The Green Phoenix Framework: a climate-positive plan for economic recovery in Ukraine

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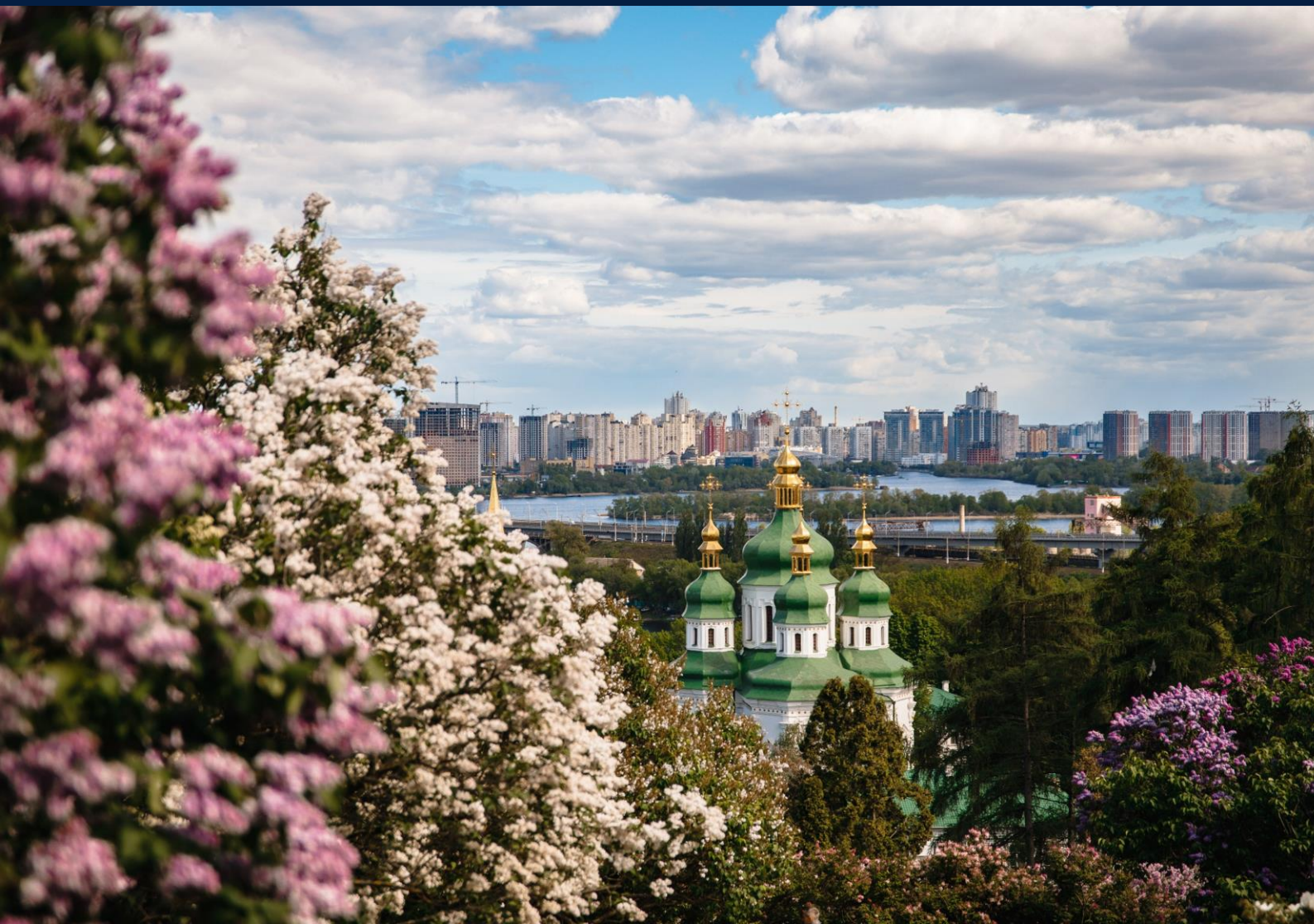

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The Green Phoenix Framework: a climate-positive plan for economic recovery in Ukraine

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Overview

Emerging from the ashes of war, Ukraine will stand at a critical economic crossroads, facing the challenge of sustainable and resilient economic recovery. Decisions taken will determine how infrastructure will be reshaped, which industries and sectors will develop on top of it, and what resulting greenhouse gas emissions profile the country will have in the long term. Clarity about Ukraine's net zero vision is required to ensure that the projected multi-billion investment ($750bn) will go into productive, net zero compatible assets to avoid massive regret in a decade. Although a rapid return to normalcy is essential, locking in the wrong type of future is dangerous.

In recovery, will Ukraine revert to its pre-war state, constrained by narrow economic diversification and vulnerability to fossil fuel market fluctuations? Or will it boldly pursue a green future, where decoupling growth from greenhouse gas emissions secures long-term economic strength and prosperity for its citizens? Admirable rhetoric from the Ukrainian government suggests aspirations for a greener future, however, so far recovery plans do not reflect this. Our analysis shows only 33% of spending in a 2022 reconstruction proposal is likely to support climate mitigation outcomes, below the 42% European average in COVID-19 recovery. Furthermore, 6% of proposed spending may have detrimental effects. We provide examples of how environmentally neutral and negative proposals can be restructured to promote environmental objectives without compromising economic performance. We also present new policies to fill gaps in existing plans and ensure long-term prosperity without accelerating emissions.

Key messages:

- Compared to European recovery in response to COVID-19, plans for Ukrainian "green" spending are low and "dirty" spending are high. 33% ($253bn) of recovery spending planned by the National Council for the Recovery of Ukraine from the War (NRC) is likely to have positive benefits to climate mitigation and 60% ($459bn) is classified as "neutral". Meanwhile, 6% ($46bn) of planned investments are likely to worsen climate change, with most negative consequences from inefficient propping up of fossil fuels.

- Green spending could lead to stronger economic and environmental outcomes for Ukraine as it seeks to recover from the economic consequences of the war.

- To maximise sustainable economic growth, each recovery policy should be designed to uphold environmental and social welfare goals while building on existing areas of economic competitive advantage. We suggest that the Government redesign planned dirty and neutral policies with consideration of green alternatives (**Fig. 1**).

Figure 1. **Suggestions for redesigning the "dirty" and "neutral" policies identified according to Ukraine's National Recovery Plan (2022)**

- Four structural gaps should be filled in future iterations of the Government's recovery planning: infrastructure resilience and adaptation to climate change, cross-sectoral linkages through electrification and sector coupling, R&D for clean technologies, human capital development with reskilling and creating green jobs (**Fig. 7**).

- Prioritising a renewables-oriented economy would offer the additional advantage of accelerating long-term net zero transition efforts while ensuring energy security.

- The Government must begin green policy development with great haste; co-optimising the recovery across economic, social, and environmental domains is possible but requires detailed planning. The moment is now. Implementing good governance practices will be essential for robust planning and diligent execution - it is critical to avoid wastage of time and financial resources.

- Besides financial aid and encouraging green investments, the UK government can play a vital role in supporting Ukraine's green transition through capacity building, knowledge sharing, and collaboration, fostering innovation and sustainable practices. Capacity building is essential for empowering Ukrainian institutions, organisations, and professionals involved in the green sector. Developing targeted training programs, sharing experiences and best practices can enhance technical expertise and managerial capabilities, helping to build a strong workforce in Ukraine, equipped with the necessary knowledge and skills to drive resilient and sustainable development. By providing guidance, expertise and coordination, the UK can also serve as a valuable partner in establishing robust green policies and regulatory frameworks that promote renewable energy, energy efficiency, and sustainable practices.

1. Introduction

After the devastation of war, the economic recovery of Ukraine holds significant potential. The scale and speed of recovery will depend directly on policy decisions made before the conflict ends. After wrestling with instability and structural economic challenges for decades, Ukraine faces a choice of either reverting to its unsustainable pre-war economic structure or turning towards a more prosperous future propelled by a green economy. Early indications from the Government of Ukraine support a vision for a greener future, however, planning does not yet align with this vision.

Drawing lessons from COVID-19 recovery models, this report argues that prioritising green initiatives in Ukraine's recovery could address urgent war-related needs while also providing

long-term economic benefits and supporting the environment. The post-war recovery of Ukraine provides a unique opportunity to direct finance towards low-GHG and climate-resilient development, creating the foundation for a green economy and setting a positive example for the rest of the world. For instance, as the fastest option to respond to Ukraine's immediate energy needs, the nation could prioritise a renewables-oriented economy. This would provide the added benefit of boosting long-term net zero transition efforts and providing energy security. As another example, as Ukraine explores new avenues for high-value exports, it could encourage green production methods that extract additional economic value from its domestic raw resources. This would set the country up as an early mover in green production, potentially establishing long-term competitive advantage and securing a strong position in the global green race. By supporting measures like these, Ukraine can become a global "lighthouse" for the world, demonstrating that decoupling economic growth from carbon emissions is possible even in the most extreme of recovery scenarios and that strategic investment in decarbonisation pays off.

The Ukrainian government has developed the *National Recovery Plan* (2022) as an early proposal targeted at international donors and investors. The report is a positive contribution that includes various recovery components likely to support a low-emissions economy; for instance, support for increased renewables capacity, storage capacity, the "green steel" value chain, energy efficiency, and more. However, the plan also includes initiatives likely to worsen carbon emissions, for example, continued oil and gas exploration.

Ukraine's international allies highlight the need for Ukraine's green recovery and call on decision-makers to prioritise sustainable economic development (World Bank et al.,2023; EIB, 2023). A joint position from Ukrainian civil society organisations reiterated these calls, suggesting that Ukraine's recovery should not be a return to the pre-war status quo but should rather prioritise sustainable development and pursue further integration into the European Community (Ecoaction, 2022).

It is clear that a green recovery could have positive consequences beyond economic and environmental progress. Chiefly, productive economic transformation could allow Ukraine to align its economy with green European Union (EU) standards, supporting efforts for accession to the Union. In supporting this, some funds have already been made available for recovery purposes and it seems likely that a cohesive green recovery strategy could help secure further resources. There is an opportunity, for example, to earmark funds from a four-year multi-billion euro European Commission financing plan for Ukraine (FT, 2023) for green projects like the exploration of Ukraine's hydrogen potential for sustainable steel-making, expanding renewables infrastructure, transitioning to no-till farming and promoting domestic energy

efficiency. Each of these could help Ukraine's economy become more competitive and secure in the long term.

This paper analyses proposals for a Ukrainian green recovery, providing guidance to policy makers and investors. Section 2 establishes context for the analysis, describing structural deficits in Ukraine's pre-war economy as well as the economic consequences of the war. Section 3 provides lessons in green recovery from COVID-19, highlighting positive examples from other European nations. Section 4 reviews the climate characteristics of the proposed Ukrainian *National Recovery Plan* using O'Callaghan's (2023) taxonomy from the Global Recovery Observatory. Section 5 provides practical suggestions to augment the proposed policies so that they better maximise economic and environmental benefits. Section 6 fills in remaining gaps in Ukraine's recovery policy landscape. Finally, Section 7 concludes by summarising the key messages of the report and emphasising the need for immediate policy planning to ensure an optimised recovery.

