Finance and Sustainability

Synthesis Report of WP7

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Finance and Sustainability[1]
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Abstract: This paper investigates the relationship between finance and environmental sustainability. The first part summarises a few crucial methodological and foundational issues underlying meaning and implications of financialisation, sustainability and their mutual relation. The second part focuses on a particularly significant case study: the unsustainability of the existing energy system based on carbon fuels focusing on the urgency of a rapid transition to a low carbon economy. The third part explores which role financial instruments may play to facilitate the transition towards a low carbon economy. In particular, it investigates the implications for sustainability of the growing trade of energy derivatives. The forth part examines the consequences of the disembedment of money from the socio-ecological flows of matter and energy. The fifth part investigates the relations between financialisation of built environments and urban sustainability. The final part of the paper draws the main policy implications from the preceding analysis in the light of the growing problems affecting environmental policy in a financialised economy. The main policy conclusion is that, notwithstanding the growing conflict between the ongoing process of financialisation and sustainability, finance has to play a crucial role to implement a process of convergence towards a sustainable path of development.

[1] Alessandro Vercelli drafted sections 1, 2, 3, 4, 9, 10, and 11, Andrew Gouldson section 5, and Eric Clark section 7 and 8. The content of this Synthesis Report has been discussed extensively by all participants in the FESSUD project, particularly those involved in the research pursued within WP7. A special thanks to Giampaolo Gabbi who contributed the first draft of section 6.

Key words: financialisation, sustainability, low carbon economy, energy derivatives, disembedment of money, financialisation of built environment, urban sustainability, green paradox, sustainability policies.

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1. Introduction

WP7 investigates the relationship between finance and sustainability seen, according to Annex-1, mainly from the point of view of environmental sustainability. It is difficult, and possibly misleading, to separate finance from the other economic aspects of development and to sever environmental sustainability from the other dimensions of sustainability. Consequently, in the WP7 deliverables finance and environmental sustainability play the main role without losing sight of the economy at large and of the other dimensions of sustainability. Our experience confirms that an interdisciplinary approach is necessary, but also that the dialogue between different disciplines is difficult to implement in concrete and synergic terms. Nevertheless, the often observed and criticised "imperialism" of standard economics has been avoided. An open attitude towards alternative paradigmatic perspectives favoured a constructive dialogue between scholars of different disciplinary backgrounds.

In this deliverable, we summarise the main methodological and substantive issues that emerged from the work carried out in WP7 on financialisation and sustainable development. This WP focused mainly on the unsustainability of the existing energy system, the need of a rapid transition to a low carbon economy, and the financialisation of built environments. This paper focuses first on a few crucial methodological issues discussed within WP7 (section 2). Section 3 deals with the foundational issues underlying meaning and implications of financialisation, sustainability and their mutual relation. Section 4 discusses the unsustainability of the existing energy system based on carbon fuels, focusing on the urgency of a rapid transition to a low carbon economy. Section 5 analyses which role financial instruments may play to promote and facilitate the transition towards a low carbon economy. Section 6 investigates the impact on sustainability of the growing trade of energy derivatives. Section 7 examines the implications of the disembedment of money from the socio-ecological flows of matter and energy. Section 8 summarises research into relations

between financialisation of built environments and urban sustainability. Section 9 discusses the growing problems affecting environmental policy in a financialised economy. Section 10 draws the main policy implications deriving from the preceding analysis. Section 11 concludes emphasising that, notwithstanding the growing conflict between the ongoing process of financialisation and sustainability, finance has to play a crucial role to implement a process of convergence towards a sustainable path of development.

2. Methodological issues

The adherence of WP7 research to a variegated but broadly convergent methodological orientation favoured a constructive dialogue between different disciplines. We briefly mention and discuss in this section a few crucial methodological principles that have inspired the work done: a particular attention for disequilibrium dynamics, long period trajectories, structural change, irreversibility of time, radical uncertainty and coevolution of the biosphere and human activity.

The first methodological principle to be emphasised is the need to escape from the strictures of equilibrium positions and steady trajectories. As is well known, the standard approach of macroeconomics focuses on market-clearing equilibrium positions. This approach diverts attention from all the problems that may jeopardize sustainability: economic and financial fluctuations, unemployment, inflation, stagflation, financial bubbles, crises, great crises. In this view, the apparent disturbances of otherwise smooth market processes are necessarily exogenous and do not affect the actual sustainability of market processes. However, the sustainability of a system crucially depends on the expected impact of endogenous disequilibrium processes that may trigger a cumulative divergence from a sustainable equilibrium trajectory. The sustainability of development at the global level may thus be only assessed by investigating the complex dynamics of the system describing the coevolutionary

interactions between economic activity and the biosphere (see in particular D7.01: Clark and Hermele 2014, and D7.02: Vercelli 2014d).

The second methodological principle to be emphasized is the need of framing any argument about the sustainability of development within a long-run time horizon. This is necessary because the concept of sustainable development refers to long-period features of the development process such as the equity of intergenerational distribution, the quantity and quality of social and natural capital, the preservation of the fundamental equilibria of the biosphere (ibidem). On the contrary, the process of financialisation has progressively shifted the focus of economic decisions towards the short period. In the view of many practitioners and observers the growing liquidity and mobility of assets seems to justify the assimilation of most economic decisions to the paradigmatic choice of an optimal portfolio of assets taking into account exclusively the short-term profitability of each asset. The growing importance in finance of computerized high frequency trading has further strengthened the orientation of decision makers and researchers to an ever-shorter period. This orientation to the short period reflected by much of standard economics raises serious problems for its application to the sustainability issues studied by FESSUD, in particular within the WP7. Unfortunately, also the section of mainstream economics studying the long period, as for example long-period growth theory, is hardly applicable to sustainability issues because structural change is usually ignored or strongly played down. In the standard approach, sustainable growth is conceived as mere "steady state growth" and ignores most environmental and social constraints.

The deliverables of WP7 tried hard to adopt a structural approach suitable to an in-depth long-term analysis of sustainability. In this view, sustainability is not a steady state within a given structure (as in standard growth theory) but sustainable structural change. Namely it is a process of coevolution complying with the requisites of sustainability, such as intergenerational equity, emphasised by the Bruntland Report (WCED, 1987), and the preservation of natural capital that is one of its pre-requisites. This coevolutionary conceptual framework acts as a powerful methodological bridge between economics and

finance on one side and natural sciences on the other side since the latter typically study the biosphere from an evolutionary point of view (Kallis and Norgaard 2010; Weisz and Clark 2011; Clark and Clark 2012; Clark 2013).

A thorough investigation of the nexus between financialisation and sustainability has also to take into account the radical uncertainty and the irreversibility of the effects of economic activity on the biosphere. The standard model of mainstream macroeconomics, ultimately based on general equilibrium theory, assumes the complete reversibility of time. This implies the irrelevance of current mistakes for long-term sustainability in the sense that, whenever policy makers discover a mistake – even a huge one impairing the sustainability of development – this can be easily and quickly remedied and its consequences undone at no cost. Unfortunately, in the real world this is not the case. Environmental deterioration cannot be undone (as in the case of a loss of biodiversity), or can be reversed only at high cost (as in the case of climate change) with a considerable and sometimes catastrophic delay.

The problem of irreversibility is made even more significant by the fact that the consequences of human activity on the biosphere are subject to radical uncertainty that cannot be taken into account through standard probabilistic methods, nor insured by applying the standard principles of commercial insurance. It is a standard result of decision theory that, under irreversibility and radical uncertainty, the conservation of options (ultimately linked to the conservation of natural capital) has significant value in itself. This suggests a policy based on a strong version of the precautionary principle (see Vercelli, 1998).

Another concept that plays a crucial role in the analysis of the substantive themes is the scarcity concept. Scarcity in standard economics is not an objective concept as it depends not only on the short-term availability of resources but also on the tastes of economic agents. Scarcity depends thus on the system of prices and is continuously modified by the interplay of demand and supply. In this view, scarcity is substantially endogenous. The insufficient supply of a certain natural resource, as compared to its demand, would bring about an increase of its price and this would deflect demand towards substitutes. In the case of oil,

demand would shift towards coal or natural gas, whose price however is strictly correlated with that of oil, and eventually towards renewable energy sources whose price is much less correlated with that of fossil fuels. In addition, the higher price of oil would encourage a series of decentralised actions contributing to increase the supply of oil and/or to reduce its price: new prospections, increased production through more expensive techniques, technological progress aiming to increase energy efficiency, and so on. All these actions are believed to succeed in general to quickly re-equilibrate demand and supply and to stabilise price along a smooth long-term trajectory based on market fundamentals. In this view, scarcity of natural resources is not worrying except when it is policy-induced for short-term purposes, as in the case of the two oil shocks of the 1970s.

According to the point of view of many natural scientists, instead, the flexibility of supply obtained through the price system may be significant only in the short period but crucial natural constraints cannot be constantly shifted or permanently removed. For example, the quantity of fossil fuels retrievable from the earth is given. Technical progress may increase the quantity of fossil fuels that may be retrieved at acceptable costs, but the natural constraint may only be shifted forward to a limited extent.

