Principles for the Development of Integrated Transformational Projects in Climate Change and Chemicals & Waste

A Report Prepared for the
Scientific and Technical Advisory Panel of the Global Environment Facility

by
Aaron E. Zazueta

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CORRESPONDING AUTHOR
Aaron Zazueta
Email: a@zazuetagroup.com

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ABOUT THE GEF
The Global Environment Facility (GEF) unites 183 countries in partnership with international institutions, civil society organizations (CSOs) and the private sector to address global environmental issues, while supporting national sustainable development initiatives. An independently operating financial organization, the GEF provides grants for projects related to biodiversity, climate change, international waters, land degradation, chemicals and waste. http://www.thegef.org

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Executive Summary

This review is intended to advise the GEF on the contribution of systems thinking to the long-term success and impact of major projects. Drawing on 32 case studies from the fields of Climate Change (CC), Chemicals & Waste (Ch&W), and Ozone Depleting Substances (ODS), it demonstrates how system thinking can enhance outcomes and lead to wider adoption of new technologies, changes and behaviours that protect and restore the environment.

The objective of this review is to produce "guidance for the GEF on how to develop integrated projects and programs, based on a review of the literature on systems thinking and similar disciplines, drawing from examples [of GEF projects] demonstrating lessons on integrated programming in support of sustainable development and delivering multiple benefits." Systems thinking is here understood as "a set of synergistic analytic skills used to improve the capability of identifying and understanding systems, predicting their behaviors, and devising modifications to them in order to produce desired effects. These skills work together as a system." (Arnold and Wade 2015). "Thus, systems thinking focuses on how the object of interest interacts with other constituents of the system – a set of elements that interact to produce behavior- of which it is part. This means that instead of focusing on isolated smaller and smaller parts of the system being studied, system thinking works by expanding its view to take into account a larger and larger number of interactions…"[1]. This emphasis on understanding how different elements interact and form a larger whole makes systems thinking particularly well suited to understanding complexity.

In this paper, integrated approaches are seen as instruments that can bring about changes in the multiple domains necessary to achieve the desired long-term transformation. Thus "integrated projects or programs" are understood to consider causes across the environment and different realms of human activity, and to generate benefits in two or more GEF focal areas[2], as well as social and economic benefits. Given the multiple factors, interconnections involved and complexity of CC and the processes related to Ch&W, the central conclusion of this review is that systems thinking can be used to derive key principles to guide the development and implementation of integrated projects that contribute to transformation at scale for both CC and Ch&W.

The GEF portfolio contains very few completed multifocal-area CC and Ch&W projects, so it was not possible to compare projects approved as multifocal with projects that were approved as a single-focal area. Instead, the approach of this review is to analyze the extent to which contributions to multiple benefits and transformational change are related to the integration of key aspects of systems thinking during project planning and implementation. An in-depth analysis of 32 projects was carried out, selected from evaluations of more than 140 projects

[1] http://www.thinking.net/Systems_Thinking/OverviewSTarticle.pdf

[2] GEF as financial instrument of the global environmental conventions includes the focal areas of climate change, biodiversity, international waters, forests, chemicals and waste and land degradation.

related to CC and Ch&W. Given the findings reported by evaluations of projects in other focal areas, it is very likely that the findings of this review also apply to projects across the GEF portfolio.

The overarching conclusion of the review is that there is a link between project performance, particularly as relates to contributions to the project's long-term goals, and the incorporation of systems thinking into project design and implementation. The approach adopted helps to establish the link between a project's adoption of integrated approaches and extent of project achievements. Projects addressing key aspects of systems thinking were found to have integrated approaches that more frequently resulted in contributions to the intended long-term objectives of the projects, when compared with projects that did not include key aspects of systems thinking. Also, projects that addressed key aspects of systems thinking resulted more frequently in social and economic benefits and benefits across focal areas.

The review also found that integration cuts across various dimensions, including sectors (e.g. environment, industry and agriculture); scales (e.g. local, national, and global); time spans; types of stakeholders; and stages of the project cycle (e.g. design and implementation). The paper identifies seven guiding principles that can help GEF develop and implement integrated projects or programs which contribute to long term transformations; each points to specific aspects in which the integration of multiple factors proved critical:

Principle 1: Identify the root causes of the problem the project seeks to address.

All projects that resulted in behavioral change at a broader scale successfully identified the root causes of the problem they were intended to address. This required the adoption of integrated approaches that included factors in multiple domains and scales. Key domains to which root causes were typically traced were: technological, financial, policy-regulatory, institutional and sociocultural. Scales that were frequently relevant were the enterprise, the market or market segment, and the country.

> *Recommendation 1: Project design should give special attention to the identification of root causes of the problem the project seeks to address. Special attention should be given to understanding interactions stemming from the technological, financial, policy-regulatory, institutional and sociocultural domains, and pertinent scales.*

Principle 2: Design projects to foster conditions (across domains and scales) that result in the desired behavioral change.

Projects which successfully identified the root causes of problems most often were designed to overcome barriers to behavioral changes leading to the desired long-term transformations. The integrated approach adopted during problem definition guided these projects to address multiple factors affecting behavioral change at different scales. For example, while testing and introducing new technologies or approaches, projects also sought to provide businesses with

incentives for adopting the new technology by raising awareness of the social and environmental consequences of current practices and by disseminating information on alternative options and their benefits. The most successful projects also ensured that policies or regulations provided incentives for change and supported the introduction of business and financial models which encouraged the proposed approaches or technologies.

> *Recommendation 2: Having identified the boundaries of the system, projects should identify and seek to generate conditions at each domain and scale to steer behavior in the desired direction.*

Principle 3: Demonstrate to targeted adopters the comparative advantage of the innovation introduced by the project.

Failure to demonstrate the comparative advantage of innovations is a key factor that distinguishes projects with a negligible impact from those that contribute to worthwhile changes at scale. These failures were not related to the effectiveness of the chosen technologies or approaches as such but rather, to incompatibilities between the chosen technology and cultural practices, settlement patterns and the financial circumstances of the target populations. Examples of such incompatibilities included technologies that disrupted daily routines but only partially addressed household needs, such as the solar cookers which only partially met the domestic fuel management needs of households. Another example is the introduction of an electrical grid to dispersed human settlements which proved difficult to maintain and delivered electricity at costs higher than users were willing to pay.

> *Recommendation 3: Projects need to give careful attention to the identification and demonstration of innovations that have comparative advantages to the status quo and that are well suited for the context in which they are introduced.*

Principle 4: Ensure the buy-in of stakeholders.

Buy-in and alignment with stakeholder interests is essential for transformative projects. Engagement of key stakeholders in the project or programs was found to be a central factor in all successful projects. This helps prevent the type of incompatibilities described above. Stakeholder engagement also helps to align incentives to interests. Information campaigns supported by projects also helped raise awareness of the urgent need to address the risks posed by CC and chemicals and waste. As many CC and Ch&W projects deal with enterprises and market change, economic considerations were particularly important factors contributing to success, for example. In the case of CC projects cost-saving efficiencies were often an important inceptive for adoption. In the case of ozone-depleting substances (ODS), enterprises were often keen to take advantages of subsidies for the transition to new technologies, which enabled them to meet new regulations and still remain competitive in the new market.

Recommendation 4: Ensure stakeholder buy-in to the innovations or changes introduced by the project through effective communication, project involvement and understanding of the benefits generated.

Principle 5: Ensure sustainability by building ongoing processes, capacities and generating benefits.

Transformations at scale are best characterized as ongoing processes that extend beyond the time span of individual projects or programs. Successful projects consider the temporal mismatches between the duration of the project and the time it takes for the system to respond to the project interventions. For example, successful projects typically consolidate the trajectory they have started by helping establish regulatory frameworks and helping business become competitive in the new markets, thus securing their long term buy-in to the new technologies. Successful projects also ensure that the capacity is in place to continue the process after the project ends.

Recommendation 5: Ensure sustainability by seeking opportunities to build ongoing processes, generate benefits to stakeholders (or at least mitigate the cost of transition), and build the capacities needed to sustain the change momentum over time.

Principle 6: Plan for further adoption after project closure.

While sustainability ensures the lasting duration of the benefits realized by the project, the extent of benefits achieved by a project or program is rarely sufficient to fully address the problem and to bring about transformation at the desired scale. Projects or programs need to put in place mechanisms that, over time, will ensure the broader adoption of the technologies or approaches introduced by the project. Three mechanisms for broader adoption frequently used by projects that resulted on changes at scale are:

1) the mainstreaming project contributes to broader mandates and processes, such as a study that informs the formulation of a regulation or policy;
2) the replication of innovations introduced by the project, through the further adoption of its innovations at similar scales; and
3) scaling-up, which seeks to achieve changes at larger geopolitical scales and often incorporates wider aspects or concerns, such as the expansion of a pilot municipal program to provincial or national level.

Projects that include replication and scaling-up in design consistently achieve broad-scale behavioral change that transcends their initial niches and contributes to much broader processes leading to environmental stress reduction.

Recommendation 6: To ensure broader adoption and impact at scale, projects need to incorporate during design, and aggressively pursue during implementation, the establishment of mechanisms that will support mainstreaming, replication and scaling-up of project contributions once the project ends.

Principle 7: Enable learning and adaptive management during implementation.

Unexpected developments and unmet assumptions often require adjustments during project implementation. A third of the reviewed projects that contributed significantly to the desired transformations went through some form of restructuring during implementation. Key factors leading to successful adaptive management during project implementation were: making finance available for information exchange and learning within and across projects; enabling good participation and communication among stakeholders; requiring projects to include systems that track risks and unexpected circumstances and regularly report back to stakeholders; and encouraging and rewarding candor and swift action when project restructuring is needed.

> *Recommendation 7: Support adaptive management by: budgeting for the costs of information exchange and learning within and across projects; enabling good participation and communication among stakeholders; requiring projects to include a system to track risks, and to regularly report back to stakeholders about how the project is mitigating risks and addressing unexpected circumstances; encouraging and rewarding candor and swift action when project restructuring is needed.*

1. Introduction

The Global Environment Facility was created in the early 1990s as a financial mechanism to support countries in meeting their commitments to the various global environment conventions within the context of each country's own sustainable development goals. The GEF provides support in six focal areas: biodiversity; chemicals and waste (Ch&W); climate change (CC, both mitigation and adaptation); forests; international waters and land degradation. It has also evolved to support more integrated, multi-focal projects which address two or more of these focal areas.

As an operating entity of the financial mechanism for the United Nations Framework Convention on Climate Change, the GEF seeks to catalyze large-scale investments in the low-carbon economy and build greater resilience by reducing the vulnerability of people, livelihoods, physical access and natural systems to the adverse effects of climate change. The GEF targets the following areas in its investments: energy efficiency, renewable energy, sustainable transport and climate-smart agriculture.

The GEF is also a financial mechanism for implementing the Stockholm Convention on Persistent Organic Pollutants and the Minamata Convention on Mercury, and has a complementary role in achieving the Montreal Protocol on substances that deplete the ozone layer. The objectives of GEF support in Chemicals and Waste (Ch&W) are to develop the enabling conditions, tools and context for the sound management of harmful chemicals and wastes, to reduce the prevalence of harmful chemicals and waste in the environment and to support the implementation of clean, safe alternative technologies and substances.

Early GEF projects typically emphasized benefits in specific single focal areas, whereas in the last three replenishments (2006, 2010 and 2014) the GEF encouraged projects that deliver benefits across multiple focal areas. Projects that result in social and economic co-benefits were also encouraged. This contributed to a sharp rise in multifocal area projects between GEF 4 (2006-2010) and GEF 5 (2010-2014)[3]. The 2020 Strategy adopted as part of GEF-6 calls for the support of transformational change, impacts at a broader scale, attention to drivers of environmental degradation, stakeholder coalition building, innovation and scalable activities[4]. To achieve these goals, the GEF is piloting integrated approaches that address time-bound global environmental challenges through three programs: 1) Fostering Sustainability and Resilience for Food Security in Sub-Saharan Africa, 2) Sustainable Cities and 3) Taking Deforestation Out of the Commodity Supply Chain.[5]

The GEF's integrated projects seek environmental benefits across two or more focal areas in which it has a mandate. Integrated projects also seek to generate global environmental benefits while improving human living conditions. This is achieved by addressing root causes, which

[3] Multi Focal Area projects almost tripled from US$ 357 million in GEF-4 to US$998 million in GEF-5 (GEF IEO 2016).
[4] http://www.thegef.org/sites/default/files/publications/GEF-2020Strategies-March2015_CRA_WEB_2.pdf
[5] http://www.thegef.org/topics/integrated-approach-pilots

have ramifications across different sectors. For this review, "integrated projects or programs" are understood to consider causes that cross the environment and different realms of human activity, and that generate benefits in two or more GEF focal areas, as well social and economic benefit.

