SCHNEIDER ELECTRIC: Energy supply, cost, and decarbonisation potential – challenges and opportunities

This article takes a look at five key questions coming from the Paris Agreement made in COP21 in December 2015 from an energy and sustainability standpoint, and what they actually involve for the glass industry.

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We all know or have heard about the Paris Agreement made in COP21 in December 2015 but what does it mean for the glass industry, which has historically been almost entirely reliant on carbon emitting fossil fuels for the melting process? Does it mean that container glass customers will start to move towards paper, bio-plastics, aluminium or a low carbon glass melting process? What about flat glass and tableware?

Let's consider for a moment the decarbonisation trajectory that the Paris Agreement binds us to. In Figure 1, the Intergovernmental Panel on Climate Change (IPCC) has advised us that in order to avoid the worst impacts of cli-

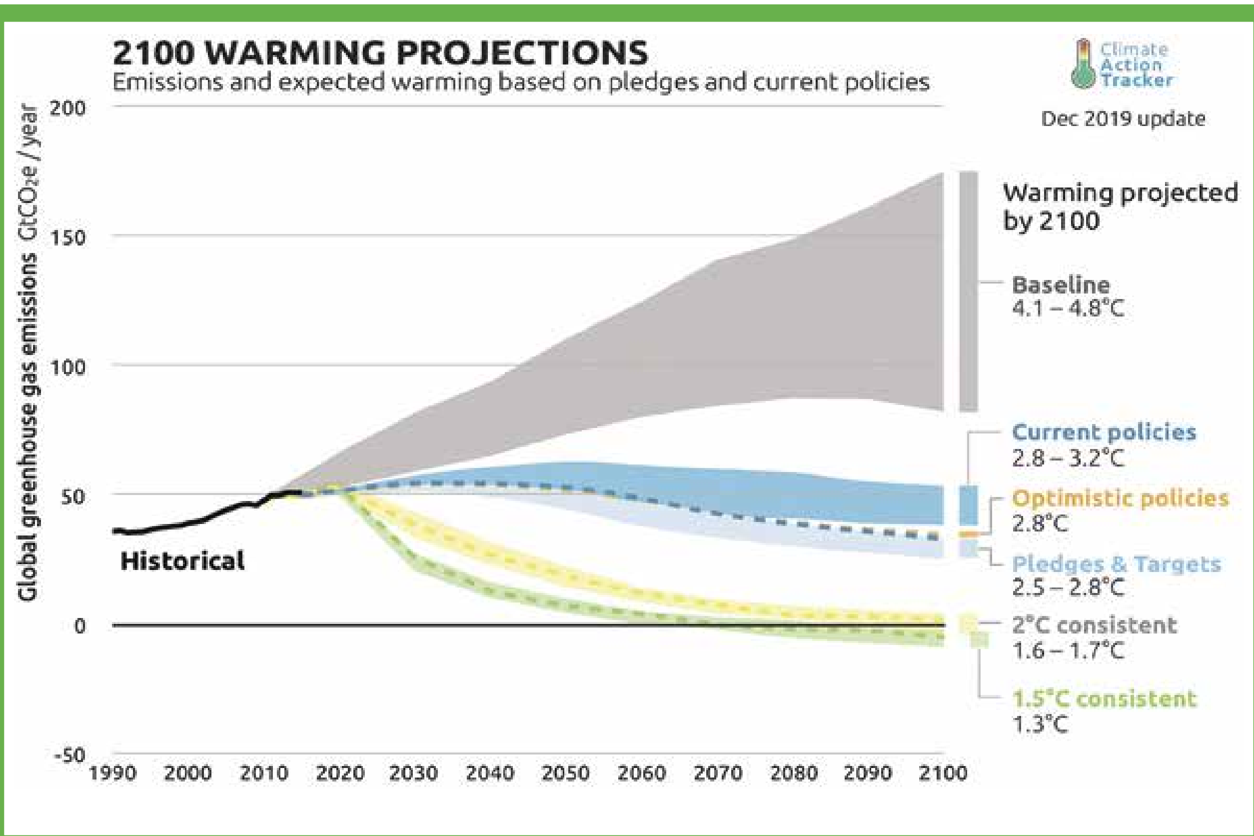


Figure 1. IPCC Dec 2018 update – With current efforts, global warming is likely to reach 1.5 degC between 2030 and 2050. How quickly it's reached is up to all of us

mate change, we must limit global warming to 1.5°C above pre-industrial levels, and this means starting NOW on a trajectory towards being carbon neutral by 2050.

