Just Transitions within Sectors and Industries Globally

‘The Energy of Freedom’?

Solar energy, modern slavery, and the just transition

July 2022

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About Just Transitions within Sectors and Industries Globally

The programme examines how just transitions whilst tackling climate change and biodiversity is key to supporting inclusive economies and societies in the future. Through the programme, the Academy awarded funding to nine research projects exploring the actions required in sectors and industries globally across supply and value chains, with a focus on key economic emitters or areas of society that will help reduce and/or eliminate greenhouse gas emissions. The programme was funded by the UK's Department for Business, Energy and Industrial Strategy.

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Introduction

Global electricity demand will triple in the next three decades.[1] Meeting that demand while reducing fossil fuel reliance requires a major increase in solar energy production and consumption. Solar energy generation is projected to grow 450% by 2030 and may account for as much as 76% of global electricity supply by 2050.[2] But is solar energy 'the energy of freedom', as the German finance minister Christian Lindner recently dubbed it? Or does it, in fact, put that freedom at risk – at least for the workers who produce solar energy equipment?

Lindner was speaking in the context of debate over Germany's dependence on Russian oil and gas. His argument was that the uptake of renewable energy will help to free German energy consumers from reliance on fossil fuels and the rent-takers who control them.[3] The perspective of workers involved in producing solar energy materials and equipment is, however, rather different.

Solar energy is made with photovoltaic (PV) panels, a key component of which – polysilicon – is often made through forced labour in China's Xinjiang Uyghur Autonomous Region. Around 40-45% of the polysilicon now used in solar panels comes from Xinjiang, where forced labour appears to be state policy.[4] As much as 97% of global supply of PV panels may contain components tainted by forced labour.[5] Likewise, solar energy is often stored in lithium-ion batteries, which use cobalt cathodes. Between 15% to 30% of global cobalt supply is thought to come from artisanal mines in eastern Democratic Republic of the Congo (DRC), where forced and child labour is prevalent. This affects tens, if not hundreds, of thousands of people.[6] Demand for cobalt is expected to double by 2030, putting even more at risk of modern slavery.[7]

So which is it? Is solar energy 'the energy of freedom'? Or in fact a *threat* to that freedom? Should energy consumers' figurative 'freedom' from fossil fuel dependency come at the expense of solar panel and battery supply-chain workers' *literal* freedom?

Answering these questions entails figuring out how to ensure enslavement is not the unintended cost of decarbonisation. Yet we also have to ensure that any steps we take to exclude modern slavery risks from the solar energy production system – such as corporate due diligence requirements or forced labour import bans – do not significantly slow the critical uptake of solar energy. Can we achieve both policy goals at once? How?

1 BNEF (Bloomberg NEF) and International Solar Alliance (2021). 'Scaling Up Solar in ISA Member Countries', 19 October 2021. Available at https://assets.bbhub.io/professional/sites/24/BNEF-Scaling-Up-Solar-in-ISA-Member-Countries_FINAL.pdf

2 Dmitrii Bogdanov et al. (2021). 'Low-cost renewable electricity as the key driver of the global energy transition towards sustainability', *Energy*, Volume 227, article number 120467.

3 'Lindner bezeichnet Erneuerbare Energien als „Freiheitsenergien"', *Oldenburger Onlinezeitung,* 28 February 2022.

4 Laura Murphy and Nyrola Elimä (2021). *In Broad Daylight: Uyghur Forced Labour and Global Solar Supply Chains*, Sheffield, UK: Sheffield Hallam University Helena Kennedy Centre for International Justice, available at https://www.shu.ac.uk/helena-kennedy-centre-international-justice/research-and-projects/all-projects/in-broad-daylight.

5 Murphy and Elimä, 2021.

6 Amnesty International (2016). '"This is what we die for": Human rights abuses in the Democratic Republic of the Congo power the Global Trade in Cobalt'. Amnesty International, AFR 62/3183/2016, 19 January 2016, available at https://www.amnesty.org/en/documents/afr62/3183/2016/en/; OECD (2019). *Interconnected Supply Chains: A Comprehensive Look at Due Diligence Challenges and Opportunities Sourcing Cobalt and Copper from the Democratic Republic of the Congo,* Paris, 15 November 2019, available at https://mneguidelines.oecd.org/Interconnected-supply-chains-a-comprehensive-look-at-due-diligence-challenges-and-opportunities-sourcing-cobalt-and-copper-from-the-DRC.pdf; World Economic Forum (2020). 'Making Mining Safe and Fair: Artisanal cobalt extraction in the Democratic Republic of the Congo', *White Paper,* 15 September 2020, available at https://www.weforum.org/whitepapers/making-mining-safe-and-fair-artisanal-cobalt-extraction-in-the-democratic-republic-of-the-congo.

7 The United Nations recognises modern slavery as an umbrella concept that encompasses a number of distinct legal phenomena, including slavery and slavery-like practices, forced labour, human trafficking (or trafficking in persons), and the worst forms of child labour. In this study we use 'modern slavery' to refer to the general, umbrella concept, and to the specific legal phenomena (such as forced labour, human trafficking, or child labour) when the evidence or allegation in question relates to that specifically.

Why this matters

Under any scenario, successful climate action will depend on a transition to renewables involving a significant solar energy component. A transition that fails to address these questions and tolerates slave-made solar energy not only risks massive human rights harms, but also risks being seen as unjust – and losing legitimacy. Whether out of ethical, reputational or liability concerns, buyers may prove reluctant to purchase – and investors, lenders and insurers may prove reluctant to finance – solar panels and batteries that are made with modern slavery, or the energy they produce and store. Concern about forced labour in our production systems is the reason that EU Commission President Ursula von der Leyen announced in September 2021 that the EU will adopt a ban on sale and import of goods made with forced labour.[8]

Equally, though, poorly designed modern slavery risk management responses could slow the roll-out of solar energy, replacement of expiring capacity, and overall decarbonisation. This is why Siemens CEO Roland Busch warned in December 2021 that "If [forced labour] bans are issued, these could mean that we can no longer buy solar cells from China – then the energy transition will come to an end at this point."[9]

Finding a way to address modern slavery risks without undermining solar energy production and uptake is critical to achieving a Just Transition. Modern slavery risks in solar energy are a pinchpoint in that Just Transition. Actors in several areas of policy and business thus have an interest in answering these questions:

- **Solar and battery manufacturing policy and finance,** including US Congressional debates over the Build Back Better agenda, the Republican-backed *Keep China Out of Solar Energy Act*, the Democrat-backed *Reclaiming the Solar Supply Chain Act*, and the *EU Battery Regulation*;

- **Purchasers of solar power** for industrial, commercial or residential use, or as part of emissions abatement or broader Environmental, Social and Governance (ESG) programmes;

- **Supply-chain due diligence and disclosure debate** participants, including the current debate over the European Commission's proposed Directive on Corporate Sustainability Due Diligence, G7 Leaders' Carbis Bay Communiqué commitment to address forced labour in supply-chains, or ongoing OECD work on the cobalt supply-chain;

- **Forced labour import ban** proponents and subjects, including the bans instituted in the US under the *Uyghur Forced Labor Prevention Act* and the related *Tariff Act 1930* section 307, and those being considered by authorities in Australia, the EU and UK.

8 Ursula Von der Leyen, (2021). *State of the Union 2021,* 15 September 2021, available at https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_21_4701.

9 Roland Busch (2021). "Siemens-Chef warnt Baerbock vor „konfrontativer Außenpolitik" gegenüber China", *Handelsblatt,* 30 December 2021.

Finally, our research suggests that how we manage these risks may tell us a lot about the deeper transitions afoot in the global economic order. Modern slavery risks and how to manage them have emerged as a flashpoint in a broader contestation of global solar energy governance. A range of state, commercial and other actors are competing for influence, promoting different policy framings and solutions. Each proposes allocating different roles to governments, manufacturers, industry associations, investors, civil society – and those vulnerable to or harmed by modern slavery. Some suggest market-led changes in business practice, others see a larger role for government in incentivising value-chain transformation, and some see a key role for litigation and rights-based activism. Each of these perspectives in turn rests on different implicit conceptions of the purpose of the global solar energy governance regime, and how the relationship between states, markets, and affected communities should be justly ordered.[10] Studying these debates thus helps us understand the nature and dynamics of larger transitions under way in the global order.

10 John Gerard Ruggie (1982). 'International Regimes, Transactions, and Change: Embedded Liberalism in the Postwar Economic Order', *International Organization,* Spring 1982, vol.36(2), pp.379–415.

About this study

Our study aims to assist solar energy stakeholders to work towards arrangements that help secure the contribution of solar energy to a global 'Just Transition'. Conducted between November 2021 and March 2022, it was funded by the British Academy's *Just Transitions within Sectors and Industries Globally* programme, and hosted by the University of Nottingham Rights Lab. Our research combined desk review, stakeholder consultations, and risk modelling. The resulting research study comprises four main sections:

1. explaining the problem,
2. tracing policy debates on these issues across 10 different policy arenas,
3. estimating forced labour risk in PV supply-chains, and
4. offering policy recommendations.

1.0 Solar energy's modern slavery problem

In the first section of the report, we explain the modern slavery concerns that have emerged around PV solar energy production and storage and consider the difficult questions raised concerning the role of solar energy in the 'Just Transition' to renewable power.

Photovoltaic panels and polysilicon

Chinese-headquartered companies make 77% of the world's polysilicon, a critical component used in 95% of solar panels.[11] Polysilicon manufacturing is capital- and energy-intensive and requires a high level of technical expertise to build and to run effectively. China's dominance emerged over the last half decade. Since 2017, 91% of new polysilicon production capacity worldwide has been developed in China.[12] Much of this is in Xinjiang Uyghur Autonomous Region (XUAR), which now accounts for around 40-45% of global supply. This is the product of cheap, coal-fired electricity, state subsidies and tax breaks, a tariff wall that protects domestic industry against foreign (US, South Korean and Japanese) competitors – and a set of labour policies designed to attract industry.[13]

This suite of labour policies forms part of a larger, oppressive development and governance strategy for the region.[14] The Chinese Communist Party's (CCP) governance strategy has tended over time towards cultural assimilation of ethnic and religious minorities, and towards an extractive development model akin to settler or carceral colonialism.[15] Over the last decade, it has also become increasingly coercive and securitised, with concerns about violent extremism and terrorism driving a move to a surveillance- and policing-based model that draws on a long CCP tradition of political control through 're-education'.[16] Some actors, including the independent Uyghur Tribunal, US State Department and UK and Canadian Parliaments, have concluded that these policies meet the legal tests to constitute crimes against humanity and genocide.[17]

11 Bloomberg NEF and International Solar Alliance, 2021.

12 Joan Fitzgerald (2021). 'The Case for Taking Back Solar', *The American Prospect,* 24 March 2021, available at https://prospect.org/environment/climate-of-opportunity/case-for-taking-back-solar/.

13 Murphy and Elimä, 2021; Nyrola Elimä (2021). "Forced Labor and the Xinjiang Solar Industry", Statement before the Congressional-Executive Commission on China, 21 September 2021, available at https://www.cecc.gov/sites/chinacommission.house.gov/files/documents/Elima--Statement%20before%20the%20Congressional-Executive%20Commission%20on%20China.pdf ; Alex Turnbull (2021). 'Xinjiang and Polysilicon', *Syncretica* (substack), 16 June 2021, available at https://syncretica.substack.com/p/xinjiang-and-polysilicon.

14 James Millward (2021). *Eurasian Crossroads: A History of Xinjiang.* Rev. edn. London: Hurst Publishers; Eric Schluessel (2016). The Muslim emperor of China: Everyday politics in colonial Xinjiang, 1877–1933. PhD dissertation, Harvard University, Cambridge, MA.

15 Guldana Salimjan (2022). 'Recruiting loyal stabilisers: On the banality of carceral colonialism in Xinjiang, in Darren Byler, Ivan Franceschini and Nicholas Loubère*, Xinjiang Year Zero* (Canberra: ANU Press), pp. 95-104; Tom Cliff (2022). 'Oil and Water', In Byler, Franceschini and Loubère, Xinjiang Year Zero, pp. 77-94.

16 James Millward (2019). '"Reeducating" Xinjiang's Muslims.' *The New York Review of Books,* 7 February. Available from: www.nybooks.com/articles/2019/02/07/reeducating-xinjiangs-muslims; Adrian Zenz (2019). "Thoroughly Reforming Them towards a Healthy Heart Attitude": China's Political Re-education Campaign in Xinjiang. *Central Asian Survey* 38(1): 102–28.

17 Uyghur Tribunal (2021). *Judgment.* London, 9 December 2021. Available at https://uyghurtribunal.com/wp-content/uploads/2022/01/Uyghur-Tribunal-Judgment-9th-Dec-21.pdf; Edward Wong and Chris Buckley (2021). 'U.S. Says Chinese Repression of Uighurs is 'Genocide"', *New York Times,* 27 July 2021.

Extensive first-hand testimony makes clear that Uyghur and other minority workers are coerced off the land, away from their traditional lifestyles, and into industrial employment – including in the PV sector. Sometimes this involves a long period of detention in camps. The Chinese Communist Party describes these as 'vocational training' facilities. External analysts identify them as sites for political 're-education', and as the locations of extensive human rights abuse, including physical and sexual assault, forced sterilisation, enforced disappearance, torture, and violations of rights to privacy, family life and religious freedom.[18] Some workers who 'graduate' from these camps are then transferred, through a government backed 'surplus rural labour transfer' programme, to work (at a subsidy) in factories in XUAR or elsewhere in China. A recent ILO expert report found that these policies likely violate China's existing commitments not to tolerate workplace discrimination.[19]

Prior research suggests that forced labour enters the PV supply-chain at several points connected to XUAR. Forced labour occurs in mining the raw silica and the making of metallurgical silicon. Eleven different producers in XUAR have been tied to forced labour.[20] These ties take several forms: participating in government run 'job fairs' that place forced labourers in private employment; otherwise participating in the subsidised 'labour transfer' scheme; or operating out of industrial parks that use forced labour. These parks are often controlled by the Xinjiang Production and Construction Corps (XPCC), a militarised parastatal that reports directly to Beijing, runs numerous XUAR cities and industrial zones, dominates certain industrial sectors in XUAR such as electricity supply – and has been integral to the systematic imposition of forced labour.[21] (For that reason it is now sanctioned by several governments.) Three of the four largest polysilicon makers in XUAR – GCL-Poly, TBEA/Xinte, and East Hope Group – are accused of using forced labour in their own operations. A fourth, Daqo New Energy Corp, is alleged to have forced labour in its supply-chain, and to directly benefit from the XPCC.[22] Together, these producers represent around 40-45% of world polysilicon supply.

Downstream from polysilicon stage, only JinkoSolar has been accused of using forced labour at the PV module production stage. Its XUAR operations appear to be co-located with a high security prison and an internment camp. But other module makers, including JA Solar, Trina Solar, LONGi and Canadian Solar have also been alleged to use polysilicon made with forced labour, or that is made from silica that is made with forced labour.[23] Figure 1, below, summarises these allegations.

