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Fossil Fuel Industry Phase-Out and Just Transition: Designing Policies to Protect Workers' Living Standards

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ABSTRACT

This paper focuses on transition policies targeted at supporting workers now employed in the fossil fuel industries and ancillary sectors within high-income economies. As a general normative principle, I argue that the overarching aim of such policies should be to protect workers against major losses in their living standards resulting through the fossil fuel industry phase-out. The impacted workers should be provided with guarantees to accomplish this, in the areas of jobs, compensation and pensions. Just transition policies should also include job search, retraining and relocation programs, but these forms of support should be recognized as supplementary. The overall set of just transition policies is fully aligned with the Energy Justice and Capabilities Approach as well as the UN's Sustainable Development Goals. Within this framework, the paper first reviews experiences with transitional policies in Germany, the UK, the EU and, more briefly, Japan and Canada. The policies either implemented or discussed in these cases do not provide the needed guarantees. The paper then presents an illustrative robust just transition program for the heavily fossil fuel-dependent U.S. state of West Virginia. This program will cost, as an annual average, about $42,000 per impacted worker, or about 0.2 percent of West Virginia's current GDP. I briefly summarize results for seven other U.S. states and for the overall U.S. economy. For the U.S. economy overall, the just transition program's costs would total to about 0.015 percent of GDP. These findings demonstrate the financial viability of robust just transition programs for high-income economies.

KEYWORDS
Fossil; fuel; phase out; workers; transition

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Introduction

Climate change presents a profound social, economic and political challenge in our present historical moment. The severity of the risks we face have been documented scrupulously for decades by the Intergovernmental Panel on Climate Change (IPCC, 2018), the most authoritative global organisation

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advancing climate change research. Thus, in its landmark October 2018 report titled *Global Warming of* 1.5°C, emphasized the necessity of limiting the increase in global mean temperatures to 1.5 degrees Celsius (1.5°C) above pre-industrial levels as of 2100. The IPCC followed up its 2018 analysis with two massive installments of its *Sixth Assessment Report*, in February and April 2022 whose conclusions were fully aligned with its 2018 study.

According to the IPCC, to stabilise the global mean temperature as of 2100 at 1.5°C above pre-industrial levels, global net carbon dioxide (CO_2) emissions will have to fall by about 45 percent as of 2030 and reach net zero emissions by 2050. Virtually all countries in the world have pledged to advance programmes that at least roughly align with these IPCC's emissions reduction targets. Correspondingly, there is, by now, a huge literature that develops specifics as to the policies that need to be pursued to achieve the IPCC's targets. Not surprisingly, this literature offers a wide range of alternative, and sometimes contradictory, perspectives.

At the same time, in broad terms, there is little ambiguity as to what are the two most important actions needed for stabilising the climate. First, the world must dramatically cut its reliance on oil, coal, and natural gas to produce energy. This is because CO_2 emissions generated through burning fossil fuels, as well as methane and nitrous oxide emissions generated in producing fossil fuel energy, are responsible for about 75 percent of all greenhouse gas emissions, with deforestation and industrial agriculture responsible for the remaining roughly 25 percent. Second, as the alternative to fossil fuel consumption, again on a global scale, we must massively expand investments in energy efficiency and clean renewable energy sources – primarily solar and wind power, but also geothermal, small-scale hydro and low-emissions bioenergy. This is for the simple reason that people still need to consume energy to light, heat, and cool buildings, to power cars, buses, trains, and airplanes, and to operate computers and industrial machinery, among other uses.

Both main components of this climate stabilisation programme will produce large-scale impacts on the employment opportunities for working people and the communities in which they live. The level of investments that are needed in efficiency and clean renewables will likely generate upwards of 160 million jobs per year throughout the global economy.[1] But workers and communities whose livelihoods depend on the fossil fuel industry will unavoidably experience losses in the clean energy transition. Unless strong policies are advanced to support these workers, they will face layoffs, falling incomes, and declining public-sector budgets to support schools, health clinics, and public safety. This in turn will increase political resistance to any effective climate stabilisation programme.

It follows that the global climate stabilisation project must unequivocally commit to providing generous transitional support for workers and communities that are currently dependent on the fossil fuel industry. The late U.S.

labour leader and environmental visionary Tony Mazzocchi pioneered thinking on what he first termed a "just transition" for these workers and communities. As Mazzocchi wrote as early as 1993:

> Paying people to make the transition from one kind of economy to another is not welfare. Those who work with toxic materials on a daily basis … in order to provide the world with the energy and the materials it needs deserve a helping hand to make a new start in life.

This paper examines just transition policies in high-income economies. My focus is on the just transition policies targeted at supporting the workers now employed in the fossil fuel industries and ancillary sectors. I consider only briefly and in passing the equally important and related, but still distinct, sets of policies aiming to support transitions for communities and regions that are now heavily dependent on the fossil fuel-based industries.[2]

In considering just transition policies targeted for fossil fuel industry workers, the first questions we need to ask are: what should be the overall goal of these policies, and what specific measures need to be implemented to accomplish this goal? As a general normative principle, I would argue that the overarching aim of just transition policies for workers should be to protect them against major losses in their living standards resulting through the fossil fuel industry phase-out. To accomplish this aim, the impacted workers should be provided with three critical guarantees. These include: (1) guarantees of a new job; (2) guarantees that the compensation at the new jobs will be comparable to that at their previous jobs; and (3) guarantees that their pensions should remain intact even as their employers' business operations are phased down. Just transition policies should also support workers in the areas of job search, retraining and relocation. These forms of support are also important but should be understood as supplementary. This is because, in themselves, they are not capable of protecting workers against major losses in their living standards resulting from the fossil fuel industry phase out.[3]

To understand these issues within a human development framework, it will be useful to distinguish between what I will term *thin* and *robust* and just transition policy frameworks. Thin just transition policies are limited to job search, retraining and relocation programmes, while robust just transition policies include employment, compensation, and pension guarantees as well as job search, retraining and relocation support. Robust just transition programmes fall squarely within the human development framework, as applied to this specific case of the fossil fuel phase out. This is because robust just transition programmes are the means through which the livelihoods of millions of fossil fuel industry dependent workers and their families will be protected as the phase out of the fossil fuel industry proceeds.

The 2021 special issue of this journal on "Energy Justice and the Capabilities Approach" provides a range of valuable perspectives on the necessary global

energy transition. The primary focus of the 9 papers in this issue is energy consumption. Thus, Medlin et al. write in issue's introductory paper that:

> It would be hard to argue that energy services are not a precondition for realizing many capabilities of relevance to day-to-day life. For example, people generally need energy in some form to cook food, to heat or cool their homes, to move around, and to light up their streets. (2021, 185)

Medlin et al. further write that "In order to promote the realization of a threshold of certain capabilities for all individuals … it would be necessary to both guarantee access to energy services and to limit the negative consequences of energy production" (2021, 186).

But limiting the negative consequences of energy production entails, first and foremost, the phasing out of fossil fuel consumption in order to maintain even a reasonable chance of achieving the IPCC's emissions reduction targets. This correspondingly means that jobs for workers now employed in fossil fuel production and ancillary activities will also be phased out. In the absence of robust just transition policies, fossil fuel industry dependent workers and communities will therefore experience major losses in income and well-being during this energy transition. This is why policies that address the production side of the energy transition need to be integrated into the energy justice and capabilities approach.

