Energising Money

An introduction to energy currencies and accounting

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Executive Summary

The world is facing an ecological crisis. Our economic system fails to properly account for the natural resources on which human prosperity depends. But attempts to remedy the problem, for example through environmental taxation, fail to address an elephant lurking in the room: the monetary system. Energy-related money offers a means to improve the qualities of the monetary system, while also stimulating the low-carbon energy transition we urgently need.

Modern interest-bearing bank-debt money creates the illusion of exponentially growing wealth and an unceasing demand for economic growth and/or inflation. In return, it has delivered instability and misallocation of investment, and encouraged myopic policy-making. To make the economy work for the planet, and therefore for the long-term interests of humanity, we need to change how money works. We need a feedback loop between nature and the economy. This report examines the potential of energy-related monetary instruments – currencies and accounting frameworks – to provide such feedback. Since energy is as fundamental to the economy as it is to the natural sciences, it is an attractive option upon which to base such feedback.

This report is a first attempt to systemically review the rich and burgeoning field of energy money proposals and projects. We present a new taxonomy of energy money to guide the reader through this work. It charts the functions of money, the important characteristics of energy, and the relationships between the two. From this we gain key insights:

- Renewable energy can be used to improve money's key functions: a unit of account, medium of exchange and store of value
- Redesigning money can also be a driver of change within the energy system by creating targeted currencies that incentivise more ecologically sustainable consumption, mobilise investment in renewable energy, and encourage energy efficiency.

Such different objectives require different currency designs, and thus searching for a single 'perfect' energy money model is unwise. A more effective proposal would be to encourage a range of different and complementary schemes at local, national and international levels.

Global systemic reform

At the global level, there is a need for one or more stable reference units of value attached to the planet's natural sustainable resources. For example, renewable energy used to produce kilowatt-hours (KWH) of electricty. This would help to 'price nature into markets', thereby improving the ecological efficiency of the economy. Similarly, concretely relating money to natural resources would make clear that such resources cannot be simply substituted for other inputs (labour or capital in the form of the productive assets), a misconception which lies at the heart of conventional economics' understanding of production. To be effective, these kinds of models will probably require top-down monetary reform to create systemic change. Further research is required both on the concepts and into the practical considerations of their implementation.

Stimulating local and regional energy transition

At local or regional levels, 'debit-energy currencies' – whereby units of energy are held in a pre—paid form like bank deposits - might be useful to promote more sustainable consumption, as well as to guard against rising energy costs. In contrast, 'Credit-energy currencies' seem promising to fund investment in renewable energy production. These latter 'self-financing' currencies would be redeemable in local participating businesses and over the longer term directly with the producers of local renewable energy. Many of the case studies in this report illustrate the potential of local and more narrowly focussed energy currencies to engineer a low carbon energy transition from the 'bottom-up'. Developments in internet and mobile communication technologies offer the opportunity for rapid upscaling of these kinds of models. For these a different research agenda is required: How can we best capture the lessons learned, disseminate the knowledge, replicate and scale-up the success, and transfer the models across national boundaries and different institutional infrastructures?

Separate but linked currencies could be issued, perhaps by the same 'energy banks' or at a national level, as a means of payment without the need to be backed directly by energy if they are referenced to an energy standard. That way, the long historical tension between using one kind of money as a store of value and means of exchange simultaneously could be addressed.

Shaping an agenda for research and action

Ultimately, a unified global energy money system might be both possible and desirable, but the most likely route to this will be via incremental experimentation, innovation, and development of a multiplicity of new energy monies.

Energy money can potentially address some of the most systemic challenges facing our world and should not be left to academic and policy fringes. We call on a range of other actors, in addition to currency designers, to consider and support energy currency innovations, in particular local government and other public sector agencies, environmental NGOs and charitable foundations.

At the same time, energy money designers and thinkers should engage with civil society and public sector actors, understand their needs and identify how energy currencies can help them achieve their goals. Where schemes are stalled by regulatory or policy obstacles, promoters of energy monies should seek to mutually support one another in gaining acceptance and support among policymakers for allowing currency competition and innovation. Energy money offers an exciting research field on the intersection of physics, economics and ecology; the best minds from all of these fields are needed to further develop some of the ideas portrayed in this report.

In 1935, H.G. Moulton defined what he called "*procreative property*" as "*the processes by which society expands its power to make nature yield its resources more abundantly*".[1]

By adding the words 'on a sustainable basis', we could consider this the ultimate test of any money system – whether it promotes or inhibits such processes. The current system fails the test. Energy-related money shows great potential to do better and so deserves wider and more serious consideration. The idea of linking energy to money is not a new one, but perhaps it is an idea whose time has come.

1. Introduction

In the aftermath of the banking rescue packages of October 2008, **nef** called for joined-up solutions to the 'triple crunch' of financial chaos, oil depletion, and climate change.[2] Today, such joined-up thinking appeared as elusive as ever as world leaders battle a pro-longed economic depression and multilateral agreement on action on climate change remains low on the political agenda. This report begins by briefly examining two propositions that could explain the scale of the interlocking ecological and financial challenges that we face today:

- Economic activities, are intrinsically linked to the ecological system on which they are dependent. The financial system is not. Conventional economic theory does not sufficiently capture the significance of this relationship, limiting the effectiveness of conventional policy responses. This argument is set out in Chapter 2.
- The monetary system has become increasingly divorced from the productive capacity of the economy, resulting in inflation, asset bubbles, and banking instability. As such it exacerbates the problem of ecological overshoot, as described in Chapter 3.

Despite compelling evidence for these propositions, the relationships both between economic activity and nature, and between money and economic activity, remain poorly understood. Ecological economics and realistic monetary economics remain at the margins of policy and academia at national and international levels. This needs to change.

In order to advance thinking in both these fields, we turn to a concept that has a surprisingly long academic pedigree and an increasing interest in practical implementation: energy-related currencies.

We can conceptualise a set of bilateral relationships between the economy, nature and money as illustrated in Figure 1, where we can describe impacts in both directions between the economy and natural world, and the economy and money. This report explores the third relationship, between money and nature, that is missing.

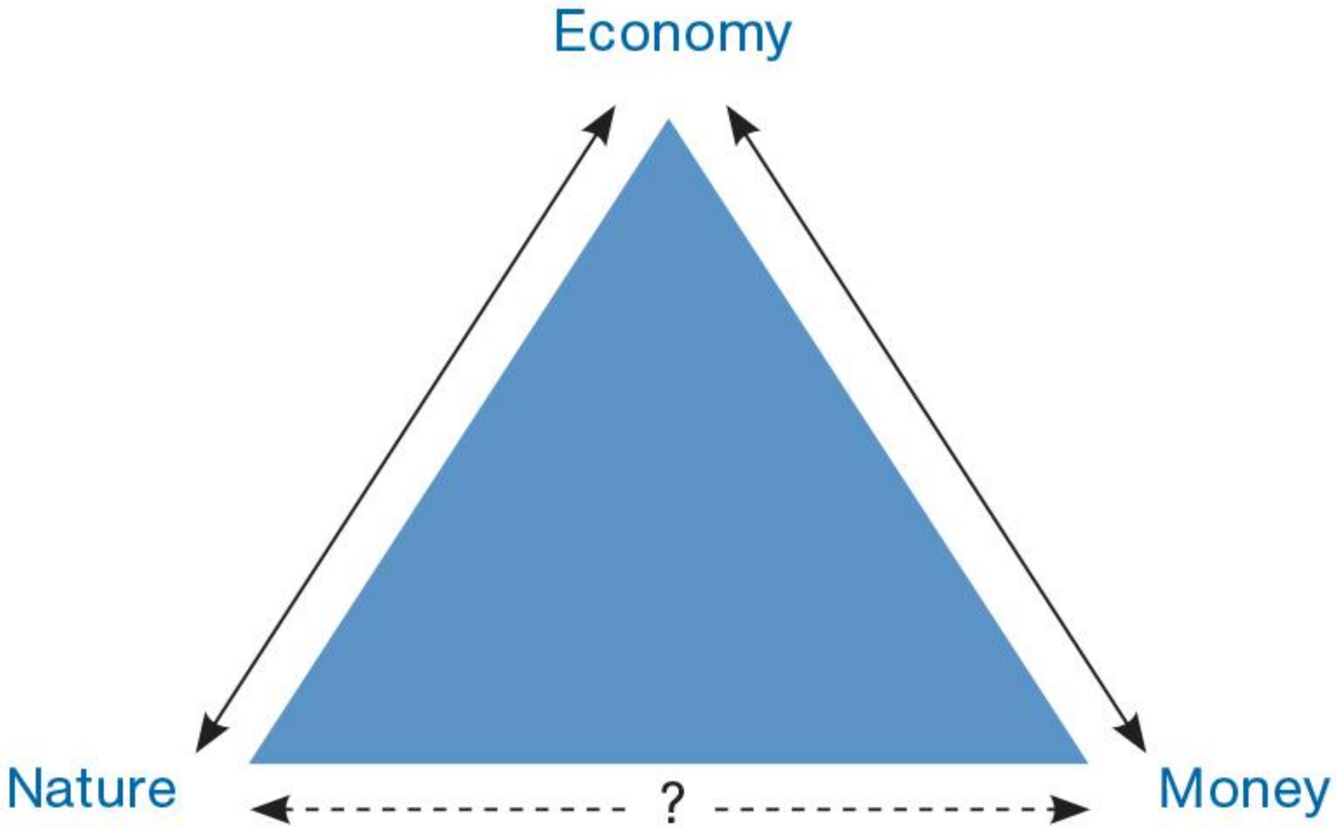
In Chapter 4 we develop a taxonomy of energy monies that aims to aid understanding of their objectives, functions and practical features, and illustrate this with a number of energy currency schemes in theory and practice.

In Chapter 5 we consider implications for the design and implementation of energy monies, and how they relate to the broader landscape of complementary currencies and monetary reform.

Finally, in Chapter 6 we offer some conclusions.

The aim of the report is to stimulate thinking and action, to perhaps build on the most promising proposals and to seek a better monetary system that can deliver us prosperity and well-being within the planet's ecological limits.

Figure 1: Economy, nature and money



2. Nature and the economy

"...the increase of wealth is not boundless. The end of growth leads to a stationary state. The stationary state of capital and wealth… would be a very considerable improvement on our present condition."

John Stuart Mill, *Principles of Political Economy*, 1848[3]

The world has reached a tipping point. We face deepening ecological crises with multiple threats from climate change, water shortages, spiralling energy costs, biodiversity loss, deforestation, ocean acidification, over-fishing and soil degradation. Inequality is rising fast and billions live on the edge of hunger. In this chapter we give a brief overview of why economic activity has an increasingly negative impact on the environment.

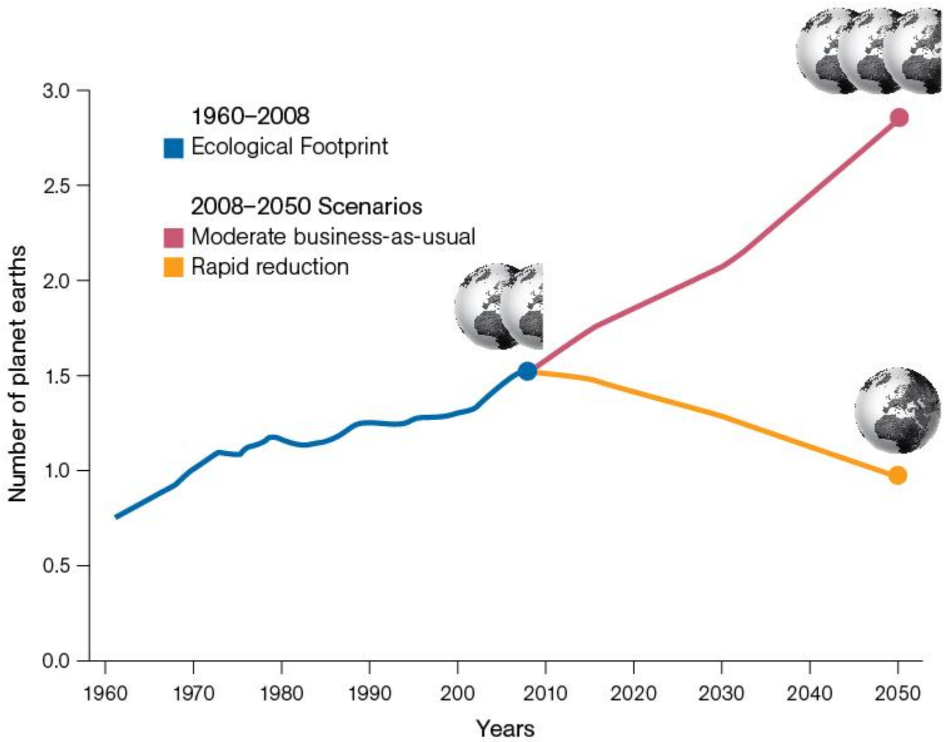
2.1 The problem of ecological overshoot

For most of humanity's existence, we have remained comfortably within the carrying capacity of the planet. However, a mounting body of scientific evidence suggests that this is no longer the case. Whilst the earth has the capacity to recycle some wastes back into the environment, from around 1970 humanity began turning resources into waste faster than waste can be turned back into resources (see Figure 2). Since then the planet has been in global 'ecological overshoot', and we are depleting the very resources on which human life and biodiversity depend. Indeed in 2008, the most recent year for which data are available, the footprint exceeded the Earth's bio capacity – the area of land and productive oceans actually available to produce renewable resources and absorb CO^2 emissions – by more than 50 per cent.[4] In other words, it takes the Earth almost 18 months to produce the ecological services that humanity uses in one year. The UK's footprint, to take an example, has grown such that if the whole world wished to consume at the same rate it would require 3.4 planets the size of Earth.

The result is collapsing fisheries, diminishing forest cover, depletion of fresh water systems, and the build-up of carbon dioxide emissions causing catastrophic and irreversible climate change. Aside from the ecological damage, overshoot also contributes to resource conflicts and wars, mass migrations, famine, disease and other human tragedies. This tends to have a disproportionate impact on the poor, who cannot buy their way out of the problem by getting resources from somewhere else.[5]

Given the incredible inefficiency of the present model of economic growth and its ecologically catastrophic impacts, developed countries need to consider seriously reducing levels of material throughput and associated consumption. For while renewable sources of energy are abundant, the environmental impacts, time, resources and the expense required to capture their energy means that a longer-term

Figure 2: Earth's ecological footprint with 'business as usual' and 'rapid reduction' scenarios. Source: Global Footprint Network.[6]



goal for society should be to live on 'sufficient' energy rather than simply meeting demand.[7] In addition, rich countries are not in a position to lecture poorer countries on their carbon emissions whilst we continue to consume goods they produce in vast quantities.

The challenge is to radically reduce our energy use through lowered consumption, changed lifestyles and energy efficiency, and to then transform the remaining energy use to as close to one hundred per cent renewable energy as possible. Renewable energy includes water (hydro, tidal, wave), wind, solar and biomass. As the late Kenneth Boulding[8] put it, we need to move from a 'Cowboy Economy' focussed on enhancing the speed of production and consumption, to a 'Spaceman economy', where gains from technological change are genuine only if we also maintain the ecosystem on which we depend.

For low income populations and countries, the challenge is to increase energy use dramatically. Whilst conventional economics assumes that new energy sources will be called forth as prices of fossil fuels rise, the real imperative of achieving equitable prosperity is to ensure energy is both widely available and affordable. Rebalancing this inequality in access to energy will inevitably lead to smarter planning of infrastructure and communities at a variety of different scales. Society is required to address a key question: How much is enough? However, conventional economic theory is ill equipped to answer.

Box 1. The notion of 'capital' in conventional economics

Capital is understood in conventional (classical and neo-classical) economics as any humanly-produced thing that can enhance a person's power to perform economically useful work – thus a spear was capital for a caveman and sewing machines are capital for clothes makers. Another term would be the 'means of production'. Capital goods are not consumed, though they may wear out through the production of goods and services. Capital is distinct from land (or natural resources) in that it must itself be produced by human labour before it can become a factor of production. Capital should be understood as a *stock*, whose value can be estimated at a certain point in time. In contrast, investment (or finance) is normally understood as a *flow* of money over a time period (e.g. a month or a year). The conventional economics theory of growth is based upon firms using money to increase their stock of procreative assets, a process often referred to as 'capital accumulation' or 'capital formation'.

Critiques of conventional economics point to the importance of other forms of capital in the production process, including the role of human and intellectual capital and natural capital. Karl Marx and John Maynard Keynes both emphasised the importance of 'financial capital' – non-productive assets that still provide an expected future return – as distinct from the means of production. Thinkers such as Pierre-Joseph Proudhon and Silvio Gesell were concerned with the inequity and inefficiency of money as a non-productive asset providing a return while the means of production wore out.

The classical economists of the eighteenth and nineteenth centuries were conscious of the role that nature played in the economy, with land featuring as key economic input. There was little sense that infinite economic growth was either possible or even desirable, as Mill's comment above illustrates. However, as industrial economies grew, the dependence of the economy on nature became of decreasing concern. For the bulk of the twentieth century, humanity has been able to enjoy high levels of growth in material consumption that has been driven in part by technology and increasing productivity, but also has been dependent on the extraction of fossil fuels – the consumption of the stored energy of many millennia – and the Earth's capacity to absorb the economy's pollution and waste.

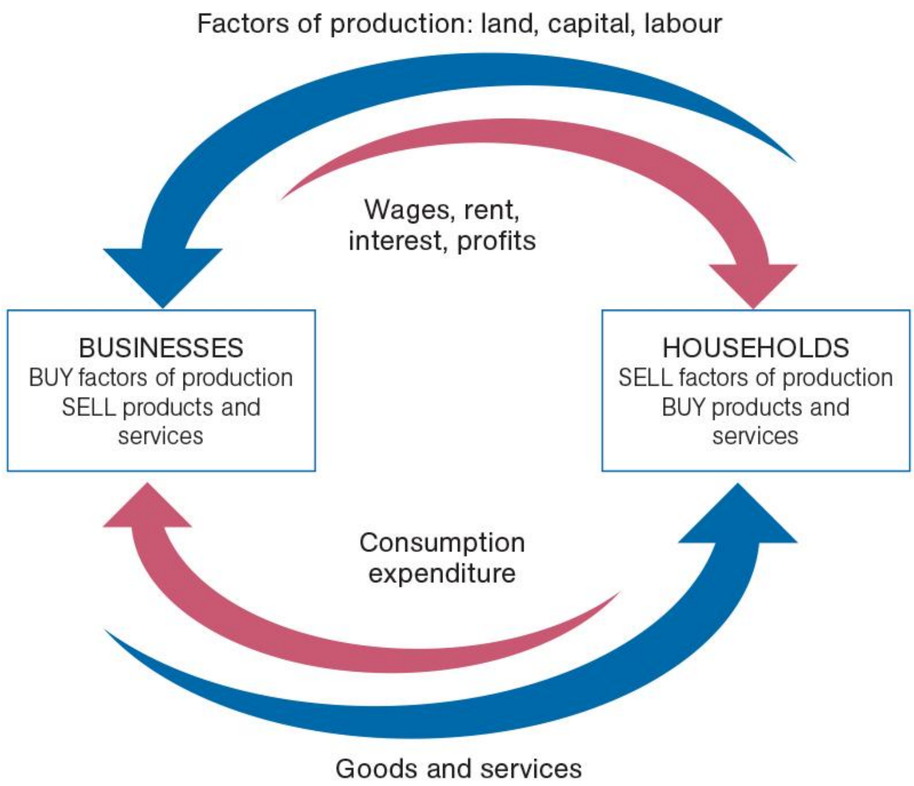
This 'flamboyant period' is now over.[10] The growth we are now experiencing can be thought of as 'uneconomic' in the sense that the costs – climate change, species extinction, ocean acidification, global energy shortages – outweigh the poorly distributed benefits.[11] Why does conventional economics have a 'blind spot' when it comes to the natural world?

