Commercial waste: industrial symbiosis, legal and theoretical methods of circular economy

Katrien Steenmans [1], Rosalind Malcolm [1], Jane Marriott [2]

[1] Environmental Regulatory Research Group, School of Law, University of Surrey, Guildford, UK
[2] School of Law, Royal Holloway, University of London, UK

[#] Working paper presented at the SMART conference 'Life-cycle based management and reporting for sustainable business', 29-30 November 2016.

Abstract. Waste can be conceived as pollution or a resource; pollution in relation to the vast amounts of waste produced that need to be managed, while a resource in that waste can be used as the virgin material in production processes. In both cases, waste is currently most commonly treated as an economic good and thus commodified as a result of approaching the ownership of goods from a Blackstonian absolute dominion perspective. In this paper we present a critique of this classic form of property ownership as it aids linear cradle to grave approaches to waste. In advocating a move towards circular systems for using waste, we propose the adopting of a Lockean conception of property. For this purpose we address three issues: (1) current property rights in waste; (2) alternative approaches to waste; and (3) impacts of applying Locke's theory. First, we address when an object becomes classified as waste, who owns waste and when ownership changes hands. In discussing the latter, a critique of the classic forms of property ownership that support linear approaches is presented. Secondly, we investigate appropriate property regimes to address these critiques, namely extended producer responsibility and common-pool resource approaches. Finally, the seminal example of industrial symbiosis in Kalundborg, Denmark, is used to provide context for discussions using Locke's property theory on the feasibility and implications of our property rights discussions and recommendations. Industrial symbiosis is a structure where waste is exchanged between industries within a given network or grouping forming micro-circular economies. In this symbiotic network, waste is thus diverted from landfill and other forms of disposal, thereby lessening the impact of the waste stream on the environment and the economy.

Keywords: Property rights; waste; industrial symbiosis; common pool resources.

1. Introduction

One of the consequences of approaching the ownership of goods from a Blackstonian absolute dominion perspective1 which is central to the western model of property ownership is that it tends to commodification. Indeed, the basis of this notion of property is that it is designed to aid trade and transactions in a linear economy. This presents problems for dealing with waste where waste is treated as a commodity which is bought and sold. Unlike other economic goods, waste is not desired or desirable. It is an economic 'bad', a consequence of a production and consumption society. Yet, it has become an object of 'trade' and the industry surrounding waste is based on private property concepts just like any other product which has become such an object of trade within the economy. It is axiomatic that waste is a problem – the production of waste grows despite all attempts to manage the problem2 and its impact on the environment breaches all elements of the sustainable development principle.

In this paper we present a critique of the classic forms of property ownership that support linear cradle to grave approaches to waste, and propose adopting a Lockean conception of property in the context of waste. Adopting a Lockean conception of property firstly resolves a number of difficulties associated with the way in which waste is envisaged by positive law and, secondly, may provide a

more appropriately adapted means of dealing with the concept of waste in circular systems. To support this investigation, we consider the application of industrial symbiosis as a structure which enables waste to be utilised by other industries within a given network or grouping. In such a structure waste is exchanged between industries forming micro-circular economies. In this symbiotic network, waste is thus diverted from landfill and other forms of disposal, thereby lessening the impact of the waste stream on the environment and the economy.

2. Contextual background to waste

There are growing waste crises as a result of the increasing amount of waste produced and to be managed.3 In 2014, 2598 million tonnes of waste were generated by all economic activity and households in the 28 European Union (EU) Member States, equating to more than 5118 kg per EU inhabitant.4 The current most prominent disposal and recovery operations to manage all this waste are landfill (43.6%), recycling (39.0%), backfilling (10.8%) and incineration both with and without energy recovery (6.5%).5 These operations all highlight the extent to which waste is a sustainable development issue, as a result of its economic, environmental and social effects.6 Environmental impacts of landfill can include air, groundwater, surface and soil pollution, as a result of methane gas that is released by the waste and as a result of the characteristics of the waste deposited in landfill.7 Additionally, landfill occupies precious land space, being commonly situated on low-lying and low-value lands. These are increasingly difficult to find.8 Despite the landfill rate of municipal waste having halved in the past two decades, a third of household waste produced is still sent to landfill. Incineration is often touted as an alternative to address the drawbacks of landfill. It however results in emissions of dangerous air pollutants and about a third of the mass burnt turns into ash, which then needs to be disposed of, often in landfill. Incineration can be used for energy recovery but again there are negative environmental impacts as a result of high levels of carbon dioxide emissions as part of the process.9 In addition to these detrimental environmental impacts, waste represents an economic loss. It is estimated that materials sent to landfill in the EU could have a commercial value of around €5.25 billion per annum.10 This is without including the cost of infrastructure required to collect, sort and manage waste. Lastly, landfill and incineration can have direct and indirect impacts on health including as a result of: methane from landfill contributing to climate change; air pollution caused by incineration emissions; risk of contamination of soil or freshwater, which can then be taken up in crops which affects crop yield and, in turn, food availability.

At the same time as this material is thrown away, there are ongoing resource crises. Currently, humanity's demand on the planet is more than 50% larger than what nature can renew: it would take 1.5 Earths to produce the resources to support current demand.11 In this context, the mismatch between used material being irretrievably discarded and the exploitation of virgin material raises the type of ethical questions which are inherent in the concept of sustainable development. To address some of these questions waste can be used as a resource. The EU's 2005 Thematic Strategy on waste cemented the shift in perception that waste 'is increasingly seen as a valuable resource for industry'.12 The strategy recognises the need to prevent waste and promote re-use, recycling and recovery to reduce negative environmental impacts, while simultaneously contributing to reducing overall negative impact of resource use. Other policies develop this further.13

The status of waste is further complicated. When waste is not used as a resource and has negative effects, there is still arguably the beneficial impact for the waste industry. This industry has grown in part because of the regulatory environment to deal with matters of disposal. It involves transport, disposal and recycling operations as well as complex legal and administrative decision-making around licensing and management. Waste is an economic good and the industry which has established itself around this good is high value.14 This waste industry has societal benefits in that it creates jobs and generates profits. Waste thus has duality in that it is both an economic good and a bad. The commodification of waste is a complex matter with benefits and demerits across society.

