federal inspection workforce (NAPSR, 2019). Operators, trade organizations, local governments, public input, and rate regulators are just some of the other stakeholders working together to oversee pipeline regulations in the United States (Pipeline101.org, 2019b).

2.4 Data and Methods

This chapter will use content analysis of secondary data to analyze decades of United States federal public laws within the pipeline policy regime and determine the change over time within three hypothesized policy regime goals: safe transportation and infrastructure, economic benefits, and environmental impacts. Next, this chapter will determine the nature of the policy mix, using Alexandra Lesnikowski et al.'s (2019) policy mix approach, by categorizing policy instruments, and also describing how the consistency and coherence of the mix has changed over time. Lastly, this chapter describes how both policy goals and instruments have changed over time alongside changing political environments.

Content analysis has been shown to be a valid technique, as shown with Nuno Quental et al.'s (2011) study on sustainable development policy goals, which used content analysis of relevant declarations ('soft law') to determine policy goals. Content analysis (CA) is "a research technique for making replicable and valid inferences from texts (or other meaningful matter) to the context of their use" (Krippendorff, 2012, p. 382). Two main types of CA are 1) quantitative, used to analyze contents of texts with word frequencies and lengths, and 2) qualitative, used to analyze and interpret the latent contents and meanings of text (Lune and Berg, 2016). Emmanuel Songsore and Michael Buzzelli (2016) study describes how they used both types of CA to understand renewable energy policies outcomes within wind energy development (WED). "The rigour of a well-operationalized CA makes it a methodology suitable for the analysis of complex issues ridden with conflict (e.g. WED)" (p. 440). WED has similarly complicated energy policy legislation to pipelines and other large energy infrastructure including permitting, siting,

and environmental impacts and economic benefits (Parfomak et al., 2013; Wolsink, 2007). Paula Kivimaa and Per Mickwitz (2011) looked at decades of federal legislation and used CA alongside Kern and Howlett's (2009) analytical framework to determine energy policy goals within bioenergy in Finland. They were able to determine the main energy policy goals and how they had changed over the period of 1970-2000s. Xibing Huang et al.'s (2010) study used content analysis to determine environmental issues and policy priorities (goals) in China from 1999-2008. Their methodology examined over 1,500 government documents for keywords and concepts for environmental policy. CA provided a thorough investigation of vast amounts of data and concluded with reliable environmental policy priorities and themes.

2.4.1 Data Collection

United States federal legislation and regulations within the pipeline policy regime have evolved over the decades to include a complex policy mix with hundreds of actors over multiple organizations. A comprehensive list of not only pipeline legislative policies, but also every federal government document such as budgets, code of federal regulations, congressional bills, congressional hearings, congressional records, presidential reports, U.S. courts opinions, and more can be found through a thorough review of govinfo.gov. An additional layer to the original data source of government documents is Comparative Agenda's Project (CAP) for United States documents (Jones, 2019). This project contains downloadable legislative databases and codebooks for congressional bills (463762 observations spanning 1947-2016), congressional hearings (100254 observations spanning years 1946-2017, Congressional Research Service Reports (35315 observations from 1997-2018), Public Law titles (35349 1948-2016), Public Laws (21242 – 1948-2018), roll call votes (1947-2018), Executive Orders (4331 – 1945-2018).

A CAP search displayed 29 bills and public laws with “pipeline” in their description and upon further inspection, 18 of those laws provide nationwide implications to pipeline and energy policy. CAP coded 17/18 laws as Energy - Natural Gas/Oil while 1/17 is coded as Environment – Hazardous Waste and Toxic Chemical Regulation, Treatment, and Disposal. Full text is available for most of the laws by searching within HeinOnline law database and Congress.gov and Govinfo.gov databases, however summaries of the full legislation have been created by the Congressional Research Service (CRS) are available on Congress.gov. CRS summaries provide better more concise content data to analyze to policy goals and instruments than full text versions of the legislation, therefore public law summaries will be used for analysis. CRS summaries do not exist for federal pipeline laws in 1953, 1968, 1971, and 1972, therefore full text of the bill will be analyzed. After further review of the 1953 Public Law 253, which described rights-of-way for natural gas pipelines, it was determined that the first relative pipeline policy public law was the 1968 Natural Gas Pipeline Safety Act of 1968. Table 2.2 lists the 17 public laws to be analyzed and their brief descriptions (per CAP).

Table 2.2 U.S. federal pipeline policy legislation

Year	Public Law Description (per CAP and CRS summaries)
1968	Natural Gas Pipeline Safety Act of 1968 – Prescribes safety standards for the transportation of natural and other gas by pipeline, and for other purposes.
1971	Amend section 8 of Act approved March 4, 1913, as amended to standardized procedures for testing utility meters to add a penalty provision to enable certification under Natural Gas Pipeline Safety Act of 1968.
1972	Amend Natural Gas Pipeline Safety Act - Extend time in which states may certify that their laws conform to the Natural Gas Pipeline Safety Act.
1974	Amend Natural Gas Pipeline Safety Act - Authorize funds to extend provisions of the Natural Gas Pipeline Safety Act of 1968.
1976	Amend the National Gas Pipeline Act of 1968 - Authorize appropriations for FY77.
1979	Pipeline Safety Act of 1979 - Authorize $ for FY 80&81 for the National Pipeline Safety Act, to clarify and expand its authority of the Dept of Transportation over liquified natural gas & natural transportation safety, and to establish a statutory framework to regulate the transportation of hazardous liquid – Hazardous Liquid Pipeline Safety Act of 1979
1982	Amend National Gas Pipeline Safety Act of 1968 and the Hazardous Liquid Pipeline Safety Act of 1979 - Authorize funds for FY82-83
1984	Amend the Natural Gas Pipeline Safety Act of 1968 and the Hazardous Liquid Pipeline Safety Act of 1979 - Authorize appropriations for FYs 1985-86.
1986	Amend the Natural Gas Pipeline Safety Act of 1968 and the Hazardous Liquid Pipeline Safety Act of 1979 - Authorize appropriations for FY87.
1988	Pipeline Safety Reauthorization Act of 1988 - Amend the Natural Gas Pipeline Safety Act of 1968 and the Hazardous Liquid Pipeline Safety Act of 1979 to authorize appropriations for FY88-89 and authorize the Secretary of Transportation to certify and require testing of individuals responsible for the operation and maintenance of pipeline facilities.
1992	Pipeline Safety Act of 1992 - Amend the Natural Gas Pipeline Safety Act of 1968 and the Hazardous Liquid Pipeline Safety Act of 1979 to authorize appropriations and to improve pipeline safety and meet the need for protection of the environment.
1996	Accountable Pipeline Safety and Partnership Act of 1996 - Amend the Natural Gas Pipeline Safety Act of 1968 and the Hazardous Liquid Pipeline Safety Act of 1979 to revise terms of “transporting gas” and extends coverage of laws to movement of gas through regulated lines, regardless of location.
2002	Pipeline Safety Improvement Act of 2002 - To amend title 49, United States Code, to enhance the security and safety of pipelines.
2006	Pipeline Inspection, Protection, Enforcement, and Safety Act of 2006 - To amend title 49, United States Code, to provide for enhanced safety and environmental protection in pipeline transportation, to provide for enhanced reliability in the transportation of the Nation's energy products by pipeline.
2011	Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011 - Amend Title 49, U.S. Code, to provide for enhanced safety and environmental protection in pipeline transportation and provide for enhanced reliability in the transportation of the nation's energy products by pipeline.
2013	Amend Title 49, United States Code, to modify requirements relating to the availability of pipeline safety regulatory documents.
2016	Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016 - To amend title 49, United States Code, to provide enhanced safety in pipeline transportation, and for other purposes.

2.4.2 Policy Goal Coding

Each policy instrument was given a unique policy goal code consistent with hypothesized policy goal themes. If the instrument was too broad or clearly covered multiple goals such as general appropriations and authorization language, the instrument policy goal was coded as "other". All text classification was conducted in NVivo. See **Appendix A** for full coding manual. Table 2.3 is an example of sample criteria used to code policy goals.

Table 2.3: Pipeline policy goals and keyword criteria

Goal	**Criteria for meeting goal (Keywords and surrounding context)**
Safe Transportation and Infrastructure	Safety, transportation, and infrastructure related policy
Economic Benefits	Economic regulation activities (market regulation, pricing, trade, etc.)
Environmental Impact	Environmental protection, mitigation, or other environmental policy concerns
Auxiliary	Policy impacting multiple goals evenly or broad instrument with no direct impact to safety, economic, or environmental policy goals.

2.4.3 Policy Instrument Coding

Policy instruments were identified within pipeline legislation and uniquely coded to indicate policy instrument category and underlying policy instrument typology. The instruments were coded as either substantive or procedural, allowing for no double coding. Identification of underlying instrument typology was determined based on NATO typology (Hood, 1983; Howlett and Rayner, 2007; Lesnikowski et al., 2019). Each identified policy instrument received a unique code for descriptive information about the policy including instrument target, geographic boundary of the target, administrative responsibility, and temporal nature of the instrument. Two dimensions of policy instruments (substantive and procedural) will be described per resource type (authority, nodality, organization, and treasure) as shown in Table 2.4.

Table 2.4 Taxonomy of pipeline safety policy instruments

		Principal Governing Resource			
		Nodality	Authority	Treasure	Organization
Governing Logic	Substantive	Advice; education and training; reports and assessments; monitoring and evaluation	Land use planning regulations; infrastructure performance standards; building regulations; strategic planning tools; intergovernmental mandates	User charges; grants; subsidies; loans; direct expenditure; demonstration projects	Procurement/ government operations; government facilities management
	Procedural	Exhortation; public outreach; sustainable practices; labeling	Agreements between governments and/or governmental actors; advisory group creation; public hearings; pipeline safety networks	Research funding; interest group funding	Conferences and workshops; organizational reforms

Adapted from Howlett and Rayner (2007) and Lesnikowski et al. (2019)

Modifications in coding were needed to fit pipeline legislation including broadening the definitions of certain procedural and substantive instruments. For example, the definition of "User Charges" was expanded to include financial fines and penalties for violating regulations. "Advisory Group Creation" was modified to include "Advisory Group modification" as multiple instruments included adjustments to the configuration of advisory boards or committees that were previously created. Some overlap was noticed within "Institutional reforms" which also define modifying committees, however the "advisory group" code best defined the instrument intent. With regards to administrative responsibility, the vast majority of instruments either authorized or required "the Secretary" (aka, Secretary of Transportation) to be responsible for the task(s). This was categorized as an "executive or legislative body".

Note, if an instrument asked for an assessment or report of a specific other instrument such as "user charges", the instrument was categorized as "user charges" and not "reports and assessments". Also note some instruments periodically fit into different types. For example, if a grant (treasure) was authorized for particular personnel increase in programs, it was coded Treasure>Operations. Operations is typically used with Organization>Operations. An additional code of "repeal" was added to the provide more context. The vast majority of instruments were adding to the instrument mix however starting with the Accountable Pipeline Safety and Partnership Act of 1996, various instruments were repealed in the bill.

2.4.4 Political Characteristic Coding

Political characteristics that accompany each public law were recorded. This includes broad congressional and executive branch political demographics at time of bill passage (presidential party, senate and house majority party) and specific political characteristics within the bill process itself including bill sponsor party, co-sponsor party(s), and district/state demographics of bill sponsors and co-sponsors. Majority party information per Congressional session was found at Senate.gov (2019) and House.gov (2019). Bill sponsor information was obtained by bill details on Congress.gov (2019). Bill sponsor information from 1968, 1971, and 1972 public laws were researched at HeinOnline.gov (2019) using associated congressional records for both the House and Senate that are attached to a search for appropriate public law number. Bill attributes were only analyzed on the final bill that was signed into law, therefore some Bills focused on final House attributes while others on Senate attributes.

2.4.5 Analytical Approach

Policy change was analyzed by showing trends and descriptive statistics in policy instrument characteristics over the seventeen federal pipeline policies spanning 1968 to 2016. These trends were then visualized using a combination of NVivo and Excel tools with exported coding data from NVivo to determine how policy goals have changed over time. Comparative analysis was used to identify correlations of political characteristics with specific pipeline policy instruments and goals over time.

2.5 Results

Resulting policy goals and policy instruments were analyzed and graphed over time, visualizing any trends and correlations between data sets. Policy goal changes over time includes a summary of policy goal instruments with examples in addition to charting policy changes over time. Next, a policy mix analysis shows how the policy mix had changed over time, including an assessment of both policy instrument and policy goal coherence and consistency over time. This section ends with an analysis of changing political characteristics compared to changing policy goals over time.

2.5.1 Policy Goal Changes Over Time

2.5.1.1 Summary of Policy Goal Instruments

A total of 315 policy instruments within the 17 federal pipeline policy laws were analyzed. Each instrument was given a single policy goal code of either safety, economic, environmental, or other. Table 2.5 shows the counts and percentages of goals.

Table 2.5 Count of federal pipeline policy instruments organized by policy goal

Policy Goal	# of Instruments	% of Total
Safety	155	49.1
Economic	43	13.7
Environmental	46	14.6
Auxiliary	72	22.8
Totals	316	100

As expected, safety, which includes the creation of policy to directly impact safe transportation of both natural gas and hazardous liquids was the primary policy goal among instruments, representing 49.1% of total policy instrument goals. Examples of safety associated policy instruments are shown in Table 2.6:

Table 2.6 Examples of policy instruments coded as “safety” policy goals

Safety Policy Instrument	Public Law	Year
Allows States to adopt additional or more stringent safety standards for intrastate pipeline facilities or the transportation of hazardous liquids.	PL96129	1979
Directs the Secretary by regulation to establish minimum Federal standards requiring that the design, construction, or replacement of transmission facilities or equipment accommodate the passage of instrumented internal inspection devices ("smart pigs").	PL100561	1988
Requires gas and hazardous liquid pipeline operators to consider the seismicity of the area in evaluating all potential threats to pipeline segments.	PL11290	2011

“Auxiliary” policy goals attributed for 22.8% of the total policy instruments. These instruments usually included broad instruments such as appropriations and authorizations of the entire Bills and more mundane instruments. “Auxiliary” also included instruments that implied policy goals in more than one area. Examples shown in Table 2.7 include:

Table 2.7 Examples of policy instruments coded as “auxiliary” policy goals

Auxiliary Policy Instrument	Public Law	Year
Authorizes the Secretary to issue orders directing compliance with this title or regulations and provide for enforcement of such orders by petitioning the appropriate U.S. District Court.	PL96129	1979
Changes the due date for the Secretary's annual report to the President and the Congress from April 15 to August 15.	PL102508	1992
GAO shall conduct a study on state pipeline safety agreements. DOT shall provide written notice to a state authority with a pipeline safety program certification of the denial of its request for an agreement authorizing it to participate in the oversight of interstate pipeline transportation.	PL114183	2016

Economic policy instruments contributed to 13.7% of the total policy instruments and were primarily focused on the commerce, distribution of commodities, and limiting costs to the government. Examples shown in Table 2.8 include:

Table 2.8 Examples of policy instruments coded as “economic” policy goals

Economic Policy Instrument	Public Law	Year
Excludes from the definition of the term "interstate transmission facilities" as set forth in the Natural Gas Pipeline Safety Act of 1968 any facility which transports gas from an interstate gas pipeline to a direct sales customer purchasing gas for its own consumption.	PL94477	1976
Directs the Secretary to review such evaluations and issue a standard only upon a reasoned determination that its benefits justify its costs. Specifies circumstances in which the requirements of this Act with respect to standards or their formulation shall not apply. Requires a report from the Secretary to the Congress on the implementation of the risk assessment requirements of this section.	PL104304	1996
Directs the Comptroller General to report to Congress on the participation of minority-owned business enterprises, woman-owned business enterprises, and disadvantaged business enterprises in the construction and operation of pipelines in the United States.	PL11290	2011

Environmental policy instruments accounted for 14.6% of all policy instruments and were strongly associated with spatialization. This observation is supported by Michael Darkoh and Meleckidzedeck Khayesi's (2009) chapter on *Spatializing development and environmental discourses*. Their chapter describes that "space is central" to sustainable development, which ties closely with the environmental focused policy instruments in federal pipeline policy. Gordan Walker (2009) describes space and distribution as "intertwined". Walker's term of distribution is used in context with environmental justice and distribution of goods and ills, but this can apply directly to the spatial distribution of goods and ills that accompany the development of a pipeline in specific geographies. Other instruments were coded as environmental if they described "damages" to pipelines. While damage to a pipeline could be a safety impact, these usually indicate a damage or leak would negatively impact the surrounding environments. Safety (human health from exposure to harsh chemicals) overlaps with environmental concerns (damage and harm to the environment), the instrument language of leaking implied environmental damage first, therefore was coded as environment and not safety. Examples of environmental instruments shown in Table 2.9 include:

Table 2.9 Examples of policy instruments coded as 'environmental" policy goals

Environmental Policy Instrument	Public Law	Year
Adds to existing certification requirements the requirement that a State agency encourage and promote programs designed to prevent damage to natural gas pipelines and other subsurface utility equipment.	PL94477	1976
Exempts a pipeline operator from the requirement to obtain a Federal permit for specified repairs if no Federal permit would otherwise have been necessary. States that environmental review provisions of this Act shall not preempt otherwise applicable Federal, State, and local environmental law.	PL107355	2002
DOT shall revise certain regulations to state explicitly that the Great Lakes, coastal beaches, and marine coastal waters are unusually sensitive areas (USA) ecological resources for purposes of determining whether a pipeline is in a high consequence area.	PL114183	2016

2.5.1.2 Policy Goal Changes Over Time

Between the 17 federal pipeline laws that were passed between 1968 and 2016, safe transportation of hazardous materials remained the primary policy goal over time, rising at a relatively steady rate. Economic policy goals began in the 1970s and increased the least amount over time. Economic goals while consistent, never featured a strong spike in volume within any particular pipeline law, which supports their importance to the overall policy mix but not the driving policy goal within any given law. Environmental policy goals increased noticeably with the passage of the Pipeline Safety Act of 1992 which

featured 16 environmental instruments accounting for 35% of the overall policy instruments within the law, higher than all other policy goal areas including safety. Another spike occurred in the Pipeline Safety, Regulatory Certainty, and Job Creation Act of 2011, featuring 11 environmental policy goal instruments, or 28% of the total policy instruments, second only to safety (38%) supporting the increasing importance of environmental goals in modern energy policy.

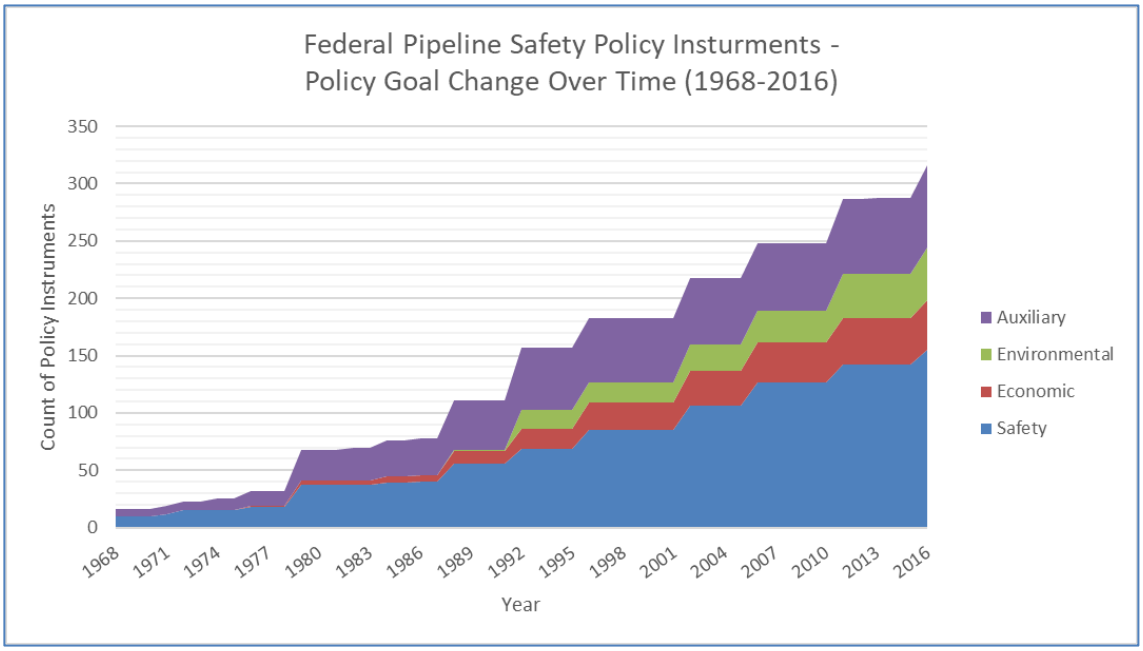


Figure 2.3 Federal pipeline policy instruments - policy goal change over time (1968-2016)

2.5.2 Policy Instrument Mix

Utilizing Lesnikowski et al., (2019)'s methodology for categorizing policy instruments, each of the 316 policy instruments from the 17 public laws received a unique code for in instrument characteristics. Administrative responsibility was overwhelmingly (95%) executive or legislative bodies, consistent with federal public laws. Responsibility was commonly directed at the Secretary of Transportation. Geographic boundaries of policy instruments were overwhelmingly (96%) nation-wide compared to state-wide or specific geographic initiatives, which is consistent with national public laws. The instrument target was divided primarily among three areas: senior government (61.5%), private sector (25.3%), and individuals (11.7%). Policy instruments targeted at private industry grew at a larger pace than individuals in policies from 1992-2016, as shown in Table 2.9. The majority of instruments were permanent policy (78.6%), while only 12.2% of instruments were episodic, or had an end date identified. Most episodic instruments were related to appropriations funding and authorization which have a fiscal year end associated with them.

Table 2.10 Pipeline policy instrument target percentages

Instrument Target	Target Description	% of total
Senior Government	Actions directed at federal agencies	61.5
Private Sector	Actions directed at or meant to impact private industry and companies. Usually pipeline operators.	25.4
Individuals	Impacts for individual citizens. Usually described as benefits (credits) or penalties for individuals.	11.7

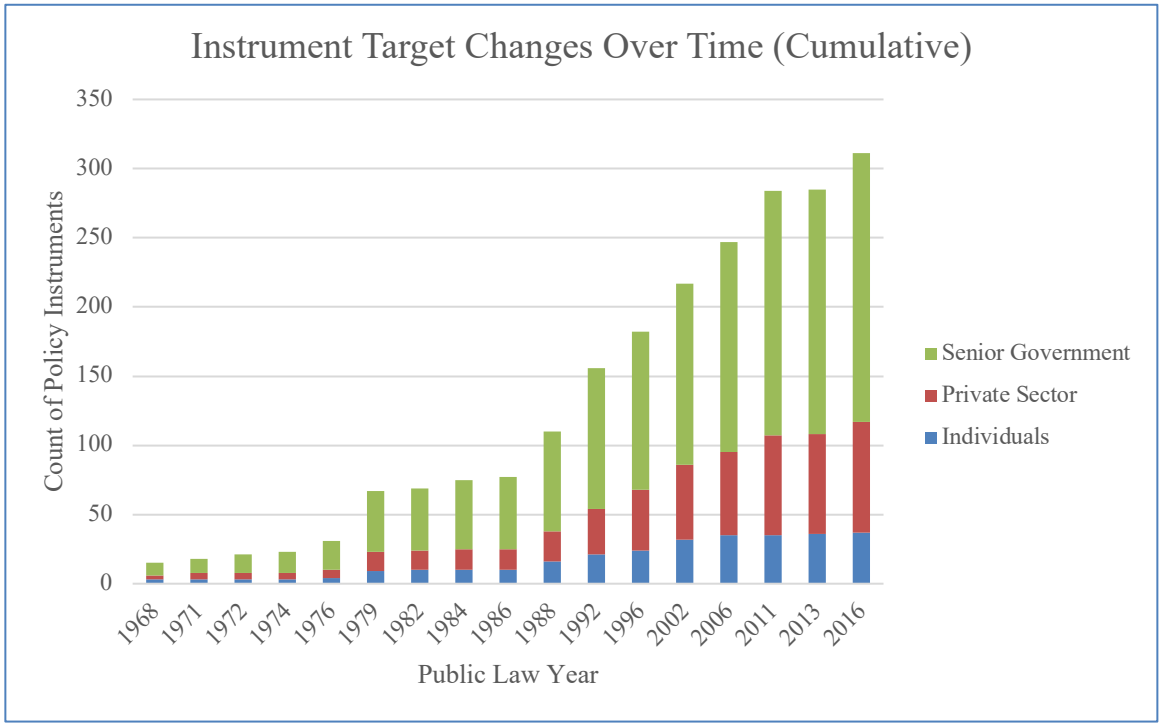


Figure 2.4 Instrument target changes over time (cumulative)

Of the 316 policy instruments, 237 (75.0%) were substantive while 79 (25.0%) were procedural. The breakdown of substantive versus procedural instrument type by principal governing resource (nodality, authority, organization, treasure) is shown in Figures 2.5 and 2.6. A detailed policy instrument mix by percentage per public law is shown in Table 2.11.

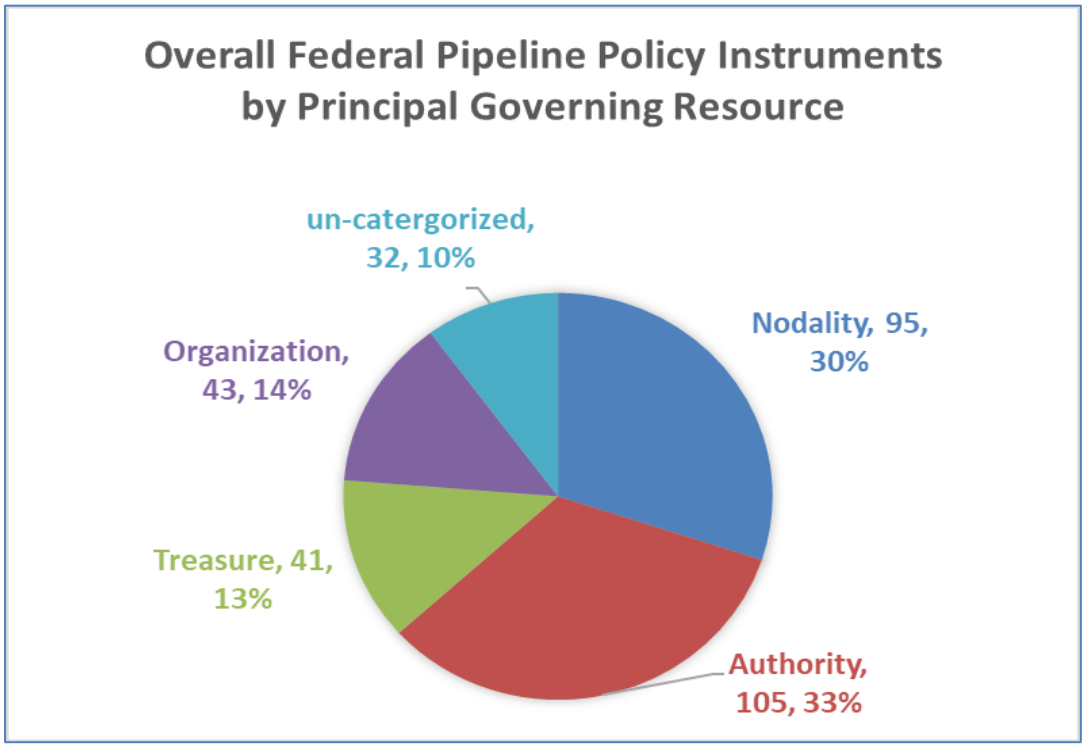


Figure 2.5 Overall federal pipeline policy instruments by principal governing resource

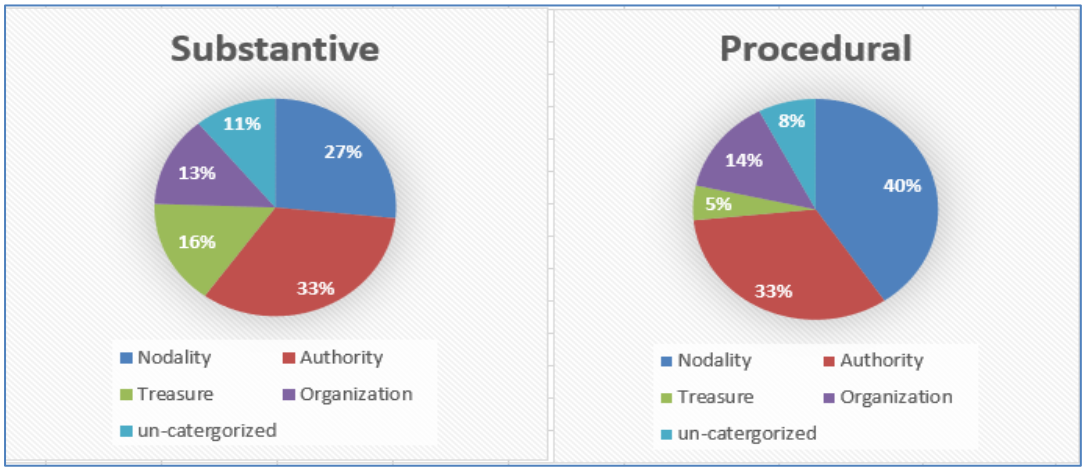


Figure 2.6 Overall federal pipeline policy instruments: substantive versus procedural by principal governing resource

Table 2.11 Policy instrument mixes by share of instrument type

Public Law																					
		1968	1971	1972	1974	1976	1979	1982	1984	1986	1988	1992	1996	2002	2006	2011	2013	2016
Total obs.: substantive instruments		9 (56%)	3 (100%)	3 (75%)	2 (100%)	5 (71%)	27 (75%)	-	5 (83%)	2 (100%)	29 (88%)	35 (76%)	19 (73%)	22 (63%)	25 (83%)	32 (22%)	-	19 (68%)
Total obs.: procedural instruments		7 (44%)	-	1 (25%)	-	2 (29%	9 (25%)	2 (100%)	1 (17%)	-	4 (12%)	11 (24%)	7 (27%)	13 (37%)	5 (17%)	7 (18%)	1 (100%)	9 (32%)
Substantive instruments (% share of total)																		
Nodality	Education and Training	-	-	-	-	20.0	3.7	-	20.0	-	6.9	5.7	5.3	4.5	4.0	3.1	-	-
	Reports/Assessments	22.2	-	33.3	-	-	22.2	-	60.0	50.0	17.2	8.6	10.5	18.2	16.0	15.6	-	42.1
	Monitoring/evaluation	11.1	-	-	-	-	-	-	-	-	-	-	-	-	16.0	-	-	15.8
	Land use planning																	
Authority	regulations	-	-	-	-	-	-	-	-	-	-	22.9	21.1	4.5	-	9.4	-	5.3
	Infrastructure standards	11.1	33.3	-	-	-	22.2	-	-	-	6.9	25.7	15.8	4.5	16.0	18.8	-	-
	Inter-governmental mandates	11.1	33.3	-	-	40.0	11.1	-	-	-	3.4	8.6	5.3	9.1	-	6.3	-	-
	Pipeline Safety Planning	11.1	-	-	-	-	3.7	-	-	-	6.9	-	5.3	9.1	-	12.5	-	-
	Strategic Planning	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.3	-	-
Treasure	User Charges	11.1	33.3	-	-	-	3.7	-	-	-	-	14.3	10.5	18.2	8.0	6.3	-	5.3
	Subsidies/grants	-	-	33.3	-	-	-	-	-	-	17.2	-	5.3	9.1	16.0	3.1	-	5.3
	Direct expenditures	11.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Demonstration projects	-	-	-	-	-	-	-	-	-	-	-	5.3	-	4.0	-	-	-
Organization	Operations	-	-	-	-	20.0	14.8	-	-	-	17.2	5.7	10.5	9.1	16.0	12.5	-	21.1
	Facilities	-	-	-	-	-	3.7	-	-	-	-	-	-	9.1	-	3.1	-	-
Other	Other	11.1	-	33.3	100.0	20.0	14.8	-	20.0	50.0	24.1	8.6	5.3	4.5	4.0	3.1	-	5.3
Procedural instruments (% share of total)																		
Nodality	Exhortation	14.3	-	-	-	50.0	-	-	-	-	50.0	9.1	-	23.1	-	28.6	-	-
	Public Outreach	-	-	100.0	-	-	-	-	-	-	-	9.1	57.1	7.7	-	-	100.0	11.1
	Labeling	-	-	-	-	-	11.1	-	-	-	-	9.1	28.6	7.7	40.0	42.9	-	33.3
Authority	Advisory group creation	14.3	-	-	-	-	22.2	-	-	-	-	27.3	14.3	7.7	-	-	-	11.1
	Agreements	28.6	-	-	-	50.0	-	-	-	-	-	18.2	-	38.5	40.0	-	-	22.2
	Pipeline Safety Networks	14.3	-	-	-	-	-	-	-	-	-	9.1	-	-	-	-	-	11.1
Treasure	Research funding	14.3	-	-	-	-	-	-	-	-	-	9.1	-	7.7	20.0	-	-	-
Organization	Institutional reforms	14.3	-	-	-	-	-	100.0	100.0	-	50.0	9.1	-	7.7	-	28.6	-	11.1
Other	Other	-	-	-	-	-	66.7	-	-	-	-	-	-	-	-	-	-	-

Adapted from Lesnikowski et al. (2019)

Note, some policy instruments that were un-categorized (32, 10% overall) due to generalized authorization language, contained multiple instrument types within instrument language, pertains to the entire public law, or did not fit any of the definitions within the coding documentation. One example from the Pipeline Safety Act of 1979 "*Authorizes the Secretary to conduct investigations, make reports, issue subpoenas, conduct hearings, and perform other specified administration duties to carry out the provisions of this title*" and the Pipeline Safety Act of 1992 "*Authorizes appropriations for FY 1992 through FY 1995".*

Overall balance of substantive and procedural instruments utilized in the policy mix show a majority substantive compared to procedural. This is consistent with Lesnikowski et al.'s (2019) study. An interesting contribution notes that the ratio is relatively unchanged over multiple of decades of policies and layering. Most policy mix studies analyze smaller time frames and would not see this observation in the data.

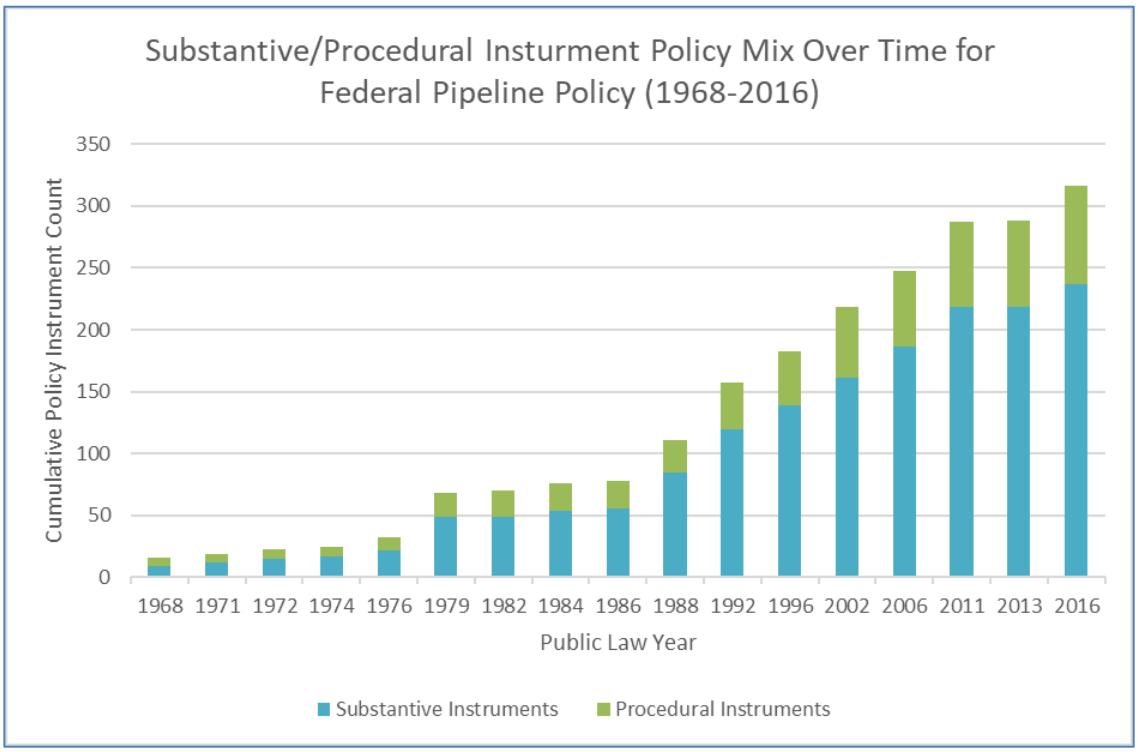


Figure 2.7 Substantive/procedural instrument policy mix over time for federal pipeline policy

Substantive policy instrument mix analysis over time, shown in Figure 2.8, shows consistent instrument usage of reports and assessments. An increase in infrastructure performance standards is noticeable and is consistent with characteristics of large technical systems, such as a national pipeline network. Defined by Beward Joerges (1988, p.24), large technical systems are "complex heterogeneous systems of physical structures and complex organizational routines", such as road infrastructure. "A key

characteristic of large technical systems in the process of technical standard setting", which evolves "with the system to ensure compatibility and interoperability of its numerous components" (Caerteling et. al., 2008; Markard and Truffer, 2006). An increase in user charges, which includes fees and penalties for violating policy, began around 1988. Charges or fees have long been used as policy instruments to deter violations or provide exclusions and barriers to enter a market (Kibert, 2001).

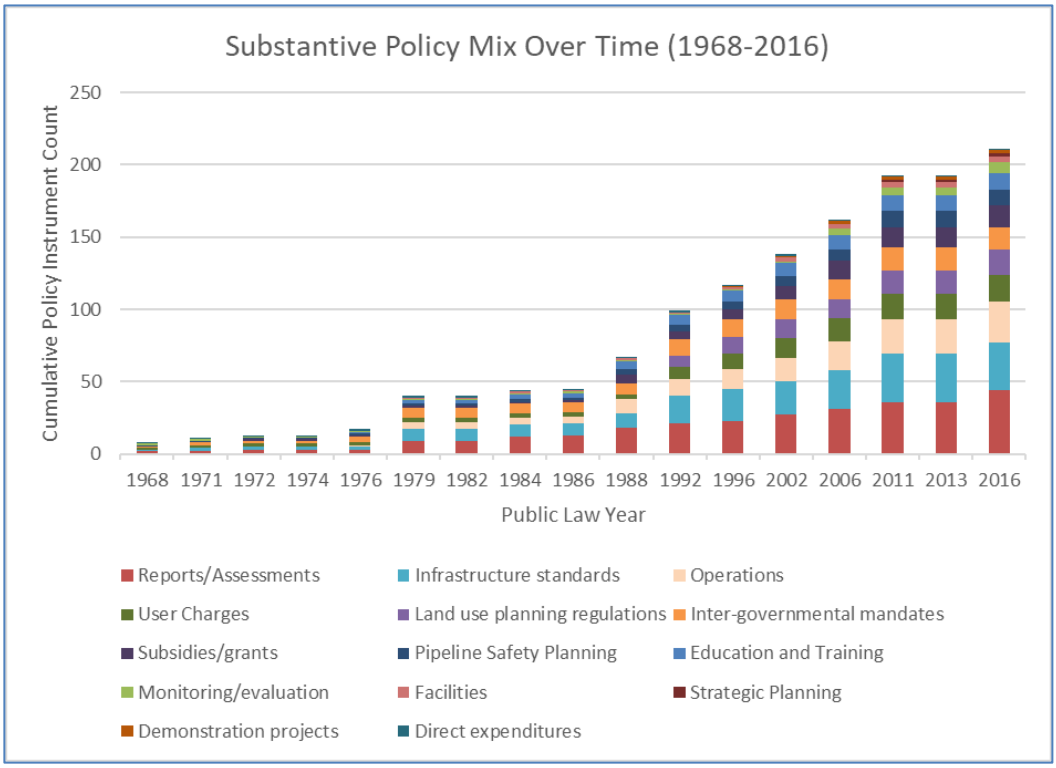


Figure 2.8 Substantive policy instrument mix over time (1968-2016) (cumulative)
*excluding "un-categorized"

Procedural policy instrument changes over time are shown in Figure 2.9, including displaying the most common instrument "agreements". Many agreements were between the Secretary of Transportation (federal supervisory office) and private industry or state entities. An example agreement from the Pipeline Safety Improvement Act of 2002 includes "*Permits the Secretary to make agreements with States authorizing them to participate in the oversight of interstate pipeline transportation if they have certification for jurisdiction over intrastate pipeline facilities and transportation*". Labeling, usually consisting of increased federal definitions within pipeline policy, increased at a noticeable rate starting with 1996. This coincides with an increase (and start) in substantive policy instruments in land planning and spatialization. These also correlate with an increase in environmental policy goals.