This review was commissioned by the Scientific and Technical Advisory Panel (STAP) of the GEF to support integrated programming within the GEF. It follows the terms of reference for the review provided by STAP: "The ultimate result is guidance for the GEF on how to develop integrated projects and programs based on a review of the literature on systems thinking and similar disciplines, drawing from examples demonstrating lessons on integrated programming in support of sustainable development and delivering multiple benefits."

This report focuses specifically on the areas of climate change mitigation (CC) and chemicals and waste (Ch&W)[6] and seeks to develop a set of principles for the development and implementation of projects based on evidence from completed projects in the GEF portfolio. A similar study was commissioned which will focus on integrated approaches in natural resource management projects, including biodiversity, forests, international waters and land degradation.

2. Overall Approach

The Intergovernmental Panel on Climate Change (IPCC) in its *Fifth Assessment Report* (2014) indicates that there is a widely-held view among scientists that the incorporation of systems thinking is likely to improve integrated program development and the contribution of projects to transformative processes. However, IPCC also indicated in the same report that there is little evidence to support, or reject this idea. This review therefore sets out to assess the extent to which systems thinking actually helps in developing integrated projects and programs, and if so, to identify systems thinking principles that can help develop integrated projects and programs .

Systems thinking is here understood as "a set of synergistic analytic skills used to improve the capability of identifying and understanding systems, predicting their behaviors, and devising modifications to them in order to produce desired effects. These skills work together as a system." (Arnold and Wade 2015). Thus, systems thinking focuses "on how the thing being studied interacts with other constituents of the system – a set of elements that interact to produce behavior- of which it is part. This means that instead of focusing on isolated smaller and smaller parts of the system being studied, system thinking works by expanding its view to take into account a larger and larger number of interactions…"[7]. This emphasis on understanding how different elements interact and form a larger whole makes systems thinking

[6] In this review Ch&W include projects include projects previously approved as Persistent Organic Pollutant's (POPs) and Ozone Destruction Substances (ODS).

[7] http://www.thinking.net/Systems_Thinking/OverviewSTarticle.pdf

particularly well suited to understand complexity and to develop principles for the development and implementation of integrated projects and programs.[8]

This report includes a review of the scientific and technical literature on complex systems, on the spread of innovations and on the factors related to the success or failure of CC and CH&W projects. It draws on previous reports by STAP related to CC (STAP 2012a), Ch&W (STAP 2012c) and the implementation of projects under changing conditions (STAP 2012b). This report also builds on an analysis carried out by the GEF Independent Evaluation Office (IEO), as part of the Fifth Overall Performance Study (OPS5) (GEF IEO 2014). OPS5 assessed factors that contribute to the impact at scale of GEF projects. In preparation for OPS5, the GEF IEO compiled a database that included information from 450 completed projects. The information sources for this database included project documents, STAP screening reviews, projects' theories of change, project terminal evaluations, review of outcomes-to-impact (ROtI) analysis, and progress to impact analysis. This vast evidence base has provided OPS5 with a sound basis enabling the characterization of factors which contribute to project impacts. Nonetheless, OPS5 did not directly relate complex systems thinking to project accomplishments, although the underlining framework of analysis did draw on complex systems thinking. As a result, the databases developed for OPS5 can serve as a basis for further analysis, explicitly linking the extent to which the adoption of complex systems principles is related to integrated approaches and changes at scale.

Three steps were followed to develop a set of complex systems thinking principles that can help design and implement integrated projects and programs that contribute to transformations at scale:

i) Identification of key systems thinking criteria for the development and implementation of integrated projects. Key criteria (Box I) were identified based on a review of the scientific literature on complex systems thinking and of the analytical publications and evaluations pertaining to the factors affecting the impacts of CC and Ch&W projects[9]. Section 3.3.1 of this review provides detailed explanations of the identified criteria.

[8] Complex systems are typically described as consisting of autonomous components that are also called agents, which are independent and interconnected and learn from one another and their environment. Through their interactions, they adapt and reorganize in unpredictable ways, thus shaping system-wide patterns that in turn also influence the behavior of the parts (Dooley 1996). Each individual agent or component is in itself also a portion of a complex system in the same way, for example, as a tree is a complex system within a forest, which is a larger complex system, which is within an even larger ecosystem. While the interactions among agents are in flux and in constant reorganization, at the system level there is a tendency towards stability, or to return to a given trajectory. The reorganization of components or external factors can result in the emergence of systems with new characteristics (Holland, John 2006). When system transitions take place, change is nonlinear and has the potential to produce multiple outcomes (Levin 2003; Cash et al. 2006) . Examples of CAS are the stock market, traffic jams and election of political officials.

[9] While there was no attempt to exclude climate change adaptation projects from the review, all climate change projects in the random sample were climate mitigation projects. The reason is that there are many more mitigation projects completed than adaptation projects. Also, a quick review of GEF adaptation projects indicated that most completed projects planning processes (development of National Adaptation Plans) refer to studies and establishment of adaptation information systems or else refer to issues related to natural resource management.

ii) Determination of the extent to which the application of key system thinking criteria are likely to result in integrated projects that contribute to transformational changes at scale. This was done by reviewing 31 projects in the CC and Ch&W focal areas, including 25 completed projects mostly drawn from the OPS5 database. These include 18 projects randomly drawn from projects that had been rated "high" in their impact, and eight projects rated as having "low" or "negligible" impact. The remaining five include multifocal area projects with CC and Ch&W objectives found in the GEF website. (Annex 1 provides more information on the selection of projects and the project sample.) This study also includes information from a cluster evaluation of 12 ozone depleting substances (ODS) in focal area evaluation projects in Eastern Europe (GEF 2010); an ODS focal area evaluation (GEF IEO 2010); a CC focal area evaluation (GEF 2013); and OPS 5 (GEF IEO 2014). Together these evaluations included the in-depth review of more than 170 projects dealing with CC, ODS, persistent organic pollutants (POPs) and Ch&W. This review also draws on information obtained by the GEF IEO, as part of OPS5, from visits to more than 20 countries to verify the evidence provided by terminal evaluations and to observe changes that had taken place years after the projects had ended. While conducting this review, the author also carried out a terminal evaluation of project 3709, a POPs project in Peru, which included an in-depth analysis of the project and field visits. Key aspects of the findings of this evaluation are also included in this review.

BOX 1
Complex systems thinking criteria for the development of integrated projects

a. Domains and scales pertinent to the long term objectives of the project:
- **Technological**
- **Financial**
- **Policy and regulatory**
- **Institutional**
- **Sociocultural**

b. Stakeholder engagement.
c. Sustainability:
- **Support to ongoing processes**
- **Social and economic benefits**
- **Capacity building**

d. Transition mechanisms:
- **Mainstreaming**
- **Replication**
- **Scaling-up**

e. Adaptive management.

iii) Derivation of key lessons and principles from thinking about complex adaptive systems, to develop integrated projects in the areas of CC and Ch&W.

This review confirmed that the use of systems thinking in project and program development in the GEF is not new, and that significant experience in integrated planning has accumulated during the GEF's 25-year history. However, the application of systems thinking and integrated planning varies significantly across the portfolio. While not always explicitly using systems thinking terminology, theories of change have often incorporated aspects of systems thinking[10].

[10] Theories of change (TOC) pertain to the chain of causality based on key assumptions referring to how project outcomes will contribute to a broader objective. As projects and programs seek to produce outcomes that contribute to some longer-term objectives, whether explicit or implicit, they are based on a theory of change.

In the CC focal area, for example, projects often seek to bring about market changes that reduce CO_2 emissions. These projects typically approach the market as a system and seek to promote regulations, processes, capacities and institutions that are likely to lead to broad market changes. A CC evaluation carried out several years after completion found projects that adopted comprehensive approaches tended to make more progress towards achieving long-term goals when compared with projects which focused only on a handful of immediate factors (GEFIEO 2013). The findings of the evaluation of the POPs project 3709 in Peru also supported this finding for Ch&W projects[11]. Evidence presented below indicates that C&W projects that adopt comprehensive approaches tend to make greater progress towards long term impact.

3. Complex Systems Thinking and Integrated Project Development

Greenhouse gas emissions and human-induced environmental toxicity pose serious threats to the Earth's climate and to human and environmental health. Their combined effects are not yet fully understood, partly because studies on this topic are fairly recent and partly because of the large number of pollutants involved (Schiedek et al. 2007). Nonetheless, research findings have pointed out that these combined effects are likely to pose insidious risks (Diamond et al. 2015; Moe et al. 2013; Noyes et al. 2009). While piecemeal responses may provide solutions to some aspects of these problems, there is a growing consensus among scientists and practitioners that complex challenges of this type are best addressed through comprehensive approaches (IPCC 2014; STAP 2012b). During the last two decades, new scientific approaches have emerged that have improved our understanding of how such complex systems work. Such approaches typically adopt integrated and inter-sectoral perspectives and treat local or global spheres as aspects of the same phenomena (Kates 2001).

3.1. Key concepts of complex systems thinking applied to social-ecological systems

The complex thinking literature is very broad and can pertain to many different types of systems. Social Ecological Systems (SES) analysis pays particular attention to the interactions between humans and the environment and is the body of literature most relevant to this review. Seeking to understand how the different components work as part of a whole, social ecological systems analysis assumes that human and ecological realms interact as part of a broader system comprised of different sectors and geographical and temporal scales (Ostrom 2007; Kajikawa 2008). The framework proposed by SES analysis is particularly useful for integrated project and program planning precisely because it seeks to explain how interactions among human and non-human system components shape and transform the whole. SES are portrayed as unpredictable due to interactions of their multiple parts and their resulting adaptive behavior. Thus, while SES approaches do not promise prediction or guarantee

[11] Terminal evaluation of project GEF ID: 3709 *Environmentally Sound Management (ESM) and Disposal of Polychlorinated Biphenyls (PCBs), UNIDO. Forthcoming.*

certainty of results or outcomes, they do provide the conceptual basis to identify key areas for attention in the development and implementation of integrated projects.