18 Murphy and Elimä, 2021; Uyghur Tribunal, 2021; Darren Byler (2021). *In the Camps: China's High-Tech Penal Colony.* New York, NY: Columbia Global Reports; James Milward and Dahlia Peterson (2020). 'China's system of oppression in Xinjiang: How it developed and how to curb it', *Brookings Institute,* September 2020, available at *https://www.brookings.edu/wp-content/uploads/2020/09/FP_20200914_china_oppression_xinjiang_millward_peterson.pdf;* Adrian Zenz (2020a). Sterilizations, IUDs, and mandatory birth control: The CCP's campaign to suppress Uyghur birthrates in Xinjiang. Working Paper, 21 July. Washington, DC: The Jamestown Foundation. Available from: *http://www.jamestown.org/wp-content/uploads/2020/06/Zenz-Internment-Sterilizations-and-IUDs-UPDATED-July-21-Rev2.pdf?x58715;* Adrian Zenz (2020b). Coercive Labor in Xinjiang: Labor Transfer and the Mobilization of Ethnic Minorities to Pick Cotton. New Lines Institute for Strategy and Policy, December 2020. Available at *https://newlinesinstitute.org/wp-content/uploads/20201214-PB-China-Cotton-NISAP-2.pdf;* and Jo Smith Finley (2019). Uyghur Islam and Religious "De-Extremification": On China's Discourse of "Thought Liberation" in Xinjiang", in Oxford Islamic Studies Online, OUP, 2019, available at *http://www.oxfordislamicstudies.com/Public/focus.html.*

19 ILO (2022). *2022 Report on the application of international labour standards.* Report of the Committee of Experts on the Application of Conventions and Recommendations, International Labour Conference, 110th Session (Geneva: International Labour Conference) Available at *https://www.ilo.org/wcmsp5/groups/public/---ed_norm/---relconf/documents/meetingdocument/wcms_836653.pdf.*

20 Murphy and Elimä, 2021.

21 Ibid. And see Eventide (2022). 'Eradicating Forced Labour from Solar Supply Chains', January 2022, available at *https://www.eventideinvestments.com/wp-content/uploads/2022/01/Eventide-SpecialReport-Uyghur-AdvisorV2-02-Single-1.pdf.*

22 Murphy and Elimä, 2021; Eventide, 2022.

23 Murphy and Elimä, 2021; Eventide, 2022.

Figure 1: Allegations of ties to XUAR forced labour

Note: Based on Murphy and Elimä, 2021; and Eventide, 2022. This list is not exhaustive. Investors and buyers should conduct their own due diligence

	Firms alleged to be using forced labour	1st tier buyers from firms tied to forced labour	
Silica and raw materials producers	1. Xinjiang Hoshine Silicon Industry Co., Ltd (新疆西合盛硅业有限公司) 2. Xinjiang Sokesi New Materials Company (aka Sokos, 新疆索科斯新材料有限公司) 3. Changji Jisheng New Building Materials Company (昌吉吉盛新型建材有限公司) 4. Xinjiang China Silicon Technology Company (aka Zhonggui, (新疆中硅科技有限公司) 5. Xinjiang Jingweike New Energy Development Company (新疆晶维克新源发展有限公司) 6. Xinjiang Jingxin Silicon Industry Company (新疆晶鑫硅业有限公司) 7. Xinjiang Yusi Technology Company (新疆宇硅科技有限公司) 8. Xinjiang Jiagesen New Energy Materials Co., Ltd. (新疆嘉格森新源材料份有限公司) 9. Xinjiang Guopeng Technology Co., Ltd. (新疆国鹏科技有限公司) 10. Xinjiang Xintao Silicon Industry Co., Ltd. (新疆鑫涛硅业有限公司) 11. Beijing Dadi Zelin Silicon Industry Company (北京大地泽林硅业有限公司)	Supplies	
Polysilicon producers	12. GCL-Poly Energy Holdings Company (保利协鑫源控有限公司) 13. TBEA Co. (特变电工) and its listed subsidiaries Xinjiang Zhonghe/Joinworld (新疆众和股份有限公司) and Xinte Energy (新特源公司) 14. East Hope Group (东方希望)	15. Daqo New Energy Corp (大全新份有限公司) 16. Asia Silicon (Qinghai) Company (亚洲硅青海有限公司)	Supplies
Wafer, cell and module manufacturers	17. JinkoSolar Company (晶科源控有限公司)	Supplies 18. LONGi Green Energy Techology Company (基绿科技份有限公司) 19. Trina Solar Company (天合光份有限公司) 20. JA Solar Holdings (上海晶澳) Tianjin Zhonghuan Semiconductor (天津中环半导体份有限公司) 21. Qinghai Gaojing Solar Energy (青海景太阳科技有限公司) 22. Canadian Solar (阿特斯阳光电力团) 23. Astronergy/Chint Solar (正泰新源)	24. Risen Energy Company (东方日升新源份有限公司)

Reports about this state-backed forced labour system began emerging in late 2019 and gathered strength in 2020.[24] In 2021, credible evidence emerged of the PV manufacturing sector's ties to the system.[25] Both the Chinese government and Chinese manufacturers have contested these allegations and the characterisation of their policies, arguing that the work in question was undertaken voluntarily, the policies were aimed at poverty alleviation and economic development, and that PV production, being highly automated, did not *need* to use forced labour.[26] However, on the ground verification and independent worksite-level audits intended to prove or disprove the allegations have been difficult to execute, with growing concern around intimidation and harassment of those involved in such verification efforts. Researchers have been doxed, facilities raided, and China has adopted a new Anti-Sanctions Law that may criminalise cooperation with such inquiries.

Steadily, a range of voices from foreign industry and governments began to advocate for withdrawal from commercial relationships with suppliers connected to XUAR.[27] In 2020, the US Department of Labor added a range of goods to an official list of goods produced by forced labour, on which many market actors rely in assessing forced labour risks.[28] (Polysilicon was quietly added to the list in 2021.) In December 2020, the Solar Energy Industries Association – US based, but including several prominent, China-based manufacturers – organised a pledge for its members to oppose forced labour and called on them to exit XUAR.[29]

Next came import and export bans. In January 2021, using a power created by section 307 of the *Tariff Act of 1930* (19 U.S.C. §1307), US Customs and Border Protection (CBP) issued a Withhold Release Order (WRO) denying entry to the US market for XUAR cotton, tomatoes and downstream products, unless the importer could demonstrate they were not made with forced labour.[30] In enforcing that rule, CBP has set the evidentiary bar quite high. In June, it adopted a similar WRO specifically for goods made with silica produced by Hoshine Silicon Industry Co. Ltd., and its subsidiaries.[31] A related action added Hoshine, and four other entities connected to the XUAR PV industry, to the US Department of Commerce 'Entities List'. This limited those firms' ability to access certain US-sourced commodities, software, and technology subject to the Export Administration Regulations.

Since Hoshine sits at one of the headwaters of the global solar energy value-chain, this ban on goods made with Hoshine-sourced silica threatened to cut off US market access for many downstream PV goods. Since polysilicon is traded as a commodity, manufacturers often mix supply from multiple sources. By one estimation, 97% of the global supply of solar panels is thus likely to include some component produced

24 Vicky Xiuzhong Xu, Danielle Cave, James Leibold, Kelsey Munro and Nathan Ruser (2020). *Uyghurs for Sale: 'Re-education', forced labour and surveillance beyond Xinjiang* (ASPI: Canberra); Zenz, 2020b; Amy Lehr and Mariefaye Bechrakis (2019). Connecting the Dots in Xinjiang: Forced Labor, Forced Assimilation, and Western Supply Chains (Washington, D.C.: CSIS). Available at https://csis-website-prod.s3.amazonaws.com/s3fs-public/publication/Lehr_ConnectingDotsXinjiang_interior_v3_FULL_WEB.pdf.

25 Murphy and Elimä, 2021.

26 ILO, 2022; China SCIO (State Council Information Office) (2020). *Employment and Labor Rights in Xinjiang,* White Paper, September 2020, available at http://english.www.gov.cn/archive/whitepaper/202009/17/content_WS5f62cef6c6d0f7257693c192.html; H. Zhang , K. Wu, Y. Qiu et al. (2020). 'Solar photovoltaic interventions have reduced rural poverty in China'. *Nat Commun* 11, 1969 (2020). https://doi-org.nottingham.idm.oclc.org/10.1038/s41467-020-15826-4; Bloomberg NEF and ISA, 2021.

27 Fair Labor Association (2020). FLA Statement on Sourcing from China. 23 December 2020, available at https://www.fairlabor.org/blog/entry/fla-statement-sourcing-china; Hannah Abdulla (2020). 'Better Cotton Initiative suspends activities in Xinjiang', *Just Style,* 30 March 2020, available at https://www.just-style.com/news/better-cotton-initiative-suspends-activities-in-xinjiang/.

28 ILAB (2020a). 'List of Goods Produced by Child Labor or Forced Labor', *Bureau of International Labor Affairs,* 2020, available at https://www.dol.gov/agencies/ilab/reports/child-labor/list-of-goods

29 SEIA (Solar Energy Industries Association) (2020). "Solar Industry Forced Labor Prevention Pledge", 10 December 2020, available at https://www.seia.org/sites/default/files/Solar%20Industry%20Forced%20Labor%20Prevention%20Pledge%20Signatories.pdf.

30 US CBP (Customs and Border Protection) (2021a). "CBP Issues Region-Wide Withhold Release Order on Products Made by Slave Labor in Xinjiang", 13 January 2021, available at *https://www.cbp.gov/newsroom/national-media-release/cbp-issues-region-wide-withhold-release-order-products-made-slave.*

31 US CBP (2021b). "The Department of Homeland Security Issues Withhold Release Order on Silica-Based Products Made by Forced Labor in Xinjiang", 24 June 2021, available at https://www.cbp.gov/newsroom/national-media-release/department-homeland-security-issues-withhold-release-order-silica.

from Hoshine silica or another source suspected of using forced labour.[32] Yet most PV manufacturers have not historically traced the upstream source of the materials in their products – making it difficult for them to prove to CBP that their goods were not made with Hoshine silica or other excluded goods. That suggested that a large portion of PV supply to the US was at risk. With the US representing 16% of global demand for solar panels, this represented a potentially significant market disruption.

Yet the risks of trade exclusion were not limited to US markets. By mid-2021, Australia, Canada, the EU, France, Germany, Japan, Netherlands, Norway, and the UK were considering adopting, or had already adopted, measures aimed at strengthening due diligence and screening arrangements to exclude goods made with forced and child labour, with a particular focus on XUAR.[33] And at the G7 in Cornwall in June 2021, leaders committed to take action on forced labour in the solar supply-chain.[34]

Through 2021, analysts offered differing perspectives on the risks this posed to the global PV supply-chain, especially as there were no immediate signs of major supply-chain disruption or price spikes. In August 2021, Roth Capital Partners, an influential source of sector analysis, warned that 2.1GW of solar projects representing a total investment of about USD 2.2 billion on a payroll of 3,000 construction workers was at risk.[35] In September, SEIA president and CEO Abigail Ross Hopper warned that the WROs, together with price increases and other supply-chain disruptions, could "significantly exacerbate supply chain constraints and increase solar system prices".[36] Reports also suggested that JinkoSolar had seen at least 100MW of modules detained at US ports and both Canadian Solar and Trina may also have had samples detained.[37] In November, LONGi Green Energy filed a report with the Shanghai Stock Exchange indicating that 40.31MW of modules it had exported to the US had been denied entry. While this represented a significant loss of sales, LONGi said the detained modules accounted for roughly 1.59% of its total 2020 export sales volume to the US.[38]

At the same time, there was little evidence that buyers or consumers were changing their behaviours. A 2021 report suggested that as much as 40% of PV recently installed in the UK may be sourced from suppliers using forced labour, including in XUAR.[39] Nonetheless, through 2021, pressure on solar energy value-chain stakeholders continued to build. The September 2021 edition of *PV Magazine,* a leading industry analysis title, described the industry as being at a "fork in the road". One analyst predicted that if both the US and EU adopted their proposed forced labour bans, "polysilicon shortages will immediately occur", disrupting the global PV market, in part because the large capital expenditure required to build new, slavery-free PV manufacturing capacity means that capacity will not come online for at least 2 years.[40]

32 Murphy and Elimä, 2021.
33 See further www.xinjiangsanctions.info.
34 G7 (2021a). Carbis Bay G7 Summit Communiqué, Cornwall, 13 June 2021, available at https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1001128/Carbis_Bay_G7_Summit_Communique__PDF__430KB__25_pages_.pdf
35 David Wagman (2021a). 'Customs enforcement is jeopardizing 2.1 GW of solar projects', *PV Magazine,* 20 August 2021, available at https://www.pv-magazine.com/2021/08/20/us-customs-enforcement-is-jeopardizing-2-1-gw-of-solar-projects/.
36 David Wagman (2021e). 'Price increases hit solar as trade uncertainties with China cloud growth goals', *PV Magazine,* 14 September 2021, available at https://pv-magazine-usa.com/2021/09/14/price-increases-hit-solar-as-trade-uncertainties-cloud-aggressive-growth-goals/.
37 David Wagman (2021c). 'Solar modules are being detained by customs agents, reports suggest', *PV Magazine,* 17 August 2021, available at https://pv-magazine-usa.com/2021/08/17/solar-modules-are-being-detained-by-customs-agents-reports-suggest/; and Wagman (2021e).
38 David Wagman (2021b). 'Border agents detained 40.31 MW of LONGi solar products, company says', *PV Magazine,* 4 November 2021, available at https://pv-magazine-usa.com/2021/11/04/border-agents-detained-40-31-mw-of-longi-solar-products-company-says/
39 Jillian Ambrose and Jasper Jolly (2021). 'Revealed: UK solar projects using panels from firms linked to Xinjiang forced labour', *The Guardian,* 26 April 2021.
40 Corinne Lin (2021). 'Polysilicon amid international trade disputes', *PV Magazine,* 14 September 2021, available at https://www.pv-magazine.com/2021/09/14/polysilicon-amid-international-trade-disputes/.

In a significant move, in late 2021 US Congress moved to exclude *all* goods made in XUAR from the US market, unless the importer can prove they are not made with forced labour. The Uyghur Forced Labour Prevention Act (UFLPA) passed 428 to 1 in the US House of Representatives, and unanimously in the Senate – a stunning show of bipartisanship. It was signed by President Biden on 23 December 2021, with most of its operational provisions taking effect from late June 2022. Once they do, goods made in part or in whole in XUAR will be excluded from the US market, unless the importer can demonstrate to CBP's satisfaction that they were *not* made with forced labour. Solar panel importers are currently grappling with the implications which will, at a minimum, raise compliance costs as importers and buyers seek greater supply-chain traceability. It may yet, however, prove more burdensome than that, forcing US buyers and importers to look for new, 'clean' sources of supply.

Some analysts have, however, suggested that the risks to US imports are likely to be limited, not least because the growing debate over modern slavery over the last two years has afforded manufacturers time to strengthen supply-chain traceability, and even to develop new, 'clean' supply capacity. JinkoSolar has signed a long-term contract for polysilicon supply from the German supplier Wacker Chemie, with the intention of manufacturing modules in Vietnam, for supply to North American and European markets.[41] This raises difficult policy questions around value-chain bifurcation, not least because the market position and size of the major integrated module manufacturers (such as JinkoSolar) gives them a head start in developing new, 'slavery-free' capacity – suggesting that they may become dominant in both 'slavery-free' and 'slave-made' value-chains. Will it be acceptable to slavery-free markets and those regulating them for buyers and investors to continue to do business with firms that are, separately, manufacturing or trading slave-made goods in other markets? How would such a policy advance the interests, or protect the rights, of those harmed by forced labour in the production and trade of such 'slave-made' goods? How can such a policy be said to be just?

Solar panel importers are not the only renewable energy value-chain stakeholders grappling with modern slavery risks. In the US, high-profile Republican Senator Marco Rubio recently targeted Tesla, the leading electric vehicle manufacturer, on Twitter, for opening a dealership in XUAR, warning that "[n]ationless corporations are helping the Chinese Communist Party cover up genocide and slave labour in the region".[42] White House Press Secretary Jen Psaki said the private sector should oppose "human rights abuses and genocide in Xinjiang" and warned that Tesla faces "serious legal, reputational, and customer risk".[43] There is also a growing regulatory focus on solar energy value-chain financing. In November 2021 Senator Rubio was joined by a number of Republican colleagues in writing to the Acting CEO of the US International Development Finance Corporation, querying whether a USD 110 million deal with Indian solar developers would finance purchases of "products made with slave labour" – i.e., XUAR-linked PV products. The deal is not precluded by the UFLPA, since that legislation works to bar such goods from entering the US – not to bar US investments in or lending to overseas firms. Nonetheless, the Republican Senators wrote, "[w]e firmly believe that this prohibition should also apply to the development spending and financing provided by the United States to companies

41 Authors' research interviews, 2022.

42 Marco Rubio (2022). *"Right after President Biden signed Sen. Rubio's Uyghur Forced Labor Prevention Act into law, @Tesla opened a store in #Xinjiang. Nationless corporations are helping the Chinese Communist Party cover up genocide and slave labor in the region."* [Twitter] 3rd January 2022, available at https://twitter.com/SenRubioPress/status/1478090139406684165

43 Morgan Keith (2022). 'Days after Tesla opened a Xinjiang store, White House press secretary Jen Psaki says private sector 'cannot look the other way' when it comes to human rights abuses of Uighur Muslims', *Business Insider,* 5 January 2022, available at https://www.businessinsider.in/politics/world/news/days-after-tesla-opened-a-xinjiang-store-white-house-press-secretary-jen-psaki-says-private-sector-cannot-look-the-other-way-when-it-comes-to-human-rights-abuses-of-uighur-muslims/articleshow/88701065.cms

overseas".[44] Similarly, several bills currently before Congress suggest measures to require US securities issuers to disclose connections to XUAR, while in the UK a group of parliamentarians has criticised HSBC for transactions with XUAR-connected entities.[45]

Cobalt in batteries

While XUAR polysilicon production has been the recent focus of modern slavery concerns relating to the solar energy value-chain, batteries are another source of such risks. Batteries play three important roles in the energy transition: 1) decarbonising transport through electrification; 2) enabling the shift from fossil fuel to renewable power generation as a dispatchable source of electricity; and 3) helping to provide access to electricity to off-grid communities.[46] While a range of power storage technologies are emerging, lithium-ion (Li-ion) batteries remain central. Cobalt plays a key role in this technology as a cathode component. EV batteries can use up to 20 kg of cobalt in each 100 kWh pack. Unfortunately, research over the last six years has made clear that much of this cobalt may be produced with forced and child labour. So, too, may some of the other minerals used in batteries.[47] But cobalt has been the primary focus of research, media, legal and investor scrutiny.

