ADAPTING LEVERAGE POINTS FOR SYSTEMS ANALYSIS OF WASHINGTON'S CLEAN ENERGY TRANSITION POLICIES

by

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ABSTRACT

Adapting Leverage Points for Systems Analysis

of Washington's Clean Energy Transition Policies

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Academic models of socio-technical transitions and systems change represent an exciting opportunity for direct qualitative analysis of policies meant to transform modern energy grids into new clean energy systems. In this research, I developed a new model of textual policy analysis based on Donella Meadows systems leverage point hierarchy. Additionally, I drew inspiration for this revised model from the Multi-Level Perspective on socio-technical transitions. A modified hierarchy of leverage points was proposed, meant for categorizing individual articles of climate legislation which act upon the energy system of Washington state. The developed analysis methodology can be used to identify gaps in current transition strategies by the legislature, such that future legislative action may be taken to create a more holistic renewable energy transition strategy statewide. Through attempting to develop a more rigorous analysis method utilizing systems transitions research, I created a starting point which reveals challenges to the development of such a technique.

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Introduction

According the most recent synthesis report from the Intergovernmental Panel on Climate Change (IPCC), the earth will likely pass 1.5C degrees warming, even with current mitigation policies (Mukherji et al. 2023). This, of course, assumes no increase in political ambition to reduce greenhouse gas (GHG) warming emissions through new policies. The predicted anthropogenic warming that will result from the current policy agenda (business-as-usual or BAU) could reach a total anywhere between 2.1-3.4C by the end of the century (Mukherji et al. 2023). If the world is to meet the goal of limiting warming to 1.5C as set during the Paris meetings in 2015, rapid dramatic changes to our current socio-economic paradigms that cause this warming need to occur this decade. We need strategies to improve upon our current transition policies. We need strategies to foster this rapid socio-economic transition by 2030.

Socio-economic transitions by their very nature occur over long spans of time within a multifarious system of interacting parts. A transition of the magnitude under consideration here includes changing our governments, businesses, policies, public attitudes, and the physical environment, both human built and natural (Geels 2002). The urgent need to act combined with the complexity of interacting parts in systemic change, it is easy to miss the forest fire for the burning tree. What is needed is a way to measure the degree of systemic impact of a proposed change-action. Thus, in this research, I synthesize research on systems transitions and leverage points to qualitatively measure the effectiveness of policies meant to foster systemic change towards climate change mitigation, developing such a tool.

To increase the effectiveness of our climate policies, several conceptual frameworks are needed for understanding the full scope of socio-economic transitions, and where to act in producing systemic level change (see Figure 1). Systems theory research in the field of

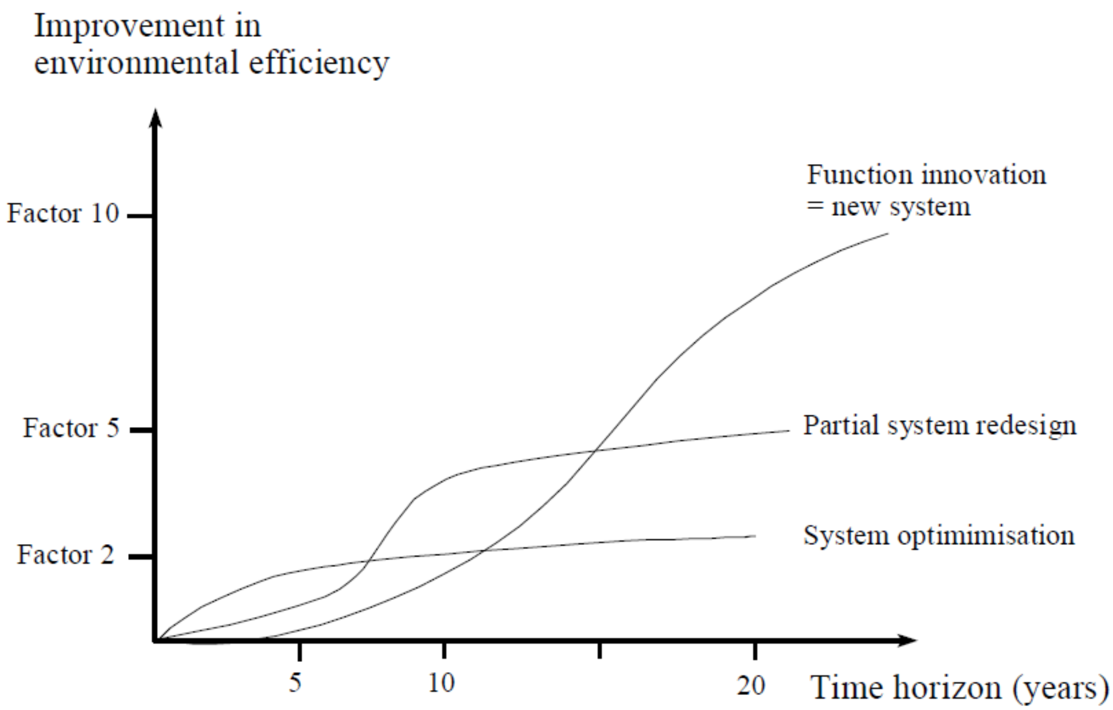

Figure 1: The different types of change in systems. In this paper, when I refer to "systemic change," I am referring to factor 10 transformations in creating entirely new systems from an older one. This is what is meant by systemic transitions, fundamentally changing the underlying structure to improve function with regard to a specific need (e.g. reducing environmental impact). Image Citation: (Geels 2006)

sustainable transitions provides a set of heuristic tools for understanding how systems are modified. Researchers in the field advocate for several explanatory models of societal change, with the ultimate aim of describing how to move to sustainable and stable economies (Loorbach, Frantzeskaki, and Avelino 2017).

One such heuristic model is the multi-level perspective (MLP) on socio-technical transitions, which presents three hierarchical levels to model change in socio-economic systems: landscapes, regimes, and niches. Landscapes exist at the broadest level, marking cultural values, societal pressures, and physical structures and limitations (Geels 2002). Regimes mark structural societal functions, actor networks, and the shared rules that maintain those functions over time. Niches represent new developments or opportunities for change that can develop and interact with regimes in multiple ways (Robertson Munro and Cairney, 2020). However, a problem in utilizing this framework for the modern transition arena's is its lack of reproducibility in application (Smith, Voß, and Grin 2010). Most evidence used to demonstrate the MLP consists of historical anecdotes of societal transitions, without clearly defined boundaries for how each term is applied as a qualitative code (Geels 2002, Kemp & Loorbach 2005, Genus & Coles 2008).

Leverage points represent another conceptual tool that articulate where in a system action can produce the greatest magnitude of change (Meadows 1999; Abson et al. 2017). Here, I used leverage point thinking to predict the magnitude of impact a system intervention might have. A common tool for system intervention is policy, which in itself is a high order leverage point since policies represent power to organize socio-economic systems (Meadows 1999). To foster a transition towards sustainability, climate policy-actions can be ranked by which leverage point they act on (Abson et al. 2017). Understanding which degrees of leverage our current climate policies influence may reveal new opportunities for acting at higher degrees of leverage, promoting more rapid systemic change towards sustainability.

To effectively utilize these two systems models for effective policy development in climate action ready governments, I articulate a method of 'map and locate' analysis of a given policy sector, utilizing qualitative codes derived from the literature of both the MLP and leverage point research. Through defining the qualitative codes with respect to the policy sector, this form of analysis solves the issue of reproducibility of systems transition research. I have chosen Washington state energy policy as my policy sector of analysis to demonstrate my methods to map and locate the most impactful leverage points to act on for fostering more rapid systemic transitions via climate policy.

The next section gives a general overview of the literature on system transitions research as relevant to the development of a policy analysis methodology. Section three gives an overview of the methods. Following that, I propose modifications to Meadow's leverage point hierarchy for the purpose of an article-by-article dissection of Washington acts, explaining why the modifications emerged. Section five gives an overview of what policies fell under each leverage point in ascending order, showing the results and trends under each degree of leverage. A discussion of these results follows to review the effectiveness of the developed methodology, including challenges that arose and potential avenues for addressing those challenges in future research.

Literature Review

Applying the conceptual frameworks from both Meadow's leverage points and Geel's Multi-Level Perspective (MLP) poses a unique challenge. Both frameworks are non-empirical and instead use heuristic tools to give a simplified understanding of highly complex processes. Critiques of the MLP have claimed that the usefulness of the framework is limited to the effectiveness of the researcher in defining the boundaries of the system being studied, as well as their effectiveness in situating the conceptual units of the framework within that bounded system (Smith, Voß, and Grin, 2010). In addition, Smith, Voß, and Grin (2010) highlighted that case study applications of the MLP lack consistent replicable use of key terms. When is consumer behavior labeled as component to a socio-technical regime, or instead, as part of the broader cultural landscape attitudes? This is a question of bounding these key terms. This study will focus on utilizing the leverage point framework to code policy actions while using terms from the MLP to situate the resulting analysis. Effective coding requires effective, operational, and replicable definitions. This literature will provide a starting point for doing just that.

In what follows, I will first give an overview of the conceptual frameworks in isolation, starting with leverage points within systems theory and moving on to the MLP and transitions research as a whole. After giving an understanding of both conceptual frameworks, key terms will be given a closer look. Here, I will interrogate definitions with respect to the Washington energy system as the bounded area of study. Specific use cases for the key terms in coding are discussed in Section Four. The goal is to operationalize both leverage points and the MLP frameworks for empirical, qualitative policy analysis for transitions. After discussing the systems transitions frameworks in depth, I present a brief review of Washington governance over the energy sector as relevant to the scope of this study.

Systems Theory and Interventions

Systems represent immensely complex structures, often comprised of many components necessitating interdisciplinary lenses to understand. They embody highly dynamic processes, requiring non-prescriptive approaches that are sensitive to unique structures (Scoones et al. 2007). Knowing how to make the most effective change in a system involves two key steps. The first is to know the system itself, but given their complexity, understanding every part of a system proves impossible in even moderately sized systems. Hence, it suffices to build a system map. The original scope of this research involved construction of a map utilizing the MLP, but this proved to be too large a task. Beyond knowing the system itself, the second key step is to know where in a system that change making actions will yield the most effect per unit of effort. Parts of a system that yield greater functional change upon action can be said to have a greater degree of leverage on the system as a whole (Meadows 1999).

Traditional political intervention within complex systems utilized prescriptive approaches that assumed the idea of sustainability embodied equilibrium that could be generalized, often leading to failed interventions that fail to acknowledge complexity (Scoones et al. 2007). Thus, dynamic sensitivity to the specific system being analyzed is required. The Social, Technological, and Environmental Pathways to Sustainability (STEPS) (Scoones et al. 2007) Center. In the STEPS Center's first working paper, Scoones et al. (2007) contended that political approaches to sustainable development require a combination of subjective and objective analyses, viewing both the structures within a system and the functions they embody.

An introduction to systems theory is incomplete without discussing its partner, complexity theory. Similar to the STEPS authors' argument to focus on understanding how systems are dynamic, complexity theorists move away from reductionist attempts to find universal rules for understanding systems, and instead seek to explain how complex emergent behaviors arise from smaller components (Cairney, 2012). Complex systems generate a sort of momentum, wherein the initial conditions carry significant weight as the system continues to function, creating what's referred to as "path dependence" (Cairney, 2012). Understanding how to create change in systems necessitates knowing how to subvert their path dependence.

