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DECOMMISSIONING: A $ 3.6 TRILLION CHALLENGE

BNP PARIBAS
ASSET MANAGEMENT

The asset manager for a changing world

INTRODUCTION

This paper aims to present an argument for the need and advantages of long-term pre-funding for the decommissioning of nuclear, power, mining and oil & gas assets and the subsequent rehabilitation and restoration of the lands and waters surrounding these assets.[1]

In section one, we provide a summary of and demonstrate the extent of global decommissioning and remediation liabilities, stranded assets and global decommissioning costs. The section concludes by examining the advantages and financial benefits of pre-funding these costs. Section two deals with the specific impact of pre-funding and decommissioning activities at both company and societal levels as perceived through an ESG lens. Finally, section three opens the wider question of environmental change and how this could be enhanced through the implementation of fiscal policy supportive of large scale decommissioning activities.

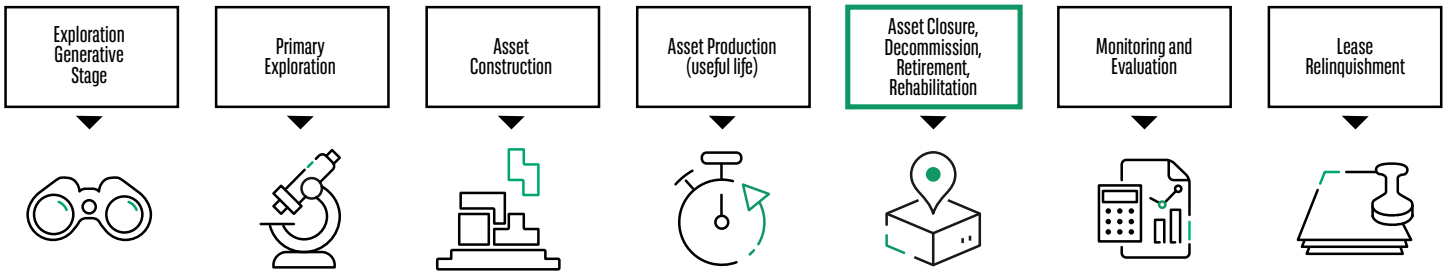
1. We refer to the long-term exposure as "**decommissioning liabilities / costs**" in the rest of the paper.

1. DECOMMISSIONING: THE ONLY WAY IS PRE-FUNDING

A number of industrial sectors have large long-term decommissioning liabilities that are wholly or partially unfunded. These stem from operating assets which need to be retired for operating reasons or have already become stranded[2]. As the transition out of fossil fuels and a carbon-dominated economy progresses, it is clear that the successful management of long-term decommissioning liabilities will be an imperative step for traditional oil & gas, power and mining companies. To achieve this transition, these companies must effectively tackle climate change through the positive management of their assets, thereby ensuring a sustainable operational business model. This adaption will enable companies to navigate successfully through an ever-tightening regulatory environment being applied to the deccommissioning of said assets.

Due to the physical environmental impact these sectors have on the surrounding landscape, companies face decommissioning costs, held as balance sheet provisions, to ensure a sufficient reversal of the negative impact that their fixed assets may have on the environment upon the end of the asset's useful life. An oil well, gold mine or nuclear power plant, all offer good examples of assets which carry significant decommissioning costs. Figure 1 demonstrates a typical process from asset exploration to fully completed decommission.

Figure 1. Standard Asset Deccomissioning Process



Our paper covers four industrial sectors: Nuclear, Mining, Oil and Gas and Coal Power Plants. It is important to note a number of key assumptions that were made during our research efforts.

- A top down desktop survey was undertaken on the four sectors. A bottom up approach (company-by-company) covering all sectors could increase the $3.6tn estimate. Other sectors such as chemicals, pharmaceuticals and waste management that are also subject to similar costs have not been included within the analysis due to limited data availability.

