Prime Coalition Inaugural Climate Impact Audit

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

2021

CEA

Introduction

Vision: A safe and equitable planet for all people

Mission: Partner with philanthropists to support market-driven solutions to climate change

Values: Passion, Authenticity, Rigor

primecoalition.org

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 document reports high-level findings from Prime's inaugural climate impact audit; to read the full-length audit report and audit methodology please visit the publications page on Prime Coalition's website. 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.

Authors

Amy Dickie, Michael Berger, Laura Roca Massana

Suggested Citation

CEA Consulting, *Prime Coalition Inaugural Climate Impact Audit*, 2021.

Acknowledgement

The authors would like to thank Sarah Armitage, Prime Impact Fellow, for the invaluable advisory role she played throughout the audit and the production of this report.

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"). In addition, Prime co-develops climate impact milestones ("CIMs") in partnership with its portfolio companies after investment and tracks progress against these milestones on an annual basis. Prime also intends to conduct backward-looking emissions reduction realized ("ERR") analyses as its portfolio companies mature.

Introduction to Prime Coalition

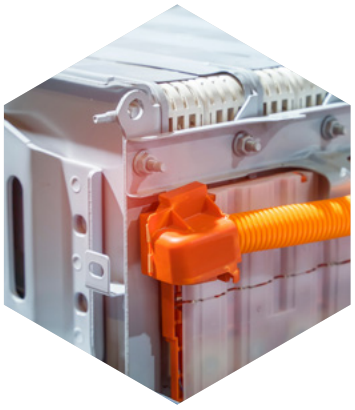
Prime Coalition ("Prime") is a nonprofit organization focused on addressing the critical funding gap for transformative early-stage solutions to climate change. Prime's unique model blends different forms of catalytic capital[1] to support innovative technologies with potential to reduce or sequester greenhouse gas ("GHG") emissions at the gigaton scale by 2050. As of 2020, Prime Coalition employed staff at the nonprofit itself (referred to in this report as "the Partnerships Team") and staff ("the Investment Team") at Prime Management Company, a subsidiary that shares nonprofit status but focuses exclusively on investment of Prime Impact Fund ("PIF"). Although functions and responsibilities are distinct, all Prime staff work toward mitigating climate change as the paramount end goal.

When this audit began in June 2020, Prime—which was founded in 2014—had invested in 16 companies. Those companies, 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 companies received investments through syndication on a deal-by-deal basis from 2014 through 2018, and eight received investments through PIF, which completed fundraising with $50 million in June 2020.[2] 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, all with the goal of having a transformative impact on GHG emissions.

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.



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").[3]

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

[2] These numbers reflect Prime's portfolio when the impact audit began in June 2020.

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

Portfolio Companies Included in this Report

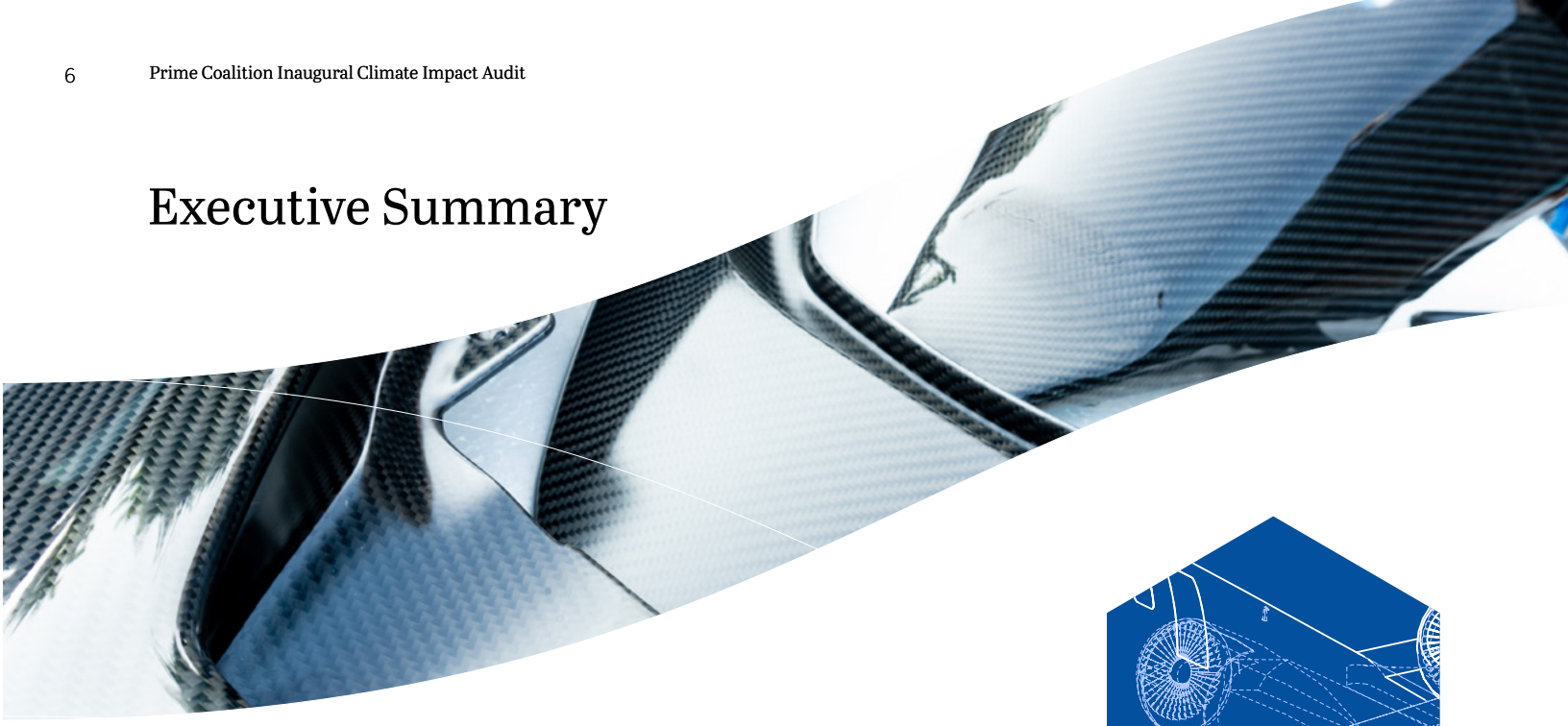
Table 1: Prime's porfolio companies (as of June 2020)