2.2 Economic theory and natural resources

Economics is generally defined as the study of the allocation of scarce resources in order to maximise welfare. In the world of conventional economics, the key resources, or ‘inputs’, are considered to be labour and capital in the form of productive assets[12] (see Box 1 for discussion of the concept of capital).

In conventional economics, the economy is generally understood as a system with a circular flow of exchange between households and businesses. Households provide firms not just with labour, but also land, natural resources and financial assets, which they collectively own. In return they receive payments in the form of wages, interest, dividends, rents and profits. Firms combine these ‘factors of production’ to produce goods and services that are consumed by households (see Figure 3).

Figure 3: Conventional economics production process with substitutable factors of production.



All models are necessarily a simplification of the real world. However, we suggest there are three significant flaws with this theory of production which all help to explain why the degradation of natural resources and eco-systems seems unstoppable under our present economic system.

First, there is the problem of externalities – impacts that are not priced and so are not taken into account by markets. This is already well recognised by environmental economists. As shown in Figure 1, the disconnection between money and nature means that there is no market feedback information to counter environmental costs. Secondly, contemporary theories have conflated man-made capital with natural resources, essentially assuming that they are substitutable. Finally, the role of energy in the economy is underplayed at best and ignored at worst, leading to a strange dissonance with the natural sciences.

Problem 1: Pricing nature and the climate

Markets value and assign costs (or prices) only to those things which can be exchanged. To be exchanged on a market, something must be subject to exclusive ownership and control and the ability to transfer that exclusivity. This implies that it must be quantifiable in some way. Yet many of the things that constitute natural resources – the sun, the air, the sea, wild birds or biodiversity – cannot be quantified, exclusively owned and hence cannot be exchanged on markets. Attempts have and continue to be made to quantify natural resources and account for them as natural capital, in particular forests, minerals and fisheries, but their valuation is often deceptive. Thus, the extraction of minerals is treated as a form of income, even though it is really a form of living off 'natural capital' and depleting it.[13] Most resource exporting and importing countries today are guilty of this 'accounting trick' and are unwittingly impoverishing themselves as a result.[14] At a broader level, national accounting and the concept of Gross National/Domestic Product similarly counts the destruction of natural resources as income.[15]

Climate change is perhaps the ultimate example of the failure of the market and its associated monetary system to guide human action effectively towards a sustainable way of living. Indeed it has been described as the 'greatest market failure in history' by Sir Nicholas Stern. The atmosphere is a vital and universal collective good, a global commons. It cannot be owned individually, yet it generates vital life-maintaining services for humankind by absorbing CO^2 and preventing a critical rise of global temperatures and its disastrous consequences. This ecosystem service of the atmosphere, like many others, is not priced into our transactions. Whether attempting to price nature into market is the best solution to this market failure is a hotly contested question which we do not explore in this report.

Problem 2: Man-made capital is not a substitute for nature

In this framework, the basis of many models of the economy, all the inputs to production apart from labour are grouped together under the term 'capital'. This has the important consequence of implying that one can be substituted for the other. In other words, depleting nature's resources does not matter as long as the stock of man-made capital is increasing.

Furthermore growth is explained mainly through increases in the quantity of labour and capital. The 'residual' economic growth not explained by these two factors is generally explained away as a result of advances in technology, or a 'technology multiplier'.[16] This theory does not provide a complete explanation of economic growth. In the words of ecological economist Robert Ayres, "…there is no theory, based on general behavioural laws, to explain quantitatively why some economies grow, but some faster than others and some do not grow at all."[17] We need to include other factors in our model of the economy.

Production depends on *physical material* as well as labour and capital (in the form of productive and financial assets). The ecological economist Nicholas Georgescu-Roegen developed an alternative theory of production that properly incorporates natural capital.[18] He distinguished between two different kinds of factors of production: first, resource *flows* that are physically transformed into flows of product and waste; and secondly, capital and labour *funds* (or stocks), the agents of transformation that are not themselves physically embodied in the product. There are various degrees of substitution between different natural resource flows (you can substitute oil for gas or stone for wood) and between the funds of labour and capital. But the funds cannot substitute for flows of resources. Natural resources must therefore be included as an *independent* factor of production, rendering the long established neo-classical 'production function'[19] redundant (at least for the real world).

It is clear that labour, capital and natural resources are *complementary* rather than substitutable. If you give a baker enough money to double his number of ovens and chefs but tell him he can't have more flour and dough, he will struggle to make more bread. In addition, as Herman Daly has pointed out, substitutability implies reversibility, i.e. that we could substitute capital for natural capital. This 'calls in to question why human beings would bother with capital accumulation in the first place since nature had already endowed us with a near perfect substitute'.[20]

Problem 3: Understanding the role of energy in the economy

Many processes in nature, technology and human activity involve the transformation of energy from one state to another. For example, light from the sun is transformed into thermal energy in the warming of soil, rocks and plants, and into chemical energy captured by the plants for photosynthesis. The laws of thermodynamics are the principles governing the accounting by which we keep track of energy as it moves through such transformations. There are two established laws of thermodynamics, an exception to which has never been observed.

The first law, also known as the law of conservation, states that, within a closed system such as the earth, energy can neither be created nor destroyed.[21] All the energy that flows into any transformation process – including all economic processes – must end up either as a useful product, a stock change or a waste. The second law of thermodynamics – the law of *entropy* – distinguishes different types of energy-matter in terms of their availability and usefulness to us as human beings. The law of entropy states that the availability of energy to do useful work[22] ('exergy') is reduced by every transformation process, whilst at the same time the non-useful component increases. Certain kinds of matter – such as fossil fuels – are low entropy and easily transformed into useful work. But in the process of transformation, their available energy is dissipated and we are left with high entropy matter – in the case of fossil fuels, a combination of heat, CO^2 and other wastes which we cannot reuse (see Figure 4).

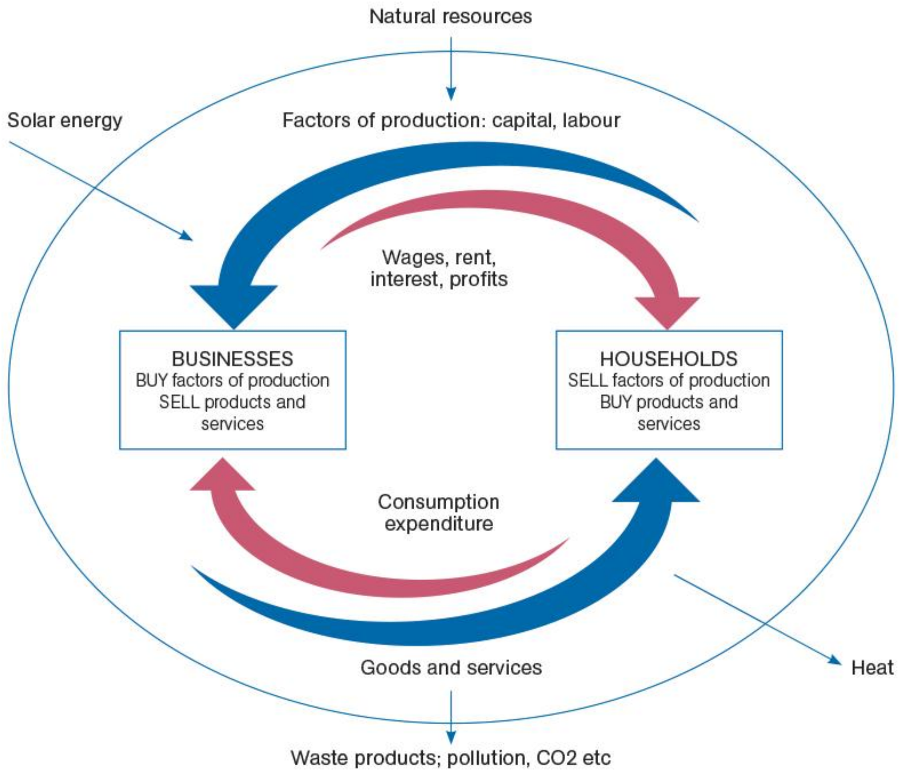
Such wastes and pollution, as we now know, have definite cost to human beings and the planet. The phenomenon of global warming, the toxification of the oceans and air and the resultant damage to species can all be thought of as 'economic bads'. The same amount of energy-mass is still there but it has changed to a form that we cannot translate into work and in many cases reduces human welfare.

Since all economic activity involves the use of natural resources, to conceptualise it as a circular flow of exchange between households and firms is incomplete. Such a model implies reversibility and only quantitative changes (in the amount of labour and capital, for example). But entropic flows are qualitative – they involve a one-way transformation of matter from one state to another, from a state with high energy availability to one with no availability[23] (Figure 4).

Peasant agricultural economies where productive capital consisted mainly of land, tools and animals depended mainly upon sunlight for their sources of energy. As such, it was free and renewable and these economies focused on producing goods with concrete use values – such as livestock - which imposed their own limits on accumulation.

In contrast, the modern industrial economy depends more on the concentrated and finite terrestrial sources of energy - fossil fuels and minerals – in order to power the machinery that has replaced animals and humans in the production process. Fossil fuels can be thought of as the product of many thousands of years of solar energy condensed into very low entropy matter (i.e. the type of matter that enables us to transform it into useful energy at a much faster rate than sunlight).

Figure 4: Entropic production process with non-substitutable natural resources and waste



Ayres and Warr have demonstrated the importance of energy to industrial growth in a longitudinal study of the US economy since 1900.[24] They use historical data which combines the exergy (useful energy) content of fuel inputs (i.e. the ability to perform useful work) and entropic conversion efficiencies. They show that the useful work obtained from fuel resources has grown much faster than the consumption of fuels themselves, owing to substantial improvements in thermodynamic conversion efficiencies, and corresponding reduction in waste. By including useful work in their aggregate production function, rather than primary energy, they obtain an extremely good fit to US GDP trends over the past century, thereby eliminating the need for the mysterious technology 'multiplier'. In this model, improvements in thermodynamic conversion efficiency have a dramatic effect on economic output and act as the primary engine of economic growth.

There is considerable evidence that the world is reaching a saturation point in terms of energy-conversion efficiency improvements and the supply of such low entropy materials. In particular, this is the case in regard to the conversion of fossil fuels into more useful, processed energy (gas, electricity, woodchips etc.), technically described as 'work'. Fossil-fuel carbon prices are almost certain to increase in the future as carbon emissions controls are put into effect across the globe at all stages of the production and consumption process. The phenomenon of 'peak oil' is likely to have an even greater effect on the price of energy as demand driven by the emerging economies outstrips global production capacity. **nef** research suggests that only half the oil and gas reserves which have been proven economically recoverable can be burned up to 2050 if we are to avoid potentially irreversible climate change.[25]

As prices rise, new sources of energy are coming into being as economic theory would predict. However, as yet, there is no convincing evidence that they can replace fossil fuels in term of the ease of conversion from raw material into useful energy. The costs of recovery are likely to be much higher than current costs and the 'energy return on investment' (EROI, a concept explained in Box 2, page 33) will be much lower.[26] Most of the alternatives, including shale gas, require very large amounts of energy (and capital) to be invested in the recovery of the raw fuels, and most estimates suggest it will take many years before such sources reach the output levels of fossil fuels today.[27]

2.3 Where does money come in?

We have highlighted three problems with the interaction between nature and the economy. Why do we consider it important to examine the impact of the money system?

Conventional economics treats money in a similar way to natural resources in terms of their role in the economy – it is just assumed into existence when required. In neo-classical models, money is a neutral commodity that optimizes exchange, enabling us to move beyond 'barter' and affecting only nominal prices and exchange rates rather than real GDP, employment or consumption in the medium to long-run.[28] Money is just the oil that lubricates the consumption and production processes.

In fact, as we explain in the next chapter, the nature and functions of money, how it is created and who controls its allocation are in fact of fundamental significance for the economy and its relationship with nature. We argue that our current monetary system makes matters worse.

3. Money, the economy and nature

"The essence of the contemporary monetary system is creation of money, out of nothing, by banks' often foolish lending."

Martin Wolf, Financial Times, 9th November 2010

Money is a social construct; a belief system held together by shared norms formalised through legal, economic and political institutions. Its creation does not follow physical laws any more than language follows physical laws. But if we accept the proposition that the economy must obey physical laws then does money also have to obey them?

Money has taken many forms throughout history. Societies have linked their money to a greater or lesser degree with physical resources. But modern money has become decoupled from such resources. In this chapter we describe the nature of money and how it has developed into its contemporary form. We consider its flaws before considering whether anchoring money to nature is a potential solution.

3.1 The nature and history of money

Money is generally defined in terms of the functions that it performs:[29]

1. **Store of value** – holding on to money gives us confidence in our ability to access goods and services in the future. It gives us future 'purchasing power'.

2. **Medium of exchange** – money enables us to conduct efficient transactions and trade with each other. Money enables us to exchange without the 'double coincidence of wants' which requires both parties to have exactly the right quality and quantity of a commodity to make an exchange.[30]

3. **Unit of account** – without a widely agreed upon unit of measurement we cannot settle debts or establish effective price systems, both key elements of market economies.

We will return to these functions of money when we examine energy currencies in Chapter 4. Over the centuries many different forms of money have been used to fulfil these functions, reflecting changing political, economic and cultural dynamics.

The origins of money

The origins of money lie with the unit-of-account function. The earliest evidence of money is the keeping of records of credit and debt, which may have even preceded the written word.[31] Historical and anthropological research suggests that the state (or its ancient equivalents, such as Chiefs or Palaces) has always been the prime determinant of what counts as unit-of-account, via the levying of taxes.[32]

For many thousands of years, in order to underpin trust in money as a medium of exchange and store of value, currencies were often issued either in the form of precious metals and thus with an inherent value, or as tokens which reflected a defined quantity of whatever stock they were issued for, as for example the Mesopotamian shekel which was backed by wheat (see Examples 2). Other commodities included salt, silk, dried fish, feathers, stones, cowry shells, beads, cigarettes, cognac and whisky and livestock. [33] In 1715, the government of North Carolina declared seventeen commodities, including maize and wheat, to be legal tender, whilst tobacco stores in New England states operated in much the same manner and enabled the crop to serve as legal tender in Virginia and Maryland for almost two hundred years, longer than the gold standard managed to survive.[34]

In his recent study on "Debt: The First 5,000 Years", anthropologist David Graeber argues that, due to a series of economic disasters since the late seventeenth century caused by government interference in money creation, it was unsurprising that *"Newtonian economics (if we may call it that) – the assumption that one cannot simply create money, or even, really, tinker with it – came to be accepted by almost everyone."* Consequently, in their view:

> *"… there had to be some solid, material foundation to all this, or the entire system would go insane. True, economists were to spend centuries arguing about what that foundation might be (was it really gold, or was it land, human labour, the utility or desirability of commodities in general?)"*[35]

Although the unit of account (the measure of gold, or weight of wheat etc.) has always been socially or politically determined, in all cases of commodity-backed money there could be said to be a link between real resources and energy and the monetary system. For instance, gold required excavation, which in itself required energy, and wheat required water and sunlight. Only if people had met their basic needs of food, water and shelter would they invest time and effort in extracting gold which would enable them to trade to receive more advanced goods and services. As late ecological economist Richard Douthwaite has pointed out, gold was thus a means by which communities could recycle surpluses.[36]

It was only during the last three centuries that the economies of the western world found ways of removing such natural constraints.

The evolution of modern money: Goldsmiths and fractional reserve banking

The origins of modern money lie in the domination of gold and silver as commodities of exchange and states' struggles to physically mint enough of it to enable expansion and warfare. The coincidence of this demand with the fraudulent practise of fractional reserve banking in the late eighteenth century gave rise to modern banking and money.[37]

In medieval Europe, gold and silver were the primary media of exchange. Merchants would deposit their coins with goldsmiths for safekeeping, receiving 'deposit receipts' in return. It was soon found easier simply to use the deposit receipts directly as a means of payment rather than having to go to goldsmith and pick up the corresponding coins. The goldsmith's deposit receipts effectively became a medium of exchange.

Since it seemed inconceivable that all of their customers would choose to withdraw all of their deposits at exactly the same time, goldsmiths soon realised that they could issue 'new' (and fictitious) deposit receipts to people who wanted to borrow money. By charging interest on these loans, goldsmiths were able to make a good and exponentially growing return on this service for very little effort.[38] Thus they created new money and fractional reserve banking was born. Goldsmiths needed to keep just a fraction of their total loan value in the form of precious metal in their vaults.[39]

Soon European sovereigns, unable to mint enough coinage or raise enough taxes to meet the costs of increasingly expensive wars, also began to borrow from goldsmiths and the practise of government bond issuance was established. This involved the state guaranteeing to repay the goldsmiths for their loan (with interest) over an extended time period via future taxation.

Early fractional reserve practises were vulnerable to periodic losses of confidence and "runs on the bank" as depositors sought to redeem their receipts as commodities. Fearful also of defaulting sovereigns, bankers and other members of the ruling elites decided to establish central banks which eventually developed monopoly rights to print paper money. Private banks continued to create credit when providing customers with a loan in the form of book entries which could subsequently be withdrawn as cash.

The twentieth century saw a brief period of relative stability in the global financial system in the post-Second World War period when the Bretton Woods agreement pegged every major currency against the dollar, which itself was tied to a gold standard. The system enabled the US to generate large surpluses, but it distributed these in paternalistic fashion to support productive activity in its client countries, preventing the kind of build up of indebtedness we have seen in the Euro.[40] This last fixed formal link between money and anything physical[41] was broken on August 15, 1971, when President Nixon ordered the US Treasury to abandon the gold exchange standard.

Money today: credit creation by commercial banks

In contemporary society, banks create money through extending credit and expanding their balance sheets. When a bank makes a 'loan', it does not borrow money from anyone else. It simply adds an accounting entry to its ledger in the form of an asset (the loan, money I owe to the bank) and a liability, (a deposit – which the bank owes to me).[42]

In modern, deregulated financial systems, central banks have chosen to have a very limited ability to control credit expansion by banks.[43] Whilst all banks must hold a proportion of central bank reserves in order to settle their accounts at the end of any particular trading day, the Central Bank is not in a position to deny the banking system sufficient reserves. This is because bank's liabilities (deposits) have come to be used as the main medium of exchange in the economy – hence if any bank was to become illiquid it could result in a collapse of the payment system.[44] The modern monetary system can thus be thought of as 'endogenous' in the sense that banks 'create loans and look for the reserves later'[45] rather than 'exogenous' with the central bank determining the amount of reserves in the economy and limiting bank's credit expansion accordingly.[46]

In summary, we can see that the emergence of a system where the bulk of the money supply is created as commercial bank credit had very little to do with conscious design in terms of enhancing general welfare or economic efficiency. It was instead the outcome of historical accident and power relations, particular those between banks and politicians. This system appears deeply flawed.