Owens Illinois, NSG and Saint-Gobain have all made public commitments towards this goal by engaging with so-called Science Based Targets which demand a trajectory towards carbon neutrality by complete decarbonisation – not just burning fossil fuels here and planting trees there to compensate. This suggests that the biggest players in the glass industry are committed to turning their melting processes entirely away from fossil fuels.

This article aims to start to address five key questions from an energy and sustainability standpoint – or at least what you should consider when answering the challenge presented to our industry.

1. What are the options today and how do they compare on a pure unit of energy basis?
2. Why do we need to think about this differently than in the past?
3. How green are those options really?
4. What are the supply risks and cost sensitivities?
5. How do we quantify the risk and find opportunity therein?

WHAT ARE THE OPTIONS TODAY AND HOW DO THEY COMPARE ON A PURE UNIT OF ENERGY BASIS?

Of course, there are potentially many options and various 'flavours', but this article will focus on the four highest potential fuels available today. Natural Gas – the business as usual case. Hydrogen – a close cousin of Natural Gas. Hybrid electric and Natural Gas or Hydrogen – A familiar path simply wound up. All electric – the big step.

We can start to compare these at a high level by comparing the end-to-end energy flow. To enable this comparison I will unapologetically make some high-level assumptions in the 'back of an envelope' example calculation based on a typical container glass furnace. The exact application and technical nuances may differ depending on the specific technologies chosen for each fuel, but I would argue that the physics and ratios can broadly be applied – even when translated to other types of glass processes.

Starting from the right-hand side of Figure 2, we can see that a 330 T/day output is required from our theoretical furnace. Two key technologies are then chosen for the furnace; either a gas fired furnace or electric. The gas furnace has three input options; Hydrogen from a Steam Methane Reformer (SMR – the most common form of hydrogen production today), hydrogen from electrolysis, natural gas. Each of these options need 4 GJ/T to melt the glass on average but three times as much volume of hydrogen is needed per unit of energy compared to natural gas. Furthermore, current SMR and electrolysis processes have roughly the same energy losses

