Competitiveness of corporate sourcing of renewable energy

Annex A.2 to Part 2 *of the Study on the competitiveness of the renewable energy sector*

Case study: Primary Aluminium Alcoa and Norsk Hydro

ENER/C2/2016-501
28 June 2019

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Luxembourg: Publications Office of the European Union, 2019

ISBN: 978-92-76-09280-3
Doi: 10.2833/74611
Catalogue: MJ-02-19-622-EN-N

EUROPEAN COMMISSION

DIRECTORATE C
Renewables, Research and Innovation, Energy Efficiency

European Commission
B-1049 Brussels

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Table of Contents

1 Introduction

This case study focuses on corporate sourcing of renewable energy[1] (RE) in the **primary aluminium sector**. More specifically, it presents the European experience of two global leaders in the aluminium industry, i.e. **Alcoa** and **Norsk Hydro**. These companies operate aluminium smelters in many countries in the world, including three Member States (Germany, Slovakia and Spain) of the European Union (EU). Historically, Alcoa's and Norsk Hydro's aluminium smelters in Norway have been sourcing electricity via **hydropower power purchase agreements** (PPAs). In the last years, the two companies have also decided to fuel their operations in Norway via long-term **wind power PPAs**. Both companies also have experience in the generation of renewable electricity in extra-EU countries. Nevertheless, after assessing the available options, for the time being they have not been able to source renewable electricity in the EU. By comparing the Norwegian case with the challenges experienced in EU Member States, this case study devises policy recommendations aiming to **enable electricity-intensive industries to further contribute to the uptake of RE in the EU**.

2 Sector

According to the NACE (Rev.2) statistical classification of economic activities in the EU, aluminium makers belong to the **non-ferrous metals group** and are included in the class 24.42. This comprises primary and secondary aluminium production, as well as semi-manufactured aluminium products. The current case study focuses on the production of primary aluminium, which represents the most electricity-intensive link of the aluminium value chain (see Section 0 for further details).

Aluminium is the most abundant crustal metal on earth and its compounds account roughly for 7% of the earth's crust. First produced in 1808, the metal has become a central element at the core of industrialised economies. Aluminium has several physical properties that make its usage particularly attractive across different industries:[2]

- **Lightweight and excellent electrical conductivity**; as a result, aluminium wires are used on a large scale for electricity transmission.
- **High workability and strength**, often used in the production of vehicles (cars, trains, aircraft) and other industries where the combination of strength and low weight allows for highly efficient fuels properties.
- **Good thermal properties and good resistance to corrosion**. Aluminium is thus widely used in construction, conditioning, refrigeration and heating exchange industries.
- **High malleability**, which facilitates the production of thin rolls and sheets that are extensively used by the packaging industry.

The primary aluminium production process is elaborate, costly and energy consuming. Once produced, however, aluminium can be recycled indefinitely without losing its main properties. To obtain a final product suitable for industrial usage, three main production phases are generally distinguished:

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[1] Hereinafter, corporate sourcing of renewable energy refers to any active strategy implemented by aluminium operators to source renewable electricity via self-generation/self-consumption, renewable power purchase agreements (RE PPAs), unbundled guarantee of origins (GOs) and/or green energy offers (see the main report for further details).

[2] Bergsdal, H., Strømman, A. H., & Hertwich, E. G. (2004), *The aluminium industry-environment, technology and production*.

- The basic raw material **bauxite** needs to be extracted;
- Bauxite is then refined into a product called **alumina**; and eventually
- Alumina is smelted into **primary aluminium**, which is then cast into ingots.

Figure 1 Primary aluminium ingots

Source: Hydro

Smelting and casting of primary aluminium are integrated into all EU smelters. The smelting process (the Hall-Heroult process) is very **electricity-intensive** and is based on three main inputs: alumina, electricity and carbon (in the form of anodes). The smelting of alumina into aluminium is based on an electrolytic process, with temperatures as high as 960°C. During the process, a high current (200 to 600 kA) is passed through the electrolytic bath to produce aluminium metal.[3] Primary aluminium can be recycled and brought back to the market as secondary aluminium. Both primary and secondary aluminium serve as inputs for downstream transformers such as rolling mills, extruders and casters.

