Infinite and Everywhere

Sam Taylor for These Islands, 29th August 2024

Introduction

The energy potential of the Sahara Desert is so enormous, covering less than 5% of its surface with solar panels would generate enough electricity to power the entire planet.

But Egypt is never going to become the Saudi Arabia of solar. It will not get fabulously wealthy from this huge renewables bounty.

Constructing the massive transmission infrastructure required to transport electricity from North Africa to the rest of the world would be prohibitively expensive. Powering the planet from the Sahara is never going to be cost competitive with alternative, and local, renewable solutions.

And there are plenty of alternatives.

Because what is true of the Sahara - that it has vastly greater renewables potential than it could ever use - is also true of most nations on earth.

Friends of the Earth recently published research which found that England could generate 13 times more renewable energy than it does today - more than enough to fully decarbonise - utilising just 3% of its land mass.[1]

Scottish nationalists make a grave error when they focus on renewables *per capita.* Yes: Scotland has a great deal of renewables per capita (both extant and potential). But *so does everybody else*, including its nearest neighbour and most important export market.

The purpose of this piece is to explore what this simple but profoundly important observation means for Scottish nationalism.

If you have a firm grasp of concepts such as return on capital, cost of capital, economic moats, short and long-run marginal costs of generation, the merit order, etc… then there will be sections you can skip over. If those concepts are completely alien to you, some of what follows will require perseverance.

And if 5,000 words on this subject is simply more than you can bear, the nub of the argument is this:

---

1 https://policy.friendsoftheearth.uk/insight/how-england-can-produce-more-onshore-renewable-energy-fast

The fossil fuel era was defined by *surfeit* and *shortage*. The surfeit, controlled by a relatively small number of petrostates, was valuable precisely because everyone else had a *shortage*. That's why petrostates could get super rich.

In the renewables era, *everybody has a surfeit so nobody is going to get super rich.* The economic opportunity from renewable resources is both *fragile* and *contingent*.

It's fragile because the profitability of harnessing abundant resources is necessarily low. This is an iron law of economics, and perhaps the most important blind spot of those who believe resource nationalism is possible with renewables.

And it's contingent because of an iron law of politics: if a state can build the infrastructure for the journey to net zero within its own borders, *that is what it will do*.

If a nation has plenty of resource, but few people, its best chance of utilising as much of that resource as possible is to be inside a fiscal union which does contain plenty of people. If the rest of that fiscal union is close by, minimising the expensive costs of transmission, then all the better.

In other words: if Scotland is to extract the maximum possible economic benefit from renewables, it must remain inside the United Kingdom.

Resource Nationalism: Then and Now

Scottish nationalism includes various different traditions and motivations. But since the 1970s, one strand of thinking has been ever present: *resource nationalism.*

The *"It's Our Oil"* campaign of the 1970s might not have delivered an electoral breakthrough for the SNP, but its ideology was still there in 2014. *Scotland's Future* - the "White Paper" published ahead of the independence referendum - promised this:

"With independence, Scotland will have full responsibility for our oil and gas reserves. An independent Scotland will aim to maximise the safe production of oil and gas from the fields off Scotland's shores, with a stable and predictable fiscal regime."

Today, the rhetoric is very different. Talk of "climate crisis" and "just transition" is everywhere. But one thing has not changed: the case for Scottish independence is still underpinned by *resource nationalism*. The resource might be different, but the argument is the same.

But is it *really* the same?

To answer that question we need to explore some concepts from business and economics that are not well understood by the general public. Or indeed by politicians.

Return on Capital

The most important of these is *return on capital*.

First of all, what do we mean by *capital*?

For the purposes of this discussion, capital means the assets a company requires to go about its business. These could be buildings, equipment, vehicles, etc (tangible assets) or perhaps a licence to operate in a particular area (an intangible asset).

There is a cost to acquiring these assets, and that cost is the *capital employed* in the business.

