Theory Culture & Society

VISIONING A SUSTAINABLE ENERGY FUTURE - THE CASE OF URBAN FOOD GROWING

earlier title: BACKCASTING FOR A SUSTAINABLE ENERGY FUTURE – THE CASE OF URBAN FOOD-GROWING

Journal:	*Theory Culture & Society*
Manuscript ID:	13-129-SIESoc.R1
Manuscript Type:	SI - Special Issue Energising Society
Key Words:	food, future, contemporary activism, utopia, city, space, ecology

Abstract:	We outline a future where society re-energises itself, in the sense both of recapturing creative dynamism, and of applying creativity to meeting physical energy needs. Both require us to embrace self-organising properties, whether in nature or society. We critically appraise backcasting as a methodology for visioning, arguing that backcasting's potential for radical, outside-the-box thinking is restricted unless it contemplates a break with class society, connects with existing grassroots struggles (notably over land) and dialogues with utopian socialist tradition. We develop a case study of food, starting from the physical parameters of combatting the entropy expressed in the loss of soil structure, and apply this to urban food-growing. Drawing upon 'real utopias' of existing practice, the paper proposes a threefold categorisation: subsistence plots, an urban forest, and an ultra-high productivity sector. We emphasise the emergent properties of such a complex system characterised by the 'free energy' of societal self-organisation.

BACKCASTING FOR A SUSTAINABLE ENERGY FUTURE – THE CASE OF URBAN FOOD-GROWING

I: BACKCASTING, A CRITICAL ANALYSIS

Widely-used definitions of backcasting emphasise its distinction from forecasting or scenario-building (Wearerising, 2009). Whereas conventional policy agendas, notably on food, typically look forward from the present (for example, Barling et al, 2008), backcasting, in contrast, begins from a desired outcome and then assesses the steps by which it may be reached. The methodology has particular relevance to the theme of this special issue because backcasting has, since its origins, had a special focus on energy. Any visioned future must make clear where its energy will come from, and backcasting arose as a response to Lovins' emphasis on the centrality of 'soft' energies, which include not just renewables but the advantages of small scale (Lovins, 1976); the essential point is that, since such a future will be radically different from what we have now, it cannot adequately be *fore*cast from the present (Robinson, 1982). Compared to other methodologies, backcasting thus opens up a stronger understanding of sustainability (Mulder and Biesiot, 1998).

I will argue that, underlying energy inputs is a deeper issue of flows and the management of entropy. Energy is conserved, and what flows into any system is what flows out. But, following the Second Law of thermodynamics, it is *degraded* in the sense that it loses the order which makes it useful (De Rosnay, 1979). At the most basic level, even the solar transition can be seen in this way: since the earth is not a closed system, its own entropy is offset by importing low entropy in the form of solar energy (Georgescu-Roegen, 1975); although conventionally we think we absorb energy from the sun, in reality the energy dissipated by the earth is equivalent to that entering it, the point being that the incoming energy has lower entropy (Penrose, 2010: 78-9). If we moreover remove the artificial distinction between energy and matter, the useable (ordered) input can be termed exergy (negative entropy) (Dincer, 2002). In a future solar economy entropy will be dissipated safely, in contrast to today's flows, where scarce exergy sources (whose extraction moreover degrades local ecosystems) are transformed into pollution and greenhouse gas emission and degrade the wider earth system. In this sense, the management of entropy is the fundamental condition of futures visioning.

How far, then, is this perspective compatible with backcasting? In principle, it should be, and existing backcasting approaches do indeed speak of 'funds' and 'flows' (Holmberg, 1998: 34). However, this literature is heavily influenced by its origins as a business planning tool. The strong point is that a business model premised on funds and flows could, in a technical sense, lead to an industrial ecology where the output of one process becomes an input to another. But green business is only one among several agents of change: social movements are arguably more important. The next task in the development of backcasting was therefore to adapt it for use by communities (James and Lahti, 2004). And then, this in turn directly inspired the Transition Towns movement (Hopkins, 2008) which has been largely responsible for the wider popularisation of the methodology. Here, the practice of collective visioning *itself* helps build the conditions for its own success, namely community participation; and again, it is intrinsically linked to energy, notably in the key focus of Transition Towns visioning, the Energy Descent Action Plan (EDAP).

So far, so good. The advantage of taking the future, rather than the present, as point of reference is to think more creatively: this is after all the point of science fiction, which doesn't have to be only dystopian (Miéville, 2002). And since, in complexity thinking, the future is open-ended (Prigogine, 2003), it suddenly becomes clear that we have choices. This is potentially liberatory, in that newly-freed creative energies (expressed as linkages, networks and collaborative experimentation) could increase reciprocally alongside (and in a way substitute themselves for) shrinking fossil fuel dependence and the reduction of entropy manifested as emissions. The context of backcasting's rise as a community visioning tool in the second half of the 2000s is very interesting, in that the threat of climate *disaster* was becoming real, but were this to be expressed in paralysing Malthusian visions of ecological meltdown, the effect could be disempowering. Therefore – in contrast to the scenarios approach which requires describing the bad lines of development as well as the good ones – it was useful to have a methodology which focussed on the positive, showing how a low-carbon future can be fun, and bring a better quality of life.

But despite these strengths, the hangover of backcasting's business origins has proved hard to shed. While the literature recognises the advantage of being less in thrall to dominant paradigms (Quist and Vergragt, 2006: 1030), and academic futurology conceptually acknowledges the need to break path-dependencies (Tiberius, 2011), this is mostly in the limited sense of facilitating a more realistic business planning: overcoming conservatism and adjusting to radical regime shifts (Quist, 2007: 55). From the business standpoint, this of course make sense: the horizons of mainstream economics are too narrow, and what is needed is take account of large-scale structures and long-term structural shifts, such as those between the accumulation regimes described by regulation theory (Aglietta, 1976). And in particular, since each such regime has its characteristic energy sources, a far-sighted entrepreneur would look forward to a future regime of clean energies. This is well and good within its limits, since green enterprise is a way of experimenting solutions in the immediate term. The problem is, however , that – given the embedded path-dependencies of speculative finance capital and militarism (Biel, 2012) – a green future may need to free itself from the capitalist mode of production as a whole, and even class society as a whole, not just one structural phase of it; a futurology which truly steps outside dominant paradigms must at least entertain this possibility, and ask whether a true unleashing of societal energies will, at some point in the transition, overthrow the ruling order. It is therefore not enough merely to add a participatory or community-driven plugin to a corporate approach. In this respect, the attempted translation of backcasting from business to communities has proved wanting. As an example, if we turn to the visioning of 2030 in the first Transition Town EDAP conducted in Totnes, Devon (which has served as a model for the whole Transition movement), we find a "forest model of society" (Hodgson, 2010) which looks very like an idealised and stagnant version of class hierarchy, perhaps a mixture of feudalism and capitalism. We must at the very least remain vigilant, bearing in mind how 'natural' and 'organic' imagery has long been used in authoritarian and fascistic ways to justify oppression (McKay, 2011).

The downside of abandoning scenarios is that it becomes too easy to neglect the struggles whereby the 'bad' lines of development are resisted, and this in turn would leave a stunted understanding of the bloody process of 'transition' in the real world. The daily reality in the global South is already one where people have no choice but to struggle for land and food in order to survive, and this has given rise to the notion of food sovereignty: a concept bringing together many issues around autonomy, freedom from global food chains, community resilience, the safeguarding of diversity and heritage, place, self-reliant networks etc. (Pimbert, 2009; Mares and Peña, 2010). These struggles are in effect agents of futures visioning. And there is a long tradition in this respect, whereby insurgent movements have always visioned their desired future (Guha, 1983). It is about bringing society into harmony with natural principles, but in a way which is qualitatively distinct from the manipulative distortion of 'organic' society by authoritarianism. The key difference is firstly the sense – evident in radical movements from the Diggers of 1649 through the Enlightenment to the utopian socialists – that a precondition for unleashing societal free energies was the overthrow of the dead hand of class society; and secondly that these energies are embodied in the associative principle, the restructuring of society around co-operative institutions. Gerard Winstanley, the Diggers' founder, found a mythology to describe this: the need to put an end to the epoch of history during which the selfish and exploitative Esau or Cain has persistently slain his brother (Winstanley, 1983 [1649]: 125 ff.). And it has been recognised that a condition for restoring the social fabric in this way is access to the land, and therefore autonomy with respect to food.

We can see these connections in the work of the early 19th-century utopian socialists. Even their fascination with industry reflects industry as a symbol of co-operative labour, which could equally be applied to food production. Thus, the harvest is taken as paradigm in a dual sense: humanity itself is ripening (towards a stage where it can finally realise co-operative principles), and the physical harvest can only be maximised if we ourselves co-operate (Weitling, 1979 [1838]: 72 ff.); one of the first communist gatherings was a collective feast (Pillot et al, 1979 [1840]). And this in turn forms a bridge with the work of Marx, which builds on that of the utopians (Engels, 1999 [1880]; Geoghan, 2008), while seeking to take it further. One of the ways Marx did take things further was his deep sense of cycles, structures and transformations. He explained the flows and loops in the natural metabolism of nutrients and energies, how these flows have come to be dominated by circuits which serve only the expanded reproduction of capital; and the potential if only they can be freed from such dominance (Perelman, 1987; Bellamy Foster, 2009).

Only on a basis of recognising what needs to be overthrown can we therefore understand transition in its deepest sense. Given that power, as a capacity to produce effects, is both a social and a thermodynamic category (Gale, 1998), and that a positive feedback operates between the two, the existing pattern of energy flows convey simultaneously on the one hand a thermodynamic degradation of energy/matter (its transformation from exergy to entropy) and on the other an exploitation and degradation of societal structure, a process which depletes both poor communities and, in an international dimension (through the act of unequal exchange), the global South (Caldwell, ND; Hornborg, 2001). But establishment futurology seems to retreat further from a recognition of this fact. The original *Limits to Growth* (Meadows, 1972) did at least sharply highlight the destructive impact of the positive feedback loop of capital accumulation, whereas more recent debates (for example Raskin, 2002), while moving beyond the *Limits* in encompassing the theory of complexity, too often take complexity as an excuse to abandon any clarity on issues of exploitation. If backcasting is itself to have a future, it will need to overcome this limitation and recognise what radical movements have to struggle for and against.

II: FOOD FUTURES: SOME FUNDAMENTAL PARAMETERS

Having suggested some pointers for a critical perspective on backcasting, let us apply these to the case of food-growing. Before focusing on the urban sector, let us consider the general parameters, in terms of energy flows, for a meaningful vision of sustainable agriculture. The dimension in which backcasting operates is that of time, and time is the dimension in which entropy tends to increase. Therefore, any favourable future must assume we will have 'managed' entropy. The possibility of a solar transition offers us optimism for a favourable outcome. But I will argue that there are three specific, and closely interrelated, strategies which must be realised, and in these the solar transition is both a *condition* for sustainable food growing, and an *outcome* of it. They are: firstly the minimisation of physical work and its replacement by knowledge; secondly, reconstituting the structure of the soil; and thirdly carbon sequestration.