Four key SES concepts, **boundaries, components and agents, interaction among elements,** and **emerging properties and transitions** can be used to assess the extent to which projects incorporate SES.

i) The **boundaries** of a system pertain to the geographical, temporal and other domains in the system relevant to the objectives of the problem addressed by the project or program. **Domains** are areas of knowledge or activity characterized by a set of concepts and terminology (Couture 2007). They can be social, ecological, economic, cultural, political, administrative or scientific in nature. System boundaries also encompass different **scales**, or levels at which systems can be observed. Scales have spatial (in the case of ecological systems or political-administrative systems) and temporal dimensions. Identifying boundaries and domains of the system that affect the project is an important first step, because this will determine areas that a project will likely need to reach if it is to address or mitigate **root causes** or **drivers** pertinent to the problem it seeks to tackle (Snderberg, Stefan and Olsson, Lennart 2010). A clear understanding of drivers will allow the identification of the conditions that need to be changed or reinforced to achieve the project's long term objectives. For example, a project that seeks to eliminate POPs must bring about technological transformations in the firms that use POPs. Awareness raising among workers and managers can help reduce discharges to the environment. But in addition to attention to immediate factors, to bring about a transition, projects and programs must also address other aspects of the system including regulatory system reforms, development and demonstration of new technologies that are within the reach of affected firms and the availability of finance.

ii) **System components** can be human or non-human **agents**. Human agents include individuals, communities, organizations and institutions; non-human agents include resources (such as water, air, forests and minerals) that are part of the natural ecology with which human populations interact. Relevant agents of a SES are identified based on their potential to influence other agents in the system. The influence or likely effects of the behavior of agents is determined by their interests, capacities, resources, goals and the scales they can reach (Anderies, Janssen, and Ostrom 2004; Brugha and Varvasovszky 2000). An important implication stemming from SES analysis is that the complex, unique and dynamic nature of SESs functions more smoothly when management and governance of the system incorporate agents from different parts of society. SES analyses typically advocate that the management of transitions include co-management schemes or other robust forms of **stakeholder involvement** in governance (Cash et al. 2006; Olsson, Folke, and Berkes 2004; Shove and Walker 2007).

iii) **Interaction among elements.** Components and agents are assumed to be interconnected but autonomous. Interactions can take place between two or more components and can trigger chain reactions that are difficult to predict and can involve feedback loops and non-linear processes (Ramalingam, et al. 2008; Ostrom 2009; Gladwell 2002). Interactions across scales and domains can sometimes obscure cause-effect links, such as the effect of time lags and geographic incongruities between generations of pollutants and the damage they cause (Mee 2012). The constant flux within the system requires agents to continually gather information about the behavior of other agents, and to adapt to change (Allen and Garmestani 2015). An agent's **adaptive behavior** further contributes to the system's complexity (Holland 1995; Holland, 2006). Intersections between domains can also vary, with domain overlaps or mismatches significantly affecting the functioning of the system (Murphree 2000). For example, in large metropolitan areas **mismatches** between the boundaries of the urban area and the boundaries of municipal authorities need to be addressed when designing metropolitan transportation systems (Holling 2001; Cash et al. 2006; G. S. Cumming et al. 2015).

iv) **Emerging properties** refer to the characteristics and processes that result from the combination of all interactions within the system, which shape the entire system but for which no single individual is responsible (Duhigg 2012). Emerging properties make systems unique and distinguish them from other systems. For example, SES may vary to the extent to which information and decisions tend to be centralized or distributed among the different agents of the system. Mismatches or overlaps between domains may give rise to tension or dysfunctions which can lead to the internal reorganization of components. This contributes to the overall dynamic equilibrium that maintains the system's stability (homeostasis) or else a tendency to return to a trajectory (homeorhensis) (Cumming, Cumming, and Redman 2006; Feeny and Mccay 1990). The concept of homeorhensis is particularly useful to GEF operations as its projects and programs seek to affect the trajectory of long term processes.

3.2. System transitions, communication of innovations and pre-conditions leading to long term objectives

Transitions from one dynamic equilibrium to another are possible. While the change process can have a specific trajectory, this is not always apparent – and change can be non-linear. Initial slow change is often followed by rapid change as different subsystems co-evolve, eventually overcoming system resilience (the tendency of the system to maintain stability), resulting in irreversible change that leads to a new equilibrium. A recent striking example is the Arab spring. Two types of transitions can be distinguished, one resulting from the evolution of the system in which case the outcomes are not planned and a second, goal-oriented transition in which visions of long-term goals guide the actions of multiple stakeholders (Rotmans and Loorbach 2009; Kemp, Loorbach, and Rotmans 2007). Development projects, programs and other such interventions are goal-oriented transitions and seek to bring transformations by

disrupting aspects of the system and overcoming system resilience or else by modifying the system's trajectory. Given the unpredictability of complex systems and the multiplicity of outcomes, managers of goal-oriented transitions can mitigate uncertainty by pursuing intermediate objectives which contribute to the achievement of long-term goals. Scholars and practitioners have also advocated **adaptive management** approaches based on learning and experimentation over the more linear traditional planning and management approaches (Folke et al. 2002).

Previous research and evaluation of innovations and transitions provide useful guidance in defining intermediate objectives. For Rodgers and Shoemaker (1971), pioneers in the study of the diffusion of innovations, the innovation process entails the spread of new ideas and practices. Human agency is key to this process, as the communication of innovations takes place through actors over time and across social groups of individuals who may differ in terms of technical skills, education, social standing, access to resources, information, beliefs and culture in general. The perceived attributes of an innovation by members of the social system are key to the rate and extent of adoption. The five perceived attributes of innovations are relative advantage over existing approaches, compatibility with beliefs and practices, complexity, "trialability" (the extent to which the approach is easily demonstrated in a given context), and observability (Rodgers 2010).

Tokle and Uitto (2009) proposed a set of five pre-conditions for market change to reduce CO2 emissions, which can help identify midterm goals: enabling policies, available financing, appropriate business models, innovative technology and awareness and knowledge in the use of technology. Worlen (2014) further developed their work to identify the likely mechanisms for change and, within this framework, focused on the factors that determine an agent's choices. Such choices are influenced by the agent's role and situation in the system. Worlen (2014) also identified barriers to change that affect the choices and behavior of agents. When flipped to their opposite, these barriers represent pre-conditions for transformation. Barriers are similar to drivers, as both are seen as key factors affecting behaviors that result in pressures on the natural system. These barriers include ignorance of the existence of a new approach, and lack of expertise, access to technology, cost effectiveness, motivation, suitable business models and funding.

The GEF Independent Evaluation Office (GEF IEO, 2012) developed a framework to assess the extent to which projects contribute to changes that reduce environmental stress. The approach focuses on pre-conditions necessary for behavioral change:

1) innovative implementation strategies, approaches or technologies;
2) institutional, legal and organizational conditions that enable innovations; and
3) knowledge and information.

The framework proposed that to sustain the interest of stakeholders, innovations need to generate social and economic benefits that go beyond the environmental domain. Projects also need to build capacities to carry out new roles related to the innovations. This framework assumed that changes will take place over time spans that extend beyond the duration of a

project. As such, this approach also seeks to determine the extent to which projects contribute mechanisms and processes likely to lead to changes at broader scales.

This approach was tested and validated through a review of 450 GEF-completed projects (GEF IEO 2014). The IEO validated this framework through several post-completion evaluations that took place from 4 to 10 years after the projects ended. One evaluation included the impact of GEF support in five emerging markets (Zazueta and Negi 2017; GEF IEO 2013). Another evaluation examined the contributions of GEF support to ODS projects in economies in transition (GEF 2010).

3.3. Complex systems thinking criteria for the development and implementation of integrated projects

A fundamental task of this review is to assess the extent to which integrated projects that lead to long-term changes incorporate complex systems thinking. The following criteria (summarized in Box 1) were used to determine the extent to which project planning and implementation incorporated relevant system thinking components. The criteria are based on the scientific literature reviewed above.

3.3.1 Extent to which a project identifies the domains and scales pertinent to the long-term objectives of the project

In one way or another, most projects seek to redirect a system trajectory or modify the state of a system to prevent or correct problems. To accomplish this, there is a need to identify and modify the **root causes** driving the current system trajectory or state. Given the interconnected nature of elements within a system, it is highly likely that projects will need to intervene at different points in the system. The first step will be to identify a goal, or desired end condition. At this point it is critical to define the reach of the project or intervention. This can be done by identifying the boundaries, domains and scales relevant to the desired changes. As we have seen, domains are areas of knowledge or activity characterized by a set of concepts and terminology (Couture 2007) and cut across levels at which systems can be observed. Social ecological systems analysis pays special attention to human representational and organizational dimensions of scales, often expressed in terms of domains. Drawing on the work discussed above on the communication of innovations and the pre-conditions leading to long term objectives, five domains/scale interactions were identified that are relevant to reaching long-term goals related to CC and Ch&W projects.

i) **Technological.** The term is used here in a broad sense, and refers to the hardware, knowhow and approaches the project or program seeks to introduce. A key aspect is the perceived relative advantage compared with alternatives known to agents. Relative advantage includes perceived complexity, ease of use or implementation, and overall applicability to specific niche needs.

ii) **Financial.** The new approach or technology will need to be compatible with existing financing. If it's not, new mechanisms will be required.

iii) **Policy and regulatory**. Policies or regulations should be friendly to the adoption of the new technology or approach. Conversely, barriers to adoption need to be eliminated and, if needed, new regulations which favor adoption introduced. Barriers or friendly preconditions can occur at different levels or scales and in different sectors. In some cases, they can refer to specific sectoral regulations or standards; at other times, they may require legal reform related to two or more sectors.

iv) **Institutional.** New approaches or technologies and accompanying regulations might require new supporting functions at different scales. Examples could include the need to train personnel in the use of new technologies, or the enforcement of new regulations not provided by existing institutions. At other times, new institutional roles might cut across mandates of one or more institutions or sectors. The transition to the new system may require institutional reforms to ensure no gaps exist in roles and to address overlaps of jurisdictions, such as different sector ministries or sectional governments.

v) **Socio-cultural**. Socio-cultural conditions can act as enablers or barriers to innovation. Cultural preferences, perceptions, forms of social organization and settlement patterns need to be considered when selecting innovations and when designing intervention processes. In some cases, interventions might need to target socio-cultural barriers. For example, projects can include public awareness campaigns and access to information addressing widely-held preferences or misinformation.

3.3.2 Extent of stakeholder engagement and buy-in to a project or program

Stakeholders are the human agents in a system. The interactions among human agents is determined by their values, perceptions, interests and goals, which can vary according to their roles, resources, history, culture and access to information. They can act at different domains and scales depending on their standing in the social structure. They include individuals or organizations such as government institutions, civil society organizations, local communities, businesses and academia. Access to financial resources, knowledge, natural resources and other stakeholders also determine the extent to which actors can pursue their interests and influence other agents in the system (Zazueta 1995). Thus, more successful projects attract and engage key stakeholders and, when necessary, strengthen stakeholder capacities to carry out their roles and pursue their interests.

3.3.3 Extent to which projects foster conditions which sustain their accomplishments

The mismatches between the span of projects and the time required for changes at scale require attention to conditions, roles or functions that will ensure the persistence of the desired trajectory in the change process after the project winds up. Projects can contribute to such conditions by:

- designing and implementing projects that **build on ongoing processes**;

- helping **ensure that benefits to stakeholders continue to flow** as a means to increase the likelihood of an enduring commitment by stakeholders to the process; and,

- **building capacities** among people and institutions to perform and expand roles needed in the new trajectory.

3.3.4 Establishment of mechanisms to continue change towards long term objectives once the project ends

Given the nature of the CC and Ch&W challenges, problems countries face on these issues are unlikely to be solved during the lifespan of a single project or program. Time mismatches between the duration of projects and the time necessary to bring about behavioral change at broader scales require mechanisms to continue the process after the project ends (GEFIEO 2014; Garcia and Zazueta 2015). Three mechanisms can help ensure ongoing change and further adoption after a project ends:

Mainstreaming: Information, lessons, or specific results are incorporated into broader stakeholder mandates and initiatives such as laws, policies, regulations and programs.

Replication (or scaling-out): Supported initiatives are copied or adopted at a comparable administrative, geopolitical or ecological scale, often in another geographical area or region.

Scaling-up: Supported initiatives are implemented at a larger geopolitical scale, often expanded to include new aspects or concerns that may be political, administrative, or ecological.

3.3.5 Adaptive management

Multiple outcomes and assumptions that are not met bring uncertainty in project implementation, and require information-gathering and – when warranted – adjustments to the original project design. Non-linearity and tipping points should be anticipated and managed wherever possible. To deal with this uncertainty, Rotmans and Loorbach (2009) proposed the adoption of learning processes based on anticipation and adaptation, where approaches are tried and results evaluated prior to their broader promotion. This approach assumes that under some circumstances, projects will encounter unforeseen situations that require modifications to their original design.

4. Integrated Approaches and Complex Systems Thinking in GEF Programing

As the GEF was set up to help countries meet their commitments to global environmental conventions, most of its operations early on were structured to deliver results related to specific conventions. Nevertheless, some aspects of GEF support have included integrated approaches that draw on complex systems thinking, learning from implementation and adaptive management. For example, the International Waters (IW) projects were explicitly designed from the perspective of complex systems thinking and incorporate considerable flexibility in project implementation. GEF support in IW has often taken place through phased projects and has included extensive diagnostics of root causes affecting transboundary environmental challenges. IW projects typically include components to facilitate information exchange and learning across different project sites and countries. GEF has also supported IWLearn for nearly two decades, as a global mechanism to facilitate information exchange, lesson sharing and learning among its IW projects worldwide.

As indicated earlier, many CC projects have approached the market as a system and thus have targeted interventions to remove barriers to change. The GEF Small Grants Programme (SGP)[12] is also a product of more than 25 years of experimentation and learning. The program started with less than a dozen national programs in 1992 and now operates in 125 countries. Proactive oversight, exchange of information and learning among national programs, coupled with strong leadership at all levels, have been important factors on SGP success (GEFEO and UNDNPEO 2008).