We now need another definition: *operating profit*. This is earnings before interest and taxes, and hence often denoted by the acronym EBIT.

Return on capital employed (or simply, *return on capital*, a shorthand I will now adopt) is then defined as operating profit divided by capital employed.

That's how it's *defined*. But what does it *mean*?

Starting a business, or expanding an existing one, almost always requires money. *Return on capital* effectively tells you what the earnings yield of ploughing money directly into the business is.

In other words: a return on capital of 20% tells you that £1m invested in the business will deliver annual profits of £200k.

It's important to emphasise that return on capital is not the same thing as profit margin. A company with annual sales of £1m and profits of £200k has a profit margin of 20%.

But if the assets required to operate the business cost £4m, the return on capital is just 5%. And if the assets cost only £500k, return on capital is 40%. Profit margin and return on capital are telling you *very different things*.

If a business does earn high returns on capital (and above 20% is relatively high), people with money that is earning relatively low returns will be incentivised to invest in starting similar businesses. And that competition will eventually push returns lower for everyone.

This is basic and uncontroversial economics: high returns on capital will tend to attract competition, and those high returns will be competed away.

But some companies, and indeed some entire industries, do earn sustainably high returns on capital. How do they achieve this?

Economic Moats

To earn sustainably high returns on capital, you must have some kind of competitive advantage, limiting the ability of new entrants to come in and drive down returns.

This is called an *economic moat*.

Economic moats can take various forms. Brands can be moats. Patented technology can be a moat. And most importantly for this discussion: *access to a scarce resource is a moat*.

Which is why extracting oil and gas is a high return on capital business. Oil and gas reserves are valuable because there is a worldwide demand for hydrocarbons, but supply is finite, and concentrated in relatively few locations.

If you find oil underneath your land, you have struck it rich. If you find common or garden rocks, you have not. Rocks have their uses, but everyone has them. You don't get rich by selling rocks. Oil and gas are valuable because they are in demand and *scarce*.

Resource nationalism with hydrocarbons is straightforward. You actually own the energy trapped in those molecules. The rest of the world wants it. And if they won't pay up for it, they can't have it.

Oil producing nations effectively hold the rest of the world to ransom. A caricature of the situation, but not much of one - this is more or less exactly the purpose of OPEC (who influence prices for everyone, since oil and gas are global markets).

And here is the crux of the matter: *renewable resources are not scarce*.

Infinite and Everywhere

The clue is in the name: *renewable*. In other words: *infinite*. And also: *everywhere*. We are largely talking about sunshine and wind. These things exist in different quantities in different places. But they exist everywhere. And they will never run out.

Renewable resources are not actual energy in the same way that oil and gas are. Renewable resources are nothing more than a place where you might build some infrastructure. Nobody owns the energy in the wind or the sun. *There is no economic moat.* All you can own is the infrastructure capable of capturing a small slice of the abundant energy which is all around us.

Which means earning outsized returns on capital from renewable infrastructure is impossible. *Renewables are a low return on capital business*. And that's a good thing. If we can obtain energy - a basic human need - without enriching a small number of petrostates, that's a net positive for mankind.

Alex Salmond famously said that Scotland would become "the Saudi Arabia of renewables". But Saudi Arabia is Saudi Arabia because it has lots of oil, and the rest of the world (mostly) doesn't.

Everywhere has lots of renewables. Which means that *nowhere* is going to become the Saudi Arabia of renewables. Resource nationalism with renewables *simply doesn't work*.

To cover the next part of the story, some more definitions are required.

The cost of electricity generation can be looked at from two different perspectives. The *short-run marginal cost* and the *long-run marginal cost*.

Short-run Marginal Cost

This is the cost of generating electricity from assets *which already exist*. The costs are different depending on the generation technology.

For a wind farm, the short-run marginal cost is effectively zero. No fuel is required, so when the wind blows, electricity is generated at zero marginal cost.