On the first of these points, viewing energy as work, physical labour and fossil fuels become equivalent, and we can then make a calorific count unifying both. In traditional food systems, when most work was manual, the calorific output must by definition be greater than the input, otherwise you would die. In modern systems, fossil fuels are substituted for human work, with the result that at least 10 calories of energy go to produce one of food (Glaeser and Phillips-Howard, 1987). In our visioned future, although we can to some extent replace fossil fuels by renewables, the issue remains that we must seek a system where the physical labour of cultivation is minimised. There seems to be a contradiction, since if we do less work we might expect to obtain less yield. But a farming system with a low input of work requires a high input of knowledge, which increases reciprocally as work declines; the knowledge element in traditional systems was immense (Fre, 1990). Moving onto the second requirement, we must now begin to think of entropy not so much in terms of energy-flows but, perhaps more profoundly, as loss of structure. Underlying what is today perceived as a food crisis is actually the loss of the soil itself. Soil conservation is "central to the longevity of any civilization," (Montgomery, 2007: 6), and Alfred Howard, the founder of organics, already graphically remarked that in his day, "the land is going on strike" (Howard, 1940). This structure-loss has rapidly accelerated since. Soil, which takes 200-1,000 years per inch to form (Arriaga et al, 2012) is now being lost at a rate of up to 50 tonnes per hectare per year, 100 times faster than its formation rate (Banwart, 2011).

Why is this happening? Organic thinking tends to see the soil as somehow 'living', and a self-organising complex system is one which maintains low entropy. In defining life itself, a key determinant for the individual organism is the boundaries within which low entropy is maintained (Ho, 1998), and at a higher level the soil achieves this by binding together both mineral and organic elements through very subtle – and fragile – bonds (Bourguignon and Bourguignon, 2009). "Soil ecosystems are probably the least understood of nature's panoply of ecosystems and increasingly among the most degraded." (McNeill and Winiwarter, 2004). But complex systems cannot by definition be understood through a reductionist approach to science, and this is precisely the problem underlying what is perceived on the surface as a food crisis: the 'scientific' agriculture of late capitalism, which is in fact *reductionist*-scientific, sought to override the complexity, thus sacrificing the emergent properties of the ensemble, an issue already foreseen by Marx (Marx, 1954 [1867]). From this standpoint, we can understand in a deeper way the purpose of the knowledge input: it replaces the kind of work – notably ploughing – which is not only a waste of calories but more importantly actively undermines soil structure. We can then permit the emergent self-organisation of the soil's complex system to re-establish itself. This is the underlying rationale of the notion of ‘do-nothing farming’ (Fukuoka, 1978) which is in reality not ‘non-action’, but rather a form of intervention which respects and works *with* natural properties, not against them. The knowledge input is often seen as a rediscovery of *traditional* knowledge, a starting point for which is recovering the essence of, for example, African and Native American approaches (Richards, 1985). But this should not be counterposed to science, it is simply a complexity-respecting form of science within which traditional and modern elements can easily be integrated. Terms such as agroecology, permaculture, biodynamics, Low-External Input Sustainable Agriculture, the Fukuoka method etc. express this aspiration, which comes about through systematising the experience of small farmers themselves (van Walsum, ND). This can in a sense be considered the knowledge base for food sovereignty as a social movement.

This takes us to the third task, the fixation of carbon. In a similar way to how soil is regarded in organic thinking, the earth-system (Gaia) is often seen as alive: it sets boundaries within which low entropy is maintained, managing the import of solar low entropy through its mechanism for temperature regulation, within which living organisms play an integral part (Lovelock, 2000). The soil plays a crucial, intermediary role in this, and in this sense agricultural reform is central to any strategy to redress anthropogenic disturbance in temperature regulation. Plants are effectively solar power stations, and while the method they use has the quirks one could expect from spontaneous evolution, it works, and the challenge of artificially replicating it proves elusive (Jones, 2012). Since plants themselves process solar energy and at the same time feed us, logically we could integrate food and solar transition as a single whole. In this, the key point is the link between carbon sequestration and fertility: a benign positive feedback loop, since high carbon-content soil, promoting a lusher growth and thus more sequestration (Brown, ND), would counteract the ‘bad’ positive feedback between global warming and decreased albedo. Soil holds nearly three times as much carbon as vegetation and twice that of the atmosphere (Yi et al, 2011), so by incorporating carbon in degraded soil we not only significantly increase crop yields but can “offset fossil fuel emissions by 0.4 to 1.2 gigatons of carbon per year, or 5 to 15% of the global fossil-fuel emissions” (Lal, 2004: 1623). And significantly, by following no-till farming methods – whereby we conserve the of soil’s structure (its negative entropy) *by not working it* – we maximise sequestration potential (Yi et al, 2011). It is thus not surprising that planetary sciences specialist David Schwartzman sees getting carbon into the soil as the sole effective – and essential – form of geoengineering (Schwartzman, 2013). In this sense, by reducing energy as work we move towards a benign relationship with energy as *flows*. For example, today’s debates include models where large-scale ranges where animal-grazing acts as a carbon pump (Savory, 1983; Norman, 2001); or a charcoal-based method replicating the ‘terra preta de indio’ of the ancient Americas (Taylor, 2010), in its contemporary form often called ‘biochar’, whereby smouldered agricultural residues simultaneously sequester carbon and improve the soil.

Transition to the technical solutions outlined above can only occur alongside a social transition, involving an unleashing of societal free energies to mirror those of physical systems, and reconnecting with the radical tradition which seeks to shift the dead weight of class society and restore co-operation. As in physical systems, transition may mean radical rupture. Traditional farming systems – for example in their use of fire – embraced disturbance because it builds resilience, and in this way, one can “avoid the accumulation of disturbance that moves across scales and further up the panarchy ...” (Berkes and Folke, 2002: 131). The contemporary mainstream food system has lost the ability to embrace disturbance, with the result that cumulative disturbance has built up, leading to crisis at a larger scale. But even this can be a harbinger of progressive change, both technically and institutionally. Historically, as Thirsk argues, there has been an intrinsic link between land tenure and innovation: “mainstream” farming features a narrow range of crops and concentrated landholding which renders it vulnerable. In times of crisis, agriculture regenerates itself through “alternative” approaches – on the one hand more diverse and experimental, on the other redistributory in terms of landholding – which then “furnish ideas for new strategies in the following age.” (Thirsk, 1997: 19). The timeline of our future vision will thus include a major revolution both of farming technique and of landholding, hence of property relations in general.

III: URBAN FOOD PRODUCTION

We will now develop this argument in relation to the case study of urban food growing. In the spirit of Eric Olin Wright’s ‘real utopias’ (Wright, 2010), we extrapolate from trends which exist at present, while remembering that they will flourish under different conditions, both because of the new emergent properties of the ensemble, and because of the challenges which they will have had to face, and overcome.

What is the rationale for growing food in cities? Today’s mainstream agriculture is caught in a ‘bad’ path-dependency where diminishing returns from chemical-based farming are met with still higher inputs of the chemicals which cause the problem. A radical change is needed, but how can it be effected? The key point is that, in this case, ‘transition’ must concretely be understood in relation to the *conversion* period of changeover to organics, which in the case of Britain’s Soil Association would be two years, aiming to provide “time to start establishing organic management techniques, build soil fertility and biological activity, as well as to develop a viable and sustainable agro-ecosystem.” (Soil Association, ND). But the city must still be fed during this conversion period, while attempts to colonise any further *‘wild’* space for food growing could only worsen local ecosystem collapses (Foley et al, 2011). By default, this only leaves the option of the city growing its own food. But actually, this is not a mere default option: it has several positive advantages. Being relatively insulated from pesticides, moncropping and risky GM experiments, the city is favourably placed as a laboratory and jumping-off point for new approaches, based both in organics and the reconstitution of ecosystems; it has, moreover, an ‘urban metabolism’ wherein entropy can be diminished by using what appears as waste from the standpoint of one process as an input (resource) for another; and finally, it has much scope for diversity in institutional experiment, grassroots innovation, and community linkages. I will now develop these points. I will propose a threefold analytical division: the subsistence sector, the urban forest and the ultra-high productivity sector. This emphasises the fact that there are several distinct reasons for urban farming; and that these can mutually interact as part of a complex system whose emergent properties outstrip the sum of its parts.

Firstly, the subsistence sector. In the European context, the paradigm is allotments and community gardens, but in developing countries it would include many types of squatted, informally-occupied land (and also *space*, for example balconies). This sector answers immediate food security needs, combined with more strategic food sovereignty objectives: maximising the democratisation of knowledge and experimentation, as well as local linkages, both social (distributing the product through food chains, knowledge-sharing) and physical. A seeming paradox is that, while we want a lot of *social* linkages, from an ecological standpoint we should minimise throughput (inputs of physical work, resources, water; outputs of entropy expressed as water runoff, leaching, methane and CO_2 emission etc.), in which case it seems desirable to view the plot as a closed system. But if we can calculate the limits within which it *can* function as a closed system, we can quantify the extent to which needs to be plugged into external loops. Let us briefly concretise this in relation to composting, the centrality of which to organic farming was established by Howard (Howard, 1940). In this respect, there is a huge area of traditional knowledge which can be reclaimed (Dailliez, 1981). The key to soil management is organic mulches (Dowding, 2007), and much of this is supplied by composting the plot's own residues (weeds, the parts of vegetables we don't eat). Russian Comfrey Bocking 14 further helps us overcome the entropy of a given area of land since its roots draw nutrients from lower regions thus turning the topsoil into an open system. But we must understand the limits within which this is possible, in order to quantify, the extent to which the plot's internal resources must be supplemented by an external input. Taking the traditional British allotment (250 m^2), converted to a no-dig method with paths between beds, our cultivable surface is about 150 m^2. Organic agriculture literature typically requires a 40mm mulch for the combined purpose of restoring fertility, shielding soil from erosion, preventing water loss, and suppressing weeds (Corbalan, 2005). Spread over 150 m^2 this gives 6 m^3 required in a given year. In the author's practical research, it can be estimated that about *half* is internally generated from the plot. This gives a figure of 3 m^3 per 250 m^2 of cultivable surface required from outside the plot's closed system. Here, urban food-growing has an advantage over rural, because of the availability of compostable waste. Where today's industrial ecology or industrial symbiosis models tend to view agriculture peripherally as an outlet or sink for industrial/domestic by-products, the visioned future will make it central, with the rest of the metabolism revolving round it.

Secondly, the urban forest. Several considerations underly our identification of this category: the need to break down dualism between the natural and the built; the need to maximise the 'creative chaos' of self organisation, both in physical systems and in society (and in relations between the two); and finally the 'wildness' which is required for biodiversity.

