Prime Coalition Inaugural Climate Impact Audit

A review of Prime Coalition's climate impact assessment tools and a methodology for future analysis

2021

CEA

ABOUT THIS REPORT

Prime has committed to conducting a climate impact audit every five years. The overarching goal of Prime's impact audits is to provide a third-party review of Prime's impact-first commitment to transformative climate ventures and to share Prime's lessons learned with the emerging field. This initial audit focuses on reviewing the impact assessment tools that Prime employs, principally the ERP models and CIMs. The audit also proposes a methodology for conducting ERR analyses, which will be part of the next five-year audit, in 2025.

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Glossary and Acronyms

CIMs	Climate impact milestones – a tool used by Prime to monitor the progress of its portfolio companies toward realized climate impact
CO_2/CO_2e	Carbon dioxide/carbon dioxide equivalent
EPA	US Environmental Protection Agency
ERP	Emissions reduction potential – an analysis of a company's potential to reduce greenhouse gas emissions over a 30-year time horizon, compared to a baseline scenario, assuming the company is successful
ERR	Emissions reductions realized – an analysis to determine the amount of greenhouse gas emissions a company has averted, compared to a baseline scenario, through its operations and market penetration
GHG	Greenhouse gas
IEA	International Energy Agency
MMT	Million metric tonnes
NYSERDA	New York State Energy Research and Development Agency
PIF	Prime Impact Fund – Prime's first formal fund, which closed at $50M in June 2020

Executive Summary

With each new day, we face reports of new climate crises. The urgency to develop effective climate solutions continues to grow and the stakes continue to rise. Organizations and individuals across all facets of society are being asked to make larger investments, to make faster decisions with greater degrees of uncertainty, and to collaborate in previously unnecessary ways.

Prime Coalition ("Prime") has been pushing the envelope in the field of impact investing for climate and the emerging field of catalytic capital for the last five years. Alongside a handful of other peer climate impact investors, Prime has been developing the practice of emissions reduction potential ("ERP") analysis, to ensure that Prime invests exclusively in companies that have the potential to significantly contribute to mitigating climate change. This kind of modeling has an important role to play for Prime, for the impact investing field, and for the climate solutions field more broadly. Like the broader field, Prime does not have time to misallocate capital; its bets must be bold and strategic.

For this reason, Prime commissioned CEA Consulting to assess how effectively it has integrated climate impact assessment into its investment diligence and management practices. The audit had three broad mandates: 1) audit the ERPs for each portfolio company, 2) evaluate the effectiveness of the climate impact milestones ("CIMs") developed to date, and 3) recommend a methodology for a backward-looking emissions reductions realized ("ERR") analysis. This audit has found that Prime's investments are generally supported by robust modeling exercises that provide a solid case that the companies in Prime's portfolio can each reach a gigaton-scale climate impact minimum threshold (500 MMT CO_2e cumulative by 2050)—Prime's impact underwriting target for each investment. It is also clear that Prime's ERP practices are at the forefront of the field. Prime is not alone in the vanguard, but it is a central player in this innovation. That said, Prime has the opportunity to take its ERP modeling to the next level.

Prime has been evolving over the last five years. It only recently closed its first formal fund, it has hired several new staff over the last two years, and the climate impact reporting process for its portfolio is new. It co-authored a report on ERP Methodology in 2017, along with the New York State Energy Research and Development Authority ("NYSERDA").[1] The ERP modeling conducted before this report can best be described as experimental, with some improvements over time. With these five years of experience as fodder for learning and Prime's staffing structure formalizing to a degree that stronger processes and standards can be implemented, this audit may be able to help transform the ERP practice at Prime from a useful step in the diligence process to a much more robust decision and management tool.

At the highest level, our audit findings are outlined in Table 1, below. In sum, the ERP models tend to get the easy stuff right, get the medium-challenging stuff right some of the time, and generally don't do well with the hard stuff. While this represents solid performance for a first generation of ERPs, Prime can do better and we hope this audit provides a guide for improving the ERP practice.

Perhaps the most important take-away from this audit is that with minimal further effort on the part of ERP modelers and investment in modeling standards and processes on the part of Prime, the ERP process and outputs could be much more valuable. By constructing models in a more intentional manner (e.g., focusing on key areas of uncertainty for the company), conducting more thorough sensitivity analysis, and standardizing formatting and reporting, the ERP modeling would allow for better insights into the questions of, "What are the key factors that determine the climate impact of the company?" and "What do we have to assume for this company to have the impact we want to see?" Not only are these key insights for Prime's investment decision process, but they can be invaluable in terms of steering and building the companies toward climate impact (e.g., in determining target markets and key performance requirements).

An abridged version of this report is available here.

[1] New York State Energy Research and Development Authority and Prime Coalition, Climate Impact Assessment for Early-Stage Ventures, December 2017. https://primecoalition.org/wp-content/uploads/2015/02/PRIME-NYSERDA-Climate-Impact-Assessment-Report_Final.pdf?x48191

Table 1: Key findings from the Climate Impact Audit

Relative areas of strength	Areas of moderate performance and/or inconsistency	Relative areas of weakness
• Modeling the correct time horizon (30 years) • Including both potential direct and indirect emissions reductions (or explaining why one of these is not material) • Clearly articulating the mechanism of impact • Modeling target markets that are in line with the companies' intent at the time of investment • Including all material sources of emissions across the full lifecycle of the product	• Documenting assumptions • Performing sensitivity analysis around key assumptions • Defining the upper-bound market penetration consistent with Prime's ERP methodology (e.g., M=100%)[2] • Including both an "upper-bound" and a "conservative" scenario • Using robust sources to support inputs and assumptions • Producing models that (in the auditors' estimation) are sufficiently robust to provide evidence of gigaton-scale impact (a key investment criterion)	• Providing justification for S-curve parameters[3] • Identifying the parameters that have the largest error bars • Considering the potential future progression of displaced products' emissions

We expect that by 2025, when Prime's next climate impact audit is due, the ERP practice at Prime will have evolved considerably, playing a more central role in diligence, supporting strategic decisions on the part of portfolio companies, and integrating effectively with the CIM and ERR reporting and analysis practices to offer Prime opportunities for continual improvement and learning.[4]

Prime deserves much credit for playing a pioneering role in this field, for investing in the practice of ERP modeling, for opening its books to an external audit, and for sharing these results. It is only through this degree of humility, inquiry, and transparency that progress can be made and breakthroughs can be accelerated.

[2] Here "M" refers to the ultimate market penetration of a given technology. This concept is discussed further as part of the portfolio-level findings later in this report.

[3] "S-curve" refers to a technology diffusion model in which market adoption follows an S-shaped trajectory. This concept is discussed further in the report's portfolio-level findings.

[4] While Prime is not able to disclose the actual ERP calculations to date given the small number of companies in its portfolio and the need to maintain company confidentiality, we note Prime probably will be able to publish aggregate ERP results at the next five-year audit as its portfolio continues to grow.

Introduction

About this Report

Prime has committed to conducting a climate impact audit every five years. This document reports the findings of Prime's inaugural climate impact audit. The overarching goal of the audits is to provide a third-party review of Prime's impact-first commitment to transformative climate ventures. This audit focused on reviewing the impact assessment tools that Prime employs, principally the ERP models and CIMs. The audit also proposes a methodology for conducting ERR analyses, which will be part of the next five-year audit, in 2025.

The report provides a summary of the audit's findings about the ERPs and CIMs; a dashboard depicting the audit findings across all companies; a discussion of several portfolio-level findings; and recommendations to Prime. The appendices provide the methodology for the ERP and CIM audit as well as a proposed methodology for future ERR analyses.[5]

Introduction to Prime's Climate Impact Analyses

Prime estimates and tracks the climate impact potential of each of its portfolio companies from pre-investment due diligence through growth stages of company development. Prime assesses the GHG emissions reduction potential ("ERP") of each company as part of its due diligence process, using a methodology that Prime developed and then published in partnership with the New York State Energy Research and Development Authority ("NYSERDA").[6] In addition, Prime co-develops climate impact milestones ("CIMs") in partnership with its portfolio companies after investment and tracks annual progress against these milestones. Prime also intends to conduct backward-looking emissions reduction realized ("ERR") analyses on its portfolio in the future, based on the growth of the companies. Because most companies in Prime's portfolio are pre-deployment and pre-revenue at this time, it is not yet possible to conduct a portfolio-wide assessment of climate impact realized to date.

This audit focused primarily on climate impacts of the portfolio and secondarily on its other charitable impacts. In short, the audit aimed to answer the following questions:

1. Is Prime identifying portfolio companies that have the potential for gigaton-scale climate mitigation impact at the time of investment?
2. Are its tools fit for the purpose?
3. Is Prime set up to answer these questions effectively going forward?

Introduction to Prime Coalition

Prime Coalition ("Prime") is a nonprofit organization focused on addressing the critical funding gap for transformative early-stage solutions to climate change. Prime's unique model blends different forms of catalytic capital[7] to support innovative technologies with potential to reduce or sequester greenhouse gas ("GHG") emissions at the gigaton scale by 2050.

As of 2020, Prime employed staff at the nonprofit itself, as well as at Prime Management Company, a subsidiary that shares nonprofit status but focuses exclusively on investment of Prime Impact Fund ("PIF"). The nonprofit team focuses on running three nonprofit programs: 1) building and supporting Prime's catalytic investments, 2) catalyzing climate investment broadly, and 3) sharing lessons learned about philanthropic investment. As part of Program 1, the nonprofit team is responsible for assessing climate impact and investment additionality for PIF during due diligence (pre-investment), while the Investment Team is responsible for driving portfolio companies toward climate impact (post-investment). As part of Program 2,

[5] In 2019, Prime launched a project to turn its in-house methodology for assessing ERP into an online, open-source software tool to advance the field writ large—for organizations already assessing climate impact and those that might not attempt ERP calculations yet. The result of this effort, the CRANE tool, launched publicly in April 2020. https://cranetool.org/

[6] NYSERDA and Prime Coalition, 2017.

[7] To read the MacArthur Foundation's definition of catalytic capital, visit its website: https://www.macfound.org/programs/catalytic-capital-consortium/

nonprofit staff are responsible for welcoming investors outside Prime into the fold of climate impact measurement and management. Members of the nonprofit team and the Investment team consider themselves part of one team, and although their functions and responsibilities are distinct, all drive toward mitigating climate change as the paramount end goal.

Since its inception in 2014, Prime has invested in 16 companies that, were it not for Prime, might not have been sufficiently funded to succeed at a scale necessary to contribute significantly to climate mitigation. Ten of these received investment through syndication from 2014 through 2018, and eight received investment through PIF, which closed at $50 million in June 2020.[8] Two companies received investments through both Prime's syndication model and PIF. The companies cover a wide range of sectors including energy, cooling, transportation, industry, agriculture, and carbon capture.

About CEA Consulting

CEA Consulting served as the auditor for Prime's Inaugural Climate Impact Audit.

CEA Consulting has helped transform business practices, public policies, nonprofit organizations, and philanthropic strategies to improve environmental outcomes. For more than two decades, our team has conducted impact-oriented work in the environmental sector, including supporting strategy development and implementation for dozens of foundations, nonprofit organizations, and private enterprises. Our topical areas of expertise include climate change and energy policy, marine conservation, land use and agriculture, freshwater management, and sustainable finance.

[8] These numbers reflect Prime's portfolio when the impact audit commenced in June 2020; additional companies received investments from PIF in summer and fall 2020.

Portfolio companies included in this report

Table 2: Prime's porfolio companies (as of June 2020)

Company	Description	Investment date and mode (syndication/PIF)	Type of company (product/ service) and type of climate impact (direct/indirect)[9]
Quidnet	Grid-scale energy storage solution	2015, syndication	product, indirect
RedWave	Technology to convert waste heat to electricity at low cost and high efficiency	2016, syndication	product, direct
ConnectDER	A meter collar to enable solar and other renewable resources to connect to the grid	2017, syndication	product, indirect
Anfiro	High-permeability and energy-efficient membranes to reduce the cost and energy of desalination and water treatment	2017, syndication	product, direct
Rebound Technologies	Refrigeration technology with potential to dramatically reduce energy requirements	2017, syndication	product, direct
Wright Electric	Innovative battery and airframe designs for electric airplanes	March 2017, syndication	product, direct
Opus 12	A device that uses electrochemistry to convert waste carbon dioxide into useful fuels and chemicals	2018, syndication	product, direct
Mallinda	Recyclable and moldable composite materials with potential to increase the fuel efficiency of the automotive and aerospace industries	2018, syndication	product, direct

[9] Some technologies do not reduce emissions directly, but instead enable greater use or higher performance of other low-GHG technologies. For example, energy storage technologies enable greater use of renewable energy, thereby reducing emissions indirectly.

Treau	New air conditioning systems that are quiet, low profile, and easy to install while delivering high efficiency and low GHG emissions	2018, syndication; 2019, PIF	product, direct
Lilac Solutions	Improved lithium extraction process, enabling low-cost and environmentally friendly lithium to power electric vehicle and energy storage	2018, syndication; 2018, PIF	service, direct
C-Motive Technologies	Innovative electric motor design that could enable ultra-efficient large wind turbines, electric vehicles, and robotics with zero rare earth materials	2019, PIF	product, indirect
Via Separations	Membrane-driven industrial separators that reduce energy consumption by replacing thermally driven industrial separators	2019, PIF	product and service, direct
MicroByre	Synthetic biology platform to rapidly domesticate wild-type bacteria, cutting GHG emissions at the microbial source	2019, PIF	service, direct and indirect
Verdox	Electrochemical technology to capture carbon dioxide directly from air at low concentrations	2019, PIF	product, direct
Clean Crop Technologies	Cold plasma technology that can degrade the pathogens, toxins, and pests responsible for food waste	2020, PIF	product and service, direct
Sublime Systems	Developing technology for the manufacture of cement using intermittent renewable electricity	2020, PIF	product, direct

Audit Findings: Emissions Reduction Potential (ERP) Analyses

ERP Overview

Prime's ERPs are developed as part of the due diligence process to help ensure that Prime invests only in companies that meet its climate impact threshold (cumulative GHG emissions reductions of at least half a gigaton of carbon dioxide equivalent ("CO_2e") by 2050). The ERP analyses are typically conducted toward the end of the due diligence process. Often, Prime's Investment Team already has a high level of confidence that the company has a gigaton-scale GHG impact potential.

The ERPs have been conducted by modelers who have been contracted by Prime. The modelers typically are Ph.D. or master's degree candidates whose research areas overlap with Prime's areas of investment. By design, the ERP modelers have limited dialogue with the Investment Team, to keep the ERP as objective as possible. The ERP modelers do have access to the companies' management teams, who often have proprietary technical information about the performance of their products that are key inputs into the ERP models.