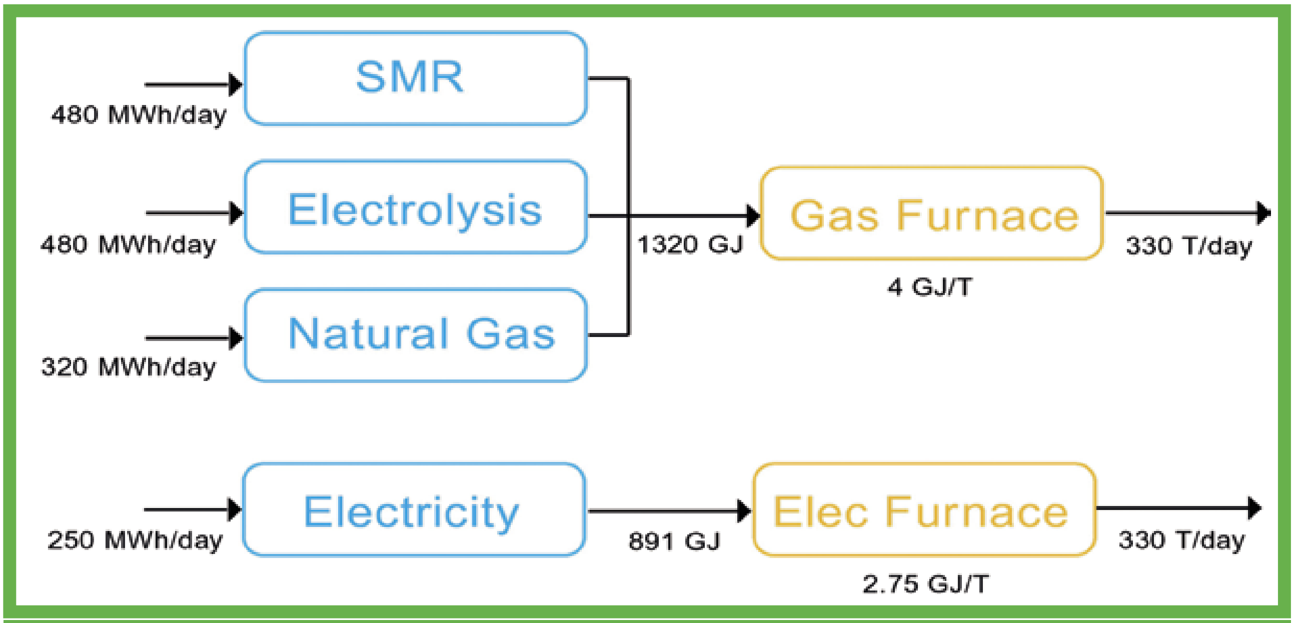


Figure 2 – Back of the envelope calculation of the energy required for each solution

as each other, meaning that both processes need 30 per cent more energy to melt the glass than burning the natural gas in the first place. SMRs are a mature technology and therefore unlikely to get significantly more efficiency in the future, but electrolysis – whilst not yet commercially proven – is witnessing significant investment resulting in breakthroughs in technology and efficiency gains of up to 50 per cent.

By comparison, the same amount of glass produced from an all-electric furnace is subject to a significantly more efficient process, needing only 2.75 GJ/T and no further conversion from the energy grid. This is then around 22 per cent more efficient than a natural gas furnace and nearly 50 per cent more efficient than its green alternative: electrolysis.

WHY DO WE NEED TO THINK ABOUT THIS DIFFERENTLY THAN IN THE PAST?

Historically, energy cost was simply relegated to a single line or two in the business case presented to management for a new furnace. The same business case that devoted 200 lines or more to the Capex breakdown. It can be surmised that with only one fuel to choose from, it made no sense to model this out further. We'd manage it as best as possible but in reality, our competitors were exposed to the same market forces and our customers knew that, and therefore had to accept price adjustments accordingly.

Now we have multiple different variables in the equation; natural gas, power, carbon and renewable electricity. Each of these have different fundamentals and are independently impacted by sovereign risk that varies between countries.

Consider now that tweaking that one energy line on the 200-page business case by just 10 per cent can make a bigger USD/T difference than that of a 50 per cent change in Capex. Said another way; one could work incredibly hard to reduce the Capex of a natural gas furnace design only to have those savings completely wiped out compared to a competitor who chose an all-electric furnace driven by fixed price renewable electricity in a country that implemented a carbon tax that drove the cost of natural gas up by 10 per cent. Complex, and hard to capture and quantify in just one line of a spreadsheet, right?

HOW GREEN ARE THOSE OPTIONS REALLY?

Let's start with the three most challenging fuel sources to decarbonise; natural gas, hybrid electric/natural gas and SMR-originated hydrogen. All of these need a breakthrough in Carbon Capture and Storage or Usage technologies or biogas.

CCS or CCU. Many attempts have been made to get a large number of CCS/CCU pilot projects off the ground in this space spread across all types of needs from SMR to concrete to steel and beyond, yet only a handful manage to get government subsidy and even fewer have worked let alone show potential for commercial application. Even if a breakthrough is made, which it could be argued is really needed to facilitate a low carbon future, it makes the energy equation from the first question look even more inefficient given the energy required to drive the additional CCS/CCU process. Biogas is potentially even more challenging to achieve due to the scale required and land availability from a growing population.

Hybrid electric with green hydrogen from electrolysis can indeed be carbon neutral when powered by renewable energy. A scenario could also be envisaged whereby the extra energy and technology cost of the hybrid approach versus all electric could be worth it due to technical advantages such as pull through rates. I'll leave that debate to the future and to better informed people on those trade-offs than I. I'm simply stating that they should be considered.

All-electric can certainly be powered by renewable electricity in many grids across the world today and therefore be considered carbon neutral when coupled with certificates deeming that electricity to be of renewable origin – even though the grid is far from carbon neutral today. We'll explore how this works in the last part of this article but for now let's say that either the all-electric or electrolysis driven hydrogen solutions can be deemed carbon neutral.