Regardless of the conception of waste, one of the key issues about the production of waste is that the pollution effects of the waste management and disposal operations operate as externalities where a consequence (cost or benefit) of an (economic) activity affects other parties without this being

reflected in market prices.15 Historically, pollution has operated as an externality, although attempts through such matters as taxation in the form of carbon taxes and landfill taxes alongside emission trading16 have sought to internalise these costs. These are regulatory approaches but Coase argues that solutions to externalities lie in transactions where the market can solve externalities (through an efficient solution) if property rights are clearly assigned and negotiation is costless.17 What Coase fails to address is that a transaction might not solve an externality but instead only compensate a private party for a demerit that they suffer individually. Coase's theorem does not challenge climate change or localised air pollution or the damage to aquatic ecosystems. Hardin's tragedy of the unmanaged commons18 is a Coasian cost problem where Hardin uses waste specifically as an example of pollution to demonstrate why privatisation or state intervention are required to internalise externalities.19 The tragedy stipulates that every individual, acting independently and rationally, will not recover or prevent production of waste if it is more expensive than discarding the waste.20 These top-down solutions have been critiqued.21 Instead it is argued that the most appropriate property regime depends on context.22 Nonetheless, approaches to externalities often seem to rest upon a structure of private property rights.23 The impacts of particular property rights in waste are investigated in the next section.

3. Who owns waste anyway?

Waste is currently treated within classic forms of property ownership. This is an issue when it comes to dealing with environmental impacts and externalities. Absolute dominion private property concepts sit uneasily in the continuum of a product from cradle to grave or during the process of manufacture. A product is the subject of absolute dominion private property during its useful lifetime. Once it is discarded then it assumes the character of waste. This moment in the lifetime of the product triggers regulatory controls. Likewise, the waste generated during production leaves the factory gate in a different fashion to the product which was the purpose of the manufacturing activity. The problem with waste is its potential to damage the environment and if nobody wants the waste then this potential is exacerbated. If the object leaves our hands or the factory gate as waste which is unwanted then the external impacts on the environment are likely to be greater than that of the product which is integrated into a cycle of use. There are two points which arise here:

- when does the object become classified as waste, and
- who owns waste and when does ownership change hands?

In this part we consider these two points in the manufacturing process and ask whether current arrangements are the most effective for dealing with the externalities caused by waste. For the purposes of this paper we are focussing on waste in the manufacturing process because we are examining industrial symbiosis networks which exchange waste forming micro-circular economies.

3.1 Definition of waste (when does the object become classified as waste?)

Definitions in law are important,24 especially in a system of regulatory control where what can and cannot be controlled,25 and when, needs to be defined. Legal definitions should be sufficiently wide to cover what needs to be controlled, while simultaneously adequately guiding behaviour and avoiding over-regulation.26 Additionally, the EU definition of waste has an international impact as the EU and international conventions are 'mutually influential'.27 The EU definition is found in the 2008 Waste Framework Directive28 (WFD).

Waste is defined in Article 3(1) of the WFD as 'any substance or object which the holder discards or intends or is required to discard'. The primary objective of the WFD supported by this definition is the protection of the environment and human health through the prevention or reduction of the adverse impacts of the generation and management of waste, and by reducing overall impacts of resource use and improving the efficiency of such use.29

The number of cases on the definition of waste indicates the complexity of waste regulations. 30 Most of those cases were decided before the most recent 2008 WFD implementation, but the European Commission guidance on interpretation of key WFD provisions considers case law decided under repealed directives relevant, albeit not legally binding.31 Additionally, the changes the WFD introduced have arguably not substantially altered the definition. One of the changes only occurred in

the English language ('dispose' was replaced with 'discard') indicating the change was for linguistic rather than substantive reasons.32 The other change to the definition was removal of reference to an annex which case law had already established could not be relied upon to determine whether a substance was waste.33

The current definition of waste and the relevant case law have three effects: (1) what can and cannot be controlled is unclear; (2) when a material or substance becomes regarded as waste lacks clarity; and (3) it is questionable whether the current approach actually protects the environment, which is one of the objectives of the WFD.

First, what counts as waste has to be determined on a case-by-case basis as there are no set characteristics of waste. The outcomes of the cases on the definition of waste have indicated that waste should be interpreted widely rather than restrictively. For example, the actual subjective intention of the holder of waste is excluded,34 the possible financial advantage of reusing the substance is irrelevant35 (even if a substance is a reusable residue, it can still be considered waste36), and leftover stone of the same composition as the rock from which it was quarried, that was stored awaiting subsequent use, can be classed as waste.37 As a result of this wide interpretation, in reality the extent to which there is uncertainty is debatable; if there is any uncertainty whether a substance or material is waste, it should be treated as waste as the definition is so broadly cast.

Secondly, it is unclear at which point material first becomes regarded as waste. Under the definition, a material becomes waste when it is discarded. There is, however, 'considerable dispute' over when this is the case. 38 Krämer acknowledges that often a case-by-case examination will result in deciding beyond reasonable doubt when a material has been discarded.39 He provides the examples of placing furniture outside the home before the official collection of bulky waste takes place, and placing bottles in a bottle bank, as examples of when a material becomes waste.40 The point at which a material becomes waste is significant, as this affects when waste law and policy begin to apply.

Thirdly, Malcolm and Clift have summarised the effect of the case law on the definition of waste within the context of industrial symbiosis by questioning whether the current approach actually protects the environment, which is part of the WFD's objective, as environmental risks associated with the material itself or with its intended life-cycle do not affect classification as waste or product.41

These shortcomings of the definition of waste have been acknowledged in the literature. Nonetheless Krämer and Pocklington argue against changing the definition as there would be a number of unwanted knock-on effects as thousands of national, regional and local laws are aligned to this concept of waste.42

3.2 Property rights in waste (when does property in waste change hands?)

The second question relates to the ownership of waste. Again, this question arises in two contexts: one involves the ownership continuum of the manufactured product; the other the material which emerges at the factory gate as waste. In this paper, our concern is mainly with the second category as it is this waste which is the subject of industrial symbiosis networks. Such waste is traditionally subject to disposal operations and, depending on the nature of the waste, it is flushed through sewerage systems or into a watercourse; removed by vehicular transport for ultimate disposal elsewhere; or, emitted as an atmospheric emission through a chimney. The nature of an industrial symbiosis network is that the material is taken by another plant in the network which utilises it as a resource (which is likely to replace a raw material).

This paper limits its discussion to different types of properties as described by Clarke and Kohler,43 and relies on Hohfeld's conception of rights.44 Hohfeld criticised the assumption that all legal relations, including property, can be reduced to rights and duties, and instead distinguished four kinds of entitlement that are commonly and indiscriminately subsumed under right: right, privilege, power and immunity.45 The former is also known as just right, but it is acknowledged that claim is synonymous to this, so to avoid confusion, using claim-right when referring to right in Hohfeldian terms, and right if in general terms. Hohfeld expresses the kinds of entitlement in a scheme of opposites and correlatives.46

Ownership of waste which is subject to some form of disposal is mixed. When it leaves the premises in the form of an atmospheric or aqueous emission then nobody owns it – it is the ultimate externality – and likewise when it is flushed into a watercourse. It is res nullius -owned by none - 'no-property' or 'open-access', in other words a regime where the resource is open to all, so that, in Hohfeld's terminology,47 everyone is at liberty to use it but has no enforceable claim-rights to the use of it enforceable against others or against the state. Of course, regulation might control these two types of emission forcing the transactional cost of disposal on the manufacturer. But the problem with such waste is to persuade others of its value and to create a desire for ownership and/or control. The problem is not that everyone wants it when it is floating in the air or the river but that no-one wants it.