The conflict between these two conceptions of scarcity is particularly visible as regards the issue of peak oil. Most mainstream economists deny the existence of a peak in the world oil production at least in the near future. Experts with natural science background disagree on the estimate of the year in which the production of cheap conventional oil will peak but most of them agree on the prediction that we are not far from it. The committee appointed by the US Energy Department emphasised in the final report (often called "Hirsch report") that most estimates agree on the proximity of a peak of conventional oil production (Hirsch et al., 2005). In any case, taking into account the strong uncertainty on the time profile of oil production and the costly and time-consuming irreversibility of its effects on the economy, it is rational to take decisions on the likely hypothesis that the peak of oil production is not too far ahead. Premature mitigation efforts may be costly but the cost of late mitigation would be much more damaging. Therefore, the Hirsch report maintained that according to standard risk

management principles it is rational to start immediately a serious and systematic mitigation policy. A generalisation of this argument may be found also in the Stern Review in reference to climate change policy (2006). As for the effects on climate change of the growing use of fossil fuels, the uncertainty of the effects is much stronger and the irreversibility much more intense. We have thus to act immediately with great determination to try to avoid catastrophic effects before the end of this century.

3. On the meaning of financialisation, sustainability and their nexus

The foundational work carried on within WP7 focused on the concept of financialisation and its impact on sustainability with particular attention to the issues that have emerged during the recent financial crisis and the ensuing Great recession. According to the view emerging from FESSUD deliverables, the nexus between financialisation and sustainability has to be framed within a long-term coevolutionary point of view taking into account strong uncertainty and irreversibility that characterise their causal feedbacks (see in particular D7.01: Clark and Hermele, 2014; D7.02: Vercelli, 2014d).

The historical evidence suggests that the process of financialisation may be seen as a long-run tendency characterising the evolution of market relations (Vercelli, 2014a, and 2016). This process has been driven by innovations that progressively increased the choice flexibility of decision makers by relaxing the constraints to the available option set. This trend, however, has always been undermined by constraints of religious, ethical and political nature. In consequence of these contradictory forces, we observe in history an alternation of periods characterised by considerable financial constraints, as in the Bretton Woods era, and periods characterised by a systematic relaxation of financial constraints leading to an acceleration of financialisation, as in the neoliberal era. Following the rise of neoliberalisation in the 1970s, financialisation started in the early 1980s and is still going on

notwithstanding the subprime financial crisis and the ensuing Great recession (see D7.01: Clark and Hermele 2014).

Processes of financialisation are historically and spatially determined as their features depend on conditions that change over time in the same place (country or geographic area), and are often discordant in different places at a given time. Financialisation should thus not be considered as homogeneous or invariant through time and space but as a variegated process (Brown, Veronese Passarella, and Spencer, 2015). It is however useful to start the analysis of financialisation by trying to capture what is, broadly speaking, common in the historical episodes that we are inclined to call processes of financialisation. It is possible to detect in the development of market relations a secular tendency towards financialisation:

"The driving force of this evolutionary process is rooted in a progressive, though discontinuous, flow of financial innovations meant to remove the existing constraints to the flexibility of economic transactions. According to received wisdom, the adoption of money as medium of exchange has removed the strictures of double coincidence of wants, while the modern forms of credit have been developed to relax the cash-in-advance constraint to economic transactions. As these examples suggest, financial innovations aim to extend the set of exchange options in time, space and contents for the decision makers who introduce them. Financial innovations are adopted because, ceteris paribus, a larger option set is positively correlated with higher expected returns. Their systemic effects, however, may have negative implications such as financial instability, underinvestment in the real sector, unemployment, stagnation. When the negative consequences accumulate beyond a tolerable threshold, the remedy has been sought in stricter rules of self-regulation, or rather of regulation by law, or even in severe measures of financial repression." (D7.02: Vercelli, 2014d).

The analysis of a particular episode of financialisation would be misleading without thoroughly investigating its specific characteristics since, as we have emphasised, financialisation has never been homogeneous through time and space as it is affected by

cultural, material, and political conditions that vary in different times and regions. We may build, however, an ideal-type of the First and Second Financialisation aiming to capture in abstract terms some features that are similar in a few prominent countries in the same period. To this end, we have first to distinguish two channels through which finance influences the real economy: one extrinsic and one intrinsic. The extrinsic channel is as old as credit itself and aims to remove the cash-in-advance constraint characterising any monetary economy. In this sense, finance has always had a crucial power as a permissive condition of political and economic decisions. In the mercantilist period, big banks assumed a systematic role in supporting and conditioning the colonialist and imperialist policies of the most powerful states. This kind of extrinsic power exerted by finance is thus pre-existent to capitalism. However, this power became more systematic and more influential after the industrial revolution when credit became a crucial condition for industrial innovations, as was well understood by Schumpeter (1934 [1911]). During the First Financialisation, this power started to be exerted in a more systematic way, leading finance to play the role of coordination and orientation of capitalistic decisions (as emphasised by Hilferding 1981 [1910]). At the turn of 19th century, a few major investment banks became sufficiently powerful to play the role of private planning authorities. The influence of finance on the real economy, however, affected mainly which of the possible decisions would be implemented rather than their contents. However, the influence of finance became increasingly intrinsic during the Second Financialisation by systematically affecting the choices of non-financial firms and households in reference to their very contents:

"As Keynes foresaw in chap.17 of the GT, the logic of choice of any subject in any field is becoming more and more influenced by the financial paradigm of portfolio selection within a time horizon that is compelled to become as short as that of financial choices. The choices consistent with sustainability are thus becoming increasingly non-competitive as compared with alternative choices since they imply immediate costs and significant benefits only in a relatively distant future." (D7.03: Vercelli 2014b).

A second significant difference between First and Second Financialisation is rooted in the distinct role of banks: we may define the First Financialisation as "bank-based financialisation" while the Second Financialisation is rather a "market-based financialisation" (see Orléan, 2009, and 2014). This is not to say that in the Second Financialisation big banks had a subordinate role as they played, on the contrary, a crucial role in shaping and manipulating financial markets both directly (as clearly revealed by the scandals of Euribor, the unreliable ratings of crony agencies, the systematic use of "creative accounting", and so on) and indirectly (through governments and policy agencies conquered by "regulatory capture"). The crucial difference has been, however, that in the Second Financialisation bank and non-bank financial institutions have exerted their power in a more indirect way, while the financial motivations have become decisive even within the real economy.

A third crucial difference may be seen in the strategy of expansion of capital investment. During the First Financialisation, the prevailing capitalist strategy pointed to an expansion, with the help of the state, in new geographical areas (imperialism and colonialism). During the Second Financialisation, the expansion was not so much territorial, although new forms of imperialism and colonialism continued to play a significant role, but aimed mainly to the systematic "invasion" of the "territory" formerly occupied by the Welfare State (health, education, pensions, and so on). In particular the rules underlying the introduction of the Euro and the austerity policies implemented after the crisis went a long way towards the dismantling of the Welfare State in the EU, and the systematic privatisation of health, education, and social security services including pensions (D7.03: Vercelli, 2014e).

Finally, a fourth crucial difference has to do with the active role of powerful central banks in the Second Financialisation. The monetary policy inaugurated by Greenspan in 1987 and pursued afterwards by himself, Bernanke and most other central bankers, has significantly undermined the expected profitability of industrial investment as compared to that of financial investment. Central banks reacted immediately to any inflationary symptom observed in the real economy by adopting restrictive monetary measures (in particular by

promptly increasing the rate of discount), while on the contrary asset inflation was not repressed but rather encouraged by massive creation of liquidity whenever the upward trend of asset prices seemed undermined. This policy of "asymmetric monetarism" translated in an implicit insurance to financial investment and speculation crowding out industrial investment (Orhangazy, 2007; Cecchetti and Kharroubi, 2013). The wealth increase of financiers and rentiers sustained to some extent aggregate demand but not enough to compensate for the declining profits and wages in the industrial sector. The stagnation tendency that has prompted the process of financialisation has been eventually strengthened by financialisation itself (D7.03: Vercelli, 2014a; Vercelli 2016).

Based on the preceding analysis, we may conclude that during the "Second financialisation":

"the logic of finance has acquired an increasingly significant role in the economic decisions of all economic units: financial and non-financial corporations, government and households. Usually formulated with a negative connotation, the notion of financialisation as an "excessive" growth of finance, however, remains elusive and with vague operative implications. Financialisation generates a range of sources and risks of non-sustainability such as a short-term orientation in investment decisions and governance, lower incentives for productive real investments, regressive distributive effects, excessive financial leverage, systemic risks in financial markets as well as new challenges for protection of environmental services and their users." (D7.03: Gabbi and Ticci, 2014)

The nexus between financialisation and its concrete consequences in time and space are not a case of direct causality. Both may be seen, at least in part, as joint effects of the existing development and technological trajectories as shaped and orientated by the existing policy strategy. The ultimate cause of the crisis itself is not so much the direct effect of financialisation but of the existing development and technological trajectories, their interaction, and the underlying policy strategy (Vercelli, 2016).

In history, however, genuine ultimate causes are rarely detectable. In its turn, the choice of a policy strategy is the consequence of a host of factors which are in part subjective and

intersubjective (that is social and cultural) and in part dictated by objective conditions related to the existing development and technological trajectories. Some of these causal factors have been produced or strengthened by the policy strategies pursued in the past according to circular patterns of causality. We can understand this complex network of circular causality only within a long-period evolutionary framework and from an interdisciplinary point of view.

4. The energy system and the transition to a low carbon economy

Since the Industrial Revolution, the process of financialisation has in fits and starts expanded into many fields of human life (including labour, money and land) that had historically remained, at least in part, outside the market logic (Polanyi 1944). Subsequently, the logic of market has progressively extended from agricultural and manufactured products to land, built environment and the biosphere in general. The long-term process of financialisation has progressively transformed nature from an end in itself to a mere instrument.