It is then useful to rank the strength of actions intended to change a system, and the magnitude of potential change certain actions may create. The first scale for ranking degrees of leverage for systemic change actions came in 1999 from the work of Donnella Meadows on what she calls *Leverage Points*. A leverage point represents a component of a system where a small, targeted change can lead to cascading effects that alter system function to varying magnitude (Meadows 1999). The magnitude of change in system behavior is argued to be dependent on the degree of leverage as ranked by Meadows in her original work. She listed twelve leverage points in hierarchical order of greatest overall alteration to total system function (See Figure 2 below).

To understand where leverage points are located in systems, a discussion of what composes systems is warranted. Meadow's depiction of systems theory takes a very quantitative approach, often referring to numerical stocks, flows of resources between stocks, parameters governing stock size, flow rate, etc. The actual unit that composes a stock or flow can be both physical (e.g. kilowatts stored in a battery) or conceptual (e.g. votes to pass a piece of legislation). A system at its most abstract is a network of stocks, flows, and actors who interact, modify, and reproduce the systems they are embedded in (Meadows, 2008).

It's also worth noting that systems can be nested within each other. The Washington Department of Ecology represents a system nested within the greater state government. Thus, it is possible that acting on a higher leverage point in a large system requires changes in a subsystem, enabling greater magnitudes of change within the larger system. For example, in 2021, Washington enacted a climate policy that included a carbon tax on big polluters, particularly the first entity selling or burning fossil fuels. Opponents blame that policy for increased gasoline prices in 2023 and are petitioning legislators to change the program. They focus on the one issue—gas prices—to critique the larger climate policy. As this demonstrates, the nested property of systems further exacerbates their complexity. Just look at any organizational chart for a large business or higher education institution to get a sense. Each individual system will have its own leverage points unique as the system structure itself. Tracking which leverage points belong to specific systems can be a useful tool working with complex multi-faceted and nested systems, such is the case with state level policy.

In 2017, researchers considered Meadow's ranking of leverage points into conversation with sustainable transitions research. They claimed that much of modern policy meant to address the causes of climate change only address shallow leverage points for mitigating human caused greenhouse gas emissions (Abson et al. 2017). Like proponents of the MLP, their goal was to increase the magnitude and rapidity of transformational change through climate policies. They expanded Meadows original work by categorizing leverage points into more intuitive groups to highlight more impactful leverage areas (see Figure 2). The intuitive groupings have the added benefit of utilization for qualitative coding of climate policies when ranking current policy effectiveness for promoting systemic change.

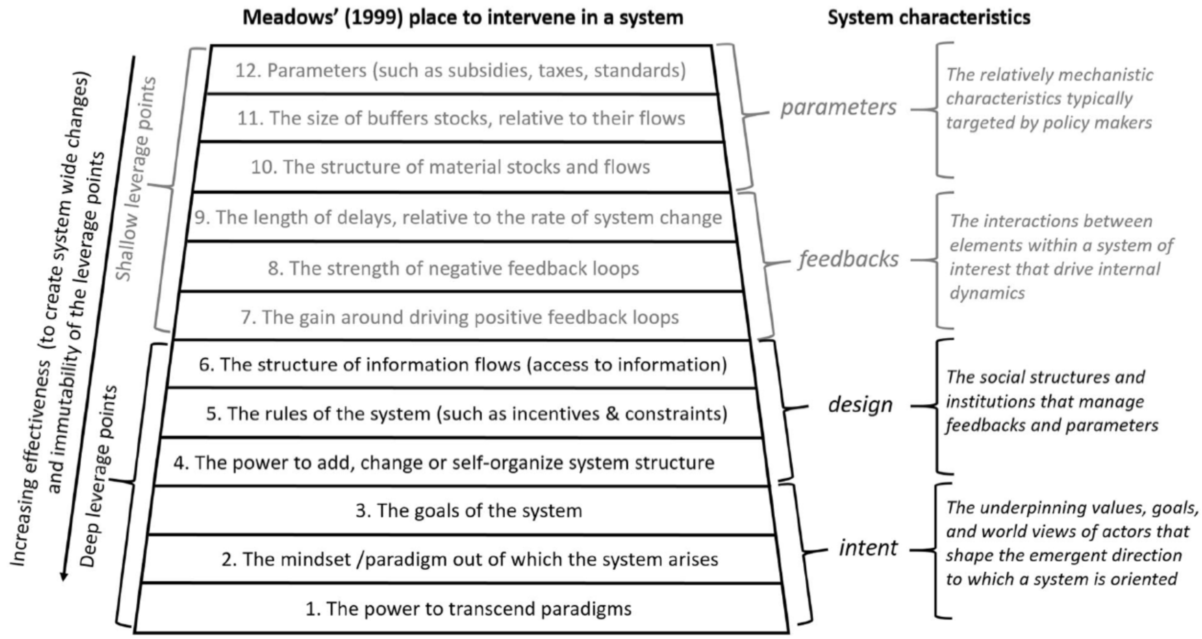

Figure 2: Abson et al.'s modified leverage point ranking. The original order of leverage points is preserved, Abson and his colleagues added the groupings of system parameters, feedbacks, design, and intent to simplify Meadows original ranking into a more intuitive framework. Climate policies that target the design and intent of systems needing to undergo sustainable transformation are more likely to achieve greater success. (Abson et al. 2017)

The researchers highlighted three areas of high leverage that climate policies should work towards. The first area deals with institutions, both the functional roles they serve and how they rise and fall with time. Understanding how groups come to agreed rules and goals may shape societal ability to achieve cooperation on goals for sustainability more surgically. Institutions as Abson and colleagues described are reminiscent of the concept of regimes from the MLP, including the quality of being self-reinforcing and resistant to change. These qualities are often described as "lock-in" effects (Geels 2011, Geels 2018).

The other two areas deal with interactions between individuals and nature, I'll refer to this as culture, and how knowledge is produced, academics. With culture, the authors argued that current culture disconnects people from nature which decreases sustainable outcomes at a societal level. Connections can be made through education on resource use, where the raw materials for goods come from, and teaching environmental ethics (Abson et al. 2017). With knowledge work in academics, the authors argued that how information is exchanged is path dependent, leading to unchanging frames for problems, which leads to path dependent solutions. For this, they suggested questioning how knowledge is framed and the perceptions behind academics and increasing interdisciplinary connectedness for solving complex problems.

Understanding how institutions are structured, cultural connectiveness of people to local ecosystems and human behavioral impact on them, and knowledge production and accessibility around transitions research. Each of these target areas deal with the design and intent of systems, deep areas of leverage. However, Meadows also admitted to the fact that complex systems comprised of many interlinking stocks, each with their own behaviors, and considerations become “way too complex to figure out” (Meadows 1999). As such, placing boundaries upon the scope of system analysis for locating leverage points was key. This research will only cover Washington energy policies dealing with electricity and natural gas use for heating passed since 2018, when the state government came under unified democratic control (Ballotpedia, 2018). While transportation fuels and industrial heating sources are a component of energy policy, the nuances of each are beyond the feasible scope of this system analysis.

A couple recent case studies have explored how leverage point thinking can be used to intensify energy transitions. In 2021, Bryant and Thomson published the results of an actor-oriented approach utilizing learning and knowledge workers to advance sustainable initiatives. Their methodology of utilizing information dispersal, Meadows’ sixth leverage point, catalyzed an entire sustainability program within the jurisdiction it was conducted in. While this leverage point is the lowest in power of Abson et al.’s “higher order” leverage points, this case study demonstrates the potential of Meadow's framework to inspire transitions at the scale of local government.

Another case study by Kellner (2021) applies leverage-point-based intervention onto water management practices in Switzerland. Researchers reviewed strategic planning documents and conducted interviews of related government officials. They then identified leverage points in a deliberative process and delivered these to the Swiss government for use. This map and identify approach mirrors the technique I developed in that it seeks to use leverage points to identify gaps in current strategy via qualitative means. However, my approach purely relies on review of policy documents whereas this study additionally utilized interviews of policy officials to understand the water-energy-food nexus of Switzerland.

Socio-Technical Transitions Research

The Multi-Level Perspective (MLP) exists within the broader research framework of Socio-Technical Transitions (STT), innovations studies, and evolutionary economics (Rip & Kemp 1998, Geels 2002, Smith 2010, Loorbach Frantzeskaki & Avelino 2017, Geels 2020). The goal of STT as a broader field is to map the social elements of technological evolution (Jørgensen 2012). The MLP emerged in the late 1990s and early 2000s as a framework for building this conceptual map of technological evolution. While the concepts within the MLP had previously been discussed in innovation studies (Rip and Kemp 1998), the integration of those concepts into a complete multilevel perspective didn't occur until 2002 with Frank Geels work (Geels 2002). The MLP's potential usefulness derives from the concept that changing an underlying system is more effective than simple process optimization and incremental change (Geels 2006; Abson et al. 2017; Meadows 1999). Figure 1 in the introduction illustrates this principle. Discussion of how to increase the speed of radical innovation is a consistent motivation of STT throughout the literature.

The MLP presents a hierarchy of dynamic interacting elements involved in technological evolution over time. The different conceptual levels describe how socio-technical changes unfold in complex socio-economic systems, deriving evidence for the model from previous socio-technical transitions. For example, Geels first articulation of the MLP outlined the transition from sail ships to steam powered ships in the 19^{th} century (Geels 2002). In order of scope, from broad to narrow, these are *landscapes*, *regimes*, and *niches*.

At the macro level of the MLP is the *socio-technical landscape*, describing the material environment and use cases technologies are situated within. At this level, change is slowest to occur, requiring overhaul of infrastructure and supply chains to support a particular technology. The prevalence of gas stations across the United States as compared to electric charging stations is an example the landscape difference between combustion and electric vehicle technologies. *Landscapes* represent overarching societal attitudes, cultural influence, physical structures, and geographic constraints. Overall, this level tends to represent the slowest evolutionary change over time, exerting consistent top-down pressure on both regimes and niche developments.

At the meso level are *socio-technical regimes*, where common place technologies exhibit a lock-in behavior to their use and perpetuation. Regimes fulfill societal functions like transportation, energy production, or information sharing and access. A regime is composed of a particular technology meant to fulfill this function, championed by a network of individual actors and firms. It is the routines and practices of actors involved with a technology's use and production that ultimately compose and reproduce it (Rip and Kemp 1998). Characteristics of successful regimes include the long term build out of supporting infrastructure, competing firms which pursue incremental development of the regime technology, and lock-in of the regime.

Regimes also display a unique behavior, path dependence, which is interchangeably also referred to as “lock-in” in the literature (Geels 2011). Recall that path dependence was an emergent behavior within complex systems, showing how entangled systems thinking is with research on socio-technical transitions. The lock-in behavior of regimes is of particular note within transitions research, as it prevents new regimes from forming due to factors like consumer preference for an older regime (Geels 2011). Thus, a key goal of a sustainable transition must be to unlock high carbon emitting regimes to be supplanted by renewable alternatives.

