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Transformational Change Taxonomy

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TRANSFORMATIONAL CHANGE TAXONOMY

Methodological framework for the assessment of transformational change in NAMAs

VERSION 1

NAMA PARTNERSHIP

International Partnership on Mitigation and MRV

United Nations Framework Convention on Climate Change

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For information on the research project, visit www.namapartnership.org

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Table of Contents:

1 Introduction

1.1 BACKGROUND AND OBJECTIVES OF THE RESEARCH PROJECT

Transformational change (TC) and paradigm shift are emerging as important terms within the vocabulary of the climate change and development community. They reflect a shared belief that a fundamental change is needed to prevent dangerous levels of climate change and to ensure that global development can be sustainable. Such a change cannot simply arise from developments in technologies or adjustments to stand-alone policies but must involve a systemic change involving alterations in "worldviews, institutions and technologies together, as an integrated system" (Beddoe et al., 2009).

In 2007, under the United Nations Framework Convention on Climate Change (UNFCCC), the Bali Action Plan agreed that enhanced action on the mitigation of climate change requires developing countries to devise Nationally Appropriate Mitigation Actions (NAMAs) "in the context of sustainable development" (BAP 1bii). However, the question of how sustainable development (SD) and transformational change (TC) through NAMAs are to be integrated into national development planning frameworks and how to monitor and assess the process and impacts in an integrated manner remain open questions.

Understanding of TC is still evolving, and innovative approaches are needed to monitor and measure activities leading to lasting transformational impacts for low-emission and sustainable development. Work is underway to develop tools and methodologies for the assessment of SD and TC impacts of climate actions through various initiatives (Mersmann and Wehnert, 2015; Mersmann et al., 2014b; Olsen, Bizikova et al., 2015), but it is still in the early stages. The Green Climate Fund (GCF), the NAMA Facility and many bilateral donors have a mandate to play a transformative role in the way climate finance is governed and delivered for low-emission and climate-resilient activities. However, the criteria and indicators needed to monitor this process and to measure impacts for TC still need to be developed and implemented. The aim of this project is to improve understanding of TC in order to monitor, report and verify (MRV) the contribution of NAMAs to low carbon development that limits global warming to well below 2°C.

The research project is entitled "Indicators for MRV of transformational change in NAMAs" and is being undertaken jointly by the NAMA Partnership and the International Partnership on Mitigation and MRV. While the objective is to operationalize what TC means in the context of NAMAs by developing a methodological framework with indicators, it is important to bear in mind that the methods of assessment are applied to indicators of change and not to change itself. This implies that TC cannot be measured simply in quantitative units but must be assessed primarily in qualitative terms.

Implementation of the project is divided into three phases. This report presents two outputs under Phase 2: 1) a methodological framework for assessment of the TC potential in NAMAs (TC taxonomy[1]); and 2) a test of the TC taxonomy for the analysis of 93 NAMAs submitted

1 By taxonomy we mean a classification scheme of concepts to define key aspects of TC operationally through a hierarchy of dimensions, factors and indicators that constitute a tool to monitor, report and verify (MRV) the potential and impacts of interventions for a paradigm shift to low carbon development.

to the UNFCCC Registry by 1 June 2015. The three phases are mutually dependent and integrated in the way that the outputs of Phase 2 directly build on the outputs of Phase 1: A concept paper entitled ‘From theory to practice: understanding transformational change in NAMAs’ (Mersmann et al., 2014a); and five case studies of TC published in *Perspectives* 2015 entitled ‘Transformational change for low carbon and sustainable development’ (Olsen and Fenhann, 2015). Phase 3 of the research project will refine the indicators based on stakeholder comments and apply the TC Taxonomy for in-depth analysis of a few selected NAMAs being implemented.

An operational definition of what TC means in practice was proposed in the concept paper and a revised operational definition is presented in this report based on analysis and lessons learned from the case studies.

1.2 OPERATIONAL DEFINITION OF TC

Departing from a theoretical understanding of TC as a complex system change – a paradigm shift involving changes in world views, institutions, and the cultural, technical, economic and environmental dimensions of a system – an operational definition of what the concept means in practice has been proposed by Mersmann et al. (2014a):

“TC through NAMAs is a change:

*(1) that disrupts established high-carbon pathways, contributes to sustainable development and sustains the impacts of the change (**goal criteria**),*

*(2) that is triggered by interventions of actors who innovate low carbon development models and actions, connect the innovation to day-to-day practice of economies and societies, and convince other actors to apply the innovation to actively influence the multi-level system to adopt the innovation process (**process criteria**),*

*(3) that overcomes persistent barriers toward the innovated low carbon development model and/or creates new barriers which hinder the transformed system to relapse into the former state (**‘low-carbon lock-in’ criteria**).”*

The operational definition was made available as a common starting point for the five case studies, which were selected to learn from the most advanced examples of transformations to low carbon development that are ongoing or being planned. A diversity of countries and sectors was selected to understand a broad range of drivers and barriers and to identify generic indicators of TC. The case studies were not limited to NAMAs, as few NAMA support programmes are at the implementation stage, but included broader developments such as low carbon transitions at sector and sub-sector levels. A balance was kept between developed and developing country examples, as early movers among developed countries have started their transformations several decades ago, while most developing countries have only started more recently, within the last one or two decades.

The case studies focus on the following aspects of TC:
Developed country cases:

- *Germany*: The ongoing transformation of the energy system is analysed from a historical perspective to understand the underlying factors that have enabled a paradigm shift in politics, society and business. The study focuses on how laws and regulations for renewable energy have enabled a low-carbon pathway aiming at 80-95% CO_2 reductions by 2050 compared to the 1990 level.

- *Denmark*: The role of wind power in electricity generation in Denmark is analysed in the context of a transformation from fossil fuel-based energy production to 100% renewable energy by 2050. In 2014 Danish wind turbines supplied 39% of total electricity demand in Denmark. The study analyses the drivers and success factors of the ongoing transformation.

Developing country cases:

- *Brazil*: The dramatic reduction in deforestation (75% over a decade from 2005 to 2014) represents the largest GHG reduction by any country. The case study analyses the main drivers and considers the causes and consequences of TC in the context of theories of change in socio-technical systems. An important finding is that the key patterns of change are not captured in the prevailing system perspectives on TC.

- *Columbia*: The transport system in Bogotá has been transformed through the political visions of a city mayor and implemented through technical solutions, which are now being replicated by other cities in Columbia and abroad. The study analyses how interventions for a bus rapid transit system, walking and biking infrastructure and travel demand management have led to structural changes in the direction of a sustainable and low-carbon transport system over a fifteen-year period. The risks of relapsing into unsustainable practices are assessed and options to sustain the transformation are discussed.

- *South Africa*: The study analyses the role of state-owned companies in leading an incremental transition from high-carbon lock-in towards a national low-carbon development pathway. The government has committed itself to reducing GHG emissions by 34% in 2020 and by 42% in 2050 compared to business-as-usual scenarios, conditional on support from the international community. Theories of sustainability transition pathways are discussed and an argument is presented for state-owned companies to take a leadership role in the areas of aviation (South African Airways), transport (Transnet) and energy (Eskom).