In conventional plots we can mimic self-formed natural systems up to a point by employing agroecology principles such as intercropping (for example, of maize, squash and legumes); but in the urban forest we are doing this at a qualitatively higher level. Farming and built environment cease being sharply separate (Wilson, 2009), with buildings becoming a bit *like* forests. Advanced architectural thinkers have long raised the issue that the built should (at least) give back to nature what it subtracts from it. Where Corbusier sought to achieve this with roof terraces, Hundertwasser strongly critiqued this modernist approach, looking to a built environment which *itself* followed natural forms (Hundertwasser, 1964). Recent understanding of the city's responsibilities towards climate mitigation, coupled with local climatic effects *within* cities (the heat island) incite us to revisit these debates (an innovative project in Milan, now under construction, being one example: Architizer News, 2013). Partly, the urban forest aims to make green space productive in food terms: for example, the trees we plant should yield fruit and nuts (Pinkerton and Hopkins, 2009), a process already underway in London (London Orchard Project, ND). And in a more developed form, trees cohere as an edible urban forest which, once established, acquires its own emergent self-maintaining ecology (Ettinger, 2012). In a social sense too, the process of *creating* these spaces is itself emergent, a spontaneous encroachment of growing spaces, as already foreshadowed by the squatted community of Bonnington Square, Vauxhall (Self-Help Housing, ND). The concept of forest is explicit in the Los Angeles community project L.A. Green Grounds (L.A. Green Grounds, ND), while the 'new ruralism' aspires to bring together smart growth, new urbanism and sustainable food and agriculture systems (SAGE, ND). All the above could be considered pathways into the category we have named urban forest. At the same time, we should not be obsessed with producing food everywhere. If the food-growing sector is to be truly sustainable, it requires biodiversity, and in this respect, a given area of wildness should not be viewed as negatively related to (subtracted from) the food-growing area, but on the contrary as a positive addition to it by supplying natural predators and pollinating insects. This in turn requires native plant species, counterbalacing the reality that many food crops are inevitably non-native (in the UK context, solanum or cucurbits, for example). Interestingly, given that in a rural context biodiversity is heavily depleted by factory farming, moncropping and pesticides, this is another area where the city can make an outstanding contribution to the wider cause of sustainable transition: in an urban context, if we provide the right substrate, native plant species will spontaneously appear astonishingly quickly, soon followed by rare birds, insects and arachnids (Kadas, 2006). Green roofs are a key aspect, and there will be many forms of symbiosis in the wider sustainability transition: for example, green roofs help solar PV operate more efficiently by lowering ambient temperatures (Gedge, 2013).

Finally, under this heading, there is a connection between the chaotic self-organisation of nature, and of society. Guerrilla gardening, referencing guerrilla as a diffuse, self-organising form (Reynolds, 2008), has an evolutionary capability to throw up new forms (one example being 'Guerrila Grafters' who in San Francisco graft fruit-bearing branches onto ornamental trees – Zimet, 2012); it is a societal struggle conducted *through* the self-organising capacity of nature, as in guerrilla gardening's adaptation of Masanobu Fukuoka's seed-balls (whereby plants themselves choose where to grow) as 'seed-bombs'. The notion of "islands of unpredictability" (Carlsson, 2008) emphasises the fact that, by allowing space for unplanned and unstructured initiatives, we actually create the terrain for structure as an *emergent* property both of society and of nature.

Thirdly, there is the case for an ultra-high productivity sector. The categories addressed so far make outstanding contributions to food sovereignty, empowerment, disalienation, social networks and the re-constitution of biodiversity, but the question remains whether the city can make a really significant contribution to its own food needs. Whilst there is untapped potential in small plots – which research in London suggests may be considerable (Tomkins, 2009: 37-38) – it remains limited. If we are to take it further still, the solution could be to escape from space constraints, either by raising productivity beyond what is 'normal' for a given area or by multiplying the growing area itself beyond its footprint through vertical stacking, or both. Part of this can happen on rooftops: in New York, a huge rooftop hydroponic farm on a single building, irrigated by captured stormwater, is planned to yield 1 million pounds (450,000 kg) of vegetables per year (Foderaro, 2012). But even more importantly, the low-energy revolution heralded by LED in principle permits food-growing inside buildings. Some futuristic visions see this as the paradigm for the urban agriculture to come (Despommier, 2010). As we write, 'plantscraper' models have just reached the point of realisation, with the first commercial vertical farm opening in Singapore (Zimmer, 2012) and a 17-story urban farm in Linköping, Sweden, due to begin construction in 2013 (Ma, 2012). In experiments by the author and others, a mixture of red and blue LEDs produce good plants even without any natural light, and given that LED efficiency is currently rising exponentially, the notion of 'Zero-Acreage

Farming' – proposed in relation to several current projects in Berlin and with aspirations as an international model (Zfarm News, 2012; ZFarm, ND) – seems closer to becoming reality: if space limitations can be escaped, the potential seems limitless.

We must again be careful not to focus excessively on sustainable energy *input* at the expense of the bigger picture of minimising entropy by resisting loss of structure. There is an issue of how far we can aspire to 'free' food from soil as a substrate, bearing in mind that plants' natural mechanisms need it to exchange information: thus, they communicate through fungal and mychorrizal filaments to trigger pre-emptive responses to disease (Song et al, 2010). Even more importantly, we must highlight the risk that the high-tech part of the solar transition could sever itself from the issues of democratisation addressed by food sovereignty, and make things even more elitist. But current developments suggest this is not inevitable: in the remarkable project of Will Allen in Milwaukee, USA (Allen, 2012), an aquaponic system with its own self-regulating physical properties combines a very high productivity, high interaction with the urban metabolism and strong stimulus to social linkages. Similarly, a community-based vertical farm is planned in Wyoming (Popovitch, 2013). The key, then, is to treat cutting-edge technical experiment as *part* of a wider energising of society.

CONCLUSION

Let us finally sum up the case study in a holistic and critical perspective. In terms of physical systems, the promise of a sustainable future is real. Nevertheless, the circuits of capital accumulation are still dominant and if this continues they will tend to subsume particular experiments. For example, carbon sequestration through the re-constitution of dark earths, potentially wonderful at a technical level, tends under the current mode of production to be subsumed as a means of accumulation, with the effect of disempowering communities (Leach et al, 2012). The condition for resisting this is that the technical solutions be part of a wider movement of unleashing society's energies in the shape of contestatory movements from below. The principle of self-organisation never disappears (to use Winstanley's image, the brother whom the ruling system tries to slay keeps being reborn). To give one example from the subsistence sector, the allotment movement is a paradigm of self-organisation which is at present circumscribed by the legislative framework (the Allotment Acts: c.f. Acton, 2011), deriving from 'food security' which can be considered an offshoot of military security, in contrast to food sovereignty which is about autonomy. But urban farming could break through its institutional containment, and develop a radicalised institutional framework, drawing perhaps upon Community land trusts (Davis, 2010), which would be more appropriate to food sovereignty. And in a more general sense, such an unleashing is in fact *required* by the complexity of solar revolution: significantly, Colin Ward, the historian of the allotment movement (Crouch and Ward, 1997) argued on explicitly cybernetic grounds that the need for a society to self-organise is a function of its complexity (Ward, 1988).

For the new agriculture to come into being in a physical sense (low entropy, linkages to food chains and metabolism loops) there must be an unleashing of societal energies, and this at some point implies a change in the control of land. It has long been argued that there are three inseparable tasks: protection of land, production of food, and distribution of land (Kumar, 1976: 7), and in terms of the argument of this paper, we interpret these as follows: protection of land means resisting the entropy of soil structure and restoring biodiversity; an adequate volume of food production is the inescapable basis for any social organisation; and distribution highlights the changes in production relations required for this to happen. These principles retain their relevance as a charter for re-energising society, and are implicitly embodied in today's social movements. A turning point may have occurred in the late 1990s, when the Mexican Zapatistas and Indian farmers' movements proved a catalyst for shaking the dead equilibrium: in the author's experience, solidarity practices and networks built at that time in Europe in support of these two struggles helped lay the groundwork for more recent developments. A Land and Freedom camp (October 2011) on London's Clapham Common (Heggs, 2011), which predated Occupy Wall Street, referenced not just the Diggers' 1649 occupation, but also global struggles. In today's London, OrganicLea provides maybe the best example of what could be achieved (OrganicLea, ND): here, the permaculture principle of bringing society and nature into harmony receives an interpretation of radical self-organisation, and conditions for replicating this approach (perhaps as a kind of constitutive cell of alternative society) are already under debate (Litherland, ND). Many of urban farming's 'real utopias' are in fact the fruits of such struggle. New York's community gardens in the 1980s were the object of a fearsome battle because they were liberated spaces, consciously seeking to embody here and now the kind of future which *could* be built, and hence viewed as threatening by the establishment (Carlsson, 2008: 93). In Argentina during the 2000s, in response to economic collapse there occurred a wave of contestatory social self-organisation from below, including barricading roads and factory occupations (Palomino, 2003), and as part of this current, a significant movement of urban food growing, all of it forming part of a historic trend to redress the loss of (societal) structure and re-constitute it on a co-operative basis. In Turkey in 2013 a struggle to protect a green space from encroachment triggered a movement of mass protests and popular assemblies raising fundamental issues about society as a whole.

In conclusion, societal restructuring co-evolves with the systems by which it is fed. Food both in a literal sense provides the energy for people to function, and at the same time acts as catalyst for the development of human society's energies of creativity and self-organisation.

=============

Acton, Lesley (2011) *The Allotment Movement in North-East Greater London 1900-2010*, PhD Thesis, London: UCL

Aglietta, Michel (1976) *Régulation et crises du capitalisme*. Paris: éds. Calmann-Lévy

Allen, Will (2012) *The Good Food Revolution: Growing Healthy Food, People, and Communities.* New York: Gotham Books

Architizer News 2013, 'Green Architecture Takes Big Leap With Milan's "Vertical Forest"', January 10 on http://www.architizer.com/en_us/blog/dyn/71460/green-architects-takes-big-leap-with-milans-vertical-forest/#.UPLe1vKI4ed

Arriaga, Francisco, Greg Andrews, Nick Schneider, Matt Ruark (2012), 'Soil erosion concerns after silage harvest", *New Horizons in Soil Science* Issue 12-03

Banwart, Steve (2011) 'Save our soils', *Nature* 474, 151–152 (June 9), doi:10.1038/474151a

Barling, David, Rosalind Sharpe and Tim Lang (2008) *Towards a National Sustainable Food Security Policy - A project to map the policy interface between Food Security and Sustainable Food Supply*. London: City University, Centre for Food Policy

Biel R., (2012) *The Entropy of Capitalism*. Leiden: Brill

Bellamy Foster, John (2009) *The Ecological Revolution - Making Peace with the Planet*. New York: Monthly Review

Berkes F. and Folke C. (2002) 'Back to the Future: Ecosystem Dynamics and Local Knowledge' in Gunderson L.H. and Holling C.S. *Panarchy – Understanding Transformation in Human and Natural Systems*. Washington DC: Island Press

Bourguignon C. and Bourguignon L. (2009) *Le Sol, la Terre et les Champs.* Paris: eds. Sang de la Terre

Brown, Sally (ND) *Connections between Compost, Soil Carbon and Climate Change* on http://www.agresourceinc.com/article_connections_print.htm

Caldwell, Malcolm (ND) [ca. 1971] *The Energy of Imperialism, and the Imperialism of Energy*, School of Oriental and African Studies, duplicated

Carlsson, Chris (2008) *Nowtopia - How Pirate Programmers, Outlaw Byciclists and Vacant-Lot Gardeners are Inventing the Future Today!* Edinburgh: AK Press

Corbalan, Jacqueline (2005) 'Compost de Broussailles', *Abécédaire du Jardinier bio, La Gazette des Jardins*, hors-série, Oct.-Dec.

