POLICY STABILITY AND RENEWABLE ELECTRICITY DEPLOYMENT: ROMANIA IN COMPARATIVE PERSPECTIVE, 2010–2025

Mădălina Ana Burduja
Dorel Mihai Paraschiv[*]

Abstract

Romania raised the renewable share of its electricity consumption by eleven percentage points between 2010 and 2014, then by one over the next seven years. This paper examines that interruption, comparing Romania with Poland, Germany and Spain, selected for their differing support instruments and policy disruptions, and with all twenty-seven European Union member states from 2010 to 2025. Stagnation periods are identified by a consistent rule and compared with the timing of support scheme revisions. Every case with a coded intervention date records prolonged stagnation beginning at or soon after intervention. Germany, which repeatedly revised its framework only for future installations, records the shortest interruption. Because stagnation is common, this association is suggestive rather than diagnostic. The Romanian case is reconstructed from legislation and exchange records, including a 2012–2020 price and volume series for green certificates compiled from the exchange's annual reports. Certificates owed to operating producers were withheld from trading between 2013 and 2020 and are being released between 2021 and 2030. None was cancelled, yet a substantial share of their value was lost. What appears to distinguish these trajectories is not how often governments revise support schemes, but whether revisions reach investors who have already committed capital.

Keywords: renewable energy policy, green certificates, policy credibility, retroactive regulation, Romania, European Union

JEL Classification: Q42, Q48, K23, O52.

1. Introduction

Between 2010 and 2014, Romania raised the renewable share of its electricity consumption by eleven percentage points. Over the next seven years it added one. This paper asks what happened in between.

The mechanism examined here is the credibility of policy commitments rather than their generosity. In 2013 Romania withheld from trading part of the certificates owed to producers already operating, promising release by 2020.

[*] Mădălina Ana Burduja is a PhD candidate at the Doctoral School of International Economic Relations, Bucharest University of Economic Studies, Bucharest, corresponding author. E-mail address: madalina@burduja.ro. Dorel Mihai Paraschiv is Professor of Economics and Prorector at the Bucharest University of Economic Studies, Bucharest. E-mail address: dorel.paraschiv@ase.ro

An earlier version of this study was presented at the BASIQ International Conference on New Trends in Sustainable Business and Consumption, Porto, 25-27 June 2026. The present paper extends that work substantially in indicator, period of observation, country sample and analysis.

Release for solar in fact began in 2021 and runs to 2030. No certificate was cancelled, yet about a fifth of the value of the support earned in those years disappeared.

Section 2 reviews the literature, Section 3 the data and method. Section 4 compares Romania with Poland, Germany and Spain, then with all member states, Section 5 examines the Romanian record, and Sections 6 and 7 discuss and conclude. The argument is that what matters is not how often schemes were revised, but whether revisions reached investors who had already committed.

2. Policy stability and renewable investment

2.1 Support instruments and investment outcomes

Renewable electricity in liberalised European markets is financed largely by private firms, whose investment decisions turn on expected profitability (Eyraud et al., 2011). Support schemes exist to close the gap between that expectation and the returns available from wholesale markets alone.

Three instruments predominate. Feed-in tariffs guarantee a fixed price over a project's life; feed-in premiums pay a supplement above the market price, leaving the producer exposed to it; quota obligations with tradable green certificates oblige suppliers to source a share of their electricity from renewable sources, with certificate prices set by supply and demand (Mitchell, Bauknecht and Connor, 2006). Comparative assessments generally find guaranteed-price instruments associated with higher deployment, and attribute the difference to lower revenue risk rather than greater generosity (Mitchell, Bauknecht and Connor, 2006; García-Álvarez, Cabeza-García and Soares, 2017; 2018). Boomsma, Meade and Fleten (2012) reach a compatible conclusion from a real options perspective, finding that the support scheme in force shapes both the timing and the scale of investment. What matters, on this reading, is not the level of support but its variance.

2.2 Policy uncertainty and the credibility of commitments

A second line of enquiry concerns not the design of a support scheme but the durability of the commitment behind it. Its foundation is the problem of time inconsistency identified by Kydland and Prescott (1977): a government that cannot bind its future self will find that rational agents anticipate its later incentives, so that policies optimal at announcement are not credible at the moment of investment.

The problem is acute where investment is irreversible and the asset cannot be moved. Blackman and Zeckhauser (1992) show that a utility becomes vulnerable to appropriation by the regulator once capital is committed. Laffont and Tirole (1996) demonstrate the parallel for environmental innovation: a government with discretion over pollution permits has an ex post incentive to devalue the technology it wished to encourage, and innovators anticipating this will not invest. Helm, Hepburn and Mash (2003) generalise the argument to

climate policy, concluding that the credibility of a commitment is a condition of its effectiveness.

Empirical work supports these propositions. In a choice experiment with European photovoltaic developers, Lüthi and Wüstenhagen (2012) find policy risk among the most important determinants of investment, with the number of policy changes ranking alongside the level of the tariff; Chassot, Hampl and Wüstenhagen (2014) report that high perceived regulatory risk reduces the probability of investment. Karneyeva and Wüstenhagen (2017) observe that the fall in photovoltaic module costs after 2009 did not produce a corresponding rise in European investment, because cost reductions were offset by increased exposure to policy and revenue risk.

The real options literature formalises the response. Boomsma and Linnerud (2015) distinguish anticipated reductions applying to new projects, which accelerate investment, from reductions with retroactive effect, which delay it; Ritzenhofen and Spinler (2016) find investment deferred or withdrawn when a regulatory shift exposing producers to price uncertainty is expected; Dalby et al. (2018) show that the investment threshold rises as the expected time to an adverse revision falls.

2.3 Retroactive intervention

The most direct empirical treatment of retroactive intervention is that of Sendstad et al. (2022), who construct a panel of European countries for 2000 to 2017 and estimate the effect of retroactive policy changes on subsequent investment using a difference-in-differences design. They find that a retroactive subsidy change reduces the investment rate by approximately 45 per cent for photovoltaics and 16 per cent for onshore wind, and conclude that once investor trust has been damaged the effect is durable. Their treated cases — Italy, Spain, Greece, Bulgaria, the Czech Republic and Portugal — fall between 2010 and 2012, and their analysis covers feed-in tariffs and feed-in premiums, the instruments then most widely used in Europe.