2. The Ukrainian Economy: Pre-War and Current State

2.1. Structural economic issues predating the war

The Ukrainian economy has struggled to operate at its full potential for several decades. Economic production has been inconsistent, development has remained below that of European neighbours, and unemployment has been consistently high. Although poverty has fallen since 2017 (**Fig.2**), Ukraine remains a Lower Middle-Income Country (World Bank, 2021), in the same grouping as Nigeria, Ghana, and Pakistan, with a per capita Gross National Income of $1,006-$3,955.

Figure 2. Actual and projected poverty rate in Ukraine

Source: World Bank, 2023, p. 105

Underlying Ukraine's economic inconsistency have been a series of structural economic issues, some of which are outlined below. Structural economic challenges are often closely interrelated in Ukraine and have been enabled by institutional weaknesses and many years of gaps in reforms. These weaknesses have been demonstrated by slow and uneven progress in implementing judicial and anti-corruption reforms, which in turn negatively contributed to access to macro-financial aid. Structural challenges have impacts beyond economics too - in Ukraine's case, they have contributed to the country's failure to meet prerequisites for accelerated EU accession (see European Commission's opinion, 2022). The review of structural reform progress in Ukraine conducted by the International Monetary Fund in the aftermath of COVID-19 pandemic also highlighted significant challenges (IMF, 2021). Based on the existing literature which analyses the systematic issues undermining Ukraine's economic performance, this paper composes and highlights six of them, which should be tackled to achieve green economic growth:

2.1.1 Untransparent privatisation and monopolisation of key industries and sectors

According to commentators, privatisation in the early years of Ukrainian independence was conducted by granting politically-connected individuals access to state assets, thus laying the

foundation for the oligarchy in Ukraine and creation of private monopolies (SAGSUR, 2019). Others suggest that "post-soviet elites have used their vast resources to subvert governing institutions and steer policies to their own benefit, irrespective of the harm caused to society" (Lohsen & Fenton, 2022, p. 2). Consequently, monopolistic control over key sectors of economy has posed challenges for both the government and society in implementing structural reforms. The issue was demonstrated in 2019 when Ukraine began rolling out a liberalised electricity market model (Savytskyi, 2020). Opposition parties criticised the excessive market power concentration in the electric power sector, controlled by a single private owner, blaming the National Anti-Monopoly Committee for overlooking the energy market's monopolisation and the National Asset Management Fund for failing to enforce compliance with power plant privatisation terms (Vasylenko, 2021).

2.1.2 Lack of investments in modernisation, clean technologies and R&D

In a pivotal 2021 policy document, the Ukrainian Government recognised as the main causes of economic stagnation, "A lack of investment, gradual wear and lack of equipment modernisation, slow pace of borrowing and development of advanced technologies and innovations in manufacturing" (National Economic Strategy 2030).

As of 2021, 68 out of 75 Ukrainian thermal power plant units were being operated beyond their intended lifespan (Accounting Chamber of Ukraine, 2021). Technological modernisation norms for the energy sector were approved more than 10 years ago. However, they have not been implemented by the entities. In addition, the wear and tear on industrial facilities continues to escalate, reaching a critical point of 70% (Ekonomichna Pravda, 2021). The positive step in the direction of industrial modernisation was made in May 2023, when the Ukrainian parliament voted in the first reading for the draft law №6004-d, which obliges enterprises to use Best Available Techniques (BATs), the available techniques which are the best for preventing or minimising emissions and impacts on the environment (Verkhovna Rada, 2023; UK Government).

In addition, the OECD points to the lack of support for innovations and new technologies. "Even before Russia's full-scale invasion, Ukraine was not realising its full research and innovation potential" (OECD, 2022, p.2), including innovation potential in clean technologies or green R&D. However, IEA (2020) notes that "numerous research programmes relate to energy technology development under various academic institutions and universities in Ukraine, but state funding in energy technology R&D remains scarce and more efforts in both professional training and research segments of R&D are required" (p. 42).

2.1.3 High energy intensity of the economy and dependence on imports of fossil fuels

The Ukrainian economy has been held back by very high energy intensity in production, with low investments into energy efficiency measures and modernisation of the legacy assets of power generation and heavy industry (most of which were under long-running structural decline since the collapse of the Soviet Union). As of 2021, the energy intensity of the Ukrainian economy was three to four times higher than the average in the European Union (German-Ukrainian Energy Partnership).

Over three decades, effective re-structuring of the country's energy sector was mired by multiple complex problems, from deeply entrenched corruption (AntAC, 2018) and reliance on imports of fossil fuels to inefficient infrastructure and monopolised markets (Sisteska, 2018). Ukraine's energy intensity per GDP at purchasing power parity (PPP) in 2018 was the second highest after Turkmenistan, and over twice the world average (0.25 vs 0.11 toe /1000 USD) (IEA, 2020).

Prior to the full-scale invasion in 2022, Russia has been a key supplier of fossil fuels to Ukraine – especially coal (roughly ¼ of domestic consumption) and oil (more than 50% imported directly or indirectly – via Belarusian refineries – from Russia). Despite the end of direct gas purchases since November 2015, most physical gas imports continued to enter Ukraine via the gas transit from Russia, as Ukraine was buying gas from EU countries via virtual reverse flows.

2.1.4 High reliance on export of raw materials instead of creating high value-added products (resource-oriented economy)

Ukraine possesses a wide range of mineral resources, 22 of which are included in the EU's list of 30 critical raw materials.[1] Yet, extraction and use of those resources was working against rather than in favour of national interests. For instance, Ukrainian titanium accounted for almost 83% of Russia's import share of this mineral resource (Accounts Chamber of Russian Federation, 2021). Regrettably, this mineral was utilised in the production of military equipment and weapons that have been deployed against Ukraine in the war. Additionally, Ukraine was exporting raw materials for glass production to Belarus and Russia, then buying-back finished glass products from these countries (Ekonomichna Pravda, 2022). Notably, non-ferrous metals and their recyclable scrap – which could be used for high-value domestic industrial production – continue to be exported from Ukraine without major hindrance (NISS, 2023).

[1] Statement from the official Telegram channel of the Prime Minister of Ukraine, Denys Shmyhal. Access via https://t.me/Denys_Smyhal/3963

The country's economy, primarily driven by the export of resources like wheat, steel, and sunflower oil rather than the creation of final value-added products, sees 54% of its exports consisting of low added-value goods (National Economic Strategy 2030). Such an approach leaves the economy vulnerable and exposed to the volatility of global commodity prices. It leads to an imbalance in foreign economic exchange and inhibits long-term, sustainable economic growth, thereby depleting the country's natural capital (OECD, 2006). Surprisingly, despite possessing reserves of rare earth metals and other critical raw materials, Ukraine has for many years imported such resources for its industries, including defence (Ukrainskyi Tyzhden, 2021).

2.1.5 Unfavourable investment environment

In part, the continuing failure to extract higher value from domestic resources through value-added production is related to Ukraine's unfavourable investment environment. The country experienced a net outflow of investment in 2020, mainly due to a lack of trust in the judicial branch of government (US Department of State, 2021). The absence of property rights' protection, which hinders investment of any kind, was considered Ukraine's "worst economic problem" (Åslund, 2021). According to 2022 Transparency International, Ukraine has a low score of 33 out 100-point Corruption Perceptions Index. However, it should be noted that since 2014 Ukraine has made efforts to enhance its oversight and accountability institutions and increase transparency in certain state functions that are susceptible to corruption (Lohsen & Fenton, 2022).

2.1.6 Ukraine's insufficient environmental performance

According to the 2022 Environmental Performance Index, which provides a quantitative basis for comparing, analysing, and understanding environmental performance, Ukraine ranks 52nd out of 180, with a score of 49.60/100. Key environmental challenges of Ukraine include: air pollution, insufficient water resources, land degradation, solid waste management, biodiversity loss, human health issues associated with environmental risk factors, and climate change (DAI).

Ukraine provided €750m in direct subsidies to support electricity generation from coal in 2018-2019, amounting to the largest sum of subsidies allocated to generate electricity from hard coal and lignite among all the member states of the Energy Community (Energy Community, 2020). Moreover, in 2020 Ukraine was the single largest emitter of sulphur dioxide (SO2) in Europe, with most of the emissions coming from coal-fired power plants. Levels of hazardous emissions at Ukrainian coal-fired plants exceed the EU standards up to 40 times, as purification of flue gases from sulphur and nitrogen oxides was practically absent at Ukrainian

coal plants (Ecoaction, 2021). Ukraine ranked 4th in the world for economic losses from air pollution, following China, Bulgaria and Hungary (Dahiya et al., 2021). Another analysis of hazardous pollutant emission data showed that 72% of total volumes of toxic fly ash emitted by coal plants in Europe were from Ukrainian thermal power plants (Alparslan, 2021). In November 2021, Ukraine declared at COP26 in Glasgow that it would advance its coal phase-out from 2050 to 2035, joining the Powering Past Coal Alliance (PPCA, 2021). However, due to the Russian invasion and the need to secure the energy supply during winter, Ukraine had to increase thermal coal production in 2022 (Reuters, 2022).

Ukraine's climate commitments, assessed through its Nationally Determined Contribution (NDC), have been assessed as "highly insufficient" by Climate Action Tracker (CAT). With the "highly insufficient" rating, CAT indicated that Ukraine's policies and action in 2030 could lead to rising, rather than falling, greenhouse gas emissions - this is inconsistent with the Paris Agreement's goal to limit global temperatures from rising beyond 1.5°C.

In support of climate action, Ukraine committed to reform greenhouse gas Measurement, Reporting, and Verification (MRV), aiming to introduce annual enterprise-level reporting and create a unified register for greenhouse gas accounting and registration of installations. However, this has not been fully implemented. The audit by Ukraine's Accounting Chamber (Accounting Chamber, 2022) found that from July to December 2021, only 15% (264) of installations emitting greenhouse gases had submitted their monitoring plans to the National Center for Greenhouse Gas Emissions Accounting. Further steps towards full accounting of Scope 1 GHG emissions and introduction of Ukrainian Emissions Trading System are yet to be made (Yevstihnieieva, 2023). As for now, Ukraine's carbon tax rate (30 UAH = €0,76/ $0,81/tonne) is amongst the lowest in Europe (Tax Code of Ukraine).