3.2 Problems with modern money

Modern fiat bank-debt money has a number of serious flaws: it creates the illusion of wealth; encourages the build up of unsustainable debt; and requires ever-increasing growth and/or inflation. As a result, it serves poorly as both a store of value and medium of exchange, as the two functions are forever in tension. It is also highly unstable and pro-cyclical, discriminates against the future, and is completely disconnected from social and ecological impacts. We examine these problems in turn below.

1) Bank-debt money as 'virtual wealth'

Pre-industrial economies focused on the production and accumulation of goods with concrete use value – mainly food, tools and livestock. Such goods, as products of the natural world, deteriorate over time when hoarded, due to the laws of entropy. However, in modern capitalist systems, as Marx noted, the goal is the accumulation of abstract *exchange value* in the form of capital (or money) which does not deteriorate nor obey any of the laws of the natural world.[47] In contrast, abstract exchange value grows by itself, earning interest and then interest upon the interest (compound interest).

Perhaps unsurprisingly, it was a scientist, the Nobel Prize winner Frederick Soddy, who was one of the first to identify this paradox that lies at the heart of capitalism. Soddy distinguishes between real wealth – which is subject to the laws of entropy and is either 'used up' (as with gas or oil) or deteriorates (as with machinery or human bodies) – and 'virtual wealth', or debt, which is not subject to such laws.

Soddy provided a simple example to explain the contradiction.[48] He imagined two pig farmers keen on developing their stock. The first farmer has two real pigs, requiring food and shelter, disposal of their waste, with reproductive cycles and other natural limits on their ability to 'grow'. The second farmer, in contrast, has two, hyper-fertile 'negative-pigs', a mathematical quantity without physical existence and capable of multiplying without limit. Both sets of pigs might grow at a rapid pace initially but before long the law of entropy will limit the further growth of real pigs, whilst the population of negative pigs will continue to expand.[49] The value of the negative pig will eventually fall to be a small fraction of value of the positive pig (negative pig inflation) and the owner of the negative pigs will struggle to exchange his negative pigs for positive pigs (debt for real assets).

The financial crisis of 2008 destroyed the illusion that the vast build up of debt in the developed world since the 1980s could somehow be converted in to real assets. In 2012, as Herman Daly has noted, the 'negative pigs' still abound despite government and central banks taking vast quantities of bad debt on their balance sheets; European and American Banks remain stuffed full of assets – mortgage-backed securities, government bonds, pension liabilities – which the real world will never be able to fund.[50] Soddy concluded that at the heart of the modern economy lay a fundamental fallacy:

> *"You cannot permanently pit an absurd human convention, such as the spontaneous increment of debt (compound interest), against the natural law of the spontaneous decrement of wealth (entropy)."*[51]

When people invest and expect a rate of return determined by interest, they are also engaging in this fallacy of misplaced composition:

> *"Although it may comfort the lender to think that his wealth still exists somewhere in the form of "capital", it has been or is being used up by the borrower either in consumption or investment, and no more than food or fuel can it be used again later. Rather it has become debt, an indent on future revenues…"*[52]

For Soddy, the culture of exponential growth that dominates modern economic systems can be seen at least partially to derive from individual's obsession with converting perishable wealth, based upon real assets, into permanently enduring debt, that is not subject to the laws of entropy and provides a permanent stream of future income.[53] In reality, of course, real future income cannot grow as fast as virtual monetary wealth. If everyone attempted to change their virtual wealth (money balances) for real assets, it could obviously not be done because all real assets are already held by someone. Yet we behave as if money is real wealth because at an individual level, money is easily exchangeable for real assets.

Society does benefit from virtual wealth since it can be seen as the value of avoiding barter or the costs associated with a full commodity currency. Virtual wealth is a collective agreement by individuals to use a particular accounting mechanism to exchange with each other which involves holding on to tokens not all of which can be translated in real wealth. Whenever such tokens are issued into existence to any particular individual, they in effect are borrowing from the community which must give up real assets to the borrower when they spend the tokens. This makes the process by which money is issued into the economy enormously important to understand.

2) Structural drivers of monetary and un-economic growth

A number of monetary reformers have argued that interest-bearing bank debt creates a structural growth or inflation dynamic in the economy. As a result the contemporary money system is incompatible with a steady-state economy or de-growth economy that remains within ecologically finite limits.[54] Firms that borrow at interest must find additional funds to repay both the principal and the interest on the loan, as well as generating profit. At the aggregate level, this implies a steady increase in productivity or a steady expansion of debts, or both, resulting in either growth or raising prices (inflation), or a continuous redistribution of wealth from the poor to the rich.[55]

However, in reality the interest received by creditors, and the profits of banks, are eventually recycled back into the economy in the form of wages, consumption or investment. It is only the retained profits that banks must hold on to as a proportion of their assets – usually termed ‘bank capital’ – to cover the potential risk of bad debts that can be seen as being withdrawn from circulation in the economy. Binswanger argues that any monetary system involving risk-based lending activity which requires money will lead to a growth or inflationary dynamic, even with all interest profits recirculating.[56]

However, the growth assumptions made in relation to bank-debt are often based upon the same ‘circular flow’ model of the economy presented in chapter 2 (Figure 3, page 14). In this conception, money flows and stocks are elided together – a loan from a bank, which is a stock, is seen to be the same as a wage bill being paid out and distributed around the economy, a flow. In reality, money is dispersed through the economy at different times for different purposes and for multiple transactions over time. So the same £100 loan could be used to enable multiple iterations of wage payments and purchases before it is returned to the bank.[57]

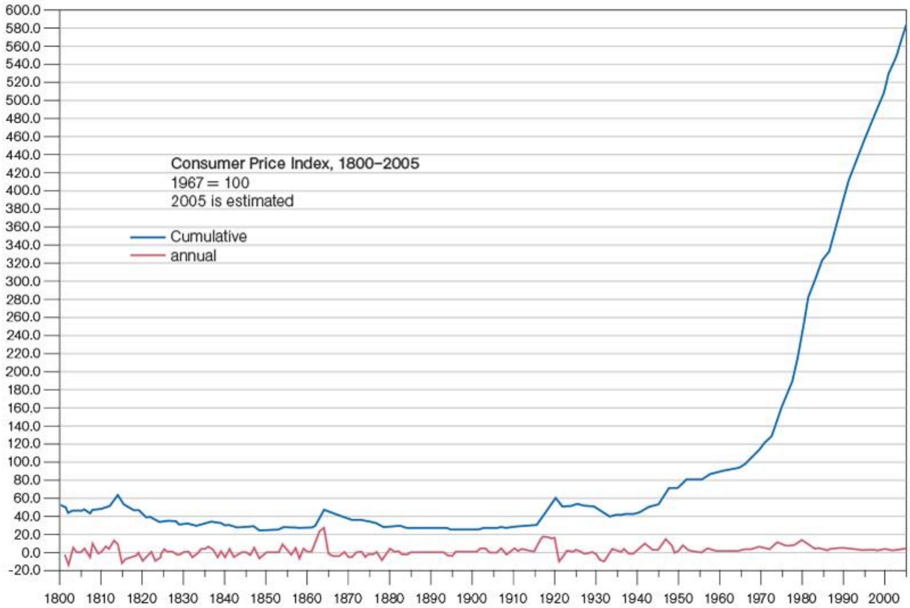
This means that theoretically it is possible for firms to both meet interest payments and make profits without growth or inflation being necessary.[58] History suggests, however, that interest-bearing debt-based monetary systems in free-market capitalist economies often lead to unsustainable increases in debt for particular classes (debtor-classes). In particular this seems to have been the case since the 1970s in developed nations as returns to capital assets have increased at a much faster rate than returns to labour. This means debtor classes have proportionately fewer funds to repay their debts and may have to rollover their debts, incurring compound interest which grows at an exponential rate that cannot be matched by any increase in transactions.[59] In such a case, large-scale redistribution of wealth and income would be necessary to allow for a zero-growth or zero-inflation economy. In reality, large-scale debt repudiation has often been preferred in the face of societal breakdown.[60] Bank and corporate profits that are ploughed into non-productive assets will have a similar inequality-producing and destabilising impact on the economy and lead to the need for greater debt for non-asset owning classes.[61]

In summary, we can conclude that even if the relationship between debt-based money and growth is not a simple mathematical one, when more complex factors such as unequal distribution of income, wealth and financial stability are taken into account, the current money system is one that is dysfunctional in the absence of constant economic growth, inflation or massive redistributions of wealth and income[62].

3) The negative effect of bank-debt money on store of value and means of exchange functions

Mainly because of the requirement to create growth and inflation in order to maintain economic and social coherence, modern fiat bank-debt money has proved itself to be a very poor ‘store of value’. As shown in Figure 5, inflation has become particularly rampant since the deregulation of the financial sector in the 1970s.

Figure 5: UK inflation since 1800



Historically consumers have lost three to four per cent of their purchasing power a year. 2000–2008 saw a particular period of low consumer-priceinflation coupled with growth in developed countries which many credited to be a result of central bank independence from political interference, and a strong focus on inflation over other policy goals. In fact, the period was accompanied by massive levels of asset price inflation as banks pumped credit into housing markets and consumers withdrew equity to maintain levels of consumption. Because most indexes of inflation do not include real estate prices, the bubble was missed and interest rates were kept at historically low rates.[63]

Creating more 'sound money' has proven historically difficult. If a central bank ever ensures that the store of value function is maintained perfectly (i.e. there is zero inflation), too little money gets into circulation to provide easy trading conditions because of the need for growth demanded by interest and the need for banks to hold capital. Ultimately, different groups and communities will always have conflicting interests over these two functions of money, a struggle that was perhaps at its most clear before and after the American Civil War, between the 'Greenbacker' farmers who wanted 'easy money' and the bankers of the East Coast who wanted to maintain sound finance.[64]

According to monetary historian Glyn Davies, the history of money can be seen as a struggle between these competing functions of money:

> *"…an unceasing conflict between the interest of debtors, who seek to enlarge the quantity of money and who seek busily to find acceptable substitutes, and the interest of creditors, who seek to maintain or increase the value of money by limiting its supply, by refusing substitutes or accepting them with great reluctance and generally trying in all sorts of ways to safeguard the quality of money."*[65]

4) Discounting the future

Not only does interest on debt-based money allow virtual wealth to detach from real wealth, and embed a structural driver of growth into the money system, it also discounts the value of the future. For example, renewable energy appears more 'expensive' than fossil fuel energy (despite being free) largely because of the commercial rates of interest charged by banks or the more expensive infrastructure required to run such projects, which must be paid out over many years.[66] Interest takes no account of the benefits for future generations of harnessing such abundant energy sources. Indeed Douthwaite argued that the prices set by the market at any particular time have nothing to with long-term values, and in particular ignore the needs of future generations:

> *"the prices that emerge merely reflect the immediate wants of that fraction of the worlds' present population fortunate enough to have the money to be able to express them….This inevitably leads to a gross misallocation of resources in favour of the present."*[67]

5) Mis-allocation of credit leading to economic instability

One of the core features of the modern deregulated financial system is the creation of credit for speculation, most of which inflates asset prices and creates vast quantities of debt. Richard Werner, amongst others, has shown how the incentives facing banks, with companies holding limited liability, drive them towards such behaviour.[68] Such a monetary system is driven mainly by the confidence of banks and firms and is thus inherently volatile and pro-cyclical.

Hyman Minsky's 'Financial Instability Hypothesis' describes multiple recurring phases in the capitalist process.[69] At the beginning of such cycles profits are low and banks act more conservatively, but over time they improve. Both banks and firms grow in confidence, becoming more leveraged with resulting over-investment in assets that results in asset price inflation which breeds even greater confidence; this eventually leads to 'ponzi-financing' where banks lend on the basis of assumed increases in asset prices rather than anything related to the real economy. Eventually, the ratio of debt to income becomes unsustainable and defaults begin, leading to contraction in loans. Growth and wages stagnate and the asset price bubble eventually bursts as asset prices begin to fall. Debt-deflation ensues, a situation whereby real outstanding debt increases as real income falls, leading to the inevitable crash.

6) Mis-allocation of credit leading to social and ecological harm

In the same way that banks do not have regard for the macroeconomic impacts of their activities, there are also no incentive structures for banks to account for the social or environmental impacts of the activities that they finance. Low-carbon infrastructure is under-provided with finance, often because of higher short-term profits, while activities with negative externalities are funded. The existence of externalities and market failure is well established in economic literature. One approach to correcting these is to use regulatory or market-based mechanisms such as green taxes to alter outcomes in product and service markets. Ultimately this should alter the investment returns from activities with high negative externalities, and thus reduce demand for finance for these activities. However, another and more direct approach to tackling the systemic failure to prevent ecological overshoot of the economy identified in Chapter 2 could be to embed environmental factors into the supply of finance itself. In the next section we examine arguments for creating a link between nature and money.

3.3 The case for anchoring money

Today's monetary 'monoculture', with a few major national or international currencies dominating global trade, is relatively unusual when set in historical context.[70] We have argued that the modern system of bank credit money is flawed in terms of the quantity and allocation of new money and, as noted above, because of its ability to earn interest at a compounding indefinite rate. It is also flawed because its value is not anchored to ecological values.

As the global banking bail-outs of 2008 and in the current stage of the Eurozone crisis have demonstrated, banking failures are extremely costly for states, taxpayers and citizens. And yet, to date, states have shown little interest in revisiting the issue of who should create money and how money should be designed.

In contrast, over the last thirty years there have been a growing number of experiments with complementary currencies and different forms of money which take seriously the arguments that money is socially constructed and that multiple forms can and should coexist. To some extent these are the modern expression of a much longer history of monetary reform activism stretching back to the 19th Century and the ideas of Pierre-Joseph Proudhon and Robert Owen.[71]

Contemporary models include forms of mutual exchange such as LETS and Time Banks, local currencies backed against national currencies like most of the Regiogeld and Transition currencies, and a wide range of other models and innovations. Many of these are rooted in the critique of the contemporary financial system that is outlined above, and as such have sought to democratise the creation of money or address the instabilities and dysfunctions of the contemporary financial system. However, the complementary currency and monetary reform movements do not overlap entirely, and there is considerable diversity in both. To date, ideas of energy money have reflected a small niche within these fields, which are themselves marginal within wider public and political discourse. Despite this, a case can be made for considering anchoring money to nature in some way, for at least three reasons:

1) Restoring trust

At a closer look, all dysfunctions of money are issues of trust. A currency's very essence is that people can rely on its various functions. Whenever trust in a currency's function is compromised, people seek ways to compensate with other means: they calculate and compare prices in a foreign currency or reference whose value they trust more;[72] they use for payment what others might consider valuable, like cigarettes or potatoes during World War II; or they flee from a currency by spending it for something which they expect to sell again later without loss, like land and buildings, gold and diamonds, or arts.

Much thought has been given to the question of how trust in a currency can be established and maintained. Anchoring money to something real seems to be an attractive option, not least because of its roots in the cultural history of what people consider to be money.

2) Preventing 'virtual wealth', instability and ecological degradation

Introducing a link between money and nature could address several of the issues with economics and money identified so far and create a more stable monetary system that internalises nature in market prices. Turnbull argues for introducing a feedback mechanism between money creation and ecological issues:

> *"Modern money is not related to nature. While money is used to allocate resources to exploit the environment, its environment does not determine the characteristics of money. There is thus no feedback mechanism for money to be a self-correcting agent in nurturing nature. Because the modern forms of money are not related to nature, the volume and cost of money have no natural limits."*[73]

3) Promoting the energy transition

The first two reasons are about preventing harm, but new forms of money could also actively promote good outcomes. Viable steps towards a more ecological economy would include a reduction of fossil energy depletion and a shift towards renewable energy production. The underpricing of fossil resources in relation to their environmental impact requires a recalibration of pricing to render renewable energy production cheaper and more competitive, which means fostering such investments today even if they do not seem profitable in pure monetary terms. The combination of debt-based money and the discounting of future returns at commercial rates of interest particularly discriminates against renewable energy. Such infrastructure has a high up-front investment cost followed by a long stream of extremely low-cost returns, as the fuels themselves (solar, wind, tides) are effectively free. The apparent economic (as well as environmental) logic of renewable energy is overturned by the nature of the monetary system itself. [74]

In the next section we explore different attempts to create a monetary system that relates more directly to the earth's natural resources.

3.4 How to anchor money – what anchor?

There is more than one way in which money could be related to nature. Two popular options are to directly reference a monetary unit against a single commodity or resource, or a basket of resources.

1) Basket of resources

The idea behind anchoring money to a basket of commodities is to allow money to mirror broadly what is considered valuable in use in the real world. Basket based currencies seek to even out price volatilities in the single commodities' values and thus stabilise the price relations between everything else. The result should be a reference unit that can be used to circumvent inflation, especially regarding world trade. As Lietaer describes in his Terra White Paper, *“Inflation is always defined as ‘the changes in value of a standardised basket of goods and services.’ By selecting the appropriate ingredients to be placed in the basket, the Terra can be protected against inflation.”*[75]

Currency concepts referring to a basket of ‘real values’ show a great variety not only in choice and number of commodities but also in terms of their architecture and characteristics. However, most are aimed at global scale and include key commodities that reflect important globally traded goods that have a high use value. Such a basket backed currency should enjoy a sustained, high degree of trust.

Greco, after studying Borsodi’s Exeter Constant experiment in detail (see Examples 1 below), concluded that twelve to fifteen commodities might be sufficient for defining the standard unit and set out how to choose which commodities to put in the basket. He argued that the chosen commodities should be:

“1. traded in one or more relatively free markets (freely exchanged);
2. important in world trade (high volume);
3. important in satisfying basic human needs (necessity);
4. relatively stable in price (in real terms) over time (stability), and;
5. uniform in quality, or standardized quality (uniformity).”[76]

Examples 1: currency concepts based on a basket of commodities

Bancor (Keynes 1941)

At the Bretton Woods Conference in 1944, Keynes proposed to politically install an International Clearing Union. The clearing framework would include the ‘Bancor’ as an international reference currency. Trade account balances would be measured in ‘Bancor’, while each country would maintain a ‘Bancor’ account vis-à-vis the ICU with a set of rules for adjustment of trade balances. While the currency was meant to be based on the gold reserves of all participating nations and not on commodities, Keynes’ plan also included a ‘commodity board’ to account and adjust the member nations’ trade balances of key commodities.[77]

Exeter Constant[78] (Borsodi 1971-4)

So concerned was Ralph Borsodi about the inflationary potential of Keynes’ proposals, he wrote a book in 1948 that sold half a million copies called: *Inflation is coming and what to do about it.*[79] He then decided to walk his talk with an experimental issue of inflation-resisting commodity based currency in his home town, Exeter. He named the currency ‘Constant’ as it was meant to keep constant in value and purchasing power while the economy fluctuated.[80] Borsodi figured that if it was a good idea to back a currency with gold and silver, it would be an even better idea to back it with a whole market basket of commodities, including coal and oil.[81] “[I]f certificates were printed and distributed with the guarantee that they'd always be 100% redeemable in fixed amounts of, say, 30 of the world's most widely used resources ... those certificates would automatically increase in value as the value of the resources increased (in terms of constantly degraded national currencies)."[82] And that's what he did: Borsodi 'invested' funds of about US$100,000 to continuously buy and sell key commodities on the global market, in order to even out price balances between the respective commodities and thus stabilise the Constant's relative purchasing power. Indeed, when Borsodi, after three years, closed his experiment the Constant still bought the same worth of goods as at the start, while the dollar had already lost 15% of its value.[83] It is worth mentioning that, in practice, the basket contained neither oil nor coal, but petroleum, as the back of a 25 Constant note indicates.[84]

Terra TRC (Lietaer)

Lietaer's concept of the Terra TRC (Trade Reference Currency) can be regarded as Keynes' Bancor Plan and Borsodi's Constant reconsidered. In contrast with Keynes' proposal, the Terra is not meant to be established by governments but by businesses, as the positive effects of a stable trading currency would be in their own commercial interest. Among the ingredients of the Terra basket, which are not accurately defined, crude oil is mentioned, as well as Carbon Emission Rights[85].