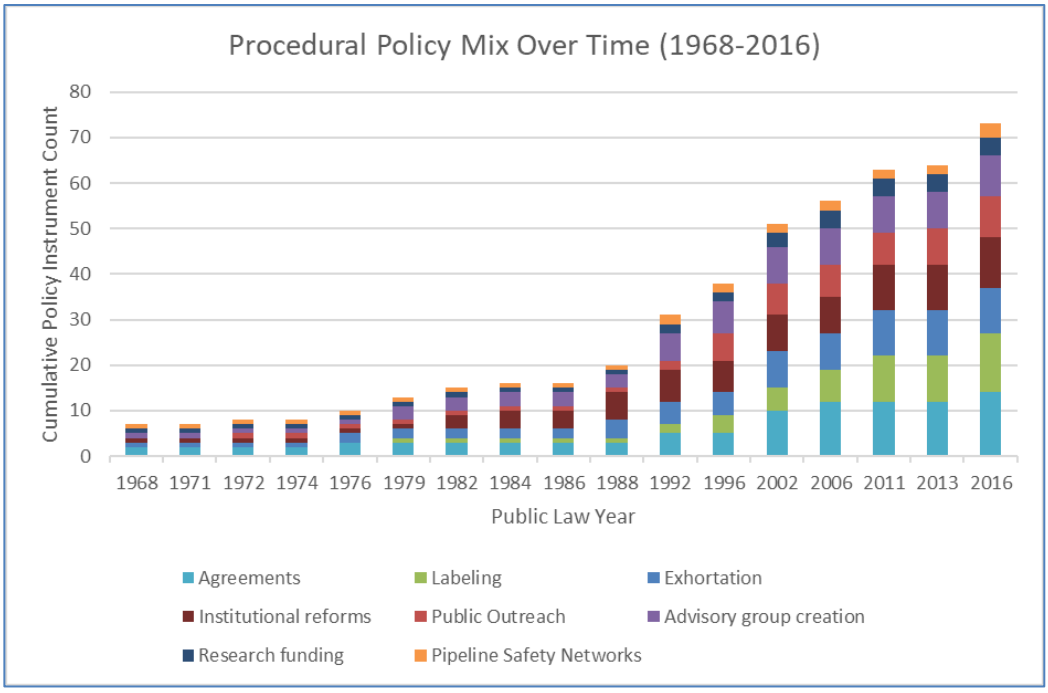


Figure 2.9 Procedural policy mix over time (1968-2016) (cumulative) *excluding "un-categorized"

Noticeable correlations between increases in policy goal themes and specific policy instruments are shown in Table 2.12. For example, as environmental policy goal instruments increased, there was also an increase in advisory group creation. This is consistent with Per-Olof Busch and Helge Jorgens (2005, p.85) international study showing steady increases in advisory councils associated with environmental policy change.

Table 2.12 Changing policy goals relationship to usage of policy instruments

Usage of Policy Instruments			
Changing Policy Goals		Increasing	Decreasing or Flat
Environmental	Increase	• Labeling • Spatialization / Land Planning • Advisory Group Creation • User Charges • Reports / Assessments	• Intergovernmental mandates • Education and Training
Safety	Increase	• Infrastructure Standards • Operations	
Economic	Increase	• Private Sector Instruments	

2.5.2.1 Consistency, Coherence, and Congruence of the Policy Mix

While Lesnikowski et al.'s (2019) policy mix analysis method does not set out to assess the consistency and coherence of a given policy mix, the resulting categorization of substantive and procedural instruments can lead to further analysis. Rogge and Reinhart (2016) define consistency, as related to policy mixes, as "how well the elements of a policy mix are aligned with each other, thereby contributing to the achievement of policy objectives." (p.1626). Elements in this context can be described as the policy instruments themselves. Coherence of a policy mix is found when "goals are tightly linked to the choice of objects and implementation…" (Rayner, Howlett, and Wellstead, 2017, p. 474). Congruence is determined when an otherwise consistent mix of instruments supports established goals (Rayner, Howlett, and Wellstead, 2017). Determinations of consistency, coherence, and congruence were made by analyzing the changing volume and content of policy instruments related to their respective policy goals. Table 2.13 summarizes the current consistency, coherence, and congruence of the three primary policy goals (safety, economic, and environmental) within the overall federal pipeline policy mix.

Table 2.13 Current federal pipeline policy mix assessment - consistency, coherence, and congruence

Pipeline policy goal	Description	Current federal pipeline policy mix		
		Consistency	Coherence	Congruence
Safety	Increase safe transportation of hazardous chemicals, oil, and natural gas	consistent	coherent	congruent
Economic	Increase availability and affordability of energy for consumers and industry	consistent	incoherent	incongruent
Environmental	Increase environmental protection of people and property	consistent	coherent	incongruent

2.5.2.1.1 Safety

Usually "layering of elements typically lead to both incoherence amongst the goals and inconsistency" (Rayner, Howlett, and Wellstead, 2017, p. 475), however, the goal to maintain and increase safety within the federal pipeline policy is consistent, coherence, and congruent with the overall federal pipeline policy. "Smart laying", or the layering instruments while goals remain consistent (Kern et al., 2017; Wellstead et al., 2016), has resulted in these designations. Continuously added and updated infrastructure specifications, increased inspection personnel, and increased required reporting and

assessments over the decades have led to a consistent, coherent, and congruent safety policy mix within the overall federal pipeline policy mix.

2.5.2.1.2 Economic

Economic related policy instruments have not increased at a similar pace to safety related instruments. This slow growth has added various instruments designed to increase participation from the private sector in expanding the federal pipeline energy system increase availability and affordability of current and new energy customers. Continuous addition of elements has led to a consistent economic policy mix within the overall mix. On the other hand, additional incentives and adjustments for economic instruments have not led to significant increases in affordability and accessibility of energy services. Figure 2.4, *Instrument target changes over time*, displays a recent plateau of new private sector targeted instruments which points towards a decreasing focus on economic incentives and programs. This results in an incoherent and incongruent policy mix assessment within the overall federal pipeline policy mix with regards to economic policy goals.

2.5.2.1.3 Environmental

Increasing volume and content of environmental related policy instruments has led to an increase in consistency with overall federal pipeline policy goals. Many of the environmental measures such as additional reporting and assessments, increased infrastructure specifications, and creation of advisory boards are tied closely with the primary safety goal of the overall policy mix. This led to the designation of environmental policy goals being both consistent and coherent within the overall mix. However, the environmental goal mix is incongruent with overall mix due to some undermining instruments restricting industry from expanding access to new markets, while adhering to the latest safety standards. Safety goal instruments and environmental goal instruments have become overlapped and potentially burdening economic goals from being achieved.

2.5.3 Political Impact on Policy Goals

Political majorities within the United States have varied without any statistical significance during the period of federal pipeline policy from 1968 to 2016. There is a noticeable consistency with Democratic and Republican House Majorities over time observing the first eleven (1998-1992) bills were passed under a Democratic House majority and the last six bills (1996-2016) were passed under a Republican House majority. This could be due to the need for re-authorization of the Bill coincidental with the House Majority party of the year. The Senate majority went back and forth with no noticeable pattern. Presidential party appears to have no specific pattern associated with pipeline legislation either. Bill sponsorship party followed the House Majority party lines closely with only 2/17 bills (1984, 1992) breaking from that pattern.

Table 2.14 Political party information during federal pipeline public law passage

	Public Law Year																
	1968	1971	1972	1974	1976	1979	1982	1984	1986	1988	1992	1996	2002	2006	2011	2013	2016
House Majority Party	D	D	D	D	D	D	D	D	D	D	D	R	R	R	R	R	R
Senate Majority Party	D	D	D	D	D	D	R	R	R	D	D	R	D	R	D	D	R
Presidential Party	D	R	R	R	R	D	R	R	R	R	R	D	R	R	D	D	D
Bill Sponsor Party	D	D	D	D	D	D	D	R	D	D	R	R	R	R	R	R	R

Bill sponsor regions, or origin geographic district of primary Bill champion, showed no significant geographic focus or patterns over time. Geographic diversity of Bill sponsorship shows pipeline policy impacts the entire United States and not just one particular region.

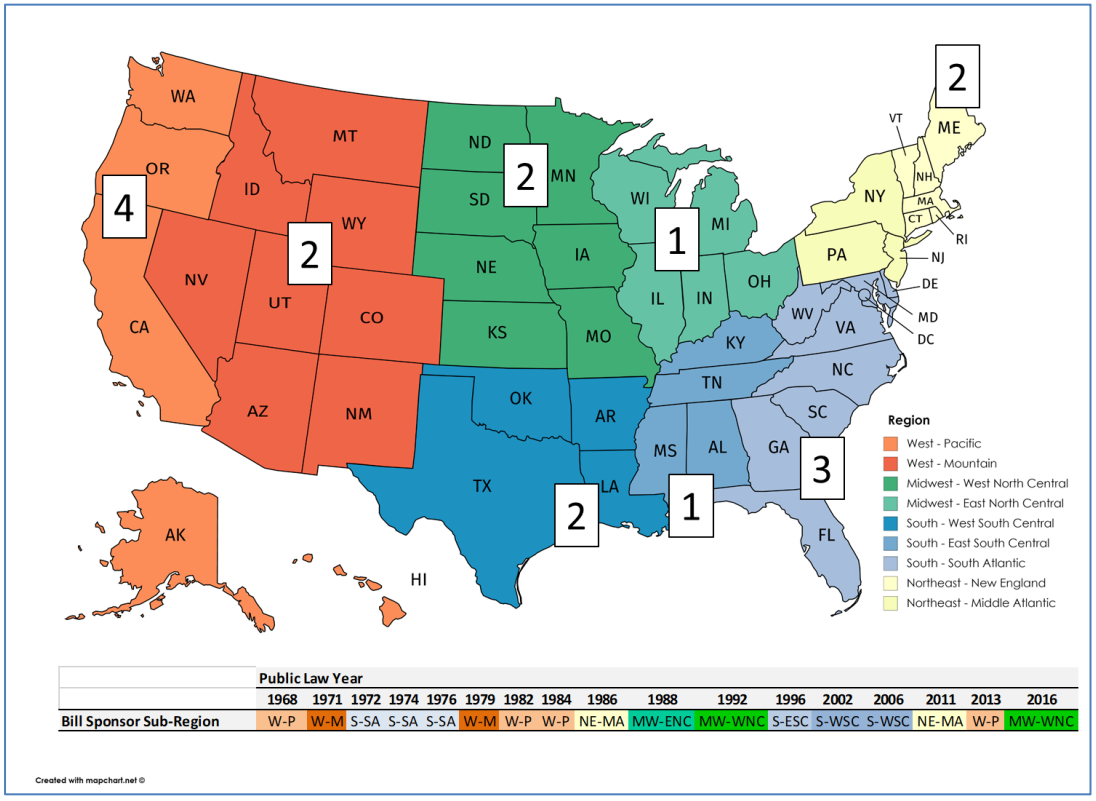


Figure 2.10 Federal pipeline bill sponsor home district region - count

When analyzing the count of Democratic and Republican co-sponsors of the Bills over time, Bills from 1996, 2002, and 2006 showed a significant increase compared to those Bills before and after. Further comparison of those Bills with policy goal data showed significant correlation with economic policy goal increases during those specific consecutive laws. While there was a noticeable increase in both Democratic and Republican co-sponsorships, Republican co-sponsorship was significantly higher than Democratic co-sponsorship. This partially supports R2:H1 stating that as economic policy goals increase support from both political parties will increase. However, support

from the Republican party increased more than that of the Democratic party support, as shown through public co-sponsorship of economic policy goal focused bills.

Table 2.15 Federal pipeline bill political party co-sponsors compared to economic policy goals over time

	Public Law Year																
	1968	1971	1972	1974	1976	1979	1982	1984	1986	1988	1992	1996	2002	2006	2011	2013	2016
# of Democratic co-sponsors	0	0	0	0	1	0	1	0	3	2	0	7	13	2	0	2	4
# of Republican co-sponsors	0	0	1	1	0	0	2	0	2	3	2	9	30	21	1	1	1
# of Instruments w/ Economic Policy Goals	0	0	0	0	1	3	0	2	0	5	6	7	7	4	6	0	2

There was no noticeable correlation between increased environmental policy goals and Bill co-sponsorship. The two spikes in environmental policy goals (1992 and 2011) has minimal co-sponsorship and featured congressional sessions with mixed party leadership. Therefore R2:H2 is inconclusive as there appears to be no significant correlation between political party majorities or bill co-sponsorship with environmentally focused pipeline policy.

Table 2.16 Federal pipeline bill political party co-sponsors compared to environmental policy goals over time

	Public Law Year																
	1968	1971	1972	1974	1976	1979	1982	1984	1986	1988	1992	1996	2002	2006	2011	2013	2016
# of Democratic co-sponsors	0	0	0	0	1	0	1	0	3	2	0	7	13	2	0	2	4
# of Republican co-sponsors	0	0	1	1	0	0	2	0	2	3	2	9	30	21	1	1	1
# of Instruments w/ Environmental Policy Goals	0	0	0	0	2	0	0	0	0	1	16	1	5	4	11	0	9

2.6 Conclusions

This chapter argues that determining how policy goals change over time within a policy regime is important to understand how to address future policy challenges. The findings demonstrate how this particular policy mix approach can elucidate policy goals within decades of legislation and determine how they change over time. Within federal pipeline policy, increased environmental goals have outpaced other policy goals but have not drastically changed overall policy safety goals. Consistency of safety policy goals remained steady over time, while consistency of environmental and economic goals slightly increased. Coherence of safety, economic, and environmental policy goals remained steady over the decades of layered federal policies. Further political analysis discovered minimal political impact on specific policy goals and instruments. While some significant correlation between Republican support of economic goals from 1996-2006 existed, all other factors were evenly distributed. While goals, instruments, and politics have evolved over time through the layering of policy, the federal pipeline policy regime has remained focused on the safe transportation of gas and hazardous liquids.

2.6.1 Implications

Insights on policy mix consistency and coherence show policymakers how their specific instruments impact the broader policy regime when compared to their intended policy goals. Furthermore, a detailed policy mix analysis such as the one performed in this chapter can provide a policy regime with a thorough look at how the policy regime has historically addressed policy challenges over the years. This technique provides valuable information to policymakers by sorting and organizing policy instruments into their respective substantive and procedural types and addressing governing typologies of nodality, authority, organization, and treasure. Analysis of instrument mix data provided a format to assess the nature of the policy mix through consistency, coherence, and congruence. This was made possible by first categorizing policy instruments by policy goal and graphing their cumulative changes over time. This chapter's combination of policy mix techniques adds to the literature for instrument-based policy mix approaches, creating the ability for researchers to address how policy goals, instruments, and politics intersect across time. There has been minimal analysis of this level for federal pipeline policy. Current stakeholders such as the Pipeline Safety Trust, whose mission is to "promote pipeline safety through education and advocacy…" (Pipeline Safety Trust, 2020, p. 1) could immediately benefit from this analysis.

2.6.2 Limitations

While these results can be translated to policymakers, it is important to note that results could be considerably different when analyzing a policy regime other than pipelines and aging infrastructure. This particular study only reviewed federal public pipeline policy laws when there is an abundance of other policy related materials that could be included in the policy mix analysis, including the public documents leading up to public laws, for example, hearing testimony, legislative Bills that did not pass, committee meeting notes, and executive orders. Most of these documents are readily available through Congress.gov and other public records. However, the design of this chapter covered multiple decades of federal policy change, therefore the decision was made to focus on passed federal laws as the product of various hearings, testimony, and other bills. While this decision limits the volume of policy instruments, it provides a solid summary of main policy elements.

2.6.3 Recommendations

A more in-depth analysis could include reviewing and coding additional public documents within the policy process. This would provide further insight to the policy goals within varying phases of the policy process. An additional policy mix analysis could be performed on the implementation and evaluation processes within the pipeline policy regime, potentially revealing different policy goals than those intended in the agenda setting and decision making (public laws) policy process. Within the pipeline policy regime regulation process, multiple levels of governance are used to regulate. These insights could provide more data to support studies on consistency and coherence

of the policy mix. Policy goals and instruments will likely vary state by state and could provide further research opportunities for comparisons or in-depth case-orientated studies. Since these results do not infer to other policy regimes, it is recommended to perform a thorough policy mix analysis on both policy goals and instruments for each regime in question.

In conclusion, since its conception in 1968, federal pipeline policy features a complex policy mix with multiple bi-partisan policy goals. A detailed policy mix analysis showed the balance and absence of potential policy instruments, which could be further investigated by policy makers to improve their efficiency. As additional documents and levels of government are added to the policy mix analysis, additional political variables such as seniority, committee membership, campaign contributions, and more could also be considered.

2.7 References

Abramowitz, A. I., & Saunders, K. L. (2006). Exploring the bases of partisanship in the American electorate: Social identity vs. ideology. *Political Research Quarterly*, *59*(2), 175-187.

Adam, C., Steinebach, Y., & Knill, C. (2018). Neglected challenges to evidence-based policy-making: the problem of policy accumulation. *Policy Sciences*, *51*(3), 269-290.

Ansolabehere, S., & Konisky, D. M. (2009). Public attitudes toward construction of new power plants. *Public Opinion Quarterly*, *73*(3), 566-577.

Asif, M., & Muneer, T. (2007). Energy supply, its demand and security issues for developed and emerging economies. *Renewable and Sustainable Energy Reviews*, *11*(7), 1388-1413.

Bahn-Walkowiak, B., & Wilts, H. (2017). The institutional dimension of resource efficiency in a multi-level governance system—Implications for policy mix design. *Energy research & social science*, *33*, 163-172.

Bang, G. (2010). Energy security and climate change concerns: Triggers for energy policy change in the United States?. *Energy policy*, *38*(4), 1645-1653.

Bouckaert, G., Peters, B. G., & Verhoest, K. (2010). *Coordination of public sector organizations*. London: Palgrave Macmillan.

Busch, P. O., & Jörgens, H. (2005). International patterns of environmental policy change and convergence. *European Environment, 15*(2), 80-101.

Caerteling, J. S., Halman, J. I., & Doree, A. G. (2008). Technology commercialization in road infrastructure: how government affects the variation and appropriability of technology. *Journal of Product Innovation Management, 25*(2), 143-161.

Clarke, C. E., Bugden, D., Hart, P. S., Stedman, R. C., Jacquet, J. B., Evensen, D. T., & Boudet, H. S. (2016). How geographic distance and political ideology interact to influence public perception of unconventional oil/natural gas development. *Energy Policy*, *97*, 301-309.

Congress.gov. (2019). Legislation search. Retrieved December 14, 2019. Congress.gov.

Darkoh, M. B. K., & Khayesi, M. (2009). 11. Spatializing development and environmental discourses: The case of sustainable development and globalization1.

da Cunha, S. B. (2016). A review of quantitative risk assessment of onshore pipelines. *Journal of Loss Prevention in the Process Industries*, *44*, 282-298.

Dey, P. K. (2004). Decision support system for inspection and maintenance: a case study of oil pipelines. *IEEE transactions on engineering management*, *51*(1), 47-56.

Dincer, I. (1999). Environmental impacts of energy. *Energy policy*, *27*(14), 845-854.

EIA. (2019) US Energy Facts Explained. March 13, 2019 https://www.eia.gov/energyexplained/?page=us_energy_home.

Fischer, C., & Newell, R. G. (2008). Environmental and technology policies for climate mitigation. Journal of environmental economics and management, 55(2), 142-162.

Gosselin, P., Hrudey, S. E., Naeth, M. A., Plourde, A., Therrien, R., Van Der Kraak, G., & Xu, Z. (2010). Environmental and health impacts of Canada's oil sands industry. *Royal Society of Canada, Ottawa, ON*, 438.

Gravelle, T. B., & Lachapelle, E. (2015). Politics, proximity and the pipeline: Mapping public attitudes toward Keystone XL. *Energy Policy*, *83*, 99-108.

Hahn, R. W., & Stavins, R. N. (1992). Economic incentives for environmental protection: integrating theory and practice. *The American Economic Review*, *82*(2), 464-468.

Handy, S. (2008). Regional transportation planning in the US: An examination of changes in technical aspects of the planning process in response to changing goals. *Transport Policy*, *15*(2), 113-126.

HeinOnline.org. (2019). Databases. U.S. Federal Legislative History. Retrieved December 19, 2019. https://heinonline.org/HOL/Page?handle=hein.leghis/ngps0001&id=501&collection=leghis&index=

Hood, C. (1983). *The tools of government* (p. 6). London: Macmillan.

House.gov (2019). Party Divisions of the House of Representatives, 1789 to Present. Retrieved on December 14, 2019. https://history.house.gov/Institution/Party-Divisions/Party-Divisions/

Howlett, M. (2005). What is a policy instrument? Tools, mixes, and implementation styles. *Designing government: From instruments to governance*, 31-50.

Howlett, M., Ramesh, M., & Perl, A. (2009). *Studying public policy: Policy cycles and policy subsystems* (Vol. 3). Oxford: Oxford university press.

Howlett, M., & Rayner, J. (2007). Design principles for policy mixes: cohesion and coherence in 'new governance arrangements'. *Policy and Society*, *26*(4), 1-18.

Huang, X., Zhao, D., Brown, C. G., Wu, Y., & Waldron, S. A. (2010). Environmental issues and policy priorities in China: a content analysis of government documents. *China: An international journal*, *8*(02), 220-246.

IEA, R. E. (2004). Market and Policy Trends in IEA Countries. *International Energy Agency, France*.

Joerges, Berward (1988). Large Technical Systems: Concepts and Issues. In: The Development of Large Technical Systems, ed. Renate Mayntz, and Thomas P. Hughes. Frankfurt am Main: Campus Verlag, 9–36.

Jones, B. (2019). Comparative Agenda's Project. United States. https://www.comparativeagendas.net/us.

Kern, F., & Howlett, M. (2009). Implementing transition management as policy reforms: a case study of the Dutch energy sector. *Policy Sciences*, *42*(4), 391.

Kibert, C. J. (2001). Policy instruments for sustainable built environment. J. Land Use & Envtl. L., 17, 379.

Kivimaa, P., & Mickwitz, P. (2011). Public policy as a part of transforming energy systems: framing bioenergy in Finnish energy policy. *Journal of Cleaner Production*, *19*(16), 1812-1821.

Krippendorff, K. (2012). Content analysis: An introduction to its methodology. Sage publications.

Kingdon, J. W., & Thurber, J. A. (1984). *Agendas, alternatives, and public policies* (Vol. 45, pp. 165-169). Boston: Little, Brown.

Lehmann, P. (2010). *Using a Policy Mix to Combat Climate Change: An Economic Evaluation of Policies in the German Electricity Sector* (Doctoral dissertation, UFZ).

Lesnikowski, A., Ford, J. D., Biesbroek, R., & Berrang-Ford, L. (2019). A policy mixes approach to conceptualizing and measuring climate change adaptation policy. *Climatic Change*, 1-23.

Lindblom, C. E. (1959). The science of" muddling through". *Public administration review*, 79-88.

Lune, H., & Berg, B. L. (2016). *Qualitative research methods for the social sciences*. Pearson Higher Ed.

Manley, D. K., Hines, V. A., Jordan, M. W., & Stoltz, R. E. (2013). A survey of energy policy priorities in the United States: Energy supply security, economics, and the environment. Energy Policy, 60, 687-696.

Magro, E., Navarro, M., & Zabala-Iturriagagoitia, J. M. (2014). Coordination-mix: The hidden face of STI policy. *Review of Policy Research*, *31*(5), 367-389.

Markard, J., & Truffer, B. (2006). Innovation processes in large technical systems: Market liberalization as a driver for radical change?. *Research policy, 35*(5), 609-625.

May, P. J., & Jochim, A. E. (2013). Policy regime perspectives: Policies, politics, and governing. *Policy Studies Journal*, *41*(3), 426-452.

Mearns, Euan. *Primary Energy in the European Union and USA Compared*. Energy Matters. http://euanmearns.com/primary-energy-in-the-european-union-and-usa-compared/. October 17, 2016.

Miller, C. A., & Richter, J. (2014). Social planning for energy transitions. *Current Sustainable/Renewable Energy Reports*, *1*(3), 77-84.

Moe, E. (2010). Energy, industry and politics: Energy, vested interests, and long-term economic growth and development. *Energy*, *35*(4), 1730-1740.

Mokyr, J. (1992). *The lever of riches: Technological creativity and economic progress*. Oxford University Press.

Mokyr, J. (1998). The political economy of technological change. *Technological revolutions in Europe,* 39-64.

NAPSR. (2019). National Association of Pipeline Safety Representatives (NAPSR). http://www.napsr.org/about-napsr.html. Retrieved January 27, 2019.

Oliver, M. E., & Mason, C. F. (2018). Natural Gas Pipeline Regulation in the United States: Past, Present, and Future. *Foundations and Trends® in Microeconomics*, *11*(4), 227-288.

Parfomak, P. W., Pirog, R., Luther, L., & Vann, A. (2013). Keystone XL pipeline project: Key issues.

Parker, C. M. (2004). The pipeline industry meets grief unimaginable: Congress reacts with the Pipeline Safety Improvement Act of 2002. *Natural Resources Journal*, 243-282.

Percy, K. E. (2012). *Alberta oil sands: Energy, industry and the environment* (Vol. 11). Newnes.

PHMSA. (2019) About Us. Pipeline and Hazardous Materials Safety Administration. Office of Pipeline Safety. About us. https://www.phmsa.dot.gov/about-phmsa/offices/office-pipeline-safety. Retrieved May 5, 2019.

Pierson, P. (2000). Increasing returns, path dependence, and the study of politics. *American political science review*, *94*(2), 251-267.

Pierson, P. (1993). When effect becomes cause: Policy feedback and political change. *World politics*, *45*(4), 595-628.

Pierson, P., & Skocpol, T. (2002). Historical institutionalism in contemporary political science. *Political science: The state of the discipline*, *3*(1), 1-32.

Pipeline101.org. (2019a). Where Are Liquids Pipelines Located? https://pipeline101.org/Where-Are-Pipelines-Located. Retrieved January 27, 2019.

Pipelie101.org. (2019b). Who Oversees Pipeline Safety? https://pipeline101.org/Are-Pipelines-Safe/Who-Oversees-Pipeline-Safety. Retrieved January 27, 2019.

Pipeline Safety Trust. (2020, May 14). Mission. Retrieved May 14, 2020. http://pstrust.org/about/mission/

Purkus, A., Gawel, E., & Thraen, D. (2017). Addressing uncertainty in decarbonisation policy mixes–Lessons learned from German and European bioenergy policy. *Energy research & social science*, *33*, 82-94.

Quental, N., Lourenco, J. M., & Da Silva, F. N. (2011). Sustainable development policy: goals, targets and political cycles. *Sustainable Development*, *19*(1), 15-29.

Ranney, A. (1968). The study of policy content: A framework for choice. *Political science and public policy*, 3-21.

Rayner, J., Howlett, M., & Wellstead, A. (2017). Policy Mixes and their Alignment over Time: Patching and stretching in the oil sands reclamation regime in Alberta, Canada. *Environmental Policy and Governance*, *27*(5), 472-483.

Rogge, K., & Reichardt, K. (2015). Going beyond instrument interactions: Towards a more comprehensive policy mix conceptualization for environmental technological change.

Rogge, K. S., & Reichardt, K. (2016). Policy mixes for sustainability transitions: An extended concept and framework for analysis. *Research Policy*, *45*(8), 1620-1635.

Rogge, K. S., Kern, F., & Howlett, M. (2017). Conceptual and empirical advances in analysing policy mixes for energy transitions. *Energy research & social science*, *33*, 1-10.

Rose, R. (1990). Inheritance before choice in public policy. *Journal of theoretical politics*, *2*(3), 263-291.

Rosenow, J., Fawcett, T., Eyre, N., & Oikonomou, V. (2016). Energy efficiency and the policy mix. *Building research & information*, *44*(5-6), 562-574.

Roth, A. (2002). Public policies: formulation, implementation and evaluation. Bogotá: *Aurora Editions*.

Sadorsky, P. (2010). The impact of financial development on energy consumption in emerging economies. *Energy policy*, *38*(5), 2528-2535.

Sari, R., Ewing, B. T., & Soytas, U. (2008). The relationship between disaggregate energy consumption and industrial production in the United States: an ARDL approach. *Energy Economics*, *30*(5), 2302-2313.

Schmalensee, R. (2011). Evaluating policies to increase electricity generation from renewable energy. *Review of Environmental Economics and Policy*, *6*(1), 45-64.

Sheikh, N. J., Kocaoglu, D. F., & Lutzenhiser, L. (2016). Social and political impacts of renewable energy: Literature review. Technological Forecasting and Social Change, 108, 102-110.

Senate.gov. (2019) Majority and Minority Leaders. Retrieved December 14, 2019. https://www.senate.gov/artandhistory/history/common/briefing/Majority_Minority_Leaders.htm

Songsore, E., & Buzzelli, M. (2017). The value of mixed method content analysis for understanding renewable energy deployment and policy outcomes. *Journal of Environmental Policy & Planning*, *19*(4), 438-456.

Sorrell, S., & Sijm, J. (2003). Carbon trading in the policy mix. *Oxford review of economic policy*, *19*(3), 420-437.

Sovacool, B. K. (2009). Energy policy and cooperation in Southeast Asia: The history, challenges, and implications of the trans-ASEAN gas pipeline (TAGP) network. *Energy Policy*, *37*(6), 2356-2367.

Strambo, C., Nilsson, M., & Månsson, A. (2015). Coherent or inconsistent? Assessing energy security and climate policy interaction within the European Union. *Energy Research & Social Science*, 8, 1-12.

USDOT. (2019). Pipeline Basics. U.S. Department of Transportation. Pipelines and Hazardous Materials Safety Administration: Pipeline Safety Stakeholder Communications. Pipeline Basics. https://primis.phmsa.dot.gov/comm/PipelineBasics.htm?nocache=2436. Retrieved January 27, 2019.

Van Hinte, T., Gunton, T. I., & Day, J. C. (2007). Evaluation of the assessment process for major projects: a case study of oil and gas pipelines in Canada. *Impact Assessment and Project Appraisal*, *25*(2), 123-137.

Viviana, M., & Castillo, O. L. (2019). Colombian energy planning-Neither for energy, nor for Colombia. Energy policy, 129, 1132-1142.

Walker, G. (2009). Beyond distribution and proximity: exploring the multiple spatialities of environmental justice. Antipode, 41(4), 614-636.

Wellstead, A., Rayner, J., & Howlett, M. (2016). Alberta's oil sands reclamation policy trajectory: the role of tense layering, policy stretching, and policy patching in long-term policy dynamics. *Journal of environmental planning and management*, *59*(10), 1873-1890.

Wilson, C. A. (2000). Policy regimes and policy change. *Journal of public policy, 20*(3), 247-274.

Winzer, C. (2012). Conceptualizing energy security. *Energy policy*, *46*, 36-48.

Wolsink, M. (2007). Wind power implementation: the nature of public attitudes: equity and fairness instead of 'backyard motives'. *Renewable and sustainable energy reviews*, *11*(6), 1188-1207.

York, R., & Bell, S. E. (2019). Energy transitions or additions?: Why a transition from fossil fuels requires more than the growth of renewable energy. *Energy Research & Social Science*, *51*, 40-43.

3 Advancing the state of energy justice research using deterministic approaches in search of causality

Abstract

Top published energy justice research predominately features probabilistic approaches and descriptive conclusions while underutilized deterministic approaches seeking causal analysis could lead to remedial recommendations for policymakers and community leaders. More specific conclusions and recommendations to help decision makers solve problems closer to their root cause, thus preventing problems from reoccurring, could leverage energy justice research to prevent future injustices from occurring. This chapter focuses on analyzing the literature from one emerging energy policy field, energy justice. To date, most studies in this field, whether qualitative or quantitative, are descriptive in nature and fail to use deterministic approaches to seek causality through their research design. One essential item in search of causality is the in-depth case-oriented approach. First, this chapter describes how in-depth case-orientated research design, an essential item for deterministic approaches, can assist scholars in seeking causal inference and subsequent causal mechanisms, a key conclusion missing from energy justice literature. Next, this chapter summarizes the current state of methods used in energy justice literature and describes examples of how certain research design components could be changed to utilize deterministic approaches. Lastly, this chapter describes a variety of existing studies using deterministic methods and demonstrates the potential to shift their focus to causal analysis. This chapter concludes with framework to provide scholars suggestions to adjust research designs to case-oriented and deterministic approaches which can lead to greater causal analysis and more actionable recommendations for policy and decision makers.

Keywords: causal mechanisms, causality, energy justice, case-orientated, comparative methods, QCA, process tracing, counterfactuals, deterministic approach

3.1 Introduction

Social scientists use a variety of qualitative and quantitative methods in an attempt to explore, describe, and explain concepts and theories about society. By describing and explaining issues impacting society, researchers seek to provide decision makers with more informed information to help them create better solutions to problems in their respective areas of interest. Environmental justice is one of the many important fields of research with direct impacts to society. Defined by Robert Bullard (1990) as "the fair treatment and meaningful involvement of all people regardless of race, color, national origin or income with respect to the development, implementation and enforcement of environmental laws, regulations and policies" (p. 138). In addition to researching forms, processes, and theory, environmental justice scholars also seek to describe and explain injustices in order to prevent future injustices from occurring. Energy justice, a new field of scholarship grounded in similar justice principles of distributive, procedural, and recognition justice, classifies energy as a human right, required to achieve primary goods

like food, water, heat, and education. Defined by Rafael Heffron and Darren McCauley (2014), energy justice centers on "providing all individuals, across all areas, with safe, affordable and sustainable energy" (p. 437). Energy justice is a growing concept of interest when implementing and evaluating energy policy.

Energy justice scholars are seeking answers to difficult questions embedded in macrosocial units (communities, states, nations). Many of these questions seek to find historical origins to particular problems (how and why a situation occurred). Mixed methods (variable and case-oriented) have been used in the literature to describe and begin to explain how explanatory variables impact outcomes in particular cases and across societies. Richard Tewksbury (2009) describes how qualitative methods (which includes deterministic approaches) are superior to quantitative methods for specifically criminal justice research. Bjorn Berg and Howard Lune (2007) further described the differences between qualitative and quantitative "quality refers to the what, how, when, and where of a thing– its essence and ambience. Qualitative research thus refers to the meanings, concepts, definitions, characteristics, metaphors, symbols, and descriptions of things" (p. 3). While aspects of criminal justice don't empirically transfer to energy justice; procedural, distributive, and recognition justice are core any justice field. Top journals and authors publishing energy justice empirical research has focused primarily on descriptive analysis of cases but have lacked further causal analysis (Jenkins et al., 2016; Fuller and McCaulley, 2016; Hall, 2013; Sovacool, Sidortsov, and Jones, 2013; McCauley et al., 2019). Causal analysis is needed to make more specific recommendations to policy and decision makers to best remedy the injustices described. Case studies featured in top energy justice publication primarily focus on a historical origin perspective, coupled with the need for causal analysis. These characteristics build a strong argument for energy justice scholars to employ deterministic approaches in their research.

Henry Brady (2008) describes four distinct deterministic approaches to seek causality, all of which should be present within strong causal inference conclusions: 1) constant conjunction and correlation; 2) counterfactuals; 3) observation of manipulations; and 4) processes linking causes and effects. While each approach uniquely leads towards causation, Brady argues that the combined results lead to overwhelmingly supporting evidence for causal arguments.

To advance an argument regarding how energy justice scholarship would benefit by shifting to the deterministic approaches, this chapter first briefly describes how an in-depth case-oriented approach can assist researchers in seeking causal inference and subsequent causal mechanisms, a key conclusion missing in current top energy justice literature. Second, this chapter summarizes the current state of methodological approaches used in energy justice literature, briefly describing specific studies and their methodological approaches. Third, this chapter selects a sample of the previously described studies and further illustrates components of their research design that could change to utilize deterministic approaches such as qualitative comparative analysis (QCA), process tracing, and counterfactual analysis. Lastly, this paper describes a few

existing studies that use deterministic approaches in their research and provides a framework to help future researches leverage the causal analysis benefits of deterministic approaches within their own research design.

3.2 Literature Review

The review literature provided below includes descriptions of case-oriented studies, the debate over quantitative vs. qualitative methods and causal mechanisms, the relationships between deterministic approaches (QCA, process tracing, and counterfactuals) and causality, and energy justice literature. Case-orientated studies are a critical element of deterministic approaches. Various deterministic approaches can be applied to studies and should specifically selected based on the case of interest. Knowledge of case-orientated studies and deterministic approaches will help future energy justice research move towards causal analysis.

3.2.1 Case-Oriented Studies

Energy justice scholars explore research questions related to forms, dimensions, and processes within theory and specific cases. In particular, case-oriented studies have the potential to inquire whether or not energy injustices occur. If energy injustices occur, there is potential for remedial recommendations. Case studies, according to Earl Babbie (2016), "focuses attention on a single instance of some social phenomenon" (p. 302). Cases can be conceived as small geographic or social groups or large nation states with broader sweeping characteristics. The field of energy justice has explored a variety of different cases across varying scales. Researchers use an assortment of methods to describe the societal phenomenon of energy justice within selected cases. However, description alone is insufficient when explanatio***n*** (or causality) is the main goal of the research question. Uncertainty is a constant concern with presenting causal relationships, however according to King, Keohane, and Verba (1994), "uncertainty should not suggest that we avoid attempts at causal inference" (p. 76). Gary Goertz (2017) suggests that the "central role of case studies is combining within-case causal inference with analyses of causal mechanisms" (p. 8). There are many definitions of causal mechanisms, but John Gerring (2008) describes them as "the pathway or process by which an effect is produced or a purpose is accomplished" (p. 178).

3.2.2 Quantitative vs. Qualitative Methods and Causal Mechanisms

For those energy justice scholars seeking to describe injustices in specific cases, the next iteration of research would be to seek the causes of such injustices, providing policy decision makers specific suggestions to remedy said ills in each case. Policymakers and various actors within a case have various levels of power and influence in procedural, distributive, and recognition justice. Differences in power and motivation of actors needs to be recognized when developing prospective remedies for perceived injustices within a case. An injustice for one actor or group may be a justice for another. Power may be

exercised visibly or hidden from view; used for collective ends or at the expense of others; concentrated or diffuse; and used for legitimate or insidious purposes" (Cairney, 2019, p. 39). It is important to recognize the nuances of power and influence throughout the research design process as it can help steer decisions on how to proceed, what data to collect, and how to interpret data.

A healthy debate exists on whether qualitative or quantitative methods are the best approach to answer these tough questions. Quantitative methods, commonly referred to as statistical methods, leverage large data sets (large-N) to perform regression analyses, determining significant correlations between dependent and independent variables. King, Keohane, and Verba (1994) feels that the rigor of quantitative methods is more important than substance. Qualitative methods, on the other hand, as described by Charles Ragin (1987), leverage in-depth case-study oriented methods to examine methodological issues. It is the substance of the case which leads researchers to stronger correlations and *causal analysis*.