Over the years, programming across the GEF has become more integrated. For instance, during GEF 4 (2006 -2010), management introduced programmatic approaches that included clusters of projects contributing to a common objective. These approaches significantly expanded the reach and scale of GEF operations. One example of a programmatic approach is the Ch&W program *GEF Gold - Global Opportunities for Long-Term Development of ASGM Sector*. The objective of the program is to reduce the use of mercury in artisanal gold production. It allows miners and communities access to financing for the adoption of low or non-mercury technology, and works with industry to develop sustainable and socially-responsible gold supply chains. The program addresses barriers to formalization of informal mining operations by addressing institutional, regulatory and financial factors. The program operates in nine countries and coordinates activities with other global initiatives related to artisanal gold production. The program also includes the support of a mechanism to facilitate the exchange of information and learning among participating countries.

More recently, during its Sixth Replenishment (2014-18), the GEF set aside funds to implement three global Integrated Approaches Pilots (IAPs). These address an issue or topic that touches upon several GEF focal areas, such as *Sustainable Cities - Harnessing Local Action For Global*

[12] https://sgp.undp.org/index.php?option=com_content&view=article&id=98&Itemid=223#.WIJFnRsrIRk

Commons. Through this IAP, the GEF can finance projects that reduce greenhouse gas emission such as sustainable transport and housing, but also address water supply, urban planning, waste disposal and other issues related to urban environments. Through this program, the GEF joins forces with other global initiatives and countries to improve living conditions in cities around the world while also addressing pressing global environmental challenges. Supporting cities is not new for the GEF, as it has financed numerous projects in the area of sustainable transport, water and sanitation for over a decade. What is new, and promising, is that through the IAPs, the GEF will coordinate support with other agencies to pursue inter-sectoral objectives and changes at much broader scales.

5. Project Contributions to Change at Scale and Incorporation of Complex Systems Thinking

As indicated earlier, the central hypothesis of this review is that projects that incorporate key complex thinking elements in their design and implementation are likely to result in integrated approaches that make a greater contribution to behavioral change at scale. To test this, a comparison was made between two sets of completed projects:

i)18 projects that had been rated "high" on their contributions to long term impact by the GEF IEO, plus one project that was visited in the field, and
ii) 8 projects rated as having "low" or negligible contribution.

Given the limited time and resources available, the selection of these extreme cases integrate a counter-factual element into the sample to assess the extent to which projects incorporating systems thinking criteria led to changes at scale. In addition to these completed projects, five multifocal area projects that are still under implementation were included together with information from several relevant evaluations of CC and ODS phase-out projects. Results of the analysis are summarized in Tables 1, 2 and 3 and Annex 1 contains more information on the sampled projects and other sources.

Projects were divided into groups according to their contributions to change at broader scales that went beyond the reach of the niche (or scale) at which the project directly operated and according to their contributions to social and economic benefits and benefits to other GEF Focal areas. Group I projects made the greatest contribution and Group III the least. An additional Group IV consisted of projects under implementation that were only assessed to the extent to which they included complex systems thinking criteria into their design.

A key finding was that projects that more completely incorporated complex systems criteria (see rows 1 to 19 of Table 1) contributed the most to multiple benefits and to behavioral change at scale. (This is consistent with the finding of OPS5 which indicated that projects with comprehensive approaches delivered higher progress to impact.) By project closure time, these projects showed significant accomplishments in the extent to which innovations had been adopted. Similarly, most of these projects generated benefits related to other focal areas and to social and economic benefits, which were found to be an important factor for the adoption

of the innovations. By contrast, the eight Group III projects that made little or no contribution to the conditions leading to long-term change and transformation (see rows 20 to 27 of Table 1) were those that had not targeted the complex systems thinking criteria or did not meet them.

5.1 Projects that contributed to conditions leading to system change

All 18 projects that received high ratings by OPS5 plus project 3709 in Peru (visited as part of another assignment (Groups I and II in Table 1)), adopted integrated approaches that met the complex systems thinking criteria. These projects introduced a new technology, business model or approach that had important comparative advantages to the *status quo*. They also helped ensure the supporting financial, institutional and regulatory conditions would enable changes in long-term goals to continue after the project itself ended. All 19 projects also included information and awareness-raising campaigns to explain the benefits of the innovations and to motivate adoption. Several projects in Russia (124), Vietnam (1336), South Africa (805) and Bulgaria (2117) adopted an integrated approach to market change that included product suppliers, regulators and consumers. These projects also resulted in significant replication of the technologies, models or approaches. All 19 projects also managed to identify, engage and build capacities of key stakeholders. Projects such as those in China (98), Russia (658), Bulgaria (2117), Ukraine (107) and Vietnam (1336) mitigated opposition by likely losers from the introduction of new technologies. The projects helped them update their technology or business models to become competitive in the new markets.

The country conditions and the long-term objectives of the projects did not always require changes in all the identified domains. For example, project 243 in Mexico helped develop and test approaches to introduce photovoltaic energy among small farmers. The project did not include new policy or regulatory frameworks, focusing instead on introducing business models which supported existing policies, on building awareness among farmers and on developing institutional capacities to support the spread of photovoltaic technology. A demonstration of a waste-processing plant with gas recovery (project 766 in Uruguay) did not include policy reform, but it did include an extensive outreach and dissemination campaign that, at the time of project closure, had led to replication in several Latin American countries. In both cases there were no significant regulatory barriers to affect the outcomes of the projects.

Projects 144 and 655 helped Russia develop a modern regulatory framework for the proactive management of ODS phase-out consistent with international practice, including international reporting as required under the Montreal Protocol, regulatory controls and licensing of residual ODS consumption. This was again accomplished by adopting an integrated approach that simultaneously tackled the different conditions necessary to bring about change. The project enabled access to the financial resources needed for ODS phase-out from a range of international and domestic sources, through a separate donor-financed project and significant levels of contribution by the firms involved. GEF support also attracted debt and equity investment. Manufacturers needed to update their technology, as the absence of an ODS supply would have rendered their old technology uncompetitive. In the aerosol sector, most of the sub-projects helped create competitive enterprises that at project completion occupied a

substantial part of the traditional domestic market, with some initiating global exports. Despite the success, terminal evaluations raised concerns about the sustainability of some of the project accomplishments due to the lack of an Office dedicated to ODS phase-out.

The 19 most highly-ranked projects generated benefits across focal areas as well as economic or social benefits. Of these, 17 were found to have generated significant social or economic benefits and 14 were found to have generated important benefits in other focal areas. The 8 low ranked projects on the other hand tended to score much lower. Only two of the eight projects generated benefits in other focal areas and three generated significant social or economic benefits (see Table 1)[13].

Among the 19 highly ranked projects (Groups I and II), significant differences were observed in the adoption of innovation and the scale at which change was taking place at project closure. The differences were related to the attention paid to the replication and scaling-up of project accomplishments beyond the niche of the project. Table 2 presents the extent and scale at which project innovations were adopted.

- Extent of adoption was assessed as low when the process was in its early stages, including conditions when individuals and organizations were aware of the benefits of the innovation and had expressed interest in the adoption but had taken no or few actions.
- Moderate adoption included situations when the information and knowledge generated by the project had contributed to the adoption of new guidelines, principles, standards, regulations or laws.
- High levels of adoption were considered when broad behavioral change was taking place that resulted in the reduction of CO_2 emissions, chemicals and waste discharges or use of ODS.

The extent of behavioral change was assessed in terms of changes that resulted in lower environmental stress, such as increases in the number or proportion of firms within a sector that had adopted a given innovation – for example, the adoption of a technology that did not use ODS, or that led to the phase out of POPs. At other times, behavioral change was measured by the increase in market share of a given technology; this was the case, for instance, with energy-efficient appliances. The scale of adoption was assessed as 1) change taking place in the niche in which the project was carried out, 2) change observed in other areas that were similar in scale and 3) changes at a broader scale at the level of a sector or nation.

As previously reported by OPS5 (GEF IEO 2014), data in Table 2 confirmed that there is a direct relationship between the extent and scale of change reached and the type of mechanisms for broader adoption used in the project (mainstreaming, replication and scaling-up). Projects that included all three mechanisms during implementation (Group I) were those that reached the

[13] Five terminal evaluations of the eight lower ranked projects did not provide sufficient information to assess the extent of social and economic benefits generated by the projects.

highest levels of adoption at higher scales. By contrast, Group II projects pursued fewer mechanisms and promoted broad adoption only in the niche they directly targeted, often at lower scales, such as the firm, the municipality or province.

It is also important to point out that in 5 of the 19 highly rated projects, resulting benefits took place largely in one focal area. These projects introduced energy efficient or renewal energy technologies and tended to have narrow objectives. Nevertheless, these projects did generate significant social and economic benefits, and four of them helped bring about significant progress towards the desired transformation. *This finding suggests that while social and economic benefits are necessary to achieve progress towards transformations, benefits in multiple areas, while desirable, are not always critical. This depends on the objectives of the project.*

5.1 .1 Group I projects, which contributed to behavioral change at broader scales and to processes leading to regime change.

The 12 highly-rated projects in Group I (Table 2) resulted in widespread adoption and behavioral change at the sectoral and national levels, and contributed ongoing regime change processes at broader scales. These projects invariably included activities that directly promoted replication and intervened at different scales to either reduce barriers or support conditions for broader adoption that could lead to regime change.

In addition to targeting key domains, engaging stakeholders and building awareness and capacities at the project niche level, these projects involved considerable resources being invested in dissemination of lessons and awareness-raising beyond the niche of the project. They included media campaigns to reach the wider public and implemented strategies to reach the private sector, academia and high-level policy-makers.

This forward-looking approach grabbed the attention and interest at broader scales. Thus policy-makers and regulatory agencies often drew on the information and lessons generated by these projects in the development of country-level policies, regulations and standards. Lessons from these projects were also often scaled up by government projects or transferred to different sectors.

Project 445 in China is credited with helping the country develop the market for energy-efficient refrigerators. The project worked with key regulatory agencies to develop standards for energy-efficient refrigerators while at the same time working with selected companies in designing, testing, producing and marketing energy-efficient appliances. The project also found ways to encourage government mass purchasing of energy-efficient appliances. Information and public awareness campaigns helped to develop a widespread understanding by consumers of the economic benefits of energy-efficient appliances. Replication and eventual scaling-up of project outcomes resulted in the successful removal of market barriers for the adoption of the new technology. The terminal evaluation reports that the project resulted in an increase of nearly 29% in the weighted-average efficiency of household refrigerators produced in China

between 1999 and 2005. This indicated it was likely that the improvements produced by the project would continue.

The GEF IEO verification, which took place several years after the project ended, reported that the share of energy-efficient refrigerators as a percentage of total production of refrigerators in China had increased from 10% in 1999 to 80-90% in 2009. Refrigerator manufacturers were also focused on delivering consistently higher efficiency products. The project also laid the groundwork for the development of efficiency standards for other appliances. Replication within firms took place through the application of technology from one type of refrigerator to another type, and from refrigerators to other household appliances. By the end of the project, replication had not only taken place within manufacturing firms, but several years after project completion, GEF IEO verification noted that other manufacturers had adopted the new technologies in their own processes at their own initiative and cost.

Projects 766 in Uruguay and 784 in Mexico were the first to demonstrate the technical and financial feasibility of landfill gas recovery technologies in Latin America, and were two of the first in the developing world. Both projects provided financing for the construction of landfill facilities, worked through public-private partnerships and included an implementation strategy that contributed to building capacity in the installation and operation of landfill gas recovery systems. In Uruguay, the project financed a 1 megawatt (MW) power plant that generated 2,609 MWh in 2005 from the combustion of approximately 879 t of methane. The project managers worked closely with the country's environmental authorities to develop specifications for the construction and operation of gas recovery landfills. The project also included an aggressive dissemination strategy through the media, the organization of conferences, presentations in numerous international workshops and visits by sponsors.
In Mexico (project 784), the dissemination and public awareness also led to a high level of interest and buy-in among the public sector, the private sector and academia, resulting in many independent initiatives in support of landfill gas (LFG) recovery systems. For example, the National Polytechnic Institute included the use of LFG as an option to reduce GHG emissions in its professional interdisciplinary engineering program. The dissemination strategy of the project in Mexico was carried out through the Ministry of the Environment (SEDESOL) and included the development of feasibility studies for the construction of similar facilities in other cities. The income generated by gas recovery and utilization provided a powerful incentive for municipal governments that used it for the expansion of public services, improvement of waste management regulations, better waste collection and classification, and establishment of recycling stations. The GEF IEO verification for this project found that three years after completion, the 12.72 MW plant had combusted 1,486,676 t of methane to generate 354,177 MWh of electricity. This had also produced substantial socio-economic benefits by providing electricity to two metropolitan train lines, the State Government Offices and other public installations in Monterrey, and public lighting services for seven municipalities in the Monterrey metropolitan area. The project demonstrated how to generate clean and cost-effective energy while at the same time providing other social and economic benefits. This began the broader transformation of the LFG sector, that previously represented 10% of Mexico's greenhouse gas

emissions. By project closure, at least five municipalities had started operating their own facilities with support of a government program partly financed by the World Bank.