Socio-technical niches compose the lowest and most rapidly changing level of the MLP. Like niches from Darwinian evolution, this level represents ongoing conflict or gaps in the utility of currently established technologies, therefore marking a demand for new innovation (Geels et al. 2018). Within niches, multiple different parties vie for their own solution to an existing problem in the dominant regime, hoping to catch the eye of investment or sponsors who can network to promote a particular solution. Within niche spaces, small actor networks vie for their own solution to a regime problem, attempting to “champion” their particular solution (Geels 2020).

One challenge Geels (2020) pointed out when revisiting his theory is the MLP’s lack of attention towards the role of political process in shaping transition goals of various actors. This could be framed as an actor-oriented question within the MLP. Geels made additional criticisms of his model in 2011. In that work, he highlighted the lack of individual actor agency within his system-oriented model, meaning the MLP could only describe change rather than help foster change. This gap called for more study into the role individual actors can play in creating systemic change.

The lack of a role for actor agency hints at another challenge with the MLP, applying it to the present world transitions instead of describing past transitions. In their 2020 meta-analysis on utilizing socio-technical transitions research for energy and climate solutions, Hirt and colleagues claimed that the literature branching the field to the real world was well saturated with interdisciplinary papers branching the topics theoretically but called for more researchers to search for more practical solutions through linking the fields (Hirt Schell Sahakian Trutnevyte 2020). In this however, they claimed the MLP is limited in its capacity to accomplish this task as it is primarily a heuristic tool.

Recent research has begun to address the role of actors however. Geels conceptualized actors as self-interested rule followers in his 2020 paper reaffirming the foundations of his MLP model; however, he didn't come to a definitive answer on agency as a whole. Instead, he explained the different formulations of agency based on the component theories that make up the MLP, that is, the social construction of technology, evolutionary economics, and neo-institutional theory. Thus, how agency manifests in an analysis utilizing the MLP depends on which of these component fields is being utilized most in an analysis. Bogel, Pereverza, Upham, and Kordas (2019) remedied the agency issue by utilizing organizational change management methods combined with the MLP to construct a heuristic analysis framework for transitioning institutions towards sustainability. Their model created a macro-meso-micro model of agency, focusing on the entire system under analysis, individual organizations, and individual participants respectively, identifying processes of change within each. In their model, actors serve as boundary spanners across all foci of change making efforts, operating in the ways that best suit their arena of changemaking.

This literature review gives an overview of both systems thinking and the study of socio-technical transitions. Special attention is given to the role of leverage points as a tool for understanding how systems change over time. Geels MLP provides additional perspectives on systemic change, focusing on broader societal transitions whereas systems theory is much more generalized. The next section will introduce the methods of this study which utilize leverage points to analyze current policy attempts at fostering a transition in Washingtons energy grid.

Methods

To analyze the potential effectiveness of current Washington state policies for promoting a rapid sustainable transition, I constructed a qualitative analysis framework rooted in the relevant literature from systems transitions. This analysis involved coding of policies meant to foster or promote sustainable transition outcomes for the energy arena, defining points of leverage for future climate policy to act on.

I coded bills from the two biennial sessions between 2018 and 2022. I selected this time period in order to limit scope and focus on the period of recent state history during which Democrats obtained control of both state houses for accomplishing their agenda (Ballotpedia 2018). During this period, significant progress was made for state climate legislation. Bills passed included a cap-and-invest program, modelled on the successes and failures of earlier state carbon pricing measures; the Clean Energy Transformation Act, mandating a carbon neutral energy grid by 2030; and the HEAL Act, a law codifying energy justice at the state level. I originally collected bills for my sample pool via key term search for renewable energy and selected relevant acts by title. However, the available time for this study only allowed me to review a handful of the bills found under the search. I use my analysis method to review the Climate Commitment Act (CCA), Clean Energy Transformation Act (CETA), and the Clean Buildings for Washington Act (CBA). These acts target three separate but representative aspects of the energy grid, overall emissions, grid infrastructure, and demand side infrastructure respectively.

To further define my scope, I only coded sections of these acts relevant to the sustainable transition of the electric and heating grid owned. I did include documents pertaining to other utilities involved in the function of this grid, such as natural gas pipelines and regulating bodies.

A further constriction on the scope of this analysis was the exclusion of publicly owned utilities. The systemic difference between public and investor-owned utilities within Washington represents a significant enough split to warrant a separate application of these methods to the two utility types. In Washington, investor-owned utilities are regulated by the Utilities and Transportation Commission, whereas publicly owned utilities are regulated by a board of governors. This difference in regulatory treatment represents significant changes in power structure for changemaking, which is why I chose to focus on investor-owned utilities.

After collecting my sample of Revised Codes of Washington (RCW) bills, I coded each document for specific “policy actions.” Policy actions represent an article or sub article of law passed that acts on some degree of leverage to enact change on the energy system of Washington. Each policy action was then rated by what degree of leverage they act on for creating systemic change. Applied codes were first taken from Abson et al.’s reclassification of Meadows (1999) leverage points, and further elaborated on through subsequent literature to produce replicable definitions for coders to apply.

My process of document coding involved an iterative cyclical approach. Because I predefined my codes based on previous theory and my research question, the coding style is largely provisional and attributional, describing how policy-actions fit the theoretical framework of sustainability transitions research and degrees of systemic leverage (Miles, Huberman, Sandana 2014). Provisional codes involve selecting excerpts that fit a particular theme from the literature (e.g. “policy action : 6th degree, reducing feedback delays). Provisional codes are outlined before the data analysis begins and can be revised, deleted, or augmented as the analysis unfolds. In order to refine definitions for my provisional codes, I coded using the predefined first round codes and noted where there were inconsistencies between the codes and text, or where provisional codes did not clearly apply to the policy-actions under consideration. After noting the issues with code definitions, I reworked them for another round of provisional coding. This cycle of redefining provisional codes and recoding with the new definitions was key to developing a robust codebook for conducting this qualitative analysis.

In some cases, multiple codes from a similar category would apply (called simultaneous coding), such as the case with coding by degree of leverage for a policy-action. Some policy-actions were coded as acting on multiple leverage points. However, Meadows herself notes in her original articulation that higher degrees of leverage are sometimes represented by lower leverage categorizations acting in a specific area of a system (Meadows, 1999). As such, policy actions were coded by the highest degree of leverage that matched their text.

One distinction had to be made on Meadow's fifth leverage point, system rule making. A system rule is defined as the establishment of a new feedback loop that reinforces (or 'discourages' for damping feedback loops) certain behaviors in a system (Meadows 2008). Given that most provisions of RCW's are enforced by the threat of legal penalty, the majority of articles would be coded as the leverage point of system rule making. A penalty from this lens counts as damping feedback for the action of policy non-compliance. As a result, I chose to make the further distinction between 'implicit' and 'explicit' rule making. Implicit rulemaking occurs when a policy establishes a damping loop by way of penalty non-compliance, while the explicit rule making leverage point is defined as a law that outlines a feedback loop that utilizes other mechanisms of behavioral feedback. For example, the Cap and Invest program establishes a damping feedback loop through pricing carbon emissions (implicit), but also a positive feedback loop by funneling that revenue into climate adaptive projects (explicit).

Additionally, I developed subcodes for articles under each degree of leverage to identify patterns that emerged under each degree. These subcodes are discussed at length for each leverage point in the results section to demonstrate underlying trends of articles acting to create different forms of change.

The qualitative codebook for this research is attached in the Appendix for review. Coded documents are listed but the collected codes themselves are excluded from this publication, but available by request. A few examples of coded elements are included in the codebook to demonstrate final use of the developed codes. In the next section, I discuss the development of those codes through modifying Meadow's leverage point hierarchy.

Adapting Meadows' Leverage Points for Policy Analysis

Meadow's developed leverage points as a framework for understanding where to make change in systems. In her book, *Thinking in Systems: A Primer (2008)*, she outlined a theoretical framework of twelve different types of leverage in generic systems. In her first paper describing the leverage point model, she explicitly stated her hierarchy is a "work in progress… an invitation to think about the many ways there might be to get systems to change" (Meadows 1999). In this research, I adapted and modified Meadow's hierarchy for looking at Washington's energy transition policy. This denotes a transition in Meadow's leverage point model from a theoretical framework to direct real-life application. In order to adapt her model for policy analysis, I proposed several modifications for the specific use-case of policy analysis.

Meadows' original hierarchy consisted of twelve degrees of leverage, ranked by order of impact each point had on a system being modified. Abson et al. further expanded Meadow's ranking by classifying the degrees of leverage by the characteristic they modify in a system: parameters, feedbacks, design, and intent (Abson et al 2017) (see figure 2). These categories served to improve the intuitive power to understand change in systems, highlighting broad areas of systems to target for different desired impacts. As a result of applying leverage points to policy analysis, I expanded on Meadows' work to include five new degrees of leverage (see figure 3). Each new leverage point described a legislative change to the Washington energy system that could not be characterized easily by Meadow's original model. Each of these new points were given a name and location within the ranking of how much impact they have over systems. Note that the modified hierarchy I described in this section is specific to classification of leverage for attempts to modify systems through legislation.

A single leverage point describes a place in a system that can be modified to create disproportionately larger magnitudes of change. Think of it like surgery. By replacing a failing organ, you can save a patient's life and subsequently maintain the health of the rest of the body. Leverage point-based intervention can be considered the surgery of generalized systems theory. In this paper, I use the term leverage point both to describe specific parts of a system being modified, as well as to indicate a generalized category as described by Meadows. I use the term *degree of leverage* to represent categories of intervention, which are ranked by the magnitude of potential change they can create in a system.

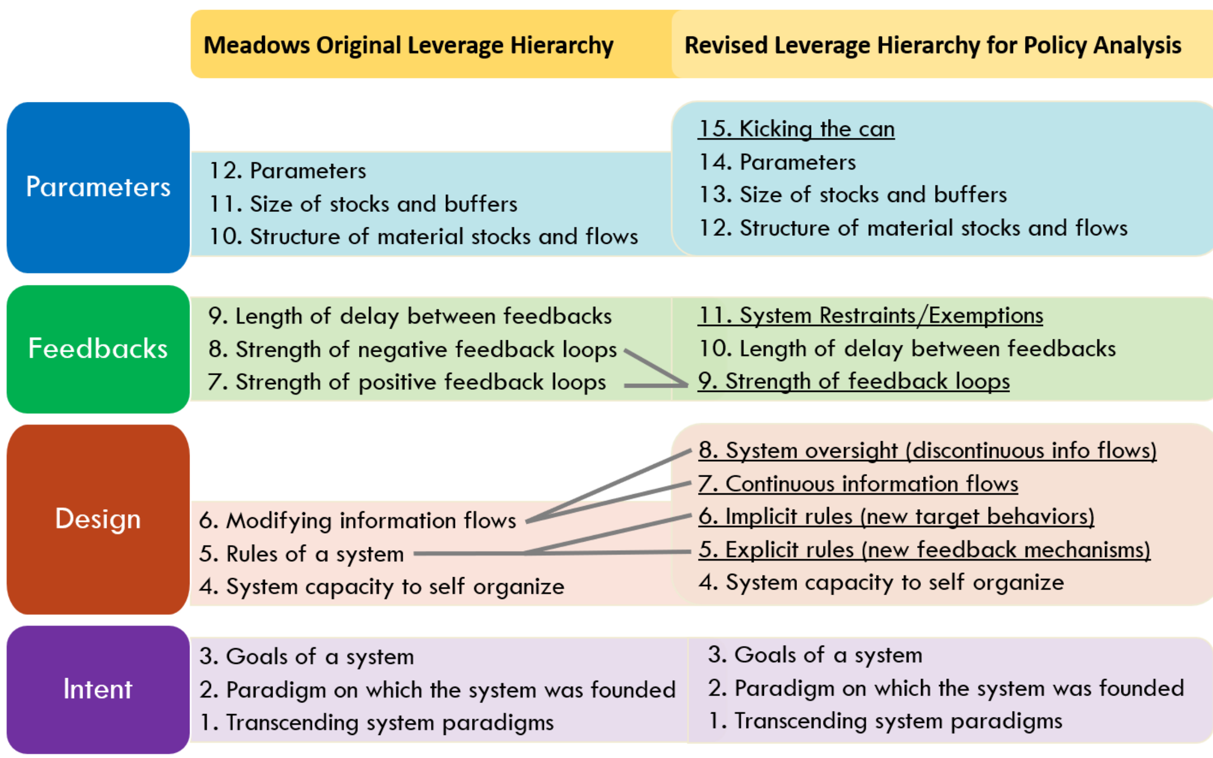

Figure 3: Modifications to Meadow's Hierarchy of Leverage Points. Meadows original hierarchy is displayed on the left, while my modified hierarchy is shown on the right for comparison. New or modified leverage points are underlined. The right hierarchy represents the primary codes I used to classify individual articles of policy by degree of impact. The lines show where leverage points were combined or split apart to help adapt the model for the purposes of coding articles of policy.