King, Keohane, and Verba (1994) describes causality as a theoretical concept, grounded in counterfactuals, or the difference between actual observations and likely observations. Causality and more specifically causal inference also have a fundamental problem, as "no matter how perfect the research, no matter how much data we collect... no matter how much experimental control we have, we will never know a causal inference for certain" (p. 79). Despite this concern, both quantitative and qualitative methods have established methods that researchers can follow to seek causal inference to an accepted level of certainty. Quantitative methods seek probabilistic causality (statistical analysis and large-N) while qualitative methods seek deterministic causality (100 percent explained, small-N).

In qualitative methods, Ragin (1987) promotes the use of many explanatory variables and few observations, leveraging causal inference and causal mechanisms to evolve to multiple causality. He argues that "some statistical methods will falsely reject the hypothesis that these variables have causal status" leading to missed causal theories. Multiple causality is described as a common situation by King, Keohane, and Verba (1994) but should "not make our definition of causality problematic" (p.89). The key is to "define the counterfactual conditions making up each causal effect very precisely" (p.89). This means the careful selection of explanatory and outcome variables is critical to understanding any causal mechanisms between them. Benoit Rihoux and Charles Ragin (2008) further suggest that causality cannot be described through conditions (or quantitatively) but must add in-depth knowledge of the situation. In-depth case knowledge is a primary feature of many energy justice studies, further encouraging scholars towards using qualitative methods to find causal inference and underlying causal mechanisms.

3.2.3 Deterministic Approaches and Causality

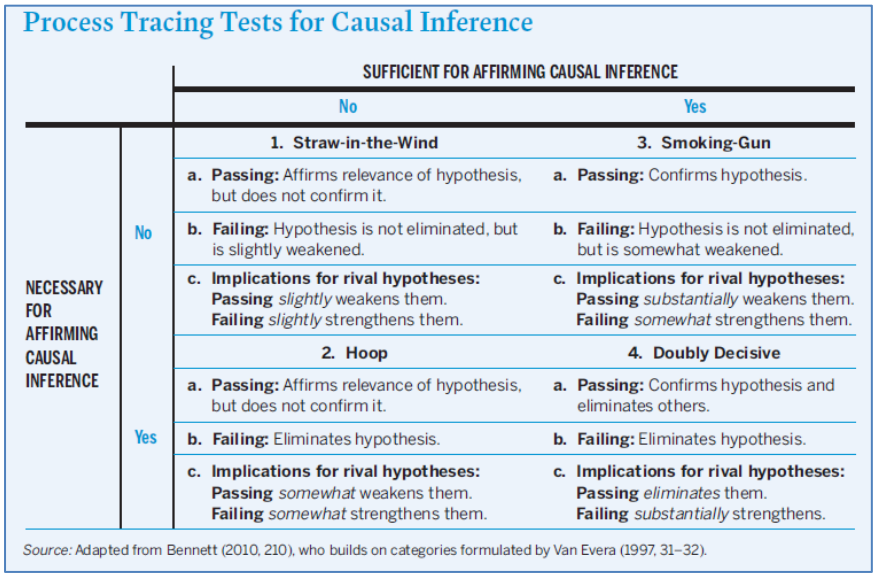
The basis of deterministic approaches is described well by James Mahoney (2008) as deterministic causality through necessary and sufficient causes in individual cases or combinations of conditions. Rihoux and Ragin (2008) further explain that "a condition is *necessary* for an outcome if it is always present when the outcome occurs" or cannot occur without it. While "a condition is *sufficient* for an outcome if the outcome always occurs, however, it could also result from other conditions" (p. 187). Once evidence for causal inference is supported, interactions of explanatory variables affecting an outcome, or causal mechanisms, can be analyzed. John Gerring (2006) notes that investigating causal mechanisms allows researchers to "peer into the box of causality to locate the intermediate factors lying between some structural cause and its purported effect" (p. 45). In quantitative methods, this is done through path analysis, a regression technique that visualizes interrelations between variables, as described by Babbie (2016) and Linneman (2011).

3.2.3.1 Counterfactuals

Brady (2008) describes counterfactuals by asserting that "if the cause had not occurred, then the effect would not have happened" (p. 220). Counterfactuals are best fit with singular causal events. The early work of David Lewis (1973) on counterfactuals acknowledges that they are best in the "closest possible world" or, in comparative methods terms, in comparisons with the highest homogeneity. This fits with well-defined case-oriented studies where many variables can be identified and accounted. Lewis also acknowledged the difficulty in the task of identifying this world. Brady (2008) goes on to describe how controlled experiments can help keep the "closest possible world" together in order to maximize validity of counterfactual statements. He also acknowledged the experimentation challenges within social science, referencing while correlations can be seen within data, supporting the case, "the counterfactual approach…like the Humean regularity approach, only describes a necessary condition, the existence of a causal connection between A and B" (p.238).

3.2.3.2 Process Tracing

Qualitative methods use the term process tracing, defined by Alfred George and Andrew Bennett (2013), as "attempts to identify the intervening causal process-the causal chain and causal mechanism - between an independent variable (or variables) and the outcome of the dependent variable". David Collier (2011) visualizes the four process tracing tests (straw-in-the-wind, hoop, smoking gun, and double-decisive) and their relationship with necessary and sufficient conditions, shown in Figure 3.1.



Process Tracing Tests for Causal Inference

NECESSARY FOR AFFIRMING CAUSAL INFERENCE	SUFFICIENT FOR AFFIRMING CAUSAL INFERENCE: No	SUFFICIENT FOR AFFIRMING CAUSAL INFERENCE: Yes
No	**1. Straw-in-the-Wind**	**3. Smoking-Gun**
	a. Passing: Affirms relevance of hypothesis, but does not confirm it.	**a. Passing:** Confirms hypothesis.
	b. Failing: Hypothesis is not eliminated, but is slightly weakened.	**b. Failing:** Hypothesis is not eliminated, but is somewhat weakened.
	c. Implications for rival hypotheses: **Passing** *slightly* weakens them. **Failing** *slightly* strengthens them.	**c. Implications for rival hypotheses:** **Passing** *substantially* weakens them. **Failing** *somewhat* strengthens them.
Yes	**2. Hoop**	**4. Doubly Decisive**
	a. Passing: Affirms relevance of hypothesis, but does not confirm it.	**a. Passing:** Confirms hypothesis and eliminates others.
	b. Failing: Eliminates hypothesis.	**b. Failing:** Eliminates hypothesis.
	c. Implications for rival hypotheses: **Passing** *somewhat* weakens them. **Failing** *somewhat* strengthens them.	**c. Implications for rival hypotheses:** **Passing** *eliminates* them. **Failing** *substantially* strengthens.

Source: Adapted from Bennett (2010, 210), who builds on categories formulated by Van Evera (1997, 31–32).

Figure 3.1 Process tracing tests for causal inference (Source: Collier (2011))

Derek Beach and Rasmus Brun Pedersen (2013) argue that causal mechanisms are more than just intervening variables, different than the position described by King, Keohane, and Verba (1994). "Understanding mechanisms in these terms enables us to capture the process whereby causal forces are transmitted through a causal mechanism to produce an outcome..." (p. 40). This helps further dispel the black and grey boxes that Gerring (2006) and many other scholars have noted. Deeper understanding of causal mechanisms is important in developing remedial strategies to energy injustices.

3.2.3.3 Qualitative Comparative Analysis (QCA)

The comparative method allows researchers to compare a single case to itself (within-case) over time (historical) or compare similar cases to each other (cross-case), discovering the necessary and sufficient conditions which lead to particular outcomes. Note that homogeneity, or conceptual equivalence, in cross-case comparison is important (don't compare apples to oranges). These pathways, or combinations of conditions, can be further analyzed to investigate causal mechanisms, the central idea of causality, as argued by Daniel Little (1991).

The majority of energy justice literature focuses on particular cases, which have defined boundaries from which a number of observations can be made. Energy justice research questions are ideal candidates for comparative methods as they are designed for examining methodological issues, or well-defined processes involving characteristics and outcomes (i.e. power plants emitting pollution lead to residents nearby getting sick). Also, these cases are suited for macrosocial units (cities, states, and nations) compared to individuals or households (which are more ideal for variable-oriented methods). By determining which characteristics (and combination of characteristics) are most likely responsible for causing energy injustices within cases, policy decision makers can

provide better solutions to existing injustices while seeking to prevent future injustices from occurring.

Another strength of comparative methods for energy justice studies is not being constrained by the sampling assumptions of large-N studies. King, Keohane, and Verba (1994) describes that quantitative researchers argue the only way to confidently infer conclusions to a broader target population is to have a large enough and diverse enough sample within the study. Sampling error, or the errors associated with selecting a representative sample of the target population, can increase with large-N studies because of the large difference between the actual sample and target population. There are many challenges in producing a random sample, which is best for generalizing to a larger population. Convenience sampling, or selecting a sample based on research constraints, is a specific challenge for both quantitative and qualitative methods. Donald Warwick and Samual Osherson (1973) identify several potential biases in case selection such as tourist bias (only picking cases a researcher can access) or religious bias (researcher uncomfortable accessing different populations based on variety of factors). Also, lack of financial resources or access to a desired sample population is common. Brady and Collier (2010) argue that while selection bias can be an issue in cross-case analysis, it is not a concern for within-case analysis. This is a direct challenge to King, Keohane, and Verba's (1994) critique of qualitative methods. Potential measurement error (coding errors, complicated questions, etc.) exists regardless of the method and needs to be carefully thought through during the research design. Strong focus on only a few cases has the same convenience sampling pressure as large-N random sampling. Sampling error can be minimized through careful research design and case selection through in-depth case knowledge.

Ragin's (1987) work resulted in the development of qualitative comparative analysis (QCA), which formalizes the logic of case-oriented research by utilizing mathematical strategies to compare and contrast like cases using different configurations of their variables, or characteristics, resulting in an outcome. Rihoux and Ragin (2008) further describe the process by organizing tables, known as truth tables, where rows are observations, or a combination of variables equaling an outcome. Each column has dichotomized explanatory variables in columns along with a dichotomous outcome variable. The presence or lack of presence of the variables per observation result in a minimized combination of explanatory variables equating in presence of the outcome variable (0,1). This is referred to as crisp-set QCA or csQCA. Criticism of the loss of data during dichotomization of variables led to the development of fuzzy-set (fsQCA) and multi-value (mvQCA) QCA, which provides more granular description of variables, (i.e. 0.1, 0.2...1).

Multiple causal pathways also occur with QCA, according to Ragin (1987). Process tracing helps describe how even though one characteristic, or combination of characteristics is required for an outcome, the actual pathway could be different. In fact, process tracing can help one of QCA's largest critiques, lack of temporality, or a time element. QCA can't tell the order in which the causes occur. Techniques like process

tracing can assist in filling those gaps in the causal analysis. The order of causes is important when assessing a particular energy justice case. A policy solution for one issue could result in the same poor outcome, failing to address the root cause.

3.2.4 Energy Justice

Expanding on Heffron and McCauley et al.'s (2014) definition of energy justice, the triumvirate framework emphasizes distributional, procedural, and recognition justice as the three aspects through which elements of injustice can be identified into one or multiple categories. Distributional justice focuses on the distribution of costs (ills) and benefits with regards to the energy supply and consumption. Procedural justice requires the use of equitable procedures (process) that engage all stakeholders in a non-discriminatory way, or equitable participation in the decision-making process (Bullard, 1990; Heffron and McCauley, 2014; Walker, 2012). Recognition justice has a strong connection to social justice. Social justice is concerned with the "benefits and burdens" in society (Miller, 1979). Recognition justice is not the same as participation, but rather acknowledges disrespect and insults of a particular individual or group (Walker, 2009; Fraser, 1995). A lack of recognition can cross into cultural and political authorities, which perpetuate the cycle of injustices through the system. Individuals also need to be free from physical threats to achieve recognition justice (Schlosberg, 2003).

Connections between energy justice and energy policy are important because one of the primary goals beyond providing a framework to describe energy dilemmas, according to Kirsten Jenkins et al. (2017a), is to "continue to develop and increasingly implement energy justice concepts in the policy sector" (p. 631). The concept of "implementing" into the policy sector is further described by Benjamin Sovacool and Michael Dworkin (2015) as using energy justice as a conceptual tool for specific justice issues, an analytical tool for understanding energy systems, and more importantly towards impacting policy, a decision-making tool to energy planners (Jenkins, 2018). One metric, the energy justice checklist, was developed by Sovacool and Dworkin (2015) and organized energy justice into eight distinct categories: 1) availability, 2) affordability, 3) due process, 4) good governance, 5) sustainability, 6) intergenerational equity, 7) intrageneration equity, and 8) responsibility. The United Nations Sustainable Development Goal 7 "ensure access to affordable, reliable, sustainable and modern energy for all" shares the principles of energy justice and measures global electrification rate, population with access to clean cooking fuels and technologies, and global renewable energy percentage of total energy consumption (ECOSOC, U., 2019, p. 13). Researchers Mine Islar et al., (2017) applied the checklist to measure energy justice (or injustices) throughout energy development efforts in Nepal, noting that a challenge for this method is that the pursuit of their principles may undermine the pursuit of more general concerns of justice as well as face ethical feasibility constraints. "This happens in cases where other normative concerns than the availability and affordability of clean and high-quality energy seem to hold more urgent priority" (p. 675). Another metric developed by Raphael Heffron et al. (2018) helped design another decision-making tool, the energy justice metric (EJM), to quantity energy justice when applied to specific cases.

In this metric, Energy Law and Policy (energy justice) is balanced by the competing aims of Politics (energy security, national politics), Economics (finance, efficiency, low-cost, competition), and Environment (climate change mitigation, reducing CO2 emissions, environmental health), as shown in Figure 3.2.

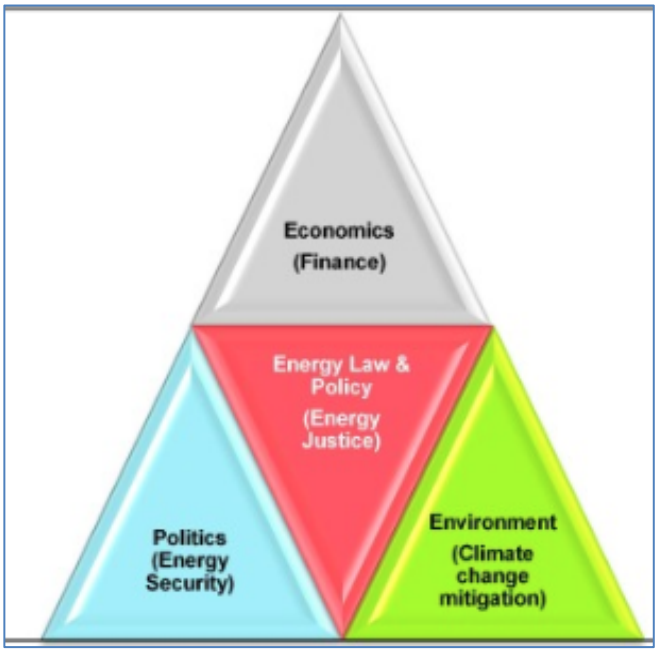


Figure 3.2: Energy Justice Metric (EJM). Source: Heffron et al. (2018)

Various metrics developed by scholars are providing ways to dissect elements within cases and describe in greater detail the boundaries and conditions of particular injustices. However, this evolution is still lacking the next step of causal analysis. One overarching theme of how energy justice as a field has emerged is a result of the need to integrate issues of large-scale shifts in energy transitions from fossil fuels to renewable energy sources in an effort to combat climate change (Allen et al., 2019; Newell and Mulvaney, 2013; Goodman, 2009). The concept of climate justice further theorizes and develops this argument (Schlosberg, 2012). The need to integrate issues and societal implications from energy transitions can be helped by the concept of restorative justice, or how society responds to injustices (harms) and prioritizing social attention for various injustices (Sullivan and Tifft, 2006; Heffron and McCauley, 2017). Some energy policies are being implemented at various scales to mandate 1) environmental impact assessments, describing in detail the potential hazards and concerns with a specific development project (Cooper, Lordes, and Sheate, 2002); 2) social-license-to-operate to ensure cooperation with the community over the life-span of energy infrastructure (Cesar, 2019); and 3) energy reserve obligations, or demonstrated financial capacity by the energy developer to clean and restore energy infrastructure at the end of its life (Heffron and McCauley, 2017). Heffron et al., (2015) encourages future energy justice scholars to engage directly in economic policymaking in pursuit of energy justice.

3.3 Current State of Energy Justice Methods

In less than a decade, energy justice has advanced from a developing concept to a useful framework for decision-making within energy policy areas (Broto et al., 2018). The term "energy justice" first emerged within NGOs and citizens' groups, with papers exploring the topic during a seminar titled "Energy justice in a changing climate" at the InCluESEV (Interdisciplinary Cluster on Energy Systems, Equity and Vulnerability) conference in London in November 2011 (Galvin, 2019; Eames, 2011; Saunders, 2011, Hall et al., 2013). While still a young field, energy justice applies procedural, distributive, and recognition justice principles with the notion that energy services are a human right. Early publications defined energy justice in terms of principles (affirmative and prohibitive) and tenants (distributional justice, procedural justice, and recognition justice) (cite that collection of publications) (Sovacool, Sidortov, and Jones, 2013; Sovacool and Heffron, 2014). As with any field, definitions are important, as they build the foundation for future researchers to develop and test hypotheses. Slowly scholars began to distinguish their own bodies of scholarship within the energy justice framework, such as globalism (Sovacool, Sidorsov, and Jones, 2013), activism (Fuller and McCaulley, 2016), spatial (Hall et al., 2013), and whole systems approaches (Jenkins et al., (2017a).

Recent efforts from Heffron et al.'s (2018) Energy Justice Metric (EJM) is a move in the right direction towards solving energy justice issues through measuring the strength and balance of the energy trilemma (politics, economics, and environment), it still primarily focuses on policy analysis via description and not explanation. Jenkins et al. (2017a) states a clear mission for energy justice scholarship in her opening paper for a 2017 special energy justice issue of the journal *Energy Policy*: "…we develop energy justice scholarship as normative, change-driven and policy focused. Specifically, we question which methods we need for assessing the prevalence of injustices in our energy systems, and for remediating them" (p. 632). Jenkins (2018) further supports the claim that "due to the recent emergence of the concept, there is little empirical evidence of its traction on energy decision-making" (p. 120). Albeit further theoretical development in energy justice literature, the field has yet to publish compelling causal inference conclusions, therefore energy justice could benefit from deterministic approaches to explain not only causal inference but also causal mechanisms.

Data for analyzing the current state of energy justice methods was obtained by searching Elsevier's ScienceDirect advanced search for "energy justice" within title, abstract, keywords. ScienceDirect searches provide an accurate ordering of search results relative to search keywords (Tober, 2011). One limitation in ScienceDirect is the bias towards Elsevier publications, but since "Energy Justice" is a young field (title keywords appearing in 2015), top journals (*Energy Policy*, *Energy Research and Social Science*) featuring energy justice issues are included in the search. As of December 2019, a total of 134 articles contained the keyword 'energy justice' within their titles, keywords, or abstracts. The top 75 articles as ranked by relevance to the 'energy justice' keyword search were analyzed and coded by authors, article title, year, journal/publisher, keywords, geography, type of article (theoretical/empirical), type of methods

(qualitative/quantitative/mixed), data collection methods, and analytical methods. The relevance after 75 articles significantly dropped off compared to those ranked higher by ScienceDirect. Data from articles 76 through 134 would lower the quality of data and inaccurately portray the current state of energy justice literature, therefore they were not included in the study.

3.3.1 Journal Summary

The 75 articles spanned from 2015 through 2019, steadily increasing in annual volume each year (data was collected in mid 2019, therefore 2019 was on pace to surpass 2018 total publications). *Energy Policy* is the most frequent publication, with 26 articles, followed by *Applied Energy* and *Energy Research & Social Science*, with 23 and 18 articles respectively. The remaining five journals have significantly lower publication in the single digits over the years.

Table 3.1 Summary of 'energy justice' articles by journal publication

Journal/Publication	2015	2016	2017	2018	2019	Total # of Articles
Energy Policy	1		15	4	6	26
Applied Energy	1		1	18	3	23
Energy Research & Social Science		4	2	8	4	18
Journal of Cleaner Production				1	1	2
Energy	1				1	2
Resources Policy				1		1
Sustainable Power Generation					1	1
Ecological Economics					1	1
Global Environmental Change					1	1
Totals	**3**	**4**	**18**	**32**	**18**	**75**

Of the 75 articles, there were 65 research articles, 1 book chapter, 3 book reviews, 1 correspondence, 2 editorials, 1 mini-review, and 2 review articles. The remainder of this summary will focus on the 65 research articles. Of the 65 research articles, Raphael Heffron had the most first authorship with 5, followed by Benjamin Sovacool with 4, ending with Kirsten Jenkins and Siddaharth Sareen with 2 each. There were 52 remaining authors listed as first authorship. Based on articles with multiple authors, Darren McCauley led the group with 9 articles, followed by Sovacool, Heffron, Jenkins, Nick Pidgeon, and Sareen with 7, 6, 3, 3, and 2 respectively. The total subset of authors from top journals included is 163.

3.3.2 Keywords Summary (Topics)

Focusing on the 65 research articles from the 75 total articles, top keywords by order of appearance in their respective listing were analyzed, including the term “Energy Justice,” which was listed as the first keyword (in addition to being in the title) 35 times. The other top keyword in listed first in the order of keywords was “Energy Transition,” with 3.

There were 27 remaining first ordered keywords. When looking at the comprehensive listing of all keywords, energy justice was listed in 63 of the 65 articles. A wealth of diverse keywords existed beyond the standard “energy justice” including “energy transition”, “renewable energy”, and “fuel poverty”, which each had 10, 8, and 6 mentions respectively (shown in Figure 3.3) while 209 other keywords can be seen throughout the word cloud in Figure 3.4.

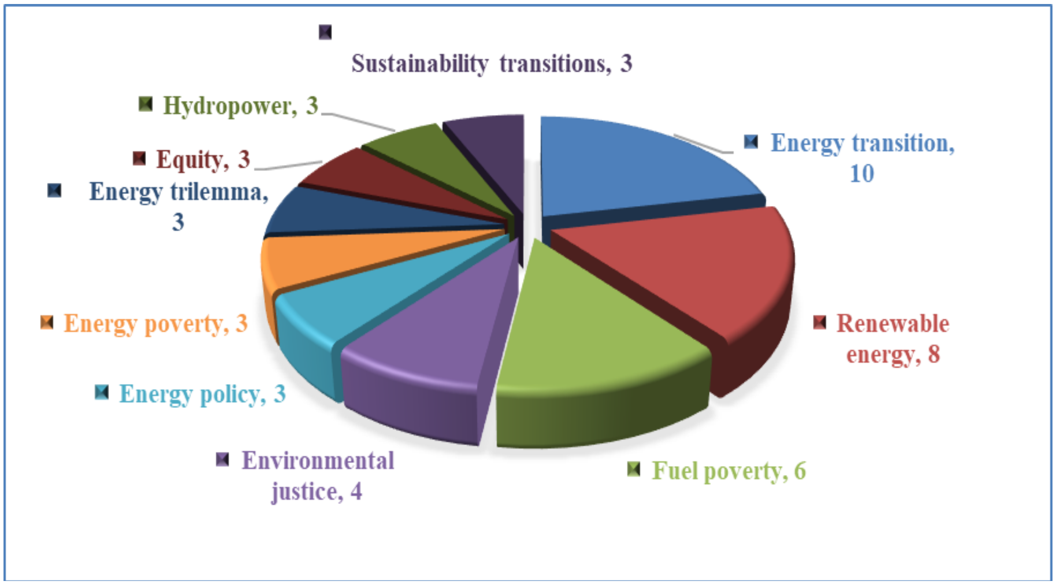


Figure 3.3 Top keywords associated with 'energy justice' keywords in Journals

Figure 3.4 Keyword word cloud for energy justice articles

3.3.3 Geographic Distribution of Case Studies

Of the 75 total articles reviewed, data showed the vast majority of research articles focused on case studies. Europe featured the most case studies with 35% of the total and the United Kingdom was the nation with the most cases (42% of Europe and 15% of all cases). Europe has progressive national energy policies compared to the United States, which provides plentiful data from energy stakeholders and public opinion on energy policy issues. Only a handful of research articles provided case studies that spanned multiple continents (Europe (United Kingdom) / North America (United States) – 2; Europe/Asia (Turkey) / South America (Columbia) - 1). Only two articles featured cases from multiple nations within Europe (Germany/Denmark - 1; Netherlands/United Kingdom – 1).

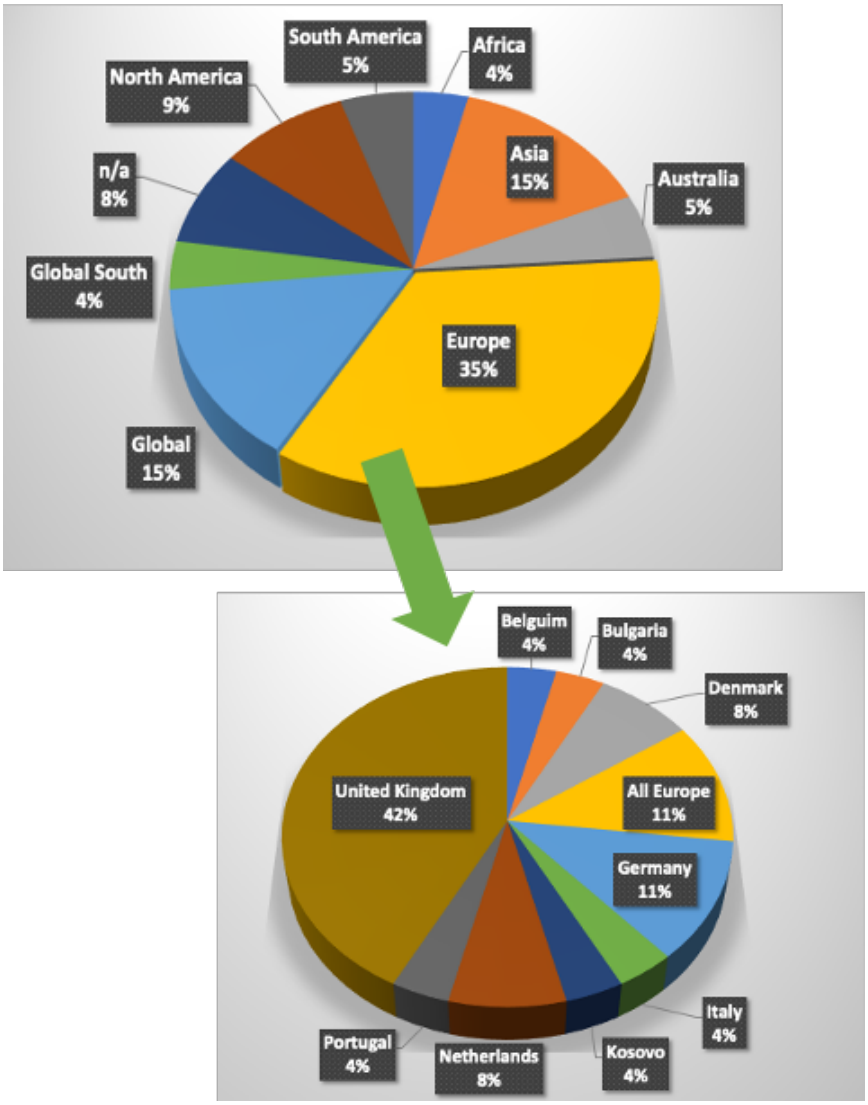


Figure 3.5 Geographic percentage distribution of case studies within 75 energy justice articles

3.3.4 Methods Summary

Energy justice scholars have used empirical methods to answer questions surrounding implementation of broad energy policies such as renewable portfolio standards (RPS), commercial wind farms, or nuclear energy policy. Of the 65 research articles, 49 (75%) were empirical while 16 (25%) were theoretical. Individuals are the most consistent unit of analysis during data collection with many questions measuring public engagement in energy policies. Analytical methods vary the unit of analysis among communities, states, and nations. Studies use mixed quantitative and qualitative methods for both data acquisition and analysis, both of which notably featuring descriptive variable based analysis. Of the 49 empirical research articles, 39 (80%) featured qualitative analysis while 9 (18%) used quantitative analysis, and 1 (2%) article used mixed methods. Quantitative analysis was used with 7 studies using secondary data and 2 studies using survey data.

Table 3.2 Summary for energy justice articles

Total Article Summary	Research	*Non-Research	Total Articles
	65	10	75
*non-research articles include book reviews, correspondences, mini-reviews, book chapters, and editorials			
Research Article Summary	Empirical	Theoretical	Total Articles
	49	16	65
Empirical Article Summary			
	Analysis Type for Empirical Articles		
Method	Mixed	Qualitative	Quantitative	Total
Mixed (Interviews)	1	18		19
Secondary Data		7	7	14
Document Analysis		6		6
Interviews		4		4
Survey		1	2	3
Workshop		2		2
Focus Groups		1		1
Totals	1	39	9	49

Stakeholder interviews were the most common data collection method, used in every mixed method study (19) as well as four studies as the main method for a total of 23 of 49 studies, or 47%. Benjamin Sovacool (2009) assessed energy stakeholders' awareness

and beliefs of specific energy policy instruments and impediments to renewable energy policy. With 181 interviews over 93 institutions in 12 countries over 3 years, the study showed correlations among nations around particular policy instruments. Alister Forman's (2017) article assessed a community's knowledge of energy justice concepts relating to production of local community energy using 42 in-depth interviews and 9 participatory workshops, to show that there is a gap in knowledge between actors in power and those on the ground potentially experiencing injustice. Gordon Walker et al.'s (2007) study sought to explain localism in national energy policy. Correlations were found by analyzing interviews from 23 national community energy leaders in the UK, concluding that the term "community" was distorted by some government programs.

Multiple studies have focused on public perception of government and industry surrounding new renewable energy project development. Patrick Devine-Wright's (2010) study of 1041 public participants found that UK adults were unaware of the technical infrastructure benefits of the "national grid". This invisibility is noted to heighten risk of public backlash when energy policy changes are proposed by government or industry. Devine-Wright (2005) targeted public community members surrounding newly constructed energy projects. It found statistical correlations among community demographics related to their beliefs in changing local energy engagement. Kirsten Jenkins et al. (2017b) dove closer to seeking causality by asking the question of attributing responsibility for energy justice within a single case. Their 26 semi-structured interviews of prominent NGO's and policy groups associated with the Hinkley Point Nuclear Complex in the U.K., ultimately assessed "who is responsible" and "who should be responsible" for energy justice principles in the energy policy process of where the next nuclear reactors should be built. Their study showed that more transparency may not always lead to collective sense of responsibility and that diffusion of responsibility with multiple groups leads to one group thinking the other is responsible for items. Each of these studies sought answers to questions that describe different components within energy justice, not what is causing the energy injustice (or perceived energy injustices) at hand within each case.

A few studies have explored comparing cases but have yet to invoke the extensive deterministic approaches. For instance, Sovacool and Ratan (2012) interviewed energy stakeholders and compared the outcome "renewable energy acceptance" for four different nations. They noted the benefits of using a qualitative approach, providing them more flexibility and ability to facilitate "a more complete flow of knowledge". Another endorsement of qualitative methods is shared as they describe quantitative methods as difficult to account for nuance and variance with regards to aspects like "acceptance". The authors coded data into three dimensions (socio-political acceptance, market acceptance, and community acceptance) which led to nine criteria for fostering acceptance of wind and solar energy. Despite the comparative nature of the project, the study did not have homogeneity among cases (Germany, Denmark, United States, and India) and did not analyze potential intervening explanatory variables (i.e. national demographics).

Envevoldsen and Sovacool (2016) examined the acceptance of wind energy in France in terms of the energy justice concepts procedural and distributional justice. Data from semi-structured interviews of energy stakeholders was "triangulated" with peer-reviewed literature on social acceptance in Great Britain and other areas of France. Their findings concluded that social opposition against wind farms exists and is a hurdle to wind energy development. The authors also recommended specific actions to remedy lack of social acceptance. Their categorization of wind farm process phases (screening, securing, and permitting) each had their own suggestions to improve social and community acceptance. The comparison attempt was faulted again by non-homogeneity of cases, making it difficult to explore further causal analysis.

Johanna Liljenfeldt and Organ Pettersson's (2017) research studied distributional justice (a key tenet of energy justice) in Swedish wind power using quantitative analysis. They sought to "statistically evaluate the extent to which decisions to approve or reject windmill proposals in Sweden can also be related to the characteristics of people living in surrounding areas." By using logistic regressions to associate socio-economic and land characteristics variables to approval or disapproval of windmill siting, they showed correlations with social capital and social position having less windmills and could contribute to their rejection of siting. This study was unique in that it was seeking to answer questions closer to the causation of why or why not windmills are developed within a single case (Sweden). The quantitative methods used rely on significance of correlation between variables and could benefit for further deterministic approaches of those specific unique correlated cases within the larger case.

In summary, energy justice literature from authors in top journals share common features conducive to shifting to deterministic approaches. Most studies analyzed used interviews to gauge perceptions and attitudes towards particular case questions. While this information is valuable, additional methods looking at observations of what occurred additional data helps develop arguments within procedural, distributive, and recognition justice. Most articles had the ability to be case study centric, obtain in-depth case knowledge, feature relatively small-n (or able to convert large-N data to small-N case comparison), allow for available homogeneity, and potential for additional causal analysis. This subset of articles creates a good opportunity to suggest either QCA, process tracing, counterfactual analysis, or a combination deterministic approaches.

3.4 Shifting to Deterministic Approaches

The primary purpose of this chapter is to show energy justice researchers a process which they can use when searching for causal mechanisms and causal analysis within their unique case studies. Not all energy justice researchers seek to determine causes of energy "injustice's", but for those interested in pursuing answers to those types of research questions, deterministic approaches can be used. The following section will first analyze a multiple energy justice studies previously described, discussing how changes in their research design can shift to the deterministic approaches, strengthening their ability to

perform causal analysis. Next, this section describes studies currently using some level of deterministic approaches to answer their research questions. Lastly, this section summarizes best practices for using deterministic approaches in energy justice studies by providing a framework to assist researchers in their research design. The framework is based on increasing homogeneity, increasing intervening variables, and developing outcome variables based on energy justice principles within procedural, distributive, and recognition justice.

3.4.1 Suggested Changes to Specific Energy Justice Articles

This subsection takes an in-depth look four energy justice articles and provides recommendations to adjust Benjamin Sovacool's (2009) article on favored policy mechanisms for renewable energy shows how homogeneity can improve the shift towards deterministic approaches. By adding additional in-depth case study variables, Alister Foreman's (2017) study on community energy in Scotland can move towards causal analysis. Lastly, two articles from addressing wind development projects from Enevoldsen and Sovacool (2016) and Liljenfeldt and Pettersson (2017) are analyzed for their ability to use QCA to help answer their research questions

3.4.1.1 Favored Policy Mechanisms for Renewable Energy *(Sovacool, 2009)*

Sovacool's 2009 study's main goals were to "explore the favored policy mechanisms for renewables and energy efficiency" (p. 1529), describe "four favored policy mechanisms" (p.1531), and "discusses why these policy mechanisms must be implemented comprehensively" (p. 1529). Data came from 181 semi-structured interviews at 93 institutions from Belgium, Canada, Denmark, France, Germany, Japan, Korea, the Philippines, Singapore, Spain, Switzerland, United Kingdom, and the United States over a period of 3 years. Institutions included representatives from investor-owned electric utilities, energy systems manufacturers, consumers, research institutes, and other electricity interest groups.

A deterministic approach could better answer the author's questions by focusing on case selection. Definitions within policy mechanisms vary for different policy environments (China, U.S. and France), skewing results and undermining conclusions. A 2018 study from Ding, Zhang, and Shuai (Ding et al 2018) showed that Chinese communities' expectations of energy subsidies were drastically different within China, let alone if compared to the United States. By selecting a more homogenous energy policy group (i.e. Germany, United Kingdom, France, Denmark, and Belgium), Sovacool could focus on comparing differences between cases to assess why certain combinations of variables favored specific policy mechanisms.

Before conducting interviews, Sovacool could perform historical comparative analysis to create more informed questions and outcome variables of interest. Recall King, Keohane, and Verba (1994) noting the key to causality is "defining counterfactuals...very precisely" (p. 78). A within-case historical comparative analysis of a single European nation

experiencing energy policy changes over time (i.e. Denmark) could prepare better hypotheses for defining explanatory variables leading to favored policy mechanisms.

Once the narrowed group of five European nation cases are selected, the author could conduct semi-structured interviews as described, featuring more focused questions thanks to the comparative historical analysis. The newly focused study could also acquire more observations within the narrowed target nations, gathering even more "precise" explanatory variables and outcomes. Sovacool could establish consistent dichotomous (or fuzzy set based on granularity of data) explanatory variables within the cases.

Table 3.3 Suggested explanatory variables for use in QCA for Sovacool (2009)

Suggested additional explanatory variables
Progressive energy policy
Liberal party in majority
Existing renewable energy percentage
Current value of energy subsidies
Political opposition to renewable energy
Strength of incumbent energy industry

Combinations of conditions would result in favorable or unfavorable attitudes towards policy mechanisms of interest (i.e. eliminate subsidies, national feed-in tariff, implement stricter building codes, etc.). Using process tracing and QCA, specific causal mechanisms could be explored for particular outcomes. For example, there could be a connection between progressive energy policy and strength of incumbent energy industry, creating multiple causality towards the outcome policy mechanism of eliminate subsidies. This multimethod approach is supported by Goertz's (2017) balanced research triad model.

Sovacool's conclusions could find that nations with progressive energy policy cause them to want to eliminate subsidies, unless they have a strong traditional energy industry, in which case they do not want to eliminate energy subsidies. A detailed causal analysis through QCA followed up with process tracing can provide more insightful causal inference conclusions for policy makers to make informed decisions. Note, he would not be able to infer results to his original list of nations from North American or Asia.

3.4.1.2 Enacting community energy (Forman, 2017)

The main goal of Alister Forman's 2017 article was to assess what impact energy justice (through procedural and distributive justice) has on community engagement in local energy initiatives. Through 51 in-depth structured interviews of energy community project leaders in Wales, data analysis addressed the question whether or not community energy enhanced energy justice from the standpoint of equal distribution of benefits (distributive justice). In addition, questions also addressed how community energy projects aided greater participation (procedural justice) in the energy system.

To switch to a more deterministic approach, Foreman could first find a similar energy community project case to compare to Wales, like in Scotland. The same semi-structured interviews for both groups can be used. After coding the outcome data (level of community project impact of distributive and procedural justice), Alister could list a variety of explanatory variables consistent among the cases, eliminating variables which don't apply for both (don't compare apples and oranges). The resulting table of dichotomous (or fuzzy set) conditions equate to perceived positive or negative impact on both distributive and procedural justice.

Say the explanatory variable significant agricultural industry in region became a sufficient condition for positive distributive justice, but significant manufacturing industry in region, showed to be a necessary condition for positive distributive justice. A logical conclusion would be the type of industry is important in considering benefits of community energy projects towards distributive justice. However, areas with high manufacturing industries are more significant than those without. Decision makers could use this study to support siting community energy projects near areas high in manufacturing. The plausibility of the now narrowed hypothetical conclusions could be further evaluated using counterfactual analysis, diving into specific examples within the case study boundaries.

Despite the hypothetical conclusions, it is clear that using QCA and subsequent causal analysis through process tracing or counterfactual analysis leads to more actionable and specific recommendations compared to descriptive variable oriented studies. A danger of stopping at descriptive analysis is that the conclusions are more open to interpretation of individual policy makers, which could be used to justify their own actions, actions that thorough causal analysis could prove as counterproductive.

