TCLP Signals of Transformational Change

Working Draft

17 May 2021

I. Introduction to Signals of Transformational Change in Climate Action

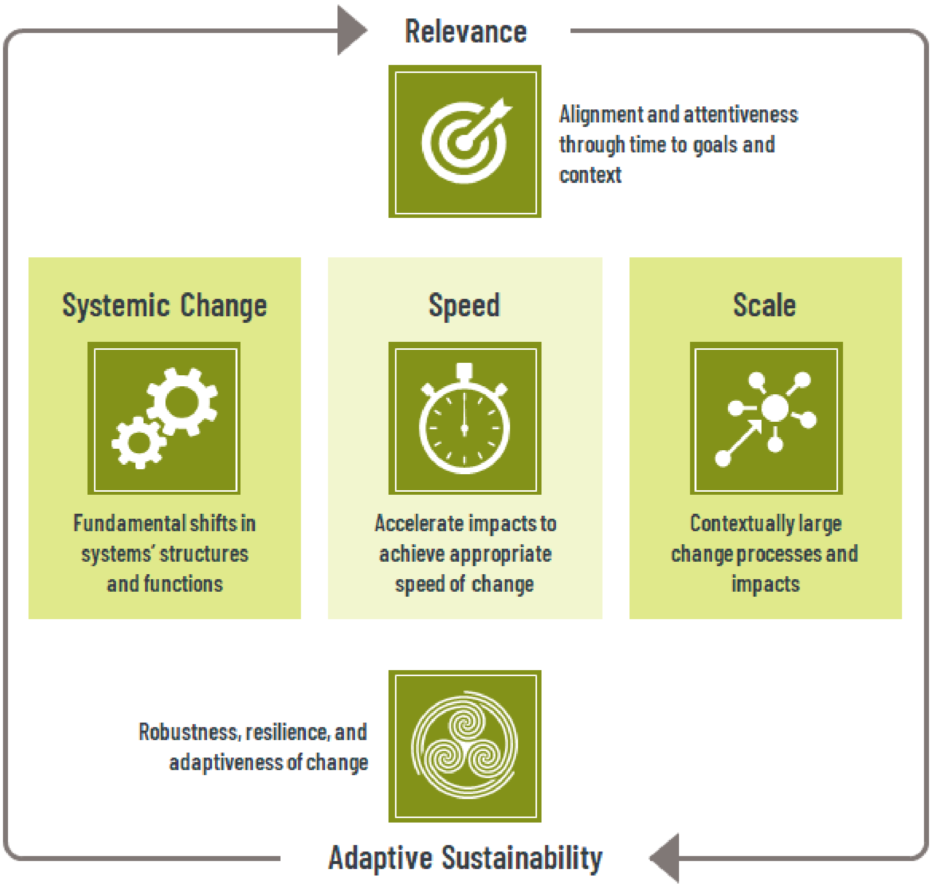
The Transformational Change Learning Partnership (TCLP) has developed a working definition and dimensions of transformational change in climate action, which provide a strong foundation for better understanding the concept and attributes of transformational change.

Broadly defined, transformational change is a *deep and fundamental change in a system's form, function, or processes*.

In the context of climate change, transformational change is *fundamental change in systems relevant to climate action with large-scale positive impacts that shift and accelerate the trajectory of progress towards climate neutral, inclusive, resilient, and sustainable development pathways.*

Transformational change dimensions are attributes of change in systems needed for transformations addressing climate change, as well as attributes that should be attended to when designing and implementing interventions for climate action. Climate action refers to efforts to mitigate climate change and enhance resilience and adaptation to climate change impacts.

Figure 1. Dimensions of Transformational Change in Climate Action

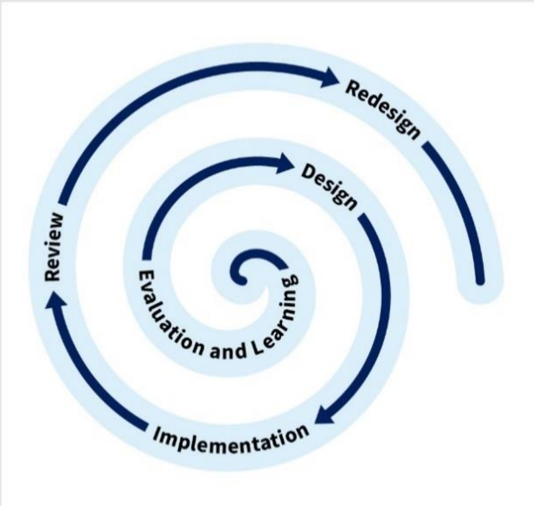


This document seeks to complement this conceptual work toward recognizing transformational change in more tangible, identifiable terms. Previous work of the TCLP and the *Evaluation of Transformational Change in the CIF* found that climate action stakeholders thought "they would know transformation when they saw it" but found it more difficult to articulate benchmarks against which progress toward transformational change might be identified. Thus, a need emerged to identify "signals" of transformational change in different contexts and sectors, at different levels, and at different stages of progress.[1] Signals attempt to respond to the question: "How will we know we are making progress toward transformational change?" They also help to identify the "directions systems are moving, and whether a policy, programme or intervention is ensuring a transformational change in the right direction."[2]

Signals are ways of observing progress toward transformational change in climate action.

Signals offer a conceptual framework for recognizing and capturing transformational change through the programmatic lifecycle. As such, signals should be of use to funders, designers, implementers, and evaluators of climate action that aims at transformational change, as shown in Figure 2.

Figure 2. Uses of signals through the programmatic lifecycle



Design/Redesign	Implementation	Evaluation and Learning/Review
• Portfolio design • Theories of transformational change • Transformational ambition • Barrier, risk, vulnerability and stakeholder analysis • Dynamic baselines	• Monitoring and reporting systems for transformational change progress • Adaptive management for ongoing transformational relevance and agility to address unforseen barriers and path dependencies	• Evaluation methods • Assessment of progress toward transformational change • Learning and insights on catalyzing transformation

II. Approach and Insights for Signals

To design our approach to identifying and categorizing signals, we first considered the work of other institutions grappling with similar challenges. Guidance and methods are starting to emerge for designing, implementing, and evaluating transformational change.[3] These include Deutsche

[1] This work builds on earlier work around signals, including those developed for each of the CIF programs to inform the *Evaluation of Transformational Change in the CIF*, and a subsequent policy brief summarizing these efforts (Savage et al., 2020).
[2] Van den berg et al., 2019.
[3] For evaluating transformational change, expert opinion and measurement approaches are emerging. An expert opinion approach, rooted in local perspective, is useful especially for assessing fundamental changes in processes and systems and can be made rigorous through methods including Delphi methods, qualitative comparative analysis, network analysis, process tracing, and others. A drawback, however, can be the loss of comparability across countries or systems. A measurement approach can resolve comparability issues but is dependent on the availability of national or global data with benchmarks for key issues (e.g., from GHG emissions to ecosystem services, to market data, to social data regarding equity and equality, and so on).

Gesellschaft für Internationale Zusammenarbeit (GIZ) guidance on transformational project design;[4] the Initiative for Climate Action Transparency's guidance on assessing the transformational impact of policies and actions;[5] the Global Environment Facility's (GEF) evaluation of transformational change;[6] the World Bank's review of transformational engagements,[7] the Wuppertal Institute for Climate, Environment and Energy's guidebook for transformation for climate action;[8] and the experience of the UK International Climate Fund in developing its Key Performance Indicator on Transformational Change.[9] We also reviewed peer reviewed literature around the concept of transformational change, spheres of transformation, and change processes in socio-technical and socio-ecological systems. (See References for literature consulted.)

A review of these efforts coupled with the TCLP's work to date provided insights that informed the development of a framework for categorizing signals and the identification of indicative signals for the energy sector (Section III).