Aluminium is an **internationally traded commodity**, whose price is globally determined on the London Metal Exchange. There are 16 primary aluminium smelters active in the EU, run by 10 different companies.[4] The EU is a net importer of primary aluminium and imports account for more than 50% of the total consumption in the EU.[5]

[3] IEA (2012), Aluminium Production. Available at: https://iea-etsap.org/E-TechDS/PDF/I10_AlProduction_ER_March2012_Final%20GSOK.pdf
[4] Ten additional smelters, run by four different companies, are based in Iceland and Norway. Authors' elaboration on data provided by European Aluminium (data refer to 2017).
[5] Authors' elaboration on Eurostat and COMEXT (2018; data refer to 2016).

3 Companies

As mentioned, this case study focuses on the production of primary aluminium. Interviews were conducted with two leading players (Alcoa and Norsk Hydro), which pursue a **mixed competitive strategy**. On the one hand, as primary aluminium is a commodity traded on the London Metal Exchange, any producer of primary aluminium is requested to keep production costs under control, thus implementing a **cost-leadership strategy**. On the other hand, both Alcoa and Norsk Hydro are striving to innovate and serve the market with premium products, thus **differentiating** (to the extent possible) their offer from those of their main competitors.

Alcoa[6] is a global leader in the production of bauxite, alumina and aluminium products. Within Europe, the company operates in Spain, Norway and Iceland, with six aluminium smelters and one refinery. Three Alcoa smelters are in Spain.[7] In the rest of the world, Alcoa has sites in North and South America, the Middle East, and Oceania. Its operations range from the bauxite mining (Alcoa owns seven bauxite mines globally and manages four of them) to the alumina refining stream, where the company is the global leading producer. Alcoa is also an aluminium supplier, operating in the aluminium smelting, casting and rolling. Furthermore, in North and South America the company participates also in the energy market, with partnerships in several hydroelectric power plants. The company is continuously innovating its aluminium production processes: for instance, in 2018 Alcoa and Rio Tinto announced the creation of Elysis, a carbon-free aluminium smelting process.[8]

Norsk Hydro[9] is an integrated aluminium company leading all the streams of the aluminium value chain, from the extraction of bauxite to the production of primary metal, semi-finished products and final products. The company operates two smelters in the EU: one in Germany, the other in Slovakia.[10] Most of the European production capacity is concentrated in Norway. It has recycling, rolling and extrusion plants, as well as power plants. In fact, Hydro is among the largest producers of hydropower in Norway. The company is a global player employing 35,000 people in 40 countries (23 European countries, North and South America, the Middle East, Asia and Oceania) and serving 30,000 customers. Norsk Hydro’s products include extruded products, rolled products (e.g. strips, sheets and foils), bauxite and alumina, casthouse products (e.g. sheer ingots, remelt ingots, wire rod), and low-carbon aluminium products that are designed to meet customers’ sustainability goals[11] and to differentiate the company’s offer.[12]

4 Countries

In 2017, the EU primary aluminium production was distributed across **10 Member States**. Most of the plants were based in Germany (four), Spain (three) and France (two). As mentioned, Alcoa operates three smelters in Spain; Norsk Hydro manages one smelter in Germany and one in Slovakia. At the EU level, in 2016 the non-ferrous metal industry accounted for about 2% of the total final energy consumption for industry and services; **16% of the total energy consumed by such industry**

[6] For further detail, please see: https://www.alcoa.com/global/en/home.asp
[7] The smelters are in the following cities: Aviles, La Coruna and San Ciprian.
[8] For further details, please see: https://news.alcoa.com/press-release/alcoa-and-rio-tinto-announce-worlds-first-carbon-free-aluminum-smelting-process.
[9] For further details, please see: https://www.hydro.com
[10] The smelters are in the following cities: Neuss (Germany) and Ziar nad Hronom (Slovakia)
[11] See for instance: https://www.hydro.com/en/products/low-carbon-aluminium-hydro-4.0-and-hydro-75r/
[12] These products allow to achieve significant emissions reduction thanks to their use-phase benefits, such as light-weight mobility, low-energy consuming buildings, resource efficient packaging and further low-carbon applications.