The ERP methodology has evolved, alongside Prime, over the last five years. When Prime was established in 2014, the practice of assessing ERP was novel and Prime's team was small. Prime's work has helped to define this modeling approach for the impact investing field. Prime's approach was codified in 2017, after a few years of experience and experimentation with ERPs, in the report that Prime published in partnership with NYSERDA.[10] This methodology lays out a broad approach to ERP modeling. One of its most important tenets is that the ERP ought to assess the technical potential of the company's product, rather than the likelihood of the company's success. Prime's Investment Team does evaluate the likelihood of commercial success of its potential investments at other points during the diligence process.

The Prime's ERP methodology outlines five steps:

1. Estimate the emissions of the product displaced
2. Estimate climate impact additionality[11]
3. Estimate emissions of the venture's product and the emissions reduced by products sold
4. Estimate potential (not probable) product deployment
    i. Use a standard market penetration curve
    ii. Adopt a market forecast for the market in question
5. Put it all together to estimate ERP

There are many challenges inherent in developing ERPs, especially for early-stage companies like the ones Prime targets. The most common challenges are data limitations, uncertainties associated with projecting out over a 30-year time horizon (to 2050), the nascent nature of technologies and products at this stage, and the complexity associated with defining an amount of GHG emissions avoided per unit of product sold. This last challenge is particularly pronounced for companies that have an indirect pathway to emissions reduction.

Overview of the ERP Audit

Among the audit's three mandates, the most work was devoted to auditing the ERPs for each portfolio company. The first step of this process was to develop a methodology for the audit, in partnership with Prime's Impact Fellow, Sarah Armitage, a doctoral candidate in energy and environmental economics. The methodology is included in the appendix.

[10] NYSERDA and Prime, 2017.

[11] In this context, climate impact additionality refers to the GHG emissions that have been displaced and that would not otherwise have been displaced were it not for the company's new product or service. Climate impact additionality is typically assessed by looking at the difference between the emissions of the new product or service and the expected GHG emissions improvements over time.

The methodology is structured as a set of questions that need to be answered for each ERP. These are split up into six categories (Set A through Set F), with each set looking at a different element of the ERP.

- Set A questions are designed to help the auditor develop a preliminary understanding of the company, its target market, and the assumptions that underpin the ERP analysis
- Set B questions are designed to assess the overall level of robustness of the model and its fidelity to the ERP methodology outlined in the Prime-NYSERDA report
- Set C questions are designed to ground truth assumptions and modeling decisions made by the ERP
- Set D questions test for consistency across the portfolio
- Set E questions assess the utility of the CIMs
- Set F questions are designed to reflect on Prime's experience using ERPs and to inform future audits

After developing the ERP audit methodology, the CEA audit team worked through the ERP of each of Prime's portfolio companies to develop a thorough understanding of how they were constructed, what assumptions were made, what inputs were used, what parameters were tested through sensitivity analysis and/or model scenarios, and whether the findings of the model met Prime's impact threshold. The audit team also reviewed the formatting and "readability" of the models, their fidelity to the Prime-NYSERDA methodology, and consistency across the portfolio.

Summary of ERP Audit Findings

CEA found the following commonalities across our assessment of the ERPs. High-level findings are discussed below. A summary of the audit findings is shown in the "dashboard" further below.

1. **Relative areas of strength:** As the dashboard below indicates, the ERP models do a consistently good job of:
   a. Modeling the correct time horizon (30 years);
   b. Including both potential direct and indirect emissions reductions (or explaining why one of these is not material);
   c. Clearly articulating the mechanism of impact;
   d. Modeling target markets that are in line with the companies' intent at the time of investment; and,
   e. Including all material emissions sources across the product's lifecycle.

Additionally, and not surprisingly given that we analyzed ERP models for companies that proceeded to investment, the ERP models also almost all produce results that meet or exceed Prime's gigaton threshold for climate impact.

Key technical terms

Sensitivity analysis: The practice of testing how certain outputs are affected by changes to certain inputs. For example, a Prime ERP may conduct sensitivity analysis to determine how much emissions reductions would change based on different emissions intensities of a company's product. Sensitivity analysis could be performed through different scenarios, or could be conducted separately (e.g., in a side table) and in a more discrete way, by evaluating how a single parameter changes the output of the model. Scenarios typically vary multiple parameters.

Dynamic baseline: The ERP analyses assess how a certain company's product or technology will reduce emissions, typically by displacing an incumbent product. To calculate this, the ERP needs the GHG emissions per unit of the Prime company's product/technology and the GHG emissions per unit of the incumbent technology. Alternatively, for companies that offer a service or an indirect path to emissions reductions, the ERP model needs to use the GHG emissions per unit of the technology that is enabled. The emissions reductions are generated by the delta between the two. However, the incumbent technology may not have a static emissions profile since climate solutions are being adopted across our economy every day. If a model makes projections about the changing emissions profile of the incumbent technology, we refer to it as a "dynamic baseline."

2. **Relative areas of weakness:** As shown in the dashboard below, the ERP models do a consistently poor job of:
   a. Providing justification for S-curve parameters;
   b. Identifying the parameters that have the largest error bars; and,
   c. Considering the potential future progression of displaced products' emissions.

3. **Areas of moderate performance and/or inconsistency:** As the dashboard below shows, the ERP models do a fair and/or inconsistent job of:
   a. Documenting assumptions;
   b. Performing sensitivity analysis around key assumptions;
   c. Including both an "upper-bound" and a "conservative" scenario;
   d. Defining the upper-bound market penetration consistent with Prime's ERP methodology (M=100%);
   e. Using robust sources to support inputs and assumptions; and,
   f. Producing models that (in the auditors' estimation) are sufficiently robust to provide evidence of gigaton-scale impact (a key investment criterion).

4. **Practical constraints:** It is obvious that there are practical constraints in developing robust ERP models within a time and effort window that is reasonable for Prime's due diligence process. Data limitations are a major constraint. This is especially a challenge for modeling multiple markets for platform technologies, or for identifying multiple future scenarios in certain markets. Model complexity is also a challenge in that it can be unduly complicated to model all of the important variables for some companies. Limitations in the modeling should be identified by the modelers and described in the model (e.g., on a cover tab).

5. **Target market:** As discussed further in question D4, below, the definition of target market is the biggest driver of climate impact for many companies and is also almost always a large driver of uncertainty. This is certainly true for companies that have platform technologies, but it is also true for companies that have discrete markets.

6. **Direct vs. indirect climate impacts:** Some of Prime's companies have a direct climate impact and others have an indirect pathway to impact. Indirect companies generate impact when their product or technology shifts a cost or performance curve that could help to open up a market for an important emissions-reducing technology. In general, indirect impact is more difficult to model. To do this well, the model should incorporate price elasticity curves and build sensitivities around these parameters. Although all of the models that were developed for indirect impact companies scored well by many measures, all could have done a better job of identifying the key assumptions and primary source of uncertainty and of building more sensitivity analysis around these parameters.

7. **Handling climate impact risk:** A few of the ERP models show that the climate impact for a company will come from a market that is in the later stages of a company's go-to-market strategy and/or that is dependent on indirect market effects. These companies probably will have a longer, less certain, and riskier pathway to climate impact than companies with a more direct, near-term pathway to climate impact. If emissions were discounted the way financial returns are, the later-stage emissions would be less valuable. However, Prime's current approach to modeling potential climate impact in ERPs does not include any kind of discounting related to climate impact risk or timeframe for impact. This issue is discussed further in question D4.

8. **Potential of additional emissions:** The ERPs for certain companies in the portfolio suggest that these technologies also have potential to generate net increases in emissions. We recommend that Prime consider adding a step or two in its diligence process when the ERP analysis reveals a possibility that the company could generate additional emissions under certain scenarios. That is, the investment thesis ought to include a robust rationale as to why the downside scenario is unlikely to occur.

Introduction to the Summary Dashboards

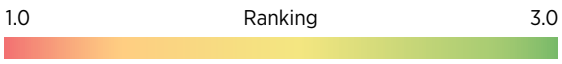
Taken as a set, the audit questions define a "gold standard" approach to ERP modeling. Table 3 shows a red, yellow, and green scale of scoring for three of the sets of ERP questions focused on the company-level audits. (This table shows Set B and C questions. Set A is omitted from the dashboard because it is descriptive rather than evaluative in nature. Set E questions and scoring are shown in Table 6, in the CIMs section.) Definitions of the red, yellow, and green scores for each question are provided in the methodological appendix.

As noted above, there are many practical challenges in developing ERPs that may lead to necessary deviations from the gold standard. Many of the areas where Prime's existing ERPs fall short of this gold standard, and many of CEA's resulting recommendations, speak to the challenges inherent in ERP modeling. For example, there is necessarily a great deal of uncertainty in projecting decades into the future in markets that may be in flux already. This reality, discussed in many places in the report, underscores the importance of the ERP exercise itself and in particular the importance of conducting sensitivity analyses around key parameters.

The audit team scored each of the ERPs along each of the dimensions below and then averaged across all companies to derive an average score. The results of this exercise are provided in Table 3 below; the scoring rubric is provided in the methodological appendix.

Table 3: ERP Audit Summary Dashboard

Definitions for the low (red, 1.0) to high (green, 3.0) rankings for each audit question are provided in the methodological appendix.



Set B and C Questions		
Audit Code	**Statement**	**Avg by question**
B1	ERP documents all assumptions clearly.	2.1
B2	ERP calculations perform sensitvity analyses around key assumptions.	2.0
B3	ERP calculations consider potential for reducing emissions both directly and indirectly.	2.6
B4	ERP calculations evaluate emissions reduction over 30-year time horizon at minimum.	3.0
B5	ERP calculations consider the potential future progression of the displaced product's emissions.	1.9
B6	ERP calculations define the upper-bound market penetration consistent with the Prime-NYSERDA methodology.	2.1
B7	Of the driver of the impact that have the greatest uncertainty, the sources of uncertainty are adequately addressed in the model.	1.8
B8a	The scenarios presented in the ERP meet or exceed Prime's gigaton threshold.	2.5
B8b	The model does not miss any sources of emissions or emissions reductions in the ful sysle of the product.	2.6
B9	ERP included an "upper-bound" and a 'conservative" scenario.	2.2
B10	Descriptive	
C1	The model is robust enough to provide confidence that the company in question (and/or its technology/product) could meet or exceed Prime's gigaton threshold.	2.2
C2	Descriptive	
C3	For the assumptions listed in AS, the sources are robust.	2.4
C4	For those scenarios that model an S-shaped diffusion curve and meet the gigaton threshold, the assumptions about market penetration are realistic.	1.9
C5	1. ERP models larger target market(s) that are consistent with the company's intent at the time of investment. 2. The modeled target markets are adequate for decision-making.	2.7
C6	The mechanisim of impact is clear, well-documented, and consistent with the intent of the company at the time of investment.	2.8

Portfolio-Level Findings

In addition to the company-specific ERP audits, the audit team assessed the consistency of the ERP modeling across the portfolio. This review was guided by a set of questions established as part of the audit methodology (referred to in the methodology as "Set D questions"). The assessment of the Set D questions for the 2020 climate impact audit is shared in the following pages.

D1: Do ERP calculations use consistent assumptions in all assessments of common sectors (e.g., do they use a common baseline, or business-as-usual, scenario)?

The companies in Prime's portfolio cover a wide range of sectors including power, cooling, transportation, industry, agriculture, and carbon capture. Many companies touch the power sector, even if they are primarily in another sector (e.g., transportation, cooling), in that they displace electricity emissions by producing more efficient products or replace fuel emissions with electricity emissions. The level of consistency of the reference scenario, or baseline, used across the ERPs varies by industry. A review of the consistency of references is shown in Table 4 below.

Table 4: Portfolio references and consistency

Sector	Primary references used	Are common assumptions/ references used?	Recommendations
Power	- Global emissions factor of electricity: IEA World Energy Outlook, 2017 - Global deployment of wind: IEA World Energy Outlook, 2017	Yes	- Continue to use the most up-to-date IEA World Energy Outlook for both global and country-specific assumptions about energy production and emission factor of electricity. - Use consistent IEA scenarios across ERP scenarios (i.e., continue to use IEA "Existing Policies" scenario for the conservative scenario, and IEA "Beyond 2 Degrees" scenario for the aggressive scenario). - Note that there is currently inconsistency in how IEA scenarios are applied to ERP scenarios. Varying how IEA scenarios are used in ERP scenarios may be justified in certain instances, but the modeler should justify this on the cover page of the ERP if the use departs from standard practice.
Transportation	- EV sales (varies by model) - LDV sales (varies by model) - Emissions factor for gasoline: EPA - Fuel efficiency of LDVs: EPA - Jet market: Boeing Market report, 2016 - Projected jet efficiency improvements: Federal Aviation Administration 2015 Report	- Yes, for fuel efficiency of internal combustion engines and emissions factor of gasoline - No for other assumptions	- Common references should be established, in particular with regard to growth of the EV market domestically and abroad. - ERP modelers should use the CRANE library for references. - The GREET model could be used to standardize lifecycle emissions of transportation vehicles and components across technologies and scenarios.

Table 4: Portfolio references and consistency (continued)

Sector	Primary references used	Are common assumptions/ references used?	Recommendations
Cooling	- Cold chain capacity (market): Global Cold Chain Alliance - Phase-out of refrigerants: in accordance with Article 5 of Kigali Amendment to the Montreal Protocol - Energy Efficiency Ratio (EER): India Bureau of Energy Efficiency - EER improvement per year: Lawrence Berkeley National Laboratory	No, although the companies are targeting different parts of the cooling market (cold chain and room air conditioners)	- Future cooling sector models should rely on IEA stock and energy consumption data for stationary air conditioning and refrigeration. - In addition, future cooling ERPs would ideally employ a spatially explicit stock-turnover model design that assumes that highest-efficiency technology will be first diffused into developed markets and then resold into developing markets (assuming no significant disruption in the market distribution and assuming higher-efficiency technology is also priced higher).
Industry	Various sources including academic papers, trade press, and proprietary company data	No. These companies target different markets (cement, petrochemicals, and a wide range of industrial processes). There is not much overlap, so different references are appropriate.	- If Prime adds companies targeting emissions savings in common areas of the industrial sector, it should consider standardizing references.
Carbon capture	Direct air capture market: academic paper	No. These companies target different markets and, as such, different references are appropriate.	If Prime adds companies with comparable approaches to carbon capture, it should consider standardizing references.
Agriculture/ food chain	- Total addressable market: from company R+D - Methane emissions from landfills: master's thesis - Global proportion of food wasted by weight: World Resources Institute - Global energy used in industrial cold storage: International Institute of Refrigeration	N/A	If Prime adds companies addressing food waste, it should consider standardizing references.