3.4.1.3 Examining the social acceptance of wind energy: Practical guidelines for onshore wind project development in France (Enevoldsen and Sovacool, 2016)

Endevoldsen and Sovacool (2016) asked the question: how can onshore wind projects achieve greater social acceptance in France? They emphasized the strength of using interviews and to measure acceptance, therefore they have a good in-depth knowledge of each case. Their research also concluded that lack of social acceptance was an issue for developing wind farms. Rewording the original research question to focus on causal mechanisms could be "Why do communities in France have low social acceptance for wind farm development?" Keeping focus on their three case studies within France (stronger homogeneity), they could further explore the characteristics of each community and align them with the outcomes of social acceptance of wind farms. Their outcome variable would be fuzzyset QCA because their already measured social acceptance is not dichotomous, but rather has variability. Intervening variables (village demographics, interview subject demographics, land/environment characteristics) are embedded within their already sorted categories of (screening, securing, and permitting) phases of the

projects. Each phase among each of the three case studies could be compared to one another, potentially narrowing in on a particular causal phase, but then allowing for further causal mechanisms to be explored with either process tracing or counterfactual analysis within the phases themselves. Liljenfeldt and Peterson's study (2017) showed that land use characteristics (wind features, climate, etc.) had a higher significance in windmill site selection than socio-economic features of a proposed area. By switching to fuzzyset QCA, Endevoldsen and Sovacool's study could incorporate those characteristics in seeking to understand why some communities in France have low social acceptance for wind farm development.

3.4.1.4 Distributional justice in Swedish wind power development – An odds ratio analysis of windmill localization and local residents' socio-economic characteristics (Liljenfeldt and Pettersson, 2017)

The research question in Liljenfeldt and Pettersson's study (2017) on Swedish wind power is to determine whether windmills are more or less likely to be approved or rejected depending on the surrounding population's socio-economic and demographic characteristics (specifically concerning sex, age, ethnicity, education, income, and employment). The authors chose their words carefully in the goals of the study by not setting causation as an objective, however the abstract does contain the following sentence "…windmill proposals in Sweden can be explained by factors…" (p. 648). Explanation infers the goal of determining why a particular phenomenon is happening, thus seeking the cause of such phenomenon. This study uses statistical methods with binary logistic regression to detect correlations of windmill siting to specific demographic trends. "The geo-referenced nature of the dataset makes it possible to match windmills to people who might be affected by it, thus making the link clearer" (p. 649). Control variables include land characteristics (ownership, land use, and location) of the areas surrounding the proposed windmill sites (3km and 10km).

Statistical methods in this case are a sound choice as their unit of analysis is individuals, all individuals in Sweden over 16 years of age in the impact zone or near windmill developments (large-N). This method determined a more significant impact on approval or rejection to windmill development based on land characteristics when compared to socio-economic variables. However, the most notable socio-economic variable of significance was *higher education* with increased rejected approvals. The authors theorized in their conclusion why this was the case, including possibilities that more highly educated individuals 1) are more likely to take part in the planning process and make appeals, 2) have more extensive networks which can be mobilized to exert influence against a wind project, and 3) may assign a higher value to preserving landscape and conflicts with wind development sites.

Further deterministic analysis could be used to further investigate causal mechanisms within the subset of data for those specific sites that were rejected and approved (outcome variable) and had a significant population of highly educated individuals. This study could compare more highly educated populations with different outcomes. Cases selected

for further investigation could have high land characteristic and other socio-economic homogeneity, a requirement for sound QCA analysis. Additional semi-structured interview methods or surveys could be used within the selected sites and populations to further test theories within their conclusion. Process tracing could eliminate collinear variables to discover which variables have differences among outcomes of approved or rejected windmills. For example, in testing their second theory regarding increased networks, interviews could determine which communities have strong and weak networks. Strong networks could be a necessary condition for having a rejected windmill site. This provides increased evidence their second theory is closer to causation of rejected windmill sites than their statistically significant conclusion, which stated that communities with higher education levels have more rejected sites. Both statements are significant, but stronger networks dig deeper towards causal mechanisms. This can be achieved through deterministic approaches.

3.4.2 Existing Studies Using Deterministic Approaches

This section will share examples of deterministic approaches in use, first featuring recent studies from energy justice literature and next sharing examples of non-energy related studies utilizing QCA, process tracing, and counterfactuals. Examples include topics of how business models impact energy justice, natural gas infrastructure justice implications, mega solar development decisions, and low-carbon impacts. While the topics are different in context, they each focus on energy justice related research and use some form of deterministic approaches in their methods.

Hiteva and Sovacool's (2017) study compares four case studies seeking to describe how different innovative business models can impact energy justice. Cases are similar and have variance by choosing different scales (local, sub national, regional, and global). This variability helps in further analysis to determine which scale is more or less effective compared to another. Descriptive analysis showed significant characteristics impacting categories within the energy justice decision making framework. The study has the basic requirements to progress to QCA (small-N, homogeneity, and variable data) and subsequent causal analysis, however their research question is not ambitious enough for causation. This study would benefit by further development of explanatory and outcome variables, thus creating a table of conditions to be further analyzed for causal inference and causal mechanisms via process tracing and counterfactual analysis.

Mary Finley-Brook et al.'s (2018) study on critical energy justice in U.S. natural gas infrastructure compared six different U.S. liquid natural gas (LNG) terminals in the Atlantic states region under development and listed their respective energy injustices by categorizing them into distributional, procedural, recognition, and environmental. Listing injustices among a group of like cases is the first step to starting a deterministic approach, but the list alone is not a deep enough look to seek causal mechanisms and correlations among cases that carry similar outcomes.

Timothy Fraser and Andrew Chapman's (2018) study on social equity impacts in Japan's mega-solar siting process analyzed 29 survey responses from local offices from Japan's 200 largest mega-solar plants constructed since 2010, combined with results from 18 interviews with relevant actors in six case studies. Using QCA and process tracing, they make the case for causation between identified siting factors and social equity impacts within one particular case study. QCA helped the authors categorize their coded surveys and interviews into explanatory factor themes such as "municipal government influential in project" and "land value influential in project" and determined each to be present or not present in each case. The next part of their research focused on one case study and organized key factors, complementary factors, and intervening factors to the outcome of social equity impacts. Their analysis showed that land availability was a necessary factor while the value of the land alone would be insufficient to explain social equity outcomes. Their research is a good example of how deterministic approaches can assist researchers in seeking causality within energy justice cases.

Luis Mundaca et. al's. (2018) study compares Germany and Denmark's "successful" low-carbon energy transition with respect to energy justice using process tracing to identify causal inferences within each case and compares the two cases for unique differences. Note that while process tracing is not QCA, Beach (2012) identified process tracing as a value-add to discover within-case causal impacts. When performed in combination with QCA, process tracing explores deeper conjunctions. Mundaca et al., found that in both cases, the low-carbon energy transition (dependent variable) was guided by a sequence of multiple events that led to a turning point, or crisis, within the communities. These crises seemed to be the determining causal factor for creating a low-carbon energy transition. An additional mechanism was the need for strong policy support from multiple levels of government, including subsidies and complementary measures. Mundaca et al. noted that qualitative analysis of a perceived (in)justice is a challenge. This is due to the temporal aspects of the data and time delay from data collection (surveys or interviews) to the time period under analysis. In this case, their data collection was from 2015-2017 while their analysis period was 1997-2007. Despite those challenges, process tracing can assist in discovering causal mechanisms within energy justice analysis.

Outside of energy justice, Giugni and Yamasaki (2009) performed a literal comparison of a new QCA study next to a previously performed statistical regression. This study compared three models of social movements: direct, indirect, and joint effect. Twenty-eight cases of social movements (from three countries) were organized with a variety of explanatory variables (i.e. public opinion, political alliances, etc.) and the outcome variable (policy change). In conclusion, QCA had similar results compared to the original regression-based study but also offered additional methodological possibilities with causal pathways. Loss of information due to dichotomization of variables was noted as a limitation to QCA, however due to the similar conclusions with regression, that risk was deemed insignificant.

A study from Dirk Berg-Schlosser (2007) used both regression analysis and QCA to assess which characteristics determine success in African nations. Their regression correlated high significance to GDP and proportion of agriculture active population to democratic transition. QCA discovered deeper case analysis that the acceptance of democratic rules by the losers in an election was a necessary, but not sufficient condition. He concluded that comparative analysis may help to better understand the situation and overcome widely held simplistic views of Africa (Berg-Schlosser, 2008).

3.4.3 Framework for Shifting to Deterministic Approaches

In summary, shifting to deterministic approaches can be achieved if by considering a variety of changes to a research design. These changes improve homogeneity by focusing upon a case study, thus eliminating unlike variables. These approaches can be used in combination with qualitative and quantitative methods, improved the overall design through a mixed methods approach. The framework shown in Figure 3.6 illustrates a process to consider during research design to make the shift to deterministic approaches.

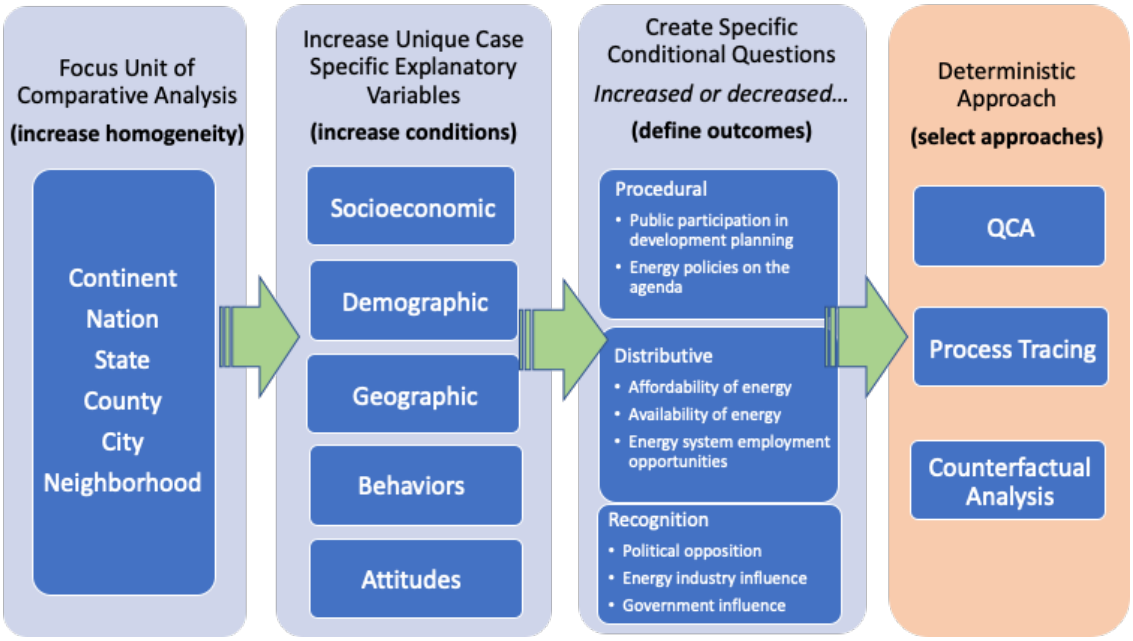


Figure 3.6 Framework for shifting energy justice research to deterministic approaches

The process starts with evaluating current unit of comparative analysis and narrowing the focus to increase homogeneity between units. Next, by increasing unique case specific variables will increase in-depth case knowledge and provide an increased opportunity to discover causal mechanisms between variables and outcomes. Creating specific energy justice conditional questions relative to procedural, distributive, and recognition justice within research topic of interest will allow for more focused results when performing the desired deterministic approach. The selection of what particular deterministic approach will depend on the volume and type of explanatory and outcome variables decided upon.

The evaluation process is typically iterative, requiring multiple analysis as the research gets to know the cases in more depth (Pattyn, Molenveld, and Befani, 2019). Process tracing and counterfactual analysis are good tools to use either to narrow down variables for further analysis or to seek final causal analysis with a limited number of variables. QCA works well with a lot of variables as "a large amount of qualitative data can be systematically analyzed" (Hellstrom, 1998, p. 262). Software tools such as Tosmana, can assists researchers with analysis (Thiem and Dusa, 2013).

3.5 Conclusions

This chapter shows that energy justice scholarship can develop research questions that move beyond descriptive analysis of injustices in society and towards causal analysis, which can provide policy decision makers with substantial evidence to change policies that will create new outcomes. An empirical analysis of current energy justice literature illustrates that energy justice questions have not yet been answered through deterministic approaches. Yet the majority of research questions have the hallmark criteria to utilize case-oriented methods, including an in-depth knowledge of the case, grounded theory development, and potential historical analysis.

3.5.1 Implications

Features within energy justice research such as case-oriented focus, potential for in-depth case knowledge, and opportunity for comparative analysis, provides researchers good research design elements to pursue deterministic approaches such as QCA, process tracing, and counterfactuals. These approaches discover causal mechanisms between combinations of explanatory variables resulting in carefully chosen outcome variables. Thorough methods analysis of top energy justice researchers and journals clearly shows that causal analysis through deterministic methods are not being employed compared to more commonly used descriptive analysis. Also, geographic distribution of case studies within the energy justice literature displays an imbalance towards European nations. Since justice issues are found throughout all parts of the globe, awareness of this imbalance should encourage researchers to explore questions of energy justice in new regions. The shifting energy justice to deterministic approaches framework developed in this chapter provides researchers with a visual process to consider in the early stages of their research design and provides experienced scholars a process to revisit prior studies if they desire to seek causal analysis through deterministic approaches in their prior case studies.

3.5.2 Limitations

One critical element of case-orientated and deterministic methods is the limited causal inference within conclusions. Results must remain within the researched case-study. In order to have confidence within case study analysis, careful attention must be paid to conceptual equivalence between cases while acknowledging sampling bias similar to that

of variable oriented designs. Many energy justice studies to date have large geographic and geo-political cases, such as nations and continents. While some deterministic approaches can be used to understand what is happening within these structures, the amount of potential intervening variables is high and should be noted when making deterministic conclusions regarding these types of cases. Even smaller in-depth case study analysis leaves room for unknown variables, therefore adding more potential variables to the analysis leads to more confidence in results.

3.5.3 Recommendations

Most importantly, causal analysis leading to insights into causal mechanisms through deterministic methods, despite being challenging, is important in providing policy and decision makers the tools needed to not only describe injustices in society. Causal analysis and causal mechanisms can lead to suggested solutions within the causal chain of events in order to prevent undesired outcomes from reoccurring. Energy justice researchers have the tools to recommend remedies to injustices across the global. A future study would be taking the suggested research design changes for multiple studies and perform the recommended shifts to deterministic approaches. Results from such a study could provide additional suggestions and evidence to shift towards these approaches. Further emphasis from energy justice researchers should be put on including deterministic approaches to answer their case-oriented research questions.

3.6 References

Babbie, E. (2007). *The practice of social research*. 11th. Belmont, CA: Thomson Wadsworth, 24(511), 66.

Beach, D. (2012). And Never the Twain Shall Meet? Lessons from the Use of Combining QCA and Process Tracing in a Nested Analysis Explaining Congruence between Voter Views and Governmental Positions in EU Constitutional Negotiations. *Lessons from the Use of Combining QCA and Process Tracing in a Nested Analysis Explaining Congruence between Voter Views and Governmental Positions in EU Constitutional Negotiations*.

Beach, D., & Pedersen, R. B. (2019). *Process-tracing methods: Foundations and guidelines*. University of Michigan Press.

Berg-Schlosser, D. (2008). Determinants of democratic successes and failures in Africa. *European Journal of Political Research*, 47(3), 269-306.

Berg, B. L., & Lune, H. (2007). Qualitative research methods for the social sciences 6th edition. *Pearson.*

Broto, V. C., Baptista, I., Kirshner, J., Smith, S., & Alves, S. N. (2018). Energy justice and sustainability transitions in Mozambique. *Applied Energy, 228,* 645-655.

Brady, H. E. (2008). *Causation and explanation in social science* (pp. 217-70). na.

Brady, H. E., & Collier, D. (Eds.). (2010). *Rethinking social inquiry: Diverse tools, shared standards*. Rowman & Littlefield Publishers.

Bullard, R. D. (2008). *Dumping in Dixie: Race, class, and environmental quality.* Westview Press.

Cairney, P. (2019). Understanding public policy. Red Globe Press.

Cesar, S. (2019). Earning a social license to operate in mining: A case study from Peru. *Resources Policy*, 64, 101482.

Collier, D. (2011). Understanding process tracing. PS: Political Science & Politics, 44(4), 823-830.

Cooper, L. M., & Sheate, W. R. (2002). Cumulative effects assessment: A review of UK environmental impact statements. *Environmental impact assessment review*, 22(4), 415-439.

Devine-Wright, P. (2005). Local aspects of UK renewable energy development: exploring public beliefs and policy implications. *Local Environment, 10*(1), 57-69.

Devine-Wright, P., Devine-Wright, H., & Sherry-Brennan, F. (2010). Visible technologies, invisible organisations: An empirical study of public beliefs about electricity supply networks. *Energy policy, 38*(8), 4127-4134.

Ding, L., Zhang, F., & Shuai, J. (2018). How Do Chinese Residents Expect of Government Subsidies on Solar Photovoltaic Power Generation? —A Case of Wuhan, China. *Energies, 11*(1), 228.

Eames, M. (2011). Energy, innovation, equity and justice.

ECOSOC, U. (2019). Special Edition: Progress towards the Sustainable Development Goals Report of the Secretary-General. *Advanced unedited version*. New York (US): *United Nations*.

Enevoldsen, P., & Sovacool, B. K. (2016). Examining the social acceptance of wind energy: Practical guidelines for onshore wind project development in France. *Renewable and Sustainable Energy Reviews, 53*, 178-184.

Finley-Brook, M., Williams, T. L., Caron-Sheppard, J. A., & Jaromin, M. K. (2018). Critical energy justice in US natural gas infrastructuring. *Energy research & social science, 41*, 176-190.

Forman, A. (2017). Energy justice at the end of the wire: Enacting community energy and equity in Wales. *Energy Policy, 107*, 649-657.

Fraser, N. (1995). Recognition or redistribution? A critical reading of Iris Young's Justice and the Politics of Difference. *Journal of Political Philosophy*, *3*(2), 166-180.

Fraser, T., & Chapman, A. J. (2018). Social equity impacts in Japan's mega-solar siting process. Energy for Sustainable Development, 42, 136-151.

Fuller, S., & McCauley, D. (2016). Framing energy justice: perspectives from activism and advocacy. *Energy Research & Social Science*, *11*, 1-8.

George, A. L., Bennett, A., Lynn-Jones, S. M., & Miller, S. E. (2005). *Case studies and theory development in the social sciences*. MIT Press.

Gerring, J. (2006). *Case study research: Principles and practices*. Cambridge university press.

Gerring, J. (2008). The mechanismic worldview: Thinking inside the box. *British journal of political science*, *38*(1), 161-179.

Giugni, M., & Yamasaki, S. (2009). The policy impact of social movements: A replication through qualitative comparative analysis. *Mobilization: An International Quarterly, 14*(4), 467-484.

Goertz, G. (2017). *Multimethod research, causal mechanisms, and case studies: An integrated approach*. Princeton University Press.

Goodman, J. (2009). From global justice to climate justice? Justice ecologism in an era of global warming. *New Political Science*, *31*(4), 499-514.

Hall, S. M., Hards, S., & Bulkeley, H. (2013). New approaches to energy: equity, justice and vulnerability. Introduction to the special issue. *Local Environment, 18*(4), pp. 413–421.

Heffron, R. J., & McCauley, D. (2014). Achieving sustainable supply chains through energy justice. *Applied Energy*, *123*, 435-437.

Heffron, R. J., & McCauley, D. (2017). The concept of energy justice across the disciplines. *Energy Policy*, *105*, 658-667.

Heffron, R. J., McCauley, D., & de Rubens, G. Z. (2018). Balancing the energy trilemma through the Energy Justice Metric. *Applied energy*, *229*, 1191-1201.

Hellström, E. (1998). Qualitative Comparative Analysis: A useful tool for research into forest policy and forestry conflicts. *Forest Science, 44* (2), 254-265.

Hiteva, R., & Sovacool, B. (2017). Harnessing social innovation for energy justice: A business model perspective. *Energy Policy, 107,* 631-639.

Islar, M., Brogaard, S., & Lemberg-Pedersen, M. (2017). Feasibility of energy justice: Exploring national and local efforts for energy development in Nepal. Energy Policy, 105, 668-676.

Jenkins, K. (2018). Setting energy justice apart from the crowd: lessons from environmental and climate justice. *Energy Research & Social Science*, *39*, 117-121.

Jenkins, K., McCauley, D., & Forman, A. (2017a). Energy justice: a policy approach. *Energy Policy, 105*, 631-634.

Jenkins, K., McCauley, D., & Warren, C. R. (2017b). Attributing responsibility for energy justice: A case study of the Hinkley Point Nuclear Complex. *Energy Policy, 108*, 836-843.

King, G., Keohane, R. O., & Verba, S. (1994). *Designing social inquiry: Scientific inference in qualitative research*. Princeton university press.

Lewis, D. (1973). Counterfactuals and comparative possibility. In Ifs (pp. 57-85). Springer, Dordrecht.

Liljenfeldt, J., & Pettersson, Ö. (2017). Distributional justice in Swedish wind power development–An odds ratio analysis of windmill localization and local residents' socio-economic characteristics. *Energy Policy, 105,* 648-657.

Little, D. (1991). *Varieties of social explanation* (Vol. 141). Boulder: Westview Press.

Linneman, T. J. (2011). *Social statistics: the basics and beyond*. Routledge.

Mahoney, J. (2008). Toward a unified theory of causality. *Comparative Political Studies, 41*(4-5), 412-436.

McCauley, D. A., Heffron, R. J., Stephan, H., & Jenkins, K. (2013). Advancing energy justice: the triumvirate of tenets. *International Energy Law Review, 32*(3), 107-110.

Miller, D. (1979). *Social justice*. OUP Oxford.

Mundaca, L., Busch, H., & Schwer, S. (2018). 'Successful' low-carbon energy transitions at the community level? An energy justice perspective. *Applied energy, 218*, 292-303.

Newell, P., & Mulvaney, D. (2013). The political economy of the 'just transition'. *The Geographical Journal*, *179*(2), 132-140.

Pattyn, V., Molenveld, A., & Befani, B. (2019). Qualitative comparative analysis as an evaluation tool: Lessons from an application in development cooperation. *American Journal of Evaluation*, 40(1), 55-74.

Ragin, C. C. (1987). *The comparative method: Moving beyond qualitative and quantitative strategies*. University of California Press.

Richard, T. (2009). Qualitative versus quantitative methods: Understanding why qualitative methods are superior for criminology and criminal justice. *Journal of Theoretical and Philosophical Criminology, Vol 1* (1).

Rihoux, B., & Ragin, C. C. (2008). *Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques (Vol. 51)*. Sage Publications.

Saunders, J. (2011). Energy justice: the policy challenges. In *Energy justice in a changing climate: defining an agenda, INCIUESEV conference*.

Schlosberg, D. (2003). The justice of environmental justice: reconciling equity, recognition, and participation in a political movement. *Moral and political reasoning in environmental practice*, *77*, 106.

Schlosberg, D. (2012). Climate justice and capabilities: A framework for adaptation policy. *Ethics & International Affairs*, *26*(4), 445-461.

Sovacool, B. K. (2009). The importance of comprehensiveness in renewable electricity and energy-efficiency policy. *Energy Policy, 37*(4), 1529-1541.

Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied Energy*, *142*, 435-444.

Sovacool, B. K., & Ratan, P. L. (2012). Conceptualizing the acceptance of wind and solar electricity. *Renewable and Sustainable Energy Reviews, 16*(7), 5268-5279.

Sovacool, B. K., Sidortsov, R. V., & Jones, B. R. (2013). *Energy security, equality and justice*. Routledge.

Sullivan, D., & Tifft, L. (2007). *Handbook of restorative justice: A global perspective*. Routledge.

Tewksbury, Richard. (2009). Qualitative Methods: Understanding Why Qualitative Methods are Superior for Criminology and Criminal Justice. *Journal of Theoretical and Philosophical Criminology, 1*(1).

Tober, M. (2011). PubMed, ScienceDirect, Scopus or Google Scholar–Which is the best search engine for an effective literature research in laser medicine?. *Medical Laser Application*, *26*(3), 139-144.

Thiem, A., & Dusa, A. (2013). QCA: A package for qualitative comparative analysis. *The R Journal*, 5(1), 87-97.

Walker, G. (2009). Beyond distribution and proximity: exploring the multiple spatialities of environmental justice. *Antipode*, *41*(4), 614-636.

Walker, G. (2012). *Environmental justice: concepts, evidence and politics*. Routledge.

Walker, G., Hunter, S., Devine-Wright, P., Evans, B., & Fay, H. (2007). Harnessing community energies: explaining and evaluating community-based localism in renewable energy policy in the UK. Global Environmental Politics, 7(2), 64-82.

Warwick, D. P., & Osherson, S. (1973). *Comparative research methods*. Prentice-Hall, Inc.

4 Why is the Enbridge Line 5 pipeline crossing at the Straits of Mackinac on the agenda? Using Twitter data to display open policy windows and how they are impacted by reinforcing spirals in social media

Abstract

Aging oil and gas pipeline infrastructure have experienced increased negative attention in recent decades due to multiple disasters, which policy scholars refer to as focusing events. While the agenda setting literature helps to explain how focusing events open policy windows, it lacks research on social media's impact and subsequent reinforcing spirals driving the agenda. This chapter uses Twitter data alongside Kingdon's multiple streams approach to provide evidence that the problem, policy, and politics streams are active and converging, therefore creating an open policy window for the Enbridge Line 5 pipeline crossing at Straits of Mackinac in Michigan. A social network analysis of related historical Twitter data from the past decade shows that reinforcing spirals within social media can contribute to larger open policy windows. This chapter concludes with recommendations for further research that broaden use of social media sources by including large Twitter datasets for a more comprehensive analysis.

Keywords: social network analysis, multiple streams approach, focusing events, pipelines, Enbridge Line 5, reinforcing spirals

4.1 Introduction

Oil and gas pipelines have experienced increased visibility of their debates in the past decade as strong anti-pipeline coalitions have challenged economic and business interests of pro-pipeline coalitions (Kandiyoti, 2012). Modern transparency and social media of large proposed energy infrastructure projects have helped mobilize broader and stronger anti-pipeline coalitions to influence policymakers in the expansion or creation of pipeline energy transport (Deschamps, 2014). For example, the Keystone XL pipeline in Nebraska, Dakota Access Pipeline, and Canada's Transmountain pipeline have all been visible in mainstream media for their development debates. These new projects all have the same things in common: visible public dissent towards their creation, companies being publicly shamed, and politicians picking partisan sides of the debate based on their core constituents, not based on sound science. Timothy Gravelle and Erick Lachapelle (2015) showed that public attitudes towards the Keystone pipeline were divided among economic and environmental political lines with some spatial proximity factors as well. Pipeline infrastructure permitting from the past allowed for millions of miles of pipelines to be installed without much visible national opposition. Individuals and interest groups can join in on a cause quickly through selective media and reinforce their own beliefs making it more difficult to hear opposing views. According to Michael Slater's (2007) study on media selectivity and its impact on behavior, these "reinforcing spirals"

in media have an impact on agenda setting for individuals and interest groups. Self-selecting media and social media now act as catalysts for policy agenda setting. This is noticeable in once "sleepy" policy universes such as today's pipeline policy regime.

Both reinforcing spirals and focusing events have an impact on agenda setting. The policy attention received by Enbridge's Line 5 issue this past decade makes a great case to study the combined impact of these two important agenda setting theories. According to Thomas Birkland (1998), "focusing events serve as important opportunities for politically disadvantaged groups to champion messages" (p.54). Birkland continues by noting "more powerful groups will work to downplay an event's significance by providing officials and the public with alternate explanations" (p. 57).

This chapter uses John Kingdon and James Thurber's (1984) multiple streams approach to explore how reinforcing spirals within social media have extended the open policy windows, using social network analysis. This is important for the agenda setting literature because in the era of social media, reinforcing spirals could challenge the traditional influence of focusing events on agenda setting. The energy policy agenda is being disrupted by the way media and news is consumed, potentially influencing which aging infrastructure projects should or should not have attention. As noted in Kingdon's agenda setting theory, agenda setting happens in "windows of opportunity" (Kingdon, 1993). Windows open and close, however the Enbridge Line 5 policy debate is still open almost a decade beyond two major oil disaster focusing events in 2010; 1) the single largest marine drilling oil spill in history, BP's Deepwater Horizon Gulf of Mexico oil spill (Barron, 2012), and 2) the second largest inland oil spill in United States history, the Enbridge Line 6B Kalamazoo, MI pipeline spill (Riesterer, 2019). One hypothesis is that reinforcing spirals in social media are causing the policy window to remain open.

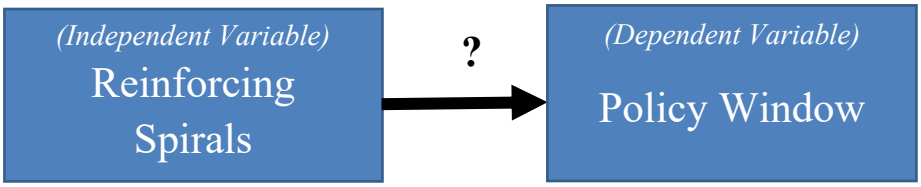
First, this study will use Twitter and Kingdon's multiple streams approach to show that the Enbridge Line 5 policy window is open, looking at the convergence of problem, policy, and politics. Next, this chapter will use social network analysis and Twitter to determine if reinforcing spirals are occurring within the Enbridge Line 5 pipeline policy issue, thus contributing to an extended policy window.

4.1.1 Research Questions & Hypothesis

Question 1: Is Enbridge Line 5 policy window open? Based on multiple streams approach, it is necessary that a problem, policy, and politic streams are active and involve policy entrepreneurs in both elected offices and individuals or organizations. Media has consistently mentioned the problem with Enbridge Line 5 over the past decade. Multiple policies have been introduced designed impact Enbridge Line 5 over the past decade. Politics have been engaged through consistent communication from politicians (policy entrepreneurs) over the past decade.

Question 2: How do reinforcing spirals in social media impact the Enbridge Line 5 policy window? A limited number of actors own content creation and distribution of

information through social media, leading to a polarized public. Reinforcing spirals in social media contribute to the policy window to remaining open.



After the 2010 Deepwater Horizon offshore oil rig disaster, President Obama issued an executive order creating a commission to study the spill. That commission provided new safety rules and recommendations to promote environmental stewardship of the ocean, coasts, and Great Lakes (The Guardian, 2016). It is not the first time that an energy policy window opened following a disaster, or "critical juncture," as noted by Darren McCauley et al. (2018), referencing Germany's nuclear policy change window following the Chernobyl nuclear disaster in Ukraine. This shows that focusing events can have an immediate impact during their "window of opportunity;" however, Enbridge Line 5 policy debates and changes have been happening for many years beyond the July 2010 Enbridge Line 6B pipeline spill focusing event, as shown through the 2018 legislative debates in both MN and MI for pipeline replacement (Nelson and Dunbar, 2018; Zaniewski, 2018; Malewitz, 2018). People select media outlets and content consistent with their beliefs, therefore reinforcing those beliefs (Wicks et al., 2014). Zhao's (2009) study investigated the impact of reinforcing spirals on attitudes towards global warming and found they did exist and were consistent with Slater's early models and theories. Therefore, it is likely that people will select media supporting their environmental beliefs, leading to reinforcing spirals in pipeline policy.

4.2 Literature Review

This review features descriptions of the multiple streams approach policy process theory and focusing events, policy windows and their connection to agenda setting, and definition of 'reinforcing spirals' and their connection to media. An understanding of the multiple streams approach is critical for this chapter because the theory of converging problem, policy, and politics streams is what creates the open policy window. Policy windows can be triggered by focusing events, therefore an understanding of focusing event literature and policy change is needed to discuss to also define the start of a policy window opening. Lastly, literature on reinforcing spirals in communication is reviewed to help define the impacts of reinforcing spirals relative to agenda setting processes.

4.2.1 Multiple Streams Approach and Focusing Events

Kingdon's multiple stream approach (MSA) expands upon Michael Cohen et al.'s (1972) article defining the "garbage can" approach, where independent problems and solutions mix together. MSA describes when three streams (problem, policy, and politics) converge

to form a policy "window of opportunity" and only in this window of opportunity can substantial policy change occur (Kingdon and Thurber, 1984).

It is important to establish that focusing events do have a significant impact on agenda setting as they bolster attention to the problem stream (Cairney and Jones, 2015). Birkland (1998) states, "a focusing event is an event that is sudden; relatively uncommon; can be reasonably defined as harmful or revealing the possibility of potentially greater future harms; has harms that are concentrated in a particular geographical area or community of interest; and that is known to policy makers and the public simultaneously" (p. 54). Birkland's article goes on to describe four elements to determine whether or not this cause and effect phenomenon is taking place. First, was there a change in the dominant issues on the agenda? Second, was there a change in the dominant issue in a policy domain? Third, was there evidence of event-driven group mobilization? Fourth, was there evidence of group attempts to expand or contain issues in the wake of these events? Geography also has an important role in determining the impact of potential focusing events as Birkland noted that harms of the event have higher impact closer to the event epicenter (earthquake, oil spill, etc.). It is considered evidence of impact on the agenda if the area well outside of the immediate geographic area is affected. This usually spans over entire policy regimes, such as the pipeline policy regime. Before Birkland, Kingdon and Thurber (1984) recognized that radical policy change only happens in a 'window of opportunity' and that it will not change if it does not receive enough attention.

Bradford Bishop's (2014) article displayed evidence that the 2010 Deepwater Horizon oil spill disaster had a dramatic impact on public opinion and subsequently the offshore drilling policy regime by measuring Google searches for "offshore oil drilling" before and after the time periods of the oil spill and comparing it to an Associated Press survey which measured public opinion on the environment. There was almost an exact correlation in a spike for Google searches with increased public opinion of the environment being important, all of which aligned with the spill timeline. Bishop was seeking public opinion data while this study will seek correlation with energy policy changes. He did not elaborate on the impact of Google searches to the debate and how that information spread changed policy. Policy change via focusing events alone is difficult to achieve for aging infrastructure which has experienced a significant accident. The presence of reinforcing spirals through social media may catalyze the agenda setting process and lengthen the 'window' for policy change.

4.2.2 Policy Windows

Understanding how and why governments make decisions surrounding policy alternatives on their agenda is a challenge for social researchers (Farley et al., 2007). There are multiple theories to how and when policy windows occur within the literature. As previously described, Kingdon's (1984) multiple streams approach describes the elements that contribute to the policy window itself. Historical institutionalism, as described by Paul Pierson (1994, 2000) and Kathleen Thelen (1999) argues that structure

matters and the 'path dependency' promotes stable policies which become further entrenched and more difficult to change (Zehavi, 2012). This is important to note for large complex infrastructure designed to last decades, because policy change is difficult within large historical structured institutions. "Political institutions are often "sticky"-specifically designed to hinder the process of institutional policy reform" (Pierson, 1996, p.126).

Frank Baumgartner and Bryan Jones's (1993) punctuated equilibrium theory (PET) describes that policy change (windows) occurs within long periods of incremental change in standing policy regimes followed by short periodic bursts of radical change during 'windows' such as disasters, extreme political change, or other unique events in the timeline. This research only strengthens Kingdon's multiple streams approach by adding a temporal element to an already established theory of policy change. Paul Sabatier and Hank Jenkins-Smith (1988, 1993) work on the advocacy coalition framework (ACF) explain policy change over long periods of time by sustained core beliefs from subsystems of actors (advocacy coalitions). ACF doesn't contradict MSA or PET, but rather further defines the context of actors and their intentions within the policy windows. Kingdon's 'policy entrepreneurs' are analogous to Sabatier and Jenkins-Smith's actors within coalitions. Both PET and ACF support and expand upon Kingdon's theory of policy change through policy windows and all three can be applied to aging infrastructure and energy pipeline policy change over time. McCauley et al. (2018, p.322) notes, "critical junctures are currently undervalued in energy research as significant moments in policy trajectories that open policy opportunity windows. We must understand when such events take place, and, above all, how change agents successfully exploit them. When we consider the 'stickiness' of policy structures and processes, we must understand that change takes place over a long time."

Three agenda setting streams (problem, policy, and politics) must be present for a policy window to be open, according to Kingdon and Thurber (1984). According to Kingdon, the problem stream represents various attempts for broad participation in an issue (Kingdon, 1995; Robinson and Eller, 2010). Problems can also be recognized through media, as discovered by Cohen (1963) and described in Stuart Soroka (2002, p.265) by stating "public agenda-setting work demonstrates that increased issue salience for the media leads to increase issue salience for the public- in agenda setting terms, that the media has an impact on the public agenda." The policy stream, as defined by Kingdon and Thurber (1984) is a community composed of researchers, advocates, and others who analyze problems and formulate possible solutions (Sabatier, 1991). Kingdon (1995) also believes that the policy stream is dependent on this diverse group (Lieberman, 2002). Steffen Brunner (2008) expands upon earlier analogies for the policy stream as a "primeval soup in which ideas float around, confront one another and combine". Kingdon's view of the political stream, according to Jan Odom-Foreen and Ellena Hahn (2006), describe it as "composed of political issues, such as national mood, election results, and changes in administration. The stream focuses on the political world itself and public opinion" (Kingdon, 2003). A key component of the multiple streams approach is the 'policy entrepreneur', which in Kingdon and Thurber's (1984) definition "…could

be in or out of government, in elected or appointed positions, in interest groups or research organizations. But their defining characteristic…is their willingness to invest their resources" (p. 122). These specific actors are engaged throughout every stream however, activity from specific entrepreneurs within this study can be analyzed to help show the political stream.

Energy policy has multiple example studies showing how policy windows within their particular cases have changed course for historically stable regimes. Wouter Poortinga et. al.'s (2013) study on public perceptions of climate change and energy futures before and after the Fukushima accident, showed how the Fukushima nuclear accident in March of 2011 had a profound impact on Japan's energy future, resulting in a goal from the Japanese government to be nuclear free by 2040. Nick Pidgeon et al. (2008) noted that the absence of any major nuclear incidents since the Soviet Union's Chernobyl in 1986, has led to the public being less attentive to the risks of nuclear power. Nuclear energy policy change is analogous to energy pipeline infrastructure with regards to major disaster incidents opening policy windows to what are traditionally stable policy regimes over long periods of time. Energy policy change has been tied to attitudes regarding energy sources and climate change. From the 2000's, Karen Bickerstaff et al. (2008) has observed that nuclear energy has been viewed as a potential means to reduce climate change when used as an alternative to fossil fuels such as coal. Adam Corner et al. (2011) explored British public attitudes on nuclear power, climate change, and energy security, and found that changes in attitudes over time were relatively modest. The public had a "reluctant acceptance" of nuclear power. This finding suggests that policy windows are even more critical to policy change within long standing energy infrastructure. Jonn Axsen's (2014) study on citizen acceptance of Canada's Northern Gateway Pipeline, which would route oil from Alberta sands to the coast of British Columbia, shows a geographical distribution of acceptance with Alberta (the producer) featuring higher acceptance than British Colombia, which is deemed to have the highest environmental risks with larger pipeline mileage, marine terminals, and coastal tanker traffic. This conclusion is not surprising, but shows that even within policy windows, policy change within energy policy and infrastructure possesses a geographical layer to both public and policy maker attitudes and will vary place to place for the same issue.

Another example of policymakers leveraging policy windows to implement policy change within pipelines is when the European Union (EU) implemented and negotiated bilateral agreements for the Southern Gas Corridor, a pipeline system that would deliver gas to Europe while bypassing Russia. "International crisis (security) and negotiations (climate) were leveraged to create urgency" (Eberlein, 2012, p. 166). This is yet another example of how policy windows are critical to create policy change within energy infrastructure decisions and specifically oil and gas pipelines.