Three features of that study define the space this paper occupies. Its treated cases cluster in the period of the European debt crisis, so interventions occurring later fall outside its window. Its scope is confined to administered-tariff instruments, which means quota-and-certificate schemes, and the countries that relied on them, are not examined. And its treatment variable takes the value one from the year of intervention onward, a specification appropriate to estimating an average effect but one in which the persistence of that effect is assumed rather than measured.

Romania falls outside that scope on two counts at once. Its intervention occurred in 2013 and 2014, after the treated window, and it operated on a quota-and-certificate scheme rather than a tariff. The deferral described in Section 5 nonetheless affected installations already in operation, and Romanian deployment subsequently stalled for seven years.

The case has accordingly received little attention. Work on the Romanian scheme is limited and largely descriptive. Zamfir, Colesca and Corbos (2016) review a decade of Romanian renewable energy policy, noting that the national target of a 24 per cent renewable share by 2020 was more ambitious than the European average and had been reached by early 2014, and setting out the tradable green certificate system together with the successive changes made to it. Their review identifies the possible effects of those changes as a matter for subsequent research rather than settling it, and quantitative assessments remain scarce. Sector-specific reviews cover the development of Romanian photovoltaic and hydroelectric capacity (Năstase et al., 2018; Năstase et al., 2017), while Buzogány and Davidescu (2022) situate the country's energy governance in its wider institutional context.

This paper addresses that omission. In doing so it takes up two of the extensions that Sendstad et al. themselves propose: widening the range of countries examined and lengthening the period observed.

3. Data and method

3.1 Data

Deployment is measured using Eurostat's dataset on the share of energy from renewable sources (nrg_ind_ren), taking the electricity balance (REN_ELC) for all twenty-seven member states, annual, 2010 to 2025, extracted on 20 September 2026. The reason for using the electricity rather than the aggregate series is set out in Section 4.1. Figures for 2025 are provisional at the time of writing and are identified as such wherever they appear.

Evidence on the Romanian support scheme is drawn from primary sources. The design of the scheme, the number of certificates awarded by technology and accreditation year, and the successive amendments are taken from the legislation itself and from the Ministry of Energy's published account of the scheme. Operational detail on the deferral and its reversal is taken from the procedure issued by the transmission system operator, Transelectrica. Certificate prices and traded volumes are taken from the annual reports of the OPCOM exchange for the years 2012 to 2020, which publish weighted average prices, transaction values and volumes for each market segment. The series in Table 4 is compiled from the nine annual reports covering 2012 to 2020 and is reproduced in full there.

Three cautions attach to the OPCOM figures. First, the reports present some series on a calendar-year basis and others for a March-to-February trading period, and the two give materially different values for the same year; the figures used here are calendar-year unless otherwise stated. Second, the architecture of the certificate market changed during the period. The centralised market (PCCV) and the bilateral contracts market (PCBCV) operated until 31 August 2017 and were replaced from 1 September 2017 by an anonymous spot

market (PCSCV) and an anonymous forward market (PCTCV), with a further segment for renewable electricity sold together with certificates (PC-ESRE-CV) added in 2019. The series reported below follows the spot segment throughout, which is the continuous price reference, and the discontinuity in 2017 is marked. Third, prices are converted to euro using the exchange rate prescribed by Law 220/2008 — the average rate published by the National Bank of Romania for the final month of the preceding year — which is the rate the scheme itself applied rather than a contemporaneous market rate.

3.2 Case selection

Four member states are examined in detail before the analysis is extended to the Union as a whole. They were selected to vary along the two dimensions that bear on the argument: the class of support instrument in use, and the character of the disruption to producer revenues that each experienced.

Romania and Poland operated quota obligations with tradable green certificates, in which the producer's revenue depends on a market price. Germany and Spain operated administered-price instruments, in which it does not. Within each pair, one country experienced a disruption reaching installations already in operation and one did not. Romania deferred certificates owed to accredited producers. Poland's certificate revenues fell through market oversupply rather than legislative action. Spain reduced remuneration for existing installations. Germany revised its framework repeatedly but confined changes to installations not yet commissioned.

The four therefore span both instrument classes in widespread European use and the principal ways in which producer revenues can be impaired: by legislative act, by market failure, and not at all. They also span the range of starting positions, from Romania at 30.4 per cent of gross electricity consumption in 2010 to Poland at 6.5 per cent, and each is among the larger electricity markets in the Union.

Cases selected in this way are not a random sample, and a comparison of four countries chosen partly for the disruptions they experienced cannot establish how common those disruptions are or whether they are necessary for the outcome observed. Section 4.2 extends the analysis to all twenty-seven member states for that reason.

3.3 Identifying periods of stagnation

Section 4 refers to periods during which renewable electricity deployment stalled. To avoid identifying these by inspection, a single rule is applied uniformly to every member state: a period of stagnation is the longest run of consecutive years during which a country's renewable electricity share never rises more than two percentage points above its level in the first year of the run.

The threshold is a judgement rather than a derived quantity. Two percentage points over several years is small relative to the movement observed in countries deploying steadily. The ordering of countries by the length of their

stagnation periods is not greatly sensitive to modest changes in the threshold, though the number of countries meeting it is, as Section 4.2 reports. A stagnation period is treated as following an intervention where it begins in the year of the intervention or within three years of it. The rule is arbitrary in the sense that any such threshold is, and results should be read accordingly. Its purpose is consistency across cases rather than precision within them.

3.4 Valuing deferred certificates

Section 5.3 reports the present value of certificates withheld from trading under the deferral provisions. The certificates valued are those withheld from producers accredited by ANRE up to 31 December 2013: one certificate per megawatt-hour for onshore wind and for new small hydro below 10 MW, withheld between July 2013 and December 2017, and two certificates per megawatt-hour for solar, withheld between July 2013 and December 2020 under the successive provisions of Emergency Ordinance 57/2013 and Emergency Ordinance 24/2017 as amended by Law 184/2018. Wind and small hydro certificates are released in equal monthly instalments between January 2018 and December 2025; solar certificates between January 2021 and December 2030.

