University of Nottingham
Rights Lab

‘The Energy of Freedom’?

Solar energy, modern slavery and the Just Transition

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Executive summary

Solar energy is critical to overcoming our dependence on fossil fuels, which is why German Finance Minister Christian Lindner recently described it as 'the energy of freedom'. Yet around 40% of global supply of polysilicon – a critical component of solar panels – comes from Xinjiang Uyghur Autonomous Region, where it may be made with state-sponsored forced labour. And between 15% and 30% of the cobalt used in lithium-ion batteries, in which solar energy is stored, comes from artisanal mines in Democratic Republic of Congo – where forced and child labour is common. Evidence suggests that several hundred thousand people have been affected by forced labour and modern slavery in these contexts in recent years.

So which is it? Is solar energy 'the energy of freedom'? Or 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?

Why this matters

Answering these questions entails figuring out how to ensure enslavement is not the unintended cost of decarbonization. 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?

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.

Equally, though, poorly designed modern slavery risk management responses could risk slowing the roll-out of solar energy, replacement of expiring capacity, and of overall decarbonization. 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."

Finding a way to address modern slavery risks without undermining solar energy 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 and end-users of solar power** for industrial, commercial or residential use, as part of emissions abatement or broader ESG programmes, or to power electric vehicles (EVs);
- **Supply-chain due diligence and disclosure** debate participants, including those involved in the current debate over the European Commission's proposed Directive on Corporate Sustainability Due Diligence, the 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.

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.

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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 incentivizing 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. Studying these debates thus helps us understand the nature and dynamics of larger transitions under way in the global economic and political order.

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, with support from 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.

Solar energy's modern slavery problem

Chinese development, economic and security policy has attracted polysilicon production to Xinjiang Uyghur Autonomous Region (XUAR) through a combination of tariff protections, low coal-fired electricity costs – and subsidized forced labour of Uyghur and other minority workers. These workforce policies are part of a larger system of carceral capitalism which has been documented as the source of a range of grave human rights abuses, including torture, sexual assault, forced sterilization and enforced disappearances. Yet XUAR now accounts for around 45% of global supply of polysilicon. By one estimate, some 97% of global photovoltaic (PV) solar panels may include components from XUAR that may have been made by forced labour.

While the Chinese government contests these allegations, reliable independent human rights due diligence and supply-chain auditing on the ground in XUAR is now effectively impossible. Researchers have been doxed, facilities raided, and China has adopted a new Anti-Sanctions Law that may criminalise cooperation with such inquiries.

As a consequence, a range of countries and bodies have now called for commercial disengagement from Xinjiang. This includes industry associations such as the Solar Energy Industries Association in the US, as well as civil society organizations such as the Coalition to End Forced Labour in the Uyghur Region. In the US, the *Uyghur Forced Labor Prevention Act* will ban the import of any goods made in whole or in part with XUAR forced labour when it comes into force in June 2022, while under section 307 of the *Tariff Act of 1930* a ban is already in place on the import of certain XUAR-linked solar manufacturers products. Tens of millions of dollars' worth of products have already been detained at the border, and analysts point to a variety of potential disruptions. Other jurisdictions, including Australia, Canada, Mexico, the EU and UK, are now actively contemplating or instituting similar bans, while other jurisdictions are imposing heightened due diligence and risk management requirements.

Meanwhile, concerns about modern slavery in the production of Congolese cobalt have also grown in recent years. In DRC cobalt production, modern slavery is not so much the product of state policy as the result of household poverty and vulnerability to income shocks. 11% of children in DRC's south-eastern copper-cobalt belt find themselves working in one sector or another, often alongside their parents. A range of industry-backed efforts have sought to tackle this, involving both cobalt buyers and traders (such as China's Huayou and Switzerland's Trafigura) and other value-chain stakeholders such as BMW, Ford, IBM, Samsung and institutional investor groups such as Principles for Responsible Investment (PRI). The OECD has provided a venue for learning, policy development, and coordination. Many of these efforts have focused not only on changing supply-chain risk management practices, but also on place-based interventions to address the structural drivers of forced and child labour through formalization of the mining sector and development of alternative livelihoods.

Transitioning solar energy – a question of justice and 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. 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. 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 view on what constitutes a 'Just Transition'. Originally a term developed by the labour movement to push for greater attention to the impacts of environmental harms and policies on workers, it is now used as a shorthand to refer to the need for planning to ensure equitable management of a variety of social interests in the transition to renewables. A range of 'justice' issues can be raised by these transitions, including questions of distributive, procedural and restorative justice, and of recognition.

How modern slavery risks are handled in solar energy's transition to a central role in our economies raises all of these questions. This is a complex public policy problem that involves long-term and complex reconfigurations of policy, infrastructures, finance and power. Different policy actors will have different perspectives on what resulting arrangements will be just and make different proposals as to how to achieve a just outcome. Embedded within those proposals are a variety of different outlooks on what roles rights, states and markets should play in global energy governance – and in the global economic order. For that reason, the question of how to deal with modern slavery risks in solar energy value-chains offers a window into deeper questions about what John Ruggie called the social 'purpose' of the international economic regime.

Tracing policy debates

To make sense of these different perspectives, we traced policy debates in 10 different arenas: 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. Our results reveal four different ideal-type Policy Currents that recur across these arenas. These offer not only different framings of the problem and different proposals for solving it, but also different outlooks on which actors have agency in international affairs, and how problems get solved – through competition or cooperation.

The **Rights** current frames the issue in terms of the need to vindicate the rights of child and minority workers that have been harmed in DRC and XUAR. This current suggests that, given access to suitable forums for enforcing rights – such as courts, tribunals and multilateral organizations – accountability is possible.

The **Supply-Chains** current moves the focus from rights to risk, and from victims and survivors to business. This policy current frames the issue as a question of how to ensure business is given the right incentives to reform its conduct, systems and practices, to identify and manage modern slavery risks in the solar energy value-chain. This current tends to look to due diligence, leverage, disclosure and trade and investment rules as the way to solve the problem. Set the right market rules, and the market will find a solution.

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The **Autarky** current takes a different approach, suggesting a greater role for the visible hand of the state. It portrays the risk in question not just in terms of a risk to human or workers' rights, or to supply-chain integrity, but to the security and autonomy of the political community. It suggests that modern slavery in solar energy value-chains is part of a bigger problem of dependence on foreign producers. The solution is onshoring, re-shoring or 'friend-shoring' of production capacity, through industrial policy.

The **Collective Action** current is the newest entrant into the debate. It suggests that the best way to avoid a tension between the goal of reducing modern slavery risks and the goal of reducing carbon footprints is to transform the production system so that it doesn't generate these externalities in the first place. This can be achieved through collective action to transition the system to a new setting.

Different currents emerge as more or less influential in different policy arenas. In several western contexts, Rights thinking has evolved into Supply-Chains thinking, apparently partly as the result of coordinated efforts by a transnational coalition to diffuse specific policy ideas, especially around human rights due diligence, leverage, and import bans. But the dry and exclusive narratives adopted by the Supply-Chains current, with a focus on managerial solutions and business audiences, have left it susceptible to being outflanked by more overtly political appeals to collective identity by proponents of the Autarky current. That thinking is now gaining ground in several arenas, notably the US, where there is a push to 'take back' solar supply-chains from China. The EU is also considering a more 'strategic' approach to solar panel manufacturing.

The Autarkic approach risks bifurcation or even splintering of the global solar energy value chain, just at the moment in climate change when the welfare benefits of free trade, including the promotion of innovation and reduction of costs, may be at their most important to date. The Collective Action current represents an alternative approach, but has yet to gain significant traction in debates on polysilicon, despite thought leadership from actors such as the Responsible Energy Initiative. On cobalt, by contrast, Collective Action policy thinking appears increasingly influential, in part because of the role that the OECD and 'stewardship' oriented institutional investors such as PRI have played. This offers important lessons for thinking about how to advance debates on managing modern slavery risks associated with polysilicon production.

Estimating forced labour risks in the solar energy value-chain

One key challenge that emerges for managing these issues is the need to complement on-the-ground modern slavery risk identification methods with new risk estimation techniques. We develop and demonstrate the potential of a social life cycle assessment (S-LCA) based approach using economic input-output (EIO) data.

Our model delivers an estimate of the forced labour risk per kWh and forced labour risk per USD LCOE (levelized cost of electricity) for on-grid PV energy production in the top 30 producing countries. Given the right data, however, our method is adaptable to the firm and product level.

The method offers new advances in analysis of where in the value-chain forced labour risks arise, both by country and by component level in the cradle-to-gate production system (i.e. module and inverter, balance of system hardware, installation, financing and design, transportation). It also combines authoritative risk metrics based on the underlying frequency of forced labour in the general population, the risk of forced labour in specific goods, and assessments of the institutional and policy setting. Breaking risk in the value-chain down along these different dimensions offers differentiated applications for different risk management contexts. These range from design of preventive programming to address modern slavery risks in producer communities, to enterprise- and portfolio-level risk management aimed at excluding goods made with forced labour, to regulatory applications calibrating market access or capital cost discounts to system-level risk metrics.

We provide a range of risk visualizations and analyses to demonstrate how this estimation method could help shine new light on how risk flows through solar energy value-chains, including a set of comprehensive, interactive country profiles available at **https://tabsoft.co/3K80caK.**

Recommendations – a 'roadmap' for 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. We argue that there is a need for solar energy stakeholders to come together to develop a 'roadmap' for transitioning solar energy, so that it addresses modern slavery risks. We identify a range of elements that such a roadmap should encompass.

Adopting a shared approach to identifying and measuring modern slavery risks at the enterprise or product level will be critical for allowing improved risk tracing, monitoring, accountability and system-level risk management. The estimation method demonstrated in our study may provide a starting-point.

Stakeholders are also looking for clarification from markets and regulators on a range of questions related to responsible business conduct. While the UN Guiding Principles on Business and Human Rights and the OECD Guidelines for Multinational Enterprises provide a shared framework for these discussions, clarification is needed from solar energy value-chain stakeholders about how they intend, collectively, to implement these standards. Specific issues that need addressing include:

- **Human rights due diligence**, especially in contexts where it is resisted by the state, such as XUAR. Beyond traceability protocols and product passports, how can firms safely and responsibly conduct human rights due diligence? Will firms adopt a default assumption that where that is not possible, high modern slavery risks are assumed?
- **Leverage**. A 'Common Approach' being developed by some multilateral development banks offers a useful starting point for discussion of how to build and use collective leverage to encourage solar energy value-chain stakeholders to address modern slavery risks.
- **Withdrawal and bifurcation**. That same Common Approach, and other policy proposals such as Eventide Funds' 'phased approach', offer a way into the question of how and when withdrawal from relationships or regions will be expected. But a coordinated approach may be needed, including potentially milestones or dates certain for phased withdrawal based on the severity of risks involved, as will greater clarity on how markets and regulators will treat bifurcated supply-chains where a producer is selling both 'clean' (i.e. slave-free) and 'dirty' solar products into different markets. Will it be acceptable to buy from, or invest in, such a producer?
- **New supply planning.** There is a clear demand for policy signalling from governments, preferably on a coordinated basis, about support for investments in new, 'clean' supply – especially of polysilicon. Governments could use not only trade and tax regulation levers, but also public procurement policy to promote these investments.
- **Remedy**. International standards set out shared expectations on enabling and providing remedy for human rights harms. To be perceived as 'just' a roadmap for transitioning the solar energy sector will need to address the question of how people enslaved to produce cobalt and polysilicon already in use in the existing solar energy production infrastructure will be identified and remediated. Given the challenges of identifying these people in some cases, creative options such as funding representative and community organizations, or supporting broader fact-finding and accountability initiatives, may need to be considered.

Finally, we consider *how* such a roadmap might be developed. To be perceived as just, the process needs to be inclusive, encompassing not only manufacturers, investors and major solar energy buyers, but also key governments, affected communities and workers, and other end-users such as Electric Vehicle (EV) companies. This aligns with prevailing thinking on Just Transitions, for example the 2015 ILO *Guidelines for a Just Transition*.

A dedicated effort should be made to find a way to include Chinese manufacturers. We report indications, during our research, that framing forced labour concerns in WTO or trade law terms may provide one way that Chinese state entities could be drawn into the discussion. But if it proves impossible for political reasons to involve Chinese entities, a variety of forums – such as the International Solar Alliance, the G7, the US-EU Trade and Technology Council, the UK Call to Action on Modern Slavery, Forced Labour and Human Trafficking or the OECD could provide trusted spaces for policy discussion and development. Failing that, it might prove necessary to develop a bespoke multistakeholder initiative, along the lines of the Global Battery Alliance. Stewardship-oriented investors may also be able to play an important policy brokering role. And national or regional approaches could also be considered, to develop more place-based and bottom-up thinking.

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.

Introduction

> *Doing business around the world, global trade – all that is good and necessary. But this can never be done at the expense of people's dignity and freedom... Human rights are not for sale – at any price.*[2]
>
> President of the European Commission Ursula von der Leyen
> State of the Union Address, 15 September 2021
>
> *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.*[3]
>
> Siemens CEO Roland Busch
> 30 December 2021
>
> *Renewable energy releases us from dependence. That's why renewable energy is the energy of freedom.*[4]
>
> German finance minister Christian Lindner
> 28 February 2022

Solar energy is crucial to decarbonisation, the transition from fossil fuels to renewable energy necessary to mitigate climate change. But is solar energy 'the energy of freedom', as the German finance minister Christian Lindner recently dubbed it, or, in fact, a threat to that freedom?

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. But solar energy is made by photovoltaic panels, a key component of which – polysilicon – appears often to be made through forced labour in China's Xinjiang Uyghur Autonomous Region. And solar energy is stored in lithium-ion batteries, which rely on cobalt – much of which is mined by forced and child labourers in the Democratic Republic of Congo.

So which is it? Is solar energy 'the energy of freedom'? Or a threat to that freedom? And if the latter, what can be done to address that threat, and secure solar energy's critical contribution to the transition to renewable energy? How can we ensure that the transition does not come at the price of injustice and unfreedom – even enslavement?

Global electricity demand is expected to triple in the next three decades.[5] Under any scenario, meeting that demand while reducing fossil fuel reliance requires a massive 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.[6] Fortunately, the price of photovoltaic modules (i.e., an assembly of solar panels) has fallen more than 99% over the last 45 years, benefiting from a significant experience curve (see Figure 1). The global levelized cost of electricity (LCOE) for on-grid photovoltaic (PV) is now competitive with fossil fuels (Figure 1). With volume-weighted battery pack prices also falling by around 89% since 2021, off-grid PV may soon also be competitive with fossil fuels (Figure 2).

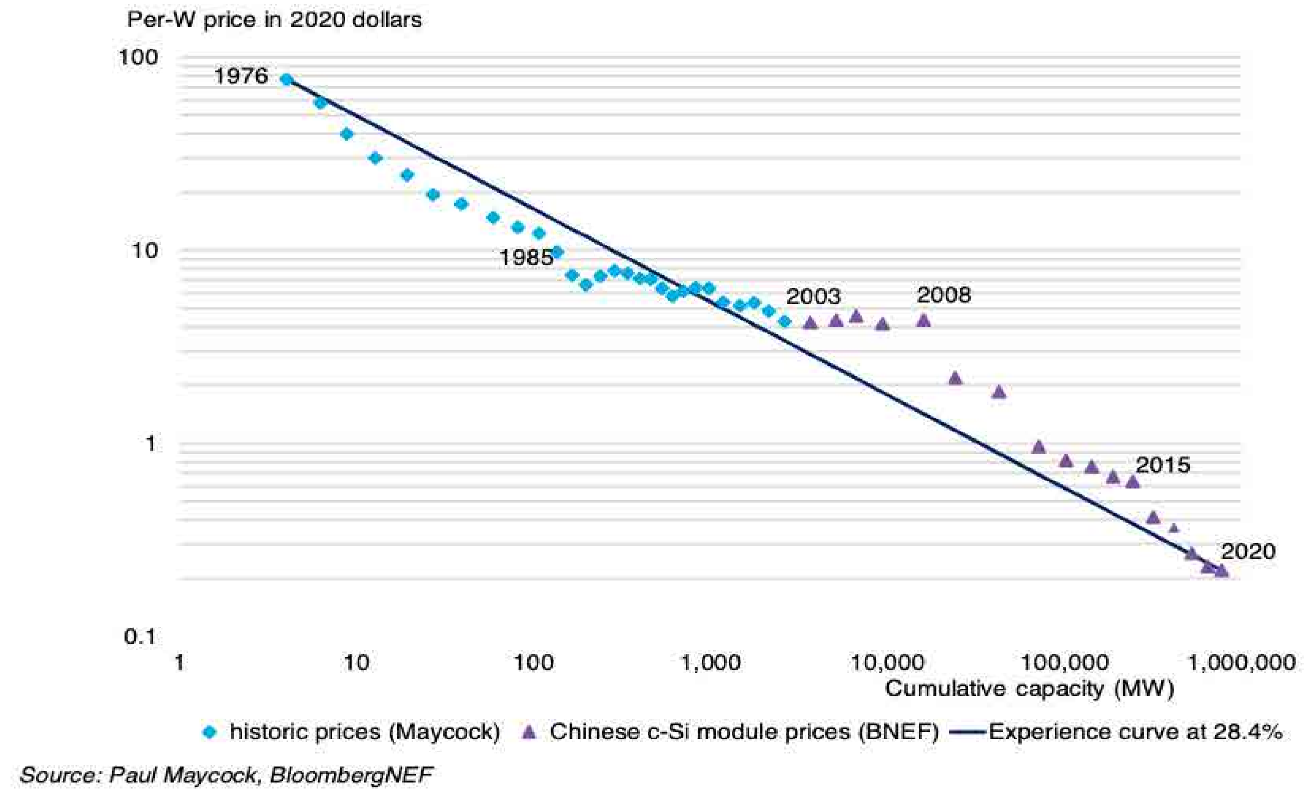


Figure 1: The levelized cost per Watt of PV energy 1976-2020

Source: Bloomberg NEF and International Solar Alliance, 2021, p. 4.

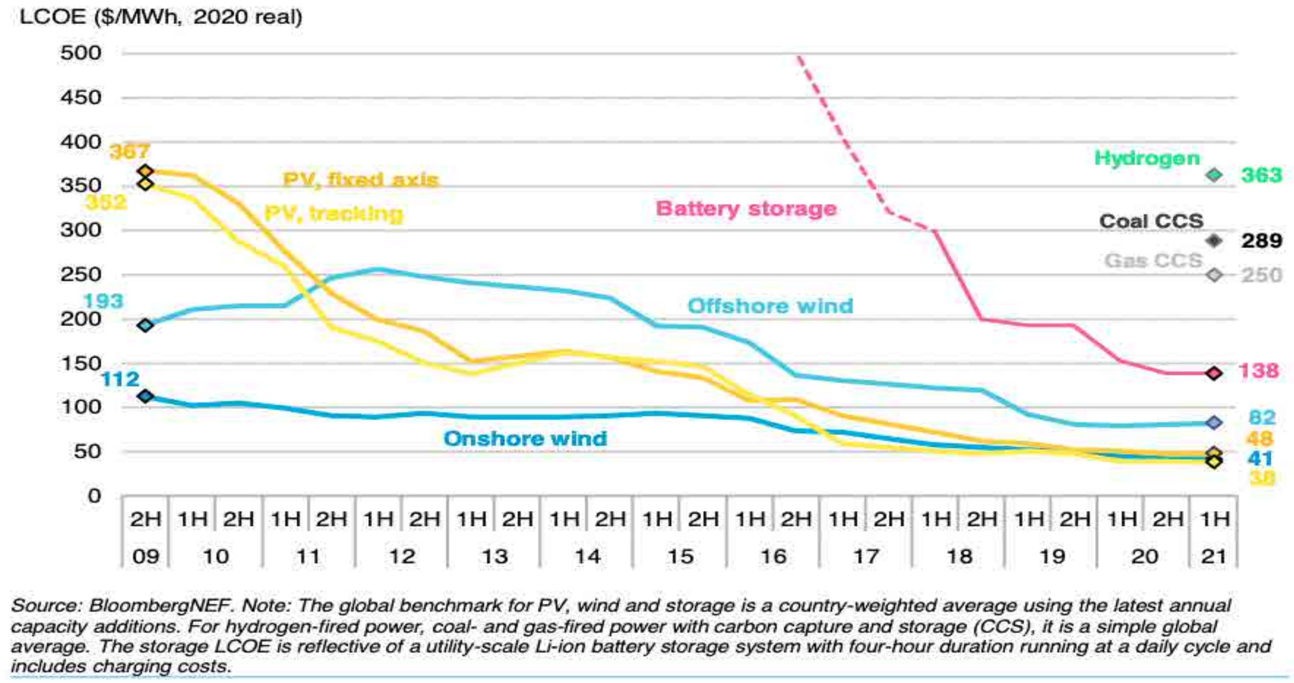


Figure 2: Global Levelized Cost of Electricity (LCOE) benchmarks for selected low-carbon technologies in the energy sector

Source: Bloomberg NEF and International Solar Alliance, 2021, p. 9.

2 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.
3 Roland Busch (2021). "Siemens-Chef warnt Baerbock vor „konfrontativer Außenpolitik" gegenüber China", *Handelsblatt*, 30 December 2021.
4 'Lindner bezeichnet Erneuerbare Energien als „Freiheitsenergien"', *Oldenburger Onlinezeitung*, 28 February 2022.
5 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
6 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.

Yet there are growing concerns around the role that modern slavery plays in solar energy.[7] (For definitions of modern slavery, forced labour and other key terms used in this report, see Figure 3.) Forced labour may be present in the production of both the photovoltaic (PV) solar panels that generate electricity from solar energy, and the batteries in which that electricity is stored. Around 40% of the polysilicon now used in solar panels comes from Xinjiang Uyghur Autonomous Region (XUAR) in China, where forced labour appears to be state policy.[8] The batteries in which solar-generated electricity are stored are also a source of modern slavery risk. Lithium-ion (Li-ion) batteries depend on cobalt. 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 in the mining population of around 250,000.[9] Demand for cobalt is expected to double by 2030, putting hundreds of thousands of people at risk.

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.

8 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**.

9 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.html;** 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**.

Modern slavery: Modern slavery covers a set of legal concepts including forced labour, debt bondage, forced marriage, slavery and slavery-like practices, and human trafficking. Although modern slavery is not defined in law, it is used as an umbrella term that focuses attention on commonalities across these legal concepts. Essentially, it refers to situations of exploitation that a person cannot refuse or leave because of threats, violence, coercion, deception, and/or abuse of power.[10]

Forced labour: According to the International Labour Organization (ILO) **Forced Labour Convention, 1930 (No. 29)**, forced or compulsory labour is "all work or service which is exacted from any person under the threat of a penalty and for which the person has not offered himself or herself voluntarily." Various indicators can be used to ascertain when a situation amounts to forced labour, such as restrictions on workers' freedom of movement, withholding of wages or identity documents, physical or sexual violence, threats and intimidation or fraudulent debt from which workers cannot escape. The **Abolition of Forced Labour Convention No. 105** adopted by the ILO in 1957 primarily concerns forced labour imposed by state authorities. It prohibits specifically the use of forced labour:

- as punishment for the expression of political views,
- for the purposes of economic development,
- as a means of labour discipline,
- as a punishment for participation in strikes,
- as a means of racial, religious or other discrimination.[11]

Human trafficking / trafficking in persons: The United Nations **Protocol to Prevent, Suppress and Punish Trafficking in Persons Especially Women and Children** ('Palermo Protocol') defines trafficking in persons (or human trafficking) as the recruitment, transportation, transfer, harbouring or receipt of people through force, fraud, deception or other forms of coercion, or the abuse of power or a position of vulnerability, for the purpose of exploitation. That exploitation could be forced labour, slavery, servitude or organ trafficking.[12]

Child labour: The ILO defines child labour as work that

- is mentally, physically, socially or morally dangerous and harmful to children; and/or
- interferes with their schooling by depriving them of the opportunity to attend school; obliging them to leave school prematurely; or requiring them to attempt to combine school attendance with excessively long and heavy work.

Whether or not particular forms of work can be called "child labour" depends on the child's age, the type and hours of work performed, the conditions under which it is performed, and the objectives pursued by individual countries. The answer varies from country to country, as well as among sectors within countries. The "*worst forms of child labour*" (as defined by **Article 3 of ILO Convention No. 182**) involves children being enslaved or exploited through forced labour or in armed conflict, involved in pornography or prostitution, illicit activities, or in 'hazardous' child labour – work that is likely to harm their health, safety or morals.[13]

Figure 3: Defining modern slavery and related terms

10 Walk Free (n.d.). "What is Modern Slavery?", available at **https://www.walkfree.org/what-is-modern-slavery/**.

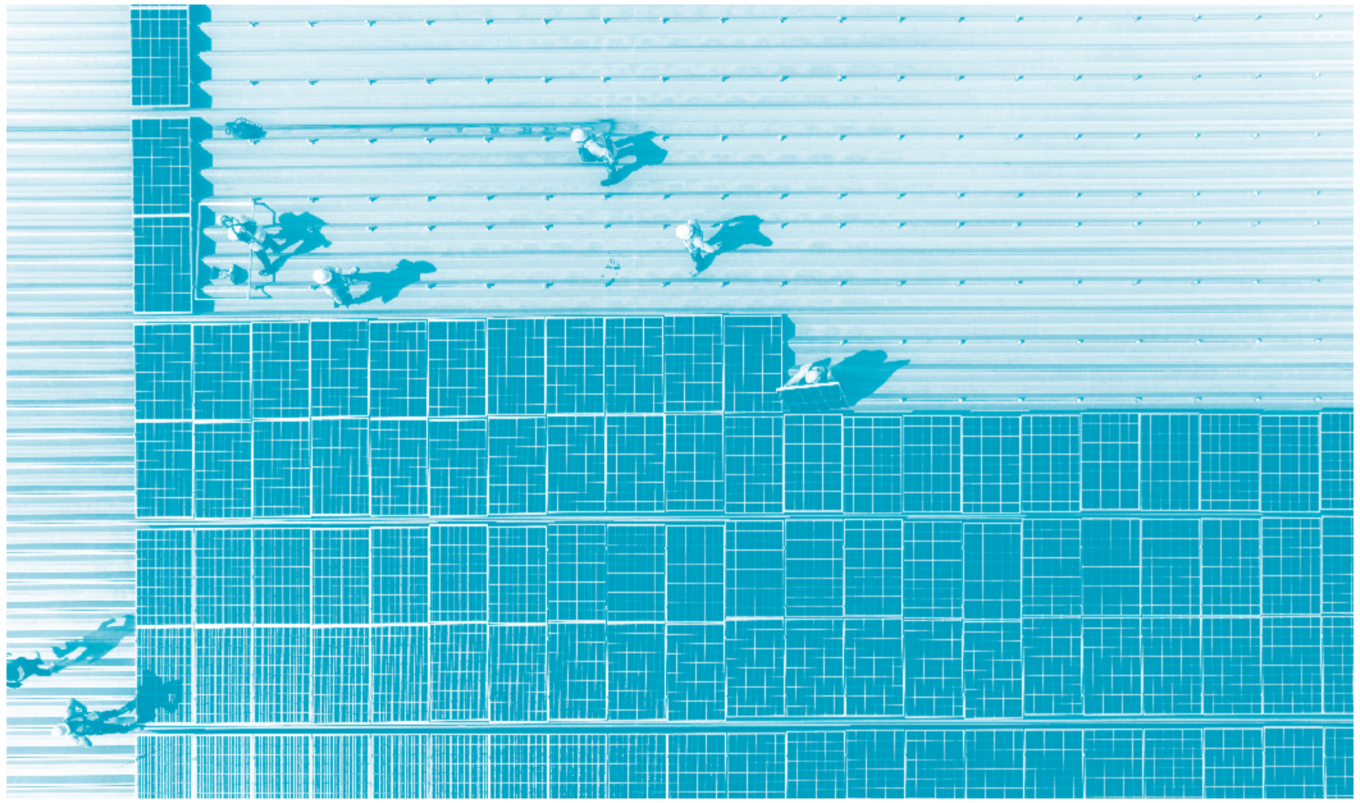
11 ILO (n.d.) "What is forced labour, modern slavery and human trafficking", available at **https://www.ilo.org/global/topics/forced-labour/definition/lang--en/index.htm**.

12 UNODC (n.d.). "Human trafficking", available at **https://www.unodc.org/unodc/en/human-trafficking/human-trafficking.html.**

13 ILO (n.d.). "What is child labour", available at **https://www.ilo.org/ipec/facts/lang--en/index.htm**.

This prospect of demand for products made with modern slavery complicates the 'justice' of the transition away from fossil fuels to renewable power. Increased enslavement risks becoming the unintended cost of decarbonisation. This risks undermining the legitimacy of the energy transition while also delaying solar energy uptake and making it more costly, as governments and market actors take steps to address modern slavery risks. New anti-slavery legislative and reporting measures in North American, European and some Asian markets may already be transforming business incentives and solar energy value-chains. There are signs of a bifurcated supply-chain emerging, with 'clean' supply-chains serving markets that exclude goods made with forced labour, and 'dirty' supply-chains supplying the rest. Modern slavery risk in the solar energy value-chain is thus emerging as a critical pinch point in global 'Just Transition' processes, with implications not only for this sector, but also for other industries, globally, that are seeking to transition away from carbon towards renewable energy sources.

Yet these modern slavery risks to the solar energy value-chain are only recently beginning to be factored into policy discussions around about the transition to renewable energy. Because the solar energy production and distribution system is relatively new, its global governance remains a contested space. A range of state, commercial and other actors are competing for influence. The technical standards, market expectations and trade and investment rules – in other words, the governance 'regime' – for the global solar energy value-chain are not yet settled. Modern slavery risks have emerged as a flashpoint for contestation of both the form and substance of that regime – including questions of voice, agency and rights. Different actors in the global solar energy value-chain, including different countries, have quite different perspectives on fundamental questions relating to the governance of multinational enterprise, including the 'purpose' of that governance.[14] This includes key issues such as the role of states and companies in identifying and managing system-level risk, the role of affected individuals and communities in shaping the rules that govern them, the rights of affected individuals to remedy for harmful business conduct, and whether system-level change is better achieved through the competitive dynamics of market competition, or through purposeful cooperation. Even where there is an appetite for cooperation, different stakeholders in the solar energy value-chain may have different perspectives on the social purpose of any resulting governance regime: is it to promote economic development and related public goods, such as poverty alleviation and conflict reduction? Is it to address climate change? Or is it to protect individual rights?



[14] 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.

Study overview

This study aims to illuminate the dynamics emerging around the governance of modern slavery risks in the solar energy value-chain. The hope is that this will assist stakeholders to work towards arrangements that help secure the contribution of solar energy to a global 'Just Transition' (a concept discussed further in section 1.3 below).

Our research included both policy analysis and development of a new approach to estimating forced labour risk in global value chains. Strengthened analysis of modern slavery risks will empower stakeholders to make more informed policy and investment decisions, for example by improving understanding of how different value-chain development pathways generate different levels of modern slavery risk, in different places. It could also help stakeholders design processes for governing the solar energy value-chain that are seen as more (or less) legitimate, depending on their distributive effects (i.e., who they impact, and how) and their procedural aspects (i.e., who is involved, in what ways, in governing the value-chain).

Our study contributes to this goal in three ways: 1) policy process tracing; 2) forced labour risk estimation techniques; and 3) policy recommendations. We begin (section 1) with an examination of the nature of the forced labour concerns raised in connection with the global solar energy value-chain, and how this generates questions about the role of solar energy in the 'Just Transition'.

In section 2, we use established policy process tracing methods to identify four major 'policy currents' being used to frame responses to modern slavery risks in debates relating to solar energy governance: Rights, Supply-Chains, Autarky and Collective Action. The four currents emerge from a desk and interview-based review of policy discourse in ten arenas of public and private governance related to the solar energy value-chain: public policy debates in seven contexts – 1) the US, 2) the UK, 3) the EU, 4) the G7, 5) Australia, 6) United Nations fora, and 7) China; and debates in three private and public-private governance contexts: 8) international solar energy industry initiatives, 9) global financial circles, and 10) multistakeholder initiatives relating to the global cobalt supply-chain. The four distinct policy currents emerge across these different arenas. Each current frames the policy puzzle in different ways, foregrounding different problems and interests, suggesting different policy responses. How these different currents interact, and which emerges as dominant in which places, will shape the governance of modern slavery risks in the solar energy value-chain – with significant broader implications for the supply of solar energy globally.

We show how transnational coalitions of policy entrepreneurs and political actors are emerging around each of these different policy currents. The balance of influence between these currents differs across contexts, depending on both prior power distributions and policy and political entrepreneurialism, and sometimes actors borrow from or mix more than one current.

By reviewing existing open source and grey literature, and through key stakeholder interviews, we map these currents on two dimensions. First, underlying assumptions about agency in global affairs – ranging from realist (state-based), through a market-oriented approach, to an 'international society' approach that recognises a role for a heterogeneous case of non-state actors, including individuals, civil society and the private sector, as well as states. Second, we plot these currents against underlying assumptions about what makes a policy solution emerge and become sustainable, ranging from a competition-based outlook to a more cooperation-based outlook. This plot 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. We see, for example, how the Supply-Chains current, which focuses on market-based solutions and has dominated debate in some policy contexts, is now being contested by a more Autarkic current – which sees as larger role for the visible hand of the state in shaping, and specifically in re-shoring, solar energy supply-chains. Elsewhere, for example in the management of modern slavery risks associated with cobalt production, we see how Supply-Chains based approaches are being influenced by a more Collective Action based approach, involving multiple stakeholders along the value-chain in transitioning systemic arrangements.

This mapping allows us to illuminate emerging points of policy conflict – and helps reveal pathways for potential policy convergence. It highlights how different policy currents empower different actors in the policy formation and implementation process, putting a spotlight on the voice and agency (or lack thereof) of affected stakeholders. We focus in particular on those communities – such as children in DRC, and Uyghurs in XUAR – vulnerable to modern slavery.

One pathway that emerges as critical for the sector's ability to converge around a shared risk-management and transition model is a strengthened capacity to identify and measure forced labour risk at the worksite, project, firm and investment instrument level. This is significantly complicated by the difficulty of using established supply-chain tracing and audit approaches in this context, given weak state capacity in DRC and state resistance to this approach in the PRC. In section 3 of the study, we therefore develop and test the viability of a *new* approach to forced labour risk estimation in the solar energy value-chain. We develop and demonstrate the viability of an estimation technique for forced labour risk per kWh (FLR/kWh), disaggregated by 5 different lifecycle components in the production of photovoltaic (PV), on-grid energy. Our demonstration operates at the national energy production system level, using export-import data (from UN Comtrade) and the latest available PV lifecycle inventory data (from IRENA). 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. An initial sensitivity analysis of our technique suggests that it may allow stakeholders to identify sources of risk more rapidly within supply-chains, targeting them for more resource-intensive due diligence, supplier upgrading and policy engagement ('leverage'). The low-cost and speed of this estimation technique also appears to make it suitable for integration into existing deal and portfolio analysis systems. Further, the technique may also be replicable for other parts of the solar energy value-chain, such as batteries, allowing extension beyond PV, on-grid applications; and to other energy production systems (such as coal, gas, wind and hydro), allowing comparison of FLR/kWh across energy sources. This could open the door to FLR/kWh being standardised in ESG analysis and even reporting.

In the final part of the study (section 4), we draw on the first three parts of the study, and stakeholder consultations conducted during our research, to identify policy process 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 aim of this section is to explore options for changing the development trajectory of solar energy value-chains, to ensure they contribute not only to a transition away from fossil fuels, but to a Just Transition – one that achieves both distributive and procedural justice.

1. Solar energy's modern slavery problem

The solar energy sector is grappling with growing reputational, compliance, market-access and financing costs arising from allegations that key components of the solar energy value-chain are made through modern slavery. Together, these risks raise important questions about the solar energy sector's place in the 'Just Transition'. In this section, we explain the modern slavery concerns that have emerged around PV solar energy production (1.1) and storage (1.2) and consider how those concerns raise difficult questions about the role of solar energy in the 'Just Transition' to renewable power (1.3).

1.1 Is solar energy being made with modern slavery?

There have been two main focuses of concern relating to the possible involvement of modern slavery in solar energy production in recent years. First, the possible role of forced labour in the production of polysilicon in China. Second, the role of forced and child labour in the production, particularly in the Democratic Republic of the Congo (DRC), of cobalt used in Li-ion batteries. We deal here with the first concern, relating to China – and in the next section with the DRC concern.

China is the dominant player in global photovoltaic (PV) manufacturing. Chinese-headquartered companies dominate at each stage of production, making 77% of the world's polysilicon, over 97% of polysilicon wafers, 83% of solar cells, and 74% of solar modules.[15] And many of those companies that are not headquartered in China nonetheless make most of their cells and modules in the country, pointing to the important role that state policies, tariffs, subsidies, geographic proximity (to suppliers and buyers) and labour costs play in China's current competitive advantage.

China's dominance starts at the headwaters of PV production – using energy-intensive processes to vaporise metal silicon, then cool it into crystalline silicon. This polysilicon is used in 95% of global solar panels.[16] It is first formed into ingots, which are then in turn sliced into hair-thin wafers, those wafers then used to manufacture solar cells. Those cells are assembled, usually in an aluminium protective frame, into modules. Those modules, connected to inverters and other electrical equipment, are formed into the arrays that generate solar electricity.

China's dominance of the polysilicon sub-sector has emerged relatively recently – over just the last decade, after its emergence as the major hub for wafer, cell and module manufacturing around 2009. While large solar manufacturing companies often have some degree of vertical integration across wafers, cells and modules, this usually does not extend all the way upstream to polysilicon production. That sub-sector is instead the domain of large chemical firms not otherwise involved in the downstream solar industry. Polysilicon factories are capital and energy intensive and require a high level of technical expertise to build and to run effectively.[17]

[15] Bloomberg NEF and International Solar Alliance, 2021.
[16] The remainder is made up of CdTe 'thin film' technology, such as that provided by First Solar, perovskite-based technology and other experimental designs.
[17] Bloomberg NEF and International Solar Alliance, 2021.

Given the right policy environment and sustainable cost structures, however, production capacity will move. China's pursuit of dominance in the polysilicon sub-sector has been purposeful, following a similar playbook to the one it used to take control of global solar wafer, cell and module supply. That playbook consists of using subsidies and access to land to attract foreign producers, acquiring know-how from them, then out-competing them through aggressive export-led sectoral growth – which some analysts say has involved illegal dumping.[18] In the cell and module sub-sector, China moved from a small player around 2005 to now producing around 74% of global supply. In the polysilicon sector, the move to start outcompeting foreign (US, South Korean, Japanese and German) manufacturers came around 2016, when China adopted a suite of policies designed to promote its own national champions and limit foreign firms' access to the Chinese market. These policies included imposing high tariffs on US and South Korean polysilicon, upgrading the Zhundong Coal Power Base in XUAR to provide very low cost (though high emission) electricity, expanding the rail and air transport infrastructure in XUAR – and the beginning of efforts to connect manufacturers to government-organised and government-subsidised 'surplus rural labour'.[19]

It is this last element that a wide array of government, academic and civil society analysts have concluded amounts to forced labour. The practices that raise human rights concerns include an array of measures by government and government-backed entities coercing Uyghurs and other XUAR minority populations to move away from their traditional lifestyles into industrialised employment, ranging from cotton picking to light and heavy manufacturing. The CCP frames this (as we discuss further in section 2 of this study) as a strategy of economic development and poverty alleviation. But the implementation of this policy can include a period of detention ('internment') in government run 'education' or 'vocational training' facilities, and placement into private workplaces, including in other provinces in China (i.e., outside XUAR) under a government-financed 'labour transfer' scheme. While workers may have some say over which workplace they join, available evidence suggests there is no real 'exit' option, violating their right to free choice of employment under Article 23 of the Universal Declaration on Human Rights, and various commitments that China has made under International Labour Organization-backed Conventions.[20] Research and first-hand testimony have also documented a wide array of human rights violations associated with this policy complex, including physical and sexual assault, forced sterilisation, enforced disappearance, torture, and violations of rights to privacy, family life and religious freedom.[21]

Research suggests that forced labour enters the PV supply-chain at several points connected to XUAR. First, forced labour occurs in mining the raw silica and the making of metallurgical silicon. Eleven different metallurgical silicon producers in XUAR have been tied to forced labour.[22] 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. (Some have been built near detention facilities.) 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.[23] 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.[24] Together, these four producers represent around 45% of world polysilicon supply. At the module stage, only JinkoSolar has been accused of using forced labour in its own XUAR operations – where its factory appears to be co-located with a high security prison and a government-run internment camp.

18 Joan Fitzgerald. 'Solar Eclipse? Can the U.S. have a coherent solar policy in the face of China's strategic trade moves?', *The American Prospect*, 20 July 2016, available at https://prospect.org/environment/solar-eclipse/

19 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.

20 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.

21 Murphy and Elimä, 2021; Darren Byler (2021). *In the Camps: China's High-Tech Penal Colony*. New York, NY: Columbia Global Reports; 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; 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.

22 Murphy and Elimä, 2021.

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

24 Murphy and Elimä, 2021; Eventide, 2022.

But other module makers, including JA Solar, Trina Solar, LONGi and Canadian Solar have also been alleged to use polysilicon made with, or made from silica that is made with, forced labour.[25] Figure 4, below, summarises these allegations.

Whatever its conformance with international human rights standards, the CCP's investment in XUAR's PV industry has proven spectacularly commercially successful. Since 2017, 91% of new polysilicon production capacity worldwide has been developed in China.[26] Most Chinese production of polysilicon now occurs in XUAR, where cheap, coal-generated electricity, low labour costs and state support have provided a favourable business environment. XUAR production alone now accounts for around 45% of global supply. Importantly, however, the largest share of the cost savings in the XUAR model appears to come *not* from labour cost savings unlocked by reliance on forced labour, but rather from the energy cost savings unlocked by use of remarkably cheap coal power to generate the large amounts of electricity required to vaporise metal silicon and transform it into polysilicon. "A ton of polysilicon uses 60-70MWh per ton, roughly seven times the energy intensity of aluminium. It is congealed electricity", says market analyst Alex Turnbull.[27] Moreover, China's cost advantage appears to draw on "a seeming indifference to short term financial viability or oversupply issues in these markets".[28] That ability to sustain long-term losses in order to drive other suppliers out of the market, made possible by government subsidies and protection, may create a range of negative externalities across the solar energy value-chain, such as depressed innovation.[29] Given the importance of innovation in this value-chain for accelerating cost reductions, solar uptake and the transition to renewables, those externalities represent significant costs borne by all of us.

25 Murphy and Elimä, 2021; Eventide, 2022.

26 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/.

27 Turnbull, 2021.

28 Ibid.

29 David M. Hart (2020). *The Impact of China's Production Surge on Innovation in the Global Solar Photovoltaics Industry*, Information Technology and Innovation Foundation, 5 October 2020.

	Firms alleged to be using forced labour	1st tier buyers from firms tied to forced labour	2nd tier buyers from firms tied to forced labour
Silica & 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 Technology 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) 21. Tianjin Zhonghuan Semiconductor (天津中环半导体份有限公司) 22. Qinghai Gaojing Solar Energy (青海 景太阳 科技有限公司) 23. Canadian Solar (阿特斯阳光电力团) 24. Astronergy/Chint Solar (正泰新源)	25. Risen Energy Company (东方日升新源份有限公司)

Figure 4: Allegations of ties to XUAR forced labour

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

These factors in the viability of the XUAR polysilicon business model may loom large when it comes to considering pathways to value-chain upgrading, as we do in section 4 of this study. China is not the first country to grapple with the challenge of transforming a strategically significant industrial sector whose business model relies on forced labour. A 2021 UN-backed study found that large-scale systems of modern slavery typically exhibit such features – with powerful actors benefitting politically and/or economically from businesses that rely on forced labour, with society at large bearing the resulting costs, including reduced innovation, human rights, health and environmental harms, and costs to the public purse.[30] Similarly, in China, the willingness of the CCP to support PV-sector firms through several years of unprofitability suggests that the logic underpinning the use of forced labour in XUAR may not be a purely commercial one, but one that serves other strategic, political, normative or ideological purposes.

This is borne out by research, which places the use of 'surplus rural labour' in the historical context of efforts by the CCP to assert control over XUAR, its most western region and a historical gateway to Central Asia, but also one of its poorest provinces.[31] The CCP's 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.[32] 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 tradition of political control through 're-education'.[33] 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.[34]

Whatever the motivation for the specific coercive practices that have been characterised as forced labour, once credible evidence of these practices began to emerge, they became a focus of concern for a wide array of solar energy stakeholders. Reports about the forced labour system began emerging in late 2019 and gathered strength in 2020, though initially focusing on ties to other production sectors, such as garments and apparel, electronics, and agriculture.[35] In May 2021, Professor Laura Murphy and Nyrola Elimä, both working with Sheffield Hallam University, published a seminal report, *In Broad Daylight*, bringing to light significant and detailed evidence concerning the Chinese PV sector's reliance on forced labour (see Figure 4 above).[36]

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.[37] However, on the ground verification and independent worksite-level audits intended to prove or disprove the allegations have been difficult to execute, with growing concerns 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.[38]

30 James Cockayne (2021a). *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**
31 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.
32 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 Darren Byler, Ivan Franceschini and Nicholas Loubère, *Xinjiang Year Zero* (Canberra: ANU Press), pp. 77-94.
33 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**; Zenz (2019).
34 Uyghur Tribunal, 2021; Edward Wong and Chris Buckley (2021). 'U.S. Says Chinese Repression of Uighurs is 'Genocide"', *New York Times*, 27 July 2021.
35 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**.
36 Murphy and Elimä, 2021.
37 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**; 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.
38 James Cockayne (forthcoming C). *Sanctioning Xinjiang forced labour: Chinese counter-measures*. Forthcoming on **www.xinjiangsanctions.info**.

Steadily, a range of voices from foreign industry and governments began to advocate for withdrawal from commercial relationships with suppliers connected to XUAR.[39] In 2020, the US Department of Labor added new entries to a list of goods produced by forced labour, on which many market actors (including commercial providers of business risk information) rely in assessing forced labour risks.[40] Polysilicon was quietly added to this 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.[41]

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.[42] 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.[43] A related action added Hoshine, and four other entities connected to the XUAR PV industry to the US Department of Commerce 'Entities List', limiting their 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 threatened to cut off US market access for all downstream PV goods containing Hoshine silica and the polysilicon made from it. But polysilicon is traded as a commodity, with manufacturers often mixing supply from multiple sources. By one estimation, 97% of the global supply of solar panels is thus likely to include components produced from Hoshine silica or another source suspected of using forced labour.[44] Yet most PV manufacturers have not historically traced the upstream source of the materials in their products – so they would not, absent further measures, be able to prove to CBP that their goods were *not* made with Hoshine silica or other excluded goods. That suggested that a large portion of, if not all, 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 were not limited to US markets. By mid-2021, a number of other jurisdictions – including 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.[45] At the G7 in Cornwall in June 2021, leaders committed to take action on forced labour in the solar supply-chain.[46]

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.[47] 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".[48] 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.[49] 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.[50]

[39] 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/.