The public-private partnership arrangement tested by both projects provided a business model that facilitated the replication of the experience for future projects. By the time these two LFG projects had been completed, 10 similar World Bank-related projects and an equal number of privately-led operations were under development.

Project 3709 in Peru sought to establish a system to manage and dispose of polychlorinated biphenyls (PBCs) by 2028. It included the introduction, adaptation of methods and technology to test equipment and eliminate PCBs; building of awareness and capacities among policymakers, businesses and technicians on the risks of PCBs, and ways to manage those risks; and the identification and elimination of PCBs, particularly in the electricity sector, where the risks are greatest. The project had a slow start and faced delays, partly because of the frequent turnover of officials in the counterpart agency. After the mid-term evaluation, the project was restructured with a new coordination unit. While officers in the counterpart agency fully trusted the new project coordination team, ownership of the project remained low. Despite this contextual situation, the project was very successful at building awareness among key stakeholders, and helped build the necessary capacities in public agencies and the electrical service industry. The project also helped generate more precise information on existence, scale and location of PCBs in Peru; it provided technical support and helped coordinate an inter-sectoral dialogue for a PCB regulation supported by all key stakeholders. By the time the project concluded, nearly all the companies in the electrical distribution subsector had adopted safe practices in the management of PCBs, and had incorporated in their strategic plan, or committed to, the goal of eliminating PCBs by 2028.

5.1.2 Group II projects, which contributed to behavioral change at niche levels and to pre-conditions likely to lead to broad regime change.

The seven projects in Group II resulted in adoption and behavioral change at the niche level in which the project was implemented, and also contributed to pre-conditions for change at a broader scale. These projects helped countries in the establishment of regulations and institutions and in capacity building at the sectoral or national levels necessary to reach behavioral change at higher levels. Nonetheless these projects did not reach widespread behavioral change at a broader level, because they did not pay sufficient attention to disseminating the experience, or were not able to overcome a context that was unfavorable to replication and scaling-up beyond the niche of the project.

The objective of project 1336 in Vietnam was to reduce the annual growth rate of GHG emissions by removing barriers to more energy-efficient technologies in small and medium enterprises within the brick, ceramics, textile, food production and pulp and paper sectors. The terminal evaluation reported that most outputs and outcomes were achieved, many exceeding their original targets. An extensive capacity program trained hundreds of industry technicians in

different aspects of energy efficiency. Workshops targeted to the finance sector increased bankers' awareness of the benefits of energy-efficient projects, and helped overcome their reluctance to finance energy efficiency improvements. As a result, by the end of the project, 11 financial institutions had started to provide loans for energy-efficient projects.

Project 1336 also worked with several government agencies to develop laws, regulations and labeling standards for energy efficiency, and helped establish the Vietnam Energy Conservation and Efficiency Association in December 2010, with some 600 members. Knowledge, regulatory and financial barriers to energy-efficient enterprises in the selected industrial sectors were removed. The project financed 12 demonstration projects and provided technical support to 481 projects. The terminal evaluation also documented 121 additional industries that had adopted the innovations without having direct support from the project. The terminal evaluation calculated that the project avoided 840kt CO_2. This project helped small and medium enterprises update their technology, reduce costs and improve competitive advantage. Replication and dissemination of lessons nearly transformed industrial production in several localities, such as ceramic production in in the village of Ba Tran and brick production in Phu Thuong Province, but behavioral change took place mostly within the sectors and localities targeted by the project. In Vietnam, provincial governments are responsible for passing and enforcement of industrial regulations. The project also included no plans for the replication of the experience across the country. With 63 provinces having to go through the process, changes at broader scales require considerable time.

Project 123, in Group II, successfully demonstrated how an unsafe landfill site in Latvia could be converted into a state-of-the-art landfill gas (LFG) producing facility that provides needed services at an affordable price. The project financed the construction of the facility and worked closely with the Riga City Council to help create a private company to manage the land. Despite some initial disagreement among participating municipalities, they collaborated in the construction of the facility. The project helped overcome differences through an awareness-raising campaign alerting the local population to economic, health and environmental benefits. The project also helped the central government to change regulations to allow the facility to sell electricity into the grid at a competitive price. Despite its success, by project closure, except for the modification of the regulations allowing the plant to sell electricity to the grid, there were no other signs of technical deployment. Little attention had been given to dissemination beyond the locality and the project included no plans for replication elsewhere.

Project 107 in Ukraine had as an objective the phase-out of ODS consumption, consistent with international agreements. It helped high-consumption enterprises make the transition to non-ODS before the supply of ODS diminished. It also provided technical assistance in the elimination of halons and helped establish regulations regarding ODS phase-out. In addition, it supported the development of a halon-management plan and halon recovery and recycling capability. At project closure, the terminal evaluation indicated that the country was fully equipped for ODS phase-out without further assistance. Project 805 in South Africa helped remove market barriers for the large-scale commercialization of solar water heaters, including limitations in standardization, awareness, affordability and financing. The project subsidized the

introduction of 500 solar water heaters as demonstrations of the technology. While the government had established a mechanism to promote the adoption of water heaters, by the end of the project there had been no adoption beyond those supported by the project. Similarly, project 637 of Macedonia successfully demonstrated micro-hydroelectric technology. The project built capacity in two municipalities to manage plants and generate revenue. It also supported demonstration visits and outreach activities to disseminate the experience. The project completion report indicates that several municipal governments in Eastern Europe had expressed interest, and that the World Bank was in the process of preparing follow-up operations in other regions. However, by the end of the project, no replication had taken place.

Project 118 in Senegal helped transform charcoal production and marketing in 317 villages through the introduction of new technology, organization of charcoal producers, media campaigns to raise awareness of the rights and obligations of charcoal producers, policy dialogue and institutional change in the Ministry of Forestry. While the lessons had not been replicated by the end of the project, the government had expressed interest in expanding the experience. One important barrier to replication and scaling-up was the mismatch between the need to devolve management responsibilities to charcoal producers and the forestry legislation, which did not recognize the traditional property rights of communities. Nevertheless, by the end of the project, the Forest Service's mode of operation and its interactions with the local population were transformed from a "paramilitary law enforcer agency" with extremely limited transparency and accountability to a technical assistance and capacity development agency.

The six projects in Group II resulted in extensive behavioral change at the implementation levels. They helped to remove some barriers to adoption at the sector and national levels, but widespread behavioral change at higher scales was not reached by project closing. It is possible that in some cases, not enough time had gone by for the changes to take place. For example, the accomplishments related to ODS replacement in Russia took place over the span of more than ten years and projects typically last from 5 to 7 years. Similarly, the accomplishments documented in the spread of solar photovoltaic (PV) power among small farmers in Mexico and in the replication and scaling-up of new refrigerator technology in China were reported to have taken place several years after the projects ended. Thus, in the cases of halon phase-outs in the Ukraine (project 107), the adoption of energy-efficient technology by small and medium enterprises in Vietnam (1336) and charcoal producers in Senegal (118), it is possible more time is needed for adoption at broader scales.

In some cases, it is likely that more attention to replication and promotion at broader scales could have expanded the reach of the impacts of the projects. For example, in Vietnam (1336) and South Africa (805), more attention to awareness-raising and outreach beyond the projects' niches could have helped speed up rates of replication and scaling-up of the new technologies in regions were the project was not active. In the case of Senegal (117), policy barriers remained. Slow uptake of micro-hydroelectric plants in Macedonia (637) could also be due to regulatory barriers that prohibit connectivity to the grid.

Group II projects included in the OPS5 cohort fell between those that made high or negligible contributions. They had similar results, achieved significant behavioral change at the niche level where they were implemented but had not yet had significant impact on pre-conditions leading to change at broader levels (GEF IEO 2014).

5.2 Projects that made little or negligible contributions to change

Group III consisted of the eight projects that made negligible contributions to change. All had significant shortcomings across several key criteria and most did not meet the complex systems thinking review criteria. Projects did not accomplish the needed changes in key domains and scales, nor did they establish the conditions that would insure that projects benefits could be sustained in the future. Few contributed to pre-conditions that have the potential to result in behavioral change at the local level. Those projects that contributed to change at broader scales, had minor effects which were small and unlikely to modify any broader trajectory. None demonstrated the comparative advantage of innovation they promoted, and none gained buy-in from key stakeholders.

5.2.1 No comparative advantages from innovation

Major shortcomings among these eight projects included a poor understanding of the system, unmet assumptions, and a tendency to overestimate the benefits of the new technology. The business models or approaches that were introduced also gave insufficient attention to socio-cultural factors such as local needs, preferences and capacities. Project 444 Cape Verde intended to ease barriers to the development of renewable energy sources (specifically wind energy) and to introduce cost-effective water and sanitation systems. By project closure, consumers found tariffs for electricity and water, and particularly sewerage, high in view of the inadequate services and frequent power cuts. The terminal evaluation indicated that the model selected was too complex to supply electricity to a widely scattered population in a cost-effective way. The evaluation also found that insufficient attention was given to the institutions and capacities needed to manage such a system.

Project 595 consisted of a Private Equity Fund to promote the spread of solar PV technology in developing countries. It had its origins in a meeting of high-level executives from multilateral financial organizations and private foundations, who concluded that a lack of financing was the main obstacle to spreading PV technology in developing countries. But one year into the project, demand for PV financing was low because the technology was too expensive, and businesses in developing countries preferred to pursue other investment opportunities. As this was a global project that had limited reach to each country, it proved difficult to provide businesses with the support needed to address specific conditions.

Project 1311 sought to promote the adoption of solar cookers in South Africa. The project concentrated on the promotion of business models for the spread of solar cooking technology. An important assumption of the project was that the abundance of sun in South Africa would result in a high interest and demand for solar cookers. But project design did not sufficiently

consider factors such as cooking habits and preferences of consumers and alternative investment opportunities for businesses. Due to low demand, very few businesses joined the project. The terminal evaluation concluded that the technology was still immature, and it therefore did not find viable points of entry into the market.

Project 1838, in Morocco, aimed to establish commercially viable energy efficiency investments and to enhance the knowledge and mechanisms necessary for financiers and end-users to fund energy-efficient projects. The project helped build capacities to conduct energy audits and pass some policies promoting energy efficiency in industrial parks. But at project closure, the accomplishments were much lower than expected. Only one ESCO had been created, when four were expected. Also, of 50 firms that carried out energy audits, only six had committed to implementing the recommendations. Even though managers of other industrial parks had expressed interest in the promotion of energy-efficient technologies, most considered that the model did not work. No replication took place. Terminal evaluation concluded that the ESCO model would have required much more time to change perceptions, and should have given more attention to awareness-raising and policy and institutional reforms.

Project 857, in Peru, sought to demonstrate a renewable energy system in a remote area of the Peruvian Amazon. The project was inspired by a model that addressed the different conditions necessary for a successful utility. Nonetheless, the project did not reach most of its objectives; only one of two plants was in operation at the time it ended. The terminal evaluation indicated that the project formulation had given insufficient attention to technical and management risks, and the project's products were not clearly defined. Project design and implementation focused on the engineering and technological aspects, giving much less attention to the suitability of the power plant to the local demand for electricity. Implementation problems and insufficient attention to capacity-building resulted in management deficiencies that led to high prices of electricity and an unreliable supply of power. The costs of operating the plant turned out to be nearly twice the income generated by the tariffs and revenues.