The process of financialisation captured long ago the vital activity of energy production, distribution and consumption (referred to here as "energy system"). The Second Financialisation strengthened the link between energy and finance by making energy resources object also of systematic financial speculation. The energy system is nowadays a crucial field of interaction between nature (environment) and finance.

This deep link clearly surfaced during the recent Great Recession (2007-2009). The subprime crisis was triggered by the interaction between, on one side, the housing bubble increasing the financial vulnerability of economic units, and, on the other side, the spike in the price of oil, soon reflected in the price of food, because of the scarcity of environmental resources (see Vercelli, 2014b and 2016). Central banks reacted to the cost inflation triggered by the sudden increase in oil and food prices by increasing the discount rate. This policy move raised to a certain extent the entire structure of interest rates including those relevant for mortgage

rates. The ensuing increase in mortgage delinquency and foreclosure rates determined a spike in the supply of houses and a consequent precipitous fall of house and mortgage-based securities prices starting the propagation of the financial crisis to other economic sectors and countries, eventually determining what came to be called Great Recession. In particular, the crisis had an impact on climate action:

"On a positive side the crisis has triggered a theoretical and policy debate about Green Growth, one element of which is the idea of green stimulus that has seen its first implementation in 2009. On a negative side … climate action has taken a serious blow due primarily to a shift in public concern and political will. The lost political time was not made up by a fall in GHGs due to lower economic activity partly because of a shift to coal. Though crises are often opportunities and can be a symptom of underlying socio-technical transitions, unlike past transitions a transition to sustainable energy systems must be a largely policy driven transition. Unlike past transitions, the time frame available is much shorter. Given the centrality of policy guidance in this transition, the greatest damage associated with the Great Recession seems to come from the shifting government priorities" (Papandreou, 2014a).

In addition, the Fukushima accident, which occurred in March 2011, had a significant impact on the process of convergence towards a sustainable development trajectory:

"The Fukushima accident made evident, and further worsened, the shortcomings of the existing energy system based on fossil sources. In particular, it reduced significantly the current and prospective contribution of nuclear energy to the global supply of energy aggravating for a foreseeable future a trend characterised, according to many experts, by structural excess demand of energy. This effect is likely to last in the longer period since, in the absence of a major technological breakthrough; a new "nuclear renaissance" such as that started in the late 2000s seems unlikely in the near future. In any case, the necessary upgrading of safety standards in nuclear reactors and the downsizing of their contribution to energy generation has been, and will continue to be in the foreseeable future, a significant

factor of cost inflation that interacts with the ongoing recession jeopardizing a durable escape from it." (Vercelli, 2014f.)

More specifically, we have to acknowledge that the accident revealed a series of failures in the design of the Fukushima plant (unable to withstand the consequences of an earthquake such as that occurred in March 2011 and the ensuing tsunami). In addition, it revealed a shortsighted management of the crisis (late decision of using seawater to cool down the reactors), poor regulation (also due to regulatory capture), late and contradictory reactions of policy authorities. The deliverable D7.05 argues that a common root in all these shortcomings may be "found in the intrinsic instability of the nuclear energy generation process due to the critical dynamic nature of the nuclear chain reaction underlying the production of energy. The structural instability of the process implies strong risks that can be only partially mitigated with precautionary measures. This casts serious doubts on the viability of nuclear energy as cheap, clean and secure source of energy able to contribute to the mitigation of global warming. In any case, the cost of nuclear energy is due to increase significantly in consequence of the new security measures that will have to be taken after the Fukushima accident." (Vercelli, 2014c and f). Only a substantial technological breakthrough could re-launch the perspectives of nuclear energy in the next two decades or so.

Whatever has been the impact of the crisis and the Fukushima accident, the transition from the current energy system towards a low carbon economy will crucially depend on the evolution of energy prices that are linked to macroeconomic fluctuations:

"When taking a very long run perspective the key message is that energy prices have shown a steady decline, but that the price rise after 2005 may be ushering in a new era of higher prices. Oil price has a central role in the energy markets ... From the first major oil shocks in early 1970 oil prices have been closely linked to the macroeconomic recessions." (D7.06: Papandreou, 2014b).

According to the deliverable D7.06, we may draw some useful lessons from the history of oil prices:

"(1) with low energy/oil prices it will be more difficult to garner support for a low carbon transition, (2) high fossil fuel prices can make climate policy easier to pursue but without strong climate policies in place they may not be a boon to a low carbon energy transition as high oil prices can just as easily induce new exploration and development of oil fields or technologies, (3) there remains controversy about the likely trajectory of future fossil fuels though the 'conventional' wisdom expects a higher plateau, (4) modelling fossil fuel prices remains a daunting challenge but is an important part of forming an effective climate policy along with understanding the interaction of a carbon price (and other mitigation policies) with fossil fuel prices. Ultimately, we need a better understanding of the way that policy and system change affect the price of energy services rather than energy prices. When energy services associated with low carbon become cheaper or more attractive than their high carbon counterpart we will have forged the road to a low carbon economy." (Papandreou, 2014b).

5. Low carbon transition and the role of financial instruments

A specific policy issue investigated by WP7 has focused on whether and how new financial instruments could better support the transition to a low carbon economy. This investigation is based on the premise that the impacts of finance on the real economy are inherently ambiguous and highly contingent and that the use of financial instruments cannot be easily separated from the contexts and conditions that co-evolve with its deployment and governance. Of course finance and financialisation, and the associated modes of governance, can choose to fund unsustainable activities and fail to invest in sustainable activities. Some of the causal factors and processes that underpin the unsustainability of financial systems are systemic and structural. Without wishing to downplay the critical importance of these factors in any way, WP7 research has sought to focus on potential solutions. In particular, a research line explored some of the ways in which new modes of finance and governance

could better support sustainability, especially by intensifying and accelerating low carbon transitions (see D7.14 and D7.15: Gouldson, 2014 and Gouldson et al. 2015a; see also Gouldson et al, 2015b).

This research line began with an evaluation of the scale of challenge and an assessment of the size of the climate finance gap – that is the difference between the levels of low carbon investment that are needed to avoid dangerous climate change and the levels of low carbon investment that have actually been made in recent years. We acknowledge that there is a compelling global economic case for climate action (Stern, 2007). However, an effective response still requires enormous levels of investment and the general, long term, social case for action on climate change does not always translate into a specific, short term, private case for investment, while the availability of public funds is frequently constrained in contexts of austerity. These factors have led to levels of financing for low carbon developments that are much lower than many estimates suggest are necessary. The IPCC (2014) estimated that global investment in climate mitigation and adaptation was in the range of USD 343 to 385 billion per year in the period between 2009 and 2012, and Buchner (2013) suggested that global climate finance flows have plateaued at USD 359 billion. Both of these estimates equate to roughly 0.5% of global GDP; approximately one third of the upper end of the investment needs as estimated by McKinsey (2010), GEA (2012), WEF (2013), McCullum et al (2013) and IEA (2013a) and one quarter of the upper end of the investment needs as set out in the Stern Review (Stern 2007).

As well as acknowledging the scale and importance of the climate finance gap, WP7 research has stressed that the need for an effective response to under-investment in climate mitigation is pressing. As the years pass, decisions are being made that are locking the world into high carbon development paths for years to come, whilst at the same time long lived emissions continue to accumulate in the atmosphere and the opportunity to make investments that will help to avoid dangerous climate change diminishes. Indeed, the IEA (2013a, p.3) reported that 'the goal of limiting warming to 2°C is becoming more difficult and more costly with each year that passes'. To avoid dangerous levels of climate change, we

have to limit GHGs atmospheric emissions to no more than 450ppm, a level that is associated with a good chance of avoiding dangerous climate change (IPCC, 2014). The IEA (2013a, p.3) finds that 'almost four-fifths of the CO2 emissions allowable by 2035 are already locked-in by existing power plants, factories, buildings, etc. If action to reduce CO2 emissions is not taken before 2017, all the allowable CO2 emissions would be locked-in by energy infrastructure existing at that time.'

Given the scale of the climate finance gap and the need for urgent action on climate change, it is important to identify and evaluate the potential contribution of innovative financing arrangements with the potential to reduce the cost and enhance the impact of low carbon investments. An interesting case study is the potential contribution of revolving funds where the savings from investments in energy efficiency and other forms of low carbon development are captured and reinvested either to reduce the need for new finance or to increase the impact of available finance.

Although revolving funds have been proposed by agencies such as the International Energy Agency and the European Commission, there has never been a formal academic evaluation of the potential contribution of such funds. This lack of academic analysis is not unusual – indeed the IPCC (2014) notes that the scientific literature on investment and finance to address climate change is still very limited and that knowledge gaps are substantial.

To make the discussion less abstract and more practicable, we focus on the role that revolving funds could play in promoting energy efficiency in buildings. Globally, over one-third of all final energy and half of electricity are consumed in buildings that are therefore responsible for approximately one-third of global carbon emissions (IEA, 2013b). Energy use in buildings is therefore of critical importance, and many reports highlight the presence of cost-effective opportunities to improve their energy efficiency (IPCC, 2014). However, the IPCC (2014) noted that many, potentially attractive, energy efficiency investments do not meet the short-term financial return criteria of businesses, investors, and individuals. As a result, the IEA (2013b) predicted that without a concerted push from policy, two-thirds of the

economically viable potential to improve energy efficiency in buildings will remain unexploited by 2035.