Wood and Roelich (2019) also focus on energy consumption issues in analyzing what they term a series of "tensions" in advancing energy justice and capabilities within a climate change mitigation framework. They write:

> These tensions arise primarily from two conflicting processes. First, our dependency on fossil fuels for well-being provisioning energy services leads to excessive greenhouse gas emissions and climactic change. Second, the resulting climate change poses large scale well-being issues, which to avoid, or at least reduce, requires substantial mitigation efforts. (2019, 115)

Here again, incorporating tensions around energy production issues, and the phase out of the global fossil fuel industry, are fully complementary with Wood and Roelich's perspectives on energy consumption, capabilities, and justice.

Similar issues emerge in considering the 17 Sustainable Development Goals by the target year of 2030.[4] This is especially the case in assessing the interrelationship between four of the seventeen SDGs. These are:

> *SDG # 7*: Ensuring access to affordable, reliable, sustainable and modern energy for all.
>
> *SDG #8*: Promoting sustained, inclusive, and sustainable economic growth, full and productive employment and decent work for all.
>
> *SDG # 12*: Ensuring sustainable consumption and production patterns.
>
> *SDG # 13*: Taking urgent action to combat climate change and its impacts.

It is clear that achieving these four SDGs concurrently will not be possible in the absence of a robust just transition programme for fossil fuel industry dependent workers. This is because: (1) ensuring access to affordable, reliable, and modern energy for all; (2) ensuring sustainable consumption and production patterns; and (3) taking urgent action on climate change will all require the transition on a global scale from the current fossil fuel-dominant energy infrastructure to a to an infrastructure dominated by clean renewable energy sources. Employment in the fossil fuel energy sectors will therefore, again, necessarily be phased out. As such, in the absence of a robust just transition programme, there will be no possibility of attaining SDG #12, promoting full and productive employment and decent work for all.

Thus, as one critically important specific component within a broad human development framework, this this paper examines the current status and prospects for robust just transition policies in high-income economies. The paper is structured as follows. Following this introductory section, Section 2 reviews experiences with transitional policies in Germany and the UK. I discuss how both countries handled the phasing out their respective coal industries starting in the 1960s as well as their current just transition initiatives as elements of their overall climate programmes. I also more briefly consider the current status of just transition initiatives in Japan and Canada. Section 2 next reviews the just transition policies that have been enacted at the level of European Union policies as one part of the EU's overall Green Deal project.

To summarise these Section 2 discussions: just transition policies have been recently enacted within the EU, Germany and, to a lesser extent the UK. By contrast, such initiatives are mainly still at the proposal stages in Japan and Canada. I do not provide a similar review for the U.S. case. But basically the U.S. situation is similar to those in Canada and Japan in not having advanced just transition policies significantly beyond a range of proposals. But even in the cases of Germany, the UK and the EU, the major point that emerges is that their just transition policies are mostly thin programmes – i.e. they are limited to providing commitments primarily with respect to job search, retraining and relocation support. In other words, to date, no countries have advanced robust just transition programmes that provide workers guarantees in the areas of reemployment, compensation levels and pensions.

This conclusion for Section 2 provides the framework for the discussion in Section 3. In Section 3, I present, as an illustrative case study, a robust just transition programme for the U.S. state of West Virginia. The results I present here are taken from a larger 2021 report that develops an overall green transition programme for the state (Pollin et al. 2021a). The broader West Virginia report is one of a series that I have written with co-authors, including those for seven other U.S. states and for the U.S. economy overall (Pollin et al. 2021b).

I have chosen to focus here on the West Virginia case because its economy is one of the most fossil fuel-dependent in the U.S. As such, West Virginia

provides a highly challenging environment in which to mount a robust just transition programme. The framework within which this programme would be mounted is a 10-year period in which fossil fuel production and consumption, as well as CO_2 emissions, in West Virginia would all fall by 50 percent. Concurrently, large-scale investments in energy efficiency and renewable energy would be undertaken throughout West Virginia during this 10-year period to compensate for the state's 50 percent cut in fossil fuel energy supply.

The results from this case study show that the costs of the just transition programme for West Virginia's fossil fuel industry dependent workers will amount to an annual average of about $42,000 per worker. This totals to an average of about $143 million per year, equal to about 0.2 percent of West Virginia's GDP. I briefly summarise results from the seven other state-level reports and for the overall U.S. economy. For the other seven states, the costs of their just transition programmes range between 0.001 and 0.02 percent of the state's GDP. For the U.S. economy overall, the just transition programme's costs would total to about 0.015 percent of GDP.

These findings across 8 U.S. states and for the U.S. economy overall demonstrate that enacting a robust just transition programme – one that is capable of protecting the living standards of displaced fossil fuel industry dependent workers – does not entail unaffordable levels of public spending. It is almost certainly the case that similarly robust just transition programmes in other high-income economies would generate comparable results with respect to overall costs.

The paper concludes by briefly considering the implications of these findings. The main conclusion is that, strictly in terms of spending requirements, robust just transition policies should be understood as an entirely realistic prospect for all high-income economies.

Just Transition Developments Among High-Income Economies

Germany[5]

Germany has pursued active industrial policies for its coal industry since the end of World War II. These policies initially focused on producing sufficient coal supplies for Germany's postwar reconstruction. But by the late 1950s, cheap imported oil flooded into the German market. Coal production fell sharply as a result, and employment for coal miners declined along with it. Between 1957 and 1967, employment in the industry declined from 600,000 to 287,000.

Initially prompted by this sharp decline in coal consumption, Germany has been consistently operating policies to manage the persistent decline of its domestic coal industry. At their inception, these policies aimed to bolster the industry, along with the workers and communities dependent on the industry, in the

face of contracting demand. The initial policy interventions were also designed to attract new industries and employment opportunities into the coal-dependent regions. But more recently, responding to the imperative of eliminating CO_2 emissions, similar policy measures have been used as components of the country's energy transition programme – the Energiewende – to phase out coal along with oil and natural gas and build a renewable energy-dominant infrastructure. These transition policies have been implemented both at the federal level and, at the state level, primarily in the main coal producing state of North Rhine-Westphalia (NRW). Saarland has also implemented similar measures to a more modest extent.

By the late 1960s, in terms of supporting businesses in the industry, the German government began offering decommissioning premiums to coal companies. In 1968, 25 coal companies merged into a single company RAG AG. The government then began providing various forms of subsidies for the industry, including price subsidies, tax cuts, loans, and purchase guarantees. It was also at that point that the NRW government enacted the Development Program Ruhr (DPR), with €8.7 billion in funds available between 1968 and 1971 to attract business investments into the region.

In support of coal industry workers, the government created targeted programmes to address workers' various specific circumstances. Thus, for workers who were remaining in the contracting coal industry, the government provided health, unemployment, and accident insurance, along with subsidised housing and bonus payments. For the workers who faced job losses in the coal industry specifically but remained in the workforce, the government provided wage subsidies, enhanced unemployment benefits, rent subsidies, and relocation support. Those moving into retirement received transitional forms of support, including hardship compensation, severance payments and pension fund subsidies. Most of these policies to support workers have continued operating to varying degrees up to the present.

The Development Program Ruhr was followed by the Action Program Ruhr (APR), from 1980 to 1984 and the Future Initiative for Coal and Steel Regions (FICSR) from 1987 to 1991. Both of these circa 1980s programmes also combined measures to subsidise the coal firms as well as the workers in the industry.

The most recent such iteration has been the Act on Financing the Termination of Subsidized Coal Mining (AFTSC), which began in 2007 and continues to the present. The AFTSC is distinct in that, unlike the previous measures, it explicitly aims to phase out the coal industry and to transition workers and communities into sustainable alternatives. The AFTSC includes three main components: (1) ending hard coal production by 2018 and financing the decommissioning process; (2) financing postmining environmental obligations; and (3) enabling a socially equitable adjustment process for workers.

