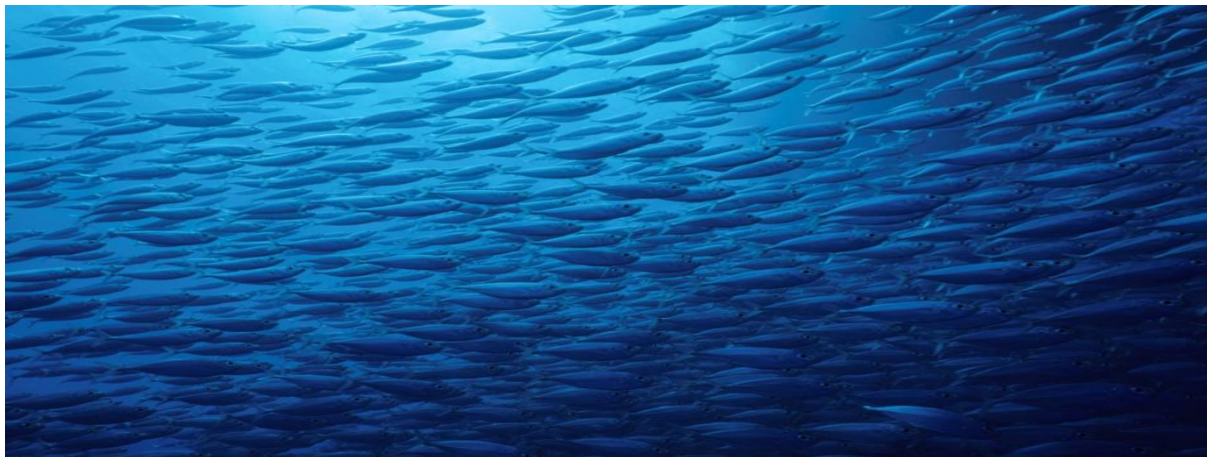Decoupling growth from resource use
and environmental impacts

The Use of Paradigms in DYNAMIX

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ACKNOWLEDGEMENT & DISCLAIMER

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DYNAMIX PROJECT PARNTERS

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List of Abbreviations

DCLG	Department for Communities and Local Government (UK)
Defra	Department for Environment, Food and Rural Affairs (UK)
NGO	Non-governmental organisation
UNEP	United Nations Environment Programme
WP	Work Package

1 Introduction

This paper forms deliverable 1.1 of the DYNAMIX project '*Preliminary list of paradigms affecting resource use and efficiency in the EU*'. It introduces the concept of paradigm to the DYNAMIX project and provides working definitions of the key terms within the associated social system of paradigm change. Finally it sets out how these will be applied within the DYNAMIX work packages.

1.1 An introduction to paradigms

Paradigm is a term that has come to be used loosely with a range of different meanings, synonymous and interchangeably with belief, concept, theory, and even tradition, practice, or attitude. In broad terms, an individual or group of people's paradigm is the worldview – the set of sometimes unconscious values, beliefs and ideologies – in which they are immersed and which they use to navigate any new evidence, challenges or choices with which they find themselves confronted. Paradigms manifest themselves externally via discourses and are reinforced within society via the creation of social technical systems.

1.2 A note on definitions

This paper defines a number of key concepts which are relevant to the application of paradigms in DYNAMIX. Whilst care has been taken to ensure consistency with existing uses of these terms, a review of the literature in this area highlights a lack of consistency in the use of some of the concepts among authors and, in some cases, with important concepts being used interchangeably. Indeed, an exploration of these issues has revealed that a given concept can justifiably be categorised differently depending on the context. In any case, the definitions provided here should be seen as working definitions to be used within the DYNAMIX team and should be carefully defined in any future stand-alone publication.

2 Scientific and socio-cultural paradigms

Paradigms exist across society in different shapes and forms. In this section, we make a key classification of paradigms into two subcategories: *scientific paradigms*, which encapsulate those paradigms held by scientists and professionals in both the natural and social sciences; and *socio-cultural paradigms* which represent the remaining non-technical ideologies, beliefs, and values of society. Scientific paradigms, as indicated above, can be further divided into *natural science paradigms* and *social science paradigms*. These distinctions arise initially from the historical emergence of the term paradigm (from its early popular use with regard to trends in the natural sciences, e.g.: Kuhn 1962) but, importantly, also serve to group different types of paradigm in terms of the actors associated with them (e.g. social scientists, natural scientists, laypeople[1]). Differentiating paradigm types by actor in this way helps to lay the foundations for an analysis of interactions between different groups of actors and paradigms, and the role of different groups of actors in achieving widespread paradigm shifts.

2.1 Socio-cultural paradigms

The concept of socio-cultural paradigms as defined here represents a particular philosophy of life or a framework of ideas, beliefs and values through which a community or an individual interprets the world and interacts with it. The term often reflected in (and reflects) religion and political ideology. Unlike scientific paradigms, which tend to be clear-cut and incommensurable with one another, it is quite common for there to be a number of socio-cultural paradigms within society, apparently contradicting one another. Socio-cultural paradigms have the capacity to create their own stability when collectively held; with observable behaviour reinforcing the prevailing world view held by those around you. So for example, if one lives in a society dominated by an altruistic type paradigm, not only will one's nurturing reward altruistic behaviour, but also other's altruistic behaviour will confirm this view of how the world works. This therefore makes culture and cultural differences essential in permitting different world views to exist and paradigm shifts to occur when cultural exchange occurs.

