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Understanding policy evolution using institutional grammar: net metering policies in the United States

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ABSTRACT

Policy process scholars have expressed a long-standing interest in policy evolution, though such assessments offer a limited understanding of how policy language changes across time. These micro-level assessments of policy design evolution lend insights into substantive aspects of policy adjustment over time. In this paper, we conduct a comparative case study of changes in the text of net metering legislation in four US states. Specifically, using the Institutional Grammar (IG), we measure policy evolution as: (1) change in policy provisions that define the net metering policy system or regulate behavior, (2) change in different types of provisions (rules), and (3) calibration of policy provisions. Furthermore, we identify the dynamics of policy patching and packaging with these measures, demonstrating more information is revealed about the dynamics of policy evolution at the micro-level. For scholars and practitioners, our novel micro-level measurement allows discernment of changes in who is being incentivized, in what ways they are being incentivized, and the extent to which they are being incentivized. Furthermore, our approach can assist practitioners in identifying policy provisions and the language of those provisions that are changing more frequently, as we find policy language does not evolve evenly.

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KEYWORDS
Policy evolution; micro-level; institutional grammar; rule types; net metering

1. Introduction

Policy process scholars have a long-standing interest in policy evolution. Yet, scholars examining policy evolution generally take a macro- or meso-level perspective, characterizing change at the whole policy level or across parts of policies conveying information through policy elements such as goals, programs, and instruments (Rayner and Howlett 2009). While instructive, these studies leave unattended the

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question of how policy language, captured in policy provisions, changes over time. Over the last ten years, scholars have increasingly explored policy design, defined here as policy content, through investigations of the syntactic and semantic features of policy provisions (Frantz and Siddiki 2021; Siddiki et al. 2022, Siddiki and Frantz 2023). This "micro-level" approach yields nuanced insights regarding the constraints and permissions conveyed through policy design (Siddiki 2020), and how these micro-level components evolve as policies are revised and reenacted in policy settings. Fundamentally motivating our analysis is that, while the goals, programs, and instruments identified at the macro- or meso-level might not change, substantial evolution might be seen at the micro-level as the constraints and permissions governing policy systems and specific behaviors within them change greatly over time. Additionally, a micro-level approach facilitates reliable measurement of policy text by capturing generalizable features (e.g. syntactic components and policy statements) across studies of policy design.

One increasingly prominent approach for capturing policy content from a micro-level perspective is Institutional Grammar (IG). This approach supports the evaluation of syntactic and semantic features of policy text, specifically those that define the structure of a policy setting and compel the behaviors of actors interacting therein (Crawford and Ostrom 1995; Frantz and Siddiki 2021). Applications of the IG yield insights regarding the specific actors targeted by policy provisions, the actions assigned to them, and the degree of discretion they have in performing these actions. Additionally, IG applications offer information about how policy entities (e.g. actor positions, decision-making venues) are defined within specific policy contexts. Systematic classification of policy provisions capturing such information yields nuanced insights regarding to whom policies apply and how they should be implemented. Furthermore, it can support detailed assessments of how policies change over time, in terms of how they govern behavior and define policy systems. Yet, applications of the IG to study policy evolution are limited.

In this paper, we apply the IG to study changes in the designs of net metering policies adopted by American states. More specifically, we ask: (1) Do net metering policies become more extensive over time? (2) Do the ways in which net metering legislation define policy systems change? (3) Do the ways in which net metering policies regulate the behaviors of policy targets change? (4) Do net metering policies emphasize different forms of policy system regulation as time passes? (5) Does the functional emphasis of net metering policies change over time?

To answer these questions, we evaluate changes in the designs of four net metering policies at the state-level. We selected net metering because of the diversity in the designs of these policies (Gregoire-Zawilski and Siddiki 2023), the frequency at which they have been amended, and their substantive relevance for advancing pressing climate goals. As a proof of concept, this paper demonstrates that micro-level evaluation of policy change helps capture how these policies evolve through processes of policy layering that include patching (layering new statements without readjusting previous policy), packaging (layering new statements while terminating others to readjust previous policy), and calibration (making changes to the text within a statement) (Rayner and Howlett 2009). Such assessments may be particularly instructive for scholars and practitioners, as it offers a way of

empirically measuring modes of policy change and other related concepts of theoretical and practical relevance. Furthermore, we show that more information is revealed regarding these dynamics, as measurement moves from a higher level of analysis to these three more granular levels. Finally, for net metering, the methods in this paper can assist practitioners in identifying the components and language of policies that are more prone to change, as we find that policy language does not evolve evenly.

2. Background and conceptualization

Policy process scholars have a long-standing interest in the topics of policy adoption and change; seeking to understand what precipitates policy evolution (Lindblom 1959), when evolution occurs (Baumgartner and Jones 1993), the influences of political and other dynamics on policy design(s) (Lowi 1964, 1972; Schneider and Ingram 1993; Wilson 1995). While such scholarship offers valuable guidance on the antecedents and consequences of policy adoption and evolution, it offers little guidance on the measurement of how policies change.

Some recent literature begins to fill this gap by examining policy evolution at the macro-level – i.e. general ideas conveyed in the policy, its stated goals, and the programs used to achieve those goals (Cejudo and Michel 2021; Givoni 2014; Howlett 2018; Howlett and Rayner 2013). Other studies focus on policy evolution at the meso-level, examining policy instruments and tools (e.g. authority, incentives, capacity-building, etc.) and the mixture of programs comprised within a single policy (Howlett 2018).

A substantial contribution of this literature has been to discern and characterize different modes of policy evolution. Rayner and Howlett (2009) identify three different forms of policy evolution at the macro-level: (1) *layering*, a process whereby new elements are added to an existing policy without removing old ones, (2) *drift*, a process where the policy's goals change without changing the instruments, and (3) *conversion*, a process where the mix of policy instruments are changed, but the goals are not. Through these dynamics, the literature suggests tensions could develop over time between policy goals and policy means. Yet, scholars and practitioners, so far, lack the measurement tools needed to explore these dynamics and the subsequent evolution of who gets what, how, and when.

In this paper, we use Howlett and colleagues' (Howlett and Mukherjee 2014; Howlett and Rayner 2013; Howlett and Cashore 2009; Rayner and Howlett 2009) macro-level conceptualization of policy evolution, as a conceptual frame. We are particularly interested in capturing the dynamics of layering, categorized as: policy packaging or policy patching. *Policy packaging* refers to the adoption of coherent groups of instruments in a single packaged policy. When prior policies exist, instruments are fully removed to maintain the coherence of the new package (Howlett and Rayner 2013). In contrast, *policy patching* occurs when adjustments are made to existing policy rather than proposing completely new, alternative policy arrangements (Howlett and Mukherjee 2014). We leverage these conceptualizations, in combination with the Institutional Grammar (IG) as an analytical approach, to guide our characterization of policy evolution at the micro-level.