The reasons for this inertia relate to the presence of strong barriers to change. The IPCC (2014) cited lack of awareness, imperfect information, split incentives, transaction costs, and inadequate access to finance, industry fragmentation, the need for new delivery mechanisms and the absence of pipelines of bankable energy efficiency projects as significant barriers. Focusing specifically on the financial barriers, the IEA (2013a) highlighted the importance of up-front costs, levels of risk, issues with interest and discount rates and the inadequacy of traditional financing mechanisms for energy-efficient projects. New forms of policy support, new institutional arrangements, new forms of finance, and new business models are therefore required if the energy efficiency opportunities in buildings are to be exploited (DECC, 2012; GEA, 2012; IEA, 2013a; IPCC, 2014).

The scale of the challenge is formidable – the IEA (2013b) estimated that over the next four decades USD 31 trillion would be required to promote energy efficiency in buildings at a rate that gives the world a good chance of limiting the temperature increases associated with climate change to 2°C. Whilst the IEA (2013a) suggests that 'it is widely recognised that mobilising huge investment into energy efficiency is essential' it also argues that 'offering advantageous financing mechanisms is likely to require public funds and these may be harder to justify with tighter public budgets' and that as a result mobilising private as well as public sector financing will be essential. In 2008, the IEA argued that one way of doing this might be to establish revolving funds for building refurbishment.

These issues are particularly relevant in Europe. The European Commission has set a target of reducing energy consumption by 20% by 2020, with performance assessed relative to business as usual projections that include assessments of background trends in energy use and energy efficiency (EU, 2012). It has also recognised that €100 billion a year will be needed to reach this target, and it has set aside €27 billion to support the transition to a low carbon economy through the European Structural and Innovation Funds and €265 million for a

European Energy Efficiency Fund. It has also recently established the Energy Efficiency Financial Institutions Group to find new ways of overcoming barriers and scaling up investment for new ways of supporting energy efficiency investments, particularly in buildings renovation (EEFIG, 2015). In each of these areas, there is a pressing need not only to make more funds available for energy efficiency and low carbon transition, but also to significantly enhance understanding of the ways in which those funds could be most effectively and efficiently deployed.

The European buildings sector is a central part of the wider drive to improve energy efficiency. Energy use in buildings accounted for 34% of total final energy demand in Europe in 2007, with the residential sector accounting for 23% and the commercial sector 11% (GEA, 2012). The European Commission (2011, p.8) stated that 'In Europe, the built environment provides low-cost and short-term opportunities to reduce emissions, first and foremost through improvement of the energy performance of buildings … emissions in this area could be reduced by around 90% by 2050'. It also stated that the buildings sector provides the second largest untapped and cost-effective potential for energy savings after the energy sector itself (EC, 2011). Like many other agencies and policy makers, the EC recognised the importance of finance and investment to implement the required transition to more energy efficient buildings. There is recognition that there needs to be a marked improvement in financial incentive structures and that 'Innovative programs will be needed to eliminate information barriers, reduce transaction costs and mobilise investment capital' and that smart financing schemes are needed that can leverage private sector investments (ECF, 2013 p16). Indeed, the European Union has stated that 'Public finance through innovative financing instruments, such as revolving funds, preferential interest rates, guarantee schemes, risk-sharing facilities and blending mechanisms can mobilise and steer the required private finance' (EC 2013, p.11).

Given the broader context as discussed above, our work has explored the case for the creation of revolving funds that could be used to increase levels and enhance the performance of investments in energy efficient and low carbon buildings in the UK. Based on

the development of a model designed to explore and illuminate the workings of a revolving fund, we considered the impacts that such a fund could have on the financing of a large-scale energy efficiency programme for the domestic sector in the UK. The results of the first stage of this research are published in Gouldson et al (2015).

The model was applied using realistic data on the costs and benefits of domestic sector retrofit drawn from a large-scale ex-post evaluation of the actual impacts of domestic sector retrofit activities (see Webber et al, 2015). The results show that the total funding required to fully deploying a range of energy efficiency and low carbon measures across the UK housing stock would be £33.7 billion. Obviously, this is a very substantial level of investment, but critically the results suggest that while £24.8 billion of this total would need to come from new capital, £8.9 billion could come from recycled investment based on savings that were recovered and reinvested. The results show that recycled investment could therefore make up 26.4% of the total investment needs over the lifetime of the fund.

In the context of a government that is actively pursuing an austerity agenda, the prospects for large-scale public sector investment in such a fund seem increasingly remote. However, our results also show that an ambitious domestic sector retrofit programme could essentially pay for itself, albeit with significant upfront investment requirements and over an extended period of time. This finding could be of great significance as it suggests that ambitious action on climate change, and very high levels of investment in low carbon transitions, need not be funded by the state. Ambitious action is therefore possible even in contexts of austerity. However, the state has to play an active enabling role, especially through policies designed to reduce risk and uncertainty in low carbon transitions.

As well as exploring the different roles that government could play in enabling significant levels of investment in low carbon transitions, this research has also considered the relative merits of different forms of private and civic action. In particular, it has examined the pros and cons of private, civic and community-based modes of finance and governance for low carbon transitions. WP7 research conducted a comparative evaluation of the characteristics

and outcomes of different applications of the revolving fund concept. In one instance, this investigation evaluated the outcomes of a private profit-driven scheme that has ready access to finance but invests only in commercially attractive low carbon measures. In another, it considered the outcomes of a civic not-for-profit scheme that has more limited access to capital but that invests in all viable low carbon measures. This investigation also considered the outcomes of a publically funded scheme that also invests in all socially beneficial low carbon options. Again the empirical case relates to the retrofit and energy efficiency up-grade of the domestic building stock in the UK.

The results of this investigation show that a public or civic scheme could have substantially greater impacts than a private scheme. Specifically, the research finds that a public or civic scheme generates approximately 4.7 times as much investment and 2.3 times as much carbon savings as the private scheme. Crucially, if a private profit-driven scheme was adopted first to exploit all of the cost-effective opportunities, the prospects for a further private or even a public or civic scheme to step in to invest in the less cost-effective measures that were left unexploited by the initial private scheme would be low. This is because the opportunities to cross-subsidise investments in the less cost-effective options with the returns from the more cost-effective options would have been removed. The early emergence of private profit-driven schemes could therefore be seen as a form of 'asset stripping' that will make longer-term transitions or deeper levels of decarburisation harder to achieve.

This investigation also argues that private schemes are likely to generate a series of negative social and behavioural spillovers that make collective action on climate change and on other issues less likely in the future, whilst civic schemes could generate positive spillovers and enhanced levels of social capital that do the opposite. We therefore call for greater support for civic investment, perhaps in the form of mutually owned, community based investment funds, and we highlight the opportunity for policy makers to put as much effort into the development of public-civic partnerships in the coming years as have put into the deployment of public-private partnerships in recent decades.

Summing up, innovative financing arrangements such as revolving funds--which capture and reinvest a share of the savings from low carbon investment--could enable very significant levels of low carbon investment. Indeed, FESSUD research shows that an extensive domestic sector retrofit scheme could be made essentially cost-neutral through the use of a revolving fund, albeit with significant up-front investments that would only pay for them over an extended period of time as energy savings come through. This research has also shown that the up-front investment costs of such a scheme could be significantly reduced through the creation of a revolving fund. Such a retrofit scheme could also generate wider social, economic and environmental benefits by tackling fuel poverty, improving energy security and reducing carbon emissions.

6. The growing diffusion of energy derivative contracts: implications for sustainability and regulation

Along with the new financial instruments supporting the transition to a low carbon economy, in the deliverable D7.12 WP7 research has explored the impact on sustainability of energy derivative contracts and the way they are traded. This analysis has been carried on in the light of the usual behaviour of agents (producers, merchants, processors, and end users on one side, money managers and financial traders on the other side). This investigation has focused on the shortcomings of the current regulation principles, the impact of commoditisation and financialisation of energy in terms of price volatility correlations. In the following deliverable D7.13 a re-regulatory framework aimed at stabilizing the markets is suggested.

The starting point of the analysis is the observation that the commoditization of energy resources (considered as a component of financialisation) has dramatically affected the energy market. Commodities markets have had massive economic impact on nations and people. Unusual disruptions caused by weather or natural disasters can not only be impulses increasing price volatility, but can also cause regional food shortages. The increasing use of financial contracts, particularly derivative contracts, on energy resources may have similar consequences.

Recently, a large stream of literature evaluated the co-movements among commodity prices and derivatives. Ghosh, Heintz, and Pollin (2011) demonstrate that the use of futures contracts and spot commodity prices had a large impact. They also conclude that regulators should design a set of rules "to enact and enforce policies capable of effectively dampening excessive speculative trading on the commodities markets for food".

Pradhananga (2015) shows that, as financialisation of the commodities futures market proceeded and more traders entered the futures market, market liquidity increased. Much of the rise in liquidity was due to increasing investment in commodity indices, which meant that futures and OTC contracts of unrelated commodities are considered as a portfolio asset. This increase in liquidity across different commodity markets, led to synchronised change and positive correlation in commodity prices. Pradhananga (2015) provides strong empirical evidence that the financialisation of the commodities market led to the recent rise in co-movement of (unrelated) commodity prices.

A significant factor to underline is the microstructure of agents trading commodity (and energy) derivatives. After the crisis, producers, merchants, processors, and end users were net short in futures positions on U.S. exchanges. This is consistent with the purpose to edge a position that is structurally long for their storage of commodities. On the other side, most index funds are "long only" funds whose value increases only when the prices of the underlying commodities rise. Investors in such instruments expect commodity prices to rise; money is lost if the values of the underlying commodities in the index decrease. Many of the

managers of index-style investments do not trade the individual components of an index on a daily basis; instead, they buy and hold these investments over periods of months or years, rolling contracts forward to avoid physical delivery.

