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The Innovation Fund:

A Complementary Financing Mechanism for Renewables and a Model for Future Infrastructure Financing?

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IASS POTSDAM

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Contents

1. Introduction

The German Renewable Energies Act (EEG) is a success story. Fixed feed-in tariffs and purchase obligations have created a secure market and operational environment for renewable energy sources (RES), thereby facilitating an innovation and learning process during operations (learning-by-doing) that goes beyond purely technological development (learning-by-searching) (SRU 2013, p. 57, subs. 93-4). This alone has led to today's cost reductions – through further technological development and economies of scale – and the market diffusion associated with them. Hence, some renewables can already compete with conventional energy carriers, even when the external effects of climate change are not yet priced in. Thanks in particular to the significant cost reductions of recent years, intermittent onshore wind and photovoltaic (PV) can now compete with new fossil-based capacities at full cost (Gerhardt et al. 2014; IPCC 2011, p. 13; IRENA 2013). Since 2012, renewables have accounted for more than half of newly installed capacity worldwide (REN21 2012, 2013, 2014). Thus, the emergence of a lead market in Germany prompted by the EEG has contributed significantly to the reduction in **global** technology costs and the transformation of energy systems worldwide.

The steady expansion of renewables can be attributed to two effects: on the one hand, fixed feed-in tariffs created a secure business model, which meant that installation operators only had to pay low-risk premiums (i.e. financing costs). On the other hand, with the EEG surcharge, the costs of expansion were borne directly by electricity consumers and were therefore not subject to recurring budget deliberations. As a result, the kind of stop-and-go behaviour seen, for example, in the USA, which hindered the development of businesses in this sector, was avoided (Mitchell et al. 2011, pp. 898–899, Box 11.5). Given these advantages, the EEG has served as a model for similar regulations in many other countries (REN21 2014; SRU 2013, p. 58, subs. 97).

Nevertheless, the success of the EEG has also stimulated discussion on the costs it entails and led to a search for alternative forms of financing. Here the focus has been on making the financing basis broader than the current model, where financing costs are borne solely by a particular group of electricity consumers – so-called non-privileged electricity consumers. Thanks to the rapid drop in the cost of technologies – especially in the case of PV and onshore wind – renewables have expanded to the extent that their share in gross electricity consumption in the first half of 2014 is likely to be 28.5%(BDEW 2014a) and they can thus be considered systemically relevant. Yet, this also means that the EEG surcharge has risen steadily and, according to medium-term prognoses, will continue to do so in future – despite a slight dip in 2015 (50hertz et al. 2014). Even if the EEG surcharge is not an appropriate cost indicator for the expansion of renewables (see SRU 2013, subs. 65-6), it has always been the focus of a recurring discussion of costs. And leaving this discussion to one side, a partial alternative financing of EEG costs is justified not only by the demands of innovation and technology policy, but also in terms of competitiveness, transparency and communication to the wider public. Indeed, the very notion of the Energiewende as a collaborative endeavour would seem to support a broader financing basis, since the matter of cost distribution has always played an important role in political projects.

The search for alternative financing models for the EEG costs can also serve as an example of how we might approach other future challenges. It must be seen in the context of the growing financing challenges faced by infrastructure projects, some of which are connected with the Energiewende and some of which are relevant to other areas (digital networks, transport infrastructure, etc.).

This leads us to the bigger question of how infrastructure projects should be financed in future. After outlining the arguments in favour of an Innovation Fund, we will describe our proposal for transferring the costs of development to this fund – based on the models currently being discussed. We then show the various financing options that could be used to cover the resulting financing requirement. Finally, we examine the possibility of the greater involvement of institutional investors in more detail.

New avenues for the Energiewende: To date, the costs of green power have been borne mainly by consumers via a surcharge. A fund could lead to a more equitable distribution of these costs in the future.

2. The Innovation Fund: why a (partial) alternative financing of the Energiewende makes sense

2.1 Technology and innovation policy: the Energiewende as a structural transformation

From the point of view of **technology and innovation policy,** it makes sense to transfer the costs of technological development from the EEG system to a complementary fund. Currently, the costs of developing renewable energy technologies and expanding renewable generation capacities – i.e. a significant part of the Energiewende – are paid directly by (non-privileged) electricity consumers. But traditionally, the costs of technological development have mainly been covered by public finances, since the benefits to society as a whole are seen to outstrip anything that can be attributed to ordinary citizens. In innovation and growth economics such benefits are called positive external effects (Matschoss 2004). The same can be said of other kinds of infrastructures that boost productivity (digital networks, transport infrastructure, etc.). Apart from the 'normal' advantages associated with the public funding of technology, in the case of renewable energies the avoidance of environmental harm (greenhouse gas emissions) would be an added benefit.

2.2 Managing structural transformation and broadening its financial basis: the Energiewende as a collaborative endeavour

A partial alternative financing of some of the differential costs arising from the EEG is further justified in terms of competiveness, transparency, acceptance and communication to the public. The aforementioned removal of the costs of technological development from the EEG surcharge would also ensure a **more level playing field** between the different energy technologies. After all, the costs of developing technologies for other energy carriers (especially nuclear energy) were also not financed via payments for electricity. Moreover, many facts (the funding of nuclear energy technology development, the subvention of hard-coal mining, the exemption of lignite mining from the EEG, etc.) show that the playing field is tilted against renewables as it is (FÖS 2012a, b; Küchler & Meyer 2012).

At the same time, removing the costs of technological development from the EEG would make **transparent** the fact that some renewable energy technologies can already compete with conventional energy technologies, when compared on the full cost basis relevant for investment decisions (IPCC 2011, p. 13). The EEG has made the costs of developing and rolling out renewables transparent in a way that never happened in the case of conventional energy carriers (Küchler & Meyer 2012). However, the rapid reduction in the cost of operating new installations is not reflected in the EEG surcharge. Instead, it is burdened with the development costs of earlier installations in the form of high feed-in tariffs, especially for PV installations that were established prior to the reform of the EEG in 2012, and will continue to be burdened to a certain degree with the feed-in tariffs for still emergent offshore wind technology (Matthes et al. 2014b). Removing these costs from the EEG surcharge would make the recent and anticipated cost reductions in the area of renewables transparent. In addition to increasing **acceptance** for the Energiewende among German electricity consumers, this would also make **communicating** the Energiewende to other countries much easier. It would dispel the myth that renewables are still an expensive option and that only 'rich' countries like Germany can afford to undertake a transformation of their energy systems.

The Energiewende is a **collaborative endeavour** and should, as such, have the broadest possible financing basis. Far from merely providing technologies that can meet future needs, this is about strategically reorienting the entire electricity supply system, a task for the whole of society. Such a fundamental transformation justifies stretching financing over a long period, since the benefits (and added value) of technological development would extend over generations (even when credit costs are incurred, unlike in the case of the current EEG). Hence, this would be a form of direct user financing (pay as you use). Instead we have a situation where the EEG surcharge is financed by the current cash flow of a limited group, namely, today's non-privileged electricity consumers. At the same time, many energy-intensive industries and (primarily conventional, industrial) own generation are privileged. This means that around 30% of electricity consumption is charged at just 0–10% of the EEG standard rate (Matthes et al. 2014b, pp. 21–22), with the result that the EEG surcharge becomes even higher for all other – non-privileged – consumers (Küchler 2014; Matthes et al. 2014a; SRU 2013, p. 65, subs. 108). While the reform of the EEG introduced on 1 August 2014 had hardly any effect on the number of exemptions granted to energy-intensive industries (Matthes 2014), it did provide for a reduced rate to apply to own generation from new installations (with the exception of coal-fired power stations). Yet with the progressive expansion of renewables, own generation is also expected to grow, leading to further erosion of the financing basis. If these generous exemptions are considered economically or politically expedient – a question that is worthy of discussion but goes beyond the scope of this study – then the exemptions form part of the collaborative Energiewende project, and we must ask ourselves why the costs that arise from that project are borne solely by non-privileged electricity consumers.