While the practical use of the IG as an analytical approach will be discussed here, a more in-depth discussion of its development, application, and use can be found here: Crawford and Ostrom 1995; Frantz and Siddiki 2021; Siddiki et al. 2022, Siddiki and Frantz 2023. The IG offers a rigorous and generalizable approach for examining the information conveyed in policy documents at two levels: (1) the institutional statement level, and (2) the intra-institutional statement level, which examines the syntactic elements making up the institutional statement (Frantz and Siddiki 2021). Institutional statements are akin to specific policy provisions of which policies are comprised, which define aspects of the policy system and activities occurring within them.

At the institutional statement level, the IG allows the identification of the statements' *institutional type* as constitutive or regulative (Siddiki and Frantz 2023). *Constitutive statements* parameterize the systems in which actors interact, whereas *regulative statements* describe the expected behavior(s) of actors in the presence or absence of constraints. Alterations in constitutive statements change how a policy defines the policy system. For example, what constitutes an "electric utility" might be redefined, realigning which electricity providers are included or excluded from participating in the net metering policy. In contrast, when observing the evolution in regulative statements, one observes changes in who should be doing what, when, and how. Keeping with the previous example, the permissions and constraints of electric utilities might change. Net metering policies often cap the net metering market, requiring utilities to procure energy supplied via net metering up to a set ceiling. When the regulative statement governing such caps changes, to increase or reduce these ceilings, the behavior of utilities may also change.

The IG further categorizes regulative statements according to their *rule type* (Frantz and Siddiki 2021; Ostrom 2011; Siddiki and Frantz 2023). Rule types span the following: (1) *scope rules* identify required, desired, or prohibited outcomes, (2) *choice rules* specify decision criteria and/or prescribing actions, (3) *information rules* govern communication and knowledge-sharing, (4) *aggregation rules* address collective decision-making processes, (5) *payoff rules* assign rewards or sanctions for specific behaviors, (6) *position rules* identify roles to be filled by individuals, and (7) *boundary rules* describe prerequisites for occupying positions (Ostrom 2011). Examining how the composition of these rules change over time offers additional nuance that macro-level depictions of policy change overlook. For example, net metering policies, defined broadly, are incentive tools aimed at encouraging the adoption of decentralized electricity generation. Macro-level measurements may show that net metering as a general incentive tool is maintained, whereas micro-level measurement allows discernment of changes in who is being incentivized, in what ways they are being incentivized, and the extent to which they are being incentivized.

At the intra-institutional level, the IG enables the analysis of changes in specific *syntactic components*. While the paragraph below identifies the specific syntactic components for regulative and constitutive statements, these components should be seen to systematically measure the who, what, when, and how embedded in policy language. By examining these components, and how they change over time, further granularity can be added to the examination of policy evolution, as we can explore the stability of components such as: the target populations, the actions incentivized,

and the stringency of prescribed actions (Frantz and Siddiki 2021; Crawford and Ostrom 1995).

To study these granular dynamics, we further examine the syntactic components embedded in regulative and constitutive statements. The syntactic components for regulative statements include: (i) Attribute: an actor that carries out or is expected to/to not carry out the statement's action; (ii) Object: the inanimate or animate part of the statement receiving the action[1]; (iii) Deontic: a prescriptive or permissive operator defining to what extent the statement's action is compelled, restrained, or discretionary; (iv) Aim: the action of the statement assigned to the statement's actor; (v) Context: condition(s) instantiating settings in which the statement applies, or constraint(s) qualifying the statement's action[2]; (vi) Or else: an incentive linked to the statement's action. Furthermore, the syntactic components for constitutive statements include: (i) Constituted Entity: the entity being defined, modified, or otherwise directly affected by a statement; (ii) Constituting Properties: properties that parameterize Constituted Entities[3]; (iii) Constitutive Function: a verb relating the Constituted Entity to the statement's setting or functionally linking the Constituted Entity with Constituting Properties; (iv) Modal: an operator signaling necessity or (im)possibility of constitution or modification of system features captured in the Constitutive Function; (v) Context: condition(s) instantiating settings in which the statement applies, or constraint(s) qualifying the statement's enactment[4]; (vi) Or else: an incentive linked to the statement's action.

Using the IG components described above, we bridge micro- and macro-level approaches by observing three possible dynamics at the institutional statement level: (1) *maintenance*, or the absence of any change across a full statement, (2) the *addition* of a full, new institutional statement, and (3) the *termination* of a full, prior institutional statement. With these three statement-level measures, we operationalize macro-level evolution concepts at the micro-level. These include *policy patching*, when several new institutional statements are introduced without the removal of prior statements, and *policy packaging*, when several institutional statements are terminated as new statements are introduced. Furthermore, our micro-level measurement approach allows us to capture gradations of policy change whereby policy patching and policy packaging occur through small changes (i.e. where one or two statements are changed) and large changes (i.e. where entire policy section(s) are changed). Furthermore, at the intra-institutional statement level, we can measure *calibrations,* defined here as the addition or termination of syntactic components within institutional statements. Stated differently, the statement is maintained from the prior policy, but its language is calibrated.

3. Methods

This paper employs a comparative case study approach, and measures change in net metering policies across four states: California, Arkansas, Illinois, and Virginia. Net metering is one of the most widely adopted renewable energy policies across the United States. While states' net metering policies vary greatly in their designs, broadly, net metering enables the interconnection of customer-generators to the electricity grid by providing a legal framework for structuring contracts between

utilities and their customers. This enables customer-generators to feed excess generation onto the grid in exchange for credits for later use. Cases were selected using a most-different-system research design, to reflect the diversity of policy context in which these policies evolved. Table 1 presents the criteria used for case selection.

First, we sampled states with regulated and deregulated electricity markets. Market (de)regulation shapes how net metering affects the finances of utilities, as well as their political influence on net metering legislation. In regulated states, utilities have less flexibility for recovering costs associated with providing interconnection, grid service, and compensation to net metering customers. However, they have a greater ability to influence policy decisions because the vertical integration of energy markets concentrates economic and political power in the hands of a few actors. Energy markets in deregulated states exhibit a greater diversity of actors and business models, along with more flexible rules, which may help these actors convert net metering into business opportunities. Furthermore, because deregulated electricity markets contain more fragmented business interests, the ability of a single utility or electricity provider to influence policy is limited. Second, we identified whether the sampled states have a renewable portfolio standard (RPS). RPS require utilities to provision a set percentage of sold electricity from renewable sources. The presence of an RPS signals that state legislators have made a commitment to advancing decarbonization goals and that the state has a more mature infrastructure for implementing green energy policies. In this context, net metering may be considered a complementary tool for advancing RPS targets.