The full analysis of the case studies can be found in the publication “Transformational change for low carbon and sustainable development” (Olsen and Fenhann, 2015). Figure 1 provides an overview of how TC is defined in each of the five cases.

Figure 1. Definition of transformational change applied in five cases

Factors	Goal	Process	Low-carbon lock-in
Questions	What are the goals and key indicators of TC?	What interventions trigger the change process? Who are the key actors? How will the intervention lead to system change?	Which barriers have been overcome? How will a low-carbon pathway be sustained?
Indicators: **Brazil**	Brazil's national climate change policy is to reduce GHG emissions from deforestation by 80% in 2020. The key indicator is a drop in deforestation in the Brazilian Amazon by 75% over a decade from 2005 to 2014.	No single, planned intervention has created the change. Concern and advocacy by academics and NGOs led to turning points, when major industry organizations imposed a moratorium on deforestation related to soy and beef production in 2006 and 2009 respectively.	Pressure from civil society was powerful enough to delink deforestation from economic interests in clearing forest land. Satellite images helped to enforce the moratoria on clearing forest land. Brazil's commitment to stop deforestation is part of the national climate change policy enacted as law in 2009. TC is not yet locked-in and opposition from small and large landowners persists.
Colombia	Sustainable urban transport in Bogotá is based on mass transit, bikeways, sidewalks and parking policies. Key indicators include operational speed (km/h), bus fleet, square meters of sidewalks and share of trips by bike (%).	Bogotá sustainable transport measures (BRT, walking and cycling infrastructure, and TDM) achieved structural change in the city and its transport system in the period 1995 to 2005. Key drivers of the change were political and technological innovations initiated by Mayor Enrique Peñalosa (1998-2000).	Sustainable urban transport in Bogotá is based on mass transit, bikeways, sidewalks and parking policies. Key indicators include operational speed (km/h), bus fleet, square meters of sidewalks and share of trips by bike (%).
South Africa	The SA Government has committed to reducing CO2 emissions in the country by 34% in 2020 and 42% in 2025 compared to BAU, conditional on international support.	State-owned companies (SOCs) can lead the transformation. Policy measures are beginning to become visible.	The Minerals Energy Complex (MEC) relies on coal and is interlinked with the electricity, finance, manufacturing and service industries, which locks the country to a carbon-intensive pathway. A low-carbon transformation has to work within an MEC paradigm to enable systemic change that is incremental, not radical.
Denmark	The Danish Parliament has agreed on the goal of 100% renewable energy in the energy system by 2050, including the heat, power and transport sectors. In 2014 wind turbines supplied 39% of total electricity demand in Denmark.	Pioneers developed the first windmill for electricity production in 1891. In the 1970s researchers, activists and politicians collaborated for wind power development to take off and since 1985, it has accelerated. Multiple interventions and broad social support have enabled a system change.	The global oil crisis in the 1970s helped to overcome barriers of low interest and resistance to wind power development. Today, political, industrial and social support is aligned and likely to sustain a low-carbon pathway.
Germany	The long-term vision of the German Parliament is for an 80% share of renewable energy in electricity production by 2050. Key indicators of the transformation are CO2 reductions in 2050 against the 1990 level (85-95%), improved energy efficiency against the 2008 level (25%) and phasing out of nuclear energy by 2022.	Policies for the transformation of the electricity sector started in the 1970s. The vision of a RE-based power and energy system has been controversial for many years and became political mainstream only in 2010, when it was translated into RE targets for 2050.	Stranded costs in the coal sector for energy-intensive industries are overcome through exemptions from surcharges and fees. Alternative low-carbon technologies (nuclear, fracking and CCS) have little or no social or political support in Germany. Rapidly falling costs of RE technologies are helping to avoid lock-in to fossil fuel-based power systems.

Only the Brazilian and Columbian cases apply the working definition directly, while the other three cases discuss their findings in the context of theories of sustainability transitions and contribute to discussions indirectly.

In the Columbian case, the evidence supports the definition of TC in relation to all three factors. Regarding the "low-carbon lock-in" factor, there is a risk that the transport system may relapse into unsustainable transport patterns due to opposition to more ambitious initiatives. With regular changes in those occupying the office of mayor, the political preferences of key decision-makers vary over time between support of and opposition to low-carbon development. This underlines the need for indicators to monitor and track whether the changes achieved qualify as continued TC towards the goals and visions agreed. It also raises the issue whether TC is best defined by qualitative criteria only, or if quantitative assessment is needed to assess the ambition of TC against quantifiable criteria reflecting the level of ambition.

In the Brazilian case, the evidence supports two of the factors in the working definition of TC, namely the goal and lock-in criteria, but it did not support the third criteria, the process of change. The process of change criterion is defined as being triggered by interventions that change the established way of doing things. This was found not to be supported, as there was no single policy or actor that triggered TC in the case of Brazil. Rather, the changes are attributed to behavioural changes in many different parts of society, with no single trigger, goal or plan steering the process. Key evidence for the transformation is identified as the delinking of deforestation from its main economic drivers related to beef and soy production. Yet, the dangers of a relapse remain, as both large-scale and small–scale landowners continue to oppose and weaken the legal protection for forests and enforcement against deforestation.

The South African, Danish and German cases do not directly apply the working definition in providing evidence of whether TC has happened or not. Rather, the issue is whether a definition with clear criteria for what qualifies as TC – as opposed to change that may be significant but that does not lead to a paradigm shift – is appropriate in developing countries as a condition for funding. In the Danish case, the argument is made that "transitional change" such as more efficient coal-fired power plants or energy-efficiency improvements do not meet criteria for a paradigm shift such as a shift to 100% renewable energy. Transitional change, however, could still make important contributions to low-carbon and sustainable development priorities in developing countries. The German case highlights the many jobs created by the energy transition and the income generated by the export of clean technologies. For developing countries it is crucial to stress that the costs of RE technologies are rapidly falling and that significant co-benefits such as technological innovation, health impacts, jobs and economic growth are associated with low-carbon policies. The South African case emphasizes the fact that a transformation to a low-carbon pathway is only acceptable if it generates benefits for development that address the primary concerns of developing countries such as reductions in poverty and inequality.

Based on the above discussions – and particularly how the Brazil case is challenging the process dimension of the operational definition – we propose a revised definition as follows (the change is highlighted in bold):

"TC through NAMAs is a change:

*(2) that is triggered by **political and civil-society reactions to unsustainable practices or** the interventions of actors who innovate low carbon development models and actions, connect the innovation to day-to-day practice of economies and societies, and convince other actors to apply the innovation to actively influence the multi-level system to adopt the innovation process (process criteria)."*

The operational definition does not attempt to quantify what constitutes an adequate level of ambition for TC but aims to distinguish TC from other change processes qualitatively. The level of ambition for how deep and fast system changes for GHG reductions should be to qualify as a paradigm shift is better assessed in a context-specific manner, and it can be monitored through indicators that can track progress against agreed goals and visions.

