

Clean and inclusive? Recycling e-waste in China and India

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Toxics Link
for a toxics-free world

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About Toxics Link

Toxics Link is an Indian environmental research and advocacy organisation engaged in disseminating information to help strengthen the campaign against toxics pollution, provide clearer alternatives and bring together people affected by these problems.

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Photo caption: Man dismantling a CRT monitor, Gowripalya area, Bangalore.

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E-waste – electrical and electronic waste – is one of today’s fastest growing waste streams. By managing it well, we can recover valuable raw materials and reusable parts, with significant associated emissions savings. But much of its potential is lost when improperly processed by informal and unregulated enterprises. This can damage both people’s health and the environment and intensify the vulnerability of workers.

Informal markets are where most of the world’s poor produce, consume and trade goods. Using case studies from China and India – both with huge informal e-waste sectors – this paper explores how to build inclusive, greener economies that retain the benefits of informal markets, while addressing how and why people are excluded from formal activities. Both countries are stepping up efforts to regulate but are failing to take into account the importance of engaging with the informal e-waste sector. How can drives to clean up harmful practices take their experience and expertise into account? And how can we develop effective policies to tackle pollution while supporting the health, livelihoods and economic activities of the poor and vulnerable?

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Executive summary

E-waste is one of the world's fastest growing waste streams. We generate over 40 million tonnes annually. By managing e-waste well, valuable secondary raw materials can be recovered. There are also significant greenhouse gas emissions savings from associated displaced mining activities. Refurbishing reusable parts makes possible cheap access to household appliances and communications technology, which is particularly important for low-income rural consumers in developing countries. Better e-waste management can play an important role in the transition to greener and more inclusive economies (see Box 1). But much of e-waste's potential as a resource is lost when it is improperly processed. Electrical and electronic equipment (EEE) contains a range of toxic materials that can be harmful to human health and the environment, and intensify the vulnerability of workers.

Why explore e-waste management in India and China?

This paper explores issues of e-waste management in China and India: two significant players in e-waste generation and recycling. China is second only to the USA in total domestic generation (4.4kg per capita in 2014 compared to 22kg in USA). India stands fifth globally, generating 1.6 million tonnes (a tiny 1.3kg per capita) (Baldé *et al.*, 2015). Over the last few decades, illegal international import 'dumping', poverty and urbanisation combined with non-existent or weak regulations have created the conditions for the growth of huge, informal and unregulated e-waste sectors in these countries. These operate at all stages of the chain – from collection, dismantling and trade to repair, recycling and metals recovery. Now, since 2012, for the first time growing domestic consumption has overtaken international imports as the main source for India and China's rising mountains of e-waste. New governance challenges are emerging in a range of specific domestic contexts, demanding national and local policy attention beyond just integrating or complying with international toxic waste import/export regulations.

What is the problem?

Driven by laudable environmental and health concerns, both countries are stepping up efforts to regulate. But attempts so far to encourage the development of a formal recycling sector and 'clean channels' are

BOX 1. A GREEN AND INCLUSIVE E-WASTE ECONOMY

The informal economy is invisible in most literature discussing the 'green economy'. This is a serious omission. A recent analysis of 15 national-level green economy plans and scoping studies by the Green Economy Coalition identifies that only six mention the informal economy – of these, most only acknowledge informality in passing. There is no specific focus or analysis on how green growth policies might impact the informal economy.

Yet informal economy is growing in many parts of the world. It is already too big to ignore, both in terms of supporting livelihoods and environmental pressures. How it evolves will be critical to the transition to a more resilient and green economy that also tackles the structural causes of inequality. To deliver on the recently agreed UN Sustainable Development Goals, it will be essential to engage with and transform informal markets as well as formal ones so that they are greener and more climate-resilient – irrespective of whether or not this will be easy.

A green, 'circular' e-waste economy must embrace waste as a valuable resource. Global recovery of reusable materials, longer product life, less use of hazardous substances and reducing overconsumption are key. But a green and inclusive e-waste economy must also promote livelihoods and protect workers, their families and community health from toxic substances released during recycling processes.

having little impact on the informal sphere or on national e-waste markets. Both countries feature thriving informal e-waste markets that are inclusive of some of the poorest, and which deal with the overwhelming majority of imported and domestic e-waste – in India this could be as high as 95 per cent.

While these informal operations are not often green and can be exploitative, they represent many thousands of livelihoods, and informal practices often have significant efficiency gains over formal counterparts, particularly

in the early stages of the chain (collecting, dismantling and refurbishing). Formal e-waste management supply chains have proved more expensive to establish and operate – in part because they must observe exacting environmental and health standards. Regulations in India have banked on the ‘extended producer responsibility’ (EPR) principle to push the burden on to EEE producers, but so far there has been little widespread implementation on the part of the producers, or enforcement by state regulators. And while the Chinese government is seeking new and innovative ways to formalise, centralise and clean up systems for e-waste collection and recycling, most recent attempts have not got far in transforming the market.

What are the challenges and opportunities for policymakers?

There is a clear mismatch between regulation and reality in both countries, where policy preference has drawn on European and US models (themselves often flawed), but has taken them out of context. Indian and Chinese policymakers’ preference is to create conditions of formal sector competition with well-established and dominant informal markets, largely ignoring or trying to further criminalise and marginalise informal e-waste enterprises – putting at risk many informal-sector livelihoods.

Policymakers should instead see the opportunity for solutions that build on established supply chains and collection practices to harness the benefits and efficiencies of the informal networks already in place. In this paper, we present a case for integrating and building on existing realities. These realities include not only a large informal sector that has matured in a relative regulatory vacuum, but also regulatory bodies’ weak capacity for enforcement (relative to their European counterparts), and household consumption habits grounded in long-standing cultural practices. Market governance that ignores these realities will present few prospects for environmental improvements and lead to ineffective incentive structures, either for new formal businesses to establish or for existing informal enterprises to clean up their operations, perhaps through formalising.

What models might work?

What interventions could better green the e-waste sector while being inclusive of existing informal small and medium enterprises? In this paper we reflect on current policy and practice across a spectrum of examples that encompass formal and informal sector players. We discuss the challenges and opportunities for improved environmental and health outcomes across these two countries’ e-waste sectors – and the degree of inclusion different potential e-waste models provide. One solution may be hybrid models, where

existing informal collection and dismantling markets (in particular) are supported by, and integrated with, formal recycling companies that use clean technologies for metal recycling and toxic compound disposal. We tentatively explore the potential of a few specific models, focusing on India.

At a conceptual level, there is a strong business case for hybrid formal–informal models. We know that the informal e-waste sectors in China and India are huge. Ignoring them or making them more illegal with punitive regulation is not likely to be effective in getting e-waste flowing into clean recycling channels. The process of inclusive formalisation of wastepickers more broadly is also certainly not new, in India and other places – recent examples include Solid Waste Collection and Handling (SWaCH) in Pune, India; National Waste Pickers Movement in Brazil; *Bogota Waste Pickers Association* in Colombia; and the *zabaleen* in Cairo, Egypt (WIEGO, 2013).

What are the main lessons?

Based on the analysis, we can draw seven broad conclusions. These point to critical challenges in governing the e-waste sector inclusively and to mechanisms which could steer e-waste markets towards greener and fairer outcomes. Exploring these further will help build an understanding of how hybrid models could work in practice, including the types of supporting policies that would help with adoption and scale. While they are directed particularly at China and India – two countries processing a very large proportion of the world’s e-waste – they also suggest useful lessons for other countries or cities where policymakers are grappling with similar challenges of how to manage the growing mountains of domestically-generated e-waste already claimed by thriving informal markets.

1. **Regulation must be inclusive, building on existing realities:** e-waste governance must consider those individuals and enterprises, particularly the poorest or smallest, already working in the sector – and their existing practices. Appropriate regulatory incentives should enable rather than disable them to engage in greener practices. Policymakers should recognise the efficacy and diversity of the informal economy, but also existing structural and power inequalities.
2. **The economics, institutions and incentives must work:** effective interventions to address livelihood, health and environment issues together must also address the realities of pricing for e-waste within current established informal markets. This is also true for the success of formal sector channels, whether or not they aim to encourage an inclusive sector. Economic and other incentives, including buying in to different organisational model options along the e-waste value chain, must be thought

through and discussed with actors along the whole value chain.

3. **Refurbishment is greener, and a critical part of current informal sector models:** policy and regulation must recognise the importance of reusable e-waste, for the informal economy and for low-income consumers, and for the environment.
4. **Municipalities can play a key role** in working with the informal sector, tackling spatial exclusion by providing valuable and much needed space for income-generating activities and helping to lower barriers to formalising. Local authorities are key stakeholders and stand to benefit significantly from efficient solid-waste – including e-waste – management.
5. **The public needs better information:** better information and education channels are vital to influence public behaviour. Existing consumer attitudes, household/office practices and cultural norms also need to be factored into policy design.
6. **Engage electronic equipment manufacturers and retailers** to promote experimentation and innovation of more inclusive e-waste management models. This must move beyond rhetoric to practical participation and experimentation in multistakeholder models – with ambitions of going to scale.
7. **Developed country governments still have a responsibility** and must pay increased attention to international law enforcement to prevent illegal shipments of e-waste to the developing world.

Fostering and scaling-up hybrid models is not an easy task. Models of formal–informal integration aiming for environmental protection or economic efficiency will not automatically lead to social welfare synergies. We need to consider carefully what incentives diverse stakeholders need to participate – and what are the potential barriers and inequalities. Hybrid models must recognise and avoid many potential risks. How can they be designed to prevent intensifying further vulnerabilities? Models will need to manage power and voice imbalances, prevent exploitation due to diverging interests, and ensure that informal worker organisations are not undermined. In addition, two of the biggest – and linked – challenges for designing greener and more inclusive models remain critical: appropriate pricing incentives for e-waste to flow into safe and clean recycling channels and the loss of livelihoods for those involved in hazardous recycling practices.

While the nature of e-waste production and disposal is of global concern, the issues are becoming increasingly complex. They go far beyond environmental injustice in developing countries. Dealing with the polluting nature of e-waste management techniques is urgent – as is the need to recover materials. But moves to cleaner,

greener futures must be equitable, protecting the most vulnerable and seeking synergies with measures towards poverty reduction and social protection.

What can be done now?

The following are practical suggestions for next steps:

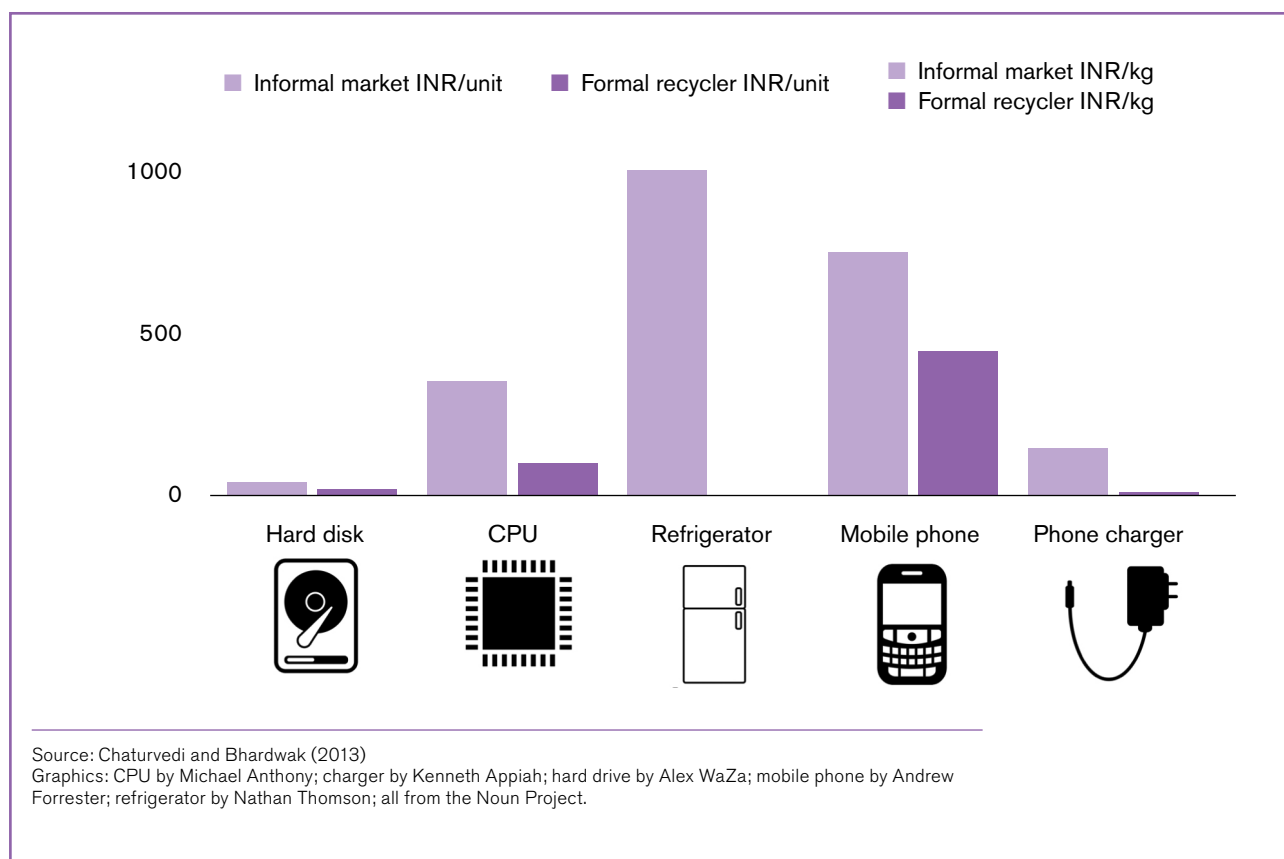
- Identify and work with **forward-thinking municipalities** to experiment with new models.
- Identify a number of **leading manufacturers** willing to invest, think creatively and work with others.
- **Create ‘safe spaces’ or forums to bring people together** – with a focus on experimentation and improving understanding of informal sector e-waste management by policymakers (national and local), manufacturers and existing e-waste value-chain stakeholders.
- Promote **cross-country learning** on promising e-waste management models and better collaboration across national governments.
- **Engage with donors and pioneers** – such as GIZ, UNEP and Toxics Link – working on e-waste management issues to build on existing learning and ensure that lessons and experiments feed into better future policy.

What needs further exploring?

In combination with the points above there are a number of areas that need more research:

- **How complex are e-waste value chains?** Better mapping is needed to understand financial and information flows and different models across different geographies.
- **What incentives are there for different parties to participate in sustainable e-waste models?** What are the right economic incentives for greener, inclusive e-waste management?
- **How can refurbishment be made legitimate and safe?** Explore options such as enabling regulations, enabling regulations, capacity building with refurbishers and raising consumer awareness. This will require policymakers to champion the issue.
- **How can we measure impacts and include gender dynamics?** Research is needed to track outcomes in rapidly evolving e-waste markets and understand differences in power. Where is value being added and what economic and non-economic forms does this value take? What are the broader social inequalities affecting e-waste management – and shaping people’s ability and willingness to work in organised groups – and how do they differ for men and women?

Figure 1. Average price differences for e-waste in formal/informal recycling sector (Indian rupees, January 2013)



- **Which livelihoods will be worst affected by change?** In most proposed sustainable e-waste models those at the end of informal e-waste value chains will still lose their livelihoods. What are the alternative livelihoods options? Can we develop safe, low-cost or intermediate e-waste recycling technology?

In this paper we have argued for policies that lead to practical change. Existing e-waste markets should be shaped for the better, rather than sitting in a regulatory vacuum. These recommendations demonstrate that getting the enabling environment right is crucial – whether for appropriate finance mechanisms or regulations on who can and cannot handle e-waste. Policy must work with existing practice if change is to happen at scale. This is more likely to work if e-waste models evolve from existing realities rather than policy requiring sudden radical change. But it requires better cooperation and trust between national and local governments, manufacturers and retailers, and small and informal businesses.

We need a better picture of how the informal sector functions alongside and with the formal – now and in future – and how new innovative models might make the situation more equitable.

What are the key economic and non-economic incentives for informal and formal, large- and small-scale stakeholders? This will require a greater understanding of the diversity, inequalities and vulnerabilities that exist within the informal e-waste sector. **Improved scientific understanding of the different environmental and health risks along the chain**, and the technologies that could mitigate risks, will also serve to inform better-targeted interventions.

Introduction



1.1 The context

More and more consumers, markets and countries have crossed over the 'digital divide'. Discarded electronic products (waste electrical and electronic equipment also known as 'e-waste' or 'WEEE') have become one of the world's fastest growing waste streams. Technology such as communications devices and electrical household appliances – large or small – contain toxic materials that can be dangerous to human health and the environment, needing special handling at end-of-life (Sthiannopkao and Wong, 2012; Wang and Ma, 2011). Besides the mountains of waste created by electrical and electronic goods (see Box 2 below), there are additional problems. If not treated properly, e-waste recycling and disposal releases toxins that increase concentrations of lead and other harmful chemicals in soil, water, air and human tissue.

Over 30 years, globalising e-waste flows have received much attention; from environmental campaigners to international agreements such as the Basel Convention (enacted in 1992). Illegally 'dumping' waste from developed markets into emerging economies such as China and India is still happening, but now booming middle classes in these countries mean that domestic e-waste is also a significant issue.

There is growing attention to and awareness of environmental externalities in policy discourse, particularly those related to climate change. Pressing issues relating to just and inclusive economic growth are high up the policy agenda and in public debates. Accelerated by the Rio+20 summit and subsequent national green economy discourse and strategies¹, the green economy is widely promoted as the solution to the challenges facing sustainable development. The 'inclusive green growth' agenda continues to gain political momentum, shaping national planning processes in developed, developing and emerging economies, international organisations' priorities, and attracting investment from donors, investors and businesses.

Incentives to dealing with e-waste vary, but generally can be understood in green terms (costly environmental problem) or resource terms (source of increasingly limited raw materials). There is much less attention on solutions which also create inclusive development opportunities. Of course, the mountains would be

reduced by greater focus on limiting consumption and stemming our 'disposable culture'. Rapid product innovation and planned obsolescence are hugely significant drivers, fuelling the growing e-waste problem. We do not address the consumption agenda in depth here, but it is hugely important, situated within the wider tensions around creating green and fair economies.²

E-waste recycling supply chains in countries like Ghana, Pakistan, China and India have largely evolved in the absence of effective national policy. Organic processes have evolved, integrating e-waste management into existing informal sector waste-management models. Many thriving small enterprises trade in international and increasingly domestic e-waste, creating jobs for some of the poorest and most marginalised in markets across the e-waste disposal chain of collection, dismantling, refurbishment and melting down for recovering secondary raw materials and disposal (for a simplified overview of e-waste value chain, see Figure 4). The problems wastepickers face in many countries are well-documented (see eg the work of Women in Informal Employment: Globalizing and Organizing or WIEGO). For e-waste, it is the last activity in the chain – smelting and recovery – that is most concerning. E-waste contains toxic and hazardous materials such as plastics, leaded glass and metals, generating environmental and human health hazards. Many informal industrial activities are also bound up with social issues including poverty, exclusion and exploitation.

