ENERGY

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Vision for the Future

My vision is to help design, build and operate mid-size multi-energy support systems in every village and neighbourhood in Ireland. These would model socio-ecological complex adaptive systems [1] of the natural world and would add resilience in the face of peak-oil and other shocks by bridging the gap between existing large-scale national systems and the micro-scale household. Irish-born engineer Mike Cooley famously re-posited Marx's question about what model the economy should adopt 'The architect or the bee?' in the early 1980s[2]. For Marx and Cooley, the bee did not work but behaved mindlessly by instinct in contrast to humans who work with purpose to create needed products and devices Although, an inspirational and compassionate writer, Cooley did not understand the honeybee's co-evolution with humans – and so missed what she and the beekeeper could tell us about active management of natural resources and ecosystems for mutual benefit. [3]

I suggest that the question of which model is right is not either/or, but both together; just as the honeybee's purpose and existence is now bound up with ours and ours with hers. My vision sees the humans designing not things but complex adaptive systems like the honeybee hive. These systems can be managed purposefully to serve human needs while still retaining their dynamic self-organisation. Energy is at the heart of all complex adaptive systems, and for the bee it is condensed into nectar and pollen, the end product of the plant's photosynthesis of solar energy. Human systems are also dependent on solar energy whether on the stored capital of fossil fuels or the solar incomes of sunlight, wind, wave, tides and bio-energy of wood fuels and food. Energy cannot be isolated to a single discrete input but runs through the system taking many different forms. Energy is essential to the functioning of all systems operating at every scale within an integrated whole. Thus the agricultural system, planning system, waste processing, and even the money system are all part of an interlinked energy system. [4]

Clear and Present Danger

The discovery of novel energy sources has shaped human history – starting with wood that burned and cooked food that released higher levels of nutrients for brain development and muscle energy, then the domesticated animals that brought motive power, then water and wind for food and material processing etc., to the coal that sparked the industrial revolution. In the period between the World Wars, human economic and social development was comprehensively transformed by abundant and cheaply available oil[5]. Oil is an extraordinarily wonderful energy carrier - dense, versatile and easy to store. Nothing else, even gas, quite substitutes. Renewable energy and

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[1] Social-ecological system (SES) – an integrated system of ecosystems and human society with reciprocal feedback and interdependence. The concept emphasizes the 'humans-in-nature' perspective. Resilience Alliance 2008.

2 Cooley, Mike, Architect Or Bee? The Human/Technology Relationship, South End Press, Boston (1982)

[3] De Bruyn, Practical Beekeeping, Crowood Press, Wiltshire, 1[st] published 1997, reissued 2008

[4] Tainter, Joseph, *The Collapse of Complex Societies,* New Studies in Archaeology, Cambridge University Press, 1988

[5] Charles Hall et al, *Hydrocarbons and the evolution of human culture,* Nature 426, 318-322 (20 November 2003) doi:10.1038/nature02130 Insight

nuclear energy combined can never completely replace oil in the global economy or in modern urban and rural settlements that have co-evolved to match its particular characteristics.

Many geologists and economists now fear that the increasing scarcity of oil as supplies peak,[6] may trigger a reverse process of global de-development. The shock to oil-dependent infrastructure and systems could be overwhelming because of the nature of our deeply interlinked production and financial systems. Following oil, gas is due to peak within our lifetimes and to do so quite suddenly because of its exploitation characteristics. Into this dangerous scenario comes the even larger and more unpredictable threat of climate change, which will severely constrain our responses to the energy threats as we mitigate and adapt to it.

If these warnings have substance, we must pay attention, as the consequences are so serious, and Ireland is in a particularly perilous place. Ireland's energy import dependency was 91% in 2006[7]. In 1990 Irish-based energy production was at 32% of the total but this has reduced to 16% in 2010 as a result of the increase in consumption and the decrease in domestic production of Kinsale gas[8]. Most Irish fossil energy imports comprise oil from the UK and Norway and natural gas from the UK, all of which are nearing depletion. As a result we are hugely vulnerable to the political and market instabilities of fossil energy exporters.