The main objective of project 1080, in Albania, was to improve the management of uncontrolled water waste discharges into international waters by reducing discharges in three cities, and by improving the management of the tidal Kune-Vain marshland. However the selected design was inappropriate for local conditions. Deficiencies in the design of the facility required major modifications and led to increased costs. Some planned facilities had to be cancelled in order to keep within budget. Plant management was too complex and when the foreign utility firm pulled out, there were no local skilled personnel to operate the plant. The terminal evaluation indicated that the model proposed was not suited to local conditions: “In retrospect, it must be concluded that the project was too ambitious in view of the scarce political support and environmental consciousness that prevailed in Albania at the time” (World Bank 2010).

5.2.2 Lack of financial support from key stakeholders

In Peru (project 857), Albania (1838) and Morocco (1080), a lack of buy-in by key stakeholders can be traced to poor design and implementation, and a deficient delivery of project outcomes. In all three projects, the counterpart government agency refused to disperse funds for replication based on the poor performance of the pilots. In project 1838, the lack of country buy-in was also related to a low priority given to sanitation and conservation in Albania at the time.

In project 264 in Syria, activities were executed exclusively through the Ministry of Energy, thereby excluding other important stakeholders. By contrast, project 1311 in South Africa, on solar cookers, and global project 595 on the Private Equity Fund, operated without much interaction with government agencies. Failure to sustain the interest and commitment of stakeholders was also a result of inaccurate assumptions or changing circumstances, resulting in mismatches in the interests of key project stakeholders. While the Private Equity Fund was initially very successful in attracting investors, it soon became clear after implementation started, that low demand for PV financing in developing countries would affect returns on the fund's stocks. Disagreements on how to deal with this situation led to the withdrawal of some stockholders, and eventually to the closing of the fund. The key issue was that some investors were not willing to accept lower returns.

In Cape Verde (444), the utility company selected to manage the electricity and water systems withdrew from the project when an agreement on tariffs could not be reached with the incoming government. The objective of project 1284 in Mexico was to reduce barriers to facilitate the installation and operation of three commercial-scale wind farms with central grid connection. However, during the project, changes of institutional mandates rendered the counterpart agency marginal to the policy-making process. Although the regulations planned by the project were passed, they cannot be attributed to the project. A promising component of this project was the development of wind turbine technology appropriate for the high wind condition of the area. The project supported the testing of turbines but the technology was not adopted, as the manufacturers were not interested in producing turbines at that time.

5.2.3 Lack of integration and shortcomings in achieving, or addressing, the necessary conditions for change at broader scales

Projects 264 in Syria and 1838 in Morocco were designed to promote replication. A few projects also contributed to pre-conditions for change at broader scales; for example, project 444, Cape Verde contributed to the strengthening of a government agency, the Agencia de Regulaceo Economica, and project 262 in Syria helped strengthen the Ministry of Energy. Project 1284 in Mexico made some contributions to wind technology development and provided comments during the elaboration of new regulations. Project 857 in Peru produced policy proposals that were not adopted. Thus, while these five projects meant to, and sometimes did, help strengthen specific agencies or pass regulations, their contributions were isolated. They did not adopt or were not successful at implementing an integrated approach that addressed the different conditions necessary to change the overall trajectory of the system. The shortcomings in demonstrating the comparative advantages of innovations at the

niche level, and lack of key stakeholder buy-in, proved to be deal-breakers for any major contribution beyond the trial or niche targeted by the project.

5.3 Adaptive management

The uncertainty inherited in complex systems and the multiplicity of possible outcomes requires flexible management that can adapt to unexpected developments. Adaptive management is the ability to reorganize in response to unexpected circumstances and unmet assumptions. This approach treats theories of change as hypotheses that need to be tested and then adapted on the basis of information and lessons derived during implementation (Folke et al. 2002). Rotmans and Loorbach (2009) proposed that long-term goals need not necessarily be precise, but must instead point broadly to the direction of the transition. Through a process of anticipation and adaptation, the results of these changes can then be evaluated prior to their broader adoption. However, adaptive management is difficult to carry out and it often does not deliver the expected results. Allen and Gunderson (2011) have identified nine "pathologies" or sources of failure that can affect adaptive management (Box 2).

BOX 2
"Pathologies" affecting adaptive management

1. Lack of stakeholder engagement
2. Experiments are difficult
3. Surprises are suppressed
4. Prescriptions are followed
5. Action procrastination
6. Avoiding hard truths
7. Lack of leadership
8. Learning is not used to modify policy and management
9. Focus on planning, not on action.

(Allen and Gunderson 2011)

Sometimes the GEF has adopted an "anticipation and adaptation" approach to adaptive management. When it is anticipated that GEF will be engaged for a long time in a process, the GEF Council has approved projects in tranches. At other times, in the face of particularly difficult and complex situations, projects or programs have started with small trials and then gradually expanded, incorporating lessons from experience. In most cases GEF's strict accountability requirements favor project designs that have a precise definition of project inputs and outputs. Yet, when warranted, projects can be adjusted during implementation. GEF agencies are responsible for providing support, keeping track of progress in project implementation and adjusting as needed to ensure that overall project objectives are met. Most of the time adjustments are minor, but on occasion unexpected developments, changes in circumstances or unmet project assumptions require significant modifications to the original design.

Terminal evaluations of 10 of the 25 projects included in this review provide evidence of project restructuring, or attempts to restructure projects. All Allen and Gunderson "pathologies" (Box 2) were to some extent present, but three mainly determined whether attempts at project restructuring succeeded in resolving the problems. In the successful project, swift restructuring, strong leadership and stakeholder buy-in stand out as key factors. The opposite was found among failed restructuring attempts, characterized by procrastination, lack of leadership and failure to retain the commitment of key stakeholders.

Among the 19 Group I and II projects that contributed to processes leading to behavioral regime changes, seven went through some form of adaptive management. Project 1336 in Vietnam adopted a form of the anticipation and adaptation approach. The project objective was to remove barriers to energy efficiency in five different industries various provinces. Given the lack of information and the difficulty in identifying up front the industries and businesses, the project adopted a phased approach to progressively define specific targets based on information generated by the project. Ultimately, the project reached over 543 small and medium enterprises, and in the process helped build considerable capacity in 12 governmental agencies, academic and non-governmental institutions.

Other projects went through significant changes during implementation as a response to unexpected developments. In all these projects, a strong leadership and consensus building around the objectives of the project were key to overcome the difficulties encountered.

i) Project 2117 in Bulgaria sought to remove barriers to the adoption of energy efficiency among private sector enterprises. It adopted an integrated approach that included the introduction of new technology, financing, capacity building and information and awareness-raising. Upon implementation, it soon became apparent that financial institutions were not interested in lending to private firms to invest in energy efficiency actions. The project therefore redirected support to public buildings, where it found willing participants and helped start a wide spread adoption of energy efficient technologies among government agencies by successfully demonstrating the technology. The project also surpassed its CO_2 emissions reduction targets.

ii) Projects 114 and 655 in Russia aimed to phase out ODS use in Russia, but would not have met this objective, as the original design did not include all the sectors using ODS. In the second tranche, this omission was acknowledged and corrected by expanding the project's reach.

iii) Project 637 in Macedonia faced a situation of intense ethnic conflict between the two targeted municipalities. Thus, project management gave much more attention than originally planned to fostering cooperation between the communities. In this way, proactive decisive action, strong project leadership and awareness-raising and information exchange convinced rival groups that it was to their interest to cooperate in the establishment of the mini-hydroelectric facilities and their management systems.

iv) The multifocal area regional project 2600, in the Mediterranean Sea, faced a complex design, including more than 170 activities and 80 demonstrations across 13 Mediterranean countries. It covered diverse thematic areas including coastal aquifers, pollution control and management, resource efficiency, biodiversity conservation and sustainable management of fisheries (Heileman 2016). Staff

turnover and unforeseen developments related to the Arab Spring further complicated project implementation, so that the midterm review rated the project as moderately unsatisfactory. Within the next three years, new project managers restructured the project by shifting activities away from conflict areas and countries that gave low priority to ODS phase-out towards countries that gave it higher priority. Project management also developed a program to facilitate the exchange of information and experiences in different thematic areas and more fully engage demonstration sites in the project. The terminal evaluation of the project indicated that, despite low ratings and implementation delays at midterm, the project had reached and in some cases surpassed its objectives (Heileman 2016).

v) Project 3704 in Peru faced a similar situation: many activities, high staff turnover in the counterpart agency, several unmet assumptions, low stakeholder participation and an unsatisfactory rating in the midterm evaluation. The implementing agency responded to the midterm evaluation by quickly deploying a team of technical experts to redirect the project based on new information it had generated, and hired a new project manager with strong leadership and facilitation skills. The new manager revitalized the project's advisory committee and used it to keep key stakeholders informed and gain consensus on adjustments to better meet project objectives. Upon completion, the project exceeded its project outputs.

Of the eight unsatisfactory Group III projects, three underwent attempts to restructure them. However, in all cases, restructuring failed to correct the problems, mainly due to lack of buy-in among key stakeholders and action procrastination.

i) Project 595 aimed to support the creation of an Equity Fund to promote PV enterprises in developing countries. Different goals and interests of investors prevented the restructuring of the fund when demand for PV financing turned out to be much lower than expected. The terminal evaluation reported: "*While the number and range of investors was a great success, having ten shareholders from across the development-finance spectrum led to a complicated governance structure. Diverging interests and priorities sometimes slowed the decision-making process. Initially, the differences were revealed during Investment Committee meetings, particularly in terms of comfort levels with technical information (e.g. audited statements, sole proprietor businesses etc.). Differences were underscored when some shareholders were unable or unwilling to accept lower return expectations, and pulled out after the presentation of the restructuring proposal. Others refused to consider investments in non-solar renewable energy because of other investments with a similar purpose. Still others were highly invested and argued to restructure the Fund. Having a greater degree of coherence among investors, especially in the case of a social investment of the nature of SDC [solar development capital] with a range of environmental, social and financial goals may have facilitated the restructuring process*"(Enterprise Solutions 1996).

ii) The terminal evaluation of project 857 in Peru reported anomalies in the selection of the company hired to build the facility, but no action had been taken. During implementation, progress in construction was slow compared to high disbursements taking place. As a response, the implementing agency slowed down disbursements to pressure the contracting firm to correct the situation. Delays continued, resulting ultimately in a substandard and inefficient facility.

iii) In the case of project 1080 in Albania, the strengthening of the dollar and higher construction costs led to a restructuring of the project, which resulted in the elimination of some infrastructure works. In restructuring the project, only some of the problems encountered were addressed. Low country ownership, a big factor, continued.

Arguably other underperforming projects could have been restructured, but in most cases lack of key stakeholder buy-in was a factor. Also, not enough information was available to do a deeper analysis; the terminal evaluation of other projects does not document whether there were attempts to restructure them.

6 Observations on Ozone Depleting Substance (ODS) Phase-Out Projects

ODS phase-out projects have been more straightforward than climate change projects because they focus on the elimination of a specific substance. ODS and in general Ch&W projects deal with results that can be observed and easily measured. Climate change mitigation seeks to prevent GG emissions, requiring much more attention to system dynamics and root causes. Nevertheless, CC and ODS projects are similar in that both adopt integrated approaches that that address root causes related to technology, financing, regulation and institutional capacities. Projects in both focal areas also address sociocultural factors, as projects frequently included training and mass media awareness raising campaigns to change behaviors. Following Montreal Protocol guidance, ODS projects have typically made provisions to prevent negative economic impacts of phase-out. This includes financial and technical support to assist private business in the transition to non-ODS technologies. Considering impending prohibitions on the use and production of ODS, this support has offered businesses the opportunity to update obsolete technology and remain competitive in the new market. This has been an important factor in building private sector commitment to ODS phase-out.

A regional evaluation of 12 GEF ODS phase-out projects in Eastern Europe (Bachelor and Smirnov 2010) found that the government support provided has represented an opportunity to meet commitments to the Montreal protocol. Incentives for Eastern European countries in the European Union (EU) have been particularly strong, because GEF ODS phase-out projects have also helped them meet related directives of the European Union. Similarly, as the issue was new for many countries, the opening of ODS offices within the ministries of the environment proved less complicated than reforming existing institutions. This appreciation holds for the five reviewed projects above, and is consistent with the findings of and with a global evaluation of GEF support to ODS phase-out (GEFIEO 2010).

