Aluminium Smelting in the Age of Renewable Energy and the Internet of Things

Geoff Matthews

The smelter of the future will need to fundamentally change the way it consumes energy. The world is changing around us and everyone and everything else will have. 1. Our consumer base will expect us to evolve with them. 2. There will be significant financial incentives to do so. 3. Grids heavy with renewable energy will seek to partner major industrial users who can vary energy consumption. The age of renewable energy is upon us, or possibly more correctly put, the age of seeking a low emissions future is upon us.

Keywords:
Aluminium – Smelting – Renewable energy – IoT

Aluminiumverhüttung im Zeitalter erneuerbarer Energien und des Internets der Dinge

Das Hüttenwerk der Zukunft muss sich hinsichtlich des Energieverbrauchs fundamental ändern. Die Welt um uns herum ändert sich und jeder und alles wird sich ebenfalls ändern müssen. 1. Unsere Kunden erwarten, dass wir uns mit ihnen gemeinsam entwickeln. 2. Es wird signifikante finanzielle Anreize geben, um diese Wende zu vollziehen. 3. Netze mit einem hohen Anteil an erneuerbarer Energie werden große Industriepartner suchen, die in der Lage sind, ihren Energieverbrauch zu variieren. Wir befinden uns im Zeitalter der erneuerbaren Energien oder, besser gesagt, im Zeitalter der Suche nach einer Zukunft mit geringeren Emissionen.

Schlüsselwörter:
Aluminium – Verhüttung – Erneuerbare Energie – IoT

La fusion de l'aluminium dans l'ère de l'énergie renouvelable et de l'Internet des objets

Fundición de aluminio en la era de energía renovable y el Internet de las cosas

1 Introduction

The public mood is shifting and consumers are driving change, but what does this mean for aluminium smelting, and what does the Internet of Things (IoT) have to do with anything? There have been a number of large societal shifts and upheavals over the last 125 years, but aluminium smelting has endured almost unchanged, as if impervious to the changes going on around us. Can we do this again during a time when energy, the second biggest cost input to primary aluminium production, is undergoing unprecedented structural and technological change? This time I think it will be different, as not only is the world is changing around us, but everyone and everything else will have to change as well. It is possible that no one on the planet will be unaffected by the changes to our energy systems over the next 20 to 30 years. For decarbonisation to occur we must all fundamentally change the way we consume energy. Aluminium smelting cannot afford to ignore, or be isolated from, its consumer base when it comes to decarbonisation. Some of the biggest brands on the planet, and some of our biggest customers, are now starting to weave a sustainability story that involves us. Fortunately, the changes to electricity generation offer aluminium smelters a potential upside. There will be significant financial incentives for large industrial users who can vary energy consumption, as grids heavy with renewable energy seek to partner with those who can help balance the grid.

2 The problem

For most countries, reducing CO_2 emissions is reliant on clean, renewably sourced energy. The problem is that there are no easy wins when moving to a renewables heavy grid. Since 1882, the steam valve has been used to keep our energy grids in balance, without the need for storage. The rules used to be simple. Exactly the same amount of active power must be generated as is being consumed – a balanced system. Thermal power stations have been able to supply exactly the right amount of power as was being consumed at any given time, thus providing reasonably stable energy grids to forge ahead and build a modern world. The problem with electricity generated from renewable solar and wind sources is that they are intermittent and flow directly into the grid, creating two sorts of power; variable and dispatchable. At certain times of the year with variable power generation, 24-hour net load curves produce the appearance of a duck (the duck curve). These conditions provide a headache for the electricity generator. Short steep ramps mean they must quickly bring on, or shut down, dispatchable generation resources to meet the electricity demand, and to maintain grid reliability. To replace dispatchable power generation with variable generation, we need demand-side response. Essentially consumers of electricity need to learn how to make hay while sun shines, and the wind blows.