Crouch, David and Colin Ward (1997) *The Allotment – its Landscape and Culture*. Nottingham: Five Leaves

Dailliez, Laurent (1981) *Les Templiers et l'agriculture, ou les composts templiers*. Nice: Presses d'Alpes-Méditerranée

Davis, J.E. (2010) *The Community Land Trust Reader*. Lincoln: Institute of Land Policy

de Rosnay, Joël (1979) *The Macroscope*, New York: Harper & Row,

Dincer, I. (2002) 'The role of exergy in energy policy making' *Energy Policy* 30 (2)

Dowding, Charles (2007) *Organic Gardening: The Natural No-Dig Way*. Totnes: Green Books

Ettinger, Jill (2012) *Seattle Building Massive Edible Forest Filled with Free Food*, Feb 28, on http://www.organicauthority.com/blog/organic/seattle-building-massive-edible-forest-filled-with-free-food/

Foderaro, Lisa W.(2012) 'Huge Rooftop Farm Is Set for Brooklyn' *New York Times* April 5

Foley, Jonathan A. et al (2011) 'Solutions for a cultivated planet' *Nature*, Vo. 478, October 20

Fre, Zeremariam (1990) *Pastoral Development in Eritrea and Eastern Sudan - Implications for Livestock Extension Programmes*, PhD thesis, Reading University

Fukuoka, Masanobu (1978) *The One-Straw Revolution: An Introduction to Natural Farming*. Rodale: Emmaus

Gale, Fred P. (1998) 'Theorizing Power in Ecological Economics' *Ecological Economics*, 27: 131-138

Gedge, Dusty (2013) presentation at workshop on *Green Roof Avant-Garde*, Garden Museum, London, June 3

Geoghan, Vincent (2008) *Utopianism and Marxism*. Bern: Peter Lang

Georgescu-Roegen, Nicholas (1975) 'Energy and Economic Myths' *Southern Economic Journal*, 41, no. 3, January

Glaeser, B. and K. Phillips-Howard (1987) "Low-energy Farming Systems in Nigeria" in Glaeser (ed.) *The Green Revolution Revisited - Critique and Alternatives*. London: Allen and Unwin

Guha, R. (1983) *Elementary Aspects of Peasant Insurgency in Colonial India*. Delhi: OUP

Heggs, Lisa (2011) *Land and Freedom Camp on Clapham Common – London*, Demotix (Crowd-Sourced News from around the Globe) September 24, on http://www.demotix.com/news/844031/land-and-freedom-camp-clapham-common-london#media-844027

Ho, Mae-Wan (1998) *The rainbow and the worm, the physics of organisms*. Singapore: World Scientific

Hodgson, Jacqi (with Rob Hopkins) (2010) *Transition in Action, Totnes 2030, an Energy Descent Action Plan* Totnes: Transition Town, on http://totnesedap.org.uk/book/part3/vision-totnes-district-2030/a-forest-model-of-society/

Holmberg J. (1998) 'Backcasting: a natural step in operationalising sustainable development', *Greener Management International - The Journal of Corporate Environmental Strategy and Practice*, 23

Hopkins, Rob (2008) *The Transition Handbook – from oil dependency to local resilience*.Totnes: Green Books

Howard, Albert (1940) *An Agricultural Testament*. Oxford: Oxford University Press

Hornborg, Alf (2001) *The power of the machine : global inequalities of economy, technology, and environment*. Walnut Creek, CA : AltaMira Press,

Hundertwasser (1964) Mouldiness Manifesto against Rationalism in Architecture, revised version of 1958 original, on http://www.hundertwasser.at/english/texts/philo_verschimmelungsmanifest.php

James, Sarah and Torbjorn Lahti (2004) *The natural step for communities : how cities and towns can change to sustainable living* Gabriola Island, BC : New Society Publishers

Jones, Nicola (2012) 'Turn a New Leaf – Can we reinvent photosynthesis to make clearn, green energy for all?' *New Scientist*, April 14

Lovelock, James (2000) *The Ages of Gaia*. Second Edition, Oxford: OUP

Kadas, Gyongyver (2006) 'Rare Invertebrates Colonizing Green Roofs in London'. *Urban Habitats*, December

Kumar, Satish (1976) 'Introduction' in Girardet, Herbert (ed) *Land for the People*, London: Crescent Books

L.A. Green Grounds (ND) on http://lagreengrounds.org/about/

Lal, R. (2004) 'Soil carbon sequestration impacts on global climate change and food security'. *Science*, 304

Leach, Melissa, James Fairhead and James Fraser (2012) 'Green grabs and biochar: Revaluing African soils and farming in the new carbon economy' *Journal of Peasant Studies* Vol. 39, No. 2, April: 285–307

Litherland, Ru (ND) *Where Next For The Community Food Movement?*, discussion document, dupicated

London Orchard Project (ND) on http://thelondonorchardproject.org/

Lovins, Amory (1976) 'EnergyStrategy - the Road Not Taken' *Foreign Affairs,* October

Ma, Julie (2012) *A 'Vertical Greenhouse' Could Make a Swedish City Self-Sufficient*, March 12 on http://www.good.is/post/a-vertical-greenhouse-could-make-a-swedish-city-self-sufficient/

Mares, Teresa M. and Devon G. Peña (2010) 'Urban Agriculture in the making of insurgent spaces in Los Angeles and Seattle' in Hou, Jeffrey ed. *Insurgent Public Space – guerrilla urbanism and the remaking of contemporary cities*. London: Routledge

Marx, Karl (1954 [1867]) Capital, Vol. I. London: Lawrence and Wishart

McKay, George (2011) *Radical Gardening.* London: Frances Lincoln

McNeill J. R. and Verena Winiwarter (2004) ‘Breaking the Sod: Humankind, History, and Soil’. *Science* 304: 1629

Meadows, D.L. et al (1972) *The Limits to Growth*. London: Earth Island

Miéville, China (2002) *Fifty Fantasy & Science Fiction Works That Socialists Should Read* on http://www.fantasticmetropolis.com/i/50socialist/full/

Montgomery, David R. (2007) *Dirt – the Erosion of Civilisations*, Berkely: University of California Press

Mulder, H.A.J. and W. Biesiot (1998) *Transition to a sustainable society: a backcasting approach to modelling energy and ecology*. Cheltenham: Edward Elgar

OrganicLea (ND) *A workers' cooperative growing food on London's edge in the Lea Valley*, on http://www.organiclea.org.uk/

Palomino, Héctor (2003) ‘Las experiencias actuales de autogestión en Argentina’, *Nueva Sociedad*, 184

Penrose, Roger (2010) *Cycles of Time*. London: The Bodley Head

Perelman, Michael (1987) *Marx’s Crises Theory – Scarcity, Labour and Finance*. New York: Praeger

Pillot, J.-J. et al ‘Premier banquet communiste le 1er juillet 1840’ in Bravo, Gian Mario (ed.) *Les Socialistes avant Marx*, Tome II. Paris: Maspero

Pinkerton Tamzin and Rob Hopkins (2009) *Local Food. How to make it happen in your community*. Totnes: Transition Books

Popovitch, Trish (2013) *With 90% of its Crop Pre-sold and a Land Lease Rate of $1 Per Year, a Vertical Farm Rises in Wyoming* on http://seedstock.com/2013/01/16/with-90-of-its-crop-pre-sold-and-a-land-lease-rate-of-1-per-year-a-vertical-farm-rises-in-wyoming/

Prigogine I. (2003) *Is Future Given?*, Singapore: World Scientific

Quist, Jaco and Philip Vergragt (2006) “Past and future of backcasting: The shift to stakeholder participation and a proposal for a methodological framework” *Futures* 38: 1027–1045

Quist, Jaco (2007) *Backcasting for a Sustainable Future - the Impact after 10 years*. Delft: Eburon

McNeill J. R. and Verena Winiwarter (2004) “Breaking the Sod: Humankind, History, and Soil”, *Science* 304: 1629

Raskin, P. et al (2002) *Great Transition – The Promise and Lure of the Times Ahead*, Stockholm: Environment Institute and Global Scenario Group; online at http://www.tellus.org/documents/Great_Transition.pdf

Reynolds, Richard (2008) *On Guerrilla Gardening – A Handbook for Gardening Without Boundaries.* London: Bloomsbury

Richards, Paul (1985) *Indigenous Agricultural Revolution - Ecology and Food Production in West Africa*. London: Hutchinson

Robinson, John Bridger (1982) “Energy backcasting – A proposed method of policy analysis” E*nergy Policy* Volume 10, Issue 4, December: 337–344

SAGE (Sustainable Agriculture Education) (ND) on http://www.sagecenter.org/projects/new-ruralism-framework-foodshed-assessments-for-metro-regions/

Savory, Allan (1983) “The Savory grazing method or holistic resource management”, *Rangelands*, Vol. 5 No 4

Self-Help Housing (ND) on http://self-help-housing.org/case-studies/bonnington-square-london/

Soil Association (ND), Frequently Asked Questions on http://www.soilassociation.org/frequentlyaskedquestions/smid/4313?key=conversion+period accessed August 5 2012

Song Y.Y., R.S. Zeng, J.F. Xu, J. Li, X. Shen (2010) "Interplant Communication of Tomato Plants through Underground Common Mycorrhizal Networks", *PLoS ONE* 5(10): e13324

Taylor, Paul (2010) *The Biochar Revolution*. Victoria: Global Publishing Group

Thirsk, Joan (1997) *Alternative Agriculture, A History: from the Black Death to the Present Day*. Oxford: Oxford University Press

Tiberius, Victor (2011) "Path Dependence, Path Breaking, and Path Creation: A Theoretical Scaffolding for Futures Studies?" *Journal of Futures Studies* Vol. 15 No. 4, June

Tomkins, Mikey (2009) "The Elephant and the Castle: Towards a London Edible Landscape", *Urban Agriculture Magazine*, no. 22, June

van Walsum, Edith (ND) *Learning to Value LEISA: Experiences in Global Knowledge Networking for Low External Input Sustainable Agriculture* on http://www.future-agricultures.org/farmerfirst/files/T3b_van_Walsum.pdf

Ward, Colin (1988) *Anarchy in Action*. London: Freedom Press

Wearerising (2009) "Backcasting" on http://wearearising.org/2009/01/13/backcasting/

Weitling, Wilhelm (1979 [1838]) "L'humanité telle qu'elle est et telle qu'elle devrait être" in Bravo, Gian Mario (ed.) *Les Socialistes avant Marx*, Tome II. Paris: Maspero

Wilson, Alex (2009) "Growing Food Locally: Integrating Agriculture Into the Built Environment", *Environmental Building News*, Vol. 18, No. 2

Winstanley, Gerard (1983 [1649]) "A Watch-Word to The City of London, and the Army" in Winstanley G. *The Law of Freedom and other Writings* (ed. Christopher Hill) Cambridge: Cambridge University Press

Wright, Eric Olin (2010) *Envisioning Real Utopias*, London: Verso

Yi Wang, Cong Tu, Lei Cheng, Chunyue Li , Laura F. Gentry, Greg D. Hoyt, Xingchang Zhang and Shuijin Hu (2011) "Long-term impact of farming practices on soil organic carbon and nitrogen pools and microbial biomass and activity", *Soil and Tillage Research* ,117: 8–16

ZFarm (ND), "Existing ZFarming Projects" on http://www.user.tu-berlin.de/wolfgang.straub/zfarm/svg/index_svg.html

ZFarm News (2012) *Aktuelle Informationen zur gebäudegebundenen Landwirtschaft*, on http://www.zalf.de/htmlsites/zfarm/Documents/newsletter/ZFarm_Newsletter_Februar.pdf accessed 23.5.12

Zimet, Abby (2012) *Guerrilla Grafters: Undoing Civilization One Fruitless Branch At a Time* on http://www.commondreams.org/further/2012/04/10-0

Zimmer, Lori (2012) "The World's First Commercial Vertical Farm Opens in Singapore", *Inhabit (Design that will save the world)* October 26, on http://inhabitat.com/the-worlds-first-commercial-vertical-farm-opens-in-singapore/

VISIONING A SUSTAINABLE ENERGY FUTURE – THE CASE OF URBAN FOOD-GROWING

I. INTRODUCTION: THE PLACE OF FOOD SYSTEMS WITHIN AN ENERGISING OF SOCIETY

Food is a basic condition for energising society even before we think of energy for manufactures, transport etc., because if society cannot be fed sustainably it cannot function at all. This includes – given that the brain consumes more than 20% of the body's energy (Swaminathan 2008) – crucially, its culture. But while food systems provide energy, they also themselves make great energy demands. As it stands, the mainstream system is in heavy deficit: studies consistently show that each calorie of food requires at least 10 calories of energy input (Glaeser and Phillips-Howard 1987; Lott 2011). Nor, in assessing sustainability, must we think only of *inputs*, but also of the pollution expelled: nitrogen runoff, CO_2 and methane.