2.3 Thinking beyond the Innovation Fund: How can we finance future infrastructure projects?

The alternative financing proposed with the Innovation Fund can be seen as a model for more far-reaching, pending future challenges. They entail investment in and financing of future infrastructure not just for the Energiewende, but also in other areas (digital networks, etc.).

As outlined above, a broad financing basis makes particular sense for collaborative projects, where the benefits outstrip anything that can be attributed to ordinary citizens and extend over a long period of time, even over generations. It is therefore too short-sighted to view investments solely in terms of costs. On the contrary, they bring benefits and generate positive returns. They lead to increased economic productivity and put society in a position where it can meet future challenges such as climate change.

Despite the arguments in favour of it, public financing is increasingly controversial, and the current political debate seems to point in an entirely different direction. The so-called 'debt brake' is now enshrined in the German constitution (*Grundgesetz*), discussions of the budget are focusing on 'breaking even', and greater direct user financing in the form of public-private partnerships and road tolls is being debated in the transport sector. At the same time, the current low interest rates are having two effects: on the one hand, they offer favourable terms for capital market financing (even when it's not clear how long this situation will last and even when financing costs increase significantly over time). On the other hand, institutional investors, especially life insurance companies, are increasingly hard-pressed to find sufficiently attractive investment opportunities for their interest payment commitments. In this context greater involvement of institutional investors in the financing of infrastructure seems to make sense. This option will be examined in greater detail after we have introduced the different fund models and financing options.

In test mode since 2012, this wind turbine in Østerild, Denmark boasts the world's largest rotor with a diameter of 154 metres. Removing the costs of technological development from the EEG system makes sense for several reasons.

3. EEG system and fund models

In section 2 it was shown that removing the costs of technological development from the EEG system makes sense for several reasons. Different fund models are currently being discussed in the political sphere, each of which proposes the removal of a different payment obligation from the EEG surcharge system based on different criteria. Aside from the various rationales for each fund model, each has different implications for the level and further development of the EEG surcharge and the financing of the respective fund.

To assess the implications of the different fund models, an Oeko Institute study (Matthes et al. 2014b) undertook a model projection of the EEG system up to 2050, which estimates the EEG payment obligations and differential costs that will have accrued by then, taking account of long-term climate and energy policy goals relevant to the Energiewende. On that basis, calculations were made for a sample of three alternative fund models from 2015 on. The study also touches on the question of how such a fund could be financed. It was commissioned by the German Council for Sustainable Development (RNE) and can be accessed on the websites of the Oeko Institute and the RNE. Unless otherwise indicated, the following descriptions of payment obligations, differential costs and fund models are based on this study.

The model projection of the EEG system implies that by 2050 80% of power generation will be based on renewables and financed via the EEG surcharge. Thus, the differential costs that will have accrued by then are not (solely) incurred as additional costs, but represent rather a (partial) reallocation of 'normal' electricity costs to the EEG surcharge. The switch to direct marketing that was ushered in by the 2014 EEG and the possible forthcoming switch to tendering processes do not call these findings into question, since they merely reflect a competitive determination of payment amounts. The same applies to other instruments that could be introduced in future, such as capacity charges for renewables (Agora Energiewende 2014; SRU 2013, subs. 47), which are also likely to be allocated to the EEG account or, in a different way, to the electricity price. While the task of enhancing the framework conditions for rising shares of renewable energies is important, the general question of how to organise an electricity market in the case of leading technologies with minimal or no marginal costs (PV and wind) cannot be addressed here. The sole purpose of the projection in the Oeko Institute study is to evaluate various fund models.

3.1 EEG differential costs up to 2050

The EEG system works like this: the payment obligations are equivalent to the sum of all technology-specific feed-in tariffs in excess of the market price (i.e. payment obligations) paid to installation operators. The electricity produced is sold on the spot market by the transmission network operators and the proceeds are transferred to the EEG account.[1] The differential costs are the difference between the payment obligations and the proceeds from the sale of electricity generated from renewables on the spot market. They form the total surcharge amount in the EEG account, although it should be noted that only the so-called core surcharge amount is dealt with here.[2] The total surcharge amount is ultimately allocated to non-privileged electricity consumers as the

EEG surcharge per kilowatt hour.[3] With the introduction of a fund, part of the surcharge amount would be transferred to it and the remaining surcharge amount would be accordingly smaller.

To estimate these differential costs, the payment obligations are projected at full cost up to 2050 (Matthes et al. 2014b, annex 1). As explained above, this is done by predicting the electricity that will be generated by all EEG installations up to 2050, taking Energiewende targets into account (minimum 80% power generation from renewables by 2050). As far as possible, empirical data and promises made in current statutory regulations were used (as of March 2014). For example, the future net increase in the various renewable capacities and – where mentioned – the respective feed-in tariffs were projected on the basis of the draft 2014 EEG reform prepared by the Federal Ministry for Economic Affairs and Energy (BMWi 2014). For the period after that, technology-specific cost degressions of established prognoses were estimated with the necessary payments arising from them (at full cost).

The power generation mix and the resulting total payment obligations required to cover the full costs in the period until 2050 (based on real 2014 prices) are derived with the help of further assumptions regarding capacity utilisation.

The level of the differential costs depends in turn on the development of the electricity trading price. If that price rises (e.g. due to an increase in emissions trading or fuel prices), the revenues generated by renewable power will grow and the differential costs will fall; if the electricity trading price falls, the opposite will be the case. The effect of the electricity price on differential costs – and thus on the level of the different fund models – is quantitatively high, but the qualitative progression of the funds is unchanged. The study presented calculations for three scenarios based on different electricity price developments (all using real 2014 prices): in the lower electricity price scenario, the electricity price sinks steadily to 25 euro/MWh in 2050; in the baseline scenario, it remains constant at 40 euro/MWh; and in the upper electricity price scenario, it rises to 80 euro/MWh in 2025, and continues to increase by 10 euro/MWh per decade, reaching 105 euro/MWh by 2050. The following observations are all based on the baseline scenario.

Figure 1a shows the level and structure of technology-specific differential costs for the baseline scenario of a constant (real) electricity price of 40 euro/MWh, the sum of which also – in the absence of a fund – represents the total surcharge amount (black line) allocated to non-privileged electricity consumers. The different technologies are represented by different colours, with a distinction made between existing installations (darker colour – entry into service up to 2014) and new installations (lighter colour – entry into service from 2015 on). The illustration shows that differential costs are still heavily influenced by existing PV installations, while the costs of wind energy (onshore and offshore) will dominate in future.

