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Should renewable energy policy be "renewable"?

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Abstract:

Political flexibility brings about trade-offs for policy-makers aiming to support the deployment of renewable energy resources (RES). On the one hand, it allows incorporating new information on *ex ante* uncertain benefits and costs of RES policy. On the other hand, it may deter RES investments. This paper scrutinizes how these trade-offs play out economically and politically when RES policy makers choose the degree of flexibility as well as the instruments to implement flexibility. The analysis builds on a theoretical framework distinguishing between flexibility by design and by adjustment. It is complemented by a discussion of three case studies: RES support schemes in Germany and the United Kingdom, and the EU Emissions Trading Scheme. Theoretical as well as empirical results suggest that the politically chosen degree of flexibility by policy design may be suboptimally low. In contrast, flexibility by policy adjustment is often excessively high.

JEL classifications: D61, D78, D81, O38, Q48, Q58

I. Introduction

The transition to low-carbon electricity generation requires private investments into technologies generating electricity from renewable energy sources (RES). Public policy may stimulate RES investments indirectly by carbon pricing, or directly by RES support schemes, such as feed-in tariffs or renewable portfolio standards. We will refer to both approaches as RES policy in the following. In real-world settings with multiple market failures and policy constraints, the optimal RES policy mix typically includes both carbon pricing and RES support schemes (Fischer and Newell, 2008; Fischer and Preonas, 2010; Kalkuhl et al., 2013; Lehmann and Gawel, 2013; Palmer and Burtraw, 2005).

When designing rules for RES policy, policy-makers face a multi-facetted agency problem. On the one hand, private investors require stable policy rules to undertake investments (Eucken, 1952) – particularly if these are long-term and largely irreversible, as for RES technologies. Policy uncertainty leads to hold-up problems and under-investment (Helm et al., 2003). On the other hand, policy-makers require some degree of freedom to adjust policy incentives over time. This is what we will refer to as political flexibility throughout our paper. Political flexibility allows incorporating new information on *ex ante* uncertain benefits and costs of RES policy. Uncertainties are related, inter alia, to the social cost of carbon, i.e., the benefits of RES investments (Greenstone et al., 2013; Tol, 2009), technological developments, i.e., the costs of RES investments (see Rubin et al., 2015 for the ranges of learning rates of RES technologies), and also to how private investors respond to policy incentives (Purkus et al., 2015). The political motivation behind flexibility may be twofold. It may help to increase social welfare if policy-makers act as benevolent principals (Aghion et al., 2009; Foxon and Pearson, 2008; Rodrik, 2014). Yet, it may also be driven by politico-economic considerations if policy-makers strive to maximise the rents of voters or specific interest groups (Kirchgässner and Schneider, 2003; Strunz et al., 2016). Hence, political flexibility therefore brings about trade-offs in terms of social welfare.

In this paper, we scrutinise how these trade-offs play out for RES policy when choosing the degree of flexibility as well as the instruments to implement flexibility. RES policy constitutes a particularly important case to understand the trade-offs related to political flexibility. Both carbon pricing (e.g., Edenhofer, 2014) and RES support schemes (e.g., Hoppmann et al., 2014; Kitzing et al., 2012; Strunz et al., 2016) have been subject to significant degrees of political flexibility. On the one hand, these ongoing political adjustments may have clearly impaired RES investments (e.g., Garnier and Madlener, 2016; Lange, 2016) – and may thus have put the attainment of targets for climate change mitigation and RES deployment at risk. On the other hand, it would have also been ill-advised to stick to RES policies implemented in the early 2000s once and for all. The extremely dynamic development

of most RES technologies as well as the limited previous experience with RES policies clearly called for political learning. Consequently, assessments of existing RES policies vary a lot. Some scholars call for a generally adaptive management and planning of the energy transition (Haasnoot et al., 2013; Köppel et al., 2014). Others are critical of ongoing policy adjustments. For example, Gross and Heptonstall (2010) argue it is "time to stop experimenting with UK renewable energy policy". Most likely, there are no simple answers to the question of whether the policies promoting the deployment of renewables should be "renewable" themselves. Given the theoretical background above, it is reasonable to assume that neither full nor absent political flexibility is economically reasonable. Moreover, the benefits and costs of political flexibility depend crucially on how it is implemented in the design of policy instruments and decision-making processes.

Consequently, we address two questions in our paper: What is the optimal degree of political flexibility for RES policies, given the trade-offs outlined above? And what are optimal instruments to implement flexibility in RES policy? For each question, we discuss the socially optimal solution. In addition, we analyse why and to what extent the politically chosen degree of flexibility may deviate from the socially optimal degree? We discuss these questions on a conceptual level throughout most of our paper. But to illustrate our arguments, we will also make reference to three specific cases of RES policies implemented in practice: Germany's and the United Kingdom's RES support scheme, and the European Union's Emissions Trading Scheme (EU ETS).

Trade-offs related to flexibility have received some attention in the analysis of economic policy. Kydland and Prescott (1977) argued in their seminal paper that the discretion to adjust policies over time would reduce welfare because it would distort the decisions of forward-looking rational agents at present. Their conclusion was subsequently qualified. Several economists pointed out that political flexibility may also generate economic benefits, for example in the presence of unforeseen events and shocks (Fisher, 1977; Lohmann, 1992; Rogoff, 1985). A similar evolution of thought could be observed for the economic analysis of environmental policy. One strand of literature argued for commitment in environmental policy and analysed how it can be implemented (Abrego and Perroni, 2002; Baldursson and von der Fehr, 2008; Biglaiser et al., 1995; Downing and White, 1986; Marsiliani and Renström, 2000; Yao, 1988). This contrasted with studies highlighting the merits of political flexibility if the benefits and costs of environmental policy are uncertain (D'Amato and Dijkstra, 2015; Krysiak, 2011; Requate and Unold, 2001, 2003). These arguments were combined to emphasize the trade-offs related to choosing the optimal degree of political flexibility for environmental policy (Kennedy, 1999; Malik, 1991; Tarui and Polasky, 2005). More recent studies derived first recommendations for choosing flexibility in RES policy. Some studies analysed more generally the optimal degree of flexibility in RES policy (Finon and Perez, 2007; Habermacher and Lehmann, 2017;

Jakob and Brunner, 2014). In addition, selected options to implement or limit political flexibility have been studied, e.g., price vs. quantity controls (Karp and Zhang, 2005; May and Chiappinelli, 2018; Purkus et al., 2015), policy mixes (Ulph and Ulph, 2013), the delegation of decision-making to an independent carbon bank (Brunner et al., 2012; Helm et al., 2003, 2004), and, more generally the role of policy targets and monitoring (Brunner et al., 2012; May and Chiappinelli, 2018; Nemet et al., 2017). In our paper, we aim to synthesize and complement this discussion for RES policy. Our major contributions consist, first, in disentangling the social planner and the politico-economic perspective when discussing political flexibility. Second, we are more specific regarding the fundamental instrument choices available to implement flexibility for RES policy. We lay out that flexibility by policy design and flexibility by policy adjustment need to be distinguished.