Company	Description	Investment date and mode (syndication/PIF)	Type of company (product/ service) and type of climate impact (direct/indirect)[4]
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

[4] 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

Executive Summary



Prime analyzes the ERP of each of its portfolio companies as part of the due diligence process, to ensure that Prime invests only in companies that meet its climate impact threshold. Prime's approach to conducting ERP analyses follows its in-house methodology published in a 2017 report with NYSERDA.

The CEA audit team worked through ERPs for each of Prime's portfolio companies to develop a thorough understanding of how the ERPs were constructed, what assumptions were made, what inputs were used, what parameters were tested through sensitivity analysis and/or model scenarios, and whether the ERPs were true to the methodology in the Prime-NYSERDA report. CEA found the following commonalities across our assessment of the individual ERPs.

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%)[5] • 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[6] • Identifying the parameters that have the largest error bars • Considering the potential future progression of displaced products' emissions

[5] 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.

[6] "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.

Additionally, the audit looked across the portfolio of ERPs to assess for consistency in application of the methodology and to reflect on portfolio-wide learnings from Prime's experience in developing ERPs. The audit answered a number of high-level questions. The findings are summarized in the rest of this report and are discussed more completely in the full report.

The high-level questions are as follows:

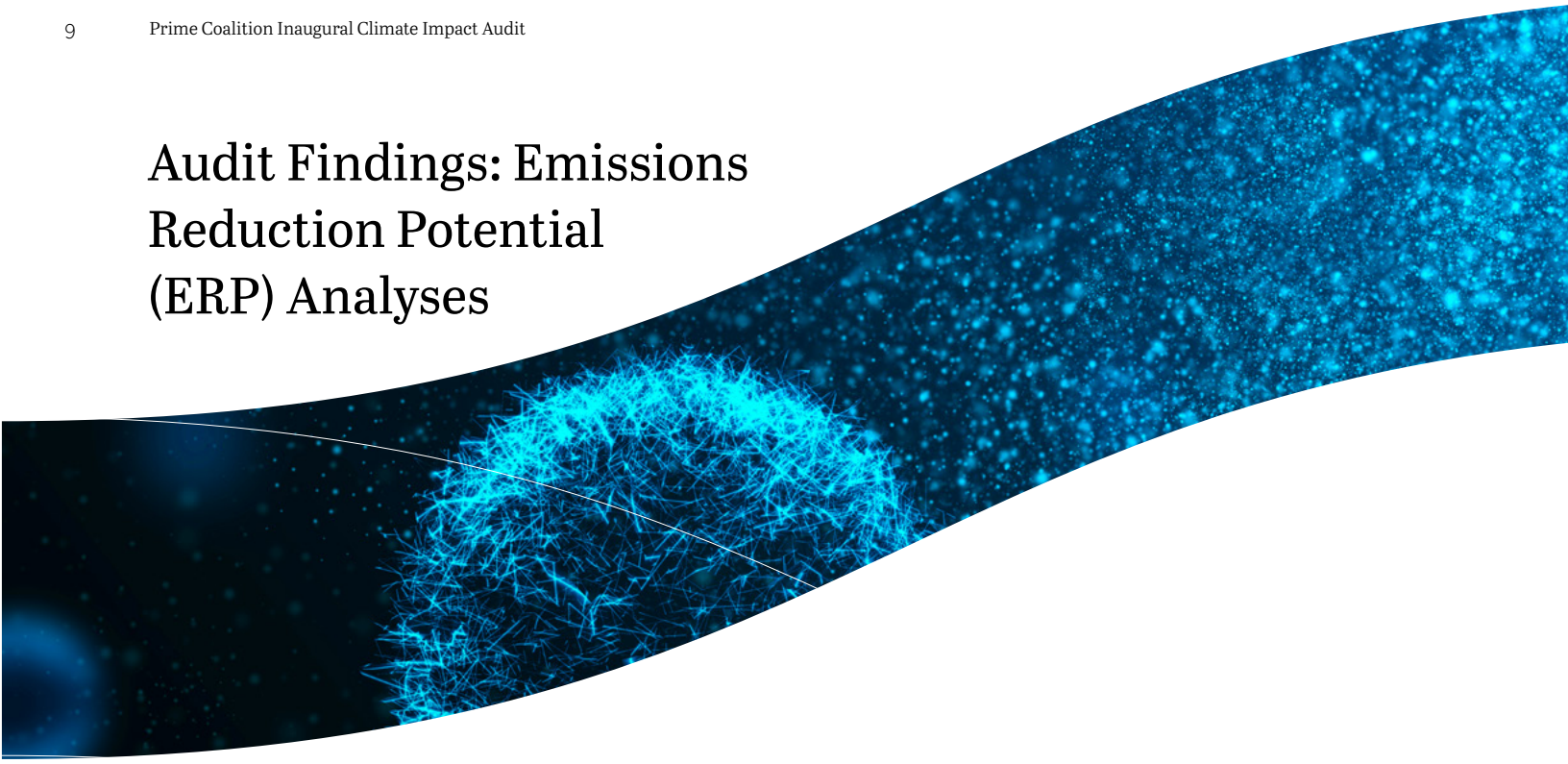
1. Do ERP calculations document all assumptions in a consistent manner across the portfolio? (link)
2. Are there agreed-upon standards for data sources that the ERPs use? (link)
3. Do ERP calculations follow consistent principles in defining target markets? (link)
4. Do ERP calculations follow consistent principles in defining the S-curve of market adoption for scenarios that model commercial-scale deployment of the company product? (link)
5. Do ERP calculations follow consistent principles in assessing uncertainty? Given the hindsight of five years, are there any lessons learned about how to effectively handle uncertainty in ERP calculations? (link)
6. 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? (link)
7. How does use of ERPs in the decision-making process compare with leading peer investor organizations, including with respect to handling uncertainty? (link)
8. Are ERP calculations at sufficient arm's length from the Investment Team? Are any internal organizational improvements recommended for ERP calculations? (link)
9. Does Prime's approach to assessing investment additionality reflect the best thinking or best practices across peer organizations? (link)

Finally, the audit team made recommendations to Prime based on the findings of the audit. These recommendations are summarized at the end of this document and are discussed more completely in the full report.

