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Policy Brief

What will investing in hydrogen transmission infrastructure mean for the UK economy?

By Karen Turner, Antonios Katris and Hannah Corbett

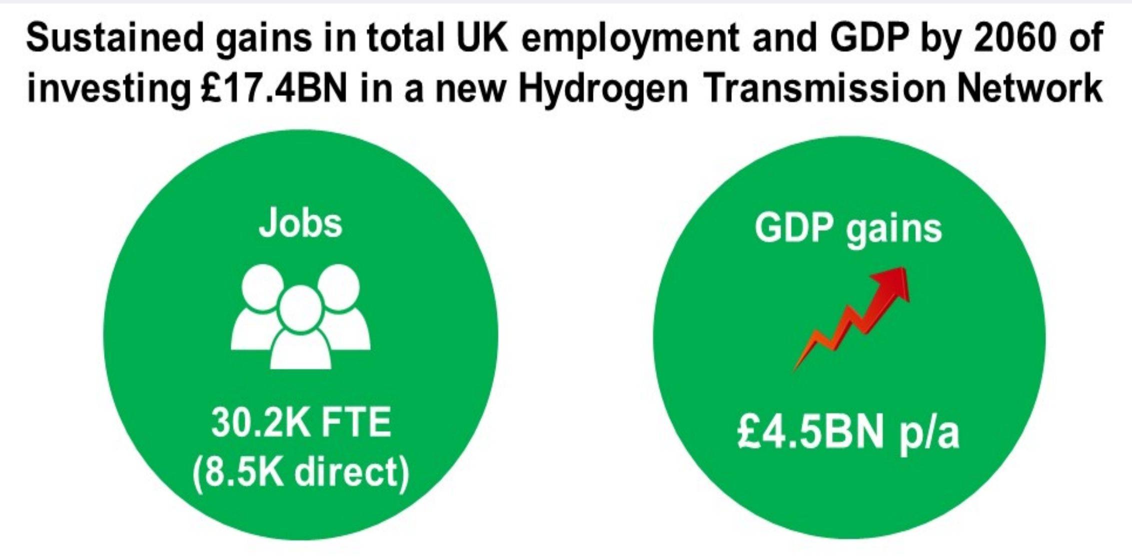
Summary

Initial research investigating the potential wider economy impacts of investing in a hydrogen transmission network in the UK has found the following:

Potential Wider Economy Benefits

An estimated £17.4BN of investment in hydrogen transmission infrastructure over the 25 years to 2050 could, by 2060, ultimately support around 30,000 jobs across the wider UK economy, associated with a 0.23% p/a uplift in GDP (£4.5BN p/a in 2018 prices).

Just over half the supported jobs (15.6K full-time equivalent, FTE) and GDP uplift (0.12% p/a) are delivered by 2040, when 48% of the investment has been made. 8,500 of the jobs are in the new hydrogen transmission sector. The biggest share of total jobs supported are in construction activity, in creating and maintaining the new infrastructure, in the energy sector, and in the service sector industries meeting the requirements of both the new supply chain activity and of UK households with more income to spend as employment and real wages increase in the expanding economy.



Our scenarios incorporate consideration of the challenge of persisting supply constraints in the UK labour market. **If worker and skills shortages can be effectively addressed, estimates of the total employment and GDP supported by hydrogen transmission activity would be greater**, and the risk of job displacement across other sectors mitigated.

Importance of understanding the capital-intensity of nascent sectors

A hydrogen transmission network does not yet exist in the UK economy. Therefore, we need to make assumptions about what the corresponding new economic sector may look like. Our key finding above involves a scenario that uses the UK electricity industry as a proxy. **If we liken to the UK gas distribution industry instead, we find the total sustained employment gain rises to 35.3K and the GDP uplift to £4.8BN (0.25%).**

However, this implies a substantially more labour-intensive hydrogen transmission sector, with 13.8K workers compared to 8.5K above. **Thus, it is crucial to understand not only the specific supply chain requirements of a potential hydrogen transmission network in the UK, but the labour- and capital-intensity of what is a relatively infrastructure-intensive activity.**

Here, CEP research on other Net Zero infrastructure investments has shown that accurate insight on the capital intensity of nascent 'green' sectors is crucial in projecting the potential level and value of economic activity enabled and, thus, the UK-wide activity and employment supported in different timeframes.