Around 70% of global cobalt supply comes from the Democratic Republic of the Congo (DRC). Most of this production occurs in formal, large-scale mines. But 15% to 30% occurs in informal artisanal and small-scale mining (ASM) – making DRC ASM the second largest source of cobalt in the world.[48] Performed by adults with no formal training or machinery and sometimes also children, ASM is largely not formally regulated and often involves trespassers scavenging, using hand-tools on land owned by industrial mines.[49] Mineshafts are poorly constructed and offer extremely hazardous working conditions including exposure to fine dust and particulates that cause DNA-level damage, high risks of death from tunnel collapse, and significant risks of injury from equipment and falls. Only desperate people would work in such conditions, so while ASM sites host voluntary workers, they are also often the site of forced labour by adults and children. Between 100,000 and 200,000 people are thought to work in ASM cobalt extraction in DRC, and many more depend on those livelihoods.[50]

Many of those working in cobalt ASM in DRC are children. Estimates vary, placing the number from around 35,000 to several multiples of that.[51] The root cause of child labour is household poverty and vulnerability to income shocks.[52] With poverty

44 Marco, Rubio, et al (2021). 'Letter to The Honorable Dev Jagadesan', 4 November 2021, available at https://www.rubio.senate.gov/public/_cache/files/c0f4744b-acb7-45f0-85cd-a0e4604b45ce/FD65DB902928A2EE4200EB4255FDE580.11.04.21---smr-et-al-letter-to-dfc-re-xuar-solar-panels.pdf.

45 Thomas Kingsley, (2022). 'HSBC holding shares in China firm linked to human rights abuses against Uyghur Muslims', *The Independent,* 10 January 2022, available at https://www.independent.co.uk/asia/china/hsbc-uyghur-china-shares-xinjiang-b1990042.html

46 World Economic Forum (2019). 'A Vision for a Sustainable Battery Value Chain in 2030: Unlocking the Full Potential to Power Sustainable Development and Climate Change Mitigation', *Global Battery Alliance,* September 2019, available at https://www.globalbattery.org/media/publications/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf.

47 Rashad Abelson (2019). *Trends in Stakeholder Reporting: Mineral Supply Chains,* OECD, 2019, available at https://tdi-sustainability.com/wp-content/uploads/trends-in-stakeholder-reporting-mineral-supply-chains.pdf.

48 WEF, 2020.

49 Dionne Searcey and Eric Lipton (2021). 'Hunt for the 'Blood Diamond of Batteries' Impedes Green Energy Push', *New York Times,* 29 November 2021, available at https://www.nytimes.com/2021/11/29/world/congo-cobalt-albert-yuma-mulimbi.html.

50 WEF, 2020; Amnesty International, 2016; Chris N. Bayer. and Anthony Cooper (2019). 'Worst Forms of Child Labour in the Democratic Republic of the Congo: Cobalt Refiner Due Diligence Reporting Development International', *Development International*, 31 July 2019, available at https://www.academia.edu/43763413/Cobalt_Refiner_Due_Diligence_Reporting; Anna Triponel, Susannah McLaren and Tom Fairlie (2021). 'Call to Action: Putting People at the Heart of the Decarbonization of Transportation', *Cobalt Institute*, 28 October 2021, available at https://www.cobaltinstitute.org/news/call-to-action-putting-people-at-the-heart-of-the-decarbonization-of-transportation/.

51 Siddharth Kara (2018). 'Is your phone tainted by the misery of the 35,000 children in Congo's mines?', *The Guardian*, 12 October 2018, available at https://www.theguardian.com/global-development/2018/oct/12/phone-misery-children-congo-cobalt-mines-drc.

52 WEF, 2020; Bundesministerium für Wirtschaft und Energie (2019). 'Analyse des artisanalen Kupfer-Kobalt-Sektors in den Provinzen Haut-Katanga und Lualaba in der Demokratischen Republik Kongo', *BGR*, 8 October 2018, available at https://www.bgr.bund.de/DE/Themen/Min_rohstoffe/Downloads/studie_BGR_kupfer_kobalt_kongo_2019.html.

widespread in DRC's south-eastern copper-cobalt belt, 11% of children in the region find themselves working in one sector or another, frequently alongside their parents, to contribute to household income or help cover (their own) school fees. If other sectors such as agriculture or domestic service offer greater income, children may be moved into those other sectors.[53] Child-centred research suggests child workers are motivated by a range of considerations: the need for supplemental income from child miners in large families; child-headed households where children have to provide for themselves due to parental death, divorce, or illness; young mothers who are considered adults and need to care for their own children; and peer pressure on older children who decide to work to have discretionary income.[54]

The growing recognition of the risks of child and forced labour in DRC cobalt mining has led to a variety of government, industry and multistakeholder responses. Several large automotive and electronics brands such as BMW, Ford and IBM have launched responsible sourcing and tracing pilot projects to drive transparency and address child labour risks. Most of these initiatives combine supply-chain upgrading and formalisation with interventions aimed at addressing the community-level poverty and under-development that pushes children into work. But concerns about the effectiveness of these strategies lingers, and analysts have begun to recognise that solar energy storage technologies, including Li-ion batteries, may yet be subject to exclusion from the US market under section 307 of the US Tariff Act.[55] In contrast to XUAR, however, governments have not to date pushed for wholesale exclusion of DRC cobalt from global commodity markets, in part perhaps due to limited alternative supply options. Instead, most of the strategies in place see continued engagement 'on the ground' as the best approach to building and using 'leverage' to address the underlying problems of sustainable development that manifest as child labour.

The modern slavery risks posed by cobalt production have both similarities and important differences to those arising from XUAR polysilicon production. One similarity relates to the risk of growing demand exacerbating risks to people. Solar energy production is expected to grow by 450% by 2030.[56] The World Bank estimates that cobalt production would need to grow by 460% by 2050 to meet energy storage requirements to keep global warming to 2°C. Most of this growth will come in the transportation sector, especially EV passenger cars and commercial vehicles, with China in the lead.[57]

China's critical role in achieving supply-chain transformation is another similarity between cobalt and polysilicon production. However, in the polysilicon value-chain, China's roles occur at the point of raw materials extraction and production, downstream use (i.e., module manufacturing), and consumption. In the cobalt supply-chain, while China is a key source of consumption demand, and central to downstream transformation (since China handles around 60% of refining operations), it is not the site of raw material extraction, where the risk of forced and child labour is highest.

53 Amnesty International, 2016; Benjamin Farber, Benjamin Krause and Raul Sanchez De La Sierra (2017). 'Artisanal Mining, Livelihoods, and Child Labor in the Cobalt Supply Chain of the Democratic Republic of Congo', *The Center for Effective Global Action,* 6 May 2017, available at https://cega.berkeley.edu/assets/cega_research_projects/179/CEGA_Report_v2.pdf; OECD (2019). I*nterconnected Supply Chains: A Comprehensive Look at Due Diligence Challenges and Opportunities Sourcing Cobalt and Copper from the Democratic Republic of the Congo*, Paris, 15 November 2019, available at https://mneguidelines.oecd.org/interconnected-supply-chains-a-comprehensive-look-at-due-diligence-challenges-and-opportunities-sourcing-cobalt-and-copper-from-the-drc.htm.

54 Pact (2014). *Breaking the Chain: Ending the Supply of Child-Mined Minerals,* 1 October 2014, available at https://www.pactworld.org/library/breaking-chain-ending-supply-child-mined-minerals.

55 David Wagman (2021d). 'What energy storage can learn from solar import's woes', *PV Magazine,* 13 October 2021, available at https://pv-magazine-usa.com/2021/10/13/what-energy-storage-can-learn-from-solars-import-woes/

56 Dmitrii Bogdanov et al. (2021). 'Low-cost renewable electricity as the key driver of the global energy transition towards sustainability', *Energy,* Volume 227, article number 120467.

57 WEF, 2019.

This points to another key difference: the role of the state in the system that generates modern slavery risks. Whereas modern slavery risks relating to XUAR PV seem connected to formal state policy, in DRC, forced and child labour seems rather to be a consequence of state incapacity and informal governance arrangements. In DRC, modern slavery occurs in "an underworld where children are put to work and unskilled and ill-equipped diggers of all ages get injured or killed".[58] The state is not, to be sure, 'absent' from the areas where ASM cobalt mining occurs. But it is also not clearly in control. State officials may have regulatory authority, but there is evidence that they use that authority for corrupt private gain.[59] Forced and child labour enter the cobalt production process precisely because governance is fragmented. In XUAR PV production, forced labour appears to enter production as the result of choices made by policy actors at the centre of a highly centralized, hierarchical governance system. This points to different sources and patterns of leverage available in any effort to transform governance and manage modern slavery risks in these different sectors. Different placed-based interventions may be needed to comprehensively address and reduce these risks, even if there is a unifying framework in place for measuring and managing those risks along the value-chain.

Already, litigation and rights enforcement actions have played different roles in prompting collective action by value-chain stakeholders in these two different sectors. Litigation targeting businesses relying on XUAR forced labour has only just begun, with actions under way in France, Germany, and the Netherlands.[60] On DRC cobalt, in contrast, litigation is more advanced. In December 2019, a class action lawsuit was filed against large technology companies on behalf of 14 Congolese families claiming that their children were killed or maimed while mining for cobalt. The lawsuit, filed in a US federal district court in Washington, DC, claimed that defendants Apple, Dell, Google, Microsoft, and Tesla "knew that DRC's cobalt mining sector is dependent on child labour which included hazardous work such as tunnel digging in primitive cobalt mines", and aided and abetted the death and serious injury of children in their supply-chains.[61] The lawsuit was dismissed in November 2021 on the grounds that plaintiffs had not demonstrated sufficient evidence of a causal connection between defendants and the harms. But it helped spur a wave of industry initiatives to strengthen governance of supply-chains, including separate economic formalisation projects initiated by China's largest cobalt refiner, Huayou Cobalt, by one of the world's leading commodity trading firms, Trafigura, and by BMW, BASF, Samsung and the German Agency for International Cooperation.[62]

58 Searcey and Lipton, 2021.

59 Ibid.; Global Witness (2017). 'Regime Cash Machine: How the Democratic Republic of Congo's booming mining exports are failing to benefit its people', *Global Witness*, 21 July 2017, available at https://www.globalwitness.org/en/campaigns/democratic-republic-congo/regime-cash-machine/; Carter Center (2017). 'A State Affair: Privatizing Congo's Copper Sector, *The Carter Centre,* November 2017, available at https://www.cartercenter.org/resources/pdfs/news/peace_publications/democracy/congo-report-carter-center-nov-2017.pdf

60 ECCHR (European Center for Constitutional and Human Rights) (2021). 'Forced labor of Uyghurs: German textile brands and retailers allegedly complicit in crimes against humanity'. Press Release, 5 September 2021, available at https://www.ecchr.eu/en/press-release/forced-labor-uyghurs-german-textile-brands/; Sherpa (2021). Complaint against 4 textile giants for forced labour of Uyghurs: French justice opens an investigation for concealment of crimes against humanity. Press release, 2 July 2021, available at https://www.asso-sherpa.org/complaint-against-4-textile-giants-for-forced-labour-of-uyghurs-french-justice-opens-an-investigation-for-concealment-of-crimes-against-humanity; DutchNews.nl (2021). C&A under fire over Chinese cotton, German NGO starts legal action. *DutchNews.nl,* 2 December 2021, available at https://www.dutchnews.nl/news/2021/12/ca-under-fire-over-chinese-cotton-german-ngo-starts-legal-action/.

61 *Doe 1 et al v. Apple Inc. et al,* (2019) No. 1:19-cv-03737 D.D.C., available at http://iradvocates.org/sites/iradvocates.org/files/stamped%20-Complaint.pdf

62 WEF, 2020.

Transitions in global energy governance and economic order

The renewable energy sector is accustomed to being perceived in positive terms, framed as the solution to the world's fossil fuel problem. Perhaps for that reason, the negative social impacts of renewable energy production systems – such as dispossession and displacement of people – have received less attention.[63] Solar energy's modern slavery risks should be seen in this larger context – as part of the larger question of how to address the injustices that may arise from transitioning energy production towards renewables.[64] Will that transition deal justly with the negative social impacts it risks – such as increased demand for goods (solar panels, batteries) made with modern slavery? Will this be a 'Just Transition'?

There is no single consensus view on what the term 'Just Transition' means. There are many conceptions of both 'justice' and 'transition'.[65] But the provenance of the term is instructive.[66] It grew out of the environmental justice movement in the US in the 1980s, shifting subsequently from a focus on local impacts and solutions to a more global framing.[67] For the last twenty years, the global labour movement has used the concept to highlight the need to consider both the distributional and procedural aspects of climate and energy governance,[68] including how to protect workers whose livelihoods are threatened by the transition to renewables.[69] Steadily, the frame has widened to include a broader range of negative impacts occasioned by the transition, and the need to transition away from unsustainable extractive business models in the energy sector.[70]

63 BHRRC (2018). *Renewable Energy Risking Rights & Returns: An analysis of solar, bioenergy and geothermal companies' human rights commitments.* (London: 2018); Éléonore Lèbre, Martin Stringer, Kamila Svobodova, John R. Owen, Deanna Kemp, Claire Côte, Andrea Arratia-Solar, and Rick K. Valenta (2020). "The Social and Environmental Complexities of Extracting Energy Transition Metals." *Nature Communications* 11(1): 4823; US Department of Energy (2021). *Solar Futures Study,* September 2021, available at https://www.energy.gov/sites/default/files/2021-09/Solar%20Futures%20Study.pdf.

64 Peter Newell and Dustin Mulvaney (2013). "The political economy of the 'just transition'". *The Geographical Journal,* 179(2) (June 2013): 132-140.

65 David Schlosberg and Lisette B. Collins, "From Environmental to Climate Justice: Climate Change and the Discourse of Environmental Justice," *Wiley Interdisciplinary Reviews: Climate Change 5,* no. 3 (2014): 359–74.

66 Dimitris Stevis, Dunja Kraus and Edouard Morena (2020). "Introduction: The genealogy and contemporary politics of just transitions." In Morena, Dunja Krause and Dimitris Stevis, eds., *Just Transitions: Social Justice in the Shift Towards a Low-Carbon World,* edited by Edouard (London: Pluto Press): 1–31.

67 Just Transition Initiative (2020). *Just Transition concepts and relevance for climate action: A preliminary framework*. Available at https://www.climateinvestmentfunds.org/sites/cif_enc/files/knowledge-documents/justtransition_final.pdf; Kirsten Jenkins (2018). "Setting Energy Justice Apart from the Crowd: Lessons from Environmental and Climate Justice," *Energy Research & Social Science* 39 (May 2018): 117–21; Ajay Gambhir, Fergus Green, and Peter Pearson (2018). "Towards a Just and Equitable Low-Carbon Energy Transition," Imperial College London, Grantham Institute Briefing paper no. 26, August 2018, https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/26.-Towards-a-just-and-equitable-low-carbon-energy-transition.pdf.

