Hector Pollitt
Bence Kiss-Dobronyi
Dora Fazekas

Green Recovery scenarios in Visegrad countries

Working Paper

November
2020

Cambridge Econometrics
Cambridge – Brussels – Budapest

info@camecon.com
www.camecon.com

1 Introduction

The COVID-19 pandemic is a health crisis that has happened on a scale not seen in recent decades. Its impact on people's lives and our society is significant and already the target of multiple research endeavours from various fields. It is also an economic crisis, stemming from changes in consumer behaviour as well as government measures to curb the extent of the pandemic.

Against this backdrop it is unquestionable that governments have an obligation to step up and provide relief for those who are in need, and to help stabilize the economy (Stiglitz 2020). They are already doing it with different policy responses, often focusing on providing credit guarantees, wage subsidies and loans (IMF 2020) to compensate reduced private sector demand. However, as the crisis passes, governments will also need to introduce longer-term recovery packages to help their economies recover and to provide new opportunities for those who lost their livelihoods.

How this will be done is an important question. For the short term, governments have already announced a multitude of "relief" programs. These programs include unprecedented spending plans (Bruegel 2020; IMF 2020), with a focus on keeping firms solvent and consumers spending. But for the long term, questions remain about the best policy response.

Building back – better?

The looming crisis, with lockdowns and travel restricted, have also created the largest fall in CO_2 emissions ever seen (Evans 2020). There are now calls for a 'green recovery' and ideas 'to build back better'. It is recognised that, without policy intervention, rates of CO_2 emissions and environmental degradation will increase again as the economy recovers (Evans & Gabbatiss 2020). Therefore, it has been proposed that economic recovery should have at least two goals now: to restore employment and economic activity, but also to support work towards reaching climate goals by limiting CO_2 emissions.

While UN Secretary General Antonio Guterres has already said that "Coal has no place in COVID-19 recovery plans" (Lewis 2020), there are countries where spending on fossil fuel based energy is a primary component of recovery plans (such as Australia) (Murphy 2020). But even without direct spending on fossil-based energy, recovery plans without elements to induce a large-scale green-transition will likely have adverse effect on the environment, given that 'decoupling' of emissions and economic activity in the current economic-energy systems has not yet happened (Mattauch *et al.* n.d.).

This paper proposes a 'Green Recovery Program' (GRP), which aims to contribute to both of these aims: *To restore employment (and economic activity) through working towards climate neutrality with government support*. The geographical coverage of the paper is the Visegrad group; we cover Poland, the Czech Republic, Hungary and the Slovak Republic individually in the analysis. None of these countries have yet announced large-scale recovery programs, but all of them face substantial challenges from the crisis because of their open economies. Furthermore, in the coming years, regardless of impacts of COVID-19, these four countries have to make serious progress towards agreed environmental goals such as energy efficiency, cutting dependency on fossil fuels and the electrification of road transport.

The main contribution of this paper is not only to outline one such 'green' recovery pathway for these countries, but also to simulate, compare and explain this recovery's labour market, economic and emissions consequences. The exercise also necessarily includes an estimation of economic and labour market impacts of COVID-19, which is then used for a point of comparison for the GRP results presented. The approach used is a model-based one, specifically using the existing E3ME macroeconomic model.

2 Green Recovery in Visegrad Countries

Challenge and opportunity

Various groups have already discussed how a 'green' recovery program could work in the EU. For example, WWF has outlined a macro-level package (WWF European Policy Office 2020) and the cities of the C40 coalition have published an agenda focusing on "Green and Just" recovery (C40 2020). These pieces often highlighting different components, such as energy efficiency measures, green energy investments or budget consolidation through carbon taxes. Similarly, Cambridge Econometrics' modelling of a Green Recovery Package (Cambridge Econometrics 2020b) has focused on subsidies to renewable energy generation projects and domestic energy efficiency programs.

Grandiose projects such as WIIW's proposed '100% RES e-highway' (Creel *et al.* 2020) are certainly appealing, and could result in a large-scale boost to economic activity if completed. Nevertheless, as the IEA notes (Varro *et al.* 2020) – based on experiences after 2008-09 – what historically works well is rather the expansion, scaling up and financing of existing schemes and frameworks. In these cases, often there is existing administrative capacity, working processes and understanding from both funding agencies and recipients. This helps to build trust and does not put unnecessary burdens on granters and grantees.

These factors are especially important in times of uncertainty. In Visegrad Countries, there is accumulated experience with such programs. After the 2008-09 crisis, multiple EU member states included 'green' elements in their recovery programs. A study for the European Commission (Cambridge Econometrics 2011) evaluated some of those programs, including those of the Czech Republic and Slovakia. At the time, both programs were deemed successful. The recovery program in Czechia included a 'Green Investment Scheme', which targeted energy efficiency improvements mostly in residential buildings. In Slovakia, there was a similar but smaller program, which was complemented with a renewable installation subsidy targeted towards households (Cambridge Econometrics 2011). Both programs also included a car scrappage scheme – similar to what we see in Germany now (Miller 2020).

The Visegrad countries therefore have experience with these programs and an opportunity to build on already-existing schemes, but there are other reasons for a ‘green’ recovery as well.

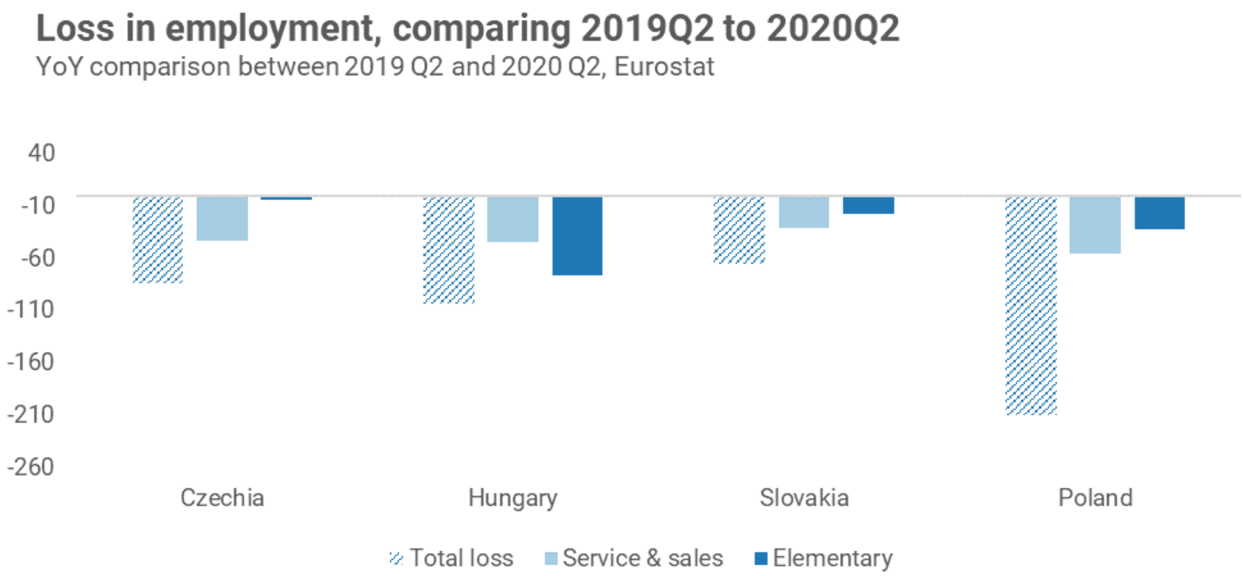
Looking back to the 2008-09 crisis the boosting of aggregate demand through government interventions happened mostly through tax cuts in developed countries and through public infrastructure investments in developing countries (International Institute for Labour Studies 2011). However, the standard alternative of general tax cuts may not be effective because V4 countries have lower savings and wealth than other countries[1] and therefore may not increase spending in response. When such measures were introduced after the financial crisis, it was questioned whether the effects can be significant even in countries like the UK (Phillips 2009).