The counterfactual is sale at the moment of issue, which is what the twelve-month validity rule then in force required. For a certificate withheld in month t, the deferral replaces a single receipt at t with an equal share of each of the N monthly instalments paid across the release window. Its present value relative to immediate sale is therefore the mean of $(1 + i)^{-(s_k - t)}$ over the N release months s_k, at a constant real discount rate i. Because certificates accrue continuously with generation, this is computed for every month of the deferral window and averaged, weighting each month equally. Uniform weighting is a simplification, though a defensible one for this population: the capacity concerned was almost entirely commissioned before the end of 2013 and its output does not trend materially across the period.

Three assumptions are involved and none is estimated. The discount rate is imposed rather than measured, and results are reported at 6, 9 and 12 per cent so that the sensitivity of the conclusion to that choice is visible. The calculation assumes that certificates are released in full, on the legislated schedule, and at unchanged real value — the assumptions most favourable to the position that no support was withdrawn. And the loss is expressed as a share of the value of all certificates earned during the deferral period, not of lifetime support under the scheme: the deferral affected four and a half years of a wind producer's entitlement and seven and a half of a solar producer's, against a support period running to 2031.

The figures should therefore be read as an illustration of magnitude, not as an estimate of the returns realised by any Romanian producer. Their purpose is to establish that a measure which reduced no producer's entitlement nonetheless removed a substantial share of its value.

4. Renewable electricity deployment in comparative perspective, 2010–2025

4.1 Four countries

Comparisons of renewable energy performance commonly rely on the share of renewables in gross final energy consumption. That indicator aggregates electricity, heating and transport, and for the question addressed here it is the wrong one. Support schemes of the kind described in Section 5 operate on electricity. Romania's green certificates, Poland's certificate obligation, Germany's feed-in framework and Spain's tariff regime all rewarded electricity generation and none of them addressed household heating or transport fuel. The appropriate measure is therefore the renewable share of gross electricity consumption, reported by Eurostat as RES-E.

The distinction is not merely technical, and Romania illustrates why. Measured across all energy uses, Romania records one of the higher shares in the European Union: 23.9 per cent in 2018, rising to 25.4 per cent in 2024. On that basis the country appears to outperform Germany, which stood at 16.7 per cent in 2018, and Spain, at 17.0 per cent. Yet neither Romania's hydroelectric capacity, the bulk of which predates the period under examination (Năstase et al., 2017), nor the biomass burned for heating in rural households, is a product of the policies considered here. The aggregate indicator flatters Romania twice over, for two reasons that have nothing to do with policy.

Table 1 reports RES-E for the four countries at three-year intervals.

Table no.1 Renewable share of gross electricity consumption (%), selected years

Country	2010	2013	2016	2019	2022	2025
Romania	30.4	37.5	42.7	42.6	43.7	49.9
Spain	29.7	36.0	36.7	37.1	50.9	60.7
Germany	18.2	25.3	32.3	40.6	48.0	57.9
Poland	6.5	10.7	13.3	14.4	21.0	32.5

Source: Eurostat, nrg_ind_ren. Figures for 2025 are provisional.

In 2010 Romania led this group. Its share of renewable electricity exceeded Spain's and was more than ten percentage points above Germany's. By 2025 it ranks third, overtaken by both. The reason is visible in the full annual series rather than in the endpoints: between 2010 and 2014 Romania added 11.3 percentage points, then added one further point over the seven years to 2021, before resuming growth.

Spain and Poland display the same shape at different times. Spain rose to 36.0 per cent by 2013 and then declined, reaching 35.2 per cent in 2018 before accelerating to the highest share in the group. Poland reached 13.4 per cent in 2015 and remained within half a point of that level until 2019, after which it more than doubled in six years.

Germany is the exception. Its series rises continuously across the whole period, from 18.2 to 57.9 per cent, without an interruption of more than two years. This is not because Germany left its support framework alone. The German system was revised repeatedly over the period, including the 2012 photovoltaic amendment and the successive reforms of the renewable energy act in 2014 and 2017. What distinguishes it is that revisions applied to future installations, with plants already commissioned remaining on the terms in force at the time of commissioning. Germany changed the rules more often than Romania did. It did not change them for investors who had already committed.

The comparison therefore suggests a distinction that the frequency of legislative amendment would obscure: what appears to matter is not how often a support framework is revised, but whether revisions reach installations that have already been built.

4.2 Evidence from the EU-27

Four countries cannot establish a general pattern. To test whether the association holds more widely, the rule set out in Section 3.3 was applied to all twenty-seven member states across the same period.

Of the member states identified in the literature as having intervened retroactively, every one whose intervention can be dated to a specific instrument records a stagnation period of at least four years beginning in the year of the intervention or within three years of it. Table 2 sets out the comparison. Portugal, also identified in that literature, is omitted because its intervention could not be attributed to a single measure; its longest stagnation period, 2015 to 2019, is reported in Appendix Table A1. The set of treated states follows Sendstad et al. (2022), with Romania added and with Poland included separately: its certificate revenues collapsed through market oversupply rather than legislative action, so no intervention date is coded, but the stagnation it records is of the same order. Germany, which made no such intervention, records the shortest stagnation period of any member state, at two years.

Table no.2 Stagnation periods and coded interventions, treated member states

Country	Intervention	Stagnation period	Duration	Lag (years)
Spain	2013	2013–2019	7	0
Italy	2014	2014–2019	6	0
Bulgaria	2012	2013–2017	5	+1
Greece	2012	2013–2016	4	+1
Romania	2013	2014–2021	8	+1
Czechia	2011	2014–2022	9	+3
Poland	market-driven	2014–2019	6	—

Source: stagnation periods are authors' calculations from Eurostat, nrg_ind_ren, applying the rule set out in Section 3.3. The set of states treated as having intervened retroactively follows Sendstad et al. (2022), with Romania added and Portugal omitted because its intervention could not be dated to a single instrument. Intervention dates refer to the principal measure in each case: for Greece, Law 4093/2012, Article I, Paragraph I.2 (Government Gazette A 222/12.11.2012); for Romania, Emergency Ordinance 57/2013. Poland's certificate revenues fell through market oversupply rather than legislative action and no intervention date is coded.