Recent policies in India and China to tackle e-waste have looked to formal-sector models in developed countries for answers. But do they consider how to 'work with' their different reality of a huge and established informal e-waste recycling sector? Here, we focus on these two countries. Both are emerging economies confronting a range of drivers: burgeoning middle-class consumption, fast-growing domestic markets for electronic goods, rapid rates of urbanisation, significant poverty and inequality, weakly regulated imports linking them to global value chains, and embryonic regulations for handling domestically-produced e-waste. These have influenced the development of deeply rooted informal e-waste markets, which handle most of India and China's international and domestic e-waste. We explore these countries' regulatory efforts to 'green', govern and (usually) formalise informal e-waste management and ask what lessons they might learn from each other. We

¹ See eg UNEP's PAGE work to setup national green economy strategies (www.unep.org/greeneconomy/page) and two major green economy initiatives: Green Economy Coalition (www.greeneconomycoalition.org/) and the Global Green Growth Institute (<http://ggi.org/>).

² The consumption and so-called 'circular economy' agenda is receiving increasing attention and recently included as Sustainable Development Goal 12 (sustainable production and consumption); European-level legislation targeting a zero-waste circular economy has been drafted, although not without its critics – see www.zerowasteurope.eu/category/circular-economy. Discourse is also re-framing waste management in the context of resource management – see eg Wilson (2015).

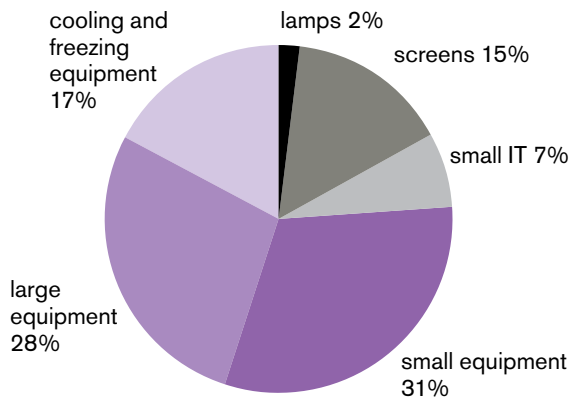
conclude with key practical approaches which could encourage inclusive market governance models that add value for informal e-waste workers and also address social, environmental and economic challenges – with responsibilities for local actors, regulators, national policymakers and manufacturers.

This is not a balanced comparison of the two countries. Opportunities for information, discussion and engagement were greater in India than in China. But there are still valuable lessons from placing these two countries' experiences side by side.

BOX 2. FACTS AND FIGURES – THE GLOBAL PICTURE

- Despite differences in definition, total global e-waste in 2014 was at least 41.8 million tonnes (Baldé *et al.*, 2015) – equivalent to 6,000 Eiffel Towers, 8 million elephants or 6.4 Great Pyramids of Giza. This is forecast to increase to 50 million tonnes in 2018 (Baldé *et al.*, 2015).

Figure 2. E-waste generated in 2014 (proportion by weight)



Small IT: mobile phones, pocket calculators etc. Small equipment: vacuum cleaners, microwaves, etc. Large equipment: washing machines, dishwashers etc.
Source: Baldé *et al.*, 2015

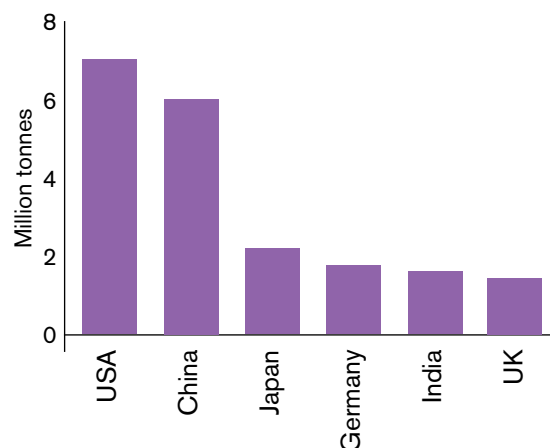
- In 2012, developing countries' total domestic e-waste overtook developed ones for the first time (UN StEP, 2013): the West produced 23.5 million tons of waste and all others 25.4 million. This gap should increase significantly over the next few years with the economic rise of emerging nations such as India, Brazil and South Africa (*ibid*).
- In 2014 six countries generated nearly half of all global e-waste: USA, China, Japan, Germany, India and the UK (Baldé *et al.*, 2015).
- China is second only to the USA in total domestic generation (4.4kg per capita in 2014 compared to 22kg per capita in USA). India stands fifth globally, generating 1.6 million tonnes (a tiny 1.3kg per capita) (Baldé *et al.*, 2015).

- National e-waste legislation (covering 'take-back' of domestic waste) exists in about 50 countries, covering approximately 4 billion people (mostly due to China's and India's large populations) (Baldé *et al.*, 2015). However, having legislation does not imply effective enforcement or successful systems for implementing take-back and recycling. In 2014, 15.5 per cent of global e-waste generated was reported as formally collected and treated through national programmes (mostly in Europe, North America, China and Japan) (Baldé *et al.*, 2015).

- Take-back systems outside of official programmes, provided through private or informal activities, can make up a third of the e-waste market in some developed countries and nearly the entire market in many developing ones. In China and India, the overwhelming majority of recycled imported and domestic e-waste still goes into the informal sector (Sthiannopkao and Wong, 2012).

- Much e-waste still ends up in landfill eg with mixed household waste. This is a waste of potential secondary raw materials. The intrinsic material value of global e-waste in 2014 was estimated to be 48 billion euros (dominated by gold, copper and plastics). It can also lead to pollution problems: an estimated 70 per cent of heavy metals in USA landfills come from discarded electronics (UNEP, 2013).

Figure 3. Top 6 e-waste generating countries, 2014



1.2 E-waste is a global and local problem and opportunity

E-waste contains valuable substances that can be recovered by crude or sophisticated means. Managing recycling and recovery well can mean significant economic opportunities. Diverting potentially valuable materials from landfill through cleaner recovery processes can create valuable savings in terms of greenhouse gas emissions and natural resources, in a global context of growing scarcity, by recovering already above-ground metals for use as secondary raw materials in manufacturing. Repairing still-working parts makes possible cheap access to household appliances and information communication technology (ICT) for low-income consumers. Some hail the potential role of refurbished e-wastes in democratising electronic communications (eg Reddy 2013). Perhaps most importantly, collecting, dismantling, trading, repairing and recycling e-waste supports the livelihoods of hundreds of thousands of urban poor men and women (and, unfortunately, children) in developing and emerging economies. Most operate informally and many have worked with e-waste for decades.

To ensure appropriate levels of environmental and human health and safety in e-waste management, there is broad consensus in research and policy that 'end-processing' (recycling) such as chemical stripping and incineration require technologically advanced approaches not widely available in developing countries, and especially not in informal e-waste sectors (Wang *et al.*, 2012). There is little research into low-cost technologies where recycling can be continued by informal or small-scale actors. Most scholars advocate for technology transfer and increasing financing to make more sophisticated recycling facilities available to private or public-sector operators (eg Chaturvedi and Bhardwak, 2013). Our starting point is that while research into low-cost technologies is needed, within current technological constraints, markets for recycled e-waste products need some degree of formalisation at certain stages of the chain to ensure safety and workers' health, and protect the environment. This is an issue of regulation as much as technology: unless regulated closely, formal recycling that adopts higher technology does not automatically ensure workers' health or protect the environment.

Beyond end-process activities, however, is expensive technology the best way forward? Studies into optimal resource recovery and GHG savings related to international flows of e-waste conclude that low-cost manual dismantling (to prepare electronic devices for recycling and metals recovery) is important – even

critical – for the economic feasibility of the recycling process. Automating (and therefore formalising) the dismantling stage could entail unfeasible investment, and increased energy consumption, whether in developed or developing countries (Eisinger *et al.*, 2011; Wang *et al.*, 2012).

We do not go into more detail on technology design here, but these issues provide a useful backdrop. From an environmental point of view it is important to collect more e-waste (to divert it from landfill) and treat it more effectively. But we need also to look to products that will one day become waste. As well as making appliances last longer, manufacturers and technology researchers must create electronic devices that use less hazardous components and design them to be easy to recycle and recover secondary raw material. Such concerns are well highlighted in the literature (eg UN's Solving the E-waste Problem (StEP) initiative.)

1.3 International e-waste flows and transnational environmental justice

Manufacturing and e-waste disposal in a globalised world makes it a global problem. Developed countries have complex legal and compliance frameworks to regulate disposal of household and business e-waste. Many have invested through public or private sector channels in expensive 'clean recycling' technologies (Sthiannopkao and Wong, 2012). Rich-country systems are frequently based on principles of 'extended producer responsibility' (EPR) or 'take-back systems', where manufacturers are responsible for the safe destruction (or recycling and materials recovery) of appliances collected from homes and workplaces, usually by retailers or local governments. EPR compliance can be difficult to assure and frequently runs against economic incentives for manufacturers (*ibid*). Large amounts of e-waste in Europe and North America still go to landfill unrecycled (Barba-Gutiérrez *et al.*, 2008). Even when diverted from landfill, the expense of proper e-waste disposal in rich countries has been a major driver for e-waste shipments to poorer countries, notably China, India, Ghana, Nigeria and Pakistan (Sthiannopkao and Wong, 2012) where abundant and low-cost manual labour in urban and peri-urban areas is available. Weak enforcement (or lack) of protective environmental regulations and comprehensive labour laws in these countries can make them more economically competitive and attractive to companies; while for developing countries, imported e-waste can represent a significant potential revenue stream, through value created in recovering secondary raw materials and income for hundreds of thousands of their urban poor.

Early attention to the environmental problems associated with e-waste management in developing countries came in the 1980s. Public outcry was sparked by international NGOs and international (and some national) media, who framed the issues through a global environmental justice lens, drawing attention to illegal exports of highly toxic waste from richer to poorer countries (eg Reuters, 2009; Greenpeace, 2009). And despite the international community's response from the early 1990s, in the form of international legal frameworks (see Chapter 3), e-waste continues to flow from developed economies to less wealthy ones.

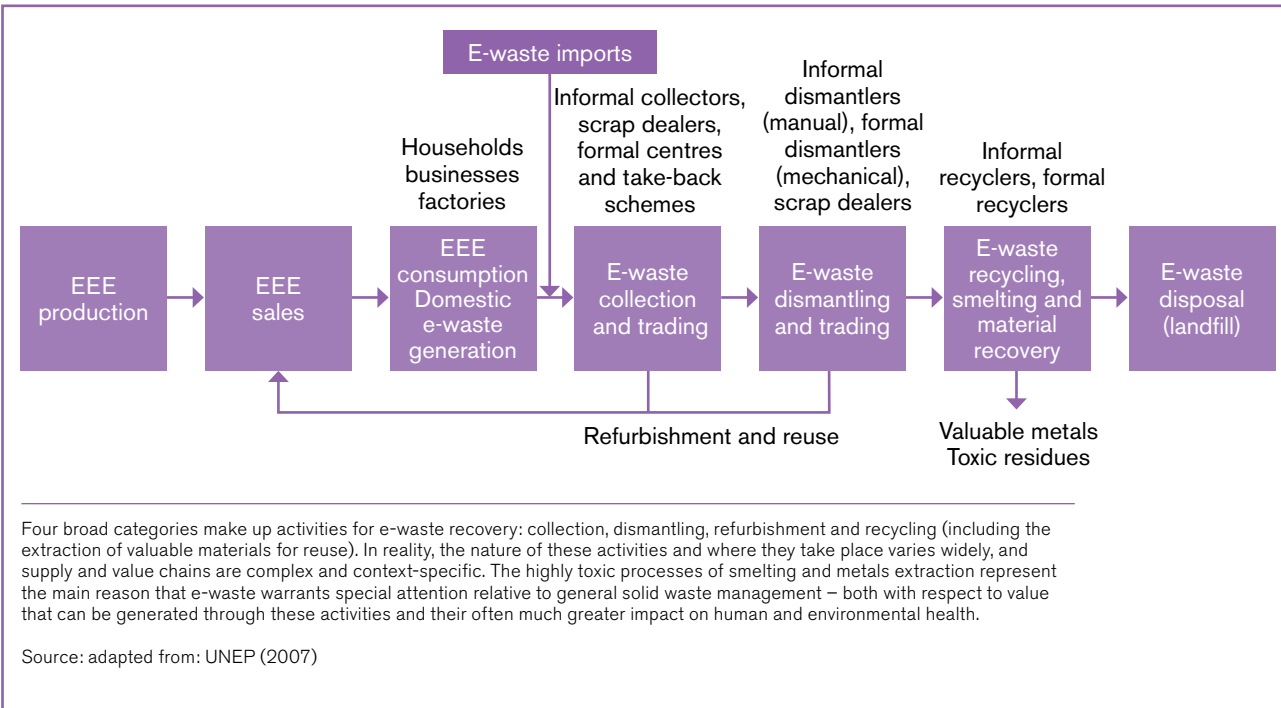
1.4 Growing domestic consumption in developing countries

Abundant, cheap and relatively unregulated labour makes many developing countries economically attractive as global workshops for the torrents of electronic products discarded by businesses and consumers in Europe, Japan and the US. Through a global environmental justice lens, many rightly see it as highly problematic that lax environmental regulations

and a large informal economy result in air, water and soil polluted by harmful chemicals from imported waste, posing challenges for authorities and local communities' health. But the context is changing. As their middle classes, consumption rates and service industries grow, developing countries are increasingly generating more domestic e-waste than rich ones. This trend has potential for a significant revenue stream associated with transforming growing domestic e-waste into secondary value. But it also points to new governance challenges in a range of specific, often very different domestic contexts; demanding policy attention beyond just integrating or complying with international import/export regulations.

The international dumping of e-waste in China and India has received international policy attention; now, the increase in domestic waste generation is sparking new in-country debates. Both situations are bound up with the concept and reality of informal economic activities in poor countries. Growing domestic flows of e-waste amplify the already clear need for market governance support to build synergies across new formal industries and existing informal livelihood-generating activities of the urban poor. We will return to this argument later.

Figure 4. Highly simplified e-waste value chain



1.5 Approach taken by this paper

Focusing on China (Chapter 4) and India (Chapter 5), we explore eight case studies across a range of approaches aimed at achieving 'clean channels' for e-waste, and illustrating the impacts of national or sub-national policies on informal workers and enterprises – and vice versa. Some describe NGOs' efforts to support informal actors to engage in new models of organising or operating, and develop evidence to inform policy that works with, rather than against, the informal economy. In particular, we draw on the work of Toxics Link, an Indian environmental research and advocacy organisation working to develop innovative hybrid models for integrating the informal sector into 'clean channel' systems for managing e-waste.

In Chapter 5 we also present findings from interviews and focus groups with e-waste collectors, dismantlers and traders operating in two cities in India: Kolkata and Delhi. What are the views and attitudes of different informal actors to the models that they work in, policy that affects them, and the opportunities, incentives and barriers they face to change to new 'cleaner' modes of operation spanning formal and informal sectors? While

more information is needed to validate and expand on these findings, they still give a useful insight into the perspectives of informal workers and business owners in e-waste supply chains. Our research partners and opportunities to speak to people who work in e-waste were mostly Indian, so we focus more closely on India, while still drawing on experiences and lessons from China.

Chapter 2 begins by framing e-waste in the broader setting of green economies, identifying what we mean by the informal economy in the context of e-waste. Chapter 3 provides a brief overview of international legal frameworks relating to e-waste. Chapters 4 and 5 then explore China and India, examining current policy frameworks and existing practices. Case studies reveal valuable lessons on what is and is not working within e-waste supply chains. We take a more in-depth look at the perspective of individuals working with e-waste in India on options for greater levels of organising and barriers to formalising. Chapter 6 distils the findings into a number of useful practical pointers for policymakers and donors. More effort is needed to thoroughly investigate the whole informal recycling chain in both countries and beyond and Chapter 7 presents suggestions for further research and options for moving forward.

Framing e-waste in informality and green economy thinking



We start with the bigger picture and argue that, as a matter of principle, governments and policies for 'greening' must engage with informal markets where these exist. We outline some key characteristics of informal e-waste economies, introduce the debate on formal–informal hybrid operating models, and summarise key conceptual questions framing this paper. Our coverage of the diverse interpretations and extensive debates around green economy, informality and formal-informal linkages is necessarily brief. The reference section lists resources where further discussion can be found (particularly by IIED, ILO, and WIEGO).

2.1 Informality and the green economy

Accelerated by the Rio+20 Summit the green economy has been widely promoted as the solution to the current challenges facing sustainable development. The 'inclusive green growth' agenda is gaining political momentum, shaping national planning processes of developed, developing and emerging economies and the priorities of international organisations, and attracting finance from donors, investors and businesses.

The adoption of the Sustainable Development Goals (SDGs) by the United Nations in 2015 adds to this momentum. Waste management is explicitly mentioned in Goal 12 (Sustainable production and consumption) and Goal 11 (make cities and human settlements inclusive, safe, resilient and sustainable). This includes language relevant to e-waste such as safe disposal of chemicals, and reduction, re-use and safe recycling of waste materials. Although there is no SDG labelled 'green economy', the language of Goal 8 targets inclusive and sustainable economic growth with ambitions of decoupling it from environmental degradation.

But what do the concepts of 'green growth' and 'green economy' actually mean to in practice for existing economies? Early discussions on the green economy largely focused on investment and the formal economy. Despite international agencies' eagerness to emphasise inclusivity and welfare as the product of green growth, many critics question why the informal economy is still seldom referred to in green growth agendas or policies (eg Benson *et al.*, 2014a; Benson *et al.*, 2014b; Chambwera *et al.*, 2011; Dawa and Kingajui 2012). A recent analysis of fifteen national-level green economy plans and scoping studies by the Green Economy Coalition (GEC) identifies only six which mention the informal economy, mostly only to acknowledge it in passing as part of the economy overall. There is no specific focus or analysis on how green growth policies

might impact the informal economy (Green Economy Secretariat, 2016). Also, in Sustainable Development Goal 8, while small, micro and medium enterprises are mentioned, it is to explicitly encourage their growth and formalisation. There is growing evidence that policymakers often fail to take sufficient account of the social implications of green growth policies, missing crucial opportunities to integrate approaches to addressing environmental unsustainability and the structural drivers of deprivation and inequality (eg Raworth *et al.*, 2014, Wilson 2015).

Informal markets are where most of the world's poor work, consume and trade. The informal economy accommodates most non-agricultural employment in low- and middle-income countries, and informal markets continue to expand across the world (Chen, 2010; ILO, 2013). The emerging body of literature points to some key flaws in mainstream approaches to 'greening' economies – highlighting the invisibility of the informal economy in the mainstream literature. Few references in green transition discussion pieces and policy papers show how greening might take place within informal markets. There is a lack of analysis of potential impacts that green growth policy could have on the livelihoods of millions of the working poor in rural and urban areas, and in many informal sectors such as e-waste.