- The estimates presented in Table 1 below are conservative. The figures presented aim to highlight the global cost of decommissioning nuclear stations, mines, oil wells/rigs and coal power plants both currently in use or abandandoned. The cost of decommissioning can fluctuate fundamentally between sites, therefore the total figure should be taken as an indication into the scale of the global cost rather than a definitive quantitative global cost estimate.

- The range of decommissioning and rehabilitation estimates vary significantly between sources. An average range has been used where applicable.

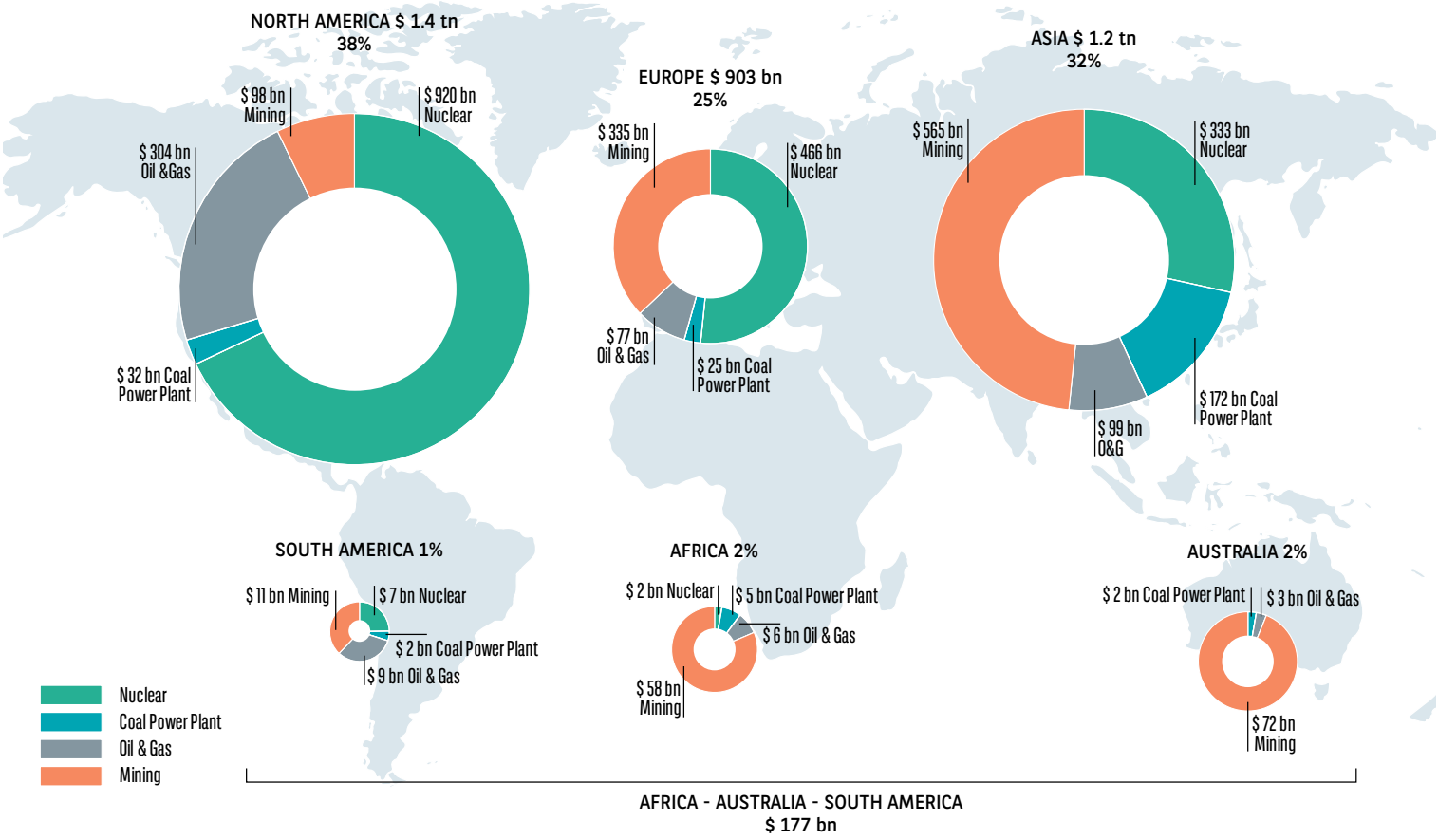
2. **Stranded assets** are "assets that have suffered from anticipated, unanticipated or premature write-downs, devaluations or conversion to liabilities". Stranded assets can arise from a variety of factors and are a phenomenon inherent in the 'creative destruction' of economic growth, transformation and innovation; as such, they pose risks to individuals and firms and may have systemic implications. Coal and other hydrocarbon resources may have the potential to become stranded as the world engages in a fossil fuel phase out.