The following section proposes taxonomy of indicators identified from the five case studies to MRV the TC potential and impacts of interventions for low-carbon development.

2 Methodological framework for assessing the TC potential in NAMAs

2.1 ANALYTICAL FRAMEWORK TO IDENTIFY KEY FACTORS AND INDICATORS OF TC

In Mersmann et al. (2014a) three approaches drawn from theories of sustainability transitions are presented to analyse the TC processes found in NAMA-type policies and actions. Each approach has a particular focus and provides a "piece of the puzzle" to understand TC processes and impacts.

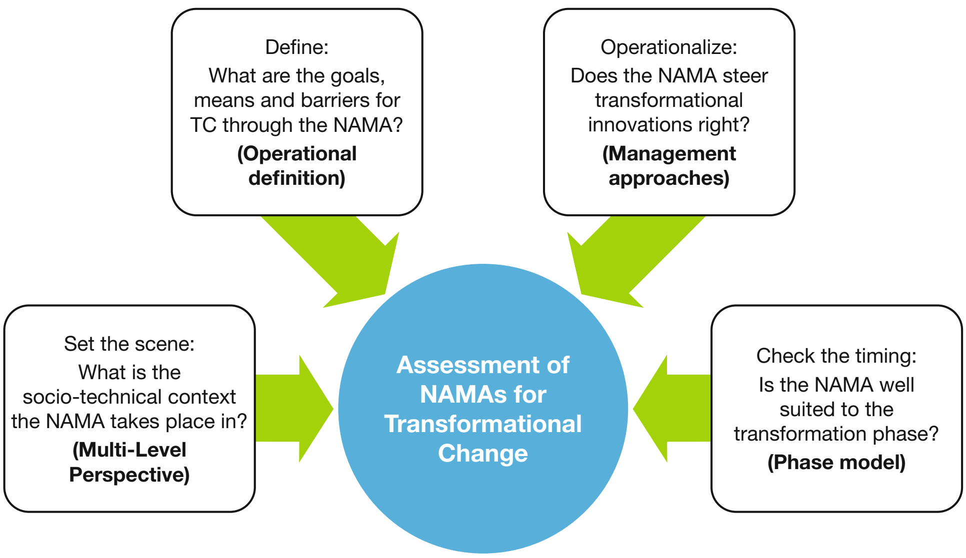
The Multi-Level Perspective provides analysts and practitioners with a framework to understand the socio-technical context in which the NAMA intervention is taking place.

The Phase Model adds to this by providing a time dimension to assess whether the NAMA intervention is timely to the country and sector context.

Strategic Niche Management and Transition Management are two management theories for sustainability transitions that offer insights and tools to steer innovations as crucial starting points for transformational change.

Based on these three approaches presented in the concept paper, we add a fourth dimension to the assessment of TC potential in NAMAs as presented in Figure 2. The fourth dimension is the revised operational definition of what constitutes TC in practice.

Figure 2. Analytical framework for assessment of TC



The analytical framework serves to raise questions for analysis of the cases by pointing to the key factors at play in TC processes. Answers to the questions serve to identify indicators for MRV of TC potential and impacts. The factors are categorised along four dimensions: 1) operational definition of TC; 2) multilevel context for the transformed socio-technical system; 3) phases in transforming the socio-technical system; and 4) management of TC. Table 1 provides an overview of the relationship between the dimensions and key factors, and shows how indicators are identified by means of questions asked to the country case studies.

Table 1. Analytical framework for case studies of TC to low-carbon development

Theory-based dimensions	Key factors	Questions asked to country cases[2]
Operational definition of TC for low-carbon and sustainable development	*Goal(s) of transformation*	What are the goal(s) and key indicator(s) of TC?
	Process of change	What intervention(s) trigger the change process? Who are the key actors? How will the intervention lead to system change?
	Low-carbon lock-in	Which barriers will be overcome? How will a low-carbon pathway be sustained?
Multilevel context for the transformed socio-technical system	*Landscape level*	What macro-level trends and changes in the socio-technical system are having an impact on the transformation?
	Regime level	How is the socio-technical regime defined? What established infrastructure and ways of doing things need to be changed with regard to rules, institutions, practices, behaviour, markets and industry structure?
	Niche level	What new technologies or policies will trigger the TC? Do protected spaces exist for technical, social and organisational experiments and learning?
	Interactions across levels	What are the key dynamics of change between the three levels?
Phases of transformation – at what stage is the socio-technical system?	*Pre-development phase*	What are the established high-carbon pathways? Who are the pioneers of change?
	Take-off phase	What new ideas, concepts, coalitions, regulations and social acceptance are emerging for low-carbon development?
	Acceleration phase	How does policy and regulation support change? How are low-carbon solutions challenging established pathways? Is opposition to new solutions increasing or decreasing?
	Stabilisation phase	Is the low-carbon pathway stable or at risk of relapse? What new barriers are hindering a relapse?
Management of TC interventions – a cyclical process of four governance activities	*Strategic*	How is the transition arena being set up as the institutional core of an intervention in collaboration with a network of innovators?
	Tactical	What are the driving sustainability and low –carbon visions, agendas and pathways?
	Operational	How are actors mobilized for executing projects and experiments?
	Reflexive	How is monitoring and evaluation of the transition process facilitating reflexive learning to modify and adjust transition goals and pathways?

2 Indicators of each factor are identified based on a synthesis of answers to the questions raised as shown in Table 3 on TC taxonomy.

While the dimensions and factors for understanding processes of TC are theory-based, answers to the questions depend on the empirical evidence in the case studies. The latter describe socio-technical systems at different levels (country, sector, sub-sector and niche level), and authors have chosen different theoretical and methodological approaches to make sense of the change processes. Cases are therefore not comparable along all dimensions and across all key factors. However, analysed as a whole, the case studies enable us to identify the key indicators of TC empirically in order to inform a methodological framework and a taxonomy that can be used as a tool to monitor, report and verify (MRV) the potential and impacts of interventions for a TC to low-carbon development.

2.2 COMPARISON OF KEY FACTORS FOR TC

While there is no blueprint for the key factors that drive TC, regardless of country or sectoral circumstances, there are commonalities and differences in how socio-technical systems are being transformed or planned to be transformed to low-carbon pathways. A comparison of experience from the five cases based on the analytical framework in Figure 1 reveals the following commonalities and differences.

Commonalities:

- Goals for GHG reductions and sustainable development
  In all cases a goal or vision exists for long-term changes in GHG reductions and/or the desire for sustainable development. In many cases the goal is quantified as a GHG reduction target by a certain year, and the goal or vision is politically and sometimes legally agreed upon by the country's government and parliament.

- Low-carbon lock-in is sustained by public opinion and national policies and laws
  In the three cases where a TC has happened (Brazil, Denmark and Germany), the change is highly likely to be sustained by two factors: 1) a broad majority of citizens and civil-society organizations support the goals of the transformation; and 2) the respective political systems have institutionalized the agreement on goals in the form of national policies and laws.