For the first new leverage point, I split Meadow's "rulemaking" leverage point into two subcategories that capture different forms of systemic rulemaking through policy. Originally, rulemaking described the act of creating new feedback loops to regulate system behavior, either encouraging or discouraging particular behaviors (Meadows 2008). The mechanism of feedback either rewarded a particular behavior via some incentive or discouraged an unwanted behavior through punishment. As I coded articles in each bill, I noticed two very different forms of feedback, which I label implicit and explicit feedback.

In *explicit* feedback rules, an article would clearly define a mechanism through which a behavior would be influenced. For example, the CCA explicitly discourages emissions by requiring emitters to purchase an allowance certificate for each emitted ton of carbon dioxide equivalent. This creates a well-defined negative feedback loop for that aims to reduce greenhouse gas emissions. However, other policies simply mandated a behavior by law without describing a mechanism of enforcement within the article itself. These I label as *implicit* forms of feedback. The mechanism of feedback is implicit by imposition of a penal fee that may be described in a later section of the act, or by threat of legal action for non-compliance with the law. Implicit feedback requires action on the part of an enforcing agency or external actor to provide the feedback, whereas explicit feedback loops are designed to function through matter-of-fact nature as the system was designed. Explicit feedback loops are truer to Meadows' original definition where feedback is automatic to system function, whereas implicit feedback loops require manual intervention to enact the feedback process. As such, rules utilizing explicit feedback mechanisms are ranked as more impactful to a system than rules that utilize implicit feedback. See the results section on implicit rules for examples.

Another of Meadows leverage points, 'Six: modifying the structure of information flows,' had to be split into two subcategories to be effectively applied to policies. This modification distinguished between *continuous information flows* that represent a source of continual feedback on system behavior, and legislative reports or *periodic information flows* that are common to monitoring the implementation and effectiveness of a policy. I labeled these latter types of information flows as '*System oversight*,' capturing the shared theme of monitoring various aspects of passed bills for the legislature to review.

After splitting two of the leverage points under system design into subcategories, I added three entirely new codes for leverage points to represent the various ways policy can act to modify a system. First, I added a code for articles that didn't propose an entirely new change, but instead elaborated on how a change stated previously would be implemented. These articles are important for defining *how* a systemic change action is executed, but do not in themselves represent a new change action.

Ranking where this leverage point falls in the hierarchy of impact was a challenge. On one hand, it isn't defining an entirely new change to the system, but it is outlining the structure present in a prior stated system change. Thus, the impact of this leverage point lies within the *Design* of a systems characteristics. However, given it isn't defining a new structure in the form of an information flow, or a new rule, it is ranked last in impact to the design of a system, behind information flows and system oversight.

Next, I added a leverage point to describe when lawmakers restrain the impact of changes a bill could make. Typically, articles that fell under this leverage degree were implemented in order to uphold some higher priority goal of system function, one that held more importance than the goal of the rest of a bill. An example of this would be the allowance of free credits to manufacturing industries in the cap-and-invest program (RCW 70A.65.120). Giving manufacturing industries free allowances weakens the negative feedback on the behavior of emitting greenhouse gases but supports the higher priority goal of keeping these industries from moving business to other jurisdictions. Here, lawmakers demonstrate that maintenance of economic activity and job availability in the state represents a higher priority system goal than the reduction of greenhouse gas emissions in the manufacturing sector.

The last leverage point I added for analyzing policy dealt with the nature of nested systems present within the legislative process--legislative bills that modify the RCW. However, the second major body of law, the Washington Administrative Code (WACs), deals with how RCWs are implemented on an operational basis. Within legislative bills, many articles in RCWs direct a state agency to conduct the rulemaking process for subsequent WACs. Sometimes the articles are specific enough to discern what leverage point will emerge from the WAC process. However, often rulemaking designations are broad and left to interpretation of the rulemaking bodies. As such, this last leverage point was labeled ‘kicking the can’ to imply that a decision has been left for future deliberative bodies to handle. Actions that fall under “*Fifteen: kicking the can*” could, in theory, be any degree of leverage within the scope of the designation of authority to make rules. But since that information has not been included in the bill as passed in the legislative session, this leverage point was ranked last in my modified hierarchy of leverage.

All of these modifications to Meadows’ hierarchy served two purposes. The first was a the creation of a revised hierarchy that showed the different ways policy acts to modify a system. Additionally, I utilized these revised leverage points as the primary codes for classifying the way individual articles of policy modify the energy grid of Washington. In Appendix-A, you can find a definition of each of these leverage points, with examples and counter examples of how they were utilized in coding. The next section will show what types of articles were coded under each degree of leverage in my modified hierarchy, and what trends emerged from this analysis.

Where are Washington State Lawmakers Focusing Legislative Efforts to Mitigate Emissions from the Private Energy Sector?

A indicated previously, I used a modified leverage point hierarchy to code a total of 298 articles and thus better understand how impactful they would be on reorganizing the Washington energy sector. These articles were taken from three major legislative bills impacting different aspects of investor-owned utilities: buildings (the Clean Buildings Act), the energy grid itself (the Clean Energy Transformation Act), and statewide emissions (the Climate Commitment Act). According to Meadows' original theory, if a system-altering actor intended to change a system dramatically, they should aim for higher order degrees of leverage (those lower number in rank). I found that the coded articles reflected that theory. In this section, I will cover the trends of policies coded under each leverage rank, starting with policies coded under the most impactful leverage points and working our way down the ladder.

Figure 4 below shows the distribution of coded policies across each degree of leverage in my revised model.

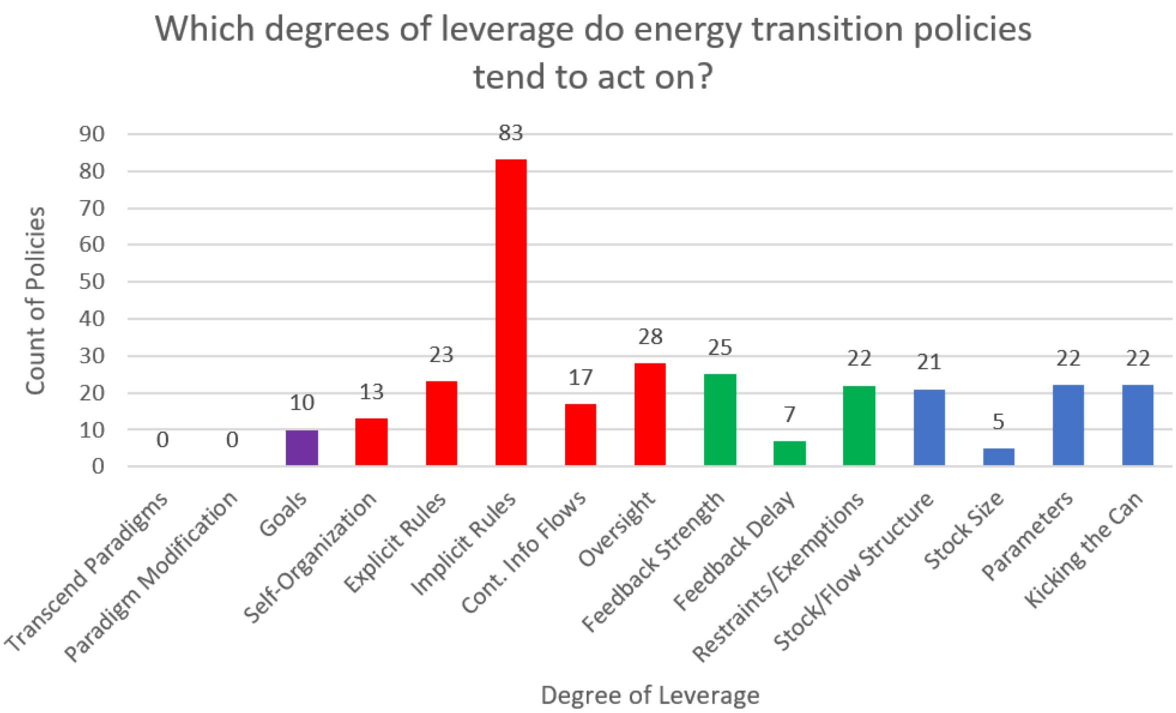

Figure 4: Distribution of policies coded under various degrees of leverage. Purple bars represent leverage points that modify system intent, red corresponds to policies modifying system structure, green corresponds to feedbacks, and blue corresponds to system parameters.

<u>Degrees of Leverage 1-3: System Intent</u>

Three degrees of leverage act on the "intent" aspect of system function, according to Abson et al.'s reclassification of Meadows' original leverage hierarchy. Of these three leverage points, two had no articles coded under them at all: Paradigm Reflexivity and Paradigm Modification. Why might that be? Meadows described system paradigms as "[t]he shared idea in the minds of society, the great big unstated assumptions, constitute that society's paradigm, or deepest set of beliefs about how the world works" (Meadows 2006). Potential examples of paradigmatic change might be socializing all private utilities or mandating that consumers should make do with a set level of grid power capacity rather than having the utilities increase energy generation to match ever-growing demand. Alteration of system paradigms lies beyond the capacity of a legislative body to achieve under a single act, without the consensus of all stakeholders. Given the number of interested stakeholders who use the electric grid, modifying paradigms in a way all stakeholders can agree on is unfeasible at best.