Second, Visegrad countries are embedded in global value chains (Cieślik 2019; Grodzicki 2014). With these disrupted, it is important to increase investment in jobs that are producing for domestic demand. Creating a domestic market for renewable energy which is anyway expected to grow considerably in coming years (IEA 2020)) might serve this purpose. Although many of the components are sourced from imports (Pasimeni 2017), installation would need to be local.

Further, while the energy industry in general is more capital than labour intensive, renewable energy technologies have higher labour needs than conventional technologies do, both in installation and operation & maintenance; they could therefore provide stable jobs (ECOTEC 2002; ILO 2011). It has been also shown that energy efficiency investments in Europe could create employment gains (Cambridge Econometrics 2015). Furthermore, installation of renewables and energy efficiency improvements are fields where low-skill workers could find employment (ILO 2011). This factor is important because that jobs lost due to the pandemic are largely in low-skilled sectors (according to Eurostat data available on 2020 Q2 and past employment). In Hungary losses in low-skilled service, sales and elementary occupations amount to 117% of net losses; in Slovakia 76% of the net loss is in these occupations (Eurostat 2020). These figures are in line with earlier

[1] Based on Eurostat data.

Figure 1 - Employment loss in highlighted groups, comparing 2019Q2 to 2020Q2 in Visegrad countries
Source: Author's own work, data: Eurostat (2020)



reports on the risk of employment loss in vulnerable groups (such as people with lower education) (Pouliakas & Branka 2020).

Finally, the region's energy profile largely calls for a 'green' recovery for two reasons: (1) energy security and (2) dependency on fossil energy sources (particularly coal and lignite) (BloombergNEF 2020). Energy security is a long-standing issue in the region; a high dependency on imported oil and gas from Russia long ago shifted the region towards a vision of more energy independence (Cambridge Econometrics 2020a). Building renewable capacities is an evident solution.

Czechia and Poland are still some of the most coal-intensive electricity producers. Poland produces 79%, and Czechia 43%, of its electricity from coal (BloombergNEF 2020). Hungary and Slovakia have less reliance on coal, but all four Visegrad countries have existing coal and lignite plants that do not meet the environmental standards coming into force in 2021 (BloombergNEF 2020). Thus, there is a choice either to invest in retrofitting those plants, potentially creating "stranded assets" as both regulations and the market moves away from financing coal, or to start building new capacities, for which the current recovery provides a potential opportunity.

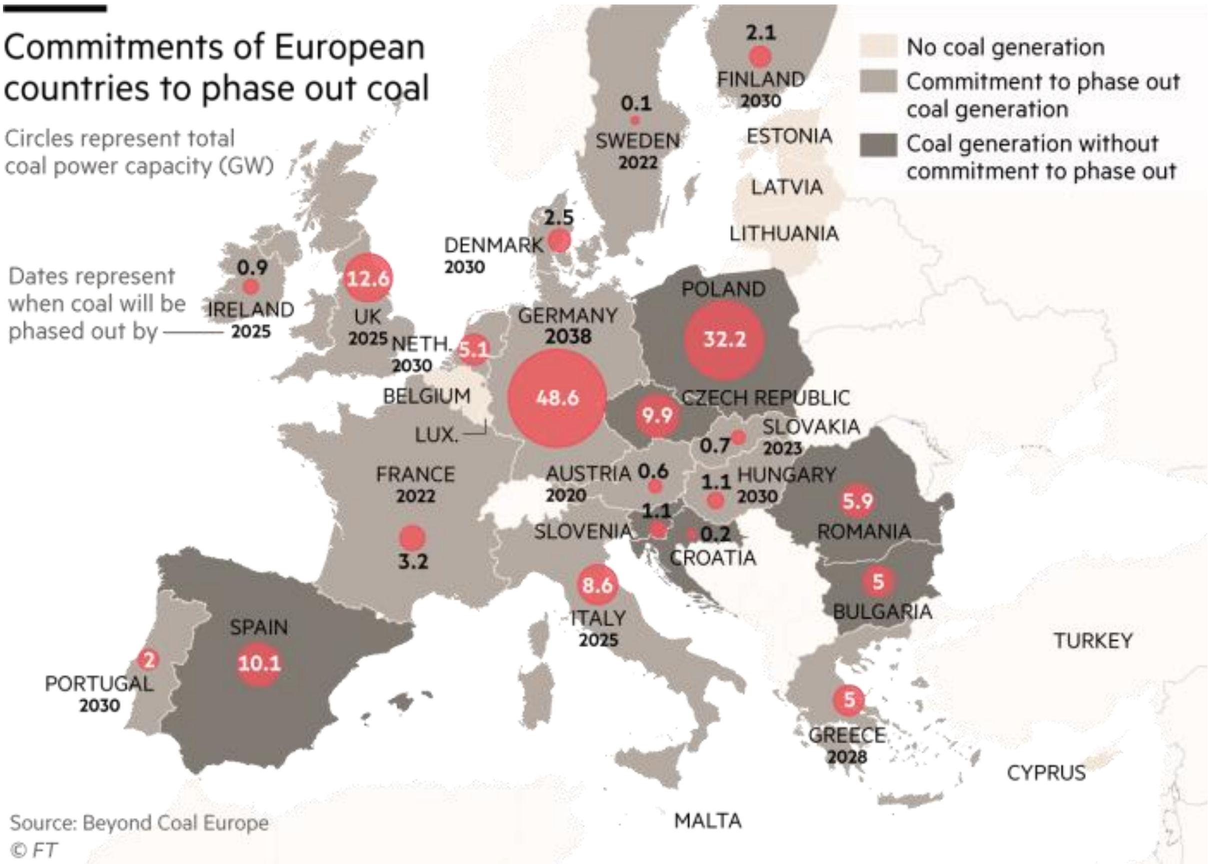


Figure 2 - Commitments of European countries to phase-out coal
Source: Financial Times, Dempsey (2019)

3 Methodology for assessment

The modelling exercises of this paper is built around the E3ME macro-econometric model. First, following the methodology set out in Pollitt et al. (2020) and Cambridge Econometrics and We Mean Business Coalition (2020), the impacts of the COVID-19 pandemic on the selected countries' economy and emissions are modelled. Second, three long-term scenarios focusing on versions of a 'green' recovery scenario are modelled. In this section first the E3ME model is described briefly, followed by a description of the scenarios.