- Landscape trends and events at the global level influence national transformations
  In the 1970s the global oil crisis created environmental awareness in developed countries, along with a desire for energy security and independence. Nuclear accidents in the Soviet Union in 1986 and Japan in 2014 have increased opposition to nuclear power and support for renewable energy as an alternative energy source. Growing international concern about climate change is influencing national climate policy-making and mobilizing support to incentivize enhanced mitigation actions in developing countries.

- TC is not managed by a single actor or intervention, but happens over time in a system of competing interests
  Pioneers and leaders of TC can be identified, such as entrepreneurs, civil-society organisations, visionary politicians and state-owned companies. In three of the cases the process of changing a socio-technical system has involved a struggle over competing interests over a medium (ten years) to long-term period (several decades) involving multiple interventions at different levels. In the cases of Bogotá in Columbia and South Africa, it remains to be seen whether the opposition to TC can be overcome to avoid a relapse and persistent barriers to high-carbon lock-in, and to mobilize the finance and political will to follow a low-carbon pathway.

Differences:

- Drivers of change processesThe primary change agents for a system are highly context-dependent. The case studies show variation regarding whether the change is being driven by bottom-up initiatives, such as the pressure from civil society in Brazil, or by top-down initiatives, such as national policies and laws, as in the later stages of acceleration in Denmark and Germany. There is also variation in the extent to which change processes are planned and managed through interventions and policies, or triggered by reactions to external shocks at the landscape level, such as oil crises or nuclear accidents.

- Overcoming the barriers to changing high-carbon lock-in
  The means to overcome the barriers to a transition to low-carbon pathways vary from campaigning to influencing public opinion against deforestation or nuclear energy to technical or economic means of compensating losers such as energy-intensive industries dependent on fossil fuels.

- The multi-level context for system change
  System changes are defined by a substantial shift in the structure of a system at different levels. In some cases system change starts at the niche level, for example, the pioneering activities to develop new technologies for wind power development in Denmark and various initiatives for renewable energy in state-owned rail, air and energy companies in SA. At later stages niche developments can influence the regime level through the support, protection and scaling up of technology and interventions. In other cases system change starts at the regime level, such as political activism followed by policies and laws against deforestation in Brazil, which has led to changes in business-as-usual behaviour in the supply chain of beef and soy production.

- Phases of transformation
  The five cases are at different stages of TC and reveal different trajectories of how they arrived there. Denmark and Germany are in the *acceleration phase* towards realising national goals of 100% and 85% RE in the energy system, respectively. Brazil has achieved a 75% reduction in deforestation over a ten-year period, with the aim of achieving an 80% reduction by 2020. This qualifies for the *stabilisation phase*, where government policies and laws are in place to enforce the TC being sustained. Bogotá is in a '*deceleration phase*' rather than accelerating, as subsequent mayors from opposing political parties have distanced themselves from the sustainable transport policies. South Africa is in the *pre-development phase*, where cheap and abundant coal has made the economy highly reliant on fossil fuels, and the reorientation to low-carbon pathways faces strong business and political resistance.

- Governance activities for the management of transitions
  Strategic, tactical, operational and reflexive governance activities are specific to each intervention in the direction of a transformation. Only the Bogotá and South African cases describe experience with planned interventions to achieve TC visions, though at the different levels of a city and at state-owned company respectively.

Comparing key factors enables us to identify potential success factors as the commonalities in how the factors listed in Table 2 play out across the cases. The differences in key factors represent the variety in national, sectoral and local contexts, an the limits of a 'one-size-fits-all' approach using generic criteria to define what constitutes TC.

2.3 INDICATORS OF TC BASED ON THE FIVE CASE STUDIES

To identify indicators of TC, we apply the analytical framework presented in Table 1 to analyse and compare TC processes in the five cases. The results of the analysis are provided in Annex 1.

The indicators are mainly qualitative, though a few are quantifiable, such as the goals of SD and GHG reductions. The quantifiable indicators can serve as key performance metrics and milestones to track the progress of NAMAs, while the qualitative indicators capture essential parts of the narratives of the TC processes. The assessed changes can be both positive and negative and indicators are neutral to track both progress and reversal of progress towards TC goals.

2.4 THE TC TAXONOMY

One way to assess the potential for and impacts of TC is to define a set of indicators. This is done by means of the TC taxonomy, which can guide a structured analysis of mitigation actions that is comparable across very different NAMA proposals and can serve to assess how a NAMA will achieve the goals of SD and GHG reductions. The generic indicators in the taxonomy are identified through a synthesis of empirical indicators from the case studies (Annex 1) complemented by analysis of the following kinds of mitigation activities: CDM projects, CDM Programme of Activities, NAMAs, REDD projects, National Communication to the UNFCCC, and GHG mitigation activities in various countries. Furthermore, the generic indicators of the TC taxonomy have been applied and refined for the analysis of 93 NAMAs submitted to the UNFCCC registry by 1 June 2015 (see the results of the analysis in the next section).

Figure 3 below gives the resulting list of the 48 TC-indicators (excluding ‘other’ indicators) and shows how they are grouped according to “dimensions” and “factors” based on the analytical framework as shown in Figure 2 and Table 1.

Figure 3. Transformational Change Taxonomy

	Definition of TC	Multilevel context	Phases of transformation	Management of transition
Dimensions	Definition of TC	Multilevel context	Phases of transformation	Management of transition
Factors	Goal	Landscape level	Pre-development	Strategic
	Process	Regime level	Take-off	Tactical
	Low-carbon lock-in	Niche level	Acceleration	Operational
		Interaction across levels	Stabilisation	Reflexive

Indicators

Goal
- Goal for a rapid large scale GHG reduction
- Sustainable development goals incentivise the transition
- Milestones/Key performance indicators

Process
- Political leadership and vision
- Actors connect innovation to day-to-day practice
- Actors influence multi-level system to adopt innovation

Low-carbon lock-in
- High-carbon barriers are overcome
- Other

Landscape level
- Growth of international concern about climate change had an impact
- Political pressure generated by organized civil society important

Regime level
- National government incentives to change/ disincentives to no change
- Improvement of regulation

Niche level
- New technologies owned by citizens
- Financial participation of citizens in local energy generation plants give local ownership
- High local involvement in the program

Interaction across levels
- Multilevel interaction
- Actors create networks for low-carbon transition
- Other

Pre-development
- Increased funding for technological R&D
- Experimentation and innovation in the policy/programme
- New testing facilities for technologies
- First of its kind programme
- Increased public awareness on new technologies

Take-off
- The programme will be replicated, model for similar programmes in other areas
- Significant capacity building included in the programme
- Modal shift in the transport sector encouraged

Acceleration
- Extended high voltage grid
- Significant reduction of deforestation/ increase of forest area
- Significant reduction of CH4 emission from waste

Stabilisation phase
- Barriers to relapse to high-carbon practice
- Government policies and laws sustain the transformation
- Other

Strategic
- Increased awareness on climate change in governmental/ municipal institutions
- New institutions created or changed
- Information campaign performed

Tactical
- Government has made a long term vision with targets that are enforced
- Strengthen enforcement of existing laws
- Risk minimization instrument introduced
- Financial support for low carbon technologies
- Negative incentives that discourage the continuation of business as usual
- Prohibits import of inefficient technologies
- Introduction of standards/ performance standards

Operational
- Reduction of subsidies for fossil energy
- Feed-in Tariffs with a purchase obligation, stable tariff over a long period of time
- Introduction of mandatory labelling or metering
- Introduction of carbon market
- Introduction of fuel tax, traffic congestion tax, import/export tax etc.