2.2 War-related damages and current economic situation

The war unleashed by Russia in February 2022 devastated the Ukrainian economy, forcing households and industries into a fight for survival. The first major economic shock occurred in March 2022, caused by suspended exports of metallurgical commodities (e.g., steel, iron ore) and agricultural commodities (e.g., wheat, maize, sunflower oil), which accounted for 26% and 41% of the country's total exports, respectively (GMK center, 2020; International Trade Administration, 2023). The exports were hindered by port blockades, unsafe airspace, constant shelling of the railways, and infrastructure damage, estimated to be around $138bn (KSE, 2023). As the war progressed, these sectors continued to suffer losses, partly due to physical damage from the hostilities to agricultural machinery, granaries, arable lands and already manufactured goods (KSE, 2023) and partly due to the occupation of two major steel plants in Mariupol, which formerly produced 40% of the country's steel (GMK center, 2022). In

the most recent spring season (2023), a considerable portion of Ukrainian land was uncultivated, due to contamination by explosive objects, with approximately 30% of the country's total territory affected (Suspilne, 2023).[2]

The economic situation has been further aggravated by attacks on energy assets. In particular, the March 2022 seizure of Zaporizhzhya nuclear power plant (IAEA, 2023), the 2022-2023 winter attacks on Ukrainian electricity networks (both generation and transmission facilities) and the June 2023 destruction of Kakhovka dam and hydroelectric power plant. Dam destruction caused low water levels in Kakhovka reservoir, raising risks for Zaporizhzhya NPP's reactors and fuel safety, dependent on cooling water availability (Greenpeace, 2023). The widespread targeting of electricity assets led to damage of over 40% of the country's power grid, worsening production constraints for sectors that drove Ukraine's GDP prior to the war (World Bank, 2023). The destruction of Kakhovka not only eliminated 351 megawatts (MW) of clean power generation but led to flooding of settlements, biodiversity loss and damage of agricultural lands (The Guardian, 2023).

The ongoing nature of the conflict has also had a detrimental impact on Micro, Small and Medium Enterprises (MSMEs), which previously provided 73% of Ukraine's jobs and generated 63% of gross sales. The sector has been hamstrung by a severe drop in consumer demand, supply chain disruptions and threats to worker safety. The effect has been widespread business closures and redundancies. Although some MSMEs have been able to adapt to new economic realities, relocating their businesses to safer areas in the country, their activity is unlikely to bounce back to pre-war levels in the short term (Swiss Confederation, UNDP, 2022).

On a macro level, one of the longest-lasting economic impacts of the conflict might be an enormous and permanent loss of human capital. The Office of the UN High Commissioner for Human Rights (OHCHR, 2023) recorded 22,734 civilian casualties in the country: 8,490 Ukrainians were killed and 14,244 were injured. Meanwhile, roughly 8 million Ukrainian refugees fled to Europe alone (UNHCR, 2023), many of whom will likely never return. Even considering the refugee outflows, as of January 2023, the unemployment rate estimated by the National Bank of Ukraine (2023) is 25-26% (3.2 million unemployed); some of these citizens will slowly lose their skills and expertise. The effects of this loss of human capital must

[2] Currently, Ukraine is the largest mined country in the world, ahead of Afghanistan and Syria (GLOBSEC, 2023).

be accounted for in recovery planning, both in terms of available workforce for recovery initiatives and expected taxation revenue to fund these initiatives.

These economic disruptions, and others, culminated in the Gross Domestic Product (GDP) of Ukraine crashing by a record 29.1% in 2022 (State Statistics Service of Ukraine). According to the World Bank, the cost of reconstruction is around $411bn (World Bank, 2023). However, the estimates should be considered as minimums given that needs will continue to rise as the war continues. Despite success in maintaining overall economic and financial stability, public debt has soared, and the fiscal deficit ballooned to accommodate additional defence and security spending (IMF, 2023). Therefore, lacking finances may prevent the authorities from adhering to planned recovery policies.

3. Lessons for Green Recovery from COVID-19

In the wake of COVID-19, nations experienced severe economic shocks, forced to respond first to rescue people and businesses, and then to engage in recovery.

The Global Recovery Observatory, a product of the University of Oxford, the United Nations, the IMF, and partners, tracked COVID-19 recovery investments. Subsequent analysis showed that while green, climate-positive, spending was lower than what was needed, examples of green investments came from every nation and in every sector (O'Callaghan, 2023). These investments exhibited characteristics thought to support both economic and environmental objectives.

Supporting this, a survey of leading economists indicated that there are several green policy types that can deliver large economic multipliers and create virtuous cycles for productive deployment of capital; they include investment in clean physical infrastructure, building efficiency retrofits, green education and training, natural capital investment, and clean R&D, (Hepburn et al., 2020). The authors explain that investment in "renewable energy generates more jobs in the short run (higher jobs multiplier), when jobs are scarce in the middle of a recession, which boosts spending and increases short-run GDP multipliers (which are derived from expanding demand)" (p. 366). A detailed literature review with machine learning supports this position, finding that such initiatives create more jobs and deliver higher fiscal multipliers than alternative traditional investments (O'Callaghan et al., 2022). In the long-term, investing in clean energy infrastructure provides substantial benefits over time as it helps reduce the expenses associated with transitioning to clean energy (Henbest, 2020). This ultimately leads to significant returns on investment. In addition, climate-positive policies could contribute to solving issues such as air pollution (through electric vehicle incentives) as well as social and health inequality (through energy efficiency incentives which lead to shrinking electricity costs)

(Hepburn et al., 2020). Moreover, harnessing the potential of new renewable energy sources, rural electrification can be improved, thereby aiding citizens in escaping the poverty trap (Aklin et al., 2018).

As Ukraine considers its own green recovery packages, it is worth studying the actions of others in response to COVID-19, using the Global Recovery Observatory to identify examples. For instance:

- **Renewable energy in Spain**: Spain's 'Just and Inclusive Energy Transition' package, part of the 2020 Recovery, Transformation and Resilience Plan 'España Puede', allocated $7.2bn to promote renewable energy (Government of Spain, 2020). The funding was directed towards investments in renewables, fostering their use in productive sectors, upgrading transmission and distribution networks, and investing in storage technologies and green hydrogen. This green transition is anticipated to facilitate job creation, as well as provide targeted support to sectors and communities whose livelihoods may be impacted by the shift to renewable energy.
- **Renewable energy in Germany**: Germany's National Hydrogen Strategy (BMWi Germany, 2020), comprises a $10.7bn financial package. According to O'Callaghan & Murdock (2021), this strategy is expected to contribute to Germany's economic recovery, primarily through job creation, while also paving the way for a sustainable green energy future.
- **Green transport in Poland**: Poland allocated $178m to the promotion of EV production and uptake (Government of Poland, 2020). This included EV subsidies aimed at local governments, entrepreneurs, and individuals to support new electric public transport, taxis, and school buses. It also included production support for EV manufacturing and charging stations. This was expected to provide economic stimulus through job creation (Wappelhorst & Pniewska, 2020).
- **Green building upgrades and energy efficiency in France**: France allocated more than $8.4bn to energy efficiency retrofits for buildings investment through the "France Relance" stimulus package (Government of France, 2020). Funding included support for energy retrofit initiatives like insulation, heating, ventilation and energy audit work for). This is expected to create many jobs in the short-term, while in the long-term, reduce energy spending (O'Callaghan & Murdock, 2021).
- **Natural capital in the United Kingdom:** The United Kingdom's Green Recovery Challenge Fund allocated $54.9m for planting 800,000 trees in rural and urban settings, expecting to create jobs, improve air quality and health outcomes, and contribute to creation of resilient new ecosystems (UK Government, 2020).

- **Green R&D in France**: France set aside $14.3bn for green R&D measures covering a variety of sectors including funding for low-carbon energy, circular economy, sustainable transport and mobility, responsible agriculture and sovereignty of food supply, and urbanisation (Government of France, 2020a).

4. Review of the existing economic recovery plan

In April 2022, the President of Ukraine established a National Council for the Recovery of Ukraine from Consequences of War, an advisory body which comprises 24 Working Groups developing a plan for Ukraine's post-war recovery and long-term development. The National Council introduced its first proposal - the Ukraine's National Recovery Plan (UNRP, 2022) in July 2022 at the Ukraine Recovery Conference (URC2022) in Lugano, Switzerland. The UNRC establishes ambitious goals for 2032, aiming to:

- Accelerate sustainable economic growth (7% annual GDP growth)
- Attain a position within the top-25 rankings of both the Economic Complexity Index and the World Bank Human Capital Index
- Achieve a 65% reduction in CO2 emissions from 1990

The Plan includes 15 national programs across sectors: defence, energy, environment, economy, infrastructure, transport, housing, education, healthcare, monetary and financial systems and culture. It also provides rough estimates for the financial needs of these sectors, which are expected to be around $750bn. However, some researchers argue that this sum is higher than what is required, suggesting that several components of the financing needs are ill-founded and that Ukraine has insufficient institutional quality and governance standards to efficiently absorb the huge amounts of funding from the EU and other donors (Bogdan et al., 2022)[3]. As an alternative estimate, 2023 World Bank projections (RDNA2) estimate that the recovery needs of Ukraine are $411bn. Nevertheless, it is crucial to acknowledge that the provided estimates represent the lower limits, since the ongoing war will inevitably result in escalating needs over time.

To date, there has been no analysis of the likely impacts of the proposed recovery plan on climate mitigation or other environmental objectives. We fill this gap. The O'Callaghan (2023)

[3] The same researchers suggest that the government's forecast for fivefold GDP growth from 2023-32 is "unrealistic".

taxonomy can be used to consider several environmental factors including climate mitigation, climate adaptation and resilience, natural capital, and air pollution. We constrain our analysis to only climate mitigation (for perspectives on extending recovery analysis to climate adaptation and resilience see Sadler et al., 2022), considering that green public fiscal expenditures are those likely to reduce net greenhouse gas emissions compared to a scenario in which the expenditure was not made. This definition encompasses not only the promotion of renewables, but also, for instance, afforestation efforts, the integration of environmental considerations in the construction of public buildings, using climate-friendly materials (e.g., precast concrete, plant-based polyurethane rigid foam), prioritising energy efficiency (e.g., insulation, smart meters), investing in climate education, installing solar panels on school and hospital rooftops, and more.

We analysed policies from the National Recovery Council using the O'Callaghan (2023) GRO taxonomy. We found that 33% of recovery spending is classified as "green" with planned investments at around $253bn, and 60% is classified as "neutral" with an estimated $459bn. Meanwhile, "dirty" policies' account for 6%, with planned investments of $46bn (mainly in the energy and defence sectors).

Compared to the recovery investments of European nations in response to COVID-19, Ukraine's National Recovery Plan exhibited less green spending and more dirty spending (**Fig.3**). A comprehensive analysis of COVID-19-related fiscal rescue and recovery efforts reveals that 88 countries invested $932bn in long-term green and recovery-type initiatives, reflecting 31.5% of total recovery spending (O'Callaghan, working paper). In many countries, the share of green spending exceeded 50% of total recovery spending, for example, Canada (82%), Denmark (63%), Belgium (59%), Poland (74%), Germany (52%) and Spain (42%). Midway through the pandemic, green COVID-19 investments had already been announced for every sector, with low-carbon investments in clean transport infrastructure totalling $211bn, green market creation $171bn, and clean energy infrastructure $161bn (O'Callaghan & Murdock, 2021).