came from renewable energy sources (RES).[13] Up to the end of 2018, one RE PPA was signed in Germany; no PPA was signed in Slovakia or Spain.[14] Whereas smelters run by Alcoa and Norsk Hydro in Iceland and Norway meet the lion's share of their overall energy demand via renewable electricity, in the EU these companies have not been able to actively source renewable electricity (see Section 0 for further details). Therefore, it is apparent that **more can be done to facilitate corporate sourcing of renewables in the aluminium industry**, thus contributing to the achievement of RE targets set by the EU.

5 Energy use

Globally, the most significant cost items for the production of primary aluminium include alumina, electricity, carbon and labour.[15] In the EU, **electricity costs represent about 40% of total production costs.**[16] Alumina is priced at the international level, and its cost is therefore roughly the same for all producers. By contrast, electricity costs vary from country to country. Interestingly, while electricity costs are local, the market price of aluminium is global, determined daily at the London Metal Exchange. Therefore, there is no room for aluminium producers to pass on local costs to their customers. This explains why the smelters are often located close to supplies of cheap and reliable electricity. Aluminium producers have a **flat consumption profile**; in other words, they demand the very same amount of electricity at every moment of the day, in every season of the year.

The aluminium industry is one of the **largest consumers of electricity**. The electricity consumption of a smelter may range between 1,000,000 and 15,000,000 MWh per year.[17] The electricity intensity of the production process in the EU is about 14 MWh/tonne of output (weighted average).[18] **Electricity prices** paid by EU primary aluminium producers includes several components. More specifically, on top of the energy components, network costs (e.g. dispatch, distribution, etc.), surcharges for renewable support schemes and other non-recoverable taxes are usually added. Electricity costs may be then reduced by payment for flexibility services to the grid and reimbursements/compensations compatible with EU state aid guidelines. Therefore, local power markets (setting the price of the energy component and revenues from flexibility schemes and affecting to some extent network costs) and EU/national regulatory frameworks (affecting to a large extent network costs, RE support schemes, other non-recoverable taxes and compensation to energy-intensive companies) have a major **impact on the competitiveness of the aluminium industry** and their long-term investment strategies. For the time being, the energy component[19] accounts for 80-90% of the electricity price paid by primary producers, while the regulated components make up 10-20% of the final price (the largest regulatory component reported by primary aluminium plants are network costs). Regulated components are relatively lower than those paid by secondary aluminium

[13] Authors' elaboration on Eurostat (2018). Figures on final consumption of RES-E are missing. Therefore, it is assumed that the share of RES-E in final consumption of electricity is equal to the share of RES-E in the national generation mix. This assumption is valid for the EU primary aluminium industry, as for the time being most of the EU smelters do not source renewable electricity via e.g. self-generation, RE PPA or green energy offers.
[14] European Commission's elaboration on Bloomberg Energy Finance.
[15] CEPS et al. (2013), Assessment of Cumulative Cost Impact for the Steel and the Aluminium Industry, European Commission.
[16] CEPS et al. (2019), Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries, European Commission.
[17] EU smelters are on the lower end of this range.
[18] CEPS et al. (2019), Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries, European Commission.
[19] It is worth remarking that the energy component includes also indirect EU ETS costs and taxation on power generation passed on downstream by electricity generators.

producers and downstream transformers (rollers, extruders, casters) due to two main factors: i) in line with the relevant EU state aid guidelines,[20] primary aluminium producers may be partially **exempted from surcharges for RE support schemes** and partially **reimbursed for indirect EU Emission Trading System (ETS) costs** passed on downstream by electricity generators; ii) primary aluminium producers are **very large**, **baseload consumers** and this is reflected in their contract prices (energy component).