Demand uncertainty and the need for coordination

Another important unknown is where demand for hydrogen and, thus, for the output of the new hydrogen transmission network, will come from. Here we simplify by assuming the capacity created is fully utilised. However, **if sufficient hydrogen demand does not emerge, the transmission network investment will not take place or will be reversed as returns to capital fall.**

Therefore, a key policy implication emerging is that, where the substantial investment required is to be economically viable and beneficial, decisions around hydrogen development and deployment and the role it may play in the UK's transition to Net Zero need to be brought forward and effectively coordinated. Moreover, it is crucial that policy, regulator and industry decision-making interact with the substantive and growing evidence base emerging.

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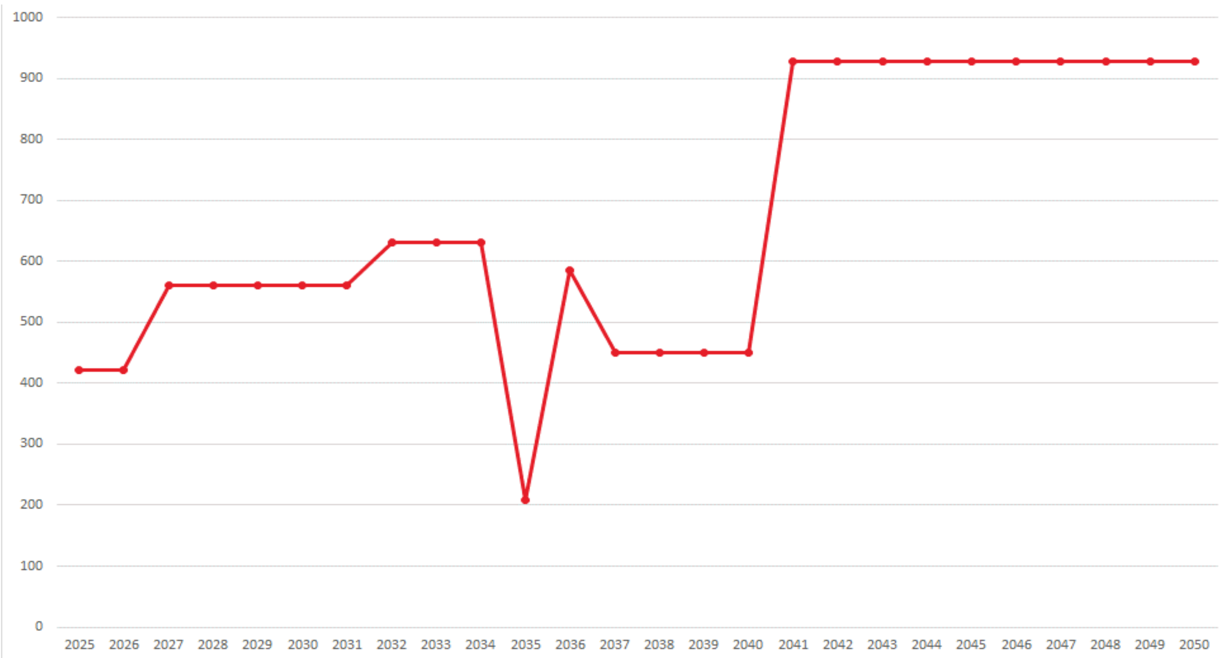
1. OUR APPROACH

The aim of this policy brief is to consider the headline macroeconomic impacts that may be triggered by investing in a hydrogen transmission network that constitutes a new industrial sector, or sub-sector, in the UK economy. Data made available to us by the National Infrastructure Commission and Ofgem from a study commissioned from Arup focus on investment that largely involves creating capacity in hydrogen transmission, with some new distribution infrastructure (largely in the highest-pressure tiers).[i]