A gas fired plant generates electricity by burning gas. So its short-run marginal cost is the cost of the gas, plus whatever price is imposed on carbon emissions.

Existing assets can be ranked in order from the lowest short-run marginal cost to the highest. Broadly speaking, renewables are the cheapest (zero fuel and zero emissions costs), followed by nuclear (fuel costs relatively low, emissions zero), followed by gas (fuel costs high, emissions costs middling) and finally the dirtiest plants fired by coal or oil (fuel and emissions costs are both high).

This ranking is referred to as the *merit order*.

At any given point in time, supply of electricity must equal demand. Capacity is utilised beginning with the cheapest and moving up the merit order as required, until the point at which the cumulative total of capacity utilised is generating enough electricity to exactly match demand.

This is why gas typically sets the wholesale price of electricity in the UK. Demand usually intersects with the merit order at a point where gas plants are the marginal producer. If the wholesale electricity price isn't high enough to cover their costs, those gas plants won't run. And then we'd have power cuts.

So, at any given time, the wholesale market price of electricity is equal to the short-run marginal cost of the marginal producer, plus a small spread to make it worth their while to operate. But if wind is the marginal producer, there is no need for that small spread. Wind turbines don't need to be incentivised to rotate when the wind blows. They just do.

Over time, the composition and shape of the merit order changes. And as we move towards net-zero, we will increasingly live in a world where wind farms are the marginal producer. We'll have so much wind capacity, demand will usually intersect with the merit order where wind farms are setting the price.

There is a nuance here: nuclear plants cannot easily be turned off and on, so they effectively sit outside the price setting mechanism, and (almost) always run. Wind farms have the opposite problem: intermittency. They cannot necessarily generate power when you want them to. Wind is free, but it's also fickle.

But one thing is certain: as renewables increasingly dominate the generation mix, the short-run marginal cost of electricity, which sets the wholesale market price, will tend towards zero. This is called the *merit order effect*.

Long-run Marginal Cost

The preceding discussion of short-run marginal costs, and how they set the wholesale market price for electricity, depended on one critical assumption: *the generation assets already exist.*

The electricity delivered by the rotations of a wind turbine might not cost anything at the moment the wind starts to blow. But wind turbines are expensive pieces of kit. And connecting them with demand customers is a complex and costly proposition.

A problem should be apparent. If emissions and prices are both heading towards zero, nobody will build all the hugely expensive infrastructure that is required to make this happen.

This is where the *long-run marginal cost* comes in. If wholesale market prices are heading towards zero, companies will require a guaranteed fixed-price for their output in order to build generation assets in the first place.

The lowest guaranteed fixed-price for output at which a developer will build new capacity using a particular technology is the *long-run marginal cost* of that technology. This will never be zero, because huge infrastructure will always have huge build costs.

In the UK, the mechanism for these guaranteed fixed prices is Contracts for Difference (CfD) auctions. Via these auctions, energy suppliers agree to pay a guaranteed fixed-price for output (over a longish period, usually 15 years), thereby underwriting the vast capital costs of constructing a generating asset.

Until recently, these prices had been trending downwards, reaching a low of £37/MWh (in 2012 prices) for offshore wind in Allocation Round 4.

But the UK Government came unstuck when it assumed prices would remain this low, setting a cap of £44/MWh (in 2012 prices) for offshore wind in the Allocation Round 5 auction, which subsequently failed to procure any new offshore wind capacity.

The price cap for offshore wind in Allocation Round 6 has been set at £73/MWh in 2012 prices, which is about £100/MWh in today's money. Notably, this is slightly higher than the current wholesale market price of electricity, set by the short-run marginal cost of gas.

The Grid

Capturing an increasing share of our energy needs from the sunshine and the wind (and perhaps eventually the tides) is a necessary part of our journey to net zero. But it is not the only part. Capturing the energy is only useful if it can also be transmitted to where it is required.