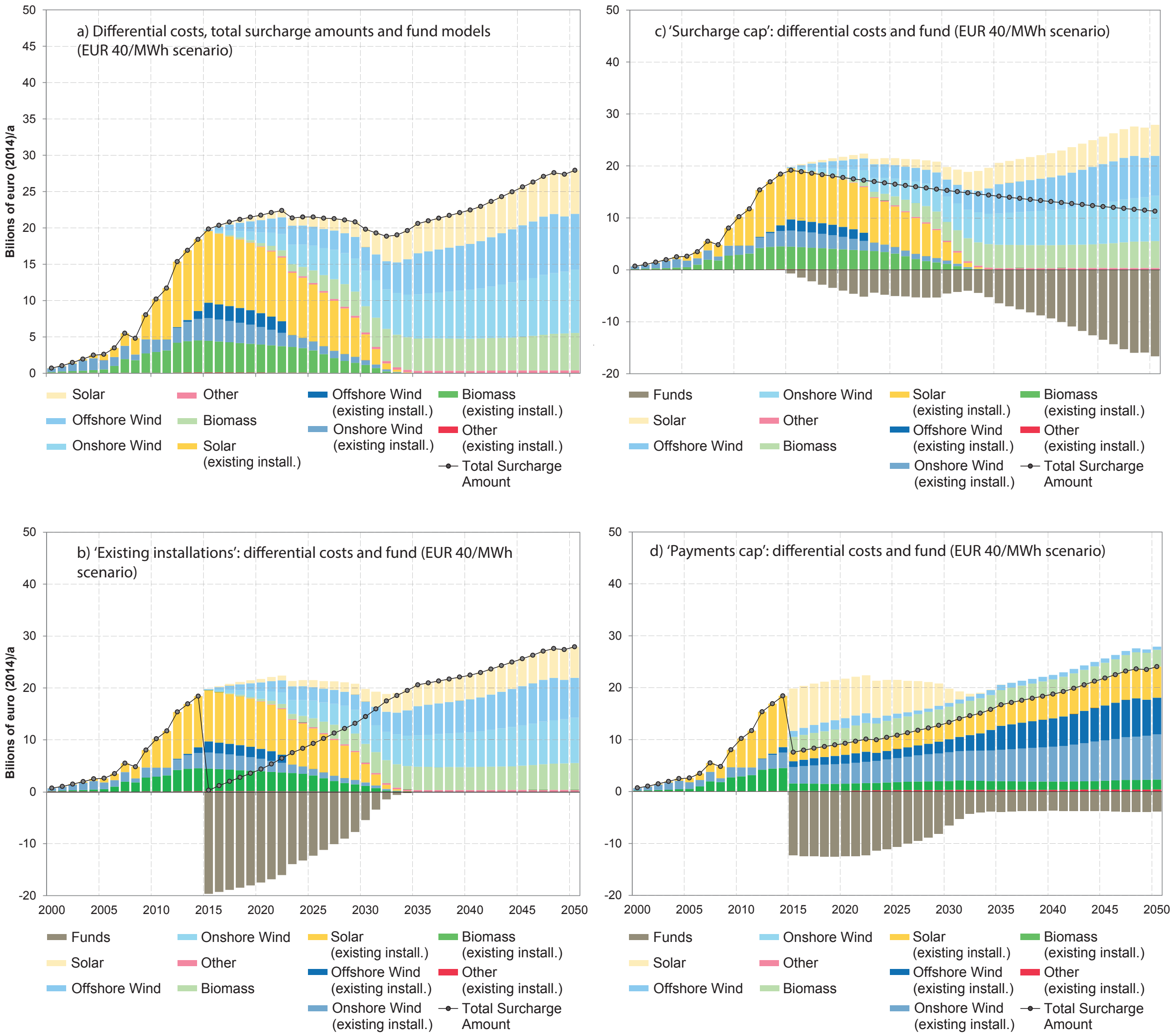
The present dominance of existing PV installations is due to capacity additions in this area in recent years (especially from 2009 to 2012) at much higher feed-in tariffs than today. The future costs of wind energy, especially onshore, can, by contrast, be attributed mainly to the anticipated high production levels, which will be possible at much lower costs due to assumed cost degressions. So this is mainly due to a quantitative effect of this future leading technology. The same applies to PV, where payments have fallen significantly since 2012 and for which even higher

[1] The EEG account is operated jointly by the transmission network operators; see (BDEW 2014b, p. 33). As of 1 August 2014, a direct marketing obligation exists for new facilities. This means that producers are obliged to market their electricity themselves (or via a trader) and are paid a market premium from the EEG account in exchange.

[2] Core surcharge refers to the total surcharge amount when other payments included in that figure such as corrections due to deviations from prognoses, liquidity reserve, etc. are not taken into account.

[3] As shown in section 2, a significant proportion of electricity consumers is privileged, i.e. they pay either no surcharge or a reduced surcharge.

FIGURE 1: DIFFERENTIAL COSTS, TOTAL SURCHARGE AND FUND MODELS



Source: Matthes et al. (2014b; a): fig. 3-5, p. 36; b): fig. 5-1, p. 45; c): fig. 5-2, p. 46; d): fig. 5-6, p. 51; all modified

cost degressions are assumed than for onshore wind. Together, these technologies will form the backbone of the future energy system. A considerable cost degression is also expected for offshore wind energy, albeit below that for onshore wind and PV. In the case of biomass, however, hardly any cost degressions are anticipated.

While the differential costs and the overall costs that underlie this new energy system seem high, they must be seen in comparison with the conventional energy system, which would also have to be modernised in this period. Thus the study shows that the overall costs of both systems would be similar when moderate increases in emissions trading and fuel prices are assumed. And a regenerative energy system offers further advantages, such as greater independence from fluctuating fuel prices and insecure supplier countries as well as the likelihood of more revenues being created within the country. However, an energy system in which renewables dominate will increasingly be based on fixed costs, i.e. the share of fixed (investment) costs will rise, while the share of variable (fuel) costs will fall (Matthes et al. 2014b, p. 34). At European level too, the share of investment costs in overall costs will rise to the extent that the investment rate within the EU will double (ECF 2010, 2011).

3.2 The basic models (according to the Oeko Institute study)

The study presented calculations for three fund models ('existing installations', 'surcharge cap' and 'payments cap') based on the assumption that each is introduced in 2015 and continues until 2050. The 'payments cap' model was also examined for different technologies. In figures 1b to d the respective differential costs are again shown above the timeline. However, only that proportion of the differential costs below the black line is now allocated to non-privileged electricity consumers. The proportion above the black line is transferred to the respective fund (sometimes differentiated by technology), which is once again represented below the timeline. While the paler bars in figures b and c (as in figure a) represent new installations, the paler bars in figure d represent the respective shares of payments (for existing and new installations) that would be financed by the fund.

3.2.1 The models

As the first concept to be elaborated, the 'existing installations' model (also known as the 'vertical cost cut' or 'old debt fund') shown in figure 1b was the first to receive significant media attention (Balser & Bauchmüller 2013; Töpfer & Bachmann 2013). Here all differential costs that have accrued by the end of 2014 are transferred at once to the fund. As a result of this one-off vertical cut, the remaining surcharge amount (and in turn the EEG surcharge) drops suddenly to zero (black line) before rising gradually until it has rejoined the path that would otherwise be followed without the fund from 2035 on. Conversely, the fund (below the timeline) peaks on its introduction before falling gradually to zero as each renewable generation site financed by the fund reaches the end of its surcharge period.