Examples of socio-cultural paradigms relevant to resource efficiency include the New Environmental Paradigm, which incorporates the concept of "limits to growth" and a rejection of the notion that nature exists solely for human use (Dunlap and Van Liere 1978).

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[1] When modeled operating outside of their professional capacity, scientists also hold socio-cultural paradigms. Since science conducted by an individual will inescapably involve some degree of subjectivity, scientists are also subject to some degree of bias from their own socio-cultural paradigm as they develop, implement, and work within their scientific paradigm.

2.2 Scientific paradigms

Thomas Kuhn popularised the concept of paradigm in his book *The Structure of Scientific Revolutions* (Kuhn 1962). Kuhn described the development, progress and lifecycle of science in terms of the broad scientific community's strength of conviction in a set of prevailing theories or methods: a dominant paradigm. Kuhn postulated that science goes through alternating periods of stability and changeability - in which a combination of factors, such as the emergence of new contradictory evidence and the availability of alternative plausible hypotheses, may coincide to provide more favourable conditions for the shift to a new paradigm.

Commonly-used examples of paradigms and paradigm shifts in the natural sciences include: the Copernican revolution in astronomy, denoting the shift from the majority acceptance of an Earth-centric solar system to a Sun-centric model; and in mechanics, the yielding of Newton's laws of motion to Einstein's theory of relativity.

The concept of social paradigm was introduced within a social science context by Handa (1986). Social science paradigms represent a subset of scientific paradigms but with a greater tendency toward numerous competing paradigms, reflecting different world views and models of how society will respond to a given intervention. They in many respects reflect the complexity and diversity in human behaviour, with different models being relevant depending on the context. The important difference between social science paradigms and socio-cultural paradigms is that the judgements and models used by social scientists are subjects to review and challenge about the degree to which they reflect how the world works, unlike the beliefs underlying socio-cultural paradigms which need not be. This highlights the potential for social science paradigms to become self-reinforcing when interacting with socio-cultural paradigms via policies; where the scope for changes in socio-cultural paradigms anticipated by the policy recommendations made by social scientists is limited by existing observations of how people will respond.

2.3 Discourses

One's paradigm can bias the way one engages externally in collective discussion about phenomena, problems and solutions. This collective external manifestation of a given paradigm is known as the *discourse*. According to Drysek (2007), discourses establish meanings, identify agents, confirm relations between actors and other entities, set the boundaries for what is legitimate knowledge, and generate what is accepted as common sense. In essence, an individual's discourse is the interface between its (inner) paradigm and the outside world. Importantly for DYNAMIX, discourses represent the main interface between scientific paradigms and socio-cultural paradigms, and therefore often highlight areas of significantly different perspectives and worldviews.

2.4 Paradigm distinctions in practice in DYNAMIX

Alongside the limits to growth discourse, the desire for resource efficiency and decoupling has increasingly become a socially co-constructed concept. Therefore, the definition of paradigm to be used within DYNAMIX requires an understanding of how socio-cultural and scientific paradigms interrelate and how they become tangible via the notion of *discourses*. A review of the literature reveals that while it is possible to define *socio-cultural paradigm*, *scientific paradigm* and *discourse* as separate concepts, many of the resource efficiency paradigms can be placed in any of these three categories depending on the context in which the paradigm is used and to whom it relates (policy makers, individuals, institutions, etc.).

For example, the concept of sustainability might be seen to be a socio-cultural paradigm within a social justice discourse which is observed and theorised by social scientists. The new constraints required by sustainability have also led to natural scientific paradigm shifts within established fields such as economics. We have maintained the conceptual distinction between social science, natural science, scientific and socio-cultural paradigms within this paper as they are valuable for any subsequent analysis of actors and interactions, these terms are not explicitly separated within the preliminary list of paradigms. We therefore also provide an example mapping exercise to illustrate how these distinctions are possible within a context, such as those that might be found within case studies.

2.5 Paradigm shifts

In the natural sciences, Kuhn (1970) posits that paradigm shifts are the culmination of several contingent factors, beginning with the emergence of new evidence that does not appear to fit within the current dominant paradigm. Should enough significant anomalies appear, science – still guided by the existing dominant paradigm – enters a state of crisis with greater potential for paradigm change. Anomalies are either: *reconciled* and the existing paradigm survives; *set aside* for the existing paradigm to explain once the tools perceived to be lacking are improved or developed; or they *become considered as counter-examples* to the existing theory or model, at which point both new and old alternative theories and models are considered for their suitability as replacements (Kuhn 1970). Factions of scientists form, arguing for and against both the existing and alternative theories and models. A paradigm shift is said to have occurred when "an older paradigm is replaced in whole or in part by an incompatible new one." (Kuhn 1970, p.92)