INSIGHT 1: Signals of transformation can be broadly mapped to the five dimensions: relevance, systemic change, scale, speed, and adaptive sustainability. The dimensions of transformational change provide a natural organizing principle for signals. Signals must be identified across all dimensions to some extent for confidence that climate actions are transformational. Observing signals across multiple dimensions helps guard against misinterpreting incremental changes as harbingers of transformational change.[10]

INSIGHT 2: Signals can be identified at multiple levels, but it is the large-system changes that matter for transformational change in climate action. A multi-level perspective on transformation gives signals a practical grounding and has roots in the literature.[11] Signals of transformational change can be observed at different nested levels, as illustrated in Figure 3, from changes at smaller levels—such as successfully demonstrating an innovative approach at the community level or passing a new policy, that could, in turn, be catalytic and influence wider systems over time—to progressively larger transformations, such as overhauling patterns of consumption and production at the sector level or relocating entire climate-vulnerable nations.

Changes relevant to transformation can occur at many levels, and meso and macro transformations may often require substantial changes at the micro and small levels to be transformational, as shown by the arrows in Figure 3. [12] Because climate change is such an urgent and grand challenge,

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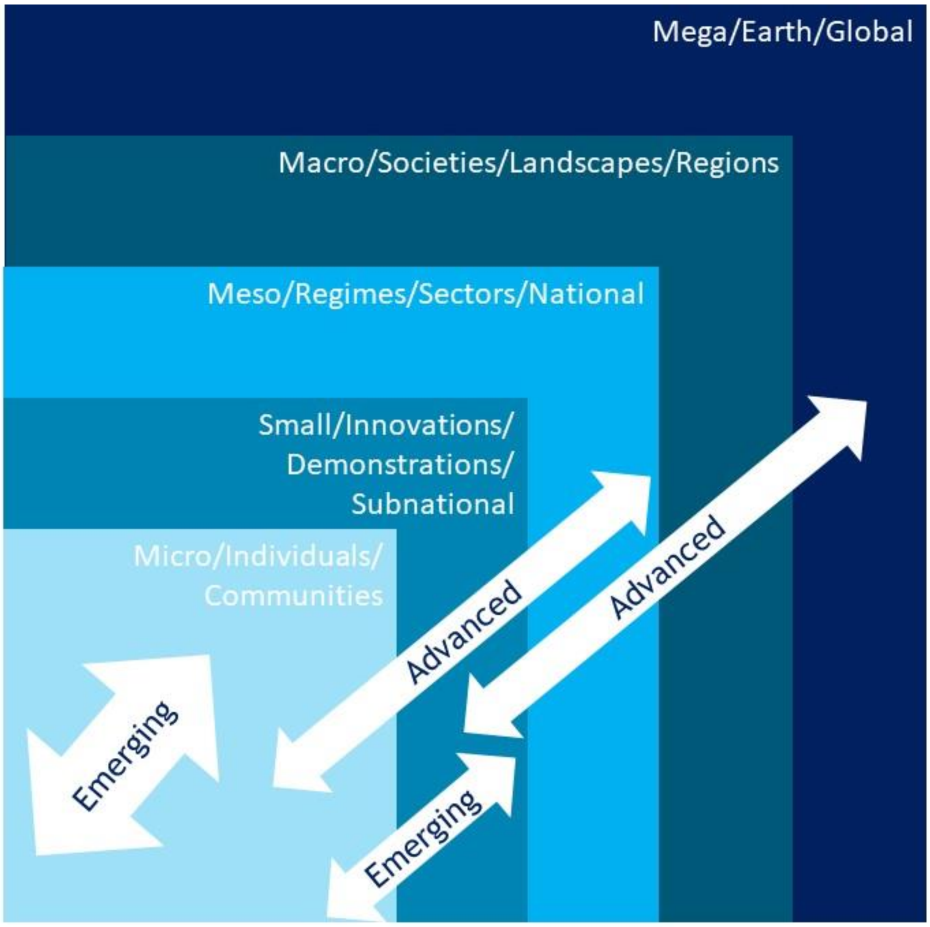
[4] GIZ, 2020.
[5] ICAT (Initiative for Climate Action Transparency), 2020.
[6] GEF IEO, 2018.
[7] World Bank Independent Evaluation Group, 2016.
[8] Wuppertal Institute, 2014.
[9] See UK International Climate Fund KPI 15 (transformational impact) methodology guidance.
[10] For example, fundamental systemic change in the structures of smallholder household economies (e.g., through livelihood diversification and community associations) may not be transformational if it is not scaled up and does not challenge structural inequality issues (e.g., land tenure and access to credit) that could affect adaptive sustainability. As described in Feola, 2015.
[11] Such as the literature on socio-technical and socio-ecological transformations, as well as transition management and laminations of scale. See for example: Geels and Schot, 2010; Loorbach 2010; Mersmann et al., 2014; Gopel, 2016; Bhaskar et al., 2010.
[12] The representation of levels, however, is not explicitly meant to describe the process of transformational change. Nor is it meant to imply that transformation starts at micro or small levels and emerges in a hierarchical manner through progressively larger levels, or that outcomes in higher-level systems (e.g., passing a national law) are transformational if they are not connected to transformational action in lower-level systems (e.g., robust implementation and enforcement supported by human and budgetary capacity at all levels of government).

ultimately, it is the connection or line of sight between the higher and lower system changes that matter for transformational change in climate action. The heuristic of the levels helps inform the distinction between stages of transformational change—i.e., signals of when transformational change is *emerging* and of when transformational change is *advanced*. This is discussed further in the framework for signals in Section III.

Figure 3. A Multi-level Perspective on Transformational Change



Source: Authors, drawing on work by GIZ (2020a, 2020b), Geels and Schot (2010), and Bhaskar et al. (2010).

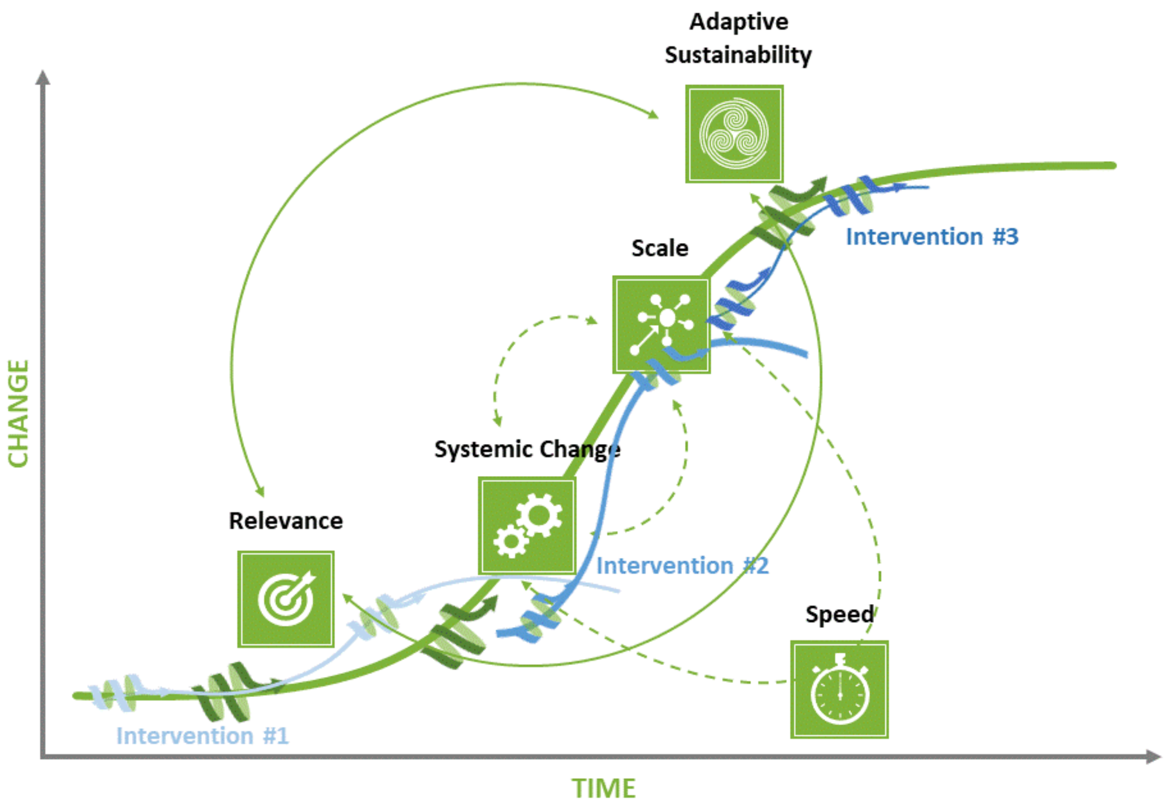
INSIGHT 3: In addition to being observed across dimensions and levels, signals should also capture the linkages among embedded "arenas" of transformation, such as techno-economic, socio-institutional, and environmental.[13] Climate actions aiming at transformational change must address these arenas holistically as well as the dynamics among them, since each arena is intrinsically intertwined with the others. These arenas provide a useful common organizing principle for signals within the systemic change, scaling, and adaptive sustainability dimensions of transformational change. Arenas are also significant considerations in the design and implementation of transformational interventions as set out in the in the relevance dimension. (see Section III on the proposed framework for signals.)