Ven

The Ven is a recently issued digital currency issued by Hub Culture Ltd. that can be spent at Hub Culture events and in their online shop on a large variety of third party products. It is freely transferable between any Hub Culture account. The Ven´s selling price is determined by a basket of over twenty weighted components, most prominently currencies like Dollar, Euro, Renminbi, Yen and others, but also commodities like gold, silver, oil, agricultural produce and carbon futures.[86] The basket of reference prices makes the Ven a more stable accounting unit compared to any single denomination, particularly for large-volume future contracts.

Since Hub Culture does not redeem Ven for any standard currency, the purchasing power of Ven as a store of wealth is only indirectly guaranteed through the pricing of goods and services in the Hub Culture online store. If more Ven would be purchased and retained by its customers, Hub Culture Ltd. would, according to its founder-director Stan Stalnaker, hedge the risk of fluctuating reference prices by actually acquiring the corresponding volumes of components of the pricing basket and thus effectively turning the Ven into a commodity backed currency.[87]

To strengthen local subsistence, as is the key objective of the Transition movement, North argues that a local basket could make sense to give value to a local currency. This money would be *"backed* *by commodities that, it is hoped, will keep their value in ways that 'fiat', paper currencies fail to.'*[88]

Basket currencies face their own particular challenge because the value of the anchor as an independent reference unit is undermined by the need for subjective judgement about their composition. Administrative discretion about the finer details of the commodities (i.e. which to include, in what proportions, when these should be adjusted) introduce potential uncertainly and scope for manipulation."[89]

Furthermore, whatever commodities are in the basket, they can hardly ever represent the complete set of planetary assets and resources, and the additional complexity of a basket may not achieve much advantage over simply choosing a single commodity, such as energy, which can be considered universal to all production processes.

2) Single commodity

For centuries, we have been culturally trained to equate money with gold and silver, and are still wedded to the idea that money itself should be backed by something of value – or itself be of intrinsic value, such as gold coins. Whilst gold and silver coins have been used as a means of payment for thousands of years the history of gold backed paper money, coins and deposits spans little more than 250 years.[90] Sir Isaac Newton's establishment of a new mint ratio between silver and gold in 1717 can be seen as one of the tipping points towards a true gold *standard,* where the gold functioned as a reference value for the money instead of the intrinsic value of the physical money itself. More recently, a plethora of privately issued digital currencies have sprung up which at least claim to be gold backed.[91]

The problem with a gold standard is that the value of the currency is completely dependent on the socially constructed value of that commodity. If, for whatever reason, the commodity's relevance should decrease, the currency's value is at risk.[92] The same is true if a spontaneous shortage or oversupply occurs, as happened repeatedly throughout the history of the gold standard. Might it be possible to find a single commodity anchor for money that is superior to gold or silver? Such a backing would need to have at least one of the following characteristics:

- its value would be important in everyday life and business, and/or;
- it would in itself be key to most other goods, and/or;
- it would have a huge influence on many other economic factors.

This might apply for food, water, energy, land and an intact global climate, just to mention a few. Indeed, a range of different single-commodity type currencies apart from gold have been imagined or tested.

Examples 2: currency concepts based on a single commodity

Currencies based on Grain/Food

Mendo's Food Futures Credits (Willits, CA)

Mendo Credits are backed by reserves of stored food and circulate in the town of Willits, California. As indicated on the note, a Mendo's Credits note at the face value (and price) of 10 US dollar can buy "one of the following: 11 pounds of pinto beans, 11 pounds of brown rice, 11 pounds of white rice, 17 pounds of triticale", during a one year period after issue. The supply of Mendo Credits is "strictly limited to the supply of grains and beans in storage", but, however, "notes can also be issued in advance to finance a necessary investment and purchase the food in the first place."[93]

Historic antecedents

Similar food backed currency types have been successfully introduced in Japan. Historical examples of "food credits" can be traced back to the Babylonian 'shekel' (around 2000 B.C.) and the 'corn-giro' in Egypt, both representing a defined amount of agricultural produce.[94]

Currencies based on H_2O

Kubik (Germany)

Water may have considerable advantages when it comes to backing a local currency. Imagine a municipality spends into circulation redeemable vouchers for its public water supply – the 'Kubik', denominated in m^3 drinking water – thus financing public and social services or the maintenance of its local infrastructure. As all residents of a town consume water every day and are obliged to connect to the water grid (in contrast to the energy grid), literally everyone could cash in the Kubik for his quarterly water bills and therefore would certainly accept Kubik as a means of payment. The Kubik could be spent at all public institutions and be used to pay local taxes. Additionally, the Kubik value can be expected to be relatively stable, because the average price of water hardly ever fluctuates.[95]

Currencies based on CO_2 Emissions

Emission rights represent tokens allowing use of the atmosphere. Fungible, tradable assets result when these entitlement tokens are divided up into small portions and certified. Their ability to hold a value and therefore back a currency lies in their inherent scarcity, which ideally reflects the maximum scientifically justifiable amount of greenhouse gases that can be emitted over a time period. Private emission trading schemes can be turned into "Carbon Currencies" on two different bases: arrangements to use emission rights directly as a currency (Carbon *Emission* Currencies), and arrangements based on the revenue from their sale (Carbon *Revenue* Currencies).[96] Apart from these macro-level considerations, there is a broad range of theoretical concepts as well as practical proposals for national, sub-national or local “Emissions Reduction Currency Systems” (ERCS), most of which would directly calculate with (personal) carbon emission rights, or account for a relative reduction of carbon emissions (‘white certificates’).

Carbon Credits

Two practical projects have recently been started in Australia. In Oct 2010, an Australian Island claimed to having introduced world's first trial of a personal carbon trading scheme, much along the lines of the “carbon card” concept discussed in UK[97] and some European countries[98]:

“Norfolk Island residents will be allocated the same number of carbon units on a credit card, which they will spend whenever they buy petrol and power. If they are frugal with non-renewable energy consumption, and walk, cycle or drive an electric car, they will be able to trade in leftover carbon credits at the carbon bank for cash at the end of a set period. Each year the quota of carbon units will be reduced, and the price of a high carbon emission lifestyle will rise.”[99]

Boya (Australia)

In Jan 2011, an initiative lead by Sam Nelson launched the Maia Maia Project[100] in western Australia. According to the project’s website and press release, a group decided to take action in carbon emissions reduction and would then issue ‘Boya’ notes denominated in kg of CO_2 equivalent on the basis of actual reductions. The Boya notes would be handed on and finally cashed in for a small discount at – to date less than a handful of – participating businesses. However, as the Boya notes are not redeemable against anything at the issuer or any other institution they represent no promise whatsoever to the bearer, and thus have no predefined monetary value. This flaw in monetary design may well be one of the reasons why the Maia Maia Project has remained marginal until today.

In a way, these concepts may be considered as a special type of energy backed currencies, as emission rights relate to the carbon actually emitted when extracting and burning fossil fuels.

What is noticeable about the single commodity approach is that, while those currencies usually refer to commodities of global importance, they do not necessarily need to be governed or implemented on a global scale.[101]

Energy may be a particular attractive option as a single commodity backing given its centrality to the economic system, as explored in chapter 2. Robert Swann, according to Douthwaite, “thinks that energy is a better way of backing for a currency than a collection of commodities because the long-run price of every product is related to the amount of human, animal, renewable and fossil energy that went into making it.”[102] The various options for the design and issue of a currency based on energy are examined in depth in the following chapter.

4. Energising money: monetising energy

"Every time we add our own labour to a product or perform a service we expend energy …. Every time we exchange money … [this] represents payment for previous energy that we expended. Money, after all, is nothing more than stored energy credits."[103]

Jeremy Rifkin

4.1 Why energy? The conceptual historical roots

Up until 1905, scientists believed that the universe was divided into two realms: the realm of energy, involving heat, light and wind; and the realm of mass, with physical objects, natural and man-made. There was thought to be no relation between the two. Then a 26-year-old Swiss patent clerk discovered that in fact the two were intimately related, indeed they were just the same thing in different forms; solid matter could explode apart and reveal hidden energy and vice versa. That clerk was Albert Einstein and he put energy at the core of his theory of relativity, with the most famous equation in physics: $e=mc^{2}$. Also known as the equation of 'energy equivalence', it essentially tells us that *everything* is energy, and matter is only a temporary 'solid' state of energy.

Energy's omnipresence makes it an attractive option for an ecologically sound and universal measure of value. Visionaries like Richard Buckminster Fuller,[104] Herman Daly and Nicholas Georgescu-Roegen have received only limited recognition for the link they made between energy and money. Ecologist Howard T. Odum took the idea further, using global energy content as an ecological and economic reference (see "Emergy" in Examples 3 below).

Odum considered the relationships between input and output of energy in complex systems. In order to obtain energy in a usable form and quality, a certain energy input is required first. For example, extracting oil from tar sands requires more than two thirds of the energy that is effectively extracted. The global availability of renewable energy may be theoretically unlimited, but when it comes to making use of it, it is in effect a 'scarce' resource. This 'relative scarcity' of use energy (or 'work') is economically even more relevant in that it forms a bottleneck for restorative and productive processes in many circumstances: salt water to freshwater, synthesis of molecules, extraction of minerals and resources and the clean-up of the environment.

If investments were made by considering not their profit in money terms (as an abstract value with no relation to planetary resources as we have discussed) but in terms of energy output, those investments with a a positive energy return on the energy invested (EROI) would be preferably ‘financed’ (see Box 2), while less energy efficient projects would be rendered less profitable.

A monetary unit that itself represents the energy dimension could determine a process of resource allocation not much different from conventional markets in terms of process, but very different concerning outcomes. If the efficient production of energy is the objective, then coupling energy production on the one hand and allocation of the means of production and investment on the other hand through an energy currency appears a logical step.[105]

How then, would we design an energy-related money? A key initial question is to identify our objective. Are we attempting to change and improve the money system in a general holistic sense, or are we seeking a transformation in energy systems via linking energy to money more concretely? Are we ‘energising money’ or ‘monetising energy’?

As we have already discussed, energy in its various forms may well be considered as a potential means to improve certain qualities of money; a more reliable store of value, a broadly accepted means of payment, or a stable and universal unit of account that can be different in different host environments. But energy-related money may also be considered as a tool intentionally designed to improve humans’ economic relation to energy and natural resources; to incentivise sustainable local development, to accelerate a transition to renewable energy, or to simply raise total renewable energy production through self-financing instruments.

Which of these objectives predominates will have an impact on the design and characteristics of energy money. In the next section we consider these various objectives and characteristics and propose a taxonomy to aid understanding of energy-related money.

4.2 A taxonomy of energy-related money

Energy-related money can be split according to two domains: its relation to energy and its relation to money. Figure 6 shows the spectrum of possible associations between money functions and different energy concepts. Money characteristics and energy characteristics are linked by two hinges in the middle of the figure. Energy-related money can either be designed as a *reference to* a certain energy type, or be *physically backed* by energy. In the latter case, the currency may also be *redeemable* against its backing or non-redeemable.

Some monetary functions are dependent on certain energy characteristics and qualities, while others are higher-level and apply for practically any type of energy – be it for a universal accounting value or for a distinct kWh unit of generated electricity.

As a result, we are faced with three important design elements when analysing or designing energy-related money:

- what energy?
- which monetary functions?
- how should these be combined?

Box 2: Energy accounting metrics

Joule

The joule (J) is the basic and common unit of energy, work and heat (the calorie being its historic predecessor and still widely used today). It is one of the universal physical units in our understanding of the natural world and for this reason often chosen as the universal basis to describe and evaluate economic phenomena. Since 1 joule roughly only equals the energy generated by the human heart in one second, the kilojoule (1000 joule) is more often chosen as the basic unit to avoid large figures. Energy can also be expressed as kilowatt-hours (kWh), meaning the energy required to deliver 1000 watts of power for one hour. 1 kWh equals 1000 watts for 3600 seconds, or 3.6 million joules / megajoule.[106]

Exergy

The joule is a unit that describes every form of energy: kinetic, potential, electrical and temperature in absolute terms, without taking into account that energy cannot be extracted and put to work equally in all its manifestations. Most of the total energy around us is not available for practical use, nor for industrial or organic processes. *Exergy* describes the share of total energy that can potentially be drawn from a source or system. In effect, exergy is the energy that is available to be used. Depending on the efficiency of harvesting this exergy, only a fraction of it can be employed to facilitate processes, be it driving engines, synthesising and transforming materials or producing other energy forms like electric currents. For this reason, today we are mostly concerned with high-gain or 'high-quality' energy sources such as fossil fuels, or strong kinetic forces such as wind, steam or hydro-power. Through the advancement of technology, more dilute resources such as sunlight have recently entered the picture.

Energy Return on Energy Invested (EROI)

To make low-gain or dilute energy resources available for consumption, a substantial input of energy is required for concentration, processing and distribution. Even with fossil fuels today, a surprising amount of energy is spent on extraction, refinement and transportation before the final product is available (e.g. diesel at the local gas station). For crude oil pumped in the US the ratio of energy returned on energy invested used to be roughly 100:1 one century ago, but is only 3:1 today and declining with the depletion of easily accessible oil fields.[107] This ratio is called the EROEI. (When the same relationship is expressed not as a ratio but as a subtraction of energy expended from energy gained, it is called the Net Energy Gain).[108] This metric proved useful to describe, for example, how in the early days of renewable energies the production of solar panels consumed more conventional energy than their total yield in solar energy throughout their operational lifespan. Through advancements in photovoltaic technology, today´s solar panels are estimated to produce 10-20 times more energy than expended during their production.[109]

Embodied Energy

Embodied energy accounts for the total energy invested or consumed throughout the whole lifecycle of a product. It serves as an assessment tool for gross energy costs but does not make reference to the different energy sources and their distinct quality and availability, as discussed above.

4.2.1 What energy?

A general distinction proposed here is between energy as a *commodity* and energy as an *accounting value.* Energy as a commodity is produced and consumed and can be allocated and traded. For energy in the form of an *accounting value,* possession and trade are irrelevant factors. What is important is that it can be measured and so there must be a socially agreed definition of a respective energy unit when using it as a value reference.

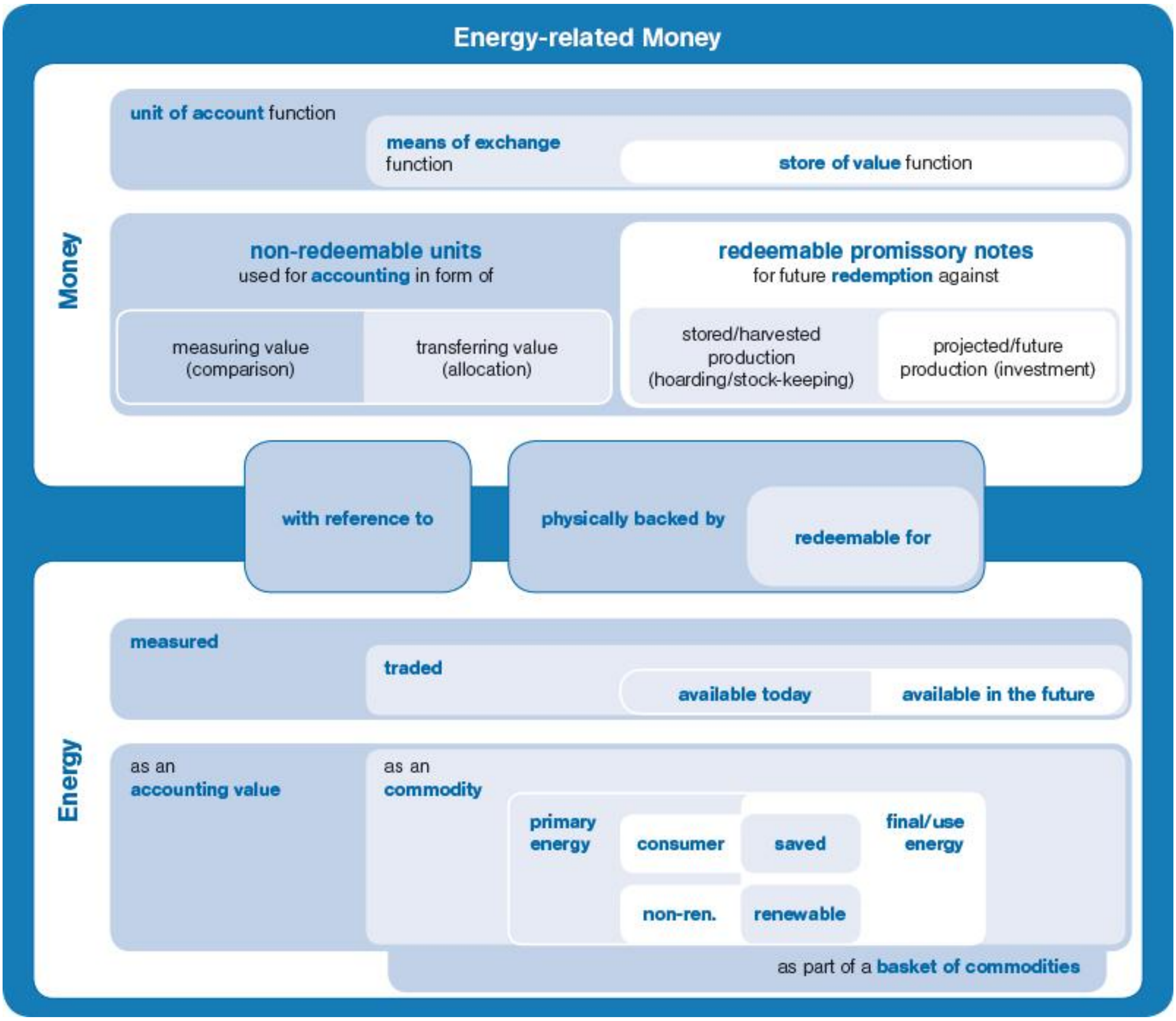
1) Energy as an accounting value

Concepts based on energy as an accounting value try to provide a framework and accounting system to evaluate products, services and whole systems from the perspective of how much energy it took to create them. The intention is to make any product, service or system comparable in absolute energy terms and independent from volatile market prices and hidden externalities.

Choosing energy as an accounting value makes intuitive sense, but to be meaningful and operational it requires a sound understanding of the systemic properties of energy and its appropriate metrics. We consider these in Box 2.