The root of this omission is the assumption that green economic growth, stimulated by green investment in the formal economy, will automatically lift people out of poverty as it absorbs and formalises informal economies (Benson *et al.*, 2014a). Like common attitudes towards modernisation, which have persisted for decades, it ignores how and why people are excluded from formal economic activity in the first place. Informal economies are increasing around the world – even in countries like India with rapid economic growth. If modelling and analysis of the green economy transition at the international level continues to not recognise the complex realities of informal economies, this is likely to affect regional, national and municipal approaches to greening, risking further marginalisation of huge sections of the economy and society (Benson *et al.*, 2014a). National and sub-national green economy plans need to consider existing economic drivers and realities – one key stakeholder for many countries being the informal sector.

Why the growing bias against informality among policymakers and donors? Chambwera *et al.* (2011) asks if the informal economy should really be seen as an impediment to green growth and development, or if it could actually be one route to deliver on the big sustainability ideals, eg by improving and supporting informal sectors and actors already producing public goods such as those engaging in proper management of natural resources such as non-timber forest products – honey, fruits, mushrooms and medicines.

BOX 3. DEFINING THE INFORMAL ECONOMY

Despite differences in definition, the informal economy is huge. In many developing countries and emerging economies it is either greater than the formal sector or growing in parallel with modern formal markets (ILO, 2002; Chambwera *et al.*, 2011).

Early discussions of economic informality were 'plagued by definitional controversy' (Meagher, 2013; see also de Soto, 1989; Moser, 1978; Castells and Portes, 1989; Hart, 1973 in Vanek, 2014). There is still no single common understanding. But more recent debate around nature and composition has crystallised into some distinct schools of thought, each with limitations and advantages (see eg Chen, 2012; Andrews *et al.*, 2011).

It is now generally accepted that the informal economy refers to **income-generating activities that operate outside the regulatory framework of the state**. Later revisions reflected improved understanding about the heterogeneity of the informal economy and its linkages to the formal economy, refining rather than radically reframing the conceptual understanding of informality (Chen, 2007; 2012). An ILO amendment in 2002 focused on the nature of employment as well as the characteristics of enterprises, expanding the definition of informality to cover unregistered or unprotected workers employed by formal sector businesses (ILO, 2002; Chen, 2012). Recent further shifts have focused on how to operationalise the definitions of informality for statistical and policy purposes (Meagher, 2013; Vanek, 2014).

Broadly, using ILO's revised definitions, economic informality can be described by three core concepts:

- **The informal sector**, which refers to production and employment in unregistered enterprises.
- **Informal employment**, ie employment outside of labour protection regulations, whether in formal or informal enterprises.
- **The informal economy**, which covers all enterprises, workers and activities operating outside of legal regulatory frameworks, and the output they generate (ILO, 2002).

It is useful to note two associated definitions (Meagher, 2013):

Informal institutions: organisational forms that govern informal economies, given that they are by definition outside the regulatory ambit of the state.

Informal markets: organisational arenas where informal economies operate, where labour, goods or services are traded outside of formal frameworks, but are often subject to a range of informal regulatory arrangements.

Intentional and unintentional ambiguities (derived from Brown *et al.*, 2014)

The ILO's definition is restricted to income-generating activities involving the sale of legal goods and services (ILO, 2013). While better for statistical calculations, this glosses over three key areas of conceptual ambiguity regarding the informal economy.

- **Unpaid work** eg the 'household care economy' and 'social reproductive' economy are excluded by limiting the informal economy to income-generating activities. This is particularly important from a gender perspective.
- **Legality:** By limiting the informal economy to legal goods and services, the criminal economy is excluded. While important with respect to goods and services themselves, in terms of actors and activities the definition of 'informality' is intentionally unclear about whether law is being evaded or not applied. Those operating in the informal economy are often treated as criminals whether they are or not, facing a range of legal issues, harassment by authorities and demands for bribes.
- **Formality:** The informal economy operates within a wide range of context-specific, overlapping and unevenly applied formal arrangements and regulations, muddying efforts to predict consequences or forms that formalisation of the informal sector might take. Examples of legal formalising processes include recognition as a business activity, payment of taxes, regulated working hours and social security, and operation in appropriately zoned areas or in buildings that meet standards specific to the nature of the enterprise.

Governments and international agencies increasingly recognise the role that cities might play in the green economy transition. Brown *et al.* (2014a) explore how municipal governments might support the positive contributions that parts of the urban informal economy could make towards greener public goods and more inclusive green economies, such as efficient household-waste collection and recycling, or where alliances of informal workers, particularly women's groups, have negotiated with local governments for welfare benefits and labour protection (*ibid*). They argue that, while green economy reports emphasise cities' dynamic ability to create new green employment opportunities, particularly through agglomeration effects, 'these do not give enough attention to the barriers that prevent or discourage informal enterprises and workers from entering the formal economy'.

It is important not to romanticise the informal economy – many informal markets, including the e-waste sector, consist of diverse people and activities. Some parts are green and provide important public benefits; some impose significant burdens on local environments and human health. Many perpetuate social inequalities and vulnerabilities. More women than men are in informal employment in most developing regions, and are often concentrated in the most casual and exploitative segments of informal work (ILO, 2002; UNRSID, 2010). Governance and justice need to remain central to green economy debates (Raworth *et al.*, 2014) – including those on economically or environmentally damaging informal economy practices – and in discussions on 'greening through formalising'. Agencies and governments must engage more critically with these issues so that green growth benefits the poorest and most vulnerable informal workers, producers and traders (Brown *et al.*, 2014).

2.2 Informal e-waste management: an overview

Waste 'picking' and 'wastepickers' have a long history in the informal sector, including in India and China. Picking, aggregating, segregating, dismantling, refurbishing, repairing and recycling of e-waste are opportunistic industries developed out of, and to some extent integrated with, wider informal waste management systems. We briefly outline some general characteristics of informal e-waste economies. More detail on India and China's e-waste markets is in chapters 4 and 5.

Developing countries often lack comprehensive or mechanised solid waste-management systems. Manual 'wastepickers' usually collect, sort and dismantle materials for recycling, from households and businesses. Most function informally in conditions (social, economic, environmental and physical) that argue for the need for improvements to the sector. The

work is dirty and hazardous. Workers generally lack sanitary services, health care or social benefits. They are often the poorest in communities, or economic migrants. Child labour is prominent and life expectancy is low. Wastepickers are often harassed by authorities, face discrimination and violence, and are vulnerable to exploitation by profiteering intermediaries working across formal and informal chains (Meagher 2013; Benson *et al.*, 2014a).

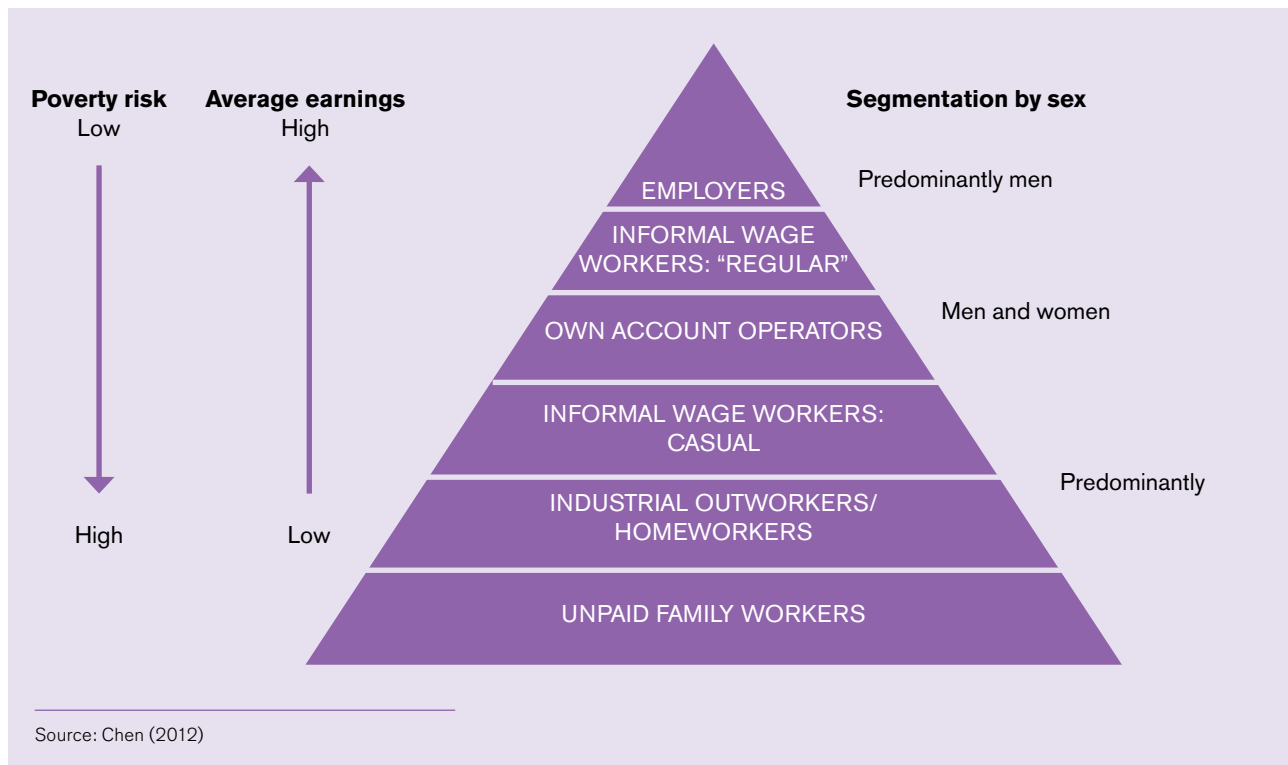
At the same time, waste picking provides livelihoods for an estimated 15 million people in Asia, Africa and Latin America. Waste collection and disposal services in developing countries make up a higher proportion of average income than in developed countries. In the current economic downturn, they offer a critical employment opportunity for people with limited education and skills. Flexible hours can make waste (including e-waste) inclusive of women who have other care responsibilities and/or when cultural or others factors constrain them to income-generating activities in or near the home. For many communities, informal waste-management systems, techniques and incomes have become interwoven into the structure of the local community (Benson *et al.*, 2014a). The importance of the informal e-waste sector for the livelihoods of many developing countries' urban and peri-urban poor is clear, as is the growing bias against informality among their policymakers.

2.3 Heterogeneity, nuances and inequalities

How does the informal sector help produce green, public benefits while also contributing to generation of public 'bads'? There is no simple answer. IIED, WIEGO and others argue for a better understanding of the informal sector as a hugely diverse range of active economic actors, who work across scales, sectors and urban and rural contexts. They make their own decisions, have different business strategies, and are to varying degrees integrated with both formal and informal markets and supply chains (Vorley, 2013) (see also Figure 5).

The nuances, diversity and inequalities that exist in the informal e-waste economy need to be well understood for policy responses to be fair and encompass all actors. This is not often easy to do. For the informal e-waste sector, significant differences exist in income levels, education and assets between poverty-driven, survivalist labourers and more autonomous owners of rapidly growing small enterprises. Some diversity is evident in the Indian e-waste traders and collectors perspectives presented in Chapter 5. There are also some clear inequalities in power and voice, including a conspicuous lack of representation for women workers and end-of-chain recyclers in this report and other studies of the

Figure 5. Informal employment: hierarchy of earnings and poverty risk by employment status and sex



Indian e-waste economy (in reality these two groups greatly overlap). There is little gender- or otherwise disaggregated data available on China and India's e-waste economies, although women and children tend to be concentrated in the most casual and exploitative segments of informal work (UNRSID, 2010).

2.4 Contribution to efficiency

A better understanding of diversity in the informal e-waste sector can support work that unpacks where contributions to green public goods already exist, which could be capitalised on, and which informal activities have a negative impact and need to be addressed. For example, two important dimensions relate to efficiency: waste collection and materials recovery. How does the informal waste sector, specifically the e-waste sector, contribute to or obstruct more efficient resource recovery? Despite the intent of new or improved national regulations and hazardous waste laws (where these exist), most recycled e-waste in low- and middle-income countries is still crudely processed by the informal sector, applying methods that salvage only a little, where more sophisticated processes might recover many more types and quantities of valuable secondary raw materials (Sthiannopkao and Wong, 2012).

Another significant factor is the amount of e-waste in developed and developing countries that is not collected for recycling in the first place, but treated as refuse. Research such as a GTZ study of India, Brazil and Egypt has found that informal waste collection tends to achieve higher collection rates than formal equivalents (up to 80 per cent in the case of Cairo), because waste is so essential for informal actors' livelihoods (Gerdes and Gunsilius, 2010). Evidence from Egypt showed a drop in recovery rates after the large-scale corporatisation of solid-waste collection a decade ago under Mubarak's government. Some Cairo municipalities have recently begun efforts to reverse this trend, disentangling themselves from multinational contracts in favour of reintegrating and reorganising the *zabaleen*, the city's vast workforce of informal waste collectors (Kingsley, 2014).

In the case above, 'over-formalising' resulted in a loss of efficiency. The same could well be true for e-waste collection in countries with well-established informal sectors. Evidence from China and India shows that, while big institutions can successfully operate high-technology e-waste recycling plants, they often cannot access sufficient e-waste to be economically feasible. Informal collectors could prove extremely useful in bridging this gap, if they are valued rather than excluded. And beyond efficiency, we argue that integrating informal workers can also provide social benefits.

However, informal recyclers have also been accused of 'cherry picking' – a practice that limits the efficiency of waste management – only collecting appliances with significant re-use and recycling value, resulting in far less than optimal recovery of secondary raw materials (Wang *et al.*, 2013) and more going to landfill. Reasons include the necessarily cheap and crude methods employed in materials recovery, pressures on traders to deal in only the most valuable materials, scarce storage space resulting in pressure to quickly turn over e-waste, and suppliers' limited access to informal markets which trade only a narrow range of recoverable raw materials, such as gold and silver. Both Chinese and Indian informal e-waste recycling sectors 'cherry pick'. Research on informal sector gold-extraction in Bangalore showed a 30 per cent efficiency rate, whereas smelting companies in Europe can achieve up to 99 per cent (Chaturvedi *et al.*, 2010).

2.5 Engagement with organised groups

Studies of other informal markets such as food production provide insights that may be relevant to the e-waste sector. A recent paper on small-scale farmers stressed the need to understand where informal sector actors are, not where we want them to be, and for a greater understanding of how the poor make markets work for them (Vorley *et al.*, 2012). There tends to be an over-focus on actors more visible to formal markets – such as small-scale producers in organised groups, usually formally registered. But most of the informal sector is not as organised (particularly the poorest) (*ibid.*). The role of 'middlemen' is important to acknowledge: in particular, non-organised wastepickers are often 'recruited' by middlemen (WIEGO, 2016).

In the context of livelihoods and informality, the poor organise into 'models of working'. Although this requires some 'coordinating function' it does not necessarily mean formality. Organising in itself can be challenging but can have advantages. Organisational models necessarily vary by social-cultural and local economic context, or in response to more formal government regulation and associated enforcement. Organisational models for e-waste occur in both the formal and informal sectors. Some groups are 'registered' but what registration means varies significantly, from more formal business (social enterprise) units, syndicates, cooperatives, or affiliation to larger labour groups such as Slum/Shackdwellers International (SDI). ILO's decent work agenda emphasises the importance of promoting informal labour organisation to strengthen voice and advocacy. For example, wastepickers in urban

or landfill sites often cluster in work groups to improve overall efficiency, particularly in pooling areas for storage and dismantling.

The complexity and reach of the rather nebulous networked 'market' systems in which the poor operate is both one of the strengths of informal systems, and often the downfall of formalisation drives that do not engage with them. Although most wastepickers operate outside of organised groups, they are gradually becoming more organised – starting through work units, and increasingly building into national movements lobbying at the policy level. For example, in Latin America national wastepicker movements now exist in most countries. National groups have formed a regional level organisation 'Red Lacre' (La Red Latinoamericana de Recicladores) representing 17 countries and millions of wastepickers.

2.6 Informal–formal links and hybrid models

How can policy be designed and implemented to reduce the risks and negatives sides of the informal economy? How can policy retain or enhance livelihoods, recognise and tackle structural inequalities, and support informal actors' existing contributions to public benefits? Hybrid models are one useful entry point, both in confronting existing realities and developing more inclusive policy.

This goes beyond a simple focus on the need to formalise (or conversely, to protect the informal economy from enforced formalisation). Formalisation should not be seen as a one-off process involving a simple set of steps, but as 'a gradual on-going process involving incremental steps and different dimensions leading towards varying degrees and types of formality' (Chen, 2012). While formalisation can bring benefits, in reality significant disincentives exist: the process is often not quick, simple, or even desirable for many informal individuals and businesses (as some of our case studies show). In particular, a focus on procedure and bureaucracy is needed, together with greater involvement of governance agencies other than those responsible for designing or enforcing new regulation, such as municipalities.

In reality, few informal enterprises operate in total isolation from formal enterprises or the formal regulatory environment (Chen, 2012). The nature of formal–informal relationships varies depending on context and specific activities, for example through independent market transactions, supplier relations along a value chain or sub-sectors providing services or goods

within a particular industry or commodity. In our cases studies, new e-waste regulations are already supporting the emergence of new, formal recycling companies, where previously there has been very little. These are in direct competition with well-established (and in some ways highly efficient) informal networks that operate all along the value chain, and are themselves encountering novel pressures in the new regulatory environment. In theory and practice, opportunities exist for hybrid models of working not currently supported by e-waste policy, which might build on the strengths of informality while enhancing environmental protection and health standards. In India, new formal–informal relationships are already developing. But policy that does not acknowledge and accommodate informality risks sustaining exploitation and exacerbating existing inequalities.

2.7 Key questions we ask in this paper

This chapter has summarised some of the voices calling for more debate on the importance of informal markets and evidence of their role in the transition to greener, more inclusive economies. Research is needed that examines the environmental costs and benefits of informality, and the relationship between market

governance mechanisms for ‘greening’ and the informal sector. Drawing on Benson *et al.* (2014a) we summarise some key ‘framing’ questions for this paper:

- Under what circumstances do informal economies prove most damaging to the local environment?
- Under what circumstances, policy-led or otherwise, are informal economies driving greater resource efficiency and protecting their natural-resource base more effectively than their formal counterparts?
- What impacts, positive or negative, can policy instruments for ‘greening’ economic activity have on informal workers and economies, including on their size and structure?
- What do experiences from the ground – successes and failures to ‘green’ and formalise informal markets – tell us about policy implementation gaps? Does ‘greening’ necessitate formalisation, or can it happen through other means or people’s own actions? Are there conditions where efforts to formalise can prove counterproductive to the greening agenda?