Thus, the scope of our initial study is limited to considering the potential wider economy impacts of a new UK hydrogen transmission network (and enabling elements of the distribution infrastructure linking to it) that will ultimately feed into a wider hydrogen supply sector. This wider sector may constitute something of an evolution of the existing natural gas supply sector, which will also require investment in converting the distribution network. Investment will also be required to disconnect many existing gas customers and connect new hydrogen users, with the latter involving what is likely to be a very different demand profile, for example with a substantial reduction in residential use relative to natural gas.

Figure 1. Spread of annual investment spending (£M) in a new UK hydrogen transmission network under a Balanced Hydrogen Scenario (total spend £17.4BN)



We take a central case where the Arup data indicate that development of the transmission network (with some linked distribution infrastructure) will involve 32.2% of a total investment of £54.07BN required under a mid-range 'Balanced Hydrogen' scenario, which links to National Grid's 'leading the way' Future Energy Scenario (FES).[ii,iii] The projected spread of the £17.4BN investment spending associated with the new network development is presented in Figure 1.

We input this investment profile into our multi-sector economy-wide computable general equilibrium (CGE) scenario simulation model, UKENVI, to build up capacity in a new Hydrogen Transmission sector.[iv]

The main challenge in doing so is that hydrogen transmission (or any hydrogen production/ supply at scale) is an activity that does not yet exist in the UK economy and, thus, in the Office for National Statistics (ONS) industry-by-industry Input-Output (IO) accounts that inform UKENVI's core structural database.[v] Thus, we adopt a modelling and simulation approach designed for considering the emergence of nascent sectors through previous work examining the impacts of introducing a new CO_2 Transport and Storage industry as part of UK carbon capture usage and storage (CCUS).[vi] This involves identifying a suitable benchmark or proxy in the form of an existing industry in the UK economy that the Hydrogen Transmission sector may share supply chain characteristics and similar labour and capital intensities, with the potential to refine as information on the new activity emerges.[vii]

Here, we identify the UK electricity industry[viii] as an initial benchmark/proxy for our hydrogen transmission sector. This choice is partly motivated by the likely shared characteristic of highly distributed infrastructure and production activity across multiple locations. Thus, our scenario simulation approach involves using the investment profile in Figure 1 to build up the capital stock in the new hydrogen transmission sector, with the labour and other supply chain requirements following in line with the electricity industry proxy. We also identify an alternative proxy in the existing UK gas distribution sector, which we consider in Section 3.[ix]