Whether, using Kuhn's characterisation, true paradigm shifts can be considered possible in the social sciences is arguable, since theories, models and therefore paradigms in the social sciences are more malleable, often less explicitly incompatible, and anomalies may be more easily explained away. However, while paradigms in the natural sciences certainly benefit from having cleaner-cut, better defined and therefore more easily identifiable (and potentially more rapid or radical) shifts, analysis of previous changes in trends in the social sciences (and in societal beliefs and values that social scientist claim to report) suggest that paradigm shifts have indeed occurred in these arenas too. Proposed examples of paradigm shifts in the social sciences include the shift from the *Neoclassical approach to welfare economics* to the

New welfare economics approach. An example of competing paradigms and processes of crises within social science is reflected within the discourse initiated by Shove (2010) when she challenged whether more collective based models of pro-environmental social change, such as those explained by practice theory, would be more relevant to policy making than the existing individualistic or so called 'ABC' models. Similarly, wide-scale socio-cultural paradigms shifts were reflected in discourses on issues such as maternity and paternity leave, women's rights, the slave trade, drink-driving, and smoking.

There are few examples of socio-cultural paradigm shifts taking place without a corresponding shift in scientific paradigm. For instance, a long-term shift in the societal perception of and policy with regard to smoking follow an enhanced scientific basis for arguments against smoking. However, these social changes occurred sometime after the scientific evidence which means that other factors might have also been at play, including the role of physical addiction among long-term older smokers as well more fundamental changes in how society perceives risks and longevity. Further, with regard to the relationship between policy and socio-cultural shifts, it may be more difficult to infer an obvious direction in the causal chain; whether, for example, the 2007 smoking ban in the UK resulted in a socio-cultural paradigm shift, or whether a paradigm shift already underway in society paved the way for government to impose a ban successfully. A 2011 report by the UK House of Lords' Science and Technology Select Committee, however, suggests that the reduction of smoking and drink-driving, and the increase in the use of condoms to prevent sexually-transmitted diseases are indeed the outcomes of successful policy in the UK.[2]

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[2] http://www.publications.parliament.uk/pa/ld201012/ldselect/ldsctech/179/179.pdf 1.1

3 The paradigm system

The interrelation between scientific and socio-cultural paradigms can best be understood via *discourses, institutions* (including *governments*) and the *tools* and *policies* they develop in order to influence *behaviour.* It is this wider system which forms the means of co-creation and re-validation of the paradigm system.

Figure 1: Mapping of interactions between the scientific and socio-cultural paradigm spheres
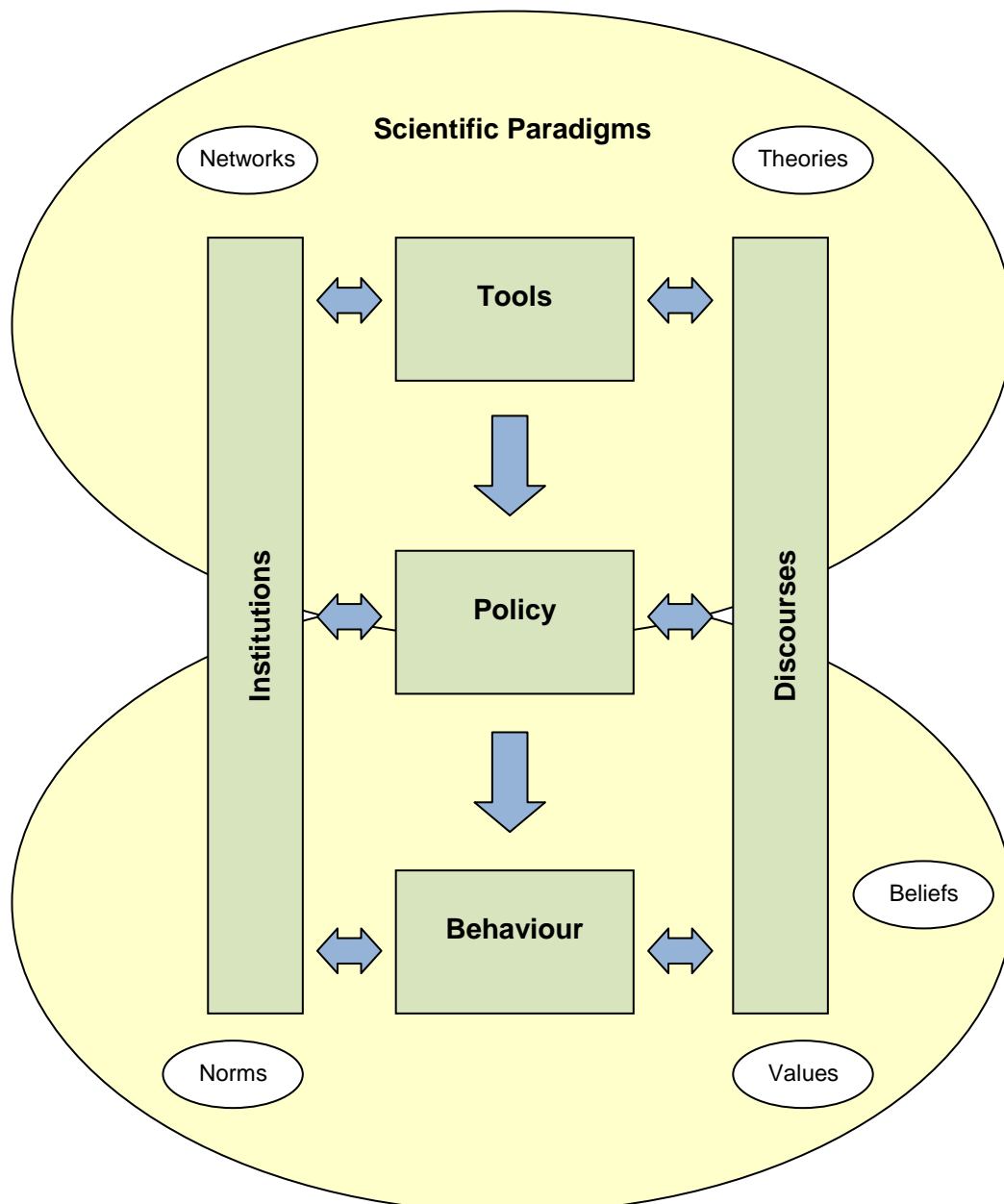
3.1 Working definitions