The remainder of our paper is organised as follows: Section II introduces the basic economic trade-offs related to political flexibility. Section III discusses how political flexibility can be implemented for RES policy. Here, we differentiate between options to implement flexibility by policy design and by policy adjustment. Based on these conceptual thoughts, section IV sheds light on selected case studies, notably Germany's and the United Kingdom's RES support scheme, and the EU Emissions Trading Scheme. Section V concludes.

II. The economics of political flexibility

In this section, we first develop a general concept of political flexibility. For this purpose, we distinguish between the degree of flexibility announced by a RES policy-maker and the degree of flexibility expected by private agents, such as RES investors. Subsequently, we analyse how political flexibility may result in trade-offs to be addressed by the RES policy-maker, depending on whether she is benevolent or driven by politico-economic considerations.

(i) Announced vs. expected degree of flexibility

The RES policy-maker chooses to announce a degree of political flexibility f, with $0 \leq f \leq 1$. Absent political flexibility ($f = 0$) implies that policy incentives decided upon today are maintained forever. With rising values of f, the degrees of freedom to adjust policy incentives increase. In the extreme case of full flexibility ($f = 1$), policy decisions taken today can be overthrown completely at any moment in time.

Yet, the policy responses of private agents will not be driven by this announced degree of flexibility but by the degree of flexibility f^* they expect, with:

$$f^* = f + (1 - f)(1 - c) \quad (1)$$

The expected degree of flexibility depends on the announced degree of flexibility and the policy-maker's political credibility c, with $0 \leq c \leq 1$. Credibility represents the likelihood, as perceived by private agents, that the policy-maker will stick to the announced degree of flexibility in the future. To keep our analysis simple, we will assume that this credibility is set exogenously – even though policy-makers may certainly also build up credibility over time.[1] Despite this simplification, this approach allows us to consider the role of expectations. Figure 1 illustrates this functional relationship. Depending on f and c, f^* can take any value in the grey-shaded triangle.

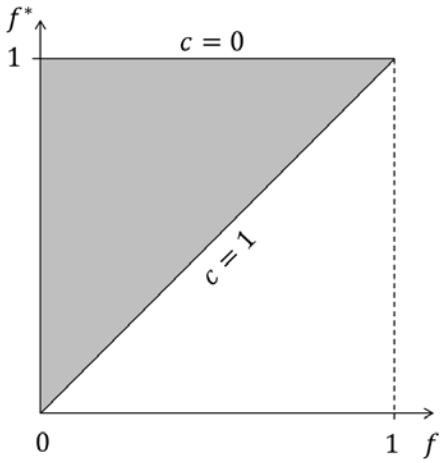

Figure 1: Expected political flexibility f^* as a function of announced political flexibility f and credibility c

Equation (1) illustrates that the expected degree of political flexibility is increasing in and typically larger than the announced degree of flexibility: $\frac{\partial f^*}{\partial f} = c \geq 0$ and $f^* - f = (1-f)(1-c) \geq 0$. No private agent will expect the RES policy-maker to be less flexible than she announces. Expected political flexibility is decreasing in credibility: $\frac{\partial f^*}{\partial c} = f - 1 \leq 0$. Credibility therefore reduces the wedge between expected and announced flexibility. Only if there is full credibility ($c = 1$), the expected degree of flexibility corresponds perfectly to the one announced ($f^* = f$). In turn, if there is no credibility at all ($c = 0$), the expected degree of flexibility is maximal ($f^* = 1$). In this case, the RES policy-maker cannot bring down expected political flexibility by announcing less political flexibility. If there is full flexibility ($f = 1$), the expected flexibility will also be maximal ($f^* = f = 1$). In this case, there is no benefit from credibility.

Overall, the RES policy-maker can therefore only partly control the expected degree of political flexibility by choosing the announced degree of flexibility. Its actual impact on the decisions taken by

[1] This holds true if policy decisions are taken in a context of repeated games between policy-makers and private actors. See, e.g., the more general reviews for monetary policy by Blackburn and Christensen (1989) and for utility regulation by Armstrong et al. (1994).

private agents will also depend on the credibility of the policy-maker. In an extreme case, if credibility is very low or absent, policy-makers may not at all be able to control the political flexibility perceived by private agents in the short run. Thus, any discussion on the optimal degree of political flexibility in RES policy can only be meaningful if there is at least a modest degree of political credibility.

(ii) Trade-offs related to choosing the degree of political flexibility

To illustrate the trade-offs related to political flexibility, we use the simple analytical model summarised in Figure 2. When choosing the announced degree of political flexibility f, the policy-maker considers impacts on two variables: the level of RES investment, $I = I\big(f^*(f)\big)$, and the net benefits per unit of investment, $B\big(f^*(f)\big)$.

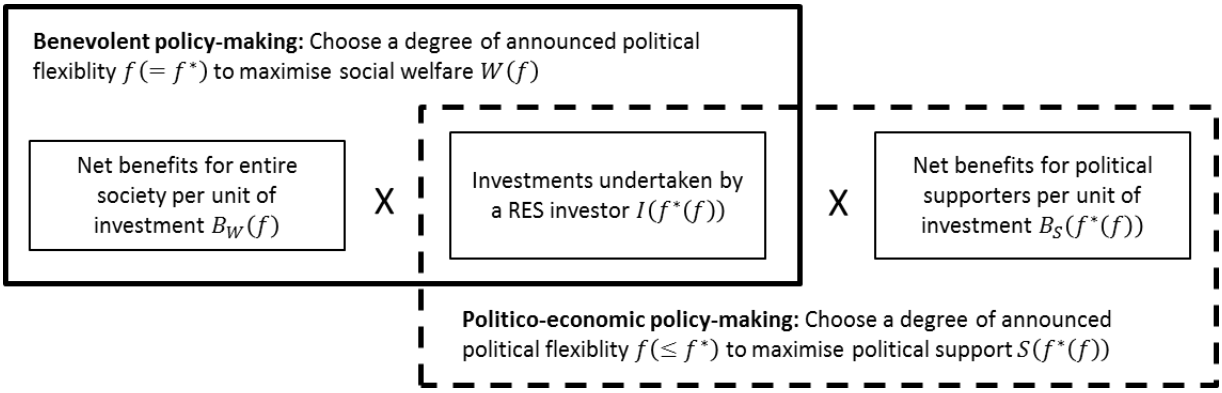

Figure 2: Optimisation problems of benevolent and politico-economic policy-makers when choosing the degree of political flexibility

We assume that RES investment $I = I\big(f^*(f)\big)$ is decreasing and convex in the expected degree of political flexibility, i.e., $\frac{dI}{df^*} < 0$ and $\frac{d^2I}{df^{*2}} > 0$. Hence, investors increasingly withhold investments with rising levels of political flexibility, and this marginal impact is more important for lower degrees of political flexibility. Certainly, the marginal impact of political flexibility on investment will depend on a variety of additional factors, such as the cost of capital for the specific RES technology under consideration or the risk aversion of the RES investors. These are considered ceteris paribus in our analysis. Combining these assumptions with equation (1) yields that the announced degree of political flexibility strictly reduces investment, $\frac{dI}{df} = \frac{dI}{df^*}c \leq 0$. This inequation additionally confirms that the marginal impact of announced political flexibility on RES investment becomes less relevant with decreasing degrees of credibility – and is zero if there is no credibility at all. This is straightforward as with less credibility RES investors will pay less attention to the announced degree of political flexibility. The dampening effect of political flexibility on RES investments has been

pointed out theoretically and empirically for RES support schemes (Bondarev and Weigt, 2018; Dijkgraaf et al., 2018; Garnier and Madlener, 2016; Jones Barradale, 2010; Lüthi and Wüstenhagen, 2012; Schleich et al., 2017) as well as carbon pricing (Fuss et al., 2009; Fuss et al., 2008; Koch et al., 2016; Lange, 2016).