For each sampled state, we collected the text of the first legislation and all subsequent amendments coding the individual institutional statements across multiple dimensions. Table 2 depicts four examples of how institutional statements were coded. For each statement, we code from right to left. First, we identify if there is any change in the statement from its previous iteration. Statement #4 shows no change from the previous iteration and is an example of policy maintenance. For modified statements, we further identify the type of change occurring. Statement #3 is an example of termination, whereby the whole statement's text was removed; Statement #2 is an example of addition, whereby a whole new statement is added; and Statement #1 is an example of calibration, where changes are made to a prior statement.

Next, we identify the institutional statement type pre- and post-change, this is, whether the statement is constitutive or regulative. In most instances, such as with Statement #1, the institutional type does not change across iterations. When changes were observed and statements were identified as regulative rules, such as with Statements #1, #2, and #3, we also identified the rule type expressed in each institutional statement pre- and post-change (i.e. scope, choice, boundary, information, aggregation, payoff, and position). Finally, as shown in Statement #1, when statements

Table 1. Selection criteria and cases.

		Renewable Portfolio Standard	
		Yes	No
Electricity market regulation	Regulated	California	Arkansas
	Deregulated	Illinois, Virginia	*No States Observed*

Table 2. Coding example from Illinois.

#	**Illinois, 2021** P.A. 102-662, § 90-50	Syntactic Elements		Rule Type		Institutional Type		Type of Change (0 = Termination; 1 = Addition; 2 = Calibration)	Change (0/1)
		Values	Change	Post-Change	Pre-Change	Post-Change	Pre-Change		
1	The electricity provider shall continue to apply those excess kilowatt-hour or monetary energy credits to subsequent billing periods to offset any customer-generator consumption in those billing periods until all credits are used or until the end of the annualized period.	Addition to Direct Object; Removal of Execution Constraint	Direct Object; Context (Execution Constraint)	Payoff	Payoff	Reg	Reg	2	1
2	For customers with transmission or capacity charges not charged on a kilowatt-hour basis, the electricity provider shall prepare a reasonable approximation of the kilowatt-hour equivalent value.	Statement Added.	Statement	Choice	N/A	Reg	N/A	1	1
3	At the end of the year or annualized over the period that service is supplied by means of net metering, or in the event that the retail customer terminates service with the electricity provider prior to the end of the year or the annualized period, any remaining credits in the customer's account shall expire.	Statement Removed.	Statement	N/A	Payoff	N/A	Reg	0	1
4	An electricity provider shall charge or credit for the net electricity supplied to eligible customers or provided by eligible customers whose electric supply service is provided based on hourly pricing in the following manner:								0

Note: Green text identifies text added compared to the prior policy; Red text identifies text removed compared to the prior policy; Black text identifies text maintained compared to the prior policy.

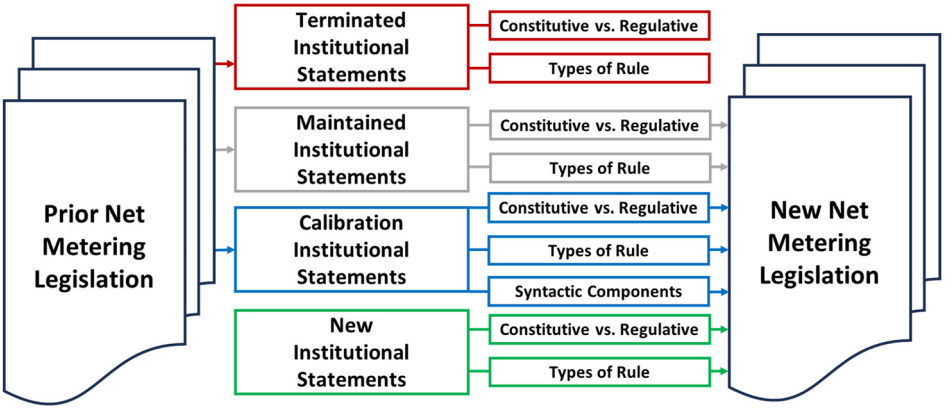

Figure 1. Coding approach.

are calibrated (i.e. intra-institutional change), we coded which syntactic components of the institutional statement were modified. Figure 1 summarizes our approach to data collection and coding.

3.1. Data

We collected data on net metering policies using the Thompson Reuters Westlaw repository. We limited our search to legislative law and excluded regulation from the sample. We focus on legislative change to have a comparable sample of policies and amendments across states. For each state, we collected data on the first net metering policy and its subsequent amendments referenced in Westlaw. We only include adopted legislation. In total, we collected 39 policy documents, totaling 2764 institutional statements. The frequency of change is unevenly distributed across the sample, with California experiencing 17 amendments between 1995 and 2023 and Illinois experiencing just five amendments from 2007 to 2023.

Table A1 in the appendix shows the timing of adoption of the first net metering policy in each state and its subsequent amendments. The rightmost column identifies the total number of policy documents included in the study. Table A2 provides further descriptive statistics on the number of additions, terminations, and calibrations observed in each state over the study period. Finally, Tables A3 and A4 offer examples of syntactic elements across both constitutive and regulative statements. These examples are not meant to be representative of the full scope of elements in this study but, rather, are offered for illustrative purposes.

4. Results

To demonstrate how our proposed methodology offers a lens for understanding broad patterns in policy evolution phenomena of theoretical interest to scholars, as well as practical realities of interest to practitioners on the ground, we present results across different measurements at the micro-level. In doing so, we identify dynamics of policy patching and packaging as well as intra-statement calibration across these

approaches, demonstrating that more information on a policy's evolution is revealed as measurement moves from a higher level of analysis to more granular levels. Furthermore, to highlight the practical value of these three different approaches, we complement our results with a detailed qualitative discussion of two select cases, Arkansas and Virginia, to illustrate how our approach captures the broader practical dynamics of the case.

4.1. How does the extent of net metering policies change over time?

We begin by presenting descriptive statistics of our sample policies based on conceptualizations commonly used in extant literature, as a benchmark for the rest of our analysis. Studies interested in understanding policy complexity often use information about the textual content of policies to measure this concept (Fukumoto 2008; Gratton et al. 2021; König and Luetgert 2009; Mulligan and Shleifer 2005). A commonly used metric is a policy's word count, which we refer to as "policy extent", rather than complexity. Figure 2 outlines, for each year, the number of words observed within the policy in blue, alongside the number of institutional statements, represented by gray bars. Figure 2 shows all policies grow in their extent. While these raw numbers begin to inform us on aspects of policy evolution such as the magnitude of change within the text of a policy, they convey little meaningful information about what exactly is changing. This highlights the need for exploring changes observed at the institutional and intra-institutional statement levels, as understanding *how* and not just *if* policies change is imperative for scholars and practitioners.