[40] 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

[41] 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.

[42] 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.

[43] 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.

[44] Murphy and Elimä, 2021.

[45] James Cockayne (2021b). *Overview Policy Brief*, www.xinjiangsanctions.info.

[46] 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

[47] 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/.

[48] 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/.

[49] 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).

[50] 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/

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.[51] 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.[52]

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 Labor 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 of this burden of proof 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 forced labour 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 Viet Nam, for supply to North American and European markets.[53] As we discuss further in section 4 of this study, 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, 'clean' capacity – suggesting that they may become dominant in both 'clean' and 'dirty' value-chains. Will it be acceptable to 'clean' markets and those regulating them for buyers and investors to continue to do business with firms that are, separately, manufacturing or trading 'dirty' 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 'dirty' goods? How can such a policy be said to be 'just'?

Solar panel importers are not the only solar energy value-chain stakeholders grappling with forced labour 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 "Nationless corporations are helping the Chinese Communist Party cover up genocide and slave labour in the region".[54] 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".[55] There is also a growing regulatory focus on solar energy value-chain financing.[56] 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, "We firmly believe that this prohibition should also apply to the development spending and financing provided by the United States to companies overseas".[57] 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.[58]

[51] Jillian Ambrose and Jasper Jolly (2021). 'Revealed: UK solar projects using panels from firms linked to Xinjiang forced labour', *The Guardian*, 26 April 2021.

[52] 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/.

[53] Authors' research interviews, 2022.

[54] 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

[55] 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

[56] James Cockayne (forthcoming D). *Sanctioning Xinjiang forced labour: capital markets sanctions*, forthcoming on www.xinjiangsanctions.info.

[57] 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.

[58] 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

1.2 Is solar energy being stored in batteries made by modern slavery?

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.[59] 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 6 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.[60] 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).[61] Most of this production occurs in formal, large-scale mines. But 15% to 30% occurs in artisanal and small-scale mining (ASM) – making DRC ASM the second largest source of cobalt in the world (after DRC formal sector mining).[62] 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.[63] 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.[64]

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.[65] The root cause of child labour is household poverty and vulnerability to income shocks.[66] With poverty 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, in order to contribute to household incomes 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 sectors.[67] 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.[68]

[59] 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.

[60] 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.

[61] 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.

[62] WEF, 2020.

[63] 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.

[64] WEF, 2020; 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/; 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/.

[65] 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.

[66] 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.

[67] 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). *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.

[68] 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.

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 (some of which are discussed further in section 2, below). 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 1307 of the US Tariff Act.[69] In contrast to XUAR, however, the US government response has not pushed for wholesale exclusion of DRC cobalt from global commodity markets. Instead, most of the strategies in place (discussed further in section 2) 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.[70] 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 degrees Celsius.[71] Most of this growth will come in the transportation sector, especially passenger cars and commercial vehicles, with China the leading market.[72]

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.

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 – and may, arguably, be susceptible to state action – 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".[73] 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.[74] 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.

One example of this is the role that litigation and rights enforcement actions have played in prompting collective action by value-chain stakeholders, in these two sectors. Litigation related to XUAR has only just begun, with actions under way in France, Germany and the Netherlands.[75] 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.[76]

[69] 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/

[70] 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.

[71] WEF, 2019.

[72] Ibid.

[73] Searcey and Lipton, 2021.

[74] 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

[75] 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/.

[76] *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

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 the lawsuit, and related media attention, 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.[77]

1.3 Implications for the Just Transition and global energy governance

Concerns around modern slavery risks in the global solar energy value-chain pose two threats to the global transition to renewable energy.

The first is a threat to the transition itself: concerns about modern slavery may impede the uptake of solar power. 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. Where governments and industry actors step in, imposing traceability, audit, or other due diligence requirements, that will raise compliance and potentially also capital costs, slowing down the roll-out of new solar power and the replacement of expiring capacity. This is the perspective that seems to underpin, for example, suggestions by Siemens CEO Roland Busch in late 2021 that a "confrontational foreign policy" such as "export bans" would not only fail to resolve forced labour concerns in China, but "could mean that we can no longer buy solar cells from China - then the energy transition will come to an end at this point".[78]

The second, alternative threat created by modern slavery risks in the solar energy value-chain is that the transition proceeds apace – but without addressing the harmful impacts that solar power production and storage have on people. 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 have received less attention. There is, however, growing recognition that these systems can have a range of negative social impacts, including through dispossession and displacement of people.[79] Solar energy modern slavery risks should be seen in this larger context – as part of the larger question of how to address the injustices that arise from transitioning production towards renewables.[80] 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'?

To answer that question, we first need a sense of what this concept of 'Just Transition' connotes. There is no single consensus view, in part because of the many interpretations of the concept of justice, and different perspectives on the scope and type of transition that should be focused upon.[81] So, it is useful to understand the genealogy of the term, and the kinds of policy and governance claims which those using the term seek to foreground.[82] By understanding what they mean by a 'just transition', we gain insights into the social purpose of the governance regime to which they are seeking to transition.

The starting point for understanding the concept of a Just Transition is the environmental justice movement that emerged in the 1980s, which protested unjust distribution of environmental hazards to marginalised communities, especially in the United States.[83] As climate change issues rose up the environmental policy agenda, the distributional impacts of climate change – and responses to it – came increasingly to the fore.[84] The global and inter-generational nature of climate change impacts shifted the focus somewhat from local impacts and local solutions to related questions of energy access and intergenerational equity.[85] This also

[77] WEF, 2020.

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

[79] 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.

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

[81] 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.

[82] 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.

[83] Labor Network for Sustainability (2016). 'Just Transition' – Just What Is It? An Analysis of Language, Strategies, and Projects (Takoma Park, MD: Labor Network for Sustainability, 2016), available at https://www.labor4sustainability.org/files/Just_Transition_Just_What_Is_It.pdf.

[84] 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.

[85] 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.

led to a greater focus on the institutions and norms for energy governance – in other words, the global energy regime and environmental regime complex.[86]

Starting in the early 2000s, the labour movement began using the concept of a 'Just Transition' to address concerns that international climate negotiations were not addressing the social and employment impacts of climate policy.[87] The call here was for greater protection for workers whose jobs and livelihoods are threatened by the transition.[88] The term has since been interpreted and harnessed by a range of environmental advocacy, governmental and intergovernmental organisations.[89] Some of these interpretations foreground the injustices faced by workers in fossil fuel industries subject to mandatory 'transition'; some have a broader social focus; and others an environmental focus, envisioning the end of the extractive economy and a transition toward sustainable local economies.[90]

The notion of a 'Just Transition' found its way into the negotiating text for the Copenhagen Summit in 2009 and later the preamble to the 2015 Paris Agreement, giving it increased prominence in subsequent policy debates.[91] Since then, a recurring theme in Just Transitions discussions has been the need for proactive, large-scale, and rapid change involving diverse stakeholders – from workers and communities to business and government. There are different views, however, about how such change should be organised and governed: through a more bottom-up, place-based approach, or through a more top-down, market- and state-driven approach.[92] Analysts have also pointed out that conceptions of Just Transition can be differentiated on four dimensions: *distributive justice*, *recognition*, *procedural justice* and *restorative justice*.[93]

Distributive justice refers to the distribution of burdens and benefits. Some approaches to Just Transition have a narrow scope on this question, focusing on reforming existing energy systems; some a more transformational scope, seeking to achieve major change in the distribution of burdens and benefits. Recognition considers whose interests and value are recognised and taken into account. Here, some Just Transition approaches have a narrower approach to inclusion, focusing on representation of those affected, while others suggest that the transition process should elevate those who have historically been harmed or marginalised by energy governance. Third, procedural justice considers which individuals and institutions are involved and have influence over decision-making. Here again, some Just Transition approaches are narrow, seeking to increase the participation of affected groups, while others are more expansive, seeking to empower them in decision-making. Finally, restorative justice addresses remediation of past harms. Some Just Transition approaches focus on the justice of the transition itself; others seek to harness the transitional process to achieve justice for past harms.

The management and governance of modern slavery risks in the solar energy value-chain will raise all these questions. Will solar energy value-chains be reformed, or even transformed, to address the burdens imposed by modern slavery, and if so, how? Who will win, and who will lose, as a result? Will the interests of those vulnerable to modern slavery, such as children in DRC, or Uyghurs in PRC, be recognised? What role will different value-chain stakeholders – including those impacted by modern slavery – have in decision-making? And how will past harms – such as the modern slavery that was used to manufacture PV and battery capacity that has already been installed and used – be remedied? How these risks and harms are understood, managed and governed will thus tell us a great deal about the 'Just Transition(s)' to which the solar energy value-chain will contribute.

Managing this tension between different policy objectives during the transition – the need to accelerate solar uptake, and the need to reduce the risk of forced labour risk in solar energy production and distribution – is a complex public policy problem. The transition involved is not simply a technological one, but also socio-technical one, that involves long-term and complex reconfigurations of policy, infrastructure,

[86] 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.

[87] 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**.

[88] 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.**

[89] Stevis et al., 2020.

[90] 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.

[91] Rosemberg, 2017; Sandeep Pai, Kathryn Harrison, and Hisham Zerriffi (2020). "A Systematic Review of the Key Elements of a Just Transition for Fossil Fuel Workers," Smart Prosperity Institute, Clean Economy Working Paper Series 20-04, April 2020, 43, available at **https://institute.smartprosperity.ca/sites/default/files/transitionforfossilfuelworkers.pdf**.

[92] 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**

[93] Just Transition Initiative, 2020; Raphael J. Heffron and Darren McCauley (2017). "The Concept of Energy Justice across the Disciplines", *Energy Policy* 105 (June 2017): 658-667.

finance and power.[94] Such transitions are inherently political,[95] and while technological standards and systems may be in play, narrowly managerial solutions cannot effectively manage the social aspects of these transitions.[96]

Moreover, this is a policy puzzle made more complicated by the global nature of the solar energy value-chain, with investors in some countries, producers in many others, and buyers and consumers in yet others. Interventions to address modern slavery risks in the solar energy value-chain will impact a complex global political economy – or, rather, an array of local and national political-economies, interconnected through the business transactions that we collectively describe as the 'solar energy value-chain'. While place-based strategies may help manage the impacts of change in this value-chain in specific contexts, the solution to modern slavery in the solar energy value-chain seems necessarily to require the involvement of stakeholders in multiple places – where cobalt and silica are extracted, where PV panels and batteries are manufactured, where that production is financed, and where products are bought, and energy is consumed. Understanding how modern slavery risks are managed and governed in this value-chain thus requires an examination of both local, place-based governance and 'Just Transition' strategies, and governance and transition at the planetary level, especially as those risks relate not only to a planetary climate system, but also to an economic order that is now organised, through global value-chains, as a planetary system.[97] By mapping how modern slavery risks are being framed, managed and governed in the solar-energy value-chain at each of these levels, we can build up a composite picture of how different actors propose to govern the tension between socio-economic and environmental policy objectives involved in this transition. And that, in turn, may offer us a window into their conception of 'justice' and the social purpose at play in the governance regime for which they advocate.

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), and state-run and multilateral entities such as export 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. While certain market-based norms and rules underpin the system we describe as the solar energy value-chain, the boundaries and reach of those norms are being actively contested: can and will states exclude from the market some products offered by the value-chain, solely on the basis that they are made with modern slavery? Will such policies be deemed compatible with the existing free trade regime, or condemned as impermissibly discriminatory non-tariff trade barriers?[98] What role should such modern slavery risks play in market valuations? And what recourse do affected individuals and firms have to contest and remedy harms caused by these practices or policies? Different stakeholders in the global solar-energy value chain are promoting different regime arrangements, based on different interests and assigning voice, agency and power to different actors.

As we explore further in section 2, some actors advocate market-based solutions, such as supply-chain traceability and commercially organised social audits. In some cases, this advocacy is organised within a national context, responding to existing national energy market governance arrangements. But in other cases, transnational groupings are emerging, pushing for the development of transnational solar energy markets and standards. Other voices suggest that solutions to forced labour risks, and broader challenges around the environmental and social impact of solar energy, can only come from states – from changing the rules of global trade to exclude goods made with forced labour or high-emission energy sources, from changing internal policies on development to, for example, formalise ASM, or from broader 'green industrial policy'.[99] A third set of voices pushes for individuals to have a role in the governance of solar energy, notably the opportunity to have harms to their individual rights remedied through effective grievance mechanisms. And a fourth strand of advocacy points to the unique opportunity that the energy transition offers to remedy inequity and historical injustice at the community level.[100]

The contestation between these different perspectives suggests that the solar energy regime is today not only a site for contesting *power* within and through global solar energy governance, but also for a contest over what John Ruggie called the *social purpose* of a regime.

Disputes over how to deal with modern slavery risks are emerging as an opportunity for different actors in the value-chain to contest this purposive aspect of the 'regime' that governs solar energy value-chains – the set of principles, norms, rules and procedures that

[94] 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.

[95] J. Meadowcroft (2009). 'What about the politics? Sustainable development, transition management, and long term energy transitions'. *Policy Sciences*, vol. 42: 323– 340.

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

[97] Dimitris Stevis and Romain Felli (2020). "Planetary just transition? How inclusive and how just?", *Earth System Governance*, vol. 6, 100065.

[98] James Cockayne and Timothy Masiko (forthcoming). Are forced labour trade bans permissible under global trade rules?, unpublished manuscript.

[99] 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.

[100] Shalanda H. Baker (2021). *Revolutionary Power: An Activist's Guide to the Energy Transition*. (Washington: Island Press).

international actors converge around.[101] But the debate is not simply one over *power*: who will control or govern the value-chain. It is also a debate over *purpose*: what is the point of solar energy value-chain governance?[102] Should solar energy simply be governed through the established trade and investment regime? Should it be subject to a different governing discipline, focused on maximising solar power uptake, with a view to maximising reductions in carbon emissions? Or should the purpose of solar energy governance encompass questions of human rights such as freedom from slavery?

As we will see in section 2, different geopolitical powers involved in debates over modern slavery in the solar energy value-chain, such as the US, China and the EU, have markedly different – and increasingly openly competitive – perspectives on how this value-chain should be regulated, and the roles that state power and private commerce should play in defining and directing solar industrial policy, remediating harm, and protecting human rights.[103] These are significant questions of global political economy, with powerful ramifications for the questions of "who wins, who loses, how and why".[104] How modern slavery risks are addressed in the solar energy value-chain may provide early insights into how the global energy system, a critical element of global order, will be organised going forward. Because solar energy will be so critical to future economic production, growth, national prosperity and political power, this debate is emerging as a critical front in a broader geopolitical struggle over the purpose of the international market regime and global trading order. And what we learn here may be instructive for understanding the *purposive* aspect of different geopolitical and geoeconomics actors' attitudes to governing global markets – and the Just Transition.

Debates over the governance of forced labour risks in the solar energy value-chain should thus be seen against the backdrop of the emerging geostrategic struggle over control of technological standards, commercial relations, and strategic technologies. This is an approach that explicitly underpins, for example, White House policy towards trade and security in the Indo-Pacific.[105] But allowing governance of the solar energy value-chain to be reduced to a zero-sum competition jeopardises the benefits derived from the cooperation that the solar energy value-chain embodies. We know, for example, that excessive protectionism and mercantilism in the PV value-chain a decade ago retarded innovation, with flow-on costs for all solar energy stakeholders, including consumers around the world, and the future generations who will not benefit from the foregone reductions in carbon emissions.[106]

As we explore further in the next section, nationalist framings and autarkic policy solutions seem to be becoming increasingly influential. Yet it is important to recognise that whatever narrative of ubiquitous, democratised energy may have been associated with solar energy in the past, the move towards more autarkic postures is not a departure from traditional energy geopolitics, but rather consistent with it. States have long sought to keep international energy governance mechanisms weak, intent on maximising sovereign control of energy.[107] That zero-sum, competitive approach arguably makes it more difficult, however, for the system-level externalities, inequities and injustices of our shared energy systems – such as modern slavery risks – to be identified and resolved.[108]

Like states, many market actors have also sought in the past to 'de-politicise' energy governance, treating it as far as possible as a question of market forces and technical standards. As we see in section 2, this tendency is also at play in debates over modern slavery in the solar energy value-chain, as many actors seek to frame the question in terms of technical tracing, audit, due diligence and financial risk standards. Yet these technical debates are politics writ small. They represent and embody, at the operational level, all the same difficult and ultimately political questions of voice, agency, resource allocation and rights that more overtly 'governance' oriented debates also grapple with.

These debates over how modern slavery risks in the solar energy value-chain will be governed are thus an important window into larger questions of 'justice' in the transition to renewable energy. On the international stage, countries have agreed some broad guidelines for the energy transition that, importantly, include a commitment to address forced labour concerns through tripartite (i.e., state, employer, worker) dialogue.[109] Yet what that looks like operationally, in any particular context, remains to be negotiated. The modern slavery issue surfaces many of the issues that such negotiations must address.

[101] Krasner, 1982.
[102] Ruggie, 1982.
[103] Allan, Lewis, Oatley, 2021.
[104] Newell and Mulvaney, 2013.
[105] Kurt M. Campbell, and Rush Doshi (2021). 'How America Can Shore Up Asian Order: A Strategy for Restoring Balance and Legitimacy'. *Foreign Affairs*, 12 January 2021.
[106] Hart, 2020.
[107] Timothy Mitchell (2011). *Carbon Democracy: Political Power in the Age of Oil*. Verso, 2011; A. Florini and Benjamin K. Sovacool (2009). 'Who governs energy? The challenges facing global energy governance', *Energy Policy*, vol. 37: 5239– 5248; F. McGowan (2009). 'International regimes for energy: finding the right level for policy', in I. Scarse and G. MacKerron, eds., *Energy for the future: a new agenda* (Palgrave, Basingstoke), pp. 35– 52.
[108] Newell and Mulvaney, 2013.
[109] ILO (2015). *Guidelines for a just transition towards environmentally sustainable economies and societies for all* (Geneva).

Some of these are questions of distributive justice and recognition: How will the costs of supply-chain reformation or transformation be distributed? Whose interests will be factored into these plans, and how? Some of these are restorative justice questions: who will determine how past harms – or harms arising from the transition itself – are remedied? And some of these are questions of procedural justice: how will the direction and speed of value-chain changes be determined? By market actors or by state actors? Working unilaterally and competitively, or in concert? Which actors – states, firms, investors, affected communities and individuals – will participate in the formulation of these change strategies? Questions of procedural justice may prove critical to the sustainability of any resulting substantive outcomes. Yet, traditionally, "[w]hether for reasons of commercial confidentiality or geo-strategic sensitivities, public participation and deliberation around questions of energy governance has traditionally been very weak".[110] A *lack* of procedural justice is arguably a recurring feature of global energy governance.[111] The lack of representation and unequal power of stakeholder groups may exacerbate (in)justice concerns.[112]

What this suggests, however, is that any effort to advance debates on how the solar energy value-chain can best respond to modern slavery risks needs to consider not only the *macro* policy level – considering the big picture questions of international trade and investment rules – but also more *micro* level questions – such as the content of global supply-chain standards on risk estimation, reporting and remediation, *and how those standards are developed*. The next two sections of the study respond to these two levels. First, in section 2, we consider the macro-level policy currents that are shaping global debates on the governance of forced labour risk in the solar energy value-chain, seeking to understand both the *purpose* promoted by different policy currents and related *process* aspects – for example which actors are assigned voice and agency in those policy currents. Then, in section 3, we address one specific, technical challenge that solar energy stakeholders face in managing forced labour risk – their inability to reliably estimate forced labour risk at different points in the value-chain. In the final section 4, we draw on all of these discussions and additional research with stakeholders, to chart pathways towards more effective governance of forced labour risks in the solar energy value-chain.

[110] Newell and Mulvaney, 2013.
[111] Benjamin K. Sovacool and Michael H. Dworkin (2014). *Global Energy Justice: Problems, Principles, and Practices* (Cambridge, UK: Cambridge University Press); Baker, 2021.
[112] Uma Outka (2012). 'Environmental Justice Issues in Sustainable Development: Environmental Justice in the Renewable Energy Transition', *Journal of Environmental and Sustainability Law*, 19 (1): 61–122.

2. Governing modern slavery risks in the solar energy value-chain

In this section, we consider the different policy and practical solutions being proposed to address modern slavery concerns relating to the solar energy value-chain. A wide array of ideas are currently being debated across numerous different policy arenas, from industry forums to parliamentary debates to the G7. Our aim in analysing these debates is not simply to document and describe them, but rather to analyse and explain their dynamics, with a view to helping stakeholders identify pathways towards arrangements that will address modern slavery concerns and secure solar energy's contribution to a 'Just Transition'.

In the first part of this section, we explain our analytical methods, including our use of policy process tracing techniques, our selection of 10 relevant policy arenas, and our data sources. In the second part of the section, we present our results, showing how four main ideal-type Policy Currents can be identified at work across these policy arenas: 1) Rights, 2) Supply-Chains, 3) Autarky, and 4) Collective Action. In the last part of this section of the study, we discuss and consider the implications of these results, showing how the four currents map onto a plot on two dimensions, differentiated by underlying conceptions of a) agency in international affairs, and b) how sustainable governance and policy solutions emerge in international affairs – i.e. through competition and adversarialism, or through cooperation. This has important implications for the procedural 'pathways' that may be suitable to resolve ongoing disputes around modern slavery risks in solar energy value-chains, pointing to different approaches to global public policy development and implementation.

2.1 Methods

The question of modern slavery risks in solar energy value-chains is currently an active topic of policy debate in a wide array of forums, from the Chinese Photovoltaic Industry Association to US Congress, and from the boards of multilateral development banks to the email list-serves of global civil society anti-slavery movement. A wide variety of ideas for how these risks should be addressed are in play, ranging from denial of the existence of forced labour, to suggestion of strengthened supply-chain due diligence, to efforts to require importers, lenders and investors to take steps to exclude goods made with forced labour from their value-chains. How can we make sense, *in media res*, of such a diverse array of ideas and voices, debating these issues in such far-flung contexts? How can we assess the convergences and divergences in the policy agendas being promoted? What evidence is available that might help us assess how these different policy proposals may play out? Given the potential commercial and environmental significance of some of the policy measures in play – such as the system of Withhold Release Orders discussed above (section 1.1) – the answers to these questions have important practical, financial and regulatory consequences. So how can we develop evidence-based answers?

2.1.1 Approaches to comparative policy process analysis

We approached this as a question of comparative policy process analysis. To understand how these issues are being framed and addressed in different policy arenas, we developed a tailored analytical framework suited to the ongoing and multi-contextual nature of these debates. Our framework seeks to make sense of and allow comparison of the contested process of social construction involved in each of these policy debates. This framework, which we label the 'Policy Currents Framework', draws on several of the major strands of contemporary policy process theory: the Multiple Streams Framework (MSF), the Advocacy Coalition Framework (ACF), the Narrative Policy Framework (NPF) and the Diffusion of Innovation Model (DIM).[113] Before explaining the Policy Currents Framework, it is important to place it in the context of these different, though inter-related, approaches to policy process analysis.

The *Multiple Streams Framework* (MSF) seeks to explain why and how specific policy solutions catch on. It explains this outcome as a product of the interaction of distinct 'streams' of discourse and debate within a particular policy setting: the problem stream, the policy stream, and the political stream. The streams are distinct though sometimes overlapping spheres of discourse and debate, populated by different casts of actors. These actors respond independently to the emergence of 'policy windows', including both windows for setting the agenda ('agenda window') and for decision-making ('decision window').[114] Those windows are in turn shaped by perceptions of the feasibility of, value-acceptability of, and public acquiescence to the solutions proposed within these streams by different actors.[115] Focusing events such as sudden crises that 'breach' the status quo, or decision-makers' learning events, can also factor into the opening or closing of these policy windows.[116]

The MSF approach is particularly well suited to analysing the process of agenda formation and setting (as opposed to policy implementation) and has to date largely been used to explain policy formation in a particular context – rather than in comparative contexts. MSF analysis has traditionally highlighted the role of 'policy entrepreneurs' in the process of policy formation and adoption, and the important agenda-setting role they play in relatively open, non-hierarchical decision-making contexts.[117] This disposes the MSF well for use in analysing emerging debates over the relationship between solar energy and worker rights, since (as we shall see below) it is not only the rules of debate and decision, but even the forums and institutions in which those debates ought to take place that are contested. To use the terms of MSF literature, in some arenas, the debate on solar energy and modern slavery is still in the "softening up" phase,[118] rather than being subject to hierarchical decision-making within defined institutional parameters. However, in other contexts – such as debates on solar energy governance and worker rights *inside* China, that characterisation clearly does not hold. In that context, given the close hold kept by the CCP on public debate over such questions, and the resulting opacity over how policy is developed, the analytical power of MSF is more limited.

The *Advocacy Coalition Framework* (ACF) focuses more on the organisational dynamics by which policy ideas emerge, spread and achieve implementation. This is particularly germane in a context where policy ideas are moving between different policy arenas – as the idea of trade bans for goods made with forced labour seems to be spreading from the US to other countries, for example. ACF views policymaking as subject to competition between coalitions of actors promoting specific policy solutions, often by appealing to the underlying policy beliefs of decision-makers and their constituencies.[119] The focus on coalitions allows for heuristic simplification of the multitudinous array of actors involved in policy debates in a given setting and can help to highlight where there is continuity over time.[120] These coalitions also emerge as instrumental for understanding the propagation of particular policy ideas and solutions,[121] with ACF highlighting the competition between advocacy coalitions to dominate particular policy 'subsystems' that control the operationalisation and implementation of specific policy solutions.

ACF appears to offer an important way to connect policy process analysis to other theoretical traditions such as international relations theory, for example by considering dynamics of coalition formation and development, such as the concept of band-wagoning.[122] One particularly important such crosswalk is not however to such realist-inspired, game-theoretic analytic traditions, but rather to those that focus more on soft power, identity formation and the power of ideas. Some recent scholarship, for example, links ACF to cognitive theory and narrative theory. The ACF tradition suggests that policy actors, being time-poor and subject to the same cognitive limitations as other human beings, process information according to certain cognitive heuristics that create efficiencies in complex decision-making systems. These heuristics are embedded in belief systems that underpin the coalition's outlook. The heuristics both represent and shape policy actors' perception of what a problem is, how it is structured, and what solutions are possible.[123]. Comparative policy process analysis, including at the international level, may thus benefit from tracing these heuristics – such as recurring frames, images and terminology – that enlist the listener through not only rational persuasion but also emotional affect and appeal to core beliefs.

[113] Christopher M. Weible and Paul. A Sabatier, eds, (2017). *Theories of the Policy Process*. 4th ed., (Boulder, CO, Westview Press).

[114] Nicole Herweg, Nikolaos Zahariadis and Reimut Zohlnhöfer (2017). "The Multiple Streams Framework: Foundations, Refinements, and Empirical Applications", in Weible and Sabatier, eds, *Theories of the Policy Process*. 4th ed. (Boulder, CO: Westview Press), pp. 17-53.
[115] John Kingdon (2011). *Agendas, Alternatives, and Public Policies* (New York: Longman).
[116] Thomas A. Birkland (1997). *After Disaster: Agenda-Setting, Public Policy and Focusing Events* (Washington DC: Georgetown University Press).
[117] Kingdon, 2011.
[118] Ibid.
[119] Christopher M. Weible, Paul A. Sabatier and Kelly McQueen (2009). 'Themes and Variations: Taking Stock of the Advocacy Coalition Framework', *Policy Studies Journal*, vol. 37(1), pp.121-140.
[120] Hank C. Jenkins-Smith, Daniel Nohrstedt, Christopher M. Weible and Karin Ingold (2017). 'The Advocacy Coalition Framework: An Overview of the Research Program', in Weible and Sabatier, eds., *Theories of the Policy Process*. 4th ed. (Boulder, CO: Westview Press), pp.135-17.
[121] Daniel Nohrsted, (2010). 'Do Advocacy Coalitions Matter? Crisis and Change in Swedish Nuclear Energy Policy', *Journal of Public Administration Research and Theory*, 20(2), pp.309-333.
[122] Richard Nadeau, Edouard Cloutier and J.H Guay (1993). 'New Evidence about the Existence of a Bandwagon Effect in the Opinion Formation Process', *International Political Science Review*, vol. 14(2), pp. 203–213.
[123] Jale Tosun and Samuel Workman (2017). 'Struggle and Triumph in Fusing Policy Process and Comparative Research', in Weible and Sabatier, eds., *Theories of the Policy Process*. 4th ed. (Boulder, CO: Westview Press), pp.329-362.

It is a short step from discussion of heuristics to discussion of narrative. The *Narrative Policy Framework* (NPF) tradition of policy process analysis considers how policy proposals operate as narratives, through reference to setting, characters, plot, and moral of the story. Effective use of narrative can successfully shift policy actors' (and broader audiences') scarce attention to new policy heuristics and options, enlarging support for particular policy solutions.[124]. NPF thus provides a framework for comparison of policy narratives used by different actors and coalitions competing for influence in a given institutional setting.

The related *Diffusion of Innovation Model* (DIM) can inform comparison of the development of single policy narratives over multiple policy settings.[125] Policy actors are not static, but dynamic and capable of learning. Innovation can diffuse. Coalitions can and do learn from each other, for example co-opting their rivals' imagery and narrative devices, learning from coalition members' experiences in one setting and emulating successful policy narratives in others, or engaging in cross-coalition resource-sharing and teaching.[126]

[124] Frank R. Baumgartner and Bryan D. Jones (1991). 'Agenda Dynamics and Policy Subsystems', *Journal of Politics*, vol. 53, pp. 1044-1074; Bryan D Jones (1994). *Reconceiving Decision-Making in Democratic Politics: Attention, Choice, and Public Policy* (Chicago: University of Chicago Press).

[125] Elizabeth A. Shanahan, Michael D. Jones, Mark K. McBeth and Claudio M. Radaelli (2017). 'The Narrative Policy Framework', in in Weible and Sabatier, eds., *Theories of the Policy Process*. 4th ed. (Boulder, CO: Westview Press), pp.173-213; Elizabeth A. Shanahan, Michael D. Jones, Mark K. McBeth, and Ross R. Lane (2013). 'An Angel on the Wind: How Heroic Policy Narratives Shape Policy Realities', *Policy Studies Journal*, vol. 41(3), pp.453-483.

[126] Frances Stokes Berry and William D. Berry (2017). 'Innovation and Diffusion Models in Policy Research', in Weible and Sabatier, eds.,*Theories of the Policy Process*. 4th ed. (Boulder, CO: Westview Press), pp. 253-297; Graeme Boushey (2010). *Policy Diffusion Dynamics in America,* (Cambridge: Cambridge University Press).

2.1.2 A tailored framework: the Policy Currents approach

The policy arenas in which modern slavery risks to the solar energy value-chain are currently being discussed are highly heterogeneous, ranging from formal parliamentary and legislative contexts in democratic settings, to transnational industry fora, to financial institution and civil society coalitions, to authoritarian countries. Debates are also at very different points of 'maturity' in these different contexts and depending on the specific source of modern slavery risk in question. Debates on the social impact of cobalt production in DRC, for example, draw on over two decades of policy debate and action on 'conflict minerals', allowing for multiple rounds of proposal, implementation and learning. Debates on forced labour risks in XUAR are, by comparison, much more nascent.

This heterogeneity calls for a flexible analytical framework that allows the tracing and comparison of policy formation, adoption and implementation across very different contexts. It also calls for an approach that identifies the movement and adoption of policy heuristics, narratives and ideas across multiple arenas – even before formal coalitions have emerged. Drawing on the MSF, ACF, NPF and DIM traditions, we developed what we characterise as a 'Policy Currents' approach.

The notion of a policy 'current' is intended to capture the flow of ideas across and between different arenas of policy debate (i.e., in different countries and international fora), while also pointing to the idea that these flows may not yet have coalesced into discernible, discrete 'streams' of problem formation, policy proposal and political action (as discussed in the MSF tradition). In our approach, a 'current' consists of a set of actors, policy ideas, heuristics and narratives adopting (even if unwittingly) a common approach to framing and solving the policy problem. This framing draws on a shared conceptualisation and set of beliefs about how the world works – a shared outlook – and how policies can (sustainably) address problems. A particular policy current may give rise to specific, articulated, shared policy solution proposals. But in the 'softening up' phase, it may involve a process of conceptual exploration as actors within the current search for feasible solutions that fit not only with their own beliefs about how the world works, but also with those of the actors needed to implement the proposal.

A Policy Current should therefore be understood as an ideal type: an abstracted representation of empirical reality that highlights key features in a manner that creates conceptual clarity or coherence.[127] Ideal types are not statistical, average or 'normal' types, in the sense of representing the most recurrent features of a sample, but rather heuristic devices used as a method of investigation and explanation, especially in comparative sociological, economic and political analysis.[128] They are not intended to provide a comprehensive rendering of empirical reality, but rather to organise empirical complexity into conceptual coherence. Thus, we should not expect any specific case or instance to manifest all (or only) the features of a single ideal type. In our case, that means that we may anticipate some actors mixing ideas, narratives or elements from more than one Policy Current; more than one Policy Current may pass through that person or organisation. But by identifying distinct Policy Current ideal types, we may better understand the underlying structure and dynamics of policy debate.

Another aspect of the Policy Currents approach that deserves highlighting is the way that it allows us to go beyond ACF by identifying influential actors within policy processes that are *not* yet parts of coalitions, but more like fellow-travellers: not actively seeking to work together, but rather – and more passively – being borne in the same direction by a shared current of ideas and beliefs or a shared outlook. This may be useful for identifying converging groups of actors even before they organise into formal coalitions: uncoalesced actors may converge on similar or shared narratives and policy solutions, even without or prior to any deliberate attempt at coordination of specific proposals, due to common underlying policy beliefs. That suggests the Policy Currents approach may be particularly useful for tracing emerging policy debates, and in contexts where purposeful and open policy debate is suppressed – for example in contexts where unitary authoritarian actors control the field of narrative debate and prevent other voices from emerging.[129] This is an important adaptation for the analysis of policy processes in illiberal and non-pluralistic policy settings – such as the People's Republic of China.

Our 'Policy Currents' approach, and prior MSF, ACF, NSP and DIM literature, guided the development of a template to analyse debates on forced labour risk and the solar energy-value chain. For each policy arena we studied (see further 2.1.3 below), we asked a common set of questions to gather qualitative evidence about: A) problem framing; B) actors; C) policy window; and D) coordination and strategy. Figure 4 below summarises this template.

[127] 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).

[128] 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).

[129] Shanahan et al., 2017.

Dimension	Focus	Question	Indicative responses
Problem and solution framing	Domain	In what domain(s) does the current frame the modern slavery problem?	as a question of labour rights, human rights, fair trade, national security, sustainable development
	Key interest affected	Whose problem does the current define modern slavery as?	a problem for affected workers, their communities, for the supply-chain itself, for the market
	Remedial agency	Who does the narrative frame as the source of the solution and what form does the solution take?	government action to level the trade playing-field, judicial accountability and remediation of harms to workers, development of alternative ('slavery-free') supply
	Imagery	What imagery is used to engage policy actors' affect?	impoverishment of constituents, abuse, risks to the nation
	Core beliefs	What core policy beliefs does this imagery appeal to?	anti-poverty, freedom from coercion, security of the nation
	Indicators	What indicators are proposed to establish and measure success in interventions?	survivors assisted, value of goods detained, countries participating in the solution
Actors	Policy brokers	Which actors are the major proponents of this problem framing and these policy solutions, in this current, *outside* formal institutional decision-making processes?	particular thinktanks, media voices, government entities, worker organisations, survivor organisations
	Political actors	Which actors are the major champions involved in advancing this approach *within* formal decision-making processes in this setting?	legislators, bureaucratic units, industry bodies
	Victims and survivors	What role, if any, do the voices of communities exposed to modern slavery play in this current?	in proactive policy framing through media interventions, in support of promoting this narrative within decision-making institutions, none
Windows	Agenda window	Assess the perception by the *policy* community (specialist policy experts and institutions involved in this setting) of the proposed solution.	Assess on dimensions of: ■ Feasibility (practical achievability, inc. financing) ■ Value acceptability (conformity w. policy values & beliefs) ■ Public acquiescence
	Decision window	Assess the perception of the proposed solution on each of the following dimensions by the *political* community (decision-makers in this institutional setting):	Assess on dimensions of: ■ Feasibility (practical achievability, inc. financing) ■ Value acceptability (conformity w. policy values & beliefs) ■ Public acquiescence
	Focusing events	What focusing event(s), if any, has the current identified or sought to harness?	sudden crises, political actors' personal learning experiences
Coordination and strategy	Coordination	Are there efforts to coordinate and develop shared strategy (inc. resource allocation)?	e.g., coalition formation, resource pooling
	Learning	Is there evidence of cross-setting learning?	policy emulation or transplantation, narrative imitation
	Forum-shopping	Is there evidence of forum-shopping?	organised efforts to shift debate to new jurisdictions or institutional settings

Figure 5: Analytic template used to identify Policy Currents

2.1.3 Case analysis

We identified ten different policy arenas in which there has been sustained debate on modern slavery risks in the solar energy value-chain. Seven of these involve debates in national and international public policy contexts: 1) the US, 2) the UK, 3) the EU, 4) at the G7, 5) in Australia, 6) United Nations fora, and 7) China. Three involve private and multistakeholder governance initiatives: 8) international solar energy industry initiatives, 9) global financial circles, and 10) multistakeholder initiatives relating to the global cobalt supply-chain. Each of these arenas provides a 'case study' for policy process tracing, using the analytic template just discussed (in section 2.1.2). For each case, we reviewed open-source documents, including official statements and publications, reported speech, and grey literature. We also consulted relevant academic literature, though the novelty of these issues means that in most cases there has been little or no scholarship to date (with our 10th case, cobalt initiatives, being the clearest exception). In some cases, we supplemented this desk analysis with direct written or spoken engagement with insider stakeholders, to corroborate and supplement information available through the public record, allowing us to confirm or develop our analysis of the Policy Currents at work in these different cases.

2.2 Results

Across the ten different policy arenas we studied, we identified four different Policy Currents in play, which we label: 1) Rights, 2) Supply-Chains, 3) Autarky, and 4) Collective Action. Three other policy framings – two different approaches to multilateralism, and a more purely 'nationalist' perspective – are also present in policy rhetoric and discourse across these arenas but have not coalesced into coherent Policy Currents.

Each of these Policy Currents frames the policy puzzle posed by allegations of forced labour in the global solar energy value-chain in a different way, foregrounding different concerns and interests, proposing different responses, and offering different narratives of policy change and success. Different Policy Currents appear presently to be more influential in different policy arenas, though there is some evidence of influence changing over time within some policy arenas (with the Supply Chains current losing ground to the Autarky current, in some arenas, for example). There is also evidence of emerging policy diffusion through nascent transnational coalitions of policy brokers (such as the global anti-slavery civil society movement, and, separately, development finance institutions and multilateral development banks) and political actors (such as the Inter-Parliamentary Alliance on China, and the G7).

In this sub-section, we introduce each of the four ideal-type Policy Currents that we have identified in present policy debates. In each case, we explain its key features, with reference to the analytic template used in our research (see Figure 5 above). Figure 6 summarises these features. Figure 7 summarises which Policy Currents are in play in which policy arenas, noting some key proponents.

		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	Systemic 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., by finance)	Just beginning to open
	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

Figure 6: Features of four Policy Currents

Policy arena	Rights	Supply-Chains	Autarky	Collective Action
US	Human Rights Watch	US Congress, IPAC, SEIA, ULCSA, FLA, GFEMS	CECC, solar re-shoring lobby	Conflict minerals movement
UK	Amnesty International	ASI, Solar Energy UK	UK Conservative Party members	Overseas development sector
EU	ECCR	EU Greens, SolarPower Europe	SolarPower Europe	European Battery Alliance
G7		Anti-slavery coalition, Germany		
Australia	Human Rights Law Centre	Be Slavery Free, Clean Energy Council		
UN and related bodies	US-led coalition			PRI
China		CPVIA	NDRC	
Solar industry		Industry associations		
Global finance		DFIs		
Cobalt initiatives	Amnesty International, diverse litigants	OECD, PRI, GBA-WEF		RCI, Cobalt Institute

Figure 7: Some proponents of four Policy Currents in different policy arenas

2.2.1 The 'Rights' current

The first Policy Current that emerges from our analysis is the Rights current, which frames modern slavery in the solar energy value-chain as a serious, large-scale violation of human, labour and child rights.

This people-centred narrative foregrounds the individuals and communities victimised by these rights violations, including Uyghur and other minority victims and survivors of state-perpetrated human rights violations in XUAR, and ASM communities extracting cobalt in DRC. Victims are platformed not only as witnesses to the facts on the ground – for example providing testimony to parliamentary and other investigative processes – 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 – like that brought against companies linked to XUAR forced labour by Uyghur victims in France, Germany and the Netherlands[130], and on behalf of child cobalt miners in DRC[131].

Apart from individual victims, in this framing states have the other key role to play in achieving accountability. For example, a letter from the Coalition to End Forced Labour in the Uyghur Region, which counts more than 400 civil society and trade union members, to the President of the European Commission in November 2021, notes that "the primary duty to protect human rights lies with States", rather than with companies, individuals, or others. "The EU and its Member States therefore have a responsibility of their own to address Uyghur forced labour".[132] States can discharge this responsibility through providing access to judicial and non-judicial grievance mechanisms, and through naming and shaming and sanctions measures. As an ideal type, the Rights current places less emphasis on the role of corporate grievance mechanisms, and on the role of supply-chain actors such as buyers, consumers and investors in changing policies and practices. (That is something that the Supply-Chains current, discussed below, focuses on more.)

The international human rights community is a key policy broker in the Rights current. Amnesty International's 2016 report on rights violations in cobalt extraction, Human Rights Watch's reporting on Uyghur human rights abuses, and strategic litigation by the European Center for Constitutional and Human Rights have all been significant.[133] But affected communities, such as the Uyghur diaspora, are also key policy brokers, mobilising effectively to promote this understanding of the policy problem. A transnational coalition of civil society actors has identified useful focusing events, such as the Beijing Winter Olympics, and developed new forums – such as the hearings of the Uyghur Tribunal – to help educate policy actors and the broader public and enlarge the policy window for action aimed at vindicating affected Rights.

Perhaps unsurprisingly, corporate actors are relatively uninvolved in promoting the Rights current – as opposed to the Supply-Chains current, discussed below. The Rights approach neither foregrounds business actors, nor looks to them as key players in the solution. But civil society has been supported by a growing array of political actors, notably the Inter-Parliamentary Alliance on China (IPAC), an international cross party-network of parliamentarians working to reform the approach of democratic countries towards China, which has called for independent legal investigations.[134] The Congressional-Executive Commission on China has provided a prominent platform for this current in the US[135] – though it has also incubated more nationalist and autarkic thinking, covered in section 2.1.3 below. China's mid-2021 adoption of sanctions on western policy brokers and political actors has also served to motivate cross-border coordination amongst proponents of the Rights current.[136] These political actors sometimes adopt slightly different heuristic devices, narrative and tropes than rights campaigners, focusing more on the general threat posed to (everyone's) freedoms than on the specific violation of individual victims' rights. "If history teaches anything, it is that we must put a higher value on freedom, or we will find that the final cost to us all becomes too high", writes Conservative MP Iain Duncan-Smith, discussing forced labour in the solar energy value-chain, in November 2021.[137]

At times, the Biden White House's rhetoric on XUAR has also reflected the Rights current.[138] Calling the use of forced labour in XUAR "both an affront to human dignity and an example of the PRC's unfair economic practices", the US has initiated efforts at the United Nations and ILO to rally states around a characterisation of the situation in XUAR in terms of grave human rights violations.[139] Yet the 'feasibility' of this approach is constrained in two ways: by China's own counter-mobilisation; and by structural features of policy discourse in the UN context, which privileges state voices over those of civil society, limiting the ability of individual rights-holders and their representatives to influence multilateral policy-making.

China's resistance has drawn on its own variation of the 'Rights' current. In this rendering, however, the focus is not individual rights, but collective (and state) rights – specifically the right to development, and a country's right to choose its own development path. While sometimes framed in 'Rights' discourse, China's approach in these forums thus tends away from the 'Rights' ideal-type policy current, towards a more nationalist or Autarky style current (discussed in section 2.2.3 below).

The Chinese government, and the leadership of the country's solar industry association (the Chinese Photovoltaic Industry Association, CPVIA) argue that the problem that needs to be resolved is not forced labour, but rather the 'slanderous' allegation of forced labour. Solar energy is presented as a key contributor not only to China's shift to renewables, but also to its ongoing transition to a modern, centralised economy. References to 'Just Transition' in Chinese discourse thus play a somewhat different role than they do in western discourse, since the transition that the state is seeking to promote is not a transition from a high-carbon, high-income economy (as in the west) to a low-carbon, high-income economy, but rather a continuation of the Chinese economic transition of the last half century, from low-carbon, low-income, to high-carbon, high-income economy. The CCP leadership links the "green transition" and a "people-centred approach" not to the protection of individual rights, but to the creation of employment opportunities and eradication of poverty, that can deliver "social equity and justice (…) increase people's sense of benefit, happiness and security".[140] 'Justice' is seen as tied to stability, and to the realisation of collective, social and economic rights of self-determination and development – not, as it sometimes is in other countries' Just Transition discussions, as a question of justice for workers who are *losing* jobs.