During the financial crisis, markets experienced a dramatic increase in the correlation between crude oil and other commodities as demand decreased for raw materials. Both before and after the world economic slowdown, there were observable increases in the correlations between commodity prices.

Energy derivatives do follow the same pricing assumptions applied to "plain vanilla" derivative contracts, which is the non-arbitrage opportunities, based on the efficient market hypothesis. The real world experiences many factors deviating from rational expectations, such as, mismatch in asset/hedge maturities: long maturity of assets vs. short maturity of hedges; mismatch in granularity: fine (daily, hourly) granularity of assets vs. coarse granularity of hedges; mismatch in underlying commodity, "dirty" hedges; violation of normality hypothesis; fat tails. Moreover, there are many liquidity constraints: for example, price and execution time may depend on the volume, while distributions are hard to calibrate because of biases due to liquidity constraints. Therefore, different hedging strategies may produce different option values. The most important issue appears to be the unpredictable volatility, which seems to be affected by the diffusion of energy financial contracts. Unlike cash flows of financial products, the cash flows of energy assets are determined by complex operating strategies: dispatch strategy for power plants or injection/withdrawal strategy for gas storage. Therefore hedges are "dirty" and result in residual cash-flow variance.

Other determinants contribute to explain why volatility on energy has not reduced with the large use of derivative contracts. First, there is a need to match instantaneous demand with instantaneous generation because it is not possible to store electricity in any significant quantity; second, the demand and supply are inelastic. This is why energy prices are characterised by extremely high volatility, seasonal jumps and daily effect. Therefore, the time horizon of such instruments must be short.

Summing up, we have to reject the usual belief that the rise of derivatives usage reduced the price volatility of energy resources. On the contrary, the financialisation of the commodity and energy markets appears to be highly correlated with a jump in volatilities, as previously explained.

The growth of innovative products written on energy commodities, along with the role of financial players, shows how these markets have been highly financialised.The pricing of energy contracts is usually based on the absence of arbitrage opportunities that require perfectly efficient markets, but the empirical evidence demonstrates that most of these assumptions are inconsistent. Hedging is concretely difficult to execute because of the volatility jumps in most liberalised markets (especially for the electricity exposures). Because of the stochastic dynamics assumptions and the physical and geopolitical elements, which affect energy prices, the time horizon of speculators (and hedgers) necessarily must be very short.

Current regulation is designed to promote a process towards the realisation of the theoretical assumptions of efficient markets. This sort of regulation, for all the reasons previously explained, is unable to constrain destabilising speculation. Therefore, regulation should be re-designed to avoid this sort of speculation. The concrete solution can be found along the following guidelines:

1. Banning any naked position;

2. Imposing a clearing scheme for all the OTC contracts;

3. Forcing clearing houses to get physical collateralisation from clearing members (and the same for the non-clearing members involved in the trade);

4. Authorising to become market makers only the players able to guarantee the maintenance of bid-ask spreads within a regulatory level. This means a liquidity buffer requirements calibrated on the minimum volume of their cumulated trade. Their exposures could remain

naked within a pre-determined period of time, after which a physical energy position to hedge the derivative exposure must be taken;

5. Regulators are expected to monitor the volatility prices and to use "non-conventional" tools to suspend derivative trades and provide penalties to non-compliant agents.

7. Disembedment of money from the "real" economy of socio-ecological flows of matter and energy

A troubling aspect of financialisation identified in previous research is the historical process of separation between finance and the real economy. One task of WP7 research has been to grasp causes and consequences of this process and how they are understood in different approaches and schools of economic theory. A first step in this analysis deals with currencies as such. Commodity currencies have commonly been juxtaposed with fiat money, implying a development from primitive forms of money that required anchoring in a commodity to gain acceptance to more sophisticated monetary regimes based on confidence and trust. Hermele (D7.16: 2014) suggests that the idea of a gradual replacement of the former by the latter is an ahistorical construct: commodity and fiat monies have replaced each other over the millennia, and the latest craze for commodity currency was as recent as the 1920's when many European currencies were based on gold. Properly understood, money is a social relationship, whereby the anchoring of money in commodities over the centuries may be seen either as strengthening the social contract between the regent and the people, or as undermining it by reducing the space of politics by relying on automatic regulators. With the break-through of democracy in the early 20th century, the benefits of automaticity were increasingly questioned and finally abandoned in the 1930's.

The Bretton Woods regime, although based on dollar-gold convertibility, is from this perspective seen not as a commodity currency system but rather as one where politics took the lead over market forces. The demise of this era is often explained by the US misusing its de facto international currency monopoly. However, the crucial shift was rather the advent of neoliberal political domination which once again disembedded markets from politics, tying the hands of politics and thus of democracy.

The main deficiency of the current international monetary order, in this perspective, does not reside in the absence of a suitable anchor, such as gold, but in the disembedment of market forces, including rules governing the world's major currencies. Just as the embedding of post-WWII markets grew out of the dismal economic, social, political and military experiences of the interwar years, so too, a re-embedment of markets may ensue from the economic, social and political turmoil following the financial crisis of 2008. This analysis suggests that it is the political embedding of markets that policies should focus on, not the binding of currencies to a commodity anchor.

A second step in grasping the historical processes of disembedding finance from the real economy is to review various perspectives in economic theory. Hermele (D7.17: 2015) critically reviews Classical, Marxist, Neo-classical, Neo-Schumpeterian and Ecological perspectives on relations between the real economy and the financial economy. Following a key distinction made by ecological economists, three levels of the economy are highlighted: the financial, the real – where production of goods and services take place – and the 'real-real' – where the physical pre-conditions for the other two are situated. The analysis suggests that the three sectors cannot be understood in isolation from each other, and that some of the recipes for a resumption of healthy relations between finance and the real economy forget to anchor this vision in a clear understanding of the limits to growth analysed by ecological economists.

Attempts to strengthen the real economy for the most part lack an understanding of one of the salient traits of the real world: its materiality, its physicality, its 'real-realness'. Thus, an

old contradiction intensifies between economists who realise that the economy is an open subsystem of the natural world, and those who prefer to visualise the economy as an entity with no other limits than those imposed by "bad" policies. The physical limits of the real economy remain a fact of the real and real-real economy that most economists have hardly begun to grapple with. The analysis suggests that bringing finance into relations with the real economy that are beneficial for society requires attendance to the ecological dimension of the real-real economy, which is the very basis for economic activities and human welfare.

Finally, this task addresses the issues surrounding experiences with, and potentials of, redesigning money as a means to bring finance more clearly into the service of society and aligned with sustainability. To this end, Hornborg (2015) draws on research in semiotics and ecological economics to analyse ways in which money can be 'domesticated'. The phenomenon of money is, he suggests, recursively intertwined with central features of the human condition, from modes of cognition, religion, and morality to power, exploitation, warfare, and the nation state. The emergence of economics has reflected and reinforced historical processes of commercialisation and monetisation. The challenge for an economics concerned with sustainability ought to be how to respond to the problems posed by Nicholas Georgescu-Roegen's (1971) observations concerning the biophysical limits to economic growth.

General-purpose money makes all values commensurable, regardless of whether they pertain to the reproduction of human organisms, communities, ecosystems, or the world-system. A way of curbing the destructive social and ecological consequences of financialisation might be to more clearly distinguish local values (such as those concerned with food, shelter, energy, community, and place) from the values pertaining to global communication. General-purpose money is a peculiar kind of sign, impossible to classify as belonging to one of Peirce's three general categories of signs: index, icon, or symbol (Peirce was founder of semiotics as a formal branch of philosophy).

Since the marginalist revolution, mainstream economics has detached itself from two closely related concerns: namely, with the material substance and with the morality of trade. Heterodox arguments appealing to moral norms such as 'justice' and 'equality' are based on real asymmetries in the flows of embodied biophysical resources, whether labour time, hectares of land, tons of materials, or Joules of energy. The general historical trend toward a transition from metal through paper to electronic money has entailed a progressive separation of finance and monetary flows from 'real' flows of matter and energy. Economics thus needs to investigate the possible connections between financial crises and the declining 'net energy' or EROI (Energy Return on Energy Investment) in modern production processes.

8. Financialisation of Built Environments and Urban Sustainability

Built environments in Europe account for eighty to ninety percent of capital formation (stock, fixed) and about sixty percent of capital investments (flow, circulation) with the credit system functioning as essential mediating link between fixed and circulating capital (Sotelo and McGreal 2013). FESSUD Work Package 7 includes overviews of research into financialisation of the environment (D7.01: Clark and Hermele 2014) and of built environments (D7.19: Clark, Larsen and Lund Hansen 2015). The literature suggests similar structures and mechanisms underlying financialisation of both natural and built environments, and that these processes are associated with rent seeking in its broadest sense and the rise to ascendancy (again) of a rentier economy. This involves the disembedding of finance from the real economy and its natural preconditions (D7.16: Hermele 2014; D7.17: Hermele 2015; D7.18; Hornborg 2015), facilitated by rapid proliferation of innovative financial derivative markets, instruments and 'vehicles' (Harvey 2010).

WP7 research into financialisation of built environments highlights the characteristics of financialisation as a spatial process, forging social relations that form conditions for urban

governance, social geographic change and urban sustainability. Work Package 7 research furthermore underscores how financialisation of built environments is enmeshed with related processes of commodification, privatisation, rent seeking and accumulation by dispossession (Harvey 2014). Land rent and the creation and capture of rent gaps – gaps between potential land rents and actually capitalized land rents – are emphasised as central to understanding financialisation of built environments (D7.19: Clark et al 2015).