[13] These spheres build on work by the CIF TCLP around arenas of intervention, as well as on literature on spheres of transformation and systems change by O'Brien, 2018; Waddell et al, 2015; and GIZ, 2020a. These spheres also link closely with the literature that conceptualizes sustainable development.

INSIGHT 4: It is useful to distinguish between signals to which individual interventions, programs, or policies more frequently contribute, versus signals of transformational change at a more meso and macro levels (often the aggregate and dynamic effects of multiple actions and actors). The former enables practitioners to consider transformational change at the level and timescale in which they are operating—and to understand an intervention's role in the broader transformational change process. The latter provides an anchor point for practitioners and policymakers to assess progress toward meso- and macro-level transformational change—and to design interventions best suited to that stage of transformation. In Figure 3 above, individual interventions are more likely to contribute to emerging signals, with some larger-scale interventions aimed, for example, at sector-wide change making contributions to increasingly advanced signals.

The starting points for individual interventions in the broader transformational change process may also affect the dimensions and stages in which signals associated with interventions can be observed, as illustrated in Figure 4 below. For example, signals of systemic change may be more emerging and virtually non-existent for scale for Intervention #1, whereas signals of systemic change might be advanced for Intervention #3.[14] (See discussion of stages of signals in Section III below.)

Figure 4. "S-Curve" Model to Illustrate Embedding Interventions in a Broader Transformational Pathway



INSIGHT 5: Signals of transformation can be found in both processes and outcomes. A focus on processes recognizes the complexity, non-linearity, and unpredictability of transformational change,

[14] The importance of starting points also illustrates the need for dynamic baselines that provide an understanding of the relevant systems and their forms, functions, and drivers, to facilitate a more informed understanding of the type of interventions that are needed, the associated theories of transformational change, and the signals of transformational change that might be expected.

and respects adaptive management in the face of these realities. Process signals can focus on change agents, changes in patterns and mechanisms of transformational change (e.g., resources, legitimacy, norms, incentives), and pathways of change.[15] All of these areas are critical for recognizing transformation related to the systemic change dimension. Process signals are also particularly important for the relevance dimension, both for describing characteristics of interventions that are aiming at and have enabling factors for transformational change (e.g., ambition, challenging regimes, identifying levers and agents of change) and for adapting actions over time to reflect the dynamism of bringing about fundamental systems changes.

Signals of outcomes can help illustrate progress along the transformational pathway, but they must be flexible, because the structure and function of systems is also changing. In addition, the long-term nature of transformational change and the lack of available data on long-term outcomes suggest a need for process-related milestones and proxies to capture likely future changes – often years after projects end.

INSIGHT 6: **Many signals will vary substantially depending on the sector or theme and must be interpreted in their relative context.** For instance, signals of speed will be relative to the sector in which the transformation is occurring (e.g., energy systems may change at different speeds than food systems). Ways of describing progress toward climate-resilient food systems will differ from ways of describing progress toward utility-scale grid decarbonization. Development of more sector- and thematic-specific signals could support the recognition of transformational change processes in those areas; in Section III, we provide examples of signals for transforming energy systems.

The context in which change is occurring and the ambition of the transformational change are also worth noting in relation to the signal of change. What might be regarded as modest capacity advancements in a developed market or governance context might be more fundamentally transformational in a less-developed country context and vice versa.

III. A Framework for Signals

Building on the insights above, the team created a framework by which to organize indicative signals. This framework considers two simultaneous aspects—dimensions and stages of transformational change—discussed in sequence below. The draft framework follows in Figure 6.

A. Signals by Dimension

Signals of transformational change can be usefully organized by dimension. As a heuristic device, within each dimension we also identify different types of signals, representing different elements of each dimension or common areas or mechanisms of change. Signals will generally be signs of positive transformational progress but might also capture negative dynamics (e.g., reducing ambition or regression to higher carbon intensive systems).

Relevance signals are those that indicate that a change process or intervention is aligned with higher level transformational change goals as well as supportive of connected transformational change processes. Relevance signals can be identified during the *design* phase of a transformational intervention or change process. This is where the context of transformation is described and where systemic change, scaling, speed, and sustainability ambitions are identified. They also emerge during the *implementation* and *evaluation* phases, where it is critical to re-assess and ensure ongoing relevance

[15] Mapfumo et al, 2017; FAO and CIFOR, 2020 (under embargo); ICAT, 2020.

of program objectives over time. Signals may be captured at critical stages of program revision or renewal (e.g., during recapitalization of programs or new strategy development). Relevance signals describe the process of identifying transformational change goals, selecting the right type of intervention for the context of change at the right time (with the right level of risk and innovation), and ensuring a robust enabling approach that maximizes likelihood of impact. Together, these signals provide some indication of the likely effectiveness of a process or intervention in delivering envisaged outcomes. Emerging relevance signals indicate that interventions have ambition to be transformative within a smaller system, whereas advanced signals set out clear theories of change to transform higher-level systems (bringing together dimensions of both systems change and scaling).

Types of relevance signals include those related to:

- ***Transformational objective*** signals provide evidence that an intervention or change process supports transformation objectives across different levels, linking project objectives to changes in higher-level, larger-scale systems (e.g., sector, economy, system wide). From a climate mitigation perspective, this might include reducing GHG emissions within a system (e.g., country, sector) to meet agreed global scientific benchmarks, targets, or burden sharing agreements. From a resilience perspective, this might be ensuring that sectoral development and investment delivers resilience to the projected impacts of climate change for vulnerable groups and sectors. Transformation objectives should also capture alignment with other transformational change processes (e.g., social justice/just transition, environmental sustainability) to avoid unintended consequences, reduce the potential for tradeoffs and promote more integrated systems thinking. Signals will therefore capture evidence of both the validity/robustness of the objective *and* its alignment with/co-benefits for other transformational change processes. In an intervention context, transformation objectives will likely be evidenced in pathways to impacts and outcomes (e.g., in theories of change and results frameworks).
- ***Intervention logic*** signals provide evidence that a transformation process or intervention has been designed in a way that is most suitable for the stage and context of transformation (e.g., its position on the S-curve). There should be evidence that the intervention considered likely development trajectories for change. The intervention should ideally incorporate or recognize the need and strategies for elements of speed, systemic change, scaling, and adaptive sustainability, or recognize that these are already in place or not required. Consideration should be given to phasing of activities over time and setting out dependencies/transitions between the dimensions.
- ***Enabling approach*** signals provide evidence that transformational change processes are able to identify barriers in the political economy and to generate strategies that create the greatest possible momentum and consensus for change. Signals will generally reflect aspects including mobilizing key institutions, stakeholders, and networking approaches, as well as addressing potential barriers to delivery. Efforts should be made to strengthen the legitimacy of transformational change processes through inclusive engagement, encouraging procedural justice, and ensuring a balance of voices.
- ***Timeliness*** signals indicate that interventions and decision-making is timely, and that the phasing of delivery takes advantage of windows of opportunity where change processes are likely to gain traction. This can be embracing emerging confluences of interests or other dynamics that can support change, identifying tipping points that can lead to greater change, or phasing implementation to ensure that activities are undertaken only when they

are credible and can build momentum. This implies a level of agility to respond to changes in the contextual environment (e.g., economic, political, technological, natural) over time. These signals capture adaptive programming changes (both strategic and operational) that address unforeseen barriers and opportunities that arise during implementation, and also link forward to the dimension of adaptive sustainability (see below).