E3ME model

E3ME is a macroeconomic model built on Post-Keynesian economic theory and on econometric estimations of macroeconomic relationships. The model was originally built by an international team, operating under the European Commission research programs (Cambridge Econometrics 2019). Since then, the model has been maintained by Cambridge Econometrics and has regularly been used in high-profile scenario-based policy analyses, including assessing the EU's 2030 environmental targets (European Commission 2020a), the EU's skills projections (CEDEFOP & Eurofund 2018) and the 2018 New Climate Economy report[2] (New Climate Economy & World Resources Institute 2018).

Recently the model has also been used in assessing various 'green' recovery scenarios globally (Pollitt *et al.* 2020), in Latin America and the Caribbean (CEPAL 2020) and in a number of selected countries (Cambridge Econometrics & We Mean Business Coalition 2020).

E3ME simulates 61 world regions 69 sectors in each EU country (corresponding to NACE Rev. 2 sectoral classification). Household consumption, which is divided to 43 categories, corresponding to COICOP classification, is linked to sectoral production in the model. Sectoral supply and demand are linked together through the use of input-output tables, while regions are linked through bilateral trade tables (Cambridge Econometrics 2019).

E3ME is macro-econometric model, that is built on Post-Keynesian thought. Its behaviour is different from that in computable general equilibrium (CGE) models (e.g. GTAP, GEM-E3) that are often used for macroeconomic

[2] For details and further project references please see Cambridge Econometrics' website http://camecon.com.

modelling. To highlight some important differences: E3ME adopts a 'bounded rationality' approach, represented through behavioural parameters estimated on historical data and the money supply is fully endogenous (Pollitt & Mercure 2018). The model is demand driven, assuming an adjustment on the supply side to fit demand, subject to constraints. While there are capacity constraints in labour and product markets that feed back to prices and investment decisions (Pollitt *et al.* 2017), there is usually spare capacity in the economy (unlike in CGE models). Policies that draw upon this spare capacity may lead to increases in output and employment (Cambridge Econometrics 2019; Mercure *et al.* 2019).

The model builds on economic relationships estimated on historical data. A full list of equations used to define these relationships can be found in Mercure et al. (2018). Historical data was collected from various sources such as Eurostat, OECD, UN. Model parameters were estimated on this data using the concepts of cointegration and error-correction, based on Engle and Granger (1987) and Hendry, Pagan, and Sargan (1984).

E3ME is primarily used for policy analysis, rather than forming absolute projections. Therefore, a baseline scenario is usually simulated first, which represents a "business-as-usual" state of the world going forward. In this paper a baseline calibrated to IEA's Current Policies Scenario (IEA 2019b) is used. In this paper this baseline scenario is a "no-virus" baseline, which is built on economic and energy projections before the start of the pandemic. This approach is used to show how fast a 'recovery' can be achieved to pre-COVID levels of activity and employment.

The exercise also takes advantage of 'Future Technology Transformations', a suite of bottom-up technology models integrated with E3ME. The FTT:Power and FTT:Transport submodels are used in the modelling exercise. These technology models assume technology diffusion and learning effects within individual technologies and employ discrete choice modelling to forecast path-dependent choices made by agents in the system (Mercure *et al.* 2014). FTT:Power is a bottom-up technology model following these principles (Mercure *et al.* 2014), while FTT:Transport uses a similar approach with heterogenous agents to simulate private passenger transport (Mercure *et al.* 2018a). These sub-models are used to simulate impacts of the 'green' recovery scenarios: e.g. subsidies for car scrappage or capital subsidies for renewables.

The E3ME model manual, which is a detailed description of data used, underlying mechanisms and equations, which form the model, is available at www.e3me.com.

4 Green Recovery scenario

The Green Recovery scenario presented here builds on (Pollitt *et al.* 2020), but considers the possible measure of the Green Recovery in the context of the Visegrad countries, plus introduces two sensitivities: a lighter and a stronger version of the recovery program. Contrary to 'green' recovery programs considered in Pollitt et al. (2020), in this exercise there is no assumption on VAT or sales tax reductions as part of the recovery programs. The different pathways will be referred to as follows:

- Pre-Covid baseline
- Baseline with estimated COVID-19 impacts
- Green Recovery Program (GRP) scenario
- "Light" GRP sensitivity
- "Strong" GRP sensitivity

The GRP scenario considers four main measures:

(1) Capital subsidy to renewable technologies
(2) Grid investment to accommodate the rapid uptake of renewable technologies
(3) Car scrappage scheme, applied only to cars replaced by electric vehicles (EVs)
(4) Energy efficiency improvements in buildings, focusing on retrofitting

First, three levels of capital subsidy are simulated. The main GRP scenario assumes a 50% capital subsidy to wind and solar PV technologies in 2021-2023, followed by 30% in 2024 and 2025. The "strong" sensitivity assumes a scaling-up of these numbers, 67% subsidy in the first period and 40% subsidy in the second period, while the "light" sensitivity uses 30% subsidy up to 2023 and 5% up to 2025. Renewables technologies are becoming cost competitive in the world, even without subsidies, especially in Europe (IEA 2019b). However, it is not just a question of becoming cheaper; renewables must first become established in the market (e.g. with ancillary services available) before they can grow quickly (Mercure *et al.* 2014). Reducing the costs of renewables accelerates this process. A connected *second* point is the need for national electricity grid investments to accommodate the increased uptake of renewable technologies. A 400 EUR / kW investment need is assumed, based on the average cost of grid-scale battery projects (IEA 2019a). Renewable energy generation is also important considering the European Union's strategic renewable energy target of 32% by 2030 (European Commission 2020b).