Reflexive
- Learning from ongoing policies and actions
- MRV frameworks inform transition management
- Other

Indicators for two of the dimensions – 1) definition of TC, and 4) management of transition – are related to the design and governance of NAMA activities. Indicators for the other two dimensions – 2) multilevel context and 3) phases of transformation – are focused on the historical and broader context of the NAMA. This is a broader approach to the MRV of NAMA proposals than what is seen in logical framework and results-based performance measurement frameworks as applied by the Green Climate Fund (GCF, 2014). The logic and linear frameworks have a narrower focus on the MRV of the NAMA interventions and focus on changes that are directly attributable to the activities being supported. In contrast, the complex systems theory perspective structuring the TC taxonomy enables a more comprehensive approach that focuses on both the NAMA intervention and its relationship to the multi-level context and the stage of the socio-technical system that is being transformed.

3 Test of the TC taxonomy in the analysis of NAMAs submitted to the UNFCCC Registry

The TC taxonomy was tested for the analysis of 93 NAMAs that had been submitted to the UNFCCC Registry by 1 June 2015, using the NAMA Pipeline published by the UNEP DTU Partnership on a monthly basis. All submissions to the UNFCCC Secretariat from developing countries and countries in transition are contained in the database and analyses are available for public use at www.namapipeline.org.

3.1 APPLICATION OF THE TC TAXONOMY IN THE ANALYSIS OF NAMAS

The NAMAs submitted to the UNFCCC Registry were subjected to textual analysis by applying the taxonomy to code the TC indicators that apply to each NAMA. In other words, TC indicators were attributed to the NAMA descriptions on the basis of the information available in the Registry. The process of applying the TC taxonomy to the analysis of each NAMA consisted of assigning a 'YES' if there is evidence to support a particular TC-indicator and a 'NO' if there is no evidence to support it.

Information available in the NAMA Registry is typically five to ten pages long, excluding attachments, and is structured under the following categories:

a) overview

b) national implementation entity

c) expected time plan for the preparation/implementation of the mitigation action

d) currency

e) cost

f) support required to prepare the mitigation action

g) estimated emission reductions

h) other indicators

i) other relevant information (g, h and i are only required for NAMAs seeking support for implementation)

j) relevant national policies, strategies, plans, programmes and/or other mitigation action,

k) attachments and

l) support received

Sections "a" and "i" are the most relevant for the assessment of TC potential.

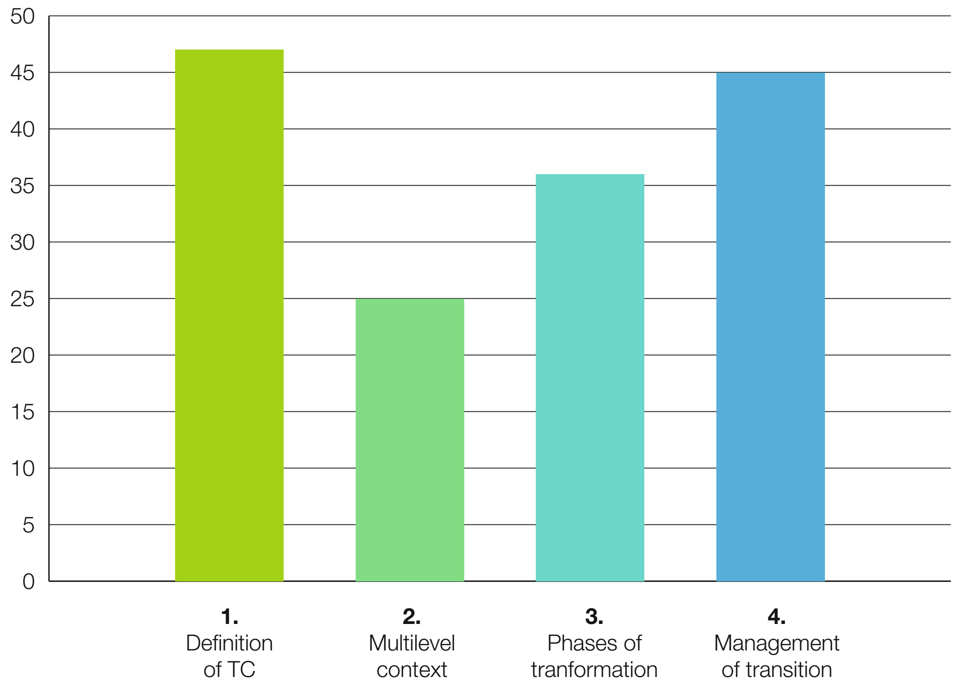
A new column was inserted into the NAMA Pipeline to indicate the applicable TC indicators for each NAMA. The next step in the analysis was to create a spreadsheet with 93 rows covering all the existing submitted NAMAs and 48 columns with all the TC indicators. Knowing which coded indicators were applicable to each NAMA, the NAMAs were then analysed to find a short description of why each TC indicator had been used for the NAMA.[3] The analysis enabled a simple scoring of each NAMA's TC potential based on the number of indicators that had been coded as relevant to the respective NAMA. The scores range from 0 to 4 indicators per NAMA out of a maximum of 48 TC indicators in the taxonomy.[4]

3.2 RESULTS OF APPLYING THE TC TAXONOMY

Figure 4 shows the number of indicators used for each of the four dimensions, ranging from 25 to 47 times. For example, TC indicators were used 47 times for dimension 1, 'Definition of TC'.

