Barriers to the Timely Deployment of Climate Infrastructure

Executive Summary

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[1] FOAK projects are first-of-a-kind projects. FOAK (1-to-n) projects are the first 1-to-n-of-a-kind projects, where n is the number of times the same type of project gets implemented. Further details around the definition of a FOAK project can be found in Chapter 3 of the full report.

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Background

In February 2021, Prime Coalition, Schmidt Futures, and Blue Haven Initiative came together to launch an exploration project implemented at Prime to characterize the gaps holding back the deployment of climate infrastructure in the U.S. and to explore whether catalytic[2] capital could help bridge those gaps.

The project focused on the dual objectives of:

- Enabling deployment of nascent climate solutions.
- Accelerating deployment of existing climate solutions.

The output of that exploration is captured here and draws on:

- Primary research: interviews with over 140 senior members[3] of the climate ecosystem.[4]
- Secondary research: written publications[5] on the topic.

Acknowledgements

The author is grateful to Richard Kauffman, Mark Barnett, Sarah Kearney, Matthew Nordan, Johanna Wolfson, and Lou Schick for their invaluable support and advice throughout the exploration phase and the production of this report; the interviewees for their time and contributions to the analysis; and Steven Fox for his contribution to sector deep dives. The author thanks Anjali Deshmukh and Sophia Sun for proofreading, and Sylvia Weir for designing the report.

[2] In this paper, we will use catalytic capital, catalytic investors, or catalytic capital providers to mean those whose paramount priority is charitable impact, for whom financial returns are not the top priority, and who are able to absorb risk, timelines, or financial returns that finance-first capital cannot. Catalytic Capital is further defined in Chapter 7.

[3] See Appendix F of the full report.

[4] Including Project Finance capital providers, VCs, federal and state governmental institutions, technology companies, developers, catalytic capital providers, academics and philanthropic organizations.

[5] See Appendix G of the full report.

1. “Code Red for Humanity”

In August 2021, U.N. Secretary General António Guterres described the latest Intergovernmental Panel on Climate Change (“IPCC”) report on climate as a “code red for humanity.” The report stated that “Global warming of 1.5°C and 2°C will be exceeded during the 21st century unless deep reductions in carbon dioxide (CO_2) and other greenhouse gas emissions occur in the coming decades.”[6] He added: “If we combine forces now, we can avert climate catastrophe. But, as today’s report makes clear, there is no time for delay and no room for excuses.”

Solving the emissions reduction puzzle will require an all-hands-on-deck approach, with a combination of (a) accelerating the deployment of renewable energy, electric vehicles, and energy efficiency measures, (b) reshaping industries and value chains, including for agriculture, transportation, manufacturing processes and hard-to-abate industries such as cement, steel, glass and others, and (c) removing atmospheric carbon.

De-risked solutions are currently being deployed at scale (e.g., wind and solar generation projects and, to a lesser extent, electric vehicle charging infrastructure), but their breadth and speed of deployment need to be accelerated. In addition, deploying wind and solar alone will not be sufficient.[7] Climate solutions need to include green hydrogen, supply chain efficiency improvements, carbon reducing and/or removal technologies, and a range of natural solutions. For most of these additional solutions, technologies are still nascent and need to be demonstrated to work; markets need to be developed, and solutions commercialized and then taken to scale. Achieving these objectives will require pushing nascent climate solutions through the scale-up and deployment process faster than would otherwise happen if left to typical market dynamics. Given the lengthy development and implementation cycles, solutions will in large part need to be commercially proven (i.e., bankable[8]) by 2030 in order for them to be scaled up between 2030 and 2050.

[6] IPCC, 2021. “Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change” [MassonDelmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press. https://www.ipcc.ch/report/ar6/ wg1/downloads/report/IPCC_AR6_WGI_Headline_Statements.pdf

[7] According to the International Energy Agency (“IEA”), around 35% of GHG emissions reduction must come from technologies currently at the prototype or demo phase.

[8] To be considered commercially proven or bankable, technologies need to have been implemented and operated continuously for a significant length of time in the same conditions (same feedstock, temperature, seasonality, equipment, etc.) as the project contemplated to be funded.