Table 1: Global summary of decommissioning liabilities within 4 major sectors

(USD'bn)	Nuclear	Mining	Oil & Gas	Coal Power Plant	Total
Europe	466	335	77	25	903
North-America	920	98	304	32	1,354
South-America	7	11	9	2	29*
Asia	333	565	99	172	1,169
Australia	0	72	3	2	77
Africa	2	58	6	5	71
Total	1,728	1,139	498	238	3,603

Sources: BNP Paribas Asset Management, December 2019. See 'References' and 'Bibliographies '*Figure for South-America expected to be significantly higher

Figure 2: summary of decommissioning liabilities in four sectors



Sources: BNP Paribas Asset Management, December 2019. See 'References' and 'Bibliographies'

DECOMMISSIONING: THE SCALE OF THE PROBLEM

- Globally there are an estimated $3.6 trillion of asset retirement obligations across the four power sectors studied.[3]
- Only **nuclear liabilities** are backed by financial assets (at least partially), but this is the exception rather than the rule and other sectors have very little or no assets set aside. However, as highlighted by a recent European Union's study on the market for nuclear decommissioning, in most cases, the level of pre-funding comes short and is barely sufficient to cover only a fraction of the estimated decommissioning costs.[4]
- The **North Sea UK Continental Shelf** area within the Oil and Gas sector **faces a £51 billion decommissioning bill** alone.[5]
- Based on a UNIDO report[6], it appears that there are over **35,000 coal mines** globally. The study has also highlighted **29,000 power plants** globally, **2,000** of which are **coal powered**.[3]
- The accuracy of decommissioning liability estimates can have a material impact on the valuation of a company. Closing the current generation of large scale sites can cost upwards of hundereds of millions and in many cases has proven to be in excess of $1bn for a single asset.[7]

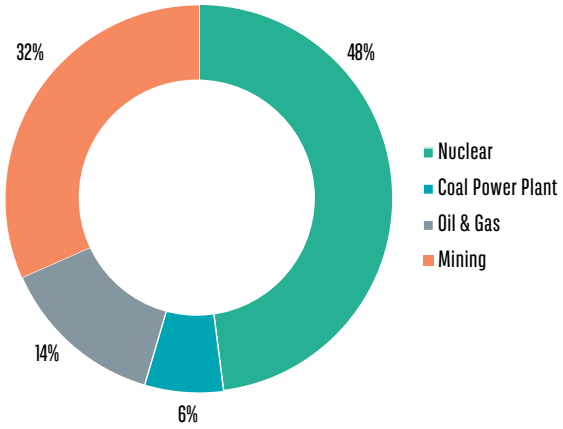
Our findings show that the nuclear and mining sectors have the highest global decommissioning costs. Aside from the technical nature involved with the work and wide ranging impact on the environmental landscape, these two particular sectors can require continued maintainance and monitoring within certain assets. In addition to standard decommissioning costs, nuclear plant fuel rods that have no permanent disposal repository can cost companies millions of dollars to monitor years after the end of the useful life of a power plant

In the case of certain mines, annual expenditures of $10m are needed in perpetuity to neutralise rock drainage from closed workings[8].

