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HARNESSING ALTERNATIVE CURRENCIES IN THE PROVISION OF ZERO CARBON HOUSING: LEARNING FROM THE GREEN DEAL

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ABSTRACT

The 2016/2019 Building Regulations updates present significant challenges to the UK building industry; there is also an urgent need for the retrofitting of existing housing stock to meet carbon reduction targets enshrined in the Climate Change Act. The recent Green Deal and other schemes have attempted to address this problem, but have fallen short of expectations. Existing research identifies that alternative finance can 'fill in the gaps' where the legal tender system falls short, unlocking previously unused assets in a community. This paper proposes a new model for collective action, reworking the basic ideas behind the Green Deal within the context of a complementary currency system.

INTRODUCTION

Since 2002, several schemes and mechanisms have been introduced by the government in order to improve the environmental performance of the UK's housing stock. The Energy Efficiency Commitment (EEC), for example, aimed to achieve energy savings of 62TWh between 2002 and 2005 (Ofgem, 2005), and exceeded its targets through a focus on assisting low income households with energy efficiency upgrades, whilst government funding for the 2000 Warm Front scheme continued to assist vulnerable demographic groups with measures such as insulation and boiler replacement until its close in 2013 (GDS, 2014). The CERT (Carbon Emissions Reduction Target) scheme ran between April 2008 and the end of 2012, and imposed obligations upon all gas and electricity providers with more than 15,000 domestic customers to assist with a variety of energy efficiency measures, including financial assistance with insulation and efficient lighting (Ofgem, 2013), before being superseded by the Energy Companies Obligation (ECO).

In 2010, the policy mechanism known as Feed-in tariffs came into force in the UK, to encourage the micro-generation of electricity on domestic and non-domestic properties via the payment of a 'generation tariff' for any electricity produced, with a further premium paid for any electricity exported back to the national grid. From November 2011, the Renewable Heat Incentive expanded upon this mechanism by providing similar incentives for the use of renewable heating technologies such as biomass boilers and solar thermal panels. More recently, the coalition government has introduced the Green Deal, a market mechanism which aims to encourage a much wider range of retrofits without limitation to either the usage or occupancy status of the building in question, by providing loans which are payable to the value of any savings made on energy bills as a direct result of any upgrades installed.

The successes of the above schemes have been notably varied. The latest effort in particular, the Green Deal, has been described as an outright failure by numerous critics. Survey rates as of September 2013 were so low that it would take an estimated 160 years to survey all UK properties (Mark, 2013), whilst take-up rates post-assessment had stalled at levels in the single digits (Bawden, 2013), and has been described by activist writer George Monbiot as 'a useless middle-class subsidy' (Monbiot, 2012). And whilst schemes like CERT, CESP, EEC and Warm Front have resulted in improvements to many homes across the UK, the limitations of centralised funding, the problem of hard-to-treat properties, and in some cases, sub-standard scheme management and design have left shortfalls in delivery. In the wake of the most recent economic recession, funding from government has been withdrawn from Warm Front (it ended at the beginning of 2013), which assisted the most economically vulnerable households. At present, CERT's successor, the Energy Companies Obligation (ECO) and the Green Deal remain to close the gap in the energy performance of homes across the United Kingdom. However, research shows that, due to the relatively high cost-per-unit involved in hard-to-treat properties being prioritised by ECO, the rate of carbon emissions reductions achieved are likely to be less than a fifth of all of the schemes it replaces (Rosenow & Eyre, 2013). Furthermore, data collected by the Committee on Climate Change has noted that market-based schemes such as EEC, CERT and ECO, by imposing additional costs on energy suppliers, have resulted in measurable increases in the price of fuel (DECC, 2013).

WHAT ARE ALTERNATIVE CURRENCIES?

A currency system using a unit of value other that the legal tender unit is known as an alternative currency. These currencies usually operate at the community level, and are administrated at this level with no input from main government. Of the three types of alternative currency Blanc (2011) identifies, 'complementary' currencies appear most capable of addressing larger scale economic issues, due to their ability to interact with national economies and act counter-cyclically, as can be observed in the functioning of Switzerland's WIR Bank, which utilises a cashless 'credit clearing' mechanism (Kennedy et. al, 2012, p.37). It is to this type of complementary currency that we turn to in reworking the Green Deal's basic premise in a more productive direction.

