Asia's race to net-zero carbon: US$12.4 trillion and counting

China, Japan and South Korea have pledged to achieve net-zero carbon by the middle of the century. We estimate the capacity costs for just the transport sector alone at US$12.4tr. Total costs will be multiples of this. But act now and it could be achievable. Just

Source: Shutterstock

Key takeaways

- Achieving net-zero carbon in just the transport sector alone in Japan, China and Korea will cost these economies around US$12.4tr in total in new electricity generating capacity.
- This is equivalent to more than 90% of China's 2020 GDP.
- But spreading this expenditure over the next 30 years (40 in the case of China) means that it is equivalent to only 1.8pp of Chinese GDP, 0.6pp of Japanese GDP and 0.6pp of Korean GDP.
- These are manageable sums, though transport only accounts for 20-30% of total energy consumption in these economies. The cost of transition for the whole economy is likely to be multiples of this.
- Even so, while the sums sound on the margins of credibility, we believe these targets are achievable, though foot-dragging now could put them out of reach.

Transport sector differences

Some sectors look easier to transform than others. Rail transport is already largely electrified. Though as a mature form of transport, it may struggle to find additional efficiency gains in the decades ahead.

Road transport is already on the right path in China with rising numbers of electric vehicles. It also benefits enormously from the inherent efficiency of electric vehicles compared to those which are conventionally fuelled.

The aviation industry's best bet may be sustainable aviation fuel (SAF), though we need to be careful how we account for the carbon sequestered in making SAF to ensure this really is carbon neutral.

Marine transport looks tricky. Ammonia looks on paper to be the best bet, but it requires a lot of energy to make and delivers little unless combined in complicated hybrid systems with hydrogen. This could be expensive.

Hydrogen hype?

The hype over hydrogen also seems overdone. As a primary energy supply, hydrogen offers few advantages to electricity and quite a few disadvantages. But it may have a role where grid supply is unavailable or as a storage unit for surplus green energy.

Some mitigation measures are inevitable

While we think it would be possible to run a transport sector on an absolute carbon-neutral basis, we concede that practical difficulties mean that carbon capture and storage will inevitably have to play a role in a target for net rather than absolute zero carbon. There is still a lot of progress to be made here.

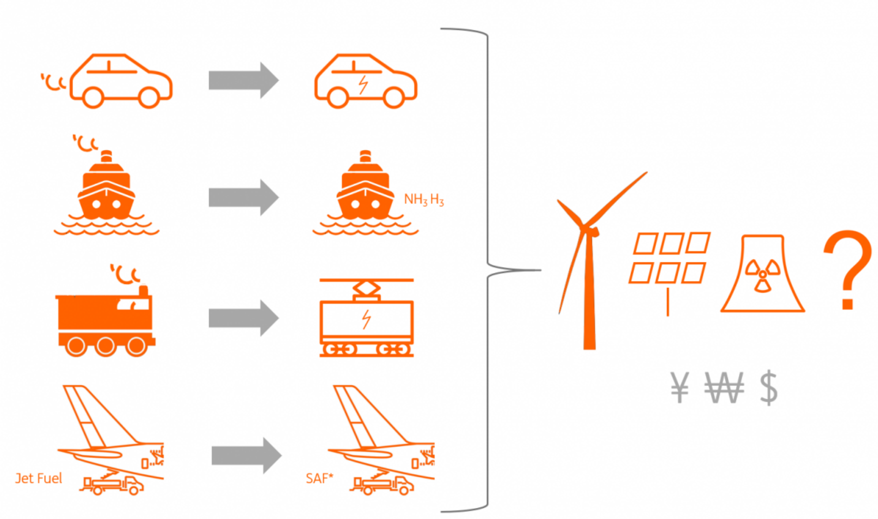
Introduction to "counting the cost"

How much are firms and governments going to have to spend transforming their electricity generating capacities to meet the demands of a future net-zero carbon transport sector? It's a question that will shed light on the cost and credibility of the overall economic transformation for the three Asian economies that have so far pledged to hit net-zero carbon emissions. In this introduction, we explain what we have done and how we reached our total cost estimate of more than US$12tr.

What are we trying to do and how?