In terms of phasing out coal, the government cut its subsidies to the industry from about €1.4 to €1 billion between 2009 and 2018. From 2019 onward, the

subsidy funds were allocated exclusively to finance decommissioning of coal firms. Correspondingly, the decommissioning subsidy for 2020, at €1.9 billion, was greater than the subsidy levels that had been provided for the industry throughout the previous decade.

Government industrial policies are also being used increasingly to support new clean energy industries.[6] As one important example of this repurposing project in the Ruhr region, RAG AG is in the process of converting its Prosper-Haniel coal mine into a 200 megawatt pumped-storage hydroelectric reservoir that acts like a giant battery. The capacity is enough to power more than 400,000 homes in NRW.[7] In addition to hydroelectric power storage, the company is also erecting wind turbines on the top of tall waste heaps and installing solar panels on the slopes. Other firms in the region have branched into producing wind and water turbines. This regional transition project has succeeded through mobilising the support of the large coal, steel and chemical companies and their suppliers, along with universities, trade unions and government support at all levels.

The mining workforce fell from 27,317 in 2009 until the last year of production in 2018, where there were 4125 workers employed. The total level adjustment support provided for these workers averaged €93 million between 2017 and 2020. If we assume these funds were distributed evenly among the 5711 workers who were employed in the industry as of 2017, that would amount to an average of about €16,000 per worker per year.

Current German government policies, operating at both at the federal and NRW state levels, do certainly address the central transition challenges facing both workers and communities resulting from the phase-out of coal. But it remains an open question as to whether the level of support being provided through these programmes is sufficient relative to what the circumstances require.

United Kingdom[8]

Like Germany, the UK has experienced a long-term decline and phase-out of what had been its major domestic coal industry. The initial period of decline began in the 1960s, when natural gas increasingly supplanted coal as the primary energy source in electricity generation. This transition then moved into a new phase in the early 2000s as part of the UK's overall project to build a low-carbon economy in response to the global climate crisis.

The UK phase-out of coal occurred in several stages. The 1960s saw a large wave of mine closures, with employment falling from 607,000 to 290,000. Nevertheless, as of the early 1980s, coal mining still directly employed more than 250,000 people in 211 mines in Wales, Scotland and England. Beginning in the early 1980s, the Conservative government under Margaret Thatcher pursued a policy of withdrawing public support for unprofitable heavy

industries, in particular, steel and coal, by privatising them and closing unprofitable sites. The electric utility sector was also privatised and allowed to pursue gas power generation, which had become cheaper than coal. As a result, 141 of what had been the remaining operating mines closed between 1984 and 199. These closures eliminated 170,000 jobs.

For most of the period from the 1960s to 1990s – the decades before the climate crisis became a major policy focus – policy measures undertaken to assist workers and communities through the coal phase-outs were minimal to non-existent. Rising et al. (2021) describe the period starting in 1979 under Prime Minister Margaret Thatcher as follows:

> The paradigm of this period was that economic growth and market-based solutions would solve social programs via a trickle-down process. Therefore, interventions in deprived regions were mostly … designed to promote market activity through private sector engagement … The private sector was seen as the essential stakeholder for the delivery of policies; both local authorities and the third sector (nongovernmental organizations) were sidelined. (2021, 15)

Specifically, in terms of supporting workers, the main vehicle other than overall welfare state policies, was the British Coal Enterprise (BCE) which was tasked with replacing the jobs lost in the coalfields. The BCE was set up in 1984 to help create jobs by supporting small and medium enterprises and to assist miners in job search and training. Its main activities were to operate a loan scheme for small businesses and to provide job search support with some retraining programmes. When a pit was scheduled to close, BCE would set up "job shops" on the site. But Fothergill and Guy (1994) estimate that the BCE managed to replace only about one in 14 jobs lost in the coalfields. Similarly, Murray et al. (2005) found through direct interviews of impacted workers that (1) 60 percent received no retraining or help with job search and applications; (2) workers who did receive career advice were seldom even asked what jobs they would like to retrain for; and (3) workers had to be on benefit schemes for six months before being allowed access to retraining.

In short, unlike with Germany, the experience in the UK with phasing out coal offers only negative lessons in developing just transition programmes in the current period.

Current Energy Transition Policies

The UK enacted the Climate Change Act in 2008. It was one of the first comprehensive climate laws to be advanced at a national level. It featured a statutory commitment for the UK to cut greenhouse gas emissions by 80 percent of 2050 relative to the country's 1990 emissions level This emissions reduction target was then increase to a net zero emissions goal by 2050 (Harrabin 2019).

The North Sea region of the UK will be the main area of the country that will face negative impacts in terms of employment and overall economic activity as the country fulfils its net zero commitment. The oil and gas sector in the region directly employs about 30,000 workers and indirectly supports another 260,000. These are tiny job figures relative to a total UK workforce totalling to nearly 33 million people. As such, in principle, it should not be difficult to provide generous support for all impacted workers.

Unlike the experience under the coal phase-out, there are programmes in place, primarily at the regional level, to support the workers and communities facing the oil and gas industry phase-out. In Scotland, they include a Just Transition Commission that was created to develop an overall programme in the region that would apply the International Labor Organization's (2015) just transition principles. The ILO's principles include job placement services, public employment programmes, reemployment training, access to unemployment benefits, and early retirement support. However, the Commission ended up achieving very little. As Rising et al. write "The scope of the JTC (Just Transition Commission) falls far short of its original proposal … it was a short-term body with no statutory basis, rather than a long-term oversight organization with associated green investment funding" (2021, 41). A Skills Development Scotland programme was more successful. It provided redundant workers with retraining, job placement and financial support. According to the Partnership Action for Continuing Employment (PACE), about 80 percent of workers who sought support finding new employment within a year (Rising et al. 2021, 38).

Wales passed the Well-Being of Future Generations Act in 2015 and followed it up with "Prosperity for All: A Low Carbon Wales" in 2019. These both include broad principles supporting transition for workers and communities. For example, Prosperity for All mandates the creation of a "climate just advisory group" on how to create employment opportunities and address inequalities in the region's process of decarbonisation.

Overall, these initiatives in Scotland and Wales give formal recognition to the challenges faced by fossil fuel dependent workers and communities. But they do not establish specific levels of financial commitments in the critical areas of employment and pension guarantees, wage replacement.

Japan

Japan has officially committed to a 46 percent emissions reduction by 2030 relative to 2013 and to achieve net zero emissions by 2050. But the policy actions undertaken to date to achieve these targets are almost certainly insufficient. According to Carbon Action Tracker, as of October 2022, "Japan still appears wedded to coal-fired power", and is unlikely to reduce emissions by more than 30 percent as of 2030.[9]

Within this context, it is not surprising that Japan has not initiated any serious just transition measures to date. According to Mabon et al. (2022),

> to date, the concept of a 'just transition' has received only limited attention within Japan. Japan's overarching climate change plan makes brief reference to the inclusion of just transitions in the Paris Agreement, and to the importance of avoiding job losses and considering regional economies and businesses during the net-zero transition. (7)

Mabon et al. further conclude that:

> At a national government level in Japan, it is clear that whilst there is an emerging understanding of the need for a just transition—as evidenced in the inclusion of the term in Japan's core climate change policy—there is less clarity on what a just transition means in a specifically Japanese context and on the steps that may need to be taken to facilitate a just transition for Japan. (29)

The Mabon et al. study recognises that some regional governments have begun to develop just transition initiatives, including in the heavily coal-dependent region of Yubari. But such local and regional governments do not have the resources to manage major initiatives without significant support at the national level.