Alternative currencies have been described by leading academics as 'antidote' to globalisation (Seyfang, 2000), protecting communities and local interests from the larger forces of the global economy, much like a small boat harbour would protect smaller vessels from the turbulence of the open sea (Greco, 2009, p.194). Alternative currencies form a natural counter to the hyper-mobility of state finance, preventing money from being leached from a community towards larger and more powerful economic centres. In this way, they also serve a social function in that they help a community to retain its own personal character.

WHY COMPLEMENTARY CURRENCIES?

Of the various types of alternative currency that exist, the 'credit clearing' system is perhaps the most advanced and, according to T.H. Greco, has the most potential to make a positive difference to the current economic status quo. The credit clearing circle is a type of cashless exchange system modelled upon the Commercial Trade Exchanges that exist within the business world. In such a system, 'credits' available within the system equal the total sum of all positive balances, or the total sum of all negative balances (the amount is the same). This design prevents the unit of value from becoming the limiting factor in exchanges – a feature of legal tender that has created a scarcity culture in mainstream economic life, and is at the source of the failures of the market mechanism discussed earlier in this paper. The notion that alternative currencies increase 'the demand multiplier' by removing such scarcity is mirrored by Groppa (2013). Unused labour capacity exists in large amounts – current UK unemployment figures stand at 27.7% as of March 2014 (Office of National Statistics, Mar. 2014). Consider then that in a complementary currency system, this labour constitutes a readily tradeable service, so long as exchangeable goods exist elsewhere in the system, which is not limited in the same way as it would be in the conventional market by artificial scarcity. However, until now, complementary currencies have been unable to operate on anything other than a relatively small scale, due to limitations imposed upon individual negative balance limits. As it stands, this places retrofit operations on scale larger than can be currently accommodated by credit clearing circles – this can be seen in the fact that the WIR Bank remained unable to fund renovation projects until it incorporated a conventional interest-based loan system into its functionality (Greco, 2009, p.35). However, it is not enough to increase credit limits in these systems, as this has adverse impacts on overall system stability. Greco (2013) advocates a limiting of negative balances, but that this limit be based on the sales volume of an individual member, such that a negative balance can be cleared in a timespan of typically 'a few weeks' through trade. However, Greco also notes that the system should maintain flexibility and, depending on circumstances, a line of credit could be potentially be extended to the equivalent of sales turnover within one hundred trading days. In a system as stable as the WIR Bank, this could be potentially be extended even further. Nevertheless, this 'extended negative balance' function is likely to open the way for financing projects such as retrofits for business members only. Many individual members may still find the figures required out of their reach. The question of how complementary currencies can address the retrofit problem, therefore, is primarily a question of scale. This paper puts forward a preliminary model for collective action, with the aim of solving the 'scale problem' by multiplying credit limits for projects by providing a mechanism for effective collaboration between credit circle participants.

CONNECTIVITY AND CO-OPERATION

In order for an alternative currency to work effectively, it must provide value to its participants, in the form of both a place to exchange their goods and services for currency, and as a source of goods and services in return for any currency they have earned. The quality of this reciprocal network, therefore, is based upon the range of goods available within the system, which will increase in tandem with number of participants. To quote a metaphor from The End of Money, the first ever fax machine was completely useless – but as more fax machines were added to the network of fax machines, each individual fax machine became more and more useful (Greco, 2009, p.199). This introduces us to the concept of 'critical mass', the idea that an alternative currency system must grow to a certain size in order to become self-sustaining. Research suggest that failing to reach this critical mass is one of the most common reasons for failure of new alternative currencies, as can be seen in the example of the Rössle Project in Stuttgart, Germany (Kennedy et. al, 2012, p.79).

Both Jankovic (2013) and Hopkins (2009) note that hyper-connectivity in a system adversely impacts its resilience against external system shocks, as well as degrading the quality of information transfer past a certain point. Combined with the 'critical mass' concept, these findings imply the existence of an optimum group size – that is, a 'cell' of connected individuals working towards the same end. Too many or too few and the collective falls apart. This would not necessitate limiting total membership to achieve ideal connectivity, but rather to aim for 'modularity', such as is advocated by Hopkins as one of three indicators of overall system stability/sustainability. This prevents the attainment of the 'percolation threshold' expounded by Jankovic, preventing extreme events from transmitting through the system at large.