D2: Do ERP calculations document all assumptions in a consistent manner across the portfolio?

While most of the ERPs document a large share of their assumptions, this information is presented in an inconsistent manner, doubtless due to the "learn by doing" approach of this first generation of ERPs. In some models, the assumptions are difficult to find or are provided as links at the bottom of spreadsheets without clear indications of which references relate to which assumptions or model parameters. Using links is generally not a best practice because the link can become broken; indeed, there are a handful of broken links throughout the ERPs. The most common documentation format is to put assumptions and references into comments. This is a fine practice, and provides some consistency across the portfolio, but it is not ideal. In general, the models are not structured or formatted consistently and are not easy to read, especially for non-technical audiences. They would be more useful tools for Prime if the assumptions were documented in a consistent, clear, accessible manner across all of the ERPs. Specifically, the audit team suggests providing a summary/assumptions tab at the front of each ERP model with the information that follows. A suggested template is provided in the methodological appendix.

i. A short description of the company and its mechanism of impact for GHG emissions reductions

ii. The main parameters that are varied across the scenarios

iii. How the model is constructed (e.g., description of scenarios and sensitivity analyses)

iv. Main assumptions, inputs, and corresponding data sources; specifically, the following assumptions should be listed and documented:

   a. Identification of target market(s) and size of target market(s)

   b. Growth rate of target markets(s)

   c. GHG emissions per unit of the incumbent product

   d. GHG emissions per unit of the company product (or % emissions efficiency gain from the company product)

   e. Diffusion curve parameters [k (slope steepness), x (the year in which the technology reaches 50% market penetration, starting from first year of sales), and M (ultimate market penetration)][12]

   f. Optional/if applicable:

      i. Projections for change in GHG emissions per unit of the incumbent product (e.g., changing emissions of grid electricity mix until 2050)

      ii. Projections for change in GHG emissions per unit of company product (e.g., expected efficiency gains of the product)

Putting all of the assumptions in one sheet would better enable readers to understand the ERP. Also important, this kind of consistent and accessible formatting would make the ERPs much easier to update, if Prime decides to update them with some frequency. These parameters could be compared across years, compared with actual metrics used in ERR analyses, and compared with other companies in the portfolio.

The practice of summarizing the ERP and documenting the assumptions in this manner has the added benefit of serving as a review loop for the modeler. The audit team found one significant modeling error during our review. A particular parameter was not correctly applied in the spreadsheet, which resulted in the ERP overstating by a factor of 20 the climate impact potential from a specific sector. (Overall emissions reductions still surpassed Prime's gigaton-scale investment threshold, given the additional emissions reductions modeled in other sectors.)

It is important to note that some companies will require different kinds of metrics, specifically those whose emissions reductions are indirect. For these companies, emissions reductions are derived through impact on the price or other characteristics of a clean-energy technology.

The latest ERPs have a companion document that provides much of the summary information we are suggesting here. These documents seem quite valuable; however, this summary information also ought to be included directly in the ERP Excel files so that the Excel files can better stand on their own. Moreover, these summary documents do not provide all of the information we believe an overview should cover. Specifically, they do not include an overview of the modeling approach, context for the key assumptions, or a discussion of limitations of the model (e.g., data availability, key sectors or applications that were not modeled).

[12] Prime's ERP methodology recommends using a logistic diffusion curve. Other S-shaped diffusion curves exist, most notably the Bass diffusion model.

D3: Are there agreed-upon standards for data sources that the ERPs use?

The ERP models use a wide variety of data sources. A single model can have dozens of sources that vary in quality. In general, we categorize types of data sources as either "high quality" or "low quality." While this distinction is overly binary, it is helpful in assessing the overall robustness of the ERP models.

Examples of "high-quality" data sources	Examples of "low-quality" data sources
i. External sources from publicly available models from public agencies (e.g., IEA or EPA) ii. Publicly available models or papers from think tanks or universities iii. Peer-reviewed literature	i. Trade publications ii. General media iii. Non-published sources such as expert opinion or non-peer-reviewed papers

Because proprietary information from the company is not peer reviewed, we can't consider it a high-quality data source. Yet all of the ERPs depend on some inputs from the companies regarding the technical performance of their products. These inputs must be used and can be considered "best-available data." A best practice for ERP model construction would be to consider the product performance of the company as an assumption. In many cases, the technical performance of the company's product will be uncertain, and sensitivity analysis ought to be conducted on these parameters.
The ERPs appear to attempt to secure high-quality data where possible, but they certainly use many low-quality sources due to unavoidable data limitations and the fact that Prime's mission is to invest in under explored areas of innovation. One response might be treating low-quality data sources as key uncertainties and running sensitivity analyses around those inputs. Prime might also consider asking the ERP modelers to document effort made to secure high- (or higher-) quality data in places where low-quality data is used so that Prime can confidently state that the ERPs use best-available information. Specific recommendations follow:

1. **Ask the ERP modelers to document justification for using low-quality sources.** For example, in one ERP, the magnitude of potential climate impact is heavily influenced by a parameter drawn from a master's thesis. Without further documentation about why this was the best available source, the validity of the assumption is called into question. The documentation of low-quality sources should certify that the ERP modeler attempted but was unable to find higher-quality sources. At a minimum, going forward, the modeler should make a practice of checking the CRANE library for references, though the auditors acknowledge that the CRANE library did not yet exist over most of the period reviewed in this audit.

2. **Ask the ERP modelers to validate the main assumptions and references with the company CEOs/executives to ensure that the expertise within the company is reflected in the ERP models.** The companies could "sign off" on the inputs as external experts without seeing the results of the modeling, although there is a risk of conflict of interest here.

3. **Consistent with recommendations made in Table 4, above, Prime might consider creating its own internal library of references to help ensure consistency across the ERPs, perhaps using the CRANE library as a starting point.** It would be valuable for the Investment Team to sign off on such a library so that their expert opinion could inform the references selected. For example, the Investment Team may have a view on the growth potential of the EV market and could weigh in on what reference scenario(s) Prime ought to use on the expected growth of this market in future ERPs. Note that reference scenarios will continually change, so a reference library will take work to maintain.

D4: Do ERP calculations follow consistent principles in defining target markets?

In speaking with portfolio company CEOs, the auditors found that the ERPs generally focused on target markets that were consistent with the intentions of portfolio companies at the time of Prime's investment. Yet some target markets were modeled more comprehensively than others, which made it more difficult to draw comparisons across various ERPs. The ERPs take two general approaches in defining target markets, depending on whether the technology can be deployed in one or multiple markets. Establishing clearer principles for each of these approaches, even if those principles result from codifying current practices, would help make the ERP modeling process more consistent from one technology to the next. This issue is particularly important to address because the audit finds that the definition of target market is the biggest driver of climate impact for many companies and is also almost always a large driver of uncertainty.

The approach to defining the target market to date has depended largely on whether the company has a product that is a fit for a specific market or rather has a "platform" product with applications in many markets.

1. **The approach for the first set, the "fit for market" set, is straightforward.** The target market is obvious and the ERP models total market penetration, usually for the global market rather than a geographic subset. A geographic subset of the total global market may be more appropriate in some instances, but that is a less fundamental modeling decision that can be made on a case-by-case basis.

2. **The approach to defining the target market for companies that have a "platform" technology is more difficult.** The approach taken in the ERPs for these companies tends to model only the markets that are easiest to obtain data for and have some alignment with the company's goals. The premise is that if the company can clear the gigaton threshold with "only" a couple of markets out of many options, then the ERP provides a robust case for investment from a climate perspective.

This approach to defining target markets for the platform companies is a practical one. Data limitations are an unavoidable reality, and the ERP exercise needs to be scaled to a practical level of effort for the diligence process. That said, a number of implications should be considered:

1. **Where possible, an "upper-bound" analysis is useful.** This can be done for platform technologies that target markets within the same meta-market. These upper-bound analyses can then be triangulated with more "bottom-up" analyses that model specific sectors or sub-sectors in greater detail.

2. **The relative risk of various paths to climate impact should be better assessed.** Most of the companies in Prime's portfolio have multiple markets that they can enter, each with a different climate profile and degree of difficulty to penetrate. Some platform technologies have several possible market applications that do not have material climate impacts. It may make commercial sense for these companies not to target climate impact markets until a late stage of their go-to-market strategy. Even companies that have a direct and immediate climate impact still need to make decisions about geographic markets and sectoral sub-markets.

   It is important to recognize that the projected climate impact of a company whose climate impact comes from a market it doesn't plan to enter for many years may not be as valuable as the projected climate impact of a company with a more direct or near-term path to climate impact. If emissions were discounted the way financial returns are, the later-stage emissions would be less valuable. However, Prime's current approach to modeling potential climate impact in ERPs does not capture this difference.

   One way to normalize these disparities across the portfolio is to add an "expected value" analysis for the companies. This analysis would multiply the likelihood of technology success in different markets by the expected emissions reduction from those markets. The aggregate across all markets the company is targeting would be the expected value of climate impact for the company. Since companies that depend on later-stage market entries would typically have lower likelihood of technology success in those markets, this calculation is a way of discounting later-stage emissions reductions. One of Prime's peer investors applies a similar methodology in its climate impact screening; this approach is discussed further in the Recommendations section. The auditors acknowledge that Prime has historically separated the analyses of "absolute climate potential" and "probability of company success" during the diligence process. The audit team believes that the approach described here could be useful for assessing the likelihood that a given technology will reach its absolute climate potential, even conditional on company success.

3. **The more markets included, the more useful the ERP.** Although it is certainly appropriate (and sufficient) to model only those markets that the company is targeting and/or those markets for which data is available, it is worth setting the gold standard for all relevant markets. This is because the ERP modeling across multiple markets can help Prime and the company better understand where the climate impact is. For example, one ERP demonstrates that for a particular company to meet Prime's gigaton-scale threshold, the technology needs to be applied in multiple markets; another ERP shows that one potential target market has a far bigger climate impact than another market that the company was also planning to target at the time of investment. As discussed further below, new markets will emerge and initial target markets will be discarded as companies inevitably pivot. The fact that a company's target markets will constantly evolve supports the case for updating ERPs periodically (we suggest annually).
4. **Documentation of rationale for target markets should be improved.** Finally, it would be a good practice to ask the ERP modelers to document how and why the target markets were chosen and if there were markets that they wanted to model but did not have sufficient data for. This would allow the Prime team to consider adding new markets to the ERPs if they are updated at a future date.

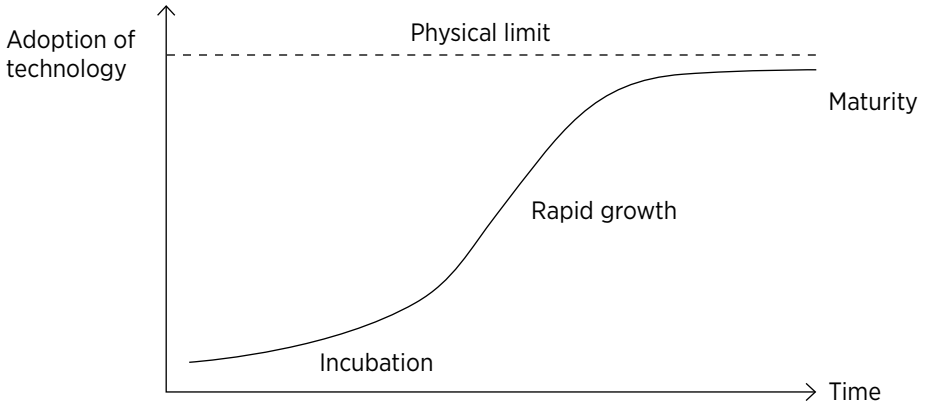
Another issue relating to the target market is that Prime's ERP methodology, as published in Prime's report with NYSERDA, instructs ERP modelers to set ultimate market penetration at 100%, since ERPs are intended to model technological potential rather than the market share of a specific company. However, eight of the 12 ERPs set target market penetration at less than 100% of whatever market is modeled, meaning that these models assume the technology will not reach total market penetration. The fact that so many of the ERPs set ultimate market penetration at less than 100% makes it more difficult to make comparisons across the portfolio of ERPs.

Part of the tension may be that ERPs are defining markets too broadly, so that 100% market penetration doesn't seem appropriate. The gold standard approach should be, where appropriate and possible, to sufficiently narrow the target market so that setting the target market penetration at 100% is a useful exercise. For example, one ERP sets the maximum market penetration at 20%; this level was selected because it is equal to the total "addressable market," based on the company's research. If the ERP instead defined the target market as the total addressable market for this particular technology, then the model could set ultimate market penetration at 100% and the model would be more readily comparable to other ERPs. This issue is discussed further in question D5, below.

D5: Do ERP calculations follow consistent principles in defining the S-curve[13] of market adoption for scenarios that model commercial-scale deployment of the company product?

All of the ERPs use a logistic technology diffusion model, which predicts that the adoption of new technology follows an S-shaped curve, following the Prime-NYSERDA methodology. The figure shows a conceptual S-shaped adoption curve. Empirical evidence shows that many successful products have followed S-curves as they are introduced to the market.

Figure 1: Standard S-curve of technology adoption



As described in the Prime-NYSERDA report, in an S-curve model, the penetration of a given product in a given year is determined by the following function. (Note that if a new venture is developing a product or service that can enter multiple markets, this analysis must be performed for each market.)

Penetration in year $y = M / 1 + e^{-K(y-x)}$

The variables are defined as follows:

- M is the maximum penetration that a product will be able to achieve (this number will be between 0% and 100%).
- k is a factor that controls the speed of penetration, also described as "maximum slope steepness." Higher values of k mean that a product will penetrate the market faster.
- x is the year in which the product achieves 50% of its maximum penetration (M).

Determining the value of each of these variables is one of the most challenging aspects of creating ERPs. The ideal way to do this is to survey a range of analogous technologies/products that exist in the marketplace and determine the shape of their S-curves. But identifying appropriate analogous companies for the set of innovative, early-stage companies that Prime is evaluating is difficult. Moreover, securing the data can be challenging or even impossible if the data is proprietary. As such, this is an area of ERP modeling where there is little consistency across Prime's portfolio and little guidance is provided to the ERP modelers. None of the ERPs provide justification or documentation for the k or x parameters, and they rarely justify M parameters, even when M was set < 100%.