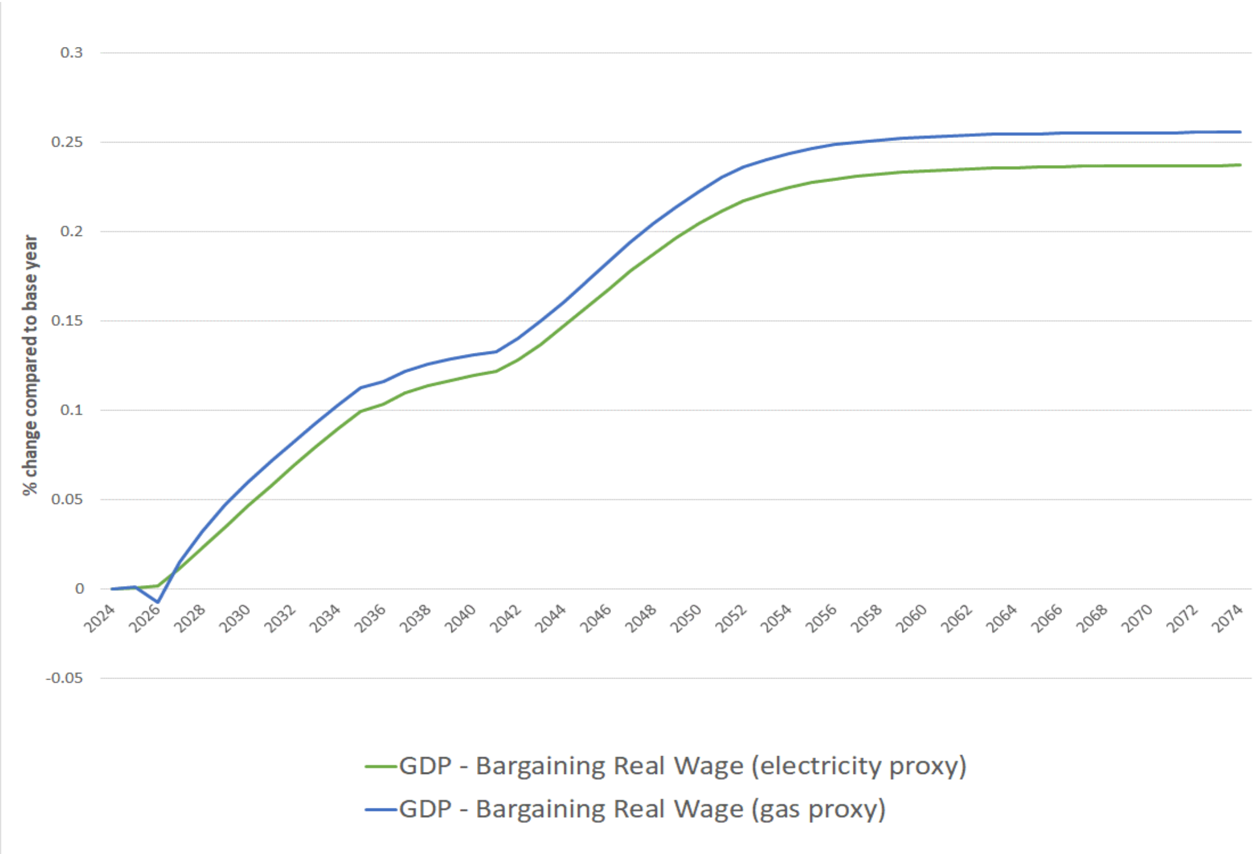
Once the new sector is fully invested, in 2050, the result is a new hydrogen transmission sector with a capital stock of £5.6BN and producing annual output with a value of £7.2BN, which directly employs 8.5K full-time equivalent (FTE) workers. Our focus here is to consider the wider economy impacts of introducing this new sector to the economy, with particular focus on total jobs supported across the UK, and the potential uplift in GDP p/a if demand emerged to fully utilise the capacity created.

At this stage, we do not have information on how the hydrogen transmission will interact with wider hydrogen production and distribution activity, nor on the nature and level of demand. Thus, we simplify here by introducing an undefined source of demand sufficient to utilise the transmission capacity created. This allows us to consider how the operation of the hydrogen transmission network may impact the wider economy, where we start by isolating these impacts by considering all results in terms of changes relative to the baseline incorporated in the database of our UKENVI model. All monetary results are reported in 2018 prices.

2. Potential Wider Economy Benefits

Figure 2 reports the trajectory of the GDP uplift delivered as the spread of investment in hydrogen transmission capacity shown in Figure 1 unfolds. Note that the upward trajectory in Figure 2 is smoothed relative to that of the underlying investment. This is due to the ripple effect throughout the economy, where we assume that producers in all sectors directly or indirectly affected by the rollout of the new Hydrogen Transmission sector have knowledge of the planned investment programme and plan their own resource requirements accordingly.