We propose the following working definitions for use in the DYNAMIX project:

- **A paradigm system** comprises all elements of the system of thinking in which paradigms are co-created and change over time. This includes scientific paradigms held among professional researchers, policy makers and their professional stakeholders; socio-cultural paradigms held among individuals and communities within society; and the discourses, tools, politics and policies which constitute the external manifestation of these inner paradigms and form the means of interaction, co-creation and re-validation of the system.

- **A paradigm** is a set of values, beliefs and ideologies in which one is immersed, and which one uses to navigate any new evidence, challenges or choices one is confronted with.

  - o **A socio-cultural paradigm** represents a particular philosophy of life or a framework of ideas, beliefs and values through which a community or an individual interprets the world and interacts with it.

  - o **A scientific paradigm** represents the set of theories, methodologies and practices to which professionals subscribe, and which they use to navigate any new evidence, and to conduct and interpret investigation and analysis.

- **A discourse** is the collective discussion and external manifestation of a given paradigm. It comprises the language, including vocabulary and underlying meaning, informed by and used to describe a given paradigmatic view of the world, its problems and solutions. A discourse is the interface between the inner paradigm and the outside world.

- **[Paradigm] tools** are the methodological manifestations of a paradigm of thinking, used by professionals to either inform decisions based on a paradigm often by anticipating how the world works in response to a given stimuli.

- **An institution**, in its broadest sense, is a collection of individuals bound by an explicit set of rules defining structure, operation and purpose. Examples of institutions include government and educational establishments. Institutions will tend adhere to a unified paradigm of thinking as reflected within its culture.

- **Behaviour** refers to the observable actions of an individual or a group in relation to its environment.

3.2 A note on alternative uses of terminology

The term *paradigm* has come to be used loosely with a range of different meanings, used interchangeably with "belief," "concept," "theory," "model," "perspective," or "attitude". Similarly, *discourse* is used synonymously with "conversation," "discussion," "expression," and even "paradigm". For example, Michael Foucault's definition of discourses, summarised by

Iara Lessa as "systems of thoughts composed of ideas, attitudes, courses of actions, beliefs and practices that systematically construct the subjects and the worlds of which they speak" (Lessa 2006), can be interpreted to overlap with the meaning of *paradigm* proposed here for use in DYNAMIX, as Foucault's definition refers to entire systems of thought, attitudes, beliefs and practices, rather than - more precisely - the externalisation and collective discussion of them.

The working definitions set out in section 3.1 above aim to clarify the way in which terms including *paradigm* and *discourse* will be used in DYNAMIX. It remains only to re-emphasise that a range of alternative interpretations and uses of the terms exist in the academic literature, with a lack of consensus and convention regarding one use of the term over another. Where alternative interpretations of such terms are referenced in DYNAMIX, care will be taken to ensure that conclusions are translated and explained using the final set of DYNAMIX definitions.

3.3 Preliminary list of paradigms

The preliminary list of paradigms encompasses scientific and socio-cultural paradigms, as well as what might be interpreted as a discourse, depending on context. As many of the resource efficiency paradigms straddle these distinctions and contain elements of more than one paradigm, the terms in the table below have been described but not categorised.

Table 1: Preliminary list of paradigms relevant to resource efficiency

Paradigm	Description	Source
Administrative Rationalism	Defined by the worldview that society is best regulated by 'leaving it to the experts', exemplified in support for the concept of a technocracy.	Dryzek 2005
Consumerism	Focus on consumption of, e.g., non-durable goods, as the basis for economic growth and economic welfare. Related to materialism.	
Democratic Pragmatism	Generally, pragmatism describes a process where theory is extracted from practice, and applied back to practice. Therefore, democratic pragmatism can be defined by the worldview that society is best regulated by 'Leave it to the people'.	Dryzek 2005
'Dominant Social Paradigm' (BAU paradigm)	A relative and evolving paradigm, described in 1978 as constituting: a belief in abundance and progress; a devotion to growth and prosperity; faith in science and technology; and commitment to a laissez-faire economy, limited governmental planning and private property rights.	Dunlap and Van Liere 1978