Where a member state intervened more than once, the date given is that of the principal measure affecting installations already operating. For Spain this is the 2013 reform rather than the tariff reductions of 2010, and for Italy the 2014 restructuring rather than the earlier levy; Sendstad et al. (2022) code the earlier measures in both cases. The stagnation periods reported here begin within three years of either date.

The second finding qualifies the first substantially. Stagnation is common. At the two-percentage-point threshold, twenty-three of the twenty-seven member states record a period of at least four years, including several — Slovenia, Hungary, Latvia and the Netherlands among them — with no documented retroactive episode. Appendix Table A1 reports the full results. Renewable deployment stalls for many reasons: recession, constraints on grid connection, shifts in electricity demand, planning restrictions, or a support scheme reaching the limit of its budget.

That count is sensitive to the threshold chosen. At one percentage point fifteen states record a period of four years or more; at three percentage points, twenty-five do. The ranking of countries is more stable than the count, and Germany records the shortest period at all three thresholds.

The implication for interpretation is precise, and it runs in one direction only. The evidence is consistent with the proposition that retroactive intervention is followed by prolonged stagnation. It does not support the converse — that stagnation indicates retroactive intervention — and the data presented here contradict that reading directly.

This limits what the analysis can claim. It does not establish that retroactive intervention caused the stagnation observed in Romania, and a descriptive comparison of this kind cannot do so. Both the timing and the sign of the association are nonetheless consistent across every case with a coded intervention date, and the country with the most sustained record of prospective-only revision shows the least interruption. Section 5 examines the Romanian case in detail, where the legislative record permits a closer account of what was altered, for whom, and when.

5. The Romanian green certificate scheme

5.1 Design and operation

Romania's support scheme for renewable electricity was established by Law 220/2008 and approved under State aid rules in July 2011 (European Commission, 2011). Rather than paying producers a guaranteed price, the scheme combined a mandatory quota with a tradable instrument. Producers received green certificates for each megawatt-hour generated and delivered to the grid. Electricity suppliers were obliged by law to buy a set number of certificates each year, and recovered the cost through consumer tariffs. Certificates were issued free of charge by the transmission system operator, Transelectrica, and traded on the OPCOM exchange.

Two features of the instrument matter for what follows. The number of certificates awarded per megawatt-hour varied by technology and by the year in which a plant was accredited, so the level of support was set at the point of accreditation and was expected to hold for the life of the installation. And certificates carried a validity of twelve months: any certificate still held by a producer when that period expired was annulled. The instrument was designed to be sold quickly.

Prices were bounded. As originally enacted, the law set a floor of €27 and a ceiling of €55 per certificate, each indexed annually to the previous year's average eurozone inflation rate as published by Eurostat. Within that band, the price was determined by supply and demand on the exchange. By 2016 indexation had raised the band to approximately €29.40 and €59.90, or 132.40 and 269.72 lei. Suppliers failing to meet their quota paid a penalty set at twice the ceiling — 539 lei per certificate in 2016 — so that non-compliance could never be cheaper than purchase.

The band was subsequently replaced. Article XIII of Emergency Ordinance 24/2017 provides that, from the ordinance's entry into force until 31 March 2032, certificates may be traded only between a minimum of €29.4 and a maximum of €35. The new bounds are fixed in euro and are not indexed. Three consequences follow. The ceiling was reduced from an indexed €55, worth approximately €60 at the time, to a flat €35 — a reduction of some 40 per cent in the highest price any producer could realise. The floor was frozen at €29.40, the level indexation had reached in 2016. And because neither bound is indexed, both erode in real terms across the fifteen years to 2032. The penalty for unmet quota obligations was set at €70, again twice the ceiling. The same ordinance extended the period during which certificates may be traded to 31 March 2032 irrespective of the expiry of a plant's accreditation, removing for certificates held thereafter the requirement to sell within twelve months.

Support was generous by European standards, particularly for solar. Table 3 shows the number of certificates awarded per megawatt-hour by technology and accreditation year.

Table no.3 Green certificates awarded per MWh, by technology and accreditation year

Technology	2011	2012	2013	2014	2015	2016
Wind	2	2	2	1.5	1.5	1.5
New small hydro <10 MW	3	3	3	2.3	2.3	2.3
Retechnologised small hydro <10 MW	2	2	2	2.3	2.3	2.3
Biomass	2	2	2	2	2	2
Solar	6	6	6	3	3	3

Source: Ministry of Energy, Schema de sprijin prin certificate verzi.

A solar plant accredited in 2012 therefore earned six certificates for every megawatt-hour. At a certificate price in the middle of the permitted band, this represented support several times the prevailing wholesale electricity price. The scheme worked as intended: renewable electricity rose from 30.4 per cent of gross electricity consumption in 2010 to 41.7 per cent in 2014, an increase of more than eleven percentage points in four years.

Where the price actually settled within that band is the central fact about how this scheme functioned.

Table 4 reports the weighted average price and traded volume on the spot segment of the certificate market.

Table no.4 Green certificate price and spot volume, 2012-2020

Year	Certificates traded	lei/certificate	EUR/certificate
2012	1,053,229	244.09	56.44
2013	4,161,317	190.71	42.66
2014	2,675,174	161.60	36.07
2015	36,618	130.95	29.36
2016	8,468	132.25	29.40
2017	523,785	132.03	29.40
2018	2,599,148	134.31	29.40
2019	4,562,134	136.82	29.40
2020	6,578,991	139.51	29.40

Source: OPCOM annual reports, 2013 to 2020. Figures to 2016 relate to the centralised market (PCCV); from September 2017 to the anonymous spot market (PCSCV) that replaced it. Euro values are converted at the rate prescribed by Law 220/2008.

In 2012 the price stood at €56.44, at the ceiling of the permitted band. By 2015 it had fallen to €29.36, a decline of 48 per cent in three years, and the market had reached the floor.

The monthly path through 2013 is worth noting. The price opened the year at 243.85 lei in January and fell to 168.69 lei by May, a decline of 31 per cent in five months, before recovering to 200.00 lei in December. Emergency Ordinance 57/2013 was adopted on 4 June and took effect on 1 July. The steepest part of the fall therefore preceded the measure itself, following the regulator's finding of overcompensation in March and the public circulation of draft reductions in the intervening months. This is consistent with investors repricing on the expectation of intervention rather than on its enactment, though the accumulating certificate surplus was depressing prices over the same period and the two effects cannot be separated with these data.