In systems thinking, such outputs are a degraded form of the inputs, in other words the system is moving towards entropy. Entropy always threatens to overwhelm any system, but the existence of the earth-system keeps this at bay: "The entire fabric of life on Earth requires the maintaining of a profound and subtle organization, which undoubtedly involves entropy being kept at a low level." (Penrose 2010: 77). How life, in its naturally-evolved form, achieves this is by avoiding 'loose' outputs and treating the output from one process as an input for another (de Rosnay 1979) – for example in food chains. Traditional farming systems, while they profoundly modified nature, generally employed biomimicry to pattern themselves on natural processes (Richards 1985): composting, intercropping, green manures and catch crops formed their basic principles.

With capitalism a 'metabolic rift' occurred, pinpointed by Marx (Marx, 1954 [1867]) , and analysed importantly by Bellamy Foster (Bellamy Foster 2009). We could say that the rift has both cultural and physical expressions: there is a sense of alienation in urban/industrial society, and at the same time, in a physical way, the chains become 'untucked' leading to a huge dissipation of degraded resources, now no longer absorbed as inputs into another cycle.

Because entropy is an arrow of time, the time dimension will be central to our enquiry. The rift itself was in a fundamental sense cyclical: in place of the approach whereby traditional farming systems had worked alongside cycles of natural regeneration (e.g. agroforestry), capitalism replaced them with accumulation circuits. Among Marx's key contributions was his deep sense of cycles, structures and transformations (Kluge, 2008): initially the flows and loops in the natural metabolism of nutrients and energies, and then how these have become dominated by circuits serving expanded reproduction (Perelman, 1987). Increasingly, accumulation circuits have become global, and it is through these that the energy deficit, and its degradation into harmful waste became entrenched (Caldwell [1971]; 1977). At the same time, through the repetition of these circuits, a *cumulative* entropy built up: the climatic payback for decades of depletion which had been 'exported to the future'. This future has now become our present, where we grapple with climate change (extreme weather events), food insecurity resulting from diminishing returns from chemical inputs, and most importantly loss of the soil itself.

The normative part of our enquiry, *healing* the rift, must therefore also address the time dimension, and in this respect we need a methodology to vision futures. Futurology has always been a key component of the normative side of culture, interrogating what exists, as the utopian tradition shows. And today, given the perilous ecological context, continuing with the status quo should not really be an option anyway.

But the energy/entropy factor, while on the one hand *demanding* such radical visioning, on the other restricts it: the forces holding social power also control physical power, and the two are interlocked (Gale 1998), reinforcing each other in a positive feedback loop: in a bizarre way, wealth flows to those who cause the most entropy (Hornborg 2001). For this reason, we will argue that any meaningful futures visioning must be political.

At the same time, it must be realistic at a very concrete level. In this paper, we will attempt a concrete visioning of food futures, taking as our focus the city.

The urban dimension has historically been key to the problem of sustainable food futures: whereas pre-capitalist societies had a fundamental basis in subsistence, it was in the urban/industrial era that large proportions of the population came to represent only a cost in food terms, not a productive factor – hence the energy deficit.

But at the same time, cities are potentially well placed to heal the rift, for two reasons. Firstly, they would throw a new element into the mix. The reason *rural* agriculture is so difficult to convert to sustainability is that we can't just suspend production and re-start from a tabula rasa, whereas in cities, experimentation could occur without subtracting from existing cultivable surfaces; and because cities *are* largely a 'blank slate' (in terms of potential for food production), the scope for experimentation is vast. Secondly – and this is what supplies the context for such experimentation – cities are particularly well-placed to heal the alienation because of the scope for tucking the loops back in, by converting entropy in the form of compostable waste, grey water or surplus heat into useful inputs. In effect, we could transform metabolic rift into 'urban metabolism'. To assess these possibilities will be our task in this paper.

This is both a technical and a social task. The common principle bridging the two is that, in any system, we cultivate the point where it is far removed from the 'dead' equilibrium of either too much order or too much chaos (Prigogine and Stengers, 1985); here, we maximise the role of emergent properties of self-organisation, and in this case the future is not constrained (Prigogine, 2003). The physical emergence of the urban metabolism on the one hand, and open-ended experiments in societal self-organisation on the other, are thus necessarily linked. It is the interplay between them which emphasises the importance of energy-focussed futures visioning.

II. BACKCASTING, A CRITICAL ANALYSIS

To explore a critical perspective on visioning methodology, let us consider the methodology of 'backcasting'.

Definitions emphasise its distinction from forecasting or scenario-building (Wearerising, 2009). Where conventional policy agendas, notably on food, typically look forward from the present (for example, Barling et al, 2008), backcasting begins from a desired outcome and then considers the steps by which it may be reached. The methodology has, since its origins, been associated with energy, responding in particular to Lovins' call for 'soft' energies, both renewable and small-scale (Lovins, 1976). It was logical that such a future, necessarily radically different from what we have now, could not adequately be *fore*cast from the present (Robinson, 1982). Compared to other methodologies, backcasting thus offers a stronger definition of sustainability (Mulder and Biesiot, 1998), an interesting aspect of which has been to frame problems in terms of 'funds' and 'flows' (Holmberg, 1998: 34).

The 'flow' perspective gives the approach a metabolic feel, in comparison to mainstream economics. The significance of this is clear if we see the 'energisation' problem as one of correcting the flow towards entropy associated with the loss of natural regeneration cycles. In practice, such an approach would tend to favour industrial ecology, which typically includes some element of urban agriculture.

But the methodology's background as a business planning tool could also prove a limitation. Because the capitalist accumulation cycles, which replace those of nature, act to reward the degradation of energy/material inputs (Hornborg , 2001), solutions to the 'flow' problem can never merely be physical; and if societal systems need to transform themselves as radically as physical ones (and as part of the same process), then social movements would become the most important agents of change. Could the backcasting methodology rise to this challenge?

A response was to re-cast the methodology as a tool for communities (James and Lahti, 2004), and this in turn directly inspired the Transition Towns movement (Hopkins, 2008) which has been largely responsible for the wider popularisation of the approach; here, futures visioning becomes a collective and participatory process, one intrinsically linked to energy, notably in the focus of Transition Towns visioning around an Energy Descent Action Plan (EDAP).

The context of backcasting's rise as a community visioning tool in the second half of the 2000s is interesting. With the threat of climate disaster now real, conventional futurology – and notably the scenarios approach which asks you to picture bad lines of development as well as good ones – might generate paralysing and disempowering visions of meltdown. Hence the attraction of an approach which focussed on the positive, emphasising how a low-carbon future can be fun and bring better quality of life. The Transition movement showed an optimistic sense that a newly-freed societal energy (expressed as linkages, networks and collaborative experimentation) could in a way substitute itself for fossil energy.

But the crucial political shift remained limited. While academic futurology conceptually acknowledges the need to break path-dependencies (Tiberius, 2011), this stops short of questioning capitalism, and the backcasting literature did not fundamentally improve on this. Although there is a recognition of the need to be less in thrall to dominant paradigms (Quist and Vergragt, 2006: 1030), this remains circumscribed by the imperative of expanding business planning horizons to encompass major regime shifts (Quist, 2007: 55). Now, from a business standpoint, this would indeed make perfect sense: the horizons of mainstream economics truly neglect large-scale structures such as the accumulation regimes described by regulation theory (Aglietta, 1976), long-term shifts between them, and crucially*, the specific energy profile each regime tends to have*. But the problem remains that – given the embedded path-dependencies of speculative finance capital and militarism (Biel, 2012) – a green future may need to free itself from the capitalist mode of production, and even class society as a whole, not just one structural phase of it; a futurology which truly steps outside dominant paradigms must at least pose this question.

In this respect, it is not enough just to add a participatory or community plugin to a corporate model, and here, the attempted translation of backcasting to communities has proved questionable. For example, if we turn to the visioning of 2030 in the first Transition Town EDAP conducted in Totnes, Devon (which has served as a model for the whole Transition movement), we find a "forest model of society" (Hodgson, 2010) which looks quite like an idealised class hierarchy, with a nostalgic dose of feudalism, where corporations supply the canopy and community initiatives creep in the undergrowth. We must at the very least be vigilant, bearing in mind how 'natural' and 'organic' imagery has long been employed to justify oppressive systems (McKay, 2011). The abandonment of the scenarios approach could even have a downside, if it becomes too easy to ignore the struggles whereby the 'bad' lines of development would (in a realistic futurology) be resisted, and this in turn would leave a stunted understanding of the inevitably bloody features of 'transition' under actual conditions.

In a more realistic sense, taking account of such struggles and conflicts, there is a long tradition, whereby insurgent movements have visioned their desired future (Guha, 1983). In the English revolution, the Diggers of 1649 already showed a consciousness, both that a precondition for unleashing societal free energies must be the overthrow of class division, and that the institutional embodiment of such energies must be the associative principle, the restructuring of society around commons and co-operatives. Gerard Winstanley, the Diggers' founder, seeking a mythology to express this, challenged the narrative through which the selfish and exploitative Esau or Cain persistently slays his brother (Winstanley, 1983 [1649]: 125 ff.). These traditions were carried forward, in the works of early 19th-century utopian socialism, where again the condition for restoring the social fabric is closely related to food autonomy. Thus, the harvest is paradigmatic in a dual sense: humanity itself is ripening (towards a stage where it can finally realise co-operative principles), and the physical harvest can only be maximised if we ourselves co-operate (Weitling, 1979 [1838]: 72 ff.); one of the first communistic gatherings was a collective feast (Pillot et al, 1979 [1840]). And this in turn forms a bridge to the work of Marx, which builds on that of the utopians (Engels, 1999 [1880]; Geoghan, 2008), while seeking to take it to the next level. Today's reality, particularly in the global South, is already one where people have no choice but to struggle for land and food if they are to survive. This finds expression in a new consciousness, often referencing the term 'food sovereignty', which assembles many issues around autonomy, freedom from global food chains, community resilience, the safeguarding of diversity and heritage, place, self-reliant networks etc. (Pimbert, 2009; Mares and Peña, 2010). Such struggles are in effect agents for visioning a future which brings society into harmony with natural principles, in a sense qualitatively different from the manipulative distortion of 'organic' images by oppressive systems.

Only on a basis of recognising what needs to be overthrown can we therefore truly understand transition. And while radical social movements have pushed futures visioning in this direction, establishment futurology has if anything retreated further away from it. Where the original *Limits to Growth* (Meadows et al, 1972) did at least sharply highlight the destructive impact of the feedback loop of capital accumulation, more recent debates (for example Raskin, 2002), under the excuse of moving beyond the *Limits* to encompass complexity theory, too often take complexity as an excuse to shirk any clarity on issues of exploitation. If backcasting is itself to have a future and be relevant at all, it would need to decide which side it is on and recognise what social movements have to struggle for and against.