Figure 2. Impacts (% change) over time on UK GDP of introducing a new Hydrogen Transmission sector (alternative benchmarks/proxies for the nascent industry)

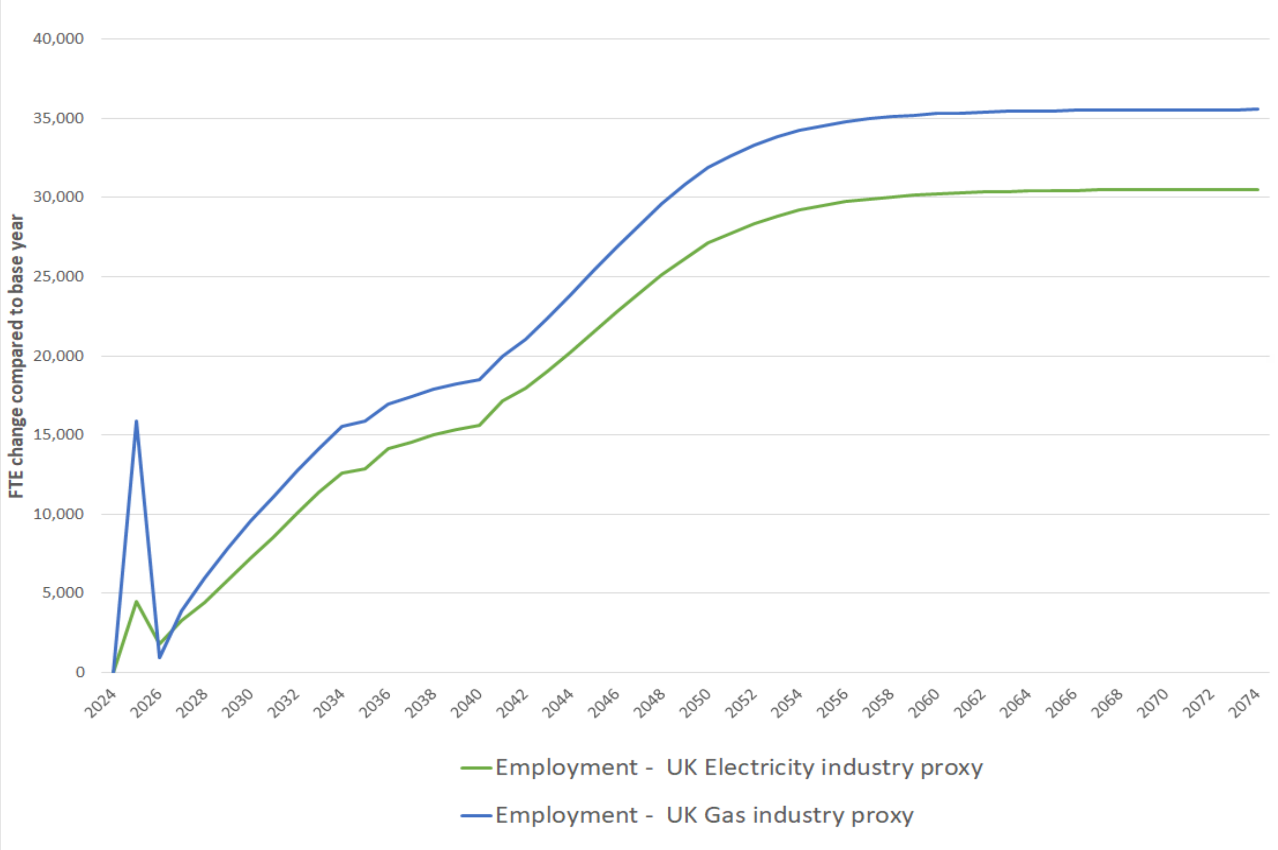


Ultimately, most of the GDP uplift is delivered by the end of the investment period in 2050, by which time UK GDP is 0.2% more than it would otherwise be. By 2060, the uplift has largely settled at 0.23% p/a (£4.5BN p/a in 2018 prices). The progress of delivery of the wider activity gains across the economy reflected by the GDP uplift largely follows the investment, with just over half the GDP uplift (0.12%) delivered by 2040, when 48% of the investment has been made.

The trajectory of total UK employment associated with the introduction of the hydrogen transmission sector is shown in Figure 3. While this largely tracks the GDP trajectory, two points should be noted. First, employment initially grows faster than GDP. This is due to a combination of the initial direct stimulus to UK construction industry and the slightly delayed response of indirectly stimulated sectors in making investment decisions.