As well as being heavily dependent on imported fuels, Ireland has a particularly rigid electricity generation system. The existing grid system and electricity industry globally is in the midst of profound and comprehensive change, including a return to the local and neighborhood scale in which the industry's early history is rooted[9]. Currently, Irish government energy policy is geared to the national scale. Electricity is generated in a few large plants at a distance from where it is consumed and the electricity transmission grid is completely separate from the distribution grid. Transport fuels are imported by a handful of companies and until very recently, the entire gas supply and distribution was in the control of a single entity. The government under EU direction is making plans to introduce competition in energy generation and services. I believe that there are serious risks in replacing public ownership of energy assets with private ownership while retaining the current centralised structure and linear processes.

There is a direct relation between connectedness and rigidity that leads to vulnerability and fragility and thus unexpected collapse[10]. An energy crisis would be considerably worse for Irish citizens than the banking crisis as the solutions would not lie in new monetary policies and financial regulation (which the government did not adopt, unfortunately), but in the laws of physics that are beyond the reach of democratic persuasion.

[6] Peak oil refers to the point at which is will be impossible to maintain a constant output of oil and supply will level and begin to fall.

[7] Rourke, F., Boyle, F., Reynolds, A., 2009, *Renewable energy resources and technologies applicable to Ireland*, Renewable and Sustainable Energy Reviews 13 (2009) 1975–1984

[8] Bazilian, O'Leary, F.,, O'Gallagher, B., and Howley, M., *Security of Supply in Ireland*, 2006, SEI

[9]

[10] P.p. 388, *Panarchy*, ibid.

Formula for Energy Resilience

Although recovery from an energy shock would be extraordinarily difficult[11] as it would require energy to muster emergency responses and reconstruction, preparation before oil-peak yields high benefits to first movers. If we move quickly before supplies are constrained and before other nation states race to secure fossil fuel supplies and thus raise prices, we can considerably improve the quality of our post-peak lives. Within this perspective, the global economic downturn that has depressed oil demand to $80 a barrel is an opportunity not to be missed.

Secondly, the laws of physics - so threatening when we ignore them - point to a mechanism that can leverage our actions in the short space of time we have left to build resilience to energy shocks and shortage. Resilience[12] is defined as the capacity of a system to absorb disturbance and reorganise while undergoing change so as to retain essentially the same function, structure identity and feedbacks; that is, to remain within one regime. In this context 'regime change' is generally not a good thing! Natural science has uncovered universal laws governing physical systems at every scale from the microscopic to galaxies. These laws can be also observed in human social and economic systems and critically in systems that include both humans and environmental systems in interaction.[13] It appears that at least in this respect, humans are fully part and parcel of the natural world![14]

The actively managed 'wild' honeybee hive is a very resilient and productive enterprise – much more productive than fully domesticated animal husbandry systems that require considerable farmer, machine and energy input. The good beekeeper is the conscious ruler of the managed hive; noting nectar and pollen supplies, egg production, drone and queen cells and signs of disease, all in the context of weather and plant bloom forecasts. She intervenes at the optimal part of the cycle by feeding, removing cells, moving frames and creating new hive nuclei; all to get the best outcome for bees and humans alike. This can be described as a 'social-ecological system' where the natural reactive and autonomous feedbacks system of the honeybees is replaced by proactive human capacity for information processing, planning and foresight. The time input by the beekeeper is no more than 20 minutes a week for two months of the year. The bees still do most of the work to produce in an average year 50lbs of honey or a good hive in an exceptional year up to 300 lbs of honey. Wax is also produced, worth in some cases more than the honey for use in pharmaceuticals. But the pollination work is almost priceless. It was estimated that the honeybee's pollination services were worth $16 billion annually in the US in 1997[15] alone. This is the factor of return on energy investment (EROI)[16]we should aim for in a new energy system for Ireland.