Third, a car scrappage scheme was a popular 'green' policy tool after the 2008-2009 crisis, and it is gaining momentum once again (Cambridge Econometrics 2011; Evans & Gabbatiss 2020). However, in our scenario it is only applicable to new EV purchases, therefore pushing the share of electric vehicles in the transport mix. In the "light" sensitivity of the scenario it is assumed that a total of 2% of the fleet in usage can be replaced in 3 years, this number is 3.5% in the main GRP scenario and 5% in the "strong" sensitivity. A subsidy amount of 15% is assumed to reach these goals; this rate has been chosen based on the observed efficiency of such programs in other countries (International Transport Forum 2011).

Finally, through retrofitting, financed by government subsidies, an energy efficiency improvement primarily in buildings is assumed. The IPCC states that retrofitting existing building stock is key to reducing emissions of the building sector (IPCC 2014). Retrofitting also provides co-benefits for residents, through savings in energy consumption and thus spending on energy. The overall effectiveness and extent of energy efficiency measures in buildings are dependent on several factors, including the building stock and the consumption reduction that can be achieved by retrofitting. The IEA's 2019 Sustainable Development Scenario assumes that, due to energy efficiency improvements, energy consumption of the buildings sector could be reduced by over 30% by 2030 (IEA 2019b). It is of course a result of combined impacts in new buildings and retrofitting. Nevertheless, taking this and studies on the energy savings potential of public buildings in Hungary and Slovakia into account (Korytarova 2011; Korytárová *et al.* 2017) an 8% total reduction was introduced in the main GRP scenario (over 5 years). In the "strong" sensitivity a 12% reduction is assumed, while in the "light" sensitivity a 6% reduction is assumed in Visegrad countries. The costs of the measures are estimated based on Ürge-Vorsatz *et al.* (2010), assuming that 1.16 mEUR investment is required to reduce energy consumption in buildings by 1 GWh. This estimate is based on Hungarian data and there have been advancements in the area since, so it is probable that costs in this aspect are overestimated.

5 Results

In this section we present the country-level results from the modelling. The results focus on three dimensions and key indicators:

1. social dimension - employment,
2. environmental dimensions - level of CO_2 emissions and
3. economic activity – gross domestic product (GDP).

These measures have been selected as together they give a summarised picture of the economy, as well as a slice of the environmental harm done by the economy. The order of the indicators is also important: the authors believe that in the current situation keeping employment up and making sure that people can maintain their livelihoods could be the most important goal of a recovery program.

To provide insights about the financing needs for these programs, total government spending in GDP terms and the cost of the individual program components are also presented and discussed. It should be noted that the modelling does not make explicit assumptions on the cost of the program, costs are calculated based on endogenous responses to the introduced measures (i.e. there is no fixed budget for RES subsidies, but the cost of the measure depends on the endogenous response to the magnitude of the subsidy).

The text in this section focuses on the main GRP scenario, but results are presented for the 'light' and 'strong scenarios as well in the figures. These results provide a range of potential impacts from the green recovery program.

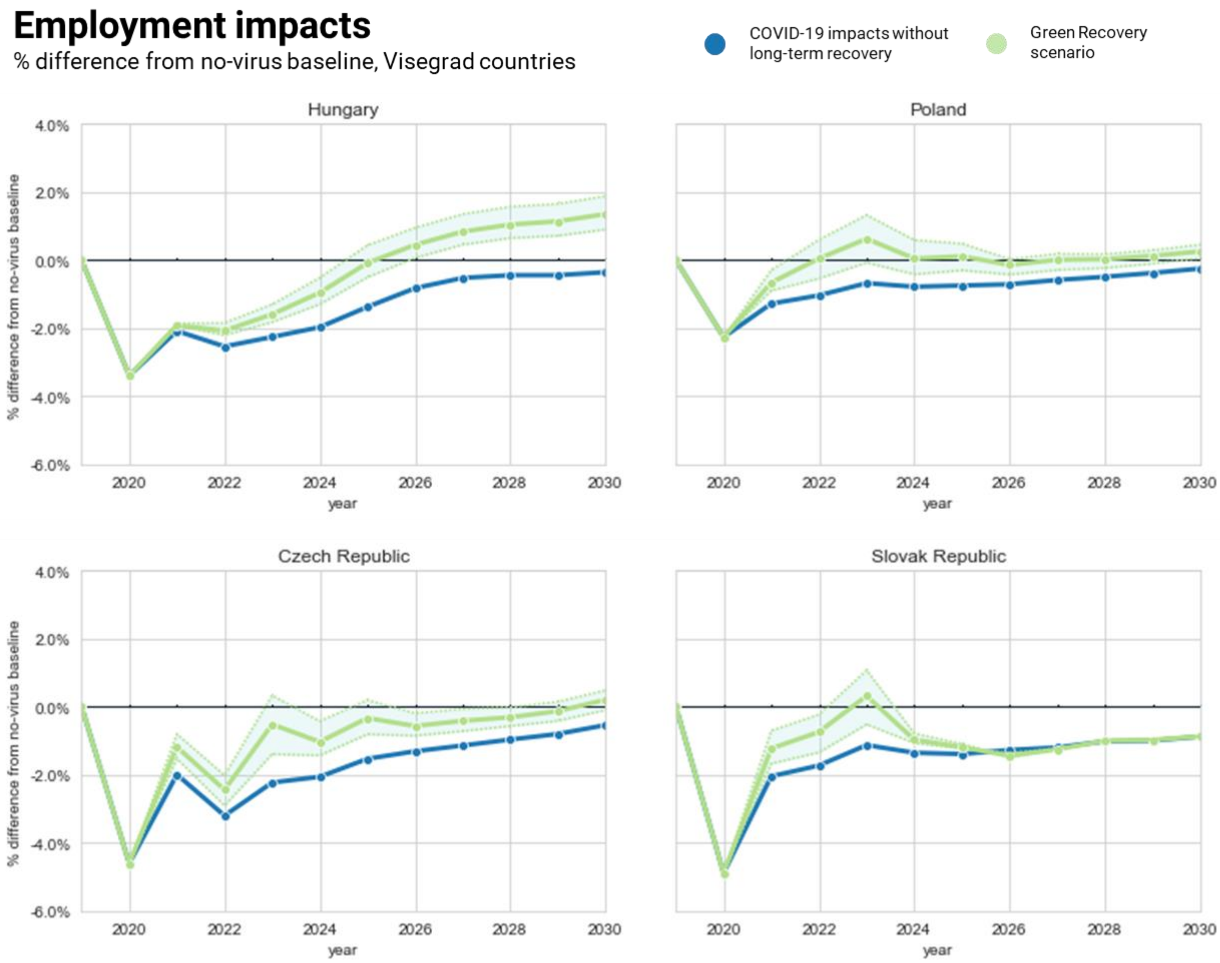


Figure 3 – Employment impacts in the modelled scenarios
Source: Author's own work, data: E3ME modelling results

Employment

The initial employment impacts of the GRP are positive for all four countries, although their magnitude differs substantially. In Hungary (HU), Czech Republic (CZ) and Poland (PL), there are also employment benefits after the support is withdrawn and beyond 2030. The main reason for the long-term benefits is the renewable subsidies; by putting these three countries on technology trajectories that rely more on domestic installation and less on imported fuel, there is a permanent boost to employment.