Second, due to the relative capital-intensity of the new hydrogen transmission sector, the trajectory of employment gains, shown in terms of full-time equivalent jobs in Figure 3, is proportionately lower than that for GDP in Figure 2. For example, the 2040/2050/2060 GDP p/a uplifts of 0.12%/0.20%/ 0.23% reported above are respectively associated with total employment uplifts of 0.05% (15.6K FTE) by 2040, 0.09% by 2050 (27.1K), and 0.10% (30.2K).

Figure 3. Impacts (FTE change) over time on UK employment of introducing a new Hydrogen Transmission sector (alternative benchmarks/proxies for the nascent industry)



A key question is which parts of the economy benefit most? The distribution of sustained employment gains by 2060 across different sectors of the UK economy is shown in Figure 4. The biggest share of jobs supported are in construction activity. By 2060 the upfront investment programme is complete, with the sustained boost of just over 10,000 construction jobs being associated with maintaining the infrastructure created in the relatively capital-intensive new activity. The second biggest share of jobs (when we use the electricity proxy) is in the new hydrogen transmission sector (8.5K). Figure 4 also shows substantial gains in the existing electricity and gas industries, but these should be considered with appropriate caution: while hydrogen transmission activity is likely to be energy-intensive, the specific outcomes here are a function of the proxy used (i.e., electricity supply uses a lot of electricity at different points in the supply chain, and gas is still used in generation).

The next biggest gains are in those service sector industries that meet the requirements of both the new supply chain activity and household spending, which increases as employment and real wages rise in the expanding economy. However, this latter point also highlights a key trade off reflected in all our scenarios, which incorporate consideration of the challenge of persisting supply constraints in the UK labour market. Here, as the demand for workers rises in the new hydrogen transmission sector and all other sectors of the economy that are positively affected by introducing the new activity, real wage bargaining in the labour market will push up nominal wage costs for all producers. This limits the extent of employment and activity gains in all sectors, and results in net displacement in some, particularly higher wage and/or more labour-intensive sectors.

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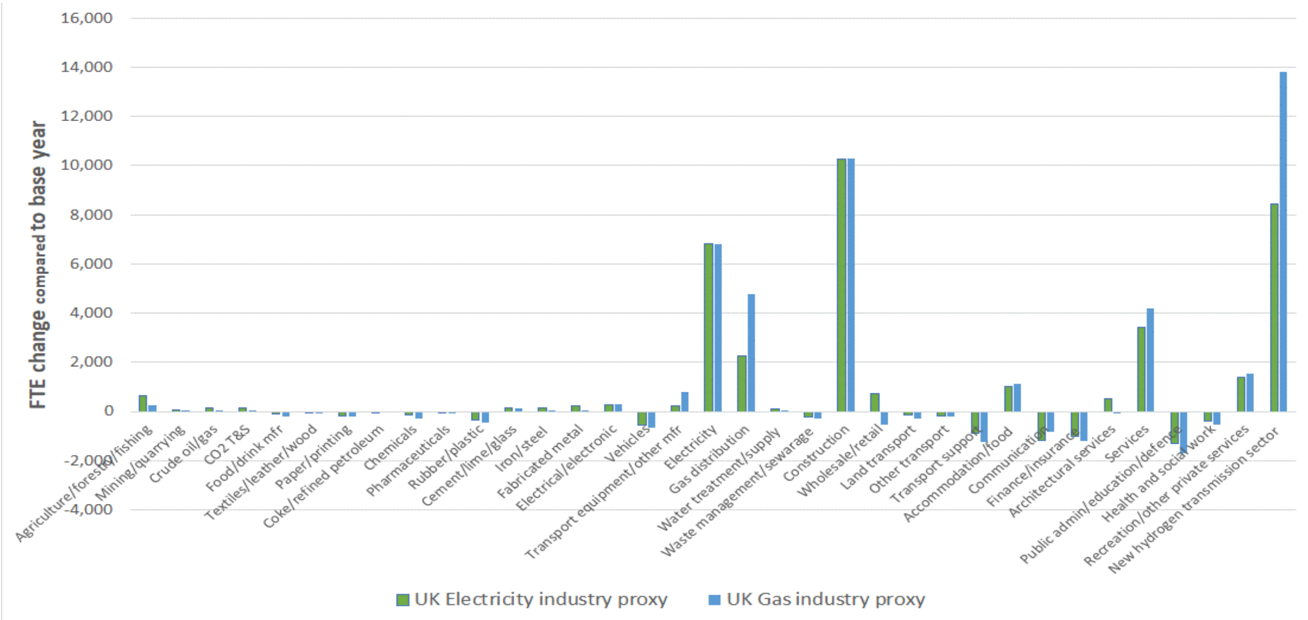
The key implication here is the importance of policy action to enable and support things like skills development and increasing participation in the UK labour market. Crucially, if worker and skills shortages can be effectively addressed, estimates of the total employment and GDP supported by hydrogen transmission activity would be greater, and the limit risk of both transitory and sustained displacement of jobs across other sectors.