Having compared Ukraine's National Recovery Plan to the COVID-19 responses of other countries, the share of dirty spending is high. Ukraine's plans to earmark 6% of investments into policies already known to increase GHG emissions might seem controversial for international donors and investors.

Figure 3. **Comparison of COVID-19 recovery spending of European countries to Ukraine's planned spending**

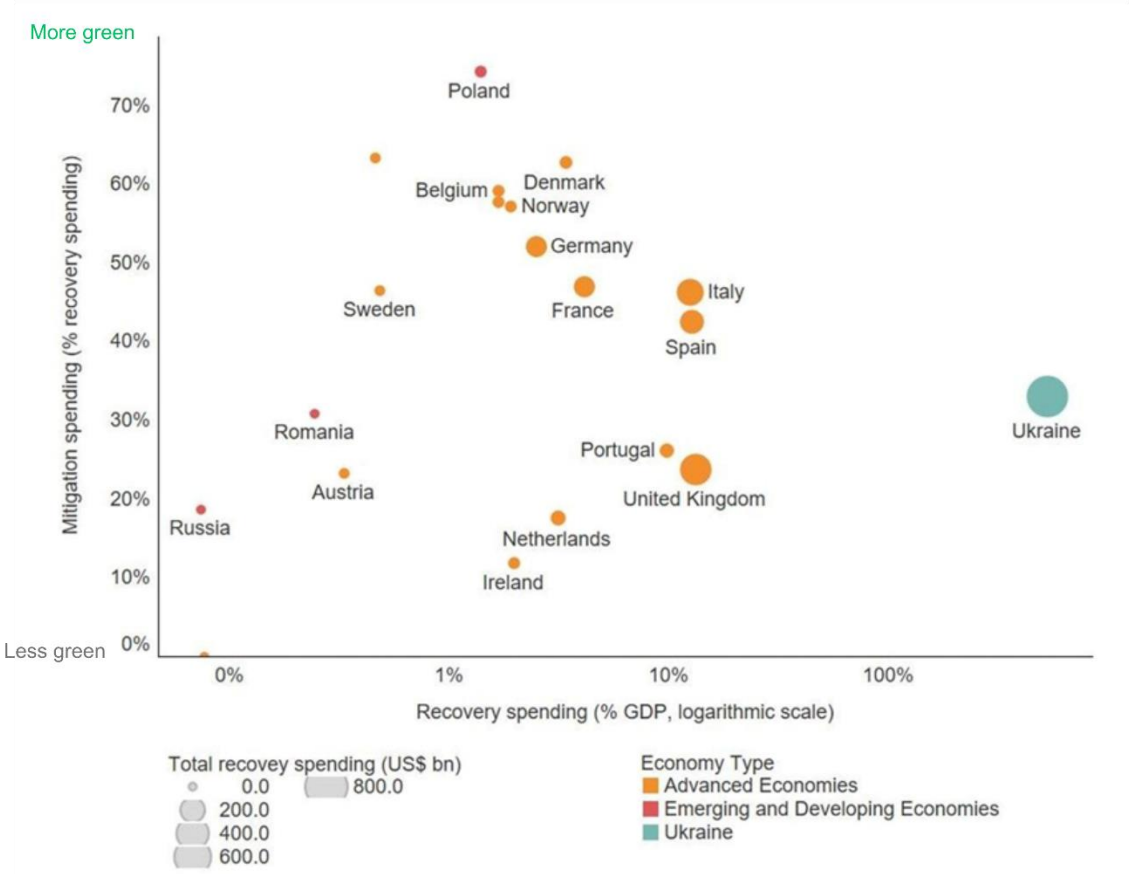


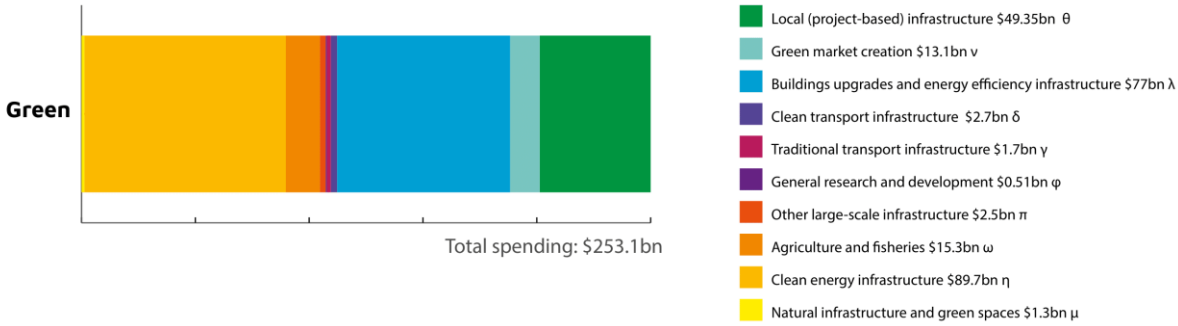
Figure 3: Green recovery spending as a percentage of total recovery spending versus recovery spending as %GDP. Sources: Global Recovery Observatory; interest rate data from OECD (2020) and CEIC (2021)

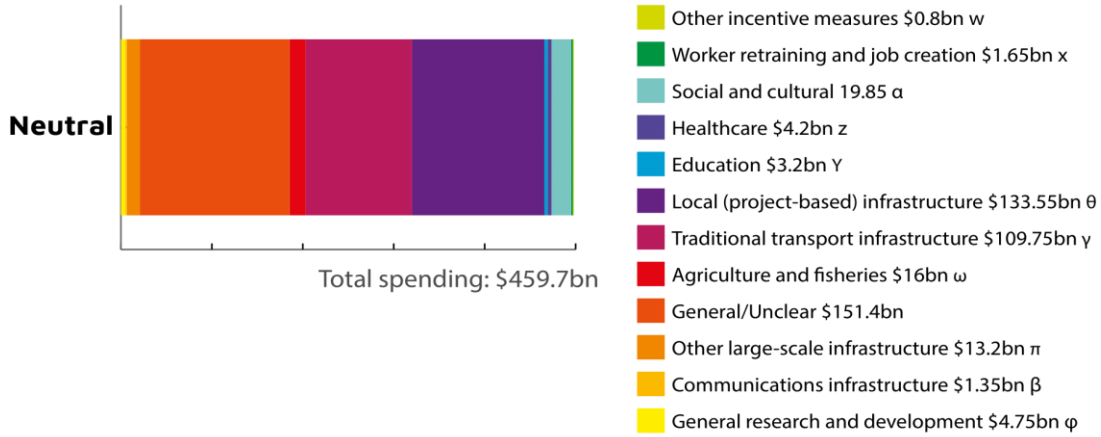
Ukraine's planned recovery measures impact a relatively wide range of archetypes (**Fig. 4**). Considering green recovery archetypes, 11.8% of total spending was allocated to clean energy, 10.1% to buildings' upgrades and energy efficiency infrastructure, 6.5% to local (project-based) infrastructure, 2% to agriculture and fisheries, 1.7% to green market creation, 0.3% to clean transport infrastructure, 0.3% to other large-scale infrastructure, 0.2% to traditional transport infrastructure (rail transport), 0.1% to natural infrastructure and green spaces and 0.06% to general research and development (digitisation and AI). No spending was proposed for electronic appliances & efficiency incentives, clean research and development, electric vehicle incentives, or green worker retraining and job creation.

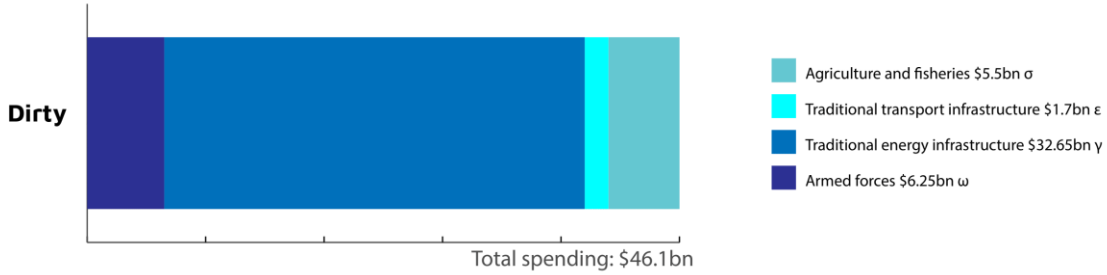
Considering neutral archetypes, 17.6% of total spending was allocated to local (project-based) infrastructure (urban development programs), 14.4% to traditional transport infrastructure (road construction), 2.6% to social and cultural sectors, 2.1% to agriculture and fisheries, 1.7% to other large-scale infrastructure, 0.5% to healthcare, 0.6% to general research and development, 0.4% to education, 0.2% to worker retraining and job creation, 0.1% to communications infrastructure, 0.1% to other incentive measures and 19.9% is identified as general/unclear.

Considering dirty archetypes, 4.3% of total spending was allocated to traditional energy infrastructure, 0.8% to armed forces, 0.7% to agriculture and fisheries and 0.2% to traditional transport infrastructure (aviation, marine).

Figure 4. Ukraine's planned investments per archetype







While the approach in this report holds many advantages for considering ex-ante investment proposals like that of the National Recovery Plan, it also has limitations. First, the analysis is bounded by what is publicly available - unpublished updates to the Plan and non-public additions could not be incorporated. Second, policy descriptions from governments tend to reflect a favourable interpretation of their spending, potentially leading to biased analysis. Third, ex-ante assessment is computed based on expectations of an *average* policy; there is likely to be variation in actual impacts depending on the specifics of policy design.

5. Practical Proposals to Improve Announced Policies

In this section, we consider opportunities to improve the environmental and economic characteristics of policies in the proposed National Recovery Plan. We first provide guidance on the aspects of the plan that are likely to increase GHG emissions and then consider those that are likely to have a neutral impact on emissions. In both cases, we propose practical policy changes with green co-benefits. **Figures 5** and **6** provide a summary of suggestions to green the policy proposals.