Total employment boost compared to the baseline with estimated COVID-19 impacts is about 213, 93, 34, 30 thousand additional full-time equivalent (FTE) employment by 2023 respectively in PL, CZ, SK and HU. Long-term employment increase (by 2030) is about 81, 41, 0, 76 thousand FTE employment in PL, CZ, SK and HU respectively.

The employment impacts result from a mix of drivers: an uptake of construction work is necessary because of energy efficiency and RES investment measures, this is complemented by increase in auxiliary sectors such as architecture, engineering, landscaping. The manufacturing of motor vehicles (due to car scrappage) is also an important driver. The boost of employment in these (and connected) sectors also causes higher disposable income, which in turn boosts employment in sectors of consumption (e.g. retail, wholesale, tourism). Finally, due to the measures being government programs, administrative jobs (e.g. public administration, legal, accounting) increase as well.

In the Slovak Republic (SK) the employment impact of the GRP does not persist because there is limited renewables take-up despite the subsidies. The short-term employment benefits (mainly the result of investment in energy efficiency and car scrappage) do not persist beyond the end of the support. While in Hungary retail sectors react favourably to the recovery of consumption inducing and employment increase in the long-term, complementing the above described effects.

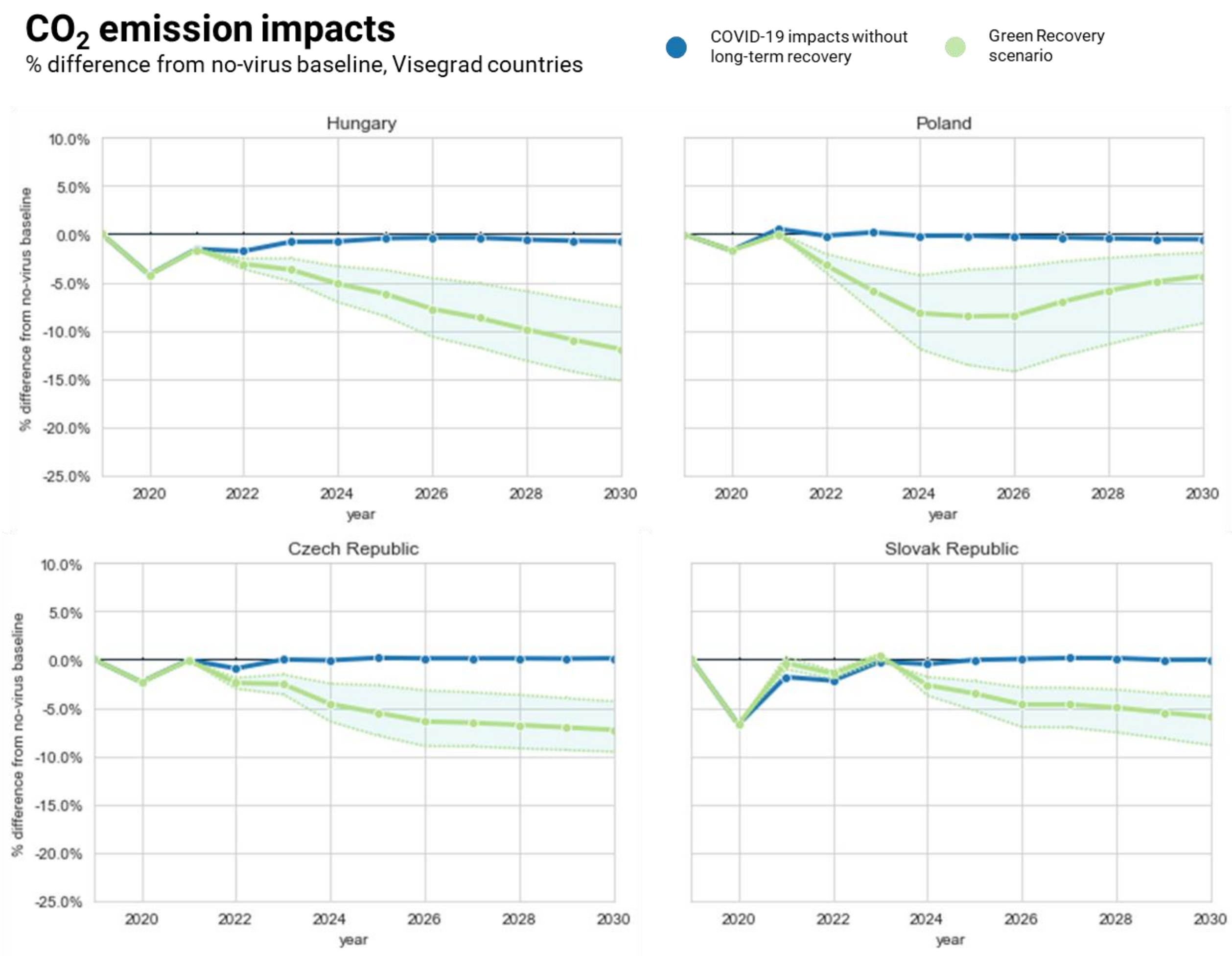


Figure 4 – CO_2 emission impacts in the modelled scenarios
Source: Author's own work, data: E3ME modelling results

Emission outcomes

An interesting side-effect of the COVID-19 pandemic is that, due to the significant reduction of economic activity, it has caused a drop in CO_2 emissions (Evans 2020; IEA 2020). However, it is likely that this reduction of emissions will not persist once economic recovery takes place. This is where a 'green' recovery could make a substantial difference. As shown in the results, a GRP would not only keep the reduction of CO_2 emissions, that the world achieved unintentionally, but could also introduce further reductions.

The effects are particularly evident and strong for Hungary, but also noticeable in the three other countries. In Hungary the reduction is driven by adoption of EVs (more than 70% of the reduction by 2025), while in Czechia both electricity (30%) and transport (50%) contribute substantially to the emission reductions (rest is energy efficiency and other spill-over effects).

In the case of Poland, the scenario leads to a substantial decarbonisation of the power sector, replacing some of the current dependency on coal and on gas with new energy sources. Under the GRP scenario, by 2025 the share of wind energy in power generation grows to 40% (up from around 13% in 2018). During the early stages of the pandemic it was already seen in Poland that the level of coal-fired generation dropped off, giving way to other energy sources. With a potential increase in carbon prices, competition from renewables and EU climate ambitions (BloombergNEF 2020), these recovery actions – as it was shown in the employment results – could help to change the track of the economic and energy systems. Even in our GRP results, however, Poland shows new investments, after the capital subsidies for RES end, for coal-based power generation (hence the upward curve in emissions). This is a stark reminder that without a restriction on new coal investments, coal will at least to some extent remain a dominant force in Poland.