Figure 4. Impacts on sectoral (full-time equivalent, FTE) employment by 2060 of introducing a new Hydrogen Transmission sector (alternative benchmarks/proxies for the nascent industry)



3. Importance of understanding the capital-intensity of nascent sectors

As indicated by the sectoral employment results, there are challenges associated with the need to use existing industries as proxies or benchmarks for a nascent sector, like Hydrogen Transmission, in conducting economy-wide scenario analysis. We can examine the sensitivity of our results to some extent by considering an alternative proxy, for example the current gas distribution industry.

Figures 2-4 include a second set of results reflecting the outcomes if we switch to that proxy. The headline outcome is that this would trigger a more extensive wider economy expansion, with the sustained GDP uplift increasing to 0.25% (£4.8BN) above what it would otherwise by 2060, with the associated total employment gain rising to 35.3K. However, this is mostly due to activity implied within the gas-proxied hydrogen transmission sector and the links carried over from the current gas industry.

Crucially, under the gas proxy, the hydrogen transmission sector is more labour-intensive, with 13.8K workers compared to 8.5K under the electricity proxy. While there are other supply chain differences between these two potential benchmarks, this difference in labour-intensity, combined with that in capital-intensity has a dominant effect. Crucially, the electricity proxy is more capital-intensive, which may be more realistic, given the likely shared characteristic with hydrogen transmission of geographically dispersed production activity and associated assets.

The key point to make here is that other CEP research – on the emergence of CO_2 Transport and Storage, as another nascent industry, linked to the deployment of UK CCUS - has shown that the capital-intensity of a nascent activity is a crucial and central determinant of the magnitude of potential economy-wide gains.[x] The issue is that the more capital-intensive an activity is, the more investment is required to deliver a given value of capital stock, limiting the value of output produced and demand served and, thus, the extent of wider economy gains. This implies an urgency in establishing what the actual picture may look like for hydrogen transmission in the UK, potentially through refinement of the benchmark(s) of existing electricity (and/or gas) industry activity.[xi]

4. Demand uncertainty and the need for coordination

Another key unknown is how and where demand for hydrogen and, thus, the new hydrogen transmission network will emerge over time. At this stage, our scenario simulations involve assuming demand commensurate with the total value of output (ultimately £7.2BN p/a, at 2018 prices, in our central case) that can be delivered by the capital stock created (with a sustained value of £5.6BN in our central case) is forthcoming. If sufficient demand for the capacity created does not emerge – and/or cannot be somehow guaranteed through some transitory policy intervention - the investment will not take place or will be reversed as returns to capital fall. Use of the hydrogen transmission network will also depend on the other investment activities (including gas network conversion and decommissioning, disconnecting natural gas customers and connecting hydrogen users) going ahead.