Across the portfolio, three out of 12 ERPs use common parameters for terms k and x (k = 0.7, x = 10 years). Likewise, only four of 12 set M = 100%, even though the Prime-NYSERDA methodology prescribes setting M at 100% so the ERP will serve as an analysis of technical potential. A scan of the literature on technology diffusion curves found that the k parameter (slope steepness) often falls between 0.155 and 0.933.[14] Most of the k parameters used in the ERPs fall within this range, albeit usually at the higher end. Three of the ERPs have k values that are equal to or above 0.9. For reference, the default logistic curve parameters in CRANE are k = 0.5, x = 2030 (equivalent to x = 10), and M = 100%.

One of Prime's peer investment funds establishes three standard technology diffusion curves ("slow," "standard," and "accelerated"), runs scenarios for companies based on each diffusion curve, and then selects one curve to present to its board. As the fund selects a diffusion curve to use as the basis of its primary climate impact calculation, it creates a narrative to explain why the curve was selected. This seems like a gold standard approach that Prime ought to consider. If three diffusion curve scenarios introduce too many variables for ERP modeling, then one standard set of diffusion curve parameters should be established. Deviations from this standard can still be used, but a rationale ought to be documented in the ERP model in these cases.

[13] Also called "logistic curves," "diffusion curves," or "technology diffusion curves."

One way to normalize these disparities across the portfolio is to add an “expected value” analysis for the companies. This analysis would multiply the likelihood of technology success in different markets by the expected emissions reduction from those markets. The aggregate across all markets the company is targeting would be the expected value of climate impact for the company. Since companies that depend on later-stage market entries would typically have lower likelihood of technology success in those markets, this calculation is a way of discounting later-stage emissions reductions. One of Prime’s peer investors applies a similar methodology in its climate impact screening; this approach is discussed further in the Recommendations section. The auditors acknowledge that Prime has historically separated the analyses of “absolute climate potential” and “probability of company success” during the diligence process. The audit team believes that the approach described here could be useful for assessing the likelihood that a given technology will reach its absolute climate potential, even conditional on company success.

D6: Do ERP calculations follow consistent principles in assessing uncertainty?

Most of the ERP models use a consistent modeling approach in that they all follow the Prime-NYSERDA methodology, test for the technical potential of the product/technology, and use an S-shaped curve to project market penetration. Most of the ERPs have two or three scenarios ranging from "conservative" to "upper-bound." These alternative scenarios typically model different markets, market growth, total market penetration, or emission intensity of the displaced product (typically fuel or the grid electricity mix).

Yet there is little consistency in how the ERPs assess uncertainty. Specifically, the ERPs are somewhat inconsistent and not transparent in how they determine which parameters to test in the scenario construction or additional sensitivity analysis. Based on our review, it appears that most of the ERPs build scenarios or sensitivity analyses to test at least one parameter that is important to driving climate impact and that tends to have a high level of uncertainty. But many of the ERPs do not run sensitivities on the majority of the parameters in the respective models that are important as climate impact drivers or that have large error bars. None of the ERPs provide any narrative discussion of their findings or identify which parameters have the biggest impact on the ERP or which of those parameters face the greatest amount of real-world uncertainty. In many cases, the audit team needed to dig deeply into the ERP models and play around with inputs to assess which parameters had the biggest impact. It would be ideal if the modelers conducted a wider set of sensitivity analyses and identified the largest drivers of impact and uncertainty upfront.

Determining the relative magnitude of parameters' error bars is somewhat subjective. Identifying the parameters with the largest error bars would require the ERP modeler to issue his/her opinion and/or require the expert input of the company leadership or the Investment Team. In this area, the audit team believes more communication between the ERP modeler and the Investment Team would be appropriate.

The ERPs appear to be used almost exclusively to determine whether the company/technology has the technical potential to exceed Prime's gigaton threshold. With a marginal amount of further effort, the ERPs could become much more useful management tools, particularly with respect to their role in assessing sensitivity and uncertainty in the key inputs. By establishing some guiding principles around scenario construction, including how much sensitivity should be included in the modeling, or establishing a process whereby the ERP modeler, the company, and the Investment Team decide on the key parameters to test in the ERP modeling at the outset, the ERPs could do a better job of identifying the parameters essential for reaching the largest climate impact. Shifting the ERP modeling in this direction could be valuable to both the company and the Investment Team by allowing for better insights into the questions of, "What are the key factors that determine the climate impact of the company?" and "What do we have to assume for this company to have the impact we want to see?"

[14] Christophe Van den Bulte. "New Product Diffusion Acceleration: Measurement and Analysis." *Marketing Science.* Fall 2000. Vol. 19, No. 4.

Implications for Future Audits

The methodology that was developed at the outset of this audit included a set of questions (referred to in the methodology as "Set F questions") designed to reflect on Prime's experience in developing ERPs over the last five years. The goal of these questions is to help Prime generate useful take-aways from the audit's granular review of the ERP models. The assessment of the Set F questions for the 2020 Climate Impact Audit are shared in the following pages.

F1: Are the ERPs consistent with the findings when using the same inputs with the CRANE model? What are the implications of transitioning to the CRANE tool for ERP calculations?

The CRANE model is designed around very specific pathways or emissions reduction technologies/interventions organized in six high-level categories (agriculture, buildings, electricity, manufacturing, transportation, and carbon dioxide removal). Examples of pathways include building insulation, flywheel storage, and high-efficiency diesel engines. The CRANE team has designed the pathways to be as specific as possible using publicly available data. The user provides a few inputs to "finish off" (or tailor) the analysis and can override some of the default values in the CRANE model, such as the S-curve parameters. The range of inputs that the user provides varies by pathway, but generally includes start year, end year, target market, and "figure of merit" (i.e., technical specifications of the new product with respect to GHG emissions). So far, the CRANE platform includes about 200 specific pathways, and it is adding more all the time. The biggest limitation of CRANE right now is that there are many technologies that are not covered by the pathways. Ten of the 12 Prime companies covered in the audit have pathways in CRANE that are closely enough aligned to provide a useful comparison.

The audit team was impressed with the CRANE software and functionality and thinks it can provide useful analysis, especially for climate impact assessment in the early stages of due diligence. In addition to continually adding pathways, CRANE is working to develop the functionality to make the pathways more customizable by the user, which will make the platform even more valuable. Several of the audit's findings relating to developing an applied ERP methodology may be directly relevant to further refinement of the CRANE tool.

While we don't think that CRANE can be a substitute for full ERP models in the near term, this conclusion could be revisited in the future. Our current view is that Prime would lose too much functionality and ability to test the sensitivity of many parameters if it transitioned from ERP modeling to CRANE. This would be especially true if Prime chose to move its ERP modeling toward a more dynamic management tool, as this audit recommends.

The audit team ran three complete comparisons with the CRANE model. We used the inputs from the ERP to generate CRANE analyses for these companies. For two of the three companies, the findings from the CRANE analysis were comparable to the findings of the ERP. For the third company, the findings from the CRANE analysis were an order of magnitude larger than the ERP's findings.

F2: What are best practices in implementing ERP calculations? How does the experience of conducting ERPs for specific portfolio companies add perspective to the methodology outlined in the Prime-NYSERDA report?

Prime's ERP methodology, published in the 2017 Prime-NYSERDA report, provides a useful framework and set of guiding principles for ERP analyses and has helped to standardize the ERP approach. Specifically, all of the ERPs test for the technical potential of the company's product/technology using a logistic diffusion curve to project market penetration, and most of the ERPs have two or three scenarios, ranging from "conservative" to "upper-bound." That said, the Prime-NYSERDA methodology is not directive enough on 1) how to construct scenarios, 2) how to define target markets, 3) how to set diffusion curve parameters, or 4) how to approach ERPs for companies that have an indirect pathway to emissions reduction. These are four areas we think are critically important to robust and useful ERPs and areas that Prime can improve upon without much effort.

1. **Scenario construction** – As described in D6, there is little consistency currently and, as far as we can tell, no guidance or guiding principles regarding how to structure the scenarios, other than the guidance of including conservative, base, and aggressive scenarios (which are not always defined in the same way across ERPs). Guiding principles, or at least a clearer process, for determining which parameters to test through the scenarios and any additional sensitivity analyses would help the ERPs to generate more consistent, transparent, and useful insights. As described in D6,

the audit team recommends establishing a process whereby the ERP modeler, the company, and the Investment Team select the key parameters they want to test through the ERP modeling at the outset, and identify those with the largest error bars. Then the modeler can construct at least three scenarios, focusing on varying the parameters with the most uncertainty. As one peer investor put it, "We spend our time on what we trust the least." If a bespoke process to identify the variable parameters for each ERP is too burdensome, then Prime could consider providing standard guidelines for constructing three scenarios. For example, a conservative scenario would define the target market in a limited way (keeping M = 100%), assume slow market growth, assume conservative efficiency gains of the product/technology, and assume conservative emissions from the baseline or displaced product (i.e., aggressive growth in baseline efficiency). An upper-bound scenario would be the opposite.

2. **Defining target markets** – While the Investment Team, Prime Board members, and the Prime-NYSERDA methodology broadly agree that the ERPs should be modeling an upper-bound technical potential and that this is operationalized by setting M = 100%, defining the target market is not always straightforward, as discussed in D4. The fact that only four of the 12 companies audited set M = 100% indicates that the modelers have some discomfort with the methodology and/or that there is some tension between assessing the technical potential and creating realistic scenarios. Clarifying the intent of the ERP and the standard modeling approach for multiple scenarios could lead to better consistency across the ERPs.

   Defining target markets is especially challenging for platform technologies because there are often data limitations or simply a desire not to overcomplicate models unnecessarily. As described in D4, the audit team thinks that the current approach of modeling only a subset of markets is practical, although if the ERP models markets that are not likely to be reached until a late phase of the company's development, then some kind of risk adjustment, or discounting, ought to be introduced (e.g., through analyzing expected value or likelihood of technology success in a given market).

   Defining target markets for products or technologies that are clearly fit for a single market can also be challenging. For example, the ERP modeler needs to determine whether the target market should be global or not. The rule of thumb seems to be that the market should be defined as wherever the product is technically viable, but markets will vary in their complexity and accessibility. Here again, the expected value analysis may help normalize the analyses.

3. **Diffusion curve parameters** – As discussed in D5, clearer guidance and more standardization should be provided for diffusion curve parameters. Currently, a few of the ERPs use common values: curve steepness (k) of 0.7, inflection time (x) of 10 years, and market adoption (M) of 100%. Providing such a standard set of parameters or, alternatively, few sets of standard parameters based on different technology archetypes or a slow, standard, and accelerated set, may help to standardize the ERPs across the portfolio.

4. **Indirect emissions reduction** – For some companies within the Prime portfolio, the ERP calculation is indirect. The product itself does not directly displace any GHG emissions, but it enables emissions reductions by improving the cost-performance curve and thereby increasing deployment of other low-carbon technologies. For these companies, the climate impact depends upon the company's ability to remove production barriers that would otherwise constrain important emission-reducing technologies. Typically, these indirect impacts are more challenging to model than direct impacts. In most cases, the indirect impact will be derived from a shift in the cost curve or performance curve of the complementary product, so literature on relevant elasticities will often be key. Incorporating this literature into the ERP modeling and building out sensitivity analysis around the cost/performance curve parameters is probably a good approach. Careful sensitivity analysis is key given the high level of uncertainty in these indirect pathways. Further discussion of how to model indirect climate impact is provided in the methodological appendix. Even though this methodology is backward-looking, the concepts apply to forward-looking ERPs.

Finally, it would be helpful for the ERPs to provide a narrative in the front tab describing the rationale for the scenario construction, the target markets, and the diffusion curve parameters, as suggested in D2.

F3: Given the hindsight of five years, are there any lessons learned about how to effectively handle uncertainty in ERP calculations?

As described in D6, the ERPs could do a better job of assessing which parameters are most critical for reaching the greatest climate impact. Even after pulling apart each of the ERPs, it was not clear to the auditors in all cases which inputs are the biggest drivers of impact. The key drivers should be made clear by the modeling and should be reported at the front of the models. Because some companies will have a large volume of variables that could be tested for impact sensitivity, a process for determining which parameters to test would be useful. As suggested in D6 and F2, the ERP modeler should get input from the Investment Team and the company leadership. Testing those parameters with the greatest degree of uncertainty ought to be the goal.

If the ERPs are constructed to determine not just what the level of emissions reductions could be, but what will drive those reductions—clearly answering the "what do we have to assume" question—then they will become more useful decision-making and, ultimately, will serve as management tools. For example, our analysis makes clear that one company will only reach the target impact threshold if it enters several markets; another company is at risk of increased emissions; and a third company's climate impact success depends on entering one particular target market.

As discussed in the Recommendations section, the audit team sees value in updating the ERPs on a periodic basis (we recommend annually), and doing so through a focused analysis of four to five key parameters.

F4: How does use of ERPs in the decision-making process compare with leading peer investor organizations, including with respect to handling uncertainty?

The audit team interviewed five leading peer investor groups within Prime's network that are also rigorously assessing potential climate impact as part of their investment decision-making. All handle ERP analysis in the due diligence and decision-making process a little bit differently. Two do not perform any quantitative modeling but rely instead on expert opinion and/or sector-level assessments. The other three do conduct some kind of ERP modeling, described below.

- **Peer #1:** This group asks the company to fill out a questionnaire that feeds into a simple web-based calculator, akin to CRANE. This early analysis is an input to its pre-screening committee. If the company proceeds, there is usually a dialogue with the company to test for the company's commitment to climate impact. Additional modeling is done for most companies, but the focus is determined on a case-by-case basis. This group also uses an "expected value" to calibrate ERP. To do this additional analysis, the group assigns probabilities to four possible outcomes: completely fail, mostly fail, mostly succeed, and completely succeed. ERP values are determined for each possible outcome, as well. Then the ERP values and the probability values are multiplied for an expected value.

- **Peer #2:** This group conducts the analysis in the opposite direction from Prime. It identifies the target market for the company, assesses the market's emissions now and into the future, assesses the ERP of the company product/technology, and then determines what level of market penetration is needed to achieve the emissions reduction threshold. Then the group asks, "Do we believe the company can achieve this degree of market capture?"

- **Peer #3:** This group conducts three different levels of impact modeling:
  - *Potential impact:* This is calculated with a methodology similar to Prime's ERP, and is specifically used to understand a product's technical potential.
  - *Planned impact:* This analysis is generated using the financial projections of the company (with a haircut) and then multiplied by the unit GHG emissions of the product. For planned emissions, a 10-year horizon is used.
  - *Realized impact:* For companies that have sales, the same technical analysis (per unit GHG emissions reductions) is applied to prior-year sales.
  - This group assesses the planned and realized impact each year and revises the potential impact analyses every three years.