However, it is not enough to merely craft 'modules' of human activity to suit a particular theory. Participants must be working towards a goal which is relevant to themselves – that is to say, on a relevant scale to themselves, and to the group. A high-rise complex of five-hundred flats, for example, would certainly exceed the optimum 'cell' size, and would therefore be an unsuitable co-operative project target for a single cell. In 1992, Robin Dunbar published a paper entitled “Neocortex size as a constraint on group size in primates”, in which he argued that the human brain is capable of maintaining a finite number of stable relationships, roughly equating to 150. Sub-dividing within this number, Dunbar found that 'bands' of individuals with even closer ties formed, ranging from between 30 and 50 individuals. It is this 'band' that I will equate to a cell of closely co-operating individuals in a credit clearing system; that multiple bands coalesce under the larger definition of 'tribe', in which not all individuals necessarily have to be very closely bonded, indicate strong potential for interrelationships between cells.

Jankovic (2013) recommends that stable inter-relational systems include a built-in ability to remain flexible, contracting in times of greater system risk, and expanding at times of lower risk, by dynamically altering the number of agents operating within the system. This suggests the possibility that the economic cells advocated in this study remain likewise flexible with regards to numbers of participants. Furthermore, Jankovic recommends that where such models reflect economic systems (as is the case here), the effects of individual limitations on agent budgets should also be studied. Quantitative data on collective action presented here therefore involves up to 50 participants with varying trading volumes as a limiting factor – the maximum specified by Dunbar, comparing the comparative benefits with smaller group sizes, down to a single agent. For simplicity's sake, one credit is assumed to be identical in material value to one pound sterling. It is worth noting of course that, in actuality, a deliberate choice to tie credit value to the national currency would give rise to certain secondary effects. However, this is beyond the scope of this study; the choice of unit here is arbitrary, and should be considered as such by the reader.

METHODOLOGY: THE 'CELL' MODEL

The models in the next section show how the independent variables Participant Number and Average Participant Income affect the derived variable Credit Limit. How this credit limit limits each participant, based on their available yearly income. Rather than adopt a fixed credit limit, such as that advocated by Greco, these models respond to contextual conditions in a dynamic manner. Credit Clearing system operators using this model would be free to assign credit limits on a case-by-case basis, based on individual risk assessment, determining whether the credit limit required is acceptable, and if not, which independent variables must be adjusted to produce a more acceptable credit limit. Figures for return on investment for part 1 are based upon on economic analysis calculations from a theoretical retrofit project conducted by the author (Burnett, 2014), based upon the results of extensive dynamic simulation and research into estimated costings for a retrofit of an Edwardian House in Birmingham, UK. In the second part, the model has been adapted to show the positive effects that may be observed when economies of scale are applied., using the example of a collectively owned solar photovoltaic array, where ownership among participants is averaged at 2kWp per person.

PART I: SINGLE RETROFIT

The basic premise behind the Green Deal market mechanism is not without its merits. The idea of repaying back initial investment costs in line with monetary savings is (theoretically) a good one, albeit one which is thrown out of balance by the combined effects of interest payments and the 'performance gap' – the difference between simulated/estimated environmental performance, and actual measured performance. The latter of the two problems can be diminished or even eradicated entirely through the application of appropriate dynamic simulation modelling; the former, however, is immutable within the mainstream economic system. When taking out a conventional loan, such as is required by Green Deal applicants, the amount paid back will be more than the amount borrowed, the net result of which is that the individual pays out more than is saved through

Required credit (trading days) calculations – Complete Retrofit (10 participants)								
Partic.	Active/ Inactive	Yearly Inc. (credits)	Income per trading day	Factor of total income	Total Investment	Equiv. Of trading days	Savings (£/yr)	Payback period (yrs)
1	1	1000	2.74	0.02	670.80	**245**	67.06	10.0
2	1	5000	13.69	0.10	3354.00	**245**	335.28	10.0
3	1	4000	10.95	0.08	2683.20	**245**	268.23	10.0
4	1	1400	3.83	0.03	939.12	**245**	93.88	10.0
5	1	12000	32.85	0.24	8049.60	**245**	804.68	10.0
6	1	6000	16.43	0.12	4024.80	**245**	402.34	10.0
7	1	500	1.37	0.01	335.40	**245**	33.53	10.0
8	1	1800	4.93	0.04	1207.44	**245**	120.70	10.0
9	1	13800	37.78	0.28	9257.04	**245**	925.38	10.0
10	1	4500	12.32	0.09	3018.60	**245**	301.75	10.0
	10	**50000**	**136.89**	**1**	**33540**		**3352.82**	
Av. £/yr:	**5000.00**						**335.282**	