Where land (in its broadest sense, as space, environment, urban or rural) is commodified, privatised and opened up to rent seeking, tensions between potential and actual uses of land manifest in the exchange values of potential and actual land rents, forcefully directing flows of capital into built environments. This is also the case in societies with relatively large public sectors and welfare state institutions. Finance capital's constant seeking of rent in 'investment' opportunities has pushed political reforms to privatise and commodify spheres of urban commons built up and institutionalised over centuries. Exchange value considerations become the primary drivers of urban policy and development of built environments. By turning built environments into vast sources of unearned income (Sayer 2015), primarily interest and land rent, financialisation has turned the production, exchange and consumption of built environments into systems that create, reproduce and intensify inequalities.

Built environments have become machines for syphoning value from the real and real-real economies into financial wealth. The research suggests that unless the singular power of finance capital and landed developer interests is kept in check, any successes of urban politics (be they environmental, cultural, social or economic) will be valorised and captured by finance and real estate capital through the mechanisms of property markets. Sustainability thus becomes vulnerable to financial exploitation and an instrument of financial speculation, exacerbating asset bubbles. A policy implication of this research is that land and built environments need to be brought into the sphere of public property and urban commons, where use value driven investment decisions can be democratically anchored (Khan and Clark 2016).

FESSUD research into these issues includes case studies of financialisation of built environments in Ankara (D7.21: Topal et al 2015), Stockholm and Copenhagen (D7.20: Lund Hansen et al 2015), with special focus on housing, and how financialisation relates with shifts in urban governance and changing social geographies. These studies show that across different political, cultural and geo-historical contexts, financialisation of housing is associated with neoliberalisation of urban politics, social exclusion and displacement, and growing inequalities.

Grydehøj et al. (D7.22: 2015) brings together the three case studies in a comparative analysis of processes of financialisation of built environments in Copenhagen, Stockholm, and Ankara, with emphasis on entrepreneurial urban governance, housing policies and the sphere of cooperative housing. The motivation for focusing specifically on forms of cooperative housing is that cooperative housing represents a particularly interesting segment because of its position between the market and the state. Entrepreneurial urban governance is especially relevant to recent developments in these case cities, as the shift from managerialism to entrepreneurialism has involved privatisation and marketization of housing, opening up this major sector of built environments to the penetration of financial interests and decision-making.

In all three cases, post-war national governments assumed expanding responsibilities for the welfare of citizens, especially in the sphere of housing. Legislation and support to cooperative housing associations were implemented as means of rapidly expanding the urban housing stock. In Copenhagen and Stockholm, the challenge lay in creating a new kind of affordable housing for a new and well-organised urban working class. Ankara also lacked affordable housing, explosive growth finding a measure of relief in the proliferation of squatter settlements. Despite Western-style city plans, the relative lack of legal and administrative control over land use in and around Ankara permitted the informal spread of low-income housing in a manner that was not possible in the Scandinavian capitals.

Another common aspect of all three cases is that legal constructs and programmes designed to provide affordable housing came under pressure to be reformed along lines rendering them vulnerable to financialisation. Legal changes in the Danish and Swedish cooperative tenure were clearly aimed to open this sector of the housing market for the flow of credit and financial investment. The historically rooted use-value oriented ideals of cooperative housing, which had been maintained by a legal framework friendly to associational property ownership, was displaced in order to install a new order of exchange-value orientation. Also in Ankara, policies geared to support forms of cooperative housing have fallen by the wayside, as housing subsidies have been channelled to private companies producing housing and amenities for high-income residents. These shifts in housing policy are associated with a broader shift in urban politics from urban managerialism to urban entrepreneurialism. The branding and selling of cities under the discipline of urban competitiveness; the 'need' to attract capital investment and the 'creative class'; municipal sell-outs and privatisation of services, institutions and built environments: this has been the context within which financialisation of built environments in Stockholm, Copenhagen and Ankara has played out, and in which changes in cooperative housing have played an important role.

Beyond these case studies, empirical analysis of cities across Europe (and globally) suggest that financialisation of built environments can be conceptualised as a generic process encompassing many variegated sets of institutional arrangements and social relations (D7.23: Farahani and Clark 2016; cf. Clark 2015). The contingencies surrounding and forming the process give rise to different political, social and environmental impacts, which do not fit easily into the categories of ideal types, and yet cannot be adequately understood as unconnected to related processes extending across geopolitical scales.

The political impacts of financialisation of housing are enmeshed with variegated neoliberalisation, manifesting in multifarious transformations toward entrepreneurial forms of urban governance. Cities are commodified, branded, and strapped to the dictates of inter-urban competition: attract capital and "the creative class", or suffer the consequences. Urban politics is furthermore impacted by growing inequalities associated with

financialisation, as consolidations of economic power appropriate and subsume processes of democratic decision making.

The social geographic impacts of financialisation of housing – social polarisation, with growing homelessness, slum formation and 'urban decay' at one end, and intensifying gentrification and absentee ownership of extravagant housing at the other end – are intertwined with the political impacts, which reinforce financialisation of housing as part and parcel of entrepreneurial urban governance. Housing is increasingly considered a pure financial asset, and decisions over housing production and distribution are made in terms of its exchange value rather than its use value. Decisions to 'invest' in housing become investor-oriented, geared to secure increasing exchange values for rentiers, rather than object-oriented, geared to the use values and basic needs of people associated with social reproduction.

The impacts of financialisation of housing on urban sustainability are the least researched and most difficult to pin down, not least due to the elusiveness and co-opted character of sustainability. Financing investments in 'green' and 'sustainable' built environments is an important element of the larger sphere of environmental politics, not least climate change and carbon politics. But while there have been significant achievements and valuable measures taken in this direction, there is an urgent need to further develop and utilise these achievements (Gouldson 2014; Gouldson et al 2015). There is also much evidence of greenwashing both existing built environments and new investments, without substantial basis for the claims: narratives of branding green and sustainable cities are widely used to "sustainability-enhance" investment vehicles and their underlying real estate values. Though difficult to answer unequivocally, it is important to ask: who is served by the increasing *aestheticisation* of "green" values (D7.24: Grydehøj 2016), and what are the actual environmental impacts of green flagship urban developments, including the faraway sources of commodity chains and material flows making the lifestyles in these places possible (Anderberg and Clark 2013; Clark and Hermele 2014)?

9. The environmental policy in a financialised economy: viability, alternative approaches, and the case study of the EU-ETS

The WP7 deliverables confirm that there is a significant convergence on the main features of a much-needed sustainable model of development. Examples of a broad agreement between experts of different disciplines and policy makers of many countries may be found in recent documents approved by the UN Assembly (see for example United Nations, 2012; UNFCC, 2015). What is missing is a sufficiently wide agreement on the actual implementation of a concrete path of transition from the current model of development to a sustainable target to be reached. This involves the difficult choice of priorities, weights, instruments that have huge implications for conflictual interests and preferences.

When environmental policy started to be implemented in the 1970s, the first instruments to be systematically adopted have been "command and control" (C&C) instruments. Their efficacy has been increasingly questioned in the 1980s and 1990s when the confidence in free markets progressively surged to new heights. In consequence of this change of attitude, environmental policies shifted towards market-based instruments, such as environmental taxes and tradable permits, believed to be in principle more efficient and less distortionary instruments. Economic theory argued that these instruments are consistent with free market principles as they internalise the negative externalities that otherwise would jeopardise the correct functioning of free markets (Pigou, 1920). In addition, they are believed to play the crucial role of completing the markets (Coase, 1960).

In recent years, however, even market-based instruments showed their weak points. First, it is difficult to identify and measure the externalities that these instruments are supposed to internalise. In addition, environmental taxes, believed by many environmental economists to be in principle the most efficient instrument (Nordhaus, 2007), are considered today to be

hardly implementable taking account of the strong hostility to new taxes shown by most citizens. In many countries, early attempts at introducing carbon taxes to reduce the emissions of GHGs have been abandoned in favour of a system of tradable permits affecting directly only one section of decision makers in commerce and industry. Their influential opposition, however, has often impaired the correct implementation of the tradable permits schemes.

A case in point is the European Emission Trading System (EU ETS) that represents the cornerstone of the European Union's policy to combat climate change adopted since 2005. This scheme has been so far the most ambitious and comprehensive plan of this kind. However, the deliverable D7.08 argues that:

"Despite being a prototype for other countries, the EU experience has shown a mixed skylight, characterized by flashing lights and dark shadows. While the emission reduction target for 2020 (-20%) has already been achieved by the EU, the estimated emissions reductions are likely to depend mainly on the worldwide economic recession that has significantly reduced industrial production (and consequently the resulting GHG emissions) rather than on carbon markets that have proved to be highly volatile" (Borghesi and Montini, 2014a).

Notwithstanding the serious shortcomings observed in the EU application of tradable permits, similar schemes have been subsequently adopted in many other world areas (namely the Regional Greenhouse Gas Initiative (RGGI), the Californian Cap and Trade System, the Australian Carbon Pricing Mechanism (CPM), and the Quebec Cap and Trade System (see Borghesi et al., 2016). Many other emission trading systems, moreover, are rapidly emerging in further world areas, such as Japan, South Korea, Kazakhstan, Switzerland, New Zealand, Mexico, and so on (Newell et al., 2013). Between 2013 and 2014, also China started implementing seven pilot projects in selected cities or provinces (Beijing, Tianjin, Shanghai, Chongqing, Guangdong, Hubei, Shenzhen) with the goal of developing a nation-wide ETS in the future. The new ETSs that are rapidly spreading at the world level

take account of some of the shortcomings of the EU-ETS introducing promising innovations. This creative process of imitation could possibly transform the EU from forerunner to follower in the ETS context, unless the EU will introduce similar innovations to improve the performance of the EU-ETS scheme (see D7.08 and D7.09: Borghesi and Montini, 2014a and 2014b; see also Borghesi et al., 2016).