WHAT ARE THE SUPPLY RISKS AND COST SENSITIVITIES?

All these solutions are great in theory but can the energy actually be delivered in a safe reliable form we've grown to expect from our good friend natural gas? Well actually, let's start with our old friend. Will it still be available? I'm not talking physically as there is likely plenty of availability but will the world be able to allow it? It may seem crazy today but if the EU Green Deal passes into law, fossil fuels will effectively be illegal in 2050 for the vast majority of users. That's right, illegal – at least so economically punitive it might as well be. That means SMR-based hydrogen is also out.

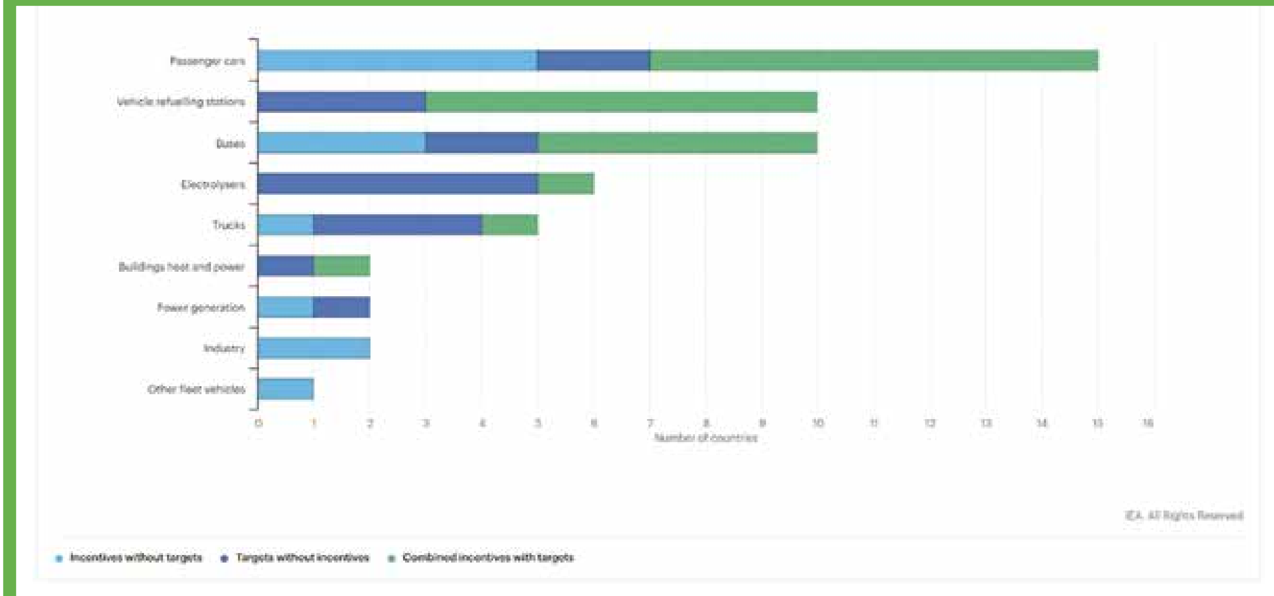
There will then be a huge demand for green hydrogen. That means a massive ramp up from the four per cent it occupies today and by the looks of current government policy as depicted by the IEA in Figure 3, industry will be a long way down the queue from transport and where does glass sit in the industrial queue? Likely behind the likes of steel for instance, right? I fear a significant supply/demand crunch which makes the green hydrogen solutions challenging at best.

Our other option is all-electric. Electricity grids are well established, but with increased electrification from industry, households and electric vehicles, significant investment is required to ensure the power can be delivered. Interconnectors between markets are also needed to ensure that when it's windy in one region, that energy can be transferred to where it's not, or stored in batteries, molten salts or hydrogen. The latter is where the seasonal storage potential of hydrogen can, and likely will, play a role in the future energy world.

HOW DO WE QUANTIFY THE RISK AND FIND OPPORTUNITY THEREIN?