If the waste is removed by municipal authorities then ownership is likely to pass on collection. Discarded in the WFD waste definition can be a way of stating that 'its owner ceded ownership'.48 Cessation of ownership may be equated with the abandonment of ownership. This is however not the case in the context of waste as Article 36(1) of the WFD states that 'Member States shall take the necessary measures to prohibit the abandonment… of waste' (emphasis added). Instead, what happens when waste is discarded is that there may be a transfer of ownership. To whom this transfer of ownership is depends on the waste management procedure adopted by the company – e.g. if have a permit to store waste or transfer waste elsewhere, or have a contract with a waste collection company or another company to transport waste to their premises. This raises interesting questions where collection might be delayed – a bank holiday, for example, or a strike. Then, if ownership remains with the manufacturer, responsibilities (or duties in Hohfeldian terms) will also follow. Alternatively, ownership might pass when a contractual relationship is entered into between the manufacturer and the disposal organisation. In which case, claim-rights and duties are established at that point. Where waste is private property this means that there is a right to exclude. Indeed, Merrill argues that the right to exclude is a necessary and sufficient condition of identifying the existence of property: 'Give someone the right to exclude others from a valued resource, i.e. a resource that is scarce relative to the human demand for it, and you give them property. Deny someone the exclusion right and they do not have property.' 49

But the widely accepted view amongst property theorists is that 'property' should not be limited to absolute exclusionary private ownership and private use rights. 50 This view recognises that the concept of property is broad and fluid and evolves with society meaning that we may need to recognise new types of property rights.51 It is becoming necessary to consider waste in such a way where the desire is to abandon this piece of property and the necessity is to encourage its evolution as the lynchpin of a circular economy.

Waste as communal property would apply to waste in the sky or the river. This is distinguished from no-property. As communal property every member of the community has the privilege to use the thing AND a right not to be excluded from it, and consequently everyone else in the world has a correlative duty not to interfere with their access to it. This type of property in waste could be open access (where everyone in the world is a member of the community) or limited access communal property (where there is closed or restricted access to a limited community) and each member of the community has both the privilege to use the resource (everyone else in the world, whether a member of the community or not, has no right to object). They also have the right to exclude all non-members of the community. For waste, the latter might be more appropriate to apply to waste more widely (beyond waste in the sky or river) in that members of a network or group – perhaps a Symbiosis Centre –can pool their waste, which is then used by others. This will only work if waste is perceived to have value so with this type of property there is again the need to drive waste reuse and recovery. If waste was open-access, well-intended individuals, in terms of re-using, recovery and recycling waste in an environmental manner, can interfere with others' waste to ensurethat it is managed properly, with others having no right to complain. Simultaneously, this means others could use or manage waste in a manner detrimental to the environment. It might, of course, be thought appropriate to impose duties on waste, but as there is no property in waste, a significant difficulty arises in how to impose or enforce those duties.

Waste could be owned by the state in a structure where individuals can still be allocated use rights of various types, or even limited management or control rights, but not property rights in the sense that such rights would be personal to holders and not transmissible. For example, if the municipality owns waste, then questions occur such as at what point do they own it – once it is discarded? Or is it once created? – E.g. discard may not have taken place, but waste may be stored. Or once bins are collected and the waste management companies have interests? – I.e. waste management companies acting on behalf of municipality. What would be the incentive for local authorities to be owners? Or should this just be part of their responsibilities? Further, it also does not mean that the authorities are currently participating in industrial symbiosis.52

The question is thus how should waste be managed? In particular, in the next section, we look at how waste should be managed to support industrial symbiosis networks exchanging waste.

4. Moving towards non-linear approaches

4.1 Managing property rights

The current linear society is consumption based where the aim is to own goods. There is no consideration beyond private ownership and this results in a short-term view of materials. The question arising from the discussion in the previous section is: what are appropriate property regimes to move away from this approach? We consider two possible options: extended producer responsibility (EPR) and common-pool resources (CPR).

The first possible option is using constructs such as leases, where EPR may have a role. Under this concept, the responsibility is shifted from consumers and authorities, the traditional assignees, to the producer of the products.53 In the WFD EPR is recognised as

> one of the means to support the design and production of goods which take into full account and facilitate the efficient use of resources during their whole life-cycle including their repair, re-use, disassembly and recycling without compromising the free circulation of goods on the internal market.54

EPR extends the responsibility of the natural or legal person who professionally develops, manufactures, processes, treats, sells or imports products (producer of product) to deal with the waste.55 What producer responsibility entails and the length of it is not defined in the

WFD, nor in its accompanying guidance document. 56 Instead, Member States may take legislative or non-legislative measures to implement EPR, and possibly define it. EPR aims to internalise the externalities of the supply chain through designing the reversed supply chain.57 In Hohfeldian terms: the producer has the privilege and the consumer has the duty to return to producer (which may be a qualified right).

But EPR is currently limited in its application. Another option is common pool (or communal) approaches to the ownership and management of waste which are more appropriate to addressing critiques of linear approaches. CPRs are economic goods which are subtractable and non-excludable. A good is subtractable (also known as rivalrous) if once a good has been exchanged, it is no longer available for others to use. The goods exchanged in industrial symbiosis, wastes and by-products, are both subtractable, because if wastes or byproducts are used by one organisation, they are no longer available for other organisations to use in their production processes. Exclusion, or control of access, 'relates to the difficulty of restricting those who benefit from a good or service'.58 This can both be in terms of physical exclusion devices or derive from other sources including the law of property, and its arguably constituent right to exclude.59 If there is a problem of exclusion, there is no legal entity that has the right to exclude others from accessing the resource. Difficult or costly exclusion provides a strong incentive for potential beneficiaries to free-ride. The free-rider problem occurs when those who benefit from goods or services do not contribute to their provision or maintenance.60

Beyond the determining characteristics of subtractability and non-excludability, CPRs have been defined as comprising 'resource systems and a flow of resource units or benefits from these systems'.61 Examples of CPR systems include lakes, rivers, irrigation systems, and forests, with water and timber as the resource units or benefits from the CPR.62 Even though examples of CPR

systems are typically natural resource systems, CPR systems can also be man-made.63 Industrial symbiosis is a man-made system with waste the resources units from the CPR.

