Overcompensation assessment in relation to the pre-2013 Flemish green certificates scheme

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1 Introduction

1.1 In the late 1990s and early 2000s, EU member states committed to increase the share of renewable energy sources ('RES') in their gross energy consumption.[1] As a result, the EU introduced legislation, such as Directive 2001/77/EC,[2] whereby EU member states adopted indicative targets for the share of electricity from renewable energy sources ('RES-E') in their gross electricity consumption that they could achieve by 2010. Belgium aimed to increase the share of RES-E in its electricity consumption from 1.1% in 1997 to 6.0% in 2010.[3]

1.2 Given the high cost of renewable electricity relative to electricity generated from non-renewable sources at the time (such as coal, natural gas and nuclear energy), the Directive allowed for subsidies to encourage investments in RES-E.[4] Specifically, the Directive incentivised member states to design their own renewable electricity support schemes, including green certificates schemes, with the aim of increasing the share of RES-E in line with EU and national targets, while also limiting the cost to consumers.

1A The functioning of green certificates schemes

1.3 Under a green certificates support mechanism, generators are awarded a certain number of green certificates depending on their production. The green certificates are then purchased by market participants as part of their legal obligation to include a certain amount of RES-generated electricity in their mix. Market participants that fail to meet their obligations are also typically fined to ensure compliance. Policymakers sometimes also guarantee minimum prices for green certificates, thereby ensuring that RES-E generators earn at least a minimum level of revenue for a given quantity of electricity produced.

1.4 The level of support awarded to RES-E producers under a green certificates scheme depends primarily on:

- the length of the period of support;
- the number of certificates awarded to the generator per unit of electricity produced; and

[1] Council Resolution of 8 June 1998 on renewable sources of energy, OJ C 198, 24.6.1998.
[2] Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market, OJ L 233, 27.10.2001.
[3] Ibid., Annex.
[4] Ibid., paras 12–16 and Article 4.

- the value of the certificates, which is often defined as a minimum value with a penalty applicable if market participants do not purchase a sufficient number of certificates.

1.5 The objective of any RES-E support scheme is to allow generators to earn sufficient revenues to meet the costs of producing electricity. Usually, European regulators calculate a technology-specific levelised cost of electricity (‘LCOE’), in line with the European Commission’s recommended approach.[5]

1.6 The LCOE represents the price per unit of electricity generated that covers the present value of the costs of producing electricity over a plant’s lifetime. In other words, it is the price of electricity that a generator should be paid over the plant’s lifetime in order to recoup the costs of producing electricity, including capital investment costs, operating costs and a reasonable rate of return.[6]

1.7 A RES-E producer benefiting from a green certificates scheme generates revenues through:

- selling its electricity production to buyers;
- selling green certificates awarded for RES-E generation to market participants.

1.8 A well-calibrated green certificates scheme that seeks to appropriately compensate investors should ensure that the combination of the revenues derived from the sale of electricity and those derived from green certificates is equal to a plant’s LCOE. To do this, regulators usually start by determining the LCOE of RES-E generators, before calibrating the correct level of support by subtracting forecast revenues derived from electricity sales from the LCOE.[7]

1.9 As it would not be practical to assess the LCOE of every single individual plant applying for support under a green certificates scheme to derive the appropriate level of support, policymakers often rely on ‘reference plants’ or ‘reference projects’. This methodology has been accepted by the European

[5] European Commission (2013), ‘Commission staff working document—European Commission guidance for the design of renewables support schemes accompanying the document Communication from the Commission—Delivering the internal market in electricity and making the most of public interventions’, 5 November, pp. 19–20.
[6] Fraunhofer ISI (2014), ‘D5.2: Best practice design features for RES-E support schemes and best practice methodologies to determine remuneration levels’, September. For those RES-E technologies that have low and/or predictable operating costs (such as solar PV plants or windfarms), regulators can calculate a LCOE over the plant’s lifetime with reasonable accuracy. However, it is more difficult to accurately estimate the LCOE for those technologies that have higher operating costs, including fuel costs (e.g. biogas or biomass plants), as the calculation requires the evolution of such costs to be forecast over the plant’s lifetime.
[7] Ibid., p. 30; European Commission (2013), op. cit., p. 20.

Commission in a number of decisions relating to RES-E support schemes.[8] The reference plant is a hypothetical project for which the LCOE is calculated by regulators using standard technological and cost parameters. Regulators expect that the level of support derived for a reference plant will be appropriate for most generators within a class of projects, which is often defined as those projects using the same technology as a reference project.[9]

1B The Flemish green certificates schemes

1.10 In Belgium, the Flemish region introduced such a support mechanism in the form of a green certificates (*groene stroom certificaten* or *GSC*) scheme, open to RES-E producers, on 1 January 2002.[10] Under this scheme, RES-E generators would be awarded one green certificate per MWh of electricity produced.[11] The initial scheme did not stipulate a minimum price of green certificates.[12]

1.11 The scheme was subsequently modified by the Flemish authorities through the introduction of a minimum price of €450 for green certificates awarded to solar photovoltaic (‘solar PV’) producers from 1 January 2006.[13] In the remainder of this report, we refer to the scheme that was notified in 2001, and subsequently modified, as outlined in the Commission’s 2006 decision, as the ‘pre-2013 scheme’.[14]

1.12 In the early 2010s, the Flemish authorities significantly amended the support scheme for those RES-E plants built after 1 January 2013 (the ‘2013

[8] Since the early 2000s, this methodology has been and is still widely used to derive the appropriate level of support for generators in the context of RES-E support schemes. Examples of decisions where the Commission has accepted this methodology are: European Commission (2006), ‘State aid NN 162/A/2003 and State aid N 317/A/2006 – Austria—Support of electricity production from renewable sources under the Austrian Green Electricity Act (feed-in tariffs)’, 4 July, paras 19 and 69; and European Commission (2005), ‘State aid no. N 602/2004 – DK—‘Support to environmentally friendly electricity production’, pp. 7–9 and 12. The Commission has also accepted this methodology in the context of the notification by Belgium of the current Flemish green certificates scheme, where the level of support was calculated using ‘typical parameters’. See European Commission (2018), ‘State Aid SA.46013 (2017/N) – Belgium—Green electricity certificates and CHP certificates in Flanders’, 16 February, para. 20 and tables 1 and 2.

[9] Within a given technology category (e.g. solar PV or windfarms), regulators can also determine sub-categories for which different LCOEs can be calculated (for example, based on generation capacity). This is in line with the approach followed by the Flemish authorities in the context of the current green certificates scheme. See European Commission (2018), ‘State Aid SA.46013 (2017/N) – Belgium—Green electricity certificates and CHP certificates in Flanders’, 16 February, tables 1 and 2.

[10] Belgian Government (2006), ‘Fourth national communication on climate change under the United Nations Framework Convention on Climate Change’, p. 47.

[11] European Commission (2001), ‘Steunmaatregel nr. N 550/2000 – België—Groenestroomcertificaten’, 25 July, p. 2.

[12] The Flemish support scheme was notified to the European Commission in 2001. At the time, the Commission considered that the support scheme did not constitute state aid. For further details, see European Commission (2001), ‘Steunmaatregel nr. N 550/2000 – België—Groenestroomcertificaten’, 25 July.

[13] Decreet houdende algemene bepalingen betreffende het energiebeleid (aangehaald als het Energiedecreet), 8 May 2009 (hereinafter, ‘the 2009 Energy Decree’), Article 7.1.6, §1.

[14] The European Commission approved the modification of the scheme on a ‘no aid’ basis. See European Commission (2006), ‘Steunmaatregel N 254/2006 – België—Fotovoltaïsche panelen’, 24 October.

scheme').[15] The main changes introduced by the authorities for the 2013 scheme relative to the pre-2013 scheme are as follows:

- the minimum certificate price is the same for all technologies;
- the number of certificates awarded to generators depends on the RES-E generator's technology and capacity (kW);
- the appropriate level of support is updated frequently (at least annually) for newly built plants, and the level of support awarded to existing solar PV and windfarms is updated (*actualiseren*) frequently over the support period.

1.13 The Commission considered that the 2013 scheme constituted state aid.[16] Therefore, the Commission assessed the compatibility of the 2013 scheme with the Guidelines on State aid for environmental protection and energy 2014-2020 ('EEAG'), and concluded that the 2013 scheme was compatible with the relevant state aid rules.[17]

1.14 New Guidelines on State aid for climate, environmental protection and energy (the 'CEEAG') were introduced in early 2022.[18] The CEEAG stipulates that 'Member States amend, where necessary, existing (…) aid schemes in order to bring them into line with these guidelines no later than 31 December 2023'.[19] As a result, it needs to be checked that the payments expected to be received by RES-E producers in exchange for their certificates will not lead to overcompensation (i.e. that producers will not achieve an 'excessive' profit).