However, an interesting connection can be made between paradigmatic change and systems transition literature. In his work articulating how system transitions unfold through his Multi-Level-Perspective (MLP), Geels highlighted that change to system landscapes is slow and gradual, often occurring over decades, and comprised of physical changes to infrastructure adapting to new dominant technological regimes (Geels 2002). Landscapes share similar properties to Meadows' articulation of system paradigms. Similarly, paradigmatic change may share this property of unfolding over longer periods of time as a result of many lower magnitude changes. I'll revisit this point in the discussion. While paradigmatic change may be difficult to achieve through legislation alone, a combination of change agents acting overtime may produce systemic change naturally. However, recall I only reviewed policies across two legislative sessions, a relatively short timeframe in the policy making world. Paradigmatic may take longer time to observe than the temporal scope of this study provides.

While paradigmatic change may be beyond the scope of this research, several of the coded articles displayed legislative alteration to system goals. Before delving into the details of goal-modifying leverage points, it is useful to consider the concept of nested systems. First, recognize that the legislative structure of Washington and the network of public and private utilities that provide power can be represented as two separate systems. Further, note that the legislative system of Washington has power to modify the structure and system of state-chartered utilities. Utilities may be able to lobby for changes to the goals set by the legislature, but the overall systemic process of policy making in Washington is codified through the state constitution, making it rigid to change. It can then be said that, at least in terms of power to make change, utilities are a system nested within or beneath the power of the state. The legislature is thus the body responsible for altering the goals of the utilities. In terms of the leverage points, within the nine articles coded as *3: Modifying System Goals*, two subtypes emerge: modifications to the goals of utilities by the legislature, and the legislature setting the guideline goals for the execution of future state policy.

The Clean Energy Transformation Act (CETA) lays out four major goals that will have sweeping ramifications for how utilities modify their structure of operations. These goals include the deprecation of coal plants by 2025 (CETA Sec 3 (1)(a)), a mandate to achieve carbon neutrality by 2030 (CETA Sec 4 (1)), zero emissions from electricity generation by 2045 (CETA Sec 5 (1)), and execution of these goals through pursuing "all cost-effective, reliable, and feasible conservation and efficiency resources to reduce or manage retail electric load" (CETA Sec 4 (1)(a)(i)). The significance of CETA could be largely described by these four articles alone. The rest of the act describes mechanisms and rule changes meant to achieve these goals. This aligns well with Meadows' articulation of system intent as being the most significant changing force that can be exercised over a system.

The legislatures' self-imposed goals largely include policy objectives for specific departments. It could be argued that state departments and the Washington Administrative Code (WAC) are subsystems of the state legislature, tasked with implementing the legislature's goals. Three of the five articles outlined goals to reduce greenhouse gases within the scope of the act, through targeting buildings, tax codes, or maximizing energy efficiency. In some sense, these articles serve as guidelines for what the rest of an/the act is trying to accomplish.

The remaining two articles coded as *3: System Goals* are unique cases. The first article, section 10 (9) of the CCA acknowledges the possibility of inter-state leakage of emissions to other jurisdictions through businesses moving operations to states with less regulation, thus not reducing emissions in a grander sense. In response, it sets the goal to minimize these leakages by mandating that industries improve the efficiency of their equipment only to a level that is feasible with current technology. It allows certain regulated businesses to be in compliance if they are “as low emitting as possible” to attempt a balance between environmental and economic concerns. The other article, section 3 (2)(a) of the Clean Buildings Act, mandates that building owners must improve the energy efficiency of their buildings to values predetermined by the Department of Commerce. Here, the senior system of legislators are imposing a goal on building owners and maintenance teams, making a significant change to their operations.

4: Improving System Capacity for Self-Organization

Articles coded under *4: Improving System Capacity for Self-Organization* had to contain new powers or allocation of jurisdictional purview to a regulating or organizing body. Additionally, the use of those powers needed to be somewhat discretionary, such that the regulating or organizing body could modify lower order degrees of leverage within the system they for which have oversight. Articles coded under this degree of leverage fell into several subtypes.

The first subtype provides directives for organizational planning. These articles direct either state agencies or regulated entities (typically electric utilities in the case of this study) to incorporate a given section of law into official planning documents. Discretion is granted as to how to incorporate policies into planning, which means these articles represent new organizational capacity around a policy’s intent being incorporated into planning decisions. This subtype was found exclusively within CETA. The most prominent example was the mandate that utilities write clean energy implementation plans to organize around the decarbonization goals of CETA. Additionally, these plans had to be approved by the Utilities and Transportation Commission (UTC), the primary regulating authority over investor-owned utilities. Within these plans, utilities have the freedom to organize their infrastructure, investments, and rate structures such that they meet the goals set forth by CETA.

A second subtype found within articles coded under this degree of leverage were policies that increase or grant new powers to regulating authorities. Typically, these new powers came with a directive guiding their use, but authorities were still granted discretion in how these powers were used within prescribed limits. An example of new authority is the UTC's authority to approve, reject, or approve with conditions any utility's clean energy implementation plan. Within this umbrella, the UTC has goals related to protecting consumers from unreasonable rate increases due to the increased cost of compliance for utilities under CETA.

In another example, the UTC gains rulemaking authority through the Washington Administrative Code to “ensure the proper implementation and enforcement of this chapter as it applies to investor-owned utilities.” (CETA Sec 10 (2)). This gives the UTC broad discretion in creating new system rules, representing new self-organizing capacity. The governor also gains powerful new authority in the mandate to “…establish a governance structure to implement the state’s climate commitment.” Both of these examples demonstrate new self-organizing capacity.

I coded thirteen total policies under this degree of leverage throughout the three bills studied. The legislature’s modifications to both the self-organization of utilities and the system organizing capacity of regulating bodies like the UTC represent powerful tools for organizing systemic change around new goals. How these self-organizing powers are utilized after the passing of these acts makes for a potentially fascinating avenue for future systems research.

5: Explicit Rulemaking

As discussed prior, I chose to split Meadows' rulemaking leverage point to accommodate how rules are conveyed through policy. I coded articles as explicit rules when they described a specific, clear, and oftentimes de facto feedback mechanism to system function. Several subtypes emerged in the seventeen articles coded as new explicit rules.

Eleven of these articles describe financial incentives for desired system behaviors. These include channeling new revenue flows (e.g. the sale of carbon allowances in cap and trade) into lowering cost rates for electricity and natural gas. This is accomplished by providing Cap and Invest Program allowances at no cost to eligible utilities, but on the condition they are sold for auction by the utilities, and subsequently earmarking that auction revenue for lowered customer rates (CCA Sec 14 (3)(a), CCA Sec 15 (1)(a)). Interestingly, all examples of new financial incentives creating new positive feedback loops come from the CCA.

We can dig a bit deeper to further understand the adherence to financial feedback through the scope of the CCA's revenue generating capacity. In the first auction of allowances in the start of the Cap and Invest program, the sales of allowances generated in excess of $300 million USD to be funneled into the various accounts (Dept. of Ecology 2023). Funded accounts include programs for energy efficiency and decarbonization (CCA Sec 15 (2)(b), Sec 29 (1)(e)), programs to reduce emissions for air quality (CCA Sec 29 (1)(c)), and alternative forms of renewable energy (CCA Sec 29 (1)(f)). However, this dependence on financial feedback begs a question: What other forms of feedback could the state use to incentivize desired energy system outcomes like clean energy, energy efficiency, and energy justice?

The reliance on financial forms of feedback continues with explicit rules that define penalties for non-compliance with a given law, another subtype where four total articles were coded. Oftentimes these penalties represent the “implied” feedback where the mechanism of feedback wasn’t described within the article of the rule itself. This highlights a flaw within the methodology of this study, where perhaps an article-by-article discussion misses the nuance of how different articles interact with each other. We will come back to this later in the discussion.

Two standout articles cover market externalities within the CCA (Sec 13 (5), Sec 15 (2)(a)). While these articles also have financial underpinnings to their incentives, they are doing so through the mandate of allowance purchases. The first article is for natural gas utilities who emit greater emissions than what can be covered with their no-cost allowance provisions (only a portion are earmarked for customer rate subsidies), while the second covers the event of manufacturing industries emitting in excess of their own no-cost provisions. Ultimately, both of these articles require the purchasing of allowances for GHG emissions, but only when a threshold is crossed. That threshold is defined by the number of no-cost allowances provided to these businesses.

Most interestingly, all mechanisms of feedback that are directly described within a new rule rely on money. Be it channeling money into a desired outcome (i.e. improvements to energy efficiency) or establishing a financial penalty for undesired behaviors, money as a tool to influence behavior is a consistent thread in rulemaking. Solely relying on money as a motivator reveals a potential gap in our decarbonization efforts. Is this a reflection of the economic reality of capitalism in money ruling the world, or are there other effective means that exist for motivating systemic behavior change?

6: Implicit Rulemaking

Most of the articles relevant to the renewable energy transition in the three bills I chose for this study fell into the implicit rulemaking's degree of leverage. These are the new system behaviors that the legislature is pushing to reduce emissions from energy and infrastructure. These rules clearly state what behavior they require. However, the enforcement of the behavior is *implicit* because the feedback mechanism is described by other articles. Given the variety of behaviors needed to encourage and support a renewable energy transition, it makes sense that this is the most prolific degree of leverage.

I observed several patterns within these articles, giving rise to five separate types of promoted behaviors. I labeled the most common behaviors "processes" as they describe different administrative workflows required to develop the new system structures across the three bills. Thirty-eight out of 83 total articles coded describe new system processes. These articles typically follow the structure of a specific condition requiring an action or several actions to be followed. For example, to enforce the minimum "floor" price for allowances to sell at auctions within the CCA, section 16 (2) states:

> In the event that the emissions containment reserve trigger price is met during an auction, the department must automatically withhold allowances as needed. The department must convert and transfer any allowances that have been withheld from auction into the emissions containment reserve account.

This example illustrates a clear trigger condition and the process that must be followed during an auction. Given that many different processes are required to fully execute the explicit rules described in the prior subsection, I observed there was a logical sense to processes being most prevalent in this leverage point relative to others, composing over a third of total articles I coded as implicit rules. Processes create the backbone of the new feedback structures meant to promote renewable energy and reductions of emissions.

Not all process articles followed this structure, however. Some articles charge agencies to create new rules under the WAC, helping develop new system processes. These charges give a clear order for an agency to define a new process that fulfills a necessary function within a new regulatory workflow. Another example from the CCA, article (3)(a) of section 17, concerns the adoption of rules within the WAC to detail how special auctions occur when the price ceiling is reached. Because these rules would define a new system process, I bundled them with other articles describing processes.

The second most frequent pattern depicted compliance criteria for various new programs under the law, with 18 of the 83 articles coded as implicit rules. These criteria typically outlined what must be included in a plan, types of energy that counted as renewable, and other qualifying factors that define compliance under the new laws.

The remaining three patterns had similar frequency, around 10 articles coded under each pattern. The subtype “permissions” describes what is allowed under new laws, clarifying interpretive grey areas. For example, article 3 section 7 of CETA specifies how the fuel mix should be calculated for the Bonneville Power Administration, allowing fuels used for out-of-state electric load to be excluded from the calculation.

In some sense the opposite of permissions, articles marked as boundaries describe specific case limitations for how certain actors comply with a given rule. For example, article 4 section 17 of the CCA blocks general market participants (customers looking to purchase allowances as an investment rather than for emissions) from participating in auctions of special allowances. These special price containment allowances are sold specifically to lower the price to be below a set price ceiling, meant to prevent the cost of compliance from being too burdensome on Washington businesses. This makes sense as having more competitors in an auction designed to lower allowance prices would work against the intended outcome of price curtailment.