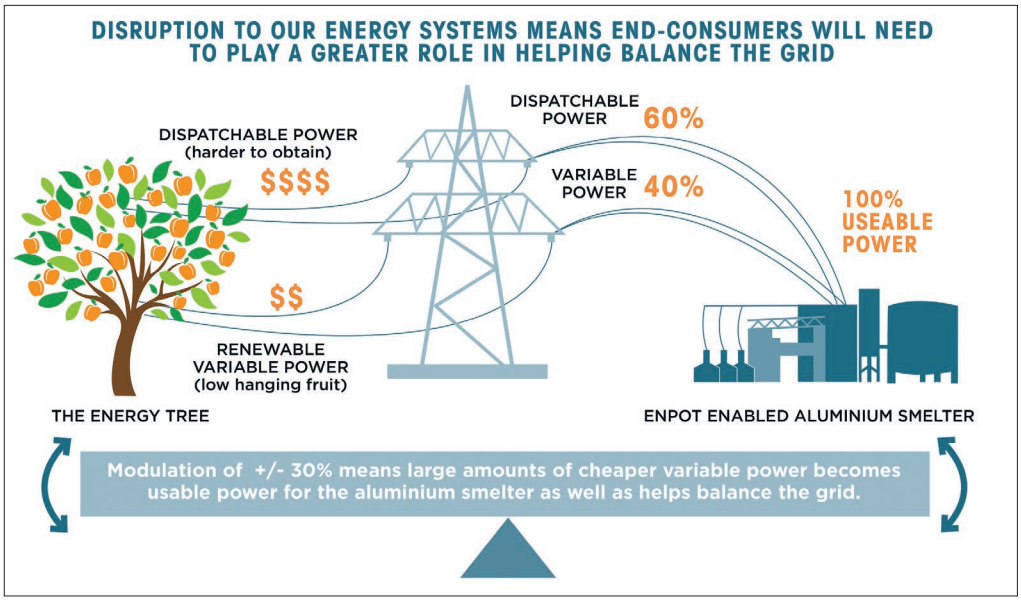

Fig. 1:
Modulating aluminium smelters can facilitate the increase use of renewable generation and aid decarbonisation (note: while all smelters should be able to go down in consumption, many would require infrastructure upgrade to go up in consumption)

3 Technologically short

The problem of intermittency is compounded by the fact that we are currently "technologically short" when it comes to technologies that can help with demand-side response:

- Grid level batteries and storage systems are in their infancy, and so to with virtual mega grids.
- Household batteries and smart homes are yet to become affordable enough for widespread adoption.
- A two-tier electricity market (different pricing for variable and dispatchable power) also seems a long way off.
- Transmission pricing in most countries is also out of date, as it is often currently structured to penalize the "peaks" in consumption at a time we increasingly need the demand-side to "take the peaks away", by absorbing the excess generation in the grid.

If you looked at it dispassionately, you could say that we are currently building capacity, to compound a problem, that we haven't yet got solutions to.

4 The Internet of Things

Requiring energy consumers to adopt new technologies and change their behaviours is no easy mission however, as human beings are inherently lazy. So, when we say, "we must fundamentally change way we consume energy," what we really mean is our devices and "things" must fundamentally change the way they consume energy, and this is where the IoT comes in. Its estimated that the IoT will connect 30 billion objects by 2020. IoT allows objects to be sensed or controlled remotely across existing network infrastructures. It is the IoT which will enable technologies such as smart grids, virtual power plants and smart homes, et al. In privatised energy markets such as the UK, aggregation companies are using IoT to connect hundreds (if not thousands) of devices as diverse as refrigerator compressors and electric vehicles, providing both frequency response and demand response, and sharing the profits with their clients. It will take a lot of refrigerators and battery electric vehicles to equal the demand response possible from just one single modulating aluminium smelter however, and this leads us directly to how and why aluminium smelters can help. There is real opportunity for large industrial users who can shift energy use from times of low generation and high demand, to times of low demand and high generation. With a grid heavy with renewables there will be times of zero or even negatively priced electricity, and lots of them.

Modulation technology allows aluminium smelters to become part of the solution (Figure 1). It allows smelters to go down in energy consumption to avoid high spot prices, as well as increasing production above normal capacity to take advantage of oversupply in the grid. In helping balance the grid, smelters are directly aiding the increase use of renewable generation, thus lowering the CO_2 emissions of the entire grid. For certain, the metals of the future will be need to be greener than they are today. Currently less than 30 % of primary aluminium is produced from clean energy, and this statistic is going in the wrong direction. I believe the answers for aluminium smelting, indeed all large electricity users, will be to embrace the change going on around us, and look for the opportunity that lies in becoming an integral part of the energy transition. I have no doubt that grid-connected aluminium smelters, which can modulate energy consumption, can play a role in helping with decarbonisation. Opportunity lies ahead, but it will require a new way of thinking.

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