It is noticeable that the sensitivities show quite a wide range in the emissions resutls. In CZ, SK and HU the difference between the 'light' and the 'strong' sensitivities is about 5 percentage points in reduction compared to the pre-Covid baseline by 2030. In the case of Poland, the different is even stronger: the 'strong' version results in reductions of about 10%, while in the 'light' version it is only about 4%. To put the numbers into context: reductions in PL could total to 150 $MtCO_2$ over the 2021-2030 period, which is equal to about half a year's total emissions in the country. In absolute terms this is the highest reduction, as PL has the highest emissions across the four countries, however the reduction is comparable in Hungary (reduction amounting to about 8 months), in Czechia (about 5 months) and even in the Slovak Republic (4 months).

Figure 5 – Economic activity impacts in the modelled scenarios
Source: Author's own work, data: E3ME modelling results

Economic activity

In general the modelling indicates that there could be a bounce-back in GDP in 2021 following the easing of restrictions introduced because of the pandemic. The E3ME model parameter estimates determine the dynamics of the bounce-back. There is an immediate recovery in Poland, while the 'natural' pace of recovery is much slower in other countries.

Looking at results of the GRP scenario in economic activity, just as in employment, two set of impacts are combined. First, the immediate effect of these government policies channelled through additional investments, and second the long-term effects of the induced transition. Economic recovery could be even faster in the GRP scenario than employment recovery, due to the slower reaction of labour markets.[3]

Long-term effects are positive in all cases when compared to the scenario with COVID-19 impacts and no recovery, and mostly positive even when compared to the pre-Covid baseline, showing effects of the energy transition as well as the recovery. This result is most prominent in Hungary, with an additional 4.0% of GDP (by 2030) compared to the scenario with COVID-19 impacts. Impacts in CZ, PL and SK, compared to the scenario with COVID-19 impacts, are 1.5%, 1.3% and 0.3%, respectively by 2030. While, when compared to a pre-Covid baseline, the results are still positive the magnitude is much less prominent, by 2030 in this case, Hungarian impacts show a 2.6% increase, with 0.8%, 0.6% and -0.5% in PL, CZ and SK, respectively.

As noted previously, due to the lack of large-scale energy system transition driven by subsidies, the results in the Slovak Republic do not show a stable increase, either in employment or in economic activity.

[3] This is a consistent result from econometric modelling. When demand increases, companies initially increase production without hiring more people (i.e. by improving efficiency or asking existing staff to work longer hours). Only once the increase in demand is seen to be permanent will companies increase employment levels. Recruitment also takes time, lengthening the lagged effect.

6 Conclusion

The analysis presented in this paper focuses on the macroeconomic potential of Visegrad countries to undertake a ‘green’ recovery. The paper sets the case for a ‘green’ recovery, arguing that it is not only important to move into the direction of climate goals, but also could provide an important push towards pre-Covid levels of employment and economic activity.

The E3ME macroeconometric model was used to assess first the macroeconomic effects of Covid-19 on the economies of the four countries, second to simulate the outcomes of different magnitudes of a ‘green’ recovery program. Results obtained from the modelling exercise indicate differing impacts for the program across countries. In all countries, significant positive impacts can be observed on the short-term: both in the Slovak Republic and the Czech Republic, as well as in Poland the GRP induces a return in employment and economic activity to pre-Covid baseline within 3 years. In Hungary the effect is similar, but somewhat more muted. This is an impact driven by initial investment stemming from the program policies, e.g. energy efficiency investment causes construction employment and thus higher incomes with spill-over effects, while increased EVs sales mean higher sectoral consumption.

It can be also observed that this initial period induces large-scale RES deployment, which in turn drives further take up of RES even after the subsidies have been phased out. This, compared with the overall effect of higher employment and activity in the early (2021-2023) period, leads to long-term effects in all countries except the Slovak Republic. This long-term effect, by 2030, means that countries gain employment and GDP compared to the economic pathway caused by the pandemic, and even greater or equal to the pre-Covid baseline.

The different pace of recovery and the lack of long-term effect in Slovakia requires some attention. As the induced RES investment, as a result of the GRP, in the Slovak Republic is smaller, so as the long-term impacts, the new RES investments will not trigger a large-enough market transition towards renewables that leads to long-term effects in the other countries.

As ‘green’ recovery programs it is important that the measures decrease carbon-dioxide emissions. This condition is reached in all countries; however, not only the magnitude of reduction differs, but also the trend. An important result is that in Poland emissions increase by the end of the period (i.e. 2030 compared to 2025). Once the RES subsidies end, coal returns to near cost-parity and path dependency means that investment in coal resumes, unless other measures are put into place. However, even considering this, with the GRP, next to a relatively impactful economic recovery, these countries can achieve CO_2 emission reductions amounting to 4-8 months of their current total emissions.

There are of course significant limitations in the analysis. Annual COVID-19 impacts are estimates based on observed impacts and assumptions. The spread of COVID-19 is an ongoing health crisis and it may cause significant changes in our future economic behaviour. The assumptions of the design of the GRP are also largely based on previous studies (in some cases conducted not in the region), which may not be relevant here.

However, it is firmly believed by the authors, that it is important to think about such packages and to understand how they can impact the economy, taking into national characteristics into account. It is an important task to understand whether pursuing climate change mitigation and economy recovery at the same time is feasible and to be able to tell the how of this as well. This paper aims to do just that, focusing on a region that faces an important challenge and opportunity to tackle in the near-future.