The Chinese outlook does not, broadly speaking, reflect a liberal vision of commercial solar power as a contributor to the achievement of individual rights. It is a more collectivist outlook than that. The state's right to steer solar energy's contribution to local and national economic development, and to poverty alleviation, is prioritized. The state's role in 'guiding' Uyghur workers out of their traditional lifestyles and into gainful, industrialised employment is framed not as illegitimate coercion or violation of individual labour or human rights, but as a perfectly legitimate discharge by the CCP of its role in realising China's right to development.[141] Against that backdrop, CCP and CPVIA officials frequently characterise allegations of forced labour in the PV industry as deliberate, malicious ploys by Western state and commercial actors to disrupt XUAR's economic development and China's dominance of the PV supply-chain. In January 2021, the CPVIA argued:

> *As we all know, the issue of 'forced labour' is a century-old lie fabricated out of thin air by institutions and personnel in certain Western countries such as the United States. There is no forced labour in the production of photovoltaic products in the Xinjiang region of China. Employees in Xinjiang choose their occupations according to their own wishes, and based on the principle of equality and voluntariness, they sign labour contracts with photovoltaic companies in accordance with the law to obtain corresponding remuneration. Xinjiang implements an active labour and employment policy to vigorously safeguard the basic employment rights of people of all ethnic groups...Using the so-called 'forced labour' as an excuse, some US agencies 'politicized' China's photovoltaic industry in Xinjiang, with the ultimate goal of curbing Xinjiang's development and progress and interfering in China's internal affairs.*[142]

Elsewhere, the CPVIA argued that

> *[t]he US uses the so-called 'forced labour' as an excuse to implement long-arm jurisdiction. In essence, it wants to slander China's photovoltaic industry in Xinjiang, so as to curb Xinjiang's development and progress, and prevent all Chinese people in Xinjiang, including the Uyghurs, from pursuing a better life.*[143]

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130 ECCHR, 2021; Sherpa, 2021; DutchNews, 2021.
131 *Doe 1 et al. vs Apple Inc. et al.*(2019).
132 CEFLUR (Coalition to End Forced Labour in the Uyghur Region) (2021). Steering Committee Letter to President of the European Commission and others, 9 November 2021.
133 Amnesty International, 2016.
134 IPAC (2021b). IPAC Statement on evidence of Uyghur forced labour in global solar supply chains. 14 May 2021. Available at **https://ipac.global/ipac-statement-on-evidence-of-uyghur-forced-labour-in-global-solar-supply-chains/**.
135 CECC (Congressional-Executive Commission on China) (2020). 'Global Supply Chains, Forced Labor, and the Xinjiang Uyghur Autonomous Region', Transcript of Roundtable, 116th Congress, Second Session, 11 March 2020, GPO, available at **https://www.cecc.gov/sites/chinacommission.house.gov/files/documents/Transcript.pdf**
136 Authors' research interviews, 2021-2022.
137 Iain Duncan-Smith (2021). 'In its rush to net-zero, the West is aligning itself with Chinese human rights abuses', *The Telegraph*, 22 November 2021.
138 White House (2021b). 'FACT SHEET: G7 to Announce Joint Actions on Forced Labor in Global Supply Chains, Anticorruption, and Ransomware', 13 June 2021, available at **https://www.whitehouse.gov/briefing-room/statements-releases/2021/06/13/fact-sheet-g7-to-announce-joint-actions-on-forced-labor-in-global-supply-chains-anticorruption-and-ransomware/**

139 White House (2021). 'New U.S. Government Actions on Forced Labor in Xinjiang. Fact Sheet', 24 June 2021, available at **https://geneva.usmission.gov/2021/06/24/fact-sheet-new-u-s-government-actions-on-forced-labor-in-xinjiang/?_ga=2.31482750.196963016.1641442803-2080661718.1639389398**; Canada, New Zealand, UK, USA (2021). *Joint Statement on Prioritizing the ILO Forced Labor Response*, 15 April 2021. Available at **https://geneva.usmission.gov/2021/04/15/joint-statement-on-prioritizing-the-ilo-forced-labor-response/**; United Nations General Assembly (2021). 'Cross-Regional Joint Statement on the Human Rights Situation in Xinjiang, on behalf of 43 Member States', UNGA, Third Committee, 21 October 2021, available at **https://onu.delegfrance.org/we-call-on-china-to-allow-immediate-meaningful-and-unfettered-access-to**.
140 Xi Jinping (2021). 'For Man and Nature: Building a Community of Life Together', Full Text: Remarks by Chinese President Xi Jinping at Leaders Summit on Climate, 26 April 2021, available at **https://english.mee.gov.cn/News_service/media_news/202104/t20210426_830358.shtml**; Laura Murphy, Kendyl Salcito and Nyrola Elimä (2022). *Financing & Genocide: Development Finance and the Crisis in the Uyghur Region* (Atlantic Council, February 2022).
141 Yangfei Zhang (2020). 'Accusations of 'forced labour' in Xinjiang refuted'. *China Daily*, 27 October 2020.
142 China Photovoltaic Industry Association (2021). 'Statement on Individual U.S. Institutions, Associations and Enterprises Slandering China's Xinjiang-related PV Supply Chain Involving "Forced Labor"', 18 January 2021, available at **http://www.chinapv.org.cn/association_news/922.html**.
143 China Photovoltaic Industry Association (2021b). 'Statement of the China Photovoltaic Industry Association on the signing of the so-called "Uyghur Forced Labor Prevention Act" into law by the United States', 28 December 2021, available at **http://www.chinapv.org.cn/association_news/1006.html**

Seeking to rally foreign government support for this narrative, the Chinese government has argued that the Rights current, as promoted by western actors, threatens not only China's right to development, but also other countries' ability to realise *their* right to development:

> *Attempts by the United States and its allies to dismantle the solar-energy industry in China's Xinjiang Uyghur autonomous region over allegations of so-called forced labour carry huge implications for cutting global carbon emissions and energy connectivity in developing countries… Any disruption of the Chinese solar industry could spell imminent energy doom for sub-Saharan Africa, where, according to the World Energy Outlook published last year by the International Energy Agency, 578 million people still lack power connectivity.*[144]

There is, however, and perhaps ironically, a certain symmetry between approaches to accountability in western and Chinese proponents of the Rights current. Western proponents of the Rights current encourage the state to take an active role in punishing rights violators through naming and shaming, and through imposition of formal economic or penal sanctions. The CCP has also moved towards such instruments in the last two years, in its own response to the forced labour issue – but in its case, uses these instruments to sanction those who promote the analysis that there is forced labour in XUAR. The Chinese government appears to have fostered online and consumer boycotts of brands seen to be too actively supporting the western Rights narrative, and has also adopted a new Anti-Sanctions Law regime that empowers the state to formally punish major proponents of that approach through prosecution and asset seizure. The same law even turns Chinese individuals into rights-holders, giving them a cause of action to sue those who harm their business interests by promoting this narrative.[145]

China has drawn explicitly on this 'right to development' counter-narrative in its efforts to resist the mobilisation of a (human) Rights narrative at the United Nations.[146] That has had some success. The UN Office of the High Commissioner for Human Rights has not yet released a study on XUAR that it has been working on for over two years. But one area of the UN system where a Rights current seems to be having greater success is the International Labour Organisation (ILO) – perhaps because, in that forum, it is not only states but also workers (through trade unions) and employers that can influence policy debates.

The tripartite architecture of the ILO, which formally gives voice and voting rights not only to states, but also to employers and to workers, creates a unique opportunity for non-state stakeholders to push for rights enforcement and accountability. Voting arrangements in the ILO also do not permit China or any other country to block action against it, as they can in other parts of the UN system. This set-up is one reason why the ILO has historically played a key role in the vindication of workers' rights when they have been impinged by state-backed systems of forced labour.[147] That pattern may recur in the context of alleged forced labour in XUAR. The International Trade Union Confederation has submitted claims to the ILO Committee of Experts on the Application of Conventions and Recommendations, alleging that China is not meeting its obligations under the ILO Employment Policy Convention, 1964 (No. 122) and the Discrimination (Employment and Occupation) Convention, 1958 (No. 111).[148] The Committee recently published its conclusions on the latter of these, calling for the Chinese government to revise its policies, specifically by ensuring that vocational training supports minority workers "in accordance with their own aspirations, account being taken of the needs of society", and by "re-orienting the mandate of vocational training and education centres from political re-education based on administrative detention towards" that purpose.[149] Though carefully worded, this is a clear statement that the Committee interprets the Discrimination (Employment and Occupation) Convention, 1958 (No. 111) to afford minority workers certain individual rights in choosing their work – and a clear signal that it believes those rights are not protected by the policies in place in PRC at present.

[144] China NDRC (National Development and Reform Commission) (2021). *China helps Africa tap new energy potential*, 19 July 2021, available at **https://en.ndrc.gov.cn/news/mediarusources/202107/t20210719_1290756.html**.
[145] James Cockayne (forthcoming C). *Sanctioning Xinjiang forced labour: Chinese counter-measures*. forthcoming on **www.xinjiangsanctions.info**.
[146] Chinese Permanent Mission to the United Nations (2021). 'The Majority of Countries Oppose the Interference in China's Internal Affairs in the Name of Human Rights', 21 October 2021, available at **https://www.fmprc.gov.cn/ce/ceun/eng/hyyfy/t1916044.htm**.
[147] Cockayne, 2021a.
[148] ILO (2021a). Direct Request (CEACR) – adopted 2020, published 109th ILC session (2021). Employment Policy Convention, 1964 (No. 122) – China. Available at **https://www.ilo.org/dyn/normlex/en/f?p=1000:13100:0::NO:13100:P13100_COMMENT_ID,P11110_COUNTRY_ID,P11110_COUNTRY_NAME,P11110_COMMENT_YEAR:4058075,103404,China,2020**;
ILO (2021b). Direct Request (CEACR) – adopted 2020, published 109th ILC session (2021). Discrimination (Employment and Occupation) Convention, 1958 (No. 111) – China. Available at **https://www.ilo.org/dyn/normlex/en/f?p=1000:13100:0::NO:13100:P13100_COMMENT_ID,P11110_COUNTRY_ID,P11110_COUNTRY_NAME,P11110_COMMENT_YEAR:4058090,103404,China,2020**
[149] ILO, 2022.

2.2.2 The 'Supply-Chains' current

The second ideal-type Policy Current that emerges from our review is the one that has made the most rapid progress in achieving policy change: the Supply-Chains current. While closely connected to the Rights Current, this current shifts the focus of policy action away from rights to risk, and from victims to business. The focus is on the risks posed by forced labour to both individual businesses and to the efficient and reliable operation of the supply-chain itself.

This shift in problem-framing generates a parallel shift in the locus of agency and responsibility for solutions – and consequently the mechanisms and forms of policy response. Whereas the Rights current tends to focus on states and individual rights-bearers as the key players in resolving these issues, through litigation and inter-state dialogue (as is under way at the ILO), the Supply-Chains current looks primarily to businesses and the market as the source of policy solutions, especially through supply-chain mapping and tracing, due diligence, and adaptation of existing enterprise and financial risk management techniques and practices. The Supply-Chains current proposes harnessing commercial and non-commercial influence within the supply-chain (and, more broadly, the value-chain) to address modern slavery risks at the operational level. These proposals typically converge around transparency and traceability arrangements, due diligence, use of 'leverage' and an active role for supply-chain actors in providing and enabling remedy.

The Supply-Chains outlook is neatly summarised in a recent *Best Practices Benchmark* published by European solar industry body, SolarPower Europe:

> *[S]olar companies have a duty to ensure and promote the respect of fundamental human rights, specifically in regard to the rights of workers. These actions must be carried out within business relationships with contractors, suppliers, and any other partners, with a particular focus on conflict-affected and high-risk contexts… Renewable energy is key for the transition to a low carbon economy, but companies' human rights policies and practices are not yet strong enough to ensure this transition is fast and fair… As renewable energy investments expand in countries with less developed frameworks for human rights protection, investors must step up their engagement to ensure projects meet international standards.*[150]

This approach sees a role not just for buyers and sellers within the supply-chain itself, but also for investors, lenders and insurers, in the broader value-chain. The US Department of Energy, in its recent *Solar Futures Study*, points to the use of ESG ratings to "preferentially rank socially responsible PV suppliers" as a way to "help incentivise transparency in the supply chain to avoid the sourcing of conflict minerals and prevent the violation of worker rights".[151] The study calls for further research into how the solar industry can use its collective leverage to drive efforts to promote responsible labour practices, including in the battery value-chain:

> *the solar industry could encourage the broader supply chain to embrace high-road labor practices. The solar industry could also encourage equitable practices in complementary supply chains, especially related to energy storage. Many key resources for batteries (e.g., lithium, cobalt) are sourced from regions with documented human rights abuses associated with materials extraction… The solar industry—as a large buyer of these resources—could potentially use its buying power to promote supply chain equity in all aspects of the clean energy transition. Measures to ensure equity in the solar supply chain are an area for further research.*[152]

The Supply-Chains policy current dominates most of the legislative, regulatory and industry proposals currently in play in the arenas we studied, though there is significant variation in the nature of the measures different corporate actors are expected to adopt, the speed of proposed adoption, and the role that other solar value-chain stakeholders, such as governments and finance, are called on to play.

The Solar Energy Industries Association (SEIA), which bills itself as "the national trade association for the U.S. solar industry" and has around 1,000 corporate members, is a major proponent of the Supply-Chains current. It reacted to forced labour allegations in 2019-2020 with "disgust", describing such practices as "abhorrent" and "a direct contrast to our values".[153] It then moved to adopt a new, voluntary Traceability Protocol and encouraged its members to take responsibility for identifying and removing forced labour risks in their supply-chains, including – notably – by exiting XUAR.

[150] SolarPower Europe (2021b). *Solar Sustainability Best Practices Benchmark*, May 2021, available at **https://www.solarpowereurope.org/wp-content/uploads/2021/05/2121-SPE-PV-Sustainability-Best-Practices-Benchmark-10-mr.pdf?cf_id=34591**
[151] US Department of Energy, 2021.
[152] Ibid.
[153] SEIA (n.d. b.). "Supply Chain Ethics & Sustainability", n.d., available at **https://seia.org/initiatives/supply-chain-ethics-sustainability**

The Traceability Protocol aims to give solar companies the ability to accurately determine the source of key components in a solar panel, including polysilicon – though it is not intended as a way to assess the conformance of production with international labour standards.[154] Over 300 solar firms have now signed the SEIA Solar Industry Forced Labour Prevention Pledge.

In Australia, the Clean Energy Council has recently instituted a similar voluntary pledge, which commits signatories to “work towards our operations and supply chains being free of adverse human rights impacts, including modern slavery”. This is to be achieved through a range of business practices including in enterprise risk management, procurement, contracting, training and peer collaboration.[155] There are signs that the UK and European industry groups – SolarEnergy UK and SolarPower Europe – are also considering moving towards such a voluntary, industry-led approach.[156] Related to this, but going further, some groups are pushing for the development of industry certification systems. For example, the Ultra-Low Carbon Solar Alliance (ULCSA) – a group of companies aiming to promote market preference for a lower carbon solar supply chain – advocates the adoption of ESG labels and certification systems to help ensure the market meets minimum ESG standards, including on forced labour.[157]

The Supply-Chains current is also central to actions taken by the US government, including the adoption and enforcement of WROs, and the adoption of the Uyghur Forced Labor Prevention Act (UFLPA) (see section 1.1 above). Both regimes require importers to develop supply-chain tracing and due diligence systems in order to demonstrate to US customs authorities, at the point of entry into the US market, that goods have not been made with forced labour. The strong bipartisan support that this approach currently enjoys in US Congress (with just one person voting against the UFLPA in both houses of Congress combined), and the increasingly robust approach to implementation, has created a powerful policy window in the US. It has also had a powerful demonstration effect in other countries, with Australia, Canada, the UK, and the EU all now actively considering adopting a similar approach.[158] A group of policy brokers in the anti-slavery and human rights movements have actively encourage the cross-country policy diffusion of this approach, promoting adoption of the US import ban model in written submissions to legislatures and civil services in multiple countries. Anti-Slavery International and the Coalition to End Uyghur Forced Labour have played a deliberate coalition-building role, seeking to expand the reach of these policy ideas into new arenas such as the G7 and global finance.[159] In parallel, the US government itself has also actively encouraged other governments to follow its lead on trade and sanctions measures.[160]

Beyond the import ban approach, an even wider set of OECD governments are taking a range of formal and informal steps to encourage businesses to improve due diligence and supply-chains arrangements.[161] In a March 2021 Resolution, the EU Parliament states:

> *compliance with the due diligence obligations should be a condition for access to the internal market and … operators should be required to establish and provide evidence, through the exercise of due diligence, that the products that they place on the internal market are in conformity with the environmental and human rights criteria set out in the future due diligence legislation; calls for complementary measures such as the prohibition of the importation of products related to severe human rights violations such as forced labour or child labour; stresses the importance of including the objective of combating forced labour and child labour in Trade and Sustainable Development chapters of Union trade agreements…*[162]

[154] SEIA (2021a). ‘Solar Industry Statement on the Passage of the Uyghur Forced Labor Prevention Act’, 16 December 2021, https://seia.org/news/solar-industry-statement-passage-uyghur-forced-labor-prevention-act; SEIA, 2021b; SEIA (2021c). *Solar Supply Chain Traceability Protocol 1.0 Industry Guidance*, April 2021, https://www.seia.org/sites/default/files/2021-04/SEIA-Supply-Chain-Traceability-Protocol-v1.0-April2021.pdf; SEIA (2021d). ‘U.S. Solar Industry Comments on Enforcement Action on Solar Products from Xinjiang’, 23 June 2021; SEIA (2021e). ‘Solar Industry Statement on Supply Chain Concerns in Xinjiang’, 14 May 2021; Abigail Ross Hopper (2021). ‘Final thought: Solar ethics, forced labor’, *PV Magazine*, iss. 4, 7 April 2021, available at https://www.pv-magazine.com/magazine-archive/final-thought-solar-ethics-forced-labor/

[155] Clean Energy Council (2022). *Pledge Against Modern Slavery*. Published at http://www.cleanenergycouncil.com.au, but since removed. Now on file with the lead author.

[156] Solar Energy UK (2021). *UK industry supply chain statement*, available at https://solarenergyuk.org/uk-industry-supply-chain-statement/; author’s research interviews, 2022.

[157] Fitzgerald, 2021.

[158] Australian Parliament (2021a). *Customs Amendment (Banning Goods Produced by Forced Labour) Bill 2021*; Australian Parliament (2021b). Commonwealth Parliament of Australia, Official Committee Hansard, Senate, Foreign Affairs, Defence and Trade Legislation Committee, *Customs Amendment (Banning Goods Produced By Uyghur Forced Labour) Bill 2020*, Tuesday, 27 April 2021, available at https://parlinfo.aph.gov.au/parlInfo/download/committees/commsen/65ab823b-8c13-4457-8ec8-faffa9903454/toc_pdf/Foreign%20Affairs,%20Defence%20and%20Trade%20Legislation%20Committee_2021_04_27_8705_Official.pdf;fileType=application%2Fpdf#search=%22committees/commsen/65ab823b-8c13-4457-8ec8-faffa9903454/0000%22; Australian Parliament (2021c). Senate, Foreign Affairs, Defence and Trade Legislation Committee, *Customs Amendment (Banning Goods Produced By Uyghur Forced Labour) Bill 2020*, Report, June 2021, available at https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Foreign_Affairs_Defence_and_Trade/UyghurForcedLabourBill/Report.

[159] Kristen Abrams et al. (2021a). ‘G7 nations should create a race to the top to eliminate forced labor- Our letter to global leaders’, Civil Society Letter to G7 Leaders, 7 June 2021; Kristen Abrams et al. (2021b). ‘G7 Trade Ministers: Fulfilling Commitments to Ending Forced Labour’, Civil Society Letter to G7 Trade Ministers, 3 October 2021, https://www.gfems.org/news_articles/g7-trade-ministers-fulfilling-commitments-to-ending-forced-labour/; authors’ research interviews, 2021.

[160] James Cockayne (forthcoming A). *Sanctioning Xinjiang forced labour: understanding government measures and corporate responses*, forthcoming on on www.xinjiangsanctions.info.

[161] Ibid., and *Overview Policy Brief*, also at www.xinjiangsanctions.info.

[162] European Parliament (2021). Resolution of 10 March 2021 with recommendations to the Commission on corporate due diligence and corporate accountability (2020/2129(INL)), 10 March 2021, https://www.europarl.europa.eu/doceo/document/TA-9-2021-0073_EN.html#title1

EU Commission President proposed in her 2021 State of the Union speech to develop just such an import ban,[163] and in a recent Communication the EU Commission announced that it

> *is preparing a new legislative initiative, which will effectively prohibit the placing on the EU market of products made by forced labour, including forced child labour. The initiative will cover both domestic and imported products and combine a ban with a robust, risk-based enforcement framework.*[164]

The policy process tracing literature tells us that one reason that policy ideas can catch on relatively quickly, like this, is that they are seen by policy and political actors as both feasible and conforming with those actors’ stated values. That is clearly the case here, with Supply-Chain policy thinking being deliberately framed as aligned with 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 which enjoy strong support from governments, business and civil society. The approach is embedded in a market logic – and thus a liberal paradigm – but sees a role for governments in setting and enforcing market rules and expectations. The role of states is not one of economic planning or command and control, but rather one of setting the rules within which the market is then expected to generate solutions to social problems such as modern slavery. The responsibility and costs of implementation are largely left to business.

There are, however, important differences within this current, particularly around risk identification. In the US government’s approach to date – as reflected for example in the UFLPA – it is the US government that identifies particular risk factors in supply-chains that require heightened corporate response (such as operation in or connection to XUAR, or sourcing minerals from a conflict zone). In the emerging EU model, by contrast, it is firms themselves that are framed as the actors best positioned to make that determination, through due diligence.[165] But what is common is a belief that governments should set the framework of market expectations within which responsible business can then operate. A civil society letter to G7 governments, ahead of the June 2021 Carbis Bay Summit, for example, argued that

> *G7 nations should create a race to the top to eliminate forced labour. G7 governments should begin by using their considerable purchasing power to set the highest standards for public procurement. G7 nations should also harmonise reporting standards and enforcement regimes and collaborate on shared challenges, including through sharing information and intelligence and coordinating enforcement and due diligence.*[166]

The G7 leaders responded by noting their concern over “all forms of forced labour in global supply chains, including state-sponsored forced labour of vulnerable groups and minorities, including in the… solar… sectors”.[167] The following October, their trade ministers, tasked with identifying areas for action to address these concerns, identified governments’ role in providing “clarity and predictability for businesses”, including through

> *guidance on human rights due diligence… [and] through sharing risk-management tools, encouraging the collection of data and evidence, upholding international labour standards in their own business operations and procurement policies, and including respect for international labour standards in their assessments of publicly funded projects.*[168]

Beyond the G7, there is also evidence of coordination amongst a small group of countries, including Australia, the US, the UK, Canada, New Zealand, Japan, and some Western European governments, around the shape and content of legislative, customs and public procurement measures. This evidence includes, unusually, formal submissions made by the representatives of some of these countries to legislative and policy processes in other countries.[169]

Our research also suggests that there has been increasingly close coordination aligned with Supply-Chains current thinking amongst development finance institutions, including multilateral development banks, bilateral development lenders and export credit agencies. Dialogue, developing into coordination, has been under way since at least the first half of 2021. Different public financial institutions have been consulting each other on how to develop and integrate a Supply-Chains based approach into their work. The aim is to figure out how to continue to invest in and lend to solar energy production, while meeting statutory obligations and market expectations around human

[163] Von der Leyen, 2021.

[164] See European Commission, ‘Communication from the Commission to the European Parliament, the Council, and the European Economic and Social Committee on decent work worldwide for a global just transition and a sustainable recover’, Brussels, 23.02.2022, COM(2022), 66 final. For some background, see European Greens (2021). *Towards an EU import ban on forced labour and modern slavery*, Discussion Paper, Prepared by Ben Vanpeperstraete for MEP Anna Cavazzini, February 2021, available at https://www.annacavazzini.eu/wp-content/uploads/Towards_an_EU_import_ban_on_forced_labour_and_modern_slavery_February.pdf.

[165] See for example European Commission, Proposal for a Directive of the European Parliament and of the Council on Corporate Sustainability Due Diligence, 23 February 2022, available at https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1145.

[166] Abrams et al., 2021a.

[167] G7, 2021a.

[168] G7 (2021b). ‘G7 Trade Ministers’ Statement on Forced Labour’, London, 22 October 2021, available at https://www.gov.uk/government/news/g7-trade-ministers-statement-on-forced-labour-annex-a.

[169] Authors’ research interviews, 2021-2022.

rights and social impacts. In recent months, a number of multilateral development banks and development finance institutions appear to have converged around a 'Common Approach' to forced labour risks in the solar energy value-chain. This is now under active consideration for formal adoption by the governance bodies of several of these organisations. This Common Approach would establish a set of timed milestones for these organisations to strengthen traceability and social impact assessment arrangements in solar energy investments and lending, encouraging clients to take specific steps to identify and address forced labour risks in their supply-chains. These would be enforceable commitments, with violation risking cross-debarment from future contracts with any the organisations involved.[170]

With its focus on business-led solutions, the Supply-Chains current offers victims and survivors a somewhat limited role. While the Uyghur community has played an important role in the Coalition to End Uyghur Forced Labour, the Supply-Chain current focuses less than the Rights current on the agency of modern slavery victims and survivors as enforcers of their own rights, and more on their role as influencers of those who make, play by and enforce market rules. A central role has been that of witness, bearing truth to the reality of the abuse. This is clearly the pattern in discussions on modern slavery risks in the polysilicon supply-chain, to date. It contrasts to the more active policy and programming design and implementation role that affected communities are increasingly afforded with regards to DRC cobalt production. There, affected communities are increasingly involved in developing supply-chain remediation plans, and in programming aimed at addressing the drivers of modern slavery through creation of alternative local development pathways (discussed further below in section 2.2.4).

Even within the Supply-Chains current, though, Anti-Slavery International and other rights-oriented partners have, however, advocated for a more active role for affected communities – for example in enforcing due diligence and risk disclosure obligations. The argument here is that these groups are not only rights-bearers but also the source of unique expertise that can help ensure efficiency and effectiveness in the design and implementation of supply-chain based solutions. In discussing the enforcement of import bans, for example, ASI and its partners write that

> *[t]hroughout the [US CBP-led] investigation process, stakeholders must be consulted for information, and be invited to submit evidence or perspectives, prior to the imposition of any import controls as part of a human rights impact assessment in order to determine potential consequences. Should restrictions be imposed, said stakeholders must be consulted, or have the ability to submit, in order to determine the most appropriate prevention, mitigation and remediation measures as possible.*[171]

Civil society has likewise pushed for Supply-Chains based solutions to include arrangements for businesses and governments to enable or provide remedy for past harms.[172] US government efforts to detain goods made with forced labour at the border, for example, have been criticised by some for failing to "remediate harm and improve working conditions of the people involved in these cases." On the contrary, some argue, WROs may in some instances *increase* modern slavery risks for workers and vulnerable people, by closing factories and forcing them out of work, into informal and insecure jobs.[173] For that reason, some advocates, combining aspects of the Rights current and the Supply-Chains current, argue that market access should be "contingent on the remediation of harmed rights-holders".[174] Interestingly, though, while the business due diligence and supply-chain remediation aspects of the Supply-Chains current have found success in several different jurisdictions, this 'remedy' component has proven less successful to this point. This raises interesting questions about the 'feasibility' of this approach, and what underlying values or beliefs the audience for this advocacy may hold that are seen to be incompatible with this approach. In other sectors, for example, business has been hesitant to commit to providing remedy for harms in part out of concerns around incompatibility with cost minimization and the maximization of shareholder value.

Finally, another source of criticism of the Supply-Chains approach is now beginning to emerge relating to the difficulty that businesses have in generating system-level change (i.e. a shift in the system-state), while operating within a given system. Many stakeholders are beginning to appreciate that while strengthened due diligence and supply-chain tracing arrangements will help ensure that investors, buyers and customs authorities can determine with increased confidence whether there is forced labour in the part of the supply-chain to which they are exposed, these arrangements do not necessarily lead to an *overall* reduction in modern slavery risk in the global solar energy value-chain. Instead, they may simply displace modern slavery risks from one part of the global market to another. The Supply-Chain approach relies on market demand signals for 'clean' goods to incentivise investment in new, 'clean' supply capacity. These signals do seem to be emerging and having the desired effect, with some manufacturers such as JinkoSolar investing in new production capacity intended to supply markets adopting forced labour exclusion and due diligence rules. This 'bifurcated' supply-chain will help ensure that those requiring slavery-free goods have access to the requisite supply.[175] But this does not necessarily translate into an overall reduction in modern slavery in the global solar energy production system. The availability of new, 'clean' supply does not prevent 'dirty' providers continuing to use forced labour to supply markets that have *not* adopted forced labour exclusion rules. With Chinese demand for solar energy expected to grow significantly in coming years, this means that even if OECD markets such as the EU and US do implement a Supply-Chains based regulatory approach, the production facilities in XUAR that use forced labour may simply switch supply to the Chinese market.[176]

This not only raises concerns about the overall effect of the Supply-Chains approach on systemic risk, but also points to the possibility of an emerging competition between two or more distinct approaches to managing these risks in global governance of the solar energy value-chain. That possibility seems even greater when we consider the third Policy Current emerging in these debates: Autarky.

2.2.3 The 'Autarky' current

While the Supply-Chains current is clearly dominant in most policy arenas, our study also suggests that a distinct policy current is now discernible alongside it in many of them: Autarky.

While there are some operational similarities in the solutions the two currents propose, the Autarky current differs from the Supply-Chains current in its conceptualisation of the original policy problem posed by modern slavery in the solar energy value-chain, and the resulting policy prescription. The Autarky perspective 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. The political community in question is usually the nation, but in the European Union context it is the larger EU community. The imagery deployed shifts from the Supply-Chains imagery of risk, taint and integrity, to stronger, more securitised and group-oriented language of threat, protection and resilience. 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).[177]

The underlying outlook here is one that anticipates geostrategic competition for control of scarce resources key to the energy transition.[178] PV is increasingly explicitly framed by some, such as First Solar, the largest US module manufacturer, as "the next strategic resource".[179] The Autarky perspective suggests that dependence on foreign suppliers creates a security risk. For example, leading Conservative MP Iain Duncan-Smith wrote in *The Telegraph* in November 2021:

> *China's dominance here is a choke point in the supply chains on which net-zero depends. Unless democratic states are able to coordinate to find alternative means of production, the CCP will strengthen this key point of leverage. We need to change this situation urgently.*[180]

The solutions in play are not changes in business practice, but rather changes in government policy – such as tax and financial incentives to re-shore production capacity. Autarky is thus closely related to Green Industrial Policy.[181]

[170] Authors' research interviews, 2021-2022.
[171] Anti-Slavery International et al. (2021). 'Key considerations for an EU instrument to control the importation of forced labour products into the EU', July 2021, available at **https://corporatejustice.org/wp-content/uploads/2021/07/Import_controls_NGO_Paper_Final_Design.pdf**
[172] Abrams et al., 2021a.
[173] Allie Brudney (2020). 'Using the masters tools to dismantle the master's house: 307 petitions as a human rights tool', available at: **https://corpaccountabilitylab.org/calblog/2020/8/28/using-the-masters-tools-to-dismantle-the-masters-house-307-petitions-as-a-human-rights-tool**; European Greens, 2021; Anti-Slavery International et al., 2021.
[174] Anti-Slavery International et al., 2021.
[175] Eventide, 2022.
[176] Authors' research interviews, 2021-2022.
[177] 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**.
[178] Jason Bordoff and Meghan L. O'Sullivan (2022). 'Green Upheaval. The New Politics of Energy.' *Foreign Affairs*, Jan/Feb 2022.
[179] Mark Hutchins (2021). 'Unchained: Political moves shift solar supply'. *PV Magazine*, Issue 04 – 2021, 7 April 2021, available at **https://www.pv-magazine.com/magazine-archive/unchained-political-moves-shift-solar-supply/**.
[180] Duncan-Smith, 2021.
[181] Allan, Lewis and Oatley, 2021.

It is also connected to an adjacent set of ideas, which focus less on the economic logic of autonomy and resilience, and more on political and security objectives – essentially, a nationalist outlook. Elements of this cropped up in a number of different policy arenas we examined, but never clearly coalesced into a distinct Policy Current. Nationalist rhetoric and thinking is usually quickly reframed in more economic terms, shading back into Autarky. This is even the case in Chinese rhetoric, where nationalist themes of independence from and resistance to foreign malefactors usually shades quickly back into a focus on China's right to economic development. But the PRC is by no means alone in this movement away from focusing on rights and responsible business conduct (at the firm and supply-chain level), towards a greater focus on macro-level political economy and geostrategic considerations. In fact, we see the same tendency emerging in the US, UK and the EU.

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*. The latter would authorise US 9.5 billion in spending from 2022 to 2026 to promote the growth of the US solar manufacturing industry, with an explicitly economic development and domestic job creation rationale. The rationales presented for this re-shoring of solar capacity range from the inconsistency with 'American values' of doing business in China,[182] to improved resilience to supply-chain disruption[183]. But it can also verge towards mercantilism, merging considerations of prosperity, welfare and security. Congresswoman Elissa Slotkin, discussing the *Reclaiming the Solar Supply Chain Act*, described it this way:

> *This bill will make it easier to build cutting-edge solar technology right here at home, and in the process, it will create good-paying jobs and help the U.S. maintain a competitive edge over countries like China. This is a win for Michigan families, our environment and our national security.*[184]

The SEIA has flirted with Autarkic rhetoric on occasion, for example arguing in a March 2021 letter to several US Senators that

> *there are significant policy benefits associated with increasing domestic supply of solar products. Though some critical solar components are already made in the United States, bolstering our domestic manufacturing capacity throughout the entirety of the solar value chain would help promote transparency, reduce the need to rely on imported products and create good-paying jobs here at home.*[185]

The US is not alone in seeking to increase its domestic production capacity for strategic reasons. With domestic demand soaring, China is also investing in domestic PV production increases.[186] And some actors within EU policy debates also lean in the Autarky direction.

In December 2020, the EU Commission proposed a new Battery Regulation that would set carbon emission limits in production, oblige managers to use recycled content (including for cobalt), and impose checks to prevent labour abuses in the supply chain. Amongst other measures, the new EU Battery Regulation, once in force, would introduce so-called 'battery passports', which will show the origin of materials used in the battery.[187] This draws on the EU's experience regulating conflict minerals. Importantly, under the proposed Battery Regulation, companies that do not act against human rights abuses in the supply-chain will face a ban from the EU market. The strategy in play here is explicitly to use the bloc's regulatory and market power to set global standards – not only to protect rights or to defensively protect EU consumers by on-shoring production capacity, but to create a first-mover commercial advantage for domestic producers well-positioned to meet these regulatory standards, while seeking to force foreign competitors to up their own game in order to meet these same standards, as the price of entry into the European market. This seems to marry aspects of the Supply-Chains approach and the Autarky approach, openly acknowledging that how a regulator chooses to set standards in global value-chains will follow not only a market, but also a geostrategic logic.

[182] Marco Rubio (2021c). 'Rubio Joins Scott, Colleagues to Introduce the Keep China Out of Solar Energy Act', 30 March 2021, available at **https://www.rubio.senate.gov/public/index.cfm/2021/3/rubio-joins-scott-colleagues-to-introduce-the-keep-china-out-of-solar-energy-act**
[183] US Department of Energy, 2021.
[184] Val Demings, 2021. 'Rep. Demings Introduces Solar Supply Chain Legislation'. Press Release, 23 September 2021, available at **https://demings.house.gov/media/press-releases/rep-demings-introduces-solar-supply-chain-legislation**.
[185] SEIA (2021f). Letter to Senator Marco Rubio and Senator Jeff Merkley, 26 March 2021, **https://seia.org/sites/default/files/2021-03/SEIA%20Response%20to%20Senators%20Rubio%20and%20Merkley%20%283.26.2021%29.pdf**.)
[186] Nature Energy (2019). 'China brings solar home'. *Nat Energy* 4, 623 (2019). **https://doi-org.nottingham.idm.oclc.org/10.1038/s41560-019-0458-3**
[187] Sean Goulding Carroll (2021). 'EU aims to dethrone Asia as world's battery powerhouse', *Euractiv.com*, 20 October 2021.

In late 2020 and early 2021, the EU-China relationship went through a period of turmoil that appears, amongst other things, to have contributed to European policy makers decision to explore a similarly geostrategic approach to PV production. The critical 'focusing event' was the collapse of a deal, signalled in December 2020, to ink an EU-China Comprehensive Agreement on Investment. Amongst other things, the deal would commit China to "make continued and sustained efforts to pursue ratification" of two key ILO Conventions relating to forced labour.[188] The agreement, however, required ratification from the European Parliament before taking effect. Some members of the European Parliament opposed the deal on human rights grounds, including over concerns relating to forced labour in XUAR. Incoming US President Joe Biden also voiced concerns about the deal. In March 2021, the EU joined the US, UK and Canada in sanctioning Chinese officials involved in XUAR human rights violations. The Chinese government responded angrily, sanctioning an array of individuals, including European thinktanks, scholars and MEPs – including every member of the European Parliament's Subcommittee on Human Rights, its Political and Security Committee and five other MEPs. The EU Parliament responded in turn by freezing efforts to ratify the CAI in May 2021 and called for the adoption of an EU import ban on forced labour goods.

Our research suggests that there may in recent months have been some tentative progress between EU and Chinese officials towards resolving aspects of this dispute.[189] But the episode has focused minds in Brussels and in European member state capitals on the geostrategic rivalry between the EU and China, and drawn attention to solar energy value-chains as one front on which that rivalry may play out. In 2021 the European Commission named solar manufacturing as one of 14 industrial strategic ecosystems that the bloc is keen to support.[190] On 26 January 2022 a group of 8 major solar energy companies, convened by SolarPower Europe, wrote to the European Commission and Council to request a European strategy for the solar PV value chain in 2022, arguing it was necessary not only to meet European climate action goals, but also to ensure the resilience of European supply in the face of potential supply disruptions.[191] The European Commission has now launched a public consultation to develop such strategic thinking.

[188] Valdis Dombrovskis (2021). Answer given by Executive Vice-President Valdis Dombrovskis on behalf of the European Commission, Question reference: E-002005/2021, 7 June 2021, available at **https://www.europarl.europa.eu/doceo/document/E-9-2021-002005-ASW_EN.html**
[189] Noah Barkin (2022). "Watching China in Europe – January 2022", *The German Marshall Fund of the United States*, 5 January 2022, **https://www.gmfus.org/news/watching-china-europe-january-2022**; authors' research interviews, 2021, 2022.
[190] Liam Stoker (2021). 'EC gives 'much-awaited signal to re-ignite' European solar manufacturing', *PV Tech*, 5 May 2021, available at **https://www.pv-tech.org/ec-gives-much-awaited-signal-to-re-ignite-european-solar-manufacturing/**.
[191] Sean Rai-Roche (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/**.

The Autarky current, even framed in these more geostrategic terms, has faced some challenges in finding broad acceptance amongst policy and political actors, specifically around what the policy process tracing literature calls 'value acceptability'.[192] There are aspects of the Autarky current's proposed policy solutions that sit uneasily with the commitment that many western elite actors have to global free trade, which may provoke hostile reactions, such as the warning by Siemens CEO Roland Busch that we encountered earlier, that a "confrontational foreign policy" with China, embodied for example in the adoption of "export bans", could mean that "the energy transition [i.e. to renewables] will come to an end at this point".[193]

In the US, government actors appear to be seeking to square the circle between a nakedly Autarkic approach and the US' historical commitment to a liberal trading order by representing anti-forced labour measures as a *defence* of free trade. The argument here suggests that state-sponsored forced labour violates the rules embedded in the liberal trading order, and specifically in the global trade regime institutionalized through the WTO. Competition between states is entirely legitimate, this perspective suggests, but only if states play by the rules – including the agreement not to allow production based on forced labour, which unfairly undercuts more costly production that does play by the rules. In June 2021, for example, the White House argued that

> *The PRC's forced labor practices run counter to our values as a nation and expose American consumers to unethical practices. They also leave American businesses and workers to compete on an uneven playing field by allowing firms to gain advantage over their competitors by exploiting workers and artificially suppressing wages.*[194]

This 'fair trade' based approach also shades, at times, into a broader geopolitical debate about the legitimacy of political governance models based on state coercion of individuals: democracy v. autocracy. When the White House organised a Summit for Democracy in December 2021, it included a formal side event on 'Galvanizing Cooperation Among Democracies to End Forced Labour', convened by The McCain Institute, with speakers including the US Trade Representative, US Secretary of Labor, influential Member of the European Parliament Heidi Hautula and a Canadian Senator, amongst others.[195]

For other critics, however, the objection to the Autarky approach is not that it is hard to reconcile with a commitment to free trade, but rather that it jeopardises another critical global public policy goal: international climate cooperation. In July 2021, more than 45 progressive groups wrote to President Biden, expressing their concern over "the growing Cold War mentality driving the United States' approach to China — an antagonistic posture that risks undermining much-needed climate cooperation… Nothing less than the future of our planet depends on ending the new Cold War between the United States and China".[196] A similar position has been championed by progressive voices in US Congress, including Sen. Bernie Sanders and Rep. Ilhan Omar.[197] This echoes the warning by Siemens chief Roland Busch (seen earlier) that an excessively 'confrontational' approach to economic policy with China, such as a forced labour import ban, risks 'ending' the energy transition; and the China NDRC's own warning (section 2.2.1 above) that excessive concern about forced labour risks in the PV supply-chain risks "energy doom".[198]

The implication here is that there is a global public policy goal that should be prioritised: effective collective action to address climate action. It is through the rapid uptake of renewable energy that we will free ourselves from dependence on fossil fuels, and from dependence on the rent-takers who control fossil fuels. This is why the German finance minister, Christian Lindner, recently described renewable energy as 'the energy of freedom' or 'freedom energy' (*Freiheitsenergien*).[199] The irony is, of course, that this freedom risks being purchased at the expense of other people's. The Autarky current risks accepting that outcome.

[192] Kingdon, 2011.
[193] Busch, 2021.
[194] White House, 2021.
[195] Summit for Democracy (2021). 'Galvanizing Cooperation Among Democracies to End Forced Labor', 7 December 2021, available at **https://summit4democracy.org/event/galvanizing-cooperation-among-democracies-to-end-forced-labor/**.
[196] 198 methods et al. (2021). Letter to President Biden and Members of U.S. Congress, 7 July 2021, available at **http://foe.org/wp-content/uploads/2021/07/Cooperation-Not-Cold-War-To-Confront-the-Climate-Crisis-129.pdf**.
[197] Bernie Sanders (2021). 'Washington's Dangerous New Consensus on China. Don't Start Another Cold War', *Foreign Affairs*, 17 June 2021, available at **https://www.foreignaffairs.com/articles/china/2021-06-17/washingtons-dangerous-new-consensus-china**; Ilhan Omar (2021). "*We need to distinguish between justified criticisms of the Chinese government's human rights record & a Cold War mentality that uses China as a scapegoat for our own domestic problems and demonizes Chinese Americans. Racism has no place in policy debates*." [Twitter] 20 May 2021, available at **https://twitter.com/ilhanmn/status/1395158066778279937**.
[198] China NDRC, 2021.
[199] *Oldenburger Onlinezeitung*, 2022.

2.2.4 The Collective Action current

The fourth and final Policy Current we identified in our review suggests a different approach to Collective Action is possible. It frames reduction of modern slavery risks and carbon emissions *not* as a tension between competing policy objectives, but as mutually 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.[200] This 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. This approach suggests that our goal should not be narrowly to reduce modern slavery risks in established supply-chains, but rather 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. This current, informed by systems thinking, 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.

The Collective Action current resembles the other three policy currents in some ways, but also differs from them in key aspects.

First, like the Supply-Chains current, it sees negative externalities as the product of poor system design. However, the Supply-Chain current tends to frame that 'system' in the narrowly technical and managerial terms of the supply-chain (or, for some, the value-chain), while the Collective Action current frames the production system in broader, socio-economic terms. Consequently, where the Supply-Chains current presents a narrative in which responsible businesses, supported by the right government policy choices, can reform their practices in ways that, cumulatively, will end modern slavery in the solar energy value-chain, the Collective Action current recognises that a range of non-commercial factors – such as national security, industrial policy and redress of historical harms – may need to be addressed in transitioning solar energy.

Second, like the Rights current, the Collective Action current sees solutions to modern slavery emerging out of purposive action by rights- and interest-holders in the production system. But where the Rights current looks primarily to individual rights-holders and states to enforce existing rights, the Collective Action current suggests a need for multistakeholder collaboration to create a shared plan for transformation, going beyond existing institutions and governance arrangements where necessary. This has significant implications for our expectations of *how* a sustainable solution to modern slavery concerns may emerge, suggesting the need for an inclusive approach to transition design and implementation.

Third, the Collective Action approach suggests a need for purposive action to intervene in and reorganize markets. The Rights current looks to courts and other accountability mechanisms, such as multilateral bodies, to create signals that the market will respond to, through competitive and adversarial action. The Supply-Chains current takes a similar approach. The Collective Action current, closer in this respect to the Autarky approach, suggests a need for purposive investment by solar energy stakeholders, for example through public-private partnerships.[201] And like the Autarky current, it sees new solutions emerging through deliberate interventions, though it suggests a role in design and implementation for a much broader array of stakeholders than the state-focused Autarky current.

One of the clearest voices in this Policy Current is the Responsible Energy Initiative (REI), a project of the Forum for the Future, which has worked with the World Wildlife Foundation, World Resources Institute, TERI (The Energy Resources Institute), Landesa, S&P Global Foundation and the UK Government. This project seeks to reconcile the benefits of the transition to renewables with potential costs, including to labour rights – with a specific focus on Asia. The REI frames this issue as one aspect of a broader search for sustainability in the renewable energy sector. "Unless the potential negative social and environmental impacts of [renewable energy] are addressed", the Initiative argues, "the growth of the sector may be put in jeopardy."[202] REI explicitly adopts a systems perspective, arguing that we can only achieve a new system equilibrium if we make all solar energy stakeholders responsible for that outcome, shifting their incentives from short-term, zero-sum competition, to longer-term win-win cooperation and stewardship thinking.

[200] 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.
[201] International Solar Alliance (2021b). 'International Solar Alliance establishes an Advisory Committee and partnership with Nordic institutional investors to mobilize $1 trillion for investment in solar'. 10 November 2021, available at **https://www.isolaralliance.org/uploads/docs/7357c72220c19c6d4f-92654c7ea50d.pdf**.
[202] Forum for the Future (n.d.) "Renewable Energy to Responsible Energy Initiative", n.d, available at **https://www.forumforthefuture.org/renewable-energy-responsible-energy-initiative**

The ambition is nothing short of enabling the renewable energy sector in Asia "to adopt business models and value chains keeping justice, equity, universal rights and resilient ecological systems at their core."[203]

The Collective Action current has, however, had its clearest expression in the policy discourse of organisations with global mandates or global systems perspectives pertaining to mineral production, such as the Organization for Economic Cooperation and Development. The OECD has pioneered multistakeholder collaboration along the cobalt value chain, building on two decades of work with stakeholders on due diligence in mineral supply-chains.[204] A range of other multistakeholder initiatives has also emerged to tackle child labour in the cobalt supply-chain. Through the UN-backed investor group, Principles for Responsible Investment (PRI), 46 institutional investors with USD 6.4 trillion AUM ran a collaborative engagement between 2018 and 2020 on responsible cobalt sourcing, working with companies in the electronics and automotive sector.[205] This included efforts to strengthen human rights due diligence, impact monitoring, on the ground remediation and – critically – collaboration on systemic issues. Investors collaborated to create an 'Investor Expectations' document that aimed to clarify market expectations along the length of the value-chain, providing a clearer framework for collective action.