Paradigm	Description	Source
Eco-communalism	Eco-communalism is the adoption of a lifestyle that turns to non-material dimensions of fulfilment – the quality of life, the quality of human solidarity, and the quality of the earth. It is a highly localist vision favoured by some environmental subcultures and is a strong theme within the anti-globalization movement.	Raskin *et al* 2002
Ecological economics	Ecological economics aims to address the interdependence and coevolution of human economies and natural ecosystems over time and space. It is distinguished from environmental economics by its treatment of the economy as a subsystem of the ecosystem and its emphasis upon preserving natural capital.	
Economic Rationalism	Defined by the worldview that society is best regulated by 'leaving it to the markets'.	Dryzek 2005
Environmental Problem Solving	Recognises the existence of ecological problems but views them as tractable within the basic framework of industrial society.	Dryzek 2005
Green Radicalism	Rejects the basic structure of industrial society and the way the environment is conceptualised and promotes transformation in human consciousness, economics and politics.	Dryzek 2005
Green Romanticism	An evolution from the literary, artistic, and philosophical romanticism movement originating in the 18th century, with an emphasis on the imagination and emotions. Defined by the worldview that the world can (and should be) saved through new politics.	Dryzek 2005
Holism	The view that wider perspectives in thinking will lead to a better understanding and improved solutions.	
Materialism	Focus on consumption of goods for increased comfort and social status. Related to consumerism.	
Natural Capitalism	In *Natural Capitalism*, the authors describe the global economy as being dependent on natural resources and ecosystem services that nature provides. Natural Capitalism is a critique of traditional "Industrial Capitalism", which calls for a system of capitalism that fully conforms to its own accounting principles, assigning value to the largest stocks of capital it employs- the natural resources and living systems, as well as the social and cultural systems that are the basis of human capital.	Hawken et al. 1999
Neoclassical economics	An approach to economics that relates supply and demand to an individual's rationality and his or her desire to maximize utility or profit.	

Paradigm	Description	Source
New Environmental Paradigm	Includes the ideas of "the inevitability of "limits to growth", the necessity of achieving a "steady-state" economy, the importance of preserving the "balance of nature", and the need to reject the anthropocentric notion that nature exists solely for human use.	Dunlap and Van Liere 1978
New Sustainability Paradigm	Sees globalization not as a threat to be resisted, but as an opportunity for forging a new category of consciousness – a global citizenship that understands humanity's place in the web of life and its link to the fate of the Earth.	Raskin *et al* 2002
Protectionism	A self-propagating world view often evident at times of economic turmoil and resource competition globally and regionally. Often evident when nations and regions clos their borders to protect their own resources populations from the impact of market forces.	
Survivalism	Generally, survivalism is a movement of individuals or groups actively preparing for emergencies, including possible disruptions in social or political order, on scales from local to international. Environmental Survivalism is based on the contention that the Earth has a limited stock of resources and prescribes drastic multidimensional action to prevent global disaster, receiving a reply from those who deny such limits exist.	Dryzek 2005
Sustainability	For humans, sustainability is the potential for long-term maintenance of wellbeing, which has environmental, economic, and social dimensions. As a discourse, sustainability has become defined by imaginative attempts to dissolve the conflicts between environmental and economic values.	Dryzek 2005
Sustainability, Strong	Strong sustainability holds that there is a limit to the substitution of human and human-made capital for natural capital as the products created by mankind cannot replace the natural capital found in ecosystem.	Pearce et al. 1989
Sustainability, Weak	Weak sustainability holds that 'human capital' is directly substitutable for 'natural capital'.	Pearce et al. 1989

Note: items in this table have been listed in alphabetical order. This preliminary list of paradigms encompasses both scientific & socio-cultural paradigms, as well as discourses, many of which may also be considered 'principles'. As many of the resource efficiency paradigms straddle these distinctions and contain elements of more than one, the terms have been defined but not categorised in the table.

Many of the resource efficiency paradigms represent an evolution or application of an existing more general paradigm. For example, Green Romanticism is an evolution from the literary, artistic, and philosophical romanticism movement originating in the 18th century which had an emphasis on the imagination and emotions. Underlying many paradigms are often even more fundamental worldviews, such as those proposed by cultural theory which include Individualists (who believe that the world is benign and resilient), Egalitarians (who believe that the world is fragile, interconnected), Hierarchists (who believe that the world is controllable, and stable until pushed beyond a critical threshold) and Fatalists (who find neither rhyme nor reason in the world around them nor any way of meaningfully anticipating change).

4 Application in DYNAMIX

4.1 Application in DYNAMIX Work Packages

It is proposed that this conceptual understanding of a paradigm system is applied to the DYNAMIX's Work Packages (WPs) in the following way:

- WP1: Common approach – The definition of paradigm system will be refined and updated within WP1 throughout the project and a common list of existing and emerging paradigms relevant for resource efficiency will be established.

- WP2: Reasons for inefficiencies – The outputs from WP2 will feed into the analysis of paradigms in WP4. In the analysis of the underlying reasons for inefficiency, socio-cultural paradigms are useful to explain the dynamics that are in play. This WP will help to form a preliminary understanding of paradigm types that sustain and reinforce inefficiencies and high resource consumption, and underlying interactions.

- WP3: Assessment of existing policies and policy mixes – This is where data will be gathered on the paradigms used to formulate existing polices. The outputs from WP3 will feed into the analysis of paradigms in WP4.