68 Newell and Mulvaney, 2013; Stephen D. Krasner (1982). "Structural Causes and Regime Consequences: Regimes as Intervening Variables". *International Organization,* 36(2): 185–205; Robert O. Keohane and David G. Victor (2010). "The Regime Complex for Climate Change." Discussion Paper, 10-33, *Harvard Project on Climate Agreements,* Belfer Center, January 2010; Edouard Morena, et al. (2018). *Mapping Just Transition(s) to a Low-Carbon World* (Geneva: UN Research Institute for Social Development, December 2018), available at http://www.rosalux-nyc.org/wp-content/files_mf/reportjtrc2018_1129.pdf.

69 Anabella Rosemberg (2017). "Strengthening Just Transition Policies in International Climate Governance," Stanley Foundation, Policy Analysis Brief, April 2017, available at https://stanleycenter.org/publications/pab/RosembergPABStrengtheningJustTransition417.pdf; Annabel Pinker (2020). *Just Transitions: a comparative perspective,* A Report prepared for the Just Transition Commission of Scotland, 22 April 2020, Sefari and the James Hutton Institute, available at https://www.gov.scot/publications/transitions-comparative-perspective.

70 T.A Krawchenko, and M. Gordon (2021). 'How do we manage a Just Transition? A comparative review of national and regional Just Transition initiatives', *Sustainability,* 13, 6070.

Since the notion found its way into the negotiating text for the Copenhagen Summit in 2009 and later the preamble to the 2015 Paris Agreement, 'Just Transition' debates have focused on the need for planning for industrial transitions. Sometimes these plans are local and place based. Sometimes they involve discussion of transnational energy markets and value-chains.[71] Countries have agreed some broad guidelines that include a commitment to address forced labour concerns through tripartite (i.e., state, employer, worker) dialogue.[72] Yet what that looks like operationally, in any particular context, remains to be negotiated.

Those negotiations tend to raise several types of justice questions, about distributive justice, recognition, procedural justice and restorative justice. All are implicated in the debate on how to handle modern slavery risks in the solar energy value chain.

- **Distributive justice** refers to the distribution of burdens and benefits of the transition. This is the central question triggered by modern slavery risks. Should energy consumers' 'freedom' come at the expense of solar panel and battery supply-chain workers' freedom?

- **Recognition** considers whose interests and value are recognised and take into account, in transition planning. How are the interest of DRC child miners, or enslaved Uyghur workers, factored into planning the growth of the solar energy value chain?

- **Procedural justice** considers which actors are involved and have influence over decision-making. For example, are Uyghur and child miner voices involved? How?

- **Restorative justice** addresses remediation of past harms. How will the people who were enslaved to make the solar panels and batteries we are already using be remediated?

Answering these questions is a complex public policy problem. The transition to solar power is not just a technological challenge, but also a socio-political one involving long-term and complex reconfigurations of policy, infrastructure, finance and power.[73] While technological standards and systems may be in play, narrowly managerial solutions may not succeed.[74] In the energy sector, the level of complexity is also magnified by the global nature of value-chains, with investors in some countries, producers in many others, and buyers and consumers in yet others. Lasting solutions will need to work at multiple levels – along the value-chain, and where it intersects with local economic, social and political dynamics.

This requires development of a complex picture of policy debates around how to manage these modern slavery risks. That picture may help us understand how different stakeholders conceive of 'justice' in the energy transition. Although actors in the solar energy value-chain operate within a shared global market regime framework, we should not assume that their outlook on that regime is identical. The value-chain includes listed and unlisted firms, state-backed firms (and even, in the XPCC, a militarised parastatal), plus state-run and multilateral entities such as export

71 A. Rainnie, A. Beer, and M. Rafferty (2019). *Effectiveness of Place Based Packages* (Regional Australia Institute: Canberra, Australia); Ben Cahill and Mary Margaret Allen (2021). *Pathways for Just Transitions: Gender-Responsive Policies and Place-Based Investment.* (CSIS and CIF, 2021), available at https://justtransitioninitiative.org/wp-content/uploads/2021/02/JTI_Pathways_Report_WEB.pdf

72 ILO (2015). *Guidelines for a just transition towards environmentally sustainable economies and societies for all* (Geneva).

73 Newell and Mulvaney, 2013; I. Scarse and A. Smith (2009). 'The non-politics of managing low carbon socio-technical transitions', *Environmental Politics,* 18: 707– 726; F. W. Geels and J. Schot (2007). 'Typology of sociotechnical transition pathways'. *Research Policy,* vol. 36: 399–417; J. Meadowcroft (2009). 'What about the politics? Sustainable development, transition management, and long term energy transitions'. *Policy Sciences,* vol. 42: 323– 340.

74 A. Goldthau and B. Sovacool (2012). 'The uniqueness of the energy security, justice and governance problem', *Energy Policy,* vol. 41: 232– 240.

credit agencies, development finance institutions and multilateral development banks. These actors have different missions and purposes, and different outlooks on how state, markets and individual rights fit together. The debate over modern slavery risks thus offers a window into a larger debate over the solar energy governance regime – the set of principles, norms, rules and procedures that international actors converge around.[75] It raises significant questions of global political economy, with powerful ramifications for the questions of "who wins, who loses, how and why".[76] But the debate is not simply one over *power*: who will control or govern the value-chain. It is also a debate over: what is the point of solar energy value-chain governance?[77] Because solar energy will be so critical to future economic production, growth, national prosperity and political power, this debate is emerging as a front in a broader struggle over the purpose of the international market regime and the nature of the global economic order.

75 Krasner, 1982.
76 Newell and Mulvaney, 2013.
77 Ruggie, 1982.

2.0 Tracing policy debates on the issue

In the second section of the study, we use established policy process tracing methods[78] to conduct desk and interview-based reviews of policy discourse in 10 policy arenas. These are: 1) the US, 2) the UK, 3) the EU, 4) the G7, 5) Australia, 6) United Nations fora, 7) China, 8) international solar energy industry initiatives, 9) global financial circles, and 10) multistakeholder initiatives relating to the global cobalt supply-chain. Through this review, we identified several 'Policy Currents' being used to frame responses to modern slavery risks in debates relating to solar energy governance.

A Policy Current consists of a set of actors, policy ideas, heuristics and narratives adopting (even if unwittingly) a common approach to framing and solving a given policy problem. This framing typically draws on a shared conceptualisation and set of beliefs about how the world works – a shared outlook – and on how policies can (sustainably) address problems. A 'Policy Current' is an ideal type: an abstracted representation of empirical reality that highlights key features in a manner that creates conceptual clarity or coherence.[79] Ideal types are not statistical, average or 'normal' types, in the sense of representing the most recurrent features of a sample. They are analytical devices used as a method of investigation and explanation, especially in comparative sociological, economic and political analysis.[80] In real life, actors may move between, borrow from, or even combine ideas from more than one Policy Current. But each Policy Current emerges as a recurring, coherent flow of policy ideas, which may surface in and flow between multiple different arenas of policy debate – in different countries, international or industry institutional settings. Policy Currents operate at different stages of development. Some are nascent, still in a 'softening up' phase where different policy actors try out different framings, heuristics, and narratives, assessing how target audiences perceive the feasibility of different ideas, and figuring out how to align narratives with their audiences' prior normative and value commitments. Others are more developed, and may cohere into problem 'formation', policy proposal and political action 'streams'. At this point, distinct policy brokers and political brokers often emerge, seeking to open and exploit 'windows' to achieve adoption of preferred policies.

We identified four coherent Policy Currents in current debates on modern slavery risks in solar energy value-chains: Rights, Supply-Chains, Autarky and Collective Action. These are summarised below and discussed at much greater length in our full research report.

78 We developed a 'Policy Currents Framework' for evaluating policy processes. This draws on several major strands of contemporary comparative policy process theorizing, including: Multiple Streams Framework (MSF), the Advocacy Coalition Framework (ACF), the Narrative Policy Framework (NPF) and the Diffusion of Innovation Model (DIM). (See generally Christopher M. Weible and Paul. A Sabatier, eds, (2017). *Theories of the Policy Process.* 4th ed., (Boulder, CO, Westview Press).) For a a full discussion, see section 2 of our full research report.

79 Max Weber (1949). "Objectivity" in social science and social policy. In Max Weber, ed., *Essays in the Methodology of the Social Sciences* (trans. Shils, EA, Finch, HA) (New York: The Free Press), pp. 50–112; Max Weber (1978). *Economy and Society: An Outline of Interpretive Sociology* (trans.Fischoff, E.) 2 vols. (Berkeley, CA: University of California Press).

80 Max Weber (2012). 'The "objectivity" of knowledge in social science and social policy'. In Max Weber, ed., *Collected Methodological Essays* (ed Bruun, HH, Whimster, S; trans. Bruun, HH). (London: Routledge), pp. 100–138; Susan J. Hekman (1983). *Weber, the ideal type, and contemporary social theory* (Notre Dame, IN: University of Notre Dame Press).

Figure 2: Features of four Policy Currents in the solar energy modern slavery debate

		Rights	Supply chains	Autarky	Collective action
Problem and solution framing	**Domain**	Human rights	Supply-chain integrity	Geostrategy	Sustainable development, climate action
	Key interest affected	Victims	Business	Political community	Value-chain or system stakeholders
	Remedial agency	Accountability mechanisms	Business	Governments	Multistakeholder initiatives
	Imagery + heuristics	Violation and abuse	Taint and risk	Protection and resilience	Collective action
	Core beliefs	Rights, freedom	Market logic	Sovereignty, autonomy	Systems thinking
	Indicators	Remedial actions	Volume and value	Self-sufficiency	System transition
Actors	**Policy brokers (non-exhaustive)**	Human rights community, Uyghur community	Anti-slavery movement, industry associations, finance, WEF	US and China 'hawks', EU 'strategic autonomy' camp	OECD, cobalt initiatives, Forum for the Future
	Political actors	Some IPAC members	US Congress, EU Commission	US and China 'hawks'	Not yet emerged
	Victims and survivor roles	Witnesses, litigants	Witnesses, supply-chain experts	Witnesses	Value-chain stakeholders
Windows	**Agenda window**	Individual accountability oriented - feasible, acceptable	Legislative and technical measures - feasible, acceptable, public support	Opening but contested (e.g., EU)	Not yet opened
	Decision window	Shifting to courts, multilateral bodies	Window open in US, EU, opening elsewhere	Ajar in US, lobbying elsewhere (e.g., EU)	Not yet opened
	Focusing events	Beijing Olympics	US WRO enforcement, UFLPA	2021 Chinese countersanctions	Pandemic supply-chain disruptions
Coordination and strategy	**Coordination**	Coalition to End Uyghur Forced Labour	MDBs and DFIs, industry associations	IPAC	Global Battery Alliance
	Learning	Litigation push	Legislative borrowing	Unclear	CIRAF, CRI
	Forum-shopping	Uyghur Tribunal	Civil society G7 push	Summit for Democracy	Cobalt initiative proliferation

The 'Rights' current

The Rights policy current frames modern slavery in the solar energy value-chain as serious, large-scale violations of human, labour and child rights. A people-centred narrative platforms victims and affected communities not only as witnesses to the facts on the ground – for example providing parliamentary testimony – but also as rights-bearers. Given the right institutional setting, these rights-bearers may be able to achieve remedy for these rights violations, for example through litigation, or through state-led action, particularly in multilateral forums such as the ILO. The international human rights community, and affected populations, are key policy brokers in the Rights current, as are the Inter-Parliamentary Alliance on China (IPAC) and the Congressional-Executive Commission on China. Corporate actors are relatively absent. Interestingly, China has presented its own 'rights'-based response to allegations of forced labour, but its focus is on the state's right to direct economic development as it chooses, rather than on human and workers' rights.

The 'Supply-Chains' current

The Supply-Chains current has made the most rapid progress in policy debates relating to polysilicon. While connected to the Rights current, it shifts the focus of policy action away from rights to risk, and from victims to business. The focus is on the risks posed by modern slavery to both individual businesses and to the efficient and reliable operation of the supply-chain itself. Solutions are not the responsibility of rights-holders, but of business and the market, with government playing a facilitation role through setting and enforcing market rules. The Supply-Chains current proposes harnessing commercial and non-commercial influence within the value-chain to address modern slavery risks at the operational level, especially through supply-chain mapping and tracing, due diligence, and adaptation of existing enterprise and financial risk management techniques and practices.

This approach is seen by a wide variety of business and government actors as both 'feasible' and as having high 'value conformity'. 'Supply-Chains' proposals are deliberately framed as aligning with states' and business' existing commitments under the OECD Guidelines for Multinational Enterprises, the UN Guiding Principles on Business and Human Rights and the ILO's Tripartite Declaration of Principles concerning Multinational Enterprises and Social Policy.

All of the major solar energy industry associations, including the US-based Solar Energy Industries Association (SEIA), SolarPower Europe, Solar Energy UK and Australia's Clean Energy Council are proponents of the Supply-Chains current. A civil society Coalition to End Uyghur Forced Labour plays a policy diffusion role. Development finance institutions, including multilateral development banks, are increasingly active implementers of this approach, with a number exploring a 'Common Approach'. In the cobalt area, the OECD has played an important policy brokering role.

Most western regulatory efforts on polysilicon – including discussions in the G7 – take place within this current, though there are important differences around the roles envisaged for government and business in identifying sources of modern slavery risk in supply-chains. The US model sees a role for government in nominating certain locations or firms that should be excluded; the European model proposed in the new draft Corporate Sustainability Due Diligence Directive leaves that to business.

One recurring question for proponents of this Policy Current, however, relates to overall systemic change. Can downstream actors in value-chains develop and exercise sufficient leverage to address the drivers of modern slavery in upstream production contexts? This has proven difficult in cobalt production in DRC, generating a move towards a new current of policy thinking (Collective Action), discussed further below. Likewise, solar panel purchasers are rapidly encountering the limits of their own influence over upstream polysilicon production conditions in XUAR.

What is more, the Supply-Chains current at present offers no clear answer to the question of the responsibility of downstream purchasers (and financiers) for addressing modern slavery risks present in the solar energy production system – but not formally in the supply-chains to which they are connected. With some mid-stream PV manufacturers now developing bifurcated polysilicon production capacities, with some established plants with high modern slavery risks selling goods into some markets (e.g., China), and other, new plants selling 'clean' goods into other markets (e.g. the US), this is an increasingly pressing question. Will markets accept purchase of, or investment in, slavery-free solar power sold by firms that are, elsewhere, selling slave-made solar power to other markets?

The 'Autarky' current

Recently, a third Policy Current has emerged, in part as a result of growing concern about western dependence on Chinese polysilicon supply. This 'Autarky' current focuses less on the risks posed to business, *per se,* and more on the risks posed to the political community and political economy by dependence on foreign producers. There is a shift from the Supply-Chains imagery of risk, taint and integrity, to stronger, more securitised and group-oriented imagery of threat, protection and self-sufficiency. And the policy solutions proposed shift from the adoption of operational risk management techniques within existing supply-chains (i.e., reformation) to industrial policy questions of the onshoring, re-shoring and 'friend-shoring' supply-chains (i.e., transformation).[81]

In the US Congress, Republicans have proposed the *Keep China Out of Solar Energy* Act, while Democrats have proposed the *Reclaiming the Solar Supply Chain Act*. Prompted by SolarPower Europe, the European Commission also recently announced a public consultation on a European strategy on the solar PV value-chain. The underlying outlook here is one that anticipates geostrategic competition for control of scarce strategic resources key to the energy transition.[82] The solutions in play are not changes in business practice, but rather in government policy – such as tax and financial incentives to re-shore production capacity. Autarky is thus closely related to Green Industrial Policy.[83]

One challenge that this Policy Current has faced to date, however, is in aligning with policy actors' pre-existing values – particularly the strong liberal commitment to free trade in the global economic order. We presently see experimentation by different actors, to reframe action on modern slavery in ways that appeal to these underlying values and normative commitments. In Europe, the Commission has

81 For the neologism 'friend-shoring' see Peter Coy (2021). "'On-shoring' is so last year. The new lingo is 'friend-shoring'", *Bloomberg Businessweek,* 24 June 2021, available at https://www.bloomberg.com/news/articles/2021-06-24/-onshoring-is-so-last-year-the-new-lingo-is-friend-shoring.

82 Jason Bordoff and Meghan L. O'Sullivan (2022). 'Green Upheaval. The New Politics of Energy.' *Foreign Affairs,* Jan/Feb 2022.