Energy as an accounting unit has proven its relevance as a value measure that helps to take environmental constraints into account for human economic activities. Any of the metrics in Box 2 can theoretically serve as the accounting value for currency designers from which other monetary functions can be developed. Just as (kilo)watt-hours or (kilo)joules are already used as the unit of account for several of the currencies presented in this report, future concepts could attempt to 'coin' any other physical standard into a means of exchange to reflect, activate and internalise the energy consequences of our economic activities.

Figure 6: Taxonomy of Energy-related Money



2) Energy as a commodity

Energy becomes a *commodity* when its distinct units can be accurately measured, located and transferred one by one, that is: when it can be possessed by either one person or by another. Or, to give a much simpler definition: if it can't be priced and purchased, it is not a commodity.

For currencies based on energy as a commodity, there are a number of questions that require addressing:

- Does the respective commodity consist of a distinct quantity of *use energy* ('work') of a certain quality (or density), in a form ready to use and finally bought by a consumer (e.g. electricity, coal), or of a *primary energy source* that requires refinement in order to be usable (e.g. crude oil, biomass, solar, wind, etc.)?
- Does the currency refer to energy that is *consumed,* or energy that is *saved* (by not consuming it)?

- Is the respective energy coming from *renewable* resources, thus continuously produced and consumed in a flow, or from the planetary stock of *non-renewable* sources?
- Is the currency actually *redeemable* for the respective energy-commodity or does it only *refer to* energy traded by third parties – or to its price?
- And, if it is redeemable: Is the energy *available now* or is it going to be *available in the future*?

The answers to these crucial questions have further implications for the design as well as for an adequate assessment of energy money.

4.2.2 Which monetary functions?

The first and basic distinction we propose here is to look at the classical functions – *unit of account*, *means of exchange* and *store of value* – that the energy money is supposed to fulfil.

A monetary unit can enable comparison and evaluation, accounting and pricing without acting as a means of exchange or store of value. To become a means of exchange it must be able to be allocated from A to B, from one holder to another. If the units cannot be transferred, payment cannot be made and debts cannot be settled. A currency's operability as an accounting unit and a means of exchange does not require it to have a store of value function. But in order for a currency to act as a store of value it must possess the other two functions – if it does not, it may still be a store of value but not a currency.

For these reasons the three functions are shown in the taxonomy in a dependent hierarchy; the store of value function and the means of exchange function of a currency both depend on the unit of account function. A currency's means of exchange function can be supported in one way or the other by the currency's store of value function (with the functional tension laid out earlier) but could also manage without it.

To help hold this distinction in mind, we will refer to money systems that go beyond the sole accounting function as energy 'c*urrencies*'. In order to be feasible as a currency, according to the definitions and distinctions laid out in this paper, the following criteria must be fulfilled:

- The currency must fulfil more than just the unit of account function.
- It must provide distinct standard units, and the related energy must be of a uniform quality, in order to allow for quantifying the currency's nominal/face value.
- The currency units must be small enough in terms of their denomination and purchasing value, otherwise calculation and payment of small or distinct prices would be impossible.
- A policy must be defined as to how a currency is issued into the economy and withdrawn.

4.2.3 Possible combinations – what works and what not?

There are many combinations that link the two functional domains of energy and money, but not all combinations have been considered in theory and practice as yet, and some don't seem to be viable.

Energy money does not need to meet all monetary functions to be of use. An energy money may be pegged to and even denominated in kWh but nonetheless not be redeemable for the energy it relates to, as for example, the Japanese WAT currency (see Box 4). Conversely, a redeemable voucher may be backed by the electricity generated in a photovoltaic power plant, but not necessarily be denominated in kWh. For example, businesses in the Austrian region Waldviertel have issued redeemable vouchers in exchange for and denominated in Euro to finance solar energy production, which were not redeemable for energy but only for goods and services sold by the issuing business (see 'solar shares' in Box 6).

Furthermore, energy in whatever form can theoretically act as a reference to compare goods and services without allowing the same accounting units to be credited to anybody or used as a means of payment.[112] And, conversely, in order to function as a means of exchange, an energy currency does not need to be physically backed by energy. A mere *reference* to energy – or even a reference to its price – may be sufficient. However, only if the respective unit of energy allows for accounting, that is, quantifying the total and subdividing it into small distinct units, many people subsequently agree upon using the units as a means of exchange, for payment and for settlement of debts. If the currency needs to provide the store of value function as well (to convince people of its value, as is often required by non-legal-tender currencies), only those units will work whose value is defined by energy in the form of a commodity.

Moreover, it is possible to add energy as a *commodity* to a commodity basket, and use this basket as a reference or backing for a currency (see section 3.4 above). But it would be futile to include energy in the form of an accounting value into any basket – as futile as trying to add, for example, light and temperature into the same basket.

A number of selected proposals and practical projects are described briefly in boxes below, with no claim to be complete. We begin with non-redeemable units and then move on to redeemable units or promissory notes.

1) Non-redeemable units

The tie between the two domains, money and energy, could be strong or weak according to design preference. Energy money may provide a link to energy without being redeemable for energy, as for example is the case with 'Emergy' (see Example 3 below). Such concepts can be distinguished according to whether they are actually *backed by* or rather *pegged to* (referenced to) the respective energy type. As described for basket-based currencies, the crucial distinction is if the commodity – in this case energy (or an entitlement to it) – is actually held in the basket by the issuer of the currency or not.

Examples 3: Emergy

Elaborating on ecologist H. T. Odum's work on *energy quality*,[113] the term 'emergy' was coined in 1986 as the common denominator for energy inputs and flows from various primary sources. The unit "emjoule" (Emergy Joule) accounts for the standardised energetic value of products, processes and entire systems in reference to a chosen primary energy base. The most commonly used base today is the solar equivalent joule (seJ, also referred to as solar emjoule). This expresses how much energy would need to be harvested for the provision or production of a good, service or system if sunlight was the only available energy source. In this way different sources of energy are normalized to their energy quality and production inputs are made universally comparable. This scaling is particularly useful when considering the gradual depletion of standard energy sources and sunlight as the primary and sustainable energy supply of the whole biosphere. Other, less often used bases to scale emergy include biomass, fossil-fuels overall, or coal alone.[114]

Emergy accounting has been applied successfully for the evaluation and developmental strategies of such diverse systems as: the state of West Virginia,[115] an eco-village in Sicily,[116] or ecosystems and industrial installations, with the aim to evaluate their overall environmental impact, the dynamics of their internal resource-flows, their sustainability strategies or their total inclusive energy usage.[117]

(i) Non-redeemable units with an energy reference value

The role of energy could be simply to define a currency's value relative to something that was considered universally comparable. The binding is no more than a social agreement to use something as a value reference or *standard* (i.e. by fixing an artificial exchange rate between the currency and its referential counterpart) and could just as well be replaced by any other reference at any time.

Greco classifies the various value standards that have been proposed as follows:

> *"1. a currency standard (an existing currency unit, like the U.S. dollar or the U.K. pound sterling);*
> *2. a commodity standard (a specified weight of some commodity, like silver or gold);*
> *3. an energy standard (a specified amount of energy, such as a kilowatt-hour of electricity);*
> *4. a labour standard (a statistical unit of labour productivity);*
> *5. an index standard (a composite group – 'market basket' – of basic commodities)."*[118]

The reference value of a currency can also be established in the form of a reference to an energy *price*, with the consequence that changes in the valuation of energy relative to all other goods would affect the value of the energy related currency. If and under what circumstances a fixed energy-price relation could be reasonable is ultimately a matter of design.

(ii) Non-redeemable (but still commodity-linked) energy currencies

It is quite possible to envisage a new value standard for a currency linked to energy but not redeemable for energy. Indeed many thinkers, including Lietaer, Douthwaite and Greco, have argued that currencies have never really served well as a value measure and means of exchange/payment and that it is not necessary for a currency to fulfil both functions at the same time.[119]

A proponent of currency competition,[120] Greco argues that payment/settlement of debts could be fulfilled in any currency (legal tender, complementary currencies, or private enterprise money) as long as the parties involved were able to reference both the price of the exchanged good as well as the price of the currency to an agreeable and reliable universal value standard. Commodities, if frequently traded, might demonstrate a stable, reliable average price which reflects on their value and could thus be used as a reference for the valuation and pricing of everything else:

> *"[U]sing a silver or gold unit of account does not mean that payment must be made in silver or gold, or that paper notes and ledger credits should be redeemable for silver or gold. Neither would a 'market basket' unit need to be backed up by commodities held for redemption. It just means that I owe you one hundred dollars worth of something, and that worth is determined by the current value of silver relative to all other goods and services and currencies that might be used as payment. We need not revert to commodity money or symbolic (redeemable) money as a means of payment in order to have an honest money system."*[121]

The emergence of high frequency trading and multiple derivatives leveraging spreads between anticipated rate differences on commodities rather undermines Greco's approach. Commodity values, including energy, appear highly volatile in today's globalised economy.

Such an approach may be more valid at a local or regional level if the currency users themselves have a hold on the commodity and the market where it is traded, as is the case with the Japanese WAT currency proposal. The WAT, although issued by its users on a peer-to-peer basis, is pegged to a locally produced and consumed energy source.

2) Redeemable units (promissory notes)

The store of value function of an energy currency (as of any other backed currency) is achieved best by one special currency feature: its *redeemability*. If a currency is irredeemable, you never know what (and how much) you will be able to buy with it in the future, as nominal prices may rise or fluctuate. If it is redeemable, you know precisely and reliably what real values you are entitled to receive, today or in the future. In this sense, a redeemable commodity currency is a hedge against future inflation of that particular commodity.

Certainly, any means of payment must fairly provide for the storing of value – at least over a certain period of time – otherwise it couldn't be used to pay later. Thus, while a non-redeemable energy currency may be good enough to measure and – possibly – to transfer value, a redeemable energy currency may be better for the purpose of storing value (saving).

Saving can take two different forms, reflected by redeemable energy currencies: saving as *hoarding*, and saving as *investment*.

Examples 4: WAT (Japan)

Eiicho Morino, head of the Gesell Society in Japan, developed the WAT project, which launched in 2000. Analogous to the Wära, the WAT is issued as a bill of exchange, a paper IOU widely used by businesses in Japan. The Wat is redeemable at the issuer against a predefined amount of work. Six minutes of easy work is valued 1 WAT. At the same time the WAT currency is pegged to renewable electricity: 1 WAT is referenced to – but not redeemable against – 1 kWh of 'clean' electricity produced in a citizen-owned power plant, representing approximately 75-100 yen.[122]

(i) Saving as hoarding (debit principle)

Prepaid mobile phone units sold on plastic cards are now widely available. Energy backed currencies, in their simplest form, are essentially the same. With an energy currency redeemable against energy readily produced and available today, be it physically stored or generated on demand, the currency is nothing else than an energy token or a redeemable energy unit on a *debit* card.

In some countries energy utilities have already introduced prepaid electricity cards for private households simply to save effort with customers' repeated shortfalls in payment, e.g. in South Africa or in the state of Arizona (USA).[123] Those prepaid energy units would become a currency as soon as they get used as a means of payment between clients, that is, be transferred to third parties. This is already done with mobile phone units. In some African countries, starting in Kenya, safaricom's mobile phone currency and banking product m-Pesa[124] is used for most financial transactions.

Prepaid energy units would be the simplest example of an energy backed currency. Three examples are illustrated below (see Examples 5).

Individuals who participate in these debit currencies may do so purely for convenience, but they are effectively securing themselves against future inflation of energy prices. The objective of the schemes must be seen more in terms of fixing dysfunctions on the monetary side rather than reforming the ecological, or energy supply side of the economy. In terms of economics, this kind of saving might be described as 'hoarding' rather than 'investment'.

Examples 5: ‘debit’ based energy currency concepts

CHARCOAL (Osaka, JP)

The redeemable voucher approach is certainly not limited to electricity but can be used with any other energy type (or commodity) to be allocated from a vendor to a buyer. For example, a complementary currency named CHARCOAL (and also based on charcoal) has been issued in Osaka, Japan. One unit equals 1 gram of charcoal. According to Lietaer, “Charcoal is a widely produced and used product in the area, and as the currency is redeemable in this good, its acceptance is spreading easily.”[125]

Kilowatt Cards (Robert Hahl, Falls Church, VA)

Robert Hahl has developed a voucher scheme called Kilowatt Cards. Based on the idea that price and value are not equivalent, and often misinterpreted, Robert Hahl’s concept[126] offers a platform where Kilowatt Cards – vouchers denominated in 10 kWh of electricity – can be purchased online from the Kilowatt-Hour Card Corporation – located in Falls Church, Virginia – and redeemed to pay electricity bills “in any residential utility account, anywhere in the world.” Whilst the customer pays for consumed electricity by redeeming his vouchers, the Kilowatt-Hour Card Corporation would send the required payments to the utilities at their respective electricity rate in the national currency. The Kilowatt Cards scheme is thus effectively an international clearing framework for electricity.

RECS

RECS stands for Renewable Energy Certification System. A renewable energy producer, for example a hydro turbine, registers at RECS and then receives a certificate for each MWh of electricity that is (expected to be) produced in a certain time period. The certificate is mirrored in a database and can be traded. When a supplier purchases a certificate and sells the related amount of electricity to consumers, the certificate is charged off in the database. RECS certificates thus realise monetary purposes and commensurate to the primary notes in Shann Turnbull’s Renewable Energy Dollar Concept (see below), but neither have been utilized in that function as yet.[127]

(ii) Saving as investment (credit principle)

A redeemable energy currency, especially if used to provide for future production, can offer more than just stabilising the value of money. It can be designed as an investment tool as well. In that case one of the key objectives could be to promote and accelerate a renewable energy transition.

Energy tokens can serve to *pre-finance* the investment required to produce the promised energy in the first place, if issued *in advance* and spent into circulation for building the power plant. The more time is allowed between issue and redemption, the more potent is the currency's credit function. The energy token thereby changes from a debit to a *credit* type, from a promise for energy produced and available today to a promise for future projected energy.

A simple and early example of this principle of 'self-financing' currency systems was discovered in Eugene, Oregon by presenters of the second E.F. Schumacher seminar in 1983. Shann Turnbull explained the principle of creating self-financing currency to two female attendees who missed his lecture as they were preparing meals to be allowed to attend the six day seminar. The cooks were not impressed. They had already put theory into practice as working members of Zoo Zoo's natural food resturant. Zoo Zoo's (prison slang for 'treats') had been nearly closed down two years earlier as their location did not meet health standards. No bank finance was available to fund the move to more suitable premises by the politically radical all gay female workers collective, so Zoo Zoo's issued vouchers entitling the bearer to ten dollars worth of future food and drink after the restaurant had relocated. They were sold to customers and the general public at $9 each and became valid for redemption on a staggered basis months later.[128] Enough money was raised to enable the restaurant to relocate and the notes, although not intended as a currency, were to a limited extent circulated as one. A similar approach was taken by a delicatessen in Great Barrington, Massachusetts, six years later, issuing 'Deli Dollars' to pre-fund their deli.[129]

In 1977, well before the emergence of Zoo Zoo's vouchers, Turnbull had suggested in an opinion article in *The Australian,* a national newspaper, that money be backed by kilowatt hours.[130] Bob Swann, who had worked with Borsodi in setting up the Constants in Exeter, took up the idea as President of the E.F. Schumacher Society based in Great Barrington, Massachusetts. The chairman of the society in 1983 was John McClaughry who was also a Senior Domestic policy advisor to US President Reagan. These connections allowed the Society to obtain permission to plan the issue of energy notes from the comptroller of the US currency and the US Secret Service, whose primary objective is to protect the nation's financial infrastructure.[131]. 'World citizen' Gary Davis then printed up some notes as featured on the cover of this report. Swann and Turnbull in their book '*Building Sustainable Communities'* advanced the idea of promissory energy notes to fund 'community energy banks' (see Examples 6 and 7). Although the energy notes model was never put in to practise, Swann was involved with the setting up of Deli Dollars and the Berkshire Farm Preserve note, both of which shared the 'sale-of-product-in-advance' feature.[132] Paul Glover heard of these projects when he attended the third E.F.Schumacher seminar, which inspired him to establish Ithaca Hours, a currency that is still circulating today.[133]

Examples 6: 'credit' based energy currency concepts

Energy Notes (R. Swann)

Robert Swann, one of the intellectual leaders of the E.F. Schumacher Society, proposed an autonomous approach to community banking, whereby a community-based organisation – ideally, a community-electricity cooperative – would produce energy and at the same time issue kilowatt-hour promissory notes ('energy notes') for future delivery of electricity. The notes would be sold at the current electricity rate to consumers and/or investors who would obtain without cost a pro-rata equity share in the cooperative. In this way the cooperative would raise the funds to purchase the wind turbines, whose ouput was then sold to the grid. Sales revenues were expected to pay for the turbines and their operations in less than ten years. As the turbines had an expected life for over twice this period, cooperative members would not only enjoy fixed prices for power during the payback period, but would also then obtain power at almost no cost for the remaining lifespan of the turbines[134] Ideally the local power distributor would accept the pre-payment notes in payment for bills of its customers.[135]

Sonnenscheine (K. Vosshenrich, Steyerberg, D) and REGIOenergie (L. Schuster/K. Vosshenrich)

In Steyerberg, a village next to Hannover, the urban planner Kay Vosshenrich projected another currency on the basis of energy vouchers, anchored to the electricity production of a solar power plant in the hands of a local cooperative. The idea goes back to the 'REGIOenergie' concept, a proposal for a regional complementary currency backed by renewable energy, first published by Schuster/Vosshenrich in 2005.[136] The cooperative would receive an income in national currency from the feed-in-tariff, while members' investments would be repaid not in Euro but directly in 'Sonnenschein' – ('sunray') vouchers redeemable against effectively produced kilowatt hours (and denominated in kWh). The 'Sonnenschein' currency would thus be spent into circulation by the shareholders of the cooperative and circulate locally among (mostly) residents until eventually used to pay an electricity bill. As in the case of the Kilowatt Cards (see Examples 5), again here the cooperative would play the role of a clearing institution to cash in the vouchers, mediating between member-investors (producers), consumers and the local grid operator.[137] Although the cooperative has successfully been set up and investments have been made in solar power generation, the 'Sonnenschein' currency has never been implemented.

Eco-regional business partnership (R. Grandits)

Rudo Grandits, who had already been involved in the 'Waldviertler' local currency project, recently prepared a concept for an 'eco-regional business partnership' for the 'bio-energy-region' Güssing. The proposal combines an investment pool for local renewable energy production with an anchored local currency. The currency's value (while denominated in Euro) would be secured by newly installed energy productive assets.[138] Intended as a tool to finance the energy transition, the pool would be used to hand out microloans at zero interest to SMEs at the start, to be invested in small renewable energy projects. As soon as the pool has enough resources to make major investments in power generation, it would be provided that electricity could also be paid for directly in the currency. The scheme is meant to help achieve local energy autonomy and at the same time foster local demand - and thus a more sustainable local economy.