Likewise, the Cobalt Institute – a global industry association representing an estimated 75% of the global cobalt market – has developed a Cobalt Industry Responsible Assessment Framework (CIRAF) that aims to provide a systems-learning and systems-monitoring perspective.[206] At the World Economic Forum, the Global Battery Alliance brings together 80 businesses, governmental and non-governmental, working together to help establish a sustainable battery value-chain by 2030, including a focus on forced and child labour. Its flagship 'Battery Passport' initiative aims to embed assessment of battery supply-chain components against ESG parameters in a digital ID that will travel with those components, facilitating not only supply-chain traceability and due diligence, but also system-level risk analysis.[207] And the Responsible Cobalt Initiative was launched by the OECD and the China Chamber of Commerce of Metals, Minerals & Chemicals Importers & Exporters (CCCMC) in 2016.

One of the key lessons of these cobalt initiatives has been the need to go beyond solutions involving only commercial partners, to include long-term engagement with the communities within which forced and child labour are occurring. There is a growing recognition that the Supply-Chains based belief that downstream value-chain actors' choices and preferences can induce change at the point of extraction or manufacturing may in fact be overstated.[208] What is needed, instead, is a common framework for transitioning DRC ASM communities to more formalised governance arrangements, providing an engine for local economic development:

> *A growing number of companies, development practitioners and stakeholders see ASM as a potential engine for local sustainable development as well as a commercially viable producer of cobalt, and agree that a commonly accepted set of expectations for responsibly produced ASM cobalt could play a key role in supporting improvements in the sector.*[209]

The shift here is from a focus on solving the problems for the businesses in the Supply-Chain, to a focus on development as a public good that benefits not only the companies operating in that community, but also the people themselves:

> *Congolese and international stakeholders spoke to the importance of not just due diligence but addressing "root causes" of risks. That is, mine site risk mitigation may reassure buyers but may not benefit all actors in the supply chain equally and may not lead to broad community development outcomes. For example, the removal of children from a particular cobalt supply chain provides benefit for companies in that supply chain but, unless underlying causes for children working in mine sites are addressed, those children will likely work at another mine site or in other sectors.*[210]

[203] Forum for the Future (n.d)

[204] Lucia Mancini, Nicholas Eslava, Marizia Traverso, and Fabrice Mathieux (2020). *Responsible and sustainable sourcing of battery raw materials*, EUR 30174 EN (Publications Office of the European Union, Luxembourg); OECD (2016). *Monitoring and Evaluation Framework : OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas*, 3rd Edition (Paris); OECD, 2019.

[205] PRI (2020). 'Collaborative engagement on responsible sourcing of cobalt', *Principles for Responsible Investment*, 2020, available at **https://www.unpri.org/collaborative-engagements/collaborative-engagement-on-responsible-sourcing-of-cobalt/6278.article**; PRI (2020b). 'Responsible Cobalt Sourcing: Engagement Results' *Principles for Responsible Investment*, 2020, available at **https://www.unpri.org/download?ac=14320**.

[206] Cobalt Institute (n.d.). *Cobalt Industry Responsible Assessment Framework (CIRAF)*, available at **https://www.cobaltinstitute.org/responsible-sourcing/industry-responsible-assessment-framework-ciraf/**

[207] Global Battery Alliance – 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', September 2019, available at **https://www.globalbattery.org/media/publications/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf**

[208] PRI, 2020; Dorothée Baumann-Pauly and Susan Cremer (2020). 'How New Business Models Can Address Human Rights Risks in the Cobalt Supply Chain', 8 September 2020, NY Stern Center for Business and Human Rights.

[209] Global Battery Alliance Cobalt Action Partnership, Responsible Cobalt Initiative and Fair Cobalt Alliance (2021). 'The ASM Cobalt Framework Vision', version 1, June 2021, available at **https://www.asm-cobalt.org/wp-content/uploads/2021/06/ASM-Cobalt-Framework-Vision-and-Approach_June2021.pdf**

[210] Global Battery Alliance Cobalt Action Partnership (2021). 'Report from Stakeholder Consultations on the Artisanal and Small-Scale Mining Cobalt ESG Management Framework', 1 October 2021, available at **https://www.globalbattery.org/media/publications/report-from-stakeholder-consultations-on-the-asm-cobalt-esg-management-framework-english.pdf**

The shift from a Supply-Chains perspective to a Collective Action approach is a shift away from risk exclusion towards risk mitigation; towards greater inclusion; and to a longer-term structural change perspective, particularly focused (in the DRC context) on ASM formalisation.[211] The resulting collective action approach blends the business process focus of Supply-Chains based action with a more developmentalist and place-based intervention strategy:

> *A common misconception is that the sector's challenges relating to ASM can be solved simply by shutting down this source or diverting supply chains away from the issue. But doing so would remove a lifeline for 1-2 million Congolese people living in extreme poverty who depend on ASM cobalt. Cobalt extraction through ASM, therefore, presents an opportunity to enable sustainable livelihoods, on the condition that responsible practices can be established. The formalisation of ASM practices is an essential step to address the issues related to artisanal mining sites. The jobs and income created on formalised ASM sites can also help reduce extreme poverty, which is a root cause of child labor.*[212]

This shift has led to a range of initiatives on the ground in DRC, in which combinations of public and private stakeholders in the value-chain finance local interventions aimed at addressing structural drivers of child and forced labour, addressing the institutional setting and incentives for these practices, as well as addressing vulnerabilities.[213]

There is also another shift in play here – a procedural one. The Collective Action approach emerging in the cobalt production sector reflects a broader recognition that in order for there to be a sustainable shift in how a value-chain works – for example, to ensure that children do not simply find their way back into ASM – affected stakeholders need to be involved in designing and implementing structural change. Consultation must be meaningful, and with those most affected. Thus the OECD's *Due Diligence Guidance for Meaningful Stakeholder Engagement in the Extractive Sector* recommends prioritising engagement with the most severely affected, rather than most influential stakeholders.[214] This is a key insight for any effort to secure the solar energy value-chain's place in the Just Transition.

Some of the ASM programmes in DRC also now go beyond structural prevention to case-level remediation. One of the lessons from the application of Supply-Chains based solutions in DRC was that it did not adequately incentivise remediation of past harms:

> *The private sector has focused on preventing artisanal cobalt from entering the supply chain altogether, or [on] working to formalise artisanal mine sites, making the mining activity more responsible (child-free, with improved safety conditions) and traceable, ensuring companies can purchase from artisanal mines without child labour involved. However, specific remediation of child labour, including connecting child workers to services and education has not been addressed. This involves ensuring ongoing benefits to artisanal miners by improving working conditions and income.*[215]

Such concerns led to the creation of a pooled Fund for the Prevention of Child Labour in Mining Communities.[216] This is indicative of increasing cooperation within the ecosystem of actors working on forced and child labour in ASM in DRC. Since 2018, the OECD Secretariat has convened an annual meeting of companies, governments and civil society along the cobalt supply chain, to improve information sharing and coordination on due diligence and responsible business conduct.[217]

Still, it is important to acknowledge that this approach faces some 'feasibility' challenges, given background assumptions and beliefs in the business community about firms' (lack of) responsibility for the development of the communities in which they operate – or indeed for remedy to individuals who have been harmed. A recent review of ASM efforts in DRC found that the interventions stood up

> *are rather effective in implementing the changes that they are designed to make, especially in the case of life-threatening working conditions, child labour, and corruption. However, the risk categories addressed by these projects are dictated by downstream expectations and do not necessarily correspond to the demands of the miners they are designed to protect. For instance, price calculation and income are particularly salient aspects [to workers' decision to participate in ASM, and thus face forced or child labour risks] and are not captured*

[211] WEF, 2020; Cobalt Institute (n.d.).

[212] Sarah McLaren (2021). The Cobalt Institute & the Pact for Sustainable Industry. *CSR Europe*, 27 August 2021, available at **https://www.csreurope.org/news-bundle-articles/the-cobalt-institute-the-pact-for-sustainable-industry?rq=COBALT**

[213] Global Battery Alliance (2020). 'Global Battery Alliance Cobalt Action Partnership Overview', September 2020, available at **https://www.responsiblemineralsinitiative.org/media/docs/GBA%20Cobalt%20Action%20Partnership%20Overview%20Sept%202020.pdf**; GBA CAP, 2021; Stewart Carter Assheton, and David Sturmes (2020). 'Digging for Change: Selected Findings and Analysis from a Review of the State of ASM cobalt Mining Working Conditions, Children's Rights, and Economic Opportunity in Two Cobalt Mining Communities in Lualaba Province, Democratic Republic of the Congo', *The Impact Facility*, June 2020, available at **https://www.theimpactfacility.com/wp-content/uploads/2020/06/20200618-%E2%80%93-Digging-for-Change-Towards-a-Responsible-Cobalt-Supply-Chain-%E2%80%93-V1.0.pdf**.

[214] OECD (2016b). *Due Diligence Guidance for Meaningful Stakeholder Engagement in the Extractive Sector*. (Paris).

[215] UNICEF (2020). 'Mapping Child Labour Risks in Global Supply Chains: An Analysis of the Apparel, Electronics and Agricultural Sectors', *UNICEF Background Paper*, January 2020, available at **https://www.unicef.nl/files/Child%20Labour%20in%20Global%20Supply%20Chains.pdf**

[216] GBA, 2020.

[217] OECD, 2019.

> *by the evaluations. The S-LCA methodology offers a promising avenue to expand the scope of enquiry in a structured manner.*[218]

We return to the potential utility of the S-LCA (Social Lifecycle Assessment) approach in sections 3 and 4 of this paper.

While the Collective Action perspective that has been emerging in cobalt and battery supply-chain arenas has now developed a level of maturity, our review suggests it is nascent in debate on how to address modern slavery in the broader solar energy value-chain. Projects like REI are beginning to move policy debates and action in this direction, but the Collective Action current is only just now emerging in consistent heuristics or narratives across different policy arenas, for example with the concept of 'responsible energy' (as opposed to 'renewable energy'). While there are some recurring heuristics of system-state transition and win-win collaboration, this Policy Current presently lacks a clear narrative or affect-based communications: it does not yet offer a clear 'story' explaining the system transformation that a Collective Action based approach to policy will induce. There are some signs that such a discourse may yet emerge around these issues, with a growing influence of bottom-up 'energy justice' discourse in official narratives.[219] And the discourse of 'freedom energy' may offer an important new heuristic, not least because it connects the push for energy-system transformation to the values of resilience, self-reliance and independence that the Autarky current is currently tapping into.

One question that emerges is why the Collective Action current has moved so much further in the cobalt production discussion than in the PV and polysilicon production context. A part of the answer may be that actors in the cobalt supply-chain have faced external pressure to address social impacts for longer than those in the PV supply-chain. But another part of the answer seems to be that there has been a cluster of active policy brokers operating from within this current, in the cobalt arena. And some of those policy brokers, such as the OECD, have significant transnational reach and influence. In the PV space, by contrast, no equivalent transnational policy broker has yet emerged. The international organizations focused on solar energy – such as the International Solar Alliance, IRENA and, to some extent, the IEA – have simply not yet focused in any meaningful way on the social impacts of solar energy production systems.

IRENA, the International Renewable Energy Agency, presents the industry's socio-economic impacts in overwhelmingly positive terms, with nary a reference to modern slavery risks.[220] Its modelling of the future of solar energy does not account for the increasingly real possibility of supply-chain disruption or bifurcation resulting from forced labour concerns.[221] The IRENA Collaborative Framework on Just & Inclusive Transitions is also silent on these issues.

Elsewhere, the International Energy Agency's *Recommendations of the Global Commission on People-Centred Clean Energy Transitions* emphasise that

> *It is equally important to ensure that new jobs created by energy transitions are of good quality and uphold the highest labour standards. There are well-developed principles for supporting those affected by employment changes in clean energy transitions, most notably the International Labour Organisation's (ILO's) 2015 Guidelines for a Just Transition Towards Environmentally Sustainable Economies and Societies for All, which provide a policy framework and specific recommendations to ensure that energy transition policies are socially inclusive and support decent work.*[222]

Those ILO *Guidelines* contain an explicit commitment (para 13(b)) to respect for fundamental rights at work – which include freedom from forced labour.[223] But despite this reference, the IEA has not yet grappled with the reality of modern slavery risks in the PV and Li-ion battery supply-chains.

Likewise, the International Solar Alliance (ISA), an intergovernmental coalition with over 100 members led by India and France, is also silent to date on these questions. ISA frames solar energy as key to low-carbon growth, and aims to provide a framework for collective action to accelerate solar uptake, through

> *better harmonizing and aggregating the demand for inter alia solar finance, technologies, innovation or capacity building, across countries, [to] provide a strong lever to lower costs, increase quality, and bring reliable and affordable solar within the reach of all.*[224]

[218] Mancini et al., 2020.
[219] For example, Shalanda Baker, the author of *Revolutionary Power: An Activist's Guide to the Energy Transition*. (Washington: Island Press), is the current nominee to serve as Director of the Office of Economic Impact and Diversity at the US Department of Energy.
[220] IRENA, 2019. *Future of Solar Photovoltaic: Deployment, investment, technology, grid integration and socio-economic aspects* (A Global Energy Transformation paper), International Renewable Energy Agency, Abu Dhabi.
[221] IRENA, 2021c. World Energy Transitions Outlook, June 2021, Abu Dhabi.
[222] IEA (International Energy Agency). *Recommendations of the Global Commission on People-Centred Clean Energy Transitions*, October 2021.
[223] ILO, 2015.
[224] International Solar Alliance (n.d.) Framework Agreement on the establishment of the International Solar Alliance (ISA), n.d.

At COP26, together with the UK Government and World Bank, ISA launched the Green Grids Initiative – One Sun One World One Grid (GGI-OSOWOG), to create a global coalition of national governments, international financial and technical organisations, legislators, power system operators and knowledge leaders to “accelerate the construction of the new infrastructure needed for a world powered by clean energy – specifically the first international network of global interconnected solar power grids”.[225] This points in the direction of the kind of multistakeholder collective action frameworks that have emerged in the battery space (see above). But the ISA does not yet appear to have engaged in any sustained way with the question of how to manage modern slavery risks.[226]

There are, however, some signs that some financial institutions may be emerging as thought leaders adopting the systems-thinking approach. Most of them continue to approach modern slavery issues from a ‘Supply-Chains’ direction, but our research suggests there is a cluster of export credit agencies and development finance institutions that is moving towards a ‘Collective Action’ approach, for example in thinking about how to use efforts to embed human rights due diligence in contracts to create a *shared* responsibility for both buyers and suppliers to co-create and use leverage.[227] This differs in important ways from the ‘top-down’, command and control approach in which buyers (and investors) use contractual representations and warranties to push compliance obligations onto suppliers – as the ‘Common Approach’ currently under consideration by some DFIs appears to (see section 2.1.2 above). This relatively new approach would instead incorporate key conduct expectations around joint and collective action, drawn from background norms such as the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights, into contractual terms. Instead of the supplier’s obligation being one of result (achieving specified certification, for example), this approach imposes obligations of conduct – including due diligence, remedy, and responsible divestment/exit.[228] The idea is to use contracts as the vector by which new responsible conduct settings are reproduced throughout the production system.

However, even these innovations continue to operate in the domain of compliance and procurement – that is, they seek to reform, rather than transform, existing supply-chains. They do not get to the questions of system-level stewardship raised by the potential disruption to solar energy value-chains caused by forced labour allegations. There is little consideration of what a shared plan for a global industry-wide path to zero modern slavery might look like.

This stands in contrast to the collective action now under way to create shared plans for reducing carbon emissions. Stewardship oriented coalitions are emerging to harness investment capital to foster a Just Transition, such as Climate Action 100+ (with over USD 55 trillion AUM), the Financing a Just Transition Alliance, and the Global Energy Alliance for People and Planet (GEAPP) launched at COP26 with USD10 billion of committed capital to accelerate investment in green energy transitions and renewable energy solutions in developing and emerging economies.[229] These processes do not yet seem to have grappled in any substantial way with the risks posed by modern slavery to the Just Transition. But they do point to possible *pathways* towards solutions that do grapple with those risks, and set out a more positive vision of what a responsible solar energy production system would look like.

2.3 Discussion

Our review of policy debates on modern slavery in the PV and battery value-chains uncovers some revealing dynamics, relating to: 1) the roles and responses each current prescribes as the basis for effective policy solutions; 2) ‘justice’ implications; and 3) what this tells us about how to design pathways for achieving policy solutions.

[225] International Solar Alliance (2021). ‘World’s First Partnership for Interconnected Solar Grids, GGI-OSOWOG, Launched at COP26 World Leaders Summit’, November 2021, available at https://www.isolaralliance.org/uploads/docs/df8a70c6691b1a1462386893a08e8f.pdf.
[226] ISA, 2021; ISA (n.d); BNEF and ISA, 2021.
[227] John F. Sherman, 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/.
[228] Ibid.
[229] N. Robins, S. Muller, S. Tickell and K. Szwarc (2021a). *Just Zero: 2021 Report of the UK Financing a Just Transition Alliance* (London: Grantham Research Institute on Climate Change and the Environment, London School of Economics and Political Science).

2.3.1 Roles and responses

In the western policy arenas we studied, we found a pattern of early Rights discourse in policy debates fairly rapidly 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).

We also identified a subsequent shift in policy themes and framings in some arenas, notably in the US, towards a more openly Autarkic approach, as concerns about geostrategic competition for scarce resources and dependence on foreign rivals become more central to political debate. In the US and to some extent in China, the policy response that this current seems to be pointing to is one of re-shoring and national industrial policy. In the EU, in contrast, the bloc-wide equivalent of the Autarky approach points in a slightly different direction: the use of the bloc’s normative and market power to set minimum global standards on issues such as emissions, recycled content – and labour standards. Finally, we identified a nascent fourth policy current, which seeks to foster Collective Action by multiple stakeholders, notably including affected communities, through cooperation along value-chains. This policy current is by now well established in a range of multistakeholder initiatives addressing cobalt production. It is in its infancy in the PV space.

The communicative and narrative aspect of each of the currents is also notable. 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. The Supply-Chains current, in contrast, is presented in drily technical and managerial language and forms, often apparently targeting risk, procurement and compliance professionals in business enterprises. The narrative framing focuses much more, here, on responsible business as the source of solutions. The Autarky current appears to date to rely on broad values- and identity-based appeals to national solidarity, though sometimes also to other core beliefs and values such as a liberal commitment to free *and fair* trade or, more recently, to an even broader concept of ‘democracy’. This narrative framing risks recasting debates over modern slavery risks in the solar energy value-chain as part of a larger geostrategic competition between democratic and autocratic forces, seeking to develop and exert influence over global technical and market standards. While this may help insulate buyers and investors in western democracies from supply-chains that rely on modern slavery, a bifurcated value-chain does not necessarily reduce the risks of modern slavery overall and may risk slowing innovation and global uptake of solar power – in other words, slowing the transition to renewable energy. Finally, in part in response to the dangers that the Autarky current may pose, we see some signs of the emergence of a current focused more on collective action to shift the business model and overall risk profile of the solar energy production system. 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, and shared heuristics and narratives have not yet emerged.

2.3.2 ‘Justice’ implications

Understanding transnational debates on modern slavery risks in solar energy value-chains through the lens of these Policy Currents also 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 the harms in question.

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.

2.3.3 Policy process design

The four Policy Currents that have emerged from our review share certain assumptions, core beliefs and outlooks. These can be plotted, based on different assumptions about 'how the world works', specifically: 1) the underlying outlook on which kinds of organizations enjoy agency in global affairs, and 2) the underlying outlook on how sustainable policy solutions or systems equilibria emerge (Figure 8). Understanding the relationship between these currents (in bold text, in Figure 8 below), and adjacent policy thinking that has not coalesced into a coherent current (unbolded) may be useful for thinking through how these policy questions can be addressed in future.

The plot (Figure 8) first differentiates policy currents based on outlook assumptions about agency in international relations (the x-axis). Autarky, and adjacent nationalist policy thinking, focuses on the role of the state, though autarky recognizes that states sometimes operate within a market logic to achieve strategic goals. The Supply-Chains current is deeply embedded in that outlook, recognizing roles for a variety of market actors in shaping international affairs. The Rights current sees an even broader cast of actors as having meaningful agency, especially rights-holders (including individuals). Similarly, the Collective Action approach also casts a wide net in understanding how different actors shape the outcomes in complex, including global, systems – such as the solar energy production system.

Second, the plot differentiates these currents based on their outlook on how sustainable policy solutions and system equilibria emerge. The Autarky current and the Rights current both see competition and adversarialism as the central dynamic. The Supply-Chains approach shares this outlook to some extent, given the competitive nature of market logic; but also recognizes a role for cooperation by different market stakeholders – including regulators – in setting and enforcing the rules of competition. The multilateral approach embedded in the ILO combines both elements of international cooperation and adversarialism (e.g. between workers and employers); while the WTO system is a more narrowly state-based international cooperation framework. Finally, the Collective Action approach operates from an underlying outlook rooted in a belief in cooperation between diverse stakeholders to achieve system state transitions.

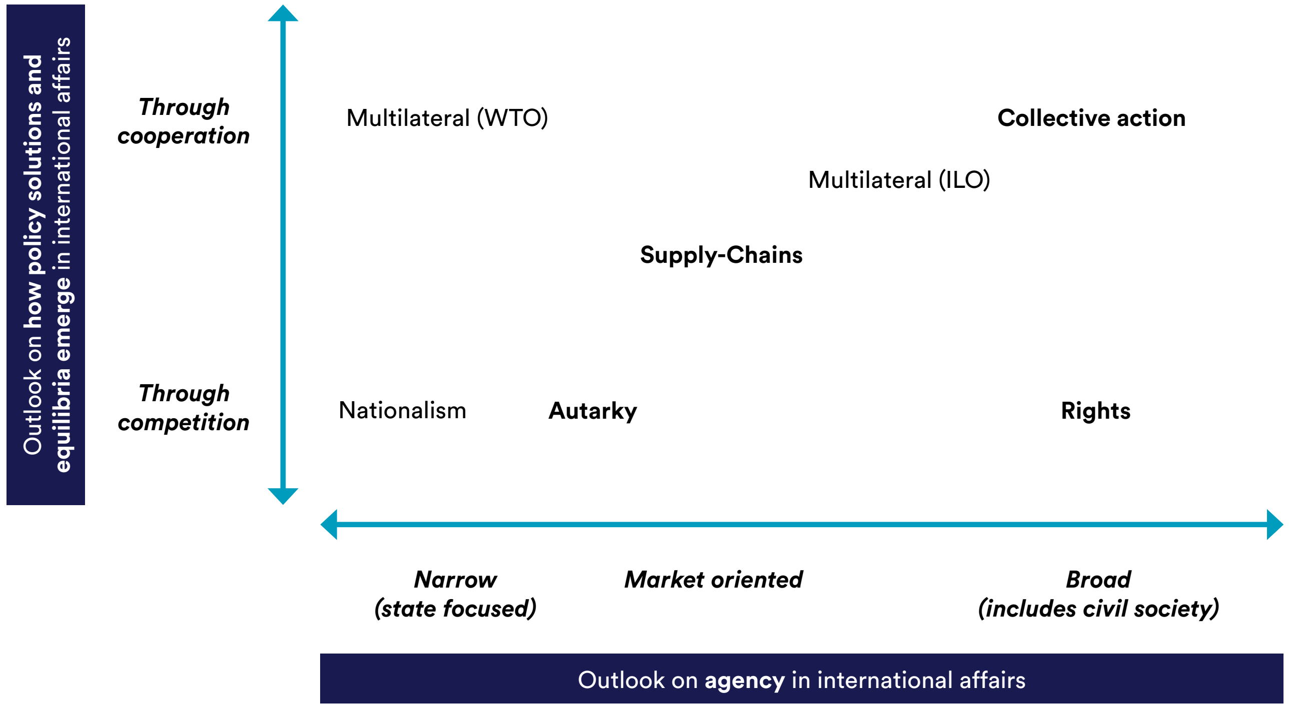


Figure 8: Charting underlying outlooks in Policy Currents

Actors operating from within each of these frames will anticipate durable solutions to solar energy modern slavery concerns emerging out of different types of interactions, between different entities. Those operating from within the Autarky current will look to unilateralist exercises of state power as the basis for finding an equilibrium, such as national trade and industrial policy, market exclusions and sanctions. The Rights current also looks to adversarial action, but those in this current may look more to judicial action, or to form inter-state coalitions for naming and shaming, sanctions and action in multilateral bodies. The impact of this approach consequently seems likely to hang significantly on the availability of suitable forums and the reach of accountability mechanisms. Those operating from within the Supply-Chains current will look to market-based solutions, which gives this approach potential global reach, but also makes the process of policy change diffuse and slow, and makes accountability relatively opaque. And with the Autarkic current gaining sway, the danger is that rather than create a single level playing-field across the global market, driving up responsible business conduct, this approach risks fracturing the global market into competing, relatively decoupled value-chains, operating under different ESG standards reflecting different levels of commitment to end modern slavery and other socio-environmental harms related to the solar energy value chain.

Finally, the Collective approach, framing the issues as complex systems change challenge involving diverse stakeholders, suggests a need to organise bespoke, inclusive and deliberative decision-making processes, combining principled action along the value-chain with place-based interventions understanding local conditions and contexts. The history of transnational, public-private governance efforts in the global economy suggests this can be a challenging path to pursue, given the complexity of negotiating in spaces in which institutions and rules have not yet crystallised, and the resulting questions of power.

The chart in Figure 8 may also help us understand the tensions between different approaches, and how they may be resolved during policy design and implementation. There is a natural tension between the Rights approach and the Supply-Chains approach, for example, on the question of how policy puzzles are resolved. The Supply-Chains approach is rooted in collective action in the market context. But the Rights approach looks to courts and other third-party accountability mechanisms to vindicate rights. Thus, we can expect proponents of the Rights current to push for any legislation implementing the Supply-Chains approach to operate in the shadow of such accountability mechanisms – including penalties and well-resourced enforcement mechanisms. Similarly, there may be a tension between the Collective Action perspective, with its focus on managing system-level risk through cooperative design and interventions (such as coordinated, multinational industrial or investment policy), and the Supply-Chains approach, which sees it as the market's role, through competition, to find sustainable solutions. The Collective Action perspective may see a larger role for a visible hand – whether the state or, for example, stewardship oriented institutional investors – in guiding the market towards socially optimal outcomes. The Supply-Chains approach sees the states' role more as a rule-setter for the market, rather than an active intervenor.

The chart in Figure 8 thus helps uncover not only the different outlooks underpinning each of the four Policy Currents shaping debates on forced labour in the solar energy value-chain, but also how different stakeholders in that value chain may approach policy processes. Understanding these contours can help increase the chances of finding a viable policy process pathway to resolution of these concerns. Before we turn to that issue (in section 4), however, we turn first to a practical and technical need surfaced by our research, relating to forced labour risk estimation.

3. Estimating modern slavery risks in solar energy value chains

As we saw in section 2, one factor that significantly inhibits stakeholders' ability to manage modern slavery risks across the global value-chain is the difficulty of using established supply-chain tracing, audit and due diligence approaches in this context, given weak state capacity (DRC) and state resistance to this approach (PRC). This makes it difficult for a range of stakeholders – whether buyers, developers, lenders or regulators – to make evidence-based risk-management decisions. Absent verified data on modern slavery incidence, value-chain stakeholders currently lack a system for estimating, assigning or managing risk. And given finite resources available for supply-chain due diligence and remediation, supply-chain actors find it difficult to know how to prioritise risk management resources.

In this section, we test the feasibility and utility of a new approach to forced labour risk estimation in the solar energy value-chain. Our aim is not to predict the actual incidence of forced labour in a supply-chain, but rather to develop a systematic approach for estimating forced labour *risk*. Using a lifecycle assessment approach, we develop and test a new approach estimating forced labour risk per kilowatt hour (FLR/kWh) in a country's PV, on-grid energy production system. The approach also allows us to calculate forced labour risk per USD in the levelized cost of electricity (LCOE) for that energy production system. Given available data and time we were not able to estimate risks associated with all solar energy production. We chose instead to focus on photovoltaic, on-grid energy production systems, specifically the product life cycle from the production of initial raw materials through to electricity production – i.e., a so-called 'cradle-to-gate' model, not including waste disposal or dismantling after the useful life of energy production equipment, nor risks arising from the *use* or consumption of the energy so produced.

To do this, based on available data, we adopted a country-level life cycle assessment approach. The choice of photovoltaic, on-grid energy production has the effect of highlighting modern slavery risks – specifically, forced labour risks – associated with photovoltaic energy production. It must be noted that this approach specifically does not incorporate modern slavery risks associated with the extraction of cobalt that is critical to Li-ion batteries in which much solar energy is stored, including in off-grid systems and in electric vehicles (EV) and electronic equipment such as mobile phones. As we discuss later, however, we believe the same estimation method could be used to estimate modern slavery risks associated with that value-chain.

To estimate forced labour risk, we developed a methodology combining economic input-output life-cycle assessment (EIO-LCA) and social lifecycle assessment (S-LCA) to provide a preliminary estimation of risk to workers. Lifecycle assessment is commonly applied by business to address environmental risks in supply chains. Here, we demonstrate its utility to estimate a specific social risk in the transnational PV value-chain. We built a risk matrix based on internationally published lifecycle inventory data for the PV value-chain. We then mapped this onto a stylised, 12-component breakdown representation of the global PV value-chain, with risks at different places and moments in the lifecycle rendered comparable by use of new, standardised risk metrics – forced labour risk per kWh and per USD LCOE.

In this section, we first explain why we adopted a lifecycle assessment approach. Second, we introduce our methods. Third, we introduce and explain our new forced labour risk measures for the sector – forced labour risk per kilowatt-hour (FLR/kWh) and forced labour risk per USD LCOE. Fourth, we present our results. Fifth, we consider the limitations of this section of the study. Sixth, we discuss the implications of these findings, including potential uses and applications of this new estimation approach by solar supply-chain firms, project developers, finance and regulators.

3.1 Adopting a lifecycle assessment approach

Life cycle assessment (LCA) is a framework used to quantify the impact of a product or a service over its lifetime. LCA has been primarily applied to the assessment of product environmental impacts, most notably to compare carbon dioxide emissions associated with the production, operation and decommissioning of specific products.

LCAs are not limited to quantifying the impacts of a country's production and consumption. They can also be used to assess organisation-level wide impacts, identify procurement hotspots and analyse environmental impacts of policies. LCAs also help ensure that risk is not simply pushed from one part of a product's life cycle (i.e., one part of the value-chain) to another, because they offer critical insights into system-level risk. They are thus useful for developing system-wide risk management strategies for complex systems. As we return to in section 4, this may make this method particularly useful in seeking to develop Supply-Chains or Collective Action-based policy solutions to modern slavery risk concerns in the global solar energy production system.

Social life cycle assessment, or S-LCA, is an emerging framework to assess the social impacts of products or services through LCA, which can facilitate the identification of areas for improvement and comparison of products from the standpoint of their social performance.[230] In recent years, S-LCA has been applied to tourism, farming, and recycling systems.[231] Surprisingly, however, the social and environmental impacts of increased resource production for renewable energy often do not take these life-cycle factors into account.[232] An important exception is Takeda et al., which uses S-LCA to analyse the social impacts of renewable electricity systems in Malaysia.[233] Yet social risk sensitivity seems increasingly likely to be required in business conduct by regulators, with some European regulatory frameworks – for example the recent Battery Regulation – already moving towards a life cycle risk management approach. In our search for a new approach to estimating modern slavery risks in global value-chains, we therefore sought an LCA-based approach, recognising that no LCA study on a global scale on renewable energies has yet been carried out.

We turned to economic input-output life cycle assessment, or EIO-LCA.[234] This uses aggregate sector-level input-output data to quantify the impact attributable to each sector of a country's economy, based on how much each sector purchases from other sectors in producing its output. Originally developed to measure environmental impact, when combined with relevant sector-level social impact data, EIO-LCA can be used to assess social impact at a sectoral level. While process LCAs are typically denominated in terms of physical mass, following the flows of materials through a supply chain and associated industrial processes, input-output LCAs are denominated in terms of a specific currency (USD in this case), following the flow of economic value-add through the economy. This facilitates macro-scale analysis (country/global), and a top-down analytic approach.

S-LCA is conducted using the Product Social Impact Life Cycle Assessment (PSILCA) database.[235] PSILCA provides data on the social impact of different sectors, and related supply-chain structure information, over the life cycle of a wide array of goods. 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.[236] The EORA database covers 187 countries, providing a list of 15,909 sectors.[237] It uses economic (export-import) flows, expressed in US dollars, to link economic processes among different sectors and countries. Each country-specific sector (CSS) receives materials and inputs from other sectors (in USD), and generates an output (i.e., a product), measured in USD. In PSILCA, these outputs are translated into worker hour equivalents, with some scaling involved to ensure comparability.[238] PSILCA provides comprehensive data for a broad range of industry sectors worldwide, making it suitable for application to the global solar-energy value-chain. Analysts can use PSILCA-based S-LCA to identify and quantify social risks in specific sectors of their trading partners or identify sectoral contributions to risk associated with production in specific sectors and countries.[239] We used this latter functionality as the basis for developing a dynamic estimation methodology to assess forced labour risk in countries' photovoltaic, on-grid energy production.

[230] 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).
[231] S. Aparcana and S. Salhofer (2013). 'Development of a social impact assessment methodology for recycling systems in low-income countries', *Int. J. Life Cycle Assess*, 18, pp. 1106–1115; G. Arcese, M.C. Lucchetti, R. Merli (2013). 'Social life cycle assessment as a management tool: Methodology for application in tourism', *Sustainability*, 5, pp. 3275–3287; A.I. De Luca, N. Iofrida, A. Strano, G. Falcone, G. Gulisano (2015). 'Social life cycle assessment and participatory approaches: A methodological proposal applied to citrus farming in Southern Italy', *Integr. Environ. Assess. Manag.* 11: pp. 383–396; C. Macombe, P. Leskinen, P. Feschet and R. Antikainen (2013). 'Social life cycle assessment of biodiesel production at three levels: A literature review and development needs', *J. Clean. Prod.*, 52: 205–216.
[232] Lèbre et al., 2020.
[233] 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/su11051370
[234] 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).
[235] 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.
[236] 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.
[237] Lenzen et al., 2013.
[238] Maister et al., 2020.

3.2 Methods

Due to time and resource limitations, we first limited our analysis of forced labour risk in global solar PV power generation to the top 30 countries ranked on production of solar PV (on grid).[240] This, however, represents 96% of global production. Next, we collected data on the levelized cost of energy (LCOE) for each of these countries.[241] 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.[242] 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 solar panels. Figure 9 below shows the main 'breakdown' components in the life cycle of a solar PV system, grouped into five main categories. Figure 10 shows the LCOE of each of the 5 main breakdown categories, for each of the top 30 solar PV producing countries. Figures 9 and 10 are based on renewable energy cost reports based on detailed inventory surveys[243] and the only existing comparable S-LCA study on renewable energy[244]. Next, we assigned harmonised commodity codes – HS-6, the codes used to track commodities in global trade – to each of the PV 'breakdowns' (see Figure 9 below). Using UN COMTRADE trade data based on these harmonised commodity codes, we estimated for each production country what share of imports of each PV breakdown came from which country of origin.[245]

Category	Breakdown	HS6 code	Elements or components covered
Module and inverter hardware	PV module	854140	Electrical apparatus: photosensitive (inc. PV) cells, whether or not assembled in modules or made up into panels, LEDs
	Inverter	850440	Electrical static converters
BoS hardware	Mounting structure	761090	Aluminium; structures (exc. prefabricated buildings) and parts of structures, plates, rods, profiles, tubes
	Energy meter	902830	Meters; electricity supply or production meters, inc. calibrating meters thereof
	Electrical protection system	853530	Isolating switches and make-and-break switches
	Balance of system	854411	Of copper
	Grid connection costs	NA (domestic)	
Installation	Installation & civil works	NA (domestic)	
Soft costs	Transport and freight insurance	NA (domestic)	
	Design, engineering, PM	NA (domestic)	
	Consulting services, licenses, permits	NA (domestic)	
O&M cost	Operation and Maintenance cost	NA (domestic)	

Figure 9: PV system life cycle breakdown

[239] Serenella Sala, Alessandro Vasta, Lucia Mancini, Jo Dewulf and Eckehard Rosenbaum (2015). *Social Life Cycle Assessment. State of the art and challenges for supporting product policies*, EUR 27624 (Publications Office of the European Union, Luxembourg).
[240] IRENA (2021b). 'IRENASTAT', *International Renewable Energy Agency*, January 2021, available at https://www.irena.org/en/Statistics
[241] World Bank (2021). *Global Photovoltaic Power Potential By Country*, 21 October 2021, [database] available at https://datacatalog.worldbank.org/search/dataset/0038379
[242] IRENA (2021a). 'Renewable Power Generation Costs 2020', June 2021, available at https://www.irena.org/publications/2021/Jun/Renewable-Power-Costs-in-2020
[243] IRENA (2020). 'Renewable power generation costs in 2019', June 2020, available at https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019; IRENA, 2021a.
[244] Takeda et al., 2019.
[245] Chris Muir (2020). *Intro to comtradr,* [source code] available at https://cran.r-project.org/web/packages/comtradr/vignettes/comtradr-vignette.html; UN (2022). *UN Comtrade database*, [database], https://comtrade.un.org

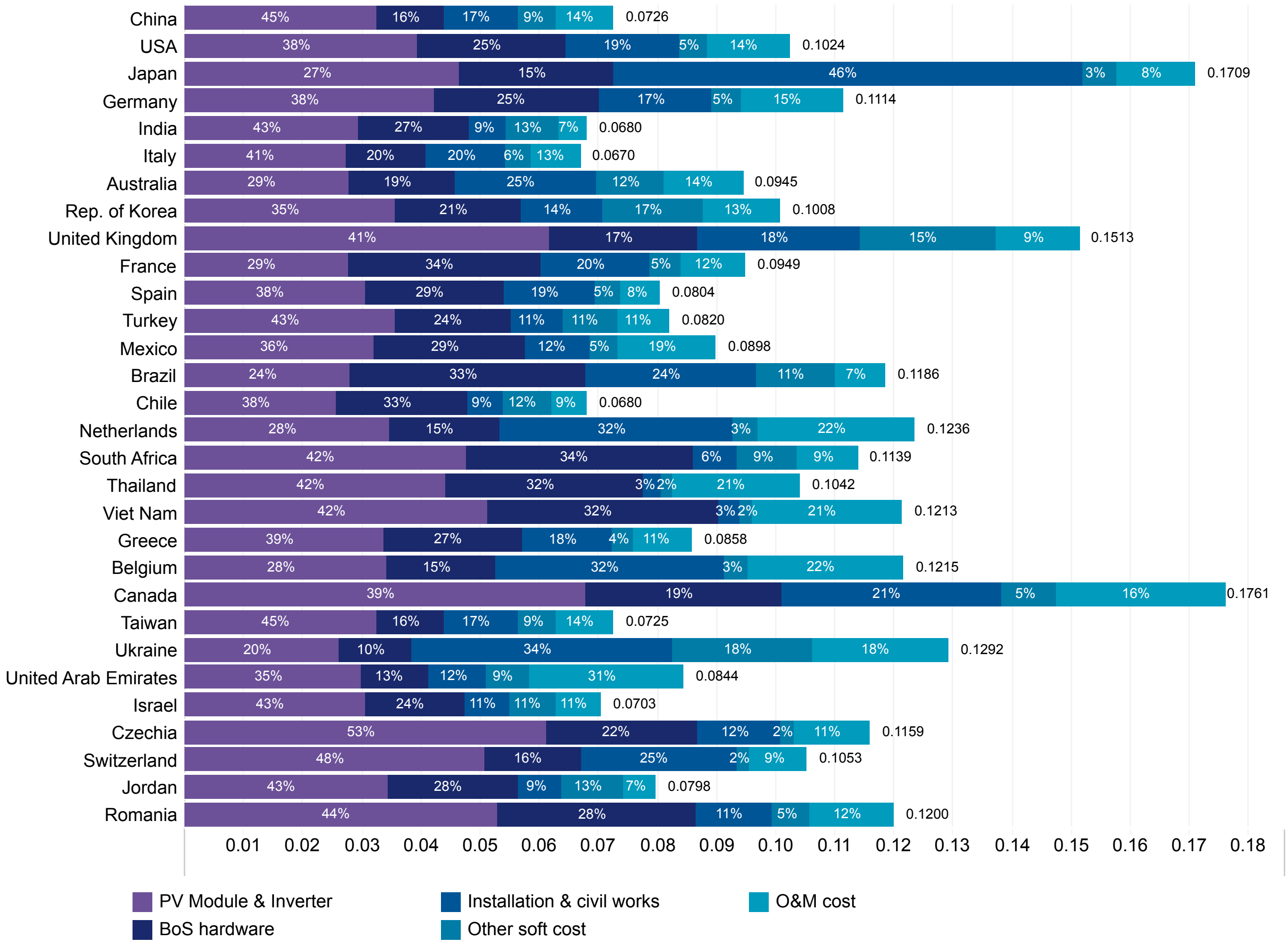


Figure 10: LCOE of the top 30 PV producing countries, disaggregated by breakdown category

The import share of each ‘breakdown’ was estimated based on the average import flow (2015-2019) for the selected breakdown, omitting countries representing less than <2% of imports for each destination country.[246] Figure 11 below provides an example of a resulting distribution – this one for the UK’s LCOE for on-grid PV energy production.

It shows the weighted (%) contribution to the overall LCOE from each component (each colour) of each country of origin (each rectangle within each colour). In each sub-rectangle, the percentage listed in the superior position is the portion of the LCOE *for that component* that derives from that country of origin. The percentage in the inferior position is the portion of the *overall* national LCOE (i.e., the entire picture) represented by that small rectangle.

[246] This restriction was necessary to limit the number of data extraction processes and computations required to perform our analysis. It has the effect of limiting the resolution of the picture provided by the resulting analysis, a point we return to in our discussion of Limits of the study, in section 3.5.

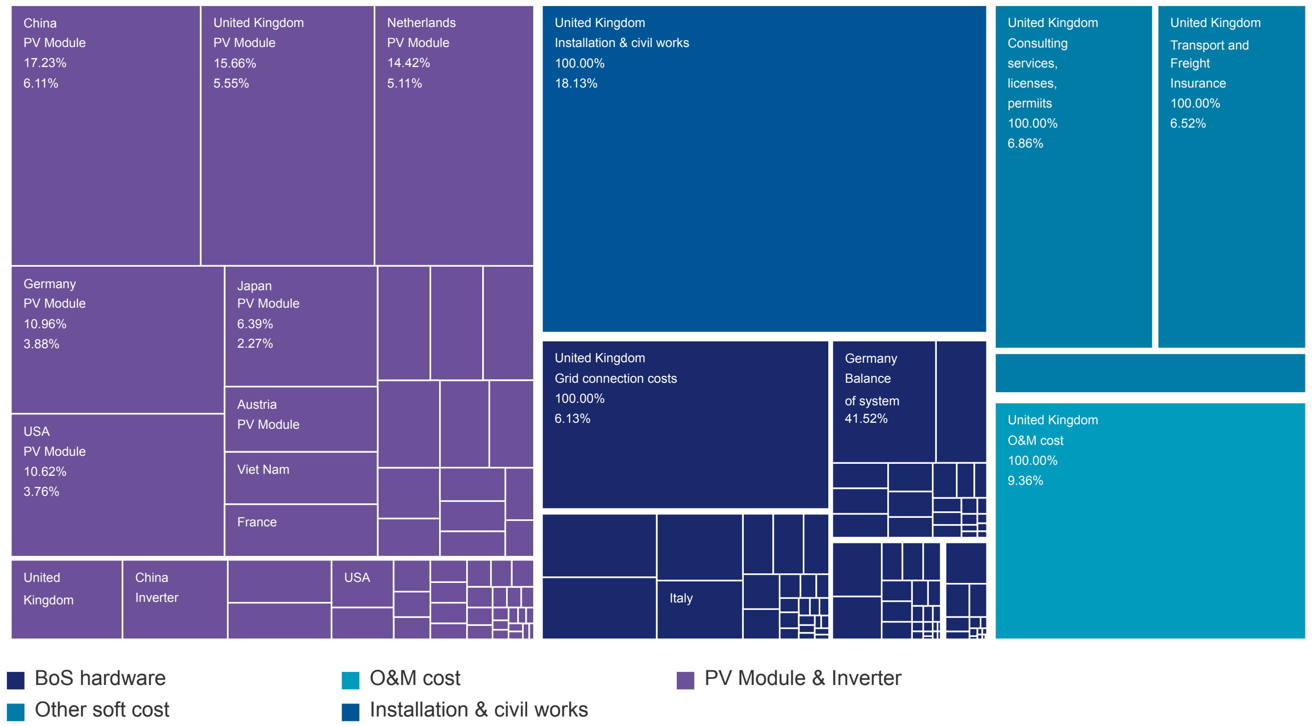


Figure 11: Example of distribution of LCOE (%) at country origin and breakdown level. Country: United Kingdom

Next, each LCOE cost element (that is, each country of origin–breakdown CSS) is assigned into a PSILCA process to calculate direct and upstream social impacts related to each of three relevant PSILCA indicators (Frequency of Forced Labour (FFL), Goods produced by Forced Labour (GFL), and Trafficking in Persons (TP) – discussed further below in section 3.3). Here ‘direct’ social impacts are the impacts that arise at that particular stage of the production system or value-chain – i.e., in relation to that breakdown (BoS hardware, installation, etc.) in that country. ‘Upstream’ impacts are the impacts that arise earlier in the value-chain but have cascaded down to this specific point in the value-chain, through trade in goods and services (as reflected in the import-export data captured in EORA). Together, these ‘direct’ and ‘upstream’ impacts represent the ‘embodied risk’ at that particular point in the value-chain. We performed this product system calculation in OpenLCA version 1.10.3 with a cut-off of 1E-5 (that is, only incorporating upstream risk where the ratio of demand of the specific process to output from the previous process is higher than 1E-5), using PSILCA database v.3.[247]

Finally, we weighted the risk of forced labour for that process output according to the proportion of the overall LCOE in a specific country that this output represents. This simply involves multiplying the CSS risk estimated by PSILCA by the share of the total LCOE for each country. For example, if 30% of the LCOE for on-grid PV energy in Australia comes from PV modules imported from China, and the FFL for that component is, say, 0.0005 mrh-eq, then the component risk (FFL) is 0.0005 × 0.3 = 0.00015 mrh-eq (medium risk hour equivalents, in this case per USD LCOE). It is important to understand what this implies. This does not mean that 0.00015 hours of forced labour *will* go into the production of a unit of Australian on-grid PV-generated electricity. Instead, this would mean that the risks associated with producing this unit include 0.00015 medium risk hour equivalents associated with forced labour risks. The utility of this measure comes from the standardization of this risk metric across projects *and across risk types*. It makes it feasible to compare the social risk associated with forced labour in one unit of Australian PV on-grid energy production and one unit of, say, Chile PV on-grid energy production; or to compare the different sources of social risk in the production of one USD LCOE of Australian PV electricity; or to compare that with one unit of Australian energy from another source, or indeed some other product entirely.