In the media, the 'surcharge cap' (or 'horizontal cost cap') model represented in figure 1c is better known as the 'Aigner proposal' after the former Bavarian Minister for Economic Affairs (Müller & Szymanski 2014; Reuters 2014), although an initial version of this model was already proposed in 2012 (Cohrs 2014, p. 20). It envisages a direct capping of the EEG surcharge, with the fund covering the residual costs. From 2015 on, the surcharge is limited to the nominal amount of 4.9 ct/kWh (falling to 4 ct/kWh by 2030 and 3 ct/kWh by 2050). This gives rise to a corresponding capping of the total surcharge amount (black line). All differential costs above and beyond that are continually transferred to the fund (below the timeline). This means that the fund grows steadily over the whole timeframe of the analysis. While this scenario is only described up to 2050, depending on the share of renewables in the years thereafter (a constant 80% or an increase to 95% or even 100%) the differential costs will continue to develop along the lines assumed by the projection. Thus we can expect that if the share of renewables remains constant, so too will the size of the fund.

In the case of the 'payments cap' (also known as the 'horizontal payments cap' or the Innovation Fund) model, which is better described by the term 'payments split' (figure 1d), only some of the payments to installation operators are covered by the EEG surcharge (9 ct/kWh; darker bars) from 2015 on, while all other payments are financed by the fund (paler bars). Given the different levels of remuneration for each technology, the shares financed by the surcharge on the one hand and the fund on the other vary from one technology to the other. Similar to the 'existing installations' model, the residual surcharge amount drops suddenly after this initial cut (black line). The resulting EEG surcharge falls to 3 ct/kWh before increasing slightly, but it remains under the level it would have reached without a fund. Conversely, the fund (below the timeline) peaks at the start and remains at this level for a few years, before falling to a constant level determined by the long-term (constant) costs of the technologies to be financed. This model was also examined from the perspective of different technologies for PV, offshore wind, and biomass. Since payments for onshore wind energy lie below the 9 ct/kWh mark as it is, they continue to be financed solely via the surcharge.

3.2.2 Critical appraisal of fund models

In addition to their respective effects on the development of the fund and the surcharge, the different starting points of the aforementioned fund models also have different political implications. While the EEG surcharge represents a resulting variable in the case of the 'existing installations' and 'payments cap' models, it is determined directly in the case of the 'surcharge cap' model. The characteristics of each model are outlined clearly in table 1. The progression of the fund and the resulting financing requirements are described in more detail in section 4.

The 'existing installations' model can be understood as the original concept, but it is likely to encounter acceptance problems in the medium term and is also not entirely consistent with innovation policy. While the proposed removal of existing installations from the surcharge is motivated by innovation policy, all costs incurred by the installations in question are transferred to the fund – not just those that exceed a certain limit and can be considered innovation costs.

Secondly, the costs of future necessary innovations are not taken into account, although an analogy can be made between the current relatively high payments for offshore wind energy and the price development of PV. Thirdly, it seems only a matter of time before the EEG surcharge will again be perceived as unacceptably high by the general public once it begins to rise steadily following the one-off cut. It is quite possible that political pressure to repeat this 'one-off' measure will grow accordingly, resulting – again similar to PV – for example in the exemption of offshore wind energy from the surcharge. Finally, the sudden drop in the surcharge also lowers the incentive to use electricity efficiently.

TABLE 1: CHARACTERISTICS OF THE FUND MODELS

Fund model	(+)	(-)
Existing installations (covers the costs of all existing installations)	■ Covers the costs of expensive installations (= development costs) ■ May be differentiated by technology	■ Covers the overall costs of existing installations, not merely innovation costs ■ Does not include future installations ■ Surcharge rises after one-off cut; follows the same path that would be taken without fund from 2035 on ■ Adverse effect on efficient electricity use
Surcharge cap (Keeps the EEG surcharge at a constant level of 4.9 ct/kWh)	■ Constant surcharge ■ Incentive to use electricity efficiently remains to some extent	■ Singular, short-term political goal ■ No innovation policy justification ■ Steadily increasing fund volume
Payments cap (Covers that portion of installation payments over 9 ct/kWh for all existing and new installations)	■ Deliberately covers innovation costs ■ Applies to both existing and future installations ■ Sustained drop in the surcharge to below the level that would be reached without a fund ■ May be differentiated by technology	■ Surcharge rises after one-off cut ■ Justification of coverage of constant innovation costs associated with biomass debatable ■ Adverse effect on efficient electricity use

Source: IASS

In the case of the 'surcharge cap' model, it is clear that its sole purpose is to limit the EEG surcharge (and the price of electricity) in order to avoid acceptance problems. Especially if we consider the steady increase in the fund volume that would result in the long term, this model can surely only be justified by current, short-term policy goals. Given this obviousness, the model has decidedly negative connotations in the public sphere as a perceived attempt to burden future generations with today's costs. In one possible variant – which is not investigated by the Oeko Institute study – the surcharge could be capped at a real rather than a nominal amount, thereby balancing inflation at least. However, this would not change the overall concept, and the development of the fund (steady increase) would probably be similar. For these reasons, this model seems particularly problematic.

Of all the models discussed here, the 'payments cap' (or 'payments split') model is the most consistent with innovation policy. On the one hand, only additional costs due to innovation are transferred to the fund – unlike the 'existing installations' model. On the other hand, this model includes the innovation costs incurred by future installations – i.e. offshore wind energy. Furthermore, by taking the costs of technological development out of the EEG surcharge, this model also contributes to the aforementioned levelling of the playing field with conventional energy technologies. In this context, the participation of future generations in the financing of the energy transition is legitimate (section 2). All this helps to ensure broad acceptance of this model. However, the steady increase in the EEG surcharge may once again lead to acceptance problems. But the level of the EEG surcharge will remain below the level it would have reached without a fund. As a result of transferring the costs of innovation to the fund, in this model any further increases in the surcharge can mainly be attributed to the quantitative growth in electricity generation from renewables. Yet with regard to technologies, the inclusion of biomass is doubtful in the long term, since no cost degressions are expected here despite the fact that this technology will dominate the fund from 2030 on. By contrast, offshore wind energy is far less of a burden on the fund. Furthermore, in the case of this relatively recent technology, the assumed rate of cost degression is less certain, so it is possible that sustained financing in the initial phase could reap greater rewards than expected. Yet here too, the incentive to use electricity efficiently is reduced as the surcharge drops. Overall however, there is more to justify this model than the others in terms of energy and innovation policy.

The study points to several unclarified legal and taxation issues related to implementation that apply to all the fund models and pertain to both the income (absorption approach, taxation system) and the expenditure (especially subsidies) sides. To explore the question of whether such a fund is permissible under state aid rules, the IASS commissioned two studies by the law firm Gaßner, Groth, Siederer & Colleagues. These studies suggest that the new EU state aid guidelines will not affect existing facilities, since the latter were promised finance prior to the introduction of the fund. However, were new installations to be (part-) financed by a state or state-administered fund – as in the case of the surcharge and payments cap models – this would probably amount to state aid. But this would be permissible, as long as the advantages it granted conformed with aid guidelines. In other words, the permissibility of this form of financing will be determined on the basis of the guidelines. The decision on the nature of refinancing (state or private) is, however, up to the individual member state (Gaßner & Siederer 2014; Gaßner et al. 2014).