Systemic Change signals indicate that transformation is occurring in the fundamental structures, functions, power dynamics, and interactions within systems. They are necessary for both scaling and sustainability but may not be transformational by themselves. Systemic change signals indicate that the quality, depth, and intensity of transformation is more likely. These signals provide evidence that specific barriers have been overcome that might otherwise prevent transformation from occurring. Such signals are often related to a thematic system (e.g., energy, natural environment, forestry, agriculture, urban), but may also describe the boundary interaction between systems (e.g., environment and social). Advanced transformation is likely to require significant work across system boundaries (e.g., environmental and social) and/or the expansion of system boundaries (e.g., the recognition that the economy and society are embedded within the environmental system).

Types of systemic change signals include those related to:

- ***Techno-economic*** signals indicate that new technical, economic, and/or operational solutions to transformation challenges have emerged or are emerging. These may include technology innovations (e.g., around function or cost) or new market approaches to addressing a challenge (e.g., business models, sectoral practices). They also capture the behaviors associated with these solutions. Innovation is a core component of these signals, and they are likely to emerge from processes that involve design, piloting, and demonstration activities, as well as more organic evolution in systems.
- ***Socio-institutional*** signals indicate that the institutional governance and policy frameworks that govern system development and influence investment and other behaviors have changed or are evolving in a way that facilitates transformation. Institutional signals may refer to fundamental shifts in relationships that are framed through policies, institutions, decision-making processes and governance structures. They also reflect fundamental developments in financing and incentive structures or the capacities of key institutions that allow or encourage transformation.

  Social signals indicate that people's beliefs, values, behaviors, and worldviews have changed. Social signals can enable or hinder transformation by delineating what people perceive as possible in terms of transformation, influencing how people perceive or interact with systems, and determining how resources are allocated. Social signals might include changes in media narratives or social media reporting, or evidence of fundamental changes in how people value ecosystem services. These changes can occur in the general population or in specific social groups as defined by their culture, profession (e.g., policy makers), ethnicity, gender, or vulnerability, etc. Social signals also capture elements that influence behavioral adoption and support (e.g., Just Transition policies).
- ***Environmental*** signals of systemic change indicate that there are demonstrable fundamental shifts in the function of environmental or natural systems, such as climate or ecosystems. These may indicate interventions delivering positive change (e.g., progress towards systems regeneration and biodiversity restoration, greater resilience of the natural system to the

impacts of climate change) or demonstrated improvements in the functioning of other systems (e.g., sustainable watershed management for hydropower production). It should be noted that transformational change in natural systems may occur over much longer periods than is typical for project scale interventions, and that human actions influence but cannot fully steer transformational change in these systems.

Speed signals capture evidence of the alignment of transformational change processes and outcomes with the need for urgent and timely climate action. In a program lifecycle, they can be observed in the design phase (e.g., planning to accelerate change), during implementation (e.g., compressing timescales for delivering outputs, deliberate actions to bring forward processes such as for technology innovation or investment decision-making, or setting earlier policy targets for decarbonization, for example), or afterward (e.g., accelerating higher level change outcomes such as decarbonization rates).

- ***Speed:*** These signals demonstrate impact by ensuring that processes and outcomes are consistent with the required pace of transformation, given the urgency of the climate crisis. Where climate action lags the science or emerging impacts, speed might be demonstrated by accelerating the rate of change (i.e., by compressing the S-curve along the X axis), thereby decreasing the time required to move through each dimension *and* the transitions between them. However, while acknowledging the urgency of delivering the transformation objective, speed signals also reflect a realistic view on the lead times associated with change processes in complex social or environmental systems and the benefits of not accelerating beyond what is prudent (e.g., recognizing trade-offs and the need to deliver on related objectives, such as inclusivity and just transition). An understanding of speed is also dependent on the ability to assess existing baselines and dynamic expectations of future business-as-usual scenarios against which progress can be assessed. Emerging signals reflect processes that seek to alter the pace of climate action in line with the urgency of the challenge, while advanced signals capture the outcomes of this alignment.

Scale signals are indications that transformational change is happening at a scale that is likely to result in new systems or approaches gaining ascendency over existing systems or approaches. Scaling signals will usually describe expansion in some form (i.e., scaling up from smaller to larger systems), or lateral scaling (e.g., scaling out across spatial or social groups). Scaling also includes improving linkages between different levels of systems (global, national, sub-national, local) in order to improve alignment and adoption of approaches. Scaling can also recognize aspects of contraction (i.e., scaling down), particularly where transformational change involves reducing harmful behaviors, technologies, or practices. Emerging signals typically represent scaling in lower-level systems (e.g., sub-national or specific market niches) or pathways towards scaling in higher-level systems (e.g., replication type initiatives). Signals should demonstrate significant outcomes relative to the scale of higher-level systems as well as linkages spanning lower-level systems to be considered advanced.

Types of scale signals include those related to:

- ***Techno-economic*** signals indicate that changes in technology or economic systems (e.g., new renewable energy technologies or business models) are increasing (e.g., in terms of their volume, relative share of market, or frequency of adoption). These signals may be

captured in units (e.g., sales, distribution, production, use data), or in other types of quantitative measurement such as finance ($) or clean energy (e.g., KWh, MW installed capacity). Scaling signals should be significant relative to the size of the technological or economic system to be transformational.

- ***Socio-institutional*** scaling signals indicate that systemic changes in policies or behaviors are being adopted by a broader set of people, institutions, or administrative areas (advanced signals), or that processes are in place to facilitate this broader adoption (emerging signals). Social groups may overlap with geographic boundaries (i.e., an administrative population), but may also be defined by other characteristics, such as professions (e.g., farmers or policy makers), consumers, cultural or ethnic groups, or specific socio-economic profiles (e.g., poor or marginalized communities). Scaling may indicate that certain groups are benefiting or changing behaviors more or that there is scaling and adoption between and across different groups. These signals can also capture dynamic elements of inclusion and diversity as set out in the overall transformational change definition.
- ***Environmental*** scaling signals indicate that there is a shift in the scale at which systemic changes in natural systems are occurring. Emerging signals would include earlier evidence of change (e.g., natural restoration) or processes seeking to replicate the benefits of local initiatives and demonstration efforts to larger-scale natural systems. Advanced signals would be successful replication, and outcomes and impacts at the scale of these larger natural systems. The scale of change might be defined in terms of their spatial aspect (e.g., local air pollution impacts, global atmospheric GHG concentrations), their natural system boundaries (e.g., biomes, watersheds, river basins), areas of similar features (e.g., agro-ecological zones). Scaling can be transformational in both positive terms (e.g., reforestation rates, increases in biodiversity, reduction in greenhouse gas emissions) and negative terms (e.g., loss of habitats).

Adaptive Sustainability signals are those that provide evidence that change processes are becoming irreversible and self-sustaining, and that earlier system path dependencies have been broken or replaced. Progress is shown to be durable. While adaptive sustainability signals do not necessarily represent a static state (as systems continue to evolve over time), they do represent a new equilibrium that is resilient and robust in that it is unlikely to revert back to its previous state. Emerging signals may be captured through the development of long-term commitments, planning frameworks and review processes, while advanced signals capture progress against and alignment with long term development goals, often materializing over time periods beyond the horizons of individual interventions.