The crucial and unsolved problem, however, is that an efficient tradable permits scheme to reduce GHGs emissions should be as global and homogeneous as possible. As the deliverable D7.09 maintains, there are three possible options: "(i) a worldwide ETS; (ii) a global network of regional/domestic ETS regimes; (iii) a linkage scheme between interacting regional/domestic ETS blocks." (Borghesi and Montini, 2014b; see also Borghesi et al., 2016). Unfortunately, none of these options seems now politically viable.

In recent years, the viability of environmental policy itself, even by means of market instruments, has been questioned because of general theoretical and empirical arguments (Vercelli, 2016). Two of them have been considered in the WP7 deliverables in some detail: the Jevons paradox (recently generalised under the name of "rebound effect"), and the Sinn paradox (also called "green paradox").

Jevons, one of the most famous economists of his time, as early as in 1866, argued that "It is a confusion of ideas to suppose that the economical use of fuel is equivalent to diminished consumption. The very contrary is the truth." (Jevons, 1866). This argument has been recently developed and generalised under the name of "rebound effect". An increase of efficiency in the use of energy, and/or a reduction of its relative price, may bring about an increase in the consumption of energy. This argument is usually presented as a reason against environmental policies at least in the field of energy efficiency and climate change control (claiming that, for example, an increase in the fuel-efficiency of cars encourages indulgence towards a greater displacement or more driving or higher speed). The empirical evidence, however, does not corroborate the strong version of the Jevons paradox as the rebound effect is generally found to be significantly less than 100%. In addition, the

downward influence of growing fuel efficiency may be easily offset by apt measures such as a tax that keeps constant the cost of fuel.

The deliverable D7.11 by Basosi and Ruzzenenti (2014) investigates the rebound effect in the European freight sector finding that, by using the standard econometric methodology, the rebound effect has a value of about 40% globally and 38% on cross-border trade. These results do not confirm the futility of the policies of internalisation of carbon externalities pursued in the EU, but confirm their weakness. However, by using a different innovative methodology based on network analysis, the cross-border rebound effect almost disappears (ibidem).

Sinn has recently generalised the argument based on the rebound effect to criticise the environmental policies pursued in recent decades, in particular in Europe. He argued that strategies of energy demand reduction, such as those pursued by the EU, "simply depress the world price of carbon and induce the environmental sinners to consume what the Kyoto countries have economized on. Even worse, if suppliers feel threatened by a gradual greening of economic policies in the Kyoto countries that would damage their future prices, they will extract their stocks more rapidly, thus accelerating global warming." (Sinn, 2008, p.360).

This "green paradox", as Sinn called it, casts serious doubts on the efficacy of green policies, at least in their usual demand-side approach. These policies based on incentives to energy saving and efficiency risk to be "self-defeating" (D7.05, D7.08, and D7.09: Papandreou, 2014a, c, and d). The green paradox, however, does not deny the possibility of a more efficient environmental policy, provided that its design takes into account all the economic fundamentals including, as Sinn himself emphasizes, the supply conditions neglected or underplayed by the existing policy strategy.

The deliverable D7.10 investigates the effectiveness of environmental policy to encourage eco-innovations (EI) in reference to the EU-ETS system:

"While the specific effect of the EU-ETS on GHG emissions can be hard to disentangle, its impact on EI and thus on the firms' capacity to abate pollution can be the object of a more direct investigation, both on the theoretical and on the empirical side. Carbon pricing can persuade the most virtuous firms to invest in new technologies, with a twofold goal: firstly, to avoid purchasing costly tradable permits; secondly, to sell, and thus monetize, the available permits in excess. Furthermore, innovative firms can gain early mover advantages from being at the forefront in the cap and trade market. This can allow them to acquire a dominant position, derived from the capacity to anticipate competitors in the implementation of environmentally friendly innovations (eco-innovations). The incentive to invest in low-carbon technologies, however, is diminished if the carbon price is low or extremely volatile. In the former case, this is because a low carbon price leads firms to keep using the old, polluting technologies and buy pollution permits rather than shift to new environmentally friendly technologies. In the latter case, it is because high price volatility generates uncertainty about the actual profitability in investing in the new technologies, and about the expected advantages of eco-innovations." (Borghesi and Montini, 2014c; see also Borghesi et al 2016, p.79).

By analysing the latest European Union Allowance (EUA) unit price trend, it is possible to understand why European firms are not stimulated to invest in EI due to low carbon price values and high price volatility. The EU could upgrade and fine-tune its ETS setting both a EUA price floor and a EUA price ceiling to combat the negative effects produced by price volatility and to better support the introduction on large scale of EI. As Borghesi et al. (2016, p.80) point out "Mixed evidence and no unanimous consensus emerges from the literature that is still in its early stages of development as it generally focuses on the early phases of the EU-ETS due to a time lag in the data availability. In the near future, it will certainly be possible to derive more precise and robust indications from the empirical analysis as the EU-ETS experience goes on and longer time series of data become available for more refined analyses. In general, however, the main conclusion that can be drawn so far is that the EU-ETS had at most a very weak impact on EI."

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10. Finance and sustainability: open problems and policy recommendations

Taking account of the shortcomings of market-based instruments as experienced in their recent concrete application, many deliverables of WP7 argue that the ideal policy mix of environmental policy should resume a more systematic use of command-and-control instruments (see in particular Clark and Hermele, 2014). For example, with regard to financialisation of built environments, a crucial policy implication of WP7 research is that land and built environments need to be brought into the sphere of urban commons, where use-value driven investment decisions can be democratically anchored (Clark et al 2015; Lund Hansen et al 2015; Topal et al 2015; Grydehøj et al 2015; Khan and Clark 2016). Social and environmental sustainability can be strengthened by securing the right to housing and the right to the city, which in turn requires bringing urban land, built environments and financial institutions engaged in financing production of built environments under public ownership, or at least under significantly stronger public control and regulation (see D7.24: Grydehøj, A. 2016).

This is not to say that policy makers should forsake market-based instruments. However, the latter should be better coordinated with the instruments and constraints of direct regulation. A case in point is the EU-ETS system discussed in the preceding section. Two main policy recommendations clearly emerge from the analyses performed in the deliverables D7.08-D7.10. In the first place, the EU ETS needs to be reformed by introducing a price collar, namely, both a price floor and a price ceiling that limit the high variability that has been observed over the initial phases. This reform seems particularly important since empirical evidence shows that presence of a price floor contributed to prevent carbon price from collapsing in the other ETSs in which this mechanism was introduced (Borghesi et al., 2016), while a price ceiling would contribute to reduce the uncertainty of entrepreneurial decisions. This suggestion is an example of how the use of market-based instruments can

be coordinated with measures of direct regulation to increase the effectiveness of environmental policy.

Within a more comprehensive policy framework, which is the contribution that finance may offer to increase the environmental sustainability of development? Policy makers may adopt, or encourage the adoption, of new financial instruments, but their efficacy is always constrained by quite strict conditions. In section 5, for example, we have seen that an extensive retrofit scheme can be made essentially cost-neutral over time through the creation of a revolving fund, albeit with significant up-front investments that would only pay for themselves over an extended period. The initial investment requirements could be significantly reduced through the creation of such a fund, while the savings realised would be sufficient to fund significant incentives schemes to encourage participation. Innovative financing arrangements such as revolving funds could therefore enable states with limited capacity (see Gouldson, 2014).

Many obstacles slow down the necessary rapid transition from the current unsustainable energy system based on the use of fossil fuels to a new sustainable energy system based on renewable energy sources. Some of these obstacles are related to the diffusion of financial derivatives written on energy underlying assets (see section 6). Their pricing models assume the non-arbitrage hypothesis, although the empirical evidence shows significant deviations from the standard assumptions, such as the mismatch in asset/hedge maturities, and the violation of normality hypothesis. Moreover, the unpredictable volatility of energy prices in liberalised markets shows that it is hard to calibrate hedging in the medium-long run. The deliverables D7.12 and D7.13 argue that it is necessary to re-design the regulation of energy derivatives (i) banning naked positions; (ii) imposing a clearing scheme for all the OTC contracts; (iii) requiring clearing houses to get physical collateralisation from clearing members; (iv) authorizing to become market makers only the players able to guarantee the maintenance of bid-ask spreads within a regulatory level. The new regulatory framework should also attribute to regulators and supervisors non-conventional tools to suspend derivative trades and provide penalties to non-compliant agents (see section 6).

This example confirms that policy makers should act consistently to shift the bulk of financial flows from speculation to a renewed role of support to the real economy accelerating the transition to a sustainable development trajectory. In particular, as argued in section 5, they should take urgent steps to close the "climate finance gap", that is the difference between actual and required investment to mitigate climate change. Although the required levels of investment are very significant, the costs of not making these investments are likely to be much greater. The flows of finance into climate mitigation and adaptation are approximately 1/3 of the level needed to avoid dangerous levels of climate change. In the existing scenario, even profitable low carbon investment opportunities are systematically overlooked. In the buildings sector, for example, the IEA forecasts that, without extra policy support, 2/3 of the economically viable potential to improve energy efficiency in buildings will remain unexploited by 2035. Innovative financing arrangements such as revolving funds could enable major public interest programmes to be undertaken in ways that both significantly reduce the need for new public investment and that even render substantial programmes cost-neutral over time. In particular, revolving funds could enable states with limited capacities and resources to act in contexts and on issues where action might otherwise be impossible, particularly in an era of austerity.