There are two main motivations for defining industrial symbiosis and the exchanged waste as a CPR system and CPR units. First, the characteristics of CPRs match those of industrial symbiosis and waste, as described in the previous paragraph. Salmi and others have recommended that industrial by-products in the industrial symbiosis between heavy industries in the Gulf of Bothnia, in Finland, should be redefined as CPRs.64 Waste has also been described as a CPR by Cavé.65 His arguments mirror those in the previous paragraph in relation to subtractability and non-excludability: the concept of CPR

> converges with our characterisation of [solid waste] deposit: we have observed both eviction effects (within the service modernisation process) and resource overuse problems (of which appropriation conflicts are the symptom).66

Park and Louka however argue that waste is not a CPR because waste is generally perceived to be of low value, an externality to society, and 'one could hesitate to call waste a resource'. 67 Park and Louka have misinterpreted Ostrom; non-excludability and subtractability are the determining characteristics, rather than value, and whether an externality or a resource. Value may influence subtractability and excludability. For example, Ostrom has recognised the effect of value in relation to CPRs as the incentive to appropriate high value resources from an unregulated, open-access CPR system may be higher than lowvalue goods. 68 This however does not affect the material's subtractability. It may affect excludability in that if the incentive is higher to appropriate, then excludability may be more costly or difficult, but this affects the extent of the problem of excludability rather than whether excludable or not. In relation to the third argument, waste is often considered as a resource as discussed earlier.

Secondly, some of the benefits of a CPR governance system have been identified by Salmi and others,69 and Schiller and others.70 These benefits include reliability of flows, costs and clear definitions. The discussions of these benefits are however limited to their identification, and neither unpack the particular benefits and their implications, nor explain whether or how these benefits are being achieved in any case studies. Lombardi and others stated that

> [i]f it can be shown that the benefits ... of a CPR system are indeed greater than dependence upon open market systems, CPR may become another useful tool for the [industrial symbiosis] community to employ.71

There are also some general advantages of CPRs that could prove useful for industrial symbiosis. In Ostrom's Governing the Commons 72 joint use of the CPR resulted in communication between individuals and establishment of agreed-upon rules and strategies, which combined resulted in improved joint outcomes. These characteristics have proven key in industrial symbiosis.73

4.2 Kalundborg industrial symbiosis

This section so far has suggested two options for addressing limitation of private property approach to move away from linear systems. These together with the property rights discussions in Section 3 are now presented in the context of industrial symbiosis. Industrial symbiosis has been identified as a supportive strategy of effective waste management and the circular economy in the 2011 Roadmap to a Resource Efficient Europe,74 2012 European Resource Efficiency Platform75 (EREP) and 2015 Circular Economy Package.76 The 2011 Roadmap outlines how Europe's economy can be transformed into a sustainable one by 2050. The EU Commission identified that industrial symbiosis could support sustainable production and consumption, and that Member States should continuously work together to make the best use of wastes and by-products they produce by, for example, 'exploring' industrial symbiosis.77 In the policy recommendations of EREP, it was stated that 'EU and Member States should foster industrial symbiosis by promoting a pan-European network of industrial symbiosis initiatives, under which facilitators could be connected to allow match-making, including across borders and beyond the EU'.78 The objective of EREP is to provide high-level guidance to the EU Commission, Member States and private actors on the transition to a

more resource-efficient Europe by aiming to secure a doubling of resource productivity compared to pre-2008 crisis resource trends. 79 Following the initial recommendations of EREP, the European Industrial Symbiosis Association (EUR-ISA) was launched on 6 November 2013. The 2015 Circular Economy Package highlights industrial symbiosis as an innovative industrial process to support the

transition to a more circular economy.80 The Roadmap, EREP, EUR-ISA, and the Circular Economy Package all indicate increasing support for industrial symbiosis, as does the EU.81

The selected case study is the Kalundborg industrial symbiosis. This is the seminal example of industrial symbiosis, and is also from where the term 'industrial symbiosis' originates.82 This case study has already been much studied in the literature,83 but it is used in this paper nonetheless as a scoping case study to determine the value of examining the role of legislation, contracts and property rights in waste for industrial symbiosis. We are currently undertaking similar further research within the context of other industrial symbiosis case studies in Linköping (Sweden), Peterborough (the UK) and Rotterdam (the Netherlands).

The Kalundborg industrial symbiosis is located in the municipality of Kalundborg, which is on the north-western coast of the largest Danish island Zealand. It is the largest industrial cluster outside of the Danish capital of Copenhagen. It emerged spontaneously in 1959, and has evolved since then, not according to a plan but spontaneously. It was not until the 1980s that the participants in the industrial symbiosis first recognised the environmental implications of partnerships and exchanges that had evolved. Upon discovery, a network was created. Economic benefits have been the main driver for the spontaneous evolution, but regulation has also played a role as well as communication between the different businesses located in Kalundborg.

The exchanges in the Kalundborg industrial symbiosis are controlled by contracts, governed by the Danish Sale of Goods Act 2014 (Købeloven).84 These contracts include prices for the exchanges for a set period, payment terms, and mechanisms for future changes (such as escape clauses and requirements for upgrading). Waste is thus currently treated as private property, as there is a right by organisations to exclude others from it.

In this case private property rights are not a barrier to industrial symbiosis. It should, however, be noted that Kalundborg provides an ideal industrial symbiosis operation. It has evolved organically over time and in this case the absent kind of engaged policymaking that Denmark used to exhibit in the first couple of decades that links were initiated is unusual. (This has now changed and having seen and understood benefits of industrial symbiosis they are taking a much more directly involved approach). Replications of Kalundborg have been attempted but unsuccessfully. This is why a CPR approach needs to be considered as it does not necessarily require the privatisation of waste, and can arguably more effectively orient to sustainable development, environmental principles and non-linear (i.e. circular) approaches. Additionally, CPR emphasises the social dimension of treating waste, rather than the property and contractual approaches.

The social dimension of waste is critical because in moving towards away from linear approaches to waste, the shift will need to be partly cultural. As Reich noted, 'it is culture that makes a diamond valuable and a pebble worthless'.85 In similar fashion, it is legal culture - the expression of values, ideas and attitudes in law - that makes property valuable and waste worthless.86 If we accept that in a linear economy approaches to waste might be flawed, not least in their inability to cope with the waste nullius problem, then one of our principal challenges in advocating the transition to a circular economy is identifying the appropriate legal form for waste – namely one which can embrace, account for and deploy unowned or unwanted waste for wider environmental and economic benefits. A Blackstonian reading of waste as private property, albeit culturally embedded in Western legal culture, is argued to lack the transformative power to achieve what we believe is required – namely a conception of property that is capable of envisaging waste as a resource and not merely an asset. That conception must be readily adaptable to the mutuality of circular systems and flexible enough to accommodate the uncertainties present in current regulatory definitions and interpretations of waste and the activities associated with it. A Blackstonian legal conception of property, which is concerned with rights in rem, property belonging to a single individual and the right to exclude other individuals,87 is suggestive of rigid norms articulating property rights that are, in the modern context, designed to be exercised in support of a well-functioning market aimed at economic growth. That is not, necessarily, what circular economies drive at. As such, it may be argued that a Blackstonian approach to property in waste is too narrowly tailored for our purposes since those traditionally posited and understood facets of the legal ownership of property - exclusion, transfer, alienation – aim