Figure 1 Retrofit calculations for 10 participants

Required credit (trading days) calculations – Complete Retrofit (1 participant)								
Partic.	Active/ Inactive	Yearly Inc. (credits)	Income per trading day	Factor of total income	Total Investment	Equiv. Of trading days	Savings (£/yr)	Payback period (yrs)
1	1	5000	13.69	1.00	33540.00	**2450**	3352.82	10.0
	1	**5000**	**13.69**	**1**	**33540**		**3352.82**	
Av. £/yr:	**5000.00**						**3352.82**	
Partic.	Active/ Inactive	Yearly Inc. (credits)	Income per trading day	Factor of total income	Total Investment	Equiv. Of trading days	Savings (£/yr)	Payback period (yrs)
1	1	50000	136.89	1.00	33540.00	**245**	3352.82	10.0
	1	**50000**	**136.89**	**1**	**33540**		**3352.82**	
Av. £/yr:	**50000.00**						**3352.82**	

Figure 2 Retrofit calculations for individual investment

Required Credit (trading days) calculations – PV Array (1 participant)											
Participant	Active/ Inactive	Yearly Income (credits)	Income per trading day	Factor of total income	Total Investment	Equiv. Of trading days	kWp ownership	Sq.m ownership	Total kWh return/yr	Energy savings + FIT income (£/yr)	Payback period (yrs)
1	1	5000	13.69	1.00	7200.00	**526**	2.0	9.0	1447.20	406.37	17.7
	1	**5000**	**13.69**	**1**	**7200.00**		**2**	**9**	**1447.2**	**406.37**	
Av. £/yr:	**5000**										
Participant	Active/ Inactive	Yearly Income (credits)	Income per trading day	Factor of total income	Total Investment	Equiv. Of trading days	kWp ownership	Sq.m ownership	Total kWh return/yr	Energy savings + FIT income (£/yr)	Payback period (yrs)
1	1	12600	34.50	1.00	7200.00	**209**	2.0	9.0	1447.20	406.37	17.7
	1	**12600**	**34.50**	**1**	**7200.00**		**2**	**9**	**1447.2**	**406.37**	
Av. £/yr:	**12600**										

Figure 3 Calculations for individual investment in a photovoltaic array

Required Credit (trading days) calculations – PV Array (10 participants)											
Partic.	Active/ Inactive	Yearly Income (credits)	Income per trading day	Factor of total income	Total Investment	Equiv. Of trading days	kWp ownership	Sq.m ownership	Total kWh return/yr	Energy savings + FIT income (£/yr)	Payback period (yrs)
1	1	4000	10.95	0.08	2293.10	**209**	1.6	7.2	1157.76	325.10	7.1
2	1	500	1.37	0.01	286.64	**209**	0.2	0.9	144.72	40.64	7.1
3	1	3000	8.21	0.06	1719.82	**209**	1.2	5.4	868.32	243.82	7.1
4	1	8500	23.27	0.17	4872.83	**209**	3.4	15.3	2460.24	690.84	7.1
5	1	6000	16.43	0.12	3439.65	**209**	2.4	10.8	1736.64	487.65	7.1
6	1	1000	2.74	0.02	573.27	**209**	0.4	1.8	289.44	81.27	7.1
7	1	5000	13.69	0.10	2866.37	**209**	2.0	9.0	1447.20	406.37	7.1
8	1	500	1.37	0.01	286.64	**209**	0.2	0.9	144.72	40.64	7.1
9	1	13800	37.78	0.28	7911.19	**209**	5.5	24.8	3994.27	1121.59	7.1
10	1	7700	21.08	0.15	4414.21	**209**	3.1	13.9	2228.69	625.82	7.1
	10	**50000**	**136.89**	**1**	**28663.72**		**20**	**90**	**14472**	**4063.74**	
Av. £/yr:	**5000**										

Figure 4 Calculations for collective investment in a photovoltaic array (10 participants)

the instalment of energy saving measures. Meanwhile, payback periods are adversely affected by inflation, which diminishes the value of any investments by merit of devaluing the currency used.