As previously mentioned, in all fund models the incentive to use energy efficiently is reduced as a result of the falling (or constant) EEG surcharge prompted by the (partial) alternative financing. When it comes to striking a good balance between the incentive to save energy and alternative financing, the relationship between the efficiency of the promotion of renewables and the effect of energy saving on the share of renewables is critical (Ecke et al. 2014). Further analyses are necessary here. However, from an energy conservation perspective, the sudden drop in the EEG surcharge (and hence in the price of electricity) foreseen by the 'existing installations' and 'payments cap' models, which can only be 'made up for' over time, seems counterproductive.

3.3 The modified payments cap

As shown above, of all the models, the 'payments cap' (or 'payments split') model is the most consistent with the technology and innovation policy goals described in section 2. In order to eliminate any remaining weaknesses as far as possible, a modified version of this model is proposed here (figure 2).

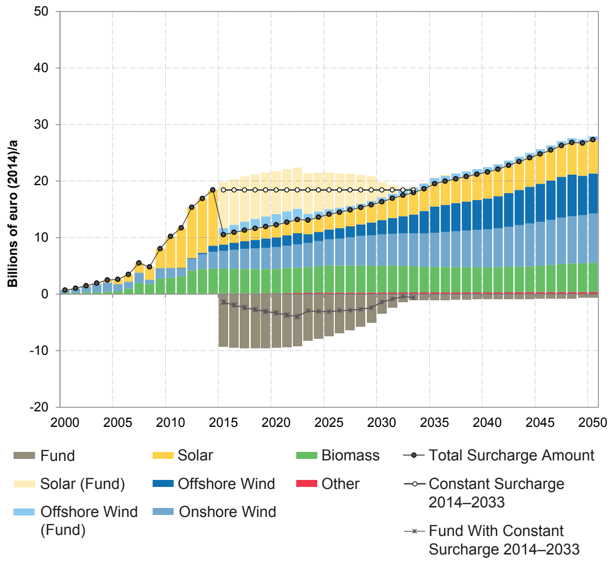
We recommend restricting the fund mainly to costs that arise from innovation (i.e. that portion of the EEG surcharge above 9 ct/kWh) in the case of PV and offshore wind energy. As demonstrated above, the long-term financing of biomass via a fund can hardly be justified from an innovation point of view, since no further reduction in technological costs are expected in this case – unlike offshore wind. Cost reductions may be expected in geothermics, but this area is of little consequence.

Like figure 1d, figure 2 represents the 'payments cap' model, but only for PV and offshore wind. Here again, the differential costs are represented above the timeline with a different colour for each technology. The darker colours represent that part of the total surcharge amount that will continue to be financed by the EEG surcharge (the black line indicates the total). Lighter colours (above the black line) represent the remainder that is expected to be financed by the fund, i.e. the share of PV and offshore wind energy that is above 9 ct/kWh. Once again, this is represented under the timeline. The abrupt drop in the surcharge after the introduction of the fund in 2015 is clear.

As mentioned previously, the steady rise of the EEG surcharge has continually been criticised. Indeed, all of the fund models presented here are motivated in part by the desire to defuse such criticism. Thus, there is a danger that acceptance problems will resurface in the case of all models where the surcharge drops suddenly before rising steadily again. The aforementioned negative effect of a sinking EEG surcharge on the incentive to save energy is another problem. In order to evade these problems, the option of not sinking the surcharge despite the introduction of the fund in 2015 should be considered. Instead, the surcharge could be kept constant (in real terms) until the total surcharge amount would necessitate a return to the former level (dotted horizontal line from 2015 to 2033 at the 2014 surcharge level in figure 2) and a further rise in 2034 became inevitable.

In this way, the problem of a rising EEG surcharge would be avoided for nearly two decades. Due to the finances that would be freed up (the difference between the constant EEG surcharge and the total surcharge amount), the fund could be correspondingly smaller, i.e. the area below the timeline up to the broken line. All conceivable permutations of a partial drop in the surcharge and part-financing of the fund are also possible.

FIGURE 2: IASS 'MODIFIED PAYMENTS CAP' FUND MODEL (SCENARIO 40 EURO/MWh)



Source: modified on the basis of (Matthes et al. 2014b, p. 51, figure 5-6)

4. Refinancing the fund

In what follows, the fund volumes and progressions that result from the aforementioned models and their corresponding financing requirements are briefly described. We examine various options for financing the fund, the effects of a 'stretched' capital market financing, the contributions generated by the 'golden end', as well as options within the EEG and electricity taxation systems.

4.1 The volumes, development and financing requirements of the funds

4.1.1. Fund volumes and the development of the various models

As described in section 3.2 and shown in figures 3 and 4 and table 2, the 'existing installations' and 'payments cap' models entail a sudden drop in the EEG surcharge as a result of their respective cuts. This means that the fund volumes peak at the start before falling gradually. Only in the case of the 'surcharge cap' model does the financing requirement increase (more or less) steadily due to the, by definition, constant surcharge. As indicated in section 3.1, the discussion of the EEG surcharge always refers to the core surcharge.

In the 'existing installations' model, the fund has a start volume of around 20 billion euro in 2015. After that, the annual finance requirement falls fairly steadily to zero by 2035, as each renewable generation site financed by the fund successively reaches the end of its surcharge period. On the introduction of the fund, the EEG surcharge drops suddenly to zero, before rising steadily until it has rejoined the path that would otherwise be followed without the fund from 2035 on, when the fund will have been phased out.

In the 'surcharge cap' model, the fund stabilises at 4 to 5 billion euro/year in the 2020s after an initial growth phase from 2015 to 2020. After that, however, it continues to grow almost continually, rising to nearly 17 billion euro by 2050 – the cut-off point for the projection.

As explained, it is difficult to predict the financing requirements of this model. But we can assume that the fund will remain in the same range after 2050. At the very least, the repayments will continue well into the second half of the century. By definition, the EEG surcharge remains nominally constant at 4.9 ct/kWh, which in real terms translates into a steady drop to 4 ct/kWh by 2030 and 3 ct/kWh by 2050.

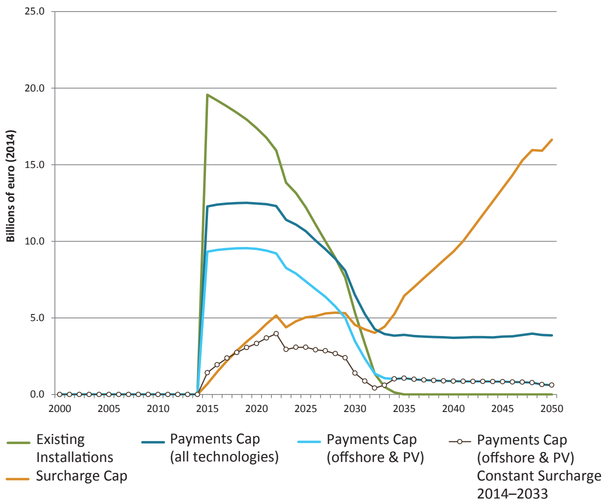
The version of the 'payments cap' (or 'payments split') model with all three technologies starts with a fund volume of around 12 billion euro/year, which then falls (relatively) steadily to under 4 billion euro/year in the period from 2022 to 2033 and remains more or less at that level until 2050. The stability of the fund after 2033 can be attributed mainly to the constant payments for biomass, which lie above the payments cap. The same applies to payments for offshore wind, albeit to a much lesser extent. On the introduction of the fund, the EEG surcharge drops suddenly by 2.8 ct/kWh, before rising steadily again. But it remains below the level of the surcharge without the fund, returning to its 2014 level in 2039.