more squarely at wealth maximization88 than at the preservation, augmentation and recycling of resources undertaken in circular systems. In circular systems, wealth maximization might be a consequence of those activities but is not a reason for them. For this reason, too, and because of its orientation toward single ownership, envisaging property as a 'bundle of rights' does not meet our purpose either. 89 The suggestion we make here is that adopting a Lockean perspective on property firstly enables the establishment of waste as a common resource. Secondly, a Lockean perspective helps to resolve a number of difficulties associated with the way in which waste is envisaged by positive law and, thirdly, may provide a more appropriately adapted means of dealing with the concept of waste in circular systems. Due to its contestability, we do not advocate that Locke's theory of property provides a complete solution to each of the issues identified in this paper.90 We do suggest that approaching those issues from a Lockean perspective might promote the cultural shift that is necessary to effect the transition towards a circular economy and respect for the environment as societal goods.

Locke's starting point is that the earth and everything on it has been given'to mankind in common'.91 In that "no body has originally a private dominion, exclusive of the rest of mankind, in any of them, as they are thus in their natural state" there must "of necessity be a means to appropriate them".92 The means identified by Locke is a person's labour. He states that:

> every man has a property in his own person;... The labor of his body and the work of his hands, we may say, are properly his. Whatsoever then he removes out of the state that Nature has provided and left it in, he has mixed his labor with, and joined to it something that is his own, and thereby makes it his property.93

Locke's concern here is the original acquisition of property rights from the stock of goods held in common,94 rather than the transfer or redistribution of existing property. In broad terms, therefore, Locke's claim is that the application of labour to 'unowned' property transforms common property into private property, enabling the acquisition of property and forming a legitimate right to it.95 The idea of labour is, thus, essential to the establishment of ownership since it is a means of exploiting a resource, adding to its value and, ultimately, taking ownership of it. Clarke and Kohler state that Locke's requirement of labour 'provides a justification for giving property rights in newly created things to the creator rather than to anyone else'. 96 This is highly significant since, in the circular economy and industrial symbiosis scenarios, the 'treatment' of waste may be seen in exactly this way: the exploitation of an unowned resource for benefit, that benefit being felt across a range from the individual to community, but where property is argued to remain in the creator – the one who treated the waste. This serves the dual purpose of enabling the 'creator' to use the waste for her own purposes and placing responsibility on her to treat the waste in accordance with any environmental regulations that may exist. From being unowned and unwanted, the waste has been transformed through labour into property, with its associated benefits and burdens. Naturally, there have been criticisms of the labour theory of property.97

As noted by Judge, 'absent an organizing telos that establishes a social objective, a labortheory of property is prejudiced against awarding rights to those naturally occurring goods, like biodiversity, the ozone layer, or clean air and water, which exist independent of human action'.98 The point is well taken but need not concern us since, in the industrial symbiosis setting, it is waste that is subjected to labour, rather than anything naturally occurring. Moreover, there is an organising telos which has established the social objective of environmental protection. That objective is expressed in society's norms governing the treatment, handling and disposal of waste.

Locke's theory, in embracing both common and individual or private forms of ownership, comports with the idea of the circular system since, as noted by Xu and Allain, it is arguably able to contemplate group access common property or limited access common property where a group of commoners can exclude outsiders but cannot exclude each other within that group. 99 In terms of the internal workings of the closed system, and the distribution of property inside, Locke's theory maintains that communities, by agreement, will settle the rights to the property that their labour has produced.100

Locke's theory of property has been criticised for its inability to impose constraints on ownership, and for justifying extensive property rights101 but, in the context of industrial symbiosis, the network

and extent of those rights are naturally bounded by the closed system in which the waste is being 'exploited'. There is, therefore, an inherent, structural limit on the creation of property rights, which may be argued to avoid those dangers.

5. Conclusion

In relation to Kalundborg, the Blackstonian absolute private dominion principles are in operation. But this is a context where the value of waste has been recognised, it has been attributed a monetary value and its commodification has worked with the trading model being used. It has however not generated a model which has been adopted in a widespread fashion. In other contexts, the notion of waste as a burden is the dominant perception and the encouragement of new approaches to resolve the problem of waste need to be addressed. Using communal property approaches where the community takes control of waste and forces the usage of waste through CPR mechanisms where management protocols are adopted seems to be a way forward.