Political flexibility is expected to produce net benefits per unit of investments $B\big(f^*(f)\big)$. These are the aggregate of benefits and costs per unit of RES investment (e.g., changes in producer and consumer surplus, changes in external costs, like climate change). We assume that expected net benefits are increasing and convex in the expected degree of political flexibility, i.e., $\frac{dB}{df^*} > 0$ and $\frac{d^2B}{df^{*2}} > 0$. Hence, political flexibility helps increasing the net benefits per unit of RES investments because it opens up for RES policy adjustments increasing the benefits and/or decreasing the costs of RES investments. This marginal effect rises with higher degrees of political flexibility. Combining these assumptions with equation (1) reveals that political flexibility has a strictly positive impact on the expected net benefits, $\frac{dB}{df} = \frac{dB}{df^*} c \geq 0$, as long as there is at least a modest degree of credibility.

The actual degree of political flexibility chosen depends on the type of policy-maker under consideration. A politico-economic policy-maker acts as a transfer broker. She aims to redistribute welfare across different political stakeholders to secure public support (McCormick and Tollison, 1981). On the one hand, she may strive to influence electoral outcomes directly by addressing the interests of the median voter (Downs, 1957). On the other hand, she may also try to satisfy interest groups which may indirectly affect electoral success by launching (or not) public campaigns. Overall, the politico-economic policy-maker will therefore aim to announce a degree of political flexibility which maximises her political support:

$$\max_f S\big(f^*(f)\big) = I\big(f^*(f)\big) B_S\big(f^*(f)\big) \tag{2}$$

The level of political support is directly and positively related to the rent the median voter or the interest group gets from RES policy-making and related RES investments (this is argued on a general basis by Downs, 1957; Stigler, 1971; Tullock, 1967). We assume that this rent is composed of the level of RES investment $I\big(f^*(f)\big)$ times the net benefits obtained by the relevant group of political supporters (not society as a whole) per unit of RES investment $B_S\big(f^*(f)\big)$. The corresponding first-order condition for optimal political flexibility writes:

$$-\frac{dI}{df^*} B_S\big(f^*(f)\big) = \frac{dB_S}{df^*} I\big(f^*(f)\big) \tag{3}$$

The politico-economic policy-maker thus trades off marginal benefits of flexibility (in terms of increased political support due to higher rents per unit of RES investment) and marginal costs of flexibility (in terms of reduced political support due to lower investment).

The optimisation problem of a benevolent policy-maker differs from that of politico-economic policy-maker in two respects. First, she maximises social welfare W, rather than political support S. Second, a benevolent policy-maker is fully credible by assumption, i.e., $c = 1$ and $f^* = f$. Private agents know that she will always stick to maximising welfare. They can therefore perfectly predict how she will respond to changing states of the world. This is in contrast to a politico-economic policy-maker whose her objective function may vary over time opportunistically (and thus unpredictably), particularly if (the preferences of) her relevant political supporters change. The expected degree of political flexibility under benevolent policy-making is therefore by definition smaller than (or equal to) that under politico-economic policy-making, given the same announced degree of f. The optimisation problem of the social planner can be written as:

$$\max_f W = I(f)B_W(f) \tag{4}$$

Social welfare is a function of RES investment $I(f)$ and the social (not the political supporters') net benefit per unit of investment $B_W(f)$. The corresponding first-order condition for optimal political flexibility is:

$$-\frac{dI}{df}B_W(f) = \frac{dB_W}{df}I(f) \tag{5}$$

The benevolent policy-maker increases flexibility until the marginal benefit from flexibility (in terms of increased net benefits per unit of investment) equals the marginal costs (in terms of forgone social net benefits due to reduced investments).

Our simple analytical exercise emphasizes two key insights on the economics of political flexibility in RES policy:

First, political flexibility brings about trade-offs for the policy-maker, no matter whether she is benevolent or driven by politico-economic considerations. Full or absent political flexibility are unlikely to be optimal, neither in terms of social welfare nor in terms of politico-economic decision-making.

Second, politico-economic considerations may lead to excessive, but also to insufficient political flexibility, compared to the social optimum. This can be seen when equations (3) and (5) are compared. Politico-economic policy-making will lead to excessive (insufficient) political flexibility if the marginal net benefit of political flexibility for the rents of political supporters, $\frac{dB_S}{df^*}$, is larger

(smaller) than marginal net benefit in terms of social welfare, $\frac{dB_W}{df}$. The wedge between the socially and the politically optimal degree of political flexibility is small if both marginal effects are similar, and if the difference between expected and announced political flexibility, $f^* - f = (1-f)(1-c)$, is small. This is the case if credibility c and/or the announced degree of flexibility f are high.

III. Assessment of options for political flexibility in RES policy

Having understood the basic economics of political flexibility, we now turn to specifying political flexibility and the related trade-offs for the context of RES policy-making. For this purpose, we distinguish two options by which political flexibility may be implemented in practice: flexibility by policy design and flexibility by policy adjustment.

(i) Flexibility by policy design vs. flexibility by policy adjustment

To make RES policy incentives adjust over time, a policy-maker can pursue two approaches. First, she may design policies such that the corresponding incentives for RES investment adjust endogenously with changing states of the world. In this case, political flexibility may be generated over time without changing the actual design of the policy instrument itself. We refer to this approach as "flexibility by policy design" (setting the rules) – in the tradition of Musgrave and Miller's (1948) built-in flexibility. Second, the policy-maker may also change policy incentives by adjusting the design of the policy instrument itself over time. The corresponding degrees of freedom depend on how and to what extent this discretion is organised. This is what we understand as "flexibility by policy adjustment" (changing the rules).

The degree of flexibility by policy design depends primarily on the importance of market signals for RES investment decisions. Prices on electricity, technology and resource markets respond dynamically to changes in private (but not social) costs and benefits of production and consumption. Consequently, the less RES policy approaches eliminate market signals, the higher the degree of flexibility by design is. Relevant decisions for RES policy design include (Table 1 gives examples):

(i) *Composition of investment incentives*: Flexibility by design increases if incentives are established in addition to electricity prices rather than instead of them. In this case, changes in electricity market prices remain directly relevant for RES investment decisions.

(ii) *Mode of regulation*: Flexibility by design also varies between price and quantity regulation, even though none is per se more flexible than the other. With price (quantity) regulation, the market responds flexibly by quantities (prices). Flexibility by design is reduced if price and quantity controls are combined. In this case market responses are restricted both in terms of prices and quantities.

(iii) *Differentiation of incentives*: Flexibility by design increases with decreasing politically set differentiation across technologies, locations and actors. A lower degree of differentiation implies that the allocation of RES deployment in terms of technologies, regions and actors is adjusted flexibly by market transactions.