In the recommended version of the 'payments cap' (or 'payments split') model with just PV and offshore wind energy, the removal of biomass (see also figure 2) results in a correspondingly smaller fund volume with a similar overall fund development.

So, after staying at a relatively constant level of 9 to 9.5 billion euro/year in the first years, the fund volume falls to a basic requirement of around 1 billion euro/year in the period from 2023 to 2033 and continues to fall gradually to around 0.6 billion euro/year by 2050. Were the total surcharge amount not allowed to fall in the period from 2015 to 2033, the required supplementary financing would instead only increase from 1.4 to 4 billion euro/year in the first eight years due to the additional funds. The financing requirement would subsequently fall to around 0.4 billion euro/year in the period from 2023 to 2032. The 'bonus' that would arise from not allowing the surcharge to fall would be 'exhausted' by 2034, when both the total surcharge amount and the fund would reach a level identical to the scenario where the surcharge falls. After falling by 2 ct/kWh on the introduction of the fund, the EEG surcharge also follows the same path as that foreseen by the model with all technologies, reaching its 2014 level in 2033. If, as recommended, the surcharge is not allowed to drop, it will, by definition, remain constant in the period from 2014 to 2033.

Thus in the case of the recommended Innovation Fund model for PV and offshore wind with a fund volume that decreases from slightly more than 9 to around 1 billion euro/year, most of the required financing would be due in the first two decades after the introduction of the fund. And when the surcharge is not allowed to drop, the financing requirement is more than halved for this period before it rejoins the path that would otherwise be followed without the fund from 2034 on.

FIGURE 3: DEVELOPMENT OF THE FUND MODELS



Source: IASS (based on Matthes et al. 2014b)

TABLE 2: ANNUAL DEVELOPMENT OF FUND VOLUMES (BILLIONS OF EURO/YEAR)

Fund model	2015–2022	2023–2033	2034–2050	Total (2015–2050)
Existing installations	Drops from 20 to 16	Drops to 0.5	0	231
Surcharge cap	Rises from 0.7 to 5	Between 4 and 5	Rises to 16	266
Payments cap (all technologies)	Between 12 and 11	Drops to 4	Almost 4	254
Payments cap … (PV & offshore)	Slightly more than 9	Drops to 1	Drops to 0.6	146
… with constant surcharge 2014–2033	Rises from 1 to 4	Drops to 0.4	Drops from 1 to 0.6	60

Source: IASS (based on Matthes et al. 2014b)

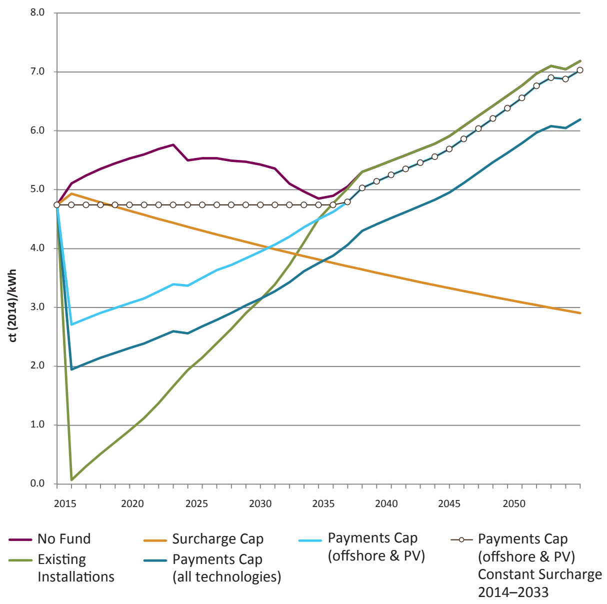
4.2.1 Contributions generated by the 'golden end' and further options within the EEG and electricity taxation systems

In the case of renewable energy sites with low operating costs (especially PV, but also wind energy), the 'golden end' refers to the time after the surcharge period, when installation operators will continue to make profits. Were some of these profits to be siphoned off and transferred to the EEG account, the additional financing requirement of the fund could be reduced accordingly. Based on several assumptions (medium scenario: 25-year lifetime, siphoning off 50% of the profits, etc.), the Oeko Institute study estimates – while underlining the uncertainties – that such profits will grow steadily from zero in 2015 to around 1 billion euro by 2035. After that, they will fluctuate between that level and 0.75 billion euro. Thus significant contributions to financing will only be generated from 2030 on. Other assumptions with regard to installation lifetime, electricity price, etc. will of course change the prognosis, but overall revenue development will remain the same (gradual rise followed by expansion in the 2030s). For example, extending installation lifetimes by five years (to 30 instead of 25 years) would mean that revenues would increase by a further 0.5 billion euro by 2035 and be 0.5 to 0.75 billion euro/year higher by 2050. In any case, the 'golden end' can only contribute to a certain extent to financing. And in the case of nearly all the fund models (with the exception of the 'surcharge cap' model), its contribution is practically negligible in the first two decades after the introduction of the fund, the period with the greatest financing requirement.

It appears that other options within the EEG and electricity taxation systems are unlikely to contribute significantly to financing the fund. While all redistributions or shifts within the EEG system – e.g. reducing or abolishing industrial exemptions or levies on own generation – lessen the burden on non-privileged electricity consumers, this does not require the construct of an Innovation Fund. Furthermore, the use of other relevant taxes, such as the electricity tax, would only mean a shift in the shares of electricity expenses. An alternative utilisation of existing electricity tax revenues would, however, lead to shortfalls in the current utilisation, which in turn would have to be covered by public finances (discussed in greater detail below).

To summarise, financing options within the EEG system only amount to redistributions, and the 'golden end' can only contribute to a certain extent to financing after 2030. Other sources of finance need to be found for the years prior to that, when (with the exception of the 'surcharge cap' model) the financing requirement is greatest.

FIGURE 4: EEG CORE SURCHARGE, ALL MODELS



Source: IASS (based on Matthes et al. 2014b)

4.2 Distribution and cost effects of different financing options

In the case of the recommended modified 'payments cap' (or 'payments split') model, the financing requirement sinks in the first two decades from slightly more than 9 billion euro/year to around 1 billion euro/year and continues to fall gradually from the 2030s on, before plateauing at 0.6 billion euro/year in 2050. When the surcharge is not allowed to drop, the financing requirement for the first two decades is more than halved. Having investigated the level of finance required over time, we now turn our attention to alternative financing options.

When it comes to refinancing the fund, fundamental political decisions are required in two areas, each of which has different implications for distribution (who's paying?) and efficiency or cost effects (how much has to be paid in total?). On the one hand, a decision must be made on whether the fund should be financed by payments within the EEG system or through public spending. On the other hand, the question of whether today's payments should be reduced and stretched over a longer period through borrowing – to implement a pay-as-you-use principle over time – needs to be resolved. The latter could be done either within the EEG system or in the context of public spending (state borrowing). Table 3 represents the different effects (keeping the fund within the EEG system with no credit financing would be equivalent to the status quo). Of course, hybrid models would also be conceivable.