Canada

In October 2022, Canada updated its strategy for reaching zero emissions by 2050. The programme presents a range of broad scenarios for reaching this emissions reduction target. But according to Carbon Action Tracker, "it does not set a particular pathway for the country to follow, nor does it outline the policies and measures needed to achieve net zero".[10]

Consistent with this lack of a concrete overall climate strategy, Canada also has not advanced a serious just transition programme for fossil fuel dependent workers or communities. In April 2018, the Canada's Minister of Environment and Climate Change did appoint a task force to engage with workers and communities that are dependent on the country's fossil fuel industry. Based on these interactions, the task force then produced a report in December 2018 that included broad language for developing a just transition programme, such as "provisions for just transition in federal environmental and labour legislation and regulations, as well as relevant intergovernmental agreements". The report addressed financial issues in very general terms, such as "create a pension bridging programme for workers who will retire earlier than planned due to the coal phase out" and "create a comprehensive funding program for workers staying in the labor market to address their needs across the stages of securing a new job, including income support, education and skills building, re-employment, and mobility" (2018, ix).

As of a July 2021 government report *People-Centered Just Transition*, it was clear that there had still been no specific proposals set out by the government

on any aspect of its just transition programme.[11] As of October 2022, the International Institute for Sustainable Development organised a webinar on "Canada's Just Transition Legislation: The Time is Now".[12] The organisers of the webinar wrote "Momentum for a just transition is building but to date their remain few public details on the federal government's concrete plans".

European Union

The most substantive commitments to just transition policies have been advanced by the European Union, within the framework of the European Green Deal. Under the European Green Deal, the EU economies have committed to cutting greenhouse gas emissions by 50–55 percent by 2030 and to become carbon neutral by 2050. These emissions reduction targets fully align with, and are, indeed, modestly more ambitious than, those set out by the IPCC itself. The EU explicitly recognises that the success of its Green Deal depends on the project achieving widespread social acceptance. This is why transition policies are understood among EU policymakers to be a central component of the Green Deal. Thus, Frans Timmermans, Executive Vice President of the European Commission (EC), stated that "We must show solidarity with the most affected regions in Europe, such as coal mining regions, and others, to make sure the Green Deal gets everyone's full support and has a chance to become a reality" (Guayo and Cuesta 2022, 215).

The EC established a Just Transition Fund (JTF) in January 2020 to advance beyond such statements of broad principles into meaningful concrete policy measures. The Just Transition Fund is the centrepiece within a more broadly focused Just Transition Mechanism that also includes the InvestEU Just Transition Scheme and a Public Sector Loan Facility. According to a European Parliament Fact Sheet (2022), the objectives of the JTF are:

> To alleviate the impact of the transition by financing the diversification and modernization of the local economy and by mitigating the negative repercussions on employment. In order to achieve its objective, the Just Transition Fund supports investments in areas such as digital connectivity, clean energy technologies, the reduction of emissions, the regeneration of industrial sites, the reskilling of workers and technical assistance.

The specific aims of the JTF include providing active support for displaced fossil fuel sector workers through skills training and job search assistance. One estimate is that, between 2021 and 2027, 1.6 million workers throughout the EU will face displacement and require support to become reemployed (Cameron et al. 2020). The JTF also provides subsidies for businesses, including small and medium-sized enterprises, to invest in the currently fossil-fuel

dependent regions. Such business subsidies aim to support firms engaged in renewable energy and energy efficiency investments, land restoration and repurposing, as well as circular economies activities such as waste prevention, resource efficiency and recycling.

The JTF distinguishes itself from most individual country-level initiatives, such as those that we have reviewed above, in that it does commit financial resources for its various transition programmes. This is a significant step forward. Nevertheless, the level of funding committed is almost certainly not close to adequate to achieve the goals set out by Vice President Timmerman, of "making sure the Green Deal gets everyone's full support".

The total funding level officially allocated is €17.5 billion over 2021–2027. A paper by the Bruegel research institute (Cameron et al. 2020), commissioned in 2020 by the European Parliament's Committee on Regional Development, argued that the level of EU funding that is newly available from the JTF is actually much less than the official €17.5 billion figure – perhaps in the range of €4.8–€7.5 billion. However, even the official €17.5 billion figure between 2021 and 2027 amounts to an average of less than €3 billion per year over six years. This is equal to roughly 0.02 percent of the combined €14.5 trillion GDP of the 27 EU member economies for 2021. It is true that for individual EU member countries to access these funds, they must provide, through the European Regional Development Fund, matching support at €1.5–€3 for every euro received through the JTF.[13] This is one avenue through which the overall level of just transition funding level should increase. In addition, with the business investment projects that are prioritised to receive subsidies, JTF support is meant to leverage much larger amounts of private investment funding. But of course, the actual level of private investment that will be forthcoming from such subsidy programmes is always a matter of uncertainty.

What is certain is that these funds are spread across all of the specific programmes within the JTF umbrella – the various areas of business and community investments as well as retraining and reemployment support for workers. Given this wide scope of commitments, it would be difficult for the JTF funding level channelled specifically into supporting displaced workers to even match the €4200 level of transitional support that had been provided between 2007 and 2016 under the European Global Adjustment Fund (Cameron et al. 2020, 6–7).

Moreover, the categories of support for displaced workers under the JTF are limited to skill development, retraining and job search assistance. The JTF does not include any provision for the most critical areas of support for workers who will be facing displacement – these being guarantees with respect to reemployment, wage levels, and pensions. It is only through such provisions, that include both generous levels of support as well as hard guarantees, that workers whose livelihoods are now tied to fossil fuel industry are likely to give their "full support" to the European Green Deal.

A Just Transition Program for West Virginia

This section presents a detailed just transition programme for workers in the fossil fuel industry as well as those in ancillary industries. The programme includes: guaranteeing re-employment for workers facing displacement; providing income, retraining, and relocation support for these workers; and guaranteeing the pensions both for workers moving into retirement and those remaining in the workforce. In short, this programme incorporates the much stronger forms of support that are absent in the EU just transition programme along with the more modest measures, such as retraining, that the EU programme includes.

In order to generate some rough cost parameters of implementing this type of generous just transition programme, I summarise the main results of a case study for the state of West Virginia in the U.S. West Virginia's economy is one of the most fossil fuel dependent in the U.S. West Virginia is also one of the poorest states in the U.S. As such, West Virginia provides a highly challenging environment in which to mount a generous transition programme. These cost estimates for West Virginia will therefore establish a high-end cost range for enacting similar programmes in less fossil fuel-dependent regions, both within the U.S. and throughout the high-income economies.

The full West Virginia case study was conducted by myself and co-authors in 2021 (Pollin et al. 2021a). Our study for West Virginia was one of a series of eight U.S. state-level studies published between 2017 and 2021 that outlined similar just transition programmes for each of the respective states. The 7 other states were California, Colorado, Maine, New York, Ohio, Pennsylvania, and Washington (Pollin et al. 2021b). I also developed with co-authors broadly similar just transition programmes for the U.S. economy as a whole, most recently in 2020 (Pollin, Wicks-Lim, and Chakraborty 2020). Because we completed the West Virginia study in 2021, the base year for the data analysis is 2018.

Once I have present the cost estimate for the programme in West Virginia, I will then also briefly summarise our estimates for other U.S. states as well as for the U.S. economy overall.