Figure 4. Dimensions of TC

Number of TC-indicators used in each dimension



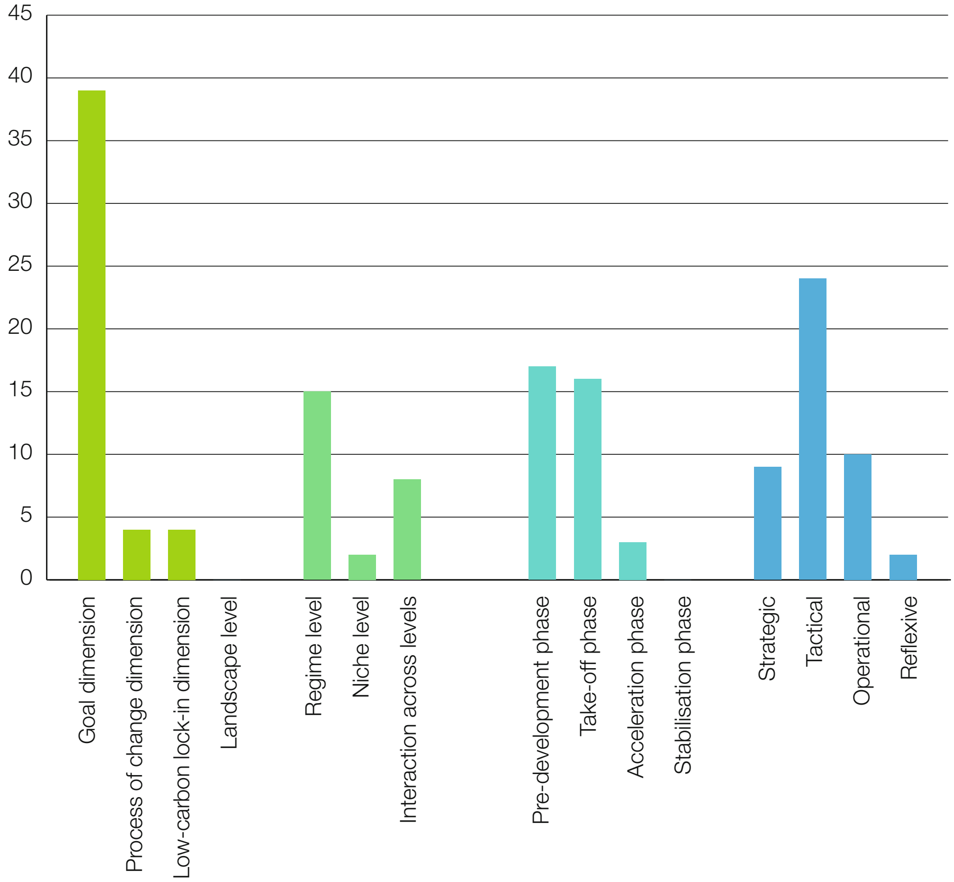
3 Documentation of how each NAMA is coded using the TC Taxonomy is available in a large Excel sheet with 93 rows covering all the existing submitted NAMAs and 48 columns with all the TC indicators. A short explanation is provided for the attribution of each TC indicator to the respective NAMA. The spreadsheet is available on request.

4 At this early stage in developing the TC Taxonomy, we do not assess the TC potential of individual NAMAs but present the scores at aggregate level for types of NAMAs. To develop a scoring system for assessment of individual NAMAs, a method of weighting the indicators may be developed in order to arrive at a total numerical figure, e.g. on a scale of 100, indicating the TC potential and the impact of each NAMA. A scoring system is envisaged to be developed in Phase 3 of the project.

Figure 5 shows how the 48 indicators were distributed over the 15 factors in four dimensions. For example, in the dimension “Phases of transformation”, there are 17 TC indicators in the “Pre-development phase”, 16 in the “Take-off phase”, 3 in the “Acceleration phase” and no indicators in the “Stabilization Phase”. This result is as expected at the present time when there has been limited movement up along the transition S-curve (Mersmann et al., 2014a) and no NAMAs have so far reached a level of stabilization.

Figure 5. Number of TC indicators used for each TC factor

Number of times the TC-indicators were used under each factor



An interesting observation can be made with regard to the second dimension (multilevel context): The “Regime level” has the highest number of indicators (15), based on the two indicators “National government incentives to change/disincentives to no change” (8 TC indicators) and “Improvement of regulation” (7 TC indicators). This finding is in line with the thinking that these indicators show the key aspects of TC: NAMAs are government-driven and based on policies and strategies for low-carbon development, rather than single-project activities that have little influence on the wider socio-technical system.

The fourth dimension (“Management of transition”) shows that most indicators are associated with the “Tactical” factor, which deals with changes in structures over a mid-term period of 5 to 15 years and covers seven indicators: “Government have made a long term vision with targets that are enforced”, “Strengthen enforcement of existing laws”, “Risk minimization instrument introduced”, “Financial support for low carbon technologies”, “Negative incentives that discourage the continuation of business as usual”, “Prohibits import of inefficient technologies”, and “Introduction of technology standards/performance”.

Table 2 shows the score of the 93 different NAMAs that were submitted to UNFCCC by 1 June 2015, grouped according to the 19 types in the NAMA Pipeline.

Table 2. Number of NAMAs in each type

Type	Indicators/NAMA	NAMAs
Agriculture	3.7	3
Geothermal	3.0	2
Transport	2.0	13
EE service	2.0	10
Fossil fuel switch	2.0	2
Biomass energy	2.0	1
All	2.0	1
EE demand-side	1.9	11
Waste	1.6	7
Solar	1.5	6
Methane avoidance	1.5	4
EE industry	1.5	2
Wind	1.3	3
Renewable energy	1.3	8
Forestry	1.0	4
Cement	1.0	1
Fugitive	1.0	1
Tourism	1.0	1
EE supply-side	0.6	13
		93

Of the 93 NAMAs, three belonged to the agricultural type, with 4, 3 and 4 TC-indicators, respectively. The total of 11 TC indicators divided by the number of NAMAs results in the average score of 3.7 indicators per NAMA for this type. Similarly the average scores were calculated for each of the remaining types.

Figure 6 shows the average TC indicators per NAMA for all the types, in descending order. NAMAs that resemble most single CDM projects, with clear boundaries to their activities, score lowest. This is the example of energy efficiency for power plants (EE supply side). NAMAs with a higher score (measured as number of TC indicators) are those with more complex activities such as policies and strategies of actions in the agricultural and transport sector, or EE service types.

Figure 6. The average number of TC indicators per NAMA for each type

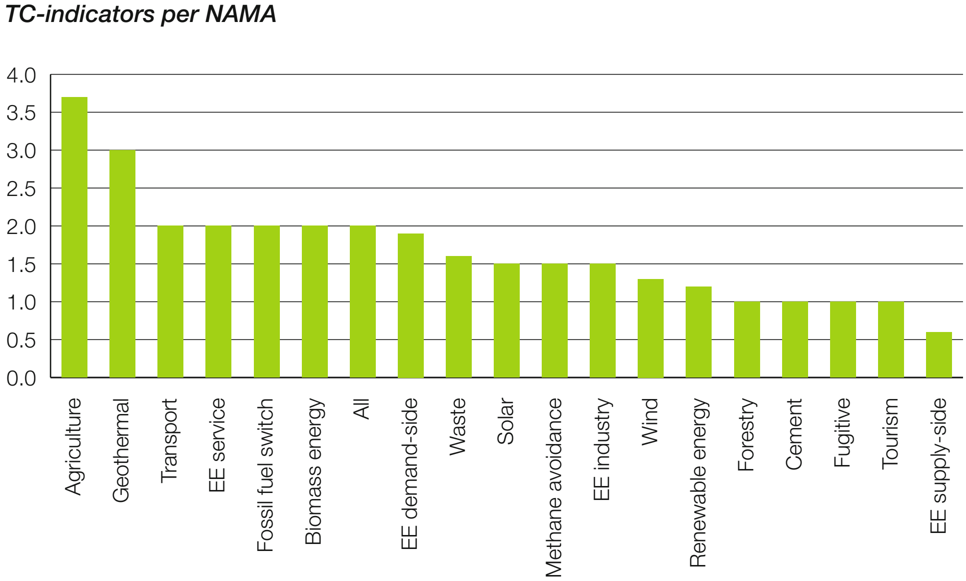


Figure 7 provides a sectoral analysis by counting the number of TC indicators per NAMA categorized by sector. The average number of TC indicators across all sectors is 1.6. Compared against this average, the figure shows there is a significant variation of the number of TC indicators across sectors (from 1 to almost 4 indicators per sector). In decreasing order, sectors with the most TC indicators are agriculture, service, industry, residential and service, transport, waste, residential and transport, residential, energy supply, forestry, tourism and water. As the number of NAMAs per sector varies significantly, with, for example, 13 NAMAs in transport and just one in tourism, the average number of TC indicators per sector is likely to change over time, as more NAMAs are developed.