While Prime conducts ERP analyses that are at least as robust as those of its peers, Prime might consider adopting innovations from the peer group in handling uncertainty in decision-making. Moreover, all of the peer organizations that conduct modeling with whom we spoke have some methodology for bridging the technical potential and what is realistic and/or what the company is actually doing. As noted elsewhere in this report, the audit team believes that analysis of expected value could be a useful addition to Prime's analysis that should not require much additional modeling effort.

F5: Has the evolution of Prime's approach to calculating ERPs been directionally appropriate?

As discussed above, the quality and robustness of the ERPs has been improving over time. The last few ERPs are notably better than the first few. They tend to build in more sensitivity, do a better job with considering the progression of displaced product emissions, and are generally easier to read. This is, of course, not a perfectly consistent trend. Companies vary greatly in their complexity, in how challenging they are to model, and in the degree of data limitations; these variances occur irrespective of time of investment. While this audit provides recommendations on improving even the most recent ERPs, the formalization over time has been directionally appropriate, and the perceived progress reflects Prime's investments in the ERP process and methodology.

F6: Are ERPs calculated at sufficient arm's length from the Investment Team? Are any internal organizational improvements recommended for ERP calculations?

The ERP calculations are clearly conducted at arm's length from the Investment Team. The ERP modelers appear to have more dialogue with the company leadership than the Investment Team, which is appropriate since the companies are experts on their products and their markets.

In the view of the audit team, the arm's-length nature of the relationship between the ERP modeler and the Investment Team may actually not be necessary and may prevent valuable information from passing in both directions.

As noted above, the Investment Team (as well as the leaders of the portfolio companies) could be helpful in identifying the parameters with the most uncertainty and ensuring that these parameters are built into the ERP scenarios (in particular, the target market). Conversely, once the ERPs are developed, it appears that there may be a more useful way in which to use them as a management tool. For example, many ERPs do a good job of identifying the biggest drivers of impact, and this could help the Investment Team and companies manage toward impact (examples are provided in F3).
Prime has been concerned that the Investment Team could "put its thumb on the scales" and inappropriately influence the findings of the ERP model. While the audit team appreciates this concern and agrees that the actual mechanics of the modeling should be kept at arm's length, we think the benefits of more collaboration between the ERP modeler and the Investment Team outweigh the risks. Moreover, if Prime takes some additional steps to standardize its references, diffusion curve parameters, and scenario construction (see Recommendations section), there should be less room for subjectivity in the ERP analyses and thus less likelihood of inappropriate influence. Specifically, we recommend that the Investment Team—and the company management—be involved in identifying target markets to model and key parameters to build sensitivity around (those that have a high degree of uncertainty). The Investment Team's insights into the main sources of uncertainty and the appropriate target markets will be invaluable to the ERP modelers and are unlikely to inappropriately tip the scale of the ERP results.

S-curve parameters, assumptions about baseline/incumbent technology emissions, and market growth are less appropriate areas for the Investment Team or company management to weigh in on. As described elsewhere in this document, the audit team recommends building better standardization into the S-curve parameters and creating common references by sector for baseline technology trajectories and market growth.

F7: Does Prime's approach to assessing investment additionality[15] reflect the best thinking or best practices across peer organizations?

Part of Prime's value proposition to the companies in which it invests and to its limited partners is that it helps to fill a capital gap. Prime seeks to invest in companies that would be unlikely to raise sufficient capital but for Prime's intervention and for whom such difficulty or inability to raise capital endangers the company's ability to realize its charitable/social impact potential. Prime operationalizes this investment "additionality test" by surveying its Investment Advisory Committee, which is made up of peer investors, regarding their professional opinion of whether the company in question would be likely to secure investment in the marketplace were it not for Prime.

Several of the peer organizations interviewed recognize that their investment activities fill important capital gaps, even if the specific nature of that gap varies across investors. Yet none of the peer organizations interviewed conduct specific analyses

[15] In this context, additionality refers to the question of whether Prime's investment is catalytic to the companies in its portfolio.

to assess investment additionality. In this sense, Prime's approach represents best practice on this issue. Yet Prime could advance its practices and push the field by developing an analysis designed to validate its investment additionality test. This could be conducted annually or could be incorporated into the five-year climate impact audit.

In an interview, Fiona Murray, a member of Prime's Board of Directors and Associate Dean at the MIT Sloan School of Management, offered two possible ways to validate Prime's investment additionality test.

- The first is to look at the set of companies that passed through the Investment Advisory Committee but then did not receive an investment from Prime. These are companies that the Investment Advisory Committee determined would not receive funding were it not for Prime. If these companies indeed close down or take years to secure venture financing, that would be evidence that Prime's investment additionality test is working. Of course, there may be confounding factors. For example, the reason that a company passed the Investment Advisory Committee but did not receive funding from Prime may be a reason that would turn off other investors but has nothing to do with the fundamental risk of the business model (e.g., an egregious issue with the management team).
- The second is to build up a database of companies comparable to those within the Prime portfolio and track over time how they perform in terms of funding and climate impact. Once the data sets are large enough, some comparisons could be run between the Prime portfolio and the comparable companies.

Audit Findings: Climate Impact Milestones (CIMs)

Introduction to CIMs

The CIMs for Prime's portfolio companies are developed by Prime's Investment Team in partnership with the management teams of the company, post-investment. They are reviewed and approved by the Fund Advisory Committee of the Board of Directors. The CIMs are then reported on biannually.

The CIM logic model suggests two sets of inputs from the company: operational milestones and products deployed. These two sets of inputs can then be used to calculate GHG avoided and allow Prime to answer the questions, "What are the use cases that matter for GHG reduction?" and "What scale of products deployed do we need to hit Prime's annual GHG reduction hurdle?"

Currently, the CIMs are wholly operational in nature. The information provided by the CIMs is insufficient alone to calculate GHG avoided. This is appropriate for metrics that are being used to track progress toward commercialization and market access, and at the time of investment it is not possible to track any additional information. At some point, however, the CIM will either need to provide a more complete set of information or be combined with the ERR data collection and analysis, so that avoided GHG can be calculated. That said, some companies will exit Prime's portfolio before full climate impact can be realized, so not all portfolio companies will reach a point at which full climate impact can be assessed.

CIM Audit Findings

The audit questions that CEA developed as part of this inaugural audit are shown in the Table 5, below. We determined E2 to be descriptive rather than evaluative in nature and thus did not score companies on this question. We also determined that E4 is a question which cannot yet be answered, but which could be used for future audits. Question E3 reflects the approach that the auditors took with the CIM audit, to consider whether the CIMs developed to date would be able to take all of the steps in the CIM logic model, including assessing emissions reductions (avoided GHGs). The scoring in Table 6 reflects this forward-looking analysis, not a concern with the function that the CIMs are playing currently.

The audit only reviewed CIMs for four companies, as only this subset of Prime's portfolio had formalized its CIMs when the audit began. The formal audit of Prime's CIMs in this inaugural audit is therefore very thin, but this section will be expanded in future audits as portfolio companies mature and additional CIMs are finalized. See Table 6, farther below for the CIM audit summary dashboard, and see the methodological appendix for the definitions.

Table 5: CIM audit questions (Set E)

E1	Are the CIMs aligned with the markets that are identified in the ERP and are likely to have the largest climate impact?
E2	If not, is there a strategy documented for why and how the company will gain market entry into the highest-impact markets?
E3	Are company operational milestones sufficient to capture the emission reduction pathways? Are the necessary steps to realize emissions reductions reflected in the CIMs?
E4	Do the CIMs allow Prime to track whether the preconditions and assumptions about market conditions in the ERP are holding true (why/why not)? If not, should they?

Discussion

As the audit team considered the role that the CIMs play in helping Prime and its portfolio companies achieve climate impact, we identified three key questions that Prime must answer internally to effectively use the CIMs for this intended purpose:

1. How should Prime manage the transition from operational milestones to climate impact?
2. How should Prime validate the CIMs and what party within Prime should hold this responsibility?
3. How might Prime help its companies target higher-leverage activities through CIMs?

Managing the transition from operational milestones to climate impact

In the estimation of the audit team, the two sets of company inputs that are captured by the CIMs—operational milestones and products deployed—are necessary but insufficient to track GHG avoided, which is the next step in Prime's CIM logic model. Prime will need to track additional information to make these calculations. It may make sense to more formally link the CIMs to the ERPs or ERRs in order to capture the information necessary to fully assess climate impact. See recommendation #1.

It is worth noting that in our interviews with the Fund Advisory Committee, the board members acknowledged that the current CIM reporting does not provide sufficient information to assess GHG avoided. Board members did not have a clear view about how Prime would transition to CIM reporting that allowed for such calculations. However, they felt confident that the CIM logic model provided a useful guide in this direction.

Validation should be owned by Prime's Partnerships Team

As we understand it, Prime's companies currently report on their CIMs biannually and the CIMs are managed and validated by Prime's Partnerships Team, as part of its role in safeguarding impact. "Validation" in this case simply means that the responsible party within Prime ensures that CIM reporting occurs, that the companies are reporting against the metrics they have established in the CIMs, and that values are subject to a high-level review to ensure they seem plausible based on what the reviewer knows about the company's business, technology, and markets. Although the Partnerships Team does have an obligation to ensure that Prime delivers on its charitable mandate, the auditors believe the Partnerships Team is not the right group within Prime to serve in role of CIM oversight or validation. The Fund Advisory Committee also has an oversight role, but these board members cannot be expected to handle granular-level management of the CIM reporting.

Given the technical nature of the CIMs, it may be most appropriate for the Investment Team to validate the CIMs. An even better solution might be for this function to move under the purview of a Data Manager, Modeler, or Impact Manager who assumes responsibility for ERP modeling, ERR data validation and collection, and CIM data validation and collection. The role could be housed within the Partnerships Team. Because this team member would have a deep understanding of the mechanisms of impact for each company from the ERP modeling work, this person would be in a good position to help define CIMs and ERR data requirements. The team member should participate with the Investment Team and company in establishing CIMs and should lead the development of ERR data reporting requirements.

Targeting higher-leverage activities through CIMs

The CIMs play a critical role for Prime, as they are a means by which companies must report on operational progress that is aligned with climate impact after receiving investment from Prime. Determining what metrics the companies should report on to track alignment with climate impact is an important, but not always straightforward, question. It can be particularly tricky for pre-revenue companies and for companies' whose climate impact markets are in a late stage of their go-to-market strategy.

To date, the CIMs have been aligned with the companies' operational milestones. This is both in line with the structure of the CIMs and appropriate for pre-revenue companies. Moreover, for a portfolio that was selected for climate impact, it makes sense that operational milestones would also be CIMs. In our view, it is important that the CIMs include operational milestones for markets that will be key for climate impact, even if a company's ability to penetrate those markets i a long way off. The company ought to be working toward penetrating those markets from day one if that's where the climate impact is.

Recommendations

1. Integrate the CIMs and the ERR data collection and analysis, as discussed above and in the main Recommendations section.
2. Shift the responsibility to validate the CIMs to the newly created Data Manager, Modeler, or Impact Manager role.
3. Ensure for all portfolio companies that operational milestones exist for key climate impact markets, as identified by the ERP, even if a company's ability to penetrate these markets are a long way out.

Table 6: CIM audit summary dashboard

Set E Questions		
Audit Code	**Statement**	**Avg by question**
E1	The CIMs are aligned with the markets that are identified in the ERP and are likely to have the largest climate impact.	2.8
E2	Descriptive	
E3	The necessary steps to realize the emissions reduction are reflected in the Climate Impact Milestones	1.0
E4	The Climate Impact Milestones allow Prime to track whether the preconditions and assumptions about market conditions in the ERP are holding true.	

Audit Findings: Other Charitable Impacts

Because Prime's primary focus has been on reducing GHG emissions, other charitable impacts made by portfolio companies have not been formally tracked to date. However, Prime would like to be able to integrate climate metrics with other important charitable impacts, both to help funders fulfill their own impact mandates and to help open paths to collaboration across Prime's different stakeholders. Prime's reporting standards for these areas of impact are continuing to evolve. What follows is a preliminary look at how Prime might incorporate other charitable impact tracking alongside climate in the future.

There are many ways of classifying impact (e.g., the United Nations' Sustainable Development Goals). Prime has chosen the IRS's charitability categories since the majority of Prime's investors are subject to philanthropic tax guidelines.

Observations

To date, the audit team has received reporting on other charitable impacts from ten of Prime's 16 portfolio companies.[16] Of these ten, companies report contributing meaningfully to areas that Prime has identified as target "other charitable impacts" as follows:

Table 7: Other charitable impacts reported

Other charitable impact	Number of companies reporting a meaningful contribution in this area (out of 10 reporting to date)
Lessening burdens of government	0
Relief of the poor and distressed	2
Economic development opportunities that relieve poor and distressed communities	2
Advancing science	8
Protecting natural resources	4

Additionally, Prime has asked for details on the areas in which the companies have made meaningful contributions to date. The audit team makes the following observations about this reporting:

- Several companies discuss the indirect benefits of reducing emissions (e.g., reducing the harmful impacts of fossil fuel pollution and climate change on disadvantaged communities and reducing destruction of natural resources).
- Several companies also noted that as they develop manufacturing capacity over time, they anticipate bringing economic value and opportunity to communities.

Recommendations

Prime should work with the companies to identify one or two areas of direct, non-climate impacts. Some companies will not have any such impacts because GHG emissions reduction is their sole focus. These companies should not be forced to issue meaningless reports on "other charitable impacts." Indirect impacts that result generally from reducing GHG emissions should not be reported. Only issue areas for which the company can clearly identify direct impact and track that impact should be reported on.

For those companies that do have direct impacts on other charitable areas, Prime could work with the companies to identify one metric per impact area to add to the CIMs that the companies would report on. The company would need to include a defined methodology and data source for this metric. The companies should self-report these indicators annually, and Prime would represent this reporting as such without taking any responsibility for assessing validity. This approach would help to generate meaningful rather than generic reporting.

[16] The audit team did not receive reporting from six companies.

Recommendations

1. Use the ERPs more completely.

One of the most important findings of this audit is that the ERPs may be underutilized by Prime and by the companies. Most of the ERPs are limited in the degree to which they identify the largest drivers of climate impact and the parameters with the greatest amount of uncertainty, and most of the ERPs do not consistently run sensitivity analyses on key parameters. Yet from reviewing the ERPs, we learned a tremendous amount about the companies and "what needs to be true about the world" for them to succeed. For example: one company's recycling program is of paramount importance; another company must find dedicated sources of renewable energy; and another company must enter multiple markets to achieve climate impact at the desired scale. While we don't want to assume that Prime and the companies are not using the ERPs in this way, or do not already have this level of understanding about the companies and markets, the ERPs are clearly not currently designed to deliver these kinds of insights. With minimal further investment in modeling standards and formatting, these insights could be more easily gleaned from the ERP modeling process. Many of the following recommendations would support a shift in this direction.