1.15 While the Commission, in its 2018 decision, assessed whether the 2013 scheme was proportionate, it did not do so for the pre-2013 scheme. Following the introduction of the CEEAG, the Flemish authorities are now required to assess whether the pre-2013 scheme leads to any overcompensation, and if so, to eliminate it in order to bring both schemes into line with state aid rules.

1.16 In this context, the Vlaams Energie- en Klimaatagentschap ('VEKA', or 'the agency')[20] has asked us to undertake an independent assessment of whether

[15] Belgium notified this scheme to the Commission in 2017. For further details, see European Commission (2018), 'State Aid SA.46013 (2017/N) – Belgium—Green electricity certificates and CHP certificates in Flanders', 16 February.
[16] Ibid., para. 65.
[17] Communication from the Commission – Guidelines on State aid for environmental protection and energy 2014-2020 (2014/C 200/01), OJ C 200, 28.6.2014; and European Commission (2018), 'State Aid SA.46013 (2017/N) – Belgium—Green electricity certificates and CHP certificates in Flanders', 16 February, section 4.
[18] Communication from the Commission – Guidelines on State aid for climate, environmental protection and energy 2022 (2022/C 80/01), OJ C 80, 18.2.2022, para. 108, read in conjunction with paras 51–53.
[19] Ibid., para. 468(a).
[20] VEKA acts as the regulator described in section 1A in relation to the green energy certificate scheme.

the pre-2013 scheme would overcompensate specific generators, in order to help the Flemish authorities ensure that any overcompensation is eliminated.

1C Structure of the report

1.17 This report is structured as follows:

- in section 2, we assess whether the green certificates prices underpinning the pre-2013 schemes for solar PV and for biogas from fermentation of green waste with composting (*GFT*) were estimated appropriately and, as such, whether the schemes are likely to overcompensate the generators;
- in section 3, we provide our overall conclusions.

2 Overcompensation assessment in relation to the pre-2013 scheme

2.1 In this section, we first assess whether certain technologies are at risk of being overcompensated under the pre-2013 scheme, prior to examining whether there has been any overcompensation.

2.2 In section 2A, we describe the main features of the pre-2013 scheme, and we identify whether there are any type(s) of RES-E generator that might be at risk of being overcompensated given the design of the scheme.

2.3 Our analysis shows that two technologies warrant a more in-depth assessment of whether there has been any overcompensation as part of the Flemish authorities' objective to eliminate any ongoing overcompensation—namely, solar PV, and biogas from the fermentation of green waste with composting (*GFT*). In sections 2B and 2C, we therefore assess whether the certificate prices for solar PV and biogas from the fermentation of green waste with composting (*GFT*) were determined appropriately under the pre-2013 scheme, and whether the generators are likely to have been overcompensated.

2A Description of the pre-2013 scheme

2.4 In section 1, we explain that, under a green certificates scheme, RES-E generators receive certificates depending on their electricity production, which they then sell to market participants. Market participants are required by law to purchase a certain number of certificates as part of their obligation to include a certain share of RES-E in their electricity mix.

2.5 According to the 2009 Energy Decree,[21] RES-E generators subject to the pre-2013 scheme receive one green certificate per 1,000kWh (or 1MWh) of electricity generated.[22] Green certificates are awarded for an initial support period of ten years.[23] This period of support can be extended: if generators seek an extension, they must present the necessary evidence to VEKA, which will evaluate the request.[24]

2.6 There are, however, two exceptions to the ten-year support period. Specifically, solar PV producers and producers of electricity using biogas from

[21] The features of the pre-2013 Flemish support scheme for RES-E producers are outlined in Flemish law, specifically in the 2009 Energy Decree.
[22] 2009 Energy Decree, Article 7.1.1, §1.
[23] Ibid.
[24] Ibid.

the fermentation of green waste with composting (*GFT*) receive green certificates for an initial support period of 20 years.[25]

2.7 The Energy Decree imposes a minimum price for each certificate awarded to RES-E producers commissioned before 1 January 2013. The minimum price depends on the technology and on the date of commissioning each individual RES-E generator (and, for solar PV generators commissioned in 2011 and 2012, on the capacity of the plant).

2.8 We understand that the minimum value of green certificates was (at least in part) determined based on a study undertaken by VITO in 2006.[26] In this study, VITO calculated the *onrendabele top* ('OT', or 'unprofitable top') per MWh, which refers to the euro amount of support required per MWh of production such that the installation is expected to be profitable.[27] Put differently, the OT represents the additional revenues (per MWh of production) that would be necessary for the generator to break even, after taking into account all costs and revenues.[28]

2.9 The OT is calculated by estimating the certificate price for which, when allowing for a reasonable return, the expected net present value ('NPV') of the investment is equal to zero.[29] In other words, the OT refers to the certificate price that is expected to lead to the producer earning a normal return on its investment.

2.10 Table 2.1 below shows the period of support in terms of the number of years, the number of certificates awarded per MWh of production, and the minimum price of a certificate depending on the plant's technology and date of commissioning.

[25] Ibid., Article 7.1.6, §1.
[26] VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June.
[27] VITO carried out this calculation for a reference installation with a 2kW capacity. See VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, p. 44.
[28] In section 1A, we describe how prices of certificates are usually calculated by subtracting revenues generated from electricity sales from a reference plant's LCOE, the calculation of which is based only on a generator's costs of production. In contrast, the OT calculation accounts for electricity market revenues in the calculation of the OT itself: specifically, they form a component of revenues in the calculation of the cash flows expected to be generated by the reference plant over its lifetime. Put differently, while the LCOE calculates the unit price of electricity that covers the net present value ('NPV') of the production costs, the OT calculates the profit shortfall per unit of electricity produced after accounting for revenues from the market. Both figures can be used to determine the level of support: revenues from the market are subtracted from the LCOE such that the level of support covers only the production costs that cannot be recouped by revenues from the market, whereas the OT can immediately be interpreted as a level of support in that it represents the profit shortfall of the generator after taking into account revenues from the market.
[29] In line with the 2009 Energy Decree, Article 1.1.3, 95°.

Table 2.1 Characteristics of the pre-2013 scheme by technology

Commissioning date	Period of support (years)	Number of certificates per MWh of production	Minimum price of a certificate (€)
Solar PV			
Before 2009	20	1	450
2010	20	1	350
1 January 2011–30 June 2011	20	1	330
1 July 2011–30 September 2011	20	1	300/240[2]
1 October 2011–31 December 2011	20	1	270/150[2]
1 January 2012–31 March 2012	20	1	250/90[2]
1 April 2012–30 June 2012	20	1	230/90[2]
July 2012	20	1	210/90[2]
1 August 2012–31 December 2012	10	1	90
Hydroelectric, tidal, wave and geothermal power			
Before 31 December 2009	10	1	95
After 1 January 2010	10	1	90
Onshore wind			
Before 31 December 2009	10	1	80
After 1 January 2010	10	1	90
Biogas from agricultural waste, fermentation of green waste with composting (*GFT*)			
Before 31 December 2009	10/20[1]	1	100
After 1 January 2010	10/20[1]	1	100/110[3]
Biomass and other biogas			
Before 31 December 2009	10	1	80
After 1 January 2010	10	1	90
Landfill gas, sewage and wastewater gas, incineration of residual waste, other technologies			
Before 31 December 2009	10	1	80
After 1 January 2010	10	1	60

Note: [1] 10 years for biogas from agricultural waste, 20 years for the fermentation of green waste with composting (*GFT*). [2] Prices on the left-hand side are applicable to generators with an installed capacity below 250kW, while prices on the right-hand side are applicable to generators with an installed capacity above 250kW. [3] The minimum certificate price is €100 for generators commissioned after 1 January 2012 that received the ecology premium (a form of aid), while the minimum certificate price of €110 is applicable for generators that did not receive the ecology premium.

Source: 2009 Energy Decree, article 7.1.6, §1.

2.11 Table 2.1 shows that, for most categories of RES-E generators, the number of certificates awarded per MWh of generation and their minimum price did not change between 2006 and 2009, or subsequently between 2010 and 2012 (except, in this latter period, for solar PV plants). This means that, for example, a solar PV plant commissioned in 2006 would be awarded certificates with the same minimum price as a solar PV plant commissioned in 2009. In the context of assessing the potential for overcompensation, this is particularly important if the cost of producing electricity for a specific type of technology has decreased significantly over the period during which the minimum certificate price remains constant. This results in the level of support becoming decorrelated from the cost of producing electricity.