We do not seek to fully answer these questions in this exploratory paper. They frame a larger research agenda. But we revisit aspects of them throughout the discussion of e-waste regulation, models and realities in China and India.

International legal frameworks and global consumption trends

3

3.1 Global environmental justice and international legal frameworks

Largely in response to environmental justice concerns by NGOs and the media, recent international regulation has focused on prohibiting movements of e-waste between developed and developing countries. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was adopted in 1989. It was the first major international multilateral response to a series of public scandals in which developed-country industries were found to be dumping hazardous wastes, including e-waste, in countries where environmental awareness, regulations and enforcement mechanisms were lacking. The Basel Convention has been ratified by 182 countries, notably excluding the USA, the largest generator of e-waste. There are flaws: the convention does not mandate specific penalties; implementation and enforcement are problematic because of definitional ambiguities between 'used equipment' and 'end-of-life' e-waste. The trading regime it imposes also allows for hazardous waste transfers between contracting parties 'for the purposes of recycling and recovery' (Khan, 2014).

Various more or less voluntary initiatives, such as Japan's 3Rs (reduce, reuse, recycle), the EU's WEEE Directive and Waste Shipments Regulation and the US NGO-led Basel Action Network encourage responsible e-waste recycling and import/export practices. But enforcement and monitoring of safe e-waste disposal still principally relies on national legislation. Even where an economic block sets top-level directives, implementation and enforcement is at national and local levels – for example, while the 2007 EU WEEE Directive established clear systems of collection and recycling based on the *extended producer responsibility* (EPR) principle, implementation has varied significantly across EU member states (Cahill *et al.*, 2011.)

How can international frameworks – and bilateral development assistance – accommodate and support developing countries to improve the situation of informal e-waste workers and enterprises? And can they go beyond assuming the need for formalisation to recognise the contributions and potential of parts of the informal sector in generating green public benefits?

3.2 Changing consumption patterns: domestic e-waste in developing countries

The lack of national legislation, implementation plans or enforcement in many developing countries means that large volumes of dumped waste electronics are still reaching countries willing to absorb them. Legal loopholes and weak monitoring of international borders also facilitate transboundary movements of e-waste: Hong Kong and Vietnam are significant routes through which illegal second-hand EEE and e-waste enters China (see Chapter 4).

But what about the relative value to others of what developed countries might consider 'waste'? Beyond low-cost labour, the demand in developing countries for cheap refurbishable EEE and the raw materials extracted from e-waste for use in manufacturing also drives international flows of e-waste, especially to China (Wang *et al.*, 2013; Shinkuma and Minh, 2009).

Global and national capacity for monitoring e-waste flows is also key. Despite improvements in measurement and metrics (notably the UN's StEP programme with the *Countering WEEE Illegal Trade* (CWIT) consortium) data on global flows of e-waste import volumes is often rough and dates quickly in the face of increasing rates of technological change, and changing patterns of consumption.

The challenges of growing domestic e-waste streams are overtaking those of international imports for developing countries and emerging economies. They are a burgeoning source of materials for the informal industries that grew up to service international e-waste. Growing populations, economies and consumption are now driving forces for countries like India and China, which principally handled e-waste from rich countries like Japan, the EU and the USA. By 2030, the 'developing world' is forecast to annually discard twice the number of personal computers as the developed world – some 600 million versus 300 million (Yu *et al.*, 2010). In China and India, growing domestic consumption with large and expanding populations mean households and businesses will generate e-waste particularly fast.

These countries' profitable markets for recycling domestic and imported e-waste will also continue to grow. They still lack adequate protective environmental regulations and comprehensive labour laws. Even with legislation, corruption and complicated or weak governance structures limit enforcement. Cheap labour in urban areas makes them attractive as global workshops. Unlike homes and businesses in developed countries which might discard appliances, there is greater market demand and willingness to reclaim the value of recovered materials, or to see the potential value of refurbishment.

Most significantly here, both countries have a large, efficient and very well-established informal e-waste sector, catering to all stages of the process. As the

lucrative nature of 'urban mining' and secondary-resource recovery becomes more apparent, the existing informal sector has come to be seen as a serious competitive threat to newer, cleaner, formal processes and companies (Schluep *et al.*, 2009). We explore China and India's national policy responses to these trends and the impact on those operating outside of regulatory frameworks. We argue that the extent to which these informal workers and enterprises are taken into account will be a significant factor in the success of any attempts to 'clean up' e-waste management practices in these countries – perhaps more so than for developing countries lacking mature informal e-waste sectors (UNEP 2009).

Case studies: China



China is both the world's largest exporter of EEE and importer of e-waste from the US, Europe and neighbouring Asian countries, including South Korea and Japan (Wang *et al.*, 2013). It has a significant stake in both strengthening import controls and harnessing the rising mountains of e-waste generated by its rapidly growing consumer class. Its e-waste has largely been collected and recycled in the informal economy, driven by industrial demand for secondary materials and expanding rural markets for second-hand EEE. Despite legislative progress and noticeable increases in domestic and foreign investment in recycling, informal actors, particularly collectors, still dominate e-waste markets (Chi *et al.*, 2011). In 2013, China reported formal collection and treatment of 1.3 million tonnes of e-waste – about 28 per cent of all domestically generated e-waste. But accurate figures are not available for the quantity of international e-waste the country receives (Baldé *et al.*, 2015). In the coming years the formal and informal sectors will both continue to operate.

In this chapter we explore why, despite China's efforts to tighten regulatory frameworks for e-waste imports over the last 15 years, significant gaps in both legislation and enforcement remain. These regulatory weaknesses – together with a lack of recognition of the realities of existing practices for managing domestically-generated e-waste – have supported the continuation of dynamic and largely informal e-waste markets. Four case studies illustrate our argument that, despite growing state attention to formalising systems for collecting and managing domestic e-waste, most recent attempts have not got far in transforming the market.

4.1 China's legal framework

As well as ratifying the Basel Convention and banning e-waste imports since 2000, China has several laws in place prohibiting hazardous waste imports such as the 2005 'management measure for the prevention of pollution from electronic products' legislation (Yang *et al.*, 2008). It draws on principles of 'reduce, reuse and recycle' and 'polluter pays' to set out further controls on materials and the shared responsibility of producers, retailers and consumers (Guo *et al.*, 2005). It stipulates general provisions for disclosing information about toxic substances in products, and for the collection, reuse, recycling and disposal of e-waste in environmentally sound ways.

Yet legal loopholes and other weaknesses remain. In 2009 around 70 per cent of e-waste shipped into China was still illegal (UNEP, 2009) – mostly via Hong Kong and Vietnam. Importing any used EEE to China is illegal, but due to differences in customs control under the 'one country, two systems' policy, Hong Kong is a major loophole through which imported e-waste can be indirectly shipped to the mainland (Wang *et al.*, 2013). Guangdong province has the most prominent informal e-waste sector: adjacent to Hong Kong, it is a logical destination for transboundary shipments and e-waste has been traced back to North America, Europe and Japan (Wang *et al.*, 2013; Salehabadi, 2013). The border with Vietnam is also a major route through which e-waste enters China, and particularly linked with China's informal electronics refurbishment industry. Like China, the Vietnamese government bans the import of e-waste, but allows imports of second-hand EEE for re-export purposes. This makes it possible for Chinese enterprises to legally import other countries' e-waste and second-hand EEE via Vietnam's international ports to the Chinese border, and from there by truck to Guangzhou, to be rebuilt and illegally exported back to Vietnam or sold on the Chinese market, or recycled (Shinkuma and Minh, 2009).

For domestically generated e-waste in China, a 2009 waste-disposal law regulates the recovery and disposal of electric and electronic products. Before this, e-waste was not explicitly covered under legislation related to general pollution prevention, manufacturer responsibility for recycling products and packaging, or solid-waste management and recycling (for example, the General Environmental law, Clean Production Promotion law, or Solid Waste Pollution Control law). The 2009 act specifically targeted e-waste with detailed guidance on financing and implementing safe e-waste recycling facilities. In particular, it locates responsibility for collecting and safely handling e-waste with manufacturers, retailers and recycling companies, and requires recyclers to be licensed.

4.2 China's existing practices

In the early 1990s, China's government invited international containers of waste, levying a fee by weight. While much has changed and measures to ban e-waste imports have gradually strengthened since 2002, significant amounts are still shipped into the

country each year; most is illegal under international and Chinese law. The continuing profitability of international e-waste means that foreign and Chinese companies are reluctant to give up importing. Many small and large informal enterprises for recycling and disposing of e-waste emerged in the pre-2002 regulatory vacuum. Despite lacking the technology for safe processing, they constitute a mature and well-established industry.

Most imported e-waste is still processed outside of China's poorly-regulated frameworks for treatment and disposal, in urban or peri-urban 'recycling villages'. Almost a whole town's economic activity can be processing imported e-waste. Resident or migrant workers dismantle and recycle e-waste with few occupational health or environmental safeguards in place, employing crude techniques for recovering gold, copper, aluminium and other materials which affect the local environment and workers' and communities' health. Together with Agbogbloshie slum in Accra, Ghana, much media and NGO attention to environmental injustices associated with imported e-waste has revolved around Chinese 'recycling villages'. Guiyu, a town in Guangdong province, is one of the most notorious (and documented) of these. In 2012, its roughly 5,500 shops employed around 150,000 people, two-thirds of whom were migrant labourers from elsewhere in China (Wei and Liu, 2012). Several studies have detected elevated levels of toxins in air, soil, water, and human tissue in Guiyu. Lead levels in road dust were over 300 times higher than those of a control village (Leung *et al.*, 2006; Sthiannopkao and Wong, 2012).

Despite increased government attention (regulation and consumer incentives) informal markets also dominate the management of domestic e-waste in China. For households and businesses, informal wastepickers (or 'pedlars') go door to door. Informal actors provide advantages of convenience. Margins are lower and competition higher in the informal sector, so pedlars are often willing to pay more for unwanted appliances than formal collection points – from tens to hundreds of RMB, according to e-waste type and quality. The urban informal e-waste sector in China is well connected, flexible and resilient, characterised by strong networks across a wide range of operations along the value chain, including pedlars, brokers and recyclers. Urban China has many formal collection centres for recycling e-waste, but (as with the far fewer Indian centres) they often face challenges getting enough materials supplied to them. As in India, Chinese cultural practices tend

to see waste as an asset and people prefer selling rather than 'donating' it. Household e-waste is stored at home or sold for further use, donated to poorer areas via charities, or – as a last option – sold to usually informal operators to be recycled. Even as China moves towards a modern consumer society, older generations – often responsible for households – still try to recover some value from discarded items, selling their families' e-waste to pedlars alongside traditionally recycled materials like paper and plastic bottles.

China has four broad categories of informal collectors: wastepickers or 'pedlars', traders and retailers, specialised collectors, and second-hand markets. Consumers can sell to any of these, but about 88 per cent of household e-waste is collected by pedlars, who ride bicycles, push carts or drive small trucks around residential areas (Wang and Ma, 2011). Waste picking is viewed as the job of the poor and marginalised, so selling to pedlars is bound up with issues of social inequality. Wastepickers in China are often older people – a symptom of the country's straining public pension system (see eg Griffiths, 2014) – or poor rural migrants. Many are homeless or live in informal shelters, lacking access to social welfare, medical insurance, clean water and sanitation. Wastepickers still operate mainly in urban areas, but as consumption of electronic devices increases across the country, rural areas will also begin to generate substantial volumes of e-waste that can be collected. In general, China's city authorities do not welcome pedlars (although presumably the households the pedlars collect the waste from do). The City Urban Administrative and Law Enforcement Bureau has cracked down on wastepickers in recent years, which must be a disincentive for informal actors to engage with formal processes or 'clean channels'.

UNEP estimates that 20 million primarily migrant workers are engaged in informal collecting and recycling of solid waste in China (Wang *et al.*, 2013). In 2007, an estimated 440,000 were involved in informal e-waste collection (Duan and Eugster, 2007) although accurate numbers are hard to gauge since many are generalists as well as those specialising in e-waste. Another estimated 250,000 work in manual dismantling and material recovery in the informal e-waste recycling industry (Duan and Eugster, 2007) including children working in family-run workshops.

Whether dispersed throughout cities or focused in 'urban villages' (key features of recent Chinese urbanisation: see eg Wang *et al.*, 2009) informal e-waste recycling in China is often primitive and lacks

environmental and health safeguards. Enterprises disassemble e-waste in the fastest and most direct way possible, often without basic precautions such as goggles, gloves or proper ventilation. Common activities – such as stripping metals in open acid baths, recovering metals by burning cables and parts, or heating printed circuit boards over a grill to melt the lead and plastic and extract embedded components – expose workers to toxic fumes and high concentrations of fine particulate lead (Leung *et al.*, 2006; Williams, 2005).

The growth of the informal e-waste sector in China is also related to e-waste refurbishment for reuse. The wide gap in income and living standards between rural and urban China and within urban areas, together with growing rural demand for electronic appliances and the fast turnover of EEE in urban areas (driven by consumption and rapid technology development), has led to burgeoning markets for second-hand devices, which are transported from urban to rural areas through informal channels. These markets deal in discarded appliances that have been repaired and products built with still-working parts salvaged from e-waste. Informal Chinese wastepickers and recyclers prioritise device or component reuse; a repaired device fetches a far higher price than the metals it contains.

E-waste is a large-scale industry in China that brings substantial economic payback through diverse combinations of formal and informal chains. While informal waste-picking and recycling activities in China are usually done by poor and marginalised social groups who need income for survival, incomes vary widely within wider informal e-waste management networks of traders and recyclers. These can be highly sophisticated, bringing together collectors, brokers, resellers and those who run recycling facilities, operating at a range of levels and scales.

High demand and favourable prices for extracted materials still drive the development of complex informal e-waste recycling and trading networks (Wei and Liu, 2012). As a result, China's e-waste recycling system is far removed from the West and requires very different regulatory approaches to manage it (Chi *et al.*, 2011). The case studies attest to the Chinese government's view that informal methods of dealing with e-waste are 'destabilising to societal harmony' – in contrast to what the ILO calls the skills of 'unrecognised waste management experts'. The cases also illustrate some of China's efforts to encourage private-sector investments to formalise the industry, and to tackle the environmental problems of handling e-waste and employing legal workers.

4.3 E-waste management in practice: examples from China

4.3.1 Haier group-sponsored pilot in Qingdao, Shandong province

This pilot was a city-level project. The main goals were to set up a collection network, develop improved recycling technologies and test them in a producer-owned recycling plant model (NDRC, 2003). Haier Group and Tsinghua University, with state financial support and in-kind contributions from the appliance manufacturer Haier, created a research group looking at e-waste recycling technology (Li *et al.*, 2006).

The biggest issue has been that the pilot project encountered significant difficulties in accessing enough material to operate at full capacity. The recycling centre mostly uses manual disassembly and mechanical recycling methods, and in 2006 four disassembly lines were installed for waste home appliances – refrigerators, washing machines, TVs and air conditioners. Together, these lines had the capacity for 600,000 units per year, but by May 2007 had only dealt with 8,000 appliances.

4.3.2 Suzhou Weixiang E-Waste Recycling Ltd., Jiangsu province

Suzhou city is a well-known manufacturing centre in Jiangsu. Well-developed industries and relatively high income levels mean that significant amounts of e-waste are generated from production and consumption processes in the city. The local recycling system is correspondingly more mature than many other cities in China.

Suzhou Weixiang E-waste Recycling Ltd was an initiative of the United Nations Environment Programme (UNEP) launched in 2006 (BCRC, 2009.) The objectives were to encourage electronics manufacturers to take responsibility for e-waste recycling, schools to influence green electronics consumption through education campaigns, and residents to take environmental responsibility by giving their e-waste to formal recyclers instead of informal peddlers. The company set up collection points in two local neighbourhoods, where residents could donate old computers, cell phones and TVs.

With advanced recycling technology and highly efficient air and water purification equipment, Suzhou Weixiang E-waste Recycling Ltd has the capacity to recycle 5,000 tonnes of computer motherboards, lithium-ion batteries and cathode ray tubes annually – equivalent to about 100,000 computers. But, like the Haier project, it has secured only an insufficient supply of e-waste. After the first six months it could not maintain normal operations and in 2012 the plants were still not operating to full capacity (Wei and Liu, 2012.) More than 400,000 computers per year were discarded in the company's catchment area when the project was launched; most continue to be collected by peddlers and informal recyclers (*ibid*).

The biggest issue the project faces is that the price paid by the Weixiang Company to consumers for their electronics is about 30 per cent of what informal collectors are willing to pay – for example RMB50 (US\$7.50) for a computer, compared to informal collectors' RMB150–200 (US\$22–30). Informal actors will also collect from consumers' residences where the formal system requires travel to a collection centre.

4.3.3 Green Communities Programme, Dalian, Liaoning province

The Dalian municipal government, in cooperation with Dongtai – the largest manufacturer in the region – introduced the Green Communities Programme in 2008. It focused on residential e-waste collection, seeking to develop a public participation mechanism by establishing infrastructure and through a joint effort by multiple stakeholders. E-waste collected was sent to Dongtai for treatment, largely circumventing informal collection channels.

The programme established 'green community partnership committees' composed of a range of stakeholders, including from the provincial Environmental Protection Bureau, local communities and property management companies. The committees' mandate included organising workshops on e-waste management to share successful experiences, and to build both participants' environmental awareness, and build programme legitimacy among stakeholders (Qu *et al.*, 2013).

The committees invite experts and specialists in e-waste from the Dalian University of Technology (a local leading national university) and the Dalian Environment Protection Bureau to disseminate knowledge on the hazardous and harmful characteristics of e-waste, bringing the academic and research community into the multistakeholder effort. This project seems to be more community oriented than the previous ones; however, it remains to be seen how successful it will be in the long run.

4.3.4 City-level pilot: subsidising 'old-for-new' home appliances

Although primarily intended to stimulate consumption and sales-channel reform in 'lower-tier markets', this programme is perhaps one of the more successful state-driven initiatives for formalising e-waste recycling (Wei and Liu, 2012), in terms of the quantities of electronics it has diverted to formal recycling channels.

Under the scheme, consumers selling their old appliances to registered recycling companies were eligible for a ten per cent discount on new appliances (China Energy Label, undated). There is little information available indicating what obstacles the scheme faced in bridging the gap between what informal collectors and formal recycling companies are willing to pay for old products, which defeated the UNEP initiative previously described. One possibility is that the scheme targeted still-working appliances (as well as end-of life products), and so competing agents may have been different.

The programme was piloted in nine Chinese cities from June 2009 and rolled out to 19 more cities or provinces the following year. By early 2011, it claimed to have encouraged the purchase of over 40 million new home appliances, while recycling around 42 million old units (People's Daily Online, 2011.) The scheme only applied to five types of product – televisions, air conditioners, computers, refrigerators and washing machines – and expired in 2011. In 2012, China trialled an improved version, explicitly promoting sales of new equivalent products with high energy-efficiency ratings and also a rural home-appliance subsidy scheme. However, both expired in 2013 and there are no similar stimulus programmes at present.