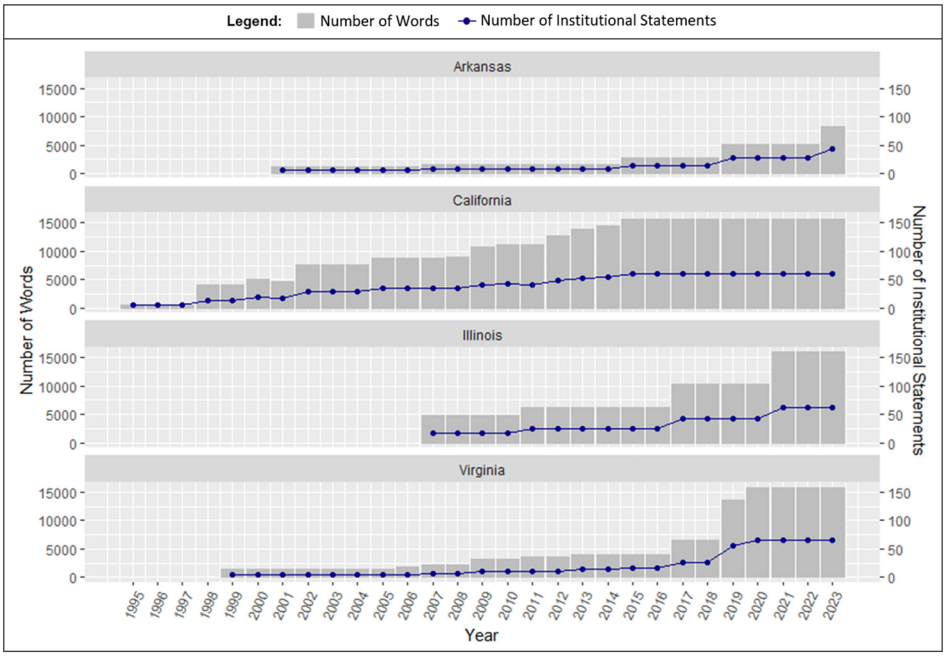

Figure 2. Change in policy extent over time.

4.2. How do net metering policies change over time?

Figure 3 begins to depict policy layering by displaying the number of words maintained, added, and terminated from one version of the policy to the next. The vertical lines represent years in which a state's net metering policy was amended. Thus, the changes observed from the year prior to the vertical lines to the years with vertical lines, and depicted by green and red triangles, represent changes from the prior policy to the new policy. In the figure, the gray portions represent words undergoing no change between policy iterations (i.e. the words are maintained), the green portions represent words added to the policy, and the red portions represent words terminated from the policy. Figure 3 uncovers greater change than what was previously shown, particularly where the word count remains relatively stable, but policy language is both added and terminated.

Additionally, Figure 3 shows greater variation across the four cases. For example, in 2023, Arkansas adds a significant number of words but also terminates a significant number. This indicates that changes in Arkansas's policy take the form of packaging. In 2023, Arkansas drastically overhauled its net metering policy to allow utilities to recover greater costs from net metering customers. The addition and removal patterns we observe in the text of the net metering legislation is consistent

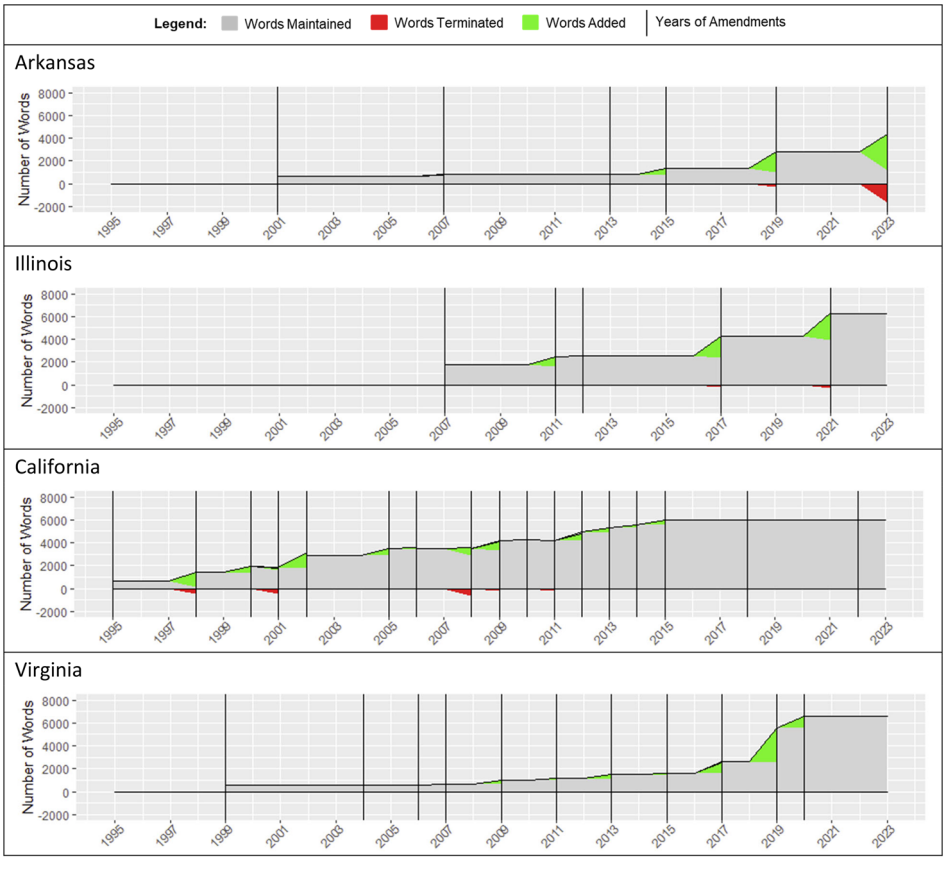

Figure 3. Policy maintenance, additions, and termination in words over time.

with this dynamic policy (re)packaging. The data suggest that similar dynamics occurred in Arkansas in 2019, and California in 1998, 2001, and 2008, albeit to a lesser extent. In contrast, throughout their history, Illinois and Virginia added vast amounts of new words while removing few, suggesting dynamics of policy patching. As an example, Virginia's 2019 amendment, adds a significant amount of language without removing other policy language. Much of this language regulates a previously unregulated entity – electric cooperatives.

While Figure 3 begins to depict policy packaging and patching, it gives us little practical information regarding what is being amended. In the examples above, we qualitatively know Arkansas restructures cost recovery for utilities and Virginia begins to regulate electric cooperatives, but this detail is still hidden at this level of analysis.

4.3. Do net metering policies change the ways in which they define (constitutive statements) and regulate the behavior of policy targets (regulative statements) over time?