2.12 In section 1A, we explained that the certificate prices are determined by reference to the cost of producing electricity for a reference plant (the LCOE, or the OT in the case of the pre-2013 scheme).[30] Therefore, if the cost of producing electricity decreases, the appropriate certificate price should decrease as well. Otherwise, a generator might benefit from a certificate price that was determined based on cost parameters that are no longer representative of the costs faced by the generator.

2.13 The potential for the level of support to become disconnected from the cost of producing electricity due to a miscalibration of the parameters used to derive the appropriate certificate price may give rise to what we define as 'structural overcompensation'.

2.14 Using the example of solar PV generators, we note that prices of photovoltaic modules (a key component of solar panels) decreased significantly between 2006 and 2009, as shown in Figure 2.1 below. At the same time, the minimum price of certificates awarded to generators commissioned between 2006 and 2009 did not change over this period.

[30] As set out in section 1A, the price of green certificates is usually determined by subtracting forecast electricity prices from a generator's LCOE. Similarly, in the case of the OT, the calculation includes forecasts of revenues and costs, including those related to electricity prices, over the plant's lifetime. However, electricity prices are not fixed over the entire support period, and may vary significantly over a plant's lifetime.

Figure 2.1 Evolution of global average solar PV module prices between 2000 and 2019 (in US$ per Watt)

Source: Our World in Data, based on Lafond, F., Bailey, A.G., Bakker, J.D., Rebois, D., Zadourian, R., McSharry, P. and Farmer, J.D. (2018), 'How well do experience curves predict technological progress? A method for making distributional forecasts', *Technological Forecasting and Social Change*, March, **128**, pp. 104–17, available at https://ourworldindata.org/grapher/solar-pv-prices?time=2002..latest (accessed 31 May 2022).

2.15 Therefore, it is likely that technologies for which the green certificate price remained constant for a period of time could have been structurally overcompensated.

2.16 Furthermore, if the price of green certificates received by a plant remains constant once it is commissioned, the plant's total revenues will vary (almost exclusively) in line with the electricity prices at which it is able to sell its production. As a result, the plant's total revenues may exceed the plant's LCOE over the duration of the plant's operational lifetime, resulting in overcompensation.[31] Similarly, in the context of the OT model used by the Flemish support scheme, the actual OT might evolve differently from the initial OT as actual electricity prices may diverge from the forecasts used to calculate the initial OT, thereby leading to overcompensation. Overcompensation arising from such price dynamics can be described as 'ex post overcompensation'.

[31] This may be particularly the case for RES-E technologies that are associated with high upfront investment costs and low operating costs (such as solar PV plants and, to a lesser extent, windfarms). For these technologies, the LCOE or OT calculations include very few time-varying assumptions. Therefore, the LCOE or OT calculated around the plant's commissioning date is likely to remain broadly constant over the plant's lifetime.

2.17 Unlike structural overcompensation, which arises from a miscalibration of the initial level of support, ex post overcompensation arises due to the inability to accurately forecast electricity prices over a plant's operational lifetime. This may result in the initial certificate price (calculated by reference to the OT, which is based on a forecast of electricity prices) being estimated inaccurately in light of the subsequent evolution of electricity prices.

2.18 While structural overcompensation usually arises when the certificate price for new plants is not updated regularly, ex post overcompensation usually arises when the certificate price for existing plants is not updated (*actualiseren*). We understand that no provision requiring certificate prices for existing plants to be updated (*actualiseren*) under the pre-2013 scheme exists in the 2009 Energy Decree.

2.19 It is therefore possible that certain technologies might have been overcompensated under the pre-2013 scheme. In particular, technologies for which the minimum certificate price remained constant for a number of years could have been overcompensated. The fact that the minimum price of certificates has declined over time might be indicative of an attempt by policymakers to catch up with the price trends and reflect the decreasing costs in order to reduce overcompensation for new plants.

2.20 In particular, it is possible that solar PV plants might have been overcompensated, particularly those that were built between 2007 and 2009. We therefore undertake an overcompensation assessment for solar PV producers in section 2B.

2.21 We also understand that the objective of the Flemish authorities is to eliminate overcompensation going forward in order to bring the pre-2013 scheme into line with the CEEAG. In order to do so, we understand that the Flemish authorities are considering modifying the pre-2013 scheme.

2.22 In this regard, as shown in Table 2.1, most technologies received support over an initial ten-year period. Given that the pre-2013 scheme benefits plants that were built before 1 January 2013, the status quo is that support will end at the end of 2022.[32] Therefore, the results from an overcompensation assessment for these plants would be unlikely to have any tractable policy implications, as we understand that the Flemish authorities do not intend to claw back

[32] See Table 2.1 for an overview of those installations with a ten-year initial support period.

overcompensation that has already been paid (and are not required to do so by the CEEAG). We consider the implications of extensions to the support in the context of possible overcompensation in section 2D.

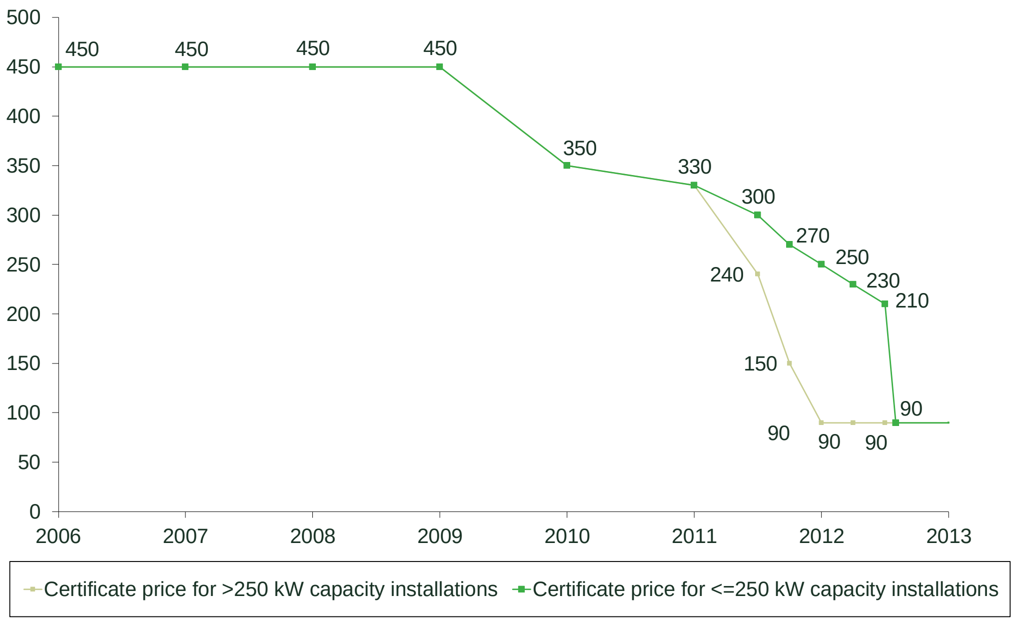
2.23 We also consider that it is relevant to assess whether plants using biogas from the fermentation of green waste with composting (*GFT*) have been overcompensated, as this is the only technology, other than solar PV, which received support over an initial 20-year period (see section 2C).

2B Overcompensation assessment for solar PV producers

2B.1 Structure of the assessment

2.24 In Table 2.1, we showed that, from 2006 to 2009, solar PV producers received a minimum support of €450 per certificate, corresponding to a certificate price of €450 for each MWh produced. The minimum price was revised to €350 per certificate in 2010 and gradually decreased to €90 in the final four months of 2012. The decrease in minimum prices per certificate was more gradual for solar PV installations with a capacity below or equal to 250kW compared with installations with a capacity above 250kW (see Figure 2.2).[33]

Figure 2.2 The evolution of certificate prices for solar PV (in €/MWh)



Source: Oxera analysis based on the 2009 Energy Decree, Article 7.1.6, §1.

2.25 The assessment that we have carried out aims to calculate the certificate prices that would have appropriately compensated solar PV electricity producers. In this context, appropriate compensation refers to a situation

[33] 2009 Energy Decree, Article 7.1.6, §1.

where the producer expects to receive a reasonable return on its investment, while avoiding overcompensation. By comparing the appropriate certificate prices with prevailing prices determined at the time, the extent of any over- or under-compensation can be quantified.

2.26 Our assessment of the appropriate certificate price considers only non-household solar PV electricity producers. This is because it is highly unlikely that households would receive a sufficient number of certificates to breach the *de minimis* aid threshold.[34] Under the *de minimis* threshold, only aid that cumulatively amounts to more than €200,000 over a period of three fiscal years per undertaking is subject to state aid rules.[35]

2.27 Our assessment of overcompensation excludes support given to solar PV installations with start dates between August 2012 and 31 December 2012, as the initial policy period for these installations was limited to ten years.[36] Therefore, as support for these installations is expected to cease to exist in the near future, the results of our assessment would, as discussed above, not lead to any tractable policy implications.