4.2.3 Reinforcing Spirals in Media

The impact of reinforcing spirals within media, or the ability to self-select news, even unknowingly, has been shown to increase attitude extremity and polarization (Stroud,

2011). Slater's (2007) "reinforcing spiral framework" helps explain the effects of media selection and its "spiral of ongoing influence". This effect is emphasized in either conservative or liberal news media and creates "echo chambers" for the respective audiences (Jamieson & Cappella, 2008). Before the reinforcing spiral framework became associated with political leaning media, Baumgartner and Jones (1993) foreshadowed the impact of reinforcing spirals in their punctuated equilibrium theory paper. They noted that greater focus on a problem can lead to more negative views of current policy, creating pressure on the dominant monopoly in power. Their later definition of positive feedback was characterized with the term "feeding frenzy" or "bandwagon effect"; this is also a precursor to Slater's reinforcing spiral framework (Baumgartner and Jones, 2002).

The concept of selection exposure is motivated by "beliefs that are linked to a person's interest in self-concept" (Feldman et al., 2014, p. 593). This theory is supported by studies showing people prefer to consume stories that confirm their existing beliefs on issues such as gay marriage, social security, and abortion, compared to stories that challenge their opinions (Garett, 2009; Knobloch-Westerwisk & Ming, 2009; Feldman et al., 2014). These studies have also shown that consequences of selective exposure have led to increased polarization of individual attitudes and greater attitude extremity (Kim, 2009; Feldman et al., 2014).

The positive rise of digital and social media has created the ability to "deepen relationships and facilitate the formation of support networks" (World Economic Forum, 2020). Consumption of digital (online) media in the United States has surpassed traditional media (includes television, radio, newspapers, and magazines) as the primary source of information as shown in Figure 4.1 (Statistica, 2020a). Negatively, the rise in social media has led to the concern of greater individual isolation from diverse perspectives, further supporting echo chambers and reinforcing spiral theory. There have been some studies rebuking those perceptions such as Michael Beam et al.'s (2018) article claiming that Facebook news in particular may not be the culprit for increased citizen polarization showing that "Facebook users showed no over-time increases in pro-attitudinal news exposure compared to non-users" (p. 12). However, they also acknowledge their study only focused on Facebook news and no other social media platforms such as Twitter. This concludes that more research is needed on the impacts of modern social media usage and reinforcing spiral theory.

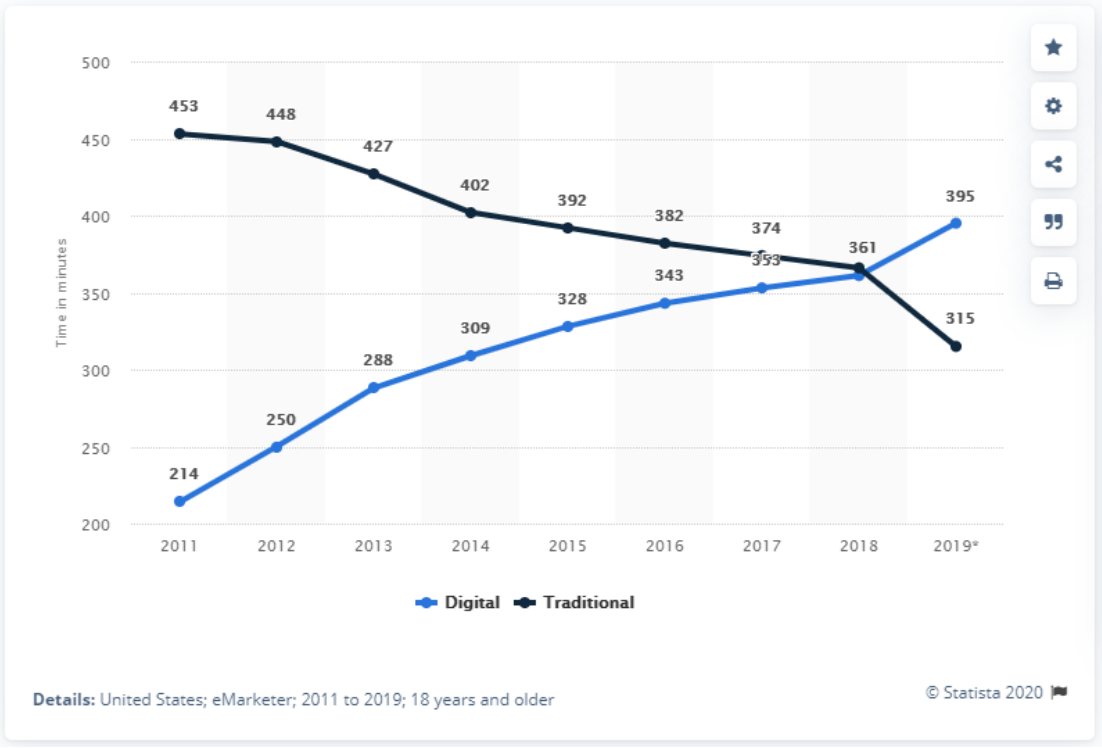


Figure 4.1 Time spent per day with digital versus traditional media in the United States from 2011 to 2019

Source: Statistica (2020a)

4.3 Background

Completed in 1953, the Enbridge Line 5 pipeline is a light crude and natural gas liquids (NGLs) pipeline that runs for 645 miles from Wisconsin, under the Straits of Mackinac, through Michigan to Sarnia, Ontario, as shown in Figure 4.2. The pipeline provides 540,000 barrels of NGLs per day, 24 hours per day, 7 days per week, 365 days per year. The Straits crossing is comprised of two 20-inch steel walled parallel pipelines secured on the bottom at maximum depths over 270ft (Enbridge, 2019).

On July 25, 2010, less than four months after the Deepwater Horizon Oil Spill in the Gulf of Mexico, Enbridge Line 6B ruptured at the Kalamazoo River crossing in southwest lower Michigan, releasing more than 800,000 gallons of crude oil, the second largest inland oil spill in United States history. Enbridge has spent over $1.2 billion in settlements, fines, and clean up fees (Riesterer, 2019). This focusing event coupled with consistent communication from Enbridge about the integrity and strength of their systems led to an increased interest in other pipeline water crossings owned and operated by Enbridge Inc., pointing at the highly hydrodynamic and environmentally sensitive Straits of Mackinac crossing featuring the over 60-year-old Line 5 pipeline. Policy makers and the public questioned the credibility of Enbridge, supported by the National

Transportation Safety Board's (NSTB) post spill investigation resulting in statements claiming Enbridge mismanagement caused the Kalamazoo tragedy (Linnet, 2012). These events led to a policy window for pipeline policy change led by multiple public protests, State Risk Assessment report requests, and policymaker statements over the past ten years. This sustained pressure for policy change creates an interesting case study for sustained policy windows.

Figure 4.2 Map of Enbridge Line 5 pipeline
Source: Enbridge Line 5 Brochure (2020)

Figure 4.3 2018 Protest to shutdown Enbridge Line 5

Source: oilandwaterdontmix.org (2018)

4.4 Data and Methods

This study uses social network analysis to determine if the Enbridge Line 5 policy window is still open and also determine if reinforcing spirals exist and how they impact the policy window duration. Concentrating on social media as the main driver of the reinforcing spirals, Twitter data was gathered and analyzed to display the social networks developed around the Enbridge Line 5 policy debate. With regards to policy windows, even in the early days of Twitter's usage, Hyokjin Kwak et al. (2010) found that nearly 85% of all tweets were topics of "headline news or persistent news in nature" (p. 591). This is supported by Bruns and Burgess's (2012) study on new methodologies with Twitter, as they found that official media Twitter accounts had become authoritative sources of information. This also applied to official accounts of elected officials. This supports the case that Twitter is a valid data source for analysis of key topics to determine whether or not the Line 5 Pipeline debate policy window is open.

Social network analysis enables researchers to map out interrelationships between each other and allows for further statistical analysis of comparing agenda networks that are displayed. Lei Guo's (2012) article described one methodological process for applying social network analysis in agenda setting research. Her study expands upon McCombs and Shaw's (1972) study describing media's ability to set the public agenda. Guo's (2012) research shows that social network analysis can examine network relationships to find "centrality" within particular media entities, or who is the most influential within the agenda setting process. Yun et al.'s (2016) study of social media and the flu, described how Twitter accounts can be a good metric for finding agenda setters. Yun used the keyword "flu" to determine network centralities (influencers), visualizing how information was connected and spread. Yun coded accounts as media, individuals, and medical professionals to further analyze the influence of particular groupings. Bruns and Burgess (2012) used key concepts to visualize hybrid social networks within Australia, clearly discovering the most influential individuals engaged in immigration policy via #GoBackSBS, as shown in Figure 4.4.

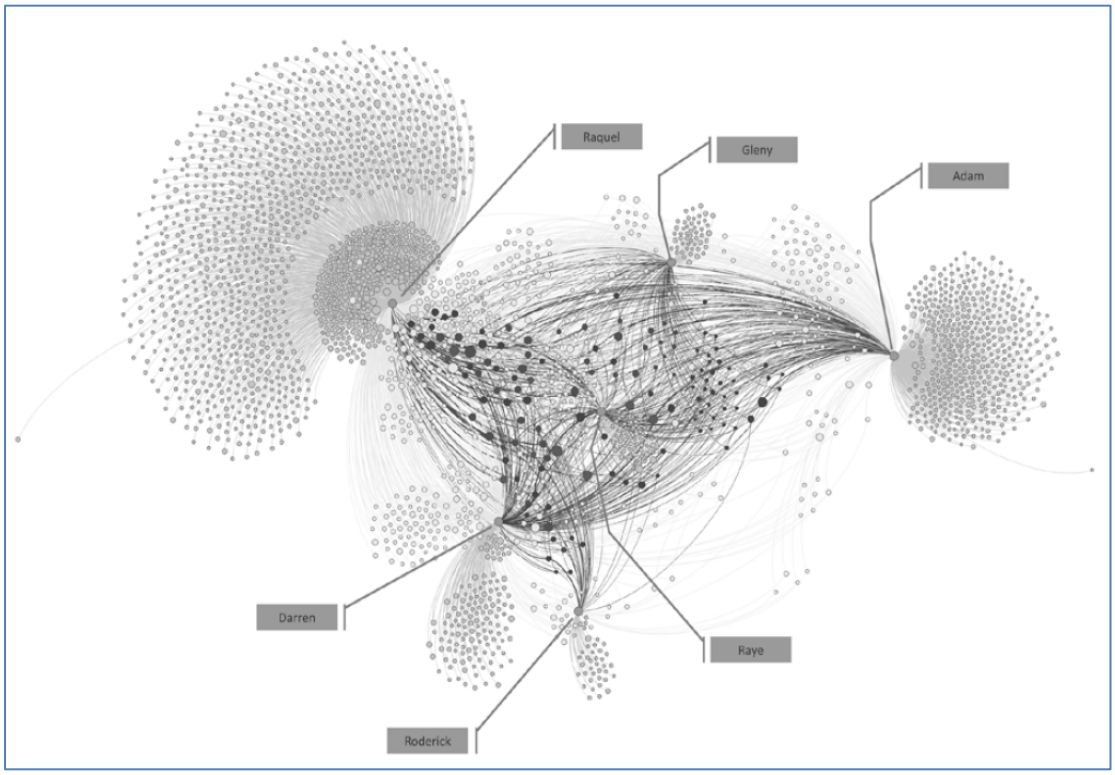


Figure 4.4 Example of social network map visualization with Twitter keywords: mentions of #GoBackSBS participants

Source: Bruns and Burgess (2012)

There are many different types of algorithms that can be used within social network graph layouts, each having their own unique benefits. The social network graph from Axel Bruns and Jean Burgess (2012) shows distinct clusters of Twitter users, which is organized by algorithms using centrality measures from edges (connections) and vertices (nodes/users). Figure 4.4 uses the Harel-Koren Fast Multiscale algorithm, which is used to visualize a clearer network pattern. This algorithm is designed to make all lines (edges) roughly the same length and minimize line crossings in order to make the graph more readable (Harel and Koren, 2001). The larger the node, the larger the centrality ranking. The Harel-Koren algorithm separates "communities" to visualize clusters of users and their influence. The other algorithm option available in NodeXL, the visualization software used in this study's graphing, is the Fruchterman-Reingold layout, which "attempts to find a layout that clusters tightly connected nodes near one another as well as simple geometric layouts like circles or grids" (Fruchterman and Reingold, 1991; Smith et al., 2009, p. 258)

Betweenness centrality is arguably the best measure of influence a user has with the social network, or as Jennifer Golbeck (2015) states, it is "widely used measure that captures a person's role in allowing information to pass from one part of the network to

another…a note with high betweenness is likely to yield insights about what both groups are doing and what is going on between those two groups" (p. 229).

$$BC(v) = \sum_{s \neq v \neq t \in V} \frac{\sigma_{st}(v)}{\sigma_{st}},$$

"where *V* is the set of vertices, *σst(v)* is the number of shortest paths from *s* to *t* passing through *v*, and *σst* is the total number of shortest paths from *s* to *t*" (Ediger et al., 2010, p. 585). All other centrality measures have their own unique mathematical algorithms, but this chapter will only describe their unique features and definitions within social network analysis.

Closeness centrality can be viewed as the efficiency of each individual spreading information to other individuals, or a measurement of "how long it takes to spread any information from a particular node to all other nodes in the network" (Farooq et al., 2018, p. 3). Warih Maharani et al. (2014) defines eigenvector centrality by noting it "favours nodes that have high correlations with many other nodes…in contrast to degree centrality it specifically favours nodes that are central within the network" (p. 2). In other words, it is similar to degree centrality but provides extra weight to influential nodes. In-degree centrality measures the number of edges others have initiated with a vertex. Out-degree centrality counts the number of edges a vertex has initiated with others. (Hansen, Shneiderman, and Smith, 2020). Within Twitter data, the interactions are following / followed, mentions, replies, and retweets.

4.4.1 *Phase 1: Determine if the Enbridge Line 5 policy window is open*

First, the "problem" can be established by reviewing the *Independent Risk Analysis for the Straits Pipeline*, a July 2018 risk assessment request led by Michigan Technological University and ordered by the State of Michigan detailing worst case scenarios for a breach in Line 5. (Michigan Technological University, 2018). The problem can be shown using broad impact data analysis from the independent risk assessment. In addition to referencing detailed risk assessment analysis of the *problem*, media affects research and agenda setting, and according to Gerald Kosicki (1993), shows connections that media content and the 'amount of space or time devoted to particular issues should be measured, and that this measurement should relate to either the amount of attention people pay to issues or to their judgements of the issue's importance" (p. 105). Note, these studies were performed well before the invention of modern social media platforms such as Twitter. Twitter has been utilized as a tool to disseminate digital media from official media outlets. Thomas Billard (2011) describes how "intermedia agenda-setting occurs among online news sources in much the same manner as among print news sources" (p.166). This opens the door to utilize online media sources as a tool to measure public awareness of problems, thus supporting the problem stream in agenda setting. Therefore, this chapter uses Twitter to summarize discussion of the Line 5 policy debate by searching

keywords “Enbridge”, “Line 5”, and the combination of “Line 5” and “Pipeline” for three major media outlets of interest identified through an initial analysis. Preliminary results of policy entrepreneur Twitter accounts resulted in three top media outlets delivering Line 5 news on Twitter: *The Detroit Free Press*, *The Detroit News*, and *MLive*. These three media outlets were chosen for Twitter analysis after initial results showed consistent mentions of the Line 5 issue compared to other media sources. *The Detroit Free Press* and *The Detroit News* are owned by the same parent company Gannett Co. through a recent 2019 acquisition. The organizations share business operations but own and operate independent newsrooms (Noble and Associated Press, 2019). MLive is owned by MLive Media Group and is Michigan’s largest news and information site with 2.7 million monthly unique visitors as of January 2019 (Hoogland, 2019). Each of the three media outlets report independent stories and produce unique content, therefore data analysis is not directly overlapping.

Next, this chapter examines the policy stream through an analysis of recent (2010-2019) Michigan legislative policy impacting and corroborating analysis of media mentioning the Line 5 debate during the same time period. This information will be obtained via Twitter keyword searches for “Enbridge”, “Line 5”, and the combination of “Line 5” and “Pipeline”. Related policies include those which have been discussed, formally introduced, and passed into legislation. Policy actions also include formal investigations from elected offices.

Lastly, looking at the politics stream, this chapter analyzes Twitter posts from key political figures during the hypothesized open policy window (2010-2019), looking specifically at content containing keywords “Enbridge”, “Line 5”, and the combination of “Line 5” and “Pipeline”. Michael Mintrom and Phllipa Norman (2009) suggest the four elements are central to policy entrepreneurship are social acuity, defining problems, building teams, and leading by example. The politicians selected which fit those entities surrounding the issue within the chosen timeframe include current Michigan United States Senators, Debbie Stabenow and Gary Peters; Michigan Governors, Rick Snyder and Gretchen Whitmer; and Michigan Attorney Generals, Bill Schutte and Dana Nessel. An earlier study from Golbeck et al., (2010) of Twitter use by the U.S. Congress showed that Congresspeople facilitated direct communication between them and citizens. This study is noted as early because Twitter was still in its infancy (less than 40 million active users in 2010 compared to over 330 million active users in 2019, (Statistica, 2020b), but it still was able to conclude that Congresspeople were able to increase outreach and transparency through Twitter communication. Therefore, analysis of Twitter posts from politicians is a justifiable data source to determine whether or not a political stream is open.

4.4.2 *Phase 2: Determine if reinforcing spirals exist in the line 5 policy debate*

Reinforcing spirals within the window of the Enbridge Line 5 pipeline debate will be investigated through social network analysis of Twitter data from specific periods of time

of expected activity surrounding pipeline focusing events. Twitter data on specific users and their connectedness to the topic of Line5 and each other can build a visual social network map to discover how users are consuming and redistributing information about a particular topic. Twitter data can be collected through the Twitter Application Programming Interface (API) to retrieve fields on specific tweets of keyword or hashtag interest such as username, location, full tweet text, replies, mentions. Mylynn Felt's (2016) article studied the history of social media usage within the social sciences and described the Twitter API as an evolving tool for researchers to resource their intended historical tweet data. Third party apps have come and gone and "given the currently expensive and limited access to the full Twitter data stream, individual and small research groups without substantial funding usually turn to tools that utilize Twitter's API capabilities, often relying on API tools created by the researchers specifically for the purposes of their study" (p. 4). Felt analyzes tools that perform both data acquisition and data analysis. "A social network analysis reveals who the influential social media users are in a given network as well as the subordinated voices. Comparing top users with network visualizations highlights the differences between those who are highly vocal and those who are highly connected" (p. 13).

A custom API will gather specific user information such as followers, favorites, following, location, and any other data from a Tweet. This data with then be imported into the software tool NodeXL, which visualize a network graph of nodes (Twitter users) and edges (connections between users- followers, following, replies, favorites). The tool also provides interpretation of social network measures important to determine strength of network users such as degree, or how many people can this person reach; betweenness, how likely is this person to be the most direct route between two people in the network; closeness; how fast can this person reach everyone in the network; and eigenvector, how well is this person connected to other well-connected people (Lieberman, 2014). According to Wasim Ahmed and Sergej Lugovic (2019), NodeXL helps "provide insight into the value of network visualizations and analytics for the news media domain" (p. 1). Catur Suratnoaji and Irwan Dwi Arianto (2018) used NodeXL to analyze Twitter data to determine the social network structure of the 2019 presidential election in Indonesia. They were able to determine specific clusters, or groups, of users; actor analysis, or prominent 'influencers'; and conversation analysis, or tweet response details. Each of these analyses described a different component of the overall data driven by hashtags related to a specific agenda item. Similar NodeXL tools will be used to analyze the social network surrounding the Enbridge Line 5 policy agenda. A detailed guide and process for Twitter API and NodeXL is shown in **Appendix B**. Analysis in Gi Woong Yun et al. (2016) uses this method to analyze public Twitter data streams for building a network map of users with the keyword "flu" over a 48 period (December 01, 2013 – January 18, 2014) when the flu season is known to be most active.

Due to the large-scale of Twitter volume, specific keywords of interest need to be defined to narrow in on the Line5 policy issue. The public Observatory on Social Media (OSoME) built by Clayton Allen Davis et al. (2016) was used to explore co-occurrence hashtags of interest within one-month windows of Twitter data. OSoME can search over

70 billion public tweets starting from August 1, 2016 through today. Preliminary searches for the hashtag #line5 from October 2019 (the month Michigan's Governor Rick Snyder announced a tunnel deal with Enbridge) displayed co-occurrence with hashtags (#line5, #mackinac, #straitsofmackinac, #pipeline). These hashtags were explored with full API usage of Twitter search and found significant extraneous data associated with #mackinac, #straitsofmackinac, #pipeline, and #enbridge. #Line5 was consistently used when users were discussing the Line 5 policy debate. Additional Twitter searches were performed on potential #Line5 synonyms such as keyword "Line 5" and "Line5". These additional searches showed additional users and therefore further in-depth social network analysis will be performed on Tweets using #Line5 and keywords "Line 5" and "Line5".

Next, determining when in the timeline to search for social activity is important in helping determine how the social network is changing over the hypothesized policy window and whether or not reinforcing spirals are involved. Stephan Dann (2015) describes Twitter research data at three levels of abstraction; tweet, timeline, and pulse. The tweet level itself is the context within a series of tweets. Timeline analysis aims to detect patterns of usage over time and is helpful when focusing on usage surrounding specific external events. Pulse level data analysis is usually considered big data and automated macro-scale capture of tweets. The time period of interest starts with the focusing event Deepwater Horizon oil spill in April 2010 through 2020. Limited financial resources for historical Twitter data also require narrowing of time periods to zero in on the most relevant data.

Preliminary searches (free Twitter.com searches) revealed common terms such as "Pipeline" and "Line 5" produced a wide range of tweets not relative to the Enbridge Line 5 case study. #Line5 was the most specific of the terms searched therefore was chosen as the single hashtag/keyword to continue historical analysis. Full historical Twitter record (all tweets in history) of #Line5 reached the free historical search limit too soon in the targeting timeframe, therefore selective months were chosen which should represent an increase in interest surrounding pipelines. According to Desmond Higham et al. (2015), social media activity spikes immediately following a focusing event. As noted, the primary focusing event for all oil spills in the United States was the Deepwater Horizon spill in April 2010, the single largest marine oil spill in history (Pallardy, 2019). The primary focusing event tailored towards Line 5 agenda was also in 2010 as the Enbridge Line 6B pipeline spill in Kalamazoo, MI on July 10, 2010, was the second largest on land oil spill in United States history (Sierraclub, 2019). Other events of interest includes: the Keystone XL pipeline decision rejection from President Obama in January 2012; the height of the Dakota Access Pipeline protests turning violent in September 2016; the Keystone XL pipeline approval by President Trump in January 2017; the State of Michigan demanding a risk analysis of the Line 5 Straits pipelines in January 2018; the risk analysis report published in July 2018; and Michigan Governor Rick Snyder striking a deal with Enbridge to build a tunnel under the straits in December 2018. A list of Twitter data acquisition time ranges is shown in Table 4.1.

Table 4.1 Focusing events used for Line 5 social network analysis of Twitter data.

Focusing Event	Date of Event	Twitter Date Range
Deep Horizon Oil Spill	April 20, 2010	April 6, 2010 - March 4, 2010
Kalamazoo Oil Spill	July 10, 2010	June 25, 2010 - July 24, 2010
President Obama Rejects Keystone XL Pipeline	January 18, 2012	January 4, 2012 - February 1, 2012
Dakota Access Pipeline Violent Protests	November 22, 2016	November 8, 2016 - December 6, 2016
Risk Analysis Draft Report Released	July 20, 2018	July 6, 2018 - August 3, 2018
Governor Snyder Line 5 Tunnel Deal Announced	December 20, 2018	December 6, 2018 - January 3, 2019

Lastly, this chapter analyzes various measures of centrality (degree centrality, closeness centrality, and betweenness centrality) using NodeXL. These metrics will display the strength of influence within the various groups of actors or individual actors themselves (Hanneman and Riddle, 2005; Guo, 2012; Himelboim et al., 2017). Further analysis of the top centrality users throughout the #Line5 policy network can be done through NodeXL's User Network tool in which further description of the users' profiles and data itself can be mapped. Michael Lieberman (2014) describes six types of Twitter social media networks: polarized, two dense clusters with little interconnection; in-group, few disconnected isolates, many connections; brand/public topic, many disconnected isolates, some small groups; bazaar, many medium sized groups, some isolates; broadcast, a hub which is retweeted by many disconnected users; and support, a hub which replies to many disconnected users. Studies from R. Kelly Garett et al. (2014) shows that 'echo chambers', or reinforcing spirals, have been linked to exposure to supportive information. In researching echo chambers and affective polarization, Wouter Van der Berg (2019) catalogs preliminary evidence showing that online environments may have limited effects on polarization however "information people encounter online is still much shaped by self-selection…" (p. 2). Therefore, reinforcing spirals, if existing, should be visible within the social network snapshots by recognizing their self-feeding network connections.

4.5 Results

Results first feature an analysis of multiple sources of evidence supporting the presence of the problem, policy, and politics streams. Next a social network analysis of Twitter data on multiple keyword searches over different date ranges provides insights to whether or not reinforcing spirals are occurring in the Enbridge Line 5 policy issue. These two distinct results answer this chapter's research questions.

4.5.1 Policy Window

The following section defines results within the problem, policy, and politics streams within the multiple streams approach policy process theory. First, the problem steam uses data from major media outlets in addition to formal risk analysis. Next, the policy stream focuses in major policy referencing the Enbridge Line 5 case. Finally, the politics stream focuses on political policy entrepreneurs connected closely to the case within the State of Michigan.

4.5.1.1 Problem Stream

Michigan Tech's risk assessment report describes the problem in various ways but details public and societal concerns in Section 10: Broader Impacts, pages 338-381. Of the 44,372 total comments received during the two commenting periods from July 6, 2017 and November 20, 2017, respectively, 95.03% opposed the Line 5 pipeline while 4.97% supported the continued operation. Also, 98.7% of all comments were submitted on behalf of stakeholder organizations including two holding the majority: Oil and Water Don't Mix (67%) and Clean Water Action (26.4%). The volume of respondents confirm that a current problem stream exists within Kindgon's definition of broad participation within an issue. The risk analysis is sufficient supporting evidence for the problem statement because it is independent of both policy and politics.

Preliminary data from policy entrepreneurs Twitter analysis of keywords 'Enbridge', 'Line 5', 'Line5' and 'Pipeline' revealed three top news media accounts referencing Line 5 policy problems; The Detroit Free Press, The Detroit News, and MLive. Media references started in June of 2013 and continued until January 2020 (when data was acquired). Table 4.2 and Figure 4.5 show a steady increase in media with plateau near 50 articles per year from the three news outlets for 2017-2019. This not only shows a presence of the Line 5 policy problem but also visualizes growth and sustained presence over time of the problem through media publications.

Table 4.2 Number of articles on Twitter referencing Enbridge Line 5 policy problem

	Year								
Media Outlet	2013	2014	2015	2016	2017	2018	2019	2020	Totals
Detroit Free Press	-	2	7	20	22	26	12	2	91
mLive	1	3	7	6	16	11	17	2	63
The Detroit News	2	1	3	10	13	11	25	4	69
Totals	3	6	17	36	51	48	54	8	223

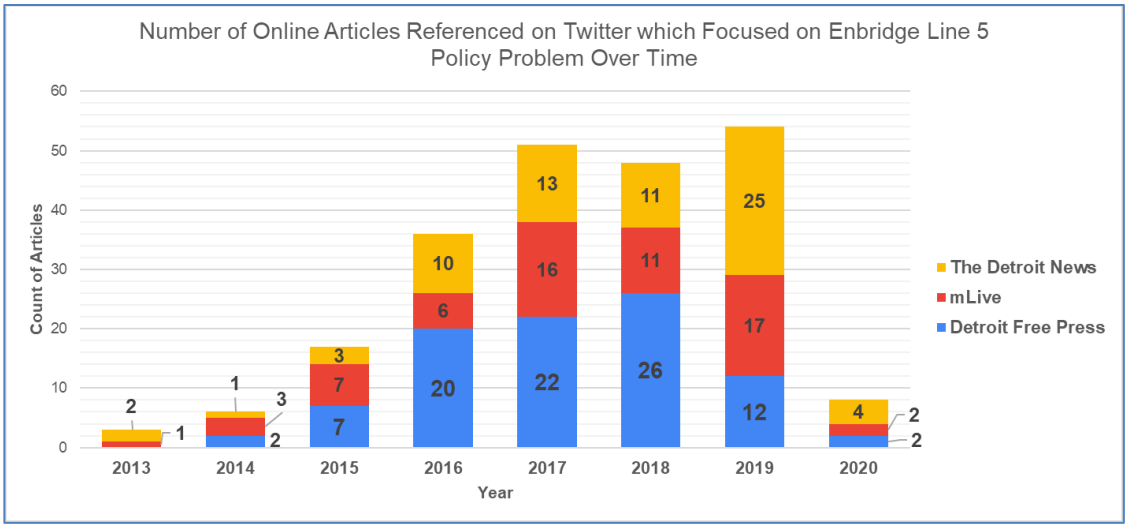


Figure 4.5 Number of online articles referenced on Twitter focused on Enbridge Line 5 policy problem over time **noting 2020YTD*

Further analysis reveals 'mini' focusing events which are displayed by spikes in coinciding media articles, as shown in Figure 4.6. Four separate months over the seven-year period featured over eight articles. The first month featuring eleven articles was June of 2017 where article content focused on the initial risk analysis report provided by the State when a conflict of interest was discovered between Enbridge and the contracted report consultant. This led to further distrust in Enbridge from an already weary public. A November 2017 spike of ten articles criticized the lack of transparency from Enbridge on the damaged coating section on the pipeline. April 2018 featured the largest media spike with fourteen articles focusing on a boat anchor strike which dented the pipeline followed by a massive storm which led to the State directing Enbridge to temporarily shut down Line 5. The last media spike from June 2019 (ten articles) did not have a shared focus.

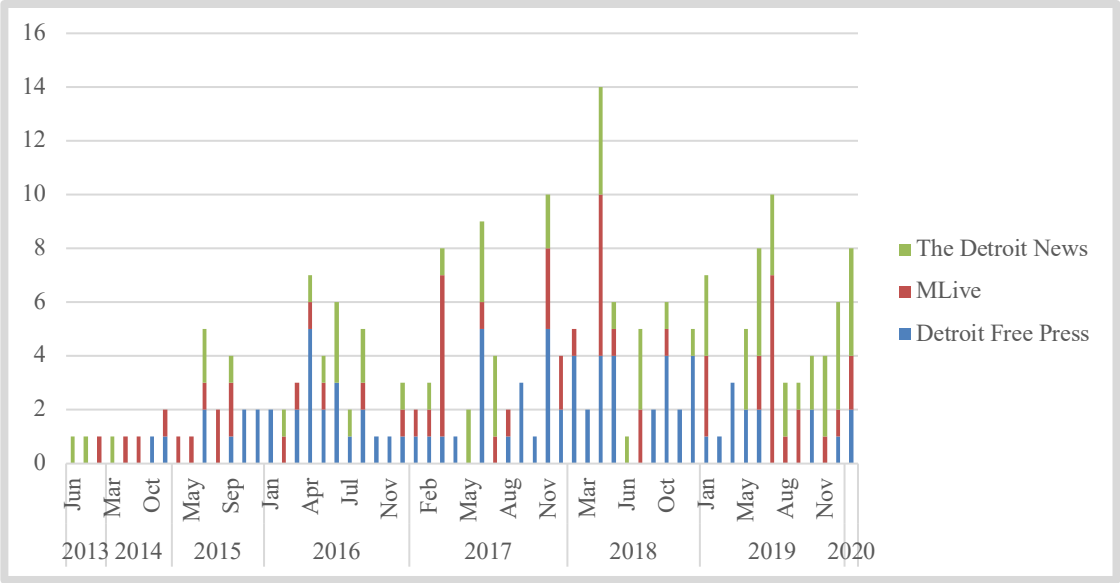


Figure 4.6 Number of online articles from Twitter referencing Enbridge Line 5 problem, by month over time

A thematic analysis of the titles of the 223 articles was performed in NVivo and notes that "shut", "shutdown", and "spill" were mentioned 23, 13, and 12 times respectively. These words by frequency were in the top 17 words overall and were the top three verbs overall. Note the negative focused of the rhetoric compared to positive.

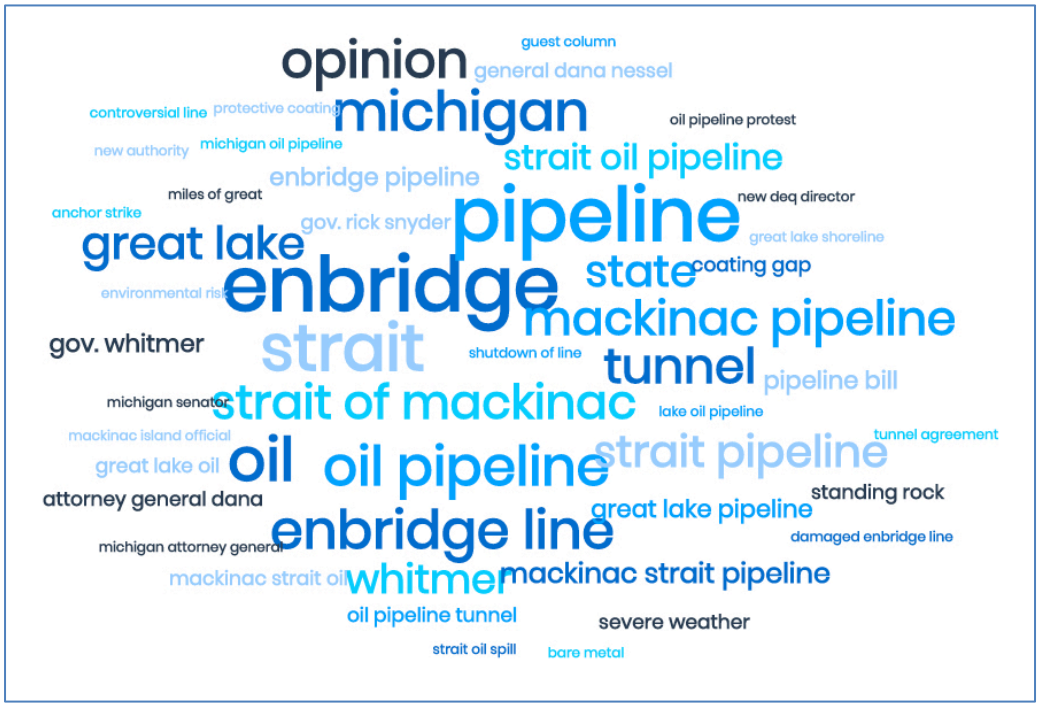


Figure 4.7 Word cloud for article headlines with Line 5 problems

4.5.1.2 Policy Stream

Keyword searches for ‘Enbridge’, ‘Line 5’, ‘Line5’ and ‘Pipeline’ on Twitter media accounts for MLive, Detroit Free Press, and The Detroit News identified nineteen specific policy actions (instruments) taken between April 2014 and January 2020, in either direct reference to Enbridge Line 5 or general reference to pipeline safety in the Great Lakes. These actions ranged from introducing both State and Federal legislation to Attorney General requests for information and Governor executive orders. Policy actions come from two Governors, two Attorneys General, U.S. Senate, U.S. House, and the Michigan Department of Natural Resources. A summary of federal and state offices is shown in Table 4.3 while the full listing of policy actions is shown in Table 4.4 including timeline in Figure 4.8. The most recent policy includes the previous State administration striking a deal to construct a commission and build a tunnel under the straits to protect the pipeline and utilities from damage and improve maintenance. The current administration which started in January 2019 has since suspended that decision and is continuing to debate alternative solutions (Gongwer News Service, 2019).

Table 4.3 Enbridge Line 5 policy instruments by government source type

Governing Level	Government Office
Federal	U.S. Senate U.S. House of Representatives U.S. Coast Guard
State	Michigan Governor (x2) Michigan Attorney General (x2) Michigan Department of Natural Resources California Attorney General Minnesota Attorney General

Table 4.4 Line 5 related policy actions between 2014 and 2020

Date	Category	Description - Headlines
4/30/2014	MI-Attorney General: Request for Information	Letter to Enbridge Requests Information on Construction of Pipelines, Inspections, Leak Prevention, Detection and Control Plans
7/24/2014	MI-Attorney General: Public Notice	Attorney General Bill Schuette and Michigan Department of Environmental Quality (DEQ) Director Dan Wyant sent a formal notice to Enbridge today, addressing the requirement to install additional anchors for two oil pipelines.
9/3/2015	MI Governor: Executive Order	Executive Order forming the Mich. Pipeline Safety Advisory Board
3/11/2016	MI-Attorney General: Request for Information	On March 11, Michigan attorney general Bill Schuette sent a letter to Enbridge Inc. vice president Cynthia Hansen asking for pipeline inspection and operating pressure data in an "unrestricted" form instead of through a "read-only data portal."
4/11/16	MI-Senate: Proposal	A Republican state lawmaker says he'll introduce legislation to stop future oil pipelines in the Great Lakes and require the Straits of Mackinac Enbridge pipeline to undergo an independent safety review.