I labeled the last trend seen within this degree of leverage *mandates*, as they describe a specific behavior being required, just without a feedback mechanism, to enforce the behavior described within the article. They are typically broad stroke orders to comply with other articles described within these acts. Consider article 7 section 5 of CETA, which simply reads “Affected market customers must comply with the obligations of this section.” Another article from CETA mandates that utilities “must demonstrate pursuit of all conservation and energy efficiency resources through compliance with the requirements in RCW 19.285.040” (CETA Sec 4 (6)(b)). Both of these articles give an order but reference another body of law where details on how to comply with the order are given.

7: Continuous Information Flows

As discussed prior, I split Meadows’ sixth degree of leverage into two types. This split reflects the nature of new information flows as described in policy being either continuous or one-off reports. Both have potentially significant impacts to a system. I ranked *7: Continuous Information Flows* above the discontinuous flows since this leverage point more closely resembles Meadows’ original articulation of information flows. In her words, they represent a “new loop” of feedback, implying that the information flow is continuous (Meadows 99). For this research, I defined the term continuous to mean that the reporting or exchanging of information had to have a periodicity of being sent every one year or less. Additionally, I included information that was mandated to be accessible at all times, such reports being made available on a state website. All other new channels of information exchange were labeled under the system oversight degree of leverage.

Many of the new continuous flows are meant to assist with implementation of new monitoring programs, oftentimes for measuring GHG emissions and energy efficiency. Some articles mandate that information be readily available upon request. Section 10 article 8 of the Clean Buildings law serves as a useful example. This article requires that both electric and gas utilities servicing a building provide aggregate monthly energy consumption data to the building owner, so that the owner can file the building's energy efficiency compliance documentation. While this information may not be continuously visible, its continuous accessibility means that information is always compiled and ready to be shared. This also ensures building owners are aware of the energy efficiency of their buildings (or lack thereof), giving them an ongoing incentive to lower energy consumption.

Not all of these new information flows have a clear connection to reducing emissions. For example, CCA section 10 article 11 mandates the state keep a publicly available roster of all participants in the Cap and Invest program. This promotes transparency, which is valuable to the tenets of climate justice, but there is no direct connection to reducing emissions with this information flow. Another article from the clean buildings law, section 3 article 13, states that "each county assessor must provide property data from existing records to the department" upon request. Assessor's tax valuations of property give little information about the energy consumption of a given location, or changes over time. However, I coded these articles as I did other emissions legislation due to their textual proximity to other emissions reduction policies within the act itself, as I often coded all articles within a section. This choice raises an issue of the boundaries within this study and for extending its reach: it is difficult to pick and choose which articles are within a set scope due to the complexities of policy analysis. I will delve into this further in the Discussion section.

8: System Oversight (Discontinous Information Flows)

I titled this degree of leverage *8: System Oversight* to capture the pattern of articles that represent new exchanges of information that are either sporadic or singular. The frequency of these new information channels is not the only characteristic that warrants a new degree of leverage to represent these articles. This degree of leverage also describes new legislative workgroups, committees, and requirements for multi-annual reports and plans. All serve a similar purpose from a system's perspective -- monitoring of policy implementation and execution.

The vast majority of these articles mandate new legislative reports. Reports within the scope of this study vary in periodicity from being required every three to every eight years. In terms of topic matter, the reports are a method for monitoring the implementation of these acts with regard to a special topic matter or aspect of their implementation. The topics can vary from how to better regulate emissions from manufacturing industries (CCA Sec 13(4)(a)), assessments of grid reliability to meet forecasted demand (CETA Sec 8(2)(a)), to assessments of emissions related to natural gas (CBA Sec 16). Each of these reports represents a valuable information transfer, but sporadic and serving special purposes. The attention being paid to these specific topics suggests an intent to pass future legislation to better accommodate specific case scenarios in the energy transition.

Some of the articles coded as discontinuous information flows establish other forms of review processes for the new laws, creating workgroups for this purpose. These include a stakeholder workgroup to look at interstate markets for cap and trade (CCA Sec 13 (1)) and a workgroup for reviewing the impact of renewable energy on transmission infrastructure (CETA Sec 25 (1)). Similar to workgroups, new tasks are assigned for legislative committees to report on. These generally involve review of program implementation.

Articles coded under this degree of leverage represent attempts at reflexivity with these sweeping new programs established to combat state energy emissions. By establishing methods to review policy implementation, especially with regard to potential problem areas, the state is setting up systems of feedback to iterate upon and modify these new policies as they are implemented. It's an admission that policy is a work constantly in progress, necessitating this valuable but distinct form of new information channels.

9: Feedback Strength

I coded twenty-five articles as modifying the feedback strength of prior, established feedback loops. Four articles modified positive feedback loops while the other twenty-one acted to set or modify the damping strength of negative feedback loops. A majority of the articles modifying the strength of feedback loops that had been established by a prior article that was categorized under explicit rules.

Of the articles codes as modifying positive feedback loops, two diverted the revenue from non-compliance penal fees into investment accounts for the state. This increased the amount of money in the accounts to be expended on the desired outcomes. The other article established the strength of an incentive offered for early compliance within the Clean Buildings Code, which in itself was a new feedback loop. However, given that the incentive was described by a prior article, this article's sole purpose was to set the strength of the feedback, earning it a leverage of rank 7 instead of rank 5.1.

For articles dealing with the negative feedback loops, some strengthen the damping power of loops meant to disincentivize a behavior, while others weaken the damping strength. Those in the latter category largely tend to emerge from the CCA with the provision of no-cost allowances to certain entities under the program. Sections 13 through 15 of the CCA outlines terms for no-cost allowances to be granted to certain manufacturing industries, electric utilities, and natural gas utilities. The inclusion of no-cost allowances lowers the price of emissions imposed by the cap-and-invest program, thus weakening the incentive to reduce emissions. In the case of manufacturing industries, the rational is to preserve the state economy by lowering the cost of emitting and preventing those industries from moving to states that do not have emissions taxes that might reduce their profitability. Natural gas and electric utilities receive no-cost allowances to preclude them from passing on the cost of compliance in the form of rate increases for their customers. This also factors in that utilities face under other legislative mandates, primarily through CETA, to reduce emissions via incentive mechanisms from other laws. These articles could also be coded under *11: Exemptions and Restraints to System Change*.

Articles that set or strengthen the damping power of negative feedback loops make up the bulk of the articles coded here. Again, many of the articles under this trend come from the CCA, with a few from CETA as well. The articles from the CCA tend to impact the price of allowances under the market, often increasing the price via increasing demand for allowances. Examples include allowing voluntary market participants to bid in addition to emitting entities (CCA Sec 11 (4)), lowering the number of allowances sold each year to meet emissions reduction targets and thus driving up the price (CCA Sec 12 (11)), and setting a price floor for allowances, which ensures the price remains high enough to incentivize emissions reductions (CCA Sec 16 (1)). An example article from CETA that increases damping strength via imposing a cost on GHG emissions is section 14 article (3)(a). It states that utilities must factor the "social cost of carbon" (a value set by the legislature) into economic calculations within their integrated resource plans, which they must submit to the UTC for approval. By imposing a social cost of carbon into the cost of business via planning documents, the economic cost of emissions increases. This should incentivize emissions reductions.

10: Feedback Delay Length

Rather than creating new flows of feedback, some legislation modifies the frequency of feedback. Those seven articles are captured in this degree of leverage. The majority describe deadlines by which time other forms of leverage must be acted on. These include submission deadlines for reports (see *8: System Oversight*), planning deadlines, and the deadlines set for the clean buildings legislation (CBA Sec 3 (8)). I argue that these deadlines constitute the timeline on which other forms of feedback become urgent for these parties to act on.

Included under this leverage point was the delayed implementation of the Cap and Invest Program for specific sectors. Section 10 articles (2) and (3) of the CCA allow a four-year delayed coverage for waste to energy programs, and an 8-year delayed coverage for landfills and railroad companies. The only other unique article under this degree of leverage gave power to the UTC to set reflexive deadlines for updating integrated resource plans, currently required every two years (CETA Sec 14 (8)).

11: Exemptions and Restraints to System Modifications

11: Exemptions and Restraints to System Modifications covers articles within a policy that place boundaries on a policy's ability to create change. These articles represent the checks-and-balances to make sure a system does not implode under the political pressure to foster rapid change. They are intentional limiters to how far new system rules can push a system to change before another aspect of system function breaks down.

One interesting example within CETA is the provision that a utility will be considered in compliance with the act if the cost of compliance for the utility reaches 102% of its annual revenue. The cost of compliance represents the cost associated with all adaptive measures to adopt renewable energy and deprecate fossil fuel electric generating infrastructure. The act itself does not describe the methodology for calculating the cost of compliance, the responsibility to develop that methodology is assigned to the Department of Commerce (see *15: Kicking the Can*). Overall, this example is emblematic of a pattern within *11: Exemptions and Restraints to System Modifications*, where a new rule or system mechanic is restricted in its scope in order to serve some higher priority system goal. In this case, that goal is the prioritization of the financial stability of electric utilities. Within CETA, numerous other provisions prioritize the financial stability and operational reliability of electric grids, highlighting a pattern of grid function taking precedent over reducing grid emissions (see Sec 4 (1)(g), Sec 6 (3)(a), Sec 9 (11)).

Section 10 of the CCA gives another discrete example of restraints to system modifications. The bulk of the act establishes a negative feedback loop for GHG sources emitting over 25,000 $MTCO_2e$ annually by requiring the responsible entity to purchase allowances for those emissions. However, in section 10 article 7, a number of emissions sources gain complete exemptions from having to participate in the program. Some are easily understandable, such as the exemption of emissions from coal-fired electricity. Those sources are already mandated to be shut down by 2025 through CETA. National security infrastructure is also exempt, likely due to a conflict of jurisdictional oversight as these are federally owned structures, for example, Joint Base Lewis-McChord. However, the rationales for other exemptions under article 7 are not as clear. Fuels used by farmers in farm equipment as well as fuels used in the transportation of agricultural products are exempt. Investigating the purpose of articles coded as *11: Exemptions and Restraints to System Modifications* may provide useful insight into what gaps remain in creating a comprehensive approach to reducing all emissions and how to fill these gaps.

Boundaries to jurisdictional oversight or power are another subtype seen within this degree of leverage. Several articles clarify whether powers that were previously established within Washington law are affected or not in their ongoing implementation by the new acts being passed. Take for example CETA section 11. This section contains a single article that draws a clear boundary between the implementation of CETA and the energy independence act. It clarifies that utilities must comply with both CETA and the Energy Independence Act separately, and that compliance with one does not confer compliance with the other. Other articles draw boundaries to reflexively limit the power of a law upon itself. The CCA allows utilities to receive no-cost allowances given they are already under immense financial pressure to comply with CETA. However, this power is limited by Section 14 (2)(d) to only allow this privilege to extend to the year 2045, the year CETA requires utilities to have a 100% renewably generated power. There are even boundaries on the extent an exemption can be used, such as section 14 article (2)(d) of the CCA which states utilities are no longer eligible for no-cost allowances after 2045.