2.28 We have modelled the expected cash flows of non-household solar PV electricity producers based on the *onrendabele topberekening*[37] used by VEKA to calculate OTs since 2013. We have followed this approach as VEKA's model is more refined in terms of modelling taxes and the timing of cash flows than the models used in VITO's 2006 and 2010 assessments.

2.29 As set out in the following sub-section, we have reviewed the appropriateness of VITO's assumptions based on information that would have been available at the time when the plants were constructed (to the extent possible). This can be referred to as an 'ex ante' methodology, as we seek to determine the appropriate level of support to be awarded to plants built in any given year on a

[34] In particular, assuming that households do not benefit from other state aid measures, a household would need to receive more than 444 certificates at a minimum price of €450 over a three-year period to potentially breach the *de minimis* threshold. This would imply an annual electricity production of approximately 148MWh. Assuming on average 899 full load hours per year, this would mean that the installation would need to have a capacity of approximately 165kW, which significantly exceeds the size of typical household installations.
[35] European Commission (2012), 'Commission Regulation (EU) No 1407/2013 of 18 December 2013 on the application of Articles 107 and 108 of the Treaty on the Functioning of the European Union to *de minimis* aid', OJ L 352, 24 December, pp. 1–8.
[36] 2009 Energy Decree, Article 7.1.6, §1.
[37] See Vlaams Energie- & Kilmaatagentschap (2021), 'Berekeningstool_OT', 5 February, available at: https://www.energiesparen.be/monitoring-en-evaluatie/rapporten (accessed 31 May 2022).

forward-looking basis, based on assumptions that (to the extent possible) would have been available at the time when these plants were built.

2.30 Specifically, we consider that it would have been appropriate to review the minimum certificate price for new installations on a frequent basis, and at least once a year, in line with VEKA's approach under the 2013 scheme.

2.31 We have also altered VEKA's OT model to calculate after-tax cash flows to equity capital providers, rather than after-tax project cash flows.[38] This allows us to analyse the appropriate OT on the same basis as VITO used in its 2006 and 2010 analyses, which relied on after-tax cash flows to equity. We have then calculated the appropriate certificate price such that the expected NPV of the equity investment, after allowing for a reasonable return, equals zero.

2.32 As noted in paragraph 1.9, our overcompensation assessment relies on a reference plant based on information that would have been available at the time the plant was constructed (to the extent possible). This reflects the methodology that is widely used in the context of RES-E support schemes, including by VITO in its 2006 and 2010 assessments and by VEKA in the context of the 2013 scheme.[39] Specifically, this means that our analysis does not take into account project-specific features, e.g. with regards to the financing structure or the nature of contractual relationships with suppliers or clients. Such considerations instead relate to how investors and entrepreneurs decide on an ex post basis to structure and operate their projects, accounting for the green certificate price (among other aspects).

2B.2 Assumptions used in the overcompensation assessment

2.33 The OT model has been populated based on a combination of the assumptions from VITO's 2006 and 2010 OT calculations as well as assumptions that we have derived specifically for the purposes of this study, based on the evidence that would have been available contemporaneously. We have set out below

[38] In our modelling, we use the normative corporate tax rate in force in Belgium between 2006 and 2012 (33.99%). In practice, it is possible that a number of solar PV generators face an effective corporate tax rate (i.e. the corporate tax rate implied from the taxes that were actually paid) that is lower than the normative corporate tax rate. In such a situation, the OT that we calculate would be higher than the actual OT: our assumption is therefore conservative, as it overestimates the level of support that is appropriate for these plants, which means that we are less likely to find evidence of overcompensation.
[39] See, for example, VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, section 0 and VITO (2010), 'Onrendabele toppen van duurzame elektriciteitsopties 2010', November, p. II; and VEKA (2013), 'Rapport 2012—Definitieve berekeningen OT/Bf', p. 3.

those assumptions and calculations that differ from VITO's approach to calculate the OT in 2006 and 2010.[40]

2.34 The number of **full load hours** (*vollasturen*) underpinning our assessment corresponds to 899 full load hours, which exceeds VITO's 2006 and 2010 assumptions of 750 and 850 full load hours respectively.[41] In our view, the assumption of 899 full load hours is more appropriate.[42] This assumption has also been used consistently by VEKA since the 2013 scheme entered into force (i.e. in its calculations of OTs from 2013 onwards for solar PV installations owned by non-households).

2.35 The benefits of producing electricity that is used by the producer for its own purposes gives rise to cost savings (a so-called mitigated electricity expense).[43] In order to determine the appropriate level of support, it is important to account for this cost saving. Although VITO did account for the mitigated electricity expense in its calculations, we have recalculated the cost savings based on contemporaneous market data each year in order to estimate an appropriate OT. Specifically, we have estimated the **mitigated expense per kWh** of electricity from data from Eurostat on electricity prices for industrial consumers in Belgium for the relevant capacities.[44] The electricity prices have then been averaged over time, and exclude VAT and other

[40] Unless explicitly mentioned in this sub-section, the assumptions underpinning our calculations are the same as the assumptions adopted in VITO's 2006 and 2010 OT calculations. For example, our assessment is based on the same capacity assumptions as those used in the VITO reports, which are 2kW for the 2006–09 period, and 50kW, 250kW, 750kW and 1,500kW for the 2010–12 period.

[41] VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, p. 58; and VITO (2010), 'Onrendabele toppen van duurzame elektriciteitsopties 2010', November, p. 64.

[42] In particular, we understand that VEKA's assumption in its calculation of OTs from 2013 onwards is based on solar irradiation data from a tool administered by the European Commission, which enables the number of full load hours for Flemish municipalities to be determined, based on a number of technical assumptions. As a result, the assumption that we have adopted in relation to the number of full load hours is in line with actual data. See, for example, VEKA (2013), 'Rapport 2013/2—Deel 1: definitief rapport OT/Bf voor projecten met een startdatum vanaf 1 januari 2014', 28 June, section 5.1.2.1. We also consider that the stakeholder engagement process undertaken by VEKA as part of the 2013 scheme (in line with the 2009 Energy Decree, Article 7.1.4, §3, and as indicated in, for example, VEKA (2013), 'Rapport 2013/2—Deel 1: definitief rapport OT/Bf voor projecten met een startdatum vanaf 1 januari 2014', 28 June, p. 15 provides further evidence that assuming 899 full load hours, an assumption that has remained constant since 2014, is appropriate.

[43] In line with the assumptions adopted by VITO in their 2006 and 2010 reports, we have assumed that 100% of the electricity produced is self-consumed by the generator. Indeed, we understand that the adoption of this parameter aims at encouraging installations that entirely self-consume their electricity production. Given this objective, and while we understand that the level of self-consumption of actual plants might differ from this assumption, we consider that our analysis (which is based on a reference plant) should not depart from the self-consumption assumption that was used to determine the appropriate minimum certificate price (in 2006).

[44] See Eurostat (2022), 'Electricity prices for industrial consumers – bi-annual data (until 2007)', available at: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_205_h&lang=en (accessed 31 May 2022); and Eurostat (2022), 'Electricity prices for non-household consumers – bi-annual data (from 2007 onwards)', available at: https://ec.europa.eu/eurostat/databrowser/view/NRG_PC_205/default/table?lang=en (accessed 31 May 2022). The approach we have adopted to estimate the mitigated expense per kWh is in line with the methodology applied by VEKA from 2016 onwards. See VEKA (2015), 'Rapport 2015/1—Deel 1: definitief rapport OT/Bf voor projecten met een startdatum vanaf 1 januari 2016', 31 August, sections 5.2.3.1 and 5.3.3.1. In its report, VEKA notes that Eurostat data is representative of the electricity expenses of solar PV generators, based on surveys carried out by VEKA.

recoverable taxes and levies. Given that electricity prices on Eurostat are published with a lag, our analysis of the appropriate OT for a given year is based on electricity prices from the two previous years, indexed using an assumption for inflation. Specifically, end-user electricity prices are assumed to increase by 3.5% each year.[45]

2.36 In relation to the initial outlay of **CAPEX** (*investeringskosten)*, our assessment is based on the parameter values from the VITO reports to derive estimates of CAPEX expected in 2006 and 2010. We understand that VITO based these estimates on information available at the time.[46] Specifically, the initial CAPEX outlay in 2006 amounts to €7,000 per kW,[47] while the amount of CAPEX per kW in 2010 ranges from €3,000 for a 50kW installation to €2,200 for a 1,500kW installation.[48] The decline in costs between 2006 and 2010 is consistent with other sources of evidence regarding the evolution of investment costs for solar PV installations during these years (as shown in Figure 2.1 above).[49]