In contrast, in non-EU Eastern European countries projects have tended not to be as successful. In the case of non-EU countries, illegal trade threatened to undermine the gains on ODS phase-out and Halon phase-outs tended to be neglected. In some of these countries, the ODS office was closed after the project ended, mostly because of fiscal constraints confronted by these governments. This placed significant limitations on any effort to continue phase-out activities (Bachelor and Smirnov 2010). For example, the GEF IEO (2010) stated that many businesses in non-EU countries reported growing stockpiles of unwanted CFLs in leaky containers. GEF set up a fund to support ODS phase-out, but by the time the GEF IEO (2010) evaluation was completed, national administrative hurdles had in most cases prevented any progress.

The ODS phase-out experiences in EU and non-EU countries underline the importance of integrated approaches that address temporal scales and foster key pre-conditions to sustain change. This includes the need to generate government buy-in to social and economic benefits that commit other stakeholders to the new technology.

7 Projects under Implementation.

Five Group IV projects under implementation (Table 3) were reviewed by applying the complex systems thinking criteria to project design, using project documents (or project identification forms when project documents were not available on the GEF web site) and STAP reviews when available. Design of all these projects met the complex systems thinking criteria related to domains and scales, agents, and temporal scales. Projects in China (2916), Chile (5150) and Bolivia (5299) aimed to help countries develop regulations, build institutional capacity for their enforcement and dispose of toxic waste.

The five projects were all designed to work closely with government agencies. Projects 5150 in Chile and 5299 in Bolivia also included activities with the private sector as well as wide media and web-based awareness-raising campaigns. As these three projects targeted sectoral and national policies, they did not include mechanisms for replication or scaling up. Instead, their focus was on mainstreaming new approaches and building capacities in government agencies and with suppliers to ensure the sustainability of the innovations. The global project 9602 “GEF Gold” focused on removing legal, financial, technological and market barriers to incorporating informal artisanal gold producers in the formal market. The project is taking place in nine countries and includes activities to support replication and scaling. Another project (4766) promotes the adoption of energy-efficient and sound chemical management in industrial zones in Vietnam. The project addresses technological, financial, regulatory and institutional factors and includes key stakeholders in the government, private sector and communities living near industrial zones. Nonetheless, as is also the case in Vietnam (1336), support for small and medium enterprises lacks a strategy to replicate and promote scaling up of demonstrated research in the pilot industrial zones.

8. Conclusions and Recommendations

The overarching conclusion of this review is there is a link between project performance – particularly as related to the contributions to the project's long-term goals – and the incorporation of complex systems thinking into project design and implementation. The approach adopted also helped establish the link between a project's use of integrated approaches and extent of project contributions intended to bring about desired long-term transitions. Projects addressing key complex systems criteria were found to have integrated approaches that more frequently resulted in contributions to the intended long-term objectives of the projects, when compared with projects that did not address key complex systems thinking criteria.

Also, projects that included CAS elements in all cases resulted in social or economic benefits, but not in benefits in other focal areas. A key finding is that while social and economic benefits are an important component of projects that significantly contribute to transformations, benefits in multiple focal areas are not. This can be explained because of the importance of economic and social factors when addressing root causes.

The review also found that effective integration must address root causes cutting across different dimensions, including sectors, administrative scales, temporal scales, types of stakeholders, disciplines and stages of the project cycle.

Seven guiding principles and their related recommendations for integrated project development and implementation emerge from this review:

Principle 1: Identify the root causes of the problem the project seeks to address.

All projects that resulted in behavioral change at a broader scale successfully identified the root causes of the problem they were intended to address. This required the adoption of integrated approaches that included factors in multiple domains and scales. Key domains to which root causes were typically traced were: technological, financial, policy-regulatory, institutional and sociocultural. Scales that were frequently relevant were the enterprise, the market or market segment and the country.

Recommendation 1. Project design should give special attention the identification of root causes of the problem the project seeks to address. Special attention should be given to understanding interactions stemming from the technological, financial, policy-regulatory, institutional and sociocultural domains and pertinent scales.

Principle 2: Design projects to foster necessary conditions (across domains and scales) that result in the desired behavioral change.

Projects which successfully identified the root causes of problems most often were designed to overcome barriers to behavioral changes leading to the desired long-term transformations. The integrated approach adopted during problem definition guided these projects to address

multiple factors affecting behavioral change at different scales. For example, while testing and introducing new technologies or approaches, projects also sought to provide businesses with incentives for adopting the new technology by raising awareness of the social and environmental consequences of current practices, and by disseminating information on alternative options and their benefits. The most successful projects also ensured that policies or regulations provided the incentives for change and supported the introduction of business and financial models which encouraged the proposed approaches or technologies.

Recommendation 2. Having identified the boundaries of the system, projects should identify and seek to generate conditions at each domain and scale to steer behavior in the desired direction.

Principle 3: Demonstrate to targeted adopters the comparative advantage of the innovation introduced by the project.

Failure to demonstrate the comparative advantage of innovations is a key factor that distinguished projects with a negligible impact from those that contribute to worthwhile changes at scale. These failures were not related to the effectiveness of the chosen technologies or approaches but rather, to incompatibilities between the chosen technology and cultural practices, settlement patterns and the financial circumstances of the targeted populations. Examples of such incompatibilities included technologies that disrupted daily routines but only partially addressed household needs, such as the solar cookers, which only partially met the domestic fuel management needs of households. Another example is the introduction of an electrical grid to dispersed human settlements, which proved difficult to maintain and delivered electricity at costs higher than users were willing to pay.

Recommendation 3. Projects need to give careful attention to the identification and demonstration of innovations that have comparative advantages to the status quo, and are well suited for the context in which they are introduced.

Principle 4: Ensure the buy-in of stakeholders.

Buy-in and alignment with stakeholders' interests is essential for transformative projects. Engagement of key stakeholders in the project or programs was found to be a central factor in all successful projects. This helps prevent the type of incompatibilities described above. Stakeholder engagement also helps to align incentives to interests. Information campaigns supported by projects also helped raise awareness of the urgent need to address the risks posed by CC and chemicals and waste. As many CC and Ch&W projects deal with enterprises and market change, economic considerations were particularly important factors contributing to success, for example. In the case of CC projects cost saving efficiencies were often an important inceptive for adoption. In the case of ozone-depleting substances (ODS), enterprises

were often keen to take advantages of subsidies for the transition to new technologies, which enabled them to meet new regulations and still remain competitive in the new market.

Recommendation 4. Ensure stakeholder buy-in to the innovations or changes introduced by the project through effective communication, project involvement and understanding of the benefits to stakeholders.

Principle 5: Ensure sustainability by building ongoing processes, capacities and generating benefits.

Transformations at scale are best characterized as ongoing processes that go beyond the time span of individual projects or programs. Successful projects consider the temporal mismatches between the duration of the project and the time it takes for the system to respond to the project interventions. For example, successful projects typically consolidate the trajectory they have started by helping establish regulatory frameworks and helping business become competitive in the new markets, thus securing their long term buy-in to the new technologies. Successful projects also ensure that the capacity is in place to continue the process after the project ends.

Recommendation 5: Ensure sustainability by seeking opportunities to build on ongoing processes, generate benefits to stakeholders (or at least mitigate the cost of transition), and build the capacities needed to sustain the change momentum over time.

Principle 6: Plan for further adoption after project closure.

While sustainability ensures the lasting duration of the benefits realized by the project. The extent of benefits achieved by a project or program are rarely sufficient to fully address the problem and to bring about transformation at the desired scale. Projects or programs need to put in place mechanisms that, over time, will ensure the broader adoption of the technologies or approaches introduced by the project. Three mechanisms for broader adoption frequently used by projects that resulted on changes at scale are: 1) the mainstreaming project contributes to broader mandates and processes, such as a study informing the formulation of a regulation or policy; 2) the replication of innovations introduced by the project, through the further adoption of its innovation at similar scales; and 3) scaling-up, which seeks to achieve changes at larger geopolitical scales and often incorporates wider aspects or concerns, such as the expansion of a pilot municipal program to provincial or national level. Projects that included replication and scaling-up in design consistently achieve broad-scale behavioral change that transcends their initial niches and contributes to much broader processes leading to environmental stress reduction.

Recommendation 6: To ensure broader adoption and impact at scale, projects need to incorporate during design, and aggressively pursue during implementation, the establishment of

mechanisms that will support mainstreaming, replication and scaling-up of project contributions once the project ends.

Principle 7: Enable learning and adaptive management during implementation.

Unexpected developments and unmet assumptions often required adjustments during project implementation. A third of the reviewed projects that contributed significantly to the desired transformations went through some form of restructuring during implementation. Key factors leading to successful adaptive management during project implementation were: making finance available for information exchange and learning within and across projects; enabling good participation and communication among stakeholders; requiring projects to include systems that track risks and unexpected circumstances and regularly report back to stakeholders; and encouraging and rewarding candor and swift action when project restructuring is needed.

Recommendation 7: Support adaptive management by budgeting for the costs of information exchange and learning within and across projects; enabling good participation and communication among stakeholders; requiring projects to include a system to track risks, and regularly reporting back to stakeholders how the project is mitigating risks and addressing unexpected circumstances; encouraging and rewarding candor and swift action when project restructuring is needed.

Table1: Incorporation of CAS criteria in project planning and implementation

		Project Info.				Domains / Scale				Actors	Sustainability							
	GROUP	GEF ID	Country	Focal Area	Comp. advantage of tech. or model	Financial systems / resources	Instit. reforms /changes	New policy & reg. systems	Social & cultural	Included and retain key actors	Capacity building	Support/linked on going processes	Arrangements for broader adoption	MFA Benefits	Social or econ. benefits	Relevance	Suportive context	Adaptive management
1	I	445	China	CC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
2		2117	Bulgaria	ODS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
3		622	China	CC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
4		98	China	CC	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N
5		3709	Peru	POPs	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
6		643	Mexico	CC	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	N
7		114	Russia	ODS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
8		655	Russia	ODS	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	NI	Y	Y	Y
9		835	Hungary	CC	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y
10		1155	Mexico	CC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
11		766	Uruguay	CC	Y	Y	N	N	NI	Y	Y	Y	Y	Y	Y	Y	Y	N
12		784	Mexico	CC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
13	II	1336	Vietnam	CC	Y	Y	Y	Y	NI	Y	Y	Y	Y	N	Y	Y	Y	Y
14		107	Ukraine	ODS	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
15		805	South Afric	CC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N
15		2600	Regional	IW	Y	Y	Y	Y	NI	Y	Y	Y	Y	Y	Y	Y	Y	Y
17		637	Macedonia	CC	Y	Y	N	N	Y	Y	Y	Y	Y	N	Y	Y	N	Y
18		118	Senegal	CC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N
19		123	Latvia	CC	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N
20	III	264	Syria	CC	N	N	Y	N	NI	N	Y	N	N	Y	NI	Y	N	N
21		857	Peru	CC	N	N	N	Y	NI	N	N	N	Y	N	Y	Y	Y	Y
22		444	Cabo Verd	CC	N	N	Y	N	NI	N	N	N	N	N	NI	Y	N	N
23		595	Global	CC	N	N	N	N	NI	N	N	N	N	N	Y	Y	N	Y
24		1080	Albania	IW	N	N	N	N	NI	N	N	N	N	Y	NI	Y	N	Y
25		1284	Mexico	CC	Y	N	N	Y	NI	N	N	N	N	N	NI	Y	Y	N
26		1311	South Afric	CC	N	N	N	N	NI	N	N	N	N	N	Y	Y	N	N
27		1838	Marroco	CC	N	Y	N	N	NI	N	N	N	Y	N	NI	Y	Y	N

Table 1

NI= No information

Y= Project accomplishment or for conditions present in the case of “Supportive context” and “Adaptive management”

N= Not achieved by the project or conditions not present in the case of “Supportive context” and “Adaptive management”