83 Bentley Allan, Joanna I. Lewis and Thomas Oatley (2021). Green Industrial Policy and the Global Transformation of Climate Politics. *Global Environmental Politics,* vol. 21(4): 1–19.

already proposed a new Battery Regulation that rather than locating production within Europe, seeks to use the bloc's standard-setting power as a market regulator to encourage foreign producers to align with European values, including supply-chain respect for labour standards. In the US, the current government tactic instead seems to be to frame action on modern slavery as a defence of the free trade system, since state-backed forced labour represents a policy of illegal subsidy to businesses, allowing them unfairly to undercut businesses that respect workers' rights. But we also see experimentation with another tactic, reframing the issues in terms of a broader commitment to democracy (rather than just workers' rights), arguing that state-backed forced labour is often part of a larger complex of oppression that is incompatible with democratic values. While suited to the XUAR PV discussion, this tactic seems less well suited to discussion of cobalt production in DRC, where the problem is generally understood to be one of weak state governance within a democratic context, not the result of government oppression.

The 'Collective Action' current

The final Policy Current that is discernible focuses on Collective Action along the value-chain. This policy current suggests we do not have to see reduced modern slavery risk and a reduced carbon footprint as competing goals. Instead, we should see them as reinforcing goals.

This builds on a growing body of evidence suggesting that, in fact, modern slavery risks often overlap with environmentally destructive production systems and business models.[84] For solar energy, this probably includes the lax environmental controls in ASM mining of cobalt, and the use of very high emission coal to generate the electricity that powers polysilicon production in XUAR – a point highlighted, for example, by the Ultra-Low Carbon Solar Alliance.

This approach suggests that our goal should not be narrowly to reduce modern slavery risks in established supply-chains, but rather something broader: collective action to transform the solar energy production system so that it is truly just and equitable, promoting not only the freedom of consumers from fossil fuel dependence but also the freedom of workers and producers. It deals with the apparent tensions between these groups' interests by arguing we need to transform the system so that tension no longer arises. This approach is informed by systems thinking. It frames modern slavery as an externality of the current global solar energy production system, which can only be addressed by the collective action of stakeholders throughout that system, to move it to a new, sustainable equilibrium – a new system state.

This kind of thinking is significantly more developed in the cobalt area than in the polysilicon discussion. On cobalt, a number of collective action initiatives have emerged, some catalysed by OECD-convened discussions, others informed by the 'stewardship' thinking of institutional investor groups such as UN-backed Principles for Responsible Investment (PRI). The Cobalt Institute is emerging as an important policy broker in this current. In the polysilicon space, in contrast, such thinking is more nascent. The Responsible Energy Initiative (REI), a project of the Forum for the Future, which has worked with the World Wildlife Foundation, World Resources

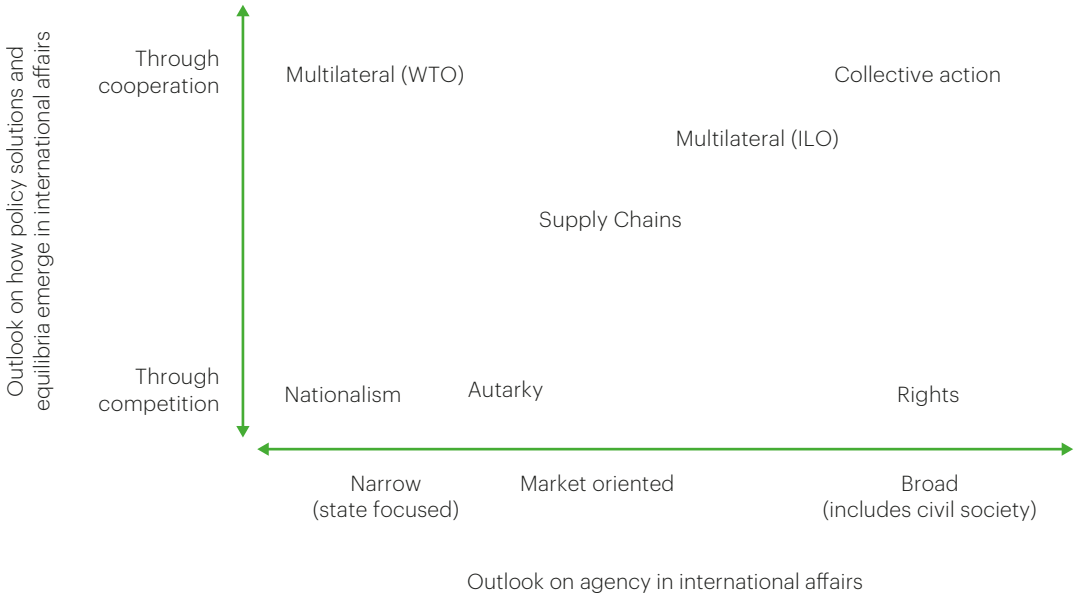
84 Kevin Bales (2016). *Blood and Earth: Modern Slavery, Ecocide, Climate Change* (Random House); Kevin Bales and Benjamin K. Sovacool (2021). 'From forests to factories: How modern slavery deepens the crisis of climate change', *Energy Research & Social Science,* vol. 77, July 2021, 102096; Bethany Jackson, Jessica L. Decker-Sparks, Chloe Brown and Doreen S. Boyd (2020). 'Understanding the co-occurrence of tree loss and modern slavery to improve efficacy of conservation actions and policies', *Conservation Science and Practice,* 2020;2:e183.

Institute, TERI (The Energy Resources Institute), Landesa, S&P Global Foundation and the UK Government, is a key thought leader.

Dynamics and implications

The Policy Currents – and related policy discourse – can be plotted on two dimensions, reflecting the underlying conceptions within each current of a) agency in international affairs, and b) how sustainable governance and policy solutions emerge in international affairs – i.e., through competition, or through cooperation. This allows us to better understand where the balance of influence between different policy currents stands in different policy arenas, and how this may change over time.

Figure 3: Charting underlying outlooks in the policy currents



Understanding transnational debates on modern slavery risks in solar energy value-chains through the lens of these Policy Currents offers us important insights into the distributive, recognition, procedural and restorative justice aspects of a Just Transition involving solar.

- The Rights current seeks to remedy unjust distribution of harms (e.g., to Uyghur workers, or child cobalt miners in DRC) by recognising the rights of victims of modern slavery and giving them access to accountability mechanisms that restore their rights or remediate harms.

- The Supply-Chains current seeks to redistribute the burdens of preventing modern slavery by making business responsible for changed practice. It recognises the interest of affected communities but gives them a limited role in designing and implementing supply-chain remediation. And, to date, it has not achieved clear change to achieve restorative justice for those whose rights have been harmed.

- The Autarky current also says little about restorative justice, instead focusing on the interests of the state and political community in transforming the value-chain to avoid dependency on foreign production, which may rely on modern slavery in their business models.

- Finally, the Collective Action approach seeks to redistribute costs and benefits by achieving a system state transition that does away with the externality of modern slavery in the first place. To do this, it seeks not only to recognise a wide array of interests and stakeholders, but also to empower them to participate in collective action to achieve system transformation.

Some patterns are also discernible in the dynamic of how these currents evolve. The Rights approach has the most well-developed narrative communications, with Uyghur victims and survivors of forced labour playing a central role in activating audiences' empathy through testimony about the widespread and systematic violation of their rights. In the western policy arenas we studied, however, we found a pattern of early Rights discourse in policy debates developing into a Supply-Chains approach. There is evidence of active and rapid coordination, policy diffusion and learning across legislatures and development finance institutions, with similar Supply-Chains based policy proposals being rolled out in parallel across multiple national and international forums. In some arenas, however, this approach has met resistance, whether from states pushing back on the reduction of sovereign discretion that such an approach implies (i.e., China), or from businesses concerned about increased business costs (e.g., Siemens, in Germany). This resistance benefits from the drily technical and managerial language sometime adopted by Supply-Chains current proponents. The Supply-Chains narrative is also exclusive, in the sense that it frames the problem as one for business – not broader society – to handle. This leaves it susceptible to being outflanked by more openly political, identity-based appeals of the Autarky current.

Yet the growing characterization of modern slavery issues in the solar energy value-chain as a question of core political values (democracy v. autocracy), and of geostrategic competition, represents a new and potentially problematic turn in the struggle over 'the energy of freedom'. While a strategy of reshoring or 'friend-shoring' solar energy value-chains may help free buyers and investors in western democracies from supply-chains that rely on modern slavery, it does not necessarily free enslaved workers. And it could in fact slow decarbonisation.

The Collective Action current that is now emerging seems best poised to square this circle, by reframing the policy question from how to manage the tensions within the existing system, to a larger question of how to transform the system as a whole so that this tension never arises. This current appears, however, to be in the 'softening up' phase in which new concepts (such as 'responsible energy') are still being explored and tried out. It has yet to reach scale or to spread in any coordinated fashion across policy arenas. Shared heuristics and narratives have not yet emerged. And no policy or political broker has yet emerged to develop a clear policy agenda or exploit political or action windows that may emerge. One capability in particular that is missing is the ability to trace, measure and explain modern slavery risk at the level of the solar energy production system. It is to that question that we now turn.

3.0 Estimating forced labour risk in PV value-chains

Across these different Policy Currents, strengthening the solar energy sector's capacity to identify and trace modern slavery risk is seen as critical to successfully managing that risk. Solar energy supply-chains currently have limited tracing capabilities, and the industry is a relative newcomer to social risk assessment and human rights due diligence. What is more, effective on-the-ground human rights risk assessment is very difficult in some of the key contexts, especially XUAR, where it is actively resisted by government bodies. Our research identified a need to explore alternative, complementary methodologies for risk analysis.

In section 3 of the study, we develop and demonstrate the viability of a new approach to forced labour risk estimation in the solar energy value-chain. We demonstrate a method to estimate forced labour risk per kWh (FLR/kWh) and per USD LCOE in the production of photovoltaic (PV), on-grid energy. We demonstrate this method at the national energy production system level, using export-import data (from UN Comtrade), the latest available PV lifecycle inventory data (from IRENA), World Bank data on the levelized cost of electricity (LCOE), and social risk data from the Product Social Impact Life Cycle Assessment (PSILCA) database. We conclude, importantly, that with supply-chain specific data, the model could potentially be adapted to firm-level inventories, allowing inter-firm and project-level comparison, which may prove useful for developers and investors.

Our aim in developing this method is not to replace but to complement more resource-intensive investigative and due diligence methods. Importantly, our method allows not only measurement of aggregate risk at the country (or potentially product or firm) level, but also identification of the sources of risk within solar energy value-chains. This will allow users with scarce resources to better target those resources for deeper dive due diligence, engagement and remediation. Our method also appears to be scalable to large universes of input data, making it potentially suitable for integration into deal and portfolio analysis systems. Our results also suggest the method could be replicated for other parts of the solar energy value-chain, such as battery supply-chains, and indeed for other product systems – whether in the energy sector or beyond. We present our results through two new metrics – forced labour risk per kWh and forced labour risk per USD LCOE – which could equally be used for other energy sources, opening up possibilities for application across global energy markets, and for integration into ESG analysis, reporting and benchmarking. This, in turn, may open the door to a new approach to managing forced labour risks at the production system level, including setting enterprise, sector or national risk parameters, or tying capital costs to forced labour risk metrics.

The estimation method

Our analysis integrates data from multiple sources to model how inputs and risk flow through the global solar energy value-chain. Our method draws on the life cycle assessment (LCA) approach used to assess the environmental impacts of a product along its lifecycle. Instead of measuring environmental impact, however, we offer a social life cycle assessment (S-LCA) focused on forced labour risk.[85] To our knowledge this is the first multi-country S-LCA in the renewable energy sector.[86]

Figure 4: Basic data workflow to estimate forced labour risk in PV value-chains

First, we use World Bank and IRENA data to model the inventory and levelized cost of electricity (LCOE) involved in the production of PV, on-grid energy. [87] LCOE is a measure of the average net present cost of electricity generation for a generating plant over its lifetime. It is used for investment planning and to compare different methods of electricity generation on a consistent and comparable basis. We use LCOE as the functional basis for comparing solar PV production across countries and markets, and as a unit of analysis for the disaggregation of the life-cycle cost structure of PV, on-grid power into different 'breakdowns'. We then use UN Comtrade data to understand the weight of trade flows between countries, for each of these breakdowns (i.e., where inputs for each stage of the PV production process are likely to come from). This is known as an economic input-output approach to life cycle assessment (EIO-LCA).[88]

For each country-component stage of this value-chain (cradle to gate), we then integrate data on social risks from the PSILCA database.[89] PSILCA provides a total of 88 qualitative and quantitative social impact indicators, each applied to the whole set of country-specific sector (CSS) combinations available in the EORA Multi-Regional Input/Output (MRIO) database.[90] The EORA database covers 187 countries, providing a list of 15,909 sectors.[91] By combining these datasets, we are able to identify the 'medium risk hour equivalents (mrh-eq)' associated with each CSS input into the production system. Within the current version of PSILCA, the risk scores for each of these indicators is based on 2018 data. Since this pre-dates allegations of modern

85 EC Joint Research Centre, G. Blengini, L. Mancini, A. Ciroth, et al., *Social assessment of raw materials supply chains: a life-cycle-based analysis* (Publications Office, 2019).

86 For a single country application see S. Takeda, A. R. Keeley, S. Sakurai, S. Managi, and C.B. Norris (2019). 'Are renewables as friendly to humans as to the environment?: A social life cycle assessment of renewable electricity'. *Sustainability* (Switzerland), 11(5). https://doi.org/10.3390/su1105137

87 World Bank (2021). *Global Photovoltaic Power Potential By Country,* 21 October 2021, [database] available at https://datacatalog.worldbank.org/search/dataset/0038379; IRENA (2021a). 'Renewable Power Generation Costs 2020', June 2021, available at https://www.irena.org/publications/2021/Jun/Renewable-Power-Costs-in-2020.

88 C. Hendrickson, S. Joshi, O. H. Juarez-Espinosa, H.S. Matthews et al. (1998). *Economic Input-Output-Based Life-Cycle Assessment (EIO-LCA)/underground-engineering-for-sustainable-urban-development* (Washington DC: The Nation Academies Press).

89 Andreas Ciroth and Franziska Eisfeldt (2016). *PSILCA—a product social impact life cycle assessment database,* [Database v.1], available at https://www.openlca.org/wp-content/uploads/2016/08/PSILCA_documentation_v1.1.pdf; Kirill Maister, Claudia di Noi, Andreas Ciroth, & Michael Srocka (2020). 'PSILCA-A Product Social Impact Life Cycle Assessment database', *Version 3 Database documentation,* June 2020, available at https://psilca.net/wp-content/uploads/2020/06/PSILCA_documentation_v3.pdf.