The degree of flexibility by policy adjustment hinges on the institutional rules guiding future decision-making. These may impose constraints to possible adjustments in RES policy design. Relevant institutional choices include (examples are provided in Table 1):

(i) *Specificity of adjustment rules:* Flexibility by adjustment increases as adjustment rules become less specific. It is minimal if adjustments are ruled out legally. Flexibility is higher if adjustment is allowed contingent on legally defined explicit adjustment rules. Flexibility further increases if only general objectives and criteria for RES deployment are defined. In this case, decision-makers are still free to decide how to respond to unforeseen regulatory outcomes. Certainly, the actual degree of freedom depends on the specificity, number, hierarchy and consistency of objectives and criteria. Adjustment rules may also be more or less specific with respect to the frequency of policy adjustments, i.e., the length of commitment.

(ii) *Responsibility for adjustment:* Flexibility by adjustment is higher if decisions are taken by a political entity, whose objective function may vary over time – compared to an independent agency, whose objective function is typically more stable and predictable.

Table 1: Examples of RES policy options representing lower and higher degrees of political flexibility

	Lower flexibility	Higher flexibility
Flexibility by RES policy design		
Composition of investment incentives	RES policy incentives instead of electricity market price (e.g., feed-in tariffs)	RES policy incentives in addition to electricity market price (e.g., carbon prices, RES quotas with tradable green certificates, premium tariffs, tenders)
Mode of regulation	Combined price and quantity regulation (e.g., price ceilings and floors for emissions trading)	Pure price or quantity regulation

Differentiation of regulation	Technology-specific (e.g., technology bands for quota systems)	Technology-neutral
	Regionally differentiated (e.g., differentiation on the basis of wind yield)	Nationally uniform
	Investor-specific (e.g., specific requirements for small-scale investors or energy cooperatives)	Investor-neutral
Flexibility by RES policy adjustment		
Specificity of adjustment rules	Adjustments only allowed to affect new investments (e.g., 20-year guarantees for feed-in tariffs)	Adjustments allowed to affect existing and new investments (e.g., by changes in carbon prices or caps, or RES quotas)
	Explicitly specified adjustment rules (e.g., breathing caps specifying a % reduction in RES tariffs if certain thresholds of RES development are surpassed)	Definition and monitoring of more general policy objectives (e.g., X% in electricity consumption by the year Y) and criteria (e.g., cost-effectiveness, security of supply, ecological and social sustainability) for RES deployment
	Explicit definition of pre-announced cycles for RES policy amendments, e.g., every four years	Ad hoc amendments
Responsibility for adjustment	Independent agency (e.g., carbon bank)	Political entity (e.g., single policy-maker, ministry, parliament)

Importantly, neither the choice of flexibility by policy design nor the choice of flexibility by policy adjustment is dichotomous. When designing RES policies, policy-makers can typically choose to

combine a certain degree of flexibility by policy design f_D, with $0 \leq f_D \leq 1$, and of flexibility by policy adjustment f_A, with $0 \leq f_A \leq 1$. The corresponding two-dimensional decision-matrix is illustrated in Figure 3. The winding dashed lines between the sectors are meant to illustrate that in either dimension decisions can be taken in a continuum between low and high.

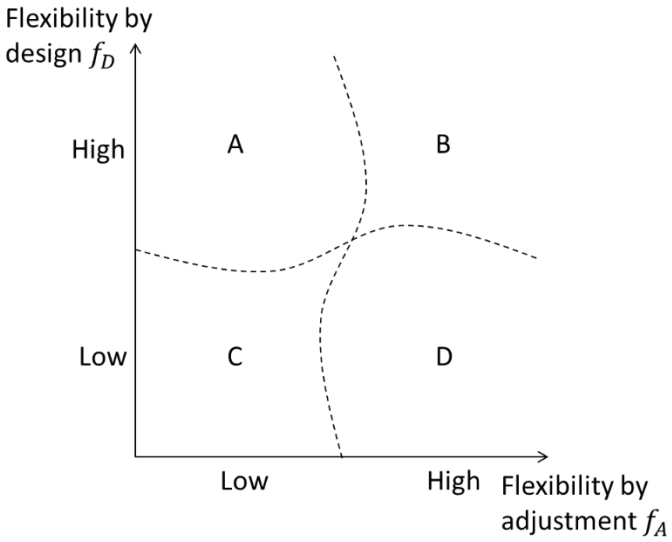

Figure 3: Dimensions of flexibility in RES policy

The combination of flexibility by policy design and by policy adjustment determines the overall degree of political flexibility. A simple analytical way to express this relationship may be:

$$f = f_D + (1 - f_D)a \tag{6}$$

where a, with $0 \leq a \leq 1$, is the policy adjustment parameter and $(1 - f_D)a = f_A$. Hence, flexibility increases in both flexibility by policy design ($\frac{\partial f}{\partial f_D} = 1 - a \geq 0$) and the adjustment parameter ($\frac{\partial f}{\partial a} = 1 - f_D \geq 0$). Figure 4 provides a graphical illustration of this functional relationship. A given degree of political flexibility may by generated by different combinations of flexibility by policy design and by policy adjustment. Consider, for example, the hypothetical case of maximum political flexibility ($f = 1$). This may come about if flexibility by design is maximal ($f_D = 1$). This case may correspond to the extreme assumption that RES investment decisions are only driven by market prices (i.e., there are no policy inventions). Obviously, flexibility by policy adjustment does not matter here. Maximum political flexibility also results if flexibility by adjustment is maximal ($a = 1$). In this case, the degree of flexibility by design chosen is not relevant for overall flexibility, as it can be adjusted completely at any point in time. Similarly, Figure 4 illustrates that a given intermediate level of political flexibility can be attained by different combinations of flexibility by design and flexibility by adjustment. For points P and Q, $f^Q = f^P$ but $f_D^Q > f_D^P$ and $f_A^Q < f_A^P$. A decisive question than is whether these points are indifferent with respect to the trade-offs related to political flexibility. In the following, we

will argue that both the choice of flexibility by policy design and flexibility by policy adjustment involve respective trade-offs. Consequently, it is important to scrutinize not only the optimal overall level of political flexibility but also its composition.

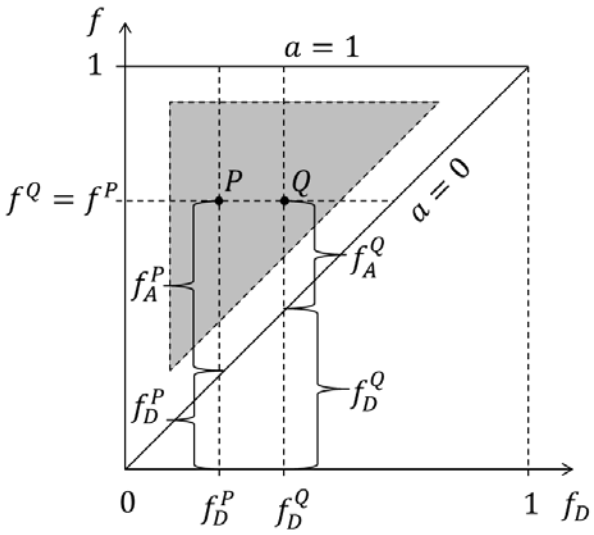

Figure 4: Analytical decomposition of political flexibility f into flexibility by policy design f_D and flexibility by policy adjustment f_A

(ii) Trade-offs with respect to social welfare

We will first discuss the socially optimal degrees of flexibility by policy design and by policy adjustment. Based on the general discussion in Section II, it is clear the both choices involve trade-offs.