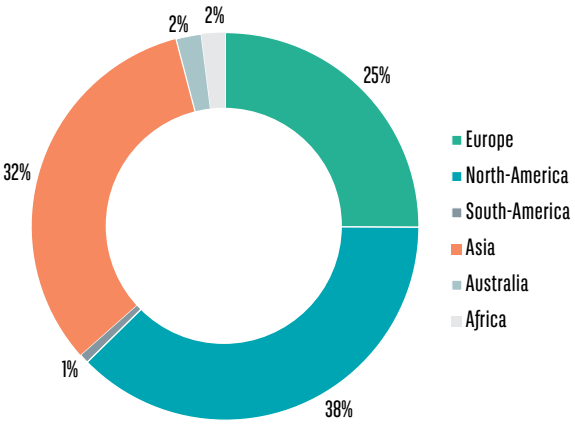
Furthermore as regulatory onus falls on the 'polluter', companies will have to consider long term responsibilities such as ongoing water treatment, dam maintainence and environmental monitoring long after the closure of sites.

3. BNPP AM UK Review of 4 power sectors, 2019
4. European Commission, 2019
5. O&G Authority, 2019
6. UNIDO, 2018
7. Lockgate 2016
8. Worldbank.org 2019

Estimated Decommissioning Costs by Sector



Estimated Decommissioning Costs by Region



WHAT IS THE SOLUTION?

By matching future decommissioning and remediation liabilities and avoiding potential cash flow draw-downs, a pre-funding strategy offers a number of financial benefits to companies. This has been observed in the case of the nuclear sector, which as mentioned above, is the only one where pre-funding has been systematic (even if not yet sufficient). Large pools of financial assets have been built up especially for North-American, Japanese and European nuclear power plants and other entities that are part of the nuclear cycle and have been used in a number of decommissioning cases.

- **Pre-funding improves efficiency of matching liabilities**. Commodity prices are partially dissociated from remediation provisioning. Meeting decommissioning liabilities with cash generated from the sale of energy or commodities can at times be problematic (as evidenced recently as a consequence of the Covid-19 pandemic). Remediation liabilities can also constrain long-term investment as they can create conflicting demands on cash flow. Separate investments in financial assets, uncorrelated to commodity prices offer precious diversification benefits.

- **It helps mitigate operating expenses volatility**. Expense volatility exposes energy, mining and oil and gas companies to potential over-runs. These can be mitigated through excess returns from an investment portfolio.

- **It reduces balance sheet, cost of capital and credit rating pressures**. Remediation obligations create a long-term debt that affect the financial standing of an operator. Pre-funding decommissioning can have a materially positive impact on ratings.

- **It offers more exit optionality**. Corporate strategic decisions or financial pressure may require the divestment of an asset. In this context, operating life and remediation obligations may form a material item in the terms of sale. The pool of potential buyers can (in part) be impacted by the ability to meet future remediation expenses.

- **It opens up deleveraging opportunities**. Best governance and practices may not involve leaving the financial assets and remediation liabilities on balance sheet but potentially transferring them to a separate entity.

- Finally, and this is more specific to nuclear decommissioning obligations, **asset pools have been crucial when nuclear power plants face early decommissioning**, driven by political decisions l(as in the case of Germany and Sweden) or following a nuclear accident (in the case of Fukushima, for example).

2. BEYOND FINANCIAL BENEFITS: IMPACT ON THE COMPANY, ESG RATING AND SOCIETY

Popular and political awareness of environmental issues has increased significantly in the last two years. This should not come as a surprise given global carbon emissions jumped to an all-time high in 2018 despite our collective efforts. Additionally, we seem to be more frequently reminded than ever before of destructive and deadly weather events, whether it is forest fires in California, hurricanes in the Caribbean, heat waves in India or typhoons in Asia.