- WP4: Scenarios and new policy mixes – This is the WP where the analysis of paradigm systems will occur and will be mapped against polices to make an assessment of influence (4.2.1). This will feed into a paradigm shift pathway for action (4.2.2).

- WP5: Qualitative assessment - This WP provides a qualitative assessment for the potential impact of the proposed policy mixes. It will be important to maintain throughout this WP that some of the policy mix scenarios come with assumed shifts in the paradigm system of thinking. So for example, 5.5.1 – 'Public acceptability and behavioural enhancements' will need to consider that people's attitudes and behaviours may well change due to the very policy being introduced within the policy mix. It is proposed that the most appropriate point of ensuring this will properly coordinated will be the management framework in 5.1.

- WP6: Qualitative assessment – As with WP5, it will be important to maintain throughout this WP that some of the policy mix scenarios come with assumed shifts in the paradigm system of thinking. However, all proposed economic models have a paradigm of thinking embedded within them so the way that we (needed to) set up WP6 means that the scope for assessment within alternative paradigms will be limited. It is proposed that the models being proposed for WP6 are analysed within WP4 so that results are presented with de reference to any changes in paradigms.

- WP7: It is intended to introduce paradigms at a session within the 1st policy platform in March 2013. The way that paradigms are communicated with policy makers will be reviewed after this session.

- WP8: Recommendations to policy-makers will be tailored to reflect the understanding developed over the course of the project with respect to promising and positively-reinforcing paradigms for sustainable resource use, incorporating findings regarding key actors, institutions, and the interaction between policy, paradigms and public acceptability.

4.2 Preliminary list of resource efficiency conceptual tools

The DYNAMIX proposal refers to the possibility that the project will develop new resource efficiency paradigms. Based on the definitions introduced here, it has been interpreted that what was intended was in-fact the possibility of developing a resource efficiency conceptual tool, such as those listed in the table below. These tools often implement the concepts behind a given paradigm and are typically highly reflective of the paradigm. It is anticipated that much of the case study literature will make reference to these tools as this is the level that the paradigm is implemented.

Table 2: Preliminary list of resource efficiency concepts, principles and tools

Conceptual tools	Description
Circular economy	A *circular economy* seeks to rebuild capital, whether this is financial, manufactured, human, social or natural. Strongly associated with *cradle-to-cradle*.
Closed loop	The *closed loop* model is a biomimetic (life-imitating) approach that considers that our systems should work like organisms, processing nutrients that can be fed back into the cycle.
Cradle-to-grave	*Cradle-to-grave* refers to the life cycle of a product, from raw-materials extraction (cradle), through manufacture and use, to disposal (grave).
Cradle-to-cradle	The ambition of *cradle-to-cradle* is to create completely safe and healthy products and to maximize the positive impact of human activities. Strongly associated with *circular economy*. The principle is "Waste = Food" Focus on material inputs and outputs that are not harmful to the people or the environment. Cradle-to-Cradle design does not seek out to reduce the flow of materials, but to "generate cyclical *cradle-to-cradle* ''metabolisms'' that enable materials to maintain their status as resources and accumulate intelligence over time (*upcycling*). This inherently generates a *synergistic relationship* between ecological and economic systems - a positive *recoupling* of the relationship between economy and ecology. [McDonough & Braungart, 2002]

Conceptual tools	Description
Life cycle thinking	Life cycle thinking is a holistic approach that takes the full life cycle of a product into account. It is the basis for, for example, the European Integrated Product Policy. It is strongly related to the *cradle-to-grave* concept. (paradigm?)
Waste Hierarchy	A classification of waste management options in order of their environmental impact. In Europe the waste hierarchy takes the following order: prevention; preparing for re-use; recycling; other recovery; and disposal.
Nexus	An attempt to view supply chains as supply nets, leaving resource optimisation in closed "silos" and instead making energy solutions, water and food – for example – smart. *Nexus* breaks down the concept of sustainability into desired goals, drivers, management and required innovation with a focus on goal-conflicts and possibilities for synergies in development strategies.
Green Economy	Green economy is one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. Green economy is an economy or economic development model based on sustainable development and knowledge of ecological economics. (UNEP) (paradigm?)
Green Growth	EU concept of Green Economy.
Factor 4	The Factor 4 concept visualizes a quadruple increase in resource efficiency with existing technologies. It was introduced by Ernst von Weizsäcker, Amory Lovins and L. Hunter Lovins (1997) Factor Four: Doubling Wealth - Halving Resource Use (Earthscan Publications Ltd., London.
Factor 10	Factor 10 is the radical idea that humanity must reduce resource turn over by 90 % within the next 30 to 50 years. This requires new technologies, policies, and manufacturing processes along with socio-cultural change. It was introduced by Friedrich Schmidt-Bleek from the Wuppertal Institute for Climate, Environment and Energy in the early 1990s.
Zero Waste	Zero waste is a concept encouraging the redesign of resource life cycles so that all products are reused. It aims to guide people in changing their lifestyles and practices to emulate sustainable natural cycles, where all discarded materials are designed to become resources for others to use. See also http://zwia.org/.
Problem of the commons	The depletion of a shared resource by individuals, acting independently and rationally according to each one's self-interest, despite their understanding that depleting the common resource is contrary to the group's long-term best interests. Reference: Hardin, G. (1968) The Tragedy of the Commons. Science 162(3859): 1243–1248.
Various assessment tools	These include life cycle assessment, material flow analysis, cost-benefit analysis, and many more.