Observable tailwinds to the deployment of climate solutions in 2021 should serve as critical evidence to catalytic investors that once projects become ready for "widespread adoption," large pools of finance-first[9] capital will be ready to take up projects for the next stage of deployment:

- Corporations are stating ambitious plans to decarbonize, signing net zero pledges (e.g., Microsoft, Amazon)[10] and/or purchasing carbon offsets (e.g., Google [11], Shopify[12]).
- Climate transition funds are being raised at unprecedented speed and in staggering amounts.
- Governments are stepping in and proposing ambitious plans to address some of the gaps.

Unfortunately, the following dimensions often keeps climate innovations stuck[13] in early deployment purgatory:

- Lengthy timelines to widespread adoption.
- Risk/size/return profile fits with neither mainstream VC nor Project Finance.
- Lack of standards from pilot to proven.
- At times, lack of compelling economics in the early days until costs come down or incentives are legislated.
- Long history of "failures" of first-of-a-kind ("FOAK") projects taint new efforts.

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[9] In this paper, we will use finance-first capital or investors to describe those that are primarily motivated by financial returns (or by both financial returns and impact), in contrast with catalytic capital or investors whose top priority is charitable impact.
[10] "Signatories." n.d. The Climate Pledge. Accessed January, 2022. https://www.theclimatepledge.com/us/en/Signatories.
[11] "Google's Carbon Offsets: Collaboration and Due Diligence." n.d. Google. Accessed January, 2022. https://static.googleusercontent.com/media/www.google.com/en//green/pdfs/google-carbon-offsets.pdf. and limited recourse debt.
[12] Kauk, Stacy, and Borja Bonaque. 2021. "Shopify Is Eliminating the Climate Impact of Shipments Over BFCM (2022)." Shopify. https://www.shopify.com/blog/bfcm-carbon-removal-2021.
[13] Despite these facts, many companies have recently been raising large amounts of capital from VCs, as illustrated by Commonwealth Fusion Systems, as an example, who recently raised $1.8Bn in Series B funding to "commercialize fusion energy."

2. On the Road from Innovation to Adoption: A Subset of Early Deployments Are Stuck in Between Asset Classes

2.1. Defining "Early Deployments": Our Focus in this Analysis

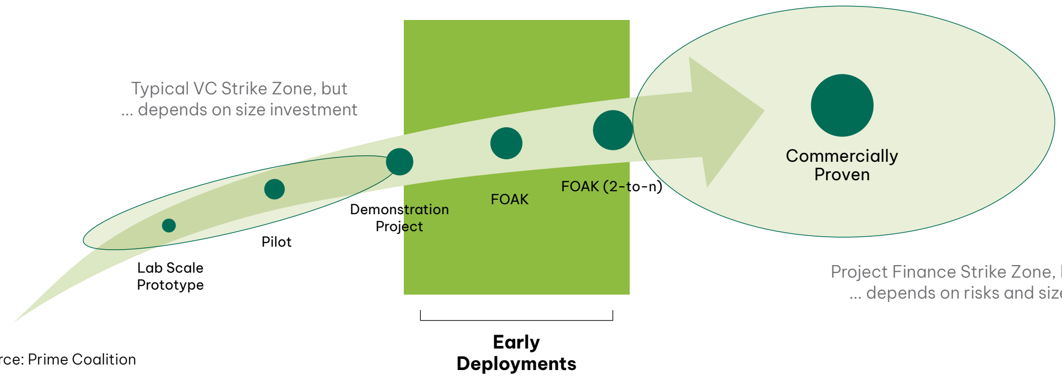
We define "early deployments" to include all of the following situations:

- In the context of a new climate innovation: early commercial deployments of projects in the sequence from innovation to adoption (including demos, FOAK, and FOAK (2-to-n) projects, as detailed in section 2.1.1. below);
- In the context of a new business venture: the first few project deployments for a business on its way to scaling up (regardless of whether the underlying technology/solution is innovative), as detailed in section 2.1.2. below; and
- In the context of a new "greenfield" project: the early stages of a project deployment's lifecycle, i.e., the ''development" of a project ahead of the project getting constructed (regardless of whether the underlying technology/solution is innovative), as detailed in section 2.1.3. below.