Table2:Extent and Scale of Project Impact

	GROUP	GEF ID	Country	Focal Area	Mainstreamed	Replication	Scalling-up	Extent of adop	Scale of adopti
1		445	China	CC	Y	Y	1	3	3
2		2117	Bulgaria	ODS	Y	Y	1	3	3
3		622	China	CC	Y	Y	1	3	3
4		98	China	CC	Y	Y	1	3	3
5		3709	Peru	POPS	Y	Y	1	3	3
6		643	Mexico	CC	Y	Y	1	3	3
7		114	Russia	ODS	Y	Y	1	3	3
8	I	655	Russia	ODS	Y	Y	1	3	3
9		835	Hungary	CC	Y	Y	1	3	3
10		1155	Mexico	CC	Y	Y	1	3	3
11		766	Uruguay	CC	Y	Y	1	3	3
12		784	Mexico	CC	Y	Y	1	3	3
13		1336	Vietnam	CC	Y	Y	N	2	3
14		107	Ukrain	ODS	Y	Y	N	2	3
15		805	South Afr	CC	Y	Y	N	2	3
16		2600	Regional	IW	Y	Y	N	3	2
17		637	Macedon	CC	Y	Y*	N	3	1
18		118	Senegal	CC	Y	y*	N	3	1
19	II	18	18	18	Y	N	N	3	1
20		264	Syria	CC	Y	N	N	0	0
21		857	Peru	CC	Y	N	N	0	0
22		444	Cabo Ver	CC	Y	N	N	0	0
23	III	595	Global	CC	N	N	N	0	0
24		1080	Albania	IW	N	N	N	0	0
25		1284	Mexico	CC	Y	N	N	0	0
26		1311	South Afr	CC	N	N	N	0	0
27		1838	Marroco	CC	Y	N	N	0	0

Table 2
Mainstreaming, replication and scaling-up
1. Present
2. Not present

Extent of adoption
0.-No, or negligible adoption
I.- Process of adoption initiated by the end of the project
2.- Adoption took place in the form of passing of key laws, regulations and the like
3.. Behavioral change that reduces environmental stress is taking place

Scale at which adoption is taking place

0.- No or negligible adoption
1.- Adoption has taken place at the project niche level, for example, locality or segment such as hospitals in given number of cities.
2.- Adoption has taken place in several localities.
3.- Adoption has taken place at the sector or national level, adoption at scale is on its way.

Table 3: Inclusion of CAS criteria in project design for Group IV projects.

	Group	GEF ID	Country	Focal Area	Comp. advantage of tech. or model	Financial systems / resources	Instit. reforms /changes	New policy & reg. systems	Social & cultural	Included and retain key actors	Capacity building	Support/linked on going processes	Arrangements for broader adoption	MFA Benefits	Social or econ. benefits	Relevance	Supportive context	Adaptive management	Sustained	Mainstreamed	Replication	Upscaled
27	IV	2926	China	MF	Y	Y	Y	Y	NI	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	N	N
28		4766	Vietnam	MF	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y		Y	Y	N	N
29		9602	Regional	MF	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y
30		5299	Bolivia	MF	Y	N	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y		Y	Y	N	N
31		5150	Chile	MF	N	N	N	Y	Y	Y	Y	N	N	Y	Y	Y	Y		Y	Y	N	N

Y= integrated
N= not integrated
NI= not enough information available

Annex 1: Approach used to select projects included in the report

Projects were drawn using two steps:

- A first of sample of 27 projects from the OPS5 database (Table A) . These include 19 projects were drawn randomly from among the projects rated highly successful in progress towards impact and all projects (8 projects) that had been rated highly unsuccessful or unsuccessful projects in progress to impact. This database contained all Climate Change and Chemicals and Waste projects for which terminal evaluations were submitted to the GEF IEO from 2005 to 2013. Of these projects, two did not have separate evaluations, as they were part of a cluster evaluation of 12 projects in Eastern Europe. These projects were excluded from the sample, but the evidence presented in the cluster evaluation was included in the report.
- A second selection of projects was carried out in response to a request from STAP reviewers who suggested including more recent projects and more Ch&W projects. As projects in the OPS 5 data base included only those that had been closed prior to 2013, the second selection was done from the GEF website project database (Table B). This included all multifocal area projects (completed and under implementation) that addressed objectives in CC, Ch&W, ODS and IW focal areas and resulted in 10 projects. Three of the projects (1420, 2095 and 2364) were excluded from the analysis because they were NRM-related projects. Two completed projects (1080 and 2600) for which terminal evaluations were available were included in the sample, replacing the two projects that had been excluded. The remaining five projects did not have terminal evaluations available (China 2926, Vietnam 4766, Regional 9602, Chile 5150 and Bolivia 5299), they were analyzed separately for the incorporation of CAS criteria at project design.

One POPs project in Peru (3704) was visited in the field and evaluated by the author under a different assignment and was included in the review . This is project ID 3709 whish was implemented by UNIDO; it consisted of a GEF POPs grant of $2.58 million and was CEO-endorsed in 2010, and completed in January 2017.

In total, this report includes reviews of 32 individual projects of which 27 are completed and were used to carry out analysis of the degree to which criteria project's success is related to the extent that it incorporates CAS criteria. 19 of these were projects that had been rated high in their contributions to impact, and eight were projects that had been rated low or negligible. All CC and Ch&W projects that had been rated low or negligible where included in the sample. Five other projects are still under implementation, or did not have a terminal evaluation available on the GEF website. These projects were used to carry out analysis of the incorporation of CAS criteria in project design. In addition to the analysis of individual projects, this study includes information from a cluster evaluation of 12 ozone depletion substance (ODS) projects in Eastern Europe (GEF 2010), an ODS focal area impact evaluation (GEF IEO 2010), a CC focal area impact evaluation (GEF 2013) and the progress to impact analysis presented in OPS 5 (GEF IEO 2014). Altogether, these evaluations included the in-depth review of more than 170 projects dealing with CC, ODS, POPs and Ch&W and field visits to more than 20 countries carried out by

the GE IEO. Country visits were used to verify the evidence provided by terminal evaluations and to observe changes that had taken place years after the projects had ended.

Table Sample of 28 completed projects drawn from the OPS5 database

GEF ID	Project Title	Progress to Impact Rating	TER/APR Rating	Focal Area	Country	Project Size	Year of completion
98 Included in the main sample	Energy Conservation	Highly Successful	Satisfactory	CC	China	FSP	2006
107 Included in the main sample	Ozone Depleting Substances Phase-out Project	Highly Successful	Satisfactory	OD	Ukrain		2004
114 Included in the main sample	Russian Federation - Ozone Depleting Substance Consumption Phase-out Project	Highly Successful	Satisfactory	C&W (Chem)	Russian Federation	FSP	2001
118 Included in the main sample	Senegal - Sustainable and Participatory Energy Management	Highly Successful	Satisfactory	CC	Senegal	FSP	2005
123 Included in the main sample	Latvia - Solid Waste Management and Landfill Gas Recovery 45716	Highly Successful	Satisfactory	CC	Latvia	FSP	2004
264 Included in the main sample	Supply-Side Efficiency and Energy Conservation and Planning	Partially Successful	Unsatisfactory	CC	Syria	FSP	2006
444 Included in the main sample	Energy and Water Sector Reform and Development	Unsuccessful	Unsatisfactory	CC	Cape Verde	FSP	2009

445 Included in the main sample	Barrier Removal for the Widespread Commercialization of Energy-Efficient CFC-Free Refrigerators in China	Highly Successful	Highly Satisfactory	CC	China	FSP	2004
595 Included in the main sample	Solar Development Group (SDG)	Unsuccessful	Highly Unsatisfactory	CC	Global	FSP	2004
622 Included in the main sample	Energy Conservation and GHG Emission Reduction in Chinese Township and Village Enterprises (TVE), Phase II	Highly Successful	Highly Satisfactory	CC	China	FSP	2007
637 Included in the main sample	Macedonia - Development of Mini-Hydropower Plants	Highly Successful	Satisfactory	CC	Macedonia	FSP	2004
643 Excluded as it is NRM	Renewable Energy for Agriculture	Highly Successful	Satisfactory	CC	Mexico	FSP	2004
665 Included in the main sample	Russia Ozone Depleting Substances Phase out Project	Successful	Satisfactory	OD	Russia		2004
766 Included in the main sample	Landfill Methane Recovery Demonstration Project	Highly Successful	Satisfactory	CC	Uruguay	MSP	2004
784 Included in the main sample	Methane Capture and Use (Landfill Demonstration Project	Highly Successful	Satisfactory	CC	Mexico	FSP	2007
805 Included in the main sample	Solar Water Heaters (SWHs) for Low-income Housing in Peri-Urban Areas	Highly Successful	Satisfactory	CC	South Africa	MSP	2008

835 Included in the main sample	Public Sector Energy Efficiency Programme	Highly Successful	Satisfactory	CC	Hungary	FSP	NI
857 Included in the main sample	PERU Renewable Energy Systems in the Peruvian Amazon Region (RESPAR) 1672	Partially Successful	Unsatisfactory	CC	Peru	MSP	2004
1155 Included in the main sample	Introduction of Climate Friendly Measures in Transport	Highly Successful	Satisfactory	CC	Mexico	FSP	2009
1226 Cluster evaluating, used in the analysis of ODS projects	Ozone-Depleting Substances Portfolio and the Methyl Bromide Regional Project	NR	Successful	OD	Cluster evaluation of 12 ODS EU projects		2010
1311 Included in the main sample	Pilot Production and Commercial Dissemination of Solar Cookers	Unsuccessful	Unsatisfactory	CC	South Africa	MSP	2006
1336 Included in the main sample	Promoting Energy Conservation in Small and Medium-sized Enterprises (PECSME)	Highly Successful	Highly Satisfactory	CC	Vietnam	FSP	2011
1838 Included in the main sample	Energy and Environment Upgrading of the Industrial Park of Sidi Bernoussi Zenata, Casablanca	Unsuccessful	Unsatisfactory	CC	Morocco	MSP	ND
2117 Included in the main sample	Energy Efficiency Project	Highly Successful	Satisfactory	CC	Bulgaria	FSP	2010

1284 Included in the main sample	Action Plan for Removing Barriers to the Full-scale Implementation of Wind Power			CC	Mexico	FSP	2012
2118 **Cluster Evaluation, used in the analysis of ODS projects**	Continued Institutional Strengthening Support for CEITs to meet the obligations of the Montreal Protocol (UNEP)			OD			2010

FSP = full size project MSP= medium size project.
CC = Climate Change OD= Ozone Depleting Substances Ch&W= Chemicals and Waste

Table B: Multifocal area projects drawn from the GEF website database with objectives in the focal areas of Climate Change, Chemicals and Waste, ODS and International Waters.

2926 in design analysis	Environmentally Sound Management and Disposal of Obsolete POPs Pesticides and	POPs	China	Under Implementation
9602 in design analysis	Global Opportunities for Long-term Development of ASGM Sector - GEF GOLD	C&W	Global	PIF
9607 in design analysis	Mediterranean Sea Programme (MedProgramme): Enhancing Environmental	IW/CW/B	Regional	Concept Approved
4766 in design analysis	Implementation of Eco-industrial Park Initiative for Sustainable Industrial Zones in	IW/CW/CC	Vietnam	Completed no TE available
1080 Incld. in the main sample	Integrated Water and Ecosystems Management Project	IW/CC/BIO	Albania	Completed
1420 Excluded it is NRM	Reducing Dependence on POPs and other Agro-Chemicals in the Senegal and Niger River Basins through Integrated Production, Pest and Pollution Management	POPs/IW	Regional	Completed
2095 Excluded it is NRM	Sustainable Management of the Water Resources of the la Plata Basin with Respect to the Effects of Climate Variability and Change	CC/IW	Regional	Completed
2364 Excluded it is NRM	Integrated and Sustainable Management of Transboundary Water Resources in the Amazon River Basin Considering Climate Variability and Climate Change	CC/IW	Regional	Completed
2600 Included in the main sample	Strategic Partnership for the Mediterranean Large Marine Ecosystem-Regional Component: Implementation of Agreed Actions for the Protection of the Environmental Resources of the Mediterranean Sea and Its Coastal Areas	POP/IW	Mediterranean	Completed
5299 in design analysis	Delivering the Transition to Energy Efficient Lighting	CC/ POPs	Bolivia	Approved
5150 in design analysis	Delivering the Transition to Energy Efficient Lighting	CC/POPs	Chile	Approved

CC = Climate Change OD= Ozone Depleting Substances Ch&W= Chemicals and Waste

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