It then stopped. From 2016 to 2020 the price in euro was €29.40 in every year, identical to the cent across five consecutive years. The figure in lei rises across the same period, from 132.25 to 139.51, but this reflects only the exchange rate at which a fixed euro amount is converted. In the currency in which the band is defined, the price did not move at all. From April 2017 this

follows directly from the statute: the floor was fixed at €29.40 and the market sat on it.

Nor did it move within years. The monthly series records 134.31 lei in every month of 2018, 136.82 lei in every month of 2019, and 139.51 lei in every month of 2020. A price that is constant to two decimal places across thirty-six consecutive months is not a price being formed by supply and demand. It is a regulatory floor, permanently binding.

A price resting on its floor is itself evidence of excess supply: at the minimum permitted price, more certificates were offered than the quota obliged suppliers to buy. Spot volumes are reported in Table 4, but they are not comparable across the 2017 change in market design, and the spot segment was in any case the smaller of the two. They are not relied on here.

5.2 The 2013 intervention

Romania's monitoring of the scheme, conducted under the conditions attached to the Commission's approval decision (European Commission, 2011), found that producers were being overcompensated. In March 2013 ANRE, the national energy regulator, reported that technology costs — particularly for solar photovoltaics — had fallen faster than the scheme's parameters anticipated, and that realised returns exceeded the reference rates used when the scheme was authorised.

The government responded with two measures in the same year. They are routinely discussed together, but they are different in kind, and the distinction is central to this paper.

The first was a reduction in support levels. Government Decision 994/2013 cut the number of certificates awarded: solar from six to three, wind from two to 1.5, new small hydro from three to 2.3. As Table 3 shows, the reduction applied to plants accredited from 2014 onwards. Emergency Ordinance 57/2013 provided explicitly that the reduction applied only to installations accredited after the decision entered into force. Investors who had not yet committed capital faced different terms; those who had were untouched. This is ordinary policy adjustment, announced in advance and applying prospectively.

The second measure was different. The same ordinance provided that, from 1 July 2013, a portion of the certificates due to producers would be temporarily withheld from trading — two certificates per megawatt-hour for solar plants, one for wind, one for new small hydro. This applied to producers accredited by ANRE up to 31 December 2013: that is, to installations already built or already committed. The certificates were still issued and still recorded in the producer's account. They simply could not be sold, nor transferred to a supplier to meet the mandatory quota. Transelectrica's operating procedure describes them as deferred from trading.

The measure was presented as temporary. Law 23/2014, which approved the ordinance with modifications, set out the arrangements for reversing it, and the government's explanatory note gave a timetable: recovery would begin in January 2017 for small hydro and solar and in January 2018 for wind, completing no later than December 2020. Producers were told that their revenue was postponed by three to four years.

That timetable was not kept, and for solar producers the deferral was extended rather than reversed. The arrangements now in force are those of article 6, paragraphs (2^2) and (2^6) of Law 220/2008 as amended: Emergency Ordinance 24/2017 withheld a further two certificates per megawatt-hour from the same producers between April 2017 and, as first enacted, December 2024, with recovery of both tranches deferred to 2025–2030. Law 184/2018, approving that ordinance with modifications, shortened the additional deferral to December 2020 and brought recovery forward to January 2021. The position that now applies is that wind and small hydro certificates deferred from 2013 are released in equal monthly instalments between January 2018 and December 2025, and that solar certificates withheld continuously between July 2013 and December 2020 are released between January 2021 and December 2030.

5.3 The value of deferred certificates

It is important to be precise about what was and was not done, because the formal position is defensible and the economic position is not.

Romania did not cancel any certificate. In its state aid file on the scheme, the European Commission records that although the country amended the legal basis repeatedly, it never reduced the number of certificates granted to installations already admitted to the support scheme. That statement is accurate. Every deferred certificate remains owed, and will eventually be released.

What changed was when. Because a certificate is a claim on future revenue, postponement reduces its present value, and postponement measured in years reduces it substantially. Table 5 sets out the effect, discounting deferred certificates at constant real rates to the point of deferral.

Table no.5 Present value of deferred certificates relative to immediate sale

Technology	Certificates deferred, per MWh	Deferral period	Release period	PV at 6%	at 9%	at 12%
Onshore wind	1 of 2	Jul 2013 – Dec 2017	Jan 2018 – Dec 2025	70%	60%	52%
New small hydro <10 MW	1 of 3	Jul 2013 – Dec 2017	Jan 2018 – Dec 2025	70%	60%	52%
Solar	2 of 6	Jul 2013 – Dec 2020	Jan 2021 – Dec 2030	61%	49%	40%

Source: authors' calculations. Present value is expressed relative to sale at the moment of issue, computed month by month across the deferral window and averaged with equal weights, as set out in Section 3.4. Discount rates are illustrative and are not estimates of the cost of capital faced by Romanian producers.

The effect differs by technology and by discount rate. At nine per cent, a deferred wind certificate was worth about three-fifths of what it would have fetched on immediate sale, and a deferred solar certificate about half. Because one certificate in two was withheld from wind producers and two in six from solar producers, this amounts to a loss of roughly a fifth of the support earned by a wind producer during the deferral period, about a sixth for a solar producer, and about an eighth for a small hydro producer. No certificate was withdrawn. Roughly a tenth to a quarter of the value of support earned in those years disappeared, depending on technology and on the rate at which future receipts are discounted.

Two further considerations sharpen this. Producers found themselves holding, for the better part of a decade, an asset the scheme's own rules treated as short-dated, a constraint relaxed only in 2017. Producers found themselves holding, for the better part of a decade, an asset the scheme's own rules treated as short-dated. Second, and more consequential for what investors could infer, the deferral was itself revised twice. A producer who accepted the 2013 measure as a temporary correction, on the assurance that repayment would be complete by 2020, learned in 2017 that repayment would instead begin in 2025, and in 2018 that it would begin in 2021 and run to 2030. The remedy proved as revisable as the original commitment, in both directions.