Figure 5. Suggestions for redesigning the "dirty" policies

'Dirty' Policies	NRC 2022 Proposal	Green Phoenix Proposal
Gas production	**Increase gas production from existing fields and develop tight gas fields** **Develop offshore gas fields in the Black Sea shelf**	**Scale green energy production & green industry** • Renewable energy generation (wind, solar) • Alternative energy storage & transport solutions (e.g., hydrogen) • Energy efficiency • Scale green industry (e.g., green steel, fertilisers, cement) using cheap renewables • Using gas in the power sector only for essential grid balancing while renewables are scaled up
Gas transmission and distribution	**Modernise domestic gas transmission and distribution networks**	**Repurpose and optimise gas infrastructure** • Transport renewably-produced energy in gaseous form (e.g., biomethane, synthetic methane) • Transport CO2 for CCUS • Store renewably-produced gases in existing gas storage facilities and underground caverns • Upgrade and strengthen electricity transmissions and distribution networks
Oil Refining	**Building a new refinery, rebuilding the old one and constructing a new oil pipeline**	**Reduce oil dependency** • Domestic production of biofuels • Switching to biorefineries • Bans on public procurement of diesel and petrol vehicles

Figure 6. Suggestions for redesigning the "neutral" policies

'Neutral' Policies	NRC 2022 Proposal	Green Phoenix Proposal
Agriculture	**Conventional agriculture practices**	**Sustainable agriculture practices** • Advanced irrigation practices - Conservation tillage, crop rotation, and cover cropping • Smart farming (e.g.drones, sensors) • Alternative proteins
Transport Infrastructure	**Construction, reconstruction and modernisation of roads and bridges**	**Greener road infrastructure** • Dedicated space for bus lanes • Cyclist-friendly design and amenities • EV charging infrastructure • Low-carbon road materials (e.g., recycled asphalt)
Banking Sector	**Post-war recapitalisation and balance sheet strengthening to sustain lending growth**	**Greener banking** • Limiting finance for the fossil fuel sector • Green bonds • Green loans

.1 Replacing “dirty” policies

5.1.1 Alternatives to gas production

One of the largest recovery plan spending proposals is **$18bn to increase gas production from existing fields and develop tight gas fields. An additional $11bn is allocated to developing offshore gas fields in the Black Sea shelf.** Both of these proposals present significant economic and environmental threats. They would hinder the energy transition, increase the carbon intensity of the economy, and increase exposure to the impacts of climate change. They would also further expose Ukraine to stranded asset risks in fossil fuel infrastructure, translating to substantial economic losses for the state as well as an uncontrolled loss of jobs, deprivation of industry, and loss of communities. Stranded assets are those likely to suffer from premature write-downs, devaluations, or conversion to liabilities as a result of the ongoing climate transition (Caldecott et al., 2021).

According to the United Nations Environment Program (UNEP) Production Gap Report (2021), global fossil fuel production must be cut by at least 6% per year in the current decade to keep global warming within 1.5°C and prevent the worst impacts of climate change. This means that there is no room for exploration and development of new fossil fuel reserves, including “natural” gas.

Many of the world’s leading energy experts highlight that the expansion of “natural” gas infrastructure hinders a renewable energy future; it should not be considered a “bridge” technology (Kemfert et al., 2022). Importantly, the EU climate targets can only be met with a reduction in gas demand of at least 35% compared with 2019 levels by 2030 (E3G, 2022). Major investments to expand gas production and associated infrastructure are likely to cause more economic harm than good (IMF, 2019), especially considering the destructive impacts of climate change, which could cost the global economy up to $178tn (Deloitte, 2022). Even prior to the full-scale Russian invasion, independent energy experts and civil society argued that Ukraine had all the reasons to not increase its dependence on “natural” gas (Savytskyi, 2020).

Moreover, apart from creating carbon lock-in in the energy sector, further investments in offshore “natural” gas would increase exposure to climate-related physical risks, where intensified storms, coastal erosion and sea level rise will create massive risks for new offshore gas infrastructure, rendering it unreliable and prone to disruptions with potentially disastrous consequences (UNEP, 2023). Considering the need to support Ukraine’s energy security, there is likely a need for using existing gas fields and infrastructure to support essential grid balancing as renewables are scaled. New fossil fuel infrastructure is unnecessary and likely to result in new stranded assets.

With financial resources amounting to tens of billions of dollars at stake, Ukraine should focus on diversifying energy supply portfolios and directing funds to clean energy programmes rather than expanding gas infrastructure. For instance, investments in wind and solar, geothermal, hydrogen, and energy efficiency. To replace gas transit and create new sources of export incomes, investments should be considered in emerging green industries with products that have high value, high market volumes and high global demand, such as green steel, fertilisers and cement.

As clean energy has become the cheapest form of new power generation according to the UN, energy policies and public spending should focus on multiplying investments in solutions like wind and solar, energy efficiency measures and electrification of the economy. As the IISD (2019, p. 6) notes, "if governments maintain policies that support fossil fuels while the gap between costs on renewables and fossil fuel-based energy grows, taxpayers will be left with a growing fiscal burden to fund the difference." The International Labour Organization points to renewable energy as a major driver of new employment as it helped to drive jobs growth in the energy sector to nearly 13 million green jobs in 2022 (IRENA & ILO, 2022), with further exponential rise projected up to 139 million by 2030. Complementary and growing research literature that investigates green job potential from all kinds of investment gives evidence of major advantages, including economic multipliers and positive spill overs (O'Callaghan et al., 2022, p.710).

In post-war reconstruction, Ukraine will need to create employment opportunities for returning soldiers and refugees. Plans to join the EU could potentially allow Ukraine to benefit from massive programmes to train clean energy workers through the new EU Skills Agenda. These programs could boost Ukraine's clean energy sector, create high-paying jobs, replace fossil fuels with local clean energy, and provide affordable, secure energy for domestic industries and advanced manufacturing.

5.1.2 Alternatives to expansion of gas transmission and distribution networks

Ukraine's Recovery Plan 2022 suggests **$2.5bn for modernising domestic gas transmission and distribution networks**. However, it does not provide a clear description of the measures involved, which, depending on their nature, could have either positive or negative effects for climate.

Ukraine has extensive gas transmission and distribution networks, among the largest in Europe (Gas Transmission System Operator of Ukraine, 2021). This infrastructure is both a major asset and a significant liability. As an asset, it can be used for the transportation and storage of renewable gases or repurposed for the needs of Carbon Capture Utilisation and

Storage (CCUS) systems. But as a liability, it requires maintenance and methane leakage abatement measures. Significant parts of gas transmission infrastructure would have to be decommissioned after the expiry of contracts for the transit of Russian gas, as the conclusion of new contracts is not possible during the war and unlikely after it ends (Center on Global Energy Policy, 2023).

According to former head of Gas Transmission System Operator of Ukraine Sergiy Makogon (UA-Energy, 2023), the country's gas infrastructure can be repurposed and effectively used in new directions, but this requires implementation of reforms and new management structures in accordance with EU energy law. Suggested measures repurposing and optimisation of gas infrastructure assets include:

- Using excess infrastructure and compressor stations for construction of energy storage facilities with air compression (CAES);
- Supporting the development of the biomethane industry by facilitating network connection of production facilities;
- Providing seasonal energy storage by using excess renewable electricity to produce synthetic methane and store it in underground caverns;
- Repurposing pipelines to transport synthetic methane;
- Repurposing pipelines to transport CO2 in future CCUS systems;
- If necessary, retrofitting existing compressor stations so that they might act as balancing gas power plants.

Public spending on gas infrastructure modernisation should be limited to these optimisation and re-purposing measures, which are largely incompatible with further expansion of Ukraine's gas infrastructure.

However, repurposing the current infrastructure to facilitate the growth of industries like biomethane or CCUS has the potential to create economic opportunities, including job prospects. For example, biomethane plays a crucial role in decarbonising the methane system, with an estimated 3425 Mt of direct CO2 emissions being avoided by replacing "natural" gas. The production of 660 terawatt hours (TWh)/year of biomethane through anaerobic digestion is projected to create 200,000–275,000 direct jobs and an additional 300,000–400,000 indirect jobs by 2050 (Gas for Climate, 2023). Meanwhile, existing research shows that CCUS has the potential to safeguard around 53,000 jobs in energy-intensive sectors and generate

approximately 31,000 jobs primarily related to construction activities by the year 2030 (Serin et al., 2021).

State support for investments in new fossil gas transmission and distribution infrastructure would provide a subsidy for domestic fossil gas extraction or potentially incentivise resumption of strategically dangerous gas imports from Russia. The effect of this subsidy could be to stimulate gas demand and exacerbate existing vulnerabilities, as climate change is intensifying and exposure of energy infrastructure to physical risks is growing. Resuming gas imports from Russia would pose difficult questions regarding the historic role of natural gas as Russia's key geopolitical weapon and source of state power (CERES, 2021; Ghaleb, 2011).

In contrast, investments in electricity transmission and distribution infrastructure in Ukraine can greatly contribute to decarbonisation and strengthening energy security both nationally and regionally. Expanding transmission grid interconnection with the EU is particularly important (Morawiecka & Savytskyi, 2022). Expanding Europe's interconnections in an optimal way would avoid curtailment of up to 110 TWh of renewable electricity per year by 2040 and would promote renewable build-out by taking advantage of national differences between fuel mixes and renewable peaking periods (ENTSO-E, 2021). In addition, interconnectors decrease CO2 emissions, decrease generation costs, promote greater convergence between electricity markets and provide opportunity for mutual support in times of stress. The EU has set an interconnection target of at least 15% by 2030, stipulating that EU Member States must have at least 15% of import capacity in relation to their installed generation capacity (European Commission, 2021). As a candidate for EU membership, Ukraine should also work to achieve this indicator.

5.1.3 Alternatives to oil refineries

The post-war period recovery plan proposes **building a new refinery, rebuilding another refinery destroyed in the war (Kremenchuk) and construction of a new oil pipeline from Brody to Adamova Zastava, at a total estimated cost of $2.5bn**.

In 2021, according to the Observatory for Economic Complexity (OEC) data, Ukraine imported $5.63bn in refined petroleum products, with more than half of supplies coming from Russia and Belarus. During the first months of Russian full-scale invasion in 2022 Ukraine had experienced supply shocks, but associated challenges were overcome and the country established alternative supply routes from Europe. These are sufficient to meet current demand. In May 2023 Ukraine effectively banned imports of Russian oil products (Reuters, 2023).

Given limited domestic reserves and production of oil, which are far from self-sufficiency, building this infrastructure will not help to reduce Ukraine's principal dependence on oil imports. It can only partly shift it from oil products to crude oil, while maintaining dependence of the transport sector on imported fuel.

Considering the long-term nature of such capital-intensive and centralised infrastructure facilities, investing in new domestic refining capacities will create carbon lock-in and can hinder rather than enhance security of supply compared to continued import supplies of oil products. Oil refineries and pipelines can become targets for military attacks, terror and sabotage (REF). This centralised infrastructure is also vulnerable to impacts of climate change (Cruz & Krausmann, 2013).

Diversifying routes for import supplies of oil products and creating distributed and properly protected strategic petroleum reserves can become better means for providing energy security and reliably meeting domestic demand for motor fuels. Moreover, feasibility of oil infrastructure expansion and associated investments are generally questionable in the context of decarbonisation and global trends towards electrification of automotive fleets. For instance, in the UK the sale of new petrol and diesel cars and vans will end by 2030, with all new cars and vans being fully zero emission from 2035 (UK Government, 2020).