Flexibility by policy design

A high flexibility by policy design allows for the ongoing and immediate incorporation of new knowledge into private investment decisions ($\frac{dB_W}{df}$ in the model in Section II). CO_2 allowance and green certificate prices – both incentives established in addition to the market price – automatically respond to new information on technology costs (e.g., of wind turbines) and benefits (e.g., power prices), as long as these are reflected in market prices. For example, empirical evidence suggests that allowances prices in the EU ETS have responded to variations in abatement costs over time (Hintermann et al., 2016). Similarly, RES policies with a low degree of differentiation – such as the EU ETS or a hypothetical EU-wide support scheme for renewables - allow for beneficial adjustments in the allocation of RES investments if the relative costs and benefits across technologies, regions and actors vary over time (Fankhauser et al., 2010; Jägemann, 2014; Jägemann et al., 2013). Certainly,

the actual extend of flexibility gains may be strongly dependent on how the policies are designed – as the long-standing debate on prices versus quantities illustrates (for an overview, see Hepburn, 2006).

However, a higher flexibility by design also comes at a cost. Compared to less flexible approaches, such as technology-specific feed-in tariffs, it increases investment risks and thus impairs investments ($\frac{dI}{df}$ in the model). There is empirical evidence that the effectiveness of RES support schemes in terms of investment decreases with flexibility by policy design (García-Álvarez et al., 2018; Kitzing, 2014), even though some studies find only minor differences (Ciarreta et al., 2017). In fact, these mixed results suggest that the actual impact on investments does not only hinge on flexibility by policy design. They also point to the relevance of the broader regulatory context, including the general credibility of the government (see Section II) as well as the role of flexibility by policy adjustment. If markets worked perfectly, the investment uncertainty related to flexibility by policy design would simply represent regular market risks, irrelevant for RES policy-making. Yet, if uncertainty combines with failures in technology and capital markets, it may be economically reasonable to choose a more moderate degree of flexibility by policy design. Based on these rationales, authors have argued in favour of (second-best) RES policy approaches with a higher degree of differentiation. Approaches include complementing emissions trading schemes with direct RES support schemes (Fischer and Newell, 2008; Fischer and Preonas, 2010; Lehmann and Gawel, 2013; Lehmann et al., 2018), or introducing technology-specific bands for RES quotas (Gawel et al., 2017b; Lehmann and Söderholm, 2018). Similarly, it may be economically sensible to adopt a less flexible mode of regulation, e.g., combining the EU ETS' quantity approach with a carbon price floor (Fankhauser et al., 2010; Hepburn, 2006). Obviously, none of these studies suggests reducing flexibility by policy design to a minimum. The socially optimal degree of flexibility by design, f_D^Q, is most likely significantly different from both full and absent flexibility, i.e., $0 \ll f_D^Q \ll 1$.

Flexibility by policy adjustment

Similarly, flexibility by policy adjustment brings about trade-offs. On the one hand, it opens up for the incorporation of new information by modifying RES policy design. This is particularly important if new knowledge relates to social costs and benefits of RES deployment. Examples include new knowledge on external environmental and system integration costs of RES deployment. Such information is barely signalled properly by market prices – and can thus not be accounted for by flexibility by policy design. On the other hand, flexibility by adjustment will also impair investments – as has been pointed out both for carbon pricing and RES support schemes (e.g., Garnier and Madlener, 2016; Lange, 2016). Thus, the socially optimal degree of flexibility by adjustment is also likely to be intermediate, i.e., $0 \ll f_A^Q \ll 1$. This is pointed out in several respects:

(i) It may be argued that if adjustments are allowed, they should usually only affect new installations (Fisch, 1996; Fouquet and Nysten, 2015). Consequently, feed-in tariffs with long-term payment guarantees may have advantage over carbon pricing or tradable green certificates. In that latter case, adjustments in prices or quotas typically also affect existing installation retroactively.

(ii) Various studies show that state-contingent adjustment rules are strictly superior to zero and full flexibility by policy adjustment (Habermacher and Lehmann, 2017; Jakob and Brunner, 2014; Kennedy, 1999; Laffont and Tirole, 1996; Requate, 2005). Breathing caps implemented for RES support schemes or the market stability reserve set up for the EU ETS may be interpreted as an approximation of such adjustment rules. As a minimum constraint, policy adjustment should be guided by clear objectives and criteria for RES deployment (Brunner et al., 2012; May and Chiappinelli, 2018; Nemet et al., 2017; Rodrik, 2014). Ideally, policy makers would specify objectives that are specific (e.g., quantified), limited in number, consistent and ranked hierarchically.

(iii) An intermediate level of flexibility by adjustment may also be warranted with respect to the frequency of RES policy adjustments. Fuss et al. (2009) show that changing RES policies less often but more drastically is superior to frequent marginal changes.

(iv) Finally, it is often suggested that flexibility by adjustment should be managed by an independent agency. This recommendation rests on the assumption that an independent agency is less driven by politico-economic considerations – and thus much closer to the social planner discussed in Section II – than political decision-makers like governments or parliaments. Hence, it is prominently proposed to install a carbon bank to manage emission trading schemes (Brunner et al., 2012; de Perthuis and Trotignon, 2014; Edenhofer, 2014; Helm et al., 2003, 2004; Levine et al., 2005; Nemet et al., 2017).

Certainly, the actual effects of flexibility by policy adjustment will crucially hinge on the credibility of the policy-maker, as any constraints to policy adjustment may be subject to adjustment over time themselves. It may be questioned why a government unable to commit to RES policy design should be able to commit to rules for RES policy adjustment. This concern has been raised for delegating decision-making to an independent authority, for example (see, more generally, McCallum, 1995). Only under certain conditions, delegation may make commitment more attractive for policy-makers and reduce the credibility issue (Perino, 2010).

Combing flexibility by policy design and flexibility by policy adjustment

Based on the above discussion of trade-offs, it is also worthwhile to discuss how flexibility by policy design and by policy adjustment may combine. Within Figure 4, a point can be identified – say point Q – which represents a) a socially optimal degree of overall political flexibility f^Q (based on a careful assessment of the trade-offs as discussed in Section II), and b) a socially optimal combination of a certain degree of flexibility by design f_D^Q and flexibility by adjustment f_A^Q. As discussed above, all degrees are likely to be significantly different from zero as well as unity. Consequently, the optimal point Q will most likely be located somewhere within the grey-shaded "optimality lens" in Figure 4.