This is the distinction the paper turns on. A government that reduces support for future installations tells investors that the terms of new projects have changed. A government that alters the terms of projects already built tells them something different and more durable: that the terms of any project may change. Deployment is consistent with the second reading. Having added more than eleven percentage points between 2010 and 2014, it added one further point over the following seven years. What investors concluded cannot be observed directly from deployment data, and Section 6.1 considers what else may account for the slowdown.

6. Discussion

6.1 What the Romanian case shows

The measures adopted in Romania in 2013 are often described together as a correction of an over-generous support scheme. On the evidence set out above, they were two measures of a different character.

The reduction in certificate numbers was a straightforward adjustment. It followed a regulatory finding of overcompensation, it was proportionate to that finding, and it applied only to installations accredited after it took effect. Investors considering a project from 2014 faced terms that were less generous than those available in 2012, and they knew it before committing. Support schemes across Europe were adjusted in this way throughout the period, as

technology costs fell, and there is no reason to treat such adjustment as a failure of policy. It is what a support scheme is supposed to do.

The deferral was different. It applied to producers already accredited, whose capital was already committed and whose revenue expectations were already embedded in financing arrangements. It did not reduce the number of certificates owed. It changed the date on which they could be sold, and for solar producers the withholding was subsequently extended rather than reversed, so that certificates earned between 2013 and 2020 are recovered over the decade to 2030. Discounted at the illustrative rates used here, roughly a tenth to a quarter of the value of the support earned during those years was removed without any entitlement being withdrawn.

The certificate price compounded the effect. By 2016 it had settled at the floor of the legal band and remained there for five years. Its level across the release period to 2030 cannot be known, but a producer forming expectations in those years saw a market that was not producing prices above its regulatory minimum.

Emergency Ordinance 24/2017, which extended the deferral, also lowered the price at which the released certificates could be sold. Until 2017 the ceiling stood at an indexed €55; from April 2017 it was fixed at €35 until 2032, with no indexation. A producer awaiting certificates deferred in 2013 therefore faced not only a longer wait but a lower maximum realisable price on arrival, and a bound that erodes in real terms throughout the waiting period. Neither change reduced the number of certificates owed.

Credibility is not the only candidate explanation for what followed, and the evidence assembled here cannot separate it from several others. The prospective reduction in certificate numbers was substantial in its own right — halving the allocation to new solar plants — and would be expected to slow new investment whatever investors inferred about the durability of the scheme. The certificate price fell by nearly half between 2012 and 2015, reducing revenues for all producers irrespective of the deferral, and the surplus driving that fall arose from a quota set below the volume of certificates the scheme was issuing. The deployment surge of 2012 and 2013 was itself a response to terms the regulator subsequently found to be over-generous, so some slowing was to be expected once those terms were corrected. Grid connection constraints and the twelve-month validity rule, which forced sales into a saturated market until it was relaxed in 2017, would each have contributed. These operated simultaneously and in the same direction, and no design available here distinguishes their contributions. What can be said is narrower: a measure that reached installations already built coincided with a seven-year interruption, the same coincidence appears in every comparable case, and the member state that confined its revisions to future installations shows no comparable interruption.

The most consequential feature, however, is the one that emerged only over time. The repayment schedule announced in 2013 promised completion by 2020. It was subsequently amended twice. Emergency Ordinance 24/2017 extended the solar deferral to 2024 and postponed recovery to 2025–2030; Law 184/2018 then shortened the extension to 2020 and brought recovery forward to 2021. A producer who accepted the original measure as a temporary emergency, on the assurance that the position would be restored within a few years, learned that the assurance was itself revisable. That is a different proposition from a support scheme being less generous than expected. It is a support scheme in which no commitment, including a commitment made in remedy of an earlier one, can be treated as fixed.

Some investors took a similar view and acted on it. Ten companies holding interests in five Romanian photovoltaic plants brought arbitration proceedings over the amendments, and in February 2024 a tribunal found that the Energy Charter Treaty had been breached and ordered Romania to pay €42.2 million in compensation, together with interest and costs (European Commission, 2026). The finding is external to the analysis presented here and reaches it by a different route, but it supports the same reading: that the amendments removed value from parties who had already invested, notwithstanding that no entitlement was formally withdrawn. The sequel is instructive in its own right. In July 2026 the Commission opened an in-depth investigation into whether payment of the award would itself constitute State aid incompatible with the internal market, and Romania gave notice of withdrawal from the Energy Charter Treaty in May 2026, with effect from May 2027. The mechanism through which these investors obtained a remedy is being closed as the remedy itself is contested.

6.2 Frequency of revision and stability of commitment

The comparison in Section 4 points to a distinction that is easily obscured. Germany revised its renewable support framework repeatedly across the period examined, through the 2012 photovoltaic amendment and the successive reforms of the renewable energy act. By any count of legislative interventions, Germany was not a country of stable energy policy. Yet Germany records the shortest interruption to renewable electricity deployment of any member state, and its share rose without a break from 18.2 per cent in 2010 to 57.9 per cent in 2025.

What distinguished the German revisions was their scope. They set the terms on which future installations would be supported and left installations already commissioned on the terms under which they had been built. An investor reading the German record would conclude that the terms of new projects were subject to change, which is ordinary commercial risk, but that the terms of a completed project were not.

Romania revised its framework less often and produced the opposite result. The relevant variable therefore appears to be not how frequently a government legislates, but whether its legislation reaches capital that has already been committed. A support scheme that is adjusted every two years but never retroactively offers a more reliable basis for investment than one that is adjusted once in a decade and reaches backwards when it is.

This has a practical implication for scheme design. The protection that matters is not a guarantee that terms will not change. No government can offer that credibly, and investors do not expect it. What matters is a guarantee that changes will apply prospectively — and, more particularly, a mechanism that makes such a guarantee costly to break.

6.3 Limitations

Three limitations bear on the interpretation of these results.

The comparative analysis is descriptive. It establishes that periods of stagnation follow retroactive interventions in every case with a coded intervention date, and that the member state with the most consistently prospective record shows the shortest interruption. It does not establish causation, and Section 6.1 sets out the alternative explanations that operated simultaneously in the Romanian case. The identification of stagnation periods relies on a threshold chosen for consistency rather than derived from theory. Deployment stalls for many reasons, and Section 4.2 shows that most member states record such a period at some point.