After the war, Ukraine should establish stocks of oil products and strategic reserves that can provide for 90 days of average domestic consumption to prevent supply shocks and contribute to energy security. This is required by EU Directive 2009/119/EC, which Ukraine has to implement as an EU membership candidate and a party to the Energy Community Treaty.

Having established strategic petroleum reserves, Ukraine should focus further efforts on reducing oil import dependency by promoting smart mobility in cities, electrification of transport and establishing domestic production of biofuels, which can create economic multipliers and contribute to the development of a circular economy (Suhaib & Fayaz, 2022). Further to that, state level authorities, local governments and municipalities should be encouraged to take measures to reduce oil demand: from imposing bans on public procurement of diesel and petrol vehicles to creating support programs and incentives for businesses and citizens to switch to electric vehicles (Volkswagen Group, 2019). As part of the economic recovery policies, the Ukrainian government should consider regulatory, tax and financial incentives – or a combination of all three.

Additionally, given that Ukraine has the largest area of arable land in Europe and significant agricultural potential, processing of specially cultivated crops, as well as by-products and agricultural residues, at integrated biorefineries can become a major vector for clean industrial

development during post-war reconstruction and help to reduce oil dependency. Biorefineries, apart from producing renewable fuels, are also able to produce a wide range of products, including biomaterials, polymers and chemicals (Jong et al., 2012). By incorporating opportunities into a whole systems approach for design and planning, biorefineries will be able to balance nexus resource trade-offs, deliver their potential for full exploitation of biomass as the only source of renewable carbon and materials, and translate nexus issues into social welfare and sustainable development (Martinez-Hernandez & Samsatli, 2017).

5.2 Improving "neutral" policies

5.2.1 Improvements for agriculture

In the National Council Recovery Plan, $37bn was allocated to agricultural initiatives. Using the GRO taxonomy, some of the proposed measures might have climate advantages (for instance, precision farming, irrigation systems in compliance with EU directives, and the development of agri-processing aligned to the EU Green Deal) while others are likely to have a neutral impact on emissions (for example, development of high value-added agricultural produce, land recultivation, and restoration of agricultural enterprises), and some are likely to have a negative overall effect on emissions (for example, increasing meat and milk production).

In 2021, agriculture accounted for the highest share of Ukraine's GDP (over 10%) (UKRINFORM, 2022). Prior to the invasion, Ukraine's agricultural exports amounted to $27.8bn, making up 41% of the country's total exports (USDA, 2022) and employing 14% of the labour force (World Bank, 2022). However, "while Ukraine is internationally very competitive as a supplier of raw materials, value addition and diversification of the agriculture production are rather weak" (SECO, 2021).

In 2019, agriculture contributed 42.5 MtCO2eq (12.8%) of Ukraine's GHG emissions (OECD, 2022). Of all emissions, agricultural emissions are often considered amongst the hardest to abate and require significant technological advancement. Considering the significance of the agricultural industry for Ukraine's economy, there are potential improvements in the sector which should be taken into account by policymakers. First, the modernisation of the irrigation system should focus on energy-efficient measures and rational use of water by using the best available technologies (Ecoaction, 2022). Such technologies include mainly piped delivery systems, laser levelling of fields, conversion to pressurised systems for sprinkler, drip, or sub-surface drip (FAO, 2017). These innovations are expected to generate two significant benefits: saving water and releasing it to other uses, and achieving more production per unit of water, which is economically beneficial for agribusiness.

Second, the development of high value-added agricultural production and recultivation of damaged land should comply with practices of Sustainable Agricultural Land Management (SALM) optimising the monetary and social benefits from the land while simultaneously guarding against all forms of land degradation that reduces land quality and productivity (Nwosu & Oshunsanya, 2021). Additionally, sustainable land management is widely recognised as the key to preventing desertification, which Ukraine is exposed to due to climate change (Lyalko et al., 2023). This can include regenerative agricultural practices like conservation tillage, cover cropping, and crop rotation, gentle processing techniques for fresh products (Rodale Institute, 2014), as well as the development of new nutritious and functional foods, the exploration of alternative protein sources, harnessing the diverse microbial ecosystem in food systems, etc. Therefore, to recover the industry from war and safeguard from climate change consequences, spending should be focused on implementing the best available technologies in the agricultural sector and R&D to explore the sector's opportunities effectively.

In developing a green agricultural policy package, Ukraine could look to the EU's Green Deal From Farm to Fork strategy. This could provide a guiding framework for the transition towards a sustainable food system. According to leading academic research this transition could bring environmental, health and social benefits, while offering economic gains (CISL, 2021). With expected increase of EU farmers' incomes in the short term, long-term economic viability of Farm to Fork strategy is expected to result in input factor reallocation, increasing production and allocation efficiency in agriculture within the EU (Wesseler, 2022). Notably, the adoption of more environmentally and climate friendly practices within the strategy is expected to reduce the GHG emissions of EU agriculture between 20% and 35% (Barreiro-Hurle et al., 2021; Henning et al., 2021). At a global level, it is estimated that aligning food and agriculture systems with the Sustainable Development Goals (SDG) would deliver nutritious and affordable food for a growing world population, help restore vital ecosystems and create new economic value of over €1.8tn by 2030 (Business & Sustainable Development Commission, 2017). According to estimates, a transition to regenerative agricultural practices, by 2030, could generate over 60 million jobs and $1.1tn in economic opportunities (WEF, 2020).

Sustainable and circular food system innovations encompass a wide range of practices. These can include smart farming (Mohammed et al., 2021), e.g. the implementation of intelligent sensors and system controls to ensure food safety and promote eco-friendly processing (including waste reduction, water conservation, and energy efficiency), the utilisation of smaller-scale technologies for local resource bio-refineries, the integration of 3D printing, the application of information and communication technology (ICT) in household appliances, and

the anticipation of upcoming digital advancements in the food industry, among other possibilities (SAPEA, 2020).

Looking at countries' post-covid fiscal spending, the agriculture sector saw little R&D investment (O'Callaghan & Murdock, 2021). This provides an opportunity for Ukraine to establish an early-mover advantage in the space. For example, the emerging market of alternative proteins (plant-based and food-technology alternatives to animal protein) has the potential to generate new jobs and income for those across the livestock industry as well as freeing up government subsidies related to animal agriculture (Money et al., 2022). According to the decarbonisation scenario, a shift in diets and the rise of the plant-based food sector will create 19 million full-time jobs by 2030 (ILO and IDB, 2020).

5.2.2 Improvements for transport infrastructure

The war has significantly damaged transport infrastructure in Ukraine. In the National Recovery plan, **$75.7bn is allocated to construction, reconstruction and modernisation of 27,200 km of roads and 3,000 bridges**. The scale of this need provides an opportunity to structurally rethink Ukraine's transport systems, for instance by pairing road reconstruction with cyclist-friendly road redesign, road modernisation with space for bus lanes, and new roads with new electric vehicle charging stations. It also provides an opportunity to consider the balance between road infrastructure and public transport infrastructure. Careful consideration for transportation investment is warranted as design and implementation of these projects can have major impacts on the overall functioning of an economy, its productivity and export potential, as well as its resilience.

Roads are key facilitators for socio-economic activity and growth, linking industry and markets, supporting tourism and providing communities with access to employment, health, educational, social and leisure opportunities and activities. Road transport also plays a key role in logistics and delivery of goods, products and services. On the other hand, when internal combustion engines are the dominant road users, the infrastructure becomes an enabler for significant greenhouse gas emissions.

Within EU member states, emissions from the transport sector continued to grow and were up by 7% in 2020, compared with 1990 levels (WEF, 2022). Unlike many other industries that were gradually taking steps to meaningfully reduce their emissions, the transport sector continued to report around 0.8% growth in metric tons of MtCO2e every year, with passenger cars accounting for the highest portion. The sharp reduction in emissions observed in 2020 due to the COVID pandemic was followed by a fast rebound, with emissions projected to return to pre-pandemic levels in 2023 (European Environmental Agency, 2022).

While technological improvements and regulations have reduced air pollutant emissions within the transport sector (UK Government, 2022), GHG emissions have increased, as internal combustion cars still dominate on the roads (Dolge et al., 2023). Consequently, the phasing-out of polluting internal combustion engine vehicles and stimulating uptake of electric transportation and smart mobility became a key part of EU climate policy (The European Green Deal, 2019). This translates into the need for major adjustments in planning, design and operations of road transportation infrastructure.

For Ukraine, which will need to rebuild significant portions of its road infrastructure as part of post-war reconstruction and improve transport connections with EU member states, the implementation of such adjustments is of outstanding importance. This is essential for embarking on a path of sustainable development and increasing the resilience of the national economy during the process of EU accession. The redesign of transport infrastructure typically faces many complexities, but once accomplished, it can have long-lasting and positive structural effects (McKinsey, 2021).

Therefore, recovery planning must aim to deliver development of sustainable transport infrastructure, which should be resilient to climate change, socially inclusive, technologically advanced, productive, and flexible. Proper organisational design, digital tools, performance indicators and a strong collaboration among all stakeholders are essential to effectively transform infrastructures and ensure long-lasting development (Milani et al., 2021).

Sustainable transport infrastructure planning should focus on increasing the uptake of more environmentally friendly modes of transportation like bicycles, light electric vehicles, electrified public transit, all-electric and hybrid service and freight vehicles. In practice, necessary changes are likely to require digitalization, integrated infrastructure planning and coupling of transportation and power sectors, with a particular need for accelerated charging infrastructure deployment (IRENA, 2021). This can yield multiple environmental and public health benefits through reduced air pollution (Garcia et. al, 2023), while also reducing dependence on oil imports (Carbon Tracker, 2020).

In urban areas, reconstruction and development planning should adequately allocate resources for construction of pedestrian and bicycling infrastructure such as sidewalks, bike lanes, and trails. These types of infrastructure have been shown to create many benefits for their users as well as the rest of the community (Mello & Pochowski). Some of these benefits are economic, such as increased revenues and jobs for local businesses, and some are non-economic benefits such as reduced congestion, better air quality, safer travel routes, and improved health outcomes (World Bank, 2022; Garrett-Peltier, 2011).

Vitally, sustainable transportation infrastructure can also support high levels of job creation. Garrett-Peltier (2011) shows that cycling infrastructure creates the most jobs for a given level of infrastructure spending: for each $1m, the cycling projects in this study created a total of 11.4 jobs. Pedestrian-only projects create an average of about 10 jobs per $1m and multi-use trails create nearly as many, at 9.6 jobs per $1m. Infrastructure that combines road construction with pedestrian and bicycle facilities creates slightly fewer jobs for the same spending, and road-only projects create the least, with a total of 7.8 jobs per $1m. With the spill over employment that is created in neighbouring areas through the supply chain, the employment impact rises by an average of 3 additional jobs per $1m spent on combined infrastructure that serves needs of pedestrians and cyclists.