Japan, China and South Korea account for almost two-thirds of all carbon dioxide emissions in Asia Pacific, and about a third of such global emissions. Net-zero carbon emissions require a total transformation of the energy-intensive sectors of their economies. In the following three short country notes, we start by looking at what the transformation of the transport sectors of these economies would cost in terms of electricity generating capacity requirements for these countries in line with their pledges to achieve net-zero carbon emissions.

How much is it going to cost for Asia's economies to achieve net-zero carbon in transportation?

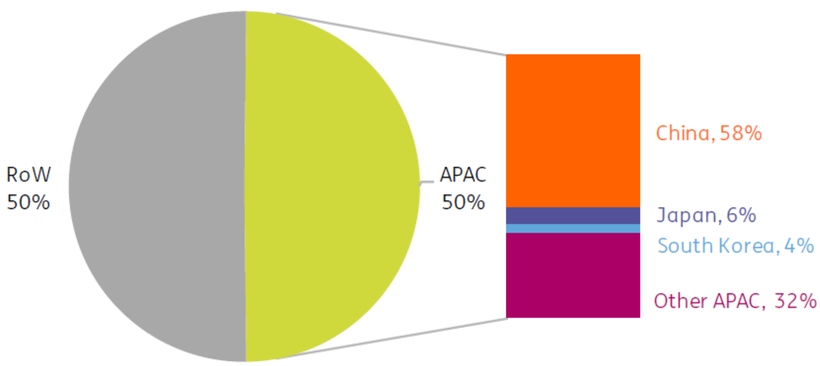


Source: ING

*Sustainable Aviation Fuel

By considering the electricity generating cost implications of transition for these three economies, we realise that we are just scraping the surface of what will inevitably be a much bigger and more complicated problem.

Asia's emissions of Carbon dioxide as a proportion of the global total



Source: Global Carbon Atlas

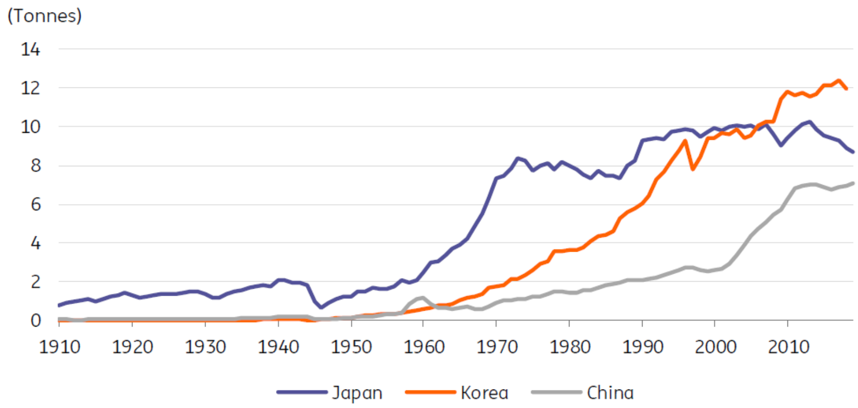
Our motivation for performing this analysis is that if the amounts for just this small part of the energy transition process are negligible, then potentially, the overall transition cost may be more manageable than many currently fear. If the costs are enormous, then it draws a question mark over the credibility of these national pledges.

What are we not trying to do?

At the outset, we want to note what we are not trying to do with these reports. We are not, for example, conducting a comparison of the levelized costs of alternative methods of zero carbon electricity generation. We also won't seek to argue how a country should meet its net-zero carbon pledge.

Beyond the capital costs of electricity generating capacity investment, our analysis does not consider the costs of other infrastructure spending. For example, the costs of installing E-vehicle charging points or adjustments to other sectors of the economy. We aren't trying to calculate how much carbon this saves or how much this reduces emissions. We have a hard end-point target to reach: net-zero carbon.

CO2 per capita (tonnes)



Source: Our World in Data

Moreover, while we refer throughout to the net-zero carbon pledges, our calculations are all essentially absolute-zero. While net-zero is a credible target for the whole economy, for sub-sectors such as transport, there seems little justification for trying to calculate the costs of only a partial adjustment first.