6 RE procurement method and technology

For the time being, **no Alcoa's or Norsk Hydro's smelter based in the EU actively sources RE**. More specifically, to date Alcoa decided not to source RE in Spain after assessing the costs, benefits and risks stemming from two different procurement methods: i) self-generation/self-consumption via solar photovoltaic or wind inshore; and ii) RE PPAs with solar or wind electricity generators. In the same vein, based on its experience in electricity generation and PPAs in Norway, Norsk Hydro has not yet been able to find any viable option to source RE in the EU.[21]

Figure 2 Alco Mosjoen (Norway): Smelter sourcing electricity via RE PPAs

Source: Alcoa/Morten Eriksen (2019)

Alcoa has recently signed three long-term (15 years) PPAs[22] with wind energy generators in Norway for above 2.2 TWh per year in total (when fully operating); such agreements cover almost 50% of the current electricity demand of the company in the

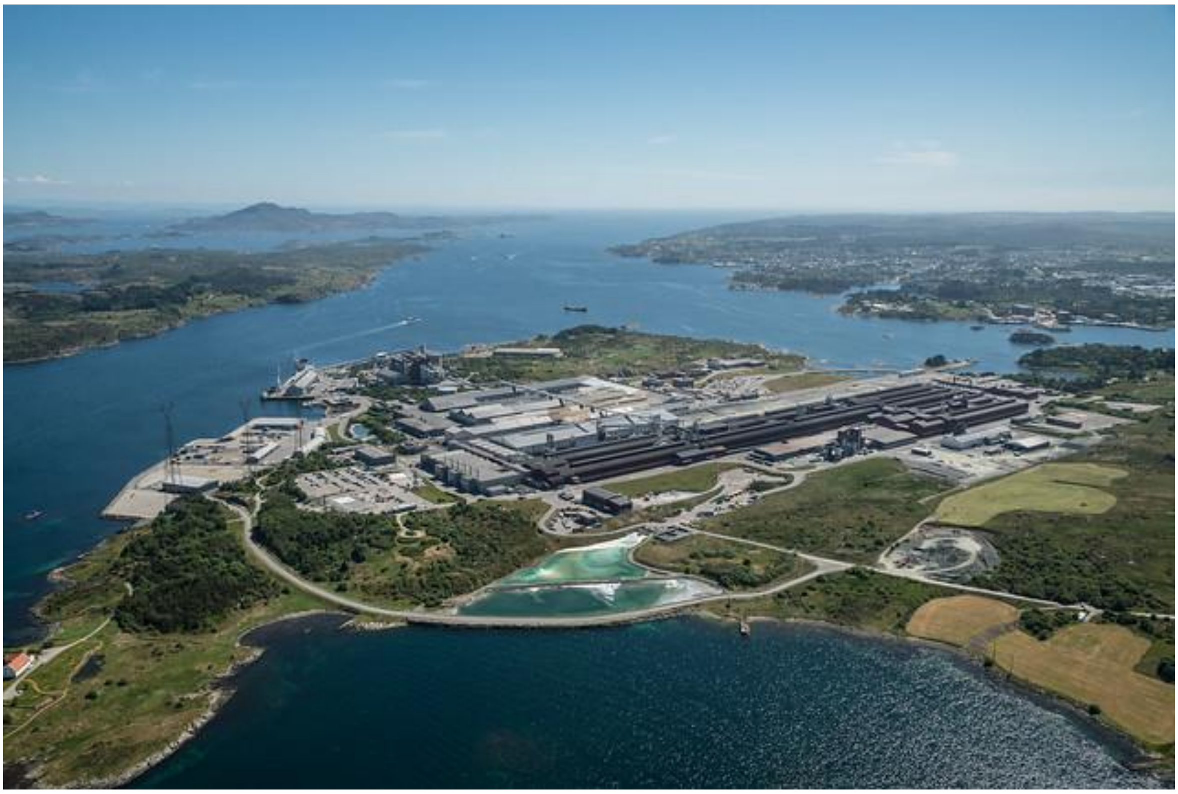
[20] For further details, see: Communication from the Commission — Guidelines on certain State aid measures in the context of the greenhouse gas emission allowance trading scheme post-2012 (SWD(2012) 130 final) (SWD(2012) 131 final) Text with EEA relevance, OJ C 158, 5.6.2012, p. 4–22; and Communication from the Commission — Guidelines on State aid for environmental protection and energy 2014-2020, OJ C 200, 28.6.2014, p. 1–55.