[247] Our computation also included addressing some anomalies in the data drawn from PSILCA, including by deconflicting how PSILCA treats certain CSS combinations. In some cases, PSILCA scores certain forced labour risks by incorporating both embodied risk in input commodities *and* risk arising in the activity involved in processing those inputs. In other cases, only commodity risk is included. After correspondence with PSILCA, we standardized our dataset to incorporate only one of these two inputs, not both – usually commodity risk, unless EORA does not provide the relevant detail at the commodity level, in which case we drew on industry risk. This helped ensure comparability and avoidance of potential double-counting.

The integration of databases and social indicators is represented in Figure 12 below.

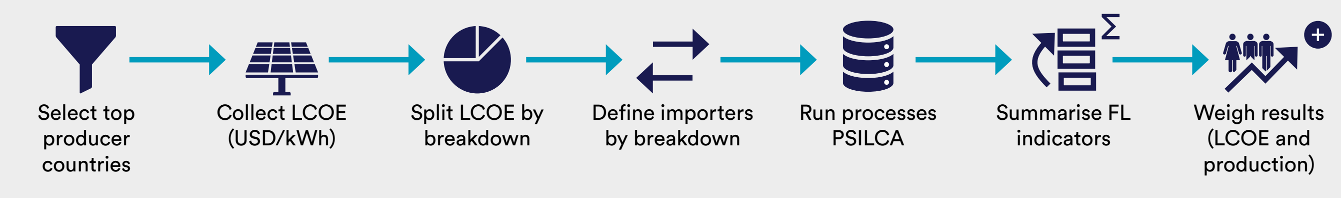


Figure 12: Basic data workflow to estimate risk of modern slavery in PV supply chain

3.3 New forced labour risk measures for the energy sector

Social risk measures are increasingly used in financial, project and enterprise risk management processes. In this context, we use 'social risk' to mean the potential for one or more parties to be exposed to negative social conditions that, in turn, undermine social sustainability.[248] How 'social risk' is defined and measured thus has important distributive *and* procedural implications. It can shape which impacts are identified, addressed and remediated through managerial and policy processes, and which are not. And it gives significant power to risk indicator controllers (e.g., ESG ratings agencies) to determine which risks and harms are recognised, and how risk management decisions are made. As we return to in section 3.6 and section 4, this has important implications for how we understand the impact that LCA and other risk assessment methods may play in energy governance, for the choice of indicators used for risk management in different contexts, and for the process of risk metric design and implementation.[249] And it makes clear that how we define and measure social risk has significant implications for how we understand the 'justice' of any transition involving solar power.

PSILCA includes a wide array of social risk indicators. While a wide array of social risks may be relevant to the social sustainability of the solar energy sector, we focused our analysis on three PSILCA indicators most relevant to our inquiry on modern slavery as it relates to photovoltaic, on-grid energy production: 1) Frequency of forced labour (FFL); 2) Goods produced by forced labour (GFL), and 3) Trafficking in persons (TP). (An extension of this analysis to include off-grid energy production and batteries would likely need to incorporate a fourth, existing PSILCA indicator, which focuses on child labour, as well as incorporating battery supply-chain inventory data. Time and resource constraints prevented us incorporating this into our analysis.) We explain each of these in turn, then explain our own composite measures: FLR/kWh and FLR/USD LCOE.

3.3.1 Frequency of forced labour

First, as provided by PSILCA, 'frequency of forced labour' (FFL) is 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).[250] PSILCA takes the GSI estimate for each country for which one is available (150) and uses the frequency (cases per 1,000 inhabitants) to create a risk index based on the equal distribution of values (Figure 13). The risk index is then used, within PSILCA, in scaling risk exposure to a common denominator used to compare across different risk indicators, namely medium risk hour equivalents (mrh-eq).[251]

Indicator value, per 1000	Risk level
0	No risk
0<y<4	Very low risk
4≤y<8	Low risk
8≤y<12	Medium risk
12≤y<16	High risk
y ≥16	Very high risk
-	No data

Figure 13: PSILCA risk levels for frequency of forced labour (FFL) indicator

[248] Nathan Pelletier, Eda Ustaoglu, Catherine Benoit, Greg Norris, Eckehard Rosenbaum, Alessandro Vasta and Serenella Sala (2018). 'Social sustainability in trade and development policy', *International Journal of Life Cycle Assessment*, vol. 23(3), pp.629–639, available at https://doi.org/10.1007/s11367-016-1059-z.
[249] 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), pp. 509-527.
[250] Walk Free Foundation (2018). *The Global Slavery Index*, 2018, available at https://www.globalslaveryindex.org/resources/downloads/.
[251] Maister et al., 2020. For each impact category, overall social impacts are calculated by aggregating the social risks of all involved processes along the life cycle. Social risks are scaled by price (inputs), working hours and characterisation factors. The PSILCA database contains an impact assessment method named "Social Impacts Weighting method" which describes exponential relations between impact factors. A characterisation factor of 1 is assigned to medium risk levels, thus results are expressed in medium risk hours (Maister et al., 2020, p. 3).

The GSI is the most authoritative country-level estimate of modern slavery incidence. But PSILCA's reliance on the 2018 GSI introduces two limitations to our approach that must be acknowledged. First, the GSI estimate of modern slavery includes estimates of not only forced labour, but also other forms of exploitation covered by the overall notion of 'modern slavery', such as forced marriage. As PSILCA acknowledges, "Hence, data comprises broader concepts than only forced labour" – though still within the internationally recognised conception of modern slavery.[252]

Second, PSILCA's use of the 2018 edition of the GSI means that FFL is estimated for a period *prior* to the emergence of most allegations of forced labour in PV production, especially relating to XUAR. We address this through a sensitivity analysis (discussed below in section 3.4), where we alter just one CSS' FFL score, to reflect the evidence of increased forced labour risk in XUAR since 2018.

3.3.2 Goods produced by forced labour

PSILCA provides a second modern slavery-related indicator, 'goods produced by forced labour' (GFL). 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).[253] PSILCA maps these goods to the sectors of the respective country in EORA (the input-output database with which PSILCA is integrated). PSILCA then assigns risk levels based on the 'technical conformance' between the products on the ILAB list and the sectors in EORA. Sectors that may be indirectly exposed to forced labour are assigned a reduced risk level. This generates a risk index summarised in Figure 14 below.[254]

Technical conformance value y, score	Risk level
1	Very high or high risk
2	High or medium risk
3	Low risk
5	No data

Figure 14: PSILCA risk levels for goods produced by forced labour (GFL) indicator

The current version of PSILCA uses ILAB data from 2018, but for our analysis we manually updated the relevant PSILCA database scores, to reflect the current (January 2022) data on the published ILAB list[255] plus subsequent amendments published on the Department of Labor website (which, critically, include polysilicon production in PRC). The resulting data amendments are summarized in Appendix 1.

3.3.3 Trafficking in persons

Third, PSILCA provides an index score for 'trafficking in persons' (TP) based on a country's Tier ranking in the authoritative *Trafficking in Persons Report* published annually by the US Department of State. Forced labour and trafficking in persons are different in law but overlap significantly in fact. Forced labour is one of the forms of exploitation into which a person can be trafficked. And both forced labour and trafficking in persons are recognised as elements of the umbrella concept of modern slavery. (See Figure 3, earlier.) US Department of State data is available for almost all the countries in Eora/PSILCA (except the smallest states, which are assigned a 'no data' value). The US Department of State assigns countries to one of 4 different, defined tiers, after a review of their efforts to address trafficking. PSILCA, in turn, uses these tiers to establish a risk index for TP (Figure 15 below).[256]

Indicator value y, tier # and text	Risk level
1	Very low risk
2	Medium risk
2.1 (watch list)	High risk
3 and 3.1 (Special case)	Very high risk
-	No data

Figure 15: PSILCA risk levels for trafficking in persons (TP) indicator

Here, due to time constraints, we rely on the existing PSILCA data, which in turn relies on the 2018 edition of the US TIP report (US Department of State, 2018). Movements between Tiers in the years since 2018 have been limited. A further extension of our analysis could however update this data.

[252] Maister et al., 2020.
[253] 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/
[254] Maister et al., 2020.
[255] ILAB (2020b). 'From Unknown to Known: The Story Behind Our Stuff Asking the Right Questions to Trace Abuses in Global Supply Chains' *Bureau of International Labor Affairs*, 2020, available at https://www.dol.gov/agencies/ilab/apps#Sweat&Toil
[256] Maister et al., 2020.

3.3.4 Forced labour risk per kilowatt hour (FLR/kWh)

PSILCA scores FFL, GFL and TP separately for each CSS. To offer a single, integrated metric as a measure of forced labour risk that is comparable across suppliers and markets, we took two further steps.

We first developed a forced labour index (FLI) based on the integration and normalisation of the three indicators (Equation 1):

$$FLI = FFL_{scaled_i} \cdot wf_{FFL} + GFL_{scaled_i} \cdot wf_{GFL} + TP_{scaled_i} \cdot wf_{TP} \quad (1)$$

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

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

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

Equations 1-4: Calculating the composite forced labour index (FLI) score

where *i* is 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 the purpose of measuring FLI is ultimately to be able to understand the relative risk arising from forced labour in the solar energy production of different countries, and 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.

Second, this FLI composite score then allows the generation of our 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.

3.4 Results

Extracting the relevant production system data from PSILCA is a complicated and time-consuming process. To make the analysis more manageable given the time and computational resources available to us, we grouped the CSS in these supply-chains, to conform PSILCA and EORA data as far as possible. This gave us a focus group of 349 product systems from which to calculate FLI. We first ran these computations using existing PSILCA data – including the FFL scores for China drawing on 2018 data (see section 3.3.1 above), before conducting a sensitivity analysis (section 3.4.4 below).

3.4.1 National FLI and FLR/kWh

The first result that emerges from this analysis is a simple calculation of FLI for these top 30 PV-producing countries. The results of this analysis are reflected in Figure 16 below. Recall that these FLI scores are calculated using 2018 data (except for GFL, which reflects ILAB listings to January 2022). On the left, China and India emerge as the countries with the highest FLI (measured in mrh-eq/kWh). In both cases, this is a result of their production systems including breakdowns that include a relatively high GFL-derived component. In other words, our method estimates that these countries produce on-grid solar energy with systems that are likely exposed to relatively high numbers of goods made with forced labour, as defined by the relevant ILAB list. However, it is notable that India, as well as the third-ranked country, Ukraine, also include relatively high FFL scores. This suggests that their 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 16). 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.

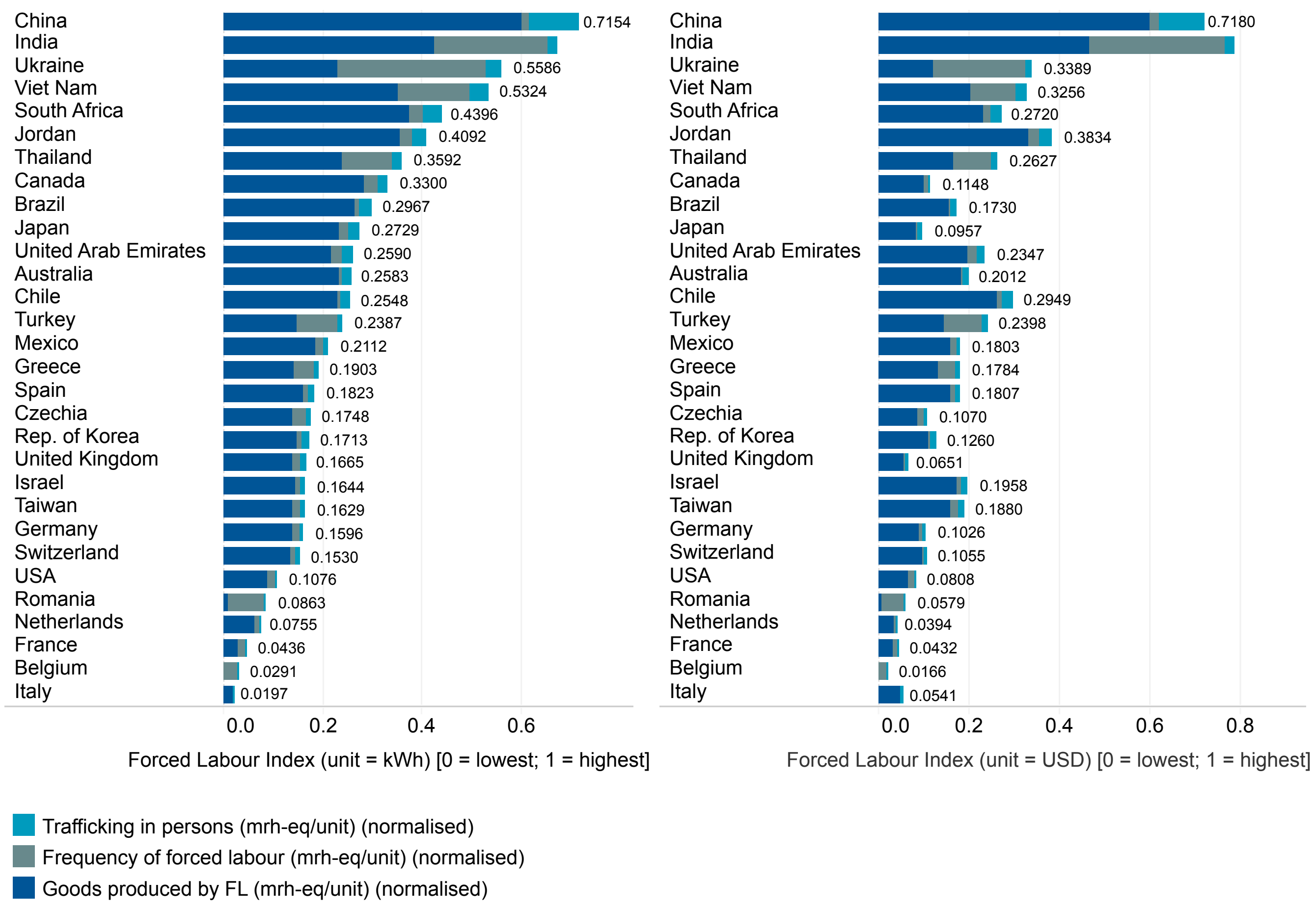


Figure 16: Estimates of forced labour risk in 30 countries’ PV, on-grid energy production systems, not accounting for heightened risk of forced labour in XUAR

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/3Hv2TBQ.

3.4.2 ‘Breakdown’-level analysis: finding outliers

The second set of results that emerges from the data relates to how different components in 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 more significant is the impact of that particular breakdown’s risk contribution in determining the FLI for that country. Figure 17 below shows the score for each of the three forced labour risk indicators (FFL, GFL, TP), broken out by the five different ‘breakdown’ groups used to map the production system.

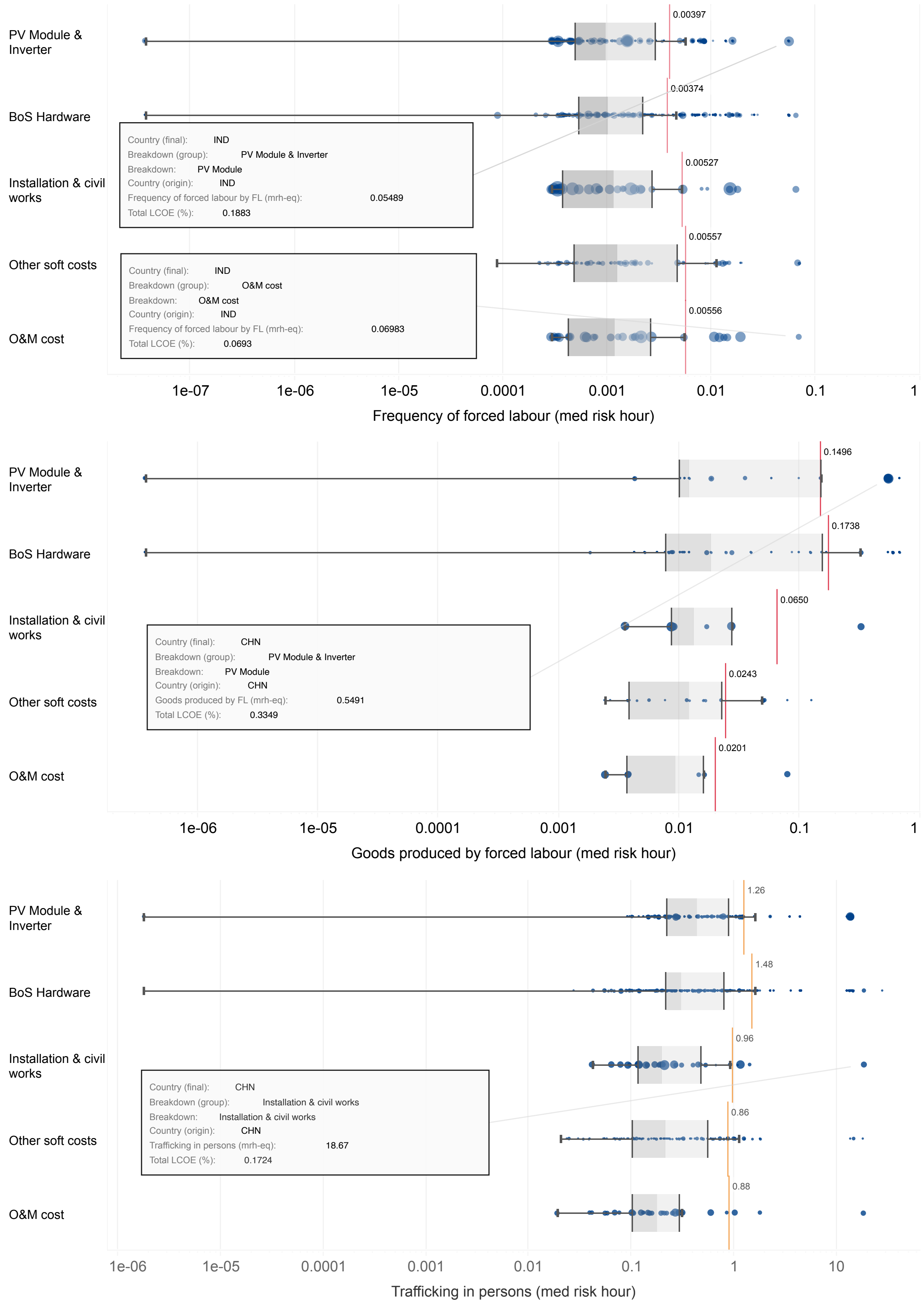


Figure 17: Boxplot differences in risk of forced labour by breakdown. X-axis in logarithmic scale

In Figure 17, each dot represents a single CSS (i.e. a country-specific sector combination), and the size of the dot represents the share that CSS makes to the total LCOE (%). Boxes represent the interquartile model spread, from the 25th to 75th quantiles. The whiskers on the boxes show all points within 1.5x the interquartile range. The orange line represents the mean risk (across all countries) for that component. The utility of this analysis lies in helping us understand how the risks associated with different indicators (FFL, GFL, TP) relate to different breakdown components within the value-chain.

For GFL, for example, the highest mean risks arise, 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 (reflecting their inclusion in the ILAB list), *and* making a relatively significant contribution to overall LCOE. This suggests a need to explore, in more detail, how this CSS contributes to overall modern slavery risk in the global solar energy value-chain – to which we return in section 3.4.4.

For FFL, by contrast the highest mean risks arise *not* in the hardware components, but in 'Other soft costs' and 'O&M' (operation and maintenance) costs. At first glance, this is less intuitive. It is explained, however, once we recognize 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 P&V 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 represented here 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 TIP listing, 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 whether or how to tie forced labour risk – or even broader sustainability – benchmarks for solar energy to labour intensity.

3.4.3 Direct and upstream risks

Based on the relationships among sectors in the multi-region input/output data, we disaggregated the contribution (location-sector) of forced labour risks in the PV supply chain. This allows us to differentiate risks depending on whether they occur in the country in which the economic activity is taking place ('direct risk' – i.e., a risk in the production operation itself) – or a risk that arises in an upstream step in the value-chain, cascading down ('upstream risk' – i.e. a risk arising and embodied in the upstream inputs to the production operation). With a cut-off of 1E-5, upstream impacts represent 55% of FFL, 30% of GFL and 69% of TP. (Figure 18 below, upper section.) However, this distribution is heterogeneous geographically and by sector. For example, the middle, map section of Figure 18 shows how the upstream (light blue) 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 18 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.

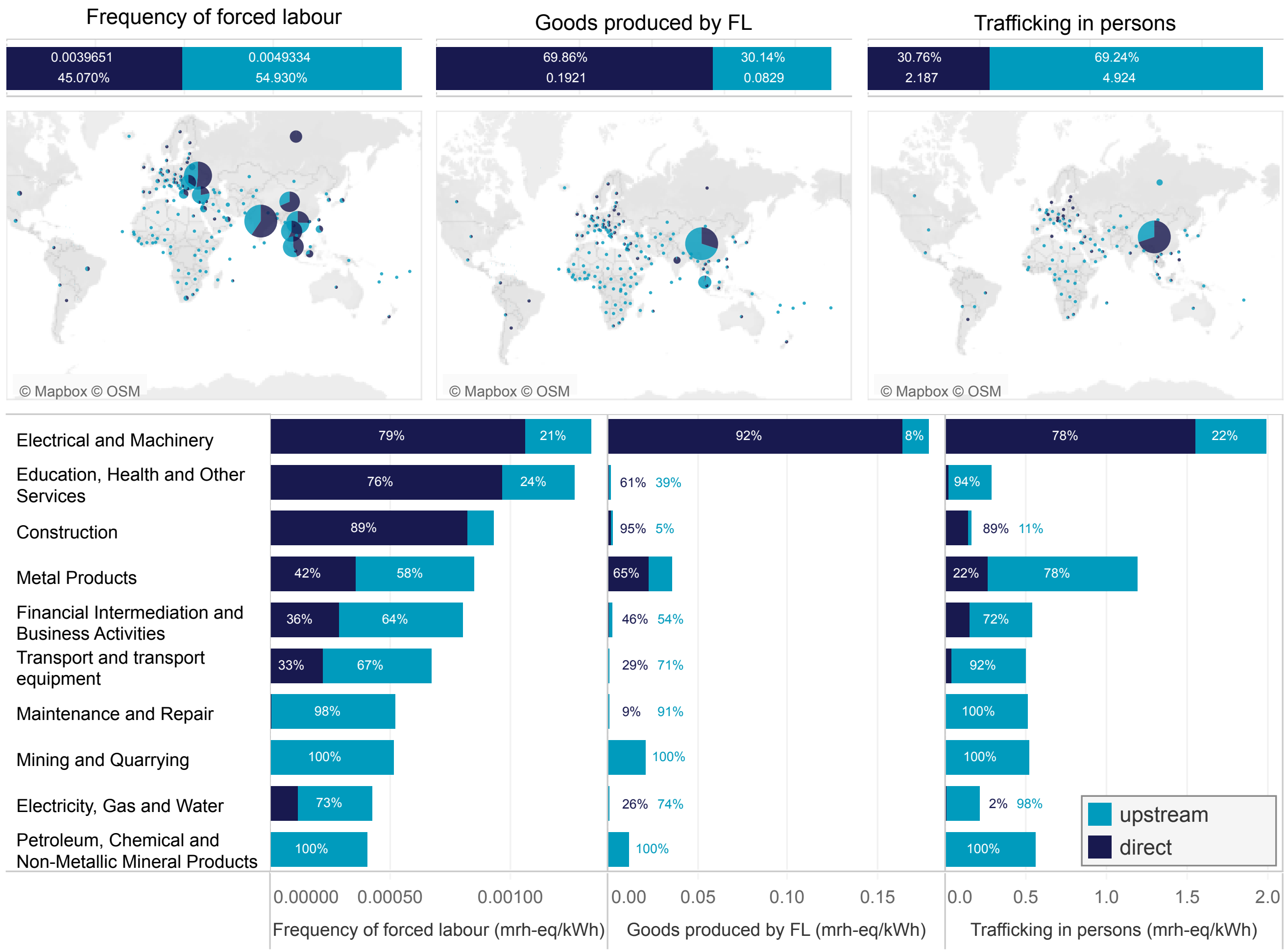


Figure 18: Contribution of location and sector on direct and upstream forced labour risks

Notes: 1. Top 10 FFL countries. 2. 'Education, Health ...' includes operation & maintenance.

3.4.4 Sensitivity analysis

A key question for us in interpreting these results was if or how this method will reflect changes in underlying, 'real-world' forced labour risks. How sensitive is this estimation methodology to small changes in underlying forced labour prevalence, as reflected in the forced labour indicators on which PSILCA draws? For example, will the reported increase in forced labour risk in Chinese polysilicon production over the last 3 or 4 years show up downstream? Does our methodology permit the identification of where and how such changes in risk cascade down the value-chain?

Our findings show that it is indeed possible with our method to analyse each CSS combination individually. Using the dimensions of analysis discussed in previous sections, we can show how a change in a single country-specific sector risk evaluation flows downstream through the value-chain to different energy producers.

This was confirmed by running a test: we changed a single CSS score and ran the computations a second time. The CSS score we picked was the one that pertains to polysilicon production in China (CN-Other electric machinery and equipment). Since the increased incidence of forced labour in Chinese polysilicon production since 2018 is already factored into GFL (through inclusion in the current ILAB List of Goods), and into TP (through US State Department analysis underlying the TIP Report), the only place it needed to be changed was the FFL risk score. In the initial computation, the FFL score in PSILCA for this CSS is 2.8, or very low risk. We then ran a second computation, after manually changing this score to 16, for very high risk. The results are shown in Figure 19, below – and can also be explored further in an interactive online data visualization at https://tabsoft.co/3Hv2TBQ.

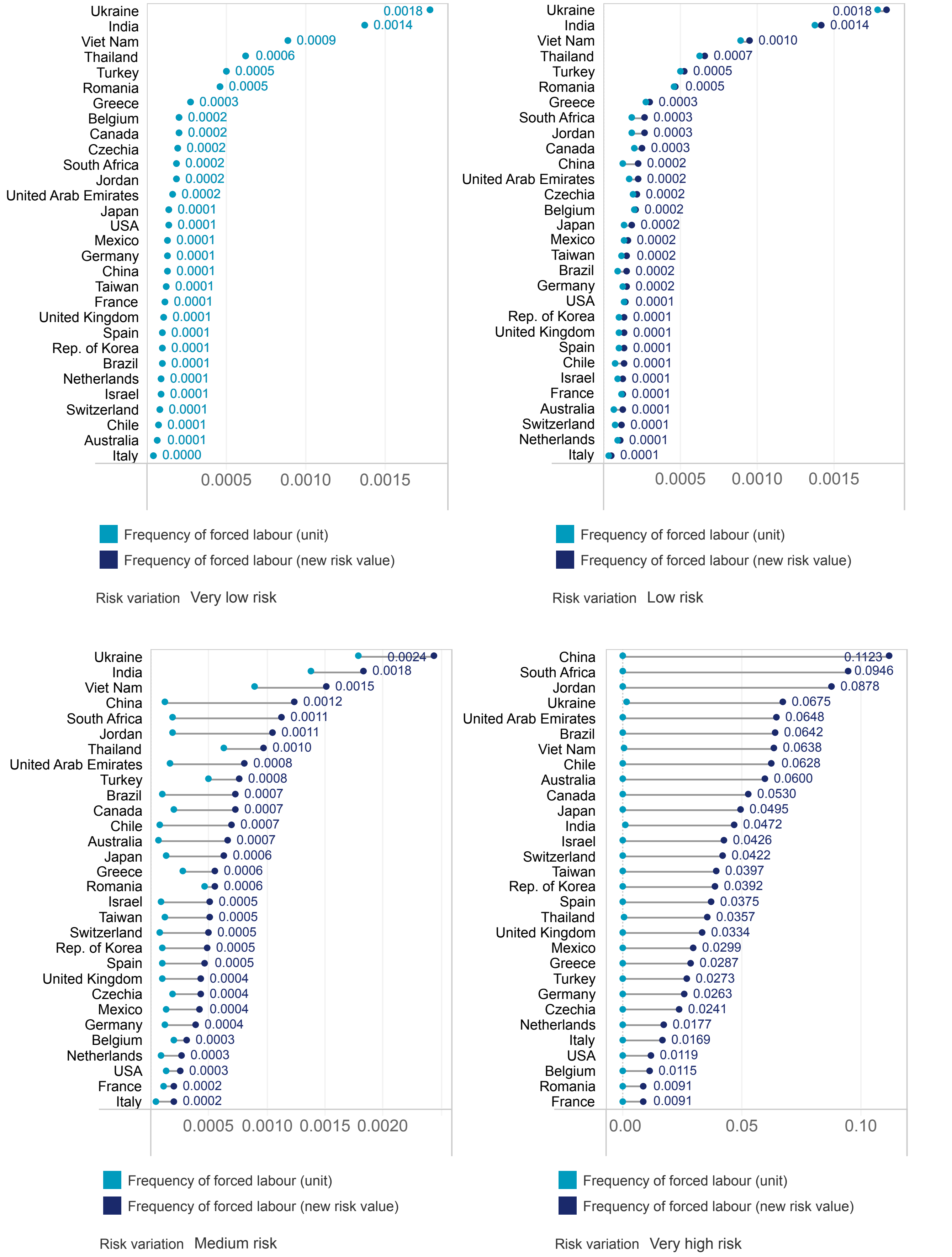


Figure 19: The effect of changing a single CSS forced labour indicator score on FFL FLR/kWh (mrh-eq/kWh)

Note: for an interactive version, visit https://tabsoft.co/3Hv2TBQ.

This particular CSS turns out to be central to many national PV, on-grid production systems, intervening in 95% of product systems (based on a 1E-5 upstream cut-off). And changing this particular CSS has significant impacts on overall system risk, increasing the mean FFL for countries 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. In this case, anything over a 10,000% increase signals that this particular CSS combination is having a greater impact on systemic risk than others.[257]

This type of analysis may thus help reveal critical points within the value-chain – i.e., those with network centrality and a significant impact on overall systemic risk levels. This may be important in developing system-level risk management arrangements that focus mitigation and remediation efforts on sectors and countries with the greatest impact and contribution to overall risk levels. We return to this point in section 4 below.

3.4.5 Country profiles

Figure 20 provides a summary of the results of our analysis for just one of the 30 top PV, on-grid producing countries we analysed – in this case the United Kingdom. A full suite of these country profiles is included in Appendix 2, and an interactive version is available online at https://tabsoft.co/3K80caK. The online version allows users to explore the data for the relevant producer country in some detail, adjusting input risk levels, selecting for forced labour risk indicators and tracing forced labour risk in that country's stylized value-chain through a Sankey diagram.

These country profile infographics include a number of components. In the top left, the country's LCOE is shared, and its position relative to others is plotted. Under this, the LCOE is then broken down into different breakdown groups and countries. On the top right, country's FLI is presented twice: once in FLR/kWh form and once in FLR/USD LCOE. The bar graph shows the different sources of these risk scores (FFL, GFL and TP), and the dot plot shows where this ranks compared to other producer countries. Below this, an interactive section allows users to select indicator parameters to explore how this FLI maps onto different breakdown groups within that country's PV, on-grid energy production value-chain, and by sourcing country. Finally, at the bottom, a user can select which 'breakdown' to trace through a Sankey diagram that shows how forced labour risk for that country's PV, on-grid energy production system differentiates by direct v. upstream risk, industry sector, source country and breakdown.

It is important to recall that the estimates reflected in these country profile images are 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 at 'very low risk'. The impact of a potential change in the FFL risk level in Chinese polysilicon production is explored in section 3.4.4, Figure 19 and through the interactive graphics available at https://tabsoft.co/3Hv2TBQ.

[257] When FFL risk is scored as 'very low' in PSILCA, it is assigned an impact factor of 0.01. In contrast, 'very high' is assigned 100. The ratio between these is 10,000%. So where a CSS' FFL risk changes from very low to very high, and the mean FFL risk score for all production systems (countries) increases by more than 10,000%, that signals that the increased risk is attributable not only to the mathematical adjustment arising from the changed impact factor in the computation, but also from the significance of the particular CSS in determining systemic risk.

'The Energy of Freedom'?: Solar energy, modern slavery and the Just Transition

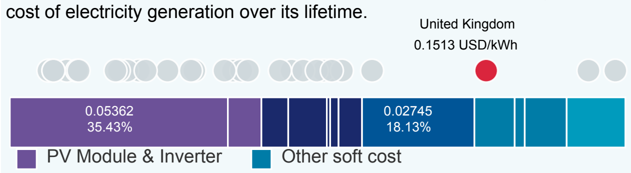
These country profiles summarize data used in and produced by the method for estimating forced labour risk in countries' on-grid PV energy production systems described in 'The Energy of Freedom'?: Solar energy, modern slavery and the Just Transition

Users can choose which country to 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.

Country profile: United Kingdom

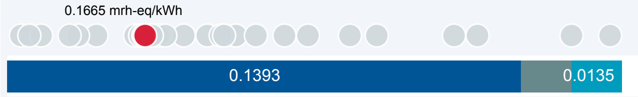
Levelized Cost of Energy (LCOE): is a measure of the average net present cost of electricity generation over its lifetime.



PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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

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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
United Kingdom	0.0101	0.0125	0.0275	0.0229	0.0142	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	0.0002				0.0022
France	0.0017	0.0004				0.0021
Viet Nam	0.0016					0.0016
Total	0.0525	0.0209	0.0275	0.0229	0.0142	0.1378

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

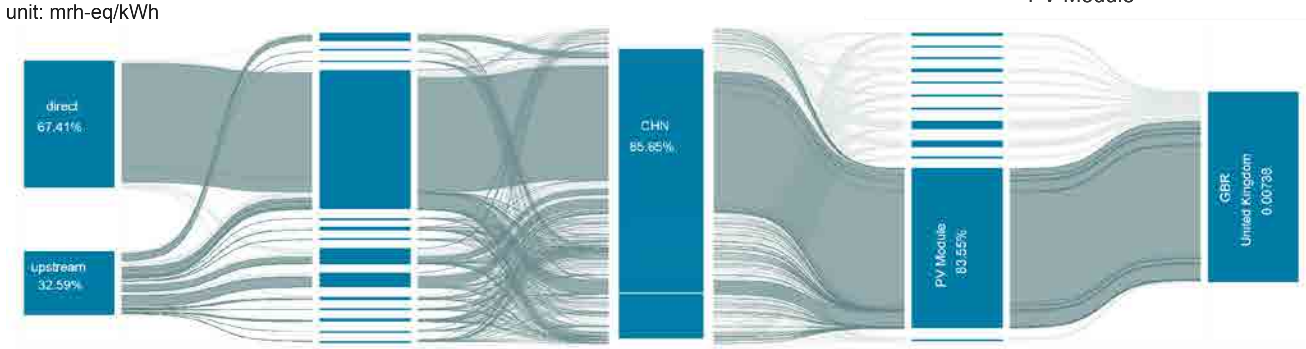
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00532	0.00036				0.00568
Malaysia	0.00056	0.00000				0.00056
United Kingdom	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
Viet Nam	0.00003					0.00003
Total	0.00636	0.00059	0.00010	0.00014	0.00005	0.00724

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
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 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) (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 normalization (min-max method) of the three indicators (FFL:30%, GFL:60%, TP:10%).
Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Figure 20: Forced labour risks in on-grid solar energy production – UK country profile

Note: for all country profiles see Appendix 2, or the interactive version available at https://tabsoft.co/3K80caK.

3.5 Limits of this analysis

Several limits to the analysis presented above must be acknowledged.

Time and resource limitations (including computational capacity) meant that we had to simplify the analysis of the PV supply-chain in certain ways, for example by limiting analysis to the top 30 PV producing countries and excluding trade flows that represent under 2% (by value) from one stage of the supply-chain to the next. This limits the granularity or resolution of the resulting risk mapping, but could be addressed by repeating our analysis for all countries and without the trade flow limitation. Likewise, our analysis is based on a stylised representation of the PV value-chain based on 12 life-cycle components, grouped into five 'breakdowns'. Moreover, we include only on-grid PV, which automatically excludes certain significant sources of risk, such as those associated with batteries – including forced and child labour in cobalt production.[258]

Another limitation is set by the data used in the analysis. EIO-LCA can provide relatively quick estimation of how materials, value and/or risk flows through a value-chain. But the precision and resolution of the resulting picture depends in part on the quality and granularity of the input/output data in the underlying database. Values at an aggregate level such as industry or sector may or may not be representative of the specific subset of sectors relevant to a particular product. In our analysis, for example, we have had to match breakdown components of the PV inventory to different HS6 codes and EORA sectors. Trade shares were calculated based on the data corresponding to the (six-digit) HS code where the relevant PV breakdown is classified. However, at the six-digit HS level, products may be too broad to capture solar PV goods exclusively or predominantly, which means that other commodities may be included in the trade data. Hence, our analysis should be seen as providing only a rough, preliminary assessment of individual forced labour risks, and specific results at the country level should be treated with caution. More research would be needed to estimate trade flows in PV with a greater level of precision.[259]

One way to do this, as we discuss briefly in section 3.6, might be to shift the unit of analysis from the country to the firm, using real-life inventory and supplier data to better estimate 'trade' shares. Access to more granular input/output data – for example along a particular PV supply-chain – would allow for more refined, higher resolution analysis. Ideally, that would also be matched by real-life forced labour incidence data, adapting this technique from an estimation approach towards something more akin to a monitoring approach.

Our analysis does not, of course, address the crucial role that corporate responses play in mitigating risk, instead focusing on embodied risk.

In addition, any MRIO data source can introduce other sources of inaccuracy or error into the analysis, such as: uncertainty inherent in original or old data, missing/incomplete original data, and the estimations and extrapolations used to fill data gaps.[260] We identified several limitations to existing forced labour risk data in the PSILCA dataset (see section 3.3 above), such as reliance on 2018 data. Where time and resources allowed, we updated this data (e.g., for GFL scores). A further extension of our analysis might seek to do this for other indicators (such as TP scores).

The analysis also relies on estimates of FFL at the national level provided by the Walk Free Foundation's Global Slavery Index. Supplementing this analysis through sub-national, sectoral, or even worksite data (such as survey data, worker voice data, or other incident data) might provide a more reliable and higher resolution picture of how modern slavery risk passes through the solar energy value chain. This also might help shed light on how modern slavery risks vary for different populations and communities with which the solar energy value chain engages – such as women, ethnic and religious minorities, or displaced people. This could be useful for understanding how different development pathways for the solar industry may in future impact different vulnerable populations, and thus which stakeholder groups may need to be involved in Just Transition planning for solar industries, in order to safeguard the legitimacy and perceived 'justice' of such industrial development.

Our analysis represents a novel and important mapping of how forced labour risk cascades through the solar energy value-chain, based on 7,485 production element (origin-country : breakdown : producer-country) combinations in the stylized value-chain, and with over 830,000 upstream CSS combinations feeding three different forced labour risk scores into the overall model. This provides the most detailed model of forced labour risk in the solar energy value chain. It is also, to our knowledge, the first time such an approach has been applied along a complex global value-chain, suggesting potential applications for other products, both in and beyond the energy sector.

[258] Extension of the technique to incorporate battery-related risks seems possible, using the lifecycle social impact data that is beginning to become available in relation to cobalt production – see e.g., Gabriel Bamana, Joshua D. Miller, Sera L. Young and Jennifer B. Dunn (2021). 'Addressing the social life cycle inventory analysis data gap: Insights from a case study of cobalt mining in the Democratic Republic of the Congo', *One Earth,* 4(12), pp. 1704-1714.

[259] World Trade Organization (WTO) & International Renewable Energy Agency (IRENA) (2021). 'Trading into a bright energy future: The case for open, high-quality solar photovoltaic markets', available at **https://www.wto.org/english/res_e/publications_e/energyfuture2021_e.htm#:~:text=publications-,Trading%20into%20a%20bright%20energy%20future%3A%20The%20case%20for%20open,high%2Dquality%20solar%20photovoltaic%20markets&text=This%20report%20looks%20at%20how,to%20rebuild%20the%20world%20economy**

[260] Joint Research Centre et al., 2018.

3.6 Discussion

Our objective in this section of the study was to test the feasibility and utility of a new approach to modern slavery risk estimation in the solar energy value-chain. The aim is not to replace but to complement more resource-intensive investigative and due diligence methods. Our results suggest that the SLCA-based approach we have piloted is feasible and offers novel and useful insights into how embodied forced labour risk cascades through the value-chain. (It does not address risk mitigation efforts.)

Several aspects of and potential applications of this estimation method are worth noting. The method has significant diagnostic power at the country-production level, as is demonstrated here (and shown in the Country Profiles in Appendix 2). It can identify how embodied forced labour risks relate to a range of different value-chain factors shaping a country's solar energy production system, and help users identify the different dimensions of forced labour risks in a supply-chain – direct and upstream, geographic, sectoral, and by PV component. Different aspects of this diagnostic may lend this method 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 with which a supply-chain intersects. This may be useful for development and community-level intervention programming. In contrast, buyers, importers or financiers that are looking to use the diagnostic to assess the risk of the presence of supply-chain components made with forced labour might find the GFL indicator is a more useful focus of the diagnostic.

While the approach is computationally intensive, that might be addressed through automation, or through use of more detailed inventory and flow data (such as may be found in some integrated manufacturing, development, or investment firms). That approach may also allow the method to be adapted from analysing country-level production to firm-level outputs and modern slavery risk exposure. This may make this method suitable for a range of applications in the finance and project development space, especially if it is also used to identify the modern slavery risk of other energy sources. By framing the metrics in terms of FLR/kWh and FLR/USD LCOE, this method may potentially provide a basis for comparing modern slavery risks associated with a range of different energy sources – not only solar, but also other renewables or fossil fuels. Further research and extension would be required to adapt the method to product-specific lifecycle inventories. But we see no theoretical bar to such an extension.

If such a method were employed by a range of value-chain stakeholders, that might also open the door to a benchmarking approach. Regulators, reporting bodies or other market actors (such as development finance groups or investors) could use the metric to set modern slavery risk exposure thresholds and benchmarks for, say, access to public contracts or lending or access to capital cost reductions. Investors could set modern slavery risk parameters in portfolio design and investment decisions. These approaches would probably need to factor risk mitigation efforts into analysis, in addition to the embodied risk our method focuses on.

The method trialled here seems to offer several advantages over existing approaches, including scalability, cost-efficiency and potential adaptation to the firm or security level of analysis. With some creativity, it might prove feasible to integrate this technique with existing enterprise and business risk identification and management systems, including supply-chain tracing and management systems.

Finally, this approach offers the first viable technique for measuring forced labour risk at the global PV production and distribution *system* level, and for understanding where pressure points and leverage within that system may emerge. For example, the sensitivity analysis described in section 3.4.4 shows the significant cascade effects caused by a change in the risk of forced labour in the production of polysilicon in China. That may provide critical information as solar energy value-chain stakeholders consider how to develop a more collective approach to managing down forced labour risks across this system, and thereby help secure its place in the Just Transition. It is to the question of how to achieve that outcome that we now turn.

4. From slavery to freedom: justly transitioning solar energy

How can solar energy truly become 'the energy of freedom'? In this final section of the study, we draw on insights from prior sections to consider what policy process pathways could allow the global solar energy sector to justly address modern slavery concerns. 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?

The analysis in section 2 (above) helps us to understand how different actors in global policy debates will approach this question. Their approaches are shaped by their interests and their different outlooks on agency in international affairs, and on whether competitive or cooperative action is more likely to achieve durable solutions. The policy process tracing in section 2 also points to several insights about how the procedural aspects of policy design and implementation may bear on their legitimacy and effectiveness. In this final section, we draw on these insights to set out ideas for a process that could more effectively address modern slavery concerns, and help secure solar energy's place in the Just Transition.

Our analysis in this section is based not only on desk review, but also on bilateral and group consultations with key stakeholders, including an off-the-record group consultation in February 2022 with over 60 solar energy product manufacturers, industry associations, investors and lenders, government actors, and civil society groups.

In closing, we reflect on what debates on how to handle modern slavery risks may tell us about the 'social purpose' of global solar energy governance.

4.1 Managing risk throughout 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 lifecycle of the solar energy production system, would represent an important first step towards more effective risk management across the value-chain.

In section 3, we provided a proof of concept for a method for estimating embodied forced labour risk in the on-grid PV supply-chain (cradle to gate). The adoption of a risk estimation technique such as this would offer a first step towards making forced labour risk more visible and manageable across the value-chain. The method we have trialled would need further testing and refinement, for example to address post-gate lifecycle impacts (i.e., during decommissioning and recycling), to incorporate non-PV production system components – notably Li-ion batteries, and to incorporate child labour risks alongside the forced labour risks we focused on due to limited time. Our method for estimating embodied risk would also need to be integrated with metrics on risk mitigation efforts. Our method is demonstrated using MRIO data, for the country-level, but it could potentially be extended to firm-level analysis using suitable supply-chain inventory and production data.

In section 3.6 we discussed some of the benefits of adopting and normalising such a risk estimation method, such as improved ability of firms 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.[261] This could raise legitimacy concerns, and meet resistance – for example through contestation or even litigation by rights-holders. Attention to the voice and agency afforded to affected communities and rights-holders in designing and executing risk management policies is thus an important way to ensure not only the effectiveness, but also the legitimacy and durability, of those policies.

4.2 Clarifying expectations on responsible business conduct

Our research suggests an urgent need to clarify expectations on responsible business conduct as they pertain to modern slavery risks in the solar energy value-chain. These need to address expectations of different stakeholders' responsibilities in relation to: 1) due diligence; 2) leverage and engagement; 3) disengagement; and 4) provision and enabling of remedy. 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, though other normative regimes – such as the broader ILO normative acquis, and the global trade law regime – may also come into play. There is, however, significant further clarification required as to *how* these norms should be applied to the solar energy production system.