2.37 These anchor points for CAPEX from 2006 and 2010, together with a third anchor point based on the 2013 CAPEX assumptions used by VEKA to determine the appropriate level of support for plants commissioned in 2013,[50] are used to derive the CAPEX assumptions underpinning our calculations over the 2007–09 and 2011–12 periods. The assumptions have been derived based on interpolating the anchor points for 2006, 2010 and 2013, reflecting the trend in the evolution of CAPEX for solar PV installations in Germany over this period. The interpolation was informed by trends in Germany as a result of its comparatively large solar PV energy market compared with other EU countries

[45] This assumption is in line with VEKA's assumption in its post-2013 OT calculations. See, for example, VEKA (2013), 'Rapport 2013/2—Deel 1: definitief rapport OT/Bf voor projecten met een startdatum vanaf 1 januari 2014', 28 June, section 14.
[46] See VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, section 3.8.1; and VITO (2010), 'Onrendabele toppen van duurzame elektriciteitsopties 2010, November, section 3.5.2.
[47] VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, section 3.8.1.
[48] VITO (2010), 'Onrendabele toppen van duurzame elektriciteitsopties 2010', November, section 3.5.2.
[49] As shown in Figure 2.1 and in International Energy Agency (2012), 'National Survey Report of PV Power Applications in Germany', July, p. 25, or Lawrence Berkeley National Laboratory (2019), 'Tracking the Sun—Pricing and Design Trends for Distributed Photovoltaic Systems in the United States', October, p. 18, these reports show that investment costs relating to solar PV have significantly declined in Germany and the USA over time, including over the 2006–10 period.
[50] See VEKA (2013), 'Centraal Parameterdocument', 8 January, section 'overzicht parameterwaarden', sub-section 2.

at the time of the pre-2013 scheme.[51] In light of this, publicly available data for Germany over the 2006–12 period is also more readily accessible.[52]

2.38 Specifically, we have considered a German index of system prices for solar PV, which is available over time on a quarterly basis.[53] We assume that an appropriate value for CAPEX in any given year reflects the CAPEX observed in the fourth quarter of the previous year. On this basis, and in order to determine appropriate CAPEX assumptions for the 2007–09 and 2011–12 periods, we have followed the steps outlined below.

- First, we have calculated the variation observed in the index of system prices for solar PV in Germany between the fourth quarters of each consecutive year over the relevant period. We have also calculated the cumulative price decrease observed between the fourth quarters of 2005 and 2009, and also between the fourth quarters of 2009 and 2012.[54]
- Second, based on this trend, we have then calculated the contribution of each year to the cumulative price decrease observed for the index of system prices for solar PV in Germany between the fourth quarters of 2005 and 2009, and also between the fourth quarters of 2009 and 2012. In other words, we have calculated the proportion of the cumulative price decrease that is imputable to any given year.[55]
- Third, based on the anchor points (i.e. the CAPEX assumptions for 2006, 2010 and 2013 for solar PV from the VITO and VEKA reports), we have calculated the overall price decrease between the anchor points (i.e. 2006, 2010 and 2013).

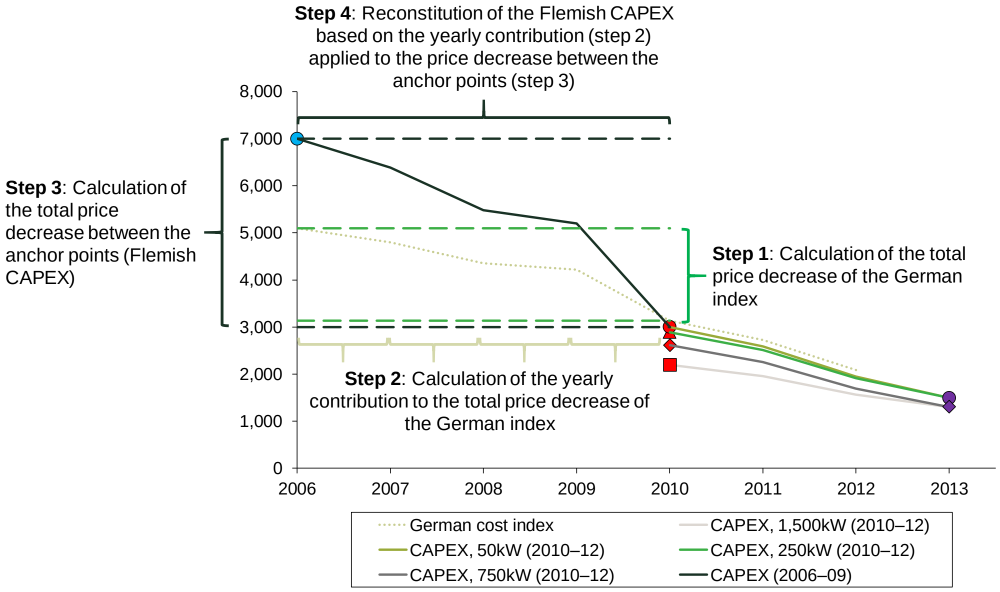
[51] See Arantegui, R.L. and Jäger-Waldau, A. (2018), 'Photovoltaic and wind status in the European Union after the Paris Agreement', *Renewable and Sustainable Energy Reviews*, January, **81**:2, pp. 2460–2471, Figure 4.
[52] The evolution of the CAPEX assumptions adopted in our calculations has been informed by CAPEX data reported for Germany in International Energy Agency (2012), 'National Survey Report of PV Power Applications in Germany', July, p. 25.
[53] Ibid. The index tracks the 'average end-customer prices (system prices) for installed roof-mounted systems of up to 100 kilowatt peak per kilowatt peak without tax'. We do not consider the level of the price index, but rather its quarter-on-quarter variations.
[54] As set out in paragraph 2.38, the assumption for investment costs that is used to determine the level of support for any given year is based on the fourth quarter of the previous year. Therefore, given that our anchor CAPEX points are for the years 2006, 2010 and 2013, we use quarter-on-quarter variations between the years 2005 and 2009, and between the years 2009 and 2012, in order to determine the yearly assumptions.
[55] Given that our methodology uses anchor points based on VITO's estimates from 2006 and 2010 and VEKA's estimate for 2013, the overall price decrease observed between 2006 and 2010 is constrained by the values of these anchor points. As a result, and in order to derive appropriate CAPEX assumptions on a yearly basis, it is necessary that we decompose the overall price decrease into yearly price decreases. In order to do so, we rely on the German price index.

- Finally, we have combined our calculations of the decrease in investment costs between the anchor CAPEX points, and our analysis of the trends observed for system prices for solar PV in Germany, to calculate yearly CAPEX assumptions that underpin our analysis. In practice, we have calculated the yearly price decrease assumed in the overcompensation assessment on the basis that the contribution of each year to the price decrease between the anchor points is the same as the contribution calculated based on the index of system prices for solar PV in Germany.

2.39 As a result of the approach outlined above, the assumptions for CAPEX that underpin our analysis do not reflect the absolute level of prices in Germany (as captured by the index). Instead, we have transposed the price dynamics of the German cost index between our anchor points, which are based on the VITO and VEKA reports, which in turn rely on data (including CAPEX data) that is appropriate in the context of the Flemish market. The resulting estimates of CAPEX that underpin our analysis are therefore reflective of the Flemish market.

2.40 The relevant steps are illustrated in Figure 2.3 below.

Figure 2.3 Deriving estimates of CAPEX for solar PV installations built between 2006 and 2012



Note: The blue, red and purple shapes represent the CAPEX anchor points (i.e. based on VITO's estimates for 2006 and 2010 and VEKA's estimate for 2013). In order to derive the CAPEX for the reference plant between 2006 and 2009, we use the CAPEX estimate underpinning VITO's 2010 report for the 50kW reference plant as the relevant anchor point. We also assume that the unit investment costs between 2010 and 2012 converge towards two different VEKA 2013 anchor points: one for low-capacity reference plants on the one hand (50kW and 250kW), and one for high-capacity reference plants on the other (750kW and 1,500kW). We therefore have four different profiles of investment costs between 2010 and 2012, converging to only two profiles in 2013. The German cost index curve indicates the values for the fourth quarter of the previous year.

Source: Oxera analysis based on VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, section 3.8.1; VITO (2010), 'Onrendabele toppen van duurzame elektriciteitsopties 2010', November, section 3.5.2; VEKA (2013), 'Centraal Parameterdocument', 8 January, section 'overzicht parameterwaarden', sub-section 2; International Energy Agency (2012), 'National Survey Report of PV Power Applications in Germany', July, p. 25.