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[11] Korowicz, D, Tipping Point, 2010, www.feasta.org

[12] Walker et al, Resilience, Adaptability and Transformability in Social-Ecological systems, 2004, Ecology and Society 9 (2): 5 www.ecologyandsociety.org/vol19/1222/art5

[13] Norberg et al, *Diversity and Resilience of Social-Ecological systems,* Norberg, J & Cummings ed., Complexity Theory for a Sustainable Future, 2008, Columbia University Press, New York.

[14] Carpenter, S., B. Walker, J.M.Anderies, and N.Abel 201, *From Metaphor to Measurement: Resilience of What to Do What?"* Ecosystems 4

[15] Pimentel D, et al. 1997. *Economic and environmental benefits of biodiversity.* BioScience 47: 747–757.

[16] The EROI is the ratio of the energy that is produced to all the energy used to discover and produce that energy. Prof. Charles http://www.feasta.org/events/general/hall_lecture.htm

The task then is to augment our single centralised and linear energy, food, planning and financial systems with a new set of consciously-designed complex adaptive systems at local level providing similar services but at a much lower resource input level.[17] More food, fuel, and fibre will have to be coaxed from nature while high ecosystem values and services are sustained. In short, to build resilience we must become 'keepers' of local integrated life support systems attuned to the wider environment.

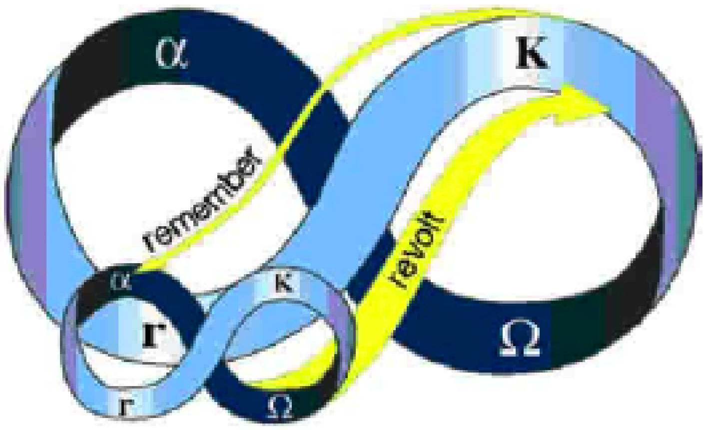
Scale and Diversity

The scale appropriate for active management of complex systems is one where all the main elements of a life support system are in place so that learning by experimentation is possible[18] There are particular benefits to acting on the local or mid scale – the size of the local ecosystem and local governance unit.[19]The village, small town or neighbourhood of 60-1000 homes can encompass all the basic elements for immediate human subsistence of water, food, shelter, warmth, transport and social and cultural supports. All these systems interact poorly in a linear mechanistic manner at the moment but they are capable at this scale, of transformation into a managed adaptive system. People can comprehend a subset of the real world i.e. a lower–dimensional representation of the whole because that is where they immediately experience it. [20] Proactive design and management of the system at this local scale will dampen shocks rippling through the national system and buy time to reorganise.

Experiencing dynamic change in small systems and going through the process of recovery/restructuring can prevent the unrecoverable collapse of the entire system. For example, the forestry policy that suppressed forest fires in the US created the conditions for the eventual conflagration of the entire forest because of the resulting build-up of dry undergrowth which was far more devastating to wildlife and plant regeneration than a series of smaller fires. This led to a change in forestry policy to allow and manage local forest fires.

Single isolated homes are particularly vulnerable to oil-peak and to severe climate events as we saw in the severe winter of 2009-10. The lifestyle choice to live in the open countryside and commute to work is an example of cultural adaptation to the cheap oil era that is coming to an end. The costs of maintaining roads and servicing families living in scattered dwellings will drain resources from settlements where the same investment would give much greater social, economic and environmental returns. No level of micro-renewable energy investment or passive-house design can offset the resilience of a well-managed local support system[21]. Whether in urban or rural areas, investment in energy efficiency and micro generation at single household level will not give the same returns as the same investment in grouped systems. I will explain why…