[21] Norsk Hydro entered a five-year PPA in Germany; however, this contract entails the purchase of 'grey' electricity.

[22] These three PPAs were signed between October 2017 and March 2018. Alcoa is the single off-taker for the three projects; all PPAs are direct.

country. Similarly, since 2014, Norsk Hydro has secured 14 long-term (10 years on average for the oldest contracts, 20-25 years for the most recent ones) PPAs with hydro and wind generators[23] to fuel its Norwegian production facilities with more than 9 TWh of renewable electricity per year (i.e. about 50% of the overall demand of the company in the country); interestingly, three of such agreements are signed with wind generators based in Sweden, which is possible in the interconnected Nordic electricity market. In this context, both companies are not interested in the guarantees of origin (GOs) linked to the renewable electricity purchased via PPAs: they report their emissions according to the standards established by the Greenhouse Gas Protocol put forward by WBCSD and WRI,[24] using the country electricity generation mix.

Figure 3 Hydro Karmøy (Norway): Smelter sourcing electricity via RE PPAs



Source: Hydro/Josten Viestad (2019)

RE PPAs in Nordic countries are quite appealing for four main reasons: i) competitive price of the energy component of the electricity price, as Norway and Sweden are a cost-effective wind and hydro location; ii) competitive price of the regulated components of the electricity price;[25] iii) competitive costs to adapt the wind production profile to the baseload profile of aluminium smelters, due to liquid electricity markets and the prominent role played by hydropower in the national energy mix[26]; and iv) market-based support schemes for renewables, which make PPAs an interesting financing mechanism for RE generators. In addition, as Nordic countries are characterised by a very stable regulatory framework, the overall electricity costs (including the energy component, the regulated components as well

[23] Four PPAs were signed in 2014, five between 2015 and 2016, additional five between 2017 and 2018. All PPAs are direct; Hydro is the single off-taker. About 46% of the electricity is generated by wind turbines.
[24] For further details, see: http://ghgprotocol.org
[25] Energy-intensive industries are exempted from the electricity consumption tax and from the costs of green certificates passed on in the energy component (Ecofys et al (2016), *Prices and Costs of EU Energy*, European Commission).
[26] For further details, please see: https://www.sintef.no/en/latest-news/norway-is-europes-cheapest-battery.

as reimbursements/compensations) tend to be quite stable and predictable. Finally, some PPAs are facilitated by the Norwegian Export Credit Guarantee Agency[27] that provides alternative collateral for the bank guarantee requested by renewable power generators.[28] It is apparent that when the **overall electricity market is competitive and support schemes are correctly designed**, both RE generators and aluminium producers have the right incentives to sign long-term PPAs.

Norsk Hydro is also generating between 8 to 10 TWh per year of **hydropowe**r in Norway. This corresponds to approximately 50% of the overall electricity demand of the company in the country. Therefore, Norsk Hydro entirely relies on green electricity in Norway.

Interestingly, Alcoa explored also the opportunity to use **renewable heating** (biomass) for their alumina refineries with the main purpose of reducing operating thermal energy costs. However, for the moment this option has been shelved.