6/14/16	Federal Legislation: Legislation Passed	Congress passes bill with Great Lakes pipeline measures
1/12/17	Federal Legislation: House Proposal	U.S. Reps. Dave Trott, R-Birmingham, and Debbie Dingell, D-Dearborn, proposed the measure today. If passed, it would require the U.S. Transportation Department to perform a year-long study to “evaluate the conditions and structural integrity” of pipelines in and around the Straits of Mackinac.
3/9/2017	MI-Attorney General: Request for Information	In a letter to Enbridge Vice President of U.S. Operations Brad Shamla on Wednesday, Schuette, along with DNR Director Keith Creagh and acting DEQ Director C. Heidi Grether, called on the company to provide detailed information on so-called holidays on Line 5 — an oil and gas industry term for areas on a pipeline where anti-corrosive coating is missing.
1/19/18	Federal Legislation: House Proposal	Federal House proposal
4/11/2018	MI-Governor: Legal action	Gov. Snyder, Lt. Gov. Calley initiate acceleration of Straits of Mackinac studies and legal action against shipping company involved in recent pipeline damage
10/4/18	MI-Governor: Business Deal	Gov. Rick Snyder, Enbridge reach deal for oil pipeline tunnel under Straits
10/15/2018	Coast Guard: Ruling	Gov. Snyder praises Coast Guard for enacting Straits 'no anchor' zone
12/12/2018	MI: Legislation Passed	The new Mackinac Straits Corridor Authority (MSCA) will oversee construction and operation of a tunnel in bedrock beneath the waters of the Straits of Mackinac. Senate Bill 1197, sponsored by Sen. Tom Casperson, is now Public Act 359 of 2018.
1/2/2019	MI-Governor: Legal Review	Governor Whitmer Takes Action on Line 5, Requests Attorney General Legal Review
5/29/19	MI-Attorney General: Public Notice	Nessel vows to act to shut Line 5 by end of June unless Whitmer gets pact
6/27/2019	MI-Attorney General: Request for Information	Attorney General Dana Nessel has asked a state court for an order to shut down and decommission Enbridge's Line 5 oil pipeline in the Straits of Mackinac.
11/13/19	MI-Attorney General: Lawsuit	Dem AGs in Wisconsin, Minnesota back Nessel's Line 5 lawsuit
1/11/20	MI, MN, and CA State friend of the court brief	The attorney generals of Minnesota, Wisconsin and California have filed friend-of-the-court briefs in a lawsuit filed by Michigan Attorney General Dana Nessel to shut down Enbridge’s Line 5 through the Straits of Mackinac.
1/13/2020	MI-Department of Natural Resources: Request for information	In a letter to the Canadian company, the state Department of Natural Resources requested documents dating back to 1953, when two 20-inch pipelines were placed across the bottom of the Straits of Mackinac

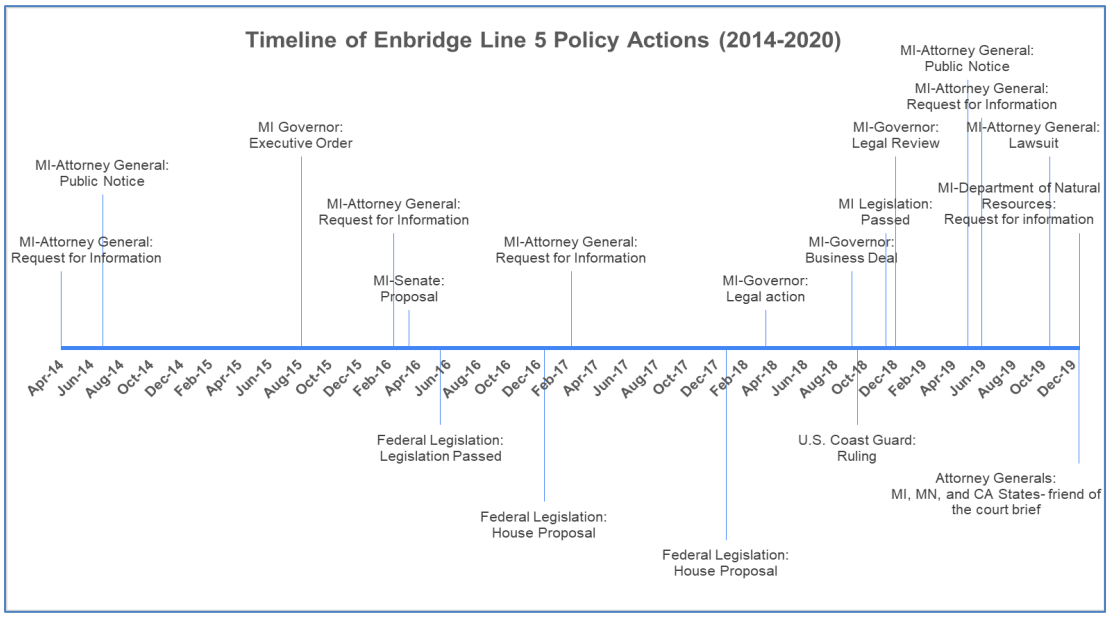


Figure 4.8 Timeline of Enbridge Line 5 policy actions (2014-2020)

4.5.1.3 Politics Stream

Politicians can represent the political stream with the multiple streams approach through their advocacy for or against a particular issue. Twitter posts (tweets) from politicians central to the Enbridge Line 5 debate showed significant and consistent mentions of the topic between 2011 and 2020 as shown in Table 4.5 and Figure 4.8.

Table 4.5 Tweets from select politicians about the Enbridge Line 5 pipeline over time

Year	Attorney General Dana Nessel (2019-present)	Attorney General Bill Schuette (2011-2018)	Governor Gretchen Whitmer (2019-present)	Governor Rick Snyder (2011-2018)	Senator Debbie Stabenow (2001-present)	Senator Gary Peters (2015-present)	Totals
2011					1		1
2012				1			1
2013					1		1
2014		8					8
2015		9		1	3		13
2016		12			2	4	18
2017	5	8	2	5	4	3	27
2018	16	2		8	2	13	41
2019	16		1			6	23
2020	2						2
Totals	39	39	3	15	13	26	135

The first mention of Enbridge Line 5 was from Senator Debbie Stabenow in 2011 which referenced U.S. Senate legislation to improve pipeline safety to “help prevent future disasters like Enbridge Oil Spill”, referring to the 2010 Kalamazoo Enbridge Oil Spill. The pace quickened on Enbridge Line 5 politics in 2014 through the peak in 2018 with a steady increase from 8 to 41 mentions. Noting that Michigan’s gubernatorial race in 2017 brought in newcomers including Gov. candidate Gretchen Whitmer and Attorney General candidate Dana Nessel. A November 2017 spike in political messaging (shown in Figure 4.9) correlates with the November 2017 spike in news articles regarding the damaged pipeline coating and lack of transparency on behalf of Enbridge resulting in bi-partisan condemnation. Senator Debbie Stabenow stated, “It’s unacceptable and deeply concerning that Enbridge failed to disclose problems with the Line 5 Pipeline for over 3 years”. Governor Rick Snyder proclaimed, “I am no longer satisfied with the operational activities and public information tactics that have become status quo for Enbridge”. A bold campaign promise was delivered by Attorney General Candidate Dana Nessel, “I'll shut down Enbridge Line 5 on my first day as AG…”.

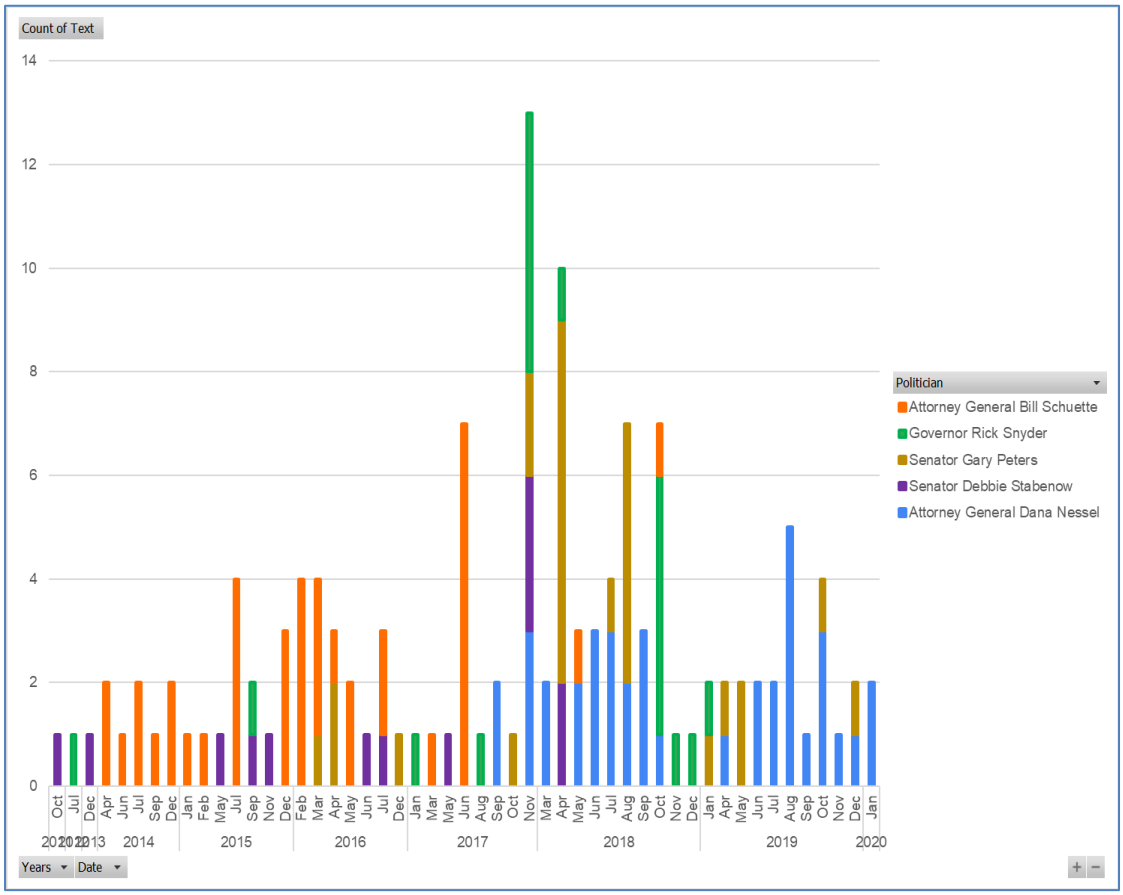


Figure 4.9 Tweets from selected politicians about Enbridge Line 5 over time

A word cloud of the 135 political tweets between 2011 and 2020 (shown in Figure 4.10) sheds light on the rhetoric used by policy makers when addressing the public about Enbridge Line 5. ‘Shut’, ‘shutdown’, ‘damage’, ‘environment’, ‘protect’, ‘alternatives’, were just some of the top words used beyond traditional geographic and descriptive words.

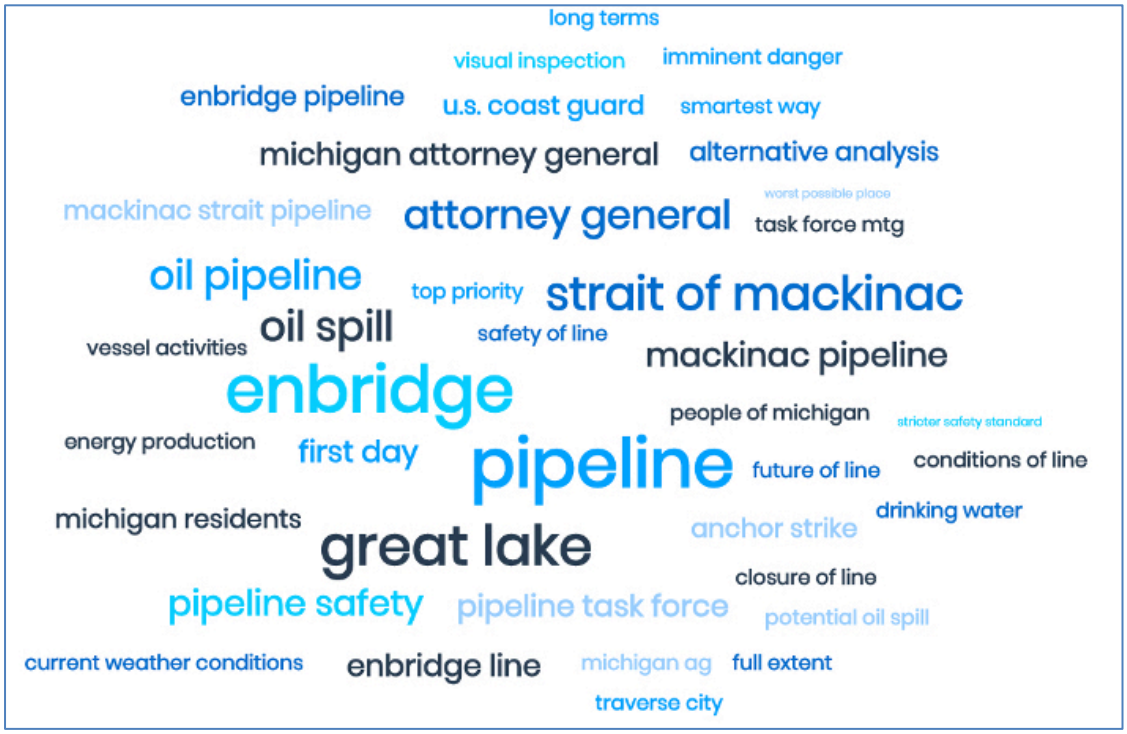


Figure 4.10 Tweet word cloud from politicians regarding Enbridge Line 5

Analysis of tweets from politicians close to the agenda setting topic clearly shows the third and final stream, politics, is open for Enbridge Line 5 policy agenda. The convergence of the problem, policy, and politics streams have created the open policy window which has been leveraged by policy entrepreneurs to remain open over multiple years. The next section will investigate those policy entrepreneurs beyond politicians and inquire if reinforcing spirals, particularly in social media, have helped keep the policy window for the Enbridge Line 5 debate open.

4.5.2 Reinforcing Spirals in the Line 5 Debate

Social network analysis was performed in two phases to test for reinforcing spirals and to graph the Enbridge Line 5 policy regime through Twitter. Due to limited access to the full Twitter archive (maximum limits for free data), hypothesized focusing events were chosen to select Tweet date ranges over the past decade. This also included a limited keyword search to narrow data. Phase 2 opened the keyword search to include more data and started a full archive search for the most recent Twitter data.

Both sets of data will be analyzed using NodeXL, a tool which calculates centrality measures for imported social network data (tweet IDs) and also creates a social network graph with either Harel-Koren Fast Multiscale or Fruchterman-Reingold algorithms. Measures of centrality are based on the number of connections (edges) a user (vertex) has in the network. Hansen, Shneiderman, and Smith's (2020) book *Analyzing social media networks with NodeXL* describes how centrality is measured throughout the network. Centrality metrics are assigned to each user and can be ranked on their scores.

Harel-Koren Fast Multiscale algorithm models through user 'replies to', 'mentions', and 'retweets' with vertex size proportional to in-degree statistics. Masami Yoshida (2015) used this technique in NodeXL and Twitter hashtags to display the social network at a conference for educators. His study was able to visualize hubs and how they are interconnected through 'replies to', 'mentions', and 'retweets'. NodeXL identifies groups through centrality metrics. A Fruchterman-Reingold is a force directed graph which encourages closely related nodes to be plotted near each other. Force directed graphs visualize all edges as close to equal length as possible and as few edge crossings has possible (Kobourov, 2012). "The effect of this is that the best-connected members of the network gravitate to the centre of the graph, and the least-connected to the edges" (BroadVision, 2020, p.1). This study will use the algorithm which best displays top groupings, which can then be used to assess whether reinforcing spirals exist.

NodeXL allows for custom weights to be imposed on edges (edge weights), which helps to highlight more influential users within a social network over time. Adding edge weights within increasing complex networks can help identify relevant connections (Serrano et al., 2009). Custom features also allow for coding of tweet sentiment (positive, negative, neutral) to create custom groups of interest. William Deitrick and Wei Hu (2013) used both weighted edges and sentiment coding to detect communities within a collection of 60,000 users and 2 million tweets. However, due to already narrowed dataset through Line 5 relevant keyword searches, NodeXL's default groupings within the graph can generate influential nodes and sub-groups.

4.5.2.1 Phase 1: Specific focusing event date ranges for keyword "Line5"

Initial Twitter data results surrounding hypothesized focusing events displayed available data for last three events from 2016, 2018, and 2019. The first three events discovered no Tweets with the '#Line5' of any significance to the Enbridge Line 5 policy issue, as shown in Table 4.6. This could be due to minimal Twitter usage of the time frame compared to time frames closer to the present.

Table 4.6 Tweets for #Line5 during focused time frames

Focusing Event	Date Range	Tweets	Re-Tweets	Totals
Deep Horizon Oil Spill	April 6, 2010 - March 4, 2010	0	0	0
Kalamazoo Oil Spill	June 25, 2010 - July 24, 2010	0	0	0
President Obama Rejects Keystone XL Pipeline	January 4, 2012 - February 1, 2012	0	0	0
Dakota Access Pipeline Violent Protests	November 8, 2016 - December 6, 2016	23	141	164
Risk Analysis Draft Report Released	July 6, 2018 - August 3, 2018	260	457	717
Governor Snyder Line 5 Tunnel Deal Announced	December 6, 2018 - January 3, 2019	22	28	50
Totals		305	626	931

The 931 tweet and re-tweet ID's were imported into NodeXL for social network analysis. The network graph, shown in Figure 4.11, was grouped by clusters (or hubs) as indicated by the Harel-Koren Fast Multiscale algorithm model. The separation (longer edges) shown by the Harel-Koren model better displayed the groupings compared to the Fruchterman-Reingold model.

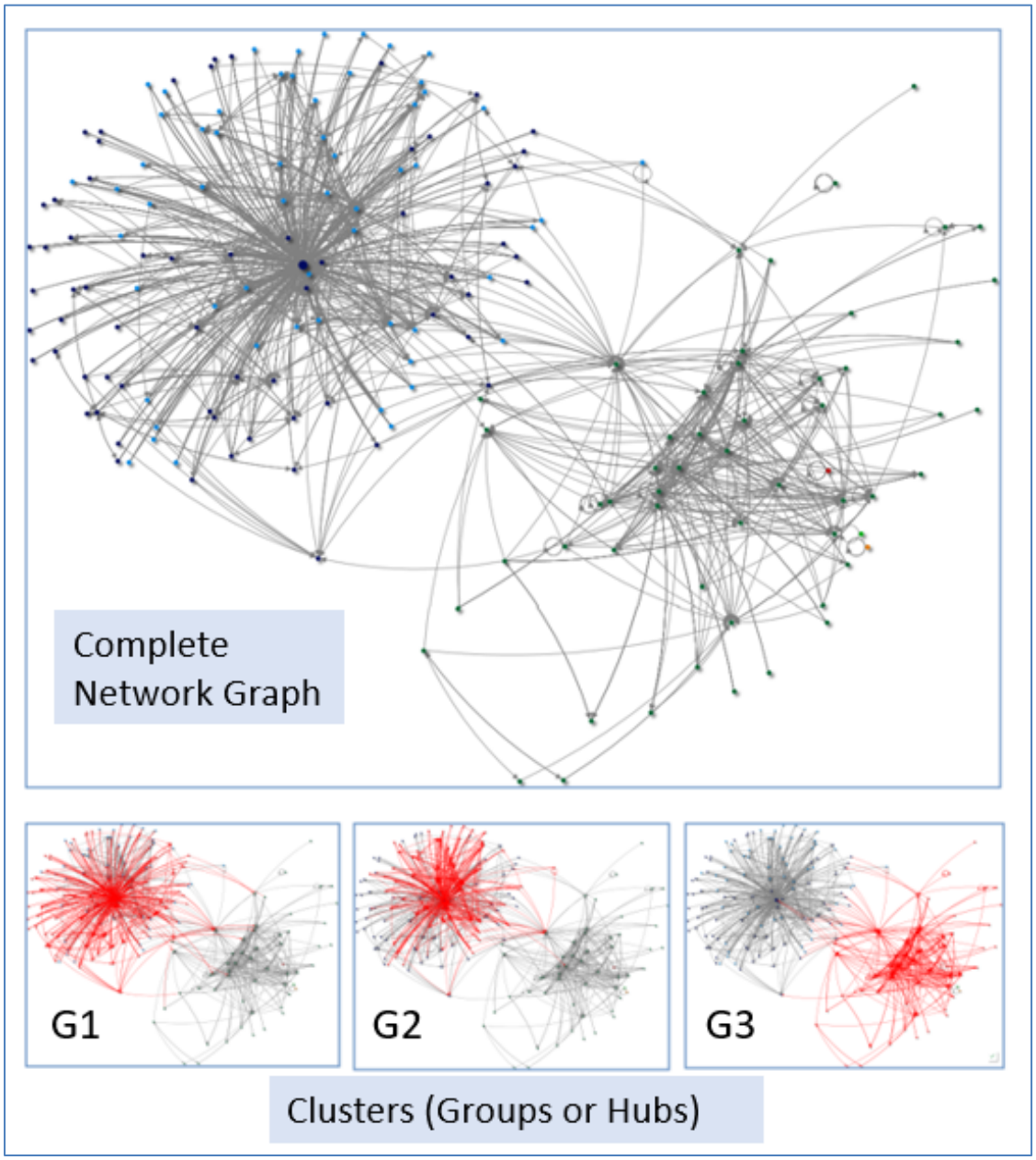


Figure 4.11 #Line5 Twitter social network graph for focused time frames

The network includes 180 vertices split into three statistically noticeable groups. A significant distinction between group 3 from groups 1 and 2 is that 8 of the top 10 influencers (betweenness centrality ranking) are organizations and not individuals. The two individuals are still associated with organizational accounts (Dana Nessel, current State of Michigan Attorney General; David Eggert, Michigan government/politics correspondent for the Associated Press). Also, the majority of group 3 is from Michigan and the United States while the majority of groups 1 and 2 are from Canada and Native American lands, as identified with location data from Twitter user profiles. This explains

why groups 1 and 2 are clustered together yet separate from group 3, as it is expected that many Canadian users would not be following Michigan news organizations but are well connected socially surrounding the topic of Line 5.

Table 4.7 shows the top ten lists for centrality measures by Twitter usernames. For every centrality metric the top ranked user @christibelcourt. Top betweenness centrality, or top influencers, had a mix of individuals and large organizations, such as the @ap (Associated Press) and @nwf (National Wildlife Foundation). This is expected as large organizations have significant reach and followers in general. Closeness centrality and eigenvector centrality top 10 showed more individual high scores, which is consistent with the tighter packed graph for groups 1 and 2, which were mostly individuals. Closeness centrality in particular features little variation, meaning almost all users could spread information just as quickly as other users. In-degree centrality scores had the most news/large organizations in the top ten, which can be explained through a larger count of unique users connecting with their news source. Out-degree centrality top ten featured a similar mix of individuals and organizations for the similar reason.

Table 4.7 Top ten Twitter users centrality measures for #Line5 for focused time frames

Betweenness Centrality	**Closeness Centrality**	**Eigenvector Centrality**	**In-Degree**	**Out-Degree**
christibelcourt	christibelcourt	christibelcourt	christibelcourt	christibelcourt
ap	*tie for 32 users	indigenousxca	terrilltf	michigansierra
nwf		terrilltf	pam_palmater	ncicnpercy
progressmich		pam_palmater	indigenousxca	indigenousxca
msconstrues		wordsandguitar	ap	nwfgreatlakes
fieryreddragon		blueravenart	wordsandguitar	miclimateaction
michigansierra		ncicnpercy	detroitnews	progressmich
oilwaterdntmix		jennyblackbird1	progressmich	oilwaterdntmix
indigenousxca		fletjan	michigansierra	michenvcouncil
jenniferlehmann		anishnation	dananessel	blueravenart

After removing duplicates (retweets and mentions), a simple sentiment analysis of the remaining 464 unique tweets was was performed by the free tool MonkeyLearn (MonkeyLearn.com). “MonkeyLearn is a platform that used machine learning to get relevant data from text…the developed algorithm uses a customize classifier that classifies tweets in English according to their sentiment polarity” (Wang et al., 2017, p.10). The sentiment analysis displayed **neutral** with 85.3% confidence. Challenges with sentiment analysis within Twitter compared to traditional text analysis includes linguistic representational challenges with short slang, frequency of misspellings, and acronyms missing sentiment cues along with the commonplace of neutral tones compared to items such as product reviews (usually polarized) (Da Silva, Hruschka, Hruschka Jr., 2014).

With regards to reinforcing spirals, the social network graph shows a split of two main clusters by measures of centrality, however they were not split based on content or attitudes towards the topic of Line 5, but rather on more traditional network separations such as individual/organization and geography. There was an overwhelming opposition to Line 5 within the data which supports the reinforcing spiral theory because of the lack of diverse thoughts and user attitudes within the social network. A further analysis of the top users themselves and visualization of the social network without a topic could reveal more insights to an insular, or reinforcing spiral of information, network.

4.5.2.2 Phase 2: Full Recent Twitter Search for Keywords 'Enbridge' AND 'Line 5 or Line5'

Based on data from both policy entrepreneurs and the Twitter archive search, a second historical Twitter data group was created searching for all recent Tweets featuring the keywords 'Enbridge' and 'Line 5 or Line5'. This will provide a shorter window (full archive searches max total free Tweets), but a more comprehensive social network analysis without data ranges. The data pulled 5884 Tweets, Replies To, Mentions, and Re-Tweets between March 9, 2020 and November 28, 2018.

Upon running the graphical analysis, specific overinfluential users (nodes) became visible and needed to be removed from the dataset to produce a more accurate social network map of the Line 5 policy issue. Due to the 2020 United States presidential campaign season, multiple candidates mentioned the Line 5 pipeline in a single tweet. A single tweet or mention within a large social network would usually be called an outlier, however the disproportionate influence of presential candidates (high number of followers compared to the average Line 5 social network user) creates an opposite effect by over influencing the entire social network graph. For instance, @petebuttigieg has 1.8 million Twitter followers compared to the next highest individual account in the data, @dananessel, with 41 thousand followers.

On February 24, 2020, then candidate Pete Buttigieg (@petebuttigieg) tweeted "With such a high risk of an oil spill under the Great Lakes, Michigan can't afford to keep the Line 5 pipeline in operation. In every community, we need new clean energy solutions to meet our climate crisis. https://t.co/NWZRwA30BO", referencing story from Michigan Radio regarding replacing part of the Line 5 pipeline in the St. Clair River, hundreds of miles away from the Straits of Mackinac (Graham, 2020). This tweet was retweeted or mentioned 862 times, accounting for 14.6 percent of all data in the study. On February 26, 2020, another presidential candidate Elizabeth Warren, tweeted "Michigan's Line 5 pipeline is a threat to millions who rely on the Great Lakes for clean water and a healthy economy. My plans for a #GreenNewDeal will rebuild our infrastructure and create over 10 million union jobs. Let's #ShutDownLine5 and build a 100% clean energy future." This was retweeted or mentioned 138 times within the selected timeframe, accounting for 2.3 percent of total data. It is important to scan data for outlying users which will skew focus away from answering social network research questions. The 1000 retweets and

mentions from @petebuttigeig and @ewarren were removed from the sample to leave a remaining 4884 data points.

The Fruchterman-Reingold algorithm was selected as the graphic layout for this network as it shows how the top groups overlap when compared to the Harel-Koren model. This is preferred compared to the Phase 1 data because there are more overall groups interacting with each other, therefore the Fruchterman-Reingold model creates a better visualization of the interested network features as shown in Figure 4.12.

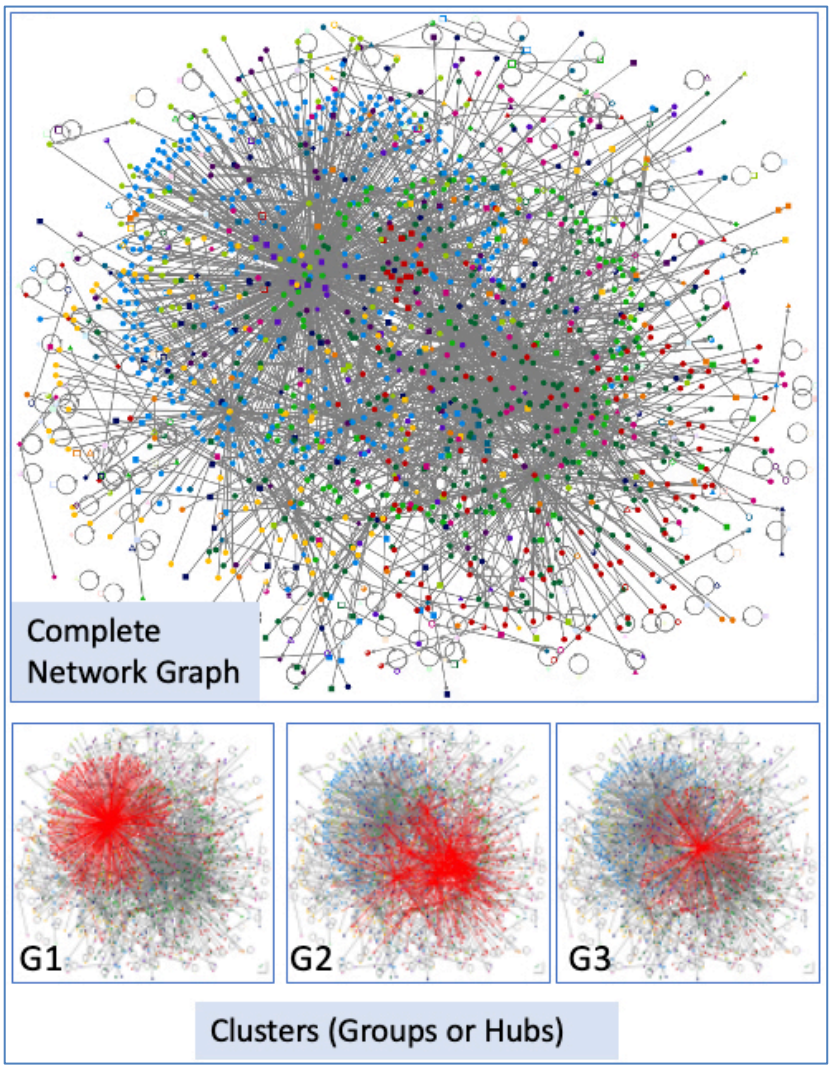


Figure 4.12 Social network graph of recent Twitter data for keywords containing 'Enbridge' and 'Line 5 or Line5' from March 9, 2020 - November 28, 2018

The new social network described features 186 different groupings, compared to the 6 total groupings from the original focusing event timeframe search. Three groups ranked significantly higher than others for influence within the social network. When reviewing usernames and tweet text for Group 1(G1) in Figure 4.12, @michiganadvance was the

top node among other users. Michigan Advance is a non-profit news outlet that features "in-depth stories, blog posts and social media updates, as well as top-notch progressive commentary" and is free of advertising (MichiganAdvance.com, 2020). As a broader news organization account, @michiganadvance has high activity and influence in general, therefore it is not surprising that their account is driving the largest social network group within this network. Group 2(G2) features two top centrality user organization accounts @oilwaterdntmix and @tarsandpipelin1, featuring more specific Line 5 content connections when compared to Group 1. Group 3(G3) is significantly less noticeable than Groups 1 and 2, however its primary users are more overlapping with specific Line 5 content from users in Group 2. Groups 1 and 2 users were primary from Michigan and the Midwest while Group 3 featured a larger geographical distribution across the United States. Neither of the three main groups had significant international based users. Top ten centrality measures, shown in Table 4.8, support the network graph visualization, noting that user @michiganadvance has the highest influence, and continues to rank highest in eigenvector centrality (favoring central nodes) and in-degree centrality (number of edges initiated with user, of number of people following, mentioning, etc.).

Table 4.8 Top ten Twitter users centrality measures for 'Enbridge' AND 'Line5 or Line 5' recent history

Betweenness Centrality	Closeness Centrality	Eigenvector Centrality	In-Degree	Out-Degree
michiganadvance	* tie for 50 users	michiganadvance	michiganadvance	lulex
dbwagner104		lainastebbinsmi	wtp__2020	tarsandpipelin1
enbridge		*tie for 355 users	enbridge	oilwaterdntmix
dananessel			thetyee	cyndystachowiak
wtp_2020			dbwagner104	frackhazreveal
oilwaterdntmix			dananessel	corruptmiusa
danacarlson8577			detroitnews	plvs2
tarsandpipelin1			bridgemichigan	2020winner1
thetyee			govwhitmer	miclimateaction
lulex			honortheearth	mipolicast

Table 4.7 (Phase 1) has more individual users than table 4.8 (Phase 2), which is due to the narrower time frames of data. Even when using issue specific search keywords, specific narrower timeframes created smaller, more personal, groups of influencers when compared to the broader open timeframe archive search. Note, there are similar accounts featured in both searches including @dananessel and @oilwaterdntmix. An interesting note is @enbridge is seen in multiple top ten centrality metrics in the more recent search. This could be due to the keyword "enbridge" was used in the search itself, or if @enbridge is presenting engaging in the policy discussion more than in the previous

timeframes. Sentiment analysis using MonkeyLearn.com showed the content as **neutral** with a 72.5% confidence. Groupings shown in this social network analysis does support a level of reinforcing spirals by showing unique groupings of users and content that support one another's beliefs and attitudes. Group 3 organizations (media and other group accounts) connect multiple groups together, but still do not have a diverse set of thoughts and beliefs.

4.6 Conclusions

Potential additions to policy theory within this study by combining focusing event theories with reinforcing spirals within social media agenda setting influence. This collective approach will add depth to agenda setting literature by seeking to establish reasoning for windows of opportunity that remain open well past hypothesized focusing events. Showing that reinforcing spirals in social media impact policy window durations could lead to further agenda setting research impacts through social media.

4.6.1 Implications

In the aging infrastructure policy universe, it is important for stakeholders to know how social media data can be used to describe open policy windows using a multiple streams approach. Within the pipeline policy regime alone "the business of maintaining and growing the oil pipeline infrastructure does not loom large in the public's consciousness" (Barr, 2007, p. 46). By understanding how these issues rise on the agenda, policy makers can help prioritize which aging infrastructure projects need the greatest attention.

This chapter has expanded upon Kingdon's multiple streams approach to include social media and specifically Twitter as a modern tool to determine whether or not a policy window is open, which is be transferable to any policy issue at any scale. Further social network analysis of Twitter data can show which specific individual and organization users are influencing the conversation, thus influencing the agenda. This will remain a powerful tool for researchers to explore how policy issues remain and grow interest on the policy agenda.

4.6.2 Limitations

There are some limits to the proposed methods, specifically with limited volumes of free historical social media data. Twitter API has limits on how many tweets a developer can extract, therefore for this chapter, timeframes surrounding focusing events were chosen to narrow in on hypothesized #Line5 activity which would be around major pipeline events or oil spill events between 2010 and 2019. This leaves potential for underrepresented users within the data which was not analyzed. There is also potential for sampling error within the Twitter API itself as Twitter does not disclose its sampling techniques and thus can be questioned by social science (Pfeffer et al., 2018). Twitter API does have a random sample rule which can help limit volume but also follow best practices for sampling large datasets. Bruns and Burgess (2012) acknowledged the lack of access to

large-scale data to researchers due to commercialization would limit usage by academics and would hinder scholarly studies. Since their study, access to full historical large-scale data has been commercialized and can impede studies where broad hashtags or keywords are needed to analyze holistic social networks.

In addition to limitations in data collection, there are geographic and demographic biases within Twitter data itself. Pablo Barbera and Gonzalo Rivero's (2014) study showed geographically smaller areas had less representation than larger urban areas. Data also showed that males represent 60-65% of all political related tweets. Their results also suggested that "Twitter is mainly driven by citizens with extreme values in the ideological scale" (p. 722). Recognizing these biases is important when inferring results on a broader population.

Other limitations include recent studies showing a potentially incomplete impact of social media on affective polarization and echo chambers (Beam et al. 2018; Boxell, Gentzkow, & Shapiro, 2017; Hutchens et al., 2019). However, the Beam (2018) study only focused on Facebook News as its empirical data source and recognized the many other types of social media including Twitter that have yet to be analyzed in this context. Barbera and Rivero's (2014) study believed "echo chamber" environments in Twitter were increasing political polarization.

Another note of caution when gathering Twitter data is to note anomalies within the searchable timeline. This was seen with the two different social network graph results by displaying the largest group was related to a presidential candidate's tweet and not necessarily focused on the social network of interest. Due to the large social network of presidential candidates, social media data surrounding a single Tweet could skew social networks towards unrelated topics of interest.

4.6.3 Recommendations

Provided financial resources, a full historical Twitter data search on the four suggested keywords ("Line5, Line 5", "Pipeline", and "Enbridge" beyond the free archive search maximum (5000 tweets) would build a larger social network analysis and reveal further influencers and policy entrepreneurs engaged in policy change within the Enbridge Line 5 issue. Additional policy window analysis could also include additional politicians and actors involved in the policy regime. This would further expand the social network analysis for the issue. A multi-level governance issue could be analyzed for larger national or global policy issues, but a limited geographical search (local and State officials) should be more relevant to case studies in particular regions.

Larger datasets could benefit from the addition of weighted edges to help identify influential users within a community. Also, additional sentiment coding with respect to positive and negative tweet content could assist in visualize polarizing user groups. Seeking further social network analysis of the identified top users with regards to #Line5 could reveal more insights on whether or not reinforcing spirals in social media play a role in polarizing policy issues through self-selection of news and commentary.

4.7 References

Ahmed, W., & Lugovic, S. (2019). Social media analytics: analysis and visualisation of news diffusion using NodeXL. *Online Information Review*.

Axsen, J. (2014). Citizen acceptance of new fossil fuel infrastructure: Value theory and Canada′ s Northern Gateway Pipeline. *Energy Policy*, *75*, 255-265.

Barberá, P., & Rivero, G. (2015). Understanding the political representativeness of Twitter users. *Social Science Computer Review*, 33(6), 712-729.

Barr, C. J. (2007). Growing Pains: FERC's Responses to Challenges to the Development of Oil Pipeline Infrastructure. *Energy LJ*, *28*, 43.

Barron, M. G. (2012). Ecological impacts of the Deepwater Horizon oil spill: implications for immunotoxicity. *Toxicologic pathology, 40*(2), 315-320.

Baumgartner, F. R., & Jones, B. D. (1993). Agendas and instability in American politics. University of Chicago Press.

Baumgartner, F. R., & Jones, B. D. (Eds.). (2002). *Policy dynamics*. University of Chicago Press.

Beam, M. A., Hutchens, M. J., & Hmielowski, J. D. (2018). Facebook news and (de) polarization: reinforcing spirals in the 2016 US election. *Information, Communication & Society*, *21*(7), 940-958.

Bickerstaff, K., Lorenzoni, I., Pidgeon, N. F., Poortinga, W., & Simmons, P. (2008). Reframing nuclear power in the UK energy debate: nuclear power, climate change mitigation and radioactive waste. *Public understanding of science, 17*(2), 145-169.

Billard, T. J. (2019). Setting the transgender agenda: Intermedia agenda-setting in the digital news environment. *Politics, Groups, and Identities*, *7*(1), 165-176.

Birkland, T. A. (1997). *After disaster: Agenda setting, public policy, and focusing events*. Georgetown University Press.

Birkland, T. A. (1998). Focusing events, mobilization, and agenda setting. *Journal of public policy*, *18*(1), 53-74.

Bishop, B. H. (2014). Focusing events and public opinion: Evidence from the deepwater horizon disaster. *Political Behavior*, *36*(1), 1-22.

Boxell, L., Gentzkow, M., & Shapiro, J. M. (2017). Greater Internet use is not associated with faster growth in political polarization among US demographic groups. *Proceedings of the National Academy of Sciences*, *114*(40), 10612-10617.

BroadVision. (2020). Using social graphs to understand enterprise social network usage (part 2). Retrieved May 7, 2020. https://broadvision.com/blog-archive/using-social-graphs-to-understand-enterprise-social-network-usage-part-2/

Brunner, S. (2008). Understanding policy change: Multiple streams and emissions trading in Germany. *Global Environmental Change*, *18*(3), 501-507.

Bruns, A., & Burgess, J. (2012). Researching news discussion on Twitter: New methodologies. *Journalism Studies*, *13*(5-6), 801-814.

Cairney, P., & Jones, M. D. (2016). Kingdon's Multiple Streams Approach: What Is the Empirical Impact of this Universal Theory?. *Policy Studies Journal*, *44*(1), 37-58.

Cohen, M. D., March, J. G., & Olsen, J. P. (1972). A garbage can model of organizational choice. *Administrative science quarterly*, *17*(1), 1-25.

Cohen, B. C. (1963). *Press and foreign policy*. Princeton University press.

Corner, A., Venables, D., Spence, A., Poortinga, W., Demski, C., & Pidgeon, N. (2011). Nuclear power, climate change and energy security: exploring British public attitudes. *Energy Policy*, *39*(9), 4823-4833.

Da Silva, N. F., Hruschka, E. R., & Hruschka Jr, E. R. (2014). Tweet sentiment analysis with classifier ensembles. Decision Support Systems, 66, 170-179.

Davis CA, Ciampaglia GL, Aiello LM, Chung K, Conover MD, Ferrara E, Flammini A, Fox GC, Gao X, Gonçalves B, Grabowicz PA, Hong K, Hui P, McCaulay S, McKelvey K, Meiss MR, Patil S, Peli Kankanamalage C, Pentchev V, Qiu J, Ratkiewicz J, Rudnick A, Serrette B, Shiralkar P, Varol O, Weng L, Wu T, Younge AJ, Menczer F. (2016) OSoMe: the IUNI observatory on social media. PeerJ Computer Science 2:e87 https://doi.org/10.7717/peerj-cs.87

Dann, S. (2015). Twitter Data Acquisition and Analysis: methodology and Best Practice. In *Maximizing Commerce and Marketing Strategies through Micro-Blogging* (pp. 280-296). IGI Global.

Deepwater Horizon – BP Gulf of Mexico Oil Spill. (2017, April 17). Retrieved May 6, 2020, from https://www.epa.gov/enforcement/deepwater-horizon-bp-gulf-mexico-oil-spill

Deitrick, W., & Hu, W. (2013). Mutually enhancing community detection and sentiment analysis on twitter networks. *Journal of Data Analysis and Information Processing 1*(3), 19-29.