In particular, there is a need to clarify market and regulatory expectations around the threshold, sequencing and timing of disengagement from actors suspected of ties to forced or child labour. The two key transition questions for the industry are: 1) how existing supply will be remediated to address modern slavery concerns, and 2) how new supply untainted by such modern slavery concerns will be developed. The need to clarify expectations on these issues is made all the more urgent by the adoption of the Uyghur Forced Labor Prevention Act, which comes into force in June 2022, and by the European move to impose mandatory human rights and environmental due diligence obligations on some corporations.

[261] Mulvaney, 2020.

Our research and analysis in section 2 suggests there are some important elements emerging that might be used to build such a consensus. The 'Common Approach' developed by several multilateral development banks and DFIs may be one starting point. The phased disengagement proposal from Eventide Funds is another (discussed further below in section 4.5.3).[262] But these leave important questions unanswered. What are the market's expectations in relation to 'bifurcated' suppliers? Will it be acceptable to finance, or procure from, suppliers who sell both 'clean' and 'dirty' goods, into different markets? What timelines or milestone should guide disengagement? How will remedy be afforded to victims and survivors of modern slavery connected to the solar energy value-chain? Likewise, while there is a growing recognition that governments will play a key role in crystallizing market expectations through formal regulation, the emerging US and European approaches rest on somewhat different allocations of due diligence responsibilities. In the US approach, the corporate obligation is to ensure that certain identified firms, or firms operating in XUAR, are not in their supply-chains. In the anticipated EU approach, the due diligence expectations on firms are broader: within certain parameters, it seems likely to be up to the firm to identify whether it is linked to modern slavery (or other human rights harms) in its supply-chain, without relying on a pre-defined list of no-go firms or regions provided by regulatory authorities. This sets up two quite different sets of expectations about what approach actors in the solar energy value chain should take to risk identification and monitoring.

The absence of clarity on these expectations may impede financing of and roll-out of solar energy. 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. We return in section 4.5, below, to the question of what issues may need to be tackled, to create greater certainty around expectations of responsible business conduct in the solar energy value-chain. Before doing so, we consider *how* this uncertainty can be addressed – in other words, through what kinds of processes, involving which actors, durable policy solutions are likely to emerge.

4.3 A trusted forum for dialogue and cooperation

How can this uncertainty be addressed? Our analysis in section 2 suggests there are four distinct answers in play, promoted by actors representing four different 'Policy Currents'.

The first, Rights, suggests 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, and are sending different signals to the market. On certain questions, such as the bifurcation issue (whether it will be acceptable to buy clean products from solar manufacturers that sell 'dirty' 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. There is a real question, for investors and developers, whether it will simply take too long for states to develop clear – and consistent – views on such questions to allow them to make solar value-chain investments with certainty. 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.

[262] Eventide, 2022.

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 decarbonization, 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, and showing how, in order to be sustainable, production 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.[263] Yet such an approach is largely absent, to date, from the debates around modern slavery risks in PV supply-chains.

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 ISA – 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 an 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. The financial sector's 'stewardship' work may offer one useful way in. Our analysis in section 2 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.[264]

A multistakeholder initiative or forum focused on forced labour and/or 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 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).[265]

[263] 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**
[264] OECD, 2019.
[265] Cockayne, 2021a.

4.4 Engaging China

One key to avoiding such a polarization of efforts to address modern slavery risks in the solar energy system is to ensure that Chinese stakeholders in the solar energy value-chain are effectively engaged. Chinese manufacturers are dominant in many tiers of the existing supply-chain. And increasing Chinese uptake of solar energy will be central to decarbonization 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.[266]

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. The solar energy value-chain has gone through significant disruption and transformation over the last 15 years. At several points along the way, China, India, the US and Europe have had solar energy-related policy choices tested through trade disputes, including in the WTO system. 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. Chinese government and solar industry officials have signalled that any policies that lead to disengagement from XUAR-linked producers, deals, factories or projects must be "objective, gradual" and based in international law. There are hints that WTO law should be the yardstick against which import bans are measured. And hints at a willingness to see disputes over solar energy production systems and policies tested before WTO or international investment dispute resolution mechanisms. Here, it is notable that 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.[267] 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.

4.5 Towards a global transition '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.[268]

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.[269]

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 described in section 3. 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 to those that are, in fact, the greatest source of risk.

[266] James Cockayne (forthcoming C). *Sanctioning Xinjiang forced labour: Chinese counter-measures*, forthcoming on www.xinjiangsanctions.info.
[267] Cockayne and Masiko, forthcoming.
[268] Cockayne, 2021a.
[269] 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_Paper-High_Road_Labor_and_Renewable_Energy-PUBLIC_RELEASE-4-13-21.pdf

Given the divergent economic and political interests in play in this debate, it may not be possible to develop such an approach immediately 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,[270] and articulate a set of shared expectations about responsible handling of modern slavery risks and allegations.

Which substantive issues would such a roadmap need to address? Here we set out some of the key issues and potential solutions that have emerged from stakeholders within our research on the solar energy value-chain.

4.5.1 Due diligence expectations

The starting point for the roadmap is likely to be the accepted normative regime governing responsible business conduct. This encompasses not only accepted ILO standards, but also the UN Guiding Principles on Business and Human Rights, and the OECD Guidelines for Multinational Enterprises. Solar energy value-chain stakeholders could work together to clarify expectations on the roles of different actors in implementing this framework, particularly in identifying sources of modern slavery risk. 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.[271] Desk-based review may sometimes be possible,[272] 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. 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.

There will also be a need for dialogue between government and market actors about the roles each of them will play in identifying particular sources of modern slavery risk. In the US, this will become clearer over the coming months as the implementation arrangements for the *Uyghur Forced Labor Prevention Act* solidify. In the EU, discussions on the Corporate Sustainability Due Diligence initiative will take centre stage. Value-chain stakeholders in other jurisdictions will need to foster dialogue between government, market and civil society actors to create greater certainty on this point. And some degree of inter-jurisdictional harmonization may also be necessary.

4.5.2 Leverage expectations

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.[273]

A key question on 'leverage' will be which specific parts of the solar energy value-chain should be the priority focus for remediation, and what collective remediation efforts should look like. As we saw in section 2, thinking on these issues is relatively advanced in the context of DRC cobalt production – and there are a number of

[270] Allan, Lewis and Oatley, 2021; Bordoff and O'Sullivan, 2022.
[271] 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.
[272] Murphy, Salcito and Elimä, 2022.
[273] Sherman, 2021.

collective action initiatives already under way. In the area of PV production, however, there is not yet any such analogous initiative, no doubt in part because of the significant sensitivities and risks involved in identifying PRC firms and locations as sources of modern slavery risks. 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. Industry associations have an important role to play here, given their ties to relevant producers. So, too, do public and private financing institutions.

4.5.3 Withdrawal and bifurcation expectations

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 *Uyghur Forced Labor Prevention Act*) 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 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 suppliers 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.[274] 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 from solar energy firms credibly tied to forced labour.[275] This might provide a useful starting point for discussion on withdrawal expectations. Figure 4, earlier in this study, which is based on the work of Prof. Laura Murphy and Nyrola Elimä, and on this Eventide proposal, shows how such a plan for phased withdrawal could be structured. Clients and investors could agree, for example, to a set date by which they will withdraw from relationships with firms that they agree evidence suggests belonging in each of the cells in this table. In the Eventide proposal, for example, six months or a year would be allowed before withdrawal from the cell at the bottom left (wafer, cell and module manufacturers credibly alleged to use forced labour). Another six months or a year would then be allowed before withdrawal from the cell above is expected or required, and to the right, of that one – that is, from relationships with polysilicon producers alleged to use forced labour, and the module manufacturers they supply. Finally, a third period of six months or a year would be allowed before withdrawal would be expected from relationships with silica producers alleged to use forced labour, and their downstream polysilicon and module manufacturer clients.

In order to be credible, however, such disengagement commitments must address two related questions.

First, the credibility of these commitments will depend on them providing clarity about the question of bifurcation. Will companies be expected to withdraw from commercial relationships where they receive 'clean' supply from a manufacturer that is using modern slavery to supply 'dirty' 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 (see Figure 4); and b) in the best position to use their know-how, access to capital and commercial relationships to quickly build new, 'clean' supply. Even as they develop new, clean supply capacity, however, they have not given any indication of drawing down on their 'dirty' capacity. If anything, there is growing investment in PRC-based production capacity, to supply anticipated increased demand in PRC for solar energy. The danger here is that commercial withdrawal from 'dirty' supply-chains by some buyers and investors does not in fact reduce modern slavery, but rather indirectly contributes to its continuation – or potentially even its expansion. 'Modern slavery free' solar-energy demand could end up cross-subsidising the continued use of forced labour in the 'slave-made' supply-chain. Yet the creation of an expectation that buyers and investors *not* do business with those firms is only credible if and when they have access to 'clean' alternative supply.

The second question that must be addressed, therefore, is where this will come from. We turn to that issue now.

[274] 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/**.
[275] Eventide, 2022.

4.5.4 Expectations for developing new supply

The International Energy Agency projects 450% growth in demand for solar energy by 2030. Securing solar power's place in the Just Transition and making it genuinely 'the energy of freedom' requires that as much of this growth as possible is modern slavery-free. A roadmap to tackle modern slavery issues in the solar energy value-chain will need to set out expectations for how developers and financial institutions will use their leverage during project development to embed commitments to respect for human rights, international labour standards, stakeholder consultation, and effective remedy, within project foundations (see section 4.5.2 above). Given the lead-times and sizeable capex for developing new PV production and formal cobalt extraction capacity, however, there is also a need for governmental actors to get involved, to lay out a credible sectoral development pathway that provides the necessary 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.[276] 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.

4.5.5 Expectations on remedy for harm

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.

Fortunately, there is no need to start from scratch. The UN Guiding Principles on Business and Human Rights and OECD Guidelines for Multinational Enterprises set out a shared expectation that companies provide or enable remedy for human rights harms which they have caused or contributed to. Our analysis in section 2 suggests, however, that these expectations are not yet consistently reflected in corporate or government policy thinking on this issue. 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.

[276] Rai-Roche, 2022.

4.6 Broader implications: solar energy, freedom and the transitioning 'purpose' of global energy governance

In this study we have examined in detail how concerns about modern slavery in the global solar energy value-chain are being debated and responded to, across a wide range of policy arenas – and what this means for the broader question of how to ensure a transition to renewable energy is 'just'. As we have shown, a wide variety of policy 'currents' are present in these debates, proposing a range of solutions based on different assumptions about which entities (state, market and individual) have agency and responsibility in international affairs, and the dynamics by which stable policy solutions and system-states emerge (e.g., through competitive or cooperative action).

These dynamics make clear that not only the concept of 'justice' in the transition to renewable energy, but the global solar energy governance regime itself remain contested spaces. A range of state, commercial and other actors are competing for influence over solar energy governance, and to tie the growth of the solar energy sector into different political projects – sometimes framed in different conceptions of 'freedom'.

The technical standards, market expectations and trade and investment rules – in other words, the governance 'regime' – for the global solar energy production system are not yet settled, especially when it comes to questions of how to manage negative social impacts. Modern slavery risks have emerged as a flashpoint for contestation of both the form and the substance of that regime – including questions of voice, agency and rights and freedoms. Different actors in the global solar energy value-chain have different perspectives on such key issues as the role of states and companies in identifying and managing enterprise-level, supply-chain-level, and system-level risk; the role of affected individuals and communities in shaping the rules that govern solar energy production; the rights of affected individuals to remedy for harmful business conduct; and whether system-level change is better achieved through the competitive dynamics of market competition, or through purposeful cooperation. And even where there is an appetite for cooperation, different stakeholders in the solar energy value-chain have different perspectives on the social purpose of any resulting governance regime: is it to promote economic development and reduce poverty? Is it to address climate change and ensure global production stays within planetary system limits? Is it to secure the freedom of energy consumers from dependence on fossil fuel owners and petrostates? Or is it to protect individual, commercial and/or states' rights?

Fundamentally, these different perspectives on the global energy regime represent quite different conceptions not only of 'justice', but also of order – or, as John Ruggie framed it in a famous article on the 'embedded liberalism' of the post-War economic order, different conceptions of the 'purpose' of international regimes.[277] Some of the actors in this contest over responses to modern slavery risk in the solar energy governance regime – notably the CCP – promote a state-driven socio-economic model that is increasingly difficult to reconcile to a market-oriented, liberal conception of international economic order and internationally recognized rights and freedoms.

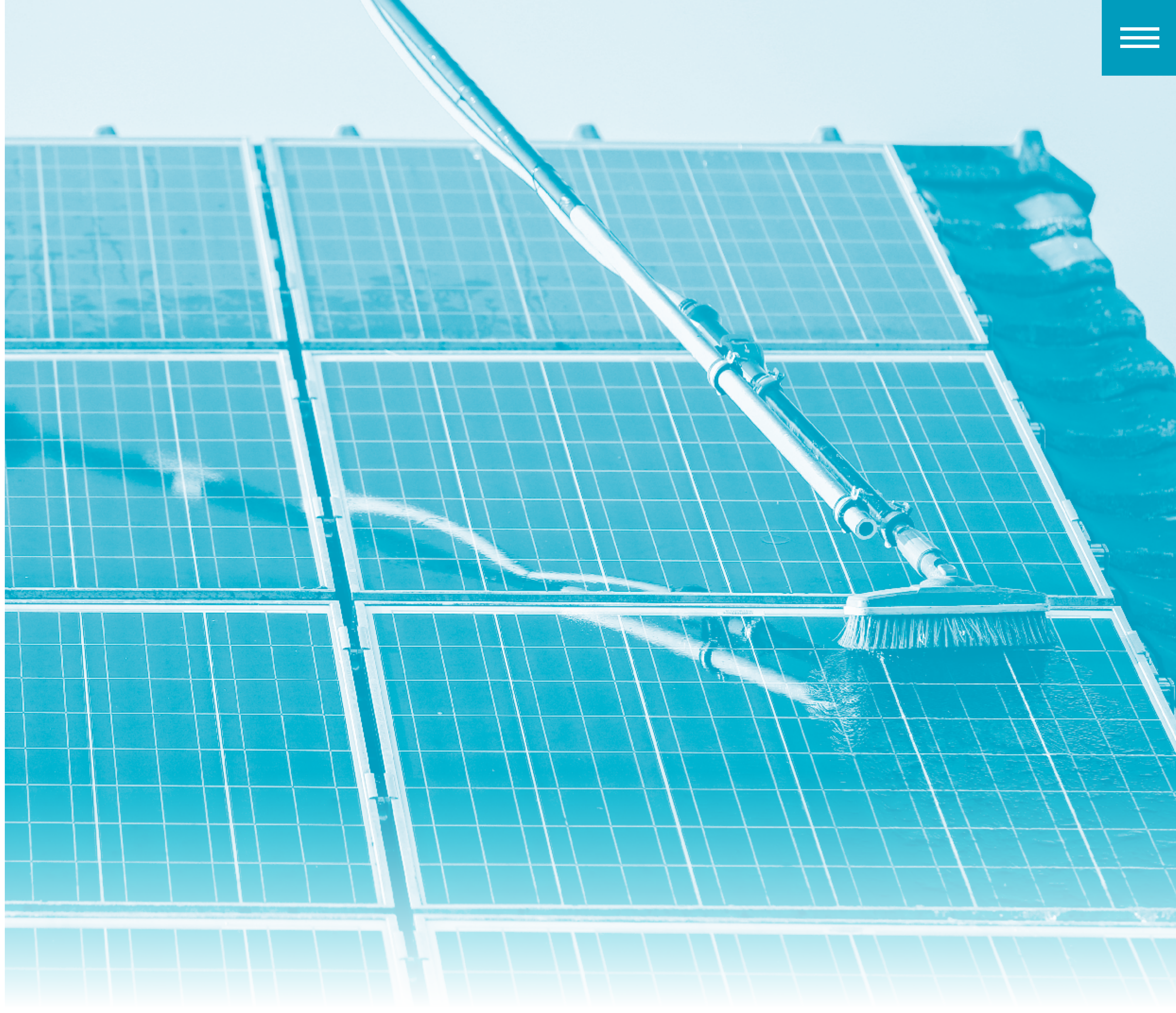
This is a point that western governments are increasingly explicit in naming. In February 2022, a study by the US Trade Representative found that "nearly two decades after its accession to the WTO, [China] has still not embraced market-oriented policies". The study identifies a range of "problematic industrial policies" and measures that support them, including state subsidies, surplus capacity, forced-technology transfer, state-sponsored theft, economic coercion – and forced labour. These policies, it argues, have

> *[s]ystematically distorted critical sectors of the global economy such as … solar … devastating markets in the United States and other countries. At the same time, as is their design, China's industrial policies are increasingly responsible for displacing companies in new, emerging sectors of the global economy, as the Chinese government and the Chinese Communist Party powerfully intervene in these sectors on behalf of Chinese companies. Companies in economies disciplined by the market cannot effectively compete with both Chinese companies and the Chinese state.*[278]

The debate over modern slavery risks in the solar energy value-chain is thus a microcosm of this larger debate about the role of the Chinese state in promoting and protecting illiberal practices in the global economy.

Yet there is not a singular 'liberal' alternative on offer – but rather several different conceptions of what a more liberal alternative should encompass. One approach focuses on individual Rights. Another focuses on the role of a liberal market in addressing modern slavery risks through Supply-Chain remediation. A third responds to Chinese economic practices – and concerns about dependence on petrostates such as Russia – with a broader, Autarkic push for sovereignty, autonomy and economic self-sufficiency. A final approach suggests a need to shift the frame of reference from market logic and individual rights to a more system-based approach to collective risk management.

[277] Ruggie, 1982.
[278] US Trade Representative (USTR) (2022). *2021 Report to Congress on China's WTO Compliance, February 2022*, available at **https://ustr.gov/sites/default/files/enforcement/WTO/2021%20USTR%20Report%20to%20Congress%20on%20China's%20WTO%20Compliance.pdf.**



The last approach, in particular, suggests a deeper transition in the purposive aspect of solar energy value-chain governance. It is a shift away from a neoliberal focus on disembedding global markets from local politics and social systems, to an approach that 're-embeds' market governance in not only socio-political institutions and considerations (such as 'democracy' and 'freedom)', but also within the physical parameters provided by planetary systems.[279] Debates over how to organise a 'just' transition to renewable energy, and how to ensure solar energy is 'the energy of freedom' connect to this same underlying question of the purposive aspect of global order and governance regimes.[280]

How stakeholders in the global solar energy value-chain respond to these dynamics remains to be seen. 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.

[279] John Gerard Ruggie (2021). Corporate Globalization and the Liberal Order: Disembedding and Reembedding Governing Norms. In *The Downfall of the American Order: Liberalism's End?* (Cornell University Press) available at SSRN: **https://ssrn.com/abstract=3865671** or **http://dx.doi.org/10.2139/ssrn.3865671**
[280] Stevis and Felli, 2020.

Appendix 1 – Data updates

Data updates to the PSILCA dataset to align with the Department of Labor's International Labor Assistance Bureau (ILAB) List of Goods Produced by Child Labor or Forced Labor (February 2022)

Country/Area	Good	Forced Labor	GFL_PSILCA_industry_commodity	Original risk (ILAB 2018)	New risk (ILAB list as of Feb 2022)	Original impact factor value	New impact factor value	Multiplier
Afghanistan	Bricks	X	Petroleum, Chemical and Non-Metallic Mineral Products	No data	High risk	0.1	10	100
Angola	Diamonds	X	Mining and Quarrying	High risk	High risk	10	10	1
Argentina	Garments	X	Fabrics	No data	High risk	0.1	10	100
Bangladesh	Dried Fish	X	Fishing	No risk	High risk	0.1	10	100
Benin	Cotton	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
Bolivia	Brazil Nuts/Chestnuts	X	Industrial agricultural products	No data	High risk	0.1	10	100
Bolivia	Cattle	X	Livestock	Very high	Very High	100	100	1
Bolivia	Corn	X	Industrial agricultural products	No data	High risk	0.1	10	100
Bolivia	Peanuts	X	Industrial agricultural products	No data	High risk	0.1	10	100
Bolivia	Sugarcane	X	Industrial agricultural products	No data	High risk	0.1	10	100
Brazil	Cattle	X	Beef and other live animals	No risk	High risk	100	100	1
Brazil	Charcoal	X	Coal	Very high	Very High	100	100	1
Brazil	Coffee	X	Coffee	No risk	High risk	100	100	1
Brazil	Garments	X	Manufacture of Wearing Apparel	High risk	High risk	10	10	1
Brazil	Sugarcane	X	Sugar cane	Very high	Very High	100	100	1
Brazil	Timber	X	Forestry products	No risk	High risk	0.1	10	100
Burkina Faso	Cotton	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
Burkina Faso	Gold	X	Mining and Quarrying	No data	High risk	0.1	10	100
Burma	Bamboo	X	Agriculture	High risk	High risk	10	10	1
Burma	Beans (green, soy, yellow)	X	Agriculture	High risk	High risk	10	10	1
Burma	Bricks	X	Petroleum, Chemical and Non-Metallic Mineral Products	Medium	High risk	1	10	10
Burma	Jade	X	Mining and Quarrying	High risk	High risk	10	10	1
Burma	Palm thatch	X	Agriculture	High risk	High risk	10	10	1
Burma	Rice	X	Agriculture	High risk	High risk	10	10	1
Burma	Rubber	X	Mining and Quarrying	High risk	High risk	10	10	1
Burma	Rubies	X	Mining and Quarrying	High risk	High risk	10	10	1
Burma	Sesame	X	Agriculture	High risk	High risk	10	10	1
Burma	Shrimp	X	Fishing	High risk	High risk	10	10	1
Burma	Sugarcane	X	Agriculture	High risk	High risk	10	10	1
Burma	Sunflowers	X	Agriculture	High risk	High risk	10	10	1
Burma	Teak	X	Agriculture	High risk	High risk	10	10	1
Cambodia	Bricks	X	Petroleum, Chemical and Non-Metallic Mineral Products	No data	High risk	0.1	10	100
China	Artificial flowers	X	Arts and crafts products	High risk	High risk	10	10	1
China	Bricks	X	Cement and cement asbestos products	High risk	High risk	10	10	1
China	Christmas decorations	X	Arts and crafts products	High risk	High risk	10	10	1
China	Coal	X	Coal mining and processing	High Risk	High Risk	10	10	1
China	Cotton	X	Cotton textiles	High Risk	High Risk	10	10	1

Country/Area	Good	Forced Labor	GFL_PSILCA_industry_commodity	Original risk (ILAB 2018)	New risk (ILAB list as of Feb 2022)	Original impact factor value	New impact factor value	Multiplier
China	Electronics	X	Electronic element and device	High Risk	High Risk	10	10	1
China	Fireworks	X	Arts and crafts products	High Risk	High Risk	10	10	1
China	Fish	X	Fisheries	No data	High risk	0.1	10	100
China	Footwear	X	Wearing apparel	High Risk	High Risk	10	10	1
China	Garments	X	Wearing apparel	High Risk	High Risk	10	10	1
China	Gloves	X	Manufacture of other textiles, n.e.c.	No risk	High risk	0.1	10	100
China	Hair products	X	Arts and crafts products	High risk	High risk	10	10	1
China	Nails	X	Metal products	No data	High risk	0.1	10	100
China	Polysilicon	X	Other electric machinery and equipment	No data	High risk	0.1	10	100
China	Textiles	X	Manufacture of other textiles, n.e.c.	No risk	High risk	0.1	10	100
China	Toys	X	Toys, sporting and athletic and recreation products	High Risk	High Risk	10	10	1
China	Tomato products	X	Crop cultivation	No data	High risk	0.1	10	100
China	Thread/yarn	X	Manufacture of other textiles	No data	High risk	0.1	10	100
Colombia	Coca (stimulant plant)	X	Other agricultural products	No data	High risk	0.1	10	100
Cote d'Ivoire	Cocoa	X	Agriculture	High Risk	High Risk	10	10	1
Cote d'Ivoire	Coffee	X	Agriculture	High Risk	High Risk	10	10	1
Democratic Republic of the Congo	Gold	X	Mining and Quarrying	High Risk	Very High	10	100	10
Democratic Republic of the Congo	Tantalum ore (coltan)	X	Mining and Quarrying	High Risk	Very High	10	100	10
Democratic Republic of the Congo	Tin ore (cassiterite)	X	Mining and Quarrying	High Risk	Very High	10	100	10
Democratic Republic of the Congo	Tungsten ore (wolframite)	X	Mining and Quarrying	High Risk	Very High	10	100	10
Dominican Republic	Sugarcane	X	Agriculture	No data	High risk	0.1	10	100
Ethiopia	Textiles (hand-woven)	X	Textiles and Wearing Apparel	No data	High risk	0.1	10	100
Ghana	Fish	X	Fishing	High risk	High risk	10	10	1
Ghana	Tilapia (fish)	X	Fishing	High risk	High risk	10	10	1
India	Bricks	X	Structural clay products	No data	High risk	0.1	10	100
India	Carpets	X	Carpet weaving	High risk	High risk	10	10	1
India	Cottonseed (hybrid)	X	Cotton	No data	High risk	0.1	10	100
India	Embellished Textiles	X	Art silk, synthetic fiber textiles	No data	High risk	0.1	10	100
India	Garments	X	Readymade garments	No data	High risk	0.1	10	100
India	Rice	X	Paddy Rice	High risk	High risk	10	10	1
India	Sandstone	X	Lime stone	No data	High risk	0.1	10	100
India	Stones	X	Lime stone	No data	High risk	0.1	10	100
Indonesia	Fish	X	Fisheries	High risk	High risk	10	10	1
Indonesia	Oil (palm)	X	Food crops	No data	High risk	0.1	10	100
Kazakhstan	Cotton	X	Cotton Products	High risk	High risk	10	10	1
Malawi	Tobacco	X	Agriculture	High risk	High risk	10	10	1
Malaysia	Electronics	X	Other electrical machinery	No data	High risk	0.1	10	100
Malaysia	Garments	X	Wearing apparel	High risk	High risk	10	10	1
Malaysia	Oil (palm)	X	Oil Palm primary products	Medium	High risk	1	10	10
Malaysia	Rubber Gloves	X	Rubber products	No data	High risk	0.1	10	100
Mali	Rice	X	Agriculture	No risk	High risk	0.1	10	100
Mexico	Chile Peppers	X	Agriculture	No risk	High risk	0.1	10	100

Country/Area	Good	Forced Labor	GFL_PSILCA_industry_commodity	Original risk (ILAB 2018)	New risk (ILAB list as of Feb 2022)	Original impact factor value	New impact factor value	Multiplier
Mexico	Tomatoes	X	Agriculture	No risk	High risk	0.1	10	100
Nepal	Bricks	X	Petroleum, Chemical and Non-Metallic Mineral Products	No data	High risk	0.1	10	100
Nepal	Carpets	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
Nepal	Embellished Textiles	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
Nepal	Stones	X	Mining and Quarrying	High risk	High risk	10	10	1
Niger	Cattle	X	Agriculture	No data	High risk	0.1	10	100
Nigeria	Cocoa	X	Agriculture	No risk	High risk	0.1	10	100
Nigeria	Granite	X	Mining and Quarrying	High risk	High risk	10	10	1
Nigeria	Gravel (crushed stones)	X	Mining and Quarrying	High risk	High risk	10	10	1
North Korea	Bricks	X	Petroleum, Chemical and Non-Metallic Mineral Products	High risk	High risk	10	10	1
North Korea	Cement	X	Mining and Quarrying	High risk	High risk	10	10	1
North Korea	Coal	X	Mining and Quarrying	High risk	High risk	10	10	1
North Korea	Gold	X	Mining and Quarrying	High risk	High risk	10	10	1
North Korea	Iron	X	Metal products	Low risk	High risk	0.1	10	100
North Korea	Textiles	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
North Korea	Timber	X	Wood and Paper	Medium	High risk	1	10	10
Pakistan	Bricks	X	Petroleum, Chemical and Non-Metallic Mineral Products	High risk	High risk	10	10	1
Pakistan	Carpets	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
Pakistan	Coal	X	Mining and Quarrying	High risk	High risk	10	10	1
Pakistan	Cotton	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
Pakistan	Sugarcane	X	Agriculture	High risk	High risk	10	10	1
Pakistan	Wheat	X	Agriculture	High risk	High risk	10	10	1
Paraguay	Cattle	X	Cattle	No risk	High risk	0.1	10	100
Peru	Brazil nuts/chestnuts	X	Agricultural, Hunting and Forestry products	No risk	High risk	0.1	10	100
Peru	Gold	X	Various Metal Products	No data	High risk	0.1	10	100
Peru	Timber	X	Agricultural, Hunting and Forestry products	No risk	High risk	0.1	10	100
Russia	Bricks	X	Other non-metallic mineral products	No data	High risk	0.1	10	100
Russia	Timber	X	Wood and products of wood and cork	Medium	High risk	1	10	10
Sierra Leone	Diamonds	X	Mining and Quarrying	High risk	High risk	10	10	1
South Sudan	Cattle	X	Agriculture	No data	High risk	0.1	10	100
Tajikistan	Cotton	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
Thailand	Fish	X	Ocean and Coastal Fishing	Medium	High risk	1	10	10
Thailand	Garments	X	Wearing Apparels Except Footwear	High risk	High risk	10	10	1
Thailand	Shrimp	X	Inland Fishing	High risk	High risk	10	10	1
Taiwan	Fish	X	Fishery Products	No data	High risk	0.1	10	100
Turkmenistan	Cotton	X	Textiles and Wearing Apparel	High risk	High risk	10	10	1
Uzbekistan	Cotton	X	Cotton Products	High risk	High risk	10	10	1
Uzbekistan	Silk Cocoons	X	Silk Products	High risk	High risk	10	10	1
Venezuela	Gold	X	Manufacture of basic precious and non-ferrous metals	No data	High risk	0.1	10	100
Viet Nam	Garments	X	Weaving of clothes (all kinds)	No data	High risk	0.1	10	100

Appendix 2 – Country profiles

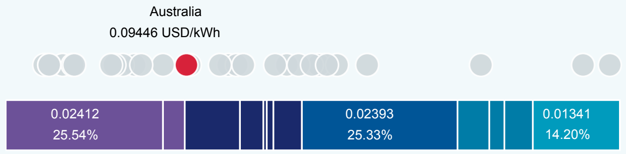
Note: These Country Profiles summarize data generated by the embodied forced labour risk estimation method discussion in section 3 of this report. The method allows for differentiation of a variety of forms of forced labour risk, and analysis of how risk cascades through the value-chain into the energy production mix for different countries, depending on different initial risk input levels, and using different risk metrics (mrh-eq/kWh and mrh-eq/USD LCOE). The data used is a mixture of 2018 and 2022 data (see section 3 of the report for more details). The images below show only one combination of input options, standardized for 'Goods produced by forced labour', for mrh-eq/kWh. Interactive versions of these country profiles, allowing the user to make their own variations to account for changing risks associated with specific production inputs (notably Chinese polysilicon production), are available at https://tabsoft.co/3K80caK. They allow users to see how the variation in the forced labour risk associated with that specific value-chain input cascade down to the country-level energy production risk profile.

Australia

Country: Australia

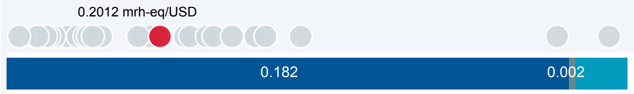
Levelized Cost of Energy (LCOE)

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

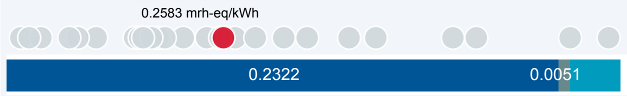


- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Australia	0.00924	0.00851	0.02393	0.01141	0.01341	0.06650
China	0.01443	0.00393				0.01836
Rep. of Korea	0.00077	0.00245				0.00322
Malaysia	0.00077	0.00065				0.00142
United Kingdom	0.00003	0.00057				0.00060
USA	0.00020	0.00035				0.00055
Germany	0.00028	0.00026				0.00054
China, Hong Kong	0.00043					0.00043
Thailand	0.00002	0.00041				0.00043
Italy	0.00015	0.00017				0.00032
Total	0.02632	0.01730	0.02393	0.01141	0.01341	0.09237

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00753	0.00222				0.00975
Malaysia	0.00038	0.00001				0.00040
Australia	0.00004	0.00004	0.00009	0.00009	0.00005	0.00031
Rep. of Korea	0.00001	0.00002				0.00003
China, Hong Kong	0.00003					0.00003
India	0.00001	0.00001				0.00002
Thailand	0.00000	0.00001				0.00001
Singapore	0.00001	0.00000				0.00001
United Kingdom	0.00000	0.00000				0.00000
Germany	0.00000	0.00000				0.00000
Total	0.00801	0.00232	0.00009	0.00009	0.00005	0.01056

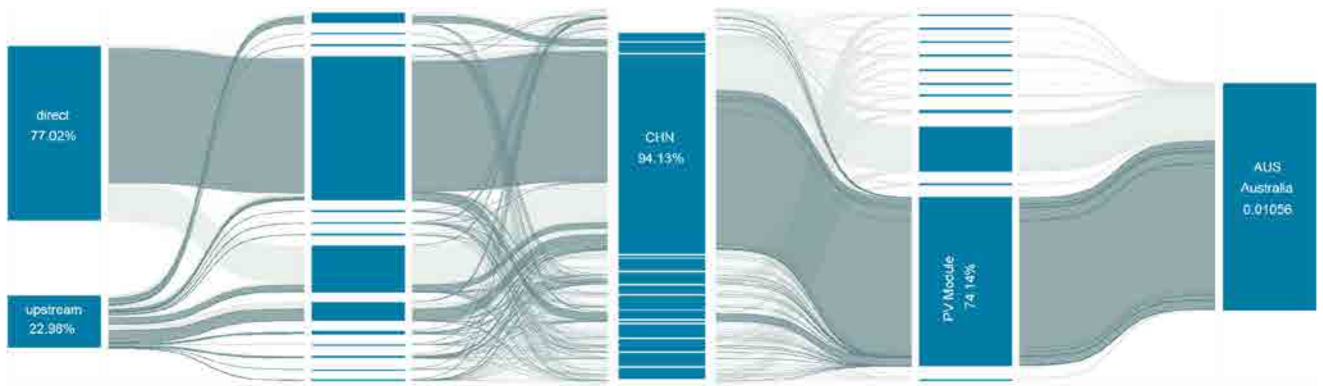
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

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 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) (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 normalization (min-max method) of the three indicators (FFL:30%, GFL:60%, TP:10%).
Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

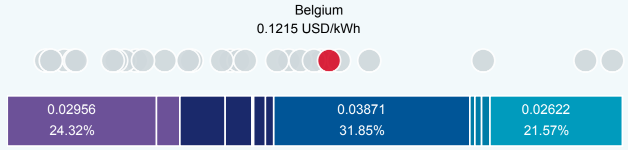
Belgium

Country profile: Belgium

Country: Belgium

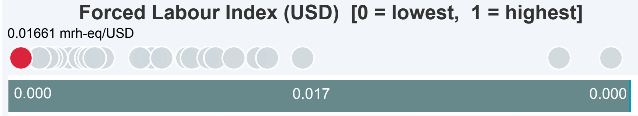
Levelized Cost of Energy (LCOE)

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

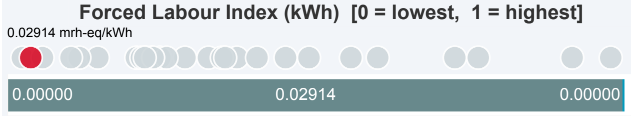


- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Belgium	0.0036	0.0073	0.0387	0.0040	0.0262	0.0799
Germany	0.0106	0.0020				0.0126
Netherlands	0.0072	0.0018				0.0091
France	0.0013	0.0016				0.0029
China	0.0025	0.0004				0.0029
Luxembourg	0.0019	0.0002				0.0021
Taiwan	0.0018					0.0018
Italy	0.0007	0.0007				0.0014
Japan	0.0011	0.0000				0.0011
Turkey		0.0009				0.0009
Total	0.0307	0.0149	0.0387	0.0040	0.0262	0.1146

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00121	0.00024				0.00145
Belgium	0.00004	0.00006	0.00034	0.00002	0.00006	0.00052
Germany	0.00011	0.00001				0.00013
Netherlands	0.00008	0.00002				0.00010
Malaysia	0.00009	0.00000				0.00009
France	0.00001	0.00001				0.00002
Slovenia	0.00002					0.00002
Turkey		0.00002				0.00002
India	0.00001	0.00000				0.00001
Taiwan	0.00001					0.00001
Total	0.00159	0.00036	0.00034	0.00002	0.00006	0.00237

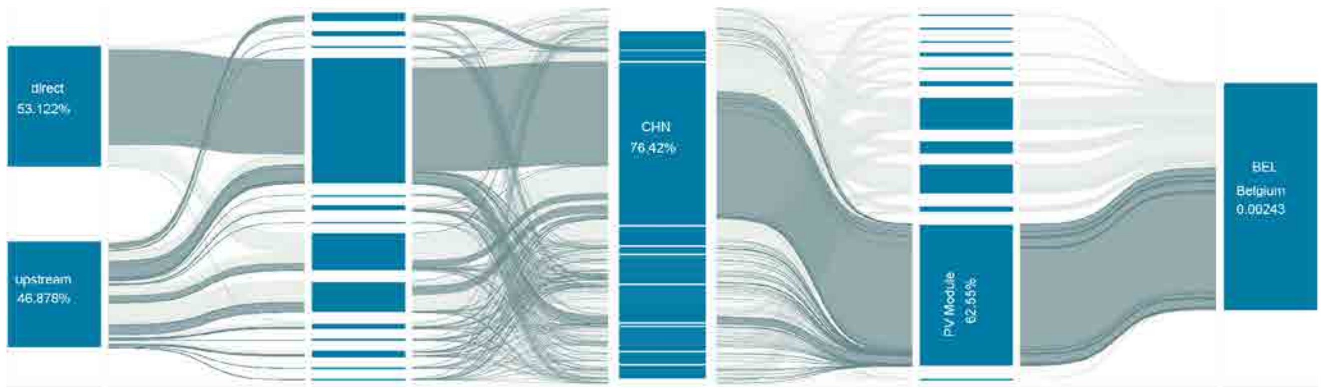
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

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 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) (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 normalization (min-max method) of the three indicators (FFL:30%, GFL:60%, TP:10%).
Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

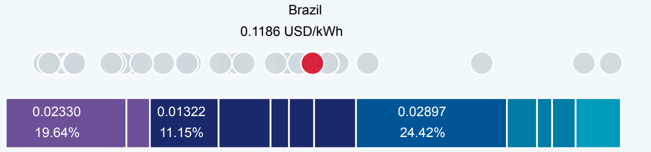
Brazil

Country profile: Brazil

Country: Brazil

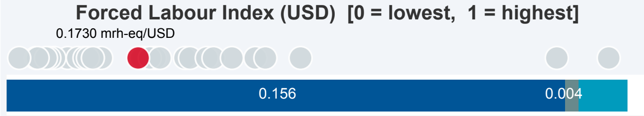
Levelized Cost of Energy (LCOE)

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

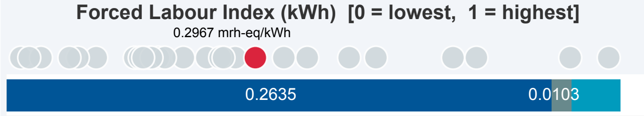


PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Brazil	0.0093	0.0198	0.0290	0.0133	0.0086	0.0800
China	0.0159	0.0040				0.0199
Belgium		0.0030				0.0030
Germany	0.0003	0.0023				0.0026
USA	0.0002	0.0018				0.0020
Spain	0.0000	0.0017				0.0018
Rep. of Korea	0.0003	0.0014				0.0017
Italy	0.0001	0.0014				0.0016
Malaysia	0.0002	0.0012				0.0014
France	0.0000	0.0007				0.0008
Total	0.0263	0.0374	0.0290	0.0133	0.0086	0.1146

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

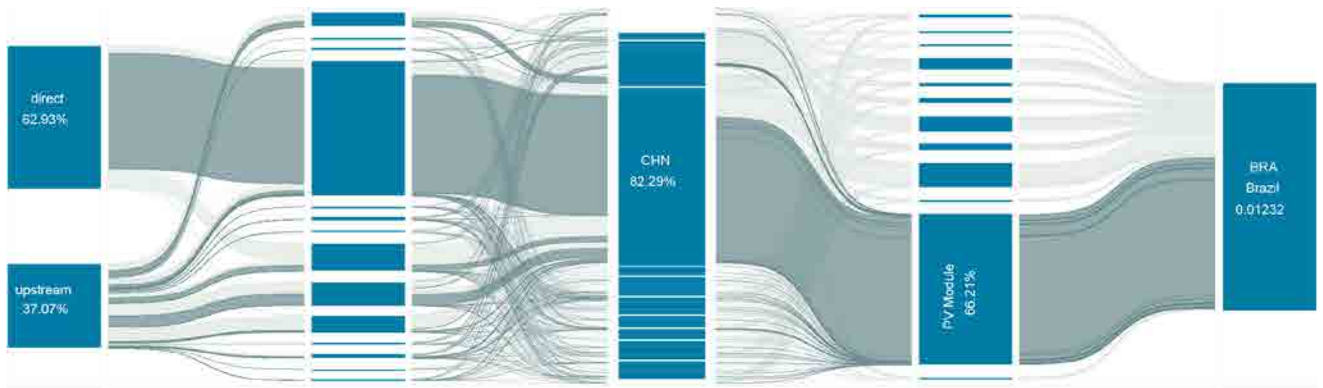
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00804	0.00180				0.00985
Brazil	0.00037	0.00065	0.00080	0.00025	0.00013	0.00220
Malaysia	0.00007	0.00003				0.00011
Argentina		0.00002				0.00002
Belgium		0.00002				0.00002
Rep. of Korea	0.00000	0.00002				0.00002
USA	0.00000	0.00001				0.00002
Germany	0.00000	0.00001				0.00002
Thailand	0.00001					0.00001
Hungary		0.00001				0.00001
Total	0.00851	0.00260	0.00080	0.00025	0.00013	0.01228

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Canada

Country profile: Canada

Country: Canada

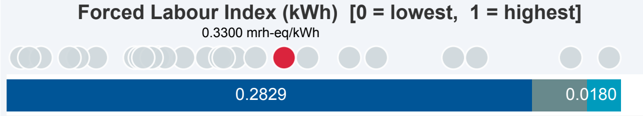
Levelized Cost of Energy (LCOE)

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

PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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

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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Canada	0.0160	0.0214	0.0372	0.0092	0.0287	0.1125
China	0.0129	0.0012				0.0141
USA	0.0062	0.0071				0.0133
Malaysia	0.0072	0.0000				0.0072
Thailand	0.0062	0.0000				0.0062
Rep. of Korea	0.0045	0.0003				0.0048
Japan	0.0035					0.0035
Viet Nam	0.0023	0.0000				0.0023
Netherlands	0.0012	0.0007				0.0020
Taiwan	0.0016	0.0000				0.0016
Total	0.0615	0.0308	0.0372	0.0092	0.0287	0.1673

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

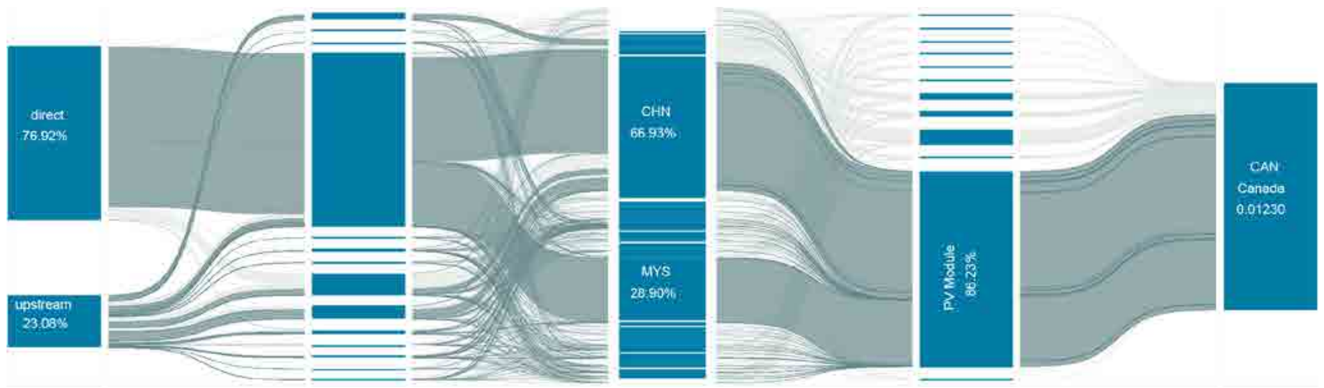
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00649	0.00068				0.00717
Malaysia	0.00358	0.00000				0.00358
Canada	0.00000	0.00017	0.00034	0.00003	0.00011	0.00065
Areas, nes	0.00031	0.00001				0.00032
Thailand	0.00020	0.00000				0.00020
USA	0.00005	0.00005				0.00010
Rep. of Korea	0.00005	0.00000				0.00005
Viet Nam	0.00005	0.00000				0.00005
Mexico	0.00001	0.00002				0.00003
China, Hong Kong	0.00003					0.00003
Total	0.01078	0.00094	0.00034	0.00003	0.00011	0.01219

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Chile

Country profile: Chile

Country: Chile

Levelized Cost of Energy (LCOE)

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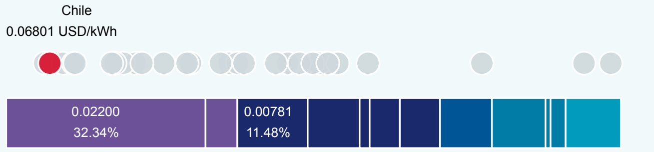
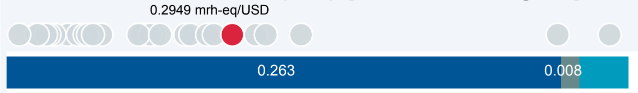
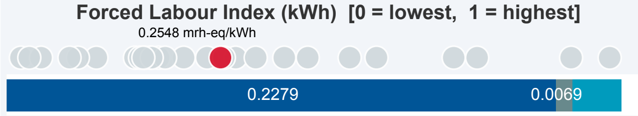


- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Chile	0.00917	0.01408	0.00589	0.00819	0.00598	0.04331
China	0.01472	0.00315				0.01787
Brazil	0.00004	0.00185				0.00189
Spain	0.00016	0.00072				0.00088
Germany	0.00026	0.00057				0.00083
USA	0.00047	0.00021				0.00068
Italy	0.00013	0.00033				0.00046
Mexico	0.00002	0.00037				0.00039
France	0.00003	0.00033				0.00036
Areas, nes	0.00009	0.00015				0.00024
Total	0.02509	0.02176	0.00589	0.00819	0.00598	0.06691

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00779	0.00176				0.00955
Chile	0.00017	0.00019	0.00010	0.00032	0.00010	0.00088
Areas, nes	0.00003	0.00008				0.00012
Malaysia	0.00008					0.00008
Brazil	0.00000	0.00008				0.00008
India	0.00000	0.00001				0.00002
Argentina	0.00000	0.00001				0.00002
Germany	0.00000	0.00000				0.00001
Mexico	0.00000	0.00001				0.00001
Spain	0.00000	0.00000				0.00001
Total	0.00808	0.00215	0.00010	0.00032	0.00010	0.01076

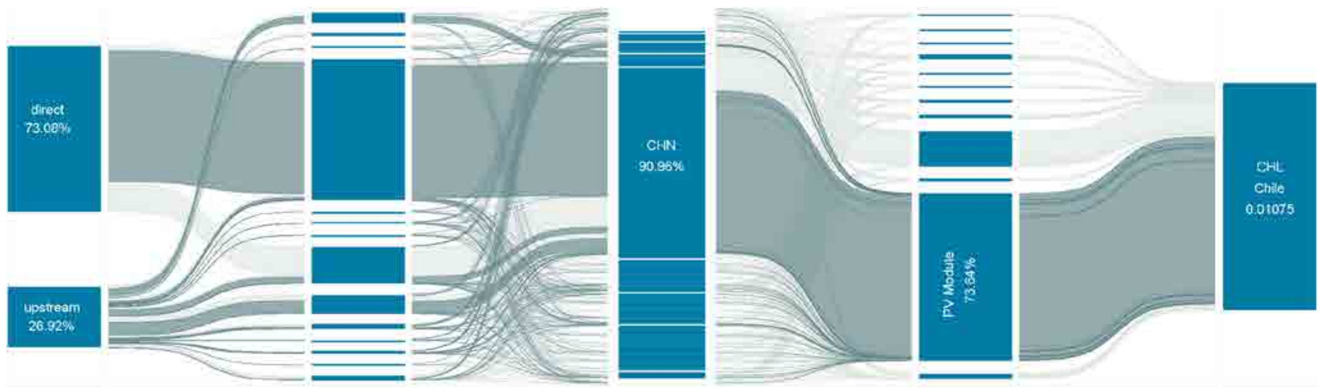
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

China

Country profile: China

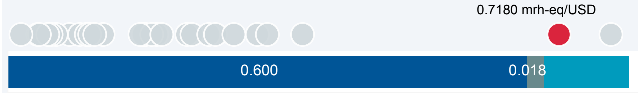
Country: China

Levelized Cost of Energy (LCOE)

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

- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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

- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.02764	0.01059	0.01253	0.00636	0.00981	0.06693
Japan	0.00134	0.00012				0.00146
Taiwan	0.00108	0.00009				0.00117
Malaysia	0.00081	0.00003				0.00084
Rep. of Korea	0.00059	0.00015				0.00074
Thailand	0.00033	0.00002				0.00035
Germany	0.00019	0.00008				0.00027
USA	0.00014	0.00005				0.00019
Viet Nam	0.00012	0.00001				0.00013
Switzerland	0.00003	0.00007				0.00010
Total	0.03227	0.01121	0.01253	0.00636	0.00981	0.07218

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.01386	0.00382	0.00406	0.00042	0.00078	0.02295
Malaysia	0.00040	0.00000				0.00040
Thailand	0.00001	0.00000				0.00001
Japan	0.00001	0.00000				0.00001
Taiwan	0.00001	0.00000				0.00001
Rep. of Korea	0.00001	0.00000				0.00001
Viet Nam	0.00000	0.00000				0.00000
Germany	0.00000	0.00000				0.00000
Philippines	0.00000					0.00000
India	0.00000	0.00000				0.00000
Total	0.01431	0.00382	0.00406	0.00042	0.00078	0.02340

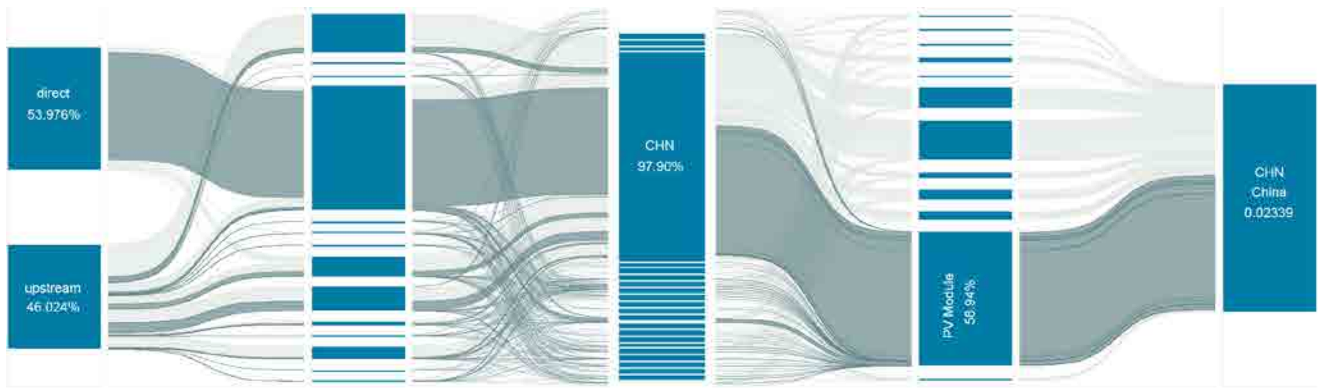
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Czechia

Country profile: Czechia

Country: Czechia

Levelized Cost of Energy (LCOE)

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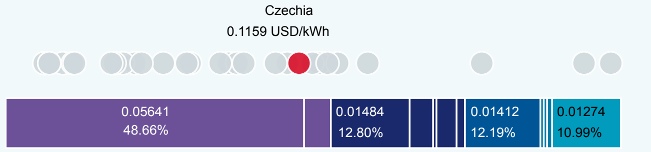
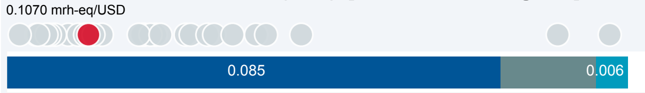


- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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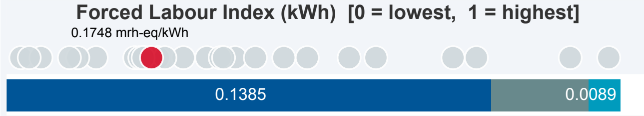


- Trafficking in persons (unit) (normalised)
- Frequency of forced labour (unit) (normalised)
- Goods produced by FL (unit) (normalised)

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Czechia	0.0131	0.0160	0.0141	0.0024	0.0127	0.0583
Taiwan	0.0116					0.0116
Germany	0.0088	0.0021				0.0109
Japan	0.0092	0.0000				0.0092
China	0.0062	0.0013				0.0075
Malaysia	0.0055	0.0000				0.0055
Italy	0.0008	0.0010				0.0018
Poland	0.0003	0.0014				0.0018
Austria	0.0004	0.0008				0.0012
Slovakia	0.0008	0.0004				0.0012
Total	0.0567	0.0230	0.0141	0.0024	0.0127	0.1090

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00285	0.00069				0.00354
Malaysia	0.00275	0.00000				0.00275
Czechia	0.00027	0.00016	0.00013	0.00001	0.00008	0.00065
Germany	0.00009	0.00001				0.00011
Taiwan	0.00008					0.00008
Japan	0.00005	0.00000				0.00005
Slovakia	0.00003	0.00001				0.00004
Poland	0.00001	0.00002				0.00002
Thailand	0.00002					0.00002
Italy	0.00001	0.00001				0.00001
Total	0.00616	0.00089	0.00013	0.00001	0.00008	0.00728

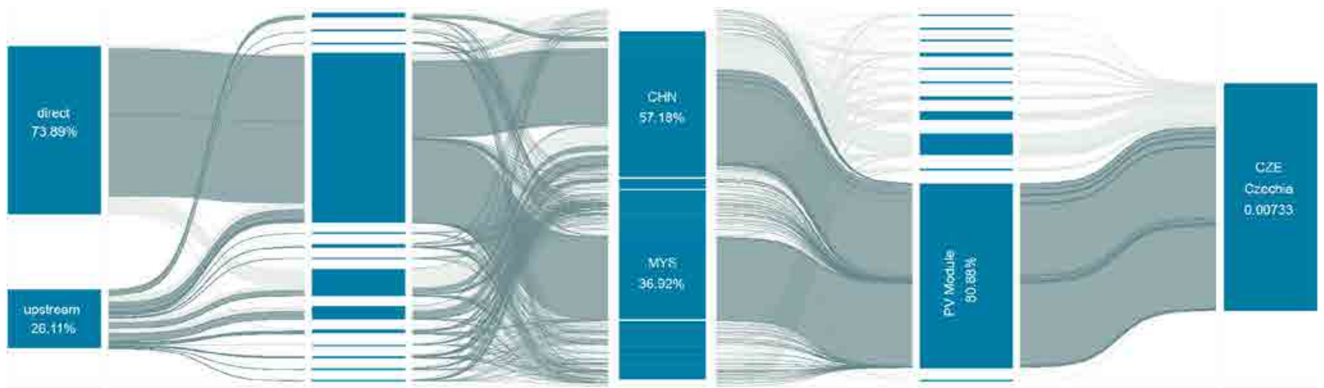
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

France

Country profile: France

Country: France

Levelized Cost of Energy (LCOE)

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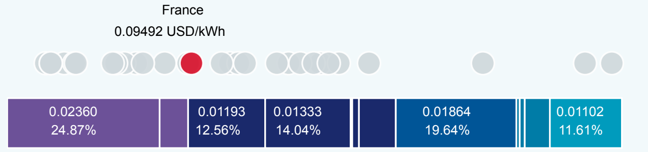
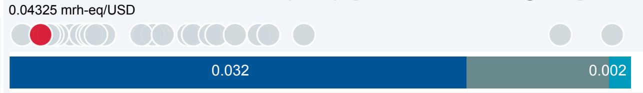
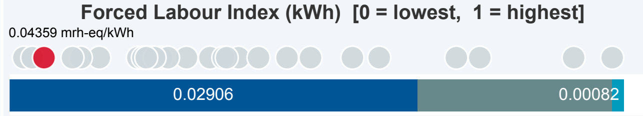


- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
France	0.00619	0.01995	0.01864	0.00509	0.01102	0.06089
Germany	0.00359	0.00341				0.00700
Philippines	0.00359					0.00359
China	0.00248	0.00106				0.00354
USA	0.00255	0.00007				0.00262
Spain	0.00020	0.00223				0.00243
Italy	0.00034	0.00178				0.00212
Malaysia	0.00177					0.00177
Japan	0.00124	0.00000				0.00124
Czechia	0.00051	0.00033				0.00084
Total	0.02246	0.02883	0.01864	0.00509	0.01102	0.08604

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00106	0.00062				0.00168
Malaysia	0.00088					0.00088
France	0.00005	0.00014	0.00014	0.00002	0.00010	0.00044
Philippines	0.00012					0.00012
Areas, nes	0.00008	0.00001				0.00009
Germany	0.00004	0.00002				0.00006
USA	0.00002	0.00000				0.00002
Thailand	0.00002					0.00002
Spain	0.00000	0.00001				0.00002
India	0.00001					0.00001
Total	0.00228	0.00080	0.00014	0.00002	0.00010	0.00334

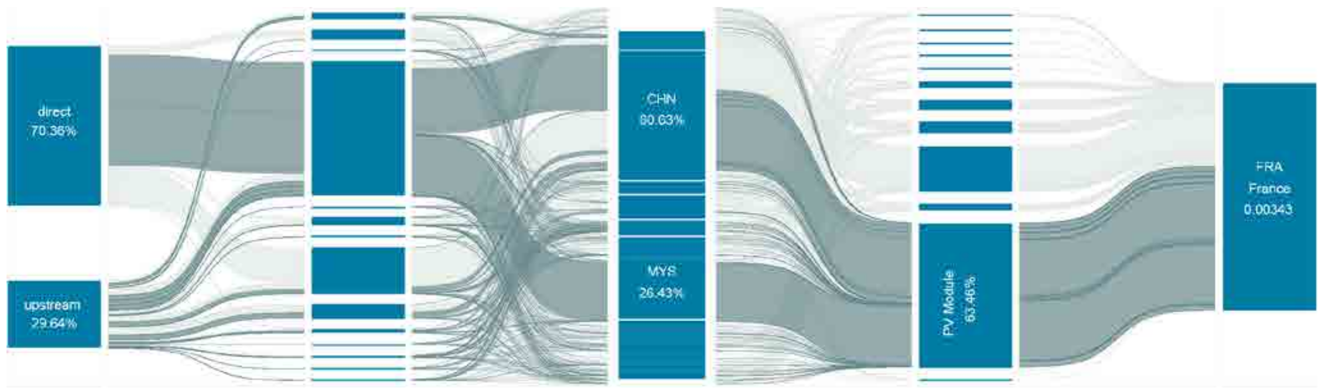
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Germany

Country profile: Germany

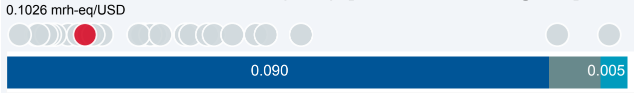
Country: Germany

Levelized Cost of Energy (LCOE)

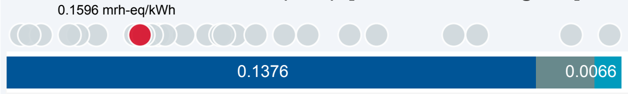
LCOE is a measure of the average net present cost of electricity generation over its lifetime.

PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Germany	0.0135	0.0188	0.0190	0.0052	0.0172	0.0736
China	0.0063	0.0007				0.0070
Malaysia	0.0060	0.0001				0.0060
Taiwan	0.0027					0.0027
Rep. of Korea	0.0024	0.0000				0.0024
Viet Nam	0.0022					0.0022
Austria	0.0003	0.0015				0.0018
Italy	0.0001	0.0016				0.0017
Thailand	0.0016	0.0000				0.0016
Japan	0.0015	0.0000				0.0015
Total	0.0366	0.0226	0.0190	0.0052	0.0172	0.1005

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

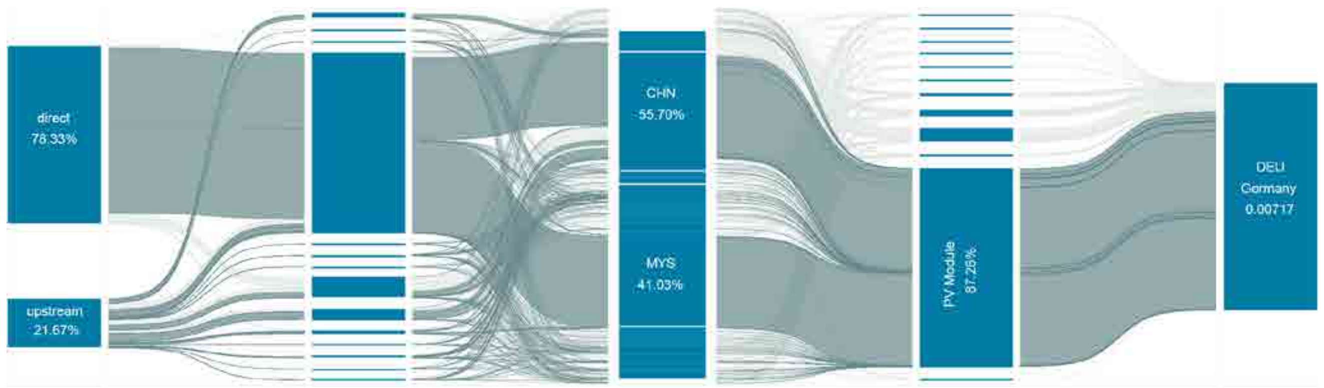
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00310	0.00037				0.00348
Malaysia	0.00298	0.00000				0.00299
Germany	0.00014	0.00006	0.00014	0.00001	0.00007	0.00042
Thailand	0.00005	0.00000				0.00005
Viet Nam	0.00005					0.00005
Rep. of Korea	0.00003	0.00000				0.00003
Taiwan	0.00002					0.00002
Philippines	0.00002					0.00002
Netherlands	0.00001	0.00000				0.00002
Singapore	0.00001					0.00001
Total	0.00642	0.00044	0.00014	0.00001	0.00007	0.00708

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Greece

Country profile: Greece

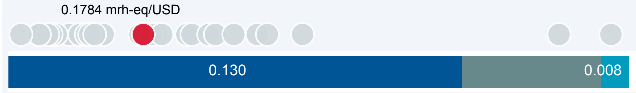
Country: Greece

Levelized Cost of Energy (LCOE)

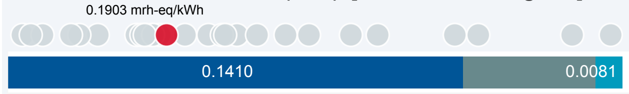
LCOE is a measure of the average net present cost of electricity generation over its lifetime.

PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Greece	0.00676	0.01305	0.01511	0.00376	0.00981	0.04849
Germany	0.00678	0.00128				0.00806
China	0.00674	0.00115				0.00789
Malaysia	0.00536	0.00000				0.00536
Italy	0.00062	0.00229				0.00291
Turkey	0.00023	0.00156				0.00179
France	0.00131	0.00023				0.00154
Austria	0.00136	0.00016				0.00152
Netherlands	0.00120	0.00020				0.00140
Switzerland	0.00012	0.00072				0.00084
Total	0.03048	0.02064	0.01511	0.00376	0.00981	0.07980

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

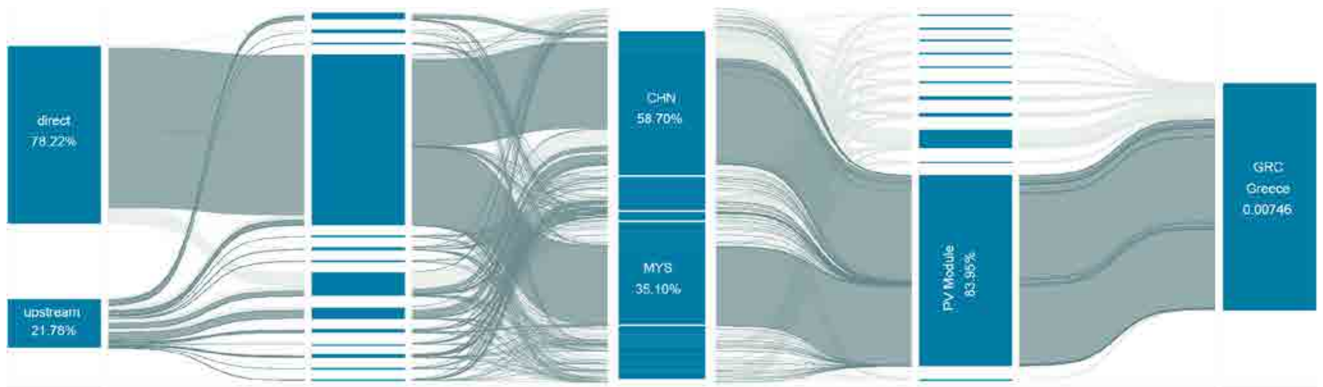
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00344	0.00061				0.00405
Malaysia	0.00267	0.00000				0.00267
Greece	0.00006	0.00012	0.00015	0.00004	0.00006	0.00042
India	0.00007	0.00001				0.00008
Germany	0.00007	0.00001				0.00008
Turkey	0.00001	0.00003				0.00004
Romania	0.00000	0.00001				0.00002
Italy	0.00000	0.00001				0.00002
Austria	0.00001	0.00000				0.00002
Netherlands	0.00001	0.00000				0.00001
Total	0.00636	0.00080	0.00015	0.00004	0.00006	0.00741

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

India

Country profile: India

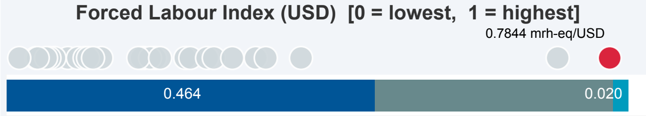
Country: India

Levelized Cost of Energy (LCOE)

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

- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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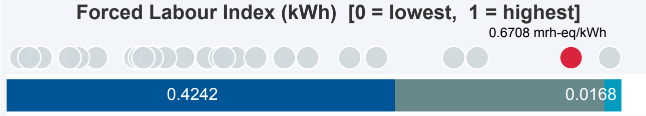


- Trafficking in persons (unit) (normalised)
- Frequency of forced labour (unit) (normalised)
- Goods produced by FL (unit) (normalised)

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
India	0.01408	0.00789	0.00632	0.00892	0.00471	0.04192
China	0.01140	0.00304				0.01444
Rep. of Korea	0.00019	0.00221				0.00240
Malaysia	0.00020	0.00092				0.00112
Italy	0.00006	0.00099				0.00105
Singapore	0.00077	0.00004				0.00081
Thailand	0.00029	0.00048				0.00077
Taiwan	0.00054	0.00019				0.00073
China, Hong Kong	0.00051	0.00018				0.00069
Germany	0.00031	0.00036				0.00067
Total	0.02835	0.01630	0.00632	0.00892	0.00471	0.06460

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
India	0.00146	0.00589	0.00912	0.00195	0.00145	0.01986
China	0.00577	0.00139				0.00717
Malaysia	0.00010	0.00002				0.00012
China, Hong Kong	0.00003	0.00001				0.00004
Rep. of Korea	0.00000	0.00003				0.00003
Thailand	0.00001	0.00001				0.00002
Singapore	0.00002	0.00000				0.00002
United Arab Emirates	0.00000	0.00001				0.00001
Japan	0.00000	0.00001				0.00001
Italy	0.00000	0.00001				0.00001
Total	0.00740	0.00739	0.00912	0.00195	0.00145	0.02730

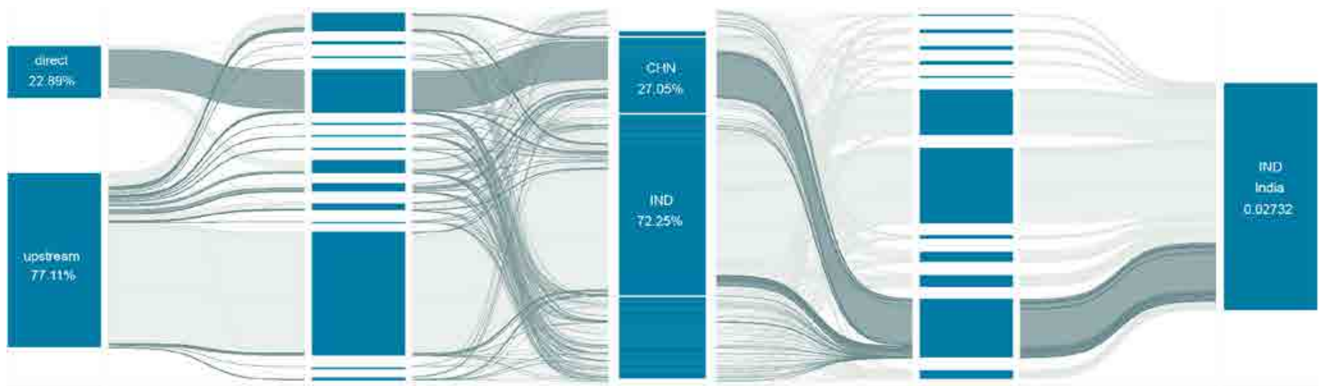
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Israel

Country profile: Israel

Country: Israel

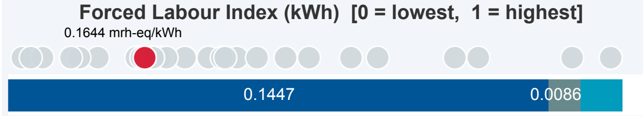
Levelized Cost of Energy (LCOE)

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

- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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

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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Israel	0.00757	0.00861	0.00747	0.00779	0.00760	0.03904
China	0.01037	0.00078				0.01115
USA	0.00316	0.00077				0.00393
Malaysia	0.00238					0.00238
Rep. of Korea	0.00001	0.00184				0.00185
China, Hong Kong	0.00162	0.00001				0.00163
Germany	0.00108	0.00048				0.00156
Turkey	0.00001	0.00148				0.00149
Spain	0.00001	0.00121				0.00122
Italy	0.00021	0.00063				0.00084
Total	0.02642	0.01581	0.00747	0.00779	0.00760	0.06509

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00529	0.00040				0.00568
Malaysia	0.00119					0.00119
Israel	0.00009	0.00008	0.00007	0.00010	0.00013	0.00047
China, Hong Kong	0.00010	0.00000				0.00010
Turkey	0.00000	0.00003				0.00003
USA	0.00002	0.00001				0.00003
Rep. of Korea	0.00000	0.00002				0.00002
Germany	0.00001	0.00000				0.00001
Thailand	0.00001					0.00001
India	0.00001	0.00000				0.00001
Total	0.00671	0.00054	0.00007	0.00010	0.00013	0.00756

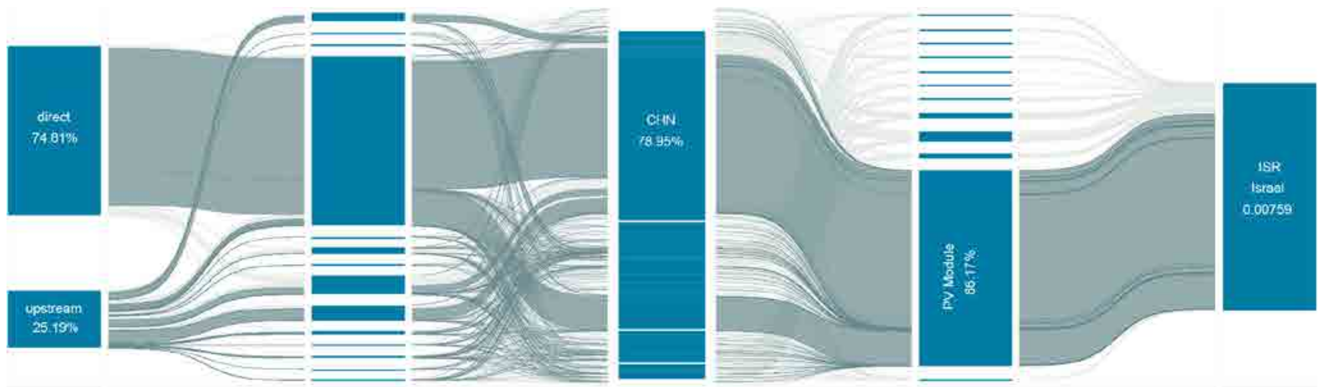
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Risk variation: change in risk of **Frequency of Forced Labour**

Italy

Country profile: Italy

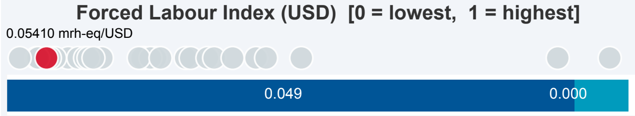
Country: Italy

Levelized Cost of Energy (LCOE)

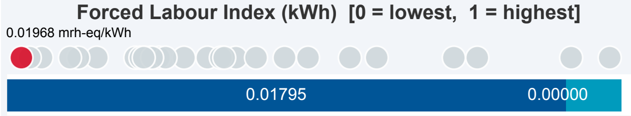
LCOE is a measure of the average net present cost of electricity generation over its lifetime.

PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Italy	0.00910	0.00717	0.01364	0.00420	0.00840	0.04251
Germany	0.00593	0.00130				0.00723
China	0.00394	0.00104				0.00498
Netherlands	0.00302	0.00004				0.00306
France	0.00094	0.00045				0.00139
Austria	0.00055	0.00044				0.00099
Taiwan	0.00076					0.00076
Spain	0.00007	0.00059				0.00066
United Kingdom	0.00040	0.00006				0.00046
Japan	0.00041	0.00001				0.00042
Total	0.02512	0.01110	0.01364	0.00420	0.00840	0.06246

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

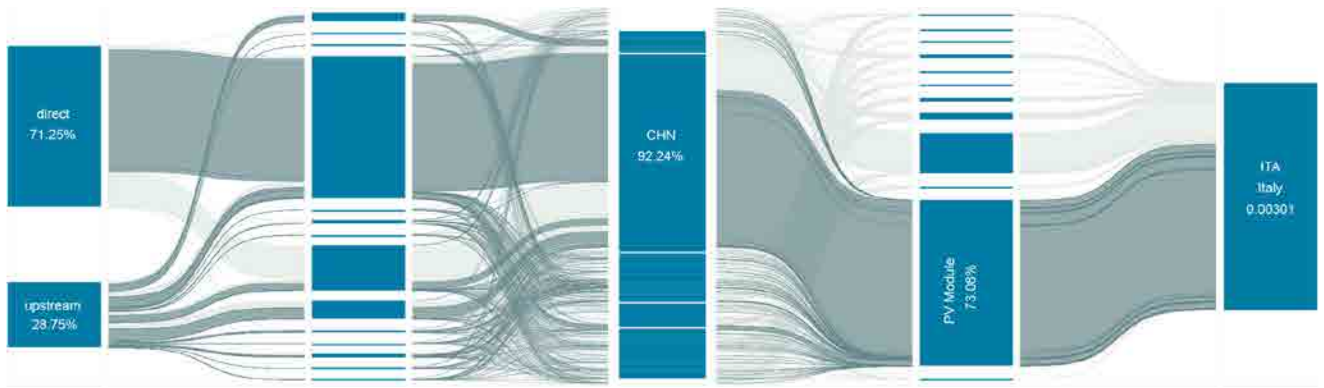
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00201	0.00058				0.00259
Italy	0.00006	0.00003	0.00004	0.00001	0.00002	0.00017
Germany	0.00006	0.00001				0.00007
Malaysia	0.00006	0.00000				0.00006
Netherlands	0.00003	0.00000				0.00003
France	0.00001	0.00000				0.00001
Austria	0.00001	0.00000				0.00001
India	0.00001	0.00000				0.00001
Czechia	0.00000	0.00000				0.00001
Taiwan	0.00001					0.00001
Total	0.00226	0.00063	0.00004	0.00001	0.00002	0.00296

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

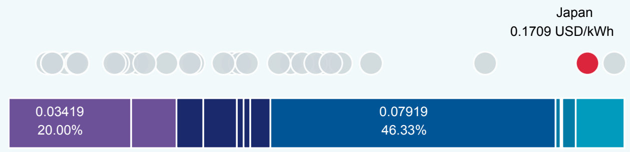
Japan

Country profile: Japan

Country: Japan

Levelized Cost of Energy (LCOE)

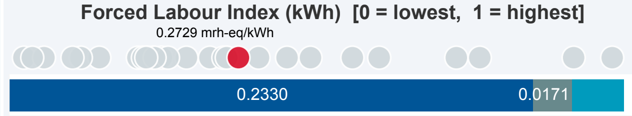
LCOE is a measure of the average net present cost of electricity generation over its lifetime.



PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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

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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Japan	0.0234	0.0179	0.0792	0.0057	0.0134	0.1396
China	0.0133	0.0043				0.0176
Malaysia	0.0024	0.0006				0.0030
Rep. of Korea	0.0016	0.0007				0.0024
Philippines	0.0016	0.0001				0.0017
Taiwan	0.0012	0.0005				0.0016
Thailand	0.0008	0.0007				0.0015
Viet Nam	0.0003	0.0007				0.0009
USA	0.0007	0.0001				0.0008
Germany	0.0004	0.0002				0.0006
Total	0.0456	0.0258	0.0792	0.0057	0.0134	0.1697

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

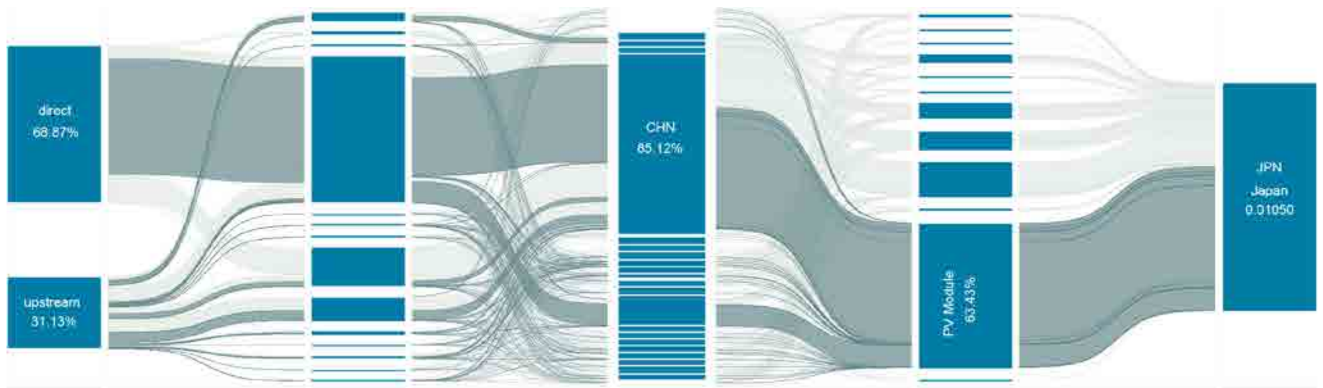
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00599	0.00200				0.00799
Malaysia	0.00120	0.00001				0.00122
Japan	0.00019	0.00017	0.00068	0.00002	0.00008	0.00114
Philippines	0.00004	0.00000				0.00005
Thailand	0.00003	0.00002				0.00004
Viet Nam	0.00001	0.00003				0.00003
Rep. of Korea	0.00002	0.00001				0.00003
Taiwan	0.00001	0.00000				0.00001
USA	0.00001	0.00000				0.00001
Indonesia	0.00000	0.00000				0.00001
Total	0.00749	0.00224	0.00068	0.00002	0.00008	0.01051

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Jordan

Country profile: Jordan

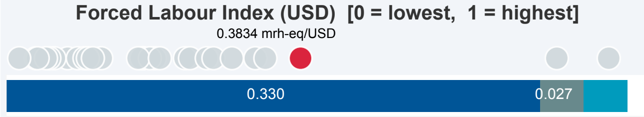
Country: Jordan

Levelized Cost of Energy (LCOE)

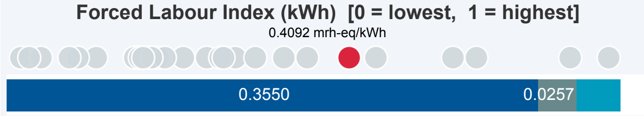
LCOE is a measure of the average net present cost of electricity generation over its lifetime.

- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Jordan	0.00790	0.00895	0.00742	0.01047	0.00552	0.04026
China	0.02057	0.00248				0.02305
Malaysia	0.00270	0.00002				0.00272
Germany	0.00082	0.00158				0.00240
Turkey	0.00012	0.00198				0.00210
Egypt		0.00205				0.00205
Italy	0.00043	0.00102				0.00145
United Arab Emirates		0.00143				0.00143
Estonia	0.00072					0.00072
Spain	0.00026	0.00041				0.00067
Total	0.03352	0.01992	0.00742	0.01047	0.00552	0.07685

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.01092	0.00144				0.01236
Malaysia	0.00135	0.00000				0.00135
Jordan	0.00019	0.00024	0.00021	0.00017	0.00011	0.00092
Turkey	0.00000	0.00005				0.00005
United Arab Emirates		0.00004				0.00004
Estonia	0.00002					0.00002
Egypt		0.00002				0.00002
India	0.00000	0.00002				0.00002
Germany	0.00001	0.00001				0.00002
Italy	0.00000	0.00001				0.00001
Total	0.01250	0.00182	0.00021	0.00017	0.00011	0.01481

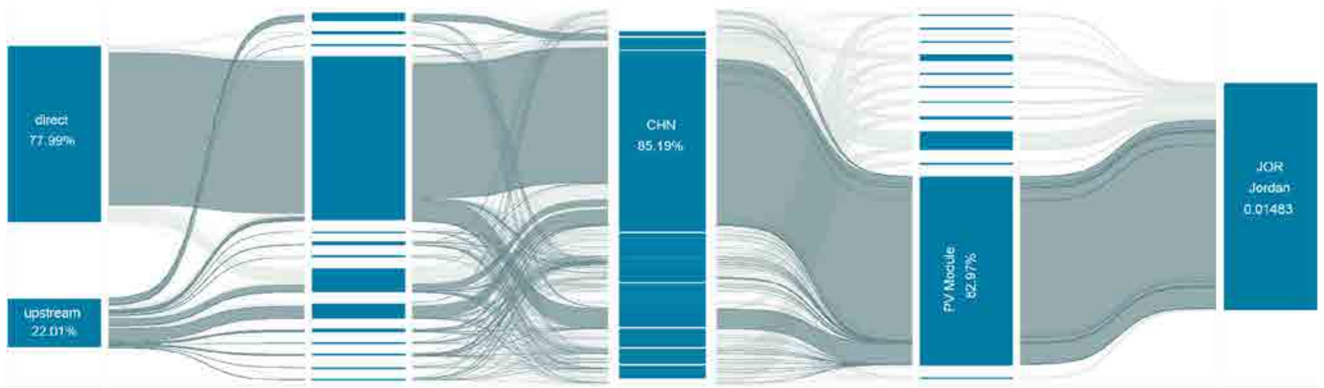
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

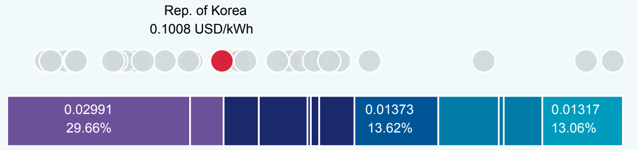
Korea

Country profile: Rep. of Korea

Country: Rep. of Korea

Levelized Cost of Energy (LCOE)

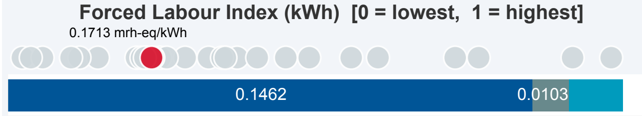
LCOE is a measure of the average net present cost of electricity generation over its lifetime.



- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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

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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Rep. of Korea	0.00900	0.01243	0.01373	0.01697	0.01317	0.06530
China	0.01021	0.00260				0.01281
Japan	0.00869	0.00152				0.01021
Taiwan	0.00308	0.00001				0.00309
Malaysia	0.00111	0.00170				0.00281
Viet Nam	0.00120	0.00050				0.00170
USA	0.00049	0.00084				0.00133
Germany	0.00048	0.00035				0.00083
Hungary	0.00004	0.00041				0.00045
Switzerland	0.00008	0.00027				0.00035
Total	0.03438	0.02063	0.01373	0.01697	0.01317	0.09888

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00493	0.00105				0.00598
Rep. of Korea	0.00011	0.00030	0.00010	0.00012	0.00006	0.00069
Malaysia	0.00055	0.00004				0.00060
Japan	0.00005	0.00003				0.00008
Viet Nam	0.00003	0.00002				0.00004
Taiwan	0.00002	0.00000				0.00002
China, Hong Kong	0.00001					0.00001
Thailand	0.00001	0.00000				0.00001
USA	0.00000	0.00001				0.00001
Germany	0.00001	0.00000				0.00001
Total	0.00572	0.00145	0.00010	0.00012	0.00006	0.00745

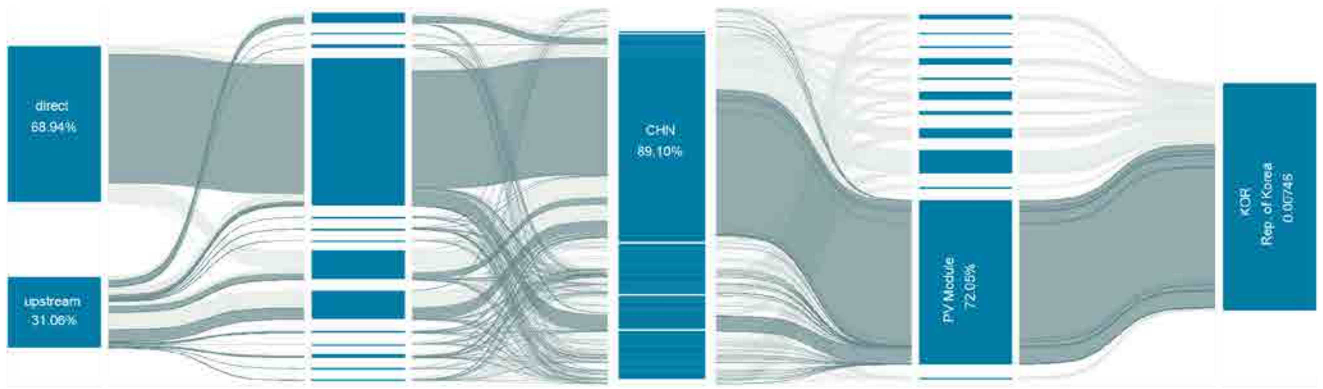
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Mexico

Country profile: Mexico

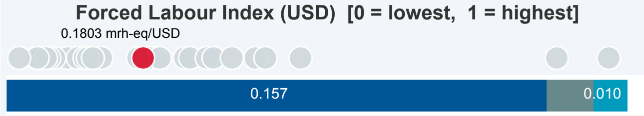
Country: Mexico

Levelized Cost of Energy (LCOE)

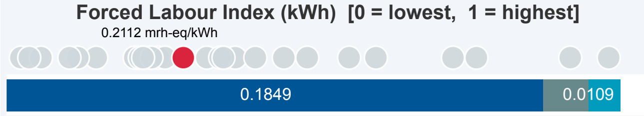
LCOE is a measure of the average net present cost of electricity generation over its lifetime.

PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Mexico	0.00531	0.01170	0.01072	0.00473	0.01664	0.04910
USA	0.00207	0.00870				0.01077
China	0.00823	0.00231				0.01054
Malaysia	0.00598	0.00005				0.00603
Japan	0.00380	0.00010				0.00390
Philippines	0.00353					0.00353
Rep. of Korea	0.00078	0.00037				0.00115
Thailand	0.00079					0.00079
Germany	0.00050	0.00028				0.00078
Spain	0.00012	0.00056				0.00068
Total	0.03111	0.02407	0.01072	0.00473	0.01664	0.08727

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

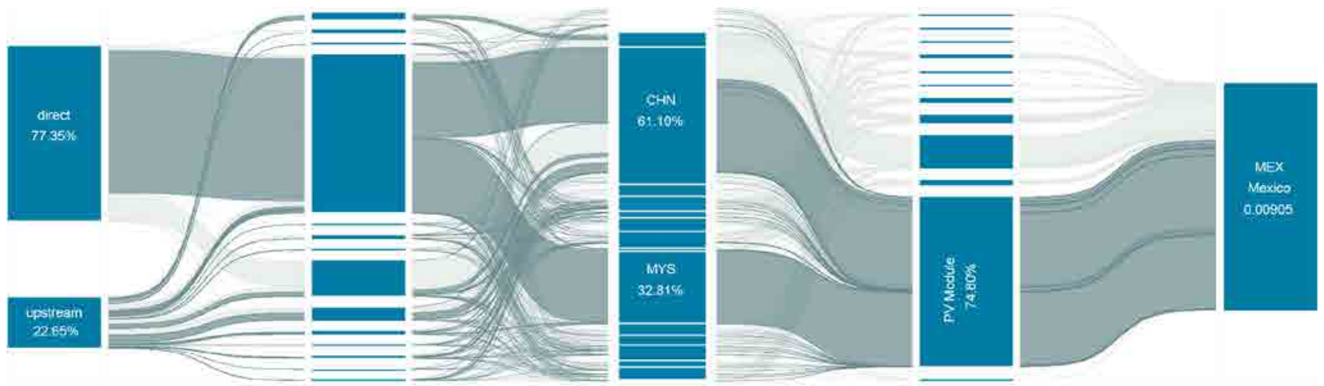
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00381	0.00137				0.00518
Malaysia	0.00298	0.00000				0.00298
Mexico	0.00009	0.00017	0.00015	0.00004	0.00015	0.00060
Philippines	0.00012					0.00012
USA	0.00002	0.00006				0.00008
India	0.00000	0.00003				0.00003
Thailand	0.00003					0.00003
Japan	0.00002	0.00000				0.00002
Rep. of Korea	0.00001	0.00001				0.00001
Germany	0.00001	0.00000				0.00001
Total	0.00709	0.00164	0.00015	0.00004	0.00015	0.00906

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

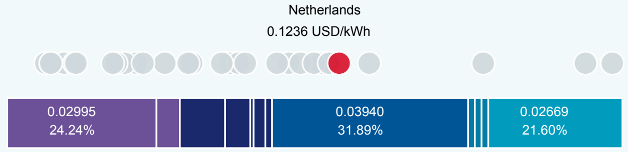
Netherlands

Country profile: Netherlands

Country: Netherlands

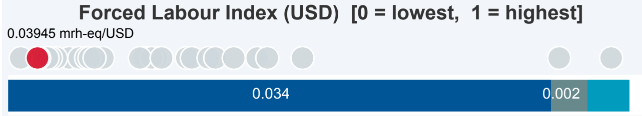
Levelized Cost of Energy (LCOE)

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

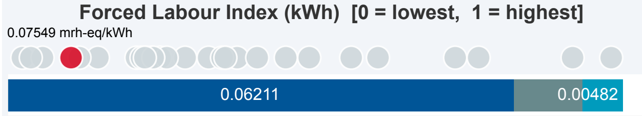


PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Netherlands	0.0116	0.0098	0.0394	0.0041	0.0267	0.0915
Germany	0.0048	0.0028				0.0075
China	0.0043	0.0009				0.0052
Rep. of Korea	0.0044	0.0000				0.0044
Malaysia	0.0022	0.0000				0.0022
Belgium	0.0002	0.0016				0.0019
Japan	0.0015					0.0015
Viet Nam	0.0012	0.0002				0.0014
Thailand	0.0013	0.0001				0.0013
USA	0.0005	0.0004				0.0009
Total	0.0319	0.0157	0.0394	0.0041	0.0267	0.1178

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

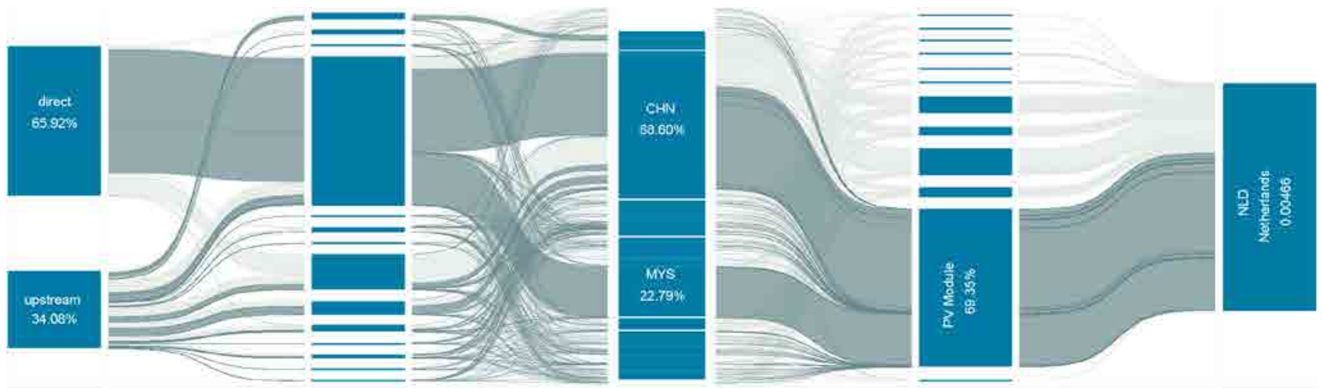
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00201	0.00051				0.00252
Malaysia	0.00107	0.00000				0.00107
Netherlands	0.00013	0.00009	0.00037	0.00003	0.00019	0.00081
Germany	0.00005	0.00002				0.00007
Rep. of Korea	0.00005	0.00000				0.00005
Thailand	0.00004	0.00000				0.00004
Viet Nam	0.00003	0.00000				0.00003
Belgium	0.00000	0.00001				0.00002
China, Hong Kong	0.00001	0.00000				0.00001
Poland	0.00001	0.00001				0.00001
Total	0.00339	0.00064	0.00037	0.00003	0.00019	0.00463

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Romania

Country profile: Romania

Country: Romania

Levelized Cost of Energy (LCOE)

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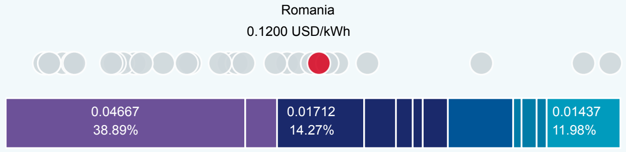
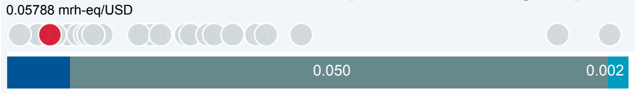
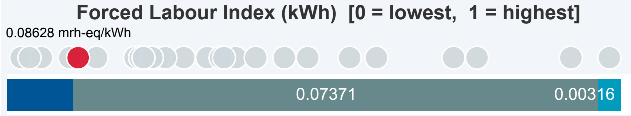


PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Romania	0.0019	0.0146	0.0127	0.0063	0.0144	0.0499
Germany	0.0314	0.0030				0.0344
Italy	0.0015	0.0034				0.0048
China	0.0023	0.0016				0.0039
Japan	0.0031					0.0031
Netherlands	0.0024	0.0005				0.0028
United Kingdom	0.0020	0.0005				0.0026
Poland	0.0003	0.0017				0.0020
France	0.0017	0.0002				0.0019
Turkey	0.0002	0.0015				0.0017
Total	0.0467	0.0269	0.0127	0.0063	0.0144	0.1070

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

Select indicator and unit

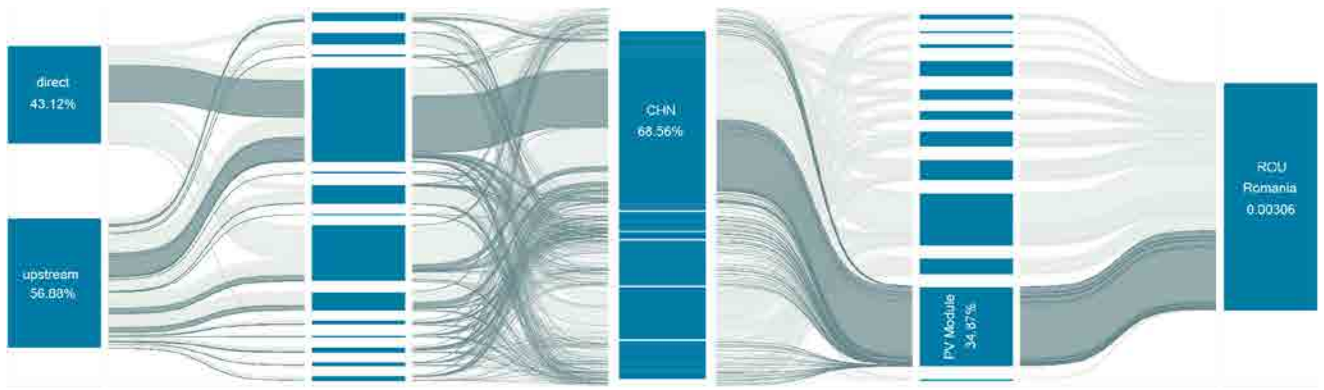
Forced labour Indicator Goods produced by FL | **Risk variation** Very low risk | **unit** mrh-eq/kWh

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00077	0.00074				0.00151
Romania	0.00004	0.00032	0.00021	0.00008	0.00022	0.00087
Germany	0.00034	0.00002				0.00035
Turkey	0.00000	0.00003				0.00004
Sweden	0.00003	0.00000				0.00003
United Kingdom	0.00003	0.00000				0.00003
Netherlands	0.00003	0.00000				0.00003
Poland	0.00001	0.00002				0.00003
Italy	0.00001	0.00002				0.00003
Hungary	0.00001	0.00001				0.00002
Total	0.00126	0.00117	0.00021	0.00008	0.00022	0.00293

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

Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

South Africa

Country profile: South Africa

Country: South Africa

Levelized Cost of Energy (LCOE)

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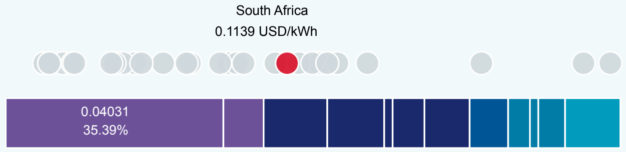
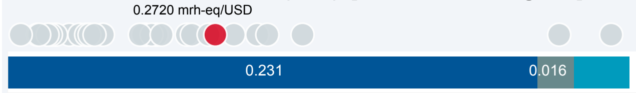
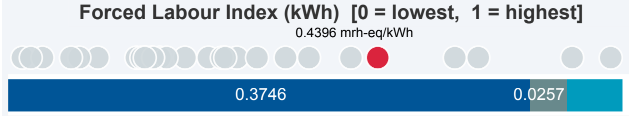


PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
South Africa	0.0159	0.0199	0.0073	0.0103	0.0103	0.0637
China	0.0235	0.0049				0.0284
Greece		0.0032				0.0032
Italy	0.0007	0.0024				0.0031
China, Hong Kong	0.0022					0.0022
Germany	0.0009	0.0011				0.0021
France	0.0004	0.0009				0.0013
USA	0.0006	0.0007				0.0013
India	0.0009	0.0002				0.0011
Lesotho		0.0009				0.0009
Total	0.0452	0.0341	0.0073	0.0103	0.0103	0.1072

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

Select indicator and unit

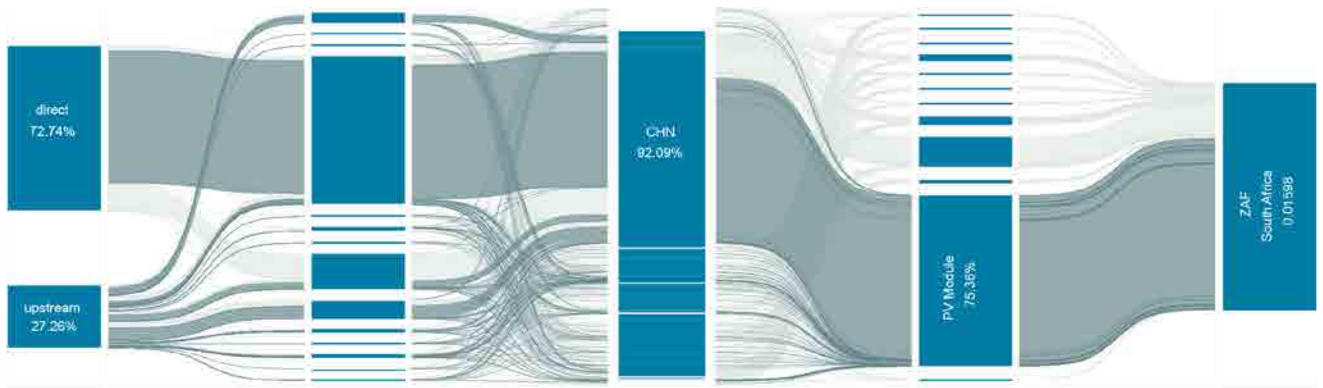
Forced labour Indicator Goods produced by FL | **Risk variation** Very low risk | **unit** mrh-eq/kWh

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.01188	0.00253				0.01441
South Africa	0.00025	0.00029	0.00012	0.00016	0.00018	0.00100
Malaysia	0.00017	0.00000				0.00017
China, Hong Kong	0.00013					0.00013
India	0.00009	0.00002				0.00011
Greece		0.00002				0.00002
Germany	0.00001	0.00001				0.00002
Italy	0.00000	0.00001				0.00002
Mauritius		0.00002				0.00002
Thailand	0.00000	0.00001				0.00001
Total	0.01253	0.00291	0.00012	0.00016	0.00018	0.01591

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

Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Spain

Country profile: Spain

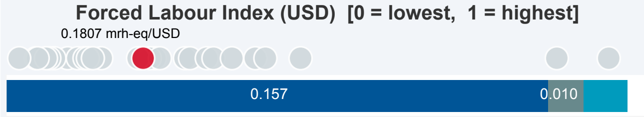
Country: Spain

Levelized Cost of Energy (LCOE)

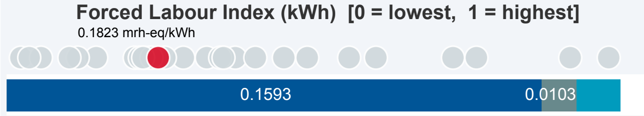
LCOE is a measure of the average net present cost of electricity generation over its lifetime.

- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Spain	0.00947	0.01216	0.01532	0.00424	0.00679	0.04798
China	0.00895	0.00354				0.01249
Germany	0.00330	0.00204				0.00534
Viet Nam	0.00210	0.00003				0.00213
Malaysia	0.00200					0.00200
Italy	0.00026	0.00172				0.00198
Thailand	0.00113	0.00002				0.00115
France	0.00048	0.00057				0.00105
Netherlands	0.00080	0.00016				0.00096
Slovakia	0.00005	0.00077				0.00082
Total	0.02854	0.02101	0.01532	0.00424	0.00679	0.07590

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

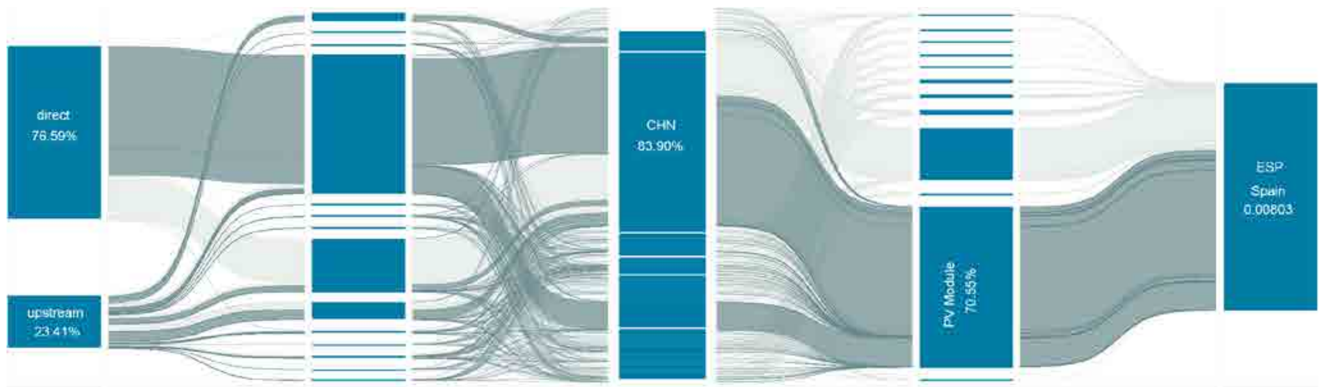
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00460	0.00190				0.00650
Malaysia	0.00100					0.00100
Spain	0.00008	0.00008	0.00011	0.00001	0.00003	0.00032
Germany	0.00004	0.00001				0.00005
Viet Nam	0.00004	0.00000				0.00005
Thailand	0.00004	0.00000				0.00004
Turkey		0.00001				0.00001
Slovakia	0.00000	0.00001				0.00001
Netherlands	0.00001	0.00000				0.00001
China, Hong Kong	0.00000	0.00001				0.00001
Total	0.00581	0.00203	0.00011	0.00001	0.00003	0.00799

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

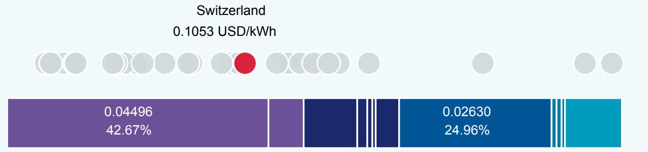
Switzerland

Country profile: Switzerland

Country: Switzerland

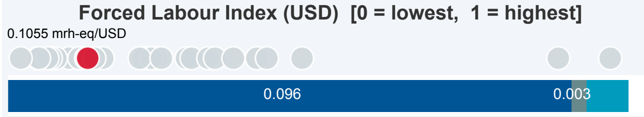
Levelized Cost of Energy (LCOE)

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

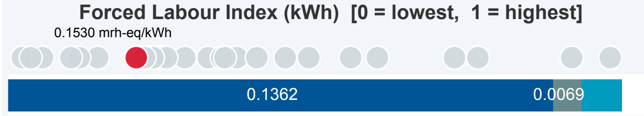


- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Switzerland	0.00856	0.00475	0.02630	0.00209	0.00980	0.05150
Germany	0.01013	0.00465				0.01478
China	0.00991	0.00044				0.01035
France	0.00263	0.00077				0.00340
Austria	0.00173	0.00153				0.00326
Netherlands	0.00290	0.00018				0.00308
Italy	0.00118	0.00171				0.00289
Japan	0.00272					0.00272
Malaysia	0.00242					0.00242
Taiwan	0.00195					0.00195
Total	0.04413	0.01403	0.02630	0.00209	0.00980	0.09635

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

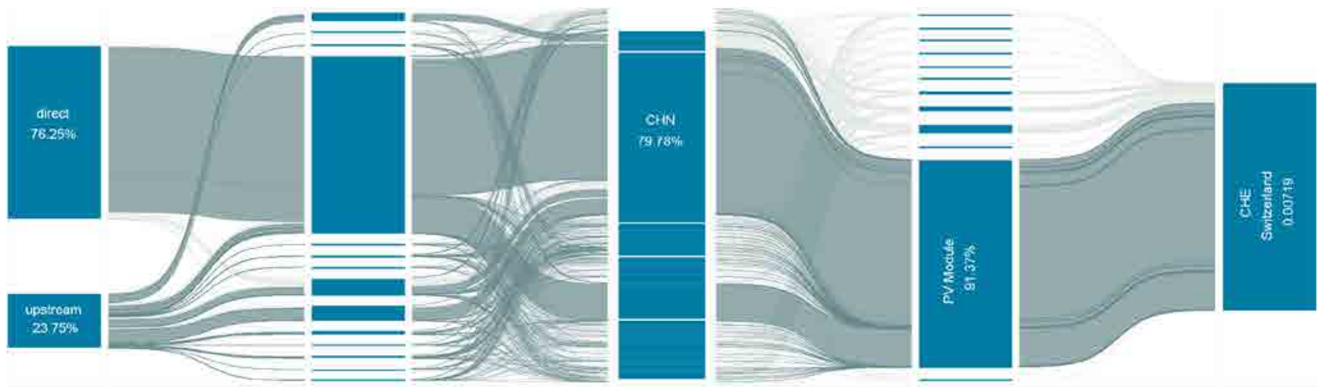
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00517	0.00024				0.00540
Malaysia	0.00121					0.00121
Switzerland	0.00004	0.00002	0.00010	0.00001	0.00003	0.00020
Germany	0.00011	0.00003				0.00013
Netherlands	0.00003	0.00000				0.00003
Austria	0.00002	0.00001				0.00003
France	0.00002	0.00000				0.00002
China, Hong Kong	0.00002	0.00000				0.00002
Philippines	0.00002					0.00002
Japan	0.00002					0.00002
Total	0.00665	0.00030	0.00010	0.00001	0.00003	0.00709

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Taiwan

Country profile: Taiwan

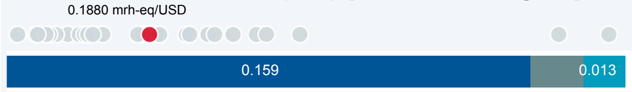
Country: Taiwan

Levelized Cost of Energy (LCOE)

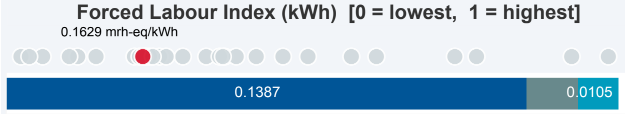
LCOE is a measure of the average net present cost of electricity generation over its lifetime.

- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Taiwan	0.00920	0.00821	0.01253	0.00636	0.00981	0.04611
China	0.01040	0.00037				0.01077
Japan	0.00415	0.00036				0.00451
Malaysia	0.00294	0.00075				0.00369
Germany	0.00187	0.00021				0.00208
USA	0.00081	0.00019				0.00100
Rep. of Korea	0.00071	0.00023				0.00094
Indonesia	0.00080	0.00010				0.00090
Thailand	0.00053	0.00026				0.00079
Viet Nam	0.00017	0.00029				0.00046
Grand Total	0.03158	0.01097	0.01253	0.00636	0.00981	0.07125

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00505	0.00022				0.00527
Malaysia	0.00146	0.00002				0.00148
Taiwan	0.00007	0.00005	0.00008	0.00004	0.00006	0.00030
Japan	0.00003	0.00001				0.00003
Thailand	0.00002	0.00001				0.00002
Germany	0.00002	0.00000				0.00002
Viet Nam	0.00000	0.00001				0.00002
Areas, nes	0.00000	0.00001				0.00001
Philippines	0.00001	0.00000				0.00001
Rep. of Korea	0.00001	0.00000				0.00001
Grand Total	0.00667	0.00033	0.00008	0.00004	0.00006	0.00718

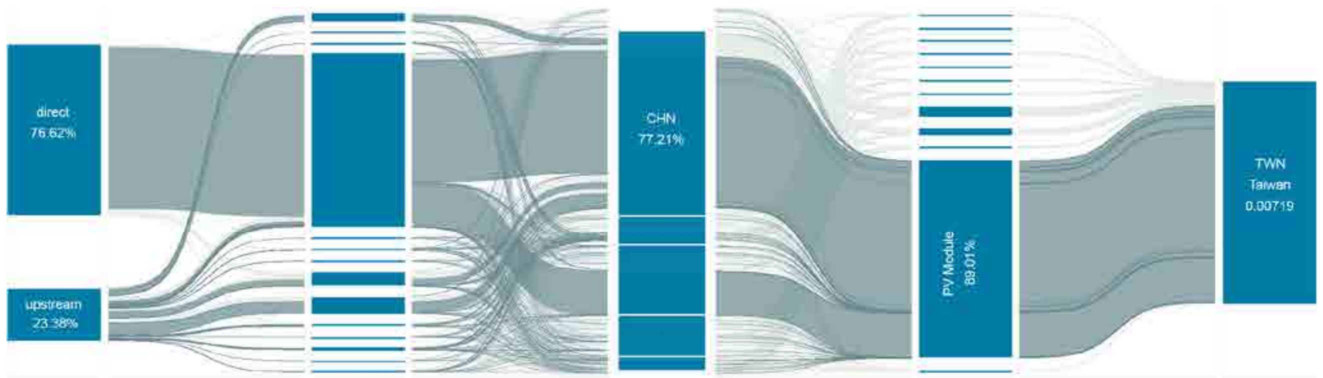
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Forced labour index (FLI): based on the integration and normalization (min-max method) of the three indicators (FFL:30%, GFL:60%, TP:10%).
Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

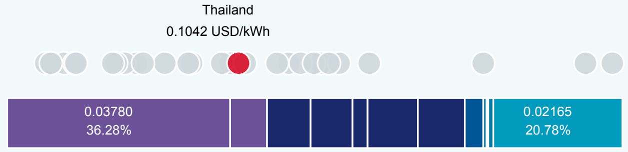
Thailand

Country profile: Thailand

Country: Thailand

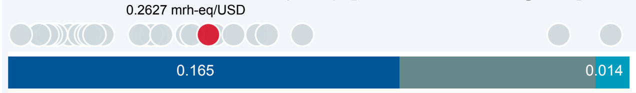
Levelized Cost of Energy (LCOE)

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

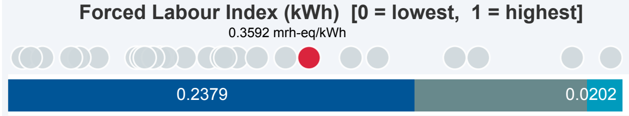


- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Thailand	0.0088	0.0158	0.0030	0.0019	0.0217	0.0512
China	0.0094	0.0066				0.0159
Japan	0.0143	0.0014				0.0157
Malaysia	0.0053	0.0019				0.0072
Rep. of Korea	0.0009	0.0026				0.0035
Switzerland	0.0000	0.0019				0.0019
USA	0.0013	0.0002				0.0016
Germany	0.0005	0.0011				0.0015
Viet Nam	0.0013	0.0002				0.0015
Taiwan	0.0008	0.0002				0.0010
Total	0.0426	0.0318	0.0030	0.0019	0.0217	0.1010

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00430	0.00238				0.00668
Malaysia	0.00266	0.00005				0.00271
Thailand	0.00029	0.00036	0.00008	0.00003	0.00027	0.00103
Japan	0.00009	0.00002				0.00011
Rep. of Korea	0.00001	0.00004				0.00005
Viet Nam	0.00003	0.00000				0.00003
Singapore	0.00001	0.00000				0.00002
Germany	0.00000	0.00001				0.00001
USA	0.00001	0.00000				0.00001
Philippines	0.00001					0.00001
Total	0.00741	0.00286	0.00008	0.00003	0.00027	0.01066

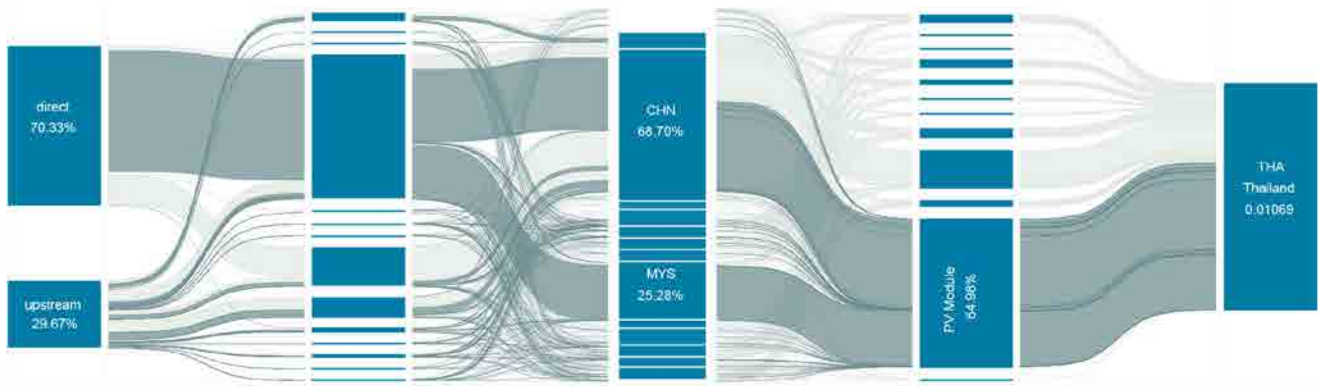
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

Turkey

Country profile: Turkey

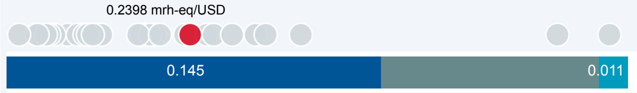
Country: Turkey

Levelized Cost of Energy (LCOE)

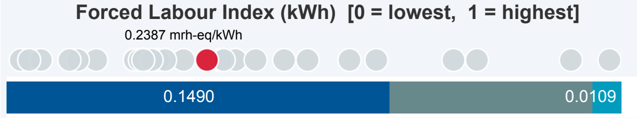
LCOE is a measure of the average net present cost of electricity generation over its lifetime.

- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Turkey	0.01184	0.01005	0.00872	0.00909	0.00887	0.04857
China	0.00681	0.00273				0.00954
Taiwan	0.00551					0.00551
Malaysia	0.00388	0.00136				0.00524
Italy	0.00024	0.00197				0.00221
Germany	0.00068	0.00111				0.00179
Viet Nam	0.00131					0.00131
Japan	0.00104	0.00003				0.00107
Thailand	0.00092					0.00092
Rep. of Korea	0.00060					0.00060
Total	0.03283	0.01725	0.00872	0.00909	0.00887	0.07676

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00330	0.00150				0.00480
Malaysia	0.00193	0.00004				0.00197
Turkey	0.00030	0.00020	0.00017	0.00013	0.00013	0.00094
Taiwan	0.00004					0.00004
Thailand	0.00003					0.00003
Viet Nam	0.00003					0.00003
India	0.00003					0.00003
Germany	0.00001	0.00001				0.00001
Japan	0.00001	0.00000				0.00001
Italy	0.00000	0.00001				0.00001
Total	0.00568	0.00176	0.00017	0.00013	0.00013	0.00787

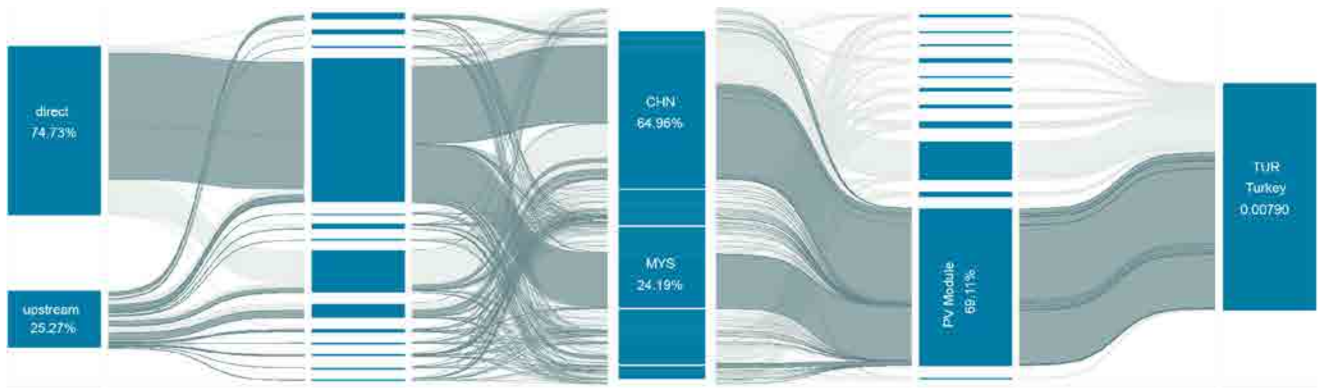
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

UAE

Country profile: United Arab Emirates

Country: United Arab Emirates

Levelized Cost of Energy (LCOE)

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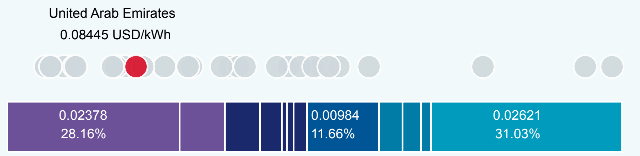
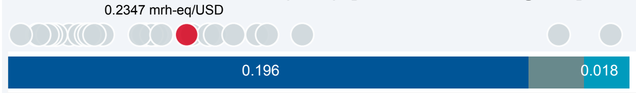
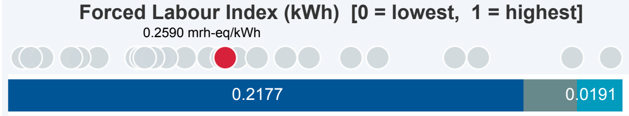


- PV Module & Inverter
- BoS Hardware
- Installation & civil works
- Other soft cost
- O&M cost

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



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



- 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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
United Arab Emirates	0.01032	0.00581	0.00984	0.00722	0.02621	0.05940
China	0.01594	0.00111				0.01705
India	0.00035	0.00086				0.00121
Spain	0.00059	0.00020				0.00079
USA	0.00046	0.00033				0.00079
Germany	0.00021	0.00053				0.00074
Malaysia	0.00030	0.00022				0.00052
Italy	0.00019	0.00026				0.00045
Switzerland	0.00008	0.00034				0.00042
Philippines	0.00041					0.00041
Total	0.02885	0.00966	0.00984	0.00722	0.02621	0.08178

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

Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00818	0.00066				0.00883
United Arab Emirates	0.00021	0.00013	0.00017	0.00008	0.00046	0.00105
Malaysia	0.00015	0.00001				0.00016
India	0.00004	0.00009				0.00012
Romania		0.00001				0.00001
Spain	0.00001	0.00000				0.00001
USA	0.00000	0.00000				0.00001
Germany	0.00000	0.00000				0.00001
Philippines	0.00001					0.00001
Thailand	0.00000	0.00000				0.00000
Total	0.00859	0.00089	0.00017	0.00008	0.00046	0.01019

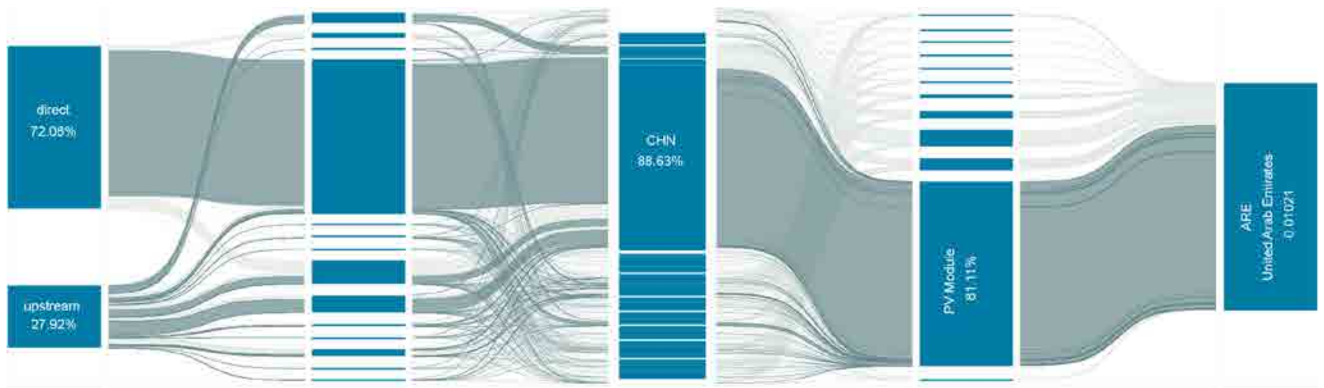
Sankey diagram: Tracing the risk of forced labour in the supply chain

Indicator: Goods produced by FL

unit: mrh-eq/kWh

breakdown to trace

PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

United Kingdom

Country profile: United Kingdom

Country: United Kingdom

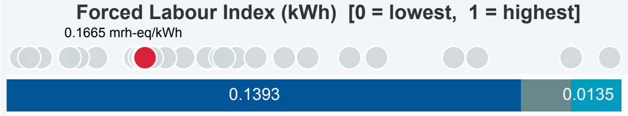
Levelized Cost of Energy (LCOE)

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

PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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

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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
United Kingdom	0.0101	0.0125	0.0275	0.0229	0.0142	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	0.0002				0.0022
France	0.0017	0.0004				0.0021
Viet Nam	0.0016					0.0016
Total	0.0525	0.0209	0.0275	0.0229	0.0142	0.1378

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

Select indicator and unit

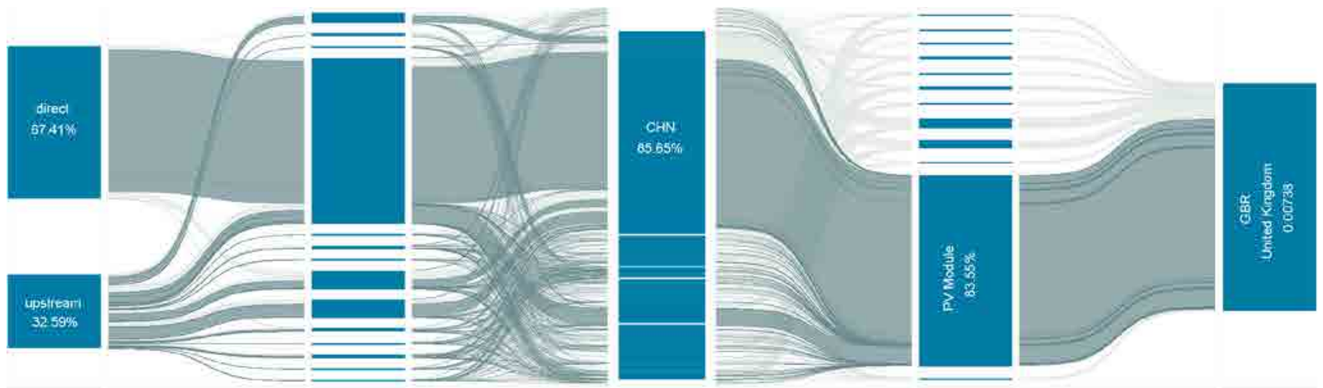
Forced labour Indicator Goods produced by FL | **Risk variation** Very low risk | **unit** mrh-eq/kWh

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00532	0.00036				0.00568
Malaysia	0.00056	0.00000				0.00056
United Kingdom	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
Viet Nam	0.00003					0.00003
Total	0.00636	0.00059	0.00010	0.00014	0.00005	0.00724

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

Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

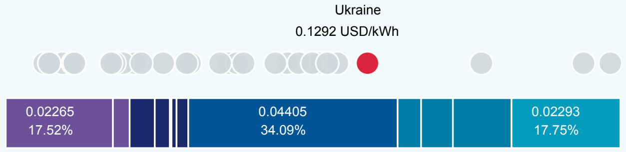
Ukraine

Country profile: Ukraine

Country: Ukraine

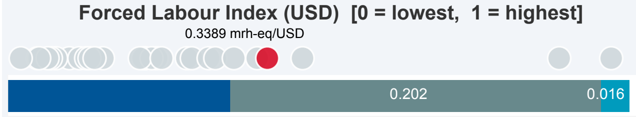
Levelized Cost of Energy (LCOE)

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

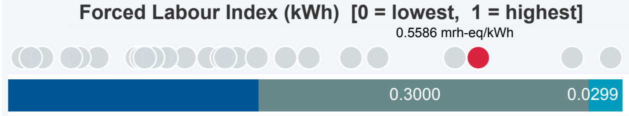


PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Ukraine	0.0087	0.0062	0.0441	0.0238	0.0229	0.1057
China	0.0161	0.0008				0.0168
Germany	0.0003	0.0013				0.0016
Belarus		0.0013				0.0013
Poland	0.0001	0.0009				0.0010
Greece		0.0004				0.0004
Turkey		0.0003				0.0003
Russian Federation	0.0000	0.0003				0.0003
Italy	0.0001	0.0002				0.0003
Hungary		0.0002				0.0002
Total	0.0252	0.0118	0.0441	0.0238	0.0229	0.1278

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

Select indicator and unit

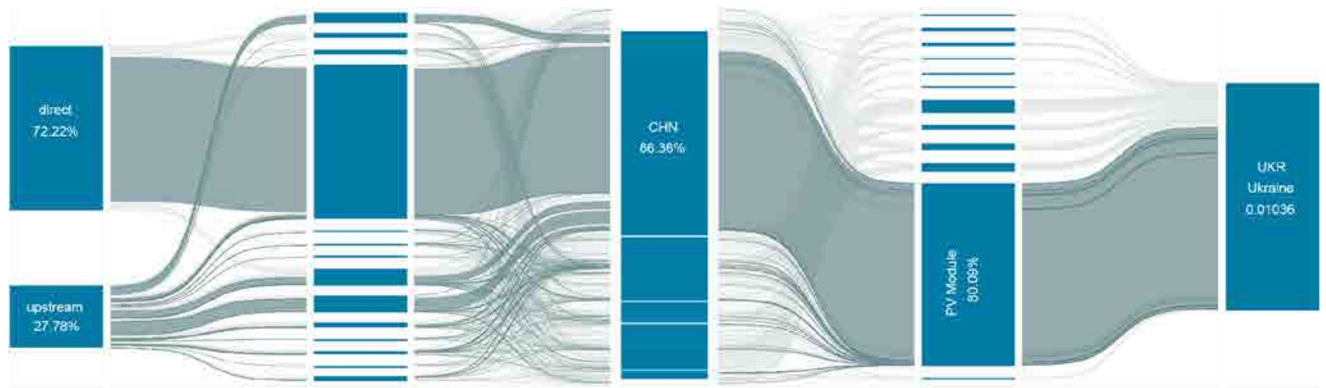
Forced labour Indicator Goods produced by FL | **Risk variation** Very low risk | **unit** mrh-eq/kWh

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00831	0.00041				0.00872
Ukraine	0.00012	0.00007	0.00063	0.00033	0.00036	0.00151
Malaysia	0.00007					0.00007
Belarus		0.00003				0.00003
Poland	0.00000	0.00001				0.00001
Germany	0.00000	0.00001				0.00001
India	0.00001					0.00001
Turkey		0.00001				0.00001
Greece		0.00000				0.00000
Hungary		0.00000				0.00000
Total	0.00852	0.00054	0.00063	0.00033	0.00036	0.01038

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

Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

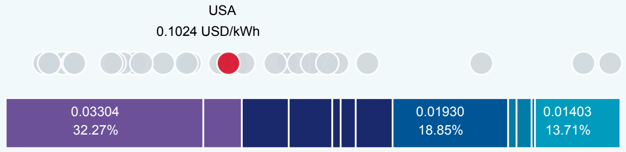
USA

Country profile: USA

Country: USA

Levelized Cost of Energy (LCOE)

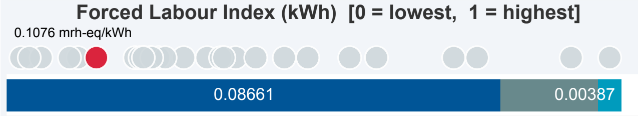
LCOE is a measure of the average net present cost of electricity generation over its lifetime.



PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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

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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
USA	0.01537	0.01390	0.01930	0.00461	0.01403	0.06721
Mexico	0.00177	0.00471				0.00648
China	0.00435	0.00104				0.00539
Malaysia	0.00515	0.00002				0.00517
Canada	0.00039	0.00267				0.00306
Japan	0.00279	0.00011				0.00290
Rep. of Korea	0.00239	0.00017				0.00256
Viet Nam	0.00144	0.00021				0.00165
Germany	0.00051	0.00078				0.00129
Italy	0.00081	0.00034				0.00115
Total	0.03497	0.02395	0.01930	0.00461	0.01403	0.09686

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

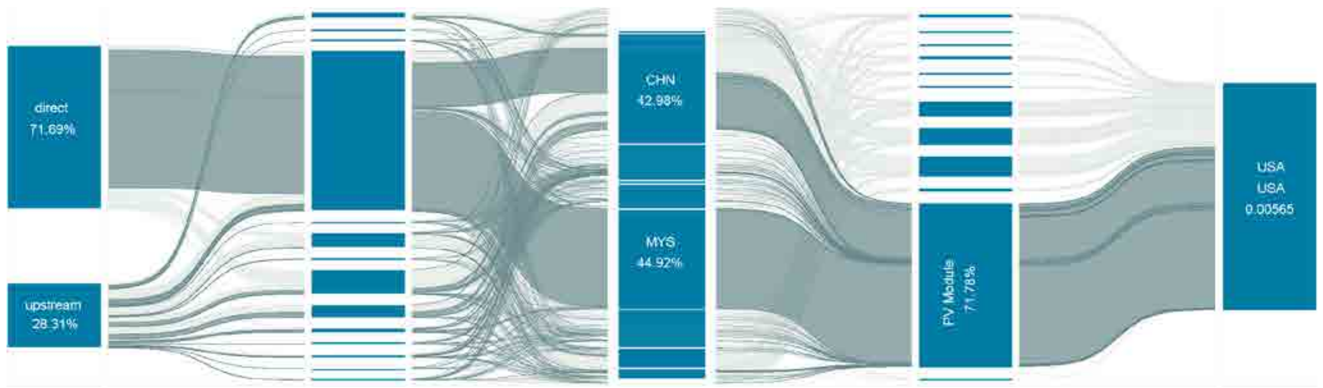
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Malaysia	0.00257	0.00000				0.00257
China	0.00155	0.00050				0.00205
USA	0.00012	0.00008	0.00038	0.00002	0.00006	0.00066
Mexico	0.00003	0.00010				0.00014
India	0.00003	0.00002				0.00005
Viet Nam	0.00003	0.00001				0.00004
Thailand	0.00003	0.00000				0.00004
Rep. of Korea	0.00003	0.00000				0.00003
Japan	0.00002	0.00000				0.00002
Canada	0.00000	0.00002				0.00002
Total	0.00441	0.00073	0.00038	0.00002	0.00006	0.00561

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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Frequency of Forced Labour (risk change): Effect of change risk value in the CSS: 'CN - Other electric machinery and equipment'
Risk variation: change in risk of **Frequency of Forced Labour**

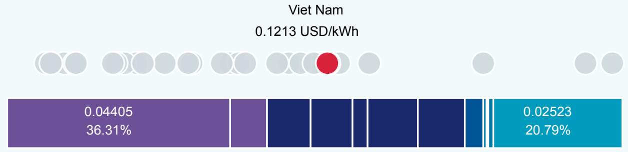
Viet Nam

Country profile: Viet Nam

Country: Viet Nam

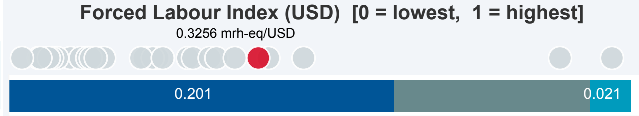
Levelized Cost of Energy (LCOE)

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

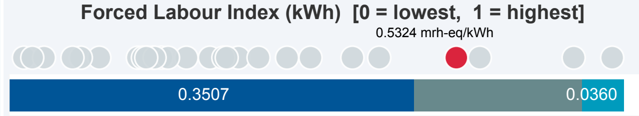


PV Module & Inverter
BoS Hardware
Installation & civil works
Other soft cost
O&M cost

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



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



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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
Viet Nam	0.0094	0.0118	0.0035	0.0023	0.0252	0.0522
China	0.0173	0.0091				0.0263
Rep. of Korea	0.0081	0.0056				0.0137
Japan	0.0090	0.0016				0.0105
Taiwan	0.0027	0.0006				0.0033
Thailand	0.0014	0.0017				0.0031
Malaysia	0.0018	0.0008				0.0026
India	0.0003	0.0017				0.0020
United Kingdom	0.0000	0.0017				0.0017
Indonesia	0.0000	0.0011				0.0011
Total	0.0499	0.0357	0.0035	0.0023	0.0252	0.1166

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

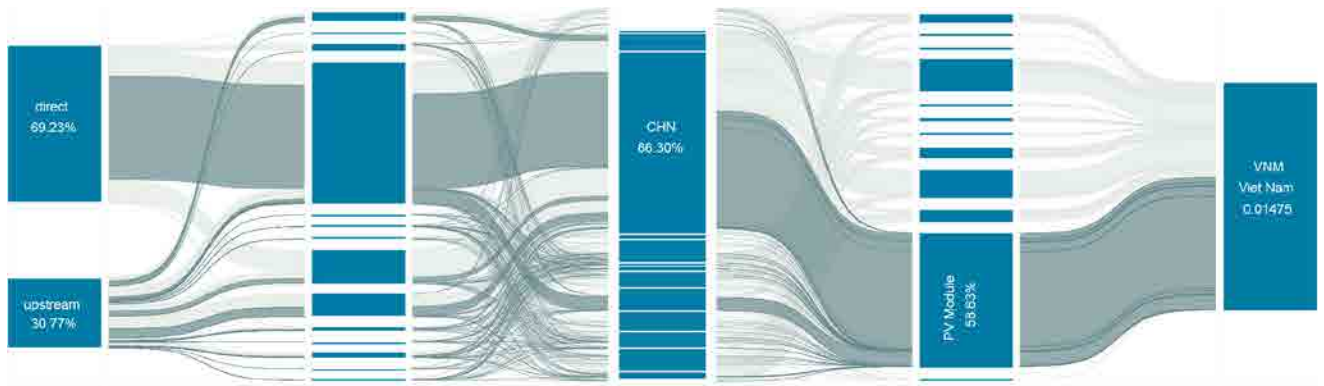
Select indicator and unit

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

	PV Module & Inverter	BoS Hardware	Installation & civil works	Other soft costs	O&M cost	Total
China	0.00796	0.00394				0.01191
Viet Nam	0.00020	0.00031	0.00008	0.00005	0.00067	0.00132
Malaysia	0.00090	0.00002				0.00092
India	0.00003	0.00017				0.00020
Rep. of Korea	0.00009	0.00007				0.00016
Thailand	0.00005	0.00004				0.00009
Japan	0.00005	0.00002				0.00008
Taiwan	0.00002	0.00000				0.00002
United Kingdom	0.00000	0.00002				0.00002
Indonesia	0.00000	0.00001				0.00001
Total	0.00930	0.00461	0.00008	0.00005	0.00067	0.01471

Sankey diagram: Tracing the risk of forced labour in the supply chain
Indicator: Goods produced by FL
unit: mrh-eq/kWh

breakdown to trace
PV Module



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