2.1.1. New Climate Innovation: Sequence from Innovation to Adoption

The road from innovation to adoption passes through several stages[14], starting with proving a concept at the lab (or prototype) scale in controlled settings, then moving to a pilot project (often a larger installation that is still subscale and not necessarily in the relevant environment), before moving to one or more incrementally larger demonstration projects to prove the technology's viability at scale. It is only then that a commercial scale demonstration project gets built, and followed by the first commercial deployment (described as FOAK). Project Finance capital providers typically look for several implementations of a FOAK project (such implementations called "FOAK (2-to-n)" , and, collectively with FOAK, "FOAK (1-to-n)" in this report) before a solution is deemed "commercially proven." Early deployments, in this context, include demonstration, FOAK, and FOAK (2-to-n) projects, where n will vary by the type of solution, but is determined by whenever a climate solution graduates to widespread adoption.

Figure 1. Sequence from Innovation to Adoption



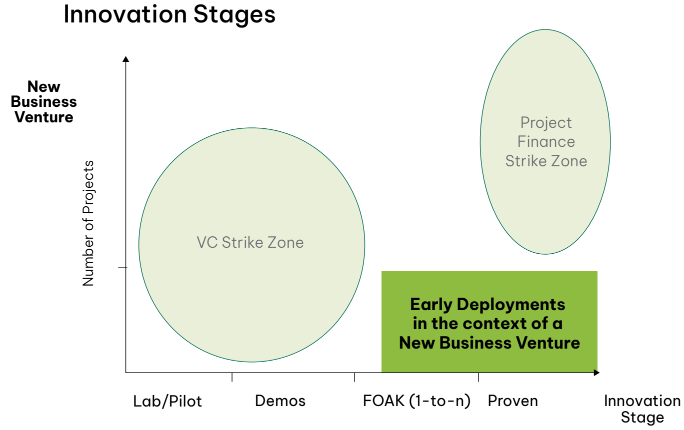
Source: Prime Coalition

[14] An attempt at defining these stages is included in the full report.

2.1.2. New Business Venture on Its Way to Scaling Up

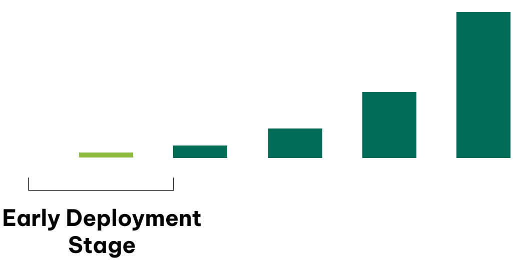
Before it scales up its commercial, engineering, development, and capital resources, a new small business will typically start by deploying projects sequentially, progressively scaling up its operations and financial resources to be able to deploy several projects in parallel. Early deployments, in this context, refer to the deployment of the first few sequential projects (whether proven or innovative).