[17] Day, John W., et al, *Ecology in Times of Scarcity* p. 328 BioScience • April 2009 / Vol. 59 No. 4
[18] Gunderson, L.H., and Holling, C.S., 2002, *Panarchy – Understanding transformations in human and natural systems*, Island Press, p.p.397
[19] Norberg J., James Wilson, b. Walker and E. Ostrom, *Diversity and Resilience of Social-ecological systems,* Complexity Theory for a Sustainable Future, 2008, Columbia Press New York
[20] Andereis j., J Norberg, *Theoretical Challenges,* Complexity Theory for a Sustainable Future, 2008
[21] O'Siochru, E., *Proximity 2.0*, The New Emergency, Feasta, forthcoming publication 2010



Diversity is important too. Ecologists have noted that during reorganisation after disturbances the potential for input of a diversity of species directly determines the rate at which the system may self-organise toward a community that reflects local conditions[22]. Policies based on general themes often fail because they miss important details of local conditions – context is important. Multiple stakeholder participation is another way to minimise the dominance of single solutions.

What this means for us is that the more and different local energy solutions there are, the quicker the recovery following disturbance as amongst them will surely be some that work particularly well or that are particularly robust and these can be quickly copied. The benefits of community scale generation are already evident in other European countries. Gussing, a small town in Austria, has a rape-oil-refinery that produces bio-diesel, a district heating unit supplied with wood, and a state of the art biomass-power plant that generates 2 MW electricity and 4.5 MW heat. The town is 45% self sufficient in energy. It has attracted 50 new companies, more than 1,000 new jobs, and a total increased sales volume of 13m Euro/year. Lunen is another example of community scale generation. It uses organic material from local farms to provide electricity for its 90,000 residents. The plant produces 6.8MW to power from the organic waste. This provides heat for 26,000 houses. The bio-methane gas is distributed through an underground biogas pipeline network.

Synergies and Bio-energy

A new energy system for Ireland should look for and design for 'complementarities' or 'synergies'. Technologies that can use local waste i.e. the output of one process or species, as the input for another are particularly useful. This is where bio-energy technologies win over the considerably more efficient wind and wave technologies that make electricity only.

Anaerobic digestion of organic biomass and agricultural and other food wastes is the most complementary energy technology available in Ireland at this time and thus the most immediately useful to build resilience. Anaerobic digesters (ADs) can deliver reliable renewable energy for electricity, transport and heat, at a scale where all the energy can be utilised without needing significant new infrastructure. Bio-Methane is

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[22] ibid

upgraded biogas produced from anaerobic digestion. Ireland has ample food waste, slaughterhouse waste and surplus grass to supply up to 15 PJ (360 ktoe) of energy from biomethane23. Biomethane produced from grass requires one third of the land required for ethanol production and one eighteenth of the land required for rapeseed biodiesel. It is by far the most efficient means of producing transport fuel from Irish farmland[24]. As transport energy accounts for 42% of total Irish energy use it will be the sector hardest hit by oil peak, as it is almost completely oil dependent. Petrol vehicles can be altered relatively easily to run on biomethane. Biomethane can also be injected into the natural gas grid and used in existing heating and cooking appliances with a little modification.

These facts alone should make the widespread development of anaerobic digestion of organic material a priority for emergency planning under the National Renewable energy Action Plan.

Anaerobic digesters reduce the need for artificial fertilizers and thus level of nitrous oxide emissions from the soil. Finally, considerable quantities of methane emissions are avoided when manure is digested properly rather than stored as slurry.

Cities and towns generate considerable food, sewage and other biological wastes that can no longer be landfilled or spread under the EU Landfill Directive. The 'gate fees' (fees charged to process this biodegradable waste) will be substantial for some years to come - circa €60-100 per ton. The co-digestion of food waste with manure produces a much more stable AD process than when food waste is processed as a sole feedstock. The income from gate fees and the reduction in farm production costs resulting from using digestate from anaerobic digestion instead of buying fertilizers can add considerably to farm incomes at a time when it is sorely needed.