2. Develop an "applied methodology."

Now that Prime has five years of ERP modeling under its belt, an addendum to the Prime-NYSERDA methodology could be developed for internal use within Prime to further guide the ERP modelers on areas where the audit has identified consistent opportunities for improvement. This document could provide guiding principles for ERP modeling and could incorporate many of the recommendations that follow, such as:

- Documenting a hierarchy of data sources and a process for verifying that best-available sources were used (discussed in D3)
- Standardized diffusion curve parameters (discussed in D5)
- Standardized reference cases for common sectors (discussed in D1)
- Standardized approaches to target market definitions (discussed in D4)
- Protocols for formatting and presenting assumptions and citations (discussed in D2)
- Process for determining scenario construction, including consultations to assess which parameters need testing (discussed in F2)

3. Use CRANE at various steps in the diligence process and ERP development.

The auditors determined that Prime should not substitute CRANE for its internal ERP modeling at this time, particularly given this audit's recommendations to increase investments in the ERP process to make the models better decision and management tools. But we do see a few discrete ways in which Prime could take advantage of the excellent work being conducted by CRANE and better integrate the resources it is developing into the diligence process and ERP development.

The first is that CRANE is actively working to build and maintain a reference library for all of its climate impact pathways, so ERP modelers should regularly check the CRANE references for relevant pathways while building ERPs. This could help ensure that ERPs use the best available data. As CRANE continues to add to its portfolio of pathways, its reference library will only grow more robust.

The second is that CRANE could be used in early stages of pipeline review to provide "back of envelope" calculations on the climate potential of a company. As we understand it, these early decisions about whether a company might have a gigaton-scale impact are made based on expert opinion of the Investment Team and its high degree of expertise in the relevant markets and areas of technical innovation. It may well prove useful to Prime to run some basic numbers as it determines which companies to invite to come pitch. As we understand it, the ERP analyses, which require at least several days to produce, provide the only point in the diligence process when climate impact numbers are run. A small addition of effort earlier on might help refine Prime's understanding of scale of impact as it starts to narrow its pipeline. With a few basic inputs, running a scenario in CRANE takes less than five minutes.

As Prime increases the quantification of climate impact diligence early in its investment pipeline, future impact audits may also want to incorporate analysis of companies that did not proceed to investment, alongside analysis of companies in Prime's portfolio. This step would enable Prime to assess more holistically whether it is investing in companies with the greatest potential for climate impact.

4. Standardize diffusion curves.

Diffusion curve parameters vary greatly across the ERPs. There is little standardization, even in parameter M (target market penetration), which is meant to be set at 100% according to the Prime-NYSERDA methodology. Prime should consider establishing either one standard set of diffusion curve parameters based in general literature about technology adoption or establishing three sets of diffusion curve parameters (e.g., slow, standard, and accelerated) and asking the ERP modeler to select the one that best fits his/her subjective understanding of a company's trajectory and/or analogous companies/technologies. The latter practice is used by one of Prime's peer impact investor groups. When deviations from these standards occur, the modeler ought to provide a rationale.

5. Add an expected value analysis to help address uncertainty.

Following the lead of one of Prime's peers, Prime should consider adding an expected value analysis to its assessment. This could be done as part of the decision-making stage, after the findings of the ERP are provided. Prime could take the results of the three scenarios that each ERP will generate (base, conservative, and aggressive) and assign a probability to each. The probabilities would not be focused on the likelihood of company success, but rather the likelihood of technology success in certain markets. The ERP values and probabilities could then be multiplied to generate an expected value for the company. While challenges are certainly inherent in this additional layer of modeling, this type of analysis would help to normalize issues relating to emissions that are projected to occur in later-stage market developments or that depend on market-making effects. The effect would be to favor companies with clearer near-term emissions reduction opportunities and put an onus on more speculative companies to have higher potential emissions reductions.

6. Consider adding a diligence step for companies for whom the ERP demonstrates a potential for *additional* emissions.

Two companies in the portfolio have ERPs that show at least one possible scenario in which the company generates net *increases* in emissions. The Investment Team has told us that it sees these two companies as presenting unique risks. In one case, the risk of additional emissions would arise from an endogenous technology and/or operational failure. In the other, the risk of additional emissions would arise from an exogenous market failure. In the latter case, the Investment Team carefully considered the likelihood of this exogenous market failure as part of its investment thesis and believes that the company would not succeed if the desired future does not emerge.

Because investing in a company that has the potential to create additional emissions does introduce some climate downside risk, we recommend that Prime add a diligence step to its process when an ERP shows this possibility. First, the viability of the upside scenario ought to be a central part of the investment thesis, and the Investment Team ought to believe that the downside scenario is highly unlikely to occur (e.g., the company would not succeed in such a market). Second, if the downside climate risk is driven by endogenous factors, Prime should include CIMs to track the likelihood that the company is heading in a positive direction. A clear investment rationale for why this downside scenario is unlikely is still needed.

7. Standardize the ERP parameters and update these forward-looking parameters regularly.

To improve the accessibility and utility of the ERPs, the ERP model ought to be standardized somewhat in terms of format (currently there is little standardization although modelers consistently follow their own style). Specifically, the audit team suggests providing a summary/assumptions tab at the front of each ERP model with the following information (see a suggested template for future ERP models in the methodological appendix):

- A short description of the company and its mechanism of impact for GHG emissions reductions
- A description of the main parameters that are varied across the scenarios
- How the model is constructed (e.g., description of scenarios and sensitivity analyses)

- Main assumptions, inputs, and corresponding data sources; specifically, the following assumptions should be listed and documented:
  - i. Identification of target market(s) and size of target market(s)
  - ii. Growth rate of target markets(s)
  - iii. GHG emissions per unit of the incumbent product
  - iv. GHG emissions per unit of the company product (or % emissions efficiency gain from the company product)
  - v. Diffusion curve parameters [k (slope steepness), x (the year in which the technology reaches 50% market penetration, starting from first year of sales), and M (ultimate market penetration)]
  - vi. Optional/if applicable:
    1. Projections for change in GHG emissions per unit of the incumbent product
    2. Projections for change in GHG emissions per unit of company product (e.g., expected efficiency gains of the product)

These main forward-looking assumptions (items i-vi in the list above) could be updated regularly. It would be ideal to update them annually, along with the ERR data collection (see the methodological appendix). But if that proves to be too cumbersome for Prime or the companies, the assumptions could be updated at five-year intervals, as part of the climate impact audit. Tracking this ERP data over time will allow Prime to compare these metrics with what had been projected by the original ERP, previous forward-looking ERP data collection, and actual GHG reductions as reported by ERRs.

8. Integrate ERP, CIM, and ERR analyses.

As Prime's climate impact infrastructure matures, Prime has the opportunity to better integrate its ERP, CIM, and ERR tools.

- **ERR <> ERP comparisons.** Because the ERRs are meant to assess what the company actually achieves and the ERPs are meant to assess technical potential, comparing the results of the ERRs and the ERPs will not be useful until 2040 or 2050, but comparing many of the assumptions that drive them will be. These comparisons will allow Prime to understand which parameters the ERP predicted accurately and which it did not. Over time, this input could help to improve ERP modeling. Our recommendations on standardizing a reporting template on the ERP models and updating these parameters annually, if possible, and collecting ERR data annually will enable such comparisons.

- **ERR <> CIM integration.** Currently, the CIMs are wholly operational in nature. At some point, they will need to provide a full suite of information so they can be used to calculate avoided GHG. According to the Fund Advisory Committee members we interviewed, a process for this transition has not been clearly articulated. We recommend that Prime allow the data collection from the ERR process to serve as the intermediate step in the CIM. This would necessarily integrate the ERR and CIM data collection processes and analyses. CIM data collection could continue to occur biannually. Since it is operational in nature, frequent tracking of progress is appropriate. Full ERR analyses need not be completed annually, but collecting data annually will likely be less burdensome for the companies, may lead to more accurate data over time, and may provide Prime with an early indication of tracking toward climate impact. This integration may mean that the "GHG Avoided" column of the CIMs logic model is subsumed by the ERR analyses. However, since the latter will be conducted only every five years, and likely by an outside party, the "GHG Avoided" analyses may prove to be useful annual internal analyses that could be conducted using the ERR data.

9. Adjust some process and ownership protocols.

- As discussed in a few places in this report, our assessment is that the arm's-length nature of the relationship between the ERP modeler and the Investment Team is not necessary, at least to the extent it is being practiced, and it may be preventing a useful transfer of information. Specifically, we recommend that the ERP modelers consult with the Investment Team and the company at the front end of the ERP modeling to determine which parameters have the highest level of uncertainty (and therefore need sensitivity analysis) and how the target market(s) should be defined. This consultation process would likely enable more useful ERP analyses. It is unlikely to unduly influence the modeling, especially if Prime better standardizes approaches to other aspects of modeling (common references; S-curves; validation of best-available sources; and approach to conservative, base, and aggressive scenarios).

- Ownership of ERP modeling and on-going parameter updates, CIM data collection and validation, and ERR data collection ought to be housed under the Partnerships Team and should be owned by the newly created Data Manager, Modeler, or Impact Manager position.

Prime Coalition Inaugural Climate Impact Audit

A review of Prime Coalition's climate impact assessment tools and a methodology for future analysis

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Methodological Appendix

Appendix A: Climate Impact Audit Methodology for ERP and CIM

This methodology, or audit standards, were developed by CEA Consulting in partnership with Sarah Armitage, Prime Coalition Impact Fellow, in summer 2020 as a first step to Prime's inaugural climate impact audit. They were reviewed by Prime's Executive Director, Investment Team, Director of Partnerships, and several board members. They were used to assess the quality of the emissions reductions potential ("ERP") calculations, the consistency of the ERP methodology in practice, fidelity to the ERP methodology established in the Prime-NYSERDA report, and the efficacy of the emergent practice of setting and tracking climate impact milestones ("CIMs").

Audit Activities

Step 1: Review of individual ERPs

1. Develop a preliminary understanding of the company, its target market, and the assumptions that underpin the ERP analysis. Answer Set A Questions (see below).
2. Assess the overall level of robustness of the model and its fidelity to the ERP methodology outlined in the Prime-NYSERDA report. Answer Set B Questions (see below).
3. Interview company management to answer any questions that have arisen, as needed.
4. Ground-truth the key assumptions and references used by the model by cross referencing relevant literature/models. Answer Set C Questions (see below).

Step 2: ERP comparison by sector/cohort and across portfolio

1. Once all individual ERP audits have been completed, answer Set D Questions.

Step 3: Review of individual company's CIMs

1. Conduct an initial review of each company's CIMs (not all companies have CIMs).
2. Map the CIMs against the relevant ERP using Set E Questions.

Step 4: Analyses to inform future audits

1. Run a subset of companies through the CRANE model; compare results between CRANE and historical ERP calculations.
2. Interview peer investment organizations.
3. Discuss with/interview internal actors to fully understand the process.
4. Answer Set F Questions.

Audit Questions

Abstract	Provide an overview of what the company does, its market, and the climate impact mechanism.
	Describe at a high level where Prime was in its evolution at the time of investment.
	Summarize the high-level findings of the audit (e.g., relating to the robustness of the scenarios, assumptions, references).
	Provide our assessment of the strength of the following attributes of the ERP: quality of the data and documentation, quality of the assumptions (e.g., S-curve, target market(s)), quality and comprehensiveness of the scenarios (e.g., changing baselines, different markets, different S-curves). Please don't describe the aspects of the ERP here, that should go in the summary of the findings.

	Set A Questions	**Notes for auditors**
	Develop a preliminary understanding of the company and its target market.	If more than one model was developed to assess the company's impact potential, the auditor should treat the most recent one as the primary ERP and refer to it principally throughout the audit. Any earlier models should be referenced to the extent they provided additional scenarios that help assess impact or answer the audit questions. It should be noted in the Abstract of the audit and in the Summary of Set A that there are two models.
A1	What is the target market?	
A2	What is happening in the counterfactual target market. E.g., what is the product or function that the company is trying to replace, and what is the assumed growth rate of that product or function over time? What is the assumed GHG trajectory of that product or function in the counterfactual world where the portfolio company's technology does not exist (e.g., what are baseline projections for market penetration and GHG emissions)?	
A3	What are the GHG emissions per unit of the new product sold (unit "CO_2 economics")? How does this compare with the incumbent product? For enabling technologies, what are the per-unit emissions of the complementary low-GHG product?	
A4	For scenarios that model an S-shaped diffusion curve, what values are used for parameters k (slope steepness), x (the year in which the technology reaches 50% market penetration, starting from first year of sales), and M (ultimate market penetration)?	
A5	Where are each of these inputs drawn from? The auditor should identify references for each major parameter in questions A1 to A4.	The auditor should explain where the sources came from fairly specifically (e.g., "trade publication," "New York Times article," or "IEA model X"). No need to include URLs, as they may become broken over time. The auditor should note when the assumptions came from the company.

A6	What are biggest drivers of ERP impact for this company?	If it's easy and possible given the construction of the ERP, please change the inputs to test the key parameters. Specifically, change the parameters 50%+ and 50%-.
A7	Describe the different scenarios that are provided by the ERP. What are the key assumptions that vary between scenarios?	
A8	Are there potential spillover effects or market-making effects, and how are they incorporated into the model, if at all?	
A9	What "other charitable impacts" does the company have the potential to achieve if commercially successful?	The auditor should reference the Charitability Memo if there is one for the company, the Investment Memos, and/or company questionnaires. This question should be answered as thoroughly as possible (i.e., include all other charitability impacts the company might have).

Set B Questions		Notes for auditors
Is the ERP robust and consistent with the ERP methodology, as outlined in the report that Prime published with NYSERDA in 2017, "Climate Impact Assessment for Early-Stage Ventures"?		Most Set B questions are basically Y/N questions, though some will require some degree of explanation or notation.
Summary of Findings		One paragraph to describe the ERP (covering Set B and Set A), describe scenarios (e.g., "upper bound"/"conservative") including GHG reduction potential of different scenarios. One paragraph with normative views on the quality of assumptions/documentation, scenario construction, analysis of baseline.
B1	Does the ERP document all assumptions clearly? The auditor should specifically note assumptions that are well documented and ones that are not well documented and describe the limitations, if any.	• Limitations of the documentation should be described (e.g., if the citation exists but is not clearly linked to the specific input it informs; or if the citations exist but are difficult to find in the document). • When noting which sources are well cited and which are not, sources ought to be described (e.g., "trade publication" or "IEA scenario X"). No need to provide links.
B2	Do ERP calculations perform sensitivity analyses around key assumptions? The auditor should explain what sensitivity analyses are performed and how they relate to the key assumptions identified in Set A Questions. Note that "sensitivity analysis around key assumptions" could be addressed through different scenarios, or they could be conducted separately (e.g., in a side table) and in a more discrete way, by looking at how a single parameter changes the output of the model.	
B3	Do ERP calculations consider potential for reducing emissions both directly (scope 1; emissions from the use of the product) and indirectly (scope 2; emissions generated by the use of the product, but emitted offsite)?	
B4	Do ERP calculations evaluate emissions reductions over 30-year time horizon at minimum?	
B5	Do ERP calculations consider the potential future progression of the displaced product's emissions (e.g., improved efficiencies of the incumbent technology or a grid mix shifting toward more renewables)?	
B6	Do ERP calculations assess potential for climate impact conditional on company success, rather than predicting the likelihood of success?	