Figure 4 also illustrates that flexibility by design and flexibility adjustment may be partial substitutes, and partial complements. If flexibility by design is high, it allows incorporating new private information on costs and benefits of RES policy. Hence, less flexibility by adjustment is required to account for this type of information. This case may be represented exemplarily by point Q in Figure 4. In turn, if flexibility by design is low, a higher flexibility by adjustment is required to provide a certain degree of flexibility. This case is illustrated by point P, with $f^P = f^Q$, but $f_D^P < f_D^Q$ and $f_A^P > f_A^Q$. In this respect, both types of flexibility are substitutes. With regard to Figure 3, optimal combinations would be located either in sector A or D. Yet, flexibility by design cannot account for new information on external costs and benefits of RES policies. In this respect, it necessarily needs to be complemented by a certain degree of flexibility by adjustment. This argument is illustrated by the optimality lens in Figure 4: All points within this grey-shaded area will involve certain non-zero degrees of flexibility by design and by adjustment. Hence, at least to some degree, both approaches are also complements. With regard to Figure 3, this argument points to choosing a combination of political flexibility located in sector B.

(iii) Trade-offs with respect to the political economy

We now turn to the question whether and under what conditions the politically chosen degrees of political flexibility by design and adjustment may deviate from the socially optimal ones. As pointed out in Section II, the key question is how political benefits of flexibility compare to social benefits of flexibility $\frac{dB_S}{df^*} \lesseqgtr \frac{dB_W}{df}$.

Flexibility by policy design

With respect to flexibility by policy design there are various reasons to assume that the political benefits of flexibility may be lower than the social benefits, i.e., $\frac{dB_S}{df^*} < \frac{dB_W}{df}$. A useful example is the frequent use of technology-, region-, and even investor-specific RES support schemes (e.g., Kitzing et

al., 2012), a regulatory approach with relatively high specificity and thus low flexibility by design. This RES policy approach may bring about lower costs for electricity consumers than technology-, region-, or investor-neutral approaches because price discrimination may help to reap producer rents (Bergek and Jacobsson, 2010; del Rio and Cerdá, 2014; Held et al., 2014; Jacobsson et al., 2009; Resch et al., 2014) – even if it increases overall societal costs (Fürsch et al., 2010; Jägemann, 2014; Jägemann et al., 2013). Consequently, voters (representing private electricity consumers) and interest groups (representing industrial electricity consumers) may push for approaches with lower flexibility by policy design. In addition, technology differentiation opens up for a "renewable pork barrel" (Helm, 2010): Lobbyists of different RES technology industries may be able to simultaneously satisfy their potentially heterogeneous interests and maximise their individual rents by pushing for technology-specific RES support. Thus, regulatory capture may result in RES policy approaches that are excessively specific (Aalbers et al., 2013; Lehmann and Söderholm, 2018; Lerner, 2009). Similarly, politico-economic logic may favour a mode of regulation (e.g., price-quantity combinations) and a composition of investment incentives (e.g., incentives established instead of market prices) that are less flexible. For RES investors, for example, such policy approaches may provide more secure and predictable revenue streams.

Flexibility by policy adjustment

With respect to flexibility by adjustment, the politico-economic considerations may lead to the opposite result. Many political supporters may favour a high degree of flexibility by adjustment to maximise their rents with ongoing changes in RES policy benefits and costs, i.e., $\frac{dB_S}{df^*} > \frac{dB_W}{df}$. For example, voters (aka electricity consumers) may push for adjustments if RES policy costs turn out to be higher than expected. This pressure will be the higher, the lower the flexibility by policy design is. The political tendency to opt for a high degree of flexibility by adjustment may be particularly pronounced if its detrimental effects on RES investment ($\frac{dI}{df} < 0$) can be controlled by payment guarantees for existing RES investments and commitment to explicit RES deployment targets. Moreover, politico-economic considerations may cast doubt on whether policy-makers will actually be willing to establish an independent authority, such as a carbon bank, to govern RES policies. By this type of delegation, they may give up an important political means to satisfy voter interests opportunistically. Consequently, policy-makers can be expected to abstain from implementing the authority, or to issue only limited competencies to the authority.

Combing flexibility by policy design and flexibility by policy adjustment

To summarise, one may expect the politico-economic policy-makers may tend to adopt excessively low degrees of flexibility by policy design, and compensate for that by excessively high degrees of flexibility by policy adjustment. Based on this perspective, RES policies may be expected to be located in sector D in Figure 3.

IV. Case studies of political flexibility

In this section, we discuss political flexibility for three prominent cases of RES policies: Germany's and the United Kingdom's RES support scheme, and the EU Emissions Trading Scheme. For each case, we will illustrate how flexibility by policy design and flexibility by policy adjustment have evolved over time. In addition, we will provide a brief economic evaluation of either evolution. We will scrutinize to what extent the evolution can be based on economic rationales – and how strong politico-economic distortions have been. This section cannot provide an in-depth analysis of each case. Instead, it means to illustrate the conceptual arguments made above. Figure 5 provides a graphical illustration of how RES policies discussed in the case studies have evolved over time. This graph aims to highlight general tendencies in policy evolution – rather than to specify an exact position of a certain RES policy.

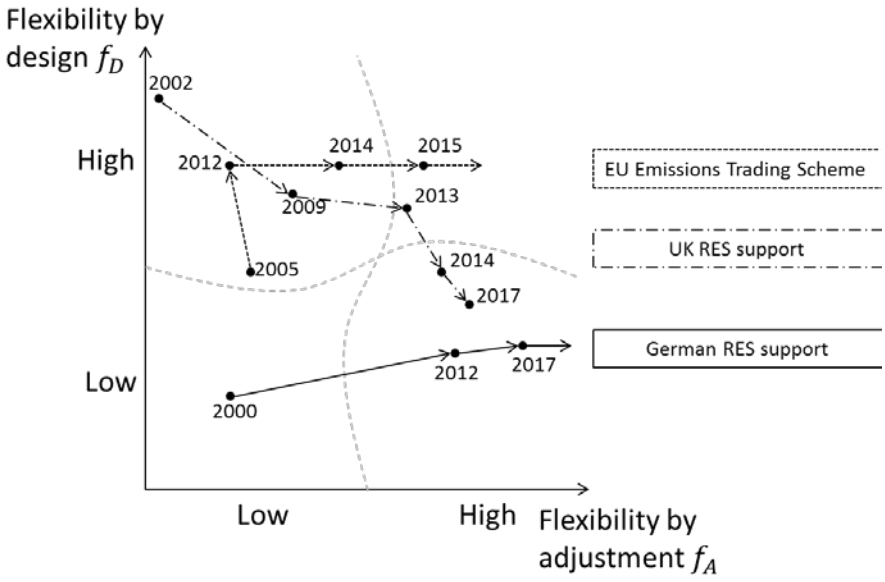

Figure 5: Evolution of political flexibility for the selected RES policy cases

(i) Germany's RES support scheme: From administered to competitive feed-in tariffs

Germany's feed-in tariff was introduced in 2000. Up to 2012, the scheme was characterised by a very low degree of flexibility by policy design. Tariff levels were set administratively and differentiated by technologies as well as regionally (depending on the wind yield at a specific site) (Mitchell et al.,

2006). The government explicitly announced a review of tariffs every four years. Thus, the government followed the economic intuition that a low flexibility by policy design required at least some degree of flexibility by policy adjustment. Up to 2012, the government was largely committed to this frequency of reviews. Feed-in tariffs were guaranteed for existing installations for 20 years, i.e., policy adjustments were only applicable to new investments. Moreover, any adjustment had to provide the attainment of legally defined RES deployment targets. The overall relatively low degrees of flexibility were economically reasonable for the initial period of policy implementation, when the feed-in tariff was primarily meant to ease market entry for a niche technology. At this stage, providing investment certainty for emerging technologies was important.