4.4 China: summary conclusions

Despite efforts to formalise the collection and management of domestic e-waste, China has yet to transform the e-waste market. Over the past decade, incentives for better collection and recycling by the public and private sector, to encourage the transfer of international recycling technologies, and to adopt Western waste management principles have led to growing domestic and foreign investment – such as the establishment of industrial recycling parks around several big cities and brands like Nokia setting up take-back schemes (Geng *et al.* 2009; Chi *et al.*, 2011). But the failure of many initiatives shows that Western models and high-tech equipment do not tackle the reality of the broader economic and social issues that underlie China's e-waste problems. Chinese policy language advocates for a 'circular economy' and state recycling efforts evolved in response to increasing resource shortages associated with rapid industrialisation and urbanisation (eg Mo *et al.*, 2009). But, so far, e-waste formalisation initiatives or technology transfer pilots have not taken into account that the quantities of e-waste it is possible for new formal systems to source will be limited by cultural practices, competition from the existing informal sector and remaining gaps in national regulation (UNEP, 2009).

The informal sector in China has grown dramatically in the last few decades. As in many developing countries, it accounts for a large proportion of today's urban livelihoods. But official statistical apparatus still does not gather systematic data on the informal economy (Huang, 2009). Many of the country's researchers and policymakers take the view that the resilient, still-growing informal waste sector is a significant part of the problem – in terms of e-waste management, one of the most prominent problems that remain. This bias towards formalisation is reflected in much of the academic literature and government reports from

China we drew on for this paper. The Chinese macro-environmental policy planning approach is technical and top down, which is not conducive to engaging with the informal sector. The approach is more often one of marginalisation, with little discussion about policy inclusive of the informal sector. There are some exceptions, arguing that state or private investment in formal recycling plants must first be supported by the formulation of a proper collection network, and China's main challenge is the integration of informal sector e-waste workers and enterprises and their activities into a formal system (Wei and Liu, 2012). Others agree that simply prohibiting or competing with informal collectors and recyclers is not an effective solution: responses should be more flexible and not just advocate for formalisation (Chi *et al.*, 2011). New formal e-waste recycling systems must 'take existing informal sectors into account', and see possible ways forward in better policies that improve recycling rates, working conditions and the efficiency of informal players (*ibid*). The key challenge is how to set up incentives for the informal sector which reduce hazardous activities and divert more e-waste to the formal recycling sector (*ibid*).

Historically, e-waste recovery has provided poor and vulnerable communities opportunities for survival and income generation. Excluding informal workers from local or national systems of e-waste management will have direct, negative effects on their livelihoods (ILO, 2014). The Chinese government is seeking innovative ways to gain control of this informal economy, and centralise and clean up e-waste collection and recycling. This is an opportunity for more successful, inclusive solutions that build on established supply chains and collection practices to harness the benefits and efficiencies of the informal networks already in place. There may be useful lessons from solid-waste practices in countries such as India, where groups of wastepickers have been supported to organise or unionise.

Case studies: India

5

In processing imported e-waste, India is second only to China. In domestic generation, it is the world's fifth-largest country, producing 1.7 million tonnes of waste electronics in 2014. Ten years ago, a study estimated that 70 per cent of e-waste processed or disposed of in India originated abroad (Sthiannopkao and Wong, 2012). Since then, some Indian and international efforts have been made to control the flows of imports into the country. But there is limited data on their success, and soaring domestic generation is likely to have a greater impact on the decrease in the overall share of imported e-waste handled in the country (eg Borthakur and Singh, 2012). Between 2006 and 2012, India's domestic e-waste generation increased by an estimated factor of eight (Chaturvedi and Bhardwak, 2013). Despite relatively low per capita consumption (see Box 1), this is likely to continue to increase significantly over the next decade, driven by population growth, rapid urbanisation, and changing consumer behaviours.

Poor infrastructure, inadequate legislation and weak regulatory frameworks mean that only a small fraction of India's e-waste is safely recycled. Domestic waste-management legislation lags behind recycling activities: around 95 per cent of India's e-waste is managed and processed informally (ILO, 2014).

In this chapter we will first outline how recent national regulatory attention to the sector has emerged. Largely good intentions to address urgent environmental and occupational health concerns have been in a vacuum and with significant omissions. This has led to growing tensions between the country's mature informal markets, which operate along all stages of the e-waste value chain, and a burgeoning new formal recycling sector employing large-scale high-tech solutions, supported by national and international finance.

Four case studies from Delhi, Kolkata and Bangalore illustrate that India's new regulations, its established informal markets and its emerging formal sector all stand to fail or succeed on the potential of the new market governance mechanisms to integrate informal and formal-sector activities and address social justice alongside environmental concerns.

We then summarise recent work by Toxics Link on theoretical models for e-waste management that bridge formal and informal sectors. These have had a key influence on the direction of this paper. They are based on good practice elsewhere and outline possible structures for facilitating formal–informal linkages within a cleaner e-waste system – integrating the informal sector into India's new legal framework for e-waste management (Toxics Link, 2013).

The final part of this chapter presents perspectives of workers and enterprise owners operating in India's informal e-waste supply chains, their views of their own situation, attitudes to the ways they currently work, and

their impressions of the incentives and barriers they face in switching to new and cleaner modes of operation.

5.1 India's legal framework

Despite decades of processing domestic and imported e-waste in the informal sector, and an information technology industry that has grown rapidly since the 1990s, until recently India had no specific law to govern e-waste disposal. The issue fell under general hazardous waste legislation. However, in 2004 national workshops organised by the Ministry of Environment and supported by GTZ (now GIZ), led to claims that India was 'one of the pioneers among developing countries in exploring management of e-waste' (Chaturvedi *et al.* 2010).

In 2008, the Indian Ministry of Environment and Forests' Central Pollution Control Board (CPCB) first produced a set of voluntary guidelines for managing e-waste. The E-waste (Management & Handling) Rules legislation was introduced in 2011 and came into force in 2012, influenced by campaigning from national and international organisations such as Greenpeace and Toxics Link. Further draft amendments are under revision as of early 2016, having gone through public consultation in 2015.

Framed around safeguarding the environment through promoting safe and more efficient recycling of e-waste, the rules emphasise three main themes: extended producer responsibility (EPR), reducing hazardous substances, and 'channelising' (sic) e-waste to authorised dismantlers and recyclers. They set out responsibilities for a range of private and government stakeholders.

The EPR principles place particular responsibility for managing e-waste on producers and retailers of EEE to safely recycle their products at end-of-life. They must create and finance collection systems for post-consumer waste, and ensure this is channelled to companies that use appropriate recycling technologies safeguarding environmental and human health. The 2015 draft amendments introduce others to whom the rules apply, requiring manufacturers and refurbishers to responsibly channel their e-waste. The new legal framework also bans imported EEE for 'charity purposes' (Pena, 2012), which adds to its problematic approach to refurbishment activities (Box 5). Outstanding issues include whether fixed targets should be applied to companies' EPR requirements.

Responsibility for ensuring EPR implementation, authorising new facilities and monitoring compliance is placed with India's Pollution Control Boards (PCBs) – state-level authorities mandated to regulate the e-waste value chain of collection, dismantling, recycling and disposal.

Neither the 2011 law nor the 2015 amendments acknowledge India's informal e-waste sector, as producers, recyclers or collectors – an early criticism in the drafting process, and not yet addressed, despite pressure from civil society organisations, and a 2011 Indian parliamentary briefing, which flagged that the law 'ignores the unorganised and small and medium sectors, where 90 per cent of e-waste is generated' and 'does not provide for any plan to rehabilitate those involved in informal recycling' (Rajya Sabha Secretariat, 2011). The same briefing emphasises the 'crucial symbiotic relationship' between formal and informal e-waste sectors, recommending that the informal sector's role in collection, segregation and dismantling 'be nurtured to complement the formal recyclers as supply chain partners' (ibid).

In contrast, new solid-waste legislation, drafted in parallel to e-waste regulations, takes a different approach. It recognises existing informality and waste management in India, mandating municipalities and other 'urban local bodies' to facilitate activities of informal companies and wastepickers, for example through providing access to waste and storage facilities for sorting, recycling etc. It also requires municipalities to organise waste collection for informal settlements.

The new e-waste rules have also done little to streamline the bureaucracy involved in complying with the new regulations, and make no mention of protecting livelihoods or simplifying or supporting the registration process for informal sector actors wishing to formalise. As the examples show, the time needed to get authorisation for an e-waste trading, dismantling or recycling enterprise can be highly prohibitive to small-scale operators – formal or informal – who generally lack capital for significant up-front costs.

Despite policy-level moves to take the handling and disposal of e-waste more seriously, in reality India has made only slow progress towards implementation. Two key challenges relate to the capacity of the already over-burdened state regulatory bodies to guide, monitor and enforce the private sector, and to the capability and willingness of producers to shoulder their EPR responsibilities. In 2014 and 2015, surveys by Toxics Link evaluated the effectiveness of the rules by appraising what action had been taken on ground, gathering information on the realities of state and corporate action from secondary data, websites and right to information requests. The exercise showed 'very serious gaps in implementation'. Among EEE companies, while a few brands have been proactive, most have failed to create even the most basic take-back systems – a key responsibility under EPR – or to provide publically available, consumer-friendly information on how to recycle their products (Toxics Link, 2014). As a result, 'most end users are still ignorant about what the problems are or what should

be done' (ibid). While this lack of effort suggests a need to strengthen the regulatory framework, Toxics Link are equally critical of governance efforts by state agencies: 'from lack of information on their website to inventorisation, from setting monitoring mechanisms to taking actions against violations, most have failed on many counts.' (ibid).

5.2 India's existing practices

Most waste collection and recycling in India is done by informal actors, who have historically played a key role in waste management and recycling by reducing the burden of formal agencies, particularly municipalities (Chaturvedi *et al.*, 2007). E-waste is no exception. In 2007, a national assessment found that just 5 per cent of e-waste recycling was done by formal companies. The other 95 per cent was handled in the informal sector (ibid). Although more recent statistics are limited and despite evidence of a growing formal e-waste recycling sector, most – likely over 90 per cent – of India's international and domestic e-waste still flows to informal markets.

While studies have looked at the quantities of e-waste that India generates and processes, there is little reliable information on the scale or differentiated characteristics of the men, women and children across India whose livelihoods are in the informal e-waste sector (Sinha and Mahesh, 2013). We know that some informal workers and small businesses have operated in the sector for decades, and that many relative newcomers with solid-waste picking or recycling backgrounds (ILO, 2014) have been attracted by growing demand for secondary raw materials (Reddy, 2013).

In India, as in China, informal collectors, traders and middlemen operate in large competitive networks, providing a door-to-door service to recover e-waste from households, offices and businesses, acting as the main suppliers of e-waste to the recycling industry (ILO, 2014). And like Chinese households, Indian consumers tend to assign value to waste and expect some reward for discarding it.

Waste picking from landfill is also a source, although many (solid) wastepickers remain unaware of the potential additional value of the e-waste products they retrieve (Raghupathy *et al.*, 2010 in ILO, 2014). Combined with a lack of consumer awareness, much still goes to landfill.

India's informal e-waste sector is highly tiered, incorporating large trading businesses, family-run enterprises, 'survivalist' casual workers (particularly for end-process recycling), men and women home-workers, and diverse states in between. Activities provide low incomes and unstable employment and

frequently operate amid unsafe working conditions. People can operate with little or no capital, but this often forces them to do so at extremely small scales, or to rely on middlemen – also in the informal sector – with more capital, for example traders who buy from small operators and sell in bulk. The sector can be characterised as consisting of entrepreneurs producing 'legitimate products' without proper permits and legal status because they lack the resources and/or the incentives to comply with the bureaucratic requirements to join the formal economy (Chaturvedi *et al.*, 2011). Informality can often prevail not because entrepreneurs are unwilling to abide by laws and regulations, but because they lack the resources to do so (Kuchta-Helbling, 2000).

As in China, at all stages of the value chain many whose livelihoods rely on e-waste are the urban and peri-urban poor. Some are independent, self-employed producers in urban areas, employing family members, hired non-family workers or apprentices. But many are more vulnerable – often rural migrants with low literacy levels, lacking minimum wages, access to social protection schemes or recognition by the authorities; for many, this is their main source of income (Sinha and Mahesh, 2013; Chaturvedi *et al.*, 2011; ASSOCHAM, 2014). Women and children frequently do the lowest-paid, dirtiest jobs, particularly end-stage recycling. Studies reveal both economic exploitation and health hazards such as bioaccumulations of toxins in informal workers in Delhi's informal recycling industries (eg Brigden *et al.*, 2005). A recent assessment estimated that 25,000 people in New Delhi earn a living from e-waste management, collection, dismantling and metal extraction, including many children (Chaturvedi and Bhardwak, 2013).

One response by the informal sector to the policy drive for more formalisation is apparent in the changing nature of spatial distribution of e-waste activities. More environmentally hazardous recycling and dismantling centres or activities are increasingly spreading outwards – from existing hubs in major cities to smaller, peripheral towns and villages, away from regulators' scrutiny or the need to bribe authorities. Space to amalgamate, sort and store waste is key to improving worker safety and supporting the growth of small collection, trading or dismantling enterprises. Land is at a premium and spatial exclusion is high in cities where the informal e-waste sector is prevalent like Delhi, Bangalore and Kolkata. In contrast to state-controlled pollution regulations, land acquisition is often subject to local or municipal zoning requirements.

Delhi is still the major hub for India's complex country-wide networks. Both the scale and qualitative nature of its e-waste sector are different to other Indian cities. China makes a clear distinction between domestic waste largely handled in inner cities and the strategically located 'villages' set up to handle international e-waste.

But Indian centres for processing these two waste streams are less distinct. Much of the 'secondary circuits of value' are created in or around Delhi, where much of the chemical processing and recovery of secondary raw materials takes place. This is where most value sits in the e-waste chain, meaning that far smaller margins of profit are available to collectors, dismantlers and traders in other parts of the country – although selling parts for refurbishment can make these activities more profitable (see Box 5).

The sector contains complex combinations of formal and informal supply chains and sources for collectors including households, small and large businesses, industry and the public sector. Collected e-waste can be traded many times before finally being processed and metals extracted, usually in Delhi. Auctions of bulk e-waste are common, where informal and formal actors often bid against each other.

While recycling in India is still dominated by the informal sector, there is evidence of a growing formal recycling sector. New regulations are giving investors confidence. As both formal and informal actors enter the market, competition for waste is increasing between formal and informal actors and within informal markets. If India's regulations are adhered to, bulk consumers will be required to discard to clean channels, and e-waste will slowly move to the formal sector. At present it seems many authorised collection and recycling facilities may be under-used and struggling to acquire enough waste to operate cost effectively, and, while there is growing wariness that they are operating outside the boundaries of the law, e-waste continues to flow into the informal sector (Mahesh, 2015).

In spite of these limitations in compliance with or enforcement of EPR, changes are beginning in response to India's new regulations which could have far-reaching implications for the informal sector. Both Indian entrepreneurs and established global recycling companies are starting to recognise business opportunities and invest in recycling facilities (although questions remain around the governance and monitoring mechanisms being put in place to ensure environmentally safe operating practices). At the last count, there were more than 99 units with authorisation. Many people we spoke to complained of stiff competition from other informal operators, which may now increase. Sources of materials will become scarcer if the new rules are effective in prohibiting waste flows to informal operators and incentivising new formal companies which provide an alternative channel for used EEE – particularly for bulk consumers such as large offices and the public sector. This has serious implications for the livelihoods of urban poor men and women engaged in e-waste collecting, trading and recycling – for many, e-waste is their principal source of income.

BOX 4. 'HYBRID' MODELS OF E-WASTE MANAGEMENT IN THEORY AND PRACTICE

Toxics Link, an Indian research NGO has developed a range of models based on good practice in the solid-waste sector. They promote formal–informal linkages which protect informal livelihoods by including existing operational networks of informal actors in the 'clean channels' promised by the new legislative framework. They also recognise that in the context of India integrating formal and informal sectors is necessary to optimise both collection of e-waste and secondary raw materials recovery. These models are outlined below.

Although largely theoretical, they are based on good practice in the informal solid-waste sector in India and elsewhere. Importantly, they do not all require informal operators to formalise. Some have been piloted in India, supported by bilateral donors, linking to 'clean' formal actors in recycling and metals extraction, ensuring materials flow to clean channels. They can be understood as a 'package' of innovative options that might work together – rather than as alternatives to each other. The model design recognises that the technology does not currently exist to enable the informal sector to safely conduct 'end-process' recycling activities. The models therefore focus on opportunities for informal actors operating at the collection, trading and dismantling stages of the supply chain.

Model A: Wastepickers as collection agents using ID cards to legitimise collection from households and businesses on condition that collected materials go to clean channels. As part of their EPR requirements, EEE producers take responsibility for issuing ID cards and arranging bulk transportation of materials collected to registered recyclers and dismantlers. A variation of this model is being trialled in Kolkata.