Figure 2. New Business Venture Across Innovation Stages



Source: Prime Coalition

Figure 3. Number of Projects Over Time for a New Business Venture

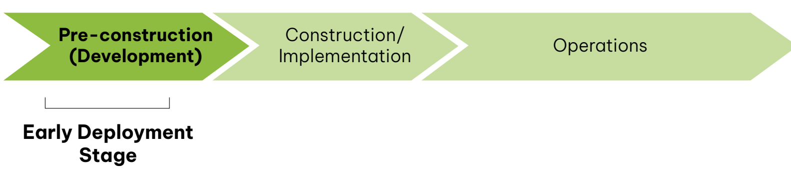


Source: Prime Coalition

2.1.3. New Greenfield Project: Early Stages of a Project's Life Cycle

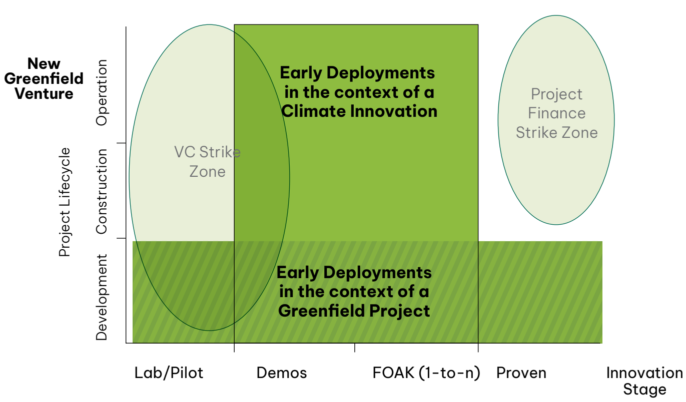
The life cycle of a project consists of three stages: (a) development (consisting of pre-construction activities), (b) construction/implementation, and (c) operations:

Figure 4. Project Life Cycle



We define early deployments, in this context, as the pre-construction activities involved with implementing any new project, whether proven or innovative.

Figure 5. New Greenfield Project Across Innovation Stages



Source: Prime Coalition

2.2. Empirical Conclusions: Four Major Gaps

Early project deployments, whether in the context of a new climate innovation, a new business venture, or a greenfield project, were nearly unanimously flagged by interviewees as unable to efficiently and effectively attract capital, primarily because returns for these projects were often not commensurate with their risks. More specifically, the gaps centered around the following four areas (ranked from most acute to least):

Gap 1: FOAK (1-to-n) projects.
Gap 2: Demonstration projects with a deployment[15] cost in excess of $20 million.
Gap 3: Early deployments of small (distributed) projects with a deployment cost below $20 million.
Gap 4: Projects in the development stage (particularly early development).

Table 1: Early Deployment Gaps, Rationale, and Examples

Included in our definition of "early deployments"	Why projects are stuck between mainstream asset classes	Examples
FOAK (1-to-n) projects	Too capital intensive and low return for VCs; too risky and sometimes uneconomical for Project Finance	The first commercial scale (200 tpd) facility for a CO_2-to-supplementary-cementitious-material technology that reduces CO_2 emissions associated with concrete
Demonstration projects >$20MM		
Early deployment of small distributed projects <$20MM	Do not meet return hurdles for VCs; too small to warrant the structuring and diligence costs of Project Finance capital providers	Modular direct-air-capture-to-food-grade-CO_2 company looking to raise $5-$10MM to fund the first few installations
Projects in the development stage	Requires deep knowledge of Project Finance; but with a binary risk/return profile, is ill-adapted to Project Finance capital providers' appetites	$10-$15MM funding to project developer to develop a large scale green hydrogen facility (i.e., find a site, do the front end design and feasibility analysis, structure the project, etc.)

Source: Prime Coalition

When interviewees were further probed on how one might accelerate the pace of deployment for projects (whether using proven or unproven technology), the following bottlenecks were repeatedly cited:

- Scarcity of qualified project developers (and industry experts more generally).
- Capital providers' credit underwriting criteria exclude some of the most impacted (and disadvantaged) communities.
- Insufficient tax equity for riskier/more complicated projects and/or lesser known developers.

[15] Deployment costs comprise project development and construction costs.

3. A Deeper Dive on FOAK (1-to-n) Projects: The Perfect Storm

For a given climate solution, the FOAK project, designed to be the first (at scale) commercial deployment, often presents the perfect storm from a financing perspective. It typically encompasses most, if not all, of the typical "Project Finance deal breakers:"[16] technology[17] risk, market risk, policy/regulatory risk, and sometimes insufficient returns relative to these risks. It is also where our research found the most acute capital gap.

3.1. Research and Interviews

Capital providers highlighted the following challenges associated with funding FOAK projects:

- Difficulty in underwriting FOAK projects without a clear track record of on-time and on-budget construction, as well as performance data. Simply put, it is hard for capital providers to accurately quantify this level of technology risk (including uncertainty around installation cost, operating costs, and performance).
- An expectation that "others" would fund early projects until a sufficient track record is built.
- Inadequacy of returns given the higher risks of the transaction.
- Lack of Project Finance sophistication for many in-house developed projects for smaller nascent solutions (e.g., poorly structured contracts; unrealistic or incomplete financial models).