We also consciously omit potential energy savings from refining crude energy sources (energy transformation). This is a substantial proportion of many countries' energy balance sheets. For a full economy assessment, including these could well be appropriate.

Efficiency gains and measurement

Our analysis is also agnostic on technology. In earlier ING reports, our colleagues have looked at the role of technology in the global transition process. In this analysis, we also allow for efficiency gains (learning costs) during the transition. But unlike our other research, how the economy gets from A to B is not our main concern. What matters here is that we assume net-zero is achieved by the endpoint.

Our calculations for these three economies suggests that around US$12.4tr in total will need to be spent to provide the additional sustainable electricity generating capacity needed to make the transition for the transport sector for these three economies, with China bearing the brunt of this spending. If this sum seems unrealistically large, consider how much money is being spent on

Covid measures around the world right now. We would argue that in terms of magnitudes, and considering the longer timeframe for these expenditures, they are plausible.

As far as the different sectors are concerned, marine seems to throw up the most problems and tends to be the costliest sector, though this is not to underplay the challenges elsewhere.

Most of these costs are likely to be met by the private sector and could be financed with green bonds, other existing sustainability linked instruments, or by green financial tools that have yet to be invented.

The figures we present are subject to a great many data inputs and assumptions. In the following methodology, we set out in some more detail the calculation process.

Methodology

The flow diagram that follows provides a stylistic description of the calculation approach used for passenger cars, though it is similar to other transportation modes. The starting point for all estimates is always the latest data on energy usage by transport sectors. In most cases, this is available from departments for energy or industry, and so is reliably hard data. We use 2019 data typically (2020 was anomalous…)

The next step is to forecast energy demand for that transport type by 2050 (2060 for China). We model the current pattern using simple econometric models, based on population growth, GDP or GDP per capita, proxies for transport cost (crude oil) and so on.

From this model estimate, we forecast an equivalent 2050 energy demand figure using forecasts of the input variables. Population forecasts are extremely reliable, so these parts of the forecast are solid. Long-run GDP forecasts too, are reasonably reliable (and, to an extent, are population-driven). Some other inputs are more subjective, though these tend to have low explanatory power.

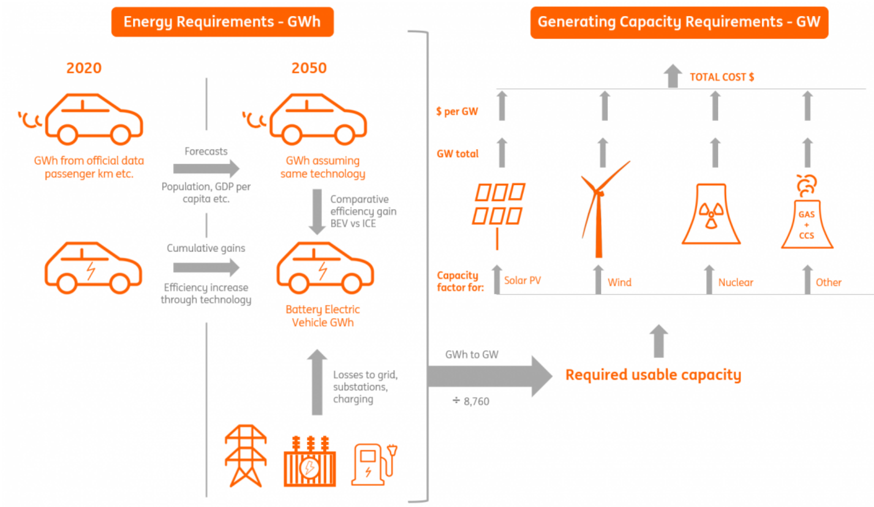
Adjust for new technology and technological progress

From these forecasts, we can calculate an energy requirement based on today's vehicle technology. We then adjust this for the transport technology we think will dominate by 2050. This is a subjective assessment. In some cases, such as passenger vehicles, there is a clear economic choice (battery electric vehicles – BEVs). In others, marine and air transport, for example, the choice is less clear.

There are already reliable comparisons of the efficiency of various vehicle types including conventional gasoline/diesel, battery electric vehicles, hydrogen fuel cells, and so on. We've taken estimates from the US Department of Energy amongst others to adjust future energy requirements from the constant technology calculations.