'Solar shares' based on a shopping voucher (Waldviertler / Wegwartehof / Sonnentor)

Heini Staudinger, creative owner of Waldviertler shoe manufacturing and retailing company, has managed to establish the Euro-backed Waldviertler currency[139] in the Austrian region of Waldviertel – a rural region facing serious economic problems. In addition, he has successfully implemented a simple voucher based investment scheme for renewable energy production.[140] Clients can invest in solar energy through buying vouchers, as in the examples above. However, in this model they won't become shareholders – the investment is only a grant to the company. What is more, vouchers are redeemable not against energy but against all products offered by the company (shoes, textiles, furniture and more). The receipts in national currency are invested in photovoltaic panels, installed on a roof at the manufacturer's production site. The harvested electricity is fed into the local power grid and recompensed through guaranteed national feed-in-tariffs. The lender receives a respectable (nominal) return, or bonus. For a grant of 200 Euro, vouchers at a value of 330 Euro are paid back, eleven vouchers at 30 Euro handed over annually for 10 years (the first one instantly) and only redeemable in the company's shops. That way, Heini Staudinger has to date raised more than €1 million and invested in solar power, and at the same time tied even more spending power to his company. The scheme has been applied by neighbouring companies – such as the herbal producers Sonnentor[141] and Wegwartehof[142], the latter partly investing in solar heat for drying herbs – but also copied by organic farmers in Germany.[143]

Kiwah[144]

The Kiwah model, developed by Edgar Kampers and Rob van Hilten of the Community Currency foundation QOIN,[145] builds on Swann's energy notes concept by adding green behavioural incentives and a green 'loyalty' program. National money is invested in renewable energy that delivers the kilowatt hours that are the backing of the Kiwah. Participants receive Kiwah in return on a weekly or monthly basis but can also receive Kiwah if they shop in participating sustainable businesses as a bonus. Kiwah can also be spent with others in an online Kiwah community, including vetted producers of energy-saving and sustainable products. Ultimately the idea would be able to use Kiwah to pay for energy directly from energy suppliers.

Wära (historic example)

The Wära currency was an emergency currency issued and organized by companies in several German city regions during the recession around the 1930's. When a coal mine was closed in the small municipality of Schwanenkirchen, 60 coal miners (of 500 inhabitants) lost their jobs and the local economy broke down completely. Max Hebecker, a mining engineer and former employee, purchased the mine in an auction. When he wanted to resume production and banks refused to finance the investment, the Wära-Society jumped in with a loan of 50,000, partly in Reichsmark but mainly in Wära. Miners were employed and paid 80% in Wära (i.e. bills of exchange), which were soon accepted by many businesses and craftsmen in Schwanenkirchen and the surrounding region. As the Wära-part of the loan was credit created for mining coal, and repaid by the mining company by selling coal against Wära, the respective Wära amount was effectively a coal backed, credit type energy currency.[146]

Most of the successfully implemented 'energy credit' projects are simple in terms of ownership and decision-making as they are run by existing, often centrally managed businesses, but share considerable complexity regarding the clearing of their currency: vouchers are denominated not in kWh but in the national currency and (usually) cannot be spent directly for the produced energy (in contrast to e.g. the food backed Mendo's credits).

In all these examples – apart from the Wära currency – the investment function is provided through a pre-sale of promissory notes against existing legal tender. The notes are not backed by reserves in national currency, however. Rather, the production and installation of new generating capacities is paid in promissory notes backed by future production. The productive assets are thus bought on credit. They are purchased today based on the expectation to be able to pay back in energy production later.

As we saw in Chapter 3, however, modern banking involves the creation of brand new credit to fund activity which does not require the existence of savings in legal tender. To achieve a rapid and global transition to a low-carbon economy, it would appear necessary to leverage the power of credit creation by banks or central banks for massive investment in renewable energy production or energy efficiency. The concept of 'Green Quantitative Easing (QE)' to fund such a transition and create jobs and sustainable prosperity has been gaining some ground in policy circles.[147] One of the big fears with QE is inflation. But if QE money was issued in return for some of kind of energy promissory note, which could later be redeemed for power, this might be a way of controlling inflation and inflation expectations. The quantity of QE money would have to relate strictly to future productive capacity. Issued that way, energy currencies could be seen as credit easing anchored to real world production. The Wära case study is an example of such a model on a local level.[148]

(iii) Energy savings currencies

Energy savings, too, could form the anchor of an energy currency. Energy savings currency proposals, or projects, usually relate to the amount of energy saved against a predefined baseline of consumption. Therefore, the amount of money issued remains small and would never be sufficient to provide the total of liquidity required for transactions in an economy. This may be one of the reasons why energy savings currencies are normally designed as incentive units, the units being given a higher value artificially and intentionally to promote energy savings and efficiency.

From a standpoint of currency design, these schemes basically provide a store of value function. If energy savings units are used to purchase certain energy savings related products which would help to save even more energy – and thus, purchasing power – in the future, saving would take place in the form of an investment. Equally, units generated by today's savings could also be saved for future consumption of the respective energy amount – when energy rates may already have gone up. This would correspond more closely to the savings as hoarding picture.

At the *Université libre de Bruxelles*, a research and development programme has been set up to find and assess possible currency based incentive solutions to enhance energy savings, in combination with smart metering (SM) and demand side management (DMS) technology. The INESPO programme involves accounting and monetising of electricity as well as value propositions based on projected Carbon Emissions Reduction ('white certificates'). The project is run at the Centre for Economic and Social Studies on the Environment (CEESE).[149]

It is worth mentioning that there seems to be no intentional *credit type* currency for energy savings and energy efficiency as yet.

(iv) More complex energy currencies

The store of value strength of the redeemable models described above is also potentially their weakness in terms of the medium of exchange function. Knowing their currency unit is effectively inflation proof, people might prefer to hold their vouchers as long as possible, instead of spending them.

One way to overcome this tension is to integrate the vouchers into a more complex monetary framework, which also stimulates spending. In his 'Renewable Energy Dollar' concept,[150] Turnbull proposes that a bank should mediate between the competing currency functions by holding the vouchers as a *reserve* and issuing a second currency into circulation which would be used as a means of payment – but wouldn't suit as a store of value, as it could not be redeemed for anything.

Examples 7: More complex energy currency concepts

Renewable Energy Dollar (S. Turnbull)151

Arguing that production costs will be relatively stable and comparable on an international scale, Turnbull suggests a community currency based on the value of locally produced renewable electricity. The 'Renewable Energy Dollar' would be built on a two-level architecture: energy producers would continuously issue dated promissory notes in strict relation to their future energy production. Held by a 'local energy bank' as a backing asset or reserve ('primary notes') these certificates would allow the bank to issue undated Renewable Energy Dollars (‘secondary notes’), which would be used in everyday life, for transactions and settlement of debts as well as for payment of bills and local taxes.

Ebcu (R. Douthwaite)[152]

The ebcu (energy backed currency unit) is a *fossil* energy backed currency and one of two currencies in a complex ecological allocation framework, the other part being special emission rights (SER) for carbon dioxide equivalents. According to Richard Douthwaite’s proposal, both SERs and ebcus would be issued by the International Monetary Fund (IMF) and allocated to national governments on a per capita basis, their quantity continuously decreasing. While SERs would be issued annually, ebcus would be issued only once. “If a government actually used ebcus to buy additional SERs from the IMF in order to be able to buy more fossil energy, the number of ebcus in circulation internationally would not be increased to make up for the loss. Instead, the ebcus paid over would simply be cancelled and the world would have to manage with fewer ebcus in circulation. In other words, the IMF's obligation to supply additional SERs would be strictly limited by the amount of ebcus it put into circulation.” If needed, countries could buy additional SERs against ebcu, as well as buy and sell ebcus from other nations; thereby exchange rates between ebcus and national currencies would emerge.

A reduction of ebcus in circulation would result in rising ebcu energy prices (i.e. not much different from a taxation of fossil energies), which would “cut the level of economic activity in the country and thus its level of energy use. In other words, national economies could only expand at the rate they became more fossil-energy efficient, which is just what we want.” In contrast to a tax based policy, the interdependencies between the currencies would provide for an automatic feedback and a self-adjustment of the relative quantities, values and exchange rates, with the effect that the currency itself would give a nation the respective market signal to switch to the path of a low-carbon economy: As the ebcu would be used for foreign trades, a relatively weak national currency, would trigger and support a more efficient use and import substitution of fossil energy, while along this path the national currency would be revalued again.[153] Douthwaite’s hope was that, “[u]nder this system, countries would control their economies by adjusting the energy supply rather than the credit supply as they do today.”

Petro unit and International Energy Clearing Union (C. Cook)

Chris Cook calls for a paradigm shift towards “Banking on Energy (Rather than Currency or Gold)”[154] which would in effect mean to “price dollars in oil, not oil in dollars.”[155] To achieve this, he proposes to establish an International Energy Clearing Union’, and an energy standard based on a nation’s reserves, to which a new trade currency would be referenced but could not be redeemed.[156] In this framework, “credit is granted bilaterally and interest-free, and the only costs to the system user are the administration/accounting costs and a share of any defaults. Furthermore, there is no reason why transactions in a 'Clearing Union' need be settled in central bank-issued money, since users may quite simply agree that they will accept 'money's worth' in (say) energy or commodities instead by reference to a value unit." One of Cook's examples to apply this framework is the unitisation and clearing of natural gas, which would refinance the massive loans which financed the gas infrastructure interest-free "simply by selling Units redeemable in natural gas to major consumers such as China, who thereby both lock in a price, and may found a new global energy based reserve currency."

Human and Resource Economic System (Forty Foundation)[157]

The Forty Foundation's[158] Human and Resource Economic System would involve the use of three separate currencies for different purposes. Within a single country there are three major different types of activities – consumption, production and international trade – for which money is needed. The currency for consumption is called the 'Life Unit', which is backed by water and used only for the acquisition of consumable goods and labour. The currency for production is called the 'Eco Unit'[159] which is backed by energy and used for production purposes such as acquisition of raw materials, different machines and equipment, or other production needs different from labour. The currency for international trade is called the 'World Wide Currency Unit' which itself represents a conversion coefficient to compare the prices of energy currencies of different countries that is based on the following:

- the country's share in the global amount of greenhouse gas emissions;
- the share in the global amount of water spent for production;
- the share in the global amount of consumed energy (the value of the currency is reduced by the percent of the share);
- the coefficient of each average unit of energy consumed divided by the average amount of energy spent for its production according to the embodied energy input-output calculations (the value of the currency is multiplied by the coefficient).

By separating out these different functions at different scales, the aim is to "bring more sustainability to the whole financial system and more importantly, will partly secure regular consumers from financial misbalances and speculative activities on the international currency market."

Both the Renewable Energy Dollar (RED) and the ebcu concepts are based on a dual-currency architecture, but work on very different scales. As renewable energies can be 'harvested' locally and are subject to natural diseconomies of scale as significant quantities of energy are lost in transportation, Turnbull's RED concept logically leads to a decentralisation of the monetary architecture.

In contrast, Douthwaite's ebcu focuses on the reduction of the negative impacts of fossil energy depletion and demands a currency framework dependent on highly centralised policy making. The basic principle is to anchor the monetary base to two different limited capacities of the planet: stored fossil energy, and the capacity of the atmosphere to act as a dump for greenhouse gases. This is reflected in the design of the currency and its management: both SER and ebcu need to be managed centrally due to the necessary global policy agreement; and both need to consider a rising currency value over time due to the wanted reduction in the related asset.

The ebcu proposal contains some inconsistencies. For example, the quantity of ebcus put into circulation – only once and forever – is continuously reduced, but at the same time people are expected to voluntarily exchange their national currency earnings in ebcu for payment of imports. Doubts arise if the ebcu could work as a foreign trade currency at all, given that its value will likely increase through the reduced quantity in circulation. There could be an inherent conflict between the means of exchange function and the store of value function.

Turnbull's Energy Dollars approach seems more pragmatic. Here, the energy producer in effect issues a store of value currency which allows an 'energy bank' to issue its own exchange currency. But such a bank could also create interest-free loans on a fiat basis to finance the productive capacities in the first place, as outlined in the non-redeemable credit models above.

In addition, the same dual currency architecture – redeemable, dated primary notes issued by producers, and non-redeemable, undated secondary notes issued by a bank on that basis – could also work for different producers with a multitude of products and services, a possible extension of the concept which Turnbull already mentioned briefly in his first writings on the Renewable Energy Dollar.[160]

Although the RED was envisaged by Turnbull as a scheme to promote decentralisation and support local renewable energy projects, he believed that "[K]ilowatt hours of electricity could provide a universal reference unit of value between communities of the world and within communities."[161]

By applying our taxonomy we can specify this further. It is the primary notes which represent the store of value function and act as a commodity backing for the kilowatt dollar notes, while only the secondary notes provide a medium of exchange. Thus, while the primary notes represent a value reference for the secondary notes, there is no simple answer to the question if one or both could also provide a universal reference unit of value. Difficulties arise regarding the local availability and generation cost of different energy sources as well as the energy quality – which might be less equal than it first seems. Electricity can be provided with different voltage, with alternating (AC) or direct current (DC), and especially if generated from renewable energy sources can additionally show huge price differences due to daytime peaks in production or demand. To handle this, a clearing framework like Robert Hahl's Kilowatt Cards could help (see above), in combination with a networked real time supply and demand side management technology.[162]

Cook's 'Petro unit', at a closer look, merges Turnbull's and Hahl's ideas on a macro level. The Petro Unit also describes a dual currency architecture consisting of, first, a token redeemable for oil (like the primary unit in Turnbull's model); and second, a non-redeemable unit (the secondary note), which he calls "'money's worth' in (say) energy or commodities", which is only referenced to the former. The relation between both is managed by an International Energy Clearing Union (IECU) providing the function of Turnbull's 'energy bank' (to manage value relations between primary and secondary notes) as well as the global clearing function between different primary note issuers, as is crucial in Hahl's concept.

4.3 Summary: Energy's place in the ecology of money

The challenges detailed above remind us that it is important not to oversell the potential of energy money, particularly given that complementary currency movements have been critiqued in the past for being unable to live up to their claims.[163] Given the still hypothetical or early stage of development of many of the models described here, perhaps the best way forward is to promote further innovation across multiple approaches rather than lumping all our eggs, to mix metaphors, in one currency basket. As North has argued:

> *"We need to build resilient communities in preparation for the inevitable energy descent, and to facilitate the major cuts in carbon emissions necessary to avoid dangerous climate change. A vibrant diversity of alternative currencies is more likely to protect us than a reliance on a single monetary monoculture that may fail. This means we need to keep innovating with alternative currencies until we develop more resilient models that do work better than the early experiments we have today, which are perhaps mere glimpses of what could be."*[164]

In contrast to our current monopolistic monoculture of money creation, energy money could shape part of what North calls an "ecosystem of currencies" or what Douthwaite described as an "ecology of money" which would consist of at least four different types of currencies:

> *"One is an international currency, playing the role taken by gold before the collapse of the gold exchange standard. The second is a national or regional (sub-national) currency that would relate to the international currency in some way. Thirdly, we would need a plethora of currencies which (…) could be created at will by their users to mobilise resources left untapped by national or regional systems. Many of these user currencies would confine their activities to particular geographic areas, but some would link non-spatially-based communities of interest. And fourth, as our current money's store of value function can so easily conflict with its use as a means of exchange, special currencies are needed for people wishing to see their savings hold their value while still keeping them in a fairly liquid form. (...) In addition to the four types of money we have mentioned, there would be a need for short-life currencies to fund particular projects."*[165]

Based on the typology developed in this report a closer examination of Douthwaite's global landscape of currencies can be undertaken, with particular reference to energy money.

The *international* currency is intended to provide a reliable universal value measure, as was once supposed to be provided by a known aggregate of gold, physically stored. To replace this function with an energy currency, the related energy would need to have a similar character: a well-known aggregate of physically stored energy in a uniform quality. Douthwaite's ebcu proposal (Examples 7) corresponds to this particular function.

National/regional/sub-national currencies would be issued as a means of payment without the need to be related to energy, as they would already be tied to the universal, international value units by taking them as a reference or, if the international currency relates to a commodity form of energy, by holding them as a reserve as during the Bretton Woods period with gold.

Among the variety of *user currencies*, which are issued in a given community (not necessarily geographical), the self-financing energy currencies, such as Turnbull's Renewable Energy Dollar would be obvious choices, as well as VEN type models (see Examples 7 and 1). Similarly, credit type models could be used for Douthwaite's fifth, additional *short life currencies*.

Relating to the *savings* aspect, which could as well be seen as a subcategory of the user currencies, the fourth currency category would clearly be represented by redeemable (energy) voucher currencies or *debit* currencies.

What this brief summary indicates is one of the core messages of this report – that the energy money reflects an emerging field of diverse theory and practice. Many of the concepts and proposals have barely been tested yet, but there are enough encouraging signs to suggest that, with the right kind of support, some of these ideas and initiatives may be able to contribute to a more sustainable future.

5. Design and implementation of energy money

“All who are really dedicated to the earliest possible attainment of economic and physical success for all humanity – and thereby realistitically to eliminate war – will have to shift their efforts from the political arena to participate in the design revolution”[166]

Richard Buckminster-Fuller

This section builds on the taxonomy and case studies, along with wider literature on the currency field, to explore some key implications for their design and implementation. These have been grouped under three headings relating to currency: *functionality*, *value*, and *governance*.

5.1 Designing and managing monetary functions

In section 3.2 it was argued that one problem with the modern monetary system is the inherent tension between the store of value and medium of exchange functions. This report suggests that at a macro-system level energy monies might help to ameliorate this tension by fulfilling some monetary functions and not others.

A useful example is the ‘Wörgler Sonnenscheine’ project (Box 6 in chapter 4).[167] Clients of the municipal energy supplier can invest up to eight times 900 Euro into a renewable electricity generating plant with a predefined capacity and receive Wörgler Sonnenscheine (i.e. certificates for pre-paid electricity) at a face value of 900 Euro. In contrast to the investment type voucher currencies mentioned above, the annual production is being directly accounted against the annual consumption over a period of 20 years in this case. While the currency clearly performs the store of value function and the accounting function, it does not fulfil the means of exchange function. Although generated kWh units are used to settle the supplier’s debt, a transfer of the certificates to third parties – which would render them into a means of payment or exchange – is not intended by the issuer, and also quite improbable due to their high face value.

Despite this example, it seems probable that currency designers will usually face tensions between different functions. One important insight of this report – and one that is somewhat counterintuitive – is that the primary purpose of energy money may not itself be monetary. For our credit based energy currency models (Examples 6) in chapter 4 – the energy notes, solar shares and Kiwah, the Sonnenscheine in Steyerberg as well as their (rather different) namesake in Wörgl, the primary function is to provide investment in renewables. Thus, whilst this necessitates that they fulfil a monetary function (in this case store of value) the ultimate purpose of the currency was not to reform money, but to reform energy. In other cases – such as the global reference currencies – the provision of a new form of money is the ultimate purpose of the proposed system.

This implies that currency designers need to reflect on aims and functions of any energy money system and how these interrelate. This can be further complicated by the fact that, in many cases, complementary currency systems can fulfil different functions for different user groups. Indeed, it has been argued that successful currency implementation necessitates the active management of different functions.[168] The most successful systems may be those that manage to fulfil a range of functions for a range of different user groups such as the German Regiogeld currencies.[169] Furthermore, the field of complementary currencies also demonstrates a considerable degree of user innovation and 'forking' where new forms of system evolve from antecedents.[170] There is no reason to believe that similar factors are not relevant within the field of energy money and will need to be considered by system designers.