III: FOOD FUTURES: SOME FUNDAMENTAL PARAMETERS

Having suggested some pointers for a critical use of backcasting, let us address our case. Before focusing on the urban sector, it will be useful to consider certain general parameters, in terms of energy flows, for a sustainable agriculture. I will suggest three specific, and closely interrelated, strategies: the minimisation of physical work and its replacement by knowledge; reconstituting the structure of the soil; and carbon sequestration.

In traditional food systems when most work was manual, the calorific output must by definition be greater than the input, or you would die. Fossil fuel inputs offered a temporary illusion of escaping this constraint, but are no longer sustainble, so how can we cut them without prohibitively increasing manual work? An important part of the answer is that, in line with traditional approaches where knowledge was immense (Fre, 1990), knowledge input must rise reciprocally as work declines. The condition for this is a complexity-respecting approach to science within which traditional and modern elements can, in principle, seamlessly be integrated.

This in turn takes us to the task of rebuilding soil. If we think of entropy as flow towards *loss of structure*, then what underlies perceived food crisis is actually the loss of soil itself. Soil takes 200-1,000 years per inch to form (Arriaga et al, 2012), its conservation being "central to the longevity of any civilization" (Montgomery, 2007: 6). Alfred Howard, the founder of organics, already graphically remarked that "the land is going on strike" (Howard, 1940) and this has accelerated to the point of soil-loss at a rate of up to 50 tonnes per hectare per year, 100 times faster than its formation (Banwart, 2011). Why is this happening? Organic thinking tends to see the soil as 'living', and a self-organising complex system is one which maintains low entropy. A key determinant for the individual organism is the boundaries within which low entropy is maintained (Ho, 1998), and at a higher level the soil achieves this by binding together both mineral and organic elements through very subtle – and fragile – bonds (Bourguignon and Bourguignon, 2009). "Soil ecosystems are probably the least understood of nature's panoply of ecosystems and increasingly among the most degraded." (McNeill and Winiwarter, 2004).

But complex systems cannot by definition be understood through reductionism, such as the 'scientific' agriculture of late capitalism which seeks to override complexity, thus sacrificing the emergent properties of the ensemble. From this standpoint, we can understand in a deeper way the role of knowledge input: it replaces the kind of work – notably ploughing – which is not only a waste of calories but more importantly undermines soil structure; we can then permit the emergent self-organisation of the soil's complex system to re-establish itself. This is the underlying rationale for 'do-nothing farming' (Fukuoka, 1978) which is in reality not 'non-action', but rather a form of intervention working *with* natural properties, not against them. Terms such as agroecology, permaculture, biodynamics, Low-External Input Sustainable Agriculture, the Fukuoka method etc. characterise an approach, systematising the experience of small farmers themselves (van Walsum, ND), which serves as a knowledge base for radical social movements, such as those identifying with 'food sovereignty'.

Moving on to the third task, the fixation of carbon, we can now see the solar transition not just as an external condition (replacing fossil fuels) for farming, but as an intrinsic part of it. As with an organism, the earth-system sets boundaries within which low entropy is maintained, managing the import of solar energy through temperature regulation, and within this mechanism, living organisms are integral (Lovelock, 2000). The soil here plays a crucial, intermediary role, and in this sense agricultural reform is central to any strategy to redress anthropogenic disturbance in temperature regulation. Plants are effectively solar power stations, and while the method they use has the quirks one could expect from spontaneous evolution, it works, and the challenge of artificially replicating it proves elusive (Jones, 2012). Since plants process solar energy and at the same time feed us, logically we could integrate food and solar transition as a single whole, and in this, the key lies in the link between carbon sequestration and fertility: a benign positive feedback loop, since high carbon-content soil, promoting a lusher growth and thus more sequestration (Brown, ND), would counteract the 'bad' positive feedback between global warming and decreased albedo. Since soil holds nearly three times as much carbon as vegetation and twice that of the atmosphere (Yi et al, 2011), by incorporating carbon in degraded soil we not only increase crop yields but can "offset fossil fuel emissions by 0.4 to 1.2 gigatons of carbon per year, or 5 to 15% of the global fossil-fuel emissions" (Lal, 2004: 1623). And significantly, by following no-till farming methods – whereby we conserve the of soil's structure (its negative entropy) *by not working it* – we maximise sequestration potential (Yi et al, 2011); planetary science specialist David Schwartzman sees getting carbon into the soil as the sole effective – and essential – form of geoengineering (Schwartzman, 2013). In this sense, by reducing energy as work we attain a benign relationship with energy as *flows*. For example, today's debates include models where large-scale ranges where animal-grazing acts as a carbon pump (Savory, 1983; Norman, 2001); or a charcoal-based method replicating the 'dark earths' of the ancient Americas (Taylor, 2010), in its contemporary form often called biochar, whereby smouldered agricultural residues simultaneously sequester carbon and improve the soil.

Transition to such technical solutions can only occur alongside a social transition, an unleashing of societal free energies to mirror those of physical systems, and reconnecting with the radical tradition which seeks to shift the dead weight of class society and restore co-operation. As in physical systems, transition may mean radical rupture. Traditional farming systems – for example in their use of fire – embraced disturbance because it builds resilience, and in this way, one can "avoid the accumulation of disturbance that moves across scales and further up the panarchy ..." (Berkes and Folke, 2002: 131). The contemporary mainstream food system has lost the ability to embrace disturbance, with the result that cumulative disturbance has built up, leading to crisis at a larger scale. But even this can be a harbinger of progressive change, both technically and institutionally. Historically, as Thirsk argues, there has been an intrinsic link between land tenure and innovation: "mainstream" farming features a narrow range of crops and concentrated landholding which renders it vulnerable. In times of crisis, agriculture regenerates itself through “alternative” approaches – on the one hand more diverse and experimental, on the other redistributory in terms of landholding – which then “furnish ideas for new strategies in the following age.” (Thirsk, 1997: 19). The timeline of our future vision should thus include a major revolution both of farming technique and of landholding, hence of property relations in general.

IV: URBAN FOOD PRODUCTION

We will now develop this argument in relation to the case study of urban food growing. In the spirit of Eric Olin Wright’s ‘real utopias’ (Wright, 2010), we extrapolate from trends which exist now, while remembering that, in a future vision, they will flourish under new conditions, both because of the emergent properties of the ensemble which can’t be predicted from its parts, and because of the challenges which they will have needed to face and overcome.

What is the rationale for growing food in cities? Today’s mainstream agriculture is caught in a ‘bad’ path-dependency where diminishing returns from chemicals are met with still higher inputs of what is causing the problem. A radical change is needed, but how can it be effected? In this case, ‘transition’ must concretely be understood in relation to the *conversion* period of changeover to organics, which in the example of Britain’s Soil Association would be two years, the “time to start establishing organic management techniques, build soil fertility and biological activity, as well as to develop a viable and sustainable agro-ecosystem.” (Soil Association, ND). But the city must still be fed during this conversion, and attempts to colonise any further ‘*wild’* space for food growing could only worsen local ecosystem collapses (Foley et al, 2011). By default, this only leaves the option of the city growing its own food. But actually, this is not a mere default option, it has positive advantages. Besides its potential for an urban metabolism, and for grassroots innovation and community linkages, the city – being relatively insulated from pesticides, moncropping and risky GM experiments – is favourably placed as a laboratory and jumping-off point for new approaches.

I will now develop these points. I will propose a threefold analytical division: the subsistence sector, the urban forest and the ultra-high productivity sector. This reflects the fact that there are several distinct reasons for urban farming, which can interact as part of a system whose emergent properties outstrip the sum of its parts.

Firstly, the subsistence sector. In the European context, the paradigm is allotments and community gardens, but in developing countries it would include many types of squatted, informally-occupied land (and also *space*, for example balconies). This sector answers immediate food security needs, combined with more strategic food sovereignty objectives: maximising the democratisation of knowledge and experimentation, as well as local linkages, both social (distributing the product through food chains, knowledge-sharing) and physical.

A seeming paradox is that, while we want a lot of *social* linkages, from an ecological standpoint we should minimise throughput (inputs of physical work, resources, water; outputs of entropy expressed as water runoff, leaching, methane and CO_2 emission etc.), in which case it seems desirable to view the plot as a closed system. But if we calculate the limits within which it *can* function as a closed system, we can quantify the extent to which needs to be plugged into external loops. Let us briefly concretise this in relation to composting, the centrality of which to organic farming was established by Howard (Howard, 1940). In this respect, there is a huge area of traditional knowledge which can be reclaimed (Dailliez, 1981). The key to soil management is organic mulches (Dowding, 2007), and much of this is supplied by composting the plot's own residues (weeds, the parts of vegetables we don't eat). Russian Comfrey Bocking 14 further helps us overcome the entropy of a given area of land since its roots draw nutrients from lower regions thus turning the topsoil into an open system. But we must understand the limits within which this is possible, in order to quantify the extent to which the plot's internal resources must be supplemented by external inputs. Taking the traditional British allotment (250 m^2), converted to a no-dig method with paths between beds, our cultivable surface is about 150 m^2. Organic agriculture literature typically requires a 40mm mulch for the combined purpose of restoring fertility, shielding soil from erosion, preventing water loss, and suppressing weeds (Corbalan, 2005). Spread over 150 m^2 this gives 6 m^3 required in a given year. In the author's practical research, it can be estimated that about *half* is internally generated from the plot. This gives a figure of 3 m^3 per 250 m^2 of cultivable surface required from outside the plot's closed system. Here, urban food-growing has an advantage over rural, because of the ready availability of compostable waste. Where today's industrial ecology or industrial symbiosis models tend to view agriculture peripherally as an outlet or sink for industrial/domestic by-products, in future it may become central, with the rest of the metabolism revolving round it.

Secondly, the urban forest. Several considerations underly our identification of this category: to break down dualism between the natural and the built; to maximise the 'creative chaos' of self organisation, both in physical systems and in society (and in relations between the two); and finally the 'wildness' which is required for biodiversity.

In conventional plots we mimic self-formed natural systems up to a point by employing agroecology principles such as intercropping (for example, of maize, squash and legumes); however, in the urban forest we are doing this at a qualitatively higher level. Farming and built environment cease being sharply separate (Wilson, 2009), with buildings becoming a bit *like* forests. Advanced architectural thinkers have long raised the issue that the built should (at least) give back to nature what it subtracts. Where Corbusier sought to achieve this with roof terraces, Hundertwasser critiqued this modernist approach, looking to a built environment which *itself* followed natural forms (Hundertwasser, 1964). Recent understanding of the city's responsibilities towards climate mitigation, coupled with local climatic effects *within* cities (the heat island) incite us to revisit these debates (an innovative project in Milan, now under construction, being one example: Architizer News, 2013). Partly, the urban forest makes green space productive in food terms: for example, the trees we plant should yield fruit and nuts (Pinkerton and Hopkins, 2009), a process already underway in London (London Orchard Project, ND). And in a more developed form, trees cohere as an edible urban forest which, once established, acquires its own emergent self-maintaining ecology (Ettinger, 2012). In a social sense too, the process of *creating* these spaces is itself emergent, a spontaneous encroachment of growing spaces, as already foreshadowed by the squatted community of Bonnington Square, Vauxhall (Self-Help Housing, ND). The concept of forest is explicit in the Los Angeles community project L.A. Green Grounds (L.A. Green Grounds, ND), while the 'new ruralism' aspires to bring together smart growth, new urbanism and sustainable food and agriculture systems (SAGE, ND).