B7	Of the leading drivers of impact identified in A6, which are subject to the greatest uncertainty? Are these sources of uncertainty adequately addressed in the model?	• Intelligence on this question could be drawn from the investment memo (risks section) and the companies themselves (e.g., ask them what they think are the greatest sources of uncertainty about how their industry/competitors will develop). • Note that the quality of the data doesn't necessarily relate to uncertainty (e.g., the reference for a certain parameter might be very robust yet still contain a high degree of uncertainty). • Finally, the auditor should comment on whether the model adequately addresses the largest sources of uncertainty. Hopefully, the ERPs have run some sensitivities or scenarios around the parameters that have the most uncertainty. If not, the auditor should try changing some of the parameters in the document (those that are easy to do, such as parameters k and x) to see how they affect the output.
B8	Do any of the scenarios presented in the ERP meet or exceed Prime's gigaton threshold (cumulative reductions of at least 500 MMT CO2e by 2050)? Is the model missing any sources of emissions or emissions reductions in the full lifecycle of the product?	
B9	Can any scenario be described as an "upperbound"? Can any be described as "conservative"? Why/why not?	
B10	Conditional on surpassing the gigaton threshold, what is the magnitude of potential impact (e.g., is the impact a lot over the threshold or a little over the threshold, and how conservative are the assumptions in these scenarios)?	

Set C Questions		Notes for auditors
Ground truthing assumptions and modeling decisions		
Summary of Findings		In the Summary of Findings for Set C, the auditor should synthesize for the reader whether the auditor thinks that the models are "good enough" for decision-making, given the analytical limitations of the model and given the combination of scenarios/ sensitivity analyses provided. (This will be somewhat repetitive to the Abstract, but with more detail.)
C1	Is the model robust enough to provide confidence that the company in question (and/or its technology/ product) could meet or exceed Prime's gigaton threshold?	This is the primary point in the audit where the auditor should provide a subjective "take" based on the auditor's thorough review. A rationale for the auditor's take should be provided based on the details of the audit (including referencing answers to other audit questions). (The "take" here will be repeated in the Summary of Findings for Set C.)
C2	In order for this company to meet or exceed Prime's gigaton threshold, what will have to be true about the world?	The purpose of this question is for the auditor to concisely explain what the crux of the investment decision or investment thesis would have been for the company in question. The auditor does not need to present a perspective on whether the auditor thinks this world is a plausible one.
C3	For the assumptions listed in A5, how robust are the sources?	There is no need to discuss each reference, but the references for the most important parameters should be addressed and generally categorized as "high-quality" or 'low-quality". Examples of "high-quality" data sources: i. External sources from publicly available models from public agencies (e.g., IEA or EPA) ii. Publicly available models or papers from think tanks or universities Peer-reviewed literature Examples of "low-quality" data sources: i. Trade publications ii. General media iii. Non-published sources such as expert opinion or non-peer-reviewed papers If the auditor believes that the ERP could have or should have used a more robust source, the auditor should note that here. If possible, the auditor should check with the company to understand what external sources it uses in its business forecasting. The auditor should just be checking here for an S-curve that is clearly outside of the bounds of historical cases for technology diffusion, based on literature.

C4	For those scenarios that model an S-shaped diffusion curve and meet the gigaton threshold, how realistic are the assumptions about market penetration (e.g., parameters k (slope steepness), x (the year in which the technology reaches 50% market penetration, starting from first year of sales), and M (ultimate market penetration)?	The auditor should just be checking here for an S-curve that is clearly outside of the bounds of historical cases for technology diffusion, based on literature.
C5	Does the ERP model target market(s) that are consistent with the company's intent at the time of investment? Are the modeled target markets adequate for decision-making?	
C6	Is the mechanism of impact clear, well documented, and consistent with the intent of the company at the time of investment?	

Set D Questions

Test for consistency across portfolio

D1	Do ERP calculations use consistent assumptions in all assessments of common sectors (e.g., do they use a common baseline, or business-as-usual, scenario)?
D2	Do ERP calculations document all assumptions in a consistent manner across the portfolio?
D3	Are there agreed-upon standards for data sources that the ERPs use?
D4	Do ERP calculations follow consistent principles in defining target markets?
D5	Do ERP calculations follow consistent principles in defining the S-curve of market adoption for scenarios that model commercial-scale deployment of the company product?
D6	Do ERP calculations follow consistent principles in assessing uncertainty?

Set E Questions		**Notes for auditors**
CIM audits		
E1	Are the CIMs aligned with the markets that are identified in the ERP and are likely to have the largest climate impact?	
E2	If not, is there a strategy documented for why and how the company will gain market entry into the highest-impact markets?	
E3	Are company operational milestones sufficient to capture the ERPs? Are the necessary steps to realize ERPs reflected in CIMs?	The Fund Advisory Committee, a subset of the board, is the entity within Prime that is responsible for asking the question about when the companies should transition from tracking only operational milestones to tracking impact and what to do if the two diverge.
E4	Do the CIMs allow Prime to track whether the preconditions and assumptions about market conditions in the ERP are holding true (why/why not)? If not, should they? (Too early to answer today; include in future audits.)	

Set F Questions

F1	Are the ERPs consistent with the findings when using the same inputs with the CRANE model? What are the implications
F2	What are best practices in implementing ERP calculations? How does the experience of conducting ERPs for specific portfolio companies add perspective to the methodology outlined in Prime's report with NYSERDA?
F3	Given the hindsight of five years, are there any lessons learned about how to effectively handle uncertainty in ERP calculations?
F4	How does use of ERPs in the decision-making process compare with peer organizations, including around handling uncertainty?
F5	Has the evolution of Prime's approach to calculating ERPs been directionally appropriate?
F6	Are ERPs calculated at sufficient arm's length from the Investment Team? Are any internal organizational improvements recommended for ERP calculations?
F7	Does Prime's approach to assessing investment additionality reflect the best thinking or best practices across peer organizations?

Table A1: ERP audit summary dashboard definitions

Set B Questions

Audit Code	Statement	Red	Yellow	Green
B1	ERP documents all assumptions clearly.	Most assumptions are not well documented or clearly presented.	Most assumptions are documented but some are not and/or assumptions are difficult to find.	All assumptions are documented and are clear and easy to find.
B2	ERP calculations perform sensitivity analyses around key assumptions.	No clear sensitivity analyses were completed.	One or two parameters were varied and/or results from the analysis are not clearly visible or accessible.	Sensitivity analysis for more than 2 parameters was constructed and results are well documented and clear.
B3	ERP calculations consider potential for reducing emissions both directly and indirectly.	Only one (either indirect or direct) is included and both are material.	Only one (either direct or indirect) is included and only one is material, but the ERP does not explain this.	Both direct and indirect are included or only one is included and the other is not material.
B4	ERP calculations evaluate emissions reductions over 30-year time horizon at minimum.	ERP calculation evaluate emissions reductions for less than a 30-year time horizon.	N/A	ERP calculations evaluate emissions reductions for a 30-year time horizon, or more.
B5	ERP calculations consider the potential future progression of the displaced product's emissions.	The ERP does not consider the potential future progression of the displaced product's emissions.	The ERP does consider the potential future progression of the displaced product's emissions, but not in all relevant dimensions.	The ERP considers the potential future progression of the displaced product's emissions in all scenarios and conducts sensitivity around this parameter.
B6	ERP calculations define the upper-bound market penetration consistent with the Prime-NYSERDA methodology.	The ERP tests for market penetration of less than 100% and does not provide a rationale.	The ERP assumes market penetration under 100%, but documents a compelling rationale for why and is still principally testing climate impact conditional upon company success.	The ERP assumes that market penetration (M) = 100%, thus is designed to test for technical potential, in alignment with the NYSERDA methodology.
B7	Of the drivers of impact that have the greatest uncertainty, the sources of uncertainty are adequately addressed in the model.	It is unclear which parameters are the largest drivers of impact and/or the largest areas of uncertainty are not addressed through conservative scenarios.	Parameters in the model that have the largest drivers of impact are clearly identified and in at least one scenario, conservative values are used for the parameters that have a lot of uncertainty.	Parameters in the model that have the largest drivers of impact are clearly identified; those that have the largest uncertainty have been identified by the model; and in at least one scenario, conservative values are used for the parameters that have a lot of uncertainty.
B8a	The scenarios presented in the ERP meet or exceed Prime's gigaton threshold.	Does not meet the gigaton threshold (500 MMT).	Meets the gigaton threshold within a few 100 MMT.	Meets the gigaton threshold by at least 2x (or 1 GT total).
B8b	The model does not miss any sources of emissions or emissions reductions in the full lifecycle of the product.	Misses a material part of the product lifecycle (note that this may be acknowledged by the ERP modelers).	Misses a material part of the product lifecycle for some of the markets modeled.	Does not miss any material emissions associated with the product lifecycle.
B9	ERP included an "upper bound" and "conservative" scenario	The ERP does not include either an "upper bound" or a "conservative scenario.	The ERP has either an "upper bound" or a "conservative" scenario.	The ERP has both an "upper bound" and a "conservative" scenario.
B10	Descriptive			

Table A1, continued: ERP audit summary dashboard definitions

Set C Questions

Audit Code	Statement	Red	Yellow	Green
C1	The model is robust enough to provide confidence that the company in question (and/or its technology/product) could meet or exceed Prime's gigaton threshold.	The model is not robust enough to provide the basis for making an investment decision with respect to Prime's gigaton threshold. There are too many limitations in scenario construction, sensitivity analysis, and/or quality of assumptions and references to consider this model robust.	While this model has some limitations in terms of its scenario construction, sensitivity analysis, and or quality of references and assumptions, it is still robust enough to provide a strong basis for making an investment decision with respect to Prime's gigaton threshold. For example, perhaps only one or two markets are modeled, but the product has many potential markets. Or perhaps a market penetration percentage of under 100% was used. Such a model would lack in some degree of robustness, but would still provide a good basis for decision-making if the gigaton threshold were cleared.	This model is robust in terms of its scenario construction, sensitivity analysis, and quality of references and assumptions. It provides a strong basis for making an investment decision with respect to Prime's gigaton threshold.
C2	Descriptive			
C3	For the assumptions listed in A5, the sources are robust.	The assumptions are primarily from sources that are generally considered low quality (e.g., expert opinion, unpublished reports, general media, proprietary information).	The assumptions are primarily from sources that are generally considered good quality (e.g., trade publications, industry reports).	The assumptions are primarily from sources that are generally considered best in class (e.g., models from public agencies, models or reports from think tanks or universities, peer-reviewed literature).
C4	For those scenarios that mode an S-shaped diffusion curve and meet the gigaton threshold, the assumptions about market penetration are realistic.	No justification for parameters was provided, and they do not fall within parameter ranges identified in academic literature.	No justification for parameters was provided, but they fall within parameter ranges identified in academic literature.	S-curve parameters are based on analogous technologies and these assumptions are well documented.
C5	"1. ERP models target market(s) that are consistent with the company's intent at the time of investment. 2. The modeled target markets are adequate for decision-making."	The ERP modeled target markets that are inconsistent with the company's intent at the time of investment and the modeled target market(s) are not adequate for decision-making.	The ERP targets markets that are part of the company's go-to-market strategy, though may be a long way off. The modeled target markets are adequate for decision-making. The ERP models some, but not all, of the markets in the go-to-market strategy that have the potential for large-scale emissions reductions.	The ERP targets markets that are consistent with the company's intent at the time of investment and the modeled target market(s) are adequate for decision-making. The ERP models all of the markets in the go-to-market strategy that have the potential for large-scale emissions reductions.
C6	The mechanism of impact is clear, well-documented, and consistent with the intent of the company at the time of investment.	Two or three of the following attributes is missing from the way that the ERP articulates the mechanism of impact: clear, well documented, consistent with the intent of the company at the time of investment.	One of the following attributes is missing from the way that the ERP articulates the mechanism of impact: clear, well-documented, consistent with the intent of the company at the time of investment.	The mechanism of impact is clear, well documented, and consistent with the intent of the company at the time of investment.

Table A2: ERP audit summary dashboard definitions

Set E Questions

Audit Code	Statement	Red	Yellow	Green
E1	The CIMs are aligned toward the markets that are identified in the ERP and are likely to have the largest climate impact.	The CIMs are not aligned with the markets that are identified in the ERP and are likely to have the largest climate impact.	The CIMs are either not aligned with the markets that are identified in the ERP or are not likely to have significant climate impact.	The CIMs are aligned with the markets that are identified in the ERP and are likely to have the largest climate impact.
E2	Descriptive			
E3	The necessary steps to realize the emissions reduction are reflected in the CIMs.	The company's operational milestones are not sufficient to capture the emission reduction pathways. And the necessary steps to realize the ERPs are not reflected in CIMs.	"One of the two elements is missing: - The company's operational milestones are sufficient to capture the emission reduction pathways. - The necessary steps to realize the ERPs are not reflected in CIMs."	The company's operational milestones are sufficient to capture the emission reduction pathways. And the necessary steps to realize the ERPs are reflected in CIMs.
E4	The CIMs allow Prime to track whether the preconditions and assumptions about market conditions in the ERP are holding true.	The CIMs do not allow Prime to track whether the preconditions and assumptions about market conditions in the ERP are holding true.	The CIMs allow Prime to whether track some, but not all, of the preconditions and assumptions about market conditions in the ERP are holding true.	The CIMs allow Prime to track whether the preconditions and assumptions about market conditions in the ERP are holding true.