Just Transition within Overall Energy Programme

In order to develop a just transition programme for workers in West Virginia's fossil fuel-dependent industries, we need to work with a set of assumptions as to the rate at which the fossil fuel industry in the state is phased out. We present here a 10-year programme through which CO_2 emissions in West Virginia will fall by approximately 50 percent. This will enable the state to be in rough alignment with the IPCC's intermediate emissions reduction target of reducing global emissions by 45 percent as of 2030.

For emissions in the state to fall by 50 percent over a 10-year period will require that fossil fuel energy consumption in the state will also fall by 50 percent within 10 years. In addition, West Virginia exports fossil fuels to other U.S. states as well as, to a lesser extent, other countries. We assume that West Virginia's domestic and international fossil fuel export markets will also decline by 50 percent over this 10-year period. This assumption is consistent with the idea that these other regions will also be moving into alignment with the IPCC's emissions reduction targets.

Based on these assumptions, it follows that over the 10-year period we are considering, production activity and employment in West Virginia's fossil fuel industries will decline at the same rate at which energy consumption is declining in West Virginia itself as well as in its export markets – i.e. by 50 percent across-the-board for all fossil fuel sources. The just transition programme will cover the workers in West Virginia employed in all of the state's fossil fuel-related sectors, all of which will be phasing down their production activity by 50 percent over the 10-year period.

Concurrent Job Creation through Clean Energy Investments

The phase-down of West Virginia's fossil fuel production activity will, of course, need to occur in conjunction with the building of a new clean energy infrastructure in the state. In turn, these clean energy investments will be a major source of new job creation in the state. West Virginia's just transition programme for the state's displaced fossil fuel workers needs to be considered within this broader context of the job creation prospects that will result from the state's clean energy investment project. I therefore present a brief summary of the clean energy investment programme for West Virginia that my co-authors and I developed, focusing, in particular on its job creation prospects.

The programme we developed for West Virginia is designed to produce sufficient clean energy supply in the state that will enable the state to maintain a reasonable economic growth path while still reducing its consumption of fossil fuel energy by 50 percent within 10 years. We assume that there will be two areas of large-scale clean energy investments over this 10-year period. They are:

- *Energy efficiency*. Dramatically improving energy efficiency standards in West Virginia's stock of buildings, automobiles and public transportation systems, and industrial production processes; and
- *Clean renewable energy*. Dramatically expanding the supply of solar, geothermal, small-scale hydro, wind and low-emissions bioenergy available at competitive process to all sectors of West Virginia's economy.

We estimated that the level of investment needed to achieve West Virginia's energy goals will average roughly $3.6 billion per year over 10 years, with most of the funding being provided by private investors. This estimate assumes that West Virginia's economic growth proceeds at an average rate of 1.0 percent per year. Clean energy investments – from both public and private funding sources combined – will amount to about 4.2 percent of West Virginia's average annual GDP over this 10-year period.

We estimated that investing an average of $3.6 billion per year in clean energy projects in West Virginia over 10 years will generate an average of about 25,000 jobs per year in the state. New job opportunities will be created in a wide range of areas, including construction, sales, management, production, engineering and office support. In the current West Virginia labour market, there are large differences in average compensation within the various clean energy sectors. For example, workers in the state's industrial efficiency sector receive an average of $92,000 per year in total compensation, while the average for mass transition jobs is much lower, at $27,000. Across all clean energy sectors, average compensation in West Virginia's current labour markets is $52,000.

Direct, Indirect, and Induced Employment Channels

There are three channels through which all categories of economic activity, within any economic sector, generate employment. These are *direct*, *indirect*, and *induced* employment creation channels. The direct channel refers to the jobs created within a sector itself. Coal mining is one clear example. The indirect channel refers to jobs created within a given sector's supply chain. An example here would be railroad engineers transporting new coal supplies. Induced jobs are those generated by multiplier effects – i.e. the job creation generated by increases or decreases in consumer spending, generally associated with fluctuations in direct and indirect employment levels.

My focus in this section is on the direct jobs that will be lost in West Virginia through the contraction of the state's fossil fuel-based industries. This is because the workers currently employed through the direct job channel will be those most in need of just transition support as the state's fossil fuel sector activities phase down. The jobs that will be lost through the indirect and induced channels will be more diffuse in their characteristics. A high proportion of the jobs lost through indirect supply-chain channels are likely to match up reasonably well with those being generated in the state's expanding clean energy economy, including in areas such as administration, clerical, professional services, and transportation services. The characteristics of the induced jobs that are lost through multiplier effects will reflect the characteristics of West Virginia's overall workforce. As such, the job losses resulting

through the indirect and induced channels can be managed through the same set of policies that are available to all workers in West Virginia who experience job losses for any reason.

Measuring Direct Fossil Fuel-Based Employment Levels

Table 1 shows employment levels for the 14 fossil-fuel and ancillary industries in West Virginia as of 2018. As we see, as of 2018, there are 40,188 people employed in the fossil fuel and ancillary industries in West Virginia. Of these, 12,793 (32 percent) are employed in coal mining, 10,892 (27 percent) work in oil and gas extraction, and 5182 (13 percent) are in support activities for oil and gas support activities. Thus, these three sectors – coal mining, oil and gas extraction and support activities for oil and gas – together account for 72 percent of total employment in all of West Virginia's fossil fuel-based industries. The other three major sources of fossil fuel industry-based employment in West Virginia are fossil fuel-based power generation, oil and gas drilling, and pipeline construction. Together, these three industries account for another 17 percent of total fossil fuel-based jobs. The six largest industries by employment therefore account for nearly 90 percent of all fossil fuel-based employment in the state.

Characteristics of Fossil Fuel-Based Industry Jobs

Table 2 provides basic figures on the characteristics of the jobs in West Virginia for workers in fossil-fuel based sectors. We first see that, on average, these are relatively high-paying jobs. The average overall compensation is $77,327 nearly

Table 1. Number of workers in West Virginia employed in fossil fuel-based industries, 2018.

Industry	2018 employment levels	Industry share of total fossil fuel-based employed
Coal Mining	12,793	31.8%
Oil and Gas Extraction	10,892	27.1%
Support Activities for Oil/Gas	5182	12.9%
Fossil Fuel Electric Power Generation	2851	7.1%
Drilling Oil and Gas Wells	2178	5.4%
Pipeline Construction	1932	4.8%
Support Activities for Coal	976	2.4%
Pipeline Transport	945	2.4%
Natural Gas Distribution	798	2.0%
Wholesale – Petroleum and petroleum products	723	1.8%
Mining Machinery and Equipment Manufacturing	401	1.0%
Petroleum Refining	347	0.9%
All other petroleum and coal products manufacturing	103	0.3%
Oil and Gas Field Machinery and Equipment Manufacturing	67	0.2%
Fossil Fuel Industry Total	***40,188***	***100%***
Total: Fossil Fuel and Biomass Electricity Generation	***40,188***	
Total Fossil Fuel Employment as Share of West Virginia State Employment *(West Virginia 2018 employment = 744,326)*		5.4%

Source: Pollin et al. (2021a).

50 percent more than the $52,000 average pay across all of the state's currently operating clean energy activities. Moreover, the formal educational credentials needed to receive this relatively high pay are modest. Nearly 60 percent of workers in West Virginia's fossil fuel-based sectors have high-school degrees only or less. At the same time, the workforce is white-male dominated, with only 4.6 percent of workers being non-white and 8.5 percent being female.

In Table 3, we gain further detailed information on workforce and employment conditions for workers in West Virginia's fossil fuel-based industries. We show the most prevalent job categories and the representative occupations in each job category.