Overall, articles coded as *11: Exemptions and Restraints to System Modifications* represent the boundaries of legislative changemaking power. Some of these boundaries represent the prioritization of a higher system goal, such as with provisions in CETA to maintain grid function and financial stability. Others represent jurisdictional power limitations such as the case with exemptions of CCA coverage over national security buildings.

12: Modifying the Structure of Material Stocks and Flows

Many of the leverage points discussed so far could be coded under this degree of leverage. However, they acted on this leverage point in such a way that met the coding definition of higher degrees of leverage as well. For example, rulemaking is often a form of structural change to material flows within a system in the form of incentives and feedback. However, when changes to flows do not act on higher order leverage points, I coded them as *12: Modifying the Structure of Material Stocks and Flows.*

During coding, I paid attention to what types of flows were being modified, be it through money, the electric grid itself, emissions, or allowances for emissions under the Cap and Invest Program. The majority of modified flows dealt with how money could be spent or where it should be transferred to, especially in the CCA. This makes sense given the CCA creates a massive new market-oriented program for trading emissions allowances. After the first two auctions alone, the state raised over 800 million dollars from allowance sales (Dept. of Ecology 2023). Most articles from section 12 of the CCA modified where this money would be placed over subsequent periods.

Additional articles from the CCA coded under this leverage point dealt with special types of allowances. In order to implement a price floor and price ceiling during the auctions of allowances, legislators mandated a percentage of allowances be kept within reserves to artificially control demand, thus modifying allowance price (CCA Sec 17 (2)). Legislators also mandated that allowance auctions be designed so that they could be linked with other jurisdictions when they implement their own cap and invest programs (CCA Sec 12 (10)).

Permitting the exchange of allowances between linked jurisdictions represents a clear intentional modification to the structure of allowance market flows.

Three articles coded under this degree of leverage modified physical flows more than money or allowances. For example, Article 2 from section 3 of CETA lays out terms for the depreciation of transmission lines no longer in use after coal plants shut down statewide in 2025. It simply requires that these transmission lines be depreciated along the same terms as coal plants if they do not have any foreseeable future use-case, that is, “on or before December 2025.” The article dealing with emissions also covers the interactions between allowances and the emissions they are meant to reduce. There is a possibility that new allowances must be introduced to auctions should the price exceed the ceiling with none left in reserve. This would then allow emissions beyond the established cap of the program in order to lower the cost of allowances. To deal with this possibility, an article was included to mandate that revenue “price ceiling” allowances must be matched with a ton or greater of emissions reduction from the state (CCA Sec 18 (3)). The third article simply regards the mitigation of emissions in overburdened communities, mandating the reduction of these emissions, if the emitter participates, is covered by the Cap and Invest Program (CCA Sec 3 (3)).

<u>13: Modifying Buffer/Stock Size</u>

This degree of leverage describes changes to the metaphorical bathtub of a given system. How much water can go in without causing an overflow, or worse? The most prominent example of this leverage point in action is one I’ve discussed extensively, the Cap and Invest program itself. The cap itself represents a legislative attempt to limit the size of “acceptable” emissions from the state, thus representing an attempt to limit the conceptual stock of state emissions. All articles that fell under this degree of leverage relate to the CCA and modifying the stocks of available allowances over time. No articles in either CETA or the clean buildings legislation contain articles that clearly modify the size of any established stocks.

14: System Parameters

Traditionally, system parameters describe the numerical qualities that define specific parts of a system. Yet, some policies modify the definition of what a parameter/word/phrase represents within the language of policy.

Consider Section 28 of CETA, in which the modification is made to what counts as an "eligible renewable resource". Articles (12)(g) and (12)(h) added improvements to energy savings through energy efficiency improvements and renewable energy credits to the sources of power that are classified as renewable. Because the term "eligible renewable resource" is used to denote a specific set of energy resources that a law promotes, I classified modifications to what is included within that definition as modifying the parameters. Modifications to sets like that one represent the majority of parameter modifications within these three acts.

Additionally, I found several examples of numerical parameter modifications throughout these three acts. Examples include setting the auction floor price within the CCA Cap and Invest market (Sec 17 (6)(a)), the establishment of energy use intensity target values for specific building types (CBA Sec 3 (2)(b)) and setting a standard emissions rate for electricity where the source is undocumented for emissions accounting purposes (CETA Sec 7 (2)). Each of these parameters serves a functional role within the system but is relatively minor in the grand scheme of how these systems function. Hence, modifications to parameters rank low on the hierarchy of leveraged impact over a system.

15: Kicking the Can

15: Kicking the Can does not so much describe a leverage point as much as it describes a defacto nature of the policy making process in Washington state. Policies falling under this degree of leverage illustrate how the RCW is not a monolithic system rulemaking structure, but a part of a process guiding systemic change. As discussed in the literature review, Washington policies are largely split between two bodies of law: the Revised Code of Washington (RCW) and the Washington Administrative Code (WAC). If the RCW is a large flat brush, then the WAC is the more subtle pointed round brush. When the RCW's start getting into finer details of how a policy is implemented, they leave empty space for the pointed brush of WACs to fill in the finer details. *15: Kicking the Can* is not a failure on the part of policy makers to describe a policy, but rather a designation of where greater expertise and consultation are required to fully implement a policy.

Almost every single article coded under this leverage degree charges a particular state agency or administrative body to write the WAC for how a policy is tracked or implemented, often with an attached deadline. Examples include charging the Department of Ecology to establish "methods of verifying the accuracy of emissions reports" (5126-S2 Sec 33 5.g.i), requirements for the Department of Commerce to establish compliance reports mandated by the Clean Buildings Code (1257-S3 Sec 3 5), and in CETA, requiring the UTC to rules describing how the cost of compliance is calculated. In each of these examples, a "methodology for compliance" is required to be articulated by an agency specializing in the type of methodology to be developed.

Conclusion

Through these results, I demonstrated how to apply my modified leverage point hierarchy towards the dissection and analysis of climate policies meant to create systemic change. I presented examples of the types of policies coded under each degree of leverage. This includes demonstrating the necessity of the new leverage points I added. In the discussion to follow, I'll explain why the new leverage points may have emerged due to the granular article-by-article analysis.

Discussion

In this section, I discuss the implications of this research. First, I review what new information this qualitative analysis can provide about the three acts that were reviewed. Next, I answer how this analysis can provide insight into where further legislative action is needed to patch gaps in the state's transition strategies. In the third and final subsection I discuss where this form of analysis might be expanded by future researchers. I firmly believe this style of analysis can be expanded for practical use in improving clean energy transition policies.

<u>Good signs for transition policies</u>

The results of this analysis suggest that policy makers are indeed utilizing higher order leverage points in legislation meant to foster a transition to a more renewable energy grid. Leverage points that modify system intent and system design represent impact that can be classified as higher order. I coded the majority of policies as "modified system design," paying special attention to rulemaking. In particular, Figure 4 showed that policies coded as *6: Implicit Rules* represented over a fourth of all coded articles.

Additionally, there were significantly fewer policies that modified the intent of systemic function compared to other high-order leverage points that modify system structure. Only nine articles modified system goals while none acted on the paradigms upon which systems are designed. To understand this spread, I propose linking the concept of system paradigms from Meadow's to that of socio-economic landscapes as articulated by Frank Geels. Geels describes landscapes as the technical, physical, and material infrastructure within which actors exert influence (Geels 2007, P.404), one that results from a dominant technology for meeting a socio-economic need. Recall that these dominant technologies and the actors that invest and manage them are called 'regimes' by Geels (2007). Investor-owned utilities could represent a regime and the infrastructure for energy generation from fossil fuels represent the landscape. Because landscapes represent the built environment, they are necessarily the slowest of the elements from the multi-level perspective (MLP) to change over time.

This slow changing nature of socio-economic landscapes may be reflected in how Meadow's articulates systemic paradigms. A paradigm represents the "big unstated assumptions" behind a system's design. As such, these assumptions have consequences for how a system is built out, where political and social power is distributed, and lead to the built environment we currently have. These underlying assumptions that influence how systems are built out over time mirror how a change in a dominant technology that defines a regime takes time to modify the corresponding landscapes to utilize that technology. Like landscape change, paradigmatic change occurs over long periods of time, as ideas about what the power grid should look like slowly changes in the minds of those in positions of leadership or grid management. Unstated assumptions embedded in the existing power grid include the prevalence of investor-owned utilities and large, centralized plants, and the notion that growth in demand will continue unabated, creating a continuous need to construct new energy resources. The overall goal of the Clean Buildings for Washington Act does start to erode this focus on continued growth by setting high standards for energy efficiency in large buildings. However, this alone does not represent a challenge to the system paradigm of unyielding growth on its own.

Like Landscapes, paradigmatic change results from many actors creating smaller shifts that build up over time into that larger paradigmatic transition. In the field of energy, we see the ongoing paradigm shifts as distributed forms of generation replace electricity delivered by the grid, as sales of electric vehicles continue to climb, and as wind and solar generated more power in the United States than coal in the first five months of 2023 (Storrow 2023). An example of paradigmatic change through legislative action emerges out of another state, Maine. In November of 2023, the state will vote on an initiative to create a statewide consumer owned utility, governed by a non-profit board of elected officials ("Pine Tree Power Company" 2023). The bill has generated a high resistance, with over 17 million spent to campaign against it, compared to less than a million raised in support (Ballotpedia, 2023). Regardless, it shows that legislative acts do have the potential to modify system paradigms but may incur intense resistance to such a dramatic system change.

Gaps in Transition Policies Revealed by Leverage Point Analysis

The analysis described in this thesis proved very useful for finding gaps in current transition strategies, as evidenced by coded policies. The most notable method to find gaps was through articles coded under *11: Exemptions and Restraints*, however, reviewing the trends within articles coded under other degrees of leverage also proved useful for finding transitional gaps.

For example, I noticed that articles coded under *5: Explicit Rules* describe the actual mechanisms of feedback, be it an incentive to encourage a new system behavior, or a penalty to discourage undesirable system outcomes. All mechanisms of feedback within the scope of this study relied on financial or economic pressures in some shape or form. The form of this financial feedback varied quite a bit: penalty fees, incentive payments, or mandated purchase of allowances for greenhouse gas emissions. However, this raises the question, are there other, non-financial, mechanisms of feedback that could prove effective for enforcement of policies fostering the transition to a renewable energy grid? (It's worth noting that the focal point of this study is investor-owned utilities, who's bottom line is a return to the Investors just as much as it is to serve power to the customer base. Given that these utilities are financially motivated, it's possible this is just the most effective manner of incentivizing systemic change on their part. Some regions of the United States have experimented with “decoupling”, which sever the connection between sales of electricity and utility revenues, but with varied results. (Cappers, Satchwell, Dupuy, Linvill, 2021))

While reviewing trends within policies coded under individual leverage points revealed some potential deficiencies in transition strategy, *11: Exemptions/Restraints* was by far the most effective place to look for gaps. Many of the gaps under this leverage point have reasonable logic for existing. For example, article 11 section 9 of the Clean Energy Transformation Act (CETA) allows the governor to delay implementation of the act should the energy system become unreliable in its delivery of power. This shows a prioritization of system goals: grid reliability takes precedence over the need to transition towards renewability. Other articles give broad sweeping exemptions that will need to be addressed in future policy. Article 7 Section 10 of the Climate Commitment Act (CCA) lays out complete program exemptions for multiple industries, including aviation fuels, watercraft, and fuels used in agriculture. Aviation fuels alone comprised 5% of statewide emissions as reported by the Department of Ecology in 2018 (Sandlin 2021). Another article coded under this section outlines the provision of no-cost allowances to the manufacturing sector in Washington, removing the financial burden of allowance purchases.