References

1. Blackstone described property as "that sole and despotic dominion which one man claims and exercises over the external things of the world, in total exclusion of the right of any other individual in the universe" – William Blackstone, II Commentaries on the Laws of England (Clarendon Press 1765-1769) Chp 1, 2. Note that this is only a short quotation from a much longer text, and therefore it can be quoted out of context: Frederick G Whelan, 'Property as Artifice: Hume and Blackstone' in J Roland Pennock and John W Chapman (eds) Nomos XXII: Property 1010 (1980) 118; Alison Clarke and Paul Kohler, Property Law: Commentary and Materials (Cambridge University Press 2005) 183.
2. In 2014 (the most recent year for which EU statistics on waste exist), the highest amount of waste was recorded for the EU-28 since the beginning of the recorded data (2004). Note that there are considerable variations between amounts of waste generation between Member States and activities. Foe example, in 2014 Croatia produced around 723kg of waste excluding major mineral wastes per inhabitant, while Estonia produced 9.5 tonnes of such waste per inhabitant. Eurostat, 'Waste Statistics' (December 2016) <http://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics> accessed 9 January 2017.
3. In 2014 (the most recent year for which EU statistics on waste exist), the highest amount of waste was recorded for the EU-28 since the beginning of the recorded data (2004). Note that there are considerable variations between amounts of waste generation between Member States and activities. For example, in 2014 Croatia produced around 723kg of waste excluding major mineral wastes per inhabitant, while Estonia produced 9.5 tonnes of such waste per inhabitant. Eurostat, 'Waste Statistics' (December 2016) <http://ec.europa.eu/eurostat/statistics-explained/index.php/Waste_statistics> accessed 9 January 2017.
4. Ibid.
5. Ibid.
6. The three pillars of sustainable development, economic development, social development and environmental protection, were acknowledged in the Johannesburg Declaration on Sustainable Development (4 September 2002) UN Doc A/CONF.199/20 (1992) as 'independent and mutually reinforcing pillars of sustainable development'. For a more detailed discussion of the three pillars, see: Adress Ross, Is the Environment Getting Squeezed out of Sustainable Development' [2003] Public Law 249.
7. See for example: Kenneth Westlake, Landfill Waste Pollution and Control (Woodhead Publishing 1995); Kenneth L Mulholland and James a Dyer, Pollution Prevention: Methodology, Technologies and Practices (American Institute of Chemical Engineers 1999); Marquita K Hill, Understanding Environmental Pollution (3rd edn, Cambridge University Press 2010).
8. See for example: William P Cunningham and Barbara Woodworth Saigo, Environmental Science: A Global Concern (WCB/McGraw-Hill 19999) 518; Raquel Pinderhughes, Planning for Sustainable Development in Cities throughout the World (Rowman & Littlefield Publishers 2004) 63; John and Sharon McEldowney, Environmental Law (Pearson 2010) 217.
9. See for example: Bernt Johnke and others, 'Emissions from Waste Incineration' in J Penman and others (eds) Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (Institution of Global Environmental Strategies on behalf of the Intergovernmental Panel on Climate Change 2000) 455; Giorgio Buonanno and Lidia Morawska, 'Ultrafine Particle Emission of Waste Incinerators and Comparison to the Exposure of Urban Citizens' (2015) 37 Waste Management 75.
10. European Commission, 'Being Wise with Waste: the EU's Approach to Waste Management' (2010) 7 <http://ec.europa.eu/environment/waste/pdf/WASTE%20BROCHURE.pdf> accessed 22 November 2016.
11. WWF, 'Living Planet Report 2014: Species and Spaces, People and Places' (2014) hhttp://bit.ly/1ssxx5mi accessed 10 November 2014, 33.
12. Commission, 'Taking Sustainable Use of Resources Forward: A Thematic Strategy on the Prevention and Recycling of Waste' (Communication) COM (2005) 666 final 3.
13. See for example: Integrated Product Policy (Commission, 'Integrated Product Policy: Building on Environmental Life-cycle Thinking' (Communication) COM (2003) 302 final,); Circular Economy Package (Commission, 'Closing the Loop – An EU Action Plan for the Circular Economy' (Communication) COM (2015) 614 final).
14. For example, the value of the UK market for the 'he collection, treatment, recycling and disposal of controlled waste was an estimated £18.9 billion in 2013, with this estimated to increase to £24bn following annual growth rates of between 3-7% per annum by 2018. Waste Management Market Report UK 2014-2018 Analysis, (AMA Research Ltd, Cheltenham, UK). Summary of contents available here: http://www.amaresearch.co.uk/waste_management_14s.html accessed 19 November 2016.
15. Even where waste is a resource, there is still some production of waste, such as heat, as a result of physics (thermodynamics).
16. Harold Demsetz, 'Information and Efficiency: Another Viewpoint' (1969) Journal of Law & Economics, 12: 1–22.
17. Ronald H Coase, 'The Problem of Social Cost' (1960) 3(1) Journal of Law and Economics 837, 850-851.
18. Garrett Hardin, 'The Tragedy of the Commons' (1968) 162(3859) Science 1243. In this article Hardin referred to the 'tragedy of the commons'. This was revised in 1981 to 'unmanaged commons' following criticism. Garrett Hardin, 'An Ecolate View of the Human Predicament' (1981) 7(2) Alternatives: Global, Local, Political 242, 243.
19. Hardin, 'The Tragedy of the Commons' (n 18) 1245. For discussions of the tragedy and Coase theorem, see for example: Gary D Libecap, 'The Tragedy of the Commons: Property Rights and Markets as Solutions to Resource and Environmental Problems' (2009) 53(1) Agricultural and Resource Economics 129, 129-130; Brett Frischmann, 'Two Enduring Lessons from Elinor Ostrom' (2013) 9(4) Journal of Institutional Economics 387, 389.
20. Hardin, 'The Tragedy of the Commons' (n 18) 1245.