The valuation in Section 5.3 rests on assumptions that are stated rather than estimated. The discount rate is imposed, results are reported across a range, and the calculation assumes that deferred certificates are released in full and at unchanged real value — the assumption most favourable to the position that no support was withdrawn. The figures indicate a magnitude, not a measured return.

Finally, the analysis addresses one instrument class in one member state in detail. Whether the transmission of policy risk observed here is characteristic of quota-and-certificate schemes generally, or specific to the Romanian design, cannot be settled on a single case. The absence of comparable studies of certificate-based schemes in Central and Eastern Europe is itself a gap worth addressing.

7. Conclusions

Romania raised the renewable share of its electricity consumption by eleven percentage points between 2010 and 2014 and by one point over the seven years that followed. In 2010 it led the four countries examined here; by 2025 it ranked third, overtaken by both Spain and Germany.

This paper has examined the interruption through the credibility of policy commitments rather than their generosity. In 2013 Romania withheld from trading a portion of the green certificates owed to producers whose installations

were already operating. The measure reduced no producer's entitlement, and the European Commission records that support levels for installations already in the scheme were never cut. But release was promised by 2020, the withholding was then extended to 2020 for solar producers, and recovery runs to 2030. Discounted at conventional rates, a substantial share of the value of the support earned in those years was removed — about a fifth for wind producers at a nine per cent rate. The certificates were, in addition, designed to be traded within twelve months, and the price at which they were then selling sat at the floor of its legal band, unchanged to the cent, from 2016 to 2020.

The comparative evidence is consistent with this reading without confirming it. Every case with a coded intervention date records prolonged stagnation beginning at or shortly after it. Stagnation is nonetheless common and has many causes, and the association observed here is suggestive rather than diagnostic.

Two implications follow for the design of support schemes. The first is that the distinction between prospective and retroactive revision deserves more weight than the frequency of revision, both in assessing a country's policy record and in designing instruments intended to attract private capital. A scheme revised often but only forward offers firmer ground than one revised rarely and backwards.

The second concerns the form in which commitments are made. Romania's support was established by statute, and a statute can be amended by a subsequent statute. The deferral, the schedule for reversing it, and the amendment of that schedule were each accomplished in this way. What redress investors eventually obtained came not from Romanian law but from the Energy Charter Treaty, and Romania has given notice of withdrawal from that treaty with effect from 2027 (European Commission, 2026). Instruments now being adopted across the Union, including in Romania, place support terms in contracts between producers and a designated counterparty. Whether that form proves more durable than legislation is an open question, and one made more pressing by the closing of the external route. The next decade of European energy policy will answer it; the Romanian record suggests it is the right question to ask.

References

Blackman, Gerald and Zeckhauser, Richard. 1992. "Fragile commitments and the regulatory process". *Yale Journal on Regulation*, 9: 73.

Boomsma, Trine Krogh and Linnerud, Kristin. 2015. "Market and policy risk under different renewable electricity support schemes". *Energy*, 89: 435-448.

Boomsma, Trine Krogh, Meade, Nigel and Fleten, Stein-Erik. 2012. "Renewable energy investments under different support schemes: a real options approach". *European Journal of Operational Research*, 220(1): 225-237.

Buzogány, Aron and Davidescu, Simona. 2022. "Energy Governance in Romania". In Knodt, Michèle and Kemmerzell, Jörg (eds), *Handbook of Energy Governance in Europe*. Cham: Springer, pp. 993-1017.

Chassot, Sylviane, Hampl, Nina and Wüstenhagen, Rolf. 2014. "When energy policy meets free-market capitalists: the moderating influence of worldviews on risk perception and renewable energy investment decisions". *Energy Research & Social Science*, 3: 143-151.

Dalby, Peder Andreas Oppebøen, Gillerhaugen, Gisle, Hagspiel, Verena, Leth-Olsen, Tord and Thijssen, Jacco J. J. 2018. "Green investment under policy uncertainty and Bayesian learning". *Energy*, 161: 1262-1281.

European Commission. 2011. *Decision on State Aid SA.33134 (2011/N) — Romania: Green certificates for promoting electricity from renewable sources, Brussels.*

European Commission. 2015. *Decision C(2015) 2886 final, State Aid SA.37177 (2015/NN) — Romania: Amendments to the green certificates support system for promoting electricity from renewable sources*, Brussels, 4 May 2015.

European Commission. 2026. *Commission opens in-depth investigation into arbitration award ordering Romania to pay compensation to ten energy investors, Press release IP/26/1685, case SA.113263*, Brussels, 29 July 2026.

Eurostat. 2026. *Share of energy from renewable sources* (nrg_ind_ren), Luxembourg, accessed 20 September 2026.

Eyraud, Luc, Wane, Abdoul Aziz, Zhang, Changchang and Clements, Benedict. 2011. "Who's going green and why? Trends and determinants of green investment". *IMF Working Papers*, 11/296: 1-38.

García-Álvarez, María Teresa, Cabeza-García, Laura and Soares, Isabel. 2017. "Analysis of the promotion of onshore wind energy in the EU: feed-in tariff or renewable portfolio standard?". *Renewable Energy*, 111: 256-264.

García-Álvarez, María Teresa, Cabeza-García, Laura and Soares, Isabel. 2018. "Assessment of energy policies to promote photovoltaic generation in the European Union". *Energy*, 151: 864-874.

Guvernul României. 2013a. *Ordonanţa de urgenţă nr. 57/2013 privind modificarea şi completarea Legii nr. 220/2008 pentru stabilirea sistemului de promovare a producerii energiei din surse regenerabile de energie*, Monitorul Oficial al României, Partea I, nr. 335, 7 iunie 2013.

Guvernul României. 2013b. *Hotărârea Guvernului nr. 994/2013 privind aprobarea măsurilor de reducere a numărului de certificate verzi în situaţiile prevăzute la art. 6 alin. (2) lit. a), c) şi f) din Legea nr. 220/2008*, Monitorul Oficial al României, Partea I, nr. 788, 16 decembrie 2013.