Signals of adaptive sustainability also provide evidence that outcomes are integrated with and reinforce wider development goals (e.g., economic, social, environmental) in a balanced and integrated way. This alignment can help avoid potential conflict with other disruptive transformation processes so that climate outcomes are not undermined, and transformational gains remain coherent with other change objectives and processes.

Types of adaptive sustainability signals include those related to:

- ***Techno-economic*** signals indicate that the economic and financial ecosystem that underpins change has adapted in such a way that it is now to a large extent self-sustaining and self-organizing. This can be evidenced, for example, by a shift to commercial operation (without subsidy), the development of competitive private markets, a sustainable reduction in costs that match or outperform alternatives, evidence of long-term, legally binding commitments

to public financing for non-market goods, or fundamental and sustainable changes in production patterns. Emerging signals primarily demonstrate long term commitments by governments and markets supporting this transition (e.g., forward looking technology and finance planning frameworks), whereas advanced signals capture outcomes (e.g., fundamental shifts in system function). Techno-economic signals also capture how durable and robust changes feed into wider economic development pathways (e.g., prosperity, green growth).

- ***Socio-institutional*** signals indicate that institutional systems, values, and behaviors supporting climate action are firmly embedded, and have become dominant. The ability of individuals, organizations, and networks of organizations to learn new ways of doing things and incorporating this learning through changed practices are important socio-institutional signals. Sustainability is indicated by clear evidence that progress on climate outcomes (mitigation, resilience) is aligned with and has addressed wider social justice considerations (e.g., just transition, job creation, equity, accessibility, affordability), and that this dynamic has strengthened social acceptance and buy-in. This includes delivering more equitable benefits for poor and marginalized communities in a sustainable way.
- ***Environmental*** signals indicate that transformational change outcomes are aligned with and contributing to wider environmental sustainability outcomes and goals. These may relate to climate change (e.g., alignment with global benchmarks such as the Paris Agreement, or with more local science-based mitigation or resilience benchmarks). These signals can also include evidence of durable co-benefits that align with and reinforce wider environmental objectives (e.g., air quality, resource efficiency, circular economy). Emerging signals indicate some confidence in the future durability of changes, while advanced signals capture progress in system outcomes.

B. Stages of Signals

Signals across the dimensions can emerge at different levels and times. We set a threshold for transformational change in climate action that it should influence and impact larger systems (e.g., meso level and higher). We also recognize however that transformation can occur within smaller systems (community, project level) and that these changes can be catalytic and influence wider systems over time. Processes can also emerge within larger systems that intend to deliver transformation over longer timescales, but where large-scale outcomes are not yet visible.

To make this distinction in the progress toward transformational change, we therefore recognize a continuum from '*Emerging*' to '*Advanced' signals*. We also recognize that there may be significant variations within these categories, especially as applied to different sectors, themes and contexts, and that judgment on the extent of transformational change progress can sometimes be subjective.

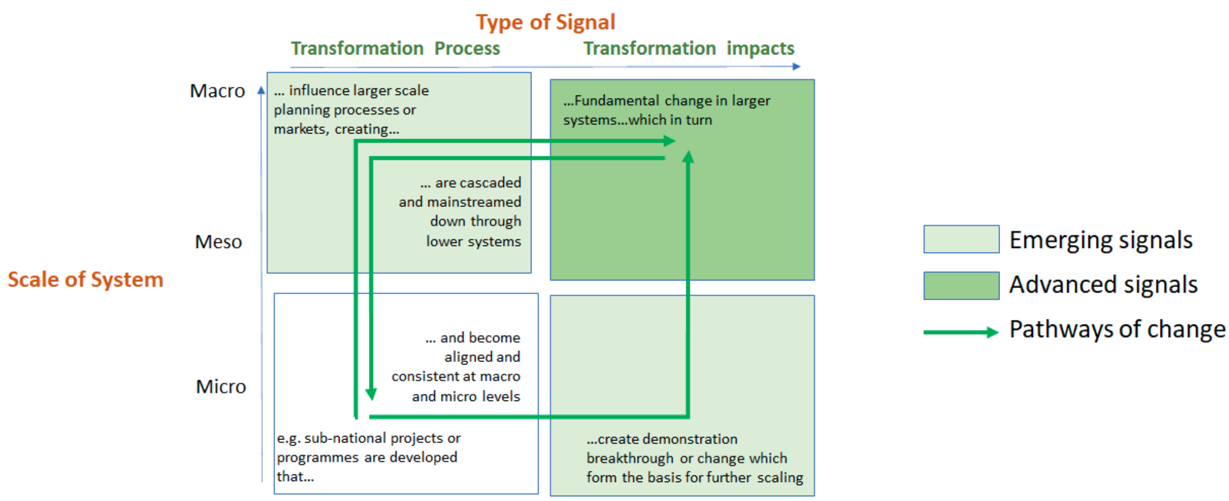
Emerging signals are those that suggest that transformational change processes are underway but where outcomes across lower- and higher-level systems are not yet visible. They capture progress on pathways towards transformation, while recognizing the long timescales and significant uncertainties often involved in delivering these outcomes. They are captured by using clear theories of change and dynamic baselines against which progress can be assessed. Emerging signals will always have a clear line of sight to connecting lower- and higher-level systems to deliver transformational impact. There should be a credible narrative for contribution to impact, although not necessarily causality. Typical emerging signals might include:

- *Processes that can facilitate fundamental shifts in the function or structure of any-level system, scaling between lower- and higher-level systems, or durability of transformational changes:* Transformational change processes can be long and complex, and it is important to capture processes (e.g., national planning, institutional reform, investment mobilization) that have been established or leveraged in order to deliver transformational impacts at-scale in the future. These signals are indications that efforts are being made to facilitate larger changes (e.g., in terms of implementing new processes or investments, or successful piloting of technologies or business models with an eye to replication). Such processes may have been enabled by an intervention (where an intervention is implemented at large scale relative to the system) but will normally occur outside of a project boundary (i.e., other stakeholders have mobilized to support transformational change in an autonomous way).
- *Transformational outcomes in unconnected systems:* These are (intended) outcomes that emerge as part of project-scale interventions where the focus is on bounded system change (e.g., local or sub-national, or smaller scale demonstration or innovation). They may also refer to changes in higher-level systems that are not cascaded down to lower-level systems (e.g., national policies that are not enforced or reflected at the sub-national or local level). These outcomes have the potential and intention to influence and impact systems at a large scale, subject to broader adoption and scaling, but have not yet done so in practice. Examples might include successfully demonstrating a new structural approach, scaling at a sub-national level, or proving the sustainable economics of a new business model. There should be clear theory of change and activity that shows how linkages between lower and higher-level systems will be made.

Advanced signals are signals of large-scale positive impacts (i.e., those changes that can be identified in larger systems such as at sector, national, and global levels) as well as fundamental changes in the structure, function, or interaction of a system. These can arise directly from specific project interventions depending on the scale, ambition, or timing, or may occur through the institutionalization of new systemic processes or scaling up demonstration interventions over time.

The above concepts are captured in Figure 5 below, noting that emerging signals should demonstrate clear line of sight (from the perspective of both strategic intent and resource allocation) towards achieving higher level impacts.

Figure 5: Signal Stages and Pathways



There may also *regressive* signals (e.g., where policy reverts to supporting higher carbon pathways) or maladaptation (where strategies to increase resilience result in increased exposure and vulnerability). These may be deliberate processes (e.g., investment or policy stances) or system outcomes (e.g., increases in deforestation rates).[16]

The following section sets out how the framework might be applied, using a set of illustrative signals drawn as an example from the energy sector. The signals have been drawn from across a broad range of thematic areas associated with the energy transition, including renewable energy generation, green grids, energy access, demand side management, just transition, and energy systems resilience. It should be noted that:

- Signals are indicative and illustrative of their categories, rather than comprehensive lists.
- Signals are not indicators, although quantitative indicators may be a sub-set of signals.
- There is a continuum from emerging to advanced signals.
- Advanced signals build upon and are additive to emerging signals, with both process and outcomes often visible.