So, with all these varying fundamentals at play, it is crucial that senior managers of glass firms are well informed and understand where the risks and oppor-

Figure 3 – Current policy support for hydrogen deployment, 2018 – Hydrogen for industry appears a long way down the queue of governmental priorities.



tunities lie. Solid 10+ year outlooks on carbon, gas and power from professional organisations are key to building potential scenarios. I use the term scenarios because no one has the ability to predict the future and there are large variables at play. The best we can do is build scenarios and perform rigorous sensitivity analysis to show what can happen and therefore what the best- and worst-case scenarios might be. Only then can our management teams move with confidence into this brave new world.

One lever to reduce these market risks is using renewable energy as it has essentially zero marginal cost of production and can therefore decouple itself financially from the energy market. Renewable electricity from technologies such as wind and solar are also dropping in cost and rising in availability. Australia, the US and increasingly, Europe (see Figure 4), are hot beds for so-called corporate Power Purchasing Agreements because Commercial and Industrial buyers are seeing them as lower cost and lower risk alternatives to regular grey procurement strategies. It's not just the B2C or telco sectors who want to green their image either. Bluescope Steel, Ball Corporation and Cummins are just some examples of industrial players taking advantage of the opportunities.

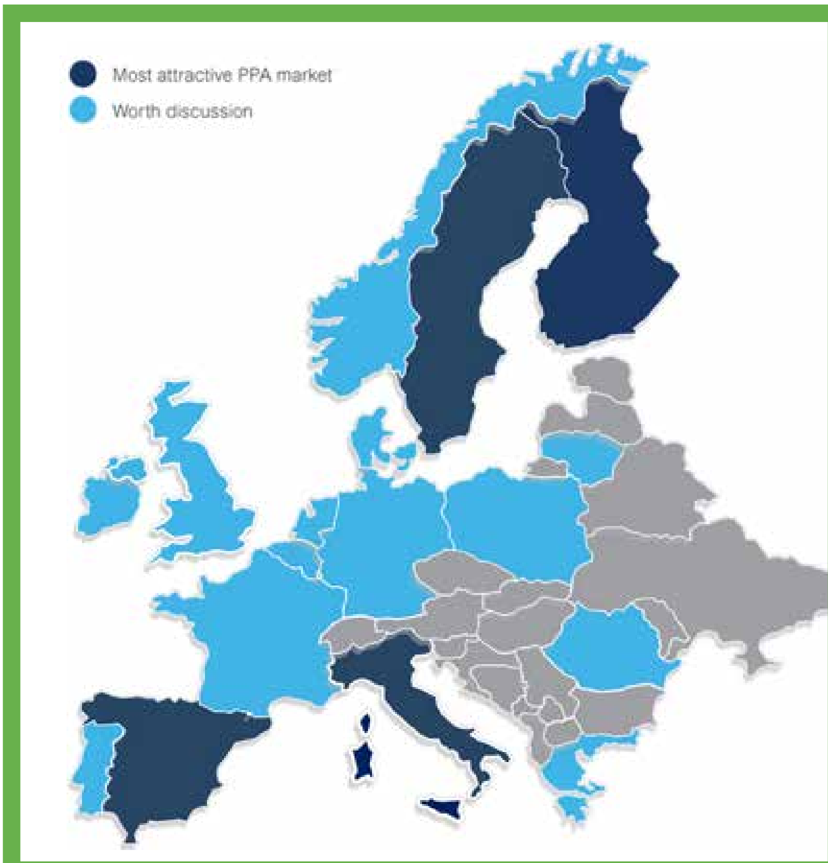


Figure 4 – PPA Pricing by Country in EUR/MWh from 'State of the European Renewable Energy Market 2019' – Europe is seeing significant growth in PPAs thanks to strong supply opportunities. Especially in Spain, Poland and the Nordics but others are fast catching up

CONCLUSIONS

Unfortunately, we are not in a position to predict the future, nor do we try, but we can take steps to understand the possibilities. The top takeaways recommended from this article are therefore:

1. ensure you build solid scenarios for your management using solid 10-year energy market outlooks;
2. start moving now to decarbonise your processes. 2050 is only two investment cycles away;
3. consider supply risks when choosing your energy source;
4. look at de-risking and greening your portfolio with renewable energy.

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