Technology companies and FOAK developers highlighted the following challenges associated with raising capital:

- Difficulties and haphazard approaches in finding capital for FOAK projects.
- Even when capital is found, it is not always the optimal structure for a given project. Sponsors have to "force fit" the structure around the capital available, which leads to suboptimal outcomes.
- Even when capital is found, it is often at the end of a long and laborious process (up to 20 years for one company, and 3-4 years of capital raising efforts on average).

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[16] See Appendix C of the full report.

[17] Technology risk encompasses construction and completion (cost and delay) risk, performance risk, and potential integration issues.

[18] This relates to the notion of different languages spoken by different constituents in the ecosystem. From the sponsor's perspective, they sometimes genuinely believe the technology is proven (i.e., "works"). Risks may lie in construction costs, yield variability, etc. but the underlying technology is indeed expected to "work."

3.2. The Track Record for FOAK Deployment Is Mixed, Biased and Poorly Publicized

It is particularly difficult to complete a comprehensive analysis of the track record of FOAK projects for a variety of reasons, including:

- Nomenclatures and the absence of processes make it difficult to differentiate between FOAK commercial projects on one hand and demonstration projects on the other. In most studies, they are blended together.
- Unless truly revolutionary, FOAK projects are rarely advertised as such, and most often presented[18] as "mostly proven, using off the shelf equipment."
- Spectacular failures and/or successes tend to be advertised, while everything in between is rarely spoken about publicly, as capital providers aren't required to publicize financial information.

Negative outcomes for FOAK projects include:

- Non-completion.
- Cost overruns and project delays beyond available contingency.
- Sub-market returns to finance-first capital providers.
- Defaults on contracts (e.g., loan or offtake agreements).

In looking at various case studies[19] and feedback from interviewees, the following factors predispose FOAK transactions toward negative outcomes:

- Skipping the demonstration phase.
- Shortcuts in the development process.
- Uneconomical solutions (either because of higher costs in the early days or inadequate regulatory or market support).
- A weak or inexperienced management team.

While the risks reduce incrementally with each iteration of a project (i.e., FOAK 2-to-n), the inadequacy of risk adjusted returns at these stages contributes to these transactions remaining hard to finance or invest in by finance-first capital providers.

[19] See Appendix D of the full report.

4. A Deeper Dive on Demonstration Projects: The Neglected Sibling in Search of an Identity

We define a demonstration project as the "deployment of a solution (a) in the relevant environment, (b) at the smallest scale needed to prove the technology works at scale, and (c) for the purpose of demonstrating whatever the industry[20] is most afraid of (including scale, performance, yield, availability, longevity, understanding of costs and serviceability, meeting customer specifications, customer validation)."[21]

From a practical perspective, the line between large scale demonstration and a FOAK project is often blurred, and relates to the objectives of the project. Mischaracterizing demonstration projects as FOAK or targeting the wrong objectives helps explain why the "track record" of projects outlined in the various case studies[22] is far from being positive, particularly for larger projects.

Table 2. Demonstration vs. FOAK projects

	Demonstration projects	FOAK projects
Objective	(a) Validate (or assess whether) the technology or solution works at scale, (b) Establish the product meets customer specifications (c) Provide the basis for a narrower band of uncertainty around cost, performance and profitability variability	(a) Be built and operated within an expected time, cost and performance band (b) Serve as first of many (c) Establish a "proven" track record
Profitable?	Unlikely to be profitable, as it (a) will often require trial and error to get the system to work, hence higher costs and longer timelines, and (b) will focus on making the system work reliably as opposed to optimizing scale, costs, and logistics	Intended to be profitable
Characteristic	Subject to enough uncertainty and variability that a traditional project financing and/or offtake package may not be the appropriate design, at least until the project reaches some level of stability	Can be structured[23] as traditional Project Finance transactions, with the ability to commit to certain output quantities and prices, and – in theory – financed with a combination of project equity and debt

Source: Prime Coalition

[20] Including capital providers, EPC firms, customers, etc.
[21] See Section 3.1.1. of the full report for definitions.
[22] See Appendix D of the full report.
[23] Subject to additional contingent equity, guarantees or subsidies where needed.