Guvernul României. 2017. *Ordonanţa de urgenţă nr. 24/2017 privind modificarea şi completarea Legii nr. 220/2008 pentru stabilirea sistemului de promovare a producerii energiei din surse regenerabile de energie şi pentru modificarea unor acte normative*, Monitorul Oficial al României, Partea I, nr. 224, 31 martie 2017.

Hellenic Republic. 2012. *Law 4093/2012, Article I, Paragraph I.2, Government Gazette A 222*, 12 November 2012.

Helm, Dieter, Hepburn, Cameron and Mash, Richard. 2003. "Credible carbon policy". *Oxford Review of Economic Policy*, 19(3): 438-450.

Karneyeva, Yuliya and Wüstenhagen, Rolf. 2017. "Solar feed-in tariffs in a post-grid parity world: the role of risk, investor diversity and business models". *Energy Policy*, 106: 445-456.

Kydland, Finn E. and Prescott, Edward C. 1977. "Rules rather than discretion: the inconsistency of optimal plans". *Journal of Political Economy*, 85(3): 473-491.

Laffont, Jean-Jacques and Tirole, Jean. 1996. "Pollution permits and environmental innovation". *Journal of Public Economics*, 62(1-2): 127-140.

Lüthi, Sonja and Wüstenhagen, Rolf. 2012. "The price of policy risk - empirical insights from choice experiments with European photovoltaic project developers". *Energy Economics*, 34(4): 1001-1011.

Ministerul Energiei. n.d. *Schema de sprijin prin certificate verzi*, Bucureşti, accessed 26 September 2026.

Mitchell, Catherine, Bauknecht, Dierk and Connor, Peter M. 2006. "Effectiveness through risk reduction: a comparison of the renewable obligation in England and Wales and the feed-in system in Germany". *Energy Policy*, 34(3): 297-305.

Năstase, Gabriel, Şerban, Alexandru, Dragomir, George, Brezeanu, Alin Ionuţ and Bucur, Ion. 2018. "Photovoltaic development in Romania. Reviewing what has been done". *Renewable and Sustainable Energy Reviews*, 94: 523-535.

Năstase, Gabriel, Şerban, Alexandru, Năstase, Andrei Florin, Dragomir, George, Brezeanu, Alin Ionuţ and Iordan, Nicolae Florin. 2017. "Hydropower development in Romania. A review from its beginnings to the present". *Renewable and Sustainable Energy Reviews*, 80: 297-312.

OPCOM. 2013-2020. *Raport anual de sinteză a rezultatelor funcţionării pieţelor centralizate operate de OPCOM*, Bucureşti, annual editions 2013 to 2020.

Parlamentul României. 2008. *Legea nr. 220/2008 pentru stabilirea sistemului de promovare a producerii energiei din surse regenerabile de energie*, republicată în Monitorul Oficial al României, Partea I, nr. 577, 13 august 2010.

Parlamentul României. 2014. *Legea nr. 23/2014 pentru aprobarea Ordonanţei de urgenţă a Guvernului nr. 57/2013*, Monitorul Oficial al României, Partea I, nr. 184, 14 martie 2014.

Parlamentul României. 2018. *Legea nr. 184/2018 pentru aprobarea Ordonanţei de urgenţă a Guvernului nr. 24/2017 privind modificarea şi completarea Legii nr. 220/2008 pentru stabilirea sistemului de promovare a producerii energiei din surse regenerabile de energie şi pentru modificarea unor acte normative*, Monitorul Oficial al României, Partea I, nr. 635, 20 iulie 2018.

Ritzenhofen, Ingmar and Spinler, Stefan. 2016. "Optimal design of feed-in-tariffs to stimulate renewable energy investments under regulatory uncertainty - a real options analysis". *Energy Economics*, 53: 76-89.

Sendstad, Lars H., Hagspiel, Verena, Mikkelsen, Wilhelm Jebsen, Ravndal, Ruben and Tveitstøl, Martin. 2022. "The impact of subsidy retraction on European renewable energy investments". *Energy Policy*, 160: 112675.

Transelectrica (Compania Naţională de Transport al Energiei Electrice). 2018. *Procedura de emitere a certificatelor verzi pentru energia electrică produsă din surse regenerabile de energie*, Cod TEL 03.11, Revizia 7, București.

Zamfir, Andreea, Colesca, Sofia Elena and Corbos, Razvan-Andrei. 2016. "Public policies to support the development of renewable energy in Romania: A review". *Renewable and Sustainable Energy Reviews*, 58: 87-106.

Appendix Table A1 Longest stagnation period by member state, 2010-2025

Member state	Start	End	Duration (years)	Coded intervention
Austria	2014	2017	4	—
Belgium	2015	2017	3	—
Bulgaria	2013	2017	5	2012
Croatia	2014	2017	4	—
Cyprus	2014	2018	5	—
Czechia	2014	2022	9	2011
Denmark	2023	2025	3	—
Estonia	2012	2017	6	—
Finland	2010	2012	3	—
France	2014	2017	4	—
Germany	2012	2013	2	—
Greece	2013	2016	4	2012
Hungary	2010	2018	9	—
Ireland	2020	2023	4	—
Italy	2014	2019	6	2014
Latvia	2017	2024	8	—
Lithuania	2016	2019	4	—
Luxembourg	2010	2013	4	—
Malta	2020	2025	6	—
Netherlands	2010	2015	6	—
Poland	2014	2019	6	market
Portugal	2015	2019	5	not dated
Romania	2014	2021	8	2013
Slovakia	2014	2023	10	—
Slovenia	2010	2019	10	—
Spain	2013	2019	7	2013
Sweden	2015	2018	4	—

Source: authors' calculations from Eurostat, nrg_ind_ren (REN_ELC), applying the rule set out in Section 3.3 at a two-percentage-point threshold. Coded interventions follow Sendstad et al. (2022), with Romania added; Greece is dated to Law 4093/2012 and Romania to Emergency Ordinance 57/2013. Poland's certificate revenues fell through market oversupply rather than legislative action. Portugal is identified in the literature as a retroactive case but could not be dated to a single instrument. A dash indicates no documented retroactive episode.