In brief, the recommendations are as follows:

1. Use the ERPs to deliver actionable insights into the companies and the conditions required for climate impact (link)
2. Develop an “applied methodology” to guide ERP modelers on key elements of ERP modeling (link)
3. Use the CRANE online software tool at various steps in the diligence process and ERP development (link)
4. Standardize diffusion curves (link)
5. Add an expected value analysis to help address uncertainty (link)
6. Consider adding a diligence step for companies for whom the ERP demonstrates a potential for additional emissions (link)
7. Standardize the ERP parameters and update these forward-looking parameters regularly (link)
8. Integrate ERP, CIM, and ERR analyses (link)
9. Adjust some process and ownership protocols, such as by encouraging greater front-end consultation between ERP modelers and the Investment Team and by housing ERP modeling and related activities under the Partnerships Team (link)

Audit Findings: Emissions Reduction Potential (ERP) Analyses



ERP Overview

Prime analyzes the ERP of each of its portfolio companies as part of the due diligence process, to help ensure that only companies that meet Prime's climate impact threshold (cumulative GHG emissions reductions of at least half a gigaton of carbon dioxide equivalent ("CO_2e") by 2050) receive investment. Prime's approach to conducting ERP analysis follows its in-house methodology published in a 2017 report with NYSERDA.

Prime's climate impact threshold is that each company it invests in must have the potential to reduce at least half a gigaton of CO_2e by 2050.

The methodology outlines five key modeling steps:

1. Estimate the emissions of the product displaced
2. Estimate climate impact additionality[7]
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

Many challenges are inherent in developing ERPs, especially for early-stage companies like the ones that Prime targets. The most common challenges are data limitations, uncertainties associated with projecting out over a 30-year time horizon, 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.

[7] In this context, climate impact additionality refers to the GHG emissions that have been displaced and *that would not otherwise have been displaced* if 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.

Summary of ERP Audit Findings: Individual ERP Review

The CEA audit team worked through ERPs for 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 methodology in the Prime-NYSERDA report, and consistency across the portfolio. CEA found the following commonalities across our assessment of the individual ERPs.

1. Relative areas of strength:

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 almost all produce results that meet or exceed Prime's gigaton threshold for climate impact.

2. Relative areas of weakness

The ERP models do a consistently poor job of:

a. Providing justification for S-curve parameters;[8]

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:

The ERP modelsdo 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%);[9]

e. Using robust sources to support inputs and assumptions; and,