Another consideration for greening transport infrastructure is reducing emissions from the road infrastructure, including material production and transportation, road construction, maintenance, and recycling of roads, which make up 5%-25% of total CO2 emissions from transport (Liu et al., 2017). To reduce this carbon burden, roads can be paved with recycled asphalt, reducing embedded emissions from material production from 15% up to 95%, depending on the recycling technique (Healthy Building Network, 2017). Instead of traditional concrete, lower-emissions “green” concrete could be used. Using recycled materials can reduce construction costs for both asphalt and concrete (Qiao et al., 2019). In the case of green concrete or cement, significant new domestic industrial capacity would be required to service demand, potentially creating thousands of jobs and positioning Ukraine to turn green cement into an export industry.

5.2.3 Improvements for the banking sector

The National Recovery Plan earmarked $15-20bn for reinforcing the banking sector through **post-war recapitalisation and balance sheet strengthening to sustain lending growth.** While these funds would hopefully crowd-in further private capital, thereby multiplying the impact of government support, the plan does not mention any policies for improving sustainability in the sector.

Emerging concepts of green banking could serve as a guideline for Ukrainian policymakers to incorporate systematic sustainability approaches into the financial sector. Green banking requires banks to consider a project’s environmental characteristics and potential impacts prior to financing (Ahmad et al., 2013). Although banks tend to generate lesser direct environmental impacts compared to other industries, their indirect impacts can be enormous through their lending and investments. Negative indirect impacts are clear when banks support and enable the expansion of polluting activities (Khairunnessa et al., 2021).

Banks stand to gain by greening their lending and investment practices. Climate change and other environmental issues can expose banks to transition risks (e.g., stranded assets due to changes in regulatory requirements), physical risks (e.g., heatwaves, wildfires) and liability risks (e.g., financial penalties, reputational damage, and legal actions from affected parties). These risks present significant threats to the financial stability of projects and parent banks (Park & Kim, 2020). Many industrial projects, including steel, paper, cement, chemicals, fertilisers, power, and textiles, rely heavily on banking institutions as their main source of finance (Wendt, 2015). However, these projects often come with considerable social or environmental risks. Therefore, implementing green banking practices can play a crucial role in promoting responsible behaviour among the businesses (Scholtens, 2020).

Ukraine's financial sector, and therefore its entire economy, could benefit from a transition to green banking. According to International Finance Corporation (IFC) estimates, "climate-smart" investment opportunities totalling $23tn exist in emerging markets by 2030 and $73bn in Ukraine. To take advantage of this opportunity, the banking sector should prioritise green bonds and green loans banks to attract foreign and domestic investors in green technologies.

The key sectors for potential green bond projects in Ukraine are natural resources, transport, energy industry, and energy efficiency. In the natural resources sector, investment in agriculture, fisheries, and forestry is crucial for climate-resilient development and reducing greenhouse gas emissions. The transport sector needs improvements to meet international environmental requirements, particularly in the Ukrainian railway system. The energy industry has a low proportion of renewable energy and aims to increase it to 17.7% by 2030, requiring significant investment. Energy efficiency is a major concern, e.g., with current inefficient use of energy resources for heating, resulting in substantial losses (. Overall, the renewable energy and energy efficiency are top priorities for Ukraine, crucial for ensuring energy security (Samoilenko et. al., 2022) and necessitating substantial funding (including through green bonds), to finance low carbon projects aligned with Sustainable Development Goals. According to the European Green Bond Standard (EU GBS), green bond issuers must demonstrate that the green projects they sponsor align with the EU Taxonomy. Thus, investors who buy the bonds can see to what extent their investments are sustainable. Taking into consideration the EU candidate membership status, it is envisioned that Ukraine completely implements the EU GBS in the long run and Amended EU GBS in the short term (UNDP, 2022).

Prior to the war, the National Bank of Ukraine introduced its Sustainable Finance Development Policy 2025, developed in cooperation with IFC, aimed at shaping the future landscape of

sustainable finance in Ukraine. This policy should be implemented as a post-war priority. The implementation roadmap proposes:

1) Implementation of ESG factors of financial institutions' operation, which will become elements of their corporate governance system;

2) Integration of environmental and social risk management (ESRM) into the overall risk management system of financial institutions;

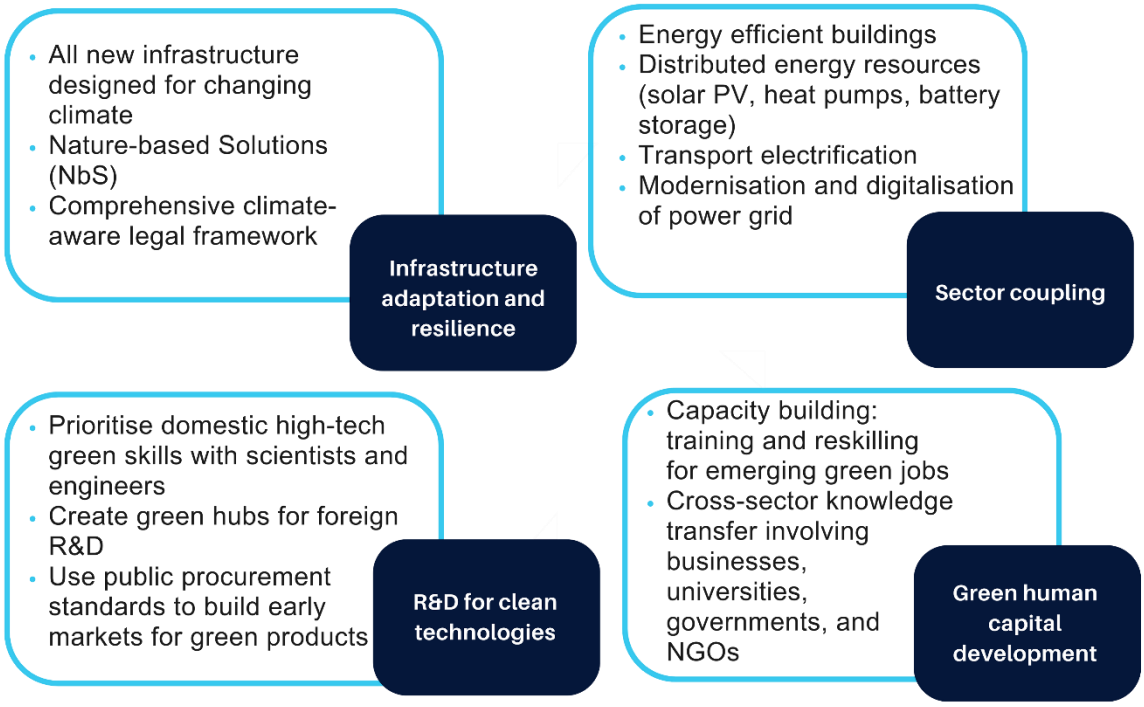
3) Evaluation and selection of projects for funding, depending on their impact on the environment, economic sustainability, and energy efficiency. They will also have to disclose information on the technical criteria and classifications (taxonomy) of economic activities and ESG metrics that go into the evaluation and selection of such projects, based on world best practices;

4) Mandatory disclosure by financial institutions of the sustainability of their activities, their impact on the environment, and the reputational and financial risks arising from the environmental impact of their operation.

6. Filling Gaps in the Proposed Recovery Plan

In general, the National Recovery Plan effectively outlines the primary directions for rebuilding a country devastated by war. It breaks down each recovery goal into various sub-goals, provides supporting measures, and incorporates legislative amendments and initiatives. However, to further advance the proposal (or other similar proposals), policymakers must consider numerous structural gaps currently not covered by the plan. To begin the conversation, this report outlines four prominent gaps and potential solutions as can be seen in **Figure 7**.

Figure 7. Structural Gaps of Ukraine's National Recovery Plan (2022) and potential solutions



6.1 Resilience of infrastructure and adaptation to climate change

Any new infrastructure must be constructed with a view to changing economic and environmental conditions to ensure that public funds are not wasted and the new Ukraine is positioned for long-term stability, security, and sustainable development. In particular, new infrastructure must be designed to cope with a changing climate, which can be challenging given uncertainty in how exactly the climate might change. According to the latest IPCC report, substantial gaps in the capacity of global human and environmental systems to adapt and be resilient in the face of adverse climate shocks highlights the urgent need for investment in adaptation and resilience (IPCC, 2022). Policy response analyses of Covid-19 recovery measures have highlighted the need for spending to bolster resilience to future shocks, including those related to climate change (OECD, 2020).

Prior to the war, Ukraine was already affected by increasing frequency and intensity of extreme weather events such as storms, heatwaves, and floods, causing fatalities and significant economic losses (World Bank, 2020). This is unsurprising as record levels of heat-trapping GHG gases are causing surging global temperatures (WMO, 2023) and leading to a global increase in the occurrence and severity of these events. These conditions emphasise the need for any new infrastructure to be resilient to climate risks at all stages of the Ukrainian recovery.

In support of this strategy to protect against coming risks, it is important to not worsen the risks by investing in "dirty" infrastructure (OECD, 2021).

Potential measures for enhancing resilience and adaptation to climate change of infrastructure in Ukraine should include:

1. *Ensuring the resilience of recovery spending* by directly influencing infrastructure and systems designed for the purpose of adaptation and resilience, as well as future patterns of capital allocation, policy, regulation, law making, business practice, or behaviour (Sadler et al., forthcoming). Specifically, climate policies in Ukraine should be designed with robust safeguards against fiscal shocks that could potentially result in their de-prioritization (e.g., by establishing funds that enable agricultural producers to transition their production processes to adapt to a changing climate).

2. *Nature-based solutions (NbS) approach*. NbS play a valuable role in supporting adaptation and resilience (Turner et al., 2022) while advancing economic priorities (Chausson et al., 2023). NbS are those measures that "protect, sustainably manage and restore natural and modified ecosystems in ways that address societal challenges effectively and adaptively, to provide both human well-being and biodiversity benefits, that flow from healthy ecosystems and target major challenges like climate change, disaster risk reduction, food and water security, health and are critical to economic development" (IUCN). NbS acknowledge that natural and managed ecosystems produce a diverse range of benefits on which sustainable infrastructure and resilience depend (OECD, 2021).

3. *Developing a comprehensive climate-aware legal framework* capable of addressing legal gaps across all sectors, oversighting responsibilities and reporting requirements, developing laws and regulations covering the public investment functions embedding consideration of mitigation and adaptation; developing legislation for specific climate change-related aspects (energy efficiency acts, spatial planning acts, building codes). This will allow to integrate climate resilience into infrastructure planning as well as comprehensive risk assessments, enhancing infrastructure monitoring and early warning systems to track the performance and condition of critical infrastructure, identify vulnerabilities and ensure infrastructure resilience over time (IMF, 2021).

4. *Cross-Sector Collaboration and Capacity Building* among different sectors (government agencies, private sector entities, academia, local communities), for

training on climate risk assessment, adaptation strategies, and incorporating climate resilience into infrastructure planning and management.