The cables and pylons - the electricity grid - which connect generation assets with demand customers is expensive infrastructure too, and *someone has to pay for it*.

Owning the cables and pylons is another *low return on capital* business. But the reason the grid earns low returns on capital is different to the reason that renewable generation assets do.

Generation assets earn low returns on capital because renewable resources are not scarce, and therefore competition is significant. The grid is basically the opposite: it is a monopoly. We only have one grid, and therefore competition is non-existent.

And for this reason, the grid is a heavily regulated business. Because the grid is a monopoly, the regulator determines the return on capital it is allowed to earn. The regulator has a dual mandate: it must ensure we have a functioning grid, but it must also keep bills as low as possible - high enough to deliver that functioning grid, but no higher.

For the GB electricity market, Ofgem is that regulator.

As well as determining the allowed return on capital, Ofgem also decides how the costs of funding the grid are apportioned. Roughly speaking, demand customers pay for about 80% of the transmission network, and generators pay for the remaining 20%.

In regions with a lot of generation but relatively little demand, ordinary customers pay lower transmission charges. But generators pay higher charges. This is the situation in Scotland.

Ordinary customers pay lower transmission charges because their proximity to the generating assets reduces the need for transmission infrastructure to send electricity over long distances.

Generators pay higher transmission charges because their location, a long way from most of the demand, *increases* the need for transmission infrastructure to send electricity over long distances.

Transmission charges for generators are often characterised as the cost of connecting to the grid, as if it's a matter of just plugging a generating asset into a pre-existing grid.

In regions which are densely populated, or relatively close to large population centres, it *is* a bit like that. Which is why it's relatively cheaper. But in Scotland, it's nothing like that at all. In Scotland, generators are not paying to connect to a pre-existing grid. They are being asked to pay towards constructing a grid which *does not yet exist*.

There is a very significant grid bottleneck between Scotland and England. This is why wind farms in Scotland are increasingly having to be paid to turn themselves off - so called constraint payments. When it's particularly windy, Scottish wind farms generate power beyond the capabilities of the grid to deliver that electricity to where it is required.

This is plainly a dysfunctional situation and transmission charges for generators are simply a way of partially remedying that dysfunction. Ofgem is effectively saying to generators in Scotland: *If we are going to pay you to switch yourselves off - because you're the wrong side of a grid bottleneck - we're going to ask for some of that money back. You are going to have to help pay for more grid, to unblock that bottleneck.*

Which is why it's a complete myth that these "unjust" transmission charges could be abolished in an independent Scotland. You cannot abolish the need for more grid infrastructure. Without substantially expanded grid connections between Scotland and England, there is simply no way of connecting generation assets in Scotland with customers.

And if you can't connect your generating asset with customers, you don't have a viable business.

A Viable Business

Turning oil and gas reserves into a viable business works like this: if you find oil and gas, you extract it, you store it, and you sell it. It's a pretty simple business. A wildcat producer (or a small independent nation) can easily get rich.

Turning a renewable resource - *a place where you might build some infrastructure* - into a viable business, is fundamentally different. There is no such thing as a wildcat renewables producer. The economics of infrastructure are not the economics of extraction.

Because renewable resources are not scarce, private capital will not speculatively build the infrastructure. Turning a renewable resource into a viable business is all about *partnership*.

It's about a partnership between a developer who will build the infrastructure and the customers who will pay for the infrastructure. The developer must find customers who will pay a guaranteed fixed-price for output, thereby underwriting the capital costs of the infrastructure.

To make it any kind of business at all, the customers will have to offer to pay a little bit more than the cost of the infrastructure. But *only a little bit.*

This is just a restatement, in plain language, of the fact that *renewables are a low return on capital business*. Because there is no economic moat, and hence plenty of competition, the guaranteed fixed-prices for output will deliver only *very modest* returns on capital. Barely enough to cover a company's *cost of capital*.

What is cost of capital?