It was obvious that this policy approach could not be welfare-optimal in the longer run. The extremely dynamic development of RES technologies and their rising share in electricity generation (i.e., a higher societal relevance of corresponding costs) called for more political flexibility. Consequently, the policy amendments made in 2012 and later on went into the right direction. They started off with a slight increase in flexibility by policy design. The feed-in tariff was transformed into a sliding market premium. This increased the relevance of market signals for investment decisions, even though only to a limited extent (Gawel and Purkus, 2013). As the actual increase in flexibility by design was low, it was also an economic necessity to increase flexibility by policy adjustment – reflecting the idea that both approaches can be substitutes to some extent. A breathing cap was introduced for major RES technologies. It defined a future trajectory for tariff levels as a function of realised RES capacity increases. Moreover, additional ad hoc adjustments became common, particularly for the dynamically developing photovoltaics. In addition, the support for biomass-based generation was significantly decreased. Hence, Germany's RES policy embarked on a path with significantly higher flexibility by adjustment (Gawel and Lehmann, 2014). Legal documents show that adjustments were at least partly driven by cost-effectiveness considerations (Gawel et al., 2017b). Hence, frequent complaints that Germany's process of policy learning may have been ill-advised on a general basis (see, e.g., Tews, 2014) were not justified economically.

However, important drivers behind the increased flexibility by policy adjustment after 2012 have also been politico-economic considerations (Hoppmann et al., 2014; Strunz et al., 2016; Sühlsen and Hisschemöller, 2014; Vossler, 2014). Policy-makers balanced concerns of meeting RES targets and controlling costs of RES deployment on the one hand with addressing interests of different interest groups on the other. Interventions from industry groups and subnational administrations of the German states confirmed the expectation of a "pork barrel" driving technology- and region-specific support schemes.

The 2017 revision of the feed-in tariff brought about another fundamental change in the scheme. Tenders were rolled out to determine the feed-in premium for large-scale wind, photovoltaics and biomass, also in response to pressure from the European Commission (Gawel and Strunz, 2014). Thus, flexibility by policy design was slightly increased again (Gawel and Purkus, 2016). The introduction has certainly strengthened the importance of market signals for the determination of tariffs. However, tenders are still held separately for each RES technology. Moreover, additional elements of differentiation have been implemented, e.g., regional caps to tendered RES capacities as well as relaxed eligibility rules for energy cooperatives. Interestingly, the increase in flexibility by policy design has not resulted in a decrease in flexibility by policy adjustment (Gawel and Amberg, 2018). To the contrary: Interest groups are increasingly unsatisfied with "adverse" market results of the tender scheme, e.g., regarding which actors and regions are mostly awarded under the scheme. Ever since its introduction, political debates to further adjust the scheme – e.g., by holding tenders more frequently and further differentiating them regionally – have thus gained momentum, suggesting that flexibility by adjustment will further decrease.

In summary, Germany's RES support scheme has experienced some increase in flexibility by policy design, which was certainly useful to improve welfare. Yet, this increase has been limited, presumably due to the political influence of interest groups. What is more, the increase in flexibility by policy design has not been complemented by a decrease in flexibility by policy adjustment, as economic theory would suggest. Instead, both types of flexibility have been used as complements, with flexibility by policy adjustment pushed strongly by politico-economic drivers.

(ii) The United Kingdom's RES support scheme: From a quota to competitive feed-in tariffs

In 2002, the United Kingdom introduced the Renewables Obligation, a quota scheme with tradable green certificates. The initial phase from 2002 to 2009 was characterised by a very high degree of flexibility by policy design (technology-neutral quota). Hence, the United Kingdom opted for a different RES policy approach than Germany. This was presumably due to the market-liberal position of the Labour government (Wood and Dow, 2011). Initially, the scheme also exhibited a very low flexibility by adjustment. This was important as any adjustments to the quota would have affected all existing investments retroactively. Hence, the scheme represented the economic insight that both types of political flexibility should be used as substitutes.

However, the technology-neutral approach clearly failed to account for the variations in technological development across RES technologies and related market failures (Lehmann and Söderholm, 2018). Against this background, the decision to introduce technology-specific bands for the Renewable Obligation in 2009 followed some economic rationale. Policy-makers were aware that

this reduction in flexibility by policy design needed to come along with an increase in flexibility by policy adjustment. Regular reviews of the scheme were announced. Consequently, bands were further differentiated in 2013 and 2014 (Ofgem, 2015). Certainly, these adjustments partly reflected policy learning about the actual impacts of bands in terms of RES deployment and costs. However, there is also evidence that these policy revisions have been driven by interest groups from the RES industry (Helm, 2010; Helm, 2017).

Banding only partly addressed the main concern regarding quota systems: It was argued that the scheme imposed excessively high risks on investors. This impaired a transition of the energy sector, particularly in the light of market failures and path dependencies (Foxon and Pearson, 2007; Mitchell et al., 2006). The 2011 decision to transition the Renewable Obligation towards a feed-in tariff schemes with contracts for difference therefore also followed a certain economic intuition. This further decrease in flexibility by policy design was again accompanied by an increase in flexibility by adjustment. During the first round held in 2014, contracts were issued at administered, technology-specific strike prices. For the second round held in 2017, contracts were tendered. The tender scheme was divided into two "pots" (for developed and less developed RES technologies). Such adjustments may be sensible economically if policy-makers need to learn by doing how to implement a new policy instrument optimally. Yet, they were also taken to respond to pressure from the European Commission. Moreover, adjustments were driven by politico-economic pressures as well: The 2015 decision to suspend tenders for the pot of developed technologies primarily aimed at calming rural constituencies worried about the growing deployment of onshore wind energy (Grubb and Newbery, 2018).

In summary, the United RES support schemes has moved to a lower degree of flexibility by policy design. This development was at least partly supported by economic rationales. This is of course not to say that the eventually chosen degree is necessarily optimal – as there is certainly scope for further improvement (Helm, 2017). Compensating for this reduction in politically flexibility, flexibility by policy adjustment has increased. This was economically rational as well, as both types of flexibility can be understood as substitutes to some extent. This notwithstanding, the increases in flexibility by design were also driven by the politico-economic framework.

(iii) EU Emissions Trading Scheme: From national fragmentation to a more European approach

Phase I (2005-2007) and II (2008-2012) of the EU Emissions Trading Scheme (ETS) were characterised by intermediate flexibility by policy design. An EU-wide market for CO_2 allowances was established. Yet, the allocation of allowances relied on regionally differentiated national allocation plans and technology-specific allocation rules. Flexibility by policy adjustment was also intermediate, with

regular re-negotiations of allocation rules and quantities. Hence, the EU ETS started off as a market-based approach, without fully trusting the market. To some extent, this approach was politically rational given the limited previous experience with trading schemes at this scale. However, there is also evidence that the limitations to flexibility by design were due to regulatory capture by EU Member States with specific energy-related interests as well as industry groups (Anger et al., 2016; Helm, 2010; Spash, 2010).