Getting into the primary goals of this paper, Figure 4 offers a clearer representation of what exactly changes in the content of these policies, capturing evolution in the composition of a policy's institutional statement types – constitutive statements

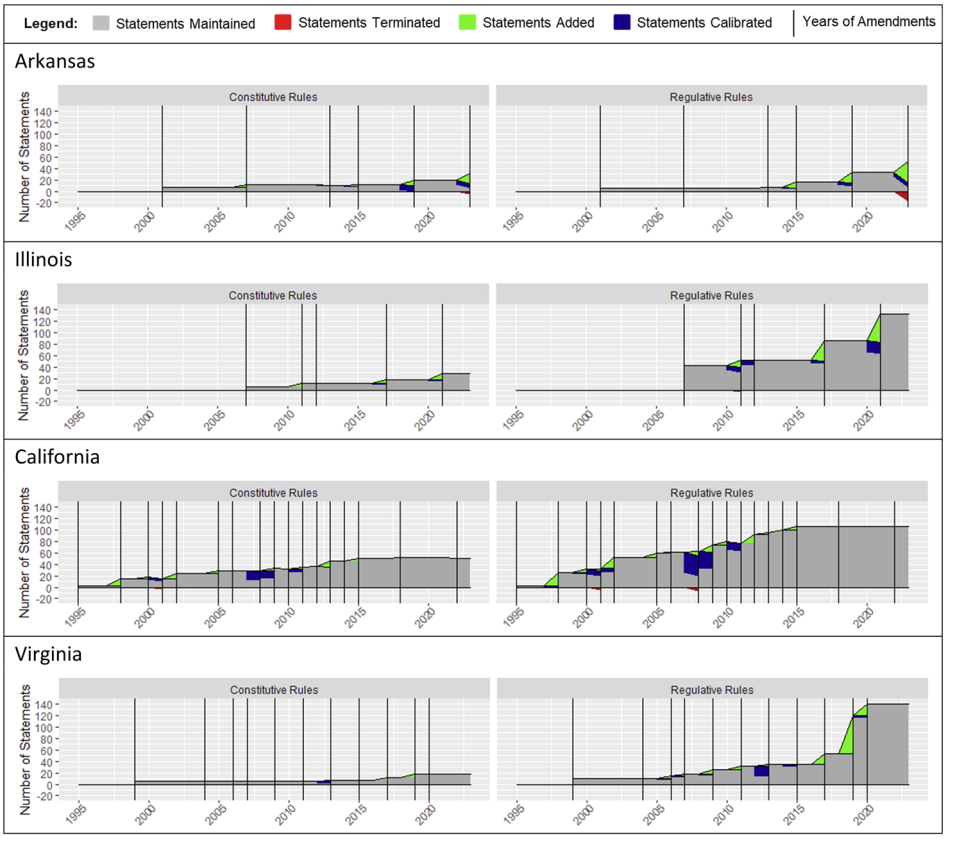

Figure 4. Constitutive and regulative Maintenance, additions, termination, and calibration over time.

defining net metering policy systems, and regulative statements prescribing the behavior of relevant actors. The dark gray, green, and red areas in Figure 4 represent changes at the institutional-statement level. Meanwhile, the blue areas represent calibrated statements, or statements observed in the prior version of the policy, but portions of which are added or terminated.

Across most cases, regulative statements are more numerous than constitutional statements with two exceptions: Arkansas and California, where the number of constitutive statements exceeded that of regulative statements in the first 14 years and 3 years, respectively. Furthermore, in our sample, we observe that the number of regulative statements grows substantially more than the number of constitutive statements, providing suggestive evidence that once the context of the policy is defined, political actors focus on iteratively detailing or changing how actors ought to participate in the policy setting. Accordingly, a substantial amount of regulative statement growth has occurred in the last 10 years, except for California, which saw substantial early growth.

While not changing as frequently as their regulative counterparts, constitutive statements are nevertheless altered in notable ways later in the life of a policy. For instance, in 2019, Arkansas added several new constitutive statements defining a broad swath of new entities including: net metering facilities, different types of recognized utilities, avoided costs, and net benefits. Additionally, all prior constitutive statements were removed or calibrated. These changes suggest that legislators completely redefined the net metering system. Observing such patterns of policy change through our measurement approach can help identify the degree to which policy packaging occurs. In this case, we capture a complete overhaul regarding which actors are allowed to participate in net metering and how.

In contrast, Virginia's 2019 amendment introduced many new regulative statements without altering prior policy language, demonstrating policy patching. In this case, a whole new section was added to Virginia's policy, addressing net metering provisions for electric cooperatives. Previously, the policy contained no statements explicitly regulating electric cooperatives. While this amendment is defined as patching, since statements are added without statements being removed, these changes represent the addition of regulative statements for a previously unregulated entity. This highlights why micro-level observations of policy evolution can better inform our understanding. Howlett and Rayner (2013) suggest that patching can lead to increased tensions within policies when added statements introduce intra-policy inconsistencies. Yet, the regulation of new entities, in contrast, might lead to greater clarity and consistency in the policy system. This latter type of patching is observed in the Virginia case.

Furthermore, at this level of measurement, we can describe the degree to which an amendment is packaging or patching. For instance, we can compare the final amendment in Arkansas (i.e. 2023) with the final amendment of Illinois (i.e. 2021). For the evolution of both, we see portions of the institutional statements are maintained in each new policy (AR: 21.1%; IL:74.1%). Yet, Arkansas legislators calibrated 24.4% of the 33 prior statements, removed 54.5%, and added the equivalent of 109.1% of the prior policy. In this way, we might think of this amendment as arguably more packaged than patched as a greater proportion of the policy is fully removed and fully added. In contrast, in 2021 Illinois legislated calibrated 22.3% of

the 85 prior statements, removed only 1.2%, and added the equivalent of 58.8% of the prior policy. Consequently, this amendment might be viewed as primarily more patching as new policy elements are added without removing prior elements. To better garner insights about the dynamics of packaging and patching, we must further assess what exactly is being added and removed. Specifically, do added statements contain similar content as those being removed? Evaluating change at the rule type level allows for further characterization of policy evolution dynamics.

4.4. Do policies emphasize different forms of policy system regulation over time?

Figure 5 depicts trends in policy change at the rule type level, using regulative statements. Overall, there are two commonalities in rule type composition and their evolution across our cases: choice and payoff rules are numerous and frequently updated. This accords with our expectation that, within an incentive-based policy like net metering, the rules distributing the benefits and burdens of the policy, and those defining actions for accessing benefits or minimizing burdens, are expected to be more salient and contested. When participation in net metering programs grows, these rules get changed more drastically.