7 References

Bank of England. (2020, June). Monthly Decision Maker Panel data - June 2020. Retrieved July 9, 2020, from http://www.bankofengland.co.uk/decision-maker-panel/2020/june-2020

BloombergNEF. (2020). *Investing in the Recovery and Transition of Europe's Coal Regions*. Retrieved from https://about.bnef.com/blog/new-report-reveals-economic-path-to-a-rapid-coal-phase-out-in-europe/

Bruegel. (2020). The fiscal response to the economic fallout from the coronavirus. Retrieved from https://www.bruegel.org/publications/datasets/covid-national-dataset/

C40. (2020). C40 Mayors' Agenda for a Green and Just Recovery. Retrieved November 11, 2020, from https://www.c40knowledgehub.org/s/article/C40-Mayors-Agenda-for-a-Green-and-Just-Recovery?language=en_US

Cambridge Econometrics. (2011). *Assessing the Implementation and Impact of Green Elements of Member States' National Recovery Plans*. Retrieved from https://ec.europa.eu/environment/enveco/memberstate_policy/pdf/green_recovery_plans.pdf

Cambridge Econometrics. (2015). *Assessing the Employment and Social Impact of Energy Efficiency* (Final Report), Cambridge, UK. Retrieved from https://ec.europa.eu/energy/sites/ener/files/documents/CE_EE_Jobs_main%2018Nov2015.pdf

Cambridge Econometrics. (2019). *E3ME Technical Manual v6.1*. Retrieved from https://www.e3me.com/wp-content/uploads/2019/09/E3ME-Technical-Manual-v6.1-onlineSML.pdf

Cambridge Econometrics. (2020a). *Oil dependency in the EU*. Retrieved from http://www.camecon.com/wp-content/uploads/2020/07/2020-TE-EU-oil-dependency-report-1.pdf

Cambridge Econometrics. (2020b, May). Green stimulus package together with a VAT rate cut could lead the UK out of recession in 2021. Retrieved from https://www.camecon.com/news/green-stimulus-package-together-with-a-vat-rate-cut-could-lead-the-uk-out-of-recession-in-2021/

Cambridge Econometrics, & We Mean Business Coalition. (2020). *Assessment of Green Recovery Plans after Covid-19*. Retrieved from https://www.wemeanbusinesscoalition.org/wp-content/uploads/2020/09/Report-Green-Recovery.pdf

CEDEFOP, & Eurofund. (2018). *Skills forecast: trends and challenges to 2030* (No. 108), Luxembourg: Publications Office of the European Union. Retrieved from http://data.europa.eu/doi/10.2801/4492

CEPAL, N. (2020). *Building a New Future: Transformative Recovery with Equality and Sustainability*, ECLAC. Retrieved from https://repositorio.cepal.org//handle/11362/46228

Cieślik, E. (2019). Looking for the sectoral interdependence: evidence from the Visegrad countries and China. *Quality & Quantity*, **53**(4), 2041–2062.

Creel, J., Holzner, M., Saraceno, F., Watt, A., & Wittwer, J. (2020). *How to Spend it: A Proposal for a European Covid-19 Recovery Programme* (No. 38), wiiw. Retrieved from https://wiiw.ac.at/how-to-spend-it-a-proposal-for-a-european-covid-19-recovery-programme-dlp-5352.pdf

del Rio-Chanona, R. M., Mealy, P., Pichler, A., Lafond, F., & Farmer, J. D. (2020). Supply and demand shocks in the COVID-19 pandemic: An industry and occupation perspective. *Covid Economics*, **1**(6), 65–103.

Dempsey, H. (2019, October 23). European coal plants forecast to lose €6.6bn in 2019. *Financial Times*. Retrieved from https://www.ft.com/content/ba190c72-f590-11e9-b018-3ef8794b17c6

ECOTEC. (2002). *Renewable Energy Sector in the EU: its Employment and Export Potential*. Retrieved from https://ec.europa.eu/environment/enveco/eco_industry/pdf/ecotec_renewable_energy.pdf

Enerdata. (2020). Country profiles: EU Energy Efficiency & Trends policies. Retrieved October 19, 2020, from https://www.odyssee-mure.eu/publications/efficiency-trends-policies-profiles/

Engle, R. F., & Granger, C. W. J. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, **55**(2), 251–276.

European Commission. (2020a). *Commission Staff Working Document SWD/2020/176: Impact Assessment on Stepping up Europe's 2030 climate ambition Investing in a climate-neutral future for the benefit of our people*, Brussels. Retrieved from https://ec.europa.eu/clima/sites/clima/files/eu-climate-action/docs/impact_en.pdf

European Commission. (2020b). Renewable energy directive [Text]. Retrieved October 19, 2020, from https://ec.europa.eu/energy/topics/renewable-energy/renewable-energy-directive/overview_en

Eurostat. (2020). Employment by occupation and economic activity (from 2008 onwards, NACE Rev. 2) - 1 000 [LFSQ_EISN2]. Retrieved November 11, 2020, from https://ec.europa.eu/eurostat/databrowser/view/tipsna61/default/table?lang=en

Evans, S. (2020, April 9). Analysis: Coronavirus set to cause largest ever annual fall in CO2 emissions. Retrieved October 12, 2020, from https://www.carbonbrief.org/analysis-coronavirus-set-to-cause-largest-ever-annual-fall-in-co2-emissions

Evans, S., & Gabbatiss, J. (2020, June 16). Coronavirus: Tracking how the world's 'green recovery' plans aim to cut emissions. Retrieved October 19, 2020, from https://www.carbonbrief.org/coronavirus-tracking-how-the-worlds-green-recovery-plans-aim-to-cut-emissions

Google. (2020). COVID-19 Community Mobility Report. Retrieved July 9, 2020, from https://www.google.com/covid19/mobility?hl=en

Gopinath, G. (2020, November 2). Global liquidity trap requires a big fiscal response. Retrieved November 5, 2020, from https://www.ft.com/content/2e1c0555-d65b-48d1-9af3-825d187eec58

Greeley, B. (2020, April 17). Stephanie Kelton: 'They're going to have massive deficits. And it's fine.' *Financial Times*. Retrieved from https://www.ft.com/content/ea25934a-7b28-11ea-af44-daa3def9ae03

Grodzicki, M. J. (2014). *Global Value Chain and Competitiveness of V4 Economies* (SSRN Scholarly Paper No. ID 2483762), Rochester, NY: Social Science Research Network. Retrieved from https://papers.ssrn.com/abstract=2483762

Hendry, D. F., Pagan, A. R., & Sargan, J. D. (1984). Chapter 18 Dynamic specification. In *Handbook of Econometrics*, Vol. 2, Elsevier, pp. 1023–1100.

ICAO. (2020, July 6). Effects of Novel Coronavirus (COVID-19) on Civil Aviation: Economic Impact Analysis. Retrieved July 9, 2020, from https://www.icao.int/sustainability/Documents/COVID-19/ICAO_Coronavirus_Econ_Impact.pdf

IEA. (2019a). *World Energy Investment 2019*. Retrieved from https://www.iea.org/reports/world-energy-investment-2019

IEA. (2019b). *World Energy Outlook 2019*, Paris: OECD.

IEA. (2020). Global Energy Review 2020. Retrieved October 12, 2020, from https://www.iea.org/reports/global-energy-review-2020/global-energy-and-co2-emissions-in-2020

ILO. (2011). *Research brief: Investment in renewable energy generates jobs. Supply of skilled workforce needs to catch up*. Retrieved from http://www.skillsforemployment.org/KSP/en/Details/?dn=FM11G_004218

IMF. (2020). Policy Responses to COVID19. Retrieved July 9, 2020, from https://www.imf.org/en/Topics/imf-and-covid19/Policy-Responses-to-COVID-19

International Institute for Labour Studies. (2011). A Review of Global Fiscal Stimulus. *EC-IILS Joint Discussion Paper Series*, (No 5.).