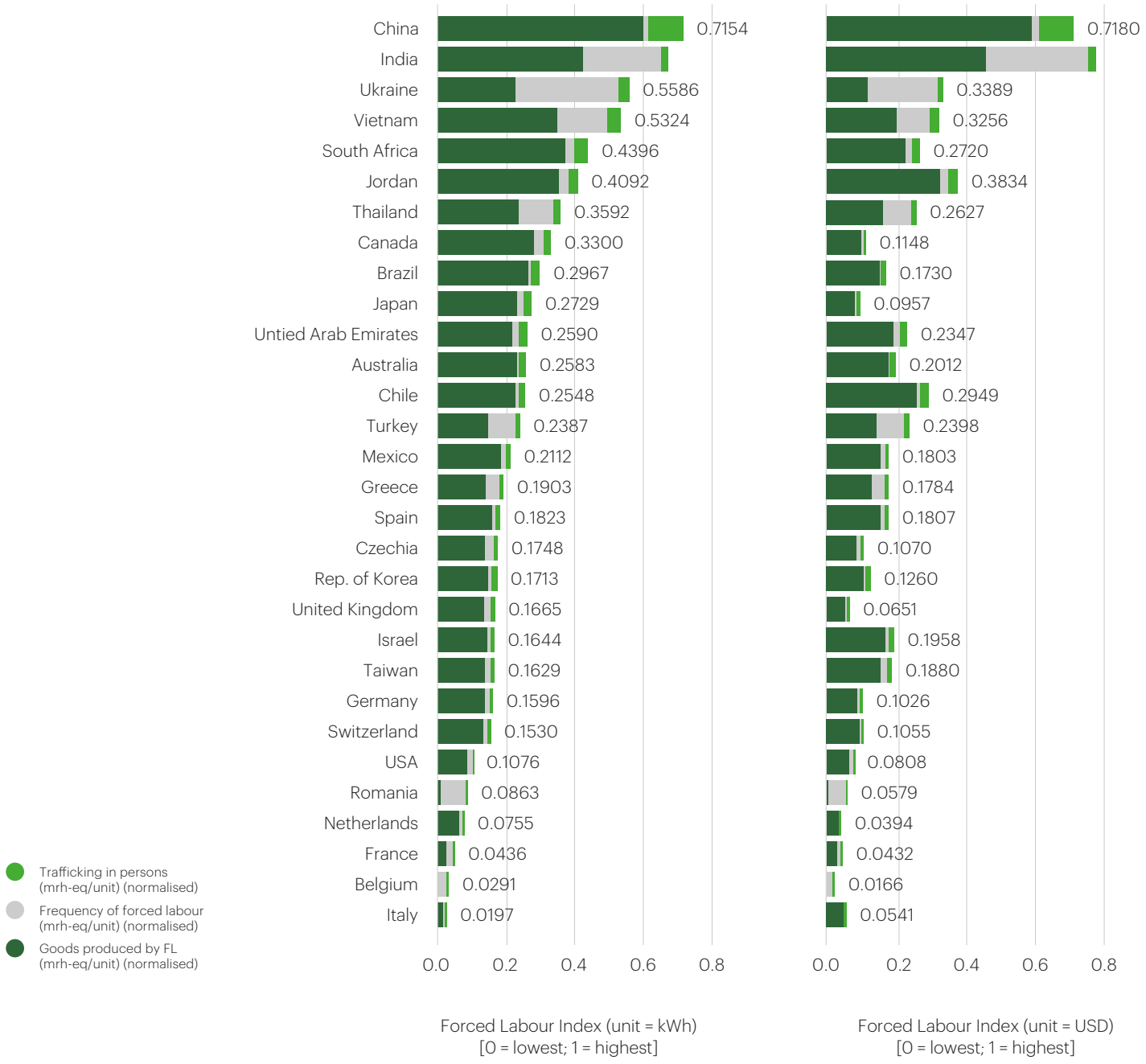
90 Manfred Lenzen, Daniel Moran, Keiichiro Kanemoto and Arne Geschke (2013). 'Building eora: a global multi-region input–output database at high country and sector resolution', *Econ. Systems Res.,* 25(1): 20–49, available at https://doi.org/10.1080/09535314.2013.769938; Maister et al., 2020.

91 Lenzen et al., 2013.

slavery in XUAR, and in order to ensure greater currency and relevance in our results, we updated this data in key respects, to reflect more recent US Department of Labor data especially on goods made with forced labour.

By combining this trade data, PV inventory data, and PSILCA data, we can estimate the forced labour risk in PV, on-grid solar energy production for the top 30 producing countries. (See Figure 5, below.) The method is described in more detail in the full research report. It is important to note certain limitations. These include the fact that it does not incorporate modern slavery risks associated with battery production, nor child labour risks associated with PV energy production. Due to limited time and computational resources, our published results cover only the top 30 PV, on-grid producing countries (though these represent 96% of global production). Given the high number of CSS components in the global solar energy value-chain, our model of flows within the value-chain omits flows representing less then 2% of imports for each destination country. The underlying forced labour metrics in PSILCA also contain certain limitations, including, for example, the inclusion of forced marriage as an aspect of 'frequency of forced labour'. These limitations and their implications are discussed at greater length in the full research report.

Figure 5: Estimates of forced labour risk in 30 countries' PV, on-grid energy production systems, not accounting for heightened risk of forced labour in XUAR



Note: these estimates are based on a combination of 2018 and 2022 data, with the risk level for 'frequency of forced labour' (FFL) in the CSS relevant to Chinese polysilicon production set by PSILCA at 'very low risk'. The impact of a potential change in the FFL risk level in Chinese polysilicon production to a higher risk level is explored in section 3.4.4, Figure 19 and through the interactive graphics available at https://tabsoft.co/3Hv2T-BQ.

Forced labour risk metrics for the energy sector

To calculate the forced labour risk involved in the production of on-grid PV electricity, we draw on three indicators for which each CSS component (i.e., each step in the value-chain) is scored in the PSILCA dataset: frequency of forced labour (FFL), foods produced with forced labour (GFL) and trafficking in persons (TP).

- FFL is an index based on the estimated proportion of a country's population in modern slavery, as estimated in the Walk Free Foundation (WFF) survey-based Global Slavery Index (GSI).[92]
- GFL provides an index based on the number of commodities or specific goods classes in a given sector that are produced in whole or in part by forced labour, as identified in an authoritative list published by the US Department of Labor's International Labor Assistance Bureau (ILAB).[93]
- TP provides an index based on countries' tier ranking in the authoritative US Department of State annual *Trafficking in Persons Report*.[94]

Using the data integration and modelling process described above, we calculate the FFL, GFL and TP score for on-grid PV electricity production in the top 30 producer countries. We then combine these into a Forced Labour Index score, as follows:

$$FLI = FFL_{scaled\ i} \cdot Wf_{FFL} + GFL_{scaled\ i} \cdot Wf_{GFL} + TP_{scaled\ i} \cdot Wf_{TP} \quad (1)$$

$$FFL_{scaled\ i} = \frac{FFL_i - \min(FFL)}{\max(FFL) - \min(FFL)} \quad (2)$$

$$GFL_{scaled\ i} = \frac{GFL_i - \min(GFL)}{\max(GFL) - \min(GFL)} \quad (3)$$

$$TP_{scaled\ i} = \frac{TP_i - \min(TP)}{\max(TP) - \min(TP)} \quad (4)$$

where *i* s the country and *wf* is the weighting factor for each of the indicators. We assigned *wf* as follows: FFL=0.3, GFL=0.6, and TP=0.1. We assigned these weighting factors based on the conformance between the indicator in question and the object of our research inquiry: understanding how changes in risk in the production of specific goods or other business inputs affects risk elsewhere in the value-chain. Since the GFL indicator is most directly related to this, we assign it the highest weight factor; then assign FFL the next highest weight factor (as frequency of forced labour is the next most directly relevant indicator); then the lowest weight factor to the TP score. Since, however, we use an indexing approach, so long as we calculate the FLI consistently across countries, the weight factor we assign will not affect these relative/comparative results.

92 Walk Free Foundation (2018). *The Global Slavery Index,* 2018, available at https://www.globalslaveryindex.org/resources/downloads/.
93 ILAB, 2018. 'List of Goods Produced by Child Labor or Forced Labor', *Bureau of International Labor Affairs,* 2018, available at https://www.dol.gov/agencies/ilab/reports/child-labor/list-of-goods/
94 Maister et al., 2020.

The FLI composite score then allows us to generate two final output measures, FLR/kWh and FLR/USD LCOE, where: FLR is forced labour risk (=FLI); FLR/kWh measures the embodied lifecycle forced labour risk in the generation of one kilowatt-hour of energy through that production method in that country, up to the 'gate'; and FLR/USD LCOE measures the same, but for one US dollar LCOE. FLR/kWh and FLR/USD LCOE are measures of the life cycle forced labour risk that cascades into solar energy produced in a country, from all the inputs in the value-chain that generate that electricity.

Different aspects of this diagnostic may be better suited to use in different risk management contexts. For example, because the FFL indicator is based on a general estimate of frequency of forced labour in a population, analysis based on that indicator may be most relevant for thinking about how to address community-based modern slavery risks. This may be useful for place-based, development and community-level intervention programming related to solar energy supply-chains. In contrast, buyers, importers or financiers that are looking to use the method to assess the risk of the presence of components made with forced labour might find the GFL indicator more useful. Regulators may prefer to use the composite FLI metric since, as we describe below, it strengthens our ability to compare how different inputs into solar energy production are associated with different kinds of forced labour risk.

Estimates of forced labour risk in solar energy production

The overall results of our estimation are presented in Figure 5 above. This shows the forced labour risk in medium risk hour equivalents per kWh (left) and forced labour risk per USD LCOE (right) for the top 30 on-grid PV producing countries.

On the left, China and India emerge as the countries with the highest forced labour risk in mrh-eq/kWh. In both cases, this is a result of their production systems including a high risk derived from goods produced with forced labour (GFL). However, India, as well as the third-ranked country, Ukraine, also include relatively high FFL scores. This suggests that their solar energy production systems are based on value-chains that involve relatively high numbers of hours worked in countries with generally high frequency of forced labour (FFL) – including India and Ukraine, themselves.

However, a somewhat different picture emerges when FLI is transformed into FLR/USD LCOE, a measure that may be useful to buyers and consumers (on the right of Figure 5). Because of its higher LCOE for solar energy, India emerges with a slightly higher FLR/USD LCOE than China. Ukraine, Viet Nam, South Africa, Jordan and Thailand continue to form a second tier, but are joined by other countries with relatively high LCOEs and FLIs – such as Chile.

Identifying sources of risk within the value-chain

The true power of this estimation method emerges when we use it to examine the value-chains that generate each of these aggregate risk scores. This allows risk analysis on a number of dimensions not currently available: 1) inventory and life cycle stages; 2) direct v. upstream risk; and 3) system-level significance. A sense of the other potential dimensions of analysis available through this method is provided by the country risk profile for the United Kingdom offered in Figure 6. Interactive country profiles for all 30 countries are available online at https://tabsoft.co/3K80caK, and non-interactive images are available in Appendix 2 of the full research report.

Figure 6: Forced labour risks in on-grid solar energy production – UK country profile

These country profiles summarise data used in and produced by the method for estimating forced labour risk in countries' on-grid PV energy production systems described in 'The Energy of Freedom'?. Solar energy, modern slavery and the Just Transition.

Users can choose which country to profile, type of forced labour risk to focus on (GPL, FFL or TP), and risk metric to use (mrh-eq/kWh or mrh-eq/USD LCOE).

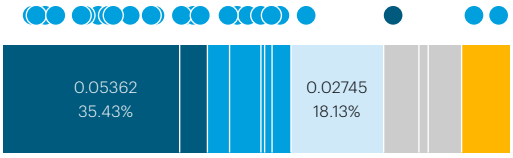
The data used is a mixture of 2018 and 2022 data (see the report for more details), with one exception: for Frequency of Forced Labour (risk change), the user can select between 5 risk levels associated with Chinese production of polysilicon (CSS: 'CN-Other electric machinery and equipment'). This allows the user to see how variations in the forced labour risk associated with that specific value-chain input cascade down to the country-level energy production risk profile.

Levelised Cost of Energy (LCOE)

LCOE is a measure of the average net present cost of electricity generation over its lifetime.

United Kingdom

0.1513 USD/kWh



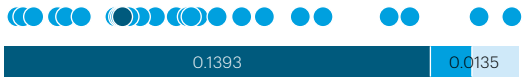
PV module and inverter
BoS hardware
Installation and civil works
Other soft cost
O and M cost

Forced Labour Index (USD) [0=lowest, 1=highest]

0.06514 mrh-eq/USD

Forced Labour Index (kWh) [0=lowest, 1=highest]

0.1665 mrh-eq/kWh



Trafficking in persons (unit) (normalised)
Frequency of forced labour (unit) (normalised)
Goods produced by FL (unit) (normalised)

LCOE by breakdown (group) and Top 10 import/ producer country

Producer country	PV module and inverter	BoS hardware	Installation and civil works	Other soft cost	O and M cost	Total
UK	0.0101	0.0125	0.0274	0.0142	0.0229	0.0871
China	0.0109	0.0008				0.0117
Germany	0.0066	0.0037				0.0103
Netherlands	0.0086	0.0015				0.0101
USA	0.0063	0.0004				0.0067
Japan	0.0038	0.0000				0.0038
Italy	0.0009	0.0014				0.0023
Austria	0.0020	0.0001				0.0022
France	0.0017	0.0004				0.0021
Vietnam	0.0016					0.0016
Total	0.0524	0.0208	0.0274	0.0142	0.0229	0.1377

Risk of forced labour by breakdown (group) and Top 10 producer/importer country

Forced labour Indicator Goods produced by FL | **Risk variation** Very low risk | **unit** mrh-eq/kWh

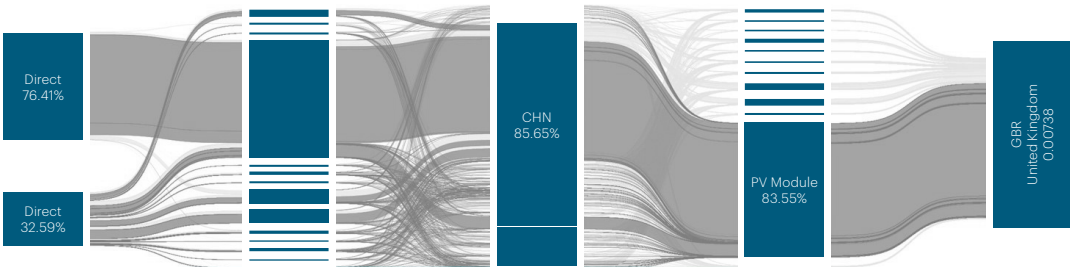
Producer country	PV module and inverter	BoS hardware	Installation and civil works	Other soft cost	O&M cost	Total
China	0.00532	0.00036				0.00568
Malaysia	0.00056	0.00000				0.00056
UK	0.00012	0.00014	0.00010	0.00014	0.00005	0.00055
Netherlands	0.00009	0.00001				0.00011
Germany	0.00007	0.00002				0.00009
China, Hong Kong	0.00007	0.00000				0.00007
India		0.00005				0.00005
USA	0.00005	0.00000				0.00005
Thailand	0.00004	0.00000				0.00004
Vietnam	0.00003					0.00003
Total	0.00636	0.00059	0.00010	0.00014	0.00005	0.00724

Sankey diagram: Tracing of risk of forced labour in the supply chain

Indicator: Frequency of Forced Labour — unit: mrh-eq/kWh

Breakdown to trace

PV Module



Frequency of Forced Labour (FFL): estimates proportion of a country's population in modern slavery, as estimated in the Walk Free Foundation (WFF) survey-based Global Slavery Index (GSI) (Walk Free Foundation, 2018). **Goods produced by forced labour (GFL):** provides an index based on the number of commodities or specific goods classes in a given section that are produced in whole or in part by forced labour, as identified in an authoritative list published by the US Department of Labour's International Labour Assistance Bureau (ILAB) (ILAB, 2018). **Trafficking in persons (TP):** based on a country's Tier ranking in the *Trafficking in Persons Report* published annually by the US Department of State. **Forced labour index(FLI):** based on the integration and normalisation (min-max method) of the three indicators (FFL:30%, GFL:60%, TP:10%). **Risk variation:** Change in risk of **Frequency of Forced Labour**

A. Inventory and life cycle stages

Our method allows identification of how different components of the on-grid PV production system (such as the module and inverter, the balance of system (BoS) hardware, installation, financing and design, transportation) contribute to the overall forced labour risk measure. Because S-LCA is based on economic relationships, the larger the contribution of a particular inventory 'breakdown' to the LCOE in a country, the larger that particular breakdown's contribution to the overall risk estimate. By comparing these results across different countries, we are able to understand how the different sources of modern slavery risk interact with the value-chain.

For GFL, for example, the highest mean risk (across the 30 countries studied) arises, perhaps intuitively, in the hardware components – the PV module and inverter, and the balance of system hardware. Here, Chinese PV modules represent an outlier, with both a high GFL score *and* making a relatively significant contribution to overall LCOE. For FFL, by contrast the highest mean risk arises *not* in the hardware components, but in 'Other soft costs' and 'O&M' (operation and maintenance) costs. This is explained by the fact that FFL is based on a generalized estimate of modern slavery across the entire national population, and includes not only industrial forced labour but also, for example, forced marriage. It is a sector-agnostic metric. This helps explain why, for example, India (which is estimated by the underlying GSI data used in the FFL metric to have the highest national prevalence of modern slavery), is an outlier in both FFL PV and inverter risks, and FFL O&M risks. This also points to the way that this indicator estimates risk across the full range of economic activities, and suggests some caution is needed in applying and interpreting these results.

Both the FFL and TP measures also suggest that a breakdown-level reading of these results may point to the relevance of labour intensity in understanding modern slavery risks in the solar energy value-chain. In the TP analysis, for example, China emerges as an outlier in the FLR associated with Installation and Civil Works in its solar energy production system. This is a result not only of China's high TP score resulting from its Tier 3 listing in the State Department's *Trafficking in Persons Report*, but also of the relatively large contribution installation costs make to China's LCOE. This points to the labour-intensive model of energy production in China. And it suggests it may be worthwhile exploring (through further research) whether or how to tie forced labour risk – or even broader sustainability – benchmarks for solar energy to labour intensity.