7 Benefits for the primary aluminium industry

Self-generation and RE PPAs are considered interesting options to **increase the environmental sustainability** of primary aluminium producers and generate **positive impacts in terms of CSR**. Whereas this does not immediately translate in higher revenues or higher demand, customers, shareholders and potential investors are paying growing attention to environmental sustainability. For instance, green value chains are becoming increasingly important and some aluminium producers are trying to serve this niche market with *ad hoc* 'green' products.[29]

Both procurement methods can also contribute to the **stability of electricity prices**; this is considered one of the most important benefits, allowing for a **long-term investment strategy** in the EU. This specific benefit, however, is cost-effective only in those markets where generation and consumption profiles (see above) can be balanced at a competitive cost. Self-generation and RE PPAs may also allow increasing the **cost-competitiveness** of aluminium producers, by reducing their operating costs, which largely depend on electricity costs. This potential impact on competitiveness depends on trends in the market price for electricity, the technical features of the renewable plant (technology/source, construction year, location) and, when it comes to PPAs, on the timing of the agreement and the off-taker's ability to strike a good deal. As further discussed below, both cost-competitiveness and stability are affected by the **relevant EU and national regulatory frameworks**. RE PPAs are also appealing because no up-front capital is required (only operating costs), they allow to control the type/source of renewable electricity and may ensure 'additionality'.[30]

RE PPAs also represent a good option to **diversify electricity procurement** in combination with medium-term contracts with energy suppliers and direct spot purchase on the wholesale market.

8 Costs for the aluminium industry

Regardless of the potential benefits listed above, for the time being, **both Alcoa and Norsk Hydro did not invest in self-generation or sign RE PPAs in the EU**.

[27] For further details, see: please https://www.giek.no/frontpage/?lang=en_GB
[28] Nevertheless, both companies have emphasised that the absence of such support would not be a deal breaker.
[29] See for instance: https://www.hydro.com/en/products/low-carbon-aluminium-hydro-4.0-and-hydro-75r/
[30] The net incremental renewable capacity deployed as a direct result of the company's decision to source renewable electricity goes beyond what would occur in the absence of such decision. This does not apply, however, to PPAs signed with old hydropower installations.

When it comes to **self-generation**, the long-term investment risk appears to be too high, especially in markets where there is high uncertainty on future prices of electricity, which are largely affected by regulated components set up by national rules. Reportedly, market prices are relevant for two reasons. First, aluminium producers still look at market prices for balancing purposes as well as to meet the share of their electricity needs that are not covered by self-generation. Second, when taking an investment decision, they mostly look at opportunity costs; hence, high market prices for electricity would make it more profitable to sell the self-generated electricity on the market rather than self-consume such electricity to produce aluminium. Additional barriers include high up-front investment costs, inadequate return on investment and costs related to grid connection.

Primary aluminium producers are not directly concerned by **changes in support schemes** for renewable generation, which for instance in Spain have been quite frequent[31]. They are generally concerned by generous support schemes, as costs of such schemes may be charged to electricity consumers, thus inflating electricity costs. In the same vein, they do not consider the **variability (fluctuating nature) of solar and wind power** as a major obstacle to purchasing renewable electricity, as long as such variability can be addressed at a competitive cost in the power market. However, the need to balance the variability of renewable power makes RE costlier. The risks (and costs) stemming from the variable nature of some RE sources are directly borne by the company in case of self-consumption. They can be borne by either the company or the generator in case of RE PPAs. Of course, in case the risk stays with the generator, the final price per MWh agreed upon in a RE PPA is higher. In case the risk lies with the off-taker, the aluminium company will incur costs to either perform balancing activities in-house or swap the risk with third parties (e.g. traders or reinsurers).

While **RE PPAs** do not entail upfront investment costs, they are still quite problematic due to the long contract duration, especially when this is coupled with the **price risk** stemming from regulatory uncertainty. In fact, while in an RE PPA the price of the energy component[32] is agreed upon by the parties,[33] network costs and other non-recoverable taxes charged to electricity consumers still depend on national legislation. In addition, the final electricity costs for the aluminium producer will be affected by reimbursement/compensation depending on EU state aid guidelines and national budgets. In other words, a **PPA is a long-term price agreement**, rather than a cost agreement. As shown by the relevant literature,[34] components of the electricity price other than the energy component as well as reimbursements/compensations may represent a substantial share of the final electricity costs borne by energy-intensive companies. Therefore, multinational companies such as Alcoa and Norsk Hydro may decide to relocate their production activities in case increasing regulated components and/or indirect costs passed on downstream by electricity generators would make it too costly to produce primary aluminium in a certain EU country. Hence, the **risk stemming from long contract duration** becomes rather high. While aluminium

[31] Besides varying across years, some of the changes to support schemes introduced in Spain had retroactive effects (Eufores et al. (2015), *EU Tracking Roadmap 2015 – Keeping track of renewable energy targets towards 2020*).