Deschamps, R. (2014). What potential for YouTube as a policy deliberation tool? Commenter reactions to videos about the keystone XL oil pipeline. *Policy & Internet*, *6*(4), 341-359.

Eberlein, B. (2012). Inching towards a common energy policy: Entrepreneurship, incrementalism, and windows of opportunity. *Constructing a policy-making state*, 147-169.

Ediger, D., Jiang, K., Riedy, J., Bader, D. A., Corley, C., Farber, R., & Reynolds, W. N. (2010, September). Massive social network analysis: Mining twitter for social good. In *2010 39th International Conference on Parallel Processing* (pp. 583-593). IEEE.

Enbridge. (2019). Line 5 Brochure. April, 2019. https://www.enbridge.com/projects-and-infrastructure/public-awareness/line-5-michigan/fact-sheets

Gravelle, T. B., & Lachapelle, E. (2015). Politics, proximity and the pipeline: Mapping public attitudes toward Keystone XL. *Energy Policy*, *83*, 99-108.

Farley, J., Baker, D., Batker, D., Koliba, C., Matteson, R., Mills, R., & Pittman, J. (2007). Opening the policy window for ecological economics: Katrina as a focusing event. *Ecological Economics*, *63*(2-3), 344-354

Farooq, A., Joyia, G. J., Uzair, M., & Akram, U. (2018, March). Detection of influential nodes using social networks analysis based on network metrics. In *2018 International Conference on Computing, Mathematics and Engineering Technologies (iCoMET)* (pp. 1-6). IEEE.

Feldman, L., Myers, T. A., Hmielowski, J. D., & Leiserowitz, A. (2014). The mutual reinforcement of media selectivity and effects: Testing the reinforcing spirals framework in the context of global warming. *Journal of Communication*, *64*(4), 590-611.

Felt, M. (2016). Social media and the social sciences: How researchers employ Big Data analytics. *Big Data & Society*, *3*(1), 2053951716645828.

Fruchterman, T. M. J., & Reingold, E. M. (1991). Graph Drawing by Force-Directed Placement, *Software: Practice and Experience*, 21(11).

Garrett, R. K. (2009). Echo chambers online?: Politically motivated selective exposure among Internet news users. *Journal of Computer-Mediated Communication*, *14*(2), 265-285.

Golbeck, J. (2015). *Introduction to social media investigation: a hands-on approach*. Syngress.

Golbeck, J., Grimes, J. M., & Rogers, A. (2010). Twitter use by the US Congress. *Journal of the American Society for Information Science and Technology*, *61*(8), 1612-1621.

Gongwer News Service. Michigan court ruling removes one path of attack on Line 5 tunnel. March 12, 2019. https://www.crainsdetroit.com/law/michigan-court-ruling-removes-one-path-attack-line-5-tunnel

Graham, Lester. (2020, February 10). Enbridge replacing part of Line 5 pipeline under the St. Clair River. Michigan Radio. Retrieved on May 8, 2020. https://www.michiganradio.org/post/enbridge-replacing-part-line-5-pipeline-under-st-clair-river.

Guo, L. (2012). The application of social network analysis in agenda setting research: A methodological exploration. *Journal of Broadcasting & Electronic Media*, *56*(4), 616-631.

Hanneman, R. A., & Riddle, M. (2005). Introduction to social network methods.

Hansen, D., Shneiderman, B., & Smith, M. A. (2020). *Analyzing social media networks with NodeXL: Insights from a connected world 2nd Edition*. Morgan Kaufmann.

Harel, D., & Koren, Y. (2001, December). On clustering using random walks. In *International Conference on Foundations of Software Technology and Theoretical Computer Science* (pp. 18-41). Springer, Berlin, Heidelberg.

Higham, D., Mantzaris, A. V., Grindrod, P., Otley, A., & Laflin, P. (2015, April). Anticipating activity in social media spikes. In *Ninth International AAAI Conference on Web and Social Media*.

Himelboim, I., Smith, M. A., Rainie, L., Shneiderman, B., & Espina, C. (2017). Classifying Twitter topic-networks using social network analysis. *Social Media+ Society*, *3*(1), 2056305117691545.

Hoogland, J. (2019, January 21). New company, MLive Media Group, formed to carry Booth Newspapers and MLive.com into next era of news media. *MLive.com*.

Hutchens, M. J., Hmielowski, J. D., & Beam, M. A. (2019). Reinforcing spirals of political discussion and affective polarization. *Communication Monographs*, 1-20.

Jamieson, K. H., & Cappella, J. N. (2008). *Echo chamber: Rush Limbaugh and the conservative media establishment*. Oxford University Press.

Jenkins, K., McCauley, D., & Forman, A. (2017). Energy justice: a policy approach. *Energy Policy*, *105*, 631-634.

Kandiyoti, R. (2012). *Pipelines: flowing oil and crude politics*. IB Tauris.

Kim, Y. M. (2009). Issue publics in the new information environment: Selectivity, domain specificity, and extremity. *Communication Research*, *36*(2), 254-284.

Kingdon, J. W. (1993). How do issues get on public policy agendas. *Sociology and the public agenda*, *8*, 40.

Kingdon, J. W. (1995). Agendas, alternatives, and public policies (2nd ed.). New York: HarperCollins.

Kingdon, J. W., & Thurber, J. A. (1984). *Agendas, alternatives, and public policies* (Vol. 45, pp. 165-169). Boston: Little, Brown.

Knobloch-Westerwick, S., & Meng, J. (2009). Looking the other way: Selective exposure to attitude-consistent and counterattitudinal political information. *Communication Research*, *36*(3), 426-448.

Kobourov, S. G. (2012). Spring embedders and force directed graph drawing algorithms. arXiv preprint arXiv:1201.3011.

Kosicki, G. M. (1993). Problems and opportunities in agenda-setting research. *Journal of communication*, *43*(2), 100-127.

Kwak, H., Lee, C., Park, H., & Moon, S. (2010, April). What is Twitter, a social network or a news media?. In *Proceedings of the 19th international conference on World wide web* (pp. 591-600).

Lieberman, J. M. (2002). Three streams and four policy entrepreneurs converge: A policy window opens. Education and Urban Society, 34(4), 438-450.

Lieberman, M. (2014, March). Visualizing big data: Social network analysis. In *Digital research conference* (pp. 1-23).

Lim, Jeongsub. 2011. "First-Level and Second-Level Intermedia Agenda-Setting Among Major News Websites." *Asian Journal of Communication* 21 (2): 167–185.

Linnet, Carol. (2012). Enbridge Mismanagement Caused Kalamazoo Tragedy, Says NTSB. July, 13, 2012. Desmog. https://www.desmogblog.com/enbridge-mismanagement-caused-kalamazoo-tragedy-says-ntsb

Maharani, W., & Gozali, A. A. (2014, October). Degree centrality and eigenvector centrality in twitter. In *2014 8th international conference on telecommunication systems services and applications (TSSA)* (pp. 1-5). IEEE.

Malewitz, Jim. "Enbridge to build $350M tunnel to protect Line 5 in Straits of Mackinac". Bridge. October 3, 2018.https://www.bridgemi.com/michigan-environment-watch/enbridge-build-350m-tunnel-protect-line-5-straits-mackinac

McCauley, D., Brown, A., Rehner, R., Heffron, R., & van de Graaff, S. (2018). Energy justice and policy change: An historical political analysis of the German nuclear phase-out. Applied energy, 228, 317-323.

McCombs, M. E., & Shaw, D. L. (1972). The agenda-setting function of mass media. *Public opinion quarterly*, *36*(2), 176-187.

MichiganAdvance. (2020). Michigan Advance mission statement. https://www.michiganadvance.com/about-mission-statement/. Retrieved March 17, 2020.

Michigan Technological University et al. Independent Risk Analysis for the Straits Pipelines. State of Michigan. September 15, 2018. https://mipetroleumpipelines.com/file/700/download?token=QTDUShlz

Michigan Legislature. https://www.legislature.mi.gov/(S(llczj4xozmjn45rje11m10lh))/mileg.aspx?page=Bills. 2

Mintrom, M., & Norman, P. (2009). Policy entrepreneurship and policy change. *Policy Studies Journal*, *37*(4), 649-667.

Nelson, Cody and Dunbar, Elizabeth. MPR News. Minn. regulators will soon decide on the Line 3 oil pipeline's fate. https://www.mprnews.org/story/2018/06/18/line-3-faq-enbridge-oil-pipeline-decision-puc. June, 18, 2018

Noble, Breana and Associate Press. (2019, August 5). GateHouse Media to acquire Detroit Free Press owner Gannett. *The Detroit News*.

Odom-Forren, J., & Hahn, E. J. (2006). Mandatory reporting of health care-associated infections: Kingdon's multiple streams approach. Policy, Politics, & Nursing Practice, 7(1), 64-72.018.

Oilandwaterdontmix.org. (2018). Hundreds Protest Enbridge Line 5 at Mackinac Straits. September 1, 2018. https://www.oilandwaterdontmix.org/hundreds_protest_enbridge_line_5_at_mackinac_straits

Pallardy, Richard. Deepwater Horizon Oil Spill. Encyclopedia Britannica. April 13, 2019.

Pierson, P. (2000). Increasing returns, path dependence, and the study of politics. *American political science review*, *94*(2), 251-267.

Pierson, P. (1996). The path to European integration: a historical institutionalist analysis. *Comparative political studies*, *29*(2), 123-163.

Pierson, P. (1994). Dismantling the welfare state: Reagan, Thatcher, and the politics of retrenchment. Cambridge, UK: Cambridge University Press

Pidgeon, N. F., Lorenzoni, I., & Poortinga, W. (2008). Climate change or nuclear power—No thanks! A quantitative study of public perceptions and risk framing in Britain. *Global Environmental Change*, *18*(1), 69-85.

Pfeffer, J., Mayer, K., & Morstatter, F. (2018). Tampering with Twitter's Sample API. *EPJ Data Science*, *7*(1), 50.

Poortinga, W., Aoyagi, M., & Pidgeon, N. F. (2013). Public perceptions of climate change and energy futures before and after the Fukushima accident: A comparison between Britain and Japan. *Energy Policy*, *62*, 1204-1211.

Robinson, S. E., & Eller, W. S. (2010). Participation in policy streams: Testing the separation of problems and solutions in subnational policy systems. *Policy Studies Journal*, *38*(2), 199-216.

Riesterer, Joseph. (2019). The Enduring Legacy of the 2010 Kalamazoo River Oil Spill. Belt Magazine. Retrieved February 14, 2020. https://beltmag.com/kalamazoo-river-line-6b-oil-spill/

Sabatier, P. A. (1991). Toward better theories of the policy process. *PS: Political Science & Politics*, *24*(2), 147-156.

Serrano, M. Á., Boguná, M., & Vespignani, A. (2009). Extracting the multiscale backbone of complex weighted networks. Proceedings of the national academy of sciences, 106(16), 6483-6488.

Sistilli, Anthony. Twitter Data Mining: A Guide to Big Data Analytics Using Python. Toptal. Retrieved April 26, 2019. https://www.toptal.com/python/twitter-data-mining-using-python

Sierra Club. Kalamazoo River Disaster. Retrieved April 26, 2019. https://www.sierraclub.org/michigan/kalamazoo-river-disaster

Slater, M. D. (2007). Reinforcing spirals: The mutual influence of media selectivity and media effects and their impact on individual behavior and social identity. *Communication theory*, *17*(3), 281-303.

Smith, M. A., Shneiderman, B., Milic-Frayling, N., Mendes Rodrigues, E., Barash, V., Dunne, C., Capone, T., Perer, A., & Gleave, E. (2009, June). Analyzing (social media) networks with NodeXL. In *Proceedings of the fourth international conference on Communities and technologies* (pp. 255-264).

Soroka, S. N. (2002). Issue attributes and agenda-setting by media, the public, and policymakers in Canada. *International Journal of Public Opinion Research*, *14*(3), 264-285.

Statistica. (2020a). Media Advertising and Media Usage. Time spent digital traditional media USA. Retrieved on January 11, 2020. https://www.statista.com/statistics/565628/time-spent-digital-traditional-media-usa/

Statistica. (2020b). Number of monthly active Twitter users worldwide from 1st quarter 2010 to 1st quarter 2019. Retrieved on January 16, 2020. https://www.statista.com/statistics/282087/number-of-monthly-active-twitter-users/

Sterett, S. (2013). *Disaster and sociolegal studies* (Vol. 4). Quid Pro Books.

Stroud, N. J. (2011). *Niche news: The politics of news choice*. Oxford University Press on Demand.

Suratnoaji, C., & Arianto, I. D. (2018). Strength Map of Presidential Candidates 2019 in Indonesia Based on a NodeXL Analysis of Big Data from Twitter. *Strength Map of Presidential Candidates 2019 in Indonesia Based on a NodeXL Analysis of Big Data from Twitter*, *6*(1), 31-38.

The Guardian. New US oil drilling regulations aim to prevent another Deepwater disaster. April 14, 2016. https://www.theguardian.com/environment/2016/apr/14/new-us-oil-drilling-regulations-deepwater-horizon-disaster

Thelen, K. (1999). Historical institutionalism in comparative politics. *Annual review of political science*, *2*(1), 369-404.

Twitter Developer. Search Tweets. Premium Search Operators. April, 2019. https://developer.twitter.com/en/docs/tweets/search/guides/premium-operators

Twitter Developer. Costs. Configure Search Tweets: Full Archive. April 2019. https://developer.twitter.com/en/pricing/search-fullarchive

Van der Brug, W. (2019). Echo chambers, affective polarization, and democracy. http://www.eelcoharteveld.nl/wp-content/uploads/2019/05/PhD-project-description.pdf

Wang, Z., Bai, G., Chowdhury, S., Xu, Q., & Seow, Z. L. (2017). Twiinsight: Discovering topics and sentiments from social media datasets. *arXiv preprint arXiv:1705.08094.*

Wicks, R. H., Wicks, J. L., & Morimoto, S. A. (2014). Partisan media selective exposure during the 2012 presidential election. *American Behavioral Scientist*, *58*(9), 1131-1143.

World Economic Forum. (2020). Digital Media and Society: Implications in a Hyperconnected Era. Section 3: Impact of Digital Media on Individuals, Organizations, and Society – Benefits and Opportunities. https://reports.weforum.org/human-implications-of-digital-media-2016/

Yoshida, M. (2015). Study on online communication emerged from centralized conference. Journal of Industrial and Intelligent Information, 3 (4), 314, 317.

Yun, G. W., Morin, D., Park, S., Joa, C. Y., Labbe, B., Lim, J., ... & Hyun, D. (2016). Social media and flu: Media Twitter accounts as agenda setters. *International journal of medical informatics*, 91, 67-73.

Zaniewski, Ann. Michigan panel approves Line 5 oil pipeline tunnel beneath Straits. Detroit Free Press. https://www.freep.com/story/news/local/michigan/2018/12/19/michigan-panel-approves-line-5-oil-pipeline-tunnel/2370925002/. December 19, 2018.

Zehavi, A. (2012). A reform less ordinary? Historical institutionalism, punctuated equilibrium, and mental health care privatization. *Administration & Society*, *44*(6), 731-753.

Zhao, X. (2009). Media use and global warming perceptions: A snapshot of the reinforcing spirals. *Communication Research*, *36*(5), 698-723.

5 Conclusions and Directions for Future Research

The problem is clear: over one million miles of pipelines are over fifty years old, crossing nearly every corner of the United States, and designed and installed during a time where limited consideration of broader environmental and sustainable concerns took place (Dreyfus and Ingram, 1976, p. 246). Aging infrastructure systems, much like the policies regulating them, have been layered over decades. These historical institutions rely on 'patching' and 'smart layering' to correct and enhance consistency and coherence of policy mix over time, striving to create better overall policy (Wellstead et al., 2016). Risks associated with aging pipelines in particular were put under a magnifying glass in 2016 as the State of Michigan hired Michigan Technological University to perform a scientific risk analysis of the Enbridge Line 5 Pipeline Mackinaw crossing (Michigan Petroleum Pipelines, 2018). While the Enbridge Line 5 crossing was determined to be at risk in part due to the sensitive and unique hydrodynamic and heavily trafficked environment in which it resides, there are countless other sensitive areas throughout the nation with their own local and regional sentiments. All of these areas cannot feasibility be analyzed and potentially replaced as it would completely disrupt the arteries of the U.S. energy system. However, that does not excuse the reason to proceed with needed policy change and evolution for the pipeline policy regime.

Aging energy infrastructure is experiencing increased scrutiny across the globe as policy makers and society demand environmental, sustainable, and climate justice for their communities (Fouquet and Johansson, 2008; Sine and David, 2003). Policy change is required to make these sweeping changes across institutions. This is especially challenging with strong policy regimes that have high capital costs spread out over decades where economies of scale incentivize larger and more centralized systems to keep energy prices low (Rui et al., 2011). With over sixty percent of the U.S. energy system dependent on natural gas and petroleum (EIA, 2019), pipeline infrastructure will remain a dominant policy regime for decades. Therefore, understanding the layered policy mix, policy goals, and how new goals and ideas get on the policy agenda, will play a crucial role in setting policy for the future. This chapter summarizes main findings from previous chapters, focusing on how they connect to the broader research problem of policy change within aging pipeline infrastructure. Next, this chapter discusses policy implications for aging pipeline infrastructure. Lastly, this chapter describes future research paths for policy change within the various policy fields addressed in this dissertation.

Chapter Two provided an in-depth policy mix analysis of federal pipeline policy from 1968 to 2016. The 316 policy instruments implemented within the seventeen public laws showed a consistent focus on pipeline safety goals with an increasing consistency towards environmental and economic policy goals over time. In addition to analyzing policy goals, this chapter adapted Lesnikowski et al.'s (2019) policy mix approach, categorizing each instrument as either substantive and procedural and further cataloging their specific instrument type within governing typologies nodality, authority, organization, and treasure (Hood, 1983). This strategy proved effective in visualizing

changes in the policy instrument mix over long periods of time. These changes were then correlated with changing in the national political structures of the decades. This particular study showed no noticeable partisan relationships existed in either pipeline policy mix or policy goal changes over time. This unique approach successfully combining policy mix with policy goal analysis and further political analysis, provides the ability to see correlations amongst the three disciplines, leading to important insights for policy change.

Chapter Three continued to focus on policy goals by introducing the concept of energy justice to the broader policy mix literature. Energy justice, or the concept of "providing all individuals, across all areas, with safe, affordable and sustainable energy" (Heffron and McCauley, 2014, p. 437) ties directly into increasing pressure on aging energy infrastructure to modernize their policies towards sustainable futures while also maintaining and increasing access and affordability of their services to all. One way to increase energy justice concepts within all policy change is to encourage growth in scholarship towards using deterministic approaches in their research. Energy justice research is particularly well situated for case-oriented studies and deterministic approaches lead towards more specific causal analysis than statistical studies (Giugni and Yamasaki, 2009). This chapter empirically showed that energy justice research is not using deterministic approaches. Further analysis described how some research design changes, such as narrowing target audience scope to fit higher homogeneity and seeking for in-depth case study variables to consider, provides a more conducive study to deterministic approaches. In particular QCA, process tracing, and counterfactual analysis provide their own unique benefits in specific cases.

Chapter Four centered around the question of how aging pipeline infrastructure is impacted by modern social media. Using the Enbridge Line 5 Mackinaw crossing policy issue as a case study, this chapter utilized Twitter data with Kingdon and Thurber's (1984) Multiple Steams Approach (MSA) to prove a policy window is active. This study showed that the problem stream, policy steam, and politics stream are indeed active and converging, thus leading to a relatively sustained open policy window. Next this chapter sought to prove if Slater's (2007) "reinforcing spiral framework" was impacting the length of the open policy window, due to the relative novelty of social media. Leveraging the Twitter API and historical archive search, a social network analysis for keywords "Line 5" and "Enbridge" was able to display a network graph with clusters of users. These clusters supported the theory that reinforcing spirals were evident in social media for the Line 5 policy issue. Social media, and in particular Twitter, has shown to be a powerful research tool for scholars to investigate agenda setting theory alongside social network analysis to discover clusters of users (actors) engaging in the policy process. Knowing which actors are engaged in the agenda setting process and how they are engaging is useful information for policy makers and the public when seeking policy change.

5.1 Policy Implications for Aging Pipeline Infrastructure Risk Analysis

With over one million miles of pipelines over fifty years old and another million plus miles of more modern pipelines spanning the United States, instances of aging pipeline infrastructure risk analysis will only be increasing. Most analysis to date on aging infrastructure has focused on economic analysis and life cycle costs (Brown and Willis, 2006), while this study focuses on policy change and the policy process. These factors are important when considering risk analysis and potential alternatives to existing pipeline policy.

Chapter Two's advanced policy mix approach added to the policy mix literature by combining a traditional policy mix approach (Lesnikowski et al., 2019) with policy goals and politics as variables to compare over decades of policies. While this study did not have the volume of policies analysis as other studies, it is the first to combine the instrument mix, policy goals, and political environments together to determine how one impacts another. In addition to providing policy scholars with another novel approach to apply to any policy regime, it provides policy makers in the aging pipeline infrastructure regime detailed information to the portfolio mix of instruments and goals in the past so they can plan for a more consistent, coherent, and congruent policy mix in the future. It also illustrates evidence that politics, which are often used as an excuse for inaction of policy change (Howitt and Wintrobe, 1995), has not historically played a significant role in influencing the federal pipeline policy regime.

Chapter Three's structured support of the usage of deterministic approaches within energy justice research provides a strong path forward for researchers to leverage these methods in search of more causal conclusions. Methods such QCA, process tracing, and counterfactual analysis can be utilized in conjunction with other methods or each other within case-orientated research to search for causality and causal mechanisms. This chapter resulted in the creation of a framework for energy justice scholars to consider using if seeking to use deterministic approaches to answer energy justice research questions. Those studies could lead to further specific remediation recommendations.

Chapter Four's usage of social media within a multiple streams approach to determine active policy windows has added another dimension to the agenda setting theory. This chapter showed that accessible social media data can be charted over time and correlated among problem, policy, and politics, thus determining an open policy window. This approach also supports agenda setting data by providing another tool to visualize focusing events and align them with other social media data charts over time. The social network analysis of historical Twitter data offered a visualization of clusters of users associated with the Enbridge Line 5 policy issue, thus providing policymakers with actionable intelligence on the influencers needed to engage (or at least monitor) in policy discussions. This chapter shows how this tool can be utilized to capture critical network data on any topic using the Twitter API.

5.2 Future Research

As a complex historically structured institution, the pipeline policy regime and more specifically aging pipeline infrastructure, will be challenged when trying to introduce and implement significant policy change as large stable regimes are "specifically designed to hinder the process of institutional policy reform" (Pierson, 1996, p. 126). However, progress can be made over long periods of time or during policy windows. This research has shown that various tools can be used to analyze historical data and discover patterns which provide policy makers information to make more informed decisions on future policy development. Further research can continue to advance this progress.

Chapter Two introduced an advanced policy mix analysis of policy instruments, policy goals, and politics over time for federal pipeline policy laws. Future research in this area should include additional policy documents involved in the policy process before and after official public laws are passed. These documents could include hearing testimony, committee meeting notes, executive orders, and regulatory documents. Additional documentation from legislative development periods as well as administrative and regulatory processes will provide further insights on policy instrument mix and policy goals. Federal regulation is only one part of the overall regulatory regime for pipeline policy. In addition to federal analysis, a more detailed multi-level governance analysis could be performed which includes State and Local governments and agencies charged with regulating pipeline policy. Due to the scale of potential differing regulations by State and Local governance, specific case studies may be more amendable for multi-level governance research.

Chapter Three's entire argument is a strong recommendation for future energy justice and environmental justice researchers to use deterministic approaches in their case-oriented studies. Causal analysis and subsequent discovery of causal mechanisms can provide communities experiencing energy and environmental in-justices, a more concrete path to eliminating and remediating the source of their concerns. A future case study applying these techniques could be performed within an aging pipeline infrastructure policy debate, setting up the research design with deterministic approaches in mind.

Chapter Four developed a novel multiple streams approach using social media to determine if a policy window is active by testing converging problem, policy, and politics streams. A benefit of social media is the large potential data sets available. Twitter has a powerful data set but requires financial resources if searching beyond the API free limits of 5000 tweets per 30-day window. The larger the data set, the more developed the social network, therefore future research recommendations include increasing the Tweets through additional financial resources or renewing the 5000 tweet limit each 30 days to include additional historical data. Also, additional social network analysis could be performed on the top ten users within the initial network results. This could reveal further connections and influencers which were unavailable when visualizing the broader network.

This dissertation provides multiple new methods within policy change literature to help scholars and researchers analyze policy regimes and policy change over time in order to recommend more consistent and coherent policy to manage aging infrastructures' changing policy landscape.

5.3 References

Brown, R. E., & Willis, H. L. (2006). The economics of aging infrastructure. *IEEE Power and Energy Magazine*, *4*(3), 36-43.

Dreyfus, D. A., & Ingram, H. M. (1976). The National Environmental Policy Act: a view of intent and practice. *Nat. Resources J.*, *16*, 243.

EIA. (2019) US Energy Facts Explained. March 13, 2019 https://www.eia.gov/energyexplained/?page=us_energy_home.

Fouquet, D., & Johansson, T. B. (2008). European renewable energy policy at crossroads—Focus on electricity support mechanisms. *Energy policy*, *36*(11), 4079-4092.

Giugni, M., & Yamasaki, S. (2009). The policy impact of social movements: A replication through qualitative comparative analysis. *Mobilization: An International Quarterly, 14*(4), 467-484.

Heffron, R. J., & McCauley, D. (2014). Achieving sustainable supply chains through energy justice. Applied Energy, 123, 435-437.

Hood, C. (1983). *The tools of government* (p. 6). London: Macmillan.

Howitt, P., & Wintrobe, R. (1995). The political economy of inaction. *Journal of Public Economics*, *56*(3), 329-353.

Kingdon, J. W., & Thurber, J. A. (1984). *Agendas, alternatives, and public policies* (Vol. 45, pp. 165-169). Boston: Little, Brown.

Lesnikowski, A., Ford, J. D., Biesbroek, R., & Berrang-Ford, L. (2019). A policy mixes approach to conceptualizing and measuring climate change adaptation policy. *Climatic Change*, 1-23.

Michigan Petroleum Pipelines. (2018). Resources and Reports. *Risk Analysis for the Straits Pipelines*. October 2018. https://mipetroleumpipelines.com/document/risk-analysis-straits-pipelines

Pierson, P. (1996). The path to European integration: a historical institutionalist analysis. Comparative political studies, 29(2), 123-163.

Rui, Z., Metz, P. A., Reynolds, D. B., Chen, G., & Zhou, X. (2011). Historical pipeline construction cost analysis. *International Journal of Oil, Gas and Coal Technology*, *4*(3), 244-263.

Sine, W. D., & David, R. J. (2003). Environmental jolts, institutional change, and the creation of entrepreneurial opportunity in the US electric power industry. *Research Policy*, *32*(2), 185-207.

Slater, M. D. (2007). Reinforcing spirals: The mutual influence of media selectivity and media effects and their impact on individual behavior and social identity. *Communication theory*, *17*(3), 281-303.

Wellstead, A., Rayner, J., & Howlett, M. (2016). Alberta's oil sands reclamation policy trajectory: the role of tense layering, policy stretching, and policy patching in long-term policy dynamics. *Journal of environmental planning and management*, *59*(10), 1873-1890.

A Policy Mix Coding Manual

Using a policy mixes approach to understand how changing policy goals and politics affect legacy policy regimes

A.1 Document search (PHASE 1):

The objective of the first phase of analysis is to collect all United States federal laws that provide policy and direction to natural gas and oil pipeline safety. The assumption leading to the selection of federal laws is that policy goals and policy instruments involved have been fully enacted and passed both House and Senate procedures and has been signed by the President. Public laws and more specifically their summaries as created by the Congressional Research Service (CRS) provide more concise document analysis compared to the formality of the full written public law. The following steps will be used to identify the relevant documents:

1. The first search was for federal public laws containing keyword "pipeline" in their description as defined by the Comparative Agenda's Project (CAP) data. This database covers all public laws from 1940-2016.

2. The search filter was then reviewed for public laws relevant to nationwide federal policy and not specific geographic pipeline projects. Specific geographic projects (i.e. laws allowing a pipeline through a particular region) were removed.

3. Once the desired list of public laws of interest is set, the next step was searching for the full text of each law and their CRS summaries if available. Congress.gov provides summaries for most public laws from 1970-present and full text for 1995-present. HeinOnline database provided full text for a few laws before 1970. Library sources provide the earlier laws. The first all-inclusive federal pipeline policy law was the Natural Gas and Pipeline Safety Act of 1968; therefore, data analysis will start with this law.

4. If no summary of the law is available, the full text will be used to code.

Where background reports or presentation files are also provided for the relevant meetings, these documents should also be saved to a separate folder titled "[City] Background Documents."

Search strategy:

Download all relevant policy documents (e.g. strategies and plans), bylaws, meeting minutes, and screenshots of webpages that have program/initiative information that describe what that municipality is doing to increase resilience/adapt to climate change. Exclude anything that is strictly emissions reduction and/or doesn't explicitly make a linkage with resilience or adaptation.

Search strings: CAP (e.g. public laws project, description of law)

1) "pipeline"

2) “pipeline safety”

Save all documents to Google Drive under folder names for full text or summary. Label each file with the public law number and year enacted.

A.2 Data inclusion test (PHASE 2):

The objective of the second phase of analysis is to identify hypothesized policy goals for safety, economic benefit, and environmental impact, within the text of each law or law summary. This phase will also find and categorize each policy instrument with the law to allow for further policy mix analysis.

Inclusion requirements:

1. Indication of policy goal support. A policy goal as defined by Rogge and Reichardt (2015) is the set of intended effects or outcomes of policy instruments. Content analysis has been used by multiple studies to seek policy goals through coding of specific keyword and phrases (Huang et al., 2010; Parfomak et al., 2013; Wolsink, 2007; Kivimaa and Mickwitz, 2011). The list of keywords or phrases used to identify policy goals are provided in indicators 10 through 12.
2. Policy instrument identified, implemented, or amended within Public Law. A policy instrument as defined by Howlett (2005) is a technique, policy, or program used to implement specific measures. The list of techniques relevant for pipeline policy are provided in indicators 14 and 15 below (types of substantial and procedural policy instruments).
3. Policy instrument was identified, implemented or amended between 1968 and 2018. Policy instruments first implemented prior to 1968 but subsequently changed are eligible for inclusion.

Grounds for exclusion:

1. Policy Goals - Economic. Standard budgetary re-authorization with no additional or subtractive measures will not be considered data towards changing policy goals.

A.3 Coding policy instruments (PHASE 3):

All text identified in phase 2 as establishing policy goals and policy instruments are exported from Nvivo12 and further coded and analyzed in an Excel spreadsheet according to the following indicators.

List of indicators:
1. Year
2. Public Law #
3. House Majority

4. Senate Majority
5. Presidential Political Party
6. Bill Sponsor Political Party
7. Bill Sponsor Geographic Region
8. # of Democrat Co-Sponsors
9. # of Republican Co-Sponsors
10. Policy Goal – Safety and Transportation
11. Policy Goal – Economic Benefit
12. Policy Goal – Environmental Impact
13. Policy Instrument Resource Type
14. Type of substantive policy instrument
15. Type of procedural policy instrument
16. Instrument calibration
17. Duration of instrument
18. Instrument target
19. Geographical boundaries of target
20. Administrative responsibility

Table 1. Policy Mix Coding Descriptions

ID	Indicator	Definition	Field Options
1	Year	Year	Open
2	Public Law #	Public Law #	Open
3	House Majority	Majority Political Party in House at time of Law Passed	Democrat Republican
4	Senate Majority	Majority Political Party in Senate at time of Law Passed	Democrat Republican
5	Presidential Political Party	Presidential Political Party at time of Law Passed	Democrat Republican
6	Bill Sponsor Party	Political party of Primary congressional sponsor of bill	Democrat Republican

7	Sponsor Geographic Region	Geographic region of primary bill sponsorship *Geographies set by US Census Regions and Divisions	1. Northeast 1. New England Division: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island and Vermont 2. Middle Atlantic Division: New Jersey, New York and Pennsylvania 2. Midwest 1. East North Central Division: Illinois, Indiana, Michigan, Ohio and Wisconsin 2. West North Central Division: Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota and South Dakota 3. South 1. South Atlantic Division: Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia and West Virginia 2. East South-Central Division: Alabama, Kentucky, Mississippi and Tennessee 3. West South-Central Division: Arkansas, Louisiana, Oklahoma and Texas 4. West 1. Mountain Division: Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming 2. Pacific Division: Alaska, California, Hawaii, Oregon and Washington

8	# of Democrat co-sponsors	# of Democrat co-sponsors	Open
9	# of Republican co-sponsors	# of Republican co-sponsors	Open
10	Policy Goal – Safety	Policy Goal – Safety and Transportation	1. Safe Operations: e.g. policy to prevent hazardous waste exposure to humans, inclusion of specific thickness of pipeline material, minimum distances away from households, infrastructure codes, etc.
11	Policy Goal – Economic	Policy Goal – Economic Benefit	1. Economic Benefits: e.g. business incentives, cost implications, market regulations, pricing, trade, etc.
12	Policy Goal – Environmental	Policy Goal – Environmental Impact	1. Environmental Impact: e.g. environmental protection provisions, mitigation, remediation, etc.
13	Resource type [Mutually exclusive]	Policy instrument categorized according to the nature of the governing resource employed. From Hood (1983).	1. Nodality: Information-based instruments; relies on voluntary compliance. Especially knowledge generation and mobilization. 2. Authority: Use of the power of the state to command, prohibit, permit behaviour. 3. Treasure: Use of public funds to (dis)incentivize, produce and maintain public goods and services, impose costs. 4. Organization: Leveraging physical and human capital of the state through direct delivery of programmes and services and government operations.
14	Type of substantive policy instrument [Mutually exclusive]	Policy instruments that are intended to directly affect the nature, type, quantity, distribution of goods and services in society. Adapted	1. Not substantive 2. Advice: Sharing of knowledge and experience with other agencies or

to pipeline safety contexts. From Howlett (2000).	departments in government or key stakeholders. [Nodality]
	3. Education and training: Formalized knowledge-sharing aimed at government staff and/or key stakeholders. [Nodality]
	4. Reports and assessments: Change system modelling, impact and vulnerability assessments, or scenario-based planning tools. [Nodality]
	5. Monitoring and evaluation: Monitoring changes in exposure or potential impact (i.e. environmental and health conditions). [Nodality]
	6. Inter-governmental mandate: Directives requiring action by other levels of government. [Authority]
	7. Spatial planning: Rules for allocating land uses, public space design standards (e.g. site planning for pipeline location). [Authority]
	8. Infrastructure performance standards: Standards for infrastructure performance, including performance assessment requirement (e.g. pipeline must withstand X amount of pressure). [Authority]
	9. Building regulations: Rules for building and construction standards (e.g. thickness and material of pipeline). [Authority]
	10. Strategic planning: Adoption of policy guidance documents that consider pipeline policy. [Authority]
	11. Pipeline safety planning: Adoption of policy guidance documents for pipeline safety. [Authority]

			12. User charges: Fees paid on the basis of service usage, including fines and penalties for violation of regulations. [Treasure]
			13. Grants or subsidies: Financial transfers awarded on a conditional basis. [Treasure]
			14. Loans: Financial transfers given on the basis of repayment. [Treasure]
			15. Direct expenditures: Capital investments (e.g. facility investment including land acquisition). [Treasure]
			16. Demonstration projects: Use of government-owned facilities to demonstrate new ideas or technologies. [Organization]
			17. Operations: Procurement; (emergency) response procedures; procedures for updating policies and protocols; routine maintenance; best practices implementation; regular inspections of infrastructure, personnel, etc. [Organization]
			18. Facilities: Adapting facilities to different purposes (e.g. pipeline pumping station); upgrading government-owned properties. [Organization]
			19. Other
15	Type of procedural policy instrument [Mutually exclusive]	Policy instruments that are intended to influence the network relationships among actors in a policy system. Adapted to pipeline safety contexts. From Howlett (2000).	1. Not procedural
			2. Exhortation: Normative arguments to persuade actors to engage in pipeline safety. Including endorsements of action from other levels of government or non-state actors and feedback to other levels of government on strategic plans. [Nodality]

3. Public outreach: General information campaigns to educate communities or stakeholders about pipeline safety. [Nodality]
4. Labelling: Forms of measurement intended to make individuals aware of pipeline safety concerns and to contribute to good design or production practices and innovation. [Nodality]
5. Agreements: Agreements between governments and/or non-government actors to common policy objectives (both governments at the same level and different levels). [Authority]
6. Advisory groups creation or modification: Creation/modification of working groups, committees, or boundary organizations for the purpose of better understanding pipeline safety challenges and providing advice to government on how to act. [Authority]
7. Hearings: Formal meeting for receiving information on public record from stakeholders on various sides of an issue. [Authority]
8. Pipeline safety networks: Collaborative actor networks for the purpose of sharing ideas, knowledge, and experience on pipeline safety. [Authority]
9. Research funding: Funding to non-government actors for knowledge production, including scenarios, assessments, projections. [Treasure]
10. Interest group funding: Funding for groups that participate in or influence public policy based on a common concern. [Treasure]

			11. Conferences and workshops: Participation in or hosting of conferences or workshops with stakeholders outside local government. [Organization]
			12. Institutional reforms: Creation of new agencies, departments, working groups, committees, personnel positions. [Organization]
			13. Other
16	Temporal nature of instrument [Mutually exclusive]	Nature of impact on the short, medium, or long term	1. Single instance: Single action occurring at one point in time.
			Example: Assessments or reports; events.
			2. Expected end date determined; episodic; transitory: A policy with a designated timeframe; action taken on a pre-determined or contingent schedule (e.g. annual reports, emergency response plans); effect permanence uncertain if dismantled (e.g. the termination of a special committee, joining a policy network).
			Example: A strategic plan; a pilot program; an administrative unit or staff position.
			3. Permanent: Implementation has a permanent effect on exposure, pipeline safety, or vulnerability.
			Example: Infrastructure projects; land use planning; building codes/standards.
17	Instrument target [Inclusive]	Nature of the group whose behaviour the policy instrument seeks to influence	1. Individuals: Population at large
			2. Households: Residents of single-family homes or occupants of multi-unit buildings

			3. Private sector (business): Local businesses, real estate development (including multi-unit buildings under application/consideration or construction)
			4. Local government: Municipal operations, agencies, departments
			5. Senior government: Regional or national governments, international organizations
			6. Other
18	Geographical boundaries of target [Mutually exclusive]	Scale of the policy instrument's target.	1. Neighbourhood: Area-specific
			2. City-wide: Not area-specific
			3. Metropolitan area: Multiple local governments, regional governments
			4. State-wide: State level government
			5. Nation-wide: National level government
			6. Unclear
			7. Other
19	Administrative responsibility [Mutually exclusive]	Government unit responsible for implementation	1. Pipeline Safety unit: Departments or offices within departments dedicated to pipeline safety policy and planning
			2. Executive or legislative bodies: Federal agency (Secretary's), State Governors, Local Leaders (Mayors)
			3. Planning and development department: Department responsible for land use planning, urban design standards, building standards
			4. Public works: Including infrastructure, and transportation: water, roads, public transportation

5. Economic development: Department responsible for jobs and local business support
6. Emergency services: Public safety services responsible for crime prevention, fires services, emergency medical response
7. Community and Health: Public health services,
community services
8. Energy and environment: Parks, water and air management, energy production and delivery services
9. Unclear
10. Other

Table 2: Linkages between governing resource and policy instrument type

Resource type	**Substantial policy instruments**	**Procedural policy instruments**
Nodality	Education, training, advice, creation of boundary organizations, production of scenarios and projections	Exhortation, knowledge-sharing networks, hosting conference and workshops, advertising
Authority	Legislation, inter-governmental mandates, regulation (zoning, standards, building codes)	Labelling, political agreements, advisory group creation
Treasure	Direct spending on infrastructure, direct spending on services, asset purchases, grants, subsidies, tax credits, levies, user charges	Research funding, interest group funding
Organization	Demonstration projects, procurements	Institutional reforms (working group creation, department re-organization or creation), evaluations, hearings, judicial reviews

B Twitter Full Archive Data Acquisition via Twitter Application Programming Interface (API) and NodeXL Analysis

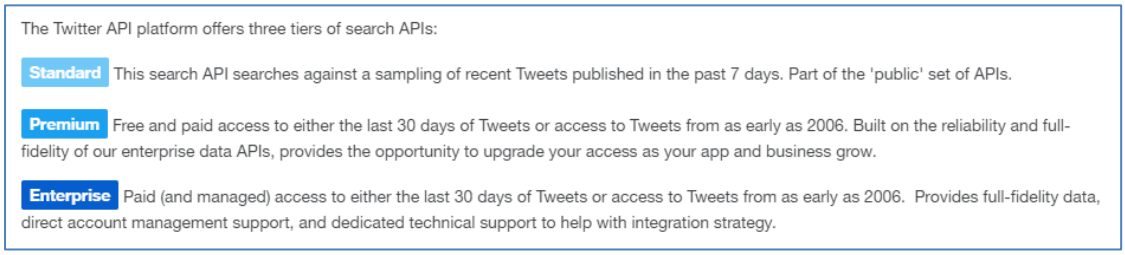
In order to acquire large volumes of specific Twitter data searches for keywords and data ranges, Twitter's application programming interface (API) is available through Twitter's developer platform. Twitter makes this API available to third parties to allow them to create custom solutions (searchers) which integrate within Twitter's platform. The following user guide is a list of steps to complete this process. Twitter Developer, https://developer.twitter.com/en/docs/basics/getting-started, has many tutorials online that include definitions and further detailed instructions to perform many tasks within the developer space. This user guide will not cover every step with full detail, but will reference official Twitter Developer tutorials as needed. The final steps within this user guide are specific to the Twitter API searches for this dissertation, but could be modified to fit other searches of interest.