All the above could be considered pathways into the category we have named urban forest. At the same time, we should not be obsessed with producing food everywhere. If the food-growing sector is to be truly sustainable, it requires biodiversity, and in this respect, a given area of wildness should not be viewed, negatively, as subtracted from the food-growing area, but rather as a positive addition to it, supplying natural predators and pollinating insects. This in turn requires native plant species, counterbalancing the reality that many food crops are inevitably non-native (in the UK context, solanum or cucurbits, for example). Interestingly, given that in a rural context biodiversity is heavily depleted by factory farming, moncropping and pesticides, this is another area where the city can make outstanding contributions to the wider cause of sustainable transition: in an urban context, if we provide the right substrate, native plant species spontaneously appear astonishingly quickly, soon followed by rare birds, insects and arachnids (Kadas, 2006). Green roofs are a key aspect, and will give rise to many forms of symbiosis in the wider sustainability transition: for example, green roofs help solar PV operate more efficiently by lowering ambient temperatures (Gedge, 2013).

Finally, under this heading, there is a connection between the chaotic self-organisation of nature, and of society. Guerrilla gardening, referencing guerrilla as a diffuse, self-organising form (Reynolds, 2008), has an evolutionary capability to throw up new forms (one example being 'Guerrila Grafters' who in San Francisco graft fruit-bearing branches onto ornamental trees – Zimet, 2012); it is a societal struggle conducted *through* the self-organising capacity of nature, as in guerrilla gardening's adaptation of Masanobu Fukuoka's seed-balls (whereby plants themselves choose where to grow) as 'seed-bombs'. The notion of "islands of unpredictability" (Carlsson, 2008) suggests that, by allowing space for unplanned and unstructured initiatives, we create the terrain for structure as an *emergent* property both of society and of nature.

Thirdly, there is an ultra-high productivity sector. The categories addressed so far make outstanding contributions to food sovereignty, empowerment, disalienation, social networks and the re-constitution of biodiversity, but do not fully explain how far the city can feed itself. Whilst there is currently an untapped area of land/space theoretically available for conventional urban agriculture – which research in London suggests may be sizeable (Tomkins, 2009: 37-38) – the question is, could we move beyond these limits into a different conception of food growing, escaping space constraints, either by raising productivity beyond what is 'normal' for a given area or by multiplying the growing area itself beyond its footprint through vertical stacking. Part of this can happen on rooftops: in New York, a huge rooftop hydroponic farm on a single building, irrigated by captured stormwater, is planned to yield 1 million pounds (450,000 kg) of vegetables per year (Foderaro, 2012). But even more importantly, the low-energy revolution heralded by LED in principle permits food-growing inside buildings. Some would vision this as the paradigm for the urban agriculture to come (Despommier, 2010). As we write, 'plantscraper' models have just reached the point of realisation, with the first commercial vertical farm opening in Singapore (Zimmer, 2012) and a 17-story urban farm planned in Linköping, Sweden (Ma, 2012). In experiments by the author and others, a mixture of red and blue LEDs produce good plants even without natural light, and given that LED efficiency is currently rising exponentially, the notion of 'Zero-Acreage Farming' – proposed in relation to current projects in Berlin and with aspirations as an international model (Zfarm News, 2012; ZFarm, ND) – seems closer to reality.

We must however be careful not to focus excessively on energy *input* at the expense of the bigger picture of minimising entropy by resisting loss of structure. There is an issue of how far we can aspire to 'free' food from soil as a substrate, bearing in mind that plants' natural mechanisms need it to exchange information: thus, they communicate through fungal and mychorrizal filaments to trigger pre-emptive responses to disease (Song et al, 2010). There is also the risk that the high-tech part of the solar transition sever itself from the issues of democratisation addressed by food sovereignty, and make things even more elitist. But current developments suggest this is not inevitable: in the remarkable project of Will Allen in Milwaukee, USA (Allen, 2012), an aquaponic system with its own self-regulating physical properties combines a very high productivity, high interaction with the urban metabolism and strong stimulus to social linkages. Similarly, a community-based vertical farm is planned in Wyoming (Popovitch, 2013). The key, then, is to treat cutting-edge technical experiment as *part* of a wider societal energising.

V. IMPLICATIONS OF THE CASE STUDY FOR THE SOCIAL CONTEXT OF FOOD SYSTEMS

In terms of physical systems, many elements for a sustainable future are in place. Nevertheless, while the circuits of capital accumulation are still dominant, these tend to subsume particular experiments. To take one example, carbon sequestration through the re-constitution of dark earths, potentially marvellous at a technical level, is currently subsumed as a means of accumulation, with the effect of disempowering communities (Leach et al, 2012). Thus, if the technical response is disconnected from the social one, and begin to act against it, nothing will be achieved, even technically.

The unleashing of societal energies therefore still remains, and is in fact *required* by the complexity of the solar revolution: Colin Ward, the historian of the allotment movement (Crouch and Ward, 1997) argued on explicitly cybernetic grounds that the need for a society to self-organise is a function of its complexity (Ward, 1988). It has long been felt that there are three inseparable tasks: protection of land, production of food, and distribution of land (Kumar, 1976: 7), and in terms of the argument of this paper, we can interpret these as follows: protection of land means resisting the entropy of soil structure and restoring biodiversity; an adequate volume of food production is the inescapable basis for any social organisation; and distribution highlights the changes in production relations required for this to happen.

These principles retain their relevance as a charter for re-energising society, and are implicitly embodied in today's social movements. A turning point may have occurred in the late 1990s, when the Mexican Zapatistas and Indian farmers' movements proved a catalyst for shaking the dead equilibrium: in the author's experience, solidarity practices and networks built at that time in Europe in support of these two struggles helped lay the groundwork for more recent developments. A Land and Freedom camp (October 2011) on London's Clapham Common (Heggs, 2011), which predated Occupy Wall Street, referenced not just the Diggers' 1649 occupation, but also global struggles. In today's London, OrganicLea provides maybe the best example of what could be achieved (OrganicLea, ND): here, the permaculture principle of bringing society and nature into harmony receives an interpretation of radical self-organisation, and conditions for replicating this approach (perhaps as a kind of constitutive cell of alternative society) are already under debate (Litherland, ND).

Many of urban farming's 'real utopias' are in fact the fruits of such struggle. New York's community gardens in the 1980s were the object of a fearsome battle because they were liberated spaces, consciously seeking to embody here and now the kind of future which *could* be built, and hence viewed as threatening by the establishment (Carlsson, 2008: 93). In Argentina during the 2000s, in response to economic collapse there occurred a wave of contestatory social self-organisation from below, including barricading roads and factory occupations (Palomino, 2003), and as part of this current, a significant movement of urban food growing, all of it forming part of a historic trend to redress the loss of (societal) structure and re-constitute it on a co-operative basis. In Turkey in 2013 a struggle to protect a green space from encroachment triggered a movement of mass protests and popular assemblies raising fundamental issues about society as a whole.

CONCLUSION

We have proposed a model for society's energy needs in terms of *flow*, interpreted in two senses: firstly we must limit the flow towards entropy, central to the definition of time itself, which in the context of the earth-system can be achieved because this is what the earth-system intrinsically exists to do ... but in this case we must take nature on our side. Secondly, a cyclical definition of flow, which is in fact the medium through nature operates to resist entropy, by acting to 'tuck' whatever is expelled by one process back as an input to another. But in the current mode of production, the accumulation circuits take ownership of the cyclical motion, distorting it so as to magnify and reward entropy, leaving us to confront the stored-up effects of expelled wastes, notably extreme climate events.

Considering how society can re-order its relationship with energy, we raised the problem of a methodology of futures visioning. We took the example of backcasting, whose strength lies in freeing us from the limitations of that form of 'realism' which would consist in taking where we are now as its point of departure. Nevertheless, given the pervasive dominance of today's ruling interests and ideologies – fuelled by the socio-political influence conferred by their control of physical power and resources – our supposedly 'free' creative visioning may merely be subsumed ito existing norms. As an antidote to this, we proposed situating ourselves consciously within the tradition of radical social movements, more specifically those linked to our case study of food systems.

In their broader sense, we argued, food systems illustrate a dual expression of principles of self-organisation in complex systems: at a physical level, arresting the loss of soil and beginning to rebuild it, through understanding and working alongside its complexity; at a social level, the change to sustainability becoming realised as part of a societal shift towards structures where power and initiative are widely distributed.

We then considered the case study of urban agriculture. It is revealed as an example of a plural and multi-faceted development, in which physical and social dimensions of self-organisation interlock and feed off each other. From this, we deduce that societal restructuring co-evolves with the systems by which it is fed. Food system development both in a literal sense provides the energy for people to function, and also acts as catalyst for an exploration of human society's energies of creativity and self-organisation.

=============

Aglietta, Michel (1976) *Régulation et crises du capitalisme*. Paris: éds. Calmann-Lévy

Allen, Will (2012) *The Good Food Revolution: Growing Healthy Food, People, and Communities.* New York: Gotham Books

Architizer News 2013, 'Green Architecture Takes Big Leap With Milan's "Vertical Forest"', January 10 on http://www.architizer.com/en_us/blog/dyn/71460/green-architects-takes-big-leap-with-milans-vertical-forest/#.UPLe1vKI4ed

Arriaga, Francisco, Greg Andrews, Nick Schneider, Matt Ruark (2012), 'Soil erosion concerns after silage harvest", *New Horizons in Soil Science* Issue 12-03

Banwart, Steve (2011) 'Save our soils', *Nature* 474, 151–152 (June 9), doi:10.1038/474151a

Barling, David, Rosalind Sharpe and Tim Lang (2008) *Towards a National Sustainable Food Security Policy - A project to map the policy interface between Food Security and Sustainable Food Supply*. London: City University, Centre for Food Policy

Biel R., (2012) *The Entropy of Capitalism*. Leiden: Brill

Bellamy Foster, John (2009) *The Ecological Revolution - Making Peace with the Planet*. New York: Monthly Review

Berkes F. and Folke C. (2002) 'Back to the Future: Ecosystem Dynamics and Local Knowledge' in Gunderson L.H. and Holling C.S. *Panarchy – Understanding Transformation in Human and Natural Systems*. Washington DC: Island Press

Bourguignon C. and Bourguignon L. (2009) *Le Sol, la Terre et les Champs.* Paris: eds. Sang de la Terre

Brown, Sally (ND) *Connections between Compost, Soil Carbon and Climate Change* on http://www.agresourceinc.com/article_connections_print.htm

Caldwell, Malcolm ([1971]) *The Energy of Imperialism, and the Imperialism of Energy*, School of Oriental and African Studies, duplicated

Caldwell, M. (1977) The Wealth of Some Nations. London: Zed Books

Carlsson, Chris (2008) *Nowtopia - How Pirate Programmers, Outlaw Byciclists and Vacant-Lot Gardeners are Inventing the Future Today!* Edinburgh: AK Press

Corbalan, Jacqueline (2005) 'Compost de Broussailles', *Abécédaire du Jardinier bio, La Gazette des Jardins*, hors-série, Oct.-Dec.