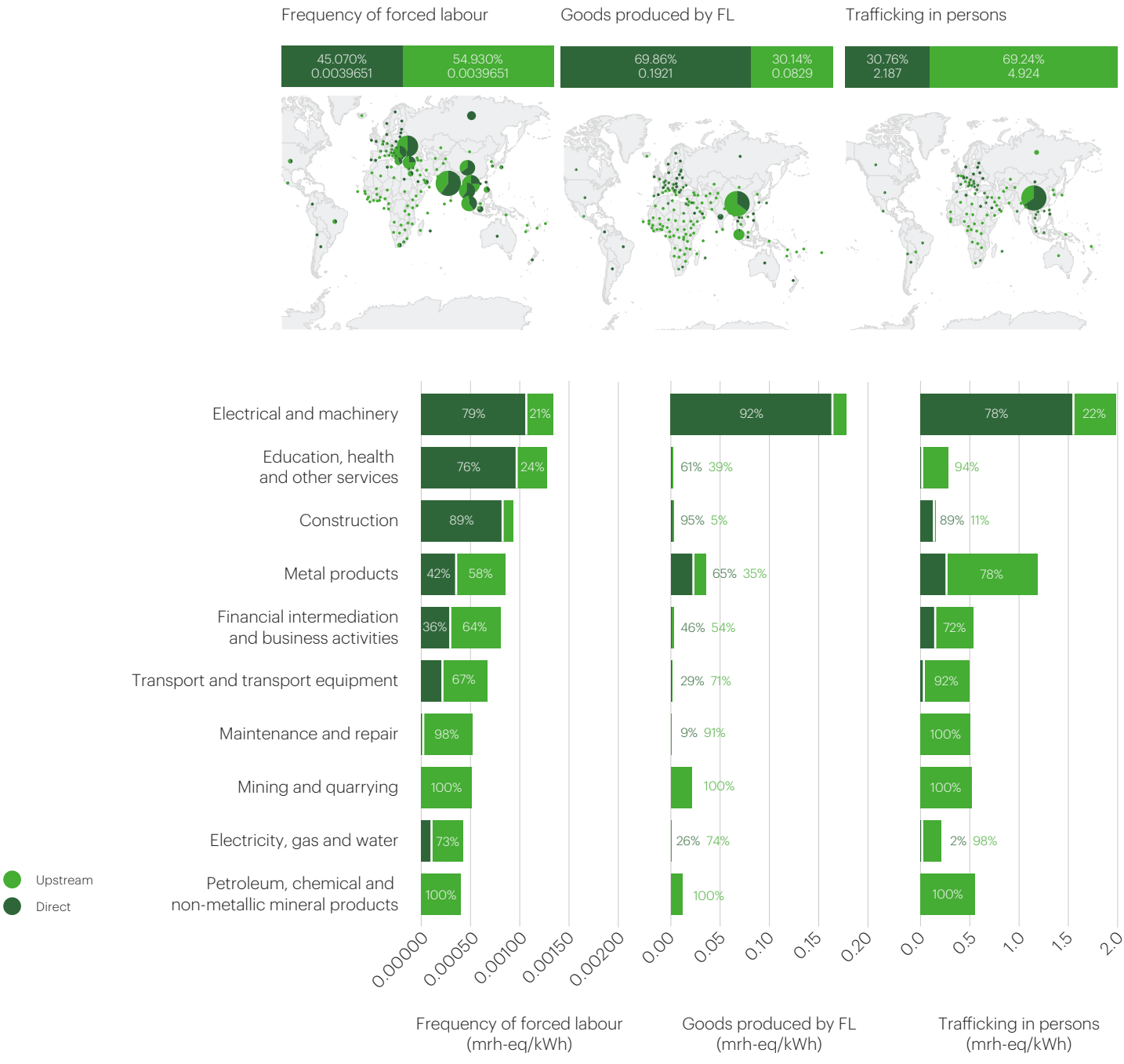
B. Direct v. upstream risk

Based on the relationships among sectors in the multi-region input/output data, we are able to map the sources of forced labour risk in the modelled value-chain. Upstream components represent 55% of FFL risk, 30% of GFL risk and 69% of TP. However, this distribution is heterogeneous geographically and by sector. Figure 7 shows how the upstream (light green) risks related to FFL come from a variety of countries, notably southeast Asia and Africa; while those (upstream) risks for GFL and TP are more likely to come specifically from China. (Recall, however, that this analysis is limited to PV, on-grid solar energy and consequently excludes, for example, Li-ion batteries.)

The bottom, bar chart section of Figure 7 shows how direct and upstream risks vary by industrial sector. 'Direct' forced labour risks – whether FFL, GFL or TP – originate overwhelmingly in the electrical and machinery sector. For FFL, the next largest source of direct risk is the 'Education, Health and Other Services' sector – which here

pertains primarily to operation and maintenance. In contrast, for GFL and TP, mining and quarrying are the secondary source of direct risk, and also the main source of upstream risk. Once again, this points to the key role that the choice of forced labour risk indicators may play in shaping risk measurement and management in the solar energy value-chain going forward, and to the potential utility of different indicators for different risk management contexts.

Figure 7: Contribution of location and sector on direct and upstream risks

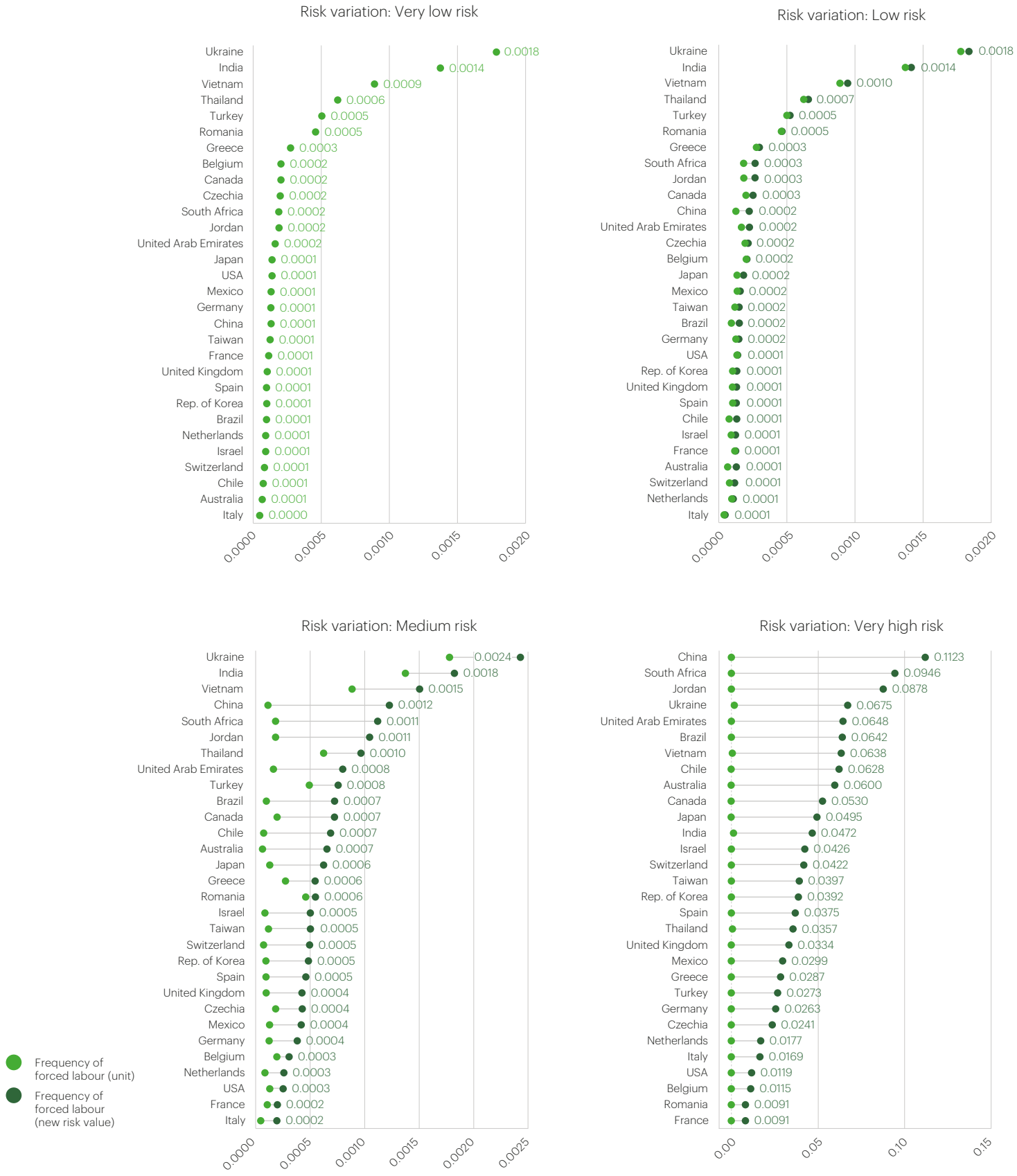


C. System-level significance – sensitivity analysis

A key question for us in interpreting these results is if or how this method will reflect changes in underlying, 'real-world' forced labour risks. How sensitive is this estimation method to small changes in underlying forced labour prevalence? Our method allows us to see how even the smallest changes in risk – at the individual CSS level – can cascade through the production system, altering both country-level results, and overall systemic risk. To demonstrate this, we changed the FFL score for the CSS component 'CN-Other electric machinery and equipment' – the CSS pertaining to polysilicon production in China – and then ran the estimation again. Figure 8 below shows how country-level on-grid PV production FLR estimates change as a result (depending on the level at which the CSS score is reset). Readers can use an interactive version of the visualisation at https://tabsoft.co/3Hv2TBQ to get a better feel for these sensitivities.

This also has important applications for understanding system-level risk. This particular CSS turns out to be central to many national PV, on-grid production systems, intervening in 95% of their value-chains. Shifting this risk score (CN-Other electric machinery and equipment, FFL) from 'very low' (the underlying PSILCA score reflecting GSI data from 2018) to 'very high' has profound effects on system risk, increasing the mean FFL across the 30 countries studied from 0.00026 to 0.04 mrh-eq/kWh. Thus a 571% increase in the FFL risk value for this one CSS translates into a 15,385% increase in the mean FFL risk score at the national production level. (Anything over a 10,000% increase indicates an outsized impact). Using the method this way, recurring analysis of all CSS scores could serve as a diagnostic for identifying which inputs into the value-chain are having the largest effect on system-level risk. This could help with risk monitoring and management at the system level, and allow risk managers to focus mitigation and remediation efforts on the most critical sectors and countries.

Figure 8: The effect of changing a single CSS forced labour indicator score on FFL FLR/kWh (mrh-eq/kWh)



4.0 Policy recommendations: justly transitioning solar energy

How can solar energy truly become 'the energy of freedom'? In the final part of the study, we identify pathways for the global solar energy sector to justly address modern slavery concerns. This analysis is based on desk review and bilateral and group consultations with key stakeholders, including an off-the-record group consultation in February 2022.

The premise of this analysis is that the current situation, with ongoing contestation of allegations of modern slavery, growing reputational and compliance costs, and ongoing risks to people, is not sustainable. A transition is coming, whether at the micro level of enterprise system reform and due diligence systems, or at the macro level of import bans and industrial policy. The question is whether this transition will be driven primarily by individual businesses, investors and governments, working unilaterally, competitively or even on an adversarial basis – or through some cooperative approach. What framework will allow the solar energy value-chain to transition justly away from a business model that tolerates modern slavery risks, and continue to play the critical role in the global energy systems that is required if we are all to mitigate or even survive climate change?

Managing risk through the system and life cycle

The identification and measurement of modern slavery risk in the solar energy production system is currently a difficult, expensive, and haphazard exercise. Limited tracking and tracing capacity within the solar energy value-chain provides one constraint. But reliable data on the incidence of modern slavery is also hard to come by, especially at the worksite, firm or project level. These constraints make it difficult for solar energy value-chain stakeholders to monitor and manage risk, not only within their own enterprises, supply-chains and portfolios, but within the solar energy production system as a whole. The development of a more scalable, reliable risk estimation method, encompassing the whole life cycle of the solar energy production system, would represent an important first step towards more effective risk management across the value-chain.

A standardized estimation method such as the one described in the previous section would improve firms' ability to identify higher risk relationships and locations that should be prioritised for more resource-intensive due diligence and engagement. Such an approach might also help facilitate the integration of forced labour risk into ESG benchmarks and standards, and into financial instruments and offerings. And that may, in turn, help spur innovation around forced labour risk management. There would also be benefits from a policy-making perspective. Such a method would allow policy actors to consider setting risk thresholds within their own organisations, or for system regulators, triggering different levels of scrutiny, or setting limits on financial

or other dealings. This may prove useful if policy actors wish to connect transition plans not to set dates, but rather to risk-based milestones.

At the same time, we should be cautious about the political effects of such a quantified (and potentially financialised) approach to risk. If policy actors tie responses to forced labour into risk metrics, that will increase the agency of market actors such as commercial risk information providers, while diminishing that of actors who have not been afforded a role in risk measurement, collection or analysis – such as victims and survivors of modern slavery.[95] This could raise legitimacy concerns and meet resistance – for example through contestation or even litigation by rights-holders.

Clarifying expectations on responsible business conduct

One way to deal with this is to involve affected communities and rights holders in the design and implementation of such risk management and governance arrangements. Our research suggests this will be particularly important to clarify a range of questions relating to responsible business conduct in the solar energy value-chain. Given the wide support they enjoy not only from governments but also business and civil society, the OECD Guidelines on Multinational Enterprises, UN Guiding Principles on Business and Human Rights, and relevant ILO standards seem to provide the starting point for such an articulation. But significant further clarification is required as to *how* these norms should be applied to the solar energy production system. Our research points to five key areas that require clarification:

A. Due diligence

Solar energy value-chain stakeholders could work together to clarify expectations on the roles of different actors in implementing the international standard on human rights due diligence captured in the UN Guiding Principles on Business and Human Rights and the OECD Guidelines for Multinational Enterprises. This could include collaborative value-chain mapping. Traceability protocols such as that offered by the Solar Energy Industries Association may be useful, and the industry may also wish to consider options such as a digital Solar 'Passport' to ensure components flowing through value-chains meet agreed ESG standards.

A key issue will involve clarifying how to conduct responsible and effective human rights due diligence (HRDD) in situations where that is resisted, including by government authorities. In some cases, it may not be possible to safely conduct independent workplace audits or site visits to assess forced labour risks, as this may in fact increase the risks to workers or other people. For example, most credible auditors now find it impossible to conduct effective and safe audits in Xinjiang.[96] Desk-based review may sometimes be possible,[97] but there will likely be an ongoing need for peer learning about the specific challenges of HRDD in this context. Chinese authorities are reported to be taking active steps to prevent individuals and firms conducting or cooperating with such inquiries relating to alleged forced labour in Xinjiang and prosecuting and confiscating property from some of those who do.

95 Dustin Mulvaney (2020). 'Integrating life cycle assessment and commodity chain analysis to explore sustainable and just photovoltaics', in Francesco Enrichi and Giancarlo C. Righini, eds., *Solar Cells and Light Management* (Elsevier, 2020): 509-527.

96 See Eva Xiao (2020). 'Auditors to Stop Inspecting Factories in China's Xinjiang Despite Forced-Labor Concerns', *Wall Street Journal*, 21 September 2020, available at https://www.wsj.com/articles/auditors-say-they-no-longer-will-inspect-labor-conditions-at-xinjiang-factories-11600697706.

97 Murphy, Laura, Kendyl Salcito and Nyrola Elimä (2022). *Financing & Genocide: Development Finance and the Crisis in the Uyghur Region* (Atlantic Council, February 2022).

In such situations, companies should seek advice from human rights experts and credible proxies with insights into the perspectives of affected stakeholders, to better understand the reality of working conditions and human rights impacts along the value chain. Companies may also need to adopt a default assumption that any work performed in a region where such due diligence is not possible, is connected to forced labour or other human rights harms.

B. Leverage

A second set of issues that any roadmap would need to address relates to how stakeholders in the solar energy system can build and use their individual and collective influence to address modern slavery risks and improve outcomes for people.