Figure 7. Sectoral analysis of TC indicators per NAMA in a sector

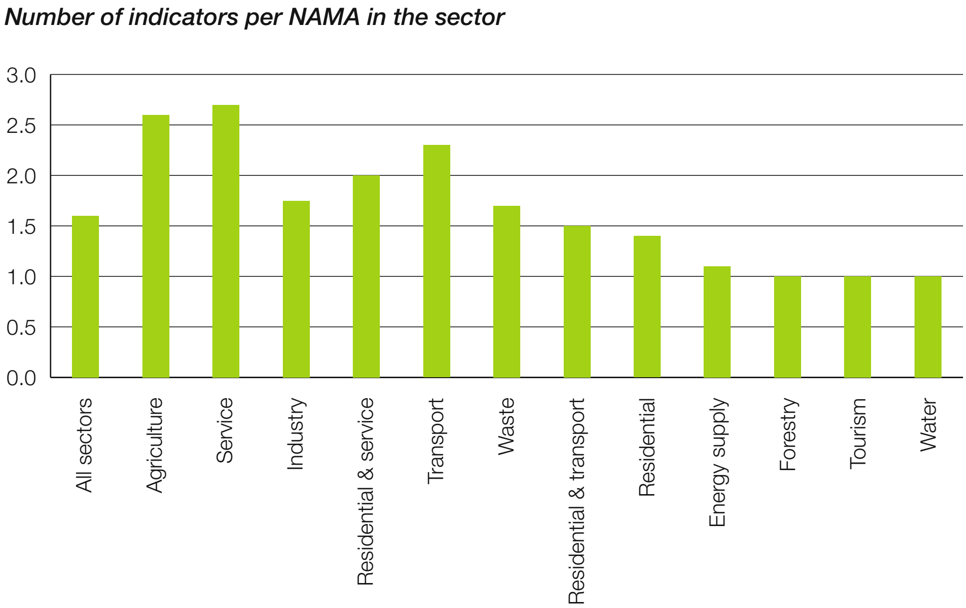


Table 3 indicates the most frequently used TC-indicator per sector, giving a brief characteristic of the key aspect of TC relevant to each sector. For instance, the most frequently used indicator in the service sector is "Information campaign performed", whereas across all sectors the most widely used indicator is "The project will transform a sector". Combined with the information in Figure 7, this analysis could help to identify which aspects of TC are most relevant to each sector, and possibly inform the development of sector-specific frameworks that can identify, which aspects of TC are the most significant by sector.

Table 3. The most frequently used TC indicator per sector

All sectors	Highest in: "The project will transform a sector"
Agriculture	Highest in: "The project will transform a sector"
Energy supply	Highest in: "Goal for a rapid large scale GHG reduction"
Forestry	Highest in: "SD goal incentivice the transition"
Industry	Highest in: "Political vision and leadership"
Residential	Highest in: "The project will transform a sector"
Residential & Service	Highest in: "The project will transform a sector"
Residential & Transport	Highest in: "First of its kind project"
Service	Highest in: "Information campain performed"
Tourism	Highest in: "Improvement of regulation"
Transport	Highest in: "The project will transform a sector"
Waste	Highest in: "Improvement of regulation"
Water	Highest in: "The project will be replicated, model for similar projects in other areas of the country"

3.3. NEXT STEPS TO DEVELOPING AND APPLYING THE TC TAXONOMY

It is clear that this assessment of the TC content of the NAMAs is limited, since the only information about the NAMAs is the information in the UNFCCC NAMA Registry, which is usually rather brief. Testing of the draft tool also shows that some TC indicators are not yet being used, such as the indicators for the factors "Process of change" e.g. "Actors connect innovation to day-to-day practices" and "Landscape level" e.g. "Growth of international concern about climate change had an impact" and "Political pressure generated from organized civil society is important". The latter two indicators are likely to become more relevant during NAMA implementation. At the proposal stage, when NAMAs are submitted to the UNFCCC Registry, information is not yet available regarding impacts for TC.

Indicators need to be further improved on the basis of the analysis of NAMAs during implementation. This will provide more comprehensive data material compared to the brief information available in submissions to the NAMA Registry. A complementary method would be to combine a theory-driven and empirical approach (version 1 of the TC Taxonomy) with the criteria and indicators used by climate finance institutions such as the Green Climate Fund, the NAMA Facility and the UK Department for International Development (DfID). In a review of how the climate funds define TC to support actions with the highest potential for paradigm shift, a synthesis of four criteria and ten indicators has been developed (Hermwille et al., 2015). The criteria and indicators used by the funds were found to reflect the concepts of TC in the scientific transition research literature to some extent, but not explicitly.

Following a revision of the indicators, the next step in developing the TC taxonomy will be to apply it to in-depth analysis of supported NAMAs being implemented in two or more countries. Data collection and analysis can result in a NAMA TC assessment report that characterises the TC potential of individual NAMAs and may lead to recommendations for additional actions to strengthen the probability of each NAMA achieving TC impacts in the direction of low-carbon development.

It is envisaged that guidance on how to use the TC framework will be developed in Phase 3 of the project along with a refinement of indicators (version 2 of the TC taxonomy) and the development of a scoring approach to weight the factors and indicators, thus reflecting their relative importance for TC. One way of developing guidance is to use the indicators to raise questions for the NAMA developers. In this way indicators will be used both to guide the design of NAMAs for TC, and to assess their impacts for TC outcomes.