The result is such populist movements as Extinction Rebellion on one side and talk of a Green New Deal by US Democrats on the other. These trends have real and growing consequences for both companies and institutions that invest. Corporates are under increasing pressure from shareholders to improve the sustainability of their operations and from regulators to report environmental data. At the same time, students continue to pressure endowments, as they recently did at a major UK University to explore fossil fuel divestment, potentially joining the $6.2 trillion of global assets, which had already done so by 2018[9]. At an institutional level, we have seen strong growth in ESG funds and thematic investment strategies, not only via green bonds but increasinglyequity and fixed income products. Global sustainable investing assets are estimated to have grown from $22.8 trillion in 2016 to $30.7 trillion in 2018, a CAGR of 16%. Sub-pockets of growth are even higher, with sustainability themed investing coming in at a 92% CAGR over the same period[10]. For oil and gas companies such trends need not lead to an abrupt cessation of activities, rather an adaptive change in their portfolio of assets (as natural gas for example, will continue to be an important part of national energy mixes).

The message is clear: Pressure on companies to respond will increase going forward. In this, lies an opportunity: by better understanding what guides sustainability investor flows, companies can improve their compatibility with a growing source of capital, build more resilient balance sheets that are less reliant on single commodity prices, while at the same time taking action that can benefit not only their shareholders, but also society.

ESG analysis broadly speaking encompasses three linked, but quite distinct areas of environmental, social and governance indicators. All are evaluated in slightly different ways depending on which firm is conducting the scoring (e.g., Sustainalytics, MSCI, CDP, RebecoSAM, Bloomberg). Increasingly asset managers, including BNP Paribas Asset Management, as well as sell-side research, have developed their own in-house methodologies. In relation to the environment, all share their reliance on underlying data, like carbon, waste and water metrics, as well as qualitative measures such as the presence of various reporting policies, although the final metric s differ (as do the weightings applied). Of course a company can improve its standing by lowering its footprint, but it can also make significant progress by disclosing information and setting up a wide range of policies. In addition to these scores, many thematic investors will pay attention to the percentage of a company's revenues that are from eligible activities or are linked to sustainable development goals (SDGs). This is a step forward from just excluding companies due to the percentage of revenues from unwanted activities such as coal. For an acceptable threshold, many in the market use a hurdle rate of 20%[11], although this varies. While this focuses on revenue, the spirit also encompasses expenditure, where relevant capex should also be taken into account, as is recommended in the EU Taxonomy[12]. In our opinion, decommissioning spending, where it restores environmental integrity or removes infrastructure related to high emission activity, could also be eligible. As the EU Taxonomy continues to evolve, we believe that decommissioning of plants should be included as long as the decommissioning process complies with relevant technical criteria and respects the "do no significant harm" principle. This could potentially be a crucial factor when decommissioning costs are significant relative to existing revenues or capex.

9. 350.org, September 10th 2018
10. Global Sustainable Investment Alliance, Global Sustainable Investment Review 2018
11. Impax Environmental Impact Report 2019
12. EU Taxonomy Technical Expert Group Report, page 74

Another way a company can benefit from a more robust approach to decommissioning is by making sure that funding for the decommissioning is not held in a general escrow or invested in cash, but rather is allocated to unambiguously green investments. This could be across a range of private and public bonds and equity and is increasingly feasible as the number of compatible investment products grow. Thematic investment funds, like those managed by BNP Paribas Asset Management for example, will have healthy allocations to businesses in wind, solar, hydro, batteries, electric vehicles, fuel cells, hydrogen, grid improvement, industrial efficiency and automation, green buildings, water treatment, sustainable food supply and more. These rich areas extend well beyond just renewable energy, because climate concerns and natural capital issues are ultimately linked in one interrelated ecosystem. Not only does this further help the profile of the company making the investment, but it lets them benefit from the revenue growth we see in many of these areas as well as the competitive cost advantage that comes from businesses that leverage Moore's Law.