Appendix B: Sample Template Cover for ERP Models

PRIME CLIMATE IMPACT AUDIT (Year)
PORTFOLIO COMPANY Xxx
XX/XX/XXXX (date)

Portfolio Company Logo

ERP Assessment information & assumptions

Short description of the company and its mechanism of impact for GHG emissions reductions

Xxx…

Describe the main parameters that are varied across the scenarios

Xxx…

How the model is constructed (e.g., description of scenarios and sensitivity analyses)

Xxx…

Main assumptions, inputs, and corresponding data sources. Specifically, the assumptions, inputs, and corresponding data sources called for in 1-6, below, should be listed and documented.

Xxx…

1. Identification of target market(s) and size of target market(s)

´Xxx…

2. Growth rate of target markets(s)

´Xxx…

3. GHG emissions per unit of the incumbent product

´Xxx…

4. GHG emissions per unit of the company product (or % emissions efficiency gain from the company product)

´Xxx…

5. Diffusion curve parameters [k (slope steepness), x (the year in which the technology reaches 50% market penetration, starting from first year of sales), and M (ultimate market penetration)]

´Xxx…

6. Optional/if applicable:

i. Projections for change in GHG emissions per unit of the incumbent product (e.g., changing emissions of grid electricity mix until 2050)

´Xxx…

ii. Projections for change in GHG emissions per unit of company product (e.g., expected efficiency gains of the product)

´Xxx…

Appendix C: Proposed Methodology for ERR

Emissions reduction realized ("ERR") is the primary metric for assessing the climate impact of Prime's portfolio companies. This metric is intended both to connect directly to Prime's assessments of ERP prior to investment and to reflect the primary lever for mitigating the harmful impacts of climate change—reducing emissions of GHGs. This methodology for assessing ERR was developed by CEA Consulting in partnership with Sarah Armitage, Prime Coalition Impact Fellow, in summer 2020. It is intended to be reviewed by Prime's Executive Director, Investment Team, Director of Partnerships, and several board members. This methodological outline is designed for Prime and/or a third-party auditor to assess the ERR of an individual company within the Prime portfolio. Because most companies in Prime's portfolio are pre-revenue at this time, it is not yet possible to assess portfolio-wide climate impact to date.

This methodology was developed as part of Prime's inaugural climate impact audit, which also reviewed the ERP models and CIMs that had been developed for Prime's portfolio as of summer 2020. As such, the recommended methodology outlined here incorporates and is informed by recommendations that CEA is making as part of the audit regarding the ongoing use of ERPs and CIMs. This methodology is intended to be used in Prime's next climate impact audit, which will include a quantitative ERR assessment, in 2025.

ERR Methodology

Step 1: Can an ERR be conducted?

- ERRs have not been conducted to date for the Prime portfolio because they are all still very early stage and most portfolio companies have not yet generated revenues. It is likely that in 2025, at the time of the inaugural ERR analysis, some companies will still be pre-revenue. It will not be possible to conduct an ERR analysis on these companies.
- Some companies in the portfolio will have revenues, but will not be selling into markets where they are displacing emissions (i.e., they are not selling into "climate impact markets"). If the company does not yet have revenues in a climate impact market, then an ERR analysis will not be useful or material.
- If a company has sales but not in a climate impact market, the following narrative information should be collected from the company:
  - Does the company still expect to enter markets that will have a climate impact? Which markets? If not, why not?
  - Are the target climate impact markets the same as those modeled in the ERP? If the markets have changed, why?
  - In what year does the company expect to enter these markets?
  - What will entry into the climate impact markets depend upon (e.g., technical improvements, cost reduction)?

Step 2a: Calculating ERR for portfolio companies with direct climate impact

As described in the Prime-NYSERDA methodology for calculating ERP, the fundamental equation that needs to be performed to understand a company's ERR is:

[number of units sold] x [tonnes of GHG emissions reduced per unit]

While the math is straightforward, both factors may require multiple inputs. For example, number of units sold might instead be expressed as [number of plants in operation]*[tonnes of emissions reduced per unit time]*[time in operation]. For companies with indirect climate impact (discussed in greater detail below), this calculation might instead take the form [growth of market beyond expected BAU case]*[attribution factor].[17]

Modeling the GHG emissions avoided per unit of product deployed typically requires technical specifications on the efficiency of the company's product as well as information about the amount of emissions the product is displacing. Since both of these factors are often dynamic, we recommend that Prime collect information on these inputs annually. The audit team believes that annual data collection will ultimately reduce the reporting burden for portfolio companies, particularly those for whom technical specifications or target markets are rapidly evolving. Annual reporting is more likely to dovetail with portfolio companies' own reporting cycles, and will eliminate the need to retrospectively compile five years' worth of information on the number of products sold with different specifications or sold into different markets.

Moreover, since the information required will be specific to each company, Prime cannot establish a standard data collection template. Instead, Prime will need to establish two to four metrics for each company, which will enable the ERR calculation. Prime may need to conduct further research on additional inputs in order to calculate per unit emission reductions, particularly for emissions of the incumbent product or counterfactual market. To the extent possible, Prime should only ask the company to report on information that is specific to the company to minimize the burden on company management.

Once the necessary information has been collected, the high-level steps to calculate ERR for portfolio companies with direct climate impact closely resemble the procedure outlined in the Prime-NYSERDA methodology for calculating ERP. ERR-specific considerations for each component of this analysis are described below:

A. Estimate the emissions of the product displaced

Identifying and estimating the emissions of the displaced product is likely to be one of the most challenging components of any ERR analysis, as it requires determining the counterfactual product that would have been consumed absent the portfolio company's product. As a technology matures, it may be especially difficult to assess whether the historical incumbent product is the relevant counterfactual or whether an alternative low-GHG product should be used instead. For example, as the electric vehicle market matures and traditional gasoline-powered vehicles become less available, modelers may find it difficult to assess whether an internal combustion engine vehicle is the relevant displaced product for an electric vehicle, or whether hybrid electric vehicles are a more realistic alternative.

Absent a full set of counterfactual simulations of the market in question, which is likely to be impractical, modelers should conduct ERR analyses with a range of plausible displaced products. Alternatively, modelers may wish to assume that a certain share of the company's product displaced one type of product, while another share displaced another type of product. The relevant counterfactual product may also differ across submarkets and may change over the time horizon of the analysis. Portfolio companies may provide useful qualitative information about the relevant displaced product in different submarkets, even if the companies themselves are not asked to quantitatively estimate the displaced emissions.

Once the displaced product(s) have been identified, the ERR modeler must estimate the lifetime emissions associated with that product. Lifecycle analysis and emissions factor databases can be used in this exercise; see, for example, the lists of resources identified by the Greenhouse Gas Protocol, the U.S. Environmental Protection Agency, and the Intergovernmental Panel on Climate Change. ERR modelers will also need to account for the lifetime of both the displaced product and the portfolio company's product, so that emissions reductions are counted for all years that the company's product is in use and measured relative to the appropriate displaced product.

B. Estimate climate impact additionality

For portfolio companies with direct climate impact, ERR modelers should follow the rules of thumb outlined in the Prime-NYSERDA methodology for determining climate impact additionality:

- For performance improvements of GHG-emitting products, the impact of the portfolio company's product is equal to the decrease in emissions associated with the improved performance of the incumbent product.
- For performance improvements for existing low-GHG products, the impact of the portfolio company's product is equal to the increase in displaced emissions associated with the improved performance of the incumbent low-GHG product.
- For the introduction of a new low-GHG product, the portfolio company's impact is equal to the displaced emissions of the incumbent product.

In each of these cases, the principles driving climate impact additionality are easy to understand, but identifying the relevant incumbent product is likely to prove challenging, as described above.

C. Estimate the emissions of the venture's product and emissions reduced by products sold

The emissions associated with the portfolio company's product will fundamentally depend on the product's technical specifications, which the portfolio company generally should supply directly (combined with third-party validation if available). In some cases, the technical specifications will relate to the product's energy consumption during manufacturing or use; the ERR modelers can then calculate emissions using external data about energy mix in the location of production or deployment.

Another nuance that ought to be accounted for carefully is the changing efficiency of the product. When calculating the ERR, Prime will need to look at the weighted average efficiency of all of the units that have been sold to date (and likely not yet retired).

D. Estimate realized product deployment

The findings of this audit report suggest that projecting a reasonable path of potential product deployment is one of the most challenging components of the ERP modeling process—and one that is rife with uncertainty. In contrast, estimating realized deployment is likely to be less onerous. Portfolio companies should generally provide this information directly (along with third-party validation if available). It is important to track separately deployment in different geographic areas and with different technical specifications, as climate impact may differ significantly across various groups of products deployed and products displaced.

E. Put it all together to estimate ERR

As with ERP calculations, it is straightforward to arrive at the final estimate of ERR once necessary data has been collected and key modeling decisions have been made. Following the notation in the Prime-NYSERDA methodology, the full ERR calculation is given as follows:

Emissions Reduction Realized

$=$ *(Total system emissions in counterfactual world without portfolio company's product)*

$-$ *(Total system emissions given portfolio company's product)*

$$= \sum_{t=1}^{T} \left[\left(\frac{\textit{(Emissions of displaced product in year t)}}{\textit{(Units of product sold)}} \right) \right.$$

$$\left. - \frac{\textit{(Emissions of portfolio company in year t)}}{\textit{(Units of product sold)}} \right)$$

$$\left. * \textit{(Deployment of portfolio company in year t)} \right]$$

While the relevant horizon for ERP calculations is defined to be 30 years, the ERR should be calculated over the years since Prime's investment in the company in question or since the company entered a climate impact market, whichever is later.

Step 2b: Calculating ERR for portfolio companies with indirect climate impact

For some companies within the Prime portfolio, the ERR calculation is indirect. The product itself does not directly displace any GHG emissions, but the product enables emissions reduction by improving the cost-performance curve and thereby increasing deployment of other low-carbon technologies. For these companies, their climate impact depends upon the companies' ability to remove production barriers that would otherwise constrain important emission-reducing technologies. In these cases, the counterfactual (what would have happened without the company) can be very difficult to establish or estimate. However, it can be approximated through more extensive economic modeling.

For example, a company's climate impact might be based upon the premise that a new technology will help to reduce the price of manufacturing a low-carbon product, ultimately leading to higher sales of the low-carbon product. The key parameter that determines how deployment responds to price is the price elasticity, which gives the percentage change in quantity for a given percentage change in price. Additional information on the pass-through rate of changes in component prices to changes in final good prices may also be useful for this analysis. By consulting external literature that has sought to measure the relevant elasticities and pass-through rates, ERR modelers can approximate to first order the climate impact of reducing the price of the complementary low-GHG technology.

Where the relevant parameters are not available, modelers may wish to draw from comparable technologies or make conservative assumptions. In performing this analysis, it is important to distinguish between short-run and long-run responsiveness to price; for example, short-term shocks to component prices may be absorbed by the manufacturer and have a negligible impact on final demand, but longer-run price changes may yield a different response. The long-run price responsiveness is generally the appropriate approach to modeling the impact of a transformative technology in the market.

Sample equation:

[% change in price of component price] * [Pass-through rate of component price to final product price] * [Price elasticity of final low-carbon product] = [% change in demand for low-carbon product]
While a fully standardized approach cannot be devised for all companies with indirect impact, in most cases this indirect impact will result from a shift in the cost curve or performance curve of the target market, so literature on relevant elasticities will often be key. For that reason, it will be important to ensure that the reference (baseline or business-as-usual) cases collected during the diligence process are best in class. They ought to provide a critical input to the ERR as a description of the counterfactual market.

Furthermore, given the high uncertainty inherent in these calculations of indirect impact, modelers may also wish to combine the exercise described above with an additional assessment of the ERR from the complementary low-GHG product, scaled to the size of the portfolio company. It may be straightforward—and highly transparent—to estimate the share of low-carbon products that are affected by the new technology and then use a single "attribution factor" to assign some fraction of the overall GHG reductions from those products to the enabling technology.

Because these estimates of ERR are likely to face significantly more uncertainty, on average, than ERR calculations for portfolio companies with direct climate impact, the audit team recommends separately reporting ERR for indirect impact companies. Clearly identifying the type of climate impact will enable more "apples-to-apples" comparisons of ERRs across Prime's portfolio.

Step 3: Other considerations

- **Market-making effects** – Some of Prime's companies may gain sufficient market penetration to influence the energy efficiency of the baseline. For example, if a new technology causes closely related competitors to enter the market, then the baseline emissions associated with that sector may shift and the emissions reduction impact of the portfolio company will be understated using the methodology outlined here. For purposes of the 2025 ERR audit, we suggest not taking these potential market influence impacts into account because they are unlikely to arise within five years. However, later audits may need to develop standards for how to assess them. Possible methods might include a patent review to see how frequently the company's patents are cited by other companies in the same market, a review of the company's technology licenses, and interviews with industry experts.
- **Jevons Paradox** – Another phenomenon that may be relevant to the assessment of ERR is that introducing some of the products or technologies within Prime's portfolio may lead to more purchases of the product or technology than otherwise would have occurred (i.e., increased efficiency of the product leads to greater consumption). This is a common dynamic, known in economics as Jevons Paradox or the "rebound effect." For some of Prime's companies, this would add emissions associated with the product that ought to be netted out of the ERR. Again, this level of analysis is unnecessary for the 2025 round of ERRs, but might need to be added for some of Prime's companies at a later time. A simple factor to account for consumption increase could be added, although the certainty in that factor will be low.

Appendix D: List of Interviewees

Prime Team Members

Amy Duffuor
Johanna Wolfson
Maggie Cutts
Matthew Nordan

Prime Board Members

Alicia Seiger
Stanford University

Fiona Murray
MIT Sloan School of Management

Nicole Systrom
Sutro Energy Group

Brian Von Herzen
(Fund Advisory Committee)
the Climate Foundation

Jeff McCarthy
(Fund Advisory Committee)
North Bridge Venture Partners

ERP Modelers

Michael Solomentsev
Ryan Macpherson
Scott Burger

Peer Organizations

Five peer organizations who are the leaders in Prime's network in their assessments of potential climate impact (names suppressed to maintain confidentiality)

Prime Portfolio Company Leadership

Brian Baynes
Verdox

Chris Kaffer
Mallinda

Dan White
Clean Crop

Heidi Lim
Opus 12

Dave Snydacker
Lilac

Jeff Engler
Wright Electric

Justin Reed
C-Motive

Leah Ellis
Sublime

Kevin Davis
Rebound Technologies

Sarah Richardson
MicroByre

Shreya Dave
Via Separations

Vince Romanin
Treau

Other Partners

Seth Sheldon
CRANE/RHO.AI

Cassie Borish
CRANE/RHO.AI

Amber Gold
CRANE/RHO.AI

Prime Coalition Inaugural Climate Impact Audit

A review of Prime Coalition's climate impact assessment tools and a methodology for future analysis

Prime

primecoalition.org

CEA

ceaconsulting.com