21. See for example: Siegfried V Ciriacy-Wantrup and Richard C Bishop, '"Common Property" as a Concept in Natural Resource Policy' (1975) 15 Natural Resources Journal 713, 714; Bonnie McCay and James Acheson, 'Human Ecology of the Commons' in Bonnie McCay and James Acheson (eds), The Question of the Commons: Culture and Ecology of Communal Resources (The University of Arizona Press 1987); Charlotte Hess and Elinor Ostrom, 'An Overview of the Knowledge Commons' in Charlotte Hess and Elinor Ostrom (eds), Understanding Knowledge as a Commons: From Theory to Practice (The MIT Press 2007) 30-32; Fikret Berkes, David Feeny, Bonnie McCay and James Acheson, 'The Benefits of the Commons' (1989) 340 Nature 91, 92.
22. Jean-Marie Baland and Jean-Philippe Platteau, 'Should Common Property Resources be Privatized? A Re-examination of the Tragedy of the Commons' (Development, Center for Research in Economic Development, Namur University) Discussion Paper No 143, 21.
23. Richard Cornes and Todd Sandler, The Theory of Externalities, Public Goods and Club Goods (2nd edn, Cambridge University Press 1996) 43.
24. Francis Lieber, Legal and Political Hermeneutics (CC Little and J Brown 1838) 303; James B Thayer, A Preliminary Treatise on Evidence (Little Brown and company 1898) 190; and Ezra R Thayer, Legal Essays (Boston Book 1908) 220.
25. Ilona Cheyne and Michael Purdue, 'Fitting Definition to Purpose: the Search for a Satisfactory Definition of Waste' (1995) 7(2) JEL 149, 149. See also: John Thomas Smith II, 'The Challenges of Environmentally Sound and Efficient Regulation of Waste – the Need for Enhanced International Understanding' (1993) 5(1) Journal of Environmental Law 91, 107. Smith states that an understanding of the definition issues is 'a perquisite to the design and implementation of sensible and compatible national and international waste management requirements'.
26. Joseph Raz, 'The Rule of Law and its Virtue' (1977) 93 LQR 195, 198-9.
27. Stephen Tromans, 'EC Waste Law - a Complete Mess?' (2001) 13 Journal of Environmental Law 133, 140.
28. Council Directive 2008/98/EC of 19 June November 2008 on waste and repealing certain Directives [2008] OJ L312/3 (WFD). This is the second revision since the WFD's first implementation in 1975. First revision of the WFD: Council Directive 75/442/EC of 15 July 1975 on waste [1975] OJ L194/39 as amended by Council Directive 91/156/EEC of 18 March 1991 on waste [1991] OJ L78/32. Second revision of the WFD: Council Directive 2006/12/EC of 5 April 2006 on waste [2006] OJ L114/9.
29. WFD, art 1.
30. Maria Lee, EU Environmental Law: Challenges, Change and Decision-making (Hart Publishing 2005) 216. Some of the more discussed case law on the definition of waste include: Joined Cases 206/88 and 207/88 Vessoso and Zanetti [1990] ECR I-1461; Case C-304/94 Euro Tombesi and Others [1997] ECR I-3561; Joined Cases C-418/97 and C-419/97 ARCO Chemie Nederland Ltd v Minister van Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, Vereniging Dorpsbelang Hees and Others v Directeur van de dienst Milieu en Water van de provincie Gelderland [2000] ECR I-4475; Case C-9/00 Palin Granit and Vehmassalon kansanterveystyön kuntayhtymän hallitus [2002] ECR I-3533; Case C-444/00 Mayer Parry Recycling Ltd and Environmental Agency, Secretary of State for the Environment, Transport and the Regions [2003] ECR I-6163; Case C-235/02 Saetti and Frediani [2004] ECR I-1005; Case C-457/02 Niselli [2004] ECR I-10875.
31. Commission, 'Guidance on the Interpretation of Key Provisions of Directive 2008/98/EC on Waste' <http://ec.europa.eu/environment/waste/framework/pdf/guidancedoc.pdf> accessed 10 August 2014.
32. Ludwig Krämer, 'The Distinction between Product and Waste in Community Law' (2003) 11(1) Environmental Liability 3, 7. Chalmers believes that there is 'no real reason' for the meaning of these two terms to be 'substantially different' – Damien Chalmers, 'Community Policy on Waste Management - Managing Environmental Decline Gently' (1995) 15(1) Yearbook of European Law 257261.
33. Saetti and Frediani (n 30) para 3; Palin Granit (n 30) paras 22, 27 and 29.
34. Vessoso and Zanetti (n 30) para 11. Damian Chalmers, 'Community Policy on Waste Management - Managing Environmental Decline Gently' (1995) 15(1) Yearbook of European Law 257, 262.
35. ARCO Chemie (n 30).
36. Euro Tombesi (n 30).
37. Palin Granit (n 33).
38. Krämer (n 32) 9.
39. Ibid 10.
40. Ibid 11.
41. Rosalind Malcolm and Roland Clift, 'Barriers to Industrial Ecology: The Strange Case of "the Tombesi Bypass"' (2002) 6(1) Journal of Industrial Ecology 4, 6.
42. Krämer (n 32) 9; David Pocklington, 'Opening Pandora's Box – the EU Review of the Definition of "Waste"' (2003) 12(7) European Environmental Law Review 204,, 215. See also: Stuart Bell, 'Refining the Definition of Waste' (1999) 1 Environmental Law Review 283, 295.
43. Clarke and Kohler, (n 1).
44. Hohfeld (n 47).
45. Ibid 30.
46. Ibid.
47. W N Hohfeld, 'Some Fundamental Legal Conceptions as Applied in Judicial Reasoning' (1913) 23 Yale Law Journal 16, 16.
48. Eva Prongrácz and Veikko J Pohjola, 'Re-defining Waste, the Concept of Ownership and the Role of Waste Management' (2004) 40 Resources, Conservation and Recycling 141, 145.
49. Thomas Merrill, 'Property and the Right to Exclude' (1998) 77 Nebraska Law Review 730, 730-731.
50. For analysis of the literature see F. von Benda-Beckmann et al, 'The Properties of Property' in: F. von Benda-Beckmann/K. von Benda-Beckmann/M. G. Wiber (eds), Changing Properties of Property, New York: Berghahn Books, 2006, Ch. 1 and J.W. Hamilton/N. Bankes, 'Different Views of the Cathedral: The Literature on Property Law Theory' in: A. McHarg et al, (eds), Property and the Law in Energy and Natural Resources, Oxford: Oxford University Press, 2000, Ch. 2 ; also (from a law and economics perspective) B. Yandle/A. P. Moriss, 'The Technologies of Property Rights: Choice among Alternative Solutions to Tragedies of the Commons ' (2001) 28 Ecology Law Quarterly 123 at 129 and (in the context of common pool resources) E. Schlager/E. Ostrom, 'Property-Rights Regimes and Natural Resources: A Conceptual Analysis', 68 Land Economics 1992, pp. 249-262. For a discussion of property rights in water, see: Alison Clarke and Rosalind Malcolm, 'The Role of Property in Water Regulation: Locating Communal and Regulatory Property Rights on the Property Rights Spectrum' in Christine Godt (ed), Regulatory Property Rights: The Transforming Notion of Property in Transnational Business Regulation (Brill Nijhoff 2016) 121 -140, and Rosalind Malcolm and Alison Clarke, 'Water: A Common Treasury', in T Xu and A Clarke (eds) Legal Strategies for the Development and Protection of Communal Property Proceedings of the British Academy, Oxford: Oxford University Press, 2017 (forthcoming).
51. Clarke and Malcolm (n 50) 121 -140.
52. In Kalundborg there are incentives, but maybe need national level intervention here to get local authorities to seek out and implement circular systems.
53. Thomas Lindhqvist, 'Extended Producer Responsibility in Cleaner Production: Policy Principle to Promote Environmental Improvements of Product Systems' (Doctoral dissertation, Lund University 2000) 29.
54. WFD, preamble, recital 27.
55. WFD, art 8(1).
56. An amendment to the WFD has been proposed to introduce a definition for EPR in Article 8(1): EPR 'means the producer's operational and/or financial responsibility for a product extended to the post-consumer state of a product's life cycle'. Commission, 'Proposal for a Directive of the European Parliament and of the Council amending Directives 2008/98/EC on waste, 94/62/EC on packaging and packaging waste, 1999/31/EC on the landfill of waste, 2000/53/EC on end-of-life vehicles, 2006/66/EC on batteries and accumulators and waste batteries and accumulators, and 2012/19/EU on waste electrical and electronic equipment' COM (2014) 397 final.