The gaps discussed so far may only be valid when looking at the policies included in this study in isolation. It’s possible, even likely, that some of these gaps have been addressed by further policies passed since. For example, the gap in transition strategies for manufacturing industries was acknowledged within the CCA itself, and tasked a report to be published researching potential transition strategies that are unique to these special case industries that have high intensity emissions. This calls for a longitudinal study of legislation to ensure that gaps of concern are addressed in future climate legislation.

Leverage Point Suitability for Policy Analysis

In the end, there certainly are advantages to reshaping Meadow's leverage point framework for the analysis of energy transition policies, but the practicality of this particular method of approach is limited. Future researchers should continue iterating on this methodology to improve the practicality and usefulness of these methods. Some suggestions of directions for doing so are included at the end of this subsection. Here, I describe several possible modifications that future researchers may investigate to improve this methodology.

One of the key challenges I set out to overcome was the replicability of codes used. I wanted to write definitions of each leverage point in such a way that others could read the same articles I did and code them as the same degree of leverage. Given that I was the only coder for this research, I was unable to test replicability.

Reading each legislative act article by article and interpreting their degree of leverage became a very time intensive process. Having a team of coders may not fair much better due to the subjective nature of coding. However, the emergence of advanced predictive language models, often referred to as AI, gives new textual analysis capabilities that are fully automated through computation (see, for example, Hong, Marsh, Feuston, Ruppert, Brubaker, and Szafir, 2022; Sestino and De Mauro, 2022). It's worth asking whether a language model could be trained in the discipline of systems theory analysis as well as policy analysis. Could such a model perform the objectives of this methodology in an automated fashion? That is, could AI reveal gaps in transition policies, and suggest further policy options that may expedite the reduction of fossil fuels? Such a policy guiding model could revolutionize the ability of decision makers to create effective objective-oriented legislation.

Additionally, analyzing policies article-by-article has some tradeoffs when utilizing the leverage point framework I adapted for policy analysis. Take a look at the modifications made to the rulemaking leverage point. To adapt modifications to system rules for article-by-article policy analysis, Meadow's original leverage point had to be split into the two components that make a rule, that is the mechanism of feedback and the desired outcome behavior. This is because most individual articles described only components of a rule, typically the behavior, with the mechanism of feedback described in a later section of an act that articulates compliance penalties. Thus, the division of Meadow's original rulemaking leverage point into a leverage point for system behaviors and another for feedback mechanisms was a direct result of choosing to analyze policies article by article. The chosen method of analysis was intimately linked to the resulting changes in Meadow's leverage hierarchy.

It's possible that as policymakers wield higher degrees of leverage to create systemic change, the complete description of that change could occur within multiple articles of a piece of legislation. In the case of modifying system goals, the change can be summarized in a focal point article that states the goal change directly. However, as was often the case in state goals, the majority of the section that followed served to outline components of the goals being modified. For example, article 6 section 1 of the Clean Buildings for Washington Act states: "It is the intent of this act to provide incentives and regulations that encourage greater energy efficiency in all aspects of new and existing buildings." This article acts as a reference point to justify the rest of the Act, and the subsequent articles serve the goal stated in this one article. In this particular case, no individual articles were observed modifying system paradigms. However, as the prior case of Maine's proposed legislation to transfer the energy grid to a consumer-owned board of directors, it is possible for legislation to modify system paradigms.

Another complication of article-by-article coding is defining the boundaries of a single article. Many coded items included several sub articles beneath them in a list format. At other times, I coded these sub articles as their own leverage point modification to the energy system. Whether or not a sub-article was labeled as a list item or a separate article deserving of its own code was yet another subjective decision by the coder. This is partially due to how the acts themselves are written; without speaking with the drafters of the act, it's not always possible to glean a clear reason for whether one article is listed beneath another and otherwise.

Ultimately, this research serves as a methodological refinement and application of Meadow's leverage point framework to the analysis of legislative acts. This analysis still serves as a heuristic overview of the potential for a policy to achieve greater magnitudes of systemic change. Revisiting the figure from the introduction on magnitudes of systemic change, the data shows that higher order leverage points are being utilized to modify the design of our energy system, and somewhat modifies the intent that governs system function, solely through the addition of new system goals. While these legislative acts may not represent factor ten change to create an entirely new system on their own (see figure 1), they do set our energy grid on the path towards transformation. Additionally, gaps in transition revealed by this analysis show where we can intensify the pace of the transition, primarily by developing additional transition strategies for manufacturing industries and rethinking the paradigms that govern the design of our energy grid.

Conclusion

My revised leverage point hierarchy developed for analysis of Washington energy policy successfully achieved several of the objectives set out in this research. Through individual article coding by degree of leverage, I present a clear summary view of the impact three major legislative acts will have on the energy grid of Washington from a systems perspective. Both trends of articles coded under specific leverage points and *11:System Restraints/Exemptions* revealed gaps in current policy that will need to be addressed by future renewable energy legislation in order create a more wholistic transition strategy. However, it is also clear that policy makers are already aware of some of these gaps, having set the intent to return and address them as the effects of current policies unfold as indicated by articles coded as *8: System Oversight* and *15: Kicking the Can*. In a sense, Washington is a living lab of political interventions for systemic change of the energy grid.

The granularity of this analysis presented tradeoffs in the applicability of this analysis as it currently exists. Coding legislative acts article-by-article limits how many acts can be included in a given studies scope. However, potential exists to train linguistic machine learning models on systems thinking to create an automated form of this analysis. Future researchers may be able to automate this analysis to review entire bodies of law for systems transitions, granting policy makers greater understanding of how to intensify transitions when needed.

There are several additional potential avenues researchers can expand on the work of this paper. I developed the revised leverage point hierarchy in conversation with three landmark energy transition acts: the Clean Energy Transformation Act, the Climate Commitment Act, and the Clean Buildings for Washington Act. Whether this leverage ranking works for analysis of other policies, be that at the state level, or potentially other levels of government, has yet to be seen. This methodology could also benefit from a comparison to other forms of policy analysis. What advantages does this form of analysis provide that traditional policy analysis does not?

Overall, the most exciting conclusion of this research is that Washington's energy transition policies *are* acting on higher order leverage points. In particular, policy makers have heavily acted through modifying system rules, with less focus on changing the intent upon which systems are designed. Likely, this is due to the difficulty present in getting stakeholders to agree on paradigmatic changes through legislation, thus paradigmatic change must unfold over time as a result of many lower order leverage points being modified over time.

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Appendix A – Codebook

Code Type	Leverage Point	Code Definition	Usage Guidelines
Attributional	15. Kicking the can	Writing into law the need to modify/further define a policy at a later date, typically after further information is obtained on what policy would work best.	Does not include designations for rule making that clearly describe the purpose of the rules to be made, such that a leverage point can be determined from the designation of purpose for the rules to be made.
Provisional	14. Parameters	Also defined as "constants, and numbers" by Meadows. Changing a specific value within a system. Examples include taxes, subsidies, flat changes in the value of a flow.	Parameters can also represent higher degrees of leverage if they act on a system point where it's conditions match the definition of a higher degree of leverage.
Provisional	13. Modifying buffer/stock size	Modifying the size of a storing body of a system with regard to a specific value type (e.g. height of a damn to store more water)	None
Provisional	12. Modifying the structure of material stocks/flows	Law modifies the rate of a flow or channels through which a value type can be exchanged between stocks. Value types are physical/tangible, examples include money, GHG emissions, KWhs, carbon offset certificates.	None
Attributional	11. System restraint/ exemptions	Limiting the power of another article to change the system, often to preserve a particular system state or protect specific actors.	These articles are typically written in the form "If <event occurs>, then this <new rule> no longer applies"
Provisional	10. Feedback delay length	Law mandates a delay time for informative feedback or exchange of information to be exchanged between two parties or modifies a system element such that feedback information can be obtained more rapidly.	None

Provisional	9. Damping strength of negative feedback loops	Law increases the magnitude of the negative feedback proportional to the magnitude of the action or system behavior being disincentivized.	Instituting flat fees for an action are parameters. Fees that increase based on how much was done represent proportional negative feedback. This is called damping. Increasing the amount of disincentive per unit of the disincentivized action constitutes this leverage point.
Provisional	9. (Gain/ Damping) Strength of Feedback Loops	Law modifies the magnitude of the positive incentive for a desired behavior OR modifies the damping strength disincentivising an undesired system behavior.	Articles that set the numeric feedback strength of a new feedback loop are also included in this category IF the loop was established in a prior article.
Attributional	8. System Oversight	Establishment or significant restructuring of an advisory or research committee to review a system and provide recommendations at a later date OR individual or limited periodic (once per year or lower frequency) review of information.	None
Provisional	7. Structure of information flows	Increasing the pathways through which information can continuously be exchanged, creating a new source of ongoing system feedback.	This leverage point represents a specific case of modifying the structure of stocks and flows, in this case, the non-material flow of information between parties. Increasing the accessibility of desired information within a system or restricting access to undesired information.

Attributional	6. Elaboration on prior system intervention	Typically involved in subsections of RCWs, these parts of law elaborate on a prior stated change-action and do not in themselves constitute a new leverage point, but rather an elaboration of action on a leverage point by a hierarchically prior policy-action.	Often contains language like "used to meet the standard under __" or explicitly refer to a prior stated policy by further describing options for compliance. If it mandates a behavior, behavior not implicit to the prior policy, then it counts as a new implicit feedback loop for a new system behavior (5.2). Usually this involves using the word "must" to describe an action, whereas a non-feedback loop is described with the word "may" to describe an optional behavior.
Attributional	6. Establishing a new implicit system rule	Introducing a new (positive or negative) feedback mechanism for (dis)incentivising a behavior in the system. Feedback mechanism is not described explicitly by the law, but there is implicit punishment for non-compliance with the mandated behavior described by the law. Includes matter of fact restriction of behaviors by rule.	None
Provisional	5. Establishing a new explicit system rule	Introducing a new (positive or negative) feedback mechanism for (dis)incentivising a behavior in the system. Feedback mechanism is described explicitly by the article or sub-article of law.	None
Provisional	4. Enhancing system capacity for self-organization	Increasing or establishing the capacity of an actor in a system to implement rules and modify system behaviors as described in the above leverage points. In short, increasing the agency of an in-	A general case involves granting rulemaking authority for a system actor (e.g. department of commerce)

		system actor to make changes to the system.	
Provisional	3. Modifying the system goal	Establishing measurable intent of the system goal, tangible change in priority that supersedes previous goals.	None
Provisional	2. Modifying mindset/paradigm the system is founded on	Modifying base assumptions upon which the system is structured (e.g. privatizing investor owned utilities)	None
Provisional	1. Establishing reflexivity of the system paradigm, transcending paradigms	Establishing total reflexivity in system structure. Not likely to be feasible.	None