International Transport Forum. (2011). *Car Fleet Renewal Schemes: Environmental and Safety Impacts*. Retrieved from http://www.internationaltransportforum.org/Pub/pdf/11Fleet.pdf

IPCC. (2014). *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]*, Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

Kelton, S. (2020). *The Deficit Myth: Modern Monetary Theory and the Birth of the People's Economy*, Illustrated edition, New York: PublicAffairs.

Keynes, J. (1936). *The General Theory of Employment, Interest and Money*, London: Macmillan.

Korytarova, K. (2011). *Energy efficiency potential for space heating in Hungarian public buildings: towards a low-carbon economy*, Budapest: Central European University.

Korytárová, K., Knapko, I., & Šoltésová, K. (2017). Energy savings potential for space heating in public buildings in Slovakia. *Eceee Summer Study Proceedings*. Retrieved from https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2017/6-buildings-policies-directives-and-programmes/energy-savings-potential-for-space-heating-in-public-buildings-in-slovakia/

Lewis, N. (2020, July 21). "Coal has no place in Covid-19 recovery plans," says UN chief. *CNN*. Retrieved from https://www.cnn.com/2020/07/09/energy/iea-clean-energy-transition-summit-spc-intl/index.html

Mattauch, L., Radebach, A., Siegmeier, J., & Sulikova, S. (n.d.). Shrink emissions, not the economy. Retrieved November 5, 2020, from https://ourworldindata.org/shrink-emissions-not-the-economy

Mercure, J.-F., Knobloch, F., Pollitt, H., Paroussos, L., Scrieciu, S. S., & Lewney, R. (2019). Modelling innovation and the macroeconomics of low-carbon transitions: theory, perspectives and practical use. *Climate Policy*, **19**(8), 1019–1037.

Mercure, J.-F., Lam, A., Billington, S., & Pollitt, H. (2018a). Integrated assessment modelling as a positive science: private passenger road transport policies to meet a climate target well below 2 ◦C. *Climatic Change*, **151**(2), 109–129.

Mercure, J.-F., Pollitt, H., Chewpreecha, U., … Edwards, N. R. (2014). The dynamics of technology diffusion and the impacts of climate policy instruments in the decarbonisation of the global electricity sector. *Energy Policy*, **73**, 686–700.

Mercure, J.-F., Pollitt, H., Edwards, N. R., … Vinuales, J. E. (2018b). Environmental impact assessment for climate change policy with the simulation-based integrated assessment model E3ME-FTT-GENIE. *Energy Strategy Reviews*, **20**, 195–208.

Miller, J. (2020, June 4). German car industry slams Berlin stimulus package. *Financial Times*. Retrieved from https://www.ft.com/content/d409971c-791e-4602-b541-60c126d2e26e

Murphy, K. (2020, September 14). Government to use $52.9m funding to unlock more gas for domestic market. *The Guardian*. Retrieved from https://www.theguardian.com/australia-news/2020/sep/15/government-to-use-529m-funding-to-unlock-more-gas-for-domestic-market

New Climate Economy, & World Resources Institute. (2018). *Unlocking the Inclusive Growth Story of the 21st Century*, Washington, D.C. Retrieved from https://newclimateeconomy.report/2018/

OECD. (2020). OECD Economic Outlook, Volume 2020 Issue 1. Retrieved from https://www.oecd-ilibrary.org/content/publication/0d1d1e2e-en

Pasimeni, F. (2017). *EU energy technology trade: import and export*, Joint Research Center. Retrieved from https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/eu-energy-technology-trade-import-and-export

Phillips, N. (2009, August 26). VAT cut had no effect on consumer spending, says report. *The Guardian*. Retrieved from https://www.theguardian.com/business/2009/aug/26/vat-cut-ineffective

Pollitt, H., Lewney, R., Bence, K.-D., & Xinru, L. (2020). *A Post-Keynesian approach to modelling the economic effects of Covid-19 and possible recovery plans*, Cambridge, UK: Cambridge Econometrics. Retrieved from https://www.camecon.com/wp-content/uploads/2020/06/The-economic-effects-of-COVID-19.pdf

Pollitt, H., & Mercure, J.-F. (2018). The role of money and the financial sector in energy-economy models used for assessing climate and energy policy. *Climate Policy*, **18**(2), 184–197.

Pollitt, H., Paroussos, L., Fragkiadakis, K., & Fragkos, P. (2017). *Case study-technical analysis on capacity constraints and macroeconomic performance*, European Commission. doi:10.13140/RG.2.2.24621.95205

Pouliakas, K., & Branka, J. (2020). *EU Jobs at Highest Risk of COVID-19 Social Distancing: Will the Pandemic Exacerbate Labour Market Divide?* (No. 13281). *IZA Discussion Papers*, Institute of Labor Economics (IZA). Retrieved from https://ideas.repec.org/p/iza/izadps/dp13281.html

Stiglitz, J. (2020). The Economy of Tomorrow: Recovering and Restructuring after COVID-19. Retrieved November 5, 2020, from https://rooseveltinstitute.org/publications/economy-of-tomorrow-recovering-restructuring-after-covid-19/

TomTom. (2020). Traffic congestion ranking | TomTom Traffic Index. Retrieved July 9, 2020, from https://www.tomtom.com/en_gb/traffic-index/ranking/

Ürge-Vorsatz, D., Tirado-Herrero, S., Fegyverneky, S., Arena, D., Butcher, A., & Telegdy, A. (2010). *Employment Impacts of a Large-Scale Deep Building Energy Retrofit Programme in Hungary*, Den Haag, The Netherlands: European Climate Foundation.

Varro, L., Beyer, S., Journeay-Kaler, P., & Gaffney, K. (2020). Green stimulus after the 2008 crisis – Analysis. Retrieved November 11, 2020, from https://www.iea.org/articles/green-stimulus-after-the-2008-crisis

WTTC. (2020, June 10). More than 197m Travel & Tourism jobs will be lost due to prolonged travel restrictions, according to new research from WTTC. Retrieved July 9, 2020, from https://wttc.org/News-Article/More-than-197m-Travel-Tourism-jobs-will-be-lost-due-to-prolonged-travel-restrictions

WWF European Policy Office. (2020). *Building resilience: WWF recommendations for a just & sustainable recovery after Covid-19*. Retrieved from https://d2ouvy59p0dg6k.cloudfront.net/downloads/wwf_recommendations_for_just_and_sustainable_recovery_april_2020_final.pdf