5. Conclusions and future directions for research

This policy brief has presented the results of an initial exploration of what the wider economy impacts of introducing a hydrogen network to the UK economy, with focus on transmission activity. We have considered this as a new sector in the economy and estimated that – abstracting from other potential developments in energy supply and the wider economy – there is the potential for substantial employment gains and a sustained uplift in UK GDP if a new hydrogen transmission network is invested and becomes operational.

We note the need for caution in considering our quantitative findings. This is due to the nature of the assumptions that we have had to make in the absence of information on what the supply chain requirements and both labour and capital intensity of a Hydrogen Transmission sector may be. Nonetheless, we have been able to identify some important issues and offer some key insights even from this very initial analysis. First, it is crucially important to understand just how capital-intensive transmission and other hydrogen supply/distribution activities may be. This is necessary if we are to understand the value of economic output that may be delivered - and, thus, the wider economy activity and employment that may be supported - by what constitutes a relatively substantial Net Zero investment. Second, there is a pressing need for policy decisions to be made that will influence and enable a fuller picture of potential hydrogen levels and routes to establishing a demand profile for the transmission network to ensure that capacity created is effectively utilised.

End-notes

i. Arup (2023). Future of GB Gas Networks Assessment

ii. Details and documents on all the National Grid FES scenarios can be found at https://www.nationalgrideso.com/future-energy/future-energy-scenarios/documents.

iii. The other two cases identified in the Arup data are 'High' and a 'Low' Hydrogen scenarios, involving £44.82Bn and £64.27 total spending respectively, where the time profiles of spending also differ.

iv. UKENVI has been used in a wide range of energy policy and Net Zero contexts (e.g., energy efficiency – see the CEP Policy Brief at https://doi.org/10.17868/strath.00082777 for a review – and in considering the impacts of actions involved in the heat pump rollout – e.g., see UKERC report at https://ukerc.ac.uk/publications/benefits-heat-pumps-role-electricity-gas-prices/).

v. The UK industry-by-industry IO accounts are publicly available at https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesindustrybyindustry. Here, we use the tables reported for 2018.

vi. The customisation of our UKENVI computable general equilibrium (CGE) model of the UK economy to consider nascent (not yet existing and/or emerging) sectors has been peer reviewed in the applied context of considering the impacts of an emerging CO_2 Transport and Storage (T&S) industry as part of UK Carbon Capture Usage and Storage (CCUS). These include two papers published in the Sage journal Local Economy in 2021 and 2023 (available open access at https://doi.org/10.1177/02690942211055687 and https://doi.org/10.1177/02690942231203932 respectively) and one the Elsevier journal Ecological Economics in 2022 (available open access at https://doi.org/10.1016/j.ecolecon.2022.107547).

vii. For example, see the outcomes of an expert stakeholder engagement exercise for the CO_2 Transport and Storage example in the CEP Policy Brief at https://doi.org/10.17868/strath.00083228, with a later economy-wide scenario simulation exercise adjusting the Oil and Gas industry benchmark to consider the implications of a greater reliance on international shipping reported in a subsequent CEP Policy Brief at https://doi.org/10.17868/strath.00084117.

viii. Identified as SIC 35.1, 'Electric power generation, transmission and distribution' in the 2018 UK industry-by-industry Input-Output, IO, accounts – https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesindustry-byindustry - that inform the core structural database of our UKENVI model.

ix. The 'gas distribution' sector is identified as SIC 35.2-3, 'Gas; distribution of gaseous fuels through mains; Steam and air conditioning supply' in the UK IO accounts that inform our UKNEVI model (see previous endnote).

x. See our new peer reviewed research published by the Sage journal Local Economy, available open access at https://doi.org/10.1177/02690942231203932.

xi. We make such refinements to a nascent industry benchmark – where the current UK oil and gas industry is used to proxy for CO_2 transport and storage within CCUS - in the Local Economy paper published at https://doi.org/10.1177/02690942231203932 and linked CEP Policy Brief at https://doi.org/10.17868/strath.00084117, with focus there on potentially greater reliance on international shipping in transporting CO_2 than is the case in the oil and gas proxy.