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Annex

Annex 1.1. Indicators of TC based on five case studies

Dimension	Definition of Transformational Change		
Factors	Goal dimension	Process of change dimension	Low-carbon lock-in dimension
Indicators: **Brazil**	Sectoral goal to reduce deforestation countrywide Reduce GHG emissions from deforestation by 80% in 2020 compared to 2005 National CC policy	Behavioural changes by many actors Concern and advocacy against deforestation by NGOs and academics Industry organisations impose a moratorium on deforestation	Deforestation delinked from economic interests of soy and beef production Satellite images help to enforce moratorium on deforestation The national CC policy is enacted as law
Indicators: **Colombia**	Vision for sustainable urban transport in Bogotá Bus fleet (number of buses) Sidewalks (square metres) Share of trips by bike (%) Operational speed (km/h)	Bus Rapid Transit system (BRT) Walking and cycling infrastructure Transport demand measures (TDM) Political and technological innovation	Corruption, transport mafias, private-sector interests are barriers overcome Strengthened political will at mayoral/city level can sustain a LCD pathway
Indicators: **South Africa**	Reduce CO_2 emissions in the country by 34% in 2020 and 42% in 2025 compared to BAU, conditional on international support National CC policy	State-owned companies (SOCs) can lead the transformation Policy measures are beginning to be visible	The Minerals Energy Complex (MEC) relies on coal and is interlinked with electricity, finance, manufacturing and service industries TC needs to come from within a MEC as incremental, systemic change
Indicators: **Denmark**	100% renewable energy in the energy system by 2050 Wind energy supplied 39% of total electricity demand in Denmark by 2014 National CC and energy policy		
Indicators: **Germany**	80% renewable energy in electricity production by 2050 Reduce CO_2 emissions in the country by 85-95% in 2050 compared to 1990 25% improved energy efficiency in 2050 against 2008 Phase out nuclear energy by 2022 National CC and energy policy	Policies for TC of the electricity sector started in the 1970s and have been controversial for many years	Stranded costs in the coal sector are overcome through exemptions from surcharges and fees Alternative technologies for LCD such as nuclear, fracking and CCS have no or little social support

Annex 1.2. Indicators of TC based on five case studies

Dimension	Multilevel context			
Factors	**Landscape level**	**Regime level**	**Niche level**	**Interaction across levels**
Indicators: Brazil	■ International support to REDD+ as symbol of support to deforestation ■ Growth in international concern over climate change	■ Changed behaviour of industry organisations to be transparent and follow the law ■ Public and private sectors make legal commitments to deforestation		■ Pressure from civil society resulted in decisions at industry and national levels against deforestation
Colombia	■ National government incentivises sustainable urban transport	■ The Metro law with 70% financing to mass-transit from national government ■ Fuel surcharge: cities can charge 25% of fuel for local transport development ■ Betterment levy: local landowners pay towards road and mass-transit development	■ Trans-Milenio BRT system ■ TDM: parking measures, reduction of road space, plate restrictions ■ Bikeway and sidewalks master plan	■ Political will at mayor level initiated policies and interventions that have spread to national level and other cities
South Africa			■ The Integrated Resource Plan for electricity targets 17,430 MW of RE by 2030 ■ Biofuels are envisaged to have a 2% penetration level in the national liquid fuels pool ■ SAA targets bio-jet fuels to meet 10% of its requirements by 2017 ■ Project Solaris aims to develop jet fuel from the nicotine-free tobacco plant called Solaris ■ Transnet will diversify its energy sources to RE ■ Eskom is engaged in R&D activity for concentrated solar power, central receiver technology and biomass co-firing	
Denmark	■ High oil prices in the 1970s made wind turbines interesting ■ The global oil crisis in the 1970s created environmental awareness and a desire for higher energy security	■ Subsidies since the late 1970s have supported wind power development to compete with coal and oil-based power ■ Grid connection was an important infrastructure support for wind power development	■ Pioneering activities to construct the first windmill started in 1891 ■ Collaboration among pioneers resulted in the Danish Wind Turbine Owner's Association in the ■ The National Laboratory at Risø supported R&D with a test centre for small wind turbines in the 1970s 1970s	
Germany	■ Nuclear power was introduced in 1970s to diversify Germany's energy mix ■ The nuclear accident at Chernobyl in 1986 led opposition to rise to 70%, and the Ministry of Environment was established	■ In 1960 about 80% of power generation was from coal ■ A strong ecological movement has since the 1970s pushed for RE and opposed nuclear energy	■ In the 1990s feed-in tariffs (FIT) created a protected niche market for renewable energy ■ State-owned power companies were excluded from support, which enabled new entrants such as IPPs, communities and cooperatives ■ Between 2009 and 2014 the average FIT for solar PV decreased by about 80% to keep track of falling solar PV system costs ■ RE rose from 6% in 2000 to 26% in 2014	■ About 50% of RE capacity is financed by new entrants, increasing the diversity of ownership triggered by market liberalization in the 1990s and the privatization of state-owned companies.

Annex 1.3. Indicators of TC based on five case studies

Dimension		Phases of transformation			
Factors		Pre-development phase	Take-off phase	Acceleration phase	Stabilisation phase
Indicators	Brazil				▪ Government policies and laws have created a framework to sustain the TC for deforestation
	Colombia			▪ Deceleration rather than acceleration ▪ Mayors from opposing political parties have distanced themselves from sustainable transport policies	▪ A relapse may occur ▪ Stabilisation may occur at lower levels of system change than expected in the vision
	South Africa	▪ Cheap and abundant coal has made SA an energy-intensive economy dependent on fossil fuels ▪ Government policy and SOCs are seeking a reorientation to LCD trajectories but face strong business and political resistance			
	Denmark		▪ The oil crisis in the 1970s triggered the take-off phase for wind turbine development in Denmark	▪ Since 1976 energy plans have supported RE ▪ In 1996 Parliament decided that 10% of electricity should be met by wind power in 2005 ▪ In 2012 Parliament decided on 50% wind power by 2020 ▪ Exponential growth in employment and exports in the wind power industry ▪ Small wind turbines are phased out and replaced with parks of large-scale turbines financed by big investments	▪ In 2014 an opinion poll indicated that 86% of Danes are positive regarding expansion of wind power development ▪ 81% of neighbours of wind turbines do not experience inconvenience ▪ A broad majority in Parliament support wind power technology
	Germany			▪ Accelerated market growth was triggered by the renewable energy source act (EEG) in 2000. ▪ The EEG 2014 includes annual technology targets driving a continued expansion of RE in Germany	▪ In 2015 the 80% RE target in electricity production is supported by all parties in Parliament and by 90% of German citizens

Annex 1.4. Indicators of TC based on five case studies

Dimension	Management of Transition			
Factors	Strategic	Tactical	Operational	Reflexive
Indicators				
Brazil	■ No single entity managed the transformation ■ Competing interests mobilize for political strength ■ TC happened suddenly and was driven unexpectedly by political agendas and dynamics			
Colombia	■ A public-private company was set up to manage the BRT and the system's concessions operations ■ Private bus operators transformed from informal to formal and business-oriented companies	■ Mayor Peñalosa had a clear vision of how the city should be transformed ■ An overarching policy for a long-term urban and sustainable transport policy was agreed in 2000	■ Technical know-how by competent staff transformed the policy vision into practice	■ Bogotá's experiences have inspired BRT systems as city-wide networks of public transport in Columbia
South Africa	■ Eskom, Transnet and SAA are SOCs internal to the MEC regime ■ SOCs can lead the transition by mobilizing multiple actors within and outside the MEC system to support policy and investments for LCD	■ The National Climate Change Response paper sets out the country's CC goals ■ The CC Policy Framework for SOCs aims to integrate CC into planning, operations and procurement	■ A carbon tax ■ A carbon budget ■ Sectoral emission reduction outcomes ■ Integrated Sustainability Reporting ■ Carbon Disclosure Project	■ A LCD pathway can succeed only if it helps to realize development goals and is not a financial burden on SOCs
Denmark				
Germany				

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