[16] *The TCLP is exploring the possibility of expanding the structure to capture these regressive signals, alongside the absence of progress in one direction or another. A traffic light system could be considered to reflect signals that are regressive (red), emerging (yellow) and advanced (green).*

Figure 6. Draft Framework for Signals of Transformational Change (with illustrative examples of Energy Signals)

<table>
<tr><th colspan="2">DIMENSIONS</th><th colspan="2">STAGE</th></tr>
<tr><th>Dimension</th><th>Types</th><th>Emerging: Enabling Processes and Pathways</th><th>Advanced: Outcomes and Systemic Processes</th></tr>
<tr><td rowspan="4">Relevance</td><td>Objective</td><td colspan="2">Objective signals provide evidence that an intervention or change process supports transformation objectives across different levels, linking intervention objectives to changes in higher-level, larger-scale systems (e.g., sector, economy, system wide). From a climate mitigation perspective, this might include reducing GHG emissions within a system (e.g., country, sector) to meet agreed global scientific benchmarks, targets, or burden sharing agreements. From a resilience perspective, this might be ensuring that sectoral development and investment delivers resilience to the projected impacts of climate change for vulnerable groups and sectors. Transformation objectives should also capture alignment with other transformational change processes (e.g., social justice/just transition, environmental sustainability) to avoid unintended consequences, reduce the potential for trade-offs and promote more integrated systems thinking. Signals will therefore capture evidence of both the validity/robustness of the objective and its alignment with/co-benefits for other transformational change processes. In an intervention context, transformation objectives will likely be evidenced in pathways to impacts and outcomes (e.g., in theories of change and results frameworks).</td></tr>
<tr><td>Energy signals (Examples)</td><td>Theories of change and results frameworks that contribute to energy sector decarbonization or mitigation objectives at a single level only
Theories of change that seek to link energy transition to other single-level/lower-level transformation processes (social, economic)</td><td>Theories of change and results frameworks that address systemic barriers and seek to transform energy sector function (e.g., integration of variable RE) across multiple levels
Theories of change that seek to link energy transition to multiple-level/higher-level transformation processes (social, economic)
Intervention objectives to connect lower- and higher-level systems for influencing and scaling purposes (e.g., cities to national governments)</td></tr>
<tr><td>Intervention logic</td><td colspan="2">Intervention logic signals provide evidence that a transformation process or intervention has been designed in a way that is most suitable for the stage and context of transformation (e.g., its position on the S-curve). There should be evidence that the intervention considered timing and likely development trajectories for change. The intervention should ideally incorporate or recognize the need and strategies for elements of speed, systemic change, scaling, and adaptive sustainability, or recognize the extent that these are already in place. Consideration should be given to phasing of activities over time and setting out dependencies/transitions between the dimensions.</td></tr>
<tr><td>Energy signals (Examples)</td><td>Analysis of stage of development on transformational pathway and suitable entry point/timing (single-level/lower-level systems)</td><td>Analysis of stage of development on transformational pathway and suitable entry point/timing (multiple-level/higher-level systems)</td></tr>
</table>

		• *Analysis of systems, scaling, and sustainability opportunities inform design of intervention or portfolio (single-level/lower-level systems)*	• *Analysis of systems, scaling, and sustainability opportunities inform design of intervention or portfolio (multiple-level/higher-level systems)*
	Enabling approach	*Enabling approach* signals provide evidence that transformational change processes are able to identify barriers in the political economy and to generate strategies that create the greatest possible momentum and consensus for change. Signals will generally reflect aspects including mobilizing key institutions, stakeholders, and networking approaches, as well as addressing potential barriers to delivery. Efforts should be made to strengthen the legitimacy of transformational change processes through inclusive engagement, encouraging procedural justice, and ensuring a balance of voices.	
	Energy signals (Examples)	• *Clear analysis of barriers and drivers of transformational change, and identification of strategies to address these (single level/lower-level systems)* • *Multi-stakeholder engagement and inclusion of champions or key institutions to create buy in and support delivery at single-level/lower-level systems.*	• *Clear analysis of barriers and drivers of transformational change, and identification of strategies to address these (higher-level systems and cascaded down)* • *Multi-stakeholder engagement and inclusion of champions or key institutions in both higher- and lower-level systems to create buy in and support*
	Timeliness	*Timeliness signals* indicate that interventions and decision making are timely, and that the phasing of delivery takes advantage of windows of opportunity where change processes are likely to gain traction. This can be embracing emerging confluences of interests or other dynamics that can support change, identifying tipping points that can lead to greater acceleration, or phasing implementation to ensure that activities are undertaken only when they are credible and can build momentum. This implies a level of agility to respond to changes in the contextual environment (e.g., economic, political, technological, natural) over time. These signals capture adaptive programming changes (both strategic and operational) that address unforeseen barriers and opportunities that arise during implementation, and also link forward to the dimension of adaptive sustainability (see below).	
	Energy signals (Examples)	• *Consideration of timing in single-level/lower-level interventions (e.g., consumer readiness, market maturity, affordability, capacity)* • *Interventions take advantage of windows of opportunity (e.g., changes in political or investment climate, emerging leadership)* • *Changes in intervention design during delivery to adapt to emerging delivery opportunities, unexpected path dependencies* • *Pursuing new partnerships or delivery models during implementation that can facilitate greater impact*	• *Consideration of timing in multiple-level/higher-level interventions (e.g., consumer readiness, market maturity, affordability, capacity)* • *Interventions take advantage of the emergence of macro-scale trends (e.g., emerging technologies, cost reductions, information, political leadership)* • *Repurposing of projects to support multiple-level//higher-level green recovery objectives and build back better agenda*
Systemic Change	Techno-economic	Practical signals indicate that new technical, economic, and/or operational solutions to transformation challenges have emerged or are emerging. These may include technology innovations (e.g., around function, cost or scale) or new market approaches to	

		addressing a challenge (e.g., business models, sectoral practices). Innovation is a core component of these signals, and they are likely to emerge from processes that involve design, piloting, and demonstration activities, as well as more organic evolution in systems.	
	Energy signals (Examples)	• *Piloting of clean energy business models and technologies (e.g., RE mini grids) to demonstrate economic sustainability of private sector solutions* • *Innovation programs support development of new energy technology prototypes and concepts (e.g., solar, wind)* • *National smart grid software/management approaches implemented to facilitate the penetration of variable RE* • *National technology programs launched to improve local application of emerging RE and storage technologies* • *New integrated RE generation approaches piloted (e.g., hybrid CSP-PV-Battery) to improve efficiency and cost* • *Innovations around energy access technologies and business models successfully demonstrated*	• *Improvements in operating efficiencies and capacity (e.g., size) for RE generation and storage technologies* • *Decreases in capital and operating costs for RE generation, storage, and other clean energy technologies* • *Changes in the cost of finance, representing improvements in investor risk perception of technologies/business models* • *Clean energy technologies successfully adapted to suit local context and operating environment (capacity, cost, robustness)* • *Emergence of indigenous RE manufacturing capacity and supply chains to meet national RE plans* • *Reduced curtailment of RE generation (e.g., associated with more flexible grid management practices, monitoring/forecasting systems)* • *Diverse entrepreneurs and new entrants in clean energy development, operation, and servicing markets*
	Socio-Institutional	Social signals indicate that people's beliefs, values, behaviors, and worldviews have changed. Social signals can enable or hinder transformation by delineating what people perceive as possible, influencing how people perceive or interact with systems, and determining how resources are allocated. Social signals might include changes in media narratives or social media reporting, or evidence of fundamental changes in how people value ecosystem services. These changes can occur in the general population or in specific social groups as defined by their culture, profession (e.g., policy makers), ethnicity, gender, or vulnerability, etc. Social signals also capture elements that influence behavioral adoption and support (e.g., Just Transition policies). Institutional signals indicate that the institutional governance and policy frameworks that govern system development and influence investment and other behaviors have changed, or are evolving in a way that facilitates transformation. Institutional signals may refer to fundamental shifts in relationships that are framed through policies, institutions, decision-making processes and governance structures. They also reflect fundamental developments in financing and incentive structures or the capacities of key institutions that allow or encourage transformation.	
	Social Energy signals (Examples)	• *More structured and inclusive processes for public consultation (e.g., on RE infrastructure development and planning or just transition)*	• *Strong voices emerge for greater clean energy development and fossil fuel phase out among elected officials*