57. R J Lifset, 'Take it Back: Extended Producer Responsibility as a Form of Incentive-based Environmental Policy' (1993) 21(4) Resource Management and Technology 163; G Ji and others, 'Constructing Sustainable Supply Chain under Double Environmental Medium Regulations' (2014) 147 International Journal of Production Economics 211.
58. Elinor Ostrom, Understanding Institutional Diversity (Princeton University Press 2005) 23.
59. Elinor Ostrom, Larry Schroeder and Susan Wynne Institutional Incentives and Sustainable Development: Infrastructure Policies in Perspective (Westview Press 1993) 81; Brett Frischmann, Infrastructure: The Social Value of Shared Resources (Oxofrd University Press 2012) 26.
60. See for example: Mancur Olson, The Logic of Collective Action: Public Goods and the Theory of Groups (Harvard University Press 1965) 14; Ostrom (n 58) 24.
61. Elinor Ostrom, 'Property-Rights Regimes and Common Goods: A Complex Link' in Adrienne Héritier (ed), Common Goods: Reinventing European and International Governance (Rowman & Littlefield Publishers 2002) 39.
62. See for example: William Blomquist and Elinor Ostrom, 'Institutional Capacity and the Resolution of a Commons Dilemma' (1985) 5(2) Policy Studies Review 383, 383; Elinor Ostrom, 'Reformulating the Commons' in Joanna Burgur and others (eds), Protecting the Commons: A Framework for Resource Management in the Americas (Island Press 2001) 15; Ostrom, 'Property-Rights Regimes and Common Goods: A Complex Link' (n 57) 39
63. Elinor Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action (Cambridge University Press 1990) 30
64. Olli Salmi and others, 'Governing the Interplay between Industrial Ecosystems and Environmental Regulation' (2012) 16(1) Journal of Industrial Ecology 119. Note that Salmi and others refer to the materials exchanged within the industrial symbiosis as by-products rather than waste.
65. Jérémié Cavé, 'A Political Economy of Urban Solid Waste Management in Emerging Countries: Learning from Vitória (Brazil) and Coimbatore (India)' in Olivier Coutard and Jonathan Rutherford (eds), Beyond the Networked City: Infrastructure Reconfigurations and Urban Change in the North and South (Routledge 2016) 173.
66. Ibid 174.
67. Elli Louka, International Environmental Law: Fairness, Effectiveness, and World Order (Cambridge University Press 2006) 77-78; Patricia Park, International Law for Energy and the Environment (2nd edn, CRC Press 2013) 4.
68. Elinor Ostrom, 'Reformulating the Commons' in Joanna Burgur and others (eds), Protecting the Commons: A Framework for Resource Management in the Americas (Island Press 2001) 18.
69. Salmi and others (n 64).
70. Frank Schiller, Alexandra Penn, and Lauren Basson, 'Analyzing Networks in Industrial Ecology - a Review of Social-Material Network Analyses' (2014) 76(1) Journal of Cleaner Production 1.
71. D Rachel Lombardi and others, 'Industrial Symbiosis: Testing the Boundaries and Advancing Knowledge'(2012) 16(1) Journal of Industrial Ecology 5, 5.
72. Elinor Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action (Cambridge University Press 1990).
73. See for example: Knight, Peter, 'A Rebirth of the Pioneering Spirit' Financial Times (London, 14 November 1990); Jørgen Christensen, 'The Kalundborg Symbiosis: What, Who, When, How and Why?' (University of Surrey, 28 March 2012) <https://www.surrey.ac.uk/ces/files/Jorgen_Christensen_Presentation.pdf> accessed 18 May 2015.
74. Commission, 'Roadmap to a Resource Efficient Europe' (Communication) COM (2011) 571 final.
75. Commission, 'European Resource Efficiency Platform' (Manifesto and Policy Recommendations 2012) <http://ec.europa.eu/environment/resource_efficiency/documents/erep_manifesto_and_policy_recommendation s_31-03-2014.pdf> accessed 21 November 2014 (EREP).
76. Circular Economy Package (n 10).
77. Commission, 'Roadmap to a Resource Efficient Europe' (Communication) COM (2011) 571 final 6-7.
78. EREP (n 60) 7.
79. Ibid 8.
80. Circular Economy Package (n 10) 5.
81. Industrial symbiosis has also further received support at EU level through a recent funding call for research into industrial symbiosis as a strategy in moving towards a circular economy - Commission, 'Waste: A Resource to Recycle, Reuse and Recover Raw Materials' (11 December 2013) <http://ec.europa.eu/research/participants/portal/desktop/en/opportunities/h2020/topics/2111-waste-1-2014.html> accessed 17 July 2014..
82. See for example: Henning Grann, 'The Industrial Symbiosis at Kalundborg' in Deanna J Richards (ed), The Industrial Green Game: Implications for Environmental Design and Management (National Academies Press 1997) 117.
83. For example, a search on journal articles discussing 'Kalundborg' in the Journal of Industrial Ecology alone already yielded more than 100 results in March 2017.
84. Bekendtgørelse af lov om køb. LBK nr 140 af 17/02/2014.
85. Charles Reich 'The New Property' (1964) 73(5) Yale Law Journal 733, 739 .
86. We acknowledge that this definition of culture is sociological and that 'culture' is a contested concept. See, for example, Roger Cotterrell, Law, Culture and Society: Legal Ideas in the Mirror of Social Theory (Ashgate 2013); Pierre Legrand and Roderick Munday, Roderick (eds.) Comparative Legal Studies: Traditions and Transitions (Cambridge University Press 2003); David Nelken 'Using the Concept of Legal Culture' (2004) 29 Australian Journal of Legal Philosophy 1.
87. Abraham Bell and Gideon Parchomovsky, 'A Theory of Property' (2005) 90 Cornell Law Review 531, 543-544. See also n 1.
88. Ting Xu and Jean Allain, Property and Human Rights in a Global Context (Haywards Heath, Hart Publishing 2016) 4-5.
89. See H Demsetz 'Toward a Theory of Property Rights' (1967) 57(2) The American Economic Review 347; A Bell and G Parchomovsky, 'Reconfiguring Property in Three Dimensions' (2008) 75 University of Chicago Law Review 1015.
90. See, for example, J Waldron, 'Enough and as Good Left for Others' (1979) 29 (117) Philosophical Quarterly 319; 'Locke, Tully and the Regulation of Property' (1984) 32(1) Political Studies 98; R Nozick, Anarchy State and Utopia (New York, Basic Books) 1974; R Arneson, 'Lockean Self-Ownership: Towards a Demolition' (1991) 39 Political Studies 36; R Ashcraft, Revolutionary Politics and Locke's Two Treatises of Government (Princeton University Press 1986); G Sreenivasan, The Limits of Lockean Rights in Property (Oxford University Press 1995). For an overview of the principal critiques of Locke see K Widerquist 'Locekan Theories of Property: Justifications for Unilateral Appropriation' (2010) 2(1) Public Reason 3
91. John Locke, Second Treatise of Government (Macpherson CB ed, Hackett Publishing Company, Inc 1980) Chapter 5 'On Property', section 25.
92. Ibid section 26.
93. Ibid section 27.
94. R P Judge, 'Restoring the Commons: Toward a New Interpretation of Locke's Theory of Property' (2002) 78(3) Land Economics 331.
95. Locke (n 91) section 45.
96. Clarke and Kohler (n 1) 91.
97. A J Simmons, The Lockean Theory of Rights (Princeton 1992) 268.
98. Judge (n 94) 334.
99. Xu and Allain (n 88) 8-9.
100. Ibid.
101. H Howe, 'Lockean Natural Rights and the Stewardship Model of Property' (2013) 3 Prop L Rev 36.

DATES
Received: 13 Oct, 2016
Revised: 28 Oct 2016
Accepted: 1 November 2016

FUNDING
NO

CONFLICT OF INTEREST STATEMENT
NO