4.2.1 Distribution effects of different options

If the fund were to be covered by public finances, the distribution of costs would be based on the respective tax burdens of individuals and companies rather than on (non-privileged) electricity consumption. In the case of reciprocal financing by means of tax increases, various options are conceivable, each of which would have different taxation and distribution effects – to be assessed in advance – and have different chances of gaining political backing, etc. (national, state or council tax? Who exactly would be burdened? What exceptions would exist within each kind of tax?). Reciprocal financing through cuts in another area of public finances would also entail further corresponding redistribution effects and raise the question of how this could be implemented politically.

In the case of financing through state borrowing (stretching of payments) the temporal distribution of payments also changes, i.e. there is a decrease in today's payments and part of the costs are transferred to future tax payers. Capital market financing is also possible within the EEG system. In terms of distribution, this would amount to a corresponding shift of costs within the existing EEG system, i.e. payment obligations would continue to be borne by (later, non-privileged) electricity consumption.

4.2.2 Efficiency and cost effects of different options

As already mentioned, the fund could be financed via the capital market in order to stretch the costs over a longer timeframe. This stretching of costs is possible either within the existing EEG system or in the context of a switch to tax financing (see above). However, depending on interest rates and duration, capital market financing would entail additional costs, which could also be different in the case of each option: EEG versus public spending. Generally speaking, the current low interest rates offer comparatively favourable conditions for capital market financing, but it is unclear how long this will last.

TABLE 3: DISTRIBUTION AND COST/EFFICIENCY EFFECTS OF DIFFERENT FINANCING OPTIONS

	Distribution effect	Cost/efficiency effect
Today's public spending: higher taxes or consolidation	In accordance with the resulting burden on people and companies **today**	
Future public spending/further borrowing: state stretching of payments	In accordance with the resulting burden on people and companies in **the future**	Additional credit costs in accordance with state borrowing conditions
Future EEG/credit financing: stretching of payments within the EEG system	Non-privileged **future** electricity consumption	Additional credit costs ▪ Possibly in accordance with state borrowing conditions (e.g. KfW guarantee) ▪ Otherwise possibly higher
EEG today	Status quo	Status quo

Source: IASS

The favourable credit terms for state bonds could be availed of in the context of state borrowing to stretch the payments. However, here too, the longer the duration of that stretching, the more credit costs will grow. The Oeko Institute study suggests that in the case of bond durations of ten years, the real financing costs would be zero at best. By contrast, they would rise to an estimated 10 to 35% of the credit amount over a 20-year financing period and to 65 to 100% of the credit amount over a 30-year financing period. Since further state borrowing may fall under the scope of the debt brake enshrined in the German constitution *(Grundgesetz)*, it would be necessary to check whether the introduction of a special state fund would be an option. Several examples of this kind of fund can be found in the history of the Federal Republic of Germany (Burden-sharing Fund, German Unity Fund, residential construction debts as part of the Redemption Fund for Inherited Liabilities, etc.).

If capital market financing is undertaken within the EEG system (i.e. paid off via the surcharge), the credit conditions must be examined. This means that the question of whether a fund within the highly regulated EEG system qualifies for the same favourable credit conditions as state bonds needs to be investigated (see section 5). Alternatively, processing via a state institution (e.g. the KfW) might be conceivable in order to guarantee such conditions. Otherwise the costs would be correspondingly higher.

The Oeko Institute study claims that a financing of the fund from the current state budget is 'inconceivable', but it assumes fund volumes of 10 to 15 billion euro/year (and up to 20 billion euro in some years) based on an average derived from all the fund models and taking account of biomass. At the same time, the study acknowledges that examples of special funds of a similar volume can be found in the history of the Federal Republic. However, in this particular case greater public financing – as described in section 2 – would certainly be justified. Furthermore, important analogies can be made with other future infrastructural challenges, including those relevant to the Energiewende. Thus in this broader context, the option of greater public financing – using general public finances or a special fund – and the involvement of new institutional investors should be considered.

Once a decision has been taken on a specific kind of financing, options for implementing it in a way that would minimise costs must be examined. Thus, in the case of public financing the question of whether there is in fact a need for a 'real' fund would have to be clarified. Alternatively, a separate disclosure of the share represented by the fund in the total EEG surcharge amount and a corresponding subsidy from the state (similar to that provided to the pension fund) could suffice and lower transaction costs accordingly.

There aren’t enough transmission networks. In future, institutional investors such as life insurance companies and pension funds could play a bigger role in the financing of all kinds of infrastructure.

5. The bigger picture: alternative infrastructure financing

5.1 Financing future tasks: do we need to get institutional investors on board?

As shown in section 2, in addition to the Energiewende and the infrastructures associated with that there are other areas where the need for investment with long-term financing is great. There are certainly good grounds for public financing here, but this is controversial in the current political context. And the current low interest rates do offer favourable terms for capital market financing (even when it's not clear how long this situation will last and even when financing costs increase significantly over time – see section 4.2.2). At the same time institutional investors – e.g. life insurance companies and pension funds – have significant funds at their disposal. For example, in 2013 the investment portfolio of German life insurance companies amounted to around 796 billion euro (GDV 2014). For institutional investors, investment in infrastructure is an attractive option that is drawing more attention in the aftermath of the financial crisis. For example, infrastructure projects have a more favourable risk-yield ratio than state bonds (Fritzsche 2014). Given their long lifetimes, they are also a particularly good fit to the planning horizons of institutional investors (IEA 2014, pp. 12–13). In the context of Germany's aging society, where life insurance policies are a popular form of private pension, new profit opportunities are urgently needed in the light of the aforementioned low interest rates (Jahberg 2014b; Zimmerer 2014). Thus new investment options would help to ease the payment difficulties of German life insurance companies, which are the flip side of the current low interest rates (Die Zeit 2014; Jahberg 2014a; Krohn 2014). Moreover, the sustainability aspect of financial investments is increasingly important to institutional investors (CERES 2014; Ellsworth & Snow Spalding 2013). Thus, when the KfW issued a bond to finance its renewable energy credit programme (so-called green bonds) with a total issue volume of 1.5 billion euro in July 2014, it was oversubscribed with orders amounting to 2.65 billion euro – above all from institutional investors – in no time at all (KFW 2014a, b).

So greater involvement of institutional investors in the financing of infrastructures relevant to the Energiewende and other areas may be advisable for sociopolitical and macroeconomic reasons. While Beckers et al. (2014) currently see no major shortages in the financing of infrastructure relevant to the Energiewende, their assessment is based solely on the investment requirements of the four transmission network operators (i.e. only for high-voltage networks) over the next ten years. And there too, greater involvement of institutional investors is seen as advantageous and potentially cost-cutting (Beckers et al. 2014, pp. 187–188, p. 275). Even though existing EU insurance regulations do not permit a "specifically German" regulation (Beckers et al. 2014, p. 198) – greater involvement of institutional investors would ultimately mean that a larger share of the returns generated would remain in the country. In this way, the principle "pension funds finance infrastructure – returns on infrastructure finance pensions" (Zimmerer 2014) has the potential to strengthen the general public's identification with and acceptance of the intergenerational and future-oriented Energiewende project.

5.2 Do regulatory barriers need to be removed?

As we have seen, the potential for involving institutional investors in the financing of infrastructure (for the Energiewende and other projects) is significant. However, regulatory barriers are blamed for the fact that the uptake hasn't been greater here.