Conceptual tools	Description
Triple Bottomline	Sustainable development using economic, social and environmental performance metrics. "Human, Natural, and Financial Capital" "People, Planet, Profit" "Equity, Ecology, Economy" [Elkington, 1994]
IPAT	I = P x A x T Environmental impact (I) is the product of Population (P); Affluence (A); and Technology (T). [Ehrlich & Holdren]
Eco-efficiency	The concept of creating more goods and services while using fewer resources and creating less waste and pollution. Eco-efficiency strategies Dematerialization Increased resource productivity Reduced toxicity Increased recyclability Extended product lifespan [World Business Council on Sustainable Development]
Industrial Ecology (Industrial Symbiosis is an example)	Industrial ecology is a new system for describing and designing sustainable economies. Arising out of an ecological metaphor, it offers guidelines to designers of products and the institutional structures in which production and consumption occur, as well as frameworks for the analysis of complex material and energy flows across economies. [Ehrenfeld, 1997]
Natural Step	The Natural Step Framework's definition of sustainability includes four system conditions (scientific principles) that lead to a sustainable society. In a sustainable society, nature is not subject to systematically increasing... 1. ...concentrations of substances extracted from the earth's crust. This means that fossil fuels, metals, and other minerals cannot be extracted at a faster rate than they can be re-deposited. 2. ...concentrations of substances produced by society. This means that toxic substances must not be produced at a faster rate than they can be broken down in nature, and that synthetic compounds that do not break down must be systematically eliminated. 3. ...degradation by physical means. This requires that we critically examine how we harvest renewable resources and adjust our consumption and land-use practices to fall well within the regenerative capacities of ecosystems. 4. ...human needs are met worldwide. This means that there must be a fair and efficient use of resources to meet human needs. [Robért, 2002]

4.3 Example mapping of a paradigm system

An example of the mapping required in WPs 3 and 4 is illustrated below using the case study of the Zero Carbon Homes Policy in England. This includes additional elements that complete the paradigm system including tools, institutions, policies, theories, networks, beliefs, norms, values and behaviour. Combined, these can reveal the paradigms behind the policy. It is intended that when these policy mapping exercises are combined in Task 4.2, the lessons learnt will reveal not only what paradigm changes are require, but also what institutional changes are required.

Figure 2: Example mapping of the paradigm system underlying the Zero Carbon Homes Policy

Scientific ParadigmsScientific ParadigmsScientific Paradigms

NetworksNetworks Net

Tools
- Environmental assessment rating methods
- Carbon accounting (incl carbon foot printing)
- Stakeholder analysis
- Technology Assessment (TA)

Cost Benefit Analysis (CBA)

Theories
- Rational actors .v. Market

Institutions

Enablers
- Government (50% funding until 2010), DCLG, Defra
- Private sector (50% funding)
- Zero Carbon Hub
- Zero Carbon Hub Management Board
- NHBC Foundation
- (via consultation): The Environment Agency,

Targets
- Homebuilders Industry & commerce (new homes)
  - Manufacturers
  - Producers
  - Suppliers
  - Retailers
  - Service providers
- Consumers

Policy
- Zero Carbon Homes Policy – the progressive tightening of **building regulations** (Part L) in 2010 and 2013, with the aim of achieving zero carbon new homes by 2016.
- Supported by:
  - the Code for Sustainable Homes,
  - the Planning Policy Statement on Climate Change and

  the Stamp Duty Land

Discourses

Key terms
- *Technological solutions*
- *Zero-carbon*
- *Energy efficiency*
- *Regulation*
- *Carbon footprint*
- *Engineering resilience*
- *Minimum standards*

Disciplines
- Waste management
- Architecture
- Materials design
- Behavioural economics

Beliefs
- Environmental limits
- Technology
- Government should take lead

BeliefsBeliefs

Behaviour
- Product choice

Norms
- Patterns of energy consumption at home
- Most popular technologies and use thereof