Crouch, David and Colin Ward (1997) *The Allotment – its Landscape and Culture*. Nottingham: Five Leaves

Dailliez, Laurent (1981) *Les Templiers et l'agriculture, ou les composts templiers*. Nice: Presses d'Alpes-Méditerranée

de Rosnay, Joël (1979) *The Macroscope*. New York: Harper & Row,

Dowding, Charles (2007) *Organic Gardening: The Natural No-Dig Way*. Totnes: Green Books

Ettinger, Jill (2012) *Seattle Building Massive Edible Forest Filled with Free Food*, Feb 28, on http://www.organicauthority.com/blog/organic/seattle-building-massive-edible-forest-filled-with-free-food/

Foderaro, Lisa W.(2012) 'Huge Rooftop Farm Is Set for Brooklyn' *New York Times* April 5
Foley, Jonathan A. et al (2011) 'Solutions for a cultivated planet' *Nature*, Vo. 478, October 20
Fre, Zeremariam (1990) *Pastoral Development in Eritrea and Eastern Sudan - Implications for Livestock Extension Programmes*, PhD thesis, Reading University
Fukuoka, Masanobu (1978) *The One-Straw Revolution: An Introduction to Natural Farming*. Rodale: Emmaus
Gale, Fred P. (1998) 'Theorizing Power in Ecological Economics' *Ecological Economics*, 27: 131-138
Gedge, Dusty (2013) presentation at workshop on *Green Roof Avant-Garde*, Garden Museum, London, June 3
Geoghan, Vincent (2008) *Utopianism and Marxism*. Bern: Peter Lang
Glaeser, B. and K. Phillips-Howard (1987) "Low-energy Farming Systems in Nigeria" in Glaeser (ed.) *The Green Revolution Revisited - Critique and Alternatives*. London: Allen and Unwin
Guha, R. (1983) *Elementary Aspects of Peasant Insurgency in Colonial India*. Delhi: OUP
Heggs, Lisa (2011) *Land and Freedom Camp on Clapham Common – London*, Demotix (Crowd-Sourced News from around the Globe) September 24, on http://www.demotix.com/news/844031/land-and-freedom-camp-clapham-common-london#media-844027
Ho, Mae-Wan (1998) *The rainbow and the worm, the physics of organisms*. Singapore: World Scientific
Hodgson, Jacqi (with Rob Hopkins) (2010) *Transition in Action, Totnes 2030, an Energy Descent Action Plan* Totnes: Transition Town, on http://totnesedap.org.uk/book/part3/vision-totnes-district-2030/a-forest-model-of-society/
Holmberg J. (1998) 'Backcasting: a natural step in operationalising sustainable development', *Greener Management International - The Journal of Corporate Environmental Strategy and Practice*, 23
Hopkins, Rob (2008) *The Transition Handbook – from oil dependency to local resilience*.Totnes: Green Books
Howard, Albert (1940) *An Agricultural Testament*. Oxford: Oxford University Press
Hornborg, Alf (2001) *The power of the machine : global inequalities of economy, technology, and environment*. Walnut Creek, CA : AltaMira Press,
Hundertwasser (1964) Mouldiness Manifesto against Rationalism in Architecture, revised version of 1958 original, on http://www.hundertwasser.at/english/texts/philo_verschimmelungsmanifest.php
James, Sarah and Torbjorn Lahti (2004) *The natural step for communities : how cities and towns can change to sustainable living* Gabriola Island, BC : New Society Publishers
Jones, Nicola (2012) 'Turn a New Leaf – Can we reinvent photosynthesis to make clearn, green energy for all?' *New Scientist*, April 14
Kluge, Alexander (2008) *Nachrichten aus der ideologischen Antike - Marx/Eisenstein/Das Kapital*, feature film
Lott, Melissa C. (2011) 10 Calories in, 1 Calorie Out – The Energy We Spend on Food, *Scientific American*, August 11
Lovelock, James (2000) *The Ages of Gaia*. Second Edition, Oxford: OUP
Kadas, Gyongyver (2006) 'Rare Invertebrates Colonizing Green Roofs in London'. *Urban Habitats*, December
Kumar, Satish (1976) 'Introduction' in Girardet, Herbert (ed) *Land for the People*. London: Crescent Books

L.A. Green Grounds (ND) on http://lagreengrounds.org/about/
Lal, R. (2004) 'Soil carbon sequestration impacts on global climate change and food security'. *Science*, 304
Leach, Melissa, James Fairhead and James Fraser (2012) 'Green grabs and biochar: Revaluing African soils and farming in the new carbon economy' *Journal of Peasant Studies* Vol. 39, No. 2, April: 285–307
Litherland, Ru (ND) *Where Next For The Community Food Movement?*, discussion document, dupicated
London Orchard Project (ND) on http://thelondonorchardproject.org/
Lovins, Amory (1976) 'EnergyStrategy - the Road Not Taken' *Foreign Affairs,* October
Ma, Julie (2012) *A 'Vertical Greenhouse' Could Make a Swedish City Self-Sufficient*, March 12 on http://www.good.is/post/a-vertical-greenhouse-could-make-a-swedish-city-self-sufficient/
Mares, Teresa M. and Devon G. Peña (2010) 'Urban Agriculture in the making of insurgent spaces in Los Angeles and Seattle' in Hou, Jeffrey ed. *Insurgent Public Space – guerrilla urbanism and the remaking of contemporary cities*. London: Routledge
Marx, Karl (1954 [1867]) Capital, Vol. I. London: Lawrence and Wishart
McKay, George (2011) *Radical Gardening.* London: Frances Lincoln
McNeill J. R. and Verena Winiwarter (2004) 'Breaking the Sod: Humankind, History, and Soil'. *Science* 304: 1629
Meadows, D.L. et al (1972) *The Limits to Growth*. London: Earth Island
Montgomery, David R. (2007) *Dirt – the Erosion of Civilisations*, Berkely: University of California Press
Mulder, H.A.J. and W. Biesiot (1998) *Transition to a sustainable society: a backcasting approach to modelling energy and ecology*. Cheltenham: Edward Elgar
OrganicLea (ND) *A workers' cooperative growing food on London's edge in the Lea Valley*, on http://www.organiclea.org.uk/
Palomino, Héctor (2003) 'Las experiencias actuales de autogestión en Argentina', *Nueva Sociedad*, 184
Penrose, Roger (2010) *Cycles of Time*. London: The Bodley Head
Perelman, Michael (1987) *Marx's Crises Theory – Scarcity, Labour and Finance*. New York: Praeger
Pillot, J.-J. et al 'Premier banquet communiste le 1er juillet 1840' in Bravo, Gian Mario (ed.) *Les Socialistes avant Marx*, Tome II. Paris: Maspero
Pinkerton Tamzin and Rob Hopkins (2009) *Local Food. How to make it happen in your community*. Totnes: Transition Books
Popovitch, Trish (2013) *With 90% of its Crop Pre-sold and a Land Lease Rate of $1 Per Year, a Vertical Farm Rises in Wyoming* on http://seedstock.com/2013/01/16/with-90-of-its-crop-pre-sold-and-a-land-lease-rate-of-1-per-year-a-vertical-farm-rises-in-wyoming/
Prigogine I. (2003) *Is Future Given?* Singapore: World Scientific
Prigogine I. and Stegers I. (1985) *Order Out of Chaos – man's new dialogue with nature*. London: Flamingo
Quist, Jaco and Philip Vergragt (2006) "Past and future of backcasting: The shift to stakeholder participation and a proposal for a methodological framework" *Futures* 38: 1027–1045
Quist, Jaco (2007) *Backcasting for a Sustainable Future - the Impact after 10 years*. Delft: Eburon
McNeill J. R. and Verena Winiwarter (2004) "Breaking the Sod: Humankind, History, and Soil", *Science* 304: 1629

Raskin, P. et al (2002) *Great Transition – The Promise and Lure of the Times Ahead*, Stockholm: Environment Institute and Global Scenario Group, http://www.tellus.org/documents/Great_Transition.pdf

Reynolds, Richard (2008) *On Guerrilla Gardening – A Handbook for Gardening Without Boundaries.* London: Bloomsbury

Richards, Paul (1985) *Indigenous Agricultural Revolution - Ecology and Food Production in West Africa*. London: Hutchinson

Robinson, John Bridger (1982) "Energy backcasting – A proposed method of policy analysis" E*nergy Policy* Volume 10, Issue 4, December: 337–344

SAGE (Sustainable Agriculture Education) (ND) on http://www.sagecenter.org/projects/new-ruralism-framework-foodshed-assessments-for-metro-regions/

Savory, Allan (1983) "The Savory grazing method or holistic resource management", *Rangelands*, Vol. 5 No 4

Self-Help Housing (ND) on http://self-help-housing.org/case-studies/bonnington-square-london/

Soil Association (ND), Frequently Asked Questions on http://www.soilassociation.org/frequentlyaskedquestions/smid/4313?key=conversion+period accessed August 5 2012

Song Y.Y., R.S. Zeng, J.F. Xu, J. Li, X. Shen (2010) "Interplant Communication of Tomato Plants through Underground Common Mycorrhizal Networks", *PLoS ONE* 5(10): e13324

Swaminathan, Nikhil 2008 "Why Does the Brain Need So Much Power? New study shows why the brain drains so much of the body's energy", *Scientific American* April 29

Taylor, Paul (2010) *The Biochar Revolution*. Victoria: Global Publishing Group

Thirsk, Joan (1997) *Alternative Agriculture, A History: from the Black Death to the Present Day*. Oxford: Oxford University Press

Tiberius, Victor (2011) "Path Dependence, Path Breaking, and Path Creation: A Theoretical Scaffolding for Futures Studies?" *Journal of Futures Studies* Vol. 15 No. 4, June

Tomkins, Mikey (2009) "The Elephant and the Castle: Towards a London Edible Landscape", *Urban Agriculture Magazine*, no. 22, June

van Walsum, Edith (ND) *Learning to Value LEISA: Experiences in Global Knowledge Networking for Low External Input Sustainable Agriculture* on http://www.future-agricultures.org/farmerfirst/files/T3b_van_Walsum.pdf

Ward, Colin (1988) *Anarchy in Action*. London: Freedom Press

Wearerising (2009) "Backcasting" on http://wearearising.org/2009/01/13/backcasting/

Weitling, Wilhelm (1979 [1838]) "L'humanité telle qu'elle est et telle qu'elle devrait être" in Bravo, Gian Mario (ed.) *Les Socialistes avant Marx*, Tome II. Paris: Maspero

Wilson, Alex (2009) "Growing Food Locally: Integrating Agriculture Into the Built Environment", *Environmental Building News*, Vol. 18, No. 2

Winstanley, Gerard (1983 [1649]) "A Watch-Word to The City of London, and the Army" in Winstanley G. *The Law of Freedom and other Writings* (ed. Christopher Hill) Cambridge: Cambridge University Press

Wright, Eric Olin (2010) *Envisioning Real Utopias*. London: Verso

Yi Wang, Cong Tu, Lei Cheng, Chunyue Li , Laura F. Gentry, Greg D. Hoyt, Xingchang Zhang and Shuijin Hu (2011) "Long-term impact of farming practices on soil organic carbon and nitrogen pools and microbial biomass and activity", *Soil and Tillage Research* ,117: 8–16

ZFarm (ND), "Existing ZFarming Projects" on http://www.user.tu-berlin.de/wolfgang.straub/zfarm/svg/index_svg.html

ZFarm News (2012) *Aktuelle Informationen zur gebäudegebundenen Landwirtschaft*, on http://www.zalf.de/htmlsites/zfarm/Documents/newsletter/ZFarm_Newsletter_Februar.pdf accessed 23.5.12

Zimet, Abby (2012) *Guerrilla Grafters: Undoing Civilization One Fruitless Branch At a Time* on http://www.commondreams.org/further/2012/04/10-0

Zimmer, Lori (2012) "The World's First Commercial Vertical Farm Opens in Singapore", *Inhabit (Design that will save the world)* October 26, on http://inhabitat.com/the-worlds-first-commercial-vertical-farm-opens-in-singapore/