For example, when observing the broad evolution dynamics in Arkansas, although the distribution of rule types is fairly even in the policy's first iteration, (i.e. boundary: 0, choice: 1, information: 0, payoff: 1, scope: 3), the bulk of rule expansion and change occurs in choice and payoff rules – ending with 22 and 28 rules, respectively. Amendments to Arkansas' net metering policy predominantly concern the distribution of policy benefits and burdens. These changes redefine the means through which entities participate in net metering (ownership versus leasing), how they are compensated for excess generation (1:1 credits or two-way billing with excess generation compensated at below-retail), and how utilities may retrieve the costs of providing interconnection to net metering facilities (grid service charge). With the expanded enrollment in net metering programs, contentious issues relating to the allocation of costs between utilities, net metering customers, and non-net-metering customers becomes salient, resulting in a greater focus on updating payoff and choice.

This payoff- and choice-centric evolution is observed in the other cases as well. While a greater number of statements exists in the original policy, the Illinois case starts with a less balanced mixture of rule types (i.e. boundary: 4, choice: 21, information: 1, payoff: 8, scope: 5), but similarly sees most of the growth and change occurring in choice and payoff rules – ending with 38 and 59 rules, respectively. These patterns are less stark in the case of Virginia, which also sees growth in the number of boundary and scope rules over time – yet choice and payoff rules nevertheless dominate its evolution.

Boundary, information, and scope rules, meanwhile, appear more durable, as they are prone to small amounts of calibration with little termination over time. In 2008 and 2009, California changed the constitutive rules defining an "electric utility". As such, the extensive calibrations simultaneously observed in boundary and scope rules are minor adjustments to align the language of related boundary and scope

rules with this change (i.e. utilities being changed to "Electric distribution utility or cooperative" from "Electric service provider").

Information and boundary rules are less emphasized, and sometimes even absent all together from net metering policies. In Arkansas, a single information rule was added in 2023, twenty-two years after the inception of the policy. This new rule required utilities to provide information regarding their electricity systems to aid in the siting of new net-metering facilities. Similarly, in Virginia, no information rules are observed until 2019. We also observe no position nor aggregation rules in any of the policy documents covered by our analysis, thus they are excluded from Figure 5. This finding is not entirely surprising as net metering policies are an incentive tool and are less oriented toward collective decision-making.

Returning to the dynamics of patching and packaging, by observing change at the rule-type level, we gain further insight into the broader dynamics of policy evolution. In the prior section, we discussed Arkansas's 2023 amendments as a case of packaging since regulative statements were both added and terminated. At the rule-type level, we observe a more nuanced packaging pattern. More specifically, policy packaging occurs in the addition and termination of payoff rules (added: 115.7%, terminated: 68.4%, calibrated: 26.3%), and to a lesser degree, of choice rules (added: 140.0%, terminated: 20.0%, calibrated: 20.0%), where many more statements are added than terminated. This finding is also consistent with the qualitative evidence from the case, where the Arkansas 2023 amendment focused on utilities' ability to recover costs (i.e. adjustments to payoff rules).

More specifically, the amendment's overhaul largely consisted in a package of payoff rules. The amendment authorized the use of either two-way billing (through which net metering facilities' excess generation would be compensated below retail rates) or a grid service charge and terminated language from the 2019 amendment enabling net metering customers to receive kilowatt-hour credits for their excess generation at a 1:1 ratio. Lengthy addition and termination of policy text in 2023 included detailed guidance on how the public utilities commission and utilities ought to calculate credits, rates, and service charge. Entire statements were also added in 2023, reflecting the compromises that those backing the amendments made to accommodate the demands of the solar industry on issues such as grandfathering existing contracts and the inclusion of nameplate capacity for net metering customers with multiple meter locations. Overall, the packaging dynamics observed in our data complements our qualitative assessment of the 2023 amendment.

Not only are we able to better discern which rule types are the targets of policy patching and packaging, at this granular level of analysis, we are also able to determine if removed statements are replaced by statements of the same rule type, allowing for insight into the relative coherence of the policy's termination(s) and addition(s). For example, in the Arkansas 2023 case, we observe payoff rules being replaced by payoff rules, thus representing packaging. Even when coding at the institutional statement type level (i.e. regulative and constitutive), we miss this nuance, as payoff rules might be terminated, and choice rules added – appear to be packaging despite different types of information being terminated and added.

Thus, through this lower level of analysis, we achieve greater clarity regarding how policies evolve and the dynamics of such evolution. Across the changes

identified in this study, net metering policies remain a general incentive tool. Yet, our approach demonstrates that significant change is occurring regarding who is being incentivized, how incentivization happens, and the extent of such incentive(s). Furthermore, we begin to observe if policy content is being replaced with new rules similar in function (packaging) or with new rules different in function (patching). Understanding the nature of these changes, as conveyed at the institutional statement level, can help scholars and practitioners better examine the function(s) of a policy's rule arrangements as the policy evolves and new, and potentially conflicting, content is added, especially since patching is expected to increase policy incoherence (Howlett and Rayner 2013). Packaging, in contrast, is expected to increase coherence as existing policy content is replaced with rules of the same type.

4.5. What features of net metering policies are changing over time?

Finally, we examine the calibration of rules via intra-institutional statement change, exploring which syntactic elements of net metering policies are transformed over time. Table 3 identifies the syntactic elements calibrated in constitutive rules across all years, while Table 4 identifies calibrations in regulative rules. For the examples of calibration included in the remainder of this section, green text identifies text that is added compared to the prior policy; red text identifies text that is removed; and black text identifies text that is maintained.

In Table 3, most constitutive calibrations occur in statements' Constituting Properties, suggesting that states often redefine entities. Example #1 is offered to demonstrate this redefinition in Illinois in 2021; its Constituting Entity (i.e. eligible customer) remains the same, but the definition of an eligible customer is expanded.

> Example #1: *"Eligible customer" means a retail customer that owns,* ***hosts,*** *or operates,* ***including any third-party owned systems,*** *a solar, wind, or other eligible renewable electrical generating facility.*

Table 3. Syntactic elements calibrated in constitutive rules.

	Arkansas	Illinois	California	Virginia	All States
Constituted Entity	1	0	10	0	11
Modal	0	0	0	0	0
Constitutive Function	0	0	0	0	0
Constituting Properties	18	5	16	10	49
Context	1	0	22	4	27

Table 4. Syntactic elements calibrated in regulative rules.