Apparently, the initial design of the EU ETS ran counter the objective to attain CO_2 reductions cost-effectively across Europe (Ellerman et al., 2016). Consequently, the significant increase in flexibility by design decided upon for phase III (2013-2020) improved the performance of the EU ETS in terms of social welfare. The EU-wide determination of the emissions cap and the transition towards auctioning were particularly important. Following economic intuition, EU policy makers also intended to decrease flexibility by adjustment as flexibility by design had been increased. Notably, a long-term reduction trajectory for the emissions cap was agreed upon. Yet, this limitation to adjustment proved to be weak. An increasing amount of excess allowances and consequently low allowance prices – due to the Eurozone crisis as well as other factors – resulted in constant calls for policy reform. In 2014, the EU adopted a decision on backloading. 900 million allowances were withdrawn temporarily from the market to respond to low allowance prices, with the intention to re-issue these allowances at a later point in time. This decision was overhauled only one year later when the EU decided to transfer allowances permanently to a market stability reserve (to become effective in 2019). Thus, flexibility by policy adjustment has continued increasing over the past years. This trend is likely to continue, given, for example, the ongoing discussions on introducing a carbon price floor (Edenhofer et al., 2017). Certainly, most of the recent adjustments may potentially improve the performance of the EU ETS in terms of welfare, particularly by stabilising allowance prices. At the same time, the political debates on reforming the EU ETS have been highly volatile, reflecting quite different views and interests regarding how a functioning EU ETS should be designed (Fuss et al., 2018; Jevnaker and Wettestad, 2017).

In summary, the EU ETS has undergone a significant and economically sensible increase in flexibility by policy design. However, flexibility by policy adjustment was increased simultaneously. Thus, both approaches have been used as complements, rather than substitutes – in contrast to economic intuition.

(iv) Comparison of case studies

A comparison of the case studies reveals overarching trends for flexibility by policy design and flexibility by policy adjustment.

Flexibility by policy design has increased over time for RES policies starting with a relatively low degree of flexibility (Germany, EU ETS). The opposite has been observed for RES policies with a high initial degree of flexibility by design (United Kingdom) (see Figure 5). All policies have therefore evolved towards more moderate degrees of flexibility by design. This observation is particularly striking for the RES support schemes in Germany and the United Kingdom. They departed from opposite ends of the flexibility continuum and eventually evolved both towards a competitive feed-in tariff. This is in line with the hypothesis that RES policies may tend to converge over time, e.g., due to diffusion processes or similar external pressures (European Commission in this case) (see, e.g., Kitzing et al., 2012; Strunz et al., 2018). From an economic point of view, this trend may have helped to increase social welfare. Our theoretical analysis has suggested that the socially optimal degree of flexibility is most likely an intermediate one. Obviously, it remains unclear whether this optimal degree was actually attained in our case studies. Politico-economic drivers where important in all cases – and may well have resulted in too limited increases (Germany, EU ETS) or excessive decreases of flexibility by policy design (United Kingdom), as suggested by our theoretical model.

Flexibility by policy adjustment has increased over time for all three case studies. First, this may have been due to economic rationales: Given the lacking experience with policy approaches when implemented and the dynamics of the market environment, ongoing adjustments were necessary to improve the performance of RES policies in terms of social welfare. A second important driver has been the politico-economic environment. With the introduction of RES policies, policy-makers have created new opportunities for re-distributing rents within an economy. These opportunities have increasingly been taken by rent-seeking interest groups, and may be an additional explanation for rising degrees of flexibility by adjustment.

Interestingly, rising degrees of flexibility by adjustment occurred irrespectively of the initial level of flexibility by design. They could be expected for policies starting with a low degree of flexibility by design. As Helm (2017, p. 101) points out: “This is a classic case of starting out with a specific intervention, leading to unintended consequences, leading to more interventions, and resulting in greater complexity. It is what might be called the ‘sticking plaster’ approach to the evolution of policy.” However, the same development may be observed for policies with an initially high degree of flexibility by policy design (United Kingdom) – or when flexibility by policy design had been increased (Germany, EU ETS). Policy-makers (aka their relevant political supporters) may be unsatisfied with the (potentially unforeseen) outcomes of markets and opt for continuous adjustments. Hence, the political economy may imply that policy makers respond to high (or increasing) degrees of flexibility by policy design by higher degrees of policy adjustment. Thus, both approaches are used as

complements – while our theoretical analysis suggests they should be treated as substitutes, at least to some extent.

V Conclusion

Our analysis has shown that a certain degree of political flexibility in RES policy will typically be necessary if social welfare is to be maximised. Consequently, RES policies should be "renewable" to some extent. Approaches with zero flexibility, aiming to conserve existing regulatory conditions for renewables once and for all, can hardly be welfare-optimal in practice. They will typically fail to account for the dynamic development of RES technologies and uncertainties regarding their private and social costs and benefits. Similarly, a regulatory framework with full flexibility – implemented either through the absence of regulation, i.e., free markets, or constant adjustments – will typically not be welfare-optimal. Some limitations to flexibility are warranted to address market failures properly and to spur RES investments. More fundamentally, it is important that any discussion on a socially optimal degree of flexibility is only meaningful if there is at least some degree of credibility.

The eventual performance of political flexibility will depend on how it is implemented. Flexibility by policy design and flexibility by policy adjustment needed to be combined smartly. They may be partial substitutes and complements. Most likely, however, some minimum restrictions to flexibility by adjustment – such as ruling out retroactive adjustments or providing a long-term framework for RES deployment (explicit objectives and targets) – are welfare improving.

Obviously, the politically chosen degree of flexibility may well deviate from the socially optimal one. Our theoretical discussion and the analysis of the case studies have revealed that politico-economic drivers may result in a suboptimally low degree of flexibility by design. In turn, the degree of flexibility by adjustment may be excessively high due to regulatory capture.

Which lessons can be learned from our discussion beyond RES policies? Most likely, trade-offs related to choosing an optimal degree of political flexibility occur in other fields of electricity policy as well. An excellent example is the discussion on the future design of electricity markets (see Helm, 2018, in this special issue). This raises questions similar to the ones addressed in our paper. What is an appropriate degree of flexibility by design, e.g., regarding the technology specificity of capacity auctions? How should flexibility by policy adjustment be organised, e.g., should the government or rather an independent system operator decide on adjustments? The optimal and the politically chosen degrees of flexibility may well be different from RES policy. The potential costs of electricity market failures – e.g., due to blackouts – may be prohibitively high, economically as well as politically. Policy-makers may be tempted to respond to this challenge by excessively low degrees of flexibility by design and adjustment (e.g., live-long and fully administered technology-specific

capacity payments) to safeguard security of electricity supply at any cost. In turn, any attempt to rely on market forces to safeguard security of electricity supply can only trigger sufficient capacity investments if the policy-maker can credibly commit to not implementing capacity payments in the future. Otherwise, investors may strategically withhold investments to force policy-makers to create additional revenue streams (Gawel et al., 2017a). Overall, this example thus illustrates that the optimal and political feasible degree and composition of political feasibility are highly case- and context-specific.

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