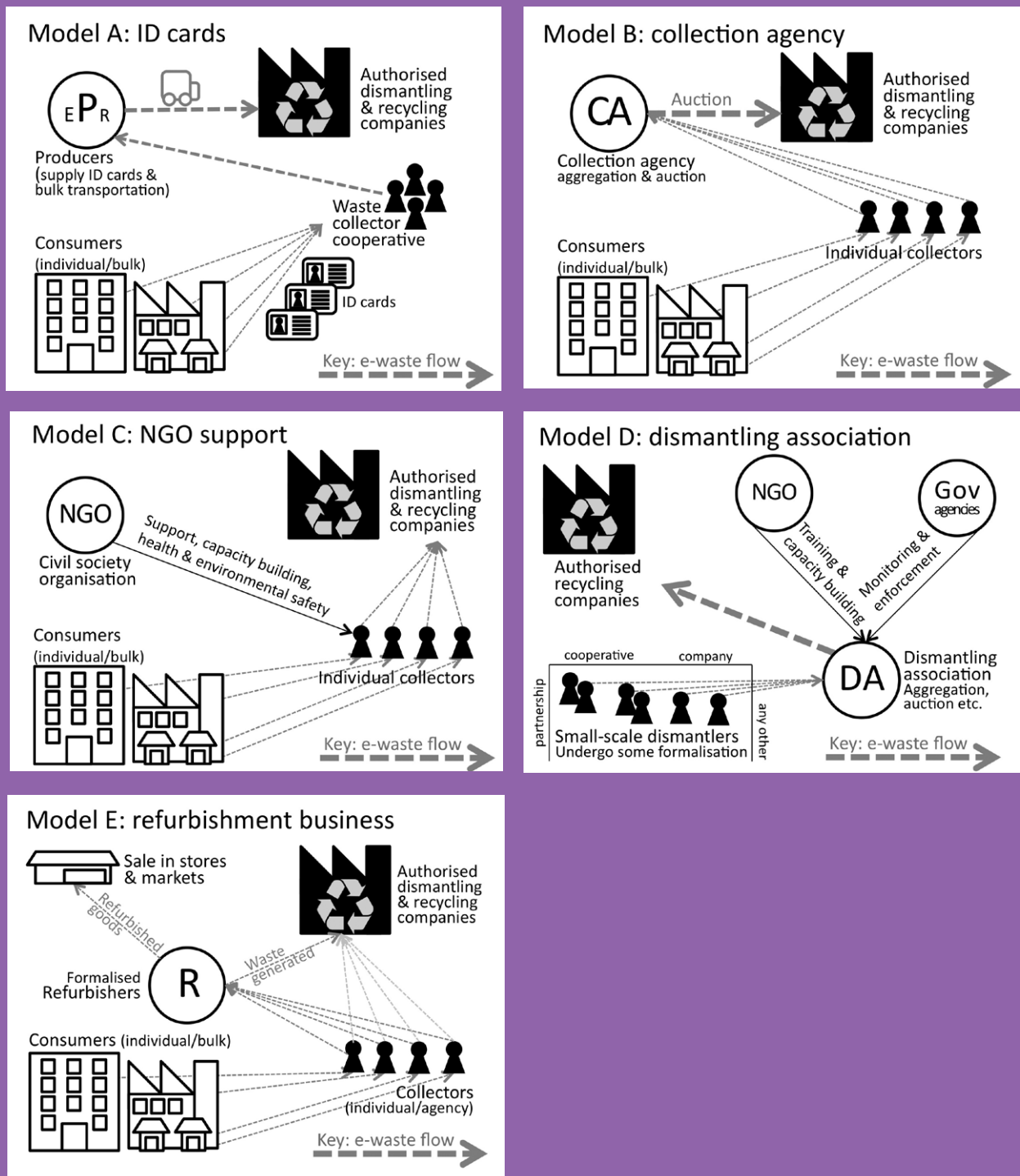
Model B: Waste collectors as a collection agency. A group of informal waste collectors formalise as a cooperative or profit-making company. Where in Model A they act as agents for EEE companies, here they are responsible for selling collected material. There are similarities here with the HRA E-waste and Sheikh Tiwari Electronics case studies, where many of the challenges associated with this model are evident – including the formalisation process, access to finance and credit, compliance, profit sharing and competition with other formal sector companies.

Model C: Waste collectors form an alliance with an NGO. This draws on examples in solid and e-waste management in India and Philippines. Waste collectors are linked to a community-based organisation, which gives them credibility when approaching households, companies and offices for waste. The NGO can facilitate access to small grants for collection equipment such as carts, and to education and capacity building around health and environmental issues, ensuring materials collected go to clean channels.

Model D: Dismantling associations, which involves formalising informal dismantling operations, through registering a business entity and complying with environmental and human health and safety requirements, since e-waste dismantling exposes workers to hazardous substances. Attention by policymakers and formal recyclers to the dismantling sector is important, since the activity is mainly manual and contains good potential for job creation. Informal actors can pool human and financial resources, and approach bulk generators for larger quantities of materials. However, the significant challenges to formalising that are listed under Model B also apply here.

Model E: Refurbishment business. We have argued the importance of refurbishment activities – which can generate larger profits, meet demand from poorer rural areas, and cut down on energy required for new products by extending the life of appliances. Refurbishment needs to be recognised to secure informal sector engagement with clean systems of e-waste management. A formalised refurbishment organisation could also be an opportunity for dismantling workers or others with the necessary skills to operate at a larger scale. As with Model D, the challenges to formalising listed under Model B also apply here.

Figure 6. Proposed hybrid models for greener, fairer and more inclusive e-waste management in India



BOX 5. E-WASTE REFRUBISHMENT

Refurbishment is crucial for the livelihoods of informal collectors and dismantlers in India. Its importance is key to recognising the realities of incentives to engage with formalisation.

Still-useful components fetch a much higher price for reuse than for metals extraction. Refurbishment is an opportunity for dismantling to be more profitable and for those with repairing skills to be more entrepreneurial. Growing demand for EEE in rural areas is also an important factor; where wealth inequalities between urban and rural areas (or within cities) exist (as in China and India) flows of refurbished products from cities to poor or rural areas are a significant driver of informal e-waste activities (Reddy, 2013). In the broader global context of manufacture, disposal and recycling, diverting e-waste to refurbishment also brings greenhouse gas savings (Eisinger *et al.*, 2011).

In making possible cheap access to household appliances and ICT for poorer households, a thriving refurbishment economy can affect markets for new

products – particularly low-cost electronics marketed at low-income consumers. There are accusations that companies who sell these products lobbied to influence the design of India's e-waste regulations for their own gain (Sinha, 2014). In addition, over-reliance on the agency of private producers/manufacturers might result in EPR being interpreted as bestowing rights to the entire product life cycle, risking an 'anti-informal' approach to e-waste management that fails to make best use of resources, through refurbishing and reusing appliances and components where possible.

Channelling components for reuse was initially not allowed for under the new rules, presenting a significant disincentive for informal actors to engage with the new formal systems. While some acknowledgement of the refurbishment industry is in the draft 2015 revisions, they focus on the refurbishment industry abstractly, as a generator of e-waste by-products that need to be appropriately 'channelised'. Recognition is needed of its key role in India's e-waste markets and value chain.

5.3 E-waste management in practice: examples from India

Here we present four short case studies of initiatives aiming to 'inclusively clean' e-waste flows in India by integrating existing informal sector actors into new models. They are qualitatively different from the Chinese cases. Although focusing on promoting safe technological solutions to hazardous e-waste recycling or channelling flows of materials away from unregulated activities, the Chinese case studies fail to acknowledge and/or aim to marginalise rather than integrate the men and women whose livelihoods depend on existing 'dirty' informal systems. Indian national policy recognises the value of the informal sector in solid-waste management and recycling (Government of India, 2006). The cases illustrate efforts to explore how the country might extend this to e-waste, by seeking to identify opportunities for the informal e-waste sector in emerging 'clean' systems.

5.3.1 Sheikh Tiwari Electronics, Kolkata

Sheikh Selim is an informal trader in Kolkata, a major hub for e-waste in northeast India. He collects both dismantled and assembled e-waste from a range of sources including his native village 50km from the city, where about 25 informal village-level collectors gather material from the city and its surrounds, dismantle it in their homes and then sell to him. Most of the e-waste he collects goes through informal channels to Delhi for the final stages of recycling and reclaiming any profitable metals, plastics and glass. But business began to struggle in 2011, when India's new regulations began to affect the country's informal e-waste market and the livelihoods of those who depend on it. Sheikh Selim's Delhi customers seemed to be accepting less e-waste from other parts of the country.

In 2011, he engaged with Toxics Link which supports informal e-waste workers to formalise their operations. Selim sought technical support to overcome barriers to upgrading from an informal to a formal business structure. Toxics Link and a local Kolkata NGO

supported him and his partners to understand the compliance requirements of the new e-waste rules and obtain necessary permissions from the state Pollution Control Board (PCB). They registered a company, Sheikh Tiwari Electronics Pvt Ltd, and set up a collection and dismantling unit 60km south of Kolkata in a largely rural area where such industrial activities are not forbidden.

To begin with, the company was still partially informal and non-compliant with 2011 regulations. The formalisation process has not been easy: it took almost a year to record the land in Sheikh Selim's name, and only then could they apply for permission to convert the land from agricultural to industrial use from the local authority, which in turn is necessary to get state permission for e-waste operations.

Other benefits to formalising the business also became clear to the e-waste traders:

I get more business opportunities if my business is formal and authorised [...] We face police harassment because our business is not a legal entity. Since the rules are in place, it would be wiser to protect my livelihood by becoming organised.

Toxics Link continues to provide technical support, but there is a long way to go before Sheikh Tiwari Electronics will be operational under a formal structure. In the meantime Selim, his partners and eight employees have received training in dismantling techniques for improved productivity and to minimise health and environmental hazards. They have linked with a formal recycler, to which they will in due course channel their materials. Once authorised, the company will also link to a network of around 100 informal workers, many of whom have organised into self-help groups, supported by Toxics Link and given basic training in safer handling of e-waste. This network includes informal village-level dismantlers and collectors who previously supplied materials to Selim.

There have been some successful precedents to this model. For example, Brazil has recognised the status of informal collectors as environmental service providers, and implemented initiatives to partner them with recycling companies, who then train the former to handle e-waste safely, efficiently and with environmentally friendly techniques (ILO, 2014).

5.3.2 HRA E-waste, Delhi

HRA E-waste Pvt Ltd is a private limited company run under a cooperative model, based in an industrial area of Delhi. It collects, segregates and stores e-waste from some 250 informal collectors who source directly from households and businesses in and around the city. It auctions the e-waste to formal recyclers, organising monthly bidding processes with four or five large companies. Profits go back to the informal collectors in proportion to the value of the materials they channelled through the HRA, less a percentage for the company's overhead costs.

HRA was the first company in Delhi to receive permission under the 2011 rules to collect and dismantle e-waste on site. It also participated in earlier GIZ-led consultations around the drafting of the legislation. Shashi Pandit, one of its two managing directors, is a university-educated trade unionist with strong links to a large Delhi-based union of wastepickers. He describes the company's purpose in social terms, as representing and providing a service to informal e-waste collectors. In 2009, Pandit took part in an 'exposure visit' to Germany organised by GIZ under the WEEE Recycle initiative in India, which included looking at business opportunities for e-waste management. HRA was established on his return to India, using funds to establish operations raised between 15 founding members, mainly informal e-waste collectors and traders, although Pandit covered much of this and holds a 50 per cent share in the company.

Establishing formal operations took a challenging two years, despite technical support from GIZ. This included dealing with an unfeasibly long gap between the two rounds of authorisation needed from the state regulator – first to set up an establishment and then to set up operations – which meant paying rent on a plant for a full year without being able to legally do business.

These experiences and those of Sheikh Tiwari Electronics illustrate some of the significant disincentives for informal operators to formalise. Many people do not have access, as Shashi Pandit did, to the finances to cover start-up costs over a long and often uncertain process. Others may lack the connections, education or technical knowhow that helped HRA establish a company and run it as a formal business.

It still faces challenges, many associated with the lack of regulatory enforcement in the e-waste sector, including corruption in the formal system. For example, office managers of companies that supply unwanted appliances to HRA for dismantling, segregation and auction often pocket half the value of the e-waste that their company sells, skewing real costs. The absence of a legal allowance for channelling materials to refurbishment is also a continuing problem for HRA's informal collector-suppliers and a significant disincentive for them to fully engage with or operate under formal systems. Under informal models, where police bribes are higher, profits lower and operations more insecure, reselling useable parts offers a far higher reward than selling them for end-of-life recycling. Even when integrated with formal structures, HRA's informal suppliers continue to channel reusable components to informal markets where profits are significantly greater.

5.3.3 Indo-German Swiss E-Waste Initiative, 2004, Bangalore

The IT industry in Bangalore received international attention in the early 2000s after groups like Greenpeace aroused media attention to e-waste (Brigden *et al.*, 2005; Reddy, 2013). A 2007 UNEP report identified the IT sector as one of the largest producers of e-waste in India, with others estimating that Bangalore's generation of e-waste increased from 8,000 tonnes in 2005 to 14,000 tonnes by 2009 (WEEE Recycle, 2012).

Launched in 2004, the Indo-German Swiss e-Waste Initiative aimed to clean up the sector and gain control of the rapidly increasing problem in Bangalore. It was a partnership between the German Society for Technical Cooperation (GTZ – now GIZ), the Swiss Federal Laboratories for Material Science and Technology (EMPA) and the Indian Ministry of Environment and Forestry (MoEF). It introduced the concept of a 'clean e-waste channel' (CEWC) to Bangalore, with the ambition to establish a separate channel of waste from beginning to end – from collecting and transporting to processing and disposal of hazardous materials.

The initiative saw 'control' of access to the e-waste materials, including those that feed down the chain, as key to a successful CEWC system. A code of conduct for recycling practices was established for Bangalore IT companies (ELCIA, 2007 in Reddy, 2013),

prescribing early separation of e-waste from other waste streams and tracking quantities of e-waste generated. Collection was to be only through authorised agents – effectively excluding any collectors not registered with the CEWC. The system was also designed to exclude informal recycling practices that happened at the end of the e-waste chain, where circuit boards and other components were being melted down in growing recycling 'villages' dotted around Bangalore, causing environmental and health hazards.

It was essential that the clean channel operated under strict regulation in the formal sector. Collectors and dismantlers operating in the CEWC were required to formally register as legal entities and be licenced by the state pollution control board. Although one smaller and one larger company was established and authorised to cater for recycling needs, the development experts preferred the larger company – arguably a bias in seeing bigger business as being 'cleaner' (Reddy 2013). A process to include informal e-wastepickers through formalisation (registration, training, and relocation to industrial zones) was also established. However, research found this inclusion process to be slow and time consuming, with only a handful of informal collectors formalised by 2011 (Reddy, 2013). Much of the e-waste now goes direct from businesses to the large company, circumventing these newly formalised e-waste collectors, whose network of relationships with facility managers in IT businesses established under the previous informal system have been effectively severed.

The initiative was deemed 'successful' by development experts in establishing a clean e-waste channel in Bangalore. Pilots to replicate it began in 2010 in Delhi, Kolkata and Pune under the WEEE Recycle initiative, hopefully having learnt from the problems faced in Bangalore. One important factor for replication is that e-waste markets in India's biggest cities have larger and more diverse sources of material and longer-established supply chains. Delhi in particular is the hub for both international and domestic e-waste; the latter often coming from smaller cities, through chains of dealers, to finally be recycled in peri-urban villages similar to those around Bangalore, but at a much larger scale. Enforcing clean e-waste channels through tactics of exclusion (eg registration and formalisation) is likely to face more problems in these markets than in Bangalore (Reddy, 2013).

5.3.4 Chintan Environmental Research and Action Group, Delhi

Chintan is a Delhi-based NGO working on issues relating to informal livelihoods in e-waste management in India, in partnership with development agencies, groups of wastepickers and EEE companies. It also explores the impact of foreign e-waste imports on India and documents the formalisation processes of informal enterprises. Their experiences illustrate some of the challenges for the e-waste recycling sector in India.

In 2008, before India's new regulations were in place and with funding from GIZ, Chintan supported a group of informal e-waste collectors in Delhi to formalise their operations, through registering as a charity (the 4R Association of Electronic Waste Recyclers). The association did not succeed, falling apart quickly due to trust issues among members, although a subset has since registered as a private company.

In 2011, building on lessons from 4R, Chintan began working with Safai Sena – an organised group representing thousands of informal workers involved in solid waste in Delhi, with whom they have a longstanding partnership – to set up a formal e-waste collection business. However, e-waste regulations were still new and state authorities unwilling to sanction a group of informal collectors. Eventually, Chintan applied for permission as an NGO to operate an e-waste collection centre, receiving authorisation in 2013.

Setting up and running an establishment in an industrial area of Delhi remains expensive and difficult, with high rent and costs of transporting the materials collected by Safai Sena members to the collection centre. Chintan aims to train Safai Sena to identify more profitable e-waste within the solid waste they collect, which can then go through the collection centre to clean, formal recyclers, and eventually transfer ownership and running of the centre to the wastepickers. But the centre struggles to acquire enough sufficiently valuable materials to be cost effective. Chintan continues to explore alternative ways to fill the centre and cover its running costs, documenting the challenges and barriers for informal actors to engage with cleaner models under the new regulations.

In 2012, Chintan also partnered with Nokia, one of India's leading mobile phone brands, under an 'extended producer responsibility' initiative. This aimed to engage itinerant buyers to channel discarded mobiles and chargers, through Chintan, to an authorised recycler. Again, the project struggled to get a sufficient supply of material and quickly failed. As with the Chinese cases, the key problem was the difference between the price that Nokia's formal recycler partner and the collectors' usual informal recycler clients were willing to pay for e-waste collected – with the latter often willing to pay double the former (see Figure 1).

Chintan's objectives include influencing middle- and upper-class consumers, initially by working with wastepickers to collect from these groups. They run school workshops and awareness-raising campaigns to encourage consumers to provide e-waste to local informal collectors (linked through Chintan to formal recyclers). Here, the focus is on changing Indian cultural attitudes – from prioritising value-recovery by selling unwanted appliances towards appreciating environmentally friendly and healthy ways of managing e-waste.

A few tonnes of free material have been collected through these drives, some via informal collectors, some donated by consumers. But overall, solutions like collection centres are unlikely to be the answer in India, while people can sell to an itinerant buyer on their doorstep. Changing cultural attitudes is necessary but is only one of a range of approaches to be tested and applied to 'green' e-waste channels. Manufacturers continuing to ignore principles of extended producer responsibility, together with the on-going need to find ways to 'plug the price gap', are bigger threats to the feasibility and financial sustainability of any clean e-waste systems.

5.4 Generating a greener, more inclusive e-waste sector in India

A key part of better understanding informal operating models and links to formal operations, and comparing green economy theory with practice, is understanding the experience of individuals working in the informal sector and its supply chains – in the case of e-waste, the small-scale, unregistered collectors, dismantlers and recyclers. What are their views and attitudes to their own situation? What models do they work in, how does policy affect them, and what are the incentives and barriers for them to change to new 'cleaner' modes of operation? Teasing apart the nuance, differences and inequalities in situation, voice and perspectives is as important as seeking areas of agreement.

We conducted a short set of one-to-one interviews with e-waste stakeholders in Delhi and Kolkata, and a focus group session in Kolkata (see Box 6 for methodology). Our sample is not representative of the sector's huge diversity. More field-work is needed – in particular, to unpack the complex flow of materials passing through supply chains and the barriers and opportunities for change at each point. Nonetheless, they provided some useful insights.

BOX 6. METHODOLOGY FOR GATHERING PERSPECTIVES

We talked to 15 individuals in Delhi and Kolkata involved in e-waste, operating along on a range of scales and business models, as well as a focus group with seven members of a Kolkata-based association who deal in scrap materials including e-waste. Interviewees were presented with open questions and a pre-designed set of possible advantages to being part of an organised group of e-waste collectors/dismantlers, and asked to prioritise these.

Nearly all interviewees worked as collectors or in both collection and dismantling. About half were managers and some of these identified as both manager and worker for different processes (eg collection manager, dismantling worker). A number of interviewees operated under registered companies, while still operating in e-waste informally. About half were part of a 'small waste-picking business model'; one worked under a formalised structure for trading e-waste. Others worked in a syndicate, directly with a company, or as individuals. Despite efforts to do so, we were only able to talk to one woman.

Gaining access to people working in recycling activities and to women workers to interview was particularly difficult, so these views are largely restricted to men working at the 'customer-facing' end of the supply-chain as collectors and dismantlers. Still, a range of income levels, education, age and time spent in the business are represented even within our small sample. Several people we talked to are already involved with NGOs such as Toxics Link, and so our findings will represent the more 'organised' end of the spectrum. Many refused to speak to us, particularly in Delhi and people involved in recycling, perhaps due to rising awareness of the illicitness of activities, or the growing outcry in Indian media about the environmental and human impacts of e-waste recycling in and around the city.