	Arkansas	Illinois	California	Virginia	All States
Attributes	1	0	29	19	49
Deontic	4	0	1	0	5
Aim	0	1	1	1	3
Direct Object	0	13	16	11	40
Indirect Object	0	3	4	6	13
Activation Conditions	1	14	0	8	23
Context	10	8	68	15	101

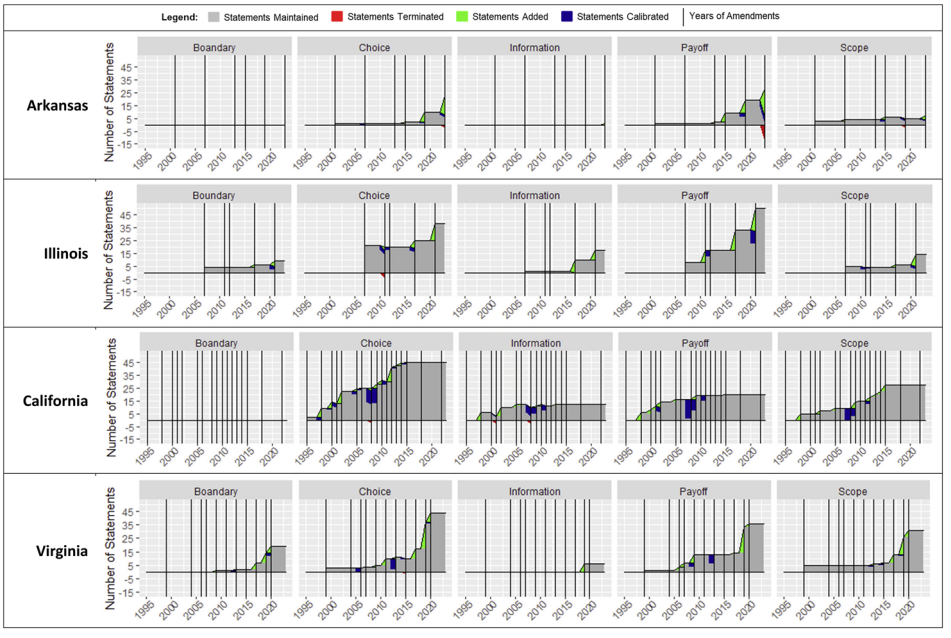

Figure 5. Rule type maintenance, additions, termination, and calibration over time.

In California, we see additional clusters of constitutive calibrations regarding Constituted Entities (i.e. what is being defined), and the context of the constitutive statement. Example #2 shows a Constitutive Entity calibration in California in 2008. In this case, the Constituting Entity's name changes almost entirely from an "Electric service provider" to an "Electric distribution utility or cooperative".

> Example #2: *"Electric **service provider distribution utility or cooperative"** means an electrical corporation, a local publicly owned electric utility, or an electrical cooperative, or any other entity, except an electric service provider, that offers electrical service.*

This Constitutive Entity calibration in California can also inform calibrations in California's regulative statements – more specifically, the substantial amount of Attribute calibrations occurring across all types of regulative rules in 2008 (see Figure 5). In Example #2, the Constitutive Entity is redefined as "*electricity distribution utility or cooperative*". In Example #3, also from California in 2008, this change is reflected as "*electricity distribution utility or cooperative*" which is now the Attribute being regulated.

> Example #3: *On an annual basis, beginning in 2003, every **electric service provider electricity distribution utility or cooperative** shall make available to the ratemaking authority information on the total rated generating capacity used by eligible customer-generators that are customers of that provider in the provider's service area.*

In 2008 and 2009, constitutive changes in California resulted in substantially higher Attribute calibration. While Virginia also exhibited high Attribute calibration, this was not driven by constitutive change, but, rather, changes associated

with the addition of an entirely new constitutive statement defining a new Constitutive Entity – "eligible agricultural customer-generator". In Virginia's regulative statements, the new Entity is added to the existing Attribute – "residential eligible customer-generator".

When observing the number of total regulative calibrations by the syntactic element, two elements become predominant: Direct Object and Context. Calibrations in Direct Objects represent changes in what the Attribute should be doing or the recipient of the Attribute's action. Example #4, from California in 2006, shows legislators modifying *what* electric service providers shall develop.

> Example #4: *Every electric service provider shall develop a standard* ***contract or*** *tariff providing for net energy metering.*

While changes in Context can be broad when observing net metering policy, Example #5, from Arkansas in 2019, represents a common change where the net excess energy calculation is modified to reflect technical changes.

> Example #5: *An electric utility shall purchase at the electric utility's* ***estimated annual average*** *avoided cost****, rate for wholesale energy plus any additional sum determined under this section,*** *any net excess generation credit remaining in a net-metering customer's account when the net-metering customer: (a) Ceases to be a customer of the electric utility; (b) Ceases to operate the net-metering facility; or (c) Transfers the net-metering facility to another person.*

Finally, while less common across cases, Illinois and Virginia policies contain substantial calibrations to Activation Conditions. Example #6 shows this modification in Illinois in 2021, where the clause determining what programs (in this case the addition of the "time-of-use-period") activates credit-earning.

> Example #6: *If the amount of electricity produced by a customer during any hourly period* ***or time-of-use period*** *exceeds the amount of electricity used by the customer during that hourly period* ***or time-of-use period****, the energy provider shall apply a credit for the net kilowatt-hours produced in such period.*

Outside of being intellectually interesting, why is tracking calibrations at the micro-level important? Broadly, such measurement allows us to capture changes robustly and granularly in policies at a level below the addition and termination of entire rules (i.e. statements). As we demonstrate and measure in this paper, substantial policy changes are happening at both the institutional statement and the intra-institutional statement scales. In the same way that examining statements at the statement-level can help us understand unobserved change at the macro-level, impactful changes might be occurring at the intra-institutional statement scale that might go unobserved at the institutional statement scale. Finally, while not in all cases, one word can be powerful! For example, inside a 62-word statement in 2010, California changed one word – "2.5" to "5". This one change doubled the percent cap of net metering programs, in effect doubling the size of the program. Although undoubtedly an extreme case of impact derived from one word, it is a clear example of how measurement at the smallest scale at the micro-level of policy evolution can be important.

5. Discussion and conclusion

Overall, the aim of this work is to evaluate how policies change over time by engaging micro-level perspectives of policy design. In this paper, we offer a novel operationalization and approach for identifying and measuring policy evolution at the micro-level, using Howlett and colleagues' work as a conceptual guide (Howlett and Mukherjee 2014; Howlett and Rayner 2013; Howlett and Cashore 2009; Rayner and Howlett 2009). In doing so, and by engaging four cases of states' net metering policies, we demonstrate the measurement of policy evolution across multiple scales at the micro-level. Specifically, by leveraging the IG as a tool, we measure three more nuanced scales of policy evolution: (1) the change in constitutive and regulative rules, (2) the change in rule types, and (3) the change in intra-rule elements measured via individual syntactic elements. Furthermore, we identify the dynamics of policy patching and packaging, and show that more information is revealed regarding these dynamics, as measurement moves from a higher level of analysis to these three more granular levels. Practically, we show macro-level measurements may overlook policy change occurring at lower levels. For example, using macro-level measurement, net metering would appear to remain unchanged over time since the policy tool type – an incentive tool – does not change. However, micro-level measurement allows to discern changes in who is being incentivized, in what ways they are being incentivized, and the extent to which they are being incentivized.