2.41 In contrast to VITO's 2006 and 2010 assumptions, our assessment includes operating and maintenance ('O&M') costs and replacement investments for replaceable components, in particular the solar inverter, in line with the methodology adopted by VEKA for the 2013 scheme.[56] The inclusion of O&M costs will reduce the expected profitability of the installation, implying that we would be less likely to conclude that there has been overcompensation.

2.42 Annual **O&M costs** are estimated to amount to €35 per kW for 2006 and €20 per kW for 2012. These values are consistent with evidence that O&M costs for solar PV installations typically represent (depending on the source) between 0.5% and 3% of total investment costs.[57] They are also consistent with the O&M assumption used by VEKA in 2013.[58] O&M costs over the 2007–11 period have been derived based on linear interpolation between €35 per kW and €20 per kW, in order to account for decreasing O&M costs over this period.

2.43 The solar inverter is assumed to be replaced every 12 years. This **replacement investment** (*vervangingsinvestering*) is modelled as 5% of the initial CAPEX in 2006 and 10% of the initial CAPEX in 2011, with replacement investment costs over the 2007–10 period derived using linear interpolation. In 2012, the replacement investment is assumed to amount to 10% of the initial CAPEX. The cost of replacement investments is capped at €350 per kW in any year. This in line with evidence that inverter costs typically represent 5% to 10% of a plant's CAPEX.[59] The evolution of replacement investment costs assumed in our analysis results in an assumption for 2012 that is consistent

[56] The solar inverter is used to convert direct current ('DC') output of a solar panel to alternating current ('AC') output. We note that the 2010 VITO report also adopts an assumption for replacement investment.
[57] Ea Energy Analyses (2008), 'Renewable Energy Costs and Benefits for Society', p. 97. Our assumption for 2006 amounts to 0.5% of that year's CAPEX assumption, whereas our assumption for 2012 is equal to around 1% to 1.3% of the corresponding CAPEX assumption.
[58] See VEKA (2013), 'Centraal Parameterdocument', 8 January, section 'overzicht parameterwaarden', sub-section 2. In this report, VEKA uses O&M cost assumptions of €19 and €14 per kW, i.e. 1.1% or 1.3% of CAPEX, depending on the reference plant's capacity. The fact that our O&M assumption is independent of the reference plant's capacity between 2010 and 2012 is likely to result in underestimating any overcompensation for plants with higher capacity, which might benefit from lower O&M costs per unit of capacity (and therefore should be awarded a lower level of support).
[59] See, for example, U.S. Department of Energy (2010), '2008 Solar Technologies Market Report', January, section 3.6; and International Energy Agency (2007), 'Cost and performance trends in grid-connected photovoltaic systems and case studies', December, p. 8.

with VEKA's assumption in its calculation of the level of support for plants commissioned in 2013.[60]

2.44 The after-tax (nominal) required **return on equity** is estimated to be 8% between 2006 and 2012. This is consistent with VITO's assumption in its 2006 report, and is also broadly consistent with estimates from the economics literature.

2.45 In particular, Donovan and Nuñez (2010) consider the after-tax cost of equity based on the capital asset pricing model, in the context of renewable energy in emerging markets. Over the period 2006–09, the authors find that the nominal cost of equity ranges from 6.6% to 14.5% on an after-tax basis.[61]

2.46 De Jager and Rathmann (2008) find that the after-tax (nominal) required returns on equity for technologies covered by renewable electricity support schemes ranged from approximately 12% to 15% for generic support schemes, while an after-tax (nominal) return on equity of approximately 7–10% is required in the context of advance support schemes.[62] Given that the Flemish pre-2013 support scheme covers an initial 20-year support period with the support depending on the particular technology, it closely resembles an advanced support scheme.[63] Therefore, the assumption we have adopted of 8% for the after-tax return on equity is consistent with the range identified in these studies.

2.47 The adopted assumption of a return on equity of 8% differs from VITO's 2010 report, which assumed a 15% after-tax return on equity. We note that this 15% return on equity was criticised by the Belgian federal regulator of energy (the 'CREG') in a study carried out in May 2010, where the regulator noted that this return on equity assumed a high degree of risk, which was not necessarily warranted as solar PV producers benefit, as a result of the green certificates, from guaranteed revenues over the 20-year support period.[64] We also

[60] VEKA (2013), 'Centraal Parameterdocument', 8 January, section 'overzicht parameterwaarden', sub-section 2.
[61] Donovan, C. and Nuñez, L. (2012), 'Figuring what's fair: The cost of equity capital for renewable energy in emerging markets', *Energy Policy*, January, **40**, pp. 49–58.
[62] de Jager, D. and Rathmann, M. (2008), 'Policy instrument design to reduce financing costs in renewable energy technology projects', October, Figure 2-7.
[63] See de Jager, D. and Rathmann, M. (2008), 'Policy instrument design to reduce financing costs in renewable energy technology projects', October, p. 26, and European Wind Energy Association (2005), 'Support Schemes for Renewable Energy: A Comparative Analysis of Payment Mechanisms in the EU', May, pp. 46–47 for a discussion on the distinction between generic and advance support schemes.
[64] CREG (2010), 'Studie over de verschillende ondersteuningsmechanismen voor groene stroom in België', 20 May, p. 32. We note that the CREG still calculated an OT based on a 15% return on equity, but also carried out a sensitivity analysis assuming a 5% return on equity.

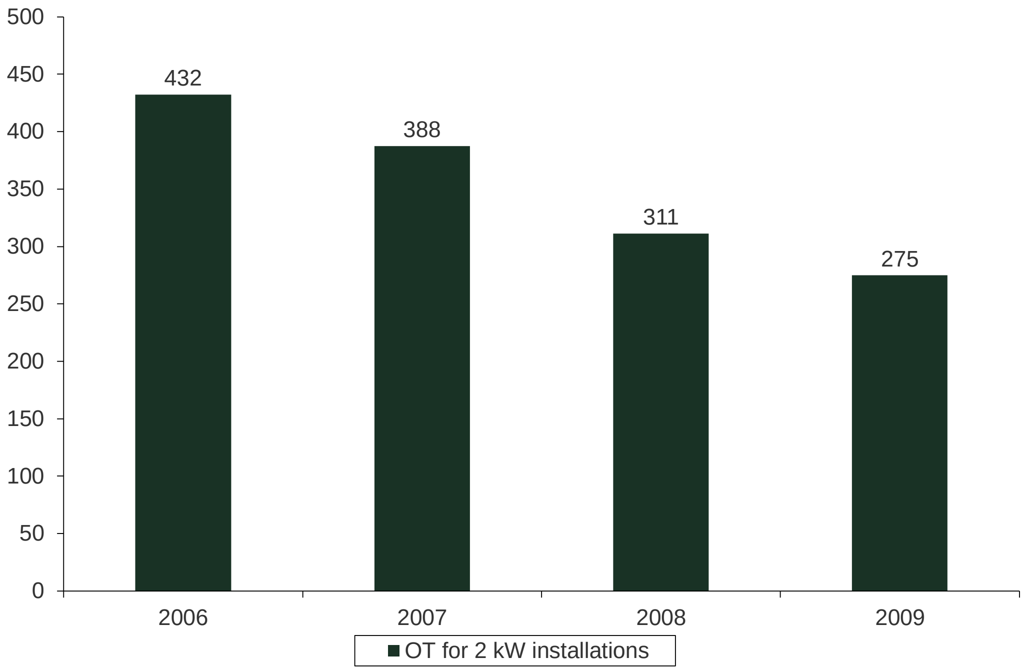
understand that the 15% after-tax return was based on a ten-year modelling period,[65] while solar PV benefited from an initial 20-year period of minimum support. The extended support for solar PV arguably makes the investment less risky, highlighting the appropriateness of using a lower return.

2.48 A full overview of the parameters underpinning the assessment of the appropriate certificate price for solar PV is presented in Appendix A1.

2B.3 Results of the overcompensation assessment

2.49 For each of the years over the 2006–12 period, we have calculated the level of OT per MWh. As shown in Figure 2.4 and Figure 2.5, the OT has consistently declined over time from €432 per MWh for installations with start dates in 2006 to €75 per MWh for 1,500kW installations in the year 2012.