Cost of Capital

The money behind the capital employed in a business does not fall from the sky. It comes from somewhere. And it comes *at a cost*.

Perhaps it is borrowed from a bank, or raised by selling securities to debt or equity investors. Even if the company has generated the money internally, through cash flows from existing operations, it still has an *opportunity cost*. In other words: using that money to invest in expanding the business must be set against alternative uses.

Governments also have a cost of capital: the interest cost of issuing government bonds. In the UK, the yield on a 30-year gilt is currently about 4.5%.

The government's cost of capital is (almost) always lower than any private company's cost of capital, because the government is the lowest risk borrower of all. It can never go bankrupt, provided it borrows in its own currency.

The cost of capital for a company developing renewable energy projects is generally somewhere in the 5-10% range. Which is also the typical range for return on capital from renewables investments.

This is another profoundly important point, which bears repeating: *the return on capital of investing in renewables infrastructure is so low, it is barely higher than cost of capital.*

Of course a well run company will try to ensure that return on capital is a reasonable amount higher than cost of capital: 2% would be the normal kind of spread a developer might target.

The contrast with oil and gas is again interesting and important. 20-30% returns on capital are typical for oil and gas investments. The cost of capital for an oil and gas company will be a little higher - at the upper end of the 5-10% range - than for a company investing purely in renewables (because oil and gas is a riskier business).

But notice that the spread of return on capital over cost of capital is substantial: 10-20% rather than something like 2% for renewables. This large spread has significant implications for two very important things: jobs and taxes.

Jobs

Because of the meaty returns on capital available from oil and gas, and because finding reserves and extracting them are complex and highly specialised tasks, *very highly paid jobs* are available for engineers with the right skillset. If you need the right people to access those returns, you will pay them whatever is necessary to secure their services.

Those high salaries will eat away a little at your return on capital. But there is a lot to eat away at.

Jobs in renewables are (mostly) not like this.

You don't have to find the wind or the sunshine. Everyone knows where they are, and that there is more than enough of them for our energy needs.

Converting the rotations of a wind turbine into electricity is an engineering challenge. But it's a well understood one, and doesn't vary much (if at all) from one wind farm to the next.

Complex problems do exist - for example how to make floating wind turbines work. But once you've cracked them somewhere, you've pretty much cracked them everywhere. There is no need to employ highly specialised engineers to solve similar but different problems in unique circumstances - which *is* the case in exploring for, and extracting, oil and gas.

Taxes

High returns on capital are *why* governments can squeeze huge taxes out of oil and gas producers: there is plenty of fat to cut into. You can impose massive taxes on oil and gas production before eating away all of the excess returns (over cost of capital).

This is emphatically *not the case* with renewables. The spread over cost of capital is already so low, any additional taxes imposed will simply be passed on to consumers via higher contracted prices for the output.

Taxing renewable electricity is just an indirect way of taxing ordinary people, and a particularly regressive way, since energy costs are a greater proportion of expenditure for those at the bottom of the income distribution.

A very similar argument applies if the government demands a minority equity stake in exchange for lease agreements. This is effectively just another form of taxation, and fails for the same reason.

It should also be apparent that if a government wants to get into the renewables business itself, there are no super-normal profits available. An established government's cost of capital should be lower than most private companies (although this would be more questionable for an independent Scotland).

But this advantage is only going to add perhaps 1% to the slim spread over cost of capital. And any cost overruns in capital expenditures will quickly drive returns into negative territory.

Those clamouring for the Scottish Government to build the ScotWind projects itself should be careful what they wish for. The ferries debacle suggests Scottish Government ownership is not a great way of avoiding cost overruns. And cost overruns are fatal to the economics of renewables projects.

Strengths and Weaknesses

The most important thing we have established is this: *a renewable resource is just a place where you might build some infrastructure.*

Some places are better than others. Stronger and more consistent wind means turbines can work more efficiently. But if those turbines are a very long way from potential customers, you have inefficiencies too: sending electricity over significant distances (and especially from out at sea) means costly additional grid expenditure.