5.4.1 Modes of operating, perspectives on organising and different organisational models

Individual attitudes to the ways in which they currently work were mixed. Most saw their occupation as nothing more than a means to earn a livelihood, with no particular benefits beyond this. Some said that it was only way they knew to make money. When asked what advantages might be associated with being part of an organised group (not necessarily requiring formalisation), people prioritised improvements in working conditions, better security (legal, financial and physical) and better access to information.

People identified advantages and disadvantages to working as part of an organisation and had different and often contrasting views. Incentives to organise included easier work because of a shared workload, greater profit because of efficiencies, financial security (regular pay and regularised employment), protection from police harassment and corruption, more and better information about sources of materials and auctions, access to wider networks creating more business opportunities, and better, safer facilities (eg ventilation, electricity supply and authorisation to use 'more effective' technologies). Challenges and disincentives to greater levels of organising included difficulties in sharing profits (how to do this fairly among many members), lack of trust between members/risk of being defrauded, loss of earnings and business through being less competitive (in the face of high levels of external competition), and loss of autonomy, for example if the group comes to be dominated by a few individuals.

5.4.2 Spatial issues

Spatial issues and land-related insecurities came across as a priority problem and a key barrier to business security and growth. Lack of appropriate space was of particular concern to those who 'had no proper place to work'. A street collector who worked alone

faced constant fear of being forcibly 'moved on' from her temporary shop. Some interviewees valued the independence and flexibility of self-employment and working in or near the home, but many also said their families were disturbed by the noise created by their home-based dismantling activities. A specific issue was loss of profits due to the lack of space for storage, disassembly or refurbishment, meaning e-waste needs to be sold quickly or risks being stolen. Some specific ideas for improving models of working and enabling businesses to grow involved access to greater and more suitable space.

5.4.3 Complex supply chains

Even within this small and relatively homogenous sample, the complexity of collection networks and supply chains is evident, often involving interaction with formal businesses, which sell to and receive materials from informal enterprises. Differences between the two cities were clear: Delhi is the national hub for both domestic and international e-waste at all stages of processing, while Kolkata acts as a sub-national collection hub, with much of its disassembled materials sent to Delhi for final processing. Kolkata interviewees' collection networks mainly consist of other informal collectors, households and companies (including showrooms, shops, call centres and offices). They principally sell to other collectors and technicians for refurbishing, as well as dismantlers, informal recyclers and large formal recyclers. Delhi enterprises sourced materials from offices, call centres, households, factories and auctions, and mainly sold to wholesale dealers in particular parts, who act as middlemen between collectors and recyclers. A few Delhi interviewees sold waste to other collectors or directly to informal recyclers, and sold repaired parts to shopkeepers, dealers and refurbishers. In both Delhi and Kolkata, interviewees said any products which can be repaired they sell on for re-use and refurbishment at a higher price.

5.4.4 Challenges of working informally and bureaucratic barriers to formalising

People were sensitive to the lack of dignity and rights for informal workers, with associated problems of harassment by police and authorities. Some voiced concern about the financial insecurity of informal business relationships (eg without contracts). A few working in dismantling had a limited awareness of the health hazards associated with handling toxic materials. Several were conscious of increasing competition for materials where they worked that was threatening their livelihoods – compounding the insecurity of operating informally. At the same time, interviewees were highly aware of the scale of the significant bureaucratic barriers faced by those who want to operate legitimately

– a reality also clearly visible in the Indian case studies. Education levels varied widely and several people identified illiteracy as a key barrier to formalising and understanding the new legal frameworks (Borthakur and Singh (2011) also identify low literacy levels as an obstacle to understanding the potential hazards of working with e-waste).

5.4.5 What about profit?

The characteristic new and better business models that most people prioritised generally focused on generating greater profit. Some people favoured working directly with formal businesses. Others said working with other informal sector actors would pay more and working with companies would mean less profit. For some, working alone as a street collector or in a small enterprise was the best option, and working in a larger group was seen as too complex and risky. Some thought working in association with others would generate more profit and help to share the workload; in particular, a syndicate model was favoured by some. A few thought the best profit was made by dealing in extracted metals and in components for refurbishment, since these activities generate products with a higher market value than collection or dismantling for smelting.

5.4.6 Identity cards

We asked our e-wastepicker focus group if they held an identity card related to their occupation, and if they thought it could improve their work. No one had an identity card, although some had a sales tax number – a good illustration that 'formalisation' is not a black and white issue. When asked, all agreed that an ID card could be a positive thing, identifying possible benefits such as improved security, proof of legal activities as protection against harassment or bribe-seeking by the police, helping make business contacts, legitimisation through 'getting more respect' as businessmen (and woman) by showing their card when collecting materials, as well as social and personal benefits such as improving recognition of and personal pride in their work.

5.4.7 Types of information people seek

Clear and compatible legislation on e-waste treatment, recycling and stakeholder competencies, and access to information for all involved are fundamental for implementing sustainable e-waste practices at all levels (ILO, 2014). We found that the importance of information is equally appreciated in the informal sector. The desire to access better information relating to business opportunities and the business environment was one of the top themes in the interviews. This suggests reasons why informal sector actors might choose to organise or engage with formalised systems. It also reflects worries over increasing competition.

BOX 7. IDENTITY CARDS

Identity cards (ID cards) have been used by informal and hybrid model wastepickers in a number of cities and countries to build confidence and a positive reputation. This can assist with end-customer relations, reduce harassment by police and authorities and build a sense of pride for wastepickers as their legitimacy in providing a service is increasingly recognised. ID cards can be issued by organised groups themselves – for example in Chile a Santiago wastepicker business, Galpón Oreste Plath, issues its network with ID cards and provides other benefits such as a safe space for the wastepicker's children to play. In recognition of the service the business is providing in reducing its workload, the municipality assists by collecting waste that is not recycled for free from the business. ID cards are also issued by the municipality itself – for example in 2012, following a rubbish crisis in Bangalore, India, the municipality piloted issuing ID cards to a wastepicker association called Hasirudala (meaning 'green force'). Hasirudala now has 7,000 members, who work with households, consumers and local authorities. Provided with

an ID card and a green jacket with a 'green force' insignia, Hasirudala members note how this has increased their social status and reduced conflict with police. 'Now there is dignity when we go to collect waste. If somebody questions us, we can show the card. Earlier, people would drive us away as though we were thieves.' The municipality is also encouraging Hasirudala members to manage local waste-recycling centres it is setting up across the city (Chakrabarty, 2014).

The interview responses relating to ID cards in this section are similar to those given by solid wastepickers in models that have been tried and tested. The need for an e-waste 'clean channel' adds an extra level of complexity to regular solid-waste collection. Still, ID cards could improve the work of existing e-wastepickers/collectors, and in combination with other measures such as those discussed below, have potential to help legitimise current e-waste collection and dismantling activities while also encouraging onward flows of e-waste to clean channels.

If awareness-raising is key for engaging companies and consumers in new cleaner systems and informing them of changing regulations, this is equally so for the informal sector.

5.5 India: interim summary conclusions

India's e-waste scenario is clearly changing. The introduction of a supportive regulatory framework is already encouraging the establishment of many new, large, formal and high-tech recycling units. These new plants have the potential – if standards are properly monitored and enforced – to bring environmental and human health benefits and to more efficiently recover secondary raw materials. But inadequate attention to existing conditions – specifically a large, well-established informal sector representing 90 per cent of the country's e-waste activity – is already threatening the viability of these new operators. Many companies are unable to access sufficient quantities of e-waste. There are indications that alongside the formal the informal e-waste sector is also increasing, attracted by opportunities to profit from bulk 'channelisation' of e-waste facilitated by the new laws, as authorised recyclers struggle to compete with the existing informal networks.

Current incentive structures governing India's e-waste market are designed principally for big business. Instead, they should focus on more socially just options and recognise the different needs of informal, small- and medium-sized enterprises (SMEs). This includes SMEs (formal or informal) involved in EEE production and refurbishment, as well as waste materials. India's e-waste rules rely on large, centralised agents to drive change – large manufacturers and producers (to finance and deliver effective systems under their EPR obligations), and big companies running recycling plants – governed and monitored by already-overstretched state environmental bodies.

The capacity of state regulators – to enforce and monitor 'clean channel' compliance, hold producers to their EPR obligations, and provide information to domestic and bulk consumers – is a key limiting factor. In particular, the limitations of the current policy framework which does not recognise current realities encompasses both the threats and opportunities posed by a well-established informal e-waste sector and the lack of political will and resources to strictly police clean channel processes at scale. Research in 2014 by Toxics Link to gauge progress in implementing the rules looked at producers and state regulatory authorities across the country, and found the activities of both groups seriously lacking. In India, in a context of weak enforcement of environmental regulations and

occupational health and safety standards large-scale, advanced, recycling technology is not automatically the answer. Big companies can just become a source of different environmental problems; formal sector players must be well monitored by effective agencies.

We argue that the integration of the formal and informal sectors in India is a necessary (but not sufficient) condition for a viable 'clean' model that evolves from existing realities to optimise collection rates and secondary resource recovery. With the introduction of a law, India's informal sector went from 'unregulated' to 'illegal' overnight. Still, it is morally and empirically wrong to say that its entire informal e-waste sector is therefore problematic or undesirable. If effectively implemented, the new legislation could result in a loss of livelihood for many poor men and women in Delhi and other parts of India. But it could instead be seen as an opportunity if policymakers and others recognised and built on the informal e-waste sector's skills and knowledge, which have developed over many years of operating in a relative regulatory vacuum.

Small-scale, low-cost informal operations can achieve significant efficiencies over larger formal alternatives at certain stages along the e-waste chain – collection, manual dismantling and re-use of discarded materials. For example, informal-sector collection skills, where strong networks enable e-waste to be collected from even very small or peripheral sources, are a comparative advantage. Formal sector or local authority-led duplication of such activities 'would demand huge expense and unfeasibly efficient management systems' (Sinha and Mahesh, 2013). The whole recycling sector in India stands to lose if these strengths are not capitalised on. While there is often a real need to improve occupational health and safety, this might be done by engaging with the informal sector, for example, through awareness-raising, training, or enforcing standards that can be met at low-cost – as illustrated in the Sheikh Tiwari Electronics case study. It is largely only in the end stages of secondary raw material recovery (eg melting down e-waste components or chemical stripping) and the more hazardous dismantling activities where negative health and environmental impacts, combined with inefficiencies in resource recovery, require operations to be carried out in facilities adopting capital-intensive, technologically advanced methods.

While our case studies illustrate a few initiatives underway, more work is needed to explore ways to actively engage with India's large informal e-waste work force and find suitable options that bring the informal sector into the new 'clean e-waste channel' that the legal framework promises. This will require a

flexible range of co-designed models to be developed and sanctioned – keeping an open mind to the value of hybrid formal–informal models, and promoting training and capacity building of the informal sector. The variety of preferred modes of operating expressed even in our small interview sample gives a glimpse of the complexity of India's e-waste sector and the heterogeneity of those individuals operating at different stages – and thus the diversity of approaches needed for an inclusive market governance policy response. In the absence of adequate government support and capacity, the innovative nature of the private sector should be harnessed, and large producers encouraged to experiment and pilot new models that both integrate informal sector activities and allow companies to fulfil their responsibilities under law – with due precautions against the asymmetrical power relations such collaborations often imply.

Work to engage with the informal sector should also aim to better understand the barriers and identify appropriate incentives to clean up the chain. Clean e-waste models may have a better chance of working at scale by lowering barriers to entry for formalisation, particularly in collection stages, or if wholesale formalisation of informal operations is not necessarily a requirement. One approach might be an alternative focus on developing the legitimacy of informal operators. Finding ways to establish and prove legality of activities to clients and protect against police harassment are important issues to the informal e-waste actors we interviewed and are borne out in the literature (see also Box 4). Improving provision of adequate, secure and designated land and space for informal actors is another approach. In both of these there is potentially a central role for municipalities, rather than just the state regulators.

The informal e-waste traders, collectors and dismantlers we talked to are seeing India's e-waste sector becoming increasingly competitive. This might either limit possibilities for dialogue, cooperation and organising among informal actors, or further incentivise such measures.

The 'elephant in the room' remains the issue of pricing and competition between informal and formal recyclers – which drives much of the rest of the e-waste value chain. Resource recovery is where much of the value lies. As the case studies illustrate, informal recyclers' costs are much lower than their formal counterparts: they can afford to pay more for the same materials. This is a key hurdle in a model based on informal collection/dismantling channelling to formal recycling. Some options that begin to address this are discussed in the next chapter.

Discussion and conclusions

6

This paper has explored issues of e-waste management in China and India, reflecting on current policy and practice across a spectrum of examples that encompass formal and informal sector players. In both countries, current thriving informal e-waste markets are inclusive of some of the poorest, but are not often green and can be exploitative; however, they are often more efficient compared to formal equivalents, particularly in the early stages of the supply chain – collecting, dismantling and refurbishing e-waste.

We have reflected on the challenges and opportunities for improved environmental and health outcomes across the e-waste sector and the degree of inclusion different potential e-waste models provide: creating jobs and protecting livelihoods for some of those most marginalised by formalisation. There is a clear mismatch between regulation and reality for e-waste management and processing in China and India. Policies draw on European and US models, but have taken them out of context: policymakers focus on competition and marginalising their large, dominant informal markets, rather than integrating and building on existing realities offering few real incentives for new formal businesses or existing informal ones to formalise, and few prospects for environmental improvements.

What are the critical challenges, and what mechanisms could steer e-waste markets towards greener and fairer outcomes? We draw seven broad conclusions here. Apart from China and India, these lessons might also be useful to other countries or cities whose policymakers are grappling with similar challenges: growing mountains of domestic e-waste that are already claimed by thriving informal markets.

Chapter 2 outlined the key research questions framing our paper, derived from a small but growing body of research highlighting how invisible the informal economy is in most literature on 'green growth' and the 'green economy'. This is a serious omission. Our intention was not to answer every question; they belong to a wider research agenda encompassing many sectors and issues, including waste and e-waste management in developing countries.

Existing informal e-waste collection and dismantling sectors in China and India are driving resource efficiencies – including re-use of e-waste materials – and there are conditions where efforts to formalise can prove counterproductive to the greening agenda. However, impacts on health and the environment are evident in peri-urban and rural areas where unregulated secondary resource recovery activities take place. Low-tech, cleaner solutions appropriate to SMEs and the informal sector do not currently exist – the only way to perform these activities cleanly and safely is through well-managed, well-regulated formal sector companies.

6.1 The emergence of regulation for domestic e-waste markets

In China and India, domestic regulation has largely focused on establishing 'clean channels' for registered businesses to manage e-waste at all stages. China has also tried to promote 'reduce, reuse, recycle' principles. But despite good policy intentions (at least from an environmental perspective) in practice these formal, authorised, clean channels have had little impact on the informal sphere or on greening national e-waste markets. Formal e-waste management supply chains have proved far more expensive than their informal competitors – partly due to strict environmental and health standards – and many early attempts proved economically unfeasible. Private-sector engagement and regulatory enforcement also remain problematic, such as India's 'extended producer responsibility' (EPR) principle adopted in 2011 which placed the financial and implementation burden on producers: monitoring by Toxics Link shows little evidence of widespread implementation or enforcement (Toxics Link, 2014; Mahesh, 2015).

Both countries have largely ignored or tried to further illegalise and marginalise their well-established informal e-waste sectors – putting at risk many informal-sector livelihoods. At the same time, waste materials, particularly metals, are becoming more lucrative. Big businesses see profit-making opportunities and are using their lobbying power to gain control of access to materials; efficiency, and (very real) human and environmental safety concerns are used as justification.

6.2 Opportunities and challenges from well-established informal markets

The vibrancy of the e-waste sector in India and China should not be underestimated. Informal e-waste actors bring important benefits, many of which are broadly representative of solid-waste management in middle- and low-income countries. Refurbishing e-waste materials (rather than recycling) is rife in the informal sector – bringing environmental and arguably economic benefits. Informal networks of small-scale, manual collectors and dismantlers have efficiency benefits over larger formal businesses, particularly in household-level collection. But the hazardous nature of e-waste makes it a special case when exploring inclusive mechanisms for 'greening' supply chains. The vulnerability of many

informal e-waste workers is exacerbated by the lack of benefits offered by formalisation, particularly basic protection from occupational health hazards (Chaturvedi *et al.*, 2011). Therefore, within current technological constraints, recycling end-processes – such as toxic component dismantling, chemical stripping and incineration – need to undergo some degree of formalisation to ensure worker safety.

6.3 Hybrid approaches to e-waste management

What interventions can both help green the e-waste sector and also be more inclusive? Hybrid models and inclusive formalisation for informal wastepickers are not new – recent examples include Solid Waste Collection and Handling (SWaCH) in Pune, India; National Waste Pickers Movement in Brazil; *Bogota Waste Pickers Association* in Colombia; and the *zabaleen* in Cairo, Egypt (WIEGO, 2013). But the particularly hazardous nature of e-waste adds another edge. We have suggested that hybrid models may be a solution, where existing informal collection and dismantling markets are supported by, and integrated with, formal recycling companies that use clean technologies for metal recycling and toxic compound disposal. There is a strong business case for this type of formal–informal integration. The informal e-waste sector is huge: ignoring it or making it illegal is unlikely to result in much more e-waste going in to clean recycling channels.

Some of our India case studies tentatively explore hybrid models. They suggest the potential for business support mechanisms – such as start-up grants, simplified company registration and land allocation – to engage organised groups of informal actors to supply materials to ‘clean channels’. The work of Chintan and Toxics Link and discussions with informal e-waste actors in Delhi and Kolkata indicate that some formal and informal agents clearly recognise the benefits of hybrid models. But current policies provide limited facilitation, particularly for addressing gaps in appropriate guidance and support, or in accommodating refurbishment. And, crucially, both the Chinese and Indian case studies point to two of the biggest – and linked – challenges for designing mechanisms or models that ‘green’ e-waste chains while promoting inclusivity: providing appropriate pricing incentives and the risk to livelihoods for those involved in hazardous recycling. We discuss both of these further below.

Fostering and scaling-up hybrid models is not an easy task. What are the incentives to participate for diverse stakeholders? What are the potential barriers and inequalities? Models of formal–informal integration that aim for economic efficiency do not necessarily lead to social welfare synergies. Hybrid models must recognise and avoid many potential risks – such as

intensifying vulnerabilities, power imbalances in the design of operating models, diverging interests leading to exploitation, and undermining of informal worker organisations (Meagher, 2013).

6.4 Recommendations

Below are seven recommendations spanning e-waste policy and practice in China and India. We hope that these will provide food for thought for policymakers, donors, businesses and practitioners who work in e-waste. Further exploring these conclusions can help build understanding on how hybrid models could work in practice, and the types of supporting policies that would help with adoption and scale.