Within a credit clearing circle, investors suffer from neither interest payments nor the effects of inflation. And in a collective where bonds are social as well as economic, the risks of performance shortfalls can also be shared. The overall effect of this is that collective investment in a project such as a zero carbon retrofit, where return on investment is linked to savings on energy and earnings via market mechanisms such as Feed-in Tariffs, becomes much more viable. Payback periods, calculated by subtracting total energy savings and income from installed renewable technology payment schemes from total initial investment year-on-year are found to be ten years, requiring a line of credit extending to 245 trading days for a group of ten with an average yearly trading volume of 5,000 credits/pounds (see Fig. 1). Increase the number of participants and the required line of credit reduces proportionately; the inverse is also true. Compare this to an individual investor who, operating on the basis of the average trading volume of 5,000 credits/pounds per year, would require a line of credit extending to almost seven years of trading, or a yearly trading volume of a massive 50,000 credits to reach the 245 credit limit imposed upon the collective of ten (see Fig. 2). Increasing the group to its theoretical maximum size (50 participants) with an average trading volume of 5,000 credits/pounds requires a credit limit of a mere 49 days. Assuming such a large collective could remain stable, this would allow a retrofit to be funded every two months or so. Whilst each participant would receive only a small monetary benefit for each project, this would be cumulative, resulting in significant return on investment, particularly after the initial ten year payback period has been reached. Greco's 100-day credit limit would allow two such retrofits to occur over the same period, with any further increase in credit limit directly transferring over into the ability to undertake retrofits at an ever-increasing rate. Again, the system shown here proves to be highly flexible, based as it is on a number of changeable variables.

PART II: ECONOMIES OF SCALE

In mainstream economics, 'economies of scale' is a concept used to explain the positive effect on rate of return that often accompanies increasing the scale of a venture. Economists frequently use the “0.6 rule” to quantify the benefits of increasing the scale of a capital investment, roughly translating into a venture of ten times the size costing four times the capital (Tribe and Alpine, 1986).

This model shows that without collective action, participants of a credit clearing circle are severely negatively affected by a lack of economies of scale (see Fig.3). However, using the example of a photovoltaic panel installation, with a project size determined by an average array size of 2kWp per participant, the benefits of collective action can be clearly seen (see Fig. 4). Whilst an individual investing separately in a 2kWp system will have to wait almost eighteen years for a full return on investment, ten individuals working collectively see their investment fully returned within just over seven years. Better still, these payback periods do not vary with level of involvement. As participants' investment amounts are taken to vary in relation to their total trading volume (as limited by a cap on negative balances), a participant is free to invest as much or as little as they are able within the rules of the clearing circle. Referring to Figure 2, one notes that a casual investor, investing money to the amount of 1% of the total cost of the 20kWp system, experiences the same payback period as a professional participant funding 28% of the investment.

Earlier, we have visited the idea of a fixed limit on negative balances within any credit clearing system, in order to assure overall system stability by limit the impact of 'bad debts'. In Figure 4, ten participants have a mean average yearly trading volume of 5,000 credits/pounds, including a range of different trading volumes, from the lowest at 500 credits/pounds per year, up to 13,800 credits for a 'full time' participant. Required credit limits are bound to average trading volume among all agents within the collective, rather than individual trading volume. In this case, an average trading volume of 5,000 credits translated into a required credit limit of 209 days. A lower average trading volume would require higher credit limits – or simply demand a higher average trading volume if the credit limit was unchangeable. Meanwhile, imposing Greco's 100-day credit limit upon the transaction would require an average trading volume of 10,418 credits/pounds over the year. This would not exclude any moderately successful trader from involvement, but would likely exclude the more casual investors, such as are likely to make up a significant proportion of the ranks of credit clearing circle participants, particularly in the early stages of an alternative currency's development. This fact is crucial when setting credit limits, as setting these limits too low may disincentivise certain participants, creating a barrier to trading that may ultimately prevent critical mass from being reached in a timely manner, resulting in a high risk of system collapse.

Lowered group size results in a requirement for much higher credit limits, with a single individual with a yearly trading volume of 5,000 credit needing the equivalent of 526 days of credit to finance a privately owned 2kWp system, or a yearly income of 12,600 credits/pounds in order to remain within the credit limit of 209 days achieved by the collective of ten participants. What emerges is a very flexible system, with multiple adjustable variables – credit limit, participant number, participant mean/minimum/maximum trading volume interact in a fluid manner, allowing for the creation of trading parameters that encourage rather than limit activity. For example, if, at the absolute upper range, 50 participants (with an average yearly trading volume of 5,000 credits/pounds) are involved in the co-ownership of a 100kWp solar project, they would require a line of credit of only 110 days, and would enjoy a payback period on their investment of only 3.7 years. However, further research is required to validate whether or not a cell of this size would be socially manageable.