The key finding that emerges from this table is that the fossil fuel industries in West Virginia provide a wide range of employment opportunities for the roughly 40,000 workers currently employed in these industries. As we see, the largest share of jobs, at roughly 28 percent, are in extraction, including earth drillers, derrick operators and roustabouts. Another 17 percent are in construction, including construction labourers, pipelayers, and operating engineers. There are also large numbers of people employed, respectively, in transportation, installation and maintenance, engineering, and office support.

Overall, from the data presented in Table 3, we can conclude that a large number of jobs match up well with new types of employment that will be generated through clean energy investments in West Virginia. These will include jobs in construction, management, engineering, and office and administrative support. But that will not be the case with *all occupations* in which workers are now employed in West Virginia's fossil fuel-based activities, starting, of course, with extraction. As such, any just transition programme to support displaced workers in West Virginia's fossil fuel related industries will need to be focused on the specific background and skills of each of the impacted workers.

Features of the Just Transition Programme

The just transition programme that my co-authors and I developed for West Virginia includes these five components:

Table 2. Characteristics of workers employed in West Virginia's fossil fuel-based sectors.

	Fossil fuel-based industries
Average total compensation	$77,327
Union membership coverage	17.0%
Educational credentials	
Share with high school degree or less	57.1%
Share with some college or Associate degree	24.1%
Share with Bachelor's degree or higher	18.8%
Racial and gender composition of workforce	
Pct. non-white workers	4.6%
Pct. female workers	8.5%

Source: Pollin et al. (2021a).

Table 3. Prevalent job types in West Virginia's fossil fuel-based sectors (Job categories with 5 percent or more employment).

Job category	Percentage of direct jobs lost	Representative occupations
Extraction	27.6%	Earth drillers; derrick operators; roustabouts
Construction	17.2%	Construction labourers; pipelayers; operating engineers
Management	10.6%	Construction managers; property managers; general managers
Transportation	10.1%	Hoist operators; pumping station operators; freight movers
Installation and maintenance	7.2%	Refractory machinery mechanics; electrical power-line installers; heavy vehicle service technicians
Architecture and engineering	7.2%	Electrical engineers; mining safety engineers; industrial engineers
Office and administrative support	5.9%	Utilities metre readers; customer service representatives; administrative assistants

Source: Pollin et al. (2021a).

(1) Pension guarantees for retired workers who are covered by employer-financed pensions, starting at age 65;
(2) Re-employment for displaced workers through an employment guarantee, with 100 percent wage insurance. With wage insurance, workers are guaranteed that their total compensation in their new job will be supplemented to reduce any losses relative to the compensation they received working in the fossil fuel-based industry;
(3) Retraining, as needed, to assist displaced workers to obtain the skills required for a new job;
(4) Relocation support for 50 percent of displaced workers, assuming only 50 percent will need to relocate; and
(5) Full just transition support for workers 65 and over who choose not to retire.

These specific proposals are, of course, meant to be illustrative. Other combinations could also be viable in terms of achieving robust levels of just transition support.

Steady versus Episodic Industry Contraction

Before presenting the cost estimate calculations, it is critical to note how any such policy measures will be affected by the conditions under which the fossil fuel-based industries contraction occurs in West Virginia. Specifically, the scope and cost of any set of just transition policies will depend substantially on whether the contraction is steady or episodic.

Under a pattern of steady contraction, there will be uniform annual employment losses over the 10-year period in the affected industries. But it is not realistic to assume that the pattern of industry contraction will necessarily proceed at a steady rate. An alternative pattern would entail relatively large episodes of employment contraction, followed by periods in which no further employment

losses are experienced. This type of pattern would occur if, for example, one or more relatively large firms were to undergo large-scale cutbacks at one point in time as the industry overall contracts, or even for such firms to shut down altogether.

The costs of a 10-year just transition will be much lower if the transition is able to proceed smoothly rather than through a series of episodes. One reason is that, under a smooth transition, the proportion of workers who will retire voluntarily in any given year will be substantially greater than if several large businesses were to shut down abruptly and lay off their full work force at a given point in time. Another factor is that it will be easier to find new jobs for displaced workers if the pool of such workers at any given time is smaller.

We proceed here by assuming that West Virginia will successfully implement a relatively steady contraction of its fossil fuel sectors. This should be realistic as long as the relevant policymakers remain focused on that goal.

Estimating Attrition by Retirement and Job Displacement Rates

Table 4 shows figures on annual employment reductions in West Virginia's fossil-fuel based industries that would result from a steady contraction of these industries over our 10-year time frame.

We also then show the proportion of workers who will move into voluntary retirement at age 65 by Year 10. Once we know the share of workers who will move into voluntary retirement at age 65, we can then estimate the number of workers who will be displaced through the 50 percent contraction of the fossil fuel industries. As described above, the just transition programme will provide support for all displaced workers through a reemployment guarantee along with wage insurance, retraining, and relocation support.

All forms of just transition support will also be fully available to those workers 65 and over who choose to continue working. I therefore estimate how many workers 65 and older are likely to choose to remain employed. For the fossil fuel sector taken as a whole, I approximate that about 20 percent of workers who are 65 and over choose to continue on their jobs.[14] I

Table 4. Attrition by retirement and job displacement for fossil fuel sector workers in West Virginia.

(1) Total workforce as of 2018	40,188
(2) Job losses over 10-year transition, 2021–2030	20,094
(3) Average annual job loss over 10-year production decline *(= row 2/10)*	2009
(4) Number of workers reaching 65 over 2021–2030 (=row 1 × % of workers 54 and over in 2019)	8078 *(20.1% of all workers)*
(5) Number of workers per year reaching 65 during 10-year transition period (=row 4/10)	808
(6) Number of workers per year retiring voluntarily	646 *(80% of 65 + workers)*
(7) Number of workers requiring re-employment (=row 3 – row 6)	1363

Source: The 80 percent retirement rate for workers over 65 derived from U.S. Bureau of Labor Statistics: https://www.bls.gov/cps/cpsaat03.htm. According to these BLS data, 20 percent of 65+year-olds remain in the workforce.

therefore assume that this same 20 percent of older workers will choose to continue working while the fossil fuel-based sectors undergo their contractions over the 10-year phase-down. Specifically, I incorporate into the calculations in Table 4 an estimate that, of the total number of workers reaching age 65 in any given year, 80 percent will retire voluntarily while 20 percent will choose to continue working.

We can see how these various considerations come into play through the figures shown in Table 4. As we again see in the second column of Table 4, there are, as of the 2018 figures, 40,188 workers in West Virginia employed in all fossil fuel-based industries. With all the fossil fuel-based industries contracting by 50 percent over the 10-year phase down, this means that total employment in these sectors will fall by exactly half at the end of the 10-year period, to 20,094. If we then assume that the contraction in these industries proceeds at a steady rate over the 10-year phase-down, this means that 2009 jobs in these industries will be lost each year, as we see in row 3.

We see in row 4 that, of the workers presently employed in these sectors in West Virginia, 8078, or 20 percent, will be between 55 and 65 over the 10-year phase-down. If all these workers were to voluntarily retire at a steady rate over these 10 years, this would mean that 808 workers will move into retirement every year. However, we are assuming that only 80 percent of these workers will retire once they reach 65. That is, as we see in row 6, we estimate that 646 workers employed in these sectors will retire voluntarily every year.

Given that total job losses each year will average 2009 over the 10-year phase-down, that in turn means that the total number of workers currently employed in West Virginia's fossil fuel-based sectors that will require re-employment will be 1363 per year. We show this figure in row 7 of Table 4.