5.2 The golden rule of a stable value relation

If we accept that value is a social construction and money only a medium, money's value is contingent on the value it is believed to represent. It is the issuer's responsibility to ensure people hold trust in their money. It is especially important in regard to energy money (and other anchored currencies, in contrast to 'fiat' legal tender currencies) that the relation between the medium (currency) and its counterpart or backing (energy) must be objective. Any currency unit (or aggregate of currency units) must refer one-to-one to a definite energy unit (or aggregate of energy units) in a certain time and vice versa in order to avoid double counting, and for the currency to work as a reliable reference value.

While the one-to-one equivalence between money and 'money's worth' is blurred with monopoly fiat money because a note can only be redeemed for another note of the same money and nothing else, the trust relation is obvious when money is tied back to something real. A promissory note redeemable against electricity at a certain date will be accepted as a means of payment at a certain value only as long as the promised electricity will truly be produced and supplied for this note at the promised date. For example, Carbon Emission certificates allowing energy producers and energy intense industries to emit only a fixed amount of greenhouse gases in the period of one year, lose their value if previously issued certificates are simply carried forward to the next year's period, as some companies have actually demanded.

The Great Depression and resultant hyperinflation led economists to reflect deeply on the value of money. Ulrich von Beckerath, for example, took on the idea of energy backing but had general doubts if energy units were feasible for a currency. In particular he feared the limitless availability of renewable energy would lead to another hyperinflation.[171] At a closer look, though, Beckerath mistook currency inflation with changes in the general price level. Whilst it was true that as more energy was harvested more currency could be issued, since all goods would be re-priced in respect to the rising volume of energy currency in circulation, such a scheme should not lead to inflation but just a change in the general price level (in energy currency), a change that would more accurately reflect the true cost of energy, in relation to all other goods and services.

Swann, in his writings about energy notes, emphasises that “[t]he community organisation or corporation would issue the notes only in amounts equal to their projected output of electricity, thus avoiding inflation of the currency”, and points out that “[t]he validity of the energy notes does not, however, rest on the agreement of the utility companies to redeem the notes”, but was secured by the actual energy production of the community corporation that issued the notes.[172]

This golden rule is also valid for non-redeemable currencies. A major critique of the Ven, for example, whose value is pegged not to distinct quantities of a basket’s ingredients but defined in relation to their price levels, is that the composition of the pricing-basket is not publicly disclosed and can only be vaguely approximated from the varying exchange rates of the Ven against other currencies. While this lack of transparency may be uncritical in boom periods, it could provoke a rapid flight from Ven, should people lose their trust in the composition and management of the basket.

So the design principle here is clear: start with and maintain clear transparency between the currency medium and the commodity reference value.

5.3 Governance, scale and capacity issues

The governance of monetary systems relates to overall implementation and oversight. Given that money has historically been one of the least democratically organised institutions in human society, there is particular importance for new money innovators in getting governance right. In addition to the specific issues of functionality and value discussed above, there are a number of other critical factors that relate to the design of energy monies. In general these issues relate to the way in which the money is managed, administered and in some cases issued.

Human institutions themselves require a steady flow of energy in order to maintain themselves.[173] In the case of complementary currencies, particularly those originating from the grassroots, much of this energy has often arisen from volunteers or short term grant funding. Arguably, this has been a contributory factor in the fragility of many systems. Unless a system is incorporated into the functioning of the formal public sector (or not-for-profit) actors and can thus be supported by the redistribution of state or other accumulated surplus, there is a need to consider how a currency system will be maintained over time.

The type of organisation that might administer and manage an energy money system will vary according to the nature of the system that is being planned. Because energy monies often operate at the interface between financial and energy systems the design of models can potentially have an effect on both systems. For example, Kay Vosshenrich, originator of the Sonnenschein model in Steyerberg (see Box 6) has argued that our centralised money order is fuelled and defined by a centralised fossil energy structure, and that a shift towards renewable energy must lead us not only into ‘small scale economies' but consequently also into a decentralised money order,[174] as envisaged by Turnbull in 1983:

> *"Non-renewable power sources are less suitable for defining units of value since a substantial proportion of their costs are fuel and labour, the value of which (relative to the original investment cost) may change over the life of the plant. Further technological advances could make small, decentralized, environmentally compatible energy sources even more competitive and so suitable as a universal democratic basis for defining a unit of value."*[175]

The argument here is that certain forms of energy money could, if structured correctly, lead to the development of not only decentralised energy systems but also decentralised economic and financial systems. Thus the rise of peer-to-peer banking and currency models and other decentralised structures offers potential.[176] For example, Chris Cook has proposed using the legal structure of Limited Liability Partnerships to create 'capital asset partnerships' in which transactions can be priced with reference to an energy standard and which can facilitate peer-to-peer credit and investment.[177] Similarly, the WAT (see Examples 4) is another example of a decentralised production currency:

> *"[O]btaining these WAT-forms is free: they can be downloaded from the WAT-website (…). Anybody accepting a bill automatically becomes a 'member'. This system is now spreading rapidly and widely in Japan, but by its very design nobody knows exactly what scale and how many participants are involved. It has to be one of the most cost-effective means of payment in existence, and it spontaneously creates 'circles of trust' among sub-groups of participants. (…)[H]igh-level electronic security systems are being developed by the Iwate Prefectural University to eliminate the risk of frauds, reuse or denial of reception with electronic WAT receipts."*[178]

Whilst the appeals of this form of distributed and decentralised governance are clear, they do come with certain risks. The management of large-scale distributed systems can be problematic, as in the case of the Argentinian *Trueque* where the loss of control over issuance of the currency at local levels has been cited as a contributory factor in the dramatic collapse of the barter markets.[179] Furthermore, a decentralised structure is clearly not suitable for all systems, some of which rely on a centralised control over issuance and coordination, as with the ebcu model or other models that would attempt to ration the useage of fossil fuels or protect the atmosphere.

Finally there is a relationship between governance structure, the scale of ambition, and the ability of monetary innovators to implement practical proposals. There is an observable dichotomy between the small-scale practical projects already in existence, and the proposals for larger-scale systems that, at this stage, remain theoretical. The latter are clearly more difficult to realise, yet the process of how such systems can be put in practice is critical if they are not to remain as idealised proposals. Any given project has implicit scale implications that in turn influence the governance structures of the system. Here there is a considerable gap in terms of research and knowledge.[180]

5.4 Summary: From theory to practice

This report has illustrated how energy monies could address the great challenges facing our economy in *theory*. The question of whether they can in *practice* is quite another. There are some encouraging grassroots projects that are seeking to test and refine some of the ideas. Yet there is also an implementation gap that faces many of the proposals – the difficulty in translating idealised conceptual models in messy realities. This report has begun to highlight some of these design and implementation challenges – challenges that must be addressed if many of these ideas are to ever move beyond their theoretical form.

We should be cautious about the claims we might make on behalf of any given system. It might not be enough to design better systems and to attempt to have more control over systems that are complex, unmanageable and with emergent properties. At best our control might only ever be partial. This suggests that we should be humble in our attempts to steer these complex systems.[181] This is not to say that we should not seek to develop new projects such as energy monies; just that, as the analysis above suggests, they are unlikely to be silver bullets or to proceed in the way that we expect.

6. Conclusions and next steps

This report has argued that the current ecological crisis is intrinsically linked to the growth of the global fossil fuel driven economy. The prevailing monetary system exacerbates this problem. Modern bank-debt money contributes to the expansion dynamic because of the need for banks to charge interest and retain profits. Fiat issued bank-debt money also creates systemic short-termism, instability and pro-cyclicality, and fails to allocate resources towards the building of a sustainable and just economic system. Our ability to collectively develop the necessary political responses to ecological overshoot is hindered by a general lack of the understanding of the relationship between nature, economy and money. This report has examined whether efforts to link nature and money via new monetary instruments might offer a means for systemic intervention.

The nascent field of energy money is rich in its variety and complexity; this report is a first attempt to systematically consider the various concepts. We provide a taxonomy for understanding the multiple ways in which money and energy can be linked, and review some of the different proposals and projects which have been developed. One important conceptual discovery was to distinguish between schemes that attempt to improve the functioning of money by linking it to energy or other natural resources ('energising money') versus schemes that attempt to use monetary instruments to better link the economy to energy ('monetising energy'). We hope that our framework and its associated grammar can communicate some of the key features of energy money to a wider audience.

We argue that energy monies could contribute to an emerging 'ecology of money', and in doing so could help reconnect money, nature and the economy.

In chapter 2, we set out three ways in which the economic system was disconnected from nature:

- **pricing nature** – the problem of market externalities;
- **non-substitutability** – the illusion that man-made capital can substitute for natural resources and eco-systems;
- **energy and entropy** – the absence from theories of production of an adequate account of the laws of thermodynamics and the role of energy.

The attraction of energy monies (and indeed any money that is anchored to natural resources) that focus on the unit of account function is that they could help to price nature into markets, thereby improving the ecological efficiency of the economy. Similarly, in relating money to natural resources, they are set apart from the other factors of production. This would bring into sharper relief the validity of equating natural resources with man-made capital and labour in theories of production. Both these might require top-down monetary reform to effect systemic change. To tackle the third problem of the dissonance of economic theory with the laws of thermodynamics, energy-related money would seem to be a promising avenue, and here it might be useful to have energy currencies operating at all geographical scales allowing for bottom-up transformation of the monetary and energy systems.

In chapter 3, we identified several problems with the modern monetary system that arguably exacerbate the nature-economy disconnect discussed above:

- **virtual wealth** – the problem of compound interest allowing monetary 'wealth' to diverge from the productive capacity of the economy
- **uneconomic growth** – structural drivers of monetary growth
- **malfunctioning** – the negative effect of interest-bearing bank-debt money on store of value and means of exchange functions
- **discounting the future** – undervaluing future wealth in economic decision-making
- **financial instability** – the problem of money creation for speculative rather than productive use
- **misallocation –** lack of incentives for money to be created for investments that create ecological and social value

Energy money can offer much scope for improvement in respect of these flaws in the present money system. If energy is the backing for money, then any returns must be related to returns in the real economy, preventing virtual wealth from detaching money from nature. This also helps to create a more stable financial system, as speculative bubbles cannot arise purely from expansion in the money supply.

Improving the performance of money as either a store of value or a medium of exchange depends entirely on the design of the currency, which must itself depend on the objectives of the currency. The realisation that one currency may not be able to fulfil all functions well is an important starting point and provides a strong case for developing several complementary currencies to fulfil different monetary functions.

Finally, solving the misallocation of financial resources is certainly an area of great potential for energy currencies. In particular, the 'credit' currencies that can fund investment in renewable energy production, or savings in energy consumption, could begin to redress the structural bias in the current money system against infrastructure that yields a long future stream of low-cost energy.

What next then for energy money? We can draw out four broad recommendations from the findings of this report.

First, that a systemic ‘top-down’ reform of money accounting holds great potential to address some of the key flaws in money-economy-nature relationships – in particular the problems of valuing nature, and the illusion of virtual wealth. **Further research is required both on the concepts and into the practical considerations of implementation.**

Second, we do not need to wait until these are solved to begin the ‘Great Transition’[182] to an ecologically sustainable and socially just economy. Many of the case studies in this report illustrate the potential of local and more narrowly focussed energy currencies to engineer a low carbon energy transition from the ‘bottom-up’. For these, a different research agenda is required: **How can we best draw out the lessons, disseminate knowledge, replicate and scale-up success by translating these across national boundaries and different institutional infrastructures?** Where such schemes are stalled by regulatory or policy obstacles, promoters of energy monies should seek to mutually support one another in gaining acceptance and indeed support among policymakers for allowing currency competition and innovation. [183]

Thirdly and relatedly, we call on a range of other actors, other than currency designers, to support energy currency innovations, in particular local government and other public sector agencies, environmental NGOs and charitable foundations. Energy money holds the allure of addressing some of the most systemic challenges facing our world and should not be left to academic and policy fringe. At the same time, energy money designers and thinkers should engage with civil society and public sector actors, understand their needs and show how energy currencies can help them achieve their goals.

Fourthly, we hope this report will make it easier for campaigners, scientists and thinkers in the world of monetary and energy reform to come together more effectively as we search for a better kind of economy. Energy money offers an exciting research field on the intersection of physics, economics and ecology, and the best minds from all of these fields are needed to further develop some of the ideas in this report.

In summary, we believe that energy money might contribute to a reframing of what we mean by terms such as ‘investment’ and ‘capital’. In his 1935 book *The Formation of Capital*, H.G. Moulton defined what he called “procreative property” as

> *“the processes by which society expands its power to make nature yield its resources more abundantly.”*[184]

By adding the words ‘on a sustainable basis’ we could consider this the ultimate test of any money system – whether it promotes or inhibits such processes. The current system fails the test. Energy-related money shows great potential to do better, and so deserves wider and more serious consideration. The idea of linking energy to money is not a new one, but perhaps it is an idea whose time has come.

Appendix: selected energy currency and accounting projects

Note: If you are reading an electronic copy of this report (available from www.neweconomics.org/publications/energising-money), the title of each project/proposal listed below is hyperlinked to its source on the internet. Please click to access.

Author	Year	Title	Summary	Source
Beckerath, Ulrich von	1951	Zur Freiheit, zum Frieden und zur Gerechtigkeit	Early discussion of labour, power or energy as monetary basis	In book: Peace Plans,(Mikrofiche), Berrima, Australia, 1983, pp 428-467
Benello, C. George Swann, Robert Turnbull, Shann	1997	Building Sustainable Communities: Tools and Concepts for Self-Reliant Change (2nd Ed.)	Seminal proposal of kWh as the basis for community currency and community banking innovations	Book published by Carpenter, Charlbury, UK, 1997
Bosordi, Ralph	1971	Exeter Constant	Pioneering project of a basket (including oil) backed currency	Online Article
Cook, Chris	2009	The Community *is* the currency	Concept for collective ownership of energy assets and redeemable units	Online Presentation
Deconinck, Geert et al. (INESPO)	2011	An approach towards socially acceptable energy saving policies via monetary instruments on the smart meter infrastructure	Currency proposal for energy saving, incorporating smart metering technology	Online Publication
Defilla, Steivan	2012	Metrological Aspects of an Energy/Based Currency System	Rational and practical explorations of an energy Numéraire of Walrasian wealth	Online Conference Proceedings
Dosch, Klaus (Kathy-Beys-Foundation)	2012	CO^2 Cards	Proposal for a consumer *cap and trade* currency, representing emission rights	Project-Website (German)
Douthwaite, Richard	2011	Degrowth and the supply of money in an energy-scarce world	Theoretical proposal to deal with peak energy scenarios through currency technology	Article: Ecological Economics, 2011 DOI:10.1016/j.ecolecon.2011.03.020
Douthwaite, Richard	1999	Ecology of Money	Global proposal including energy backed currency unit (the ebcu) and emission certificates issued by the IMF	Book published by Green Books, Totnes, UK, 2000
Fawzi, Marc	2009	P2P Energy Economy	General framework for peer-to-peer energy production, distribution and trading	Online Publication
Fleming, David Chamberlin, Shaun	2011	TEQs Tradable Energy Quotas	Transferable emission units centrally allocated to individuals and auctioned to market, proposed by the UK House of Commons	Published policy framework
Fuller, Richard Buckminster	1981	Cosmic Wealth Accounting	Theoretical proposal for global energy management and resource accounting in energy	In book: Critical Pathby Fuller,R. B. & Kuromiya, K.B., St. Martins Press, NY, 1981

Author	Year	Title	Summary	Source
Gogerty, Nick Zitoli, Joseph	2011	DEKO: An Energy Backed Currency Proposal	Central Bank to hold electricity delivering assets instead of government bonds or gold to back the national currency they issue	Online Publication
Grandits, Rudo	2010	Energy Backed Regional Currency	Proposal for coupling regional currency and investment in renewables	Online-Publication (German)
Green Money Working Group	2011	Green Money Working Group	Campaign alliance arguing for financial reform, proposing stamp script and energy currencies	Project Website
Hahl, Robert W	2008	Kilowatt Cards	Transferable certificates redeemable for payment of 10 kWh electricity worldwide	Project Website
Hahl, Robert W	2008	Fixed Reference Money System based on Electrical Capacity	Patent (US), describing an intergrated electricity currency system	US-Patent, 2007
Hudon, Marek et al.	2010	Innovative Instruments for Energy Saving Poilicies	Belgian academic research project on energy saving currency instruments	Research Project Website
Lietaer, Bernard	2004	Terra TRC	Global trade reference currency backed by a commodity basket	Online Publication
Lovins, Amory	1989	Negawatt	Theoretical proposal for trading saved energy as currency	Online Publication
Meyer, John Erik	2012	The Perfect Currency	Theoretical proposal and campaign for monetary reform and global reference currency backed by energy	Online Publication
Morino, Eiichi	2000	WAT	Peer issued bills of exchange in Japan, denomitaned in kWh	Project Website
Odum, Howard Thomas	1996	Environmental Accounting:Emergy and Environmental Decision Making	General accounting framework using emergy as the base of value	Book published by John Wiley, NY, 1996
Qoin.org	2012	Kiwah	Dutch platform prospecting a loyalty/bonus points currency for sustainable consumption and renewables	Project Website
Regiostar e.G.	2011	Solar Cooperative and Regional Currency	German regional currency integrating local investment in renewables	Project Website (German)
Sam Nelson (Maia Maia Project)	2011	Boya	Local unbacked certificates issued on saved CO^2 equivalent in Western Australia	Project Website
Sgouridis, Sgouris Kennedy, Scott	2009	Tangible and fungible energy: Hybrid energy market and currency system for total energy management. A Masdar City case study	Policy proposal for a city currency (Ergo) denominated in and redeemable for energy-provision	Article: Energy Policy, Volume 38, Issue 4, April 2010, Pages 1749–1758

Author	Year	Title	Summary	Source
Sgouridis, Sgouris	2012	Energy-Denominated Currencies as a Viable Pathway for Sustainable Societal Transition	Energy based system of exchange that combines the commodity and credit-clearing characteristics	Online Article
Stalnaker, Stan (Hub Culture Ltd.)	2007	Ven	Digital currency, price pegged to a commodity basket including emission futures	Project Website
Staudinger, Heini	2003	Waldvierteler Sonnenstrom Gutscheine	Local project for investment in renewable energies, with dicount credit for local products	Project Website (German)
Swann, Robert	1981	The Place of a Local Currency in a World Economy	General proposal for local currencies redeemable for energy	Online Publication
Timm, Hans	1926	Wära	Historic German regional stamp script currency, locally redeemable for coal	Online Article
Turnbull, Shann	2009	Options for Rebuilding the Economy and the Financial System	Proposal for financial reforms using demurrage money and energy linked currency	Online Publication
Turnbull, Shann	2008	Energy Development and Sustainable Monetary Systems	Energy linked replacement currency to avoid market failure	In book: Urban Energy Transition by P. Droege, Elsevier, Amsterdam, NL, 2008, pp 121–140
Turnbull, Shann	1977	Killowatt-Hour Currencies	Pilot proposal for community-energy backed currency	In book: The Money Changers by D. Boyle, Earthscan, London, UK, 2002, pp. 207 - 210
Winker, Grant	2009	Energybackedmoney.com	Proposal for an energy backed US dollar	Online Publication
Vosshenrich, Kay	2007	Sonnenscheine Steyerberg	Partly implemented regional voucher system, redeemable for electricity, coupling local trade and renewable energy investment	Project Website (German)
Youssef, Hares (40 Foundation)	2012	Eco Unit, Human and Resource Economic System	Proposal for global political and monetary reforms, specifying a national currency backed by energy and an internationl energy reference currency	Online Publication
Otsuka, Noriaki (Satoyama Institute)	2000	Charcoal Currency, Osaka JP	Regional currency backed by grams of charcoal in Osaka Japan	Project Website (Japanese)

Note: if you are reading an electronic copy of this report (available from www.neweconomics.org/publications/energising-money), the title of each project/proposal listed above is hyperlinked to its source on the internet. Please click to access.