		• *Awareness raising and agenda setting initiatives to promote clean energy by a range of public, private, and civil society actors* • *National assessment of distributional impacts of clean energy transition to ensure additional costs offset through social policy programs and retraining opportunities* • *Promotion campaigns developed to promote the uptake of energy efficient goods (e.g., cooling, cooking, consumer electronics)* • *Development of national energy labeling, rating, and benchmarking systems (consumer, industrial)* • *Research processes to quantify and communicate benefits of clean energy for SME development (e.g., reliability, productive uses)* • *Clean energy pilots demonstrate effective and affordable access for underserved populations, supporting fuel switch behavior* • *Enforcement initiatives developed to encourage new norms and rules in energy use (e.g., building codes, emissions control)*	• *Emergence of high-quality job market opportunities in clean energy supply chains, contributing to just transition* • *Qualitative change in public awareness and support for renewable energy deployment (e.g., as measured through opinion surveys)* • *Voluntary consumer adoption of green energy tariffs issued by utilities and distribution companies* • *Consumer behavior switching towards higher energy efficiency goods and services (e.g., as measured through purchase data)* • *Measurable improvements of electricity affordability/reliability for end consumers (household, industrial) associated with clean energy transition* • *Public institutions integrate energy efficiency and renewable energy into their own operations and procurement* • *Emergence of a more diverse and inclusive workforce in the energy sector as a result of just transition* • *New forms of ownership and purpose within a sustainable, inclusive and equitable energy system*
	Institutional Energy signals *(Examples)*	• *National capacity development and training programs developed in key ministries to support clean energy development* • *Policy development processes and consultations launched to improve incentives for investment in clean energy* • *Investments in improving the quality/ availability of information to facilitate better decision making (e.g., RE resource mapping)* • *National planning exercises to integrate higher levels of renewables into power sector, grid extension and universal access*	• *Investment grade policy and regulatory frameworks in place to mobilise private investment in renewable energy generation* • *Regulations to reduce fossil fuel investment in place (e.g., coal moratorium, carbon taxes, portfolio standards)* • *National design standards for climate resilience planning in the energy sector mainstreamed into new power sector projects* • *Key national/subnational institutions have capacity to successfully plan for/ implement major RE, EE, and energy access programs*

		• *Processes to establish financing frameworks to ensure sufficient operating reserve and back up capacity under greater variability* • *Financial institutions and ESCOs strengthened to successfully support increased access to finance for clean energy projects* • *Processes to strengthen national utilities and distribution companies to improve bankability of projects* • *Processes to mainstream clean energy considerations into sectoral planning*	• *Ministries of finance make budgetary allocations to support clean energy transition (e.g., renewables integration, green grids)* • *New political structures established to support regional energy market integration and power trading to offset RE variability* • *Emergence of deeper primary and secondary markets for energy trading and financing instruments* • *Economically robust national utilities and distribution companies are able to act as creditworthy offtaker for private investment* • *Policies/regulations adopted for mainstreaming clean energy policy into sectoral planning and procurement*
	Environmental	Environmental signals of systemic change indicate that there are demonstrable fundamental shifts in the function of natural or environmental systems, such as climate or ecosystems. These may indicate interventions delivering positive change (e.g., progress towards systems regeneration and biodiversity restoration, greater resilience of the natural system to the impacts of climate change) or demonstrated improvements in the functioning of other systems (e.g., sustainable watershed management for hydropower production). It should be noted that transformational change in natural systems may occur over much longer periods than is typical for project scale interventions, and that human actions influence but cannot fully steer transformational change in these systems.	
	Energy signals (Examples)	• *Processes to assess impacts of clean energy transition on natural systems established (e.g., offshore wind and fisheries)* • *Piloting of models to assess integration of energy and resilience planning (e.g., watershed management-hydropower generation)* • *Development and demonstration of integrated multi-purpose energy – agriculture land use approaches* • *Development of national standards for reducing environmental impacts or energy systems planning (e.g., ecosystem-based)*	• *Reduction in rates of deforestation demonstrated through the switch to clean fuels and cooking* • *Improved biodiversity as a result of better linkages between watershed restoration and hydropower development planning* • *Cleaner air and reduced environmental pollution associated with industrial energy efficiency and shift to advanced technologies* • *Improved hydrological systems function due to clean energy technology evolution (e.g., switch from CSP wet to dry cooling).*
Speed	Speed	Speed signals demonstrate impact by ensuring that processes and outcomes are consistent with the required pace of transformation, given the urgency of the climate crisis. Emerging signals reflect processes that seek to alter the pace of climate action in line with the urgency of the challenge, while advanced signals capture the outcomes of this alignment.	

	Energy signals (Examples)	• *Efforts to improve efficiency of processes for deployment of clean energy (e.g., reduction in RE permitting times)* • *Capacity enhancement underway to expedite energy sector policy and regulatory development approaches* • *Coordinated actions by industry and government for targeted acceleration of energy technology research and development*	• *Phasing of national renewable energy scaling scenarios align with net Zero decarbonization pathways* • *Ongoing growth in clean energy jobs and supply chains offsets concurrent reduction in fossil fuel sector* • *Vulnerable stakeholders enabled in a timely way to engage and benefit from transition dynamics and decision making*
Scale	Techno-economic	Techno-economic signals indicate that changes in technology or economic systems (e.g., new renewable energy technologies or business models) are increasing (e.g., in terms of their volume, relative share of market, or frequency of adoption). These signals may be captured in units (e.g., sales, distribution, production, use data), or in other types of quantitative measurement such as finance ($) or clean energy (e.g., KWh, MW installed capacity).	
	Energy signals (Examples)	• *Increased deployment of RE generation (units, installed capacity) at local or sub-national level* • *Upward trends at sub-national/sector level in sales of energy efficient goods and appliances relative to less efficient alternatives* • *Launch of initiatives to encourage replication of energy storage pilot projects from sub-national to national level* • *Launch of initiatives to improve lending volumes for clean energy technologies through local financial institutions* • *Increase in number of technology distributors and service organisations present in local markets for off-grid energy systems*	• *Increased deployment of renewable power generation (units, installed capacity), changing national power generation mix* • *National level increases in volumes of green energy consumption (e.g., using green tariffs, auto generation)* • *Significant increase in financing flows (public and private) to support low carbon energy deployment at national scale* • *Reduction in fossil fuel consumption and energy imports at national level as % share of energy balance* • *Large scale phase out of energy intensive goods and services from market (e.g., incandescent bulbs, low efficiency A/C)*
	Socio-institutional	Socio-institutional scaling signals indicate that systemic changes in policies or behaviors are being adopted by a broader set of people, institutions, or administrative areas (Advanced), or that processes are in place to facilitate this broader adoption (Emerging). Social groups may overlap with geographic boundaries (i.e., an administrative population), but may also be defined by other characteristics, such as professions (e.g., farmers or policy makers), consumers, cultural or ethnic groups, or specific socio-economic profiles (e.g., poor or marginalized communities). Scaling may indicate that certain groups are benefiting or changing behaviors more or that there is scaling and adoption between and across different groups or regions. These signals can also capture dynamic elements of inclusion and diversity as set out in the overall transformational change definition.	
	Energy signals (Examples)	• *Development of national programs to promote energy efficiency benchmarking across businesses within industrial sectors*	• *Large numbers of market participants (developers, financers, service providers) actively bid for national utility-scale RE auctions*