Until now, our discussion of how we can use this micro-level measurement to discern different types of policy change was anchored in a classification offered by the policy design literature. As our case demonstrates, our measurement approach is particularly useful for capturing the (re)packaging and patching of existing policies. In future work, this approach could be used to empirically test propositions for explaining the occurrence of different modes of policy change, and how they shape policy implementation and impact. Investigating such questions is beyond the scope of our study, as these variables are unobserved in our dataset. However, advancing understanding of these dynamics is front and center to recent parallel efforts that have leveraged the Institutional Grammar to characterize institutional change (Angulo Cázares 2023; Pérez-Ibarra et al. 2023; Lemeilleur et al. 2022). These studies analyze change at the rule-type level (Ostrom and Basurto 2011; Crawford and Ostrom 1995), whereas our study distinguishes itself in using the rule typology to identify the locus of change, while simultaneously classifying observed patterns into broader categories of policy change (i.e. packaging/patching). Given this, our approach shows promise for greater cross-fertilization with the literature on institutional change. A possible extension could be to use our measurement approach to empirically test some of the theoretical propositions formulated by Mahoney and Thelen (2009) about actor dynamics and institutional properties associated with different modes of institutional change. Because our approach centers on measuring change in the formal text of policies, rather than change in their interpretation and implementation, it would be best suited to studying the dynamics of layering and displacement introduced by this framework.

Beyond academic pursuits, we believe a micro-level conceptualization of policy evolution can also help practitioners who are designing policy. More specifically, the approach helps identify which aspects of policy language are changeable. As we

can see across the results, policy language does not evolve evenly. For instance, when examining changes in rule type for this study, we see that choice and payoff rules tend to undergo more change (across additions, terminations, and calibrations) compared to other rule types. This finding might suggest that choice and payoff rules are more fertile grounds for legislatures to modify compared to other rule types, or that they are places of common debate and contention. While the rules that change more frequently are expected to vary from case to case, the measurement approach in this paper would help practitioners identify these differences, highlighting places to engage policy. Furthermore, the approach helps identify what types of rules are being patched and packaged. For instance, when designing new payoff rules, practitioners could choose to package similarly to Arkansas in 2023, terminating prior payoff rules while adding similar but new ones; or they could patch, as done in Virginia in 2019 where new rules were added. Focusing on these dynamics at the micro-level helps identify, more systematically, along what components policies are evolving.

While the academic and practical contributions of this work are identified above, the authors acknowledge the limitations of the study. First, we acknowledge this approach solely leverages text data in the form of policy language over time. While this allows for robust measurement, it leaves out many important dynamics of policy devolution and design, such as the goals of the policy (Howlett 2018; Givoni 2014; Howlett and Rayner 2013; Cejudo and Michel 2021) as well as the activities and aims of policy actors (Lowi 1964, 1972; Wilson 1995; Schneider and Ingram 1993). These are important dynamics at the macro- and meso-levels of policy evolution that are not captured in this study. Furthermore, the study only examines four cases from one type of policy (i.e. net metering). We acknowledge that other cases (including different levels of government), as well as different policies might result in substantially different evolutionary outcomes. As such, we believe this approach should be extended to include other types of data and should be replicated in other cases and policy domains.

In conclusion, our work offers a promising approach for advancing the understanding of salient policy phenomena such as policy stasis and change, and for linking policy designs to their political antecedents, implementation patterns, and policy outcomes. For example, observing policy design at the micro-level helps capture policy evolution with finer resolution. Furthermore, this approach may help distinguish and more accurately characterize the substance of major and minor policy change(s) that have been the focus of many policy process theories and frameworks.

Notes

1. Objects can be further delineated as direct and indirect following defining characteristics of English grammar. The classification of Attributes and Objects can account for actors and objects and properties (i.e., descriptors) of those (Crawford and Ostrom 1995; Frantz and Siddiki 2021).
2. The different types of Contexts (i.e., instantiating or qualifying) are Activation Conditions (Cac) and Execution Constraints (Cex), respectively.

3. Constituted Entities and Constituting Properties may contain additional nuance through their properties.
4. Contexts in Constitutive Statements can be further delineated as Activation Conditions and Execution Constraints.

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Appendix A

Table A1. Timing and total count of policy amendment for each state.

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	Total
Arkansas							1	0	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	1	**6**
Illinois													1	0	0	0	1	1	0	0	0	0	1	0	0	0	1	0	0	**5**
California	1	0	0	1	0	1	1	1	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	1	0	0	0	1	0	**17**
Virginia					1	0	0	0	0	1	0	1	1	0	1	0	1	0	1	0	1	0	1	0	1	1	0	0	0	**11**

1 identifies year in which a policy amendment is observed; 0 identifies year in which no policy amendment is observed.

Table A2. Descriptive statistics of additions, terminations, and calibrations across states.

	Additions			Terminations			Calibration		
	Total	Mean	St. Dev.	Total	Mean	St. Dev.	Total	Mean	St. Dev.
Arkansas	96	19.20	19.60	31	6.20	10.06	40	8.00	6.89
Illinois	117	23.4	26.7	10	2.0	2.0	48	9.6	8.0
California	142	8.35	10.90	23	1.35	2.55	187	11.00	15.10
Virginia	139	11.58	20.22	1	0.08	0.29	48	4.00	6.24
All States	494	12.67	17.70	65	1.63	4.12	323	8.08	11.26

The counts above represent the changes observed in the policies and do not account for maintained statements. Total identifies the total number of statements that fall into the respective category across all amendments for each state; mean and St. Dev. represent the mean and standard deviation for the change observed in each amendment.

Table A3. Examples of constitutive syntactic elements.

Constitutive Elements	Example #1 (Arkansas 2001)	Example #2 (Illinois 2021)
Constituted Entity	"Electric utility"	"eligible customer"
Modal		
Constitutive Function	means	means
Constituting Properties	a public or investor-owned utility, an electric cooperative, municipal utility, or any private power supplier or marketer that is engaged in the business of supplying electric energy to the ultimate consumer or any customer classes within the state	a retail customer that owns, hosts, or operates, including any third-party owned systems, a solar, wind, or other eligible renewable electrical generating facility.
Activation Condition		
Execution Constraint		As used in this Section,

Table A4. Examples of regulative syntactic elements.

Regulative Elements	Example #1 (Virginia 2007)	Example #2 (California 2011)
Attributes	The default service provider	(c)(1) Every electric utility
Deontic	[shall]	shall a standard contract or tariff providing for net energy metering
Aim	purchase	develop
Direct Object	excess electricity	a standard contract or tariff providing for net energy metering
Indirect Object		
Activation Conditions		
Execution Constraint	at the rate that is provided for such purchases in a net metering standard contract or tariff approved by the Commission, unless the parties agree to a higher rate.	