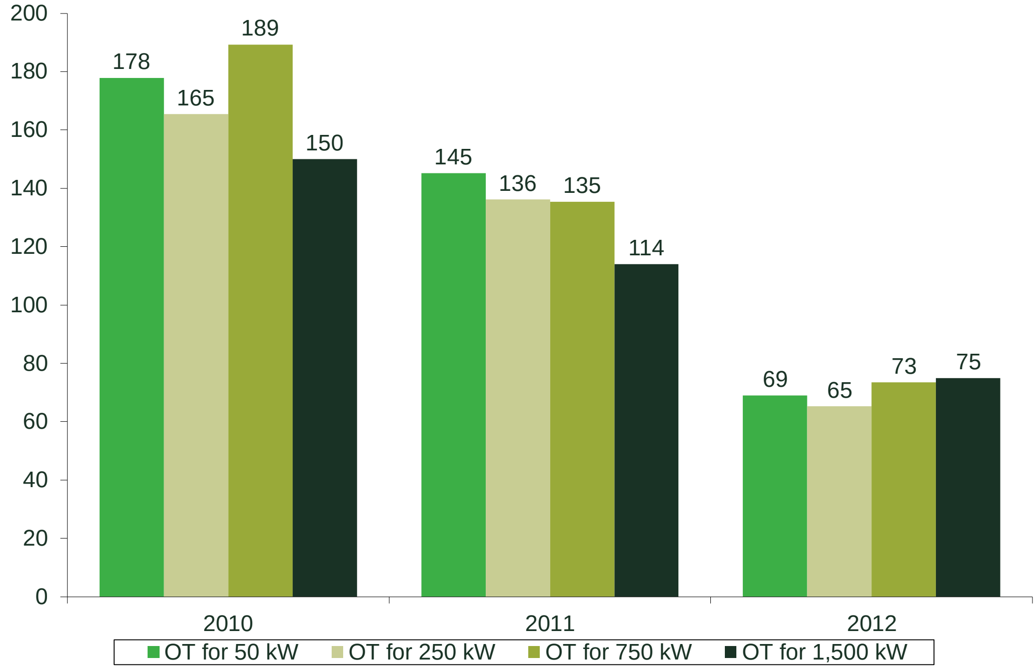
Figure 2.4 OT for 2kW solar PV installations, 2006–09 (in €/MWh)



Source: Oxera analysis.

[65] Commissie Benchmarking Vlaanderen (2007), 'Rentabiliteitsberekening Appendix', 24 April.

Figure 2.5 OT for 50–1,500kW solar PV installations, 2010–12 (in €/MWh)



Source: Oxera analysis.

2.50 The OT per MWh corresponds to the appropriate certificate price. Comparing this with the actual prices of the certificates, as presented in Figure 2.2, shows that the current certificate prices result in the overcompensation of solar PV generators built between 2006 and July 2012. The amount of overcompensation is presented in Table 2.2 below.

Table 2.2 Overcompensation for non-household solar PV installations 2006–12

Category	Certificate price (€/MWh)	OT result (€/MWh)	Over-compensation (€/MWh)	Over-compensation (%)	Internal rate of return on equity (%)
2006	450	432	18	3.9%	8.8%
2007	450	388	62	13.9%	11.3%
2008	450	311	139	30.8%	17.7%
2009	450	275	175	38.9%	21.9%
2010: 50kW	350	178	172	49.2%	26.5%
2010: 250kW	350	165	185	52.7%	29.5%
2010: 750kW	350	189	161	45.9%	29.2%
2010: 1,500kW	350	150	200	57.2%	45.3%
2011 H1: 50kW	330	145	185	56.0%	33.4%
2011 H1: 250kW	330	136	194	58.7%	36.5%
2011 H1: 750kW	330	135	195	59.0%	42.3%
2011 H1: 1,500kW	330	114	216	65.6%	59.1%
2011 Q3: 50kW	300	145	155	51.6%	27.6%
2011 Q3: 250kW	300	136	164	54.6%	30.2%
2011 Q3: 750kW	240	135	105	43.6%	21.8%
2011 Q3: 1,500kW	240	114	126	52.7%	29.9%
2011 Q4: 50kW	270	145	125	46.2%	22.4%
2011 Q4: 250kW	270	136	134	49.6%	24.5%
2011 Q4: 750kW	150	135	15	9.7%	9.5%
2011 Q4: 1,500kW	150	114	36	24.3%	12.5%
2012 Q1: 50kW	250	69	181	72.4%	44.2%
2012 Q1: 250kW	250	65	185	73.9%	46.3%
2012 Q1: 750kW	90	73	17	18.3%	10.2%
2012 Q1: 1,500kW	90	75	15	16.3%	10.1%
2012 Q2: 50kW	230	69	161	70.0%	38.1%
2012 Q2: 250kW	230	65	165	71.6%	39.9%
2012 Q2: 750kW	90	73	17	18.3%	10.2%
2012 Q2: 1,500kW	90	75	15	16.3%	10.1%
2012 July: 50kW	210	69	141	67.1%	32.6%
2012 July: 250kW	210	65	145	68.9%	34.1%
2012 July: 750kW	90	73	17	18.3%	10.2%
2012 July: 1,500kW	90	75	15	16.3%	10.1%

Note: The percentage of overcompensation is calculated by dividing the overcompensation by the certificate price. Small differences may occur due to rounding when calculating the percentage of overcompensation.

Source: Oxera analysis.

2.51 The degree of structural overcompensation can be expressed by dividing the euro amount of overcompensation by the minimum support: the resulting percentage represents the extent to which the actual certificate price exceeds the appropriate certificate price that would result in the generators earning a ‘reasonable’ return. This percentage varies over time and across capacity bands. In particular, the percentage of overcompensation ranges from 3.9% to 73.9% of the actual certificate price. This means that there the current scheme results in systematic and sometimes substantial structural overcompensation for reference plants that were built between 2006 and July 2012.

2.52 Table 2.2 also presents the internal rate of return on equity[66] achieved by the reference plant, depending on its year of commissioning and its capacity. The internal rate of return on equity is based on the assumptions outlined in section 2B.2 and assumes that the reference plant receives the minimum certificate price as stipulated in the 2009 Energy Decree.[67] These returns can be compared to the assumption of a reasonable return of 8%, as discussed in paragraphs 2.44 to 2.47. Specifically, returns in excess of the reasonable return of 8% show evidence of overcompensation. In this regard, we note that the internal rates of return on equity range from 8.8% to 59.1%.

2.53 Our finding of overcompensation is consistent with studies that were carried out in the early 2010s, which considered that the pre-2013 scheme was likely to overcompensate solar PV producers. In particular, the CREG’s study calculated that the appropriate level of support for solar PV generators should have been €228/MWh.[68] Our results are also consistent with the findings from the SERV in 2011.[69] While these studies arrive at this conclusion using assumptions that differ from our assumptions, their findings corroborate our own conclusions and findings of overcompensation. We also note that, while our analysis has been undertaken in 2022, concerns regarding

[66] In a valuation model, the internal rate of return represents the discount rate that makes the NPV of the expected cash flows generated by a project equal to 0. We have calculated the internal rate of return on equity, in order to compare it to the appropriate return target used in our OT calculations, which is a return on equity.
[67] Specifically, we have calculated the internal rate of return on equity based on the same assumptions as in our OT model; however, we have modelled the cash flows arising from the revenues generated by the sale of certificates at the minimum price indicated in the 2009 Energy Decree, depending on the year of commissioning and the capacity of the reference plant.
[68] CREG (2010), ‘Studie over de verschillende ondersteuningsmechanismen voor groene stroom in België’, 20 May, section 3.1.2.1. The CREG also carried out a sensitivity analysis using a 5% return on equity target, which resulted in an OT of €195 (see *Bijlage 3*). In 2010, the CREG was responsible for setting the tariffs of the Flemish network companies, which covered the costs incurred by distribution networks in relation to their purchase of green certificates at a minimum price. Therefore, the CREG had an interest in analysing potential overcompensation.
[69] SERV (2011), ‘Rapport Hernieuwbare Energie—Informatiedossier voor het debat’, 6 April, pp. 423–427.

overcompensation had already been raised by the Belgian and Flemish institutions when the pre-2013 scheme was still in force.

2C Overcompensation assessment for biogas from fermentation of green waste with composting (*GFT*)

2.54 In contrast to solar PV generators, the minimum certificate price for biogas from the fermentation of green waste with composting (*GFT*) remained constant over the course of the pre-2013 scheme, at €100 per certificate (as shown in Table 2.1). The initial support period for biogas from the fermentation of green waste with composting (*GFT*) is 20 years.[70]

2.55 Based on data from VEKA, only two projects using this technology have been implemented under the pre-2013 scheme, in 2001 and 2003. This is corroborated by VITO in its 2006 report[71] and by VEKA in its reports that discuss the determination of the level of support under the 2013 scheme.[72] According to VITO, the reason for such a low take-up of support for this particular technology is due to such projects being implemented only by municipalities (such as the two projects mentioned above). VITO notes, in particular, that it would expect private investors to use other technologies.[73]

2.56 Given the limited take-up and the highly specific nature of this particular type of technology, an analysis of the extent of any overcompensation to a similar level of detail to that undertaken for solar PV generators is made difficult by significant data limitations. In light of a lack of independent sources of data for this technology, our assessment of potential overcompensation for this technology is therefore qualitative in nature, rather than quantitative.

2.57 We also note that, given the initial duration of support (20 years) and the construction dates of the two plants that use this technology (2001 and 2003), support for this technology under the pre-2013 scheme will have expired by the end of 2023. Furthermore, the pre-2013 scheme does not cover any other plants using this technology (aside from the two mentioned above).

2.58 We have examined VITO's calculations of the OT for this technology in its 2006 and 2010 reports. In these reports, VITO calculates an OT of €99/MWh (in 2006),[74] and €133–€144/MWh (in 2010, depending on the assumptions).[75]

[70] 2009 Energy Decree, article 7.1.6, §1.
[71] VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, section 3.4.5.
[72] VEKA (2013), 'Centraal Parameterdocument', 8 January, p. 31.
[73] VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, p. 37.
[74] VITO (2006), 'Onrendabele toppen van duurzame elektriciteitsopties in Vlaanderen', June, p. 38.
[75] VITO (2010), 'Onrendabele toppen van duurzame elektriciteitsopties 2010', November, p. 62.

Although we have not carried out a parameter-by-parameter audit of VITO's modelling, we have reviewed the structure of VITO's OT assessment for this specific technology. We have not identified any errors in the structure of VITO's calculations.

2.59 Based on our assessment, we have not seen any indication that biogas plants using the fermentation of green waste with composting (*GFT*) have been structurally overcompensated based on a €100 minimum certificate price.

2D Overcompensation in light of extensions of the support period for the pre-2013 scheme

2.60 As noted previously, most of the technologies covered by the pre-2013 scheme received support for an initial ten-year period. Given that the status quo is that support for these technologies will end no later than the end of 2022, we have not focused on these technologies for the purposes of our overcompensation assessment. This section, however, considers the implications of the potential for extensions to the support scheme.

2.61 As shown in Table 2.1, RES-E producers that make use of technologies other than solar PV and biogas from fermentation of green waste with composting (*GFT*) in principle receive support for an initial period of ten years.[76] The 2009 Energy Decree, however, provides the option of extending the support period for these installations. This extension is granted for the duration required for the installation to obtain the number of certificates that it initially expected to receive, based on the capacity and full load hours of the installation. In order to qualify for such an extension, three conditions must be met:[77]

- the installations were installed correctly and operated in an appropriate manner;
- the generation of green electricity is not through solar energy;
- the installation has received at least 5% fewer certificates than was initially envisaged based on its expected capacity and full load hours.

2.62 In addition to the option to extend the period of support mentioned above, all RES-E producers with installations covered by the pre-2013 scheme can

[76] In addition to solar PV, another exception to this is biogas from the fermentation of green waste with composting (*GFT*), which has an initial 20-year support period. See 2009 Energy Decree, article 7.1.6, §1.
[77] Ibid., article 7.1.1, §1.

request a five-year extension, with a potential renewal for five further years.[78] The number of certificates to be received per MWh of electricity produced over the five-year period of the extension is calculated based on a banding factor.[79] The banding factor reflects the investment value of the installation and of any additional investments that have not yet been depreciated. Additional investments are taken into account only if the value of such investments amounts to at least €100,000 net of depreciation, and if the investments relate to components that are required for electricity production.[80]

2.63 From an economics perspective, it is imperative to take into account the implications of extensions for the assessment of overcompensation. In principle, the granting of extensions does not by definition lead to overcompensation. In particular, overcompensation could be avoided if, at the time of the request, (i) the return earned by the RES-E producer has not exceeded a reasonable level; and (ii) the duration and amount of further support under the extension is limited to no more than the amount that would lead the RES-E producer to obtain a reasonable return over the remaining economic lifetime of the project.

2.64 In order to ensure that RES-E producers are not remunerated over and above a reasonable return, we recommend that extension requests should take into account the amount of support that has already been received, as well as the amount of support to be granted as part of any extension. By updating and extending the OT calculation of an existing project, both aspects could be taken into account.

2.65 In order to avoid less efficient RES-E producers receiving greater support than more efficient RES-E producers, this assessment could be carried out by calculating the OT for reference projects, rather than for individual installations.

[78] Ibid., article 7.1.1, §1.
[79] Under the 2013 scheme, banding factors determine the number of certificates that an installation receives per MWh of electricity produced. Banding factors are calculated by dividing a technology-specific OT by a scaling factor. See, for example, VEKA (2013), 'Rapport 2012—Definitieve berekeningen OT/Bf', section 2.
[80] See 2009 Energy Decree, article 7.1.1, §1.

3 Conclusions

3.1 We have undertaken an independent assessment of whether the pre-2013 Flemish green certificates scheme might overcompensate specific RES-E producers.

3.2 To the extent possible, based on contemporaneous evidence, we have reconstructed the appropriate calculation of the *onrendabele toppen* (OTs) for solar PV installations covered by the pre-2013 support scheme. The OT refers to the amount of support required per MWh of production such that the installation is expected to be profitable. The OT represents the amount of additional revenues (per MWh of production) that would be necessary for the generators to break even, after taking into account all costs and revenues.

3.3 Our results indicate that the pre-2013 scheme overcompensates solar PV generators built between 2006 and July 2012. This means that the current scheme results in systematic and sometimes substantial structural overcompensation for reference plants that were built in this period. Our results are consistent with findings from earlier studies, including a study by the CREG in 2010[81] and by the SERV in 2011.[82]

3.4 We have also assessed whether, under the pre-2013 scheme, biogas plants using the fermentation of green waste with composting (*GFT*) (which, similarly to solar PV, benefited from an initial 20-year support period) might be overcompensated. Although it was not feasible to scrutinise overcompensation in this context to the same level of detail as for solar PV, there are no indications that this technology has been structurally overcompensated under the pre-2013 scheme.

3.5 We have also considered possible ways in which to mitigate the risk of overcompensation when granting extensions to the scheme. We recommend that both past and future compensation to RES-E producers are considered when granting extensions following the pre-2013 scheme. In particular, we suggest that the OT calculations are updated (*actualiseren*) and extended for

[81] CREG (2010), 'Studie over de verschillende ondersteuningsmechanismen voor groene stroom in België', 20 May, section 3.1.2.1. In 2010, the CREG was responsible for setting the tariffs of the Flemish network companies, which covered the costs incurred by distribution networks in relation to their purchase of green certificates at a minimum price. Therefore, the CREG had an interest in analysing potential overcompensation.
[82] SERV (2011), 'Rapport Hernieuwbare Energie—Informatiedossier voor het debat', 6 April, pp. 423–427.

reference projects in order to avoid both structural and ex post overcompensation when assessing whether to grant extensions to the scheme.

A1 Solar PV parameters

Parameter	2006	2007	2008	2009	2010				2011				2012			
Gross electric power (kW)	2	2	2	2	50	250	750	1,500	50	250	750	1,500	50	250	750	1,500
Full load hours	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899	899
Economic lifetime (years)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Investment costs (€ per kW)	7,000	6,389	5,481	5,201	3,000	2,890	2,614	2,200	2,588	2,508	2,253	1,953	1,943	1,911	1,688	1,566
Fixed maintenance costs (€ per kW)	35	32.5	30	27.5	25	25	25	25	22.5	22.5	22.5	22.5	20	20	20	20
Replacement investments (€ per kW)	350	350	350	350	270	260	235	198	259	251	225	195	194	191	169	157
Lifetime of replaceable component (years)	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Share of own consumption (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Mitigated expense (€ per kWh in year of construction)	0.140	0.135	0.137	0.146	0.152	0.152	0.109	0.102	0.140	0.140	0.117	0.107	0.139	0.139	0.113	0.101
Inflation assumption (%)	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
Corporate tax rate (%)	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99	33.99
Investment deduction applicable	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Investment deduction rate (%)	14.5	14.5	14.5	14.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
CAPEX share eligible for deduction (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Investment support applicable	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No
Investment support percentage (%)	35	35	35	35	–	–	–	–	–	–	–	–	–	–	–	–
Maximum investment support (€)	3.6m	3.6m	3.6m	3.6m	–	–	–	–	–	–	–	–	–	–	–	–
Total additional costs (%)	70	70	70	70	–	–	–	–	–	–	–	–	–	–	–	–
Equity share of investment (%)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Debt share of investment (%)	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80	80
Interest on loan (%)	5	5	5	5	6	6	6	6	6	6	6	6	6	6	6	6
After-tax return to equity (%)	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Term of the loan (years)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Depreciation period (years)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Support period (years)	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20

Source: Oxera analysis.

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