Feedback gathered during the interview process indicate:

- The funding gap for demonstration projects is particularly acute for projects exceeding $20MM in construction costs (smaller projects are usually funded by a mix of VCs and government grants).
- While the government does play a role in funding certain demonstration projects, it typically does so in collaboration with private capital, and the scale of the need is outsized compared to availability of willing capital.[24]

Beyond capital constraints, some of the issues preventing demonstration projects from either being implemented or being successfully implemented include:

- Uncertainty around whether what is being demonstrated will address what project financiers will want to see a track record of for the next deployment.
- Lack of clear interpretation/documentation on the lessons learned from demonstration projects.
- Pressure from existing investors and/or management teams to skip steps and build the biggest "commercial" project as quickly as possible, in the hope of reaching higher profitability faster.

5. A Deeper Dive on Early Deployment of Distributed Solutions

As indicated earlier, a new business – on its way to scaling up – will tend to deploy solutions sequentially in the early days. For solutions at the small distributed level (i.e., where project implementation costs are less than $20MM), it is typically very difficult to find Project Finance capital until several of these projects can be aggregated, regardless of how proven the technology itself may be.

Paradoxically, it is often easier to find capital (typically VC) to fund the earlier stages of demonstration for these small-scale distributed deployments. The issue primarily rises when companies look for cheaper Project Finance capital, e.g. for FOAK projects or even for proven solutions.

The primary drivers that make these projects fall into a capital gap include:

- Becoming uneconomical once the investment team overhead and diligence/structuring costs are included.
- Business model scaling risk.
- Credit risk (for offtakers as well as technology providers).

[24] This could be changed in the U.S. depending on the implementation of President Biden's infrastructure bill, which significantly increased amounts allocated to demonstration projects.

[25] While it is natural to focus on very large scale projects as a faster and more meaningful solution to the problem, the reality is that both distributed (i.e., small and numerous) and centralized solutions will be needed. In addition, many of the large scale solutions themselves, when modular, have their first deployments at a small scale.

6. A Deeper Dive on Projects in the Development Stage: A Bottleneck to the Proliferation of Climate Solutions

Beyond the capital gaps outlined above, other areas of underfunding persist, resulting in bottlenecks[26] to the broader and faster proliferation of climate solutions. One of the main underfunded areas includes project development (also known as pre-construction activities), for both proven and nascent solutions. Taking one extreme example, proven low risk solutions such as renewable projects (solar or onshore wind generation projects) have no shortage of capital to fund construction of these projects. If anything, there aren't sufficient projects for the amount of capital available (or for the targets one needs to achieve by 2050), which is partially attributable to the difficulties in funding early project development activities.

Project development includes the following pre-construction activities:

- Development of a concept.
- Site selection and control (lease/purchase).
- Preliminary feasibility analysis and design.
- Permitting, interconnection (where applicable), licenses, environmental assessments.
- Detailed engineering/FEED study.
- Equipment provider and contractor selection.
- Sometimes down payments for equipment orders with long lead times.
- Locking in offtake arrangements (and feedstock, where applicable).
- Development and negotiation of commercial agreements (including offtake, engineering, procurement, and construction contracts).
- Financial structuring and negotiations.

The development process is one of the most important (and riskiest) steps of the process of deploying a solution. The viability of the project relies on the fact that project development activities accurately pre-empt potential issues in the construction and operating phases, and properly allocate these risks to the parties involved. The order in which these activities will/should be performed and the risks associated with each step of the process will depend on the technology, location, regulatory regime and market conditions. It is typically a balancing act between capital at risk and retiring important risks first.

In addition to typical development risks (e.g., permitting, offtake) applicable to proven solutions, for nascent technologies, the uncertainty around the project costs, competitiveness, and the ability of the project to raise capital for a FOAK project, add additional significant risk to the development process.