Values
- Energy security

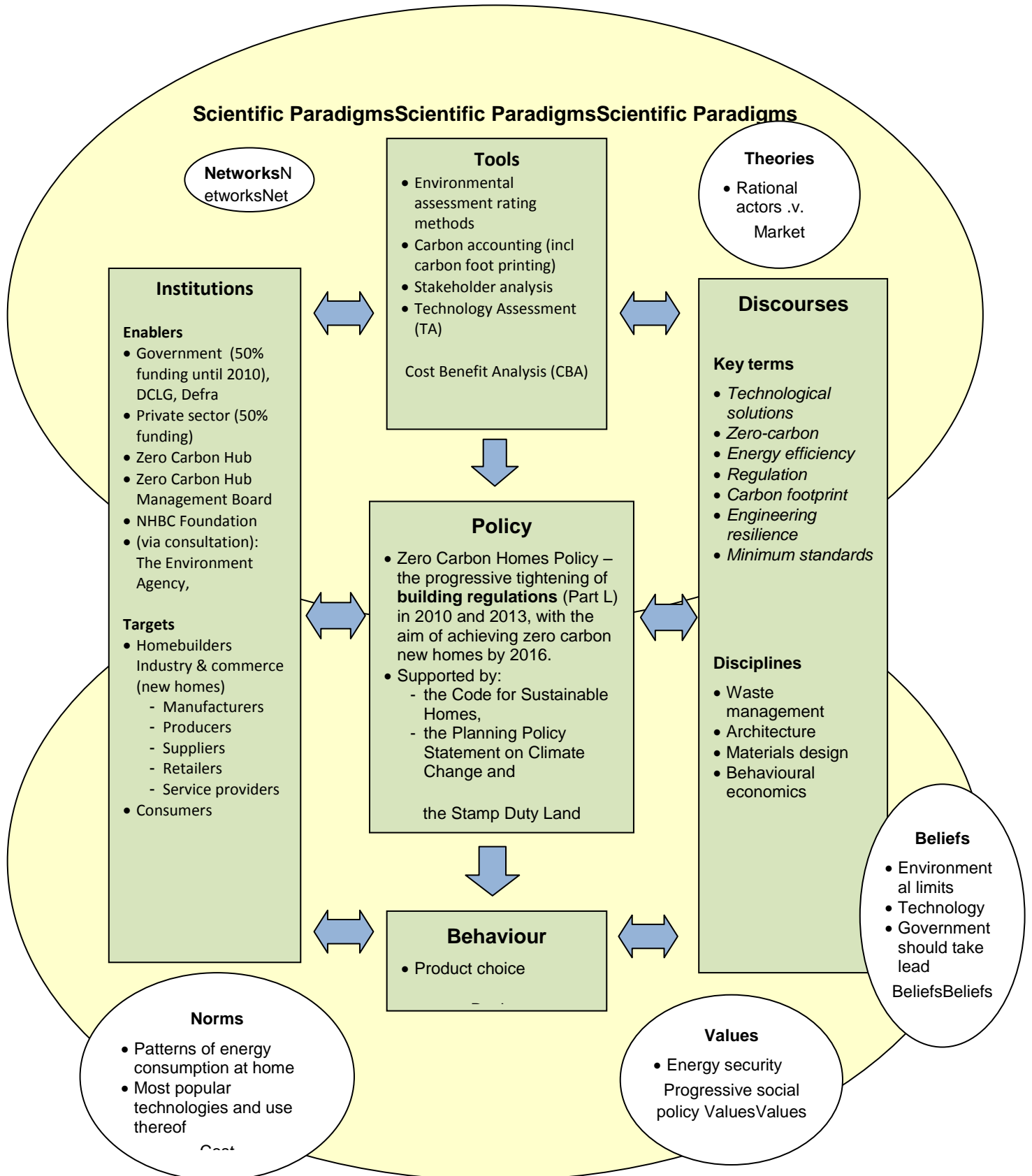Progressive social policy ValuesValues

Figure 2 illustrates an example of a paradigm mapping as restricted to a specific policy. Announced in 2006, the Zero Carbon Homes policy obliges new homes in England from 2016 to be zero carbon, supported through the progressive implementation of tighter building regulations. Taking this policy as the starting point, the diagram expands on the surrounding context, listing the key tools, actors and institutions involved, as well as the behaviour targeted and the underlying and associated norms, values and beliefs. Tools include those which have been used to develop the policy (e.g. stakeholder analysis and engagement), and those which will play a key role in its implementation (e.g. cost-benefit analysis; environmental assessment rating systems). Institutions are split into: enablers, who have a direct role in shaping, supporting or implementing the policy; and targets, whose practices are the subject of the policy. Enablers in this case include: the Zero Carbon Hub (a public-private partnership launched in 2008 to help lead the transition to zero-carbon homes in 2016); Government, who has provided partial funding to the Zero Carbon Hub, and in particular the Government Departments for Communities and Local Government (DCLG) and for the Environment, Food and Rural Affairs (Defra); and other key stakeholder groups such as the Environment Agency. Target actors and their corresponding targeted behaviours are: the homebuilders and upstream industry, whose designs, products and choice thereof will be affected; and consumers or house buyers, whose demand for zero-carbon homes will also be addressed.

In terms of how the underlying social science paradigms that have been made manifest via discourses, the common terminology permeating the literature and discussion surrounding this policy largely accepts that the market has failed in this area and therefore moves on from an 'Economic Rationalism' paradigm and rely instead on a regulatory approach via building standards. The conceptual headline of the policy (i.e. ZERO Carbon homes) points towards a 'Strong Sustainability' or the 'New Environmental Paradigm' in its conception and presentation. However, the discourses revealed in its analysis and implementation *(such as energy efficiency & carbon foot printing)* suggests that a weak(er) sustainability paradigm was in action in the central part of the policy making cycle processes. A range of existing disciplines (from Architecture and Waste Management to Materials Design) will have come equipped with their own vocabulary and conceptual and semantic understanding of the concept of 'Zero Carbon Homes'. These will have both influenced the discourses and constrain the thinking and analysis of how this concept can be implemented. Finally, an initial selection of associated norms, values, beliefs and theories is also given. These help to provide further context to the underlying socio cultural paradigm, and help to identify potential barriers and drivers for the policy.

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