The 'Common Approach' now under consideration by some multilateral development banks offers a useful starting point. It demonstrates that investors and lenders can use their leverage to promote anti-slavery business practices in new and existing solar projects, through use of contractual modalities, commercial incentives, and non-commercial opportunities such as supplier engagement and education. Stakeholders may benefit from insights in other value-chain initiatives, for example about how to ensure such efforts avoid simply displacing risk management burdens on to suppliers, incentivising avoidance. Alternative approaches can enlist the participation of suppliers in collective, ongoing due diligence and remediation efforts, by making that conduct (rather than the result of 'absence of modern slavery in the supply-chain') the heart of the contractual commitment.[98]

A critical question for major solar energy value-chain stakeholders – including investors, developers, buyers and governments – is therefore how to develop a collective leverage strategy for engaging relevant PRC firms and government bodies to address these concerns.

C. Withdrawal and bifurcation

Where leverage proves ineffective to remediate modern slavery risks, stakeholders will need to withdraw from commercial relationships. In some contexts, governments have already signalled that this is required (e.g., under the US UFLPA) or should be considered (e.g., existing UK government business guidance). Industry associations have also begun clarifying expectations, with the SEIA having already called for its members to withdraw from XUAR by mid-2021. However, this signalling process remains haphazard and leaves a great deal unclear, including around continued engagement with, or disengagement from, firms who are receiving PV components from upstream firms using forced labour. Accordingly, a critical component of any effective roadmap for the industry will be the identification of specific milestones for collective disengagement or withdrawal from relationships with particular firms or regions, or from relationships that meet announced risk criteria.

A phased transition approach may be necessary, based on the salience of the risks posed to people.[99] One notable proposal in this regard comes from Eventide Funds, a US asset manager. It suggests an 18-month to three year, three-phase withdrawal

98 Sherman, John F., III (2021). 'No Need to Reinvent Wheels: Drafting Meaningful Human Rights Due Diligence through Model Suggested Supply Chain Contract Clauses'. *Shift Viewpoints,* March 2021, available at https://shiftproject.org/aba-contract-clauses/.

99 For more on the concept of salience, see 'Salient Human Rights Issues', n.d., *UN Guiding Principles Reporting Framework,* available at https://www.ungpreporting.org/resources/salient-human-rights-issues/.

from solar energy firms credibly tied to forced labour.[100] This might provide a useful starting point for discussion on withdrawal expectations. (See further Figure 1, above, and the full research report for further discussion.)

In order to be credible, however, such disengagement commitments must address the question of bifurcation. Will companies be expected to withdraw from commercial relationships where they receive 'slavery-free' supply from a manufacturer that is using modern slavery to supply slave-made products to other clients or other markets? This is emerging as a critically important question precisely because the dominant integrated PV manufacturers are both a) those alleged to be using polysilicon and silica made with forced labour; and b) in the best position to use their know-how, access to capital and commercial relationships to quickly build new, 'slaver-free' supply. Slavery-free solar-energy demand could end up cross-subsidising the continued use of forced labour.

Yet the creation of an expectation that buyers and investors *not* do business with those suppliers will only be credible if and when buyers and investors have access to truly slavery-free alternative supply.

D. New, slavery-free supply

Given the lead-times and sizeable capex for developing new PV production and formal cobalt extraction capacity, there is a need for governmental actors to lay out a credible sectoral development pathway that provides the tariff environment, public procurement commitments and financial support necessary to secure investment in modern slavery free capacity, particularly in silica and polysilicon production.

Building blocks for such an approach are available. SolarPower Europe's call for an EU solar supply-chain strategy points in this direction.[101] The public procurement commitment made by Australia, Canada, New Zealand, the UK and US, pursuant to the *UK Call to Action on Forced Labour, Modern Slavery and Human Trafficking* could offer a way into such a discussion, for example if those countries agreed to take a coordinated approach to how they will manage modern slavery risks in their purchasing of solar power and/or financing of new solar projects. The US-EU Trade and Technology Council might provide a venue for trans-Atlantic discussion of such issues. And given India's important potential role in the PV value-chain, the International Solar Alliance, or the Quad, could also be useful forums for exploring coordinated industrial strategy for developing new, 'clean' supply. France also has an important role to play here, given its own *duty of vigilance* supply-chain law, its leadership of the International Solar Alliance and its role in chairing Alliance 8.7, the UN's anti-slavery group.

E. Remedy

The final component that any roadmap would need to encompass, to ensure its legitimacy and sustainability, is a set of expectations regarding remedy for harm. To date, few policy proposals have been offered to address the modern slavery already suffered in the production of existing solar panels and batteries. The UN Guiding Principles on Business and Human Rights and OECD Guidelines for Multinational

100 Eventide, 2022

101 Rai-Roche, Sean (2022). European solar developers call for solar supply chain strategy, target 20GW of manufacturing capacity by 2030. *PV Tech*, 27 January 2022, available at https://www.pv-tech.org/european-solar-developers-call-for-solar-supply-chain-strategy-target-20gw-of-manufacturing-capacity-by-2030/.

Enterprises set out a shared expectation that companies provide or enable remedy for human rights harms which they have caused or contributed to.

A roadmap would need to set out how different stakeholders are expected to provide or enable remedy in different circumstances. Since it may be difficult to identify specific individuals harmed by modern slavery in the solar energy value chain in some circumstances (whether in XUAR or DRC), the solar energy industry may need to work with stakeholders to identify creative ways to enable effective remedy. This could include funding representative and community organisations, supporting those displaced by modern slavery systems, or supporting broader fact-finding and accountability initiatives. Here, lessons from cobalt production-oriented initiatives, and in other value-chains (such as in the garment and apparel sector) may be useful sources of learning.

How will this uncertainty be addressed?

The absence of clarity on these expectations may impede financing and roll-out of solar power. It also makes it more difficult for stakeholders to build the cooperation frameworks, internal risk management systems and broader infrastructure – in other words, the 'regime' – needed to address modern slavery concerns. So how can this uncertainty be addressed?

Our analysis suggests that different policy actors currently offer very different answers to this procedural question. Those espousing the 'Rights' Policy Current argue that expectations on responsible business conduct in this space will emerge from rights enforcement, by individuals and states, through courts, and through multilateral forums such as the WTO and ILO. Even if this is so, however, that process is likely to take many years, placing many people at risk of modern slavery in the meantime, and leaving value-chain stakeholders with ongoing uncertainty.

This is one reason why the second current has emerged, focused on Supply-Chain based solutions, in which states set clear expectations on responsible business conduct, and markets in turn respond by developing cost-effective solutions. Our analysis suggests that this approach faces two challenges in the solar energy/modern slavery context.

First, states have diverging views about what these parameters for responsible business conduct should be (based in part on different aspirations for the global economic order) and are sending different signals to the market. On certain questions, such as the bifurcation issue (whether it will be acceptable to buy slavery-free products from solar manufacturers that sell slave-made products to other buyers), states are so far silent. Yet this is a very real, live and pressing question for those actors looking to make significant investments in, or offer financing to, the solar energy industry, such as development finance institutions. Without clear engagement by state policy actors, financial actors may soon emerge as the default policy brokers in this space. This raises important process legitimacy – and even procedural justice – questions, given the limited access that some actors, such as affected communities, have to these financial policy circles and deal-making processes.

A third approach to resolving these issues is however also emerging, in which state actors take a clear leadership role: the Autarky based approach. In this approach, we see governments actively considering onshoring, re-shoring and 'friend-shoring' of solar energy value-chains, both as a way to avoid modern slavery risks, and to strengthen sovereign control over strategic resources. This approach raises its own questions. For one thing, it may sacrifice the collective welfare gains such

as improved innovation that free trade has long been argued to offer. That may come with real costs – such as a slower pace of decarbonisation, and an increase in broader geostrategic competition. An Autarky-based approach that promotes the development of new PV production capacity may also do little to reduce modern slavery risks within existing capacity. And it may be of limited relevance to those parts of the value-chain where production is constrained by resource distributions outside states' control – such as the geomorphology of cobalt deposits.

This leads us, then, to the final Policy Current, which seeks to govern solar energy production through Collective Action by diverse system stakeholders. It has played an important role in clarifying expectations of responsible business conduct in cobalt production. This strongly suggests that, in order to be sustainable, the governance of production conditions cannot be shaped only by the interests and preferences of downstream actors (such as buyers), but also needs to factor in the interests and preferences of upstream actors (such as producer communities). This is consistent with the emerging emphasis on 'social dialogue' in Just Transitions thinking.[102] Yet such an approach of co-design and cooperative governance by stakeholders along the value chain is largely absent, to date, from the solar industry.

One reason for this may be the absence of a trusted forum for dialogue on these issues. The relevant international organisations on solar and renewables – such as IRENA and the International Solar Alliance – have yet to engage in a meaningful or sustained way with supply-chain social impacts. Industry associations – such as SEIA, SolarPower Europe, SolarEnergy UK and the Clean Energy Council in Australia – are beginning to engage with these issues. But since solar power has long been seen in positive terms (as a sustainable alternative to fossil fuels), there is a learning curve to be traversed – both on procedural questions (how to conduct effective social dialogue) and on substantive questions (what interests and norms are at stake, and what solutions are possible). Other forums, such as the G7 Trade Ministers process and the US, UK, Australia, Canada and New Zealand cooperation on public procurement and modern slavery (under the UK Call to Action) may also be relevant for testing and actioning specific policy ideas in certain parts of the solar energy production system, but will not offer the inclusive, neutral forum needed to engage all system stakeholders effectively.

Solar energy value-chain stakeholders may therefore need to consider developing a new, bespoke multistakeholder initiative or forum to grapple with these issues, especially in relation to PV production systems. Experiences in analogous initiatives related to conflict minerals, cobalt and batteries may be instructive – or even offer infrastructure on which such discussions could be initially piggybacked. Our analysis suggests that an inclusive approach should be pursued, guided by the OECD's suggestion that consultation should focus on those most affected by a particular production process or system – not those most influential within or over it.[103]

A multistakeholder initiative or forum focused on modern slavery and other human rights risks associated with the solar energy value-chain could provide a sandpit for developing new practical solutions such as passports, certification and/or labelling approaches, or setting common certification standards. This may prove important

102 S. Smith (2017). *Just Transition: A report for the OECD.* (Paris, May 2017), available at https://www.oecd.org/environment/cc/g20-climate/collapsecontents/Just-Transition-Centrereportjust-transition.pdf

103 OECD (2019). *Interconnected Supply Chains: A Comprehensive Look at Due Diligence Challenges and Opportunities Sourcing Cobalt and Copper from the Democratic Republic of the Congo,* Paris, 15 November 2019, available at https://mneguidelines.oecd.org/interconnected-supply-chains-a-comprehensive-look-at-due-diligence-challenges-and-opportunities-sourcing-cobalt-and-copper-from-the-drc.htm.

to ensure that human rights standards are not instrumentalised in a geostrategic competition for regulatory influence over global solar energy systems, through duelling certification standards (as has occurred in the palm oil sector, for example).[104]

Towards a global roadmap

All of the preceding analysis points in one direction: to the need to develop a shared 'roadmap' for transitioning global solar energy production to be modern-slavery free. This would take the sector beyond the Supply-Chains approach towards a Collective Action approach. Lessons from other international efforts to address large-scale modern slavery systems, such as in the production of Central Asian cotton, may be instructive here.[105]

Our study suggests it may be possible to develop such a roadmap. The reporting and due diligence frameworks currently under discussion motivate a bare-minimum response from markets that does little to address the underlying drivers of modern slavery risks – and therefore does not address the underlying legitimacy and sustainability problems the sector faces. An announced roadmap for transitioning the value-chain could help stakeholders align conduct and incentives – including financial and economic incentives, such as sustainability-linked finance, or tax credits – to push businesses towards a more responsible business model that accounts for and addresses the system-level effects of solar energy-related industrial policies in energy production, storage and in related high-use industries such as transportation.[106]

Financial actors may have an important 'stewardship' role here and seem well positioned to learn from experiences in PRI and emerging financial coalitions focused on the Just Transition. Financial institutions could work together to agree transitional arrangements for the path towards zero modern slavery risk in solar energy value-chains. There may need to be transitional arrangements which accelerate progress down that path by linking product and capital costs to modern slavery risk metrics. That would be facilitated by the adoption of a scalable forced labour risk estimation method, like that demonstrated in this study.

Such an approach would create greater certainty for developers, investors and consumers, and help create efficiency by allocating costs to those that are the highest sources of risk in the system. The current approach, which relies on relatively non-uniform, unscalable and organic risk identification process of civil society actors raising complaints with US CBP and other enforcement agencies, is less efficient. It is less predictable, and spreads risk-mitigation costs across all actors, rather than allocating them – more justly – to those that are, in fact, the greatest source of risk.

104 James Cockayne, *Developing Freedom: The Sustainable Development Case for Ending Modern Slavery, Forced Labour and Human Trafficking,* UNU-CPR, 2021, available at https://cpr.unu.edu/research/projects/developing-freedom.html#outline

105 Ibid.

106 Erin Mayfield and Jesse Jenkins (2021). Influence of High Road Labor Policies and Practices on Renewable Energy Costs, Decarbonization Pathways, and Labor Outcomes. Working Paper, Net Zero America, Princeton University, available at https://netzeroamerica.princeton.edu/img/Working_PaperHigh_Road_Labor_and_Renewable_Energy-PUBLIC_RELEASE-4-13-21.pdf

Engaging China

A key question is whether it will be politically feasible to involve Chinese stakeholders in the development of such a roadmap. Chinese manufacturers are dominant in many tiers of the existing supply-chain. And increasing Chinese uptake of solar energy will be central to decarbonisation efforts in the years ahead. Yet our research suggests that Chinese voices are currently largely absent from discussions over how to transition the solar energy industry to arrangements that reduce modern slavery risks, in part because of the barriers to such participation, such as risk of criminal liability, that exist under Chinese law.

This suggests there is a need for a dedicated effort to explore ways to reframe these debates in ways that may facilitate Chinese participation, without sacrificing the interests of other stakeholders (such as victims or survivors). Significantly, our research has revealed glimpses of one possible such pathway, focused on WTO and trade law remedies. As we explain further in the full research report, several sources that we engaged during our research for this study suggested that the Chinese government may be signalling that it would find this an acceptable ground on which to engage in policy debate – and potentially to resolve aspects of the disputes relating to – forced labour in XUAR. Here, it is notable while the US' bar on imports of goods made with forced labour was grandfathered in when the US acceded to the WTO, other jurisdictions that are contemplating similarly wide-ranging bans (such as Australia and the EU) do not enjoy such a historical carve-out from the GATT commitment to free trade. If these import and related bans are to survive legal challenge, they will need to be written in a way that reflects existing jurisprudence on what constitutes a permissible trade barrier, including avoiding discrimination on product origin. The European Commission's move to frame any ban on forced lab our goods as a product withdrawal instrument, rather than import ban, points in just this direction.

Given the divergent economic and political interests in play in this debate, it may ultimately not be possible to develop such an approach at the global level. It may be necessary first to experiment at the local or regional level or, for example, with a trans-Atlantic grouping (for example through the US-EU Trade and Technology Council, or the UK Call to Action's public procurement sub-group). Projects such as the Forum for the Future's Responsible Energy Initiative may provide a vehicle for country level dialogue. Nonetheless, it will be important to try to overcome the Autarkic and mercantilist tendencies emerging in contemporary Green Industrial Policy,[107] and articulate a set of shared expectations about responsible handling of modern slavery risks and allegations.

Such a 'roadmap' for transitioning the solar energy sector will be critical to ensuring that it is regarded in future not as a source of modern slavery risk, but as 'the energy of freedom'. How different policy actors suggest we can achieve that result tells us a lot about not only their conception of a 'Just' transition, but more broadly of their preferences for global economic order. Whether solar energy will prove to be 'the energy of freedom' for energy consumers alone, or also for workers and producer communities, has not yet been decided. The policy choices we make around these questions in the months and years ahead may reveal much about the emerging political economy of the global Just Transition – and the freedoms that the emerging global order will offer, and deny.

107 Allan, Lewis and Oatley, 2021; Bordoff and O'Sullivan, 2022.

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Published July 2022

To cite this report: British Academy (2022), *'The Energy of Freedom'? Solar energy, modern slavery, and the just transition*, The British Academy, London

doi.org/10.5871/just-transitions-s-i/J-C

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