Putting it all Together

We have now most of the ingredients of a managed complex adaptive system of our formula for energy resilience in rural areas. The formula requires one further input which transforms the economic and environmental equation to multiply return on capital. That element is human waste. Conventional human waste processing is egregiously wasteful of water, energy and nutrients: a fact that has received little critical attention form environmentalists although sewage pollutants in ground water are well recognised. Anaerobic digestion is already used to process the sludge from conventional sewage plants into a stable soil amendment. The question arises then, why not pipe fresh sewage directly into an AD and bypass the expensive and not very effective 'water treatment 'plant? The obstacle is the high volume of water needed to transport waste in gravity drainage systems and the fact that anaerobic digesters cannot operate efficiently with very high water content. The answer is overlooked Victorian technologies - vacuum sewers - that require very little water to transport waste.

Vacuum technology is based on differential air pressure and drainage making it cheaper to build and install than conventional systems. When a system is well designed, the

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[23] Singh, Anoop, University College Cork. *A Biofuel Strategy for Ireland with an emphasis on production of biomethane and minimisation of land take*. Renewable and Sustainable Energy Reviews 14 (2010) 277-288

[24] Murphy, Jerry D., University College Cork. *An argument for using biomethane generated from grass as a biofuel in Ireland*. Biomass and Bioenergy 33 (2009) 504-512

sewers have absolutely no leakages (vacuum avoids exfiltration) so sewers may be laid in the same trench as other mains including potable water or rain-water and in water protection areas.

dAlthough the energy and environmental benefits of rural anaerobic digesters processing human, food and agricultural wastes together are convincing, the financial argument for them is overwhelming. For the same cost or less (circa €1.7 million) of a conventional 'wastewater' treatment plant that will cost a further €40,000 p.a. to maintain, a village could build an anaerobic digester with combined heat and power plant which would not only pay for its construction and running costs but produce an annual surplus to satisfy investors. It would comprise a resilient life support system for the community, one that protects existing bio-system services, recycles wastes to increase agricultural productivity, and provides energy in four different forms not counting food.

The addition of a managed private wire serving the area would facilitate renewable energy production from wind as electricity generation from biogas can alter output to maintain a steady current whatever the weather. With local energy grids come the potential to manage energy demand with smart grid and meter technologies. The electrical generation capacity required in a managed embedded energy system is approximately 2/3rds that required for a conventional grid system[25]. A balanced land-use plan is the best foundation for such technology; - yet another good reason to build settlements with living, working and service areas in close proximity.

Social sustainability dictates that the economic returns of the system do not flow to an elite few but to a wide group, especially the farmers who maintain environmental services and produce the food. Farmers have a strong claim to urban food waste on advantageous terms, as without the return of a significant percentage of the original agricultural production of the land, to the land, the nutrient cycle cannot be closed. The phosphate resources and natural gases that go into NPK can no longer be relied upon.

Other Potential Systems

Closing nutrient and energy loops by anaerobic digestion is but one example of a viable managed complex adaptive system. It suits locations with good agricultural land, a large number of housed animals within 5kl (km Emer?), food waste within 20kl and a requirement to upgrade sewage treatment facilities within 1kl. These conditions are met in large areas of the midlands and south west of Ireland. For poorer land in more mountainous areas, a different configuration of feedstock's and technology that builds on its unique eco-system services and agricultural production characteristics is mandated. A good candidate is one centered on the pyrolysis of woody biomass wastes and biomass crops to produce a variety of useful energy products and services. Pyrolysis suits upland forested areas found mainly in the West where it is difficult to make a decent income from farming alone.

If our aim is to rapidly build local resilience by producing energy and food while enhancing eco-system services, easily the most exciting product of pyrolysis reactors is biochar. Biochar is produced from the biomass that has taken up co2 in its growing phase in such a way that 25%-50% of the co2 is locked into the char as carbon. When

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[25] O'Siochru et al, ENLIVEN Report, Irish Rural Link & Feasta, 2004, http://www.feasta.org/cgi-bin/search/search.pl?Terms=ENLIVEN

applied to the soil the biochar contributes its own stable carbon and stimulates further co2/carbon uptake and storage by soil microbes[26]. Applied to poor or degraded soils, biochar has shown very significant increases in crop yields as well as reduced nitrous oxide (a powerful greenhouse gas) emissions from the soil. These attributes makes pyrolysis for biochar one of the very few technologies powerful enough to address the climate change challenge without reducing food security as attested by James Hansen[27].