[26] This section describes one of the bottlenecks to the proliferation of Climate solutions. Additional barriers to meeting 2050 climate targets include: (a) an immature ecosystem around climate solutions, (b) credit risk of underserved communities, and (c) difficulties in the ability to monetize tax benefits for less established developers or riskier projects.

7. Can Catalytic Capital Bridge the Gaps Identified?

Many tools will be necessary to unlock the trillion dollar scale of annual investment required to rise to our global climate challenge, and while unprecedented amounts are being raised to support climate solutions, our research shows catalytic capital is critical to bridge the gaps identified – and is needed in multiple forms.

In contemplating potential solutions, we first explored[27] how other initiatives have either attempted or are currently attempting to fill in some of these gaps. Our early ideas around catalytic capital interventions are not intended to compete with existing efforts, but rather to complement many other public and private actors with private, philanthropic or other catalytic support.

For the purposes of this research effort, we adopted the Catalytic Capital Consortium's definition of catalytic capital:

> *"Investment capital that is patient, risk-tolerant, concessionary, and/or flexible in ways that differ from conventional investment, and whose aim is to unlock impact and additional investment that would not otherwise be possible."*

We then looked at different ways catalytic capital could be structured and deployed to ease the barriers discussed in this report. The first approach brings catalytic capital into the fold (potentially blending it with finance-first capital in an investment vehicle) to fund 100% of the third-party funded costs of a project (in all but one case as a bridge to finance-first capital once the risks are retired). The second approach injects catalytic capital selectively to retire specific risks or improve returns, typically alongside independent finance-first capital. Each approach takes different forms when attacking each of the four gaps previously discussed, as laid out in the tables on the following pages.

[27] See Appendix E.

7.1. Approach 1 - Wholesale Risk Reduction, via Pooled Capital to Fund 100% of Costs

The main advantage of this approach is its simplicity vis-a-vis the solutions provider, complemented by speed of execution. This not only enables the deployment of hard-to-fund projects, but also accelerates the deployment process with simple catalytic solutions. Each of the proposed solutions below addresses a specific gap, and most of these financial products could be structured using a "blended finance" approach: blending (a) capital accepting below market financial returns with (b) risk-tolerant capital, as well as (c) finance-first capital.

Table 3: Possible Catalytic Solutions in a Wholesale Risk Reduction Approach

Gap targeted	Solution	Financial products	Capital per project	Summary
FOAK projects	Bridge to performance	Project equity, potentially with warrants in the solutions provider	$10-$70MM	Fund construction of FOAK projects until completion and comissioning, plus ramp up to steady state operations – Finance once steady state, then sell equity. May be combined with DOE LPO or similar loans or loan gaurantees at the start of contruction.
	Bridge to market readiness	Project equity	$10 - $70MM	Fund contruction of FOAK projects, sell when specific policy, regulatory, market or design risk is passed.
Demonstration projects	Fund demonstration projects	Project equity with warrants, growth equity	$20 - $70MM	Fund demonstration projects in combination with grants where available and self-funding by company.
Projects in the development stage	Fund development costs	Convertible loan, growth equity	<$30MM	Fund project development for both proven and nascent solutions. Loan is paid off at the start of construction and/or converts to project equity.
Early deployment of small, distributed projects	Bridge to scale	Project equity	<$10MM	Aggregation of small projects—sell to frontier or mainstream investors once aggregated.
	Bridge to equity	Pledge fund	<$50MM	Origination, diligence and underwriting of tax equity investments in small projects on behalf of tax equity.

Source: Prime Coalition

7.2. Approach 2 - Surgical Intervention

This approach focuses on surgically deploying the minimum amount of catalytic capital where needed. A variety of financial products can be used to retire specific (and typically single-issue) drivers of risk and/or return that make it prohibitively difficult for finance-first capital providers to participate. The advantage of this approach is the allocation of a scarce, precious resource for a very specific purpose, in a manner that complements finance-first investors and/or lenders. While these solutions are applicable at any of the early deployment stages and for any project size, from a practical purpose, they are likely to be more useful for larger projects (where Approach 1 may be too onerous), within the capital stack of Approach 1 products, and/or for a next generation of project (e.g., FOAK (2-to-n)).