At present, strict capital requirements mean that life insurance companies and pension funds hardly ever make 'normal' investments (e.g. in stocks) but focus rather on investing in state bonds and similar papers (with an AAA credit rating). The same strict capital requirements also apply to investments in infrastructure, although their risk level is often just as low as that of state bonds. The aforementioned bond issued by the state-owned KfW has the same credit rating as a state bond, which explains its oversubscription.

For that reason, the creation of a specific class of investment for infrastructures with correspondingly low capital requirements in the context of the European insurance supervisory law that will come into force in 2016 (the 'Solvency II regulation') is being considered, which would reflect the lower default probability of such investments. A number of different approaches could be taken to classifying this investment category: from investments subject only to the German incentive-based regulation ('incentive regulation approach') to the identification of particularly low-risk investments based on certain criteria ('criteria-based approach') or the inclusion of all infrastructures ('broad approach') (Beckers et al. 2014, section 5.2.1.3). And the criteria-based approach proposed by the German Insurance Association (GDV) (GDV 2013) seems to be a conceivable compromise. While the incentive regulation approach would create a specific category for German projects and companies within the European regulation, the broad approach would also include publicly traded companies that are engaged in infrastructure projects and whose risk profile is no different (i.e. lower) than 'normal' investments. In the case of the criteria-based approach, it is crucial that the criteria are clearly defined. Beckers et al. (2014) believe, however, that some criteria are essential (no risk of competition, contractual relationships with a public institute or an institute subject to government regulation, low price elasticity of demand), while they are undecided about others (realisation and operational risk, contractual risk). Overall, this catalogue of criteria is very similar to that of the GDV (so that it is likely that incentive regulation projects would also be included). In line with the criticism of the broad approach, the GDV proposal is limited to non-listed projects. Given their secure and predictable payment flows and their lack of correlation with listed infrastructure projects or global stocks, these are considered low-risk (bond-like character). In order to address realisation, operational and technology risks, an alternative staggered financing is conceivable, where operators sell shares to institutional investors when the risks are reduced accordingly (ECF 2011, pp. 9–10).

Critics argue that insurance regulations should stick to their main function instead of deliberately creating incentives for the financing of infrastructure. This position reflects the Tinbergen rule, according to which a specific independent instrument is required for each objective (Tinbergen 1952, 1956). Yet it does make sense not just to exploit existing synergies but also to create and expand such synergies, even if the danger of interdependencies and conflicts of interest (Beckers et al. 2014, pp. 197–200) should indeed be taken seriously.

6. Summary and conclusions

There are many good reasons for a more broad-based financing of the Energiewende, not least the demands implicit in innovation and technology policy. Above all the fact that the reorientation of the entire German energy supply system is a strategic project involving the whole of society, a collaborative endeavour, makes it worthy of public financing, even stretched over the longer term. Instead, the cost of developing technologies and expanding capacity for renewable energies – a significant part of the Energiewende – has been financed through the EEG system by the current payments of non-privileged electricity consumers (see section 2). We therefore recommend that the costs of technological development are taken out of the EEG system and financed via a complementary 'Innovation Fund'.

Based on a study by the Oeko Institute that made calculations for different fund models, we recommend a modified version of one of the models, which would take the (past and future) costs of technological development for photovoltaic and offshore wind (defined as that portion of the EEG surcharge above 9 ct/kWh) out of the EEG system and transfer them to an Innovation Fund (see section 3). Were the fund to be introduced in 2015, there would be an additional annual requirement of slightly more than 9 billion euro/year in the first eight years (see section 4.1). After that, the annual volume of the fund would shrink over a period of ten years to the relatively constant requirement of around 1 billion euro/year; it would then continue to fall gradually before plateauing at around 0.6 billion euro/year by 2050. The (core) EEG surcharge would fall suddenly by 2 ct/kWh on the introduction of the fund. After that, it would begin to rise steadily – but at a slower pace than without the fund – until 2050, returning to its 2014 level by 2033. In order to avoid politically controversial increases in the EEG surcharge for almost two decades (until such time as the surcharge exceeds its previous level regardless of the fund), it is still proposed not to let the surcharge fall, but to keep it at a constant level until 2033 – despite the introduction of the fund. In this way, the negative effect of sinking prices on the incentive to use electricity efficiently would also be avoided. As a result, the additional financing requirement for the first 20 years would drop to less than half. The fund would rise gradually from around 1.4 to 4 billion euro/year over the first eight years, before sinking to around 0.4 billion euro in the period from 2023 to 2032. The 'bonus' that would arise from not allowing the surcharge to sink would be 'exhausted' by 2034 and the annual financing requirement would reach a level identical to the scenario without a constant surcharge. The 'golden end' (recovery of profits made by renewable generation sites after the end of the surcharge period) will only begin to generate significant amounts from 2030 on – an average of 0.75 billion euro/year – and could thus mainly be used to cover the annual financing requirements of the later period. All other options either do not require the construct of a fund (diminishing EEG exemptions) or lead simply to shifts within the price of electricity (electricity tax).

For the refinancing of the fund, political decisions are required in two areas: (i) whether the fund should be taken out of the EEG system and financed through public spending and (ii) whether today's payments should be reduced and stretched over a longer period through borrowing (either within the EEG system or as state borrowing) (see section 4.2). Each combination implies different distribution (who pays?) and efficiency/cost effects (how much has to be paid in total?), while keeping the fund within the EEG system with no credit financing would be equivalent to the status quo. Public financing would be in line with the aforementioned broader societal financing of the collaborative Energiewende project. In terms of distribution, that would mean a reallocation of financing from non-privileged electricity consumption to the taxable entity. When it comes to reciprocal financing from the current public budget, various tax increases and/or spending cuts are conceivable, each of which would have different distribution effects. As a further distribution effect, the further state borrowing option would entail a partial transfer of payment obligations to tomorrow's taxpayers. With regard to efficiency/cost effects, capital market financing would mean additional credit costs. In general, the current low interest rates offer good conditions for this, and the favourable credit terms for state bonds could be availed of in the context of state borrowing. Credit financing within the EEG system would, on the other hand, only amount to a partial temporal shift of financing by the non-privileged electricity consumption. This would also entail credit costs, which could possibly be higher than those incurred in the context of state borrowing if, for example, the option of a KfW fund cannot be used.

Despite the arguments in favour of a publicly financed Innovation Fund, public financing is increasingly controversial, and some recent political developments (the 'debt brake', 'breaking even', direct user financing in the form of road tolls) seem to point in an entirely different direction. At the same time, the flip side of low interest rates is that life insurance companies, for example, are increasingly hard-pressed to meet their interest payment commitments. In this context greater involvement of institutional investors in the financing of infrastructure can make sense. These investments are attractive for life insurance companies, which could provide their (considerable) funds on terms that are – for infrastructure projects – relatively favourable. However, before this can happen, the regulatory barriers that make it difficult for life insurance companies to invest in anything other than state bonds must be removed. An Energiewende that is funded via capital markets (rather than via the EEG) could set an example for the financing of other infrastructure projects. Linking pension funds to infrastructure in accordance with the principle of pension funds financing infrastructure projects and the return on those projects flowing back into pension funds would ultimately mean that a larger share of the returns generated would remain in the country. Hence, such a link has the potential to strengthen the general public's identification with and acceptance of the intergenerational and future-oriented Energiewende project.

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