Scotland has plenty of wind, but it doesn't have plenty of customers. Or plenty of grid capacity connecting it to where the customers (mostly) are - England.

Scotland's renewable resources have strengths, but also weaknesses. This is not "talking Scotland down". It's just the real world. We are all a mixture of strengths and weaknesses. Nations are no different.

The Positive Case for the Union

If you care about the climate, and want Scotland to seize the greatest possible opportunities from the journey to net zero, Scotland's renewable resources are one of the most positive cases for the Union.

Why? Because it is only through union and partnership that Scotland's renewables strengths can be harnessed and weaknesses overcome.

Scottish independence would not, ***cannot***, change the fundamental economics of renewables.

The partnership between developers and customers - the only way infrastructure gets built - is mediated in the UK by two government run mechanisms: CfD auctions for generation infrastructure, and Ofgem regulation for grid infrastructure. These are the mechanisms via which customers underwrite the capital costs of the assets.

Would an independent Scotland have access to these mechanisms?

Perhaps. But would it have access to them on the same terms as developers in what would then be another country? Clearly not. An independent Scotland, if it had access at all, would have "back of the queue" access.

Monetising a renewable resource for export is effectively the same thing as asking people in another country to pay for the construction of infrastructure inside your own borders.

If the export market you have in mind doesn't have much in the way of its own renewable resources, you *might* be able to pull this off. But remember: a renewable resource is just a place where infrastructure might be built.

If your export market has plenty of its own places where infrastructure might be built, it will obviously have *a very strong incentive* to build that infrastructure inside its own borders, not inside yours.

And the rest of the UK has huge renewable resources of its own, much of which remain unexploited. This is particularly true of onshore wind. Scotland's disproportionate share of the UK's existing onshore wind capacity is largely due to the previous UK Government's de facto ban on new onshore wind capacity in England.

But that ban was never a law of nature. It was the misguided dogma of a Tory government. The new Labour government overturned it within weeks of taking office. There is huge untapped renewable potential in England - more than enough to satisfy its needs.

The jobs and taxes created by renewables infrastructure might not be as attractive as those created by the oil and gas industry. But they are not nothing. Wherever possible, a nation will build the renewables infrastructure it requires in such a way that the economic benefits accrue to its own population. This is just the way the world works.

Scotland's renewables potential depends on two things: (1.) good locations for infrastructure projects, and (2.) customers who will underwrite the capital costs of those projects *who are part of the same political and fiscal union*. One without the other is not enough.

Partnership and political union in the context of renewables are bound up together. You cannot ditch the union without damaging the partnership. To believe otherwise is Scottish nationalist cakeism.

Independence means being independent. This is not "project fear". It's the realpolitik of independence. And the real, and unavoidable, economics of renewables.

Scotland *is* a powerhouse in renewable energy *because it is part of the United Kingdom*. Outside of the United Kingdom, Scotland would be a considerably diminished power. Its opportunities would be smaller. It is the Union which unlocks Scotland's potential in renewables. What could be more positive than that?

Addendum: But What About Hydrogen?

Some Scottish nationalists will have read this far, and be thinking to themselves: *“but what about hydrogen?”*

Hydrogen can be produced via electrolysis - splitting water molecules with electricity. And if renewable electricity is used, the hydrogen produced is *green hydrogen*.

The combustion of green hydrogen is green too: burning it simply reverses the electrolysis process, creating only water. It might one day be used to help balance the grid. Hydrogen manufactured during periods of excess wind supply can be burned (to power turbines, emitting only water) when the wind isn’t blowing.

But hydrogen is a very difficult molecule to transport and store, meaning it is most practically (and economically) used close to where it is produced. All of the same arguments made about the economics of renewables apply equally to the economics of hydrogen.