This is a critical result. The immediate point it establishes is that the just transition programme will need to focus in two areas: (1) Guaranteeing the pensions for the 646 workers per year moving into voluntary retirement; and (2) Providing all the forms of re-employment support, including the re-employment guarantee, for the 1363 workers per year facing displacement. Of course, these figures are not meant to be understood as precise estimates, but rather as broadly accurate magnitudes. Among other factors beyond what these figures themselves show, we again have to recognise that the pattern of contraction is not likely to be as smooth as is being assumed in this illustrative exercise.

Nevertheless, precise details aside, it is the overall finding that these results convey that is most central: that the number of workers in West Virginia who are likely to experience job displacement through the state's transitioning away from fossil fuel energy production will be small – indeed, the number of workers facing displacement should be in the range of 1400 per year.

Cost Estimates for a Just Transition Programme

Pension Guarantees for Retiring Workers

The fossil fuel-based companies in West Virginia will almost certainly face major financial challenges through the 10-year phase-down period. Under such circumstances, these firms are not likely to consider their pension fund commitments to be their top financial priority. Despite this, guaranteeing workers' pensions as a first-tier financial obligation for employers can be established through regulatory policies. For example, for this situation in West Virginia, the state government could work in coordination with U.S. federal regulators at the Pension Benefit Guarantee Corporation (PBGC) to place liens on company assets when pension funds are underfunded. Through such measures, the pension funds for most of the affected workers can be protected through regulatory intervention alone, without the government having to provide financial infusions to sustain the funds.[15]

Guaranteed Reemployment

New employment opportunities will certainly open up in the expanding clean energy sectors, with approximately 25,000 jobs created per year in West Virginia through clean energy investments at the level of $3.6 billion per year. These projects will also be financed substantially through public-sector funding. Given such public sector funding, the state could require job preference provisions for the displaced fossil fuel industry workers. Within the overall pool of at least 25,000 jobs being generated through the clean energy investments, it should not be difficult for the state to set aside 1400 guaranteed jobs per year for these displaced workers.

At the same time, there does not need to be a requirement that the displaced fossil fuel industry-based workers should move specifically into clean energy jobs, as opposed to other possible employment areas. The multiplier effects generated by the clean energy investments will themselves create an additional pool of new employment opportunities. These jobs will be in the full range of sectors across the state.

Income Support through Wage Insurance

There is a strong likelihood that, for workers currently employed in the fossil fuel-based industries and re-employed elsewhere, including in clean energy activities, their new jobs will be at lower pay levels than their previous jobs. As we have seen, the average compensation for fossil fuel-based workers in West Virginia was about $77,000. This compares with the average compensation in the clean energy areas of $52,000.

The data in Table 5 presents a framework for calculating a rough estimate as to what the costs would be to provide 100 percent wage insurance compensation for all displaced workers. In row 1, the table shows the figures we have

seen in Table 4 on the number of displaced workers in the fossil-fuel based sectors – i.e. 1363 workers per year. Row 2 then shows their average compensation level of $77,300. In row 3, I show the mean compensation level for all of West Virginia's clean energy sectors, which is $52,200. From this difference in average compensation levels, I then calculate that the annual cost of compensation insurance for 1363 workers will be about $25,000 per worker, totalling to about $34 million. The total spending amount for 3 years of support for each displaced worker would be about $103 million.

Retraining Support

The range of new jobs that are being generated through clean energy investments vary widely in terms of their formal educational credentials as well as special skill requirements. Some of the jobs will require skills closely aligned with those that the displaced workers used in their former fossil fuel-based industry jobs. These include a high percentage of construction-related jobs for efficiency investments as well as most management, administrative and transportation-related positions throughout the clean energy industries. In other cases, new skills will have to be acquired to be effective at the clean energy industry jobs. For example, installing solar panels is quite distinct from working in extraction. This is why a just transition programme must include a provision for retraining for the displaced fossil fuel-based industry workers. The just transition programme will also need to serve as a job placement clearinghouse for all displaced workers.

There will be two components of this job retraining programme for displaced workers. The first will be to finance the actual training programmes themselves. We can estimate this with reference to the overall costs of providing community college education. An upper-end figure for annual non-housing costs for community college in West Virginia is $4313.[16] We then also allow an additional $2500 per year per worker to cover other expenses during their training programme, such as purchases of textbooks and equipment. We assume that workers would require the equivalent of two full years of training, which they would most likely spread out on a part-time basis, as they move into their guaranteed jobs. By this measure, the average costs of the training programme for 1363 workers would be about $16 million per year.

Table 5. Estimating costs of 100 percent compensation insurance for displaced workers in West Virginia's fossil-fuel based sectors.

1. Number of Fossil Fuel-Based displaced workers per year requiring re-employment	1363
2. Average compensation for displaced workers	$77,300
3. Average compensation for clean energy sector jobs	$52,200
4. Average Compensation difference between fossil fuel-based and clean energy jobs *(=row 2 – row 3)*	$25,100
5. Annual cost of compensation insurance for 1363 workers *(=row 4 × row 1)*	$34.2 million
6. Total Cost of compensation insurance for 3 years *(=row 5 × 3)*	$102.7 million

Source: Tables 2 and 4 and Pollin et al. (2021a).

Relocation Support

Some of the displaced workers will need to be relocated to begin their new jobs. For the purposes of our discussion, we assume that one-half of the 1363 displaced workers per year will need relocation allowances, at an average of $75,000 per displaced worker.[17] That would bring the annual relocation budget to about $51.2 million for 682 workers each year.

Overall Costs for Supporting Displaced Workers

Table 6 shows estimates of the full costs of providing this set of wage insurance, retraining and relocation support for 1363 workers per year. As Table 6 shows, the total level of annual spending will vary, depending largely on the number of cohorts of displaced workers that are receiving just transition benefits.

For example, in Year 1, the first cohort of 1363 displaced workers will receive support through the just transition programme, including wage insurance, retraining and relocation support, as needed. As we can see in column 4, these full costs will amount to $94.2 million in Year 1. Costs then increase in Year 2, since we now have two cohorts of displaced workers receiving income and retraining support, as well as one cohort receiving relocation support. Thus, total costs in Year 2 rise to $137.2 million. In Year 3, there are now three cohorts of displaced workers receiving income support, along with 2 cohorts receiving retraining support and, again, one cohort receiving relocation support. This totals to $171.5 million, the figure that then prevails through Year 10. In Years 11 and 12, with smaller cohorts eligible for income and retraining support, and no further cohorts receiving relocation support, the costs of the programme fall correspondingly, to $77.3 million, then to $34.1 million.

In total over the full 10-year period, just transition benefits provided to 1363 displaced workers in West Virginia will total to $1.7 billion, or an average of $142.9 million per year over 12 years. This is equal to about 0.2 percent of West Virginia's GDP of $79 billion in 2018. The total costs per worker will amount to about $42,000 per year and about $126,000 per worker in total over three years.

Other U.S. States and US economy

Measured on a per-worker basis, the $42,000 per year cost estimate of this just transition programme in West Virginia is broadly in line with programmes that my co-authors and I have developed with similar features for other U.S. states. Thus, the average annual costs per year for the three years of coverage of the programmes we developed for California, Maine, Ohio, Pennsylvania, and Washington ranged between $38,000 and $50,000 per worker. New York and Colorado were higher, at between $68,000 and $78,000. But in the case of

Table 6. Total and annual average costs for just transition support for displaced fossil fuel-based workers in West Virginia.