		• *Launch of sector wide marketing/labelling campaigns to promote mass adoption of more efficient products (e.g., appliances, cooling)* • *Development of national off-grid clean power access initiatives to support off grid access by poorer or marginalised communities* • *Increasing national developer interest in RE project development (e.g., pipeline development activities, investor conferences)* • *Development of initiatives to transfer renewable energy technology and business models between countries or regions* • *Replication of projects or uptake of clean energy technologies or business models at local or sub-national level* • *Coalitions of cities coming together to support and adopt low carbon energy targets and transition planning approaches* • *Development of initiatives to transfer energy efficient technologies between countries or regions* • *Evidence of uptake of solar home systems in target*	• *Significant shifts in consumer use of clean energy solutions (e.g., solar home systems), improving national energy access metrics* • *Large numbers of businesses investing in energy efficiency (e.g., investment, audit), improving sectoral energy intensity* • *National-scale shifts in employment within clean energy sector supply chains, displacing high carbon sectors* • *Expansion of renewable production in new regions by investment in green grid networks to remove transmission bottlenecks* • *Successful replication of successful RE demonstration or pilot initiatives at national or international scale* • *Replication of new energy technologies or business models by public or private developers in other countries* • *Regional peer to peer transfer and adoption of best practices on green grid management by national regulators/ system operators*
	Environmental	Environmental signals of scaling indicate that there is a shift in the scale at which systemic changes in natural systems are occurring. Emerging signals would include earlier evidence of change (e.g., natural restoration) or processes seeking to replicate the benefits of local initiatives and demonstration efforts that might influence larger-scale natural systems. Advanced signals would be successful replication, and outcomes and impacts at the scale of these larger natural systems. The scale of change might be defined in terms of their spatial aspect (e.g., local air pollution impacts, global atmospheric GHG concentrations), their natural system boundaries (e.g., biomes, watersheds, river basins), areas of similar features (e.g., agro-ecological zones). Scaling can be transformational in both positive terms (e.g., reforestation rates, increases in biodiversity, reduction in greenhouse gas emissions) and negative terms (e.g., loss of habitats).	
	Energy signals (examples)	• *National initiatives to scale up adoption of sustainable biomass production, promoting biodiversity offsets for mono-energy crops* • *Programs to integrate hydropower in watershed management and restoration planning frameworks at regional scale* • *National- scale interventions to replicate energy related air quality monitoring systems across multiple cities or regions*	• *Reduction in national deforestation rates or increases in reforestation rates in countries with unsustainable forest use* • *National or regional level increases in protected areas to reduce fossil fuel extraction and transport* • *Large scale reductions in energy sector emissions from (e.g., fossil fuel consumption, power generation, transport)*

		• *Early evidence of scaling of change in natural systems (e.g., natural rewilding, reforestation in former FF mining areas)*	
Adaptive Sustainability	Techno-Economic	Techno-economic signals indicate that the technology, economic and financial ecosystem that underpins change has adapted in such a way that it is now to a large extent self-sustaining and self-organizing. This can be evidenced, for example, by a shift to commercial operation (without subsidy), the development of competitive private markets, a sustainable reduction in costs that match or outperform alternatives, evidence of long-term, legally binding commitments to public financing for non-market goods, or fundamental and sustainable changes in production patterns. Emerging signals primarily demonstrate long term commitments by governments and markets to supporting this transition (e.g., forward looking technology and finance planning frameworks), whereas Advanced signals capture outcomes (e.g., fundamental shifts in system function). Techno-economic signals also capture how durable and robust changes feed through into wider economic development pathways (e.g., prosperity, green growth).	
	Energy signals (Examples)	• *Long-term planning and investment frameworks for development of clean energy innovation and manufacturing capacity in country* • *Processes to review and revise long-term technology pathways and roadmaps for energy transition on a regular basis* • *Processes underway to mobilize long-term private finance for low carbon energy systems development in line with RE targets* • *Long-term public financing frameworks developed to provide financial support for non-market aspects (e.g., green grids)* • *Ratcheting processes to increase ambition around renewable energy or energy efficiency deployment targets over time* • *Shift to technology neutral procurement approaches for new capacity to create level playing field for clean energy*	• *Significant reduction/elimination of concessionality necessary to incentivise renewable energy deployment at national/global scale* • *Elimination of subsidy regimes for carbon-intensive energy fuels (oil and gas, coal), with level playing field for capacity procurement* • *Fully commercial private sector supply chains and manufacturing capacity for RE development* • *Fully competitive private markets for RE financing/development opportunities* • *Sustained reduction in commercial and technical losses from utility reform or green grid operations* • *Successful integration of mini-grids and other off-grid generation into national grid infrastructure*
	Socio-institutional	Socio-institutional signals indicate that institutional systems and behaviors supporting climate action are firmly embedded and have become dominant. The ability of individuals, organizations, and networks of organizations to learn new ways of doing things and incorporating this learning through changed practices are important socio-institutional signals. Socio-institutional signals may also include signs that social outcomes (i.e., co-benefits) are aligned to or reinforce wider social justice considerations (e.g., just transition, job creation, equity, accessibility, affordability) as reflected in social justice frameworks. This includes delivering more equitable benefits for poor and marginalized communities in a sustainable way.	
	Energy signals (Examples)	• *Clean energy fully integrated into energy sector planning through a single institutional and policy framework*	• *Conclusion of national public debate on relative merits of clean energy vs. fossil fuels (e.g., reliability, affordability, social benefits)*

		• *Long-term decarbonisation pathways (e.g., to 2050) inform policy development and institutional response* • *Processes to integrate clean energy sector development into wider social-economic development strategy, including COVID recovery* • *Long-term education and information campaigns to increase energy literacy, including public debates by elected officials* • *Long-term monitoring processes to assess progress on social impacts of energy transition, (affordability and job creation)* • *Launch of long-term just transition frameworks to underpin energy transformation (training, reskilling, regional development)*	• *Employees of the fossil fuel industry re-employed at scale in other workforces; long-term job creation and sector growth* • *Clean energy transition fully mainstreamed into national economic development planning and green recovery budgets* • *Evidence of fundamental shift in social attitudes to clean energy transition (e.g., efficient purchasing patterns, auto-generation)* • *Positive media narratives of RE contribution to national socio-economic development and future prosperity are dominant* • *Compelling evidence of contributing role played by clean energy transition in delivering SDG7 and other development priorities*
	Environmental	Environmental signals indicate that transformational change outcomes are aligned with and contribute towards wider environmental sustainability outcomes and goals. These may relate to climate change (e.g., alignment with global benchmarks such as the Paris Agreement, or with other more local science-based mitigation or resilience benchmarks). These signals can also include evidence of durable co-benefits that align with and reinforce wider environmental objectives (e.g., air quality, resource efficiency, circular economy). Emerging signals indicate some confidence in the future durability of changes, while advanced signals capture progress in system outcomes.	
	Energy signals *(Examples)*	• *Long-term monitoring processes to assess and inform authorities on energy related environmental impact (including GHG emissions)* • *Robust enforcement mechanisms to ensure long-term environmental and emissions compliance within the energy sector* • *Legally binding accountability mechanisms to ensure government adherence to GHG targets (with potential for judicial review)* • *Policies and programs that align with long-term scientific GHG emission benchmarks (e.g., Paris Alignment screening)*	• *Substantive changes in GHG emissions over time at national, regional, or global scales* • *Long-term trends in GHG emissions intensity (sector, per capita, GDP) aligned with long-term scientific benchmarks (Net Zero, 1.5C)* • *Evidence of impacts of energy transition on improvements within environmental systems (e.g., air quality, resource conservation)* • *Robust performance of energy systems under extreme events (e.g., major floods, storms) or slow onset events (e.g., heat, drought).*

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