There is a great deal still to be learnt about the exact processing conditions to manufacture biochar to give predictable results so that it can be sold as a high valuable soil amendment i.e. higher value than the energy content of the char. Biochar is not a new discovery. The ancient Amazonians created the *Terra Preta* ("dark earth" in Portuguese), extraordinarily productive soils that fed a sophisticated civilisation[28] for hundreds of years before the conquistadores brought the diseases that ended it abruptly. Unfortunately, there are things that the ancients knew which must be re-discovered before modern biochar can match the amazing productivity and renewability of Terra Preta.

Luckily for us Ireland has one of the leading biochar/Terra Preta research centres in the world based in Limerick University and headed by Dr Michael Hayes[29]. Their research and crop trials are indicating promising results. With modest government support we can be reasonably confident that the last piece of the biochar puzzle will soon be in place to balance the economic equation.

Challenges

Accommodating large-scale wind developers in the current government's plans for renewable energy in the National Renewable Energy Action Plan (NREAP) will divert resources and starve investment from smaller scale *embedded* energy generation that does not have the same requirements for comprehensive grid upgrade. The drive to optimize efficiency leads to the exploitation of the best terrestrial wind sites that are invariably in remote areas, often with high biodiversity value. Some of the proposed wind farms that have planning permission and connection offers are in areas now designated as Natura 2000 sites with vulnerable bird migration patterns or in upland peat-bogs whose valuable carbon storage systems will be compromised. While large-scale wind projects, perhaps offshore and/or perhaps combined with hydro-storage do have potential, resilience cannot be built at the cost of biodiversity or a stable climate.

Policy makers seem oblivious to the potential of mid-scale renewables and of local authorities to find synergies and lead the transition to a low carbon future. Mid-size local renewable energy generation is greatly facilitated by access to a 'private wire' the electrical infrastructure necessary to supply electricity directly to 3rd parties located on near the generator, independent of the national transmission / distribution system. But

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[26]Kwapinski, Witold et al, University of Limerick, *Biochar from biomass and waste*, Waste and Biomass Valorization Journal 2010 DOI 10.1007/s12649-010-9024-8

[27] Hansen, James, et al, *"Target Atmospheric CO2: Where Should Humanity Aim?",* in press. [Supporting materials].

[28] Sombroek, W., et al., *Amazonian Dark Earths as carbon stores and sinks*. In Amazonian Dark Earths: Origin, Properties, Management, J.K. Lehmann, D.C., Glaser, B. and Woods, W.I., Editor. 2003, Kluwer Academic Publishers.: Dordrecht, . p. 125-139.

[29] Carbolea, Advanced Biomass Research for Beyond the Petroleum Age. http://www.carbolea.ul.ie/biochar.html

the National Renewable Energy Action Plan is unenthusiastic. It notes a provision under Directive 2009/72/EC that owners of a private network must allow full third party access for alternative suppliers through its network. Translated, this means mid-size electricity producers must sell their electricity into the monopoly that is ESB Networks, owned and operated by the ESB, the dominant energy supplier, and cannot use long-term purchase agreements with customers to help fund their initial investment. Or as one frustrated mid-size renewable developer put it "it's like selling bread to a baker".

In short, the National Renewable Energy Action Plan as it stands does not recognise mid-size generation as an essential element of Irish energy resilience, does not recognize the multi-benefits of bioenergy, provides no assistance with 'private wire' and gives no particular role to local authorities in the development of energy resilience.

It is difficult to get support for a change of direction as the issues are quite technical and accessible only to insiders. The financial crisis may be our best ally in getting a change of course as the economic benefits of the distributed, embedded bio-energy model, especially for anaerobic digestion, are so compelling. Even one demonstration project would be very persuasive.