Other monetary and financial innovations may contribute to accelerate the transition to a sustainable development trajectory. For example, the deliverable D7.18 argues that electronic money could open new possibilities to design currencies that promote equality, democracy, and sustainability, while insulating people's basic material needs from the vicissitudes of financial speculation. The shortcomings of earlier experiments with alternative currencies provide a foundation for trying to design and implement a complementary currency system that is fair, widely utilised, government-regulated, easily administrated, and efficient. It is conceivable that national authorities could issue a complementary currency, which can only be used to purchase locally produced goods and services, and to distribute it as a basic income to all citizens (Hornborg 2015a, 2015b).

Notwithstanding these and other interesting and constructive examples, the main contribution of finance to environmental sustainability is still that of providing an adequate support to the huge investments necessary to converge towards a more sustainable development trajectory. As the deliverable D7.03 argues, "The transition to a sustainable model of development crucially depends on the quantity and quality of investment and this in turn crucially depends on the adequate support of the financial system. In order to use investment as a concrete lever to push towards sustainability the existing trajectory of the economic system we have to grasp the nexus between the existing development trajectory and the ongoing technological trajectory. The understanding of this nexus provides valuable insights on the requirements of a financial system able to support a sustainable model of development and a rapid transition to it." (Vercelli, 2014e). The financial system should support in particular the so-called eco-innovations referring to any product, process or organisational innovation that is more environmental friendly than relevant alternatives. The most relevant investment, namely "strategic investment", produces all its benefits only in the very long period. In addition, its benefits are typically public goods that private investors may only partially appropriate. The expectations of the costs and benefits produced by the process of strategic investment typically extend along many decades and are subject to strong, even radical, uncertainty. In consequence of the process of financialisation, private investors take decisions within a progressively shorter time horizon and are strongly uncertainty averse (see Vercelli, 2016). This explains why "from the development of aviation, nuclear energy, computers, the Internet, biotechnology, and today's development in green technology, it is, and has been, the State – not the private sector – that has kick-started and developed the engine of growth" (Mazzucato 2013, 13).

As is well known, financial markets are reluctant to finance innovation investment, the more so the more radical is the departure from existing routines. This is because the expected returns on innovative investment are not only risky but also very uncertain in the sense of Knight and Keynes. This has a series of consequences that discourage innovative investment. First, credit ratings focus on the financial performance of the firm rather than on its

industrial performance: "in some cases, it is the most 'productive' firms that have the worst credit ratings, perhaps due to their greater spending on long-run growth investments" (Demirel and Mazzucato 2014, 51). In addition, the widespread practice of stock 'buybacks' in the interest of shareholders and top managers (particularly if the latter are endowed of generous stock options) has been found to be detrimental to R&D spending. The recent crisis increased the bias against innovative investment as the enhanced uncertainty aversion of lenders produced an increase in the cost of credit that hit the innovative firms more than the non-innovative ones (ibidem). Finally, the kind of strategic innovative investment that may accelerate the transition towards sustainable development has a long-run time horizon as its most significant returns are destined to emerge much beyond the short-term horizon of finance. This contributes to explain why private investment often keeps aloof from this sort of strategic investment.

There is one possible way out from this problem. The government, as representative of the long-term interests of all the citizens, has to play the role of catalyser for the strategic innovation necessary for a new sustainable trajectory. Contrary to some well-publicised myths, this is what happened in the past: "for example, the infrastructure of the ICT revolution, laying the basis for the Internet, was lavishly funded by the State from its beginning stages until it was installed and fully functional and could be turned over for commercial use" (Perez 2013, xxii).

Either the Government has to intervene by investing directly in the strategic sectors to enhance sustainability, or by financing the relevant private investment, or by providing incentives and insurance for private investors and lenders able to correct the market distortions mentioned above. These different channels of intervention do not exclude each other and are likely to have synergic effects. In the US, for example, the state played a crucial role in all the most significant innovations since World War II through specific agencies and initiatives.

A significant recent example is the policy recently pursued in Germany to develop solar PV that made it the world leader in this field: " . . . by revising its feed-in tariffs (FIT) policy in 2000 to provide better pricing for solar PV . . . Germany made solar PV competitive with traditional power sources and even wind energy. At the same time, Germany also established a '100,000 roofs' programme to encourage residential and commercial investment in the technology . . . Germany grew its solar PV capacity from just 62 MWs in 2000 to over 24,000 MWs by 2011. This is similar to completing 24 nuclear power plants in about 10 years . . . " (Mazzucato 2014, 156).

Public finance has thus a crucial role to play in the field of strategic investment for sustainability. Investing in strategic technology implies uncertain returns and unavoidable mistakes. It is thus encouraging to see that the public banks providing "patient capital" show often very good results even in the light of mere standard accounting. The BNDES, for example, has been earning record-level returns: the return on equity (ROE) in 2010 has reached the remarkable rate of 21.2% allowing not only the refinancing of strategic investment but also much needed investment in health and education (Mazzucato, 2014, 5). Analogously, the Chinese development bank catalysing the country's investment in the green economy obtained excellent results (ibidem). Similarly, in 2012 the Kreditanstalt für Wiederaufbau (KfW), the German state investment bank, reported $3 billion in profits.

The intervention of the state as catalyser of the investment required to implement the transition to a sustainable development trajectory is thus not necessarily inconsistent with the public debt problems haunting many countries.

11. Concluding remarks

Financialisation poses new challenges to ecological, social and economic sustainability, regardless of whether we consider it a novel or a recurrent phase of capitalist development.

We may distinguish two basic paradigms on the issue under discussion, each of which has many variants. According to the viewpoint of mainstream economics, financialisation is a physiological process contributing to the welfare of economic agents provided that it is introduced, promoted and self-regulated by unfettered markets. In this view, sustainability (conceived as mere "steady growth" of GDP) is guaranteed by market-led technological progress. This view is criticised by various heterodox streams. Typically, they distinguish sharply two different aspects of finance, a physiological one of support to the real economy and a pathological one of self-referential speculation. The work done in WP7 confirms that the increasingly strict link between financialisation and sustainability has far-reaching implications. Its causes and consequences may be understood only by taking a long period, interdisciplinary and evolutionary approach.

The results of WP7 deliverables converge to show that the process of financialisation, as occurred in the last three decades, is inconsistent with sustainability. Actually, the second financialisation started in the early 1980s has significantly altered the balance between physiological and pathological functions of finance in favour of the second. Sustainability may thus be reached only within a model of development radically different from the existing one. In particular, sustainable growth cannot be recovered within a business-as-usual perspective, as many current policies seem to believe.

Summing up the view emerging from the research done in WP7, financialisation as a variegated and evolutionary process has clear implications for the sustainability of development. Sustainability, in all its definitions, is about the compliance of the process of development with well-defined economic, social, and environmental constraints. Therefore, the compatibility between financialisation, which is about the relaxation of constraints to economic decisions, and sustainability that is about compliance with crucial constraints, is in principle problematic. This does not imply, however, that the conflict between finance and sustainability is necessarily insurmountable. Finance could, and should, give a fundamental contribution to a rapid transition towards a trajectory of sustainable development and provide the necessary funding for its deployment by making possible the massive investments

necessary to reach these goals. This requires, however, a radical reform of finance by constraining its growing self-referentiality and by channelling its activity at the service of the real economy in the direction of a new trajectory of development consistent with sustainability.

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THE ABSTRACT OF THE PROJECT IS:

The research programme will integrate diverse levels, methods and disciplinary traditions with the aim of developing a comprehensive policy agenda for changing the role of the financial system to help achieve a future which is sustainable in environmental, social and economic terms. The programme involves an integrated and balanced consortium involving partners from 14 countries that has unsurpassed experience of deploying diverse perspectives both within economics and across disciplines inclusive of economics. The programme is distinctively pluralistic, and aims to forge alliances across the social sciences, so as to understand how finance can better serve economic, social and environmental needs. The central issues addressed are the ways in which the growth and performance of economies in the last 30 years have been dependent on the characteristics of the processes of financialisation; how has financialisation impacted on the achievement of specific economic, social, and environmental objectives?; the nature of the relationship between financialisation and the sustainability of the financial system, economic development and the environment?; the lessons to be drawn from the crisis about the nature and impacts of financialisation? ; what are the requisites of a financial system able to support a process of sustainable development, broadly conceived?'

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THE PARTNERS IN THE CONSORTIUM ARE:

Participant Number	Participant organisation name	Country
1 (Coordinator)	University of Leeds	UK
2	University of Siena	Italy
3	School of Oriental and African Studies	UK
4	Fondation Nationale des Sciences Politiques	France
5	Pour la Solidarite, Brussels	Belgium
6	Poznan University of Economics	Poland
7	Tallin University of Technology	Estonia
8	Berlin School of Economics and Law	Germany
9	Centre for Social Studies, University of Coimbra	Portugal
10	University of Pannonia, Veszprem	Hungary
11	National and Kapodistrian University of Athens	Greece
12	Middle East Technical University, Ankara	Turkey
13	Lund University	Sweden
14	University of Witwatersrand	South Africa
15	University of the Basque Country, Bilbao	Spain

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