[32] The negotiation over the energy price component is affected by the market price for electricity. In fact, RE generator may always chose between signing a PPA or selling the electricity on the market; hence, any deal will look at the relevant market price, although a discount may apply as the off-taker ensures a stable demand for many years. Reportedly, as the market price affects the deal, indirect EU ETS costs (that are accounted for in the market price) affect also the price of RE PPAs.

[33] Interestingly, as costs of RE generation are expected to go down (more capacity will be installed, installation costs will decrease, generators will compete with each other to secure funding), some companies are adopting a "wait and see" approach and may wait some years before entering new RE PPA.

[34] For further details, please see: CEPS et al. (2019), Composition and Drivers of Energy Prices and Costs: Case Studies in Selected Energy Intensive Industries, European Commission.

companies have in-house skills to cope with long-term forecasts of the energy component of the electricity price and can (either directly or via intermediaries) balance the variability of RE generation with their flat consumption profile, they have no commercial solution to address changes in regulated components of the electricity price or in reimbursement/compensation mechanisms. In addition, in some countries, some taxes are also charged on self-consumption of electricity (see for instance the so-called 'sun tax' in Spain[35]), thus making this option less attractive.

In spite of decreasing levelized cost of energy for solar and wind power, **RE PPAs are still quite expensive**. In fact, when negotiating the selling price, generators look at the wholesale market price rather than at generation costs, as the electricity market represents the main alternative to selling electricity via a PPA. This also means that **the 'strike price' in RE PPAs includes ETS costs** as long as such costs are embedded in the wholesale electricity price. In this respect, the current implementation of the relevant Commission's guidelines[36] in Germany discourages aluminium producers from signing RE PPAs. In fact, German companies purchasing renewable electricity are not allowed to get compensated for indirect EU ETS costs even if they pay a price very close to the wholesale market price, which includes such costs. Therefore, for energy-intensive companies, green electricity would cost substantially more than 'grey' electricity when accounting for missed reimbursements/compensations.

Also, **creditworthiness standards and/or bank guarantees** requested by the seller may be problematic and costly, especially in a market where credit institutes are not familiar with RE PPAs such as the Spanish one. In addition, in Spain and other EU countries, generous public support schemes reduced the generators' need for signing RE PPAs with corporates, insofar as stable revenues were ensured by public funding. By reducing the revenues stemming from support schemes and limiting the capacity financed via auctions, new market-based support schemes may increase the interest for RE generators to sign RE PPAs for funding new projects. It is worth remarking that both Alcoa and Norsk Hydro did not detect **any specific regulatory barrier** restricting corporate RE PPA in the EU country where they produce primary aluminium.

As mentioned, Alcoa explored also the opportunity to use renewable heating for their alumina refineries with the main purpose of reducing operating costs. However, for the time being, this option has been shelved, as it is still quite **difficult to procure the quantity of biomass required by a refining plant** at a reasonable price (including transport costs).

9 Policy recommendations

Both PPAs and self-generation require long-term commitments. Therefore, price risk and uncertainty about future electricity prices may discourage companies to purchase green electricity. Public policies may help mitigate such risks by **stabilising those components of the overall electricity costs that depend on the regulatory framework**; these include the regulated components of the electricity prices (network costs, surcharges for RE support schemes, other non-recoverable taxes) and the indirect EU ETS costs which are passed on by electricity generators and contribute to inflating the market price for electricity.[37]

[35] For further details, please see: https://www.renewableenergyworld.com/articles/2015/10/spain-approves-sun-tax-discriminates-against-solar-pv.html. However, this tax has been recently abolished.