There are further serious threats to mid-scale bio-energy projects. Many large urban-based anaerobic digesters are in the planning pipeline and have been attracted by the super profit potential of gate fees introduced under new regulations to reduce landfill. Their focus will be on the gate fee and electricity generation revenue and not on producing useful fertiliser or eco-system services. With maximising throughput comes increased risk that the digested material might not be fully digested (stabilised) and therefore not be of any use in agriculture. Nevertheless, mega anaerobic digesters promoted by waste companies who have regulated monopolies of municipal waste could crowd out mid-scale projects set in rural areas. The same dynamics may prevent the adoption of pyrolysis systems delivering integrated solutions at local level.

Gate fees and tariffs must be carefully set and adjusted to foster the more resilience-building solutions. Planners, Services Engineers and County Managers should be alive to assisting mid-size local initiatives and not conflate them with the large waste-processing projects that are more of a burden than an asset to a local community.

Another obstacle to this energy vision relates to landownership patterns and privileges. A managed complex adaptive energy system bringing many local benefits, will add value to nearby land that can connect to it. The landowners of such land who have not have made any contribution to the project can pocket this added value through a higher sale price or higher rents. The project developer can get income through the sale of electricity, heat, gas etc to locals but cannot recoup any of this 'connectivity' value on 3rd party land. Neither can the local authority, which may be a partner in the project, recoup a share of the value created, under its current powers.

A Site Value tax (SVT) could transform this situation by capturing some of this upswing in value for re-investment in further resilience building projects. It would enable local authorities to lead development of managed complex adaptive energy systems because they could be partly financed from site value tax income. It is of utmost importance therefore that the proposal for a Site Value Tax in the current Programme for Government comes to fruition. A Site Value Tax will dampen incentives to speculate in property in the hopes of reaping unearned gains through general economic uplift – the end game of which has nearly destroyed the economy. This should liberate savings for investment in truly productive assets and there are none better than renewable energy. Widespread ownership of mid-size embedded energy assets should be actively fostered with new company structures and partnerships between developers, farmers, and consumers[30] backed up by tax incentives aimed at pension funds and ordinary people.

Finally, a multi-disciplinary approach is needed to build successful social ecological systems. It is time to ditch blinkered, over-specialised professions and departments. The integration of architectural and structural, energy and sanitary engineering, farming, ecological and financial expertise is needed to replace the current practice of designing and managing naturally interacting elements in isolation. Although necessarily complicated because of the synergistic functioning, the technology should not be complex i.e. it should be sufficiently simple and robust that local expertise can fix any problem that might arise. The benefits to community-run energy systems are local expertise, local job creation and community resilience.

Conclusion

It is ironic to note that as the Congested District Board was busy scattering the village settlements along the West coast at the end of the 19th century and resettling the people in isolated farm holdings (thus setting the seeds of emigration for years to come), it also distributed specially designed beehives to the hapless farmers. The CDB hive as it is known, was manufactured and sold by Abbott Bros. in Dublin and **is** still used in windy and wet locations throughout these islands. Hardy Irish black bees were also distributed to the farmsteads where they thrived until farming practices changed. Despite modernisation, 60% of honeybees in Ireland survived in the wild until the turn of the millennium when they were all but wiped out by the Varroa mite that was carelessly, if not criminally imported with a consignment of non-native bees. The Irish bee did survive; some in the mountains and some in the midland bogs were adopted by an unsung Irish hero, Jim Donohue of the *Midland Bee Keepers* Association. Jim has been breeding to improve temper and productivity of the bog bee at his base in Belvedere House Mullingar for over 20 years. He has developed a system that manages hives so well that he can produce 40 new healthy, gentle colonies a year. He trains new beekeepers to replicate his results in order to create an abundance of healthy bee colonies ideally suited to Irish conditions that can survive any external or internal threat.

That should be our aim too.

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[30] Cook, Chris, Open Capital using Limited Liability Partnerships,