As mentioned above, the world is likely to see offshore wind capacity growth of almost 17% each year through 2040[13]. Similarly, with more countries proposing bans of internal combustion engines(from Norway in 2025 to India in 2030 and France in 2040) forecasted electric vehicle CAGR is even stronger at 38% through 2025 and 94% through 2040[14]. Investing in these growth trends could create extra returns over the longer-term. Taking the second point, many sustainable business models are driven by technology and as a result benefit from simultaneously increasing capability whilst reducing costs. As an example, solar systems have roughly gone from costing $100 per watt in 1970 to 30 cents today, an improvement of 99.7%, while oil has gone from costing $3.18 a barrel in 1970 to $64.4 today, an increase of 20.2 times. On a cost basis solar has improved its position relative to oil by 6,749 times! This is because while early oil could be accessed easily in 1859 in Titusville Pennsylvania, now we have to drill thousands of feet in sub-sea operations or employ complex and contentious fracking processes. At the same time, technology has not stopped advancing and the solar numbers will be even better next year. Investing in line with these cost trends can help create long-term disruptive returns for companies.

The benefit to society partly comes from the funding of green investments, but it also comes directly from decommissioning. Stopping the operation of old emission-heavy plants and restoring the local environment is beneficial both for the climate and natural capital. Furthermore, there are creative options for repurposing existing infrastructure into more environmentally friendly uses. For example, by 2018 almost 532 offshore platforms had been repurposed as artificial reefs in the Gulf of Mexico, mostly in Louisiana and Texas[15]. Vertical reefs such as these have a higher fish biomass than natural reefs and they discourage commercial trawler fishing[16]. California, which passed a rig-to-reef bill in 2010, is now discussing new laws that would make it easier to put into practice. On land, Ontario Power Generation converted its Thunder Bay Unit 3 from coal to 100 percent biomass using steam exploded wood pellets in 2015. Similarly, a coal-fired plant in Wales owned by SIMEC Atlantis Energy is currently evaluating switching to waste-derived energy pellets that contain a high proportion of plastic that cannot economically be recycled[17]. There is scope to apply these ideas more widely across the four sectors discussed.

13. International Energy Agency, Offshore Wind Outlook 2019
14. Bloomberg New Energy Finance, Electric Vehicle Outlook 2019
15. Ajemian, M.J., An analysis of artificial reef fish community structure, 2015
16. Claisse, J.T., Oil platforms off California are among the most productive marine fish habitats globally, 2014
17. Power Engineering International, Uskmouth Version Project, 2019

3. POLICY OUTLOOK: WILL FISCAL POLICY BE A FURTHER CATALYST FOR ENVIRONMENTAL CHANGE?

Combatting climate change and environmental damage will require significant change in economic agents' behaviour overtime. This will require incentives for agents to change their behaviour beyond just moral persuasion. Fiscal policy is one of the major policy tools for changing behaviour at both the micro and macro level and has two broad channels of influence:

(i) The first is the broad macro channel of influencing aggregate demand and centres around counter cyclical policy.
(ii) The second is the micro channel through taxation and government expenditures designed to influence economic agents' behaviours.

Whilst counter-cyclical fiscal policy is usually focused on demand management, it can have supply-side implications via infrastructure expenditure, which boosts the long-term productive potential of an economy. From an environmental perspective, there is a clear opportunity to marry counter-cyclical policy with measures that improve the environmental impact of infrastructure (investing in infrastructure with zero carbon emission) that then boost the supply-side of an economy whilst dampening demand fluctuations. Though counter-cyclical policy can be used to help tackle environmental issues, the main channel for fiscal policy to achieve environmental objectives will be through taxation and expenditure (including subsidies) that change economic agents' behaviours from outcomes that negatively impact the environment to ones that positively impact the environment. Environmental taxation aims to tax environmentally damaging activities such carbon-based energy generation, waste production and transportation activities for example, leading to an increase in relative prices,thus reducing the demand for these activities that damage the environment. Similarly, environmental expenditure programs aim to alter agents' behaviour by reducing the relative price of activities that are positive for the environment through subsidies for renewable energy generation for example.