DISCUSSION

The failure of the Green Deal, the looming Kyoto carbon reduction targets, and to a lesser extent the impending Building Regulations of 2016 and 2019, are regarded as intractable problems by many in the industry. Few studies have attempted a resolution with any great optimism, and none thus far have attempted to do so outside the paradigm of the mainstream financial system. Within such a context, where contemporary attempts provide so little productive guidance, this study has not aimed to present any wholly conclusive findings. This study positions itself as preparatory work to redirect the energies of research in more fruitful directions by re-analysing the paradigm in which researchers may work towards the solution. By drawing together research from several fields, this study has aimed to produce the beginnings of a highly flexible model which works alongside both the existing institution of the mainstream financial system as well as human nature, and can respond quickly to adjustments of a number of variables. Such and approach works with, rather than against, the inherently unpredictable nature of individuals within a social setting.

This paper is a valuable addition to research on complementary currencies in its own right, notwithstanding its link to its specific aim of identifying methods of producing capital for housing retrofits and similar projects. Collective action is an under-researched area within the complementary currency research field; many researchers and founders of complementary currency systems appear to have tacitly assumed that these currencies are either desirable only at smaller scales, or cannot function at larger scales by failing to study them at these scales. Some complementary currencies operate on almost separatist principles, resulting in decisions that deliberately remove any chance of them affecting the mainstream economy in any notable way. This paper has also produced a valid argument against the idea that investors are required to fund larger projects. A viable alternative to approaching single wealthy investors is presented within a context which has already been proved to be capable of success – complementary currencies – as can be seen in numerous systems operating around the world. This paper has shown that social cohesiveness is an absolute requirement for this alternative to become viable. The implication is that investors, and therefore interest, is a mechanism only required in a system where the economic is profoundly removed from the social.

The quantitative part of this study again presents the beginnings of a direction of research rather than absolute answers to such a large question – if it claimed to, it would be less valuable. The 'cell' model espoused here, though based on peer-reviewed and widely accepted research, has not yet been tested in practice among complementary currency groups. Therefore, as of now, it is a hypothesis only. However, it opens up a natural counterargument to prescriptive limitations within a complementary currency system, such as Greco's 'one-hundred day rule' of credit limits. It would be premature to prescribe a new number to this limit. In any case, it appears more prudent at this stage to present the credit limit as a dependent variable, derived from other independent variables rather than presented as an inflexible goal to attain. In real terms, of course, acceptable credit limits would be likewise highly variable, depending on the levels of risk that they represent in a complementary system. This suggests that it should be up to the administration of each credit clearing circle to adjust credit limits, based upon the often subjective assessment of risk, on a case-by-case basis. This study therefore addresses the idea of a credit limit in a manner which is appropriate to its reality.

CONCLUSION

The main research outcome presented in this paper is the production of a quantitative model to analyse the benefits and limitations of collective action within a credit clearing system. This model is less of a final outcome, but rather a particular structure to apply to further research into the problem of larger scale transactions in an economic system excluding the mechanism of monetary interest. This model provides a strong basis and a definite direction for this future research, and has shown enough evidence of the potential benefits of fusing economic and social functioning to solve the retrofit problem to justify significant further research to this end.

The several unanswered questions in this study logically lead on to several specific avenues of research. A central question relates to the most appropriate scale of collection action between individuals – what is the maximum workable cell size? This study has shown that the benefits increase proportionately with the scale of co-operation, so the largest stable cell would also confer the most notable benefits upon participants. However, before these cells are formed within real-life credit clearing circles, the threshold beyond which they become unmanageable needs to be ascertained through primary research as well as secondary sources, as has been done here.

Further work is recommended into refining the methods used in this study to quantify the benefits gained from economies of scale. As a general rule, the '0.6 power' rule is effective in a variety of situations. Further research should work towards ascertaining whether this rule applies in the particular case of zero carbon retrofits, and within the context of complementary currencies. Until this research is undertaken and verified, the figures shown in this study can be taken as estimates only.

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