The prospects for implementing these strategies are envisioned within Ukraine's National Energy and Climate Plan (NECP), which will be developed and implemented according to Energy Community Contracting Party requirements (Energy Community) and as a part of EU accession process. According to the Regulation on Governance of the Energy Union and Climate Action, NECPs play a crucial role in contributing to climate resilience, while fostering coordination across all government departments and facilitating an integrated planning level that could simplify public and private investment (Regulation 2018/1999). In particular, by including national objectives and targets as well as respective policies and measures for decarbonisation, energy efficiency, energy security, internal energy market, and research, innovation and competitiveness, NECPs are promoting: a) the deployment of renewable energy technologies, which are less vulnerable to climate-related risks compared to fossil fuel-based energy systems; b) energy efficiency measures in various sectors, such as buildings, transportation, and industry, aiming to reduce energy consumption and withstand climate-related shocks; c) diversification of energy sources; d) integration of climate adaptation measures (e.g. strengthening electricity grids, upgrading infrastructure to withstand extreme weather events, or relocating energy facilities away from vulnerable areas); e) cross-sectoral collaboration allowing identification of synergies between climate resilience efforts and infrastructure planning.

Leveraging available technical assistance from the European Commission and the Energy Community Secretariat, Ukraine's NECP, is expected to improve regulatory certainty, while contributing to de-risking framework for future investments (Energy Community, 2023), bolstering investor confidence and encouraging long-term engagement from international public and private capital in the reconstruction of Ukraine's infrastructure.

6.2 Cross-sectoral linkages through electrification and sector coupling

The Recovery Plan currently lacks a vision for **sector coupling of heat, mobility, and electricity**. Sector coupling refers to the integrating or linking of different energy-consuming sectors with the goal of optimising energy efficiency and reducing overall carbon emissions. It typically involves the use of renewable electricity for meeting the energy demand in these sectors, thus creating a unified, sustainable energy system. There is an opportunity in Ukraine for the large-scale electrification of industry, transportation, heating and buildings through integrated infrastructure planning.

Sector coupling broadly describes an important strategy to optimise the energy system by increasing its flexibility and reliability through direct or indirect use of electricity across applications in end-use sectors, with the aim of accelerating the transformation towards 100% renewable energy. This concept of combining different energy supply and demand options has been applied to energy systems for many years (IRENA, 2022).

Electrification and energy efficiency efforts have accelerated in Europe since the Russian invasion, driven by higher fossil energy costs (Ember, 2023). Current decarbonisation scenarios suggest that Europe needs to more than double the proportion of electricity in its energy mix to reach climate neutrality by 2050 (Dickson, 2021). In doing so, European electricity demand might double by 2050 (ETIP Wind, 2021). Driven by economic and political factors, Ukraine's interests will be advanced through detailed planning for an integrated energy sector (FSR, 2022). This will likely involve a paradigm shift from large-scale, centralised conventional power generation, with one-way transmission and distribution of electricity to consumers, towards a flexible, renewables-based, distributed and decentralised energy system with two-way flows of energy and data. Sector coupling, namely the electrification and interconnection of all energy-using sectors (including transport, industry, heating and cooling, buildings and municipal utilities), should become a core focus of infrastructure planning and development.

In practice, this means investing in smart and resilient buildings, municipal service facilities, logistical centres, and modern factories – all with built-in distributed energy resources, incorporating batteries, solar PV and other local generation, power supply automation, heat pumps and other controllable loads. Large investments will be needed for enabling infrastructure, particularly in modernisation of distribution grids to adapt them for broader electrification of the economy, deployment of renewables and distributed energy resources. These investments will require deep technical support and should be steered through integrated infrastructure planning.

The economic benefits of accelerated sector coupling are likely to be significant, including lower total system costs (Brown et al., 2018). Beyond economic benefits, an electrified and more energy efficient economy will support greater energy security and assist efforts to achieve deep decarbonisation (Arabzadeh et al., 2020).

That said, it is important that recovery plans do not repeat mistakes made in unsuccessful attempts to restructure the country's Soviet-inherited energy sector (Kazanskyi et al., 2017); they should consider human rights, national security and sovereignty concerns.

6.3 R&D for clean technologies

The National Recovery Plan includes policies reliant on recent or future innovation: high-tech energy efficiency measures for buildings, green hydrogen production, smart grids and switching steel production methods from using coal-heavy Furnace-Basic Oxygen Furnaces (BF-BOF) to Direct Reduced Iron (DRI) technology and Electric Arc Furnaces (EAF), which can operate with green hydrogen and renewable electricity respectively. These technologies are relatively nascent, although governments and companies are currently investing billions in their development and deployment (Agora Energiewende, 2021). If Ukraine would like to use these emerging technologies it can either (a) rely entirely on foreign R&D and imports or (b) develop domestic clean R&D capabilities with the help of skilled scientists and engineers. For some of the more technologically ambitious proposals in the recovery plan, progress might be entirely stalled without sufficient domestic capabilities – in that case, post-war reconstruction plans may exist only on paper.

Supposing the financial resources were available, it would be strategic for Ukraine to begin accelerating domestic clean R&D immediately, even as hostilities are ongoing. This would provide a stronger foundation from which to implement innovative green projects after the war. The economic impacts of clean R&D are expected to be very large but might not reveal themselves for some time after the initial investment (Jaekyung Yang et al., 2011; Piva & Vivarelli, 2017).

According to the most recent *World Investment Report* from the International Energy Agency, approximately $38bn was dedicated to energy R&D in 2021 (IEA, 2023). Nearly 90% of this funding was allocated to clean-energy technologies. The prioritisation of clean energy is largely driven by the urgency of addressing the climate crisis and the economic incentives of being an early-mover in the transition.

By prioritising investment in clean R&D, the Ukrainian government could increase business confidence to invest in clean industries following the war. In terms of specific incentive design, it could follow the example of 20 OECD countries (out of 37) with special deduction rules for R&D costs, 18 countries with R&D credits, and 19 with a patent box (IP tax incentive) (Bunn, 2021).

As an additional policy tool in support of such incentives, the government could create early markets for domestically-manufactured green products by mandating public procurement to meet environmental criteria. Green Public Procurement (GPP) can be a significant driver for investments in clean R&D and innovations, providing incentives to develop environmentally-friendly works, products and services, while securing financial savings for public authorities,

especially if considering the full life-cycle costs of a contract rather than only the purchase price (OECD, 2015).

In the long run, by prioritising R&D, the government would be building an ecosystem in which local companies can build competitiveness, leading to improved productivity and stronger profitability. The potential benefit to job creation and economic product could be enormous.

6.4 Green human capital development

As discussed in Section 2, driven by military casualties and massive population displacement, Ukraine faces a significant loss in human capital with long-term and dramatic economic consequences. As such, investments in capacity building and reskilling will be crucial mechanisms to support recovery. By focusing these initiatives on developing skills needed in emerging green industries, Ukraine can build capacity to capitalise on its inevitable green economic transformation. There is a need to strengthen knowledge, skills, and resources across technical and managerial domains, with a focus on innovation capacity.

The shift to a green economy will create jobs within new emerging sectors. The UK already holds over 460,000 green jobs in just the electric vehicle manufacturing and offshore wind industries (UK Government, 2020). Estimates for job creation in emerging sectors of domestic expertise are also significant; the UK Government estimates that the domestic hydrogen sector will create 8,000-10,000 new jobs by 2030 and potentially up to 100,000 by 2050, while making buildings more energy efficient will deliver around 50,000 jobs by 2030 (UK Government, 2020).

According to the Ukraine's National Recovery Plan, numerous new energy projects are planned, which will require specialists both to develop new facilities and to be involved in the future operations of these projects. A key capacity building opportunity is to provide training and reskilling programs for workers in the energy sector. This could include programs for engineers, managers, technicians, construction workers, fitters and other professionals in the field, covering a range of topics, such as renewable energy technologies, energy efficiency, and smart grid systems. To create and implement these programmes, the government of Ukraine should collaborate with national and international universities and training organisations. However, the creation of green jobs is not limited to the energy sector. For example, protection of the natural environment which includes building flood and coastal defences also requires skilled workers, does green finance and innovation.

Knowledge transfer is another essential capacity-building strategy. Effective and swift reskilling efforts are most successful when there is collaboration across multiple sectors, including

businesses, governments, and non-governmental organisations (NGOs) (XPRIZE, 2021). As one example, public-private partnerships are being used worldwide with co-benefits in facilitating certifications, apprenticeships, and on-the-job training. An illustrative case is India, where the national government established the Skill Council for Green Jobs in 2015, engaging the private sector as a platform for training and learning. This initiative was specifically designed to enhance the skills of India's workforce in order to meet the demand for over 50 million anticipated green jobs by the year 2030.

7. Conclusion

The Russian invasion will eventually cease and in the ashes of war, Ukraine's economy and its people will recover. In line with the nation's long-term economic interests, the Ukrainian Government has set a vision for a greener future. Immediate planning is required to ensure that the opportunity for economic rejuvenation, that comes in recovery, takes every opportunity to maximise climate benefits and set a sustainable path for a prosperous Ukraine. The scale of transformation required is significant and the government needs to act immediately to develop favourable conditions for productive deployment of capital, provide sector-specific roadmaps, and mobilise the required finance.

Recent suggestions for a "Green Marshall Plan" for Ukraine (GMF, 2023), are alluring in their promise to accelerate the emerging industries of renewable energy and energy efficiency, among other green sectors. In the late 1940s, technical and financial support from the United States complemented strong fiscal and anti-monopoly policies in the German "Wirtschaftswunder" - together they facilitated the rapid transformation of the German economy, albeit towards an energy sector dependent on fossil fuels. Today, as the era of fossil fuels is in decline, renewable energy and other green industries are already a source of economic and political power - this will only continue. Green fiscal policy at home, combined with generous international support, could facilitate accelerated economic recovery - Ukraine's green phoenix rising.

Designing Ukraine's economic recovery in the spirit of post-World War II reconstruction also holds strong potential for Europe as a whole, addressing energy security threats and the climate crisis while enhancing continental resilience. The Russian invasion has underscored the connection between the European Green Deal and geopolitics, transforming the energy transition into a security and defence concern for the EU. Ukraine's green reconstruction offers durable solutions and can bolster the energy transition throughout the region by integrating Ukraine into European energy markets and green technology production chains. With the EU poised for the green transition, Ukraine's strategic advantages including proximity,

connectivity, renewable energy potential, and space for new industries make it an ideal partner. It is clear that European partners stand to gain by providing financial support to reconstruction efforts, acting to crowd-in substantial additional private investment.

Now is the opportune moment to initiate thorough policy development, secure the required funding, and guarantee that each policy contributes to Ukraine's long-term prosperity. In many instances, this will involve implementing environmentally-friendly measures that yield stronger economic benefits compared to traditional approaches.

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