Table 4: Possible Catalytic Solutions in a Surgical Intervention

Target	Financial Products	Risk Retired	Capital per project	Summary
Insurance	First loss equity	Completion risk Credit risk	TBD	Provide the first loss catalytic capital to insurance providers to help expand the universe of risks covered and reduce exclusions for insurance products.
FOAK (2-to-n) projects, or as part of the blended pool for demonstration projects and FOAK	First loss equity	Technology market risk Low risk-adjusted returns	Depends on risk — to be sized as needed. (Likely between $1 MM - $30MM)	Provide the first loss subordinated equity tranche to fund constrction of projects. Subordination can be specific to certain risks or thresholds, depending on needs. This has the added benefit of improving returns for finance-first investors.
	Guarantee	Technology risk	TBD	Technology provider would provide performance warranties for equipment (e.g., guarantees a certain yield or availability). Given technology provider is unlikely to be creditworthy, catalytic investors could provide a guarantee to investors and lenders backstopping technology provider's warranties.
	Below market debt	Low risk-adjusted returns	> $30MM	Provide below-market debt to fund project construction. Such debt would boost overall equity returns to levels commensurate with the risks for finance-first investors, while still being senior to equity.
	Contingent equity	Technology risk	$10-$30MM	Provide contingent equity to cover potential construction cost overruns. While structured as equity, these are effectively contigent grants for projects.
	Carbon offset pool/Advance market commitments	Market risk Low risk-adjusted returns	TBD	Creating a vehicle to pool voluntary purchases of CO_2 offsets and offer "offtake" arangements.

Source: Prime Coalition

7.3. A New "Climate Transition" Approach

To successfully bridge early deployment gaps, the finance sector needs a new "climate transition" approach that blends elements of and expertise in (a) Project Finance structuring and risk management, (b) late stage venture/growth investing, and (c) catalytic capital deployment.

Today's projects are trying to fit their needs into the traditional project financing or venture capital mould, which is problematic because:

- The point at which an early deployment should be structured as a project (as a proof of concept for later iterations) is earlier than the point at which the project meets requirements of traditional Project Finance capital.
- The risk/return profile for these transactions doesn't fit with either VC or Project Finance (returns are too low for VC, risks are too high for Project Finance).
- Many of these transactions require some level of support from catalytic capital.
- The expertise needed to assess project development, construction and operating risks lies with Project Finance experts, whereas the expertise to assess technology and market risks lies with VC/growth investors.

7.4. Looking Beyond Funding Gaps: Programmatic Toolkit

Beyond existing asset classes and risk/return considerations, one of the main reasons it is so hard for companies or developers to cross early deployment gaps is that companies and capital providers alike must navigate without a compass. Programmatic tools that could support a catalytic capital investment ecosystem include:

7.4.1. Accelerator for Projects

Creation of an ecosystem/accelerator to facilitate access, third-party cooperation, education of VCs and growth stage companies on Project Finance, and provision of technical assistance to developers.

7.4.2. Early Stage Deployment Validation Advisory Group ("Seal of Approval")

Establishment of an advisory group consisting of engineers, operations experts, contractors, industry users, market experts, and relevant government entities that would opine on:

- Whether a project meets its proposed stage (e.g., demonstration vs. FOAK – i.e. appropriate prior relevant step/objective has been completed).
- Realistic expected cost reduction pathway when contemplated.
- Expected market adoption (availability of long-term contracts).
- Whether a proposed project is replicable (permanent FOAK or expected to be first of many).

10. Endnotes

The objective of this report was to assess the bottlenecks and opportunities to enable and/or accelerate the deployment of climate solutions. New investment vehicles and government support have emerged since our research commenced, as the ecosystem is evolving on a daily basis, and the analysis should remain dynamic. In addition, our work primarily focused on the US capital providers and projects. We recommend a similar analysis be performed on other OECD countries as well as developing economies.

When looking at how catalytic capital may bridge the gaps, no assessment of the impact of a particular solution is included in the research, nor does the paper make a recommendation about where and how such an effort should be housed.

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