B.1 Create Twitter Developer accout

Visit https://developer.twitter.com/en/docs/basics/developer-portal/overview to apply for a Twitter Developer account. This process requires a name, institution, and brief description of your intent of becoming a developer. For this dissertation, the intent was described as seeking historical full archive Twitter data for subsequent social network analysis needed to answer questions within an academic dissertation for Michigan Technological University. This dissertation required a Premium account, which allows for Full Archive Search with free limits of 5000 Tweets in a 30-day period. The Premium account allow includes a 30-day (last 30 days from present) search with a 25,000 Tweet max (within a 30-day window).

Reference Sites:

- https://www.youtube.com/watch?v=M_gGUqhCJoU
- https://developer.twitter.com/en/apply-for-access



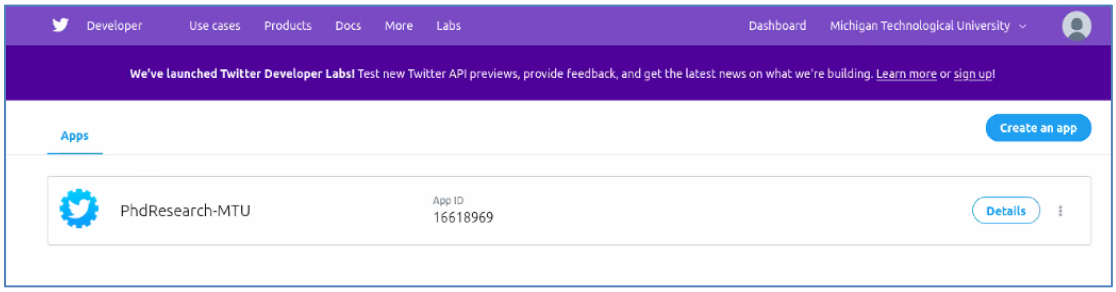
Source. https://developer.twitter.com/en/docs/tweets/search/overview

B.2 Create Twitter Developer App (or project)

The Twitter project for this dissertation was named *PhD Research MTU* . The Twitter App is essentially the specific space to perform the API work. Analagous to a file in another software program.

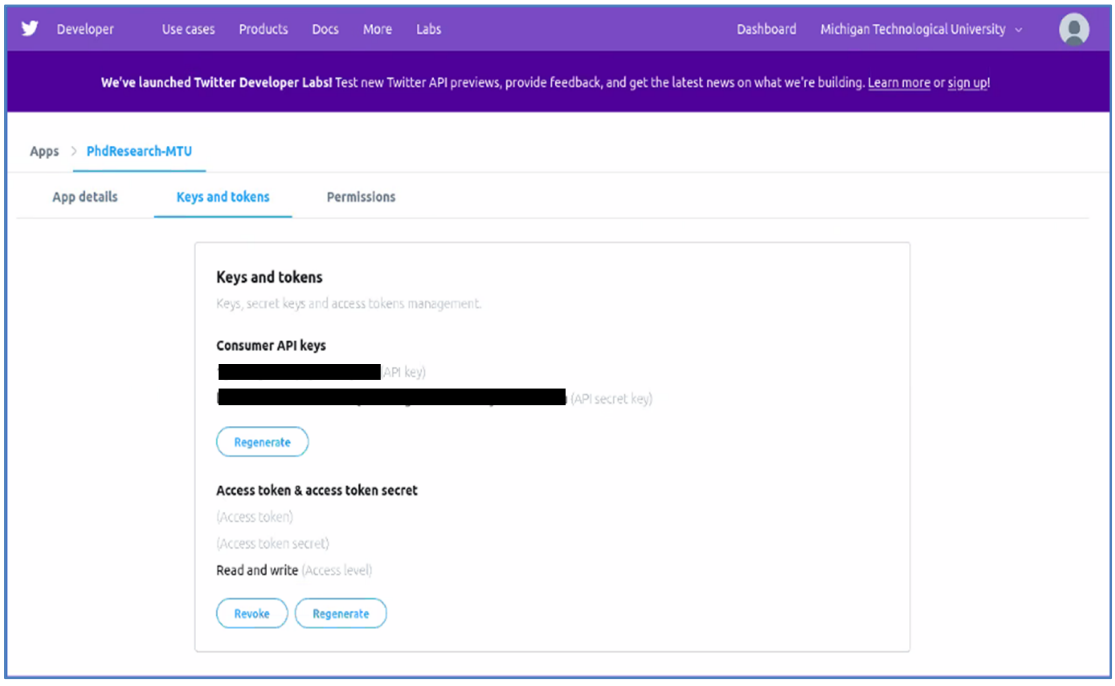
Reference Sites:

https://developer.twitter.com/en/docs/basics/apps/guides/the-app-management-dashboard



B.3 Generate API Key Pair

An API Key pair is analogous to creating a username and password to when connecting (searching) Twitter within the API. The API keys confirm that your API is being used and keeps all activity associated with a Twitter App.

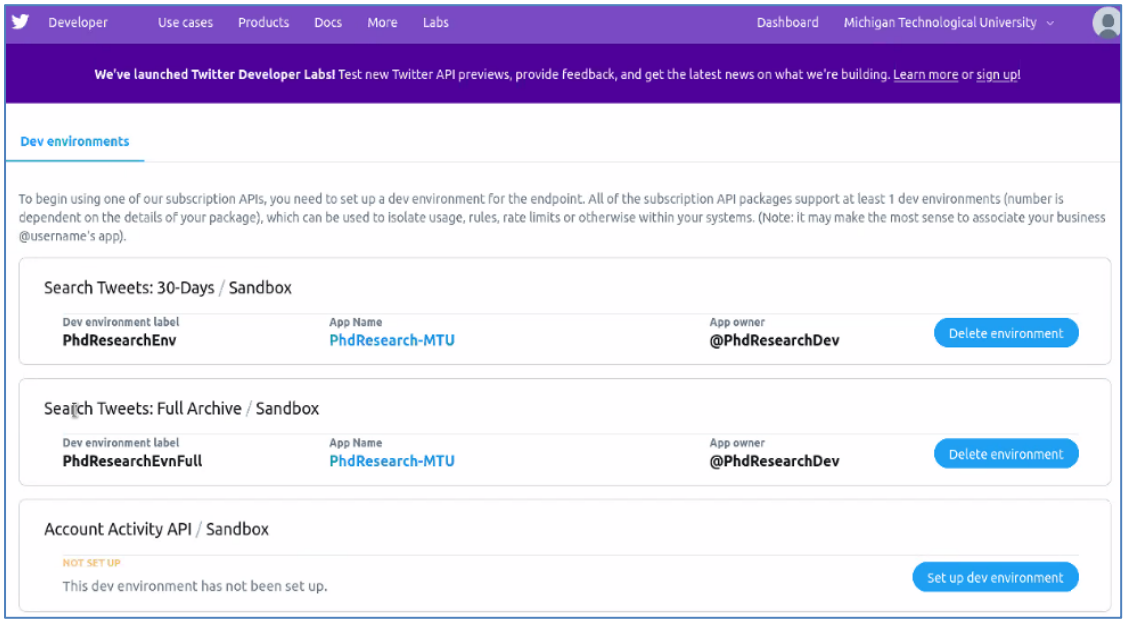


B.4 Set up Dev Environment

Dev Environments within the Twitter Developer system contain your API count data (limits for Free data) and billing information for those apps that wish to pay for additional data past the free allotment.

For this dissertation, two dev environments were set up with the Premium API.

1) 30-Day Search - used to test specific searchers prior to accessing Full Archive Search
2) Full Archive Search – used for Twitter



Example of Dev Environment Dashboard which shows the number of 'requests' used towards the allowed free quota. Each 'request' returns 100 Tweets worth of data.

B.5 Search Twitter data using Postman interface

Postman was chosen as the API interface for the Twitter API. Postman, https://www.postman.com/, is a collaboration platform for API development

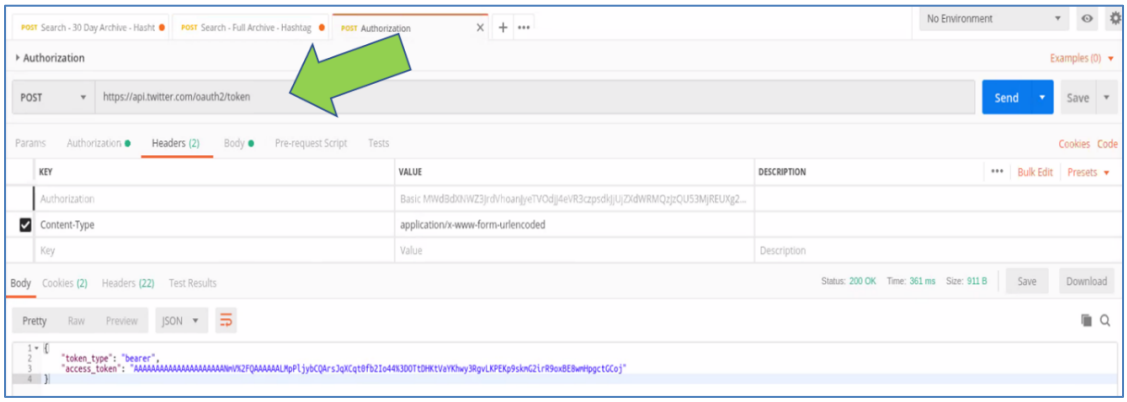
Generic Postman and Twitter Reference Guide:

- https://www.dataneb.com/post/how-to-make-calls-to-twitter-apis-using-postman-client

B.5.1 Create bearer token

A bearer token is needed for authentication (ensures to Twitter that the developer is who they say they are). To get a bear token, use the following steps within Postman.

- Enter http:///api.twitter.comOauth2/token into Post URL

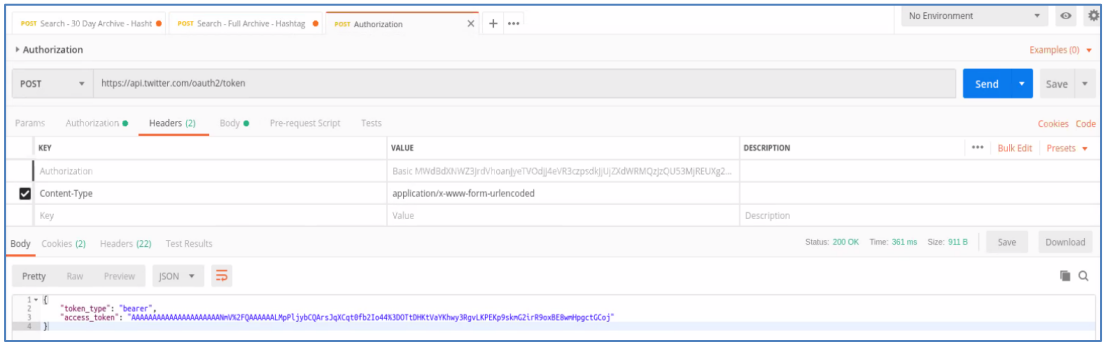


- Authorization Tab

Input in the Authorization Tab username and password as the API tokens created from Step 3 – username and password (from Twitter API key pair)

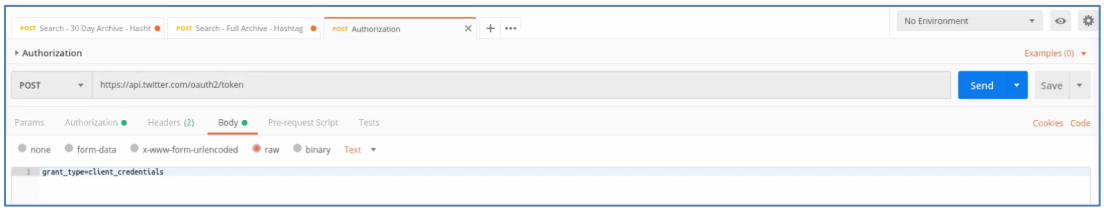
- Headers Tab

Input in the Headers Tab – Content-Type – (2) application/x-www-form-urlencoded

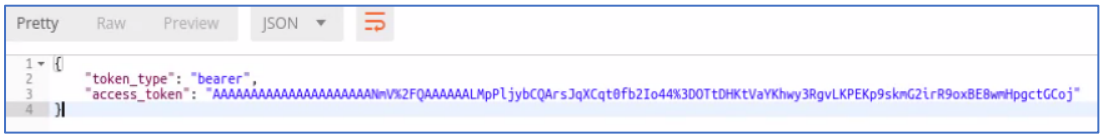


- Body

Input - Grant_type=client_credentials then Click SEND

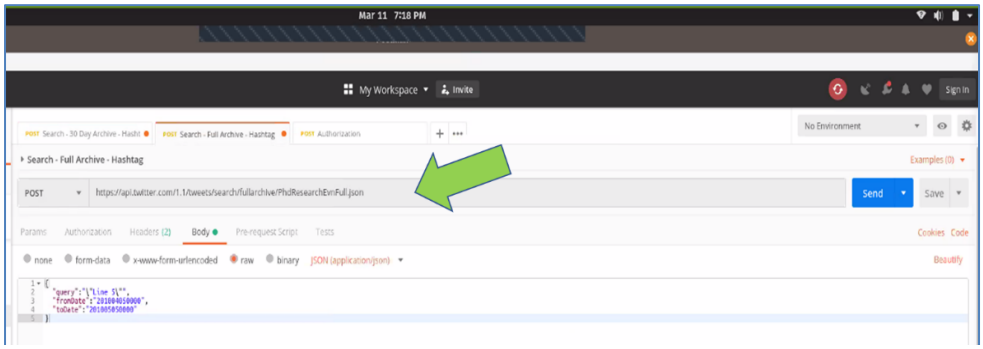


Generates Bearer Token

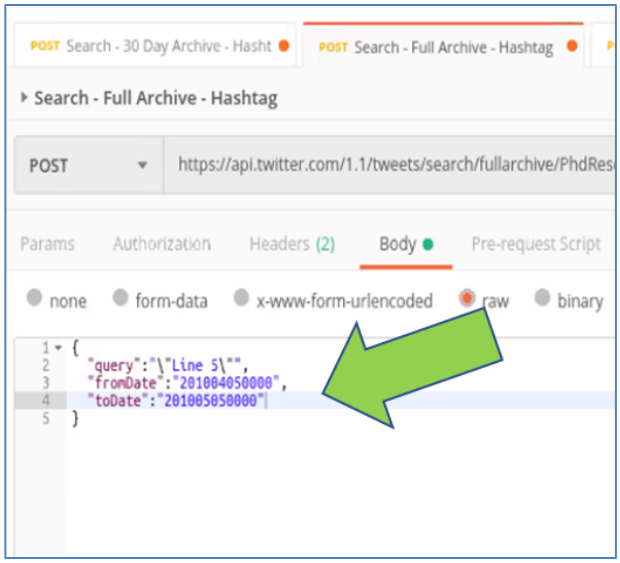


B.5.2 Submit request to Twitter full archive

- Enter URL into Post section:
  https://api.twitter.com/1.1/tweets/search/fullarchive/<dev env>.json



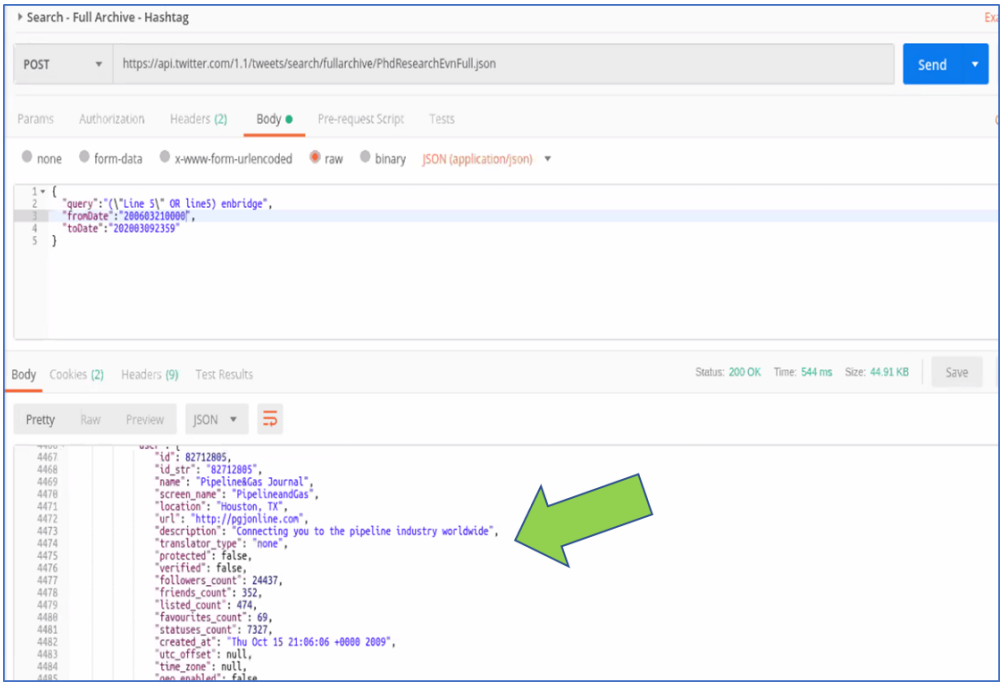
- Headers – paste bearer token into value for authorization in header tab
  - Content – application/json
- Body – Input search query Code for keyword query and from/to dates.



Example of additional search with AND / OR operators.

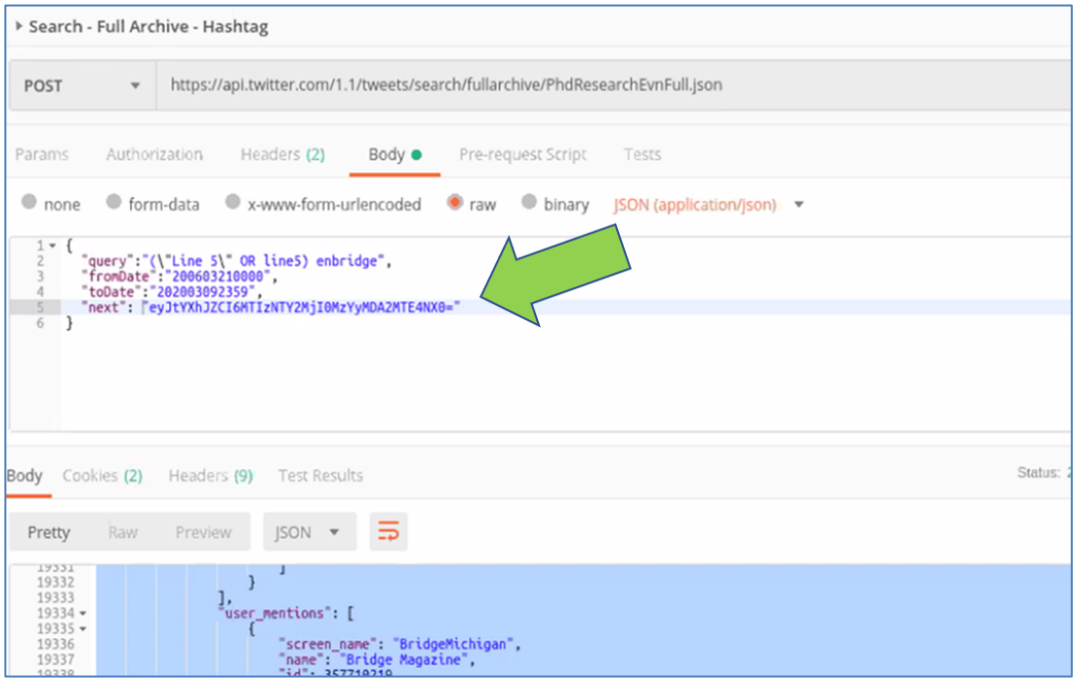
“Line 5” OR “Line5” AND Enbridge – remove date ranges – start from present and go backwards. 3-9-20 backwards.

JSON (Twitter Data format) is produced in the output area. Produces one CALL of data, or 100 Tweets worth of information. Each Tweet has many lines of data in JSON format.



B.5.3 Data Collection – Move data from Postman into Text Editor

- Copy entire RESPONSE and PASTE into any Text Editor (ex. NotePad). Save new txt files in same folder. If multiple CALLS used, please note the First Tweet Date and the Last Tweet Date within the Call. This will help organize the files to ensure your date ranges are covered. For example, this study displayed on Page 1 – 100 Tweets – Monday, March 9, 2020 through Thursday March 5, 2020. Note these dates can be used in the file names to organize txt data files.
- Collect Page 2, 3, 4, etc.
    - Find "next" token at the end of the page
    - Use Next token, put into Body of Call – then resend
    - Repeat process for each page– copy and paste "Next" token, put into "next" location, re-send.



B.5.4 Convert Raw Data to Useable Format – unlimited text files

Use the application Node.js to extract desired data from folder of txt files. A custom script was developed to extract Tweet ID, Tweet Created Date, and full Tweet Text (only value needed for analysis was Tweet ID, however the Date and Full Text is helpful in checking data for potential errors.

Custom Code

- Reads directory – (folder of 50 .txt files)
- Pulls out Tweet ID, created at date, Tweet Text
- Output in delimited text file

Custom Code

```
const fs = require('fs');
const path = require('path');

const directoryPath = "input-data";

fs.readdir(directoryPath, function(err, files) {
  if (err) {
    console.log("Error getting directory information." + err)
  } else {
    files.forEach(function(file) {
        let rawdata = fs.readFileSync(directoryPath + "/" + file);
        let twitterJSON = JSON.parse(rawdata);

        twitterJSON.results.forEach(tweet => {
          let tweetText = tweet["text"];
          if( tweet.extended_tweet != undefined ) {
            tweetText = tweet.extended_tweet.full_text;
          }
          console.log(file + "~" + tweet["id_str"] + "~" + tweet["created_at"] + "~" +  tweetText.split("\n").join(" ").split("\"").join(""));
        });
    })
  }
})
```

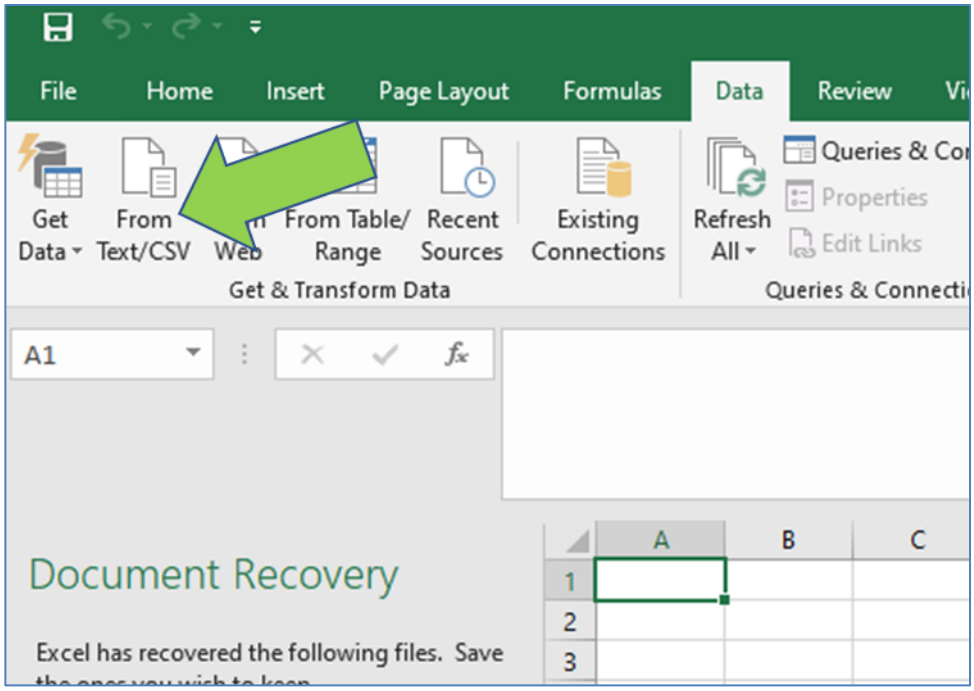
How to run Node.js file from command screen

```
node twitter-data-parser.js > parsed-data.txt
```

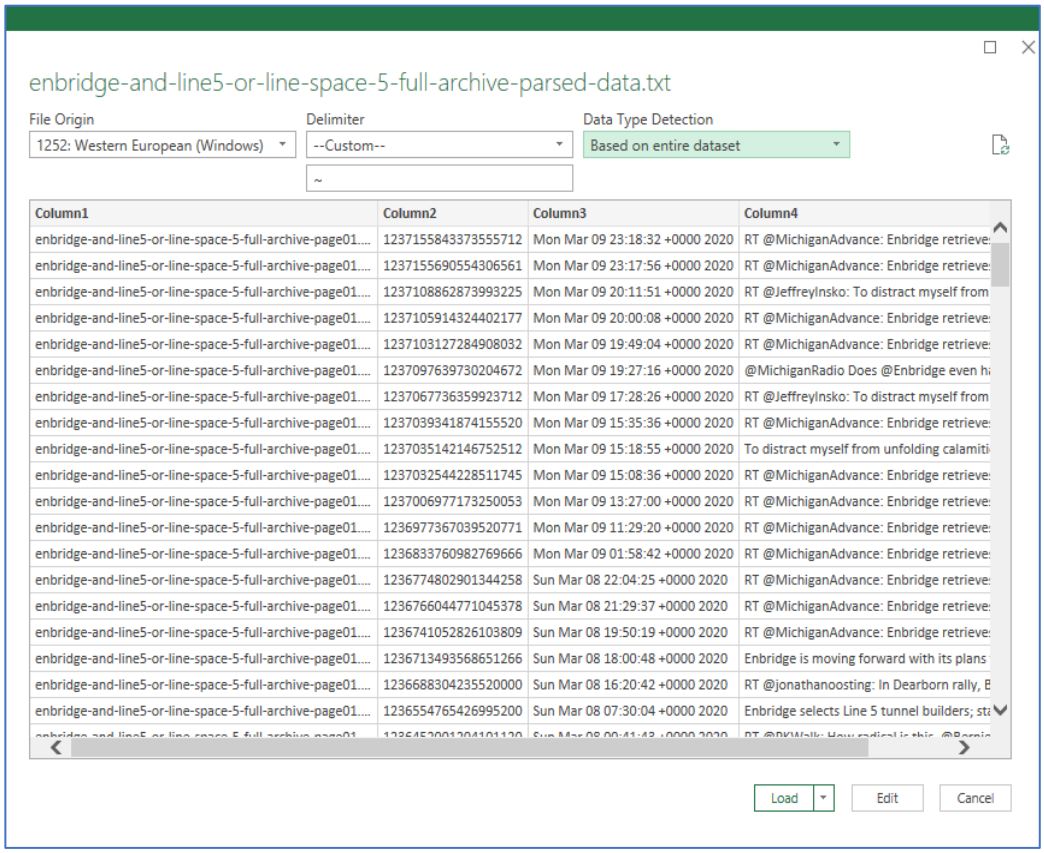
Reference for Node.js: https://nodejs.dev/run-nodejs-scripts-from-the-command-line

B.5.5 Import Text data from Node.js file – convert to delimited text

- Open excel
- Import txt data



- Adjust settings shown below, hit load

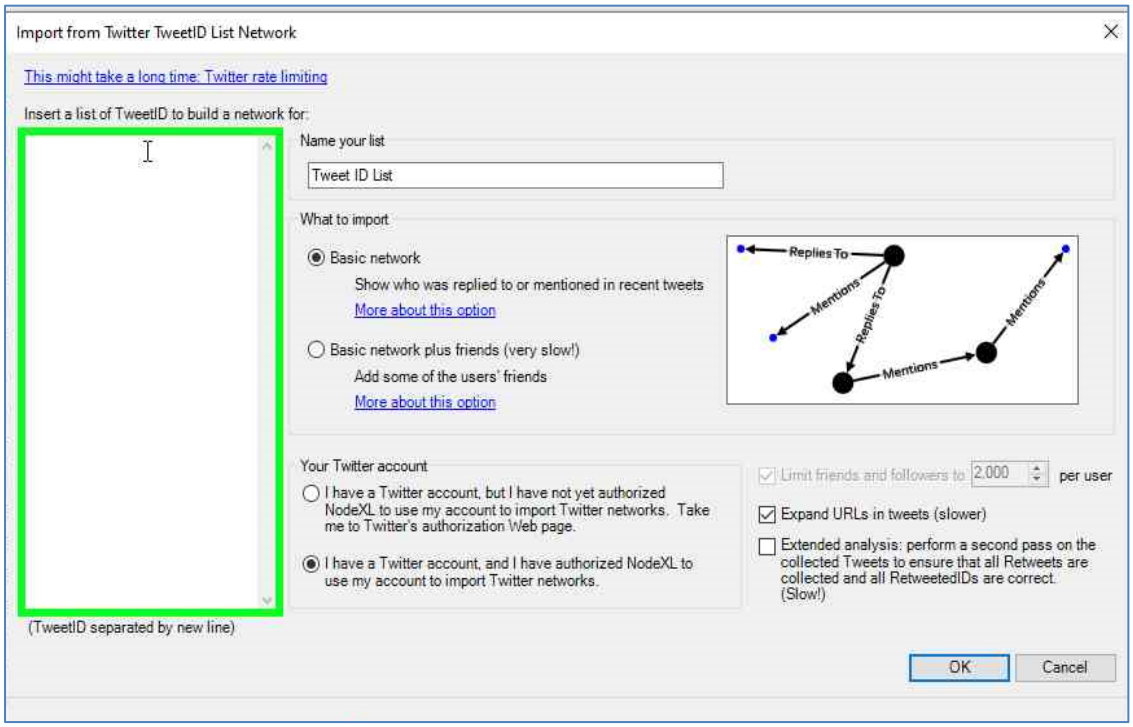


B.6 Import Tweet IDs into NodeXL

- Select and Copy all numbers in Column 2 (Tweet IDs)

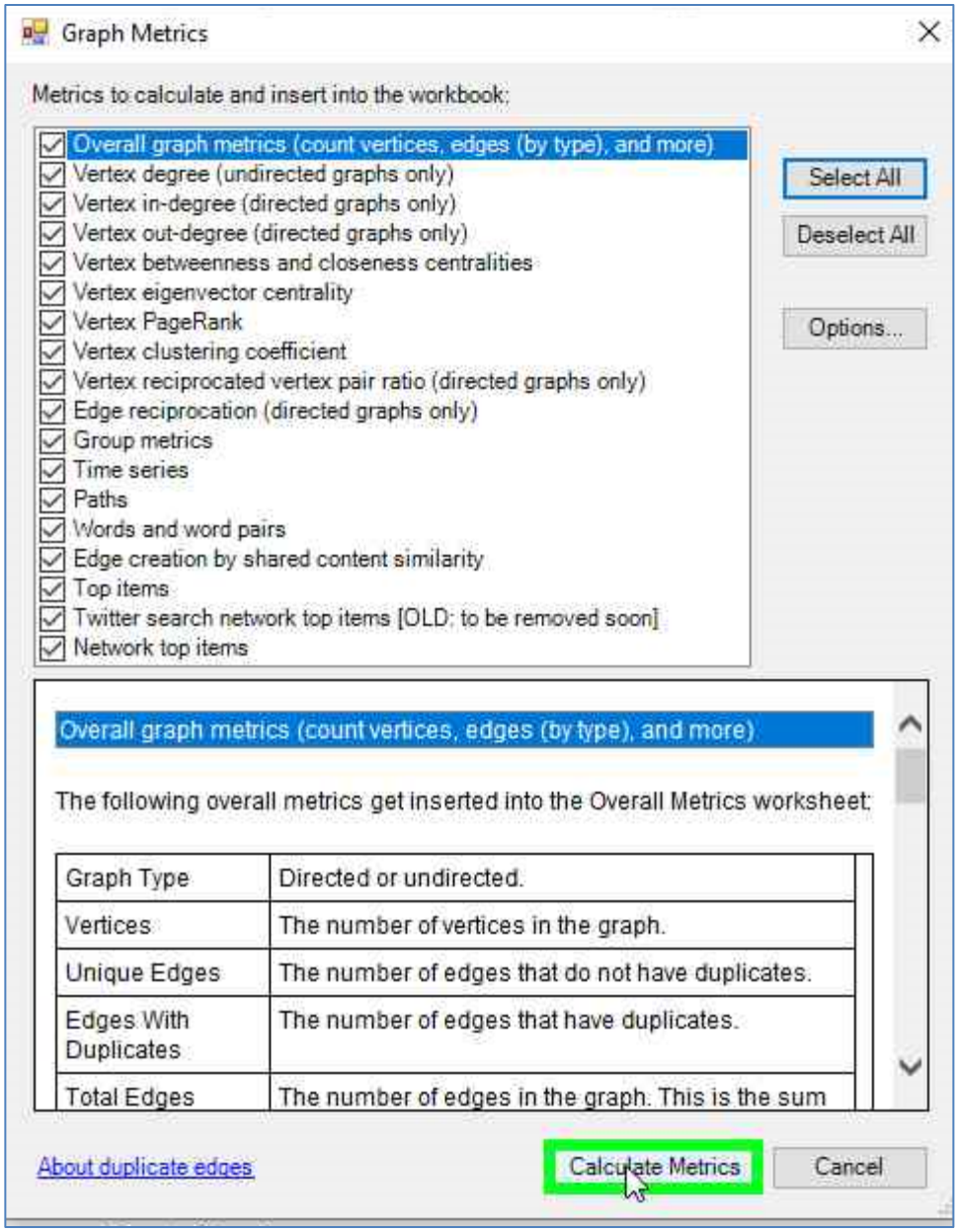
A	B	C	
	Column2	Column3	Colu
6-or-line-space-5-full-archive-page01.json	1237155843373555712	Mon Mar 09 23:18:32 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1237155690554306561	Mon Mar 09 23:17:56 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1237108862873993225	Mon Mar 09 20:11:51 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1237105914324402177	Mon Mar 09 20:00:08 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1237103127284908032	Mon Mar 09 19:49:04 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1237097639730204672	Mon Mar 09 19:27:16 +0000 2020	@M
6-or-line-space-5-full-archive-page01.json	1237067736359923712	Mon Mar 09 17:28:26 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1237039341874155520	Mon Mar 09 15:35:36 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1237035142146752512	Mon Mar 09 15:18:55 +0000 2020	To c
6-or-line-space-5-full-archive-page01.json	1237032544228511745	Mon Mar 09 15:08:36 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1237006977173250053	Mon Mar 09 13:27:00 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1236977367039520771	Mon Mar 09 11:29:20 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1236833760982769666	Mon Mar 09 01:58:42 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1236774802901344258	Sun Mar 08 22:04:25 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1236766044771045378	Sun Mar 08 21:29:37 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1236741052826103809	Sun Mar 08 19:50:19 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1236713493568651266	Sun Mar 08 18:00:48 +0000 2020	Enb
6-or-line-space-5-full-archive-page01.json	1236688304235520000	Sun Mar 08 16:20:42 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1236554765426995200	Sun Mar 08 07:30:04 +0000 2020	Enb
6-or-line-space-5-full-archive-page01.json	1236452001204101120	Sun Mar 08 00:41:43 +0000 2020	RT @
6-or-line-space-5-full-archive-page01.json	1236406509631913985	Sat Mar 07 21:40:57 +0000 2020	As M
6-or-line-space-5-full-archive-page01.json	1236339578325200896	Sat Mar 07 17:15:00 +0000 2020	The
6-or-line-space-5-full-archive-page01.json	1236338555422638082	Sat Mar 07 17:10:56 +0000 2020	How
6-or-line-space-5-full-archive-page01.json	1236336038534053888	Sat Mar 07 17:00:56 +0000 2020	Enb
6-or-line-space-5-full-archive-page01.json	1236335804827332608	Sat Mar 07 17:00:00 +0000 2020	Enb
6-or-line-space-5-full-archive-page01.json	1236335492532187136	Sat Mar 07 16:58:46 +0000 2020	RT @

- Open NodeXL
- Go To – NodeXL Pro Tab > Import > Twitter List ID Network
- Paste Tweet ID's into space
- Depending on how many Tweet ID, check or uncheck options to get more data

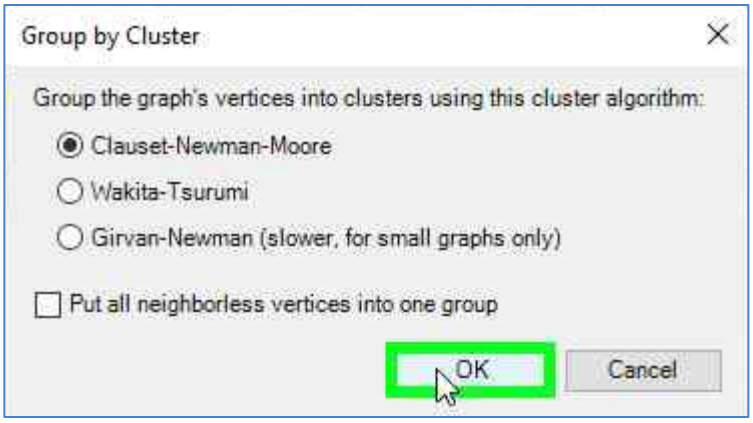


B.7 Create Social Network Graph in NodeXL

- Go To Graph Metrics > Select All check boxes > Click Calculate Metrics



- Create Groups > Group by Cluster > Group by Clauset-Neuman-Moore



- Graph Network – select Create/Refresh Graph
    - Note choose either Fruchterman-Reingold or Harel-Koran Fast Multiscale, whichever one provides a better visualization for the network/group trying to see.
    - There are many other graphing feature and options within NodeXL to be explored to fit desired visualization
        - https://www.smrfoundation.org/nodexl/tutorials/
        - https://sunlightfoundation.com/2012/05/24/tools-for-transparency-a-how-to-guide-for-social-network-analysis-with-nodexl/