Year	Income support *(3 years of support for 1363 workers)*	Retraining support *(2 years of support for 1363 workers)*	Relocation support *(1 year of support for 682 workers)*	Total (Cols. 1 + 2 + 3)
1	$34.2 million (1 cohort)	$8.8 million (1 cohort)	$51.2 million	$94.2 million
2	$68.4 million (2 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$137.2 million
3	$102.7 million (3 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$171.5 million
4	$102.7 million (3 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$171.5 million
5	$102.7 million (3 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$171.5 million
6	$102.7 million (3 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$171.5 million
7	$102.7 million (3 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$171.5 million
8	$102.7 million (3 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$171.5 million
9	$102.7 million (3 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$171.5 million
10	$102.7 million (3 cohorts)	$17.6 million (2 cohorts)	$51.2 million	$171.5 million
11	$68.4 million (2 cohorts)	$8.8 million (1 cohort)		$77.3 million
12	$34.2 million (1 cohort)			$34.2 million
Total	**$1.0 billion**	**$176.4 million**	**$511.5 million**	**$1.7 billion**
Average Annual Costs	**$85.6 million** *(12 years of support)*	**$16.0 million** *(11 years of support)*	**$51.2 million** *(10 years of support)*	**$142.9 million** *(12 years of support)*

Sources: Tables 2, 4, 5 and Pollin et al. (2021).

New York especially, the number of workers in the state that would be displaced would be very low, probably less than 100 per year.

As a share of GDP, the programmes that we developed for these seven other states are all much lower than for West Virginia. This follows from the fact that all of these other states are much less fossil fuel dependent than West Virginia and their overall GDP levels are significantly higher. For these other seven states, the just transition programme we developed, with features similar to those in West Virginia, range between 0.001 and 0.02 percent of GDP. For the U.S. economy overall, the cost of the just transition programme we developed, again with similar features to those for West Virginia, was approximately $3 billion per year in total, equal to about 0.015 percent of 2022 GDP.

These findings across 8 U.S. states and for the U.S. economy overall illustrate that the costs of a generous just transition programme – one that is capable of protecting the living standards of displaced fossil fuel industry dependent workers – will be tiny within a macroeconomic framework. It is almost certainly the case that similarly robust just transition programmes in other high-income economies would generate similar results. That is, the total costs of most such programmes will likely also be in the range of 0.01–0.02

percent of GDP and lower in some cases. In a few highly fossil fuel industry dependent regions, the costs could possibly rise to the 0.2 percent of GDP level that we estimated for West Virginia.

Conclusion

Advancing a comprehensive global climate stabilisation programme that offers a serious prospect for success is, without question, a massive, hugely complex undertaking. But it is also clear that the single most important task in moving onto a viable global climate stabilisation path is straightforward. It is to phase out the burning of fossil fuels to produce energy and to replace the global fossil fuel energy infrastructure with a zero-emissions, renewables-dominant infrastructure.

In order for this global energy system transformation to achieve society-wide levels of support in all countries, it will be necessary to enact just transition policies that move beyond strong pronouncements of intentions but only modest levels of actual provisions for workers currently employed in fossil fuel-dependent sectors. I have defined *robust* just transition programmes here as those that are capable of assuring workers that they will not experience major blows to their living standards when their jobs in the fossil fuel dependent sectors are eliminated. Such robust programmes therefore need to include guarantees to workers in terms of pensions, reemployment, and income levels. As we have reviewed, the just transition initiatives have been enacted in recent years in Germany, the UK, and within the overall European Union are mostly *thin* programmes, in that they are limited to providing job search, retraining and relocation support. Such forms of support are useful but not nearly adequate.

The illustrative robust just transition programme for West Virginia that I have reviewed demonstrates that such programmes do not entail excessive public spending commitments. We found that even in West Virginia, with its heavy dependence on the fossil fuel industry, the average annual costs of a robust just transition programme falls in the range of 0.2 percent of the state's GDP. The budgets for comparable programmes in less fossil fuel dependent U.S. states, and for the U.S. economy overall, are much lower still, in the range of 0.01–0.02 percent of GDP.

Robust just transition programmes should be recognised as imperative for protecting the well-being of workers and their families in fossil fuel-dependent sectors and, thereby, for achieving the level of political support needed to enact a viable global climate stabilisation project. The evidence reviewed here shows that, strictly in terms of spending requirements, robust just transition policies should be understood as an entirely realistic prospect for all high-income economies. This result should help elevate robust just transition policies into a first-tier priority within each country's overall climate stabilisation projects.

It is true that such robust just transition programmes for fossil fuel industry dependent workers are substantially more generous than the levels of support typically provided for workers who face job displacement through the impact of major structural changes in technologies or policies. But this only underscores the fact that the typical forms of support are inadequate, not that the robust just transition policies are excessive. One major example that illustrates this point is the Trade Assistance Adjustment (TAA) programme that has been in place in various forms in the United States since the early 1960s. In principle, the aim of the TAA has been to support workers who become displaced through tariff reductions and other international trade opening policies. But the TAA has long been derided as nothing more than "burial insurance" by U.S. labour leaders as well as both Republican and Democratic members of Congress. This is because the level of support provided has never been close to adequate to prevent workers from experiencing major living standard losses (Whitman 2016).

A robust just transition programme for fossil fuel industry dependent workers can therefore provide a template for enacting generous assistance measures that would apply across economic sectors and for countries at varying levels of development. Following from the discussion in this paper's introduction, establishing robust just transition programmes as a general standard is fully aligned with the SDG #8 of promoting "full and productive employment and decent work for all" and is, correspondingly, fully consistent with a broader human development framework.

Notes

1. This estimate is derived in Pollin (2020).
2. I discuss community and regional industrial transition policies in Pollin, Wicks-Lim, and Chakraborty (2020), among other studies.
3. Green and Gambhir (2020) and Abram et al. (2022) provide extensive discussions of what should constitute the aims of just transition policies. As their overarching perspective, Abram et al. write "The transition to net-zero will be neither sustainable nor credible if it creates or worsens social inequalities; a backlash is likely if the transition is not perceived to be just."
4. United Nations Department of Economic and Social Affairs (2023), https://sdgs.un.org/goals.
5. Unless otherwise noted, the discussion on Germany draws from Furnaro et al. (2021), Oei, Brauers, and Herpich (2020), and Kretschmann, Efromenkov, and Kooreshok (2017).
6. The general descriptions in this paragraph is based on Galgóczi (2014) and Dohmen and Schmid (2011).
7. See, for example, Chow (2017).
8. Unless otherwise noted, the discussion on the UK draws from Rising et al. (2021).
9. https://climateactiontracker.org/countries/japan/.
10. https://climateactiontracker.org/countries/canada/.

11. https://www.rncanengagenrcan.ca/sites/default/files/pictures/home/just_transition_discussion_paper_-_en_-_july_15.pdf.
12. https://www.iisd.org/events/canadas-just-transition-legislation-time-now.
13. World Resources Institute (2021). https://www.wri.org/update/european-unions-just-transition-mechanism-transnational-funding-and-support-just-transition; https://www.bruegel.org/policy-brief/how-good-european-commissions-just-transition-fund-proposal.
14. According to data published by the U.S. Labor Department, 20 percent of 65+ year-olds remain in the workforce. See: https://www.bls.gov/cps/cpsaat03.htm.
15. See more detailed discussions on these pension fund policies in, for example, Pollin and Callaci (2019).
16. https://www.univstats.com/community-colleges/?state=WV
17. According to the 2020 article in Moneyzine "Job Relocation Expenses", these expenses for an average family range between $25,000 and $75,000 (https://www.money-zine.com/career-development/finding-a-job/job-relocation-expenses/). The costs include: selling and buying a home, including closing costs; moving furniture and other personal belongings; and renting a temporary home or apartment while house-hunting for a more permanent residence. For our calculations, we assume the upper-end figure of $75,000.

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