6.4.1 E-waste regulation must be inclusive and build on existing realities

On principle, e-waste regulation should build on existing practice and enable informal actors. Inclusive and formal–informal hybrid models for cleaner e-waste can add significant value and there are efficiency gains in models that integrate small-scale and informal enterprises. While formalisation is one possible way to bring the informal sector into ‘greener’ processes, we still need to better understand the barriers and constraints to formalising.

Informal e-waste collectors have a competitive advantage. They have established networks and flexibility (eg door-to-door collection). ILO recommends strengthening and/or formalising the collection phases of informal e-waste recovery. This option requires the least capital investment and could bridge both informal (collectors) and formal (recycling companies) sectors and use their respective skills to build more inclusive and sustainable e-waste chains (ILO, 2014). Governments can support this by adopting policies and legislation that promotes the role and participation of informal workers, improves or formalises collection performance, and supports informal actors to partner with formal recyclers (ILO, 2014). However, this type of model relies on resolving issues of pricing (see below).

One model does not fit all, and inclusive regulations must accommodate a hugely heterogeneous informal sector. Supply and value chains can be complex, posing problems for organising. Unequal access to business information and the changing nature of information flows are important factors, intersecting with highly nuanced power dynamics in the informal economy relating to wider social inequalities. For example, although little e-waste literature in China or India takes a gendered perspective, evidence from broader studies of informality show that women are more likely to work in lower-paid, more hazardous activities associated with e-waste dismantling and recycling, or be paid less for the same work as men. Research into new hybrid

models or ways of organising needs to consider how to tackle gendered inequalities.

In contexts of high levels of poverty and informality there is a strong case for reconceptualising waste management and how it is governed. In developing countries, it must be seen not just as an environmental issue, but also of social justice and urban planning – policy formation involving coordination between a number of ministries (Wilson, 2015).

Equally, in implementation, collaboration across national, sub-national and (critically) municipal levels is key to realising the social and environmental benefits of an inclusive approach to e-waste management. This could draw on the concept of a circular economy which sees the value of waste enhanced when segregated and resources extracted. But realising the benefits of such an approach would require broad collaboration across levels of government and ministries. For inclusive resource management and for the informal sector to take full advantage of this transition, local governments will be key to facilitating private and informal operators to work together in hybrid models (ibid, 2015).

6.4.2 The economics, institutions and incentives must work

Effective interventions addressing livelihoods, health and the environment together must also confront the realities of e-waste pricing within established informal markets. It is also key to the success of formal sector 'clean channels' (whether they are inclusive or not). Economic and other incentives, including buying into different operational models and organisational options, must be carefully considered with all actors along the chain.

The potential impacts of 'modernisation' of e-waste management on the poor and vulnerable are significant. As more developing countries start to grapple with new domestic e-waste streams, exclusionary policies of formalisation and privatisation of waste will impact millions of low-income livelihoods. A degree of formalisation is needed at the 'melting down' end of the chain, unless small-scale low-cost recycling technology options advance. But for this to happen – in a way that is still inclusive and protects livelihoods – the economics must work. New models must factor in existing pricing realities, so that new formal recyclers can compete with 'dirty' informal recycling markets willing to pay collectors, dismantlers and traders far more for materials. Getting pricing incentives right is important for a successful model – from collection to final recycling and refurbishment.

In Brazil, India, Serbia and Bolivia the informal sector is more competitive than the formal sector in e-waste collection (ILO, 2014). The informal collectors and middlemen offer higher prices for e-waste than private companies – often because costs are offset by low wages, poor health/environmental compliance, and lack of appropriate technology (ibid).

Other informal workers such as disassemblers and recyclers also operate with few *occupational safety and health (OSH)* or environmental standards. In fact, both small and larger recycling businesses currently profit from low wages and lax or absent regulations regarding public health and environmental safety (Puckett *et al.*, 2002).

The most visible issues are interdependent: workers who collect, disassemble, treat and extract valuable materials from e-waste are often not sufficiently aware of the toxic nature of the substances they are dealing with – while the low cost of processing e-waste without following strict guidelines and regulations keeps recycling costs low overall (Sepúlveda *et al.*, 2010).

Does encouraging health and safety compliance by informal operators naturally push up their operating costs and make them less competitive? If yes, it is a significant disincentive, particularly for small businesses whose competitiveness relies on low wages and overheads (ILO, 2014).

As our case studies show, regulations with little enforcement or attention to the pricing signals of these huge informal markets are unlikely to drive significant positive change. Policies design should be practical, working with the realities of existing e-waste markets to shape them for the better, rather than sitting in a vacuum that lacks context or the ability to implement or enforce. Providing incentives or 'carrots' (as well as punitive 'sticks') might encourage e-waste markets to comply with well-intentioned environmental, health and safety principles. Incentives are particularly important, given the cost and logistic difficulty in punitive enforcement of regulations.

To create an inclusive hybrid model where recycled goods enter formal, clean channels, closing the gap in price differences for e-waste between formal and informal sectors is a key way to change incentives and realise the vision. For example, a subsidy funded by a percentage of the retail price would give informal collectors and dismantlers an incentive to prefer these channels and help create the hybrid model in practice. It could provide workers in informal melting shops with an avenue into formalised businesses, while trusted organisations could help to raise awareness of hazards in hotspots where these activities take place.

6.4.3 Refurbishment can be greener and is critical to current informal sector models

E-waste is not just an issue of affluent urban consumption. Flows of refurbished products from cities to poor or rural areas are a significant driver of informal e-waste activities and make possible cheap access to household appliances and ICT for poorer households.

Still-useful components fetch a far higher price for reuse than for metal extraction. Sales of reusable e-waste will remain crucial to the livelihoods of many informal workers in India and China. Any 'clean channel' framework that does not factor in the demand for refurbished goods will face significant challenges. If channelling e-waste for re-use has no legal allowance what incentive will informal collectors and dismantlers have to engage with or operate within formal or hybrid systems? For example, under India's 2011 e-waste rules all e-waste must be channelled to registered recyclers and there are no provisions for refurbishment of goods.

Under informal models, where police bribes are higher, profits lower and operations more insecure, reselling useable parts still offers a higher reward than end-of-life recycling. As we found with HRA in India – and during our interviews with informal e-waste traders in Delhi and Kolkata – even where informal dismantlers and wastepickers are becoming integrated with formal structures, they often continue to supply informal markets with material for refurbishment.

For hybrid models to work there is a clear need to guarantee channels for reusable parts (Sinha and Mahesh, 2013; Reddy, 2013). Policymakers should recognise the importance of reusable e-waste – to the informal economy and low-income consumers – while ensuring refurbished appliances are safe. Developing light-touch (but mandatory) standards might help, while municipalities could provide sanctioned spaces for second-hand markets (Wilson, 2015).

6.4.4 Municipalities can play a key role

Municipalities (and local authorities) can play important roles in supporting inclusive e-waste models – providing local resources and when defining e-waste management policy.

Waste materials fetch better prices when sold in bulk. Dismantling, storage and processing also require space, which many informal and small-scale wastepicker enterprises lack. This is also one reason why the work is dirty – there is little room to compartmentalise it in ways that could be cleaner.

Space is at a premium in large cities such as Bangalore, Kolkata and Delhi (Toxics Link, 2014). Municipalities could assist by providing it, viewing e-wastepickers as part of the solution in reducing volumes of e-waste going to landfill. Once dismantled, materials not being refurbished should still go to clean channels. One multistakeholder solution proposed by Chintan in India is to establish an industrial park for e-waste trading and dismantling, with the state providing the land and the producer and retail companies financing infrastructure, transportation, technical innovation and training. A problem identified with this type of support is cherry-picking: recyclers and collectors only deal with higher-value e-waste. Unless they comprehensively collect all e-waste, municipalities will have to deal with the rest.

In India, municipal solid-waste rules offer municipalities a range of waste-management systems they can choose to adopt depending upon local conditions. Yet contracting out doorstep refuse collection to private local and multinational operators is becoming popular, as a strong lobby believes that it is cheaper and more efficient. These measures bestow contractors with direct control over the waste and its disposal, displacing wastepickers (WIEGO, 2013). However, as informal collectors offer better prices for e-waste, there is likely to be a continued preference for them. Municipal policy that ignores this may just drive the informal sector further underground.

Municipalities can also help reduce barriers such as weighty bureaucracy surrounding formalisation (see the Sheikh Tiwari case study). There are no quick-fix or universal solutions and space is needed at the local policy level for experimentation and dialogue with local stakeholders. Local authorities and municipalities should be proactive rather than reactive in driving this forward.

6.4.5 The public needs better information

In many developing countries, civil society is unaware of the importance of recycling e-waste or of those private and public initiatives that do exist for collecting or recycling (ILO, 2014). For consumers to understand the environmental and human impacts of unregulated e-waste recycling, better information and education are needed that influence public behaviour.

While informal e-waste management might be very different in China and India, both countries' policy and regulatory guidelines have been influenced by those in developed countries, but without accounting for specific cultural differences that make such models harder to implement. In particular, Chinese and Indian households see waste as a commodity with resale value (Chaturvedi *et al.*, 2010; Wang *et al.*, 2013). This can be seen as

a positive attitude, but consumers still need to better understand the environmental and human impacts of unregulated e-waste recycling, since public support for locally organised schemes can be hugely helpful. Consumer attitudes and cultural norms also need to be factored into policy design: if people are used to rewards and convenient door-to-door collection, models based on systems that require very different behaviour will struggle to succeed.

It is important to establish clear roles and enforce agents' different responsibilities for providing this information. Under Indian e-waste rules, responsibilities lie with both state and private actors, but public information is very inadequate, with both manufacturers and state regulators failing to fulfil their responsibilities to provide web-based information on the new rules, take-back systems, collection centres or recycling facilities (Toxics Link, 2014).

6.4.6 Engage electronic equipment manufacturers and retailers

In India, extended producer responsibility (EPR) legislation has had little enforcement. Manufacturers have done little to ensure their goods or waste materials are safely and cleanly recycled. A study found that only seven out of 50 Indian-based manufacturers had set up more than 10 e-waste collection points for their goods (none had more than 20) (Toxics Link, 2014). In China, manufacturers have little direct legal responsibility and some government schemes to incentivise recycling have effectively encouraged retail consumption via a publicly funded subsidy which exceeded informal channels, to encourage formal sector e-waste collection and recycling (see Section 4.3.4).

Without sufficient political will or resources to enforce EPR-style systems, how else can positive models be developed which encourage more gradual change? Government, NGOs and e-waste businesses could encourage manufacturers to engage in piloting models which both include the informal sector and ensure e-waste is disposed of via clean channels. Working with leading manufacturers to explore and finance options for addressing the pricing differences between 'clean' versus 'dirty' channels (ie how to 'close the gap') might also help. For manufacturers, there are benefits of improving their brand image and relations with policymakers by being associated with positive demonstration schemes.

Public education and awareness is also vital if consumers are to understand the benefits of clean and safe disposal of e-goods – consumer demand being another key level in convincing producers to act: equipment retailers are a key consumer interface where this awareness raising could take place.

Better cooperation and trust between manufacturers, regulators, policymakers and informal recyclers is critical to making EPR-style systems work. More effort is needed to identify and broker dialogue between stakeholders who are most likely to lead experimentation on how new models for collaboration might work.

6.4.7 Developed country governments have a responsibility

Developed countries must pay increased attention to international law enforcement to prevent the illegal shipping of e-waste to the developing world. While this is improving (eg in 2013, executives at a Colorado recycling firm received prison sentences for exporting toxic e-waste), much more needs to be done – including tightening up definitional inconsistencies. Current disastrous practices could become business opportunities, if the private sector, government and civil activist groups collaborate to trace the whole cycle of WEEE, which often goes beyond any single country's national borders. Achieving better economies of scale through collection practices is also an opportunity: the cost of recycling in wealthy countries is a key driver of illegal exports. Costs could reduce if companies were dealing with greater volumes. Developing countries are also responsible for regulatory enforcement, including import bans. But without adequate resources and capacity to enforce a system that aims to circumvent the informal sector, in reality much of this will come down to hybrid informal–formal models that work in practice.

These recommendations demonstrate that getting the enabling environment right is crucial – whether for appropriate finance mechanisms or regulations on who can and cannot handle e-waste. Policy must work with existing practice if change is to happen at scale. From current evidence, this is more likely to work through gradual evolution of e-waste models that work with existing realities rather than policy requiring sudden radical change. But it requires better cooperation and trust between national and local governments, manufacturers and retailers, and small and informal businesses. One way to start is by building local best-practice examples, experimenting with stakeholders who are willing to engage. In the next section we outline a number of ways forward for dialogue, research and action.

Ways forward, further research and action



Dealing with the polluting nature of e-waste management techniques is urgent – as is the need to recover resources from waste. But moves to cleaner, greener futures must be equitable, protecting the most vulnerable who might lose out and seeking synergies with measures towards poverty reduction and social protection.

7.1 What can be done now?

Picking up on a number of the recommendations in the previous section, the following are practical steps to move towards improving e-waste models and supporting inclusive interpretation and implementation of policy that is already in place:

- **Identify and work with forward-thinking municipalities to experiment with new models,** particularly those municipalities more willing to allocate space for accumulation, and participate in dialogue on more effective local regulation for e-waste management.
- **Identify a number of leading manufacturers willing to invest, think creatively and work with others.** Extended producer responsibility (EPR) will only function in practice if manufacturers are willing to work within existing realities and with others to experiment – and are supported and incentivised to do so by an enabling regulatory environment. Some experimentation may require leaders to be bold – for example, exploring financial incentives for e-waste collected by informal actors to enter formal recycling chains, such as subsidies or extra charges at point of sale. Manufacturers could adopt more flexible attitudes to proprietary rights, actively or passively supporting the re-use/refurbishment of e-waste components. Incentives for manufacturers to engage must be explored: these could include being seen as a socially responsible business and respecting the EPR law.
- **Create ‘safe spaces’ or forums to bring people together:**
 - Improve understanding by policymakers (national and local), manufacturers and existing e-waste value-chain stakeholders of the informal sector with respect to e-waste management. This includes building consensus and understanding on ways to protect and improve livelihoods, as well as incentives for existing (and new) stakeholders to engage in more sustainable e-waste models.
 - Encourage action-learning experimentation to develop and test new hybrid models. On-ground pilots should focus on exploring systemic issues, so that adapting and scaling in different contexts is integrated into thinking from the beginning.

Toxics Link’s theoretical models are a good starting point for such dialogue. Initially, separate spaces might be required for different stakeholder groups, to build confidence and trust. Attention needs to be paid to trusted facilitation and minimising power imbalances. A national-level forum could bring together learning from local pilots, and enable informal sector representation to organise, engage with and advise decision makers.

- **Promote cross-country learning:** India, China and other countries such as Ghana have big e-waste disposal issues and a large informal processing industry. More work is needed focusing on learning between countries through, for example, cross-country exchanges and adapting promising models or strategies to work in different national, socio-cultural and policy contexts.
- **Engage with donors and early pioneers who have been working in this space:** in trying to address e-waste issues in India and China, national and international actors including GIZ, UNEP and Toxics Link have pioneered early experimentation and support networks. Existing energy and learning should be drawn on, and international networks capitalised on in moving forward. Donors and governments should collaborate to ensure individual experiments are more than the sum of their parts and contribute to real policy change and build regulatory capacity. This includes improving cross-country learning, and lessons that could improve an understanding of the informal sector beyond the e-waste sector.

7.2 What needs further exploring?

In combination with the points above there are a number of areas that need more research:

- **Better mapping of e-waste value chains** in their complexity, diversity and contexts is needed to understand financial and information flows, and the variety of models across different geographies.
- **Further explore stakeholder incentives to participate in sustainable e-waste models:** what would it take to get economic incentives right for all parties, so that waste is safely recycled whilst also leveraging the dynamism of existing informal e-waste markets? More research is needed on what it would take to bridge the gap between what the informal and formal sectors are willing to pay – including where finance could come from (for example, if from point of sale, what percentage would this add to retail price?). Further work this and on non-economic incentives to participate in various models will likely require the safe spaces discussed above, and the leadership of a few enlightened manufacturers.

- **Better understanding of how refurbishment could be made legitimate and safe:** explore options to improve the quality and safety of refurbished goods, which could include light-touch certification or enabling regulation, capacity building with refurbishers and raising consumer awareness. Testing and implementing any of these options will face pushback from some manufacturers, and will require policymakers willing to experiment and champion the issue.
- **Measure impacts and include gender dynamics:** research is needed on how best to track intervention outcomes within rapidly changing and evolving e-waste markets, including where value is added (and what economic and non-economic forms this value takes from the perspective of different stakeholders). We also need to pay attention to how broader social inequalities intersect with power dynamics and inequalities within the informal e-waste sector, including how the ability to participate in organised groups, and social, health and economic impacts, differ for men and women.
- **Attention to recycling livelihoods:** in most proposed sustainable e-waste models that engage with the informal sector those at the recycling/melting-down end of informal e-waste value chains will still

lose their livelihoods. Effort is needed to explore alternatives for this segment – for example through training and jobs in formal-sector recycling – as well as technical research and development of low-cost or intermediate technology that could in the future allow for safe small-scale recycling facilities with fewer negative environmental impacts.

Waste flows are complex and highly context specific, particularly where an informal unregulated system has evolved over time. Official understanding, on which policies are based, is too simplistic. **We need a better picture of how the informal sector functions alongside and with the formal – now and in future – and how new innovative models might make the situation more equitable.** What are the key economic and non-economic incentives for informal and formal, large and small-scale stakeholders? This will require a greater understanding of the diversity, inequalities and vulnerabilities that exist within the informal e-waste sector. **Improved scientific understanding of the different environmental and health risks along the chain,** and the technologies that could mitigate risks, will also serve to inform better-targeted interventions.

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E-waste – electrical and electronic waste – is one of today's fastest growing waste streams. By managing it well, we can recover valuable raw materials and reusable parts, with significant associated emissions savings. But much of its potential is lost when improperly processed by informal and unregulated enterprises. This can damage both people's health and the environment and intensify the vulnerability of workers.

Informal markets are where most of the world's poor produce, consume and trade goods. Using case studies from China and India – both with huge informal e-waste sectors – this paper explores how to build inclusive, greener economies that retain the benefits of informal markets, while addressing how and why people are excluded from formal activities. Both countries are stepping up efforts to regulate but are failing to take into account the importance of engaging with the informal e-waste sector. How can drives to clean up harmful practices take their experience and expertise into account? And how can we develop effective policies to tackle pollution while supporting the health, livelihoods and economic activities of the poor and vulnerable?

IIED is a policy and action research organisation. We promote sustainable development to improve livelihoods and the environments on which these livelihoods are built. We specialise in linking local priorities to global challenges. IIED is based in London and works in Africa, Asia, Latin America, the Middle East and the Pacific, with some of the world's most vulnerable people. We work with them to strengthen their voice in decision-making arenas that affect them – from village councils to international conventions.



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