Given the extent of the environmental challenges facing humanity and the potential existentialist threat along with the economic costs of the business-as-usual climate policy (see: NBER working paper 2019 - the current Coronavirus crisis being a perfect illustration of both), fiscal policy will inevitably have to take centre stage in driving change towards achieving the Paris agreement targets and an environmentally sustainable economy. There are a number of key areas that fiscal policy will seek to focus on in terms of delivering environmental change. These are:

- **De-carbonisation of energy and transport:** The Paris agreement aims to tackle climate change by restricting the rise in global temperatures this century to less than 2 degrees Celsius above pre-industrial levels. The agreement will also pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius. Logically, carbon taxes will be an effective way to reduce greenhouse gases through carbon emissions. Whilst some countries already operate some form of limited carbon taxes (the market for carbon trading is currently trading around $8 -10 per ton), there is a clear need for countries to adopt a more comprehensive taxation of carbon emissions both unilaterally and in a coordinated multilateral manner if we are to achieve the Paris agreement objectives. Recently, the IMF has mooted the idea that all economies should introduce carbon taxation with differential rates between developing and developed economies in-order to reduce the distributional effect that uniform global carbon taxation would have. Poorer economies and the poorest in society, tend to suffer disproportionately more from the cost impact of carbon taxes than the rich. In that context, the IMF proposals suggest the introduction of a carbon tax for developed economies with the objective of reaching at least $75 a ton by 2030 and $50 a ton for developing economies by the same date.

- **Green expenditure:** Apart from taxing environmentally damaging activity, government expenditure programs have an important role in helping economic agents adjust to more environmentally sustainable behaviour. Green expenditure can come either directly from the government, in the form of infrastructure programs that support renewable energy, non or low carbon intensive transport systems or subsidies to the private sector to support such initiatives. Alternatively the government, through regulation of energy markets, can indirectly initiate subsidies for non or low carbon energy sources and thereby help with the development of renewable energy sources adopted by the UK coalition government of 2010-15 for example, as well as direct expenditure to support the switch to a non-carbon-based economy. Government expenditure can support programs for greater efficiency such as subsidies, grants etc for building insulation. Additionally, public subsidies or tax breaks can be used to support both private and public initiatives to restore environmentally damaged land / geographies such as oil, mining and nuclear decommissioning programs. Similarly, subsidies for agriculture will also be designed to help minimise the adverse consequences of agriculture on the environment. Another crucial aspect for green expenditures is in the area of mitigating the distributional consequences of carbon and other environmental taxes on the least advantaged in society, thereby minimising the political pushback (public unrest) to environmental policies that have been seen in a number of developed and developing countries.

- **Fiscal support, regulation and markets:** Apart from the impact of public taxation and expenditure on agents' behaviour, governments will use fiscal initiatives to boost research and development of new environmentally friendly technologies and combine fiscal initiatives with regulation to develop new financial markets. Here public policy will be used to help deepen markets (such as green bonds and carbon trading) and reduce(?) the trading volumes in other pollutants. Carbon trading has already had benefits in terms of spurring technological developments (such as enabling companies like Tesla to fund its R&D program for electric cars via sales of its carbon certificates to polluters).

4. CONCLUSION

Secular trends are forcing companies to reconfigure their business models. Those that succeed will build more sustainable balance sheets by diversifying and taking advantage of key trends driven in part by populism but increasingly by regulatory pressure.

The pre-funding of long-term liabilities for nuclear, oil & gas, power and mining companies can be seen as a leading opportunity to further develop and enhance a sustainable business model. Avoiding cash flow draw downs, improving efficiency of liability matching, mitigating operating expense volatility and realising the associated financial benefits that can be provided to companies will enable these businesses to operate more cost-efficiently and more effectively within the increasingly regulated decommissioning environment.

Moreover the challenge facing society and the global economy is momentous. Going forward governments are likely to adopt a more holistic approach to taxation, expenditure and regulation. Furthermore there must be developments and support of new financial instruments and markets if the climate change challenge is to be addressed. Countries such as France and New Zealand are already planning towards green budgeting, in addition the OECD is working with Eurostat and other EU countries to develop methodologies to assess the effectiveness of their environmental efforts across their whole fiscal policy. The challenge facing humanity can only be met with a concerted effort from both the public and private sectors and the realisation that there will be a short to medium-term cost to all environmental actions that have to be offset against the greater longer cost of taking no action against climate change.