We adjust this future energy requirement for assumed technological improvements using a constant cumulative increment. This is the simplest possible approach, and at 1% cumulative efficiency gains per annum, we've set the gains at a level which is low relative to recent progress, so although we acknowledge the technology issue, we remain very conservative.

Stylistic methodology for calculating the cost of transformation to net-zero carbon for passenger cars



Source: ING

Convert energy required (GWh) into capacity (GW) – generating mix critical

At this point, we have our technology-adjusted energy requirement for the vehicle type in question, and we need to convert that into an electricity generating capacity and cost.

The first stage is to take a GWh energy figure and turn it into a simple GW capacity figure.

To figure out how much this generating capacity will cost, we need to know what proportion will be solar photovoltaic (solar PV), what proportion onshore and offshore wind and so on. We use official projections where possible.

In cases where the guidance lacks credibility, we have made allowances for what look to be policy goals made in a time of rapid change. These will inevitably be modified and we have tried to pick a position we feel is more consistent with longer-run goals.

The generating capacity mix also has to be adjusted because much of the renewable generating capacity is sporadic and requires other generating approaches to bridge periods where they aren't generating. To do this, we use the capacity factors published by the International Energy Association (IEA) to scale up the capacity required.

From usable capacity required to the capacity cost

Turning these capacity figures into a cost, we've used capacity costs published by the IEA (sometimes referred to as overnight costs). This is an extremely simple and arguably unrealistic concept. But it makes sense given that we are trying to describe a 20-30-year process where we have no idea of the path of travel and only a solid idea of the start and endpoints. This approach provides a simple way of encapsulating the scale of the sums of money involved without having to consider financing costs, the speed of implementation, or net present values etc. The approach may be somewhat unrealistic, but the figure it produces is at least intuitive.

Helpfully, the IEA provides estimates of capacity cost for different countries and different generating technologies in 2020 and 2050. We have used these to calculate an average cost over the period, which assumes the constant investment profile we alluded to earlier.

There are some yawning uncertainties

Of course, not all transport types are as easy as road passenger transport to estimate. In these cases, we've moved further from "fact" and established "convention" and more in the direction of assumption and in some cases, pure guesswork. Wherever we have done this, we've tried to indicate where our assumptions come from, and you can decide for yourselves if these approaches invalidate our estimates or simply add uncertainty about their accuracy. Like it or not, there is sometimes no alternative to a reasoned guess in fields like this.

We have also presented the estimated cost as a single figure. We think it would be unhelpful to deliver a range of scenario figures so large that it answered no questions at all. But we are certainly not trying to claim that our estimates are not subject to considerable uncertainties and scope for error. They are.

Macroeconomic implications

We don't want to make too big a deal of the macroeconomic implications of all this. There are so many unknowns that doing so seems unrealistic. But it is important to recognise what our calculated spending figures mean. The temptation is to think of this total as a "cost" of transition - a "drag" on business activity and a "loss" of competitiveness. And if we were considering a single firm or a single industry transforming relative to the bulk which were not, then this might indeed be a reasonable interpretation.

But this isn't what we are describing here. These processes we are calculating are being undertaken by three of the largest economies globally, not just in Asia. And against a backdrop where other global economies are doing the same.

All this spending is actually business and government investment. It contributes to GDP. One firm's cost will be another firm's revenue. Aggregate activity could well rise rather than fall as a result.

We think the best analogy for this is the comparison with a period more than twenty years ago when economies around the world were undertaking preparations for Y2K. There was vast spending on IT upgrades and measures to prevent a hypothetical information apocalypse. Whether or not any of this expenditure was ever necessary is irrelevant. What is important is that the process led to extremely strong business investment growth, which in turn, drove GDP higher, leading to rising productivity growth. There would have been other factors involved, but in using up surplus global savings, 10Y US Treasury yields rose by more than 200bp in the two years leading up to the new millennium. For stagnating economies such as Japan, a prolonged period of rapid investment growth may provide a catalyst for economic growth that has been absent for decades.

Author

Iris Pang
Chief Economist, Greater China
iris.pang@asia.ing.com