Endnotes

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[5] See the 'Up in Smoke' coalition's set of reports which reveal the threat from global warming to reverse progress in human development and render the Millennium Development Goals unachievable: http://www.neweconomics.org/publications/smoke-reports-summary

[6] Global footprint network. http://www.footprintnetwork.org/en/index.php/GFN/page/world_footprint/

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[49] Indeed, some animals are capable of exponential growth – hamsters for example double in size each week from birth up to puberty – but only for a limited period until they reach 'maturity'. As **nef** have pointed out, if a hamster continued to grow at this speed, on its first birthday we would be facing a nine billion tonne hamster. If it kept eating at the same ratio of food to body weight, by then its daily intake would be greater than the total, annual amount of maize produced worldwide. (2010). *Growth isn't possible*. London: **nef** (the new economics foundation) and online: http://www.youtube.com/watch?v=Sqwd_u6HkMo

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[84] See Community Currency Magazine Vol. 25, March 2009, Fig. 8.8, p. 24.

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[86] Despite being the least component in the basket, the partial influence of carbon futures on the floating price of Ven is regularly portrait as making the Ven a “green currency” with ecological benefits. Source: Personal communication between the authors and Stan Stalnaker.

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[91] The DCG magazine (digital gold currency magazine) might serve to give a first impression on the variety of proposals and their promoters’ motivations. Accessible at: http://www.dgcmagazine.com

[92] This is valid for the current method of credit creation as well, where bank deposits are backed by bank assets which are mostly secured on property. When in autumn 2008 real estate market prices (as a socially constructed value) collapsed in the US because “the markets” no longer believed in the capacity of borrowers to pay back their loans, this caused a chain reaction of re- and devaluation of currencies worldwide, which is still ongoing.

[93] Quote: *Food-Backed Local Money.* Online article by Jason Bradford on the oildrum, March 4, 2009. Available at http://campfire.theoildrum.com/node/5158

[94] According to Mederos et al. (2001)., the value of the currency units was related to a “grain standard”. The smallest unit, *uttetu* or *se* represented a single grain. One *talent* corresponded to 30,3 kg of grain, equal to 60 *minas* à 0,505 kg, while one *mina* equaled 60 *shekel*. The *shekel* represented 8,4 gram of grain, corresponding to 180 single grains (180 *se*). Their study showed that “diverse weight systems (…) were in use from the Indus Valley to the Aegean from the middle of the third millennium to the end of the second millennium BC”, revealing that “[t]he integration of different weight systems was crucial in developing the scale and nature of commercial exchange in the Near East and would have facilitated the emergence of the Ancient World System.”

[95] The conceptual framework for the Kubik was laid out in Kassel, Germany, by the former (savings) banker Heinz-Ulrich Eisner, and was considered legal by the German banking regulatory authority, BaFin. However, it has not yet been implemented.

[96] Theoretical considerations of how a “Carbon Currency” could be designed are laid out in depth in Schuster (2009). Emission Rights as a Carbon Currency. Berlin: Aachener Stiftung Kathy Beys.

[97] In the UK, former environment secretary David Miliband had announced to implement a carbon credit swipe card for all UK citizens, but his plans

were finally scrapped in 2008, officially because a Defra study expected high costs for acquiring relevant personal data of all inhabitants.

[98] In Germany, the Kathy Beys Foundation has dedicated itself to this issue, see http://www.co2card.de.

[99] Smith, D. (2010). Islanders lead world on personal carbon test scheme. Newspaper Article, Sydney Morning Herald, 27/10/2010. Available at: http://www.smh.com.au/action/printArticle?id=2009314

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[101] This clearly corresponds with the findings of Nobel Prize winner Elinor Ostrom in her empirical studies of self-governed commons.

[102] Douthwaite, R. (1996). *Short Circuit. Strengthening Local Economies for Security in an Unstable World.* Dublin: The Lilliput Press / Totnes: Green Books. p. 106.

[103] Rifkin, Jeremy. (1980). *Entropy: A New World View*. New York: Viking Press.

[104] Buckminster-Fuller proposed a global electricity grid which could deliver power to anywhere in the world with one common rate. This would create “a world-around uniform costing and pricing system for all goods and services based realistically on the time-energy metabolic accounting system of the universe.” Buckminster-Fuller, R. (1981). *Critical Path*. St Martin’s Press. pxxxi

[105] “The technology of power production from renewable energy sources has diseconomies of scale and so favours small discrete autonomous communities. For this reason, the unit of electrical power, the Kilowatt-hour (Kwhr) has much appeal as a universal unit of value for an autonomous community banking and monetary System.” Turnbull, S. (1997). pp. 159–166.

[106] Thus, the nomenclature or denomination of several currency concepts presented above are misleading: WAT and Kilowatt Cards for example represent (kilo)watt-hours and not (kilo)watt.

[107] Figures presented by Prof. Charles S. A. Hall, SUNY-ESF. Accessed through: http://en.wikipedia.org/wiki/Energy_returned_on_energy_invested (last visited 18/06/12)

[108] More on the conceptual details of Net Energy, Energy Return on Energy Investment (EROEI) and Energy Internal Rate of Return (EIRR) see: Vernon, C. (2010). *Future energy availability: the importance of ‘net energy’*. In: Douthwaite, R. (2010). pp. 43–51.

[109] Murphy, D. J., Hall, C. A. S. (2010). *Year in review: energy return on (energy) investment.* In: Constanza, R., Limburg, K. (eds.) Ecological Economics Reviews. Ann. N.Y. Acad. Sci. 1185, pp. 102–118.

[112] The unit of account vs. unit of value issue is discussed in depth in Greco’s early paper on Money and Debt, PART III – Segregated Monetary Functions And An Objective, Global, Standard Unit Of Account (Greco, T. H. (1990). pp. 44–)

[113] Brown, M. T., Ulgiati, S. (2004). Energy Quality, Emergy, and Transformity: H.T. Odum's contribution to quantifying and understanding systems in Ecological Modelling. 178: pp. 201–213.

[114] http://en.wikipedia.org/wiki/Emergy (last visited 18/06/12)

[115] http://www.epa.gov/nheerl/publications/files/wvevaluationposted.pdf (last visited 18/06/12)

[116] For a brief description of the emergy accounting project at a sicilian ecovillage see Siracusa et al. (2005). Available at: http://ec.europa.eu/environment/etap/inaction/showcases/italy/243_en.html

[117] General information on applied emergy accounting can be found here: http://www.emergysystems.org

[118] Greco, T. H. (2009). pp. 117–118.

[119] "The 'measure of value' or 'unit of account' function has not historically been well served by any currency. Government or bank-issued fiat currencies, the type that are almost universal today, are especially unreliable measures of value because they are undefined and subject to gross manipulation by governments and central banks. (...) While political currencies might appropriately be used in the settlement of accounts, they need not and should not be used in defining the value of goods and services to be exchanged." (Greco, T. H. (2009). p. 118.)

[120] An early protagonist of currency competition is F. A. Hayek, an economist of the "Austrian School" of economics. His ideas are pinpointed in Hayek, F. A. (1970). *Denationalization of Money.*

[121] Greco, T. H. (2009). op cit, p. 122.

[122] Lietaer, B. A. (2004/1). *Complementary Currencies in Japan Today: History, Originality and Relevance*. In: International Journal of Community Currency Research (IJCCR), Vol.8, pp. 1–23 pp. 12–13.

[123] http://www.srpnet.com/payment/mpower

[124] See for example http://www.bbc.co.uk/news/business-11793290 and on safaricom's homepage: http://www.safaricom.co.ke/index.php?id=250. The rate for mobile phone minutes currency, the "m-Pesa" is available in real time online, e.g. at http://www.rich.co.ke (accessed on 09.06.2009)

[125] Lietaer, B. A. (2004/1). op cit, p. 13.

[126] Hahl, Robert. (2007). *Fixed-Value Paper Backed by Electricity. The Electricity Standard.* Hard copy. More information available at: http://www.kilowattcards.com

[127] Apart from that, RECS is contested not only because the system is owned and operated by big conventional energy producers, but also because RECS certificates can be traded and resold independently from actual renewable energy production and not even demand any new investment in Renewables – thus in effect provide greenwashing for conventional energy producers.

[128] E.F Schumacher Newsletter, Spring 1983, available from the report authors.

[129] Douthwaite, R. (1999). *The Ecology of Money*. Totnes: Green Books. p. 73.

[130] Turnbull, S. (1977). Let the market correct itself. *The Australian*, Op Ed., p. 8, May 25.

[131] "The mission of the United States Secret Service is to safeguard the nation's financial infrastructure and payment systems to preserve the integrity of the economy, and to protect national leaders, visiting heads of state and government, designated sites and National Special Security Events." http://www.secretservice.gov/mission.shtml

[132] Douthwaite, R. (1996). op cit., pp. 106–107.

[133] http://www.ithacahours.org

[134] "One of his proposals would, in effect, turn electricity producers into currency-issuing banks: "Almost every community has renewable resources for producing energy," he writes in one of the chapters he contributed to Building Sustainable Communities, a book on the methods that communities can use to become more self-reliant, published in 1989. "All such energy resources can be converted into electricity or measured in kilowatt hours." He envisages community companies established to develop these resources financing themselves by selling energy notes. "For example, if local utility rates are presently 10 cents a kilowatt hour, then one dollar would buy 10 kilowatt hours for future delivery. Owners of the notes, sold in lots of 10, 50, and 100 units (comparable to current values of one, five and ten dollars) would hold them for future redemption no matter what their future dollar rate. (…) Since the notes would always be worth the current price of the amount of electricity they represented, they would be accepted instead of national currency by people living in the generating plant's service area in payment for goods and services, particularly if, as with the Constant or the Wörgl schilling, a local bank stood ready to redeem the notes for cash." In: Douthwaite, R. (1996). op cit, pp. 106–107.

[135] Quotations from Swann, R., Benello, G. C., Turnbull, S. (1997). *Building Sustainable Communities: Tools and Concepts for Self-Reliant Economic Change*. Edited by Ward Morehouse. New York City, NY: The Bootstrap Press. Second Edition. pp. 179–181.

[136] More information available at: http://livingcity.de/regioprojekt/Energie/index_energie.htm (in German)

[137] Project website: http://www.sonnen-scheine.de/die-idee (in German)

[138] Concept in brief available at http://www.docstoc.com/docs/45685881/Kurzfassung-Energiegedeckte-Regi

[139] http://www.waldviertler-regional.at/

[140] See company website at: http://www.gea.at/pages/frameset_wv.html

[141] For further details see the company's blog at: http://www.sonnentor.com/news_community/Sonnenblog/Bei-uns-daheim/photovoltaik_beteiligungsaktion#n70179

[142] For a description see: http://www.wegwartehof.at/blog.php/viertausend-mal-sonnenschein/

[143] For example, a crowd-funded PV investment realized at Hof Schwalbennest, Brandenburg: http://www.hofschwalbennest-brodowin.de/direktdarlehen

[144] http://www.kiwah.org/

[145] QOIN website: www.qoin.org

[146] In 1931, due to Brüning's emergency decree, the finance minister stopped this and similar financial self help experiments of that time. Again, the miners lost their job and the mine was closed, and only reopened after World War II when coal was a demanded resource. A comprehensive essay on the brief history of the Wära (in German) is available at: http://www.moneymuseum.com/moneymuseum/library/texts/text.jsp?lang=de&pid=345&i=4#6

[147] Green New Deal Group. (2008). A Green New Deal. London: **nef** (the new economics foundation). http://www.neweconomics.org/projects/green-new-deal; For a recent intervention by the government's chief scientific advisor, David King: http://www.guardian.co.uk/environment/2012/jun/26/david-king-quantitative-easing-green

[148] In Solothurn, Switzerland, ZEITPUNKT editor Christoph Pfluger is currently negotiating his "Solarschecks" concept with the municipality, which is in effect an IOU for investments in energy efficiency.

[149] Project website: http://www.inespo.be

[150] Turnbull, S. (1997). op cit. Chapter 21.

[151] "The owners of the power generator would create money. It would be in the form of a voucher or contract note to supply a specified number of Kwhrs at a specified time in the future. These notes would be created and issued by the owners of the generator to pay for its purchase and Installation. The value of notes that could be issued for redemption in any given time period would be limited by the output of the generator. The notes with a specified maturity date would represent the 'primary' currency. Such currency notes would mainly be held by Investors, Investment banks, and banks. Commercial banks would hold the primary currency notes as a reserve currency in like manner to a bank holding gold or a merchant banker holding grain or other commodities. Similarly, the commercial bank would issue its own 'secondary' notes, which would be based on the primary notes and which the holder could convert cash in to the primary notes or reserve currency (to be used to pay his power bills at the time specified). The secondary notes could be denominated in Kwhrs but without any specified redemption time. They could be used as hand-to-hand money in the community…" In: Turnbull, S. (1997). ibid, pp. 159–166.

[152] Douthwaite, R. (1999). *The Ecology of Money*. Devon: Green Books. p. 53–74.

[153] Jane Jacobs described the very same monetary policy principle and feedback mechanisms with two currencies and floating exchange rates, not for the relation between fossil energy dependent and post-fossil economies, but for the relation between nations and city regions. See: Jacobs, J. (1984*). Cities and the wealth of Nations.* New York: Random House. pp. 156–181

[154] Blog article, accessible at http://seekingalpha.com/article/129500-banking-on-energy-rather-than-currency-or-gold. The example of the Petro Dollar is taken from here.

[155] Asia Times online article, 27/05/2005. Available at: http://atimes01.atimes.com/atimes/Global_Economy/GE27Dj01.html

[156] Consequently, his proposal for Iran included the set-up of an Iranian oil bourse, to date a geopolitical no-go.

[157] See www.econunit.org

[158] http://the40.org/

[159] For a full decription of The Eco-Unit, see www.ecounit.org

[160] "A currency based on each of the principal goods or services may be required to create the credits to finance their production." In: Turnbull, S. (1997). p. 176.

[161] Turnbull, S. (1997). op cit., p. 173.

[162] As for example the "virtual power plants", in effect a platform which allows for real time accounting and management of both expected decentral energy consumption and expected energy production fed onto the grid by decentral producers. See, for example: Fang, X., Misra, S., Xue, G., Yang, D. (2011). *Smart Grid – The New and Improved Power Grid: A Survey*; IEEE Communications Surveys and Tutorials 2011. doi:10.1109/SURV.2011.101911.00087.

[163] See for example: Stott, M., Hodges, J. (1996). Local exchange and trading schemes: Never knowingly undersold? *Local Economy*, 11(3), pp. 266–268; Aldridge, T., Patterson, A. (2002). LETS get real: Constraints on the development of local exchange trading systems. *Area*, 34(4), pp. 370–381.

[164] North, P. (2010). pp. 204–205.

[165] Douthwaite, R. (1999). Ibid.

[166] Buckminster Fuller, R. (1981). *Critical Path*. New York, NY: St Martin's Press. p. 27. Quoted in: Greco, T. H. (2009). *The End of Money and the Future of Civilization*. Vermont: Chelsea Green. p. 111.

[167] It is quite probable that the municipal energy supply company in Wörgl was inspired directly or indirectly by Shann Turnbull's visit at Unterguggenberger Institut in Wörgl, Feb 2006. A detailed report is available in German at: http://www.unterguggenberger.org/page.php?id=41

[168] For a discussion of this issue see Longhurst, N. (2012). The Totnes Pound: A grassroots technological niche. In: Davies, A. (ed.) *Enterprising Communities: Grassroots sustainability innovations.* Bingley: Emerald.

[169] Thiel, C. (2011). The German Regiogeld System and its Handling in Everyday Life. Paper presented at the International Conference on Community Currencies, February 16 – 17th, 2011, Lyon. Thiel suggests that at least part of the success of the Chiemgauer system in Germany is due to the way in which it appeals to a range of different user constituencies.

[170] Seyfang, G., Longhurst, N. (2012). Money, Money, Money? A Scoping Study of Grassroots Complementary Currencies for Sustainability. Working Paper of the Science, Society and Sustainability Research Group, University of East Anglia, Norwich. On forking see Douthwaite, R. (2002). *Enabling Innovation.* London: Zed Books.

[171] Beckerath, U, V. (1951). Letter to Humbert, 03/09/1951. First published in: Ulrich von Beckerath: Zur Freiheit, zum Frieden und zur Gerechtigkeit; Gesammelte Briefe, Papiere, Notizen, Besprechungen. PEACE PLANS 428–467 (Mikrofiche), Berrima, Australia, 1983. pp. 1892–1893. Available at: http://reinventingmoney.com/documents/beckerath.html

[172] Quotations from Swann. (1997). op cit. pp. 179–181.

[173] Tainter, J. (1988). *The Collapse Complex Societies*. Cambridge: Cambridge University Press. p. 91.

[174] Vosshenrich, K. (2005). *Renewable Energy Currencies for structural sustainability – fundamental economic values for a solar age.* Presentation at the 1st World Renewable Energy Assembly, Bonn.

[175] Turnbull, S. (1997). op cit. p. 172.

[176] See for example: www.bitcoin.org and www.metacurrency.org

[177] See: http://www.slideshare.net/ChrisJCook/money-30

[178] Lietaer, B. (2004/1). op cit. pp. 12–13.

[179] Gómez, G. (2009). *Argentina's Parallel Currency: The Economy of the Poor.* London, Pickering and Chatto.

[180] Although for a literature review and theoretical framework, see: Jones, A. D. S. (2011). A Theoretical Framework for Shared Monetary Governance. *International Journal of Community Currency Research*, Vol 15, A pp. 23–31. Available online at: http://www.ijccr.net/IJCCR/2011_%2815%29.html

[181] Rip, A. (2006). A co-evolutionary approach to reflexive governance – and its ironies. In: Voß, J-P., Bauknecht, D., Kemp, R. (eds.) *Reflexive Governance for Sustainable Development.* Cheltenham: Edward Elgar. pp. 82–100.

[182] Spratt, S., Simms, A., Neitzert, E., Ryan-Collins, J. (2010). *The Great Transition: A tale of how it turned out right.* London: **nef** (the new economics foundation).

[183] The various possibilities of how regulators may accept mobile phone monetary innovations are presented by Turnbull, S. in: How should regulators control e-money? Available online at: http://ssrn.com/abstract=2202108

[184] Moulton, H. G. (1935). *The Formation of Capital*. Washington D.C.: The Institute of Economics, Brookings Institute, Publication No. 59.

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