5.REFERENCES & BIBLIOGRAPHY

NUCLEAR

Title / Link	Author	Date
Study on market for decommissioning nuclear facilities in the European Union https://op.europa.eu/en/publication-detail/-/publication/2bf03904-ebf1-11e9-9c4e-01aa75ed71a1	EU Publications	09/10/2019
https://www.callan.com/wp-content/uploads/2019/04/Callan-2018-NDT-Study.pdf	Callan Institute	2018
Decommissioning US Power Plants - Decisions, Costs, and Key Issues	Raimi	2017

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Link	Author	Date
https://geographical.co.uk/nature/energy/item/3086-dossier-oil-rigs	Geographical - Mark Rowe	28/02/2019
https://www.woodmac.com/news/editorial/opportunities-decommissioning/	Wood Mackenzie	15/12/2016
https://www.woodmac.com/news/editorial/are-cost-rises-inevitable-for-global-upstream2/	Wood Mackenzie	15/01/2018
https://www.ogauthority.co.uk/media/5906/decommissioning-estimate-cost-report-2019.pdf	Oil and Gas Authority	2019
https://www.nao.org.uk/wp-content/uploads/2019/01/Oil-and-gas-in-the-UK-offshore-decommissioning.pdf	National Audit Office	2019
Oil and Gas Decommissioning International - Subsea Engineering Opportunity	Scottish Enterprise	01/03/2018
https://oilandgasuk.co.uk/product/decommissioning-insight-report/	Oil and Gas UK	2019
https://www.bsee.gov/sites/bsee.gov/files/fact-sheet/decommissioning-costs-fact-sheet-2016.pdf	Bureau of Safety Environmental Enforcement	2016

COAL-FIRED POWER PLANTS

Link	Author	Date
http://datasets.wri.org/dataset/globalpowerplantdatabase	World Resources Institute	03/12/2019

MINING

References

UNIDO (2018). World Statistics on Mining and Utilities 2018. 1st ed. Edward Elgar Publishing.
Diggins.com (2019) Mining in Burundi. [online] Available at: https://thediggings.com/bdi [Accessed 5 Dec. 2019].
Gov.bw. (2019). Republic of Botswana - Government portal. [online] Available at: http://www.gov.bw/en/Ministries--Authorities/Ministries/Ministry-of-Minerals-Energy-and-Water-Resources-MMWER/ [Accessed 5 Dec. 2019].
Parshley, J. (2019) Group Chairman and Corporate Consultant. SRK Consulting Interview.

Bibliography	Author	Date
UNIDO (2018). World Statistics on Mining and Utilities 2018. 1st ed. Edward Elgar Publishing	UNIDO	01/01/2002
https://www.bgs.ac.uk/mineralsuk/mines/home.html	BGS	03/12/2019
http://siteresources.worldbank.org/INTOGMC/Resources/notoverwhenover.pdf	Journal of World Energy Law and Business	03/12/2019
https://www.projectsiq.co.za/mines-in-africa.htm	Africa Mining IQ	03/12/2019
https://www.rvo.nl/sites/default/files/2016/06/Mining-industry-in-China%202016.pdf	RVO	02/06/2016
http://ficci.in/spdocument/20317/Mining-Industry.pdf	FICCI Mines and Metals Div.	01/10/2013
https://www.mining.com/china-shutting-another-4300-coal-mines/	Mining.com	03/12/2019
https://www.ga.gov.au/scientific-topics/minerals/mineral-resources-and-advice/aimr/operating-mines	Aus Gvt.	03/12/2019
https://www.newmontgoldcorp.com/wp-content/uploads/2019/03/Final-Akyem-EIS_18-Nov-2008_Text-Sec-8-Closure_0.pdf	Newmont Gold Corp	01/11/2008
https://business.financialpost.com/commodities/mining/gold-mines-are-bleeding-cash-but-wave-of-closures-unlikely	Koven P.	24/07/2015
https://www.nicnewmanoxford.com/paying-for-mine-reclammation-and-well-decommissioning/	Newman N.	07/11/2018

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