[36] Communication from the Commission — Guidelines on certain State aid measures in the context of the greenhouse gas emission allowance trading scheme post-2012 (SWD(2012) 130 final) (SWD(2012) 131 final) Text with EEA relevance, OJ C 158, 5.6.2012, p. 4–22

[37] As mentioned, indirect EU ETS costs are embedded in the wholesale electricity price, therefore they are also reflected in the 'strike price' agreed upon in RE PPAs.

On the one hand, EU Member States should provide **long-term guidance when it comes to regulated components**; in fact, in the last decade, such components became a prominent part of the final energy prices, more than compensating the decrease registered in the energy component. On the other hand, the EU should draft **multiannual guidelines enabling compensation for indirect EU ETS costs and for RE support schemes**; in fact, the current guidelines were meant to last only five years, a time span that is much shorter than a standard PPA or the payback period of investments in self-generation. Ideally, long-term EU guidance should be accompanied by a **stable budgetary and regulatory framework** at the national level securing compensation for energy-intensive players. In addition, new EU guidelines for compensating indirect EU ETS costs should avoid the distortion introduced by the German implementation of the current guidelines and **make sure that also those companies that purchase electricity via RE PPAs are entitled to compensation**.

RE PPAs also require a **revision of the current RE support schemes** and the **introduction of market-based auction mechanisms** reflecting the reduction in renewable generation costs and making more interesting for generators to search for corporate buyers as an alternative to public support.

Reportedly, a stable medium- to long-term regulatory framework would provide aluminium companies with the right incentives to invest in self-generation and, more importantly, sign RE PPAs in the EU. For the time being, RE PPAs do not seem to enhance the cost-competitiveness of EU smelters; nevertheless, if Member States will manage in completing the green electricity transition and drive overall electricity costs down, aluminium producers and, more generally, **electricity-intensive sectors may find attractive again to operate production facilities in the EU**.

CASE STUDY

Primary Aluminium, Alcoa and Norsk Hydro

Source: Alcoa/Morten Eriksen (2019)

Source: Hydro/Josten Viestad (2019)

Overview

Alcoa

- Global leader in the production of bauxite, alumina and aluminium products
- 6 aluminium smelters and one refinery in Europe (Spain, Norway, Iceland); 3 smelters operated in Spain

Procurement method

- Norway: 3 long-term PPAs with wind generators for above 2.2 TWh/year (covering almost 50% of the current electricity demand in the country)
- Currently no active sourcing of RE in the EU

Norsk Hydro

- Integrated aluminium company leading all the streams of the aluminium value chain
- 2 aluminium smelters in the EU (Germany and Slovakia); most of the European production concentrated in Norway

Procurement method

- Norway: 14 long-term PPAs with hydro and wind generators (3 RE installations based in Sweden) for more than 9 TWh/year (about 50% of current electricity demand in the country); self-generation from hydropower (about 50% of current electricity demand in the country)
- Currently no active sourcing of RE in the EU

Energy use

- Range of electricity consumption of a smelter: 1,000,000 and 15,000,000 MWh/year
- Flat consumption profile
- Electricity costs represent about 40% of total production costs

Primary Aluminium, Alcoa and Norsk Hydro

Overview

Costs

- Self-generation: long-term investment risk, upfront investment costs, limited return on investment
- RE PPAs: long contract duration and price risk stemming from regulatory uncertainty, still quite expensive, creditworthiness standards and/or bank guarantees requested may be problematic and costly

Benefits

- Self-generation and RE PPA:
  - Environmental sustainability and CSR
  - Participation in green value chains
  - Stability of electricity prices, where generation and consumption profiles can be balanced at competitive costs
  - Potential reduction of production costs

Policy Recommendations

- Member States could provide long-term guidance when it comes to regulated components
- The EU could draft multiannual guidelines enabling compensation for indirect EU ETS costs and for RE support schemes
- Long-term EU guidance could be accompanied by a stable budgetary and regulatory framework at the national level securing compensation for energy-intensive players
- Make sure that also those companies that purchase electricity via RE PPAs are entitled to compensation for indirect EU ETS costs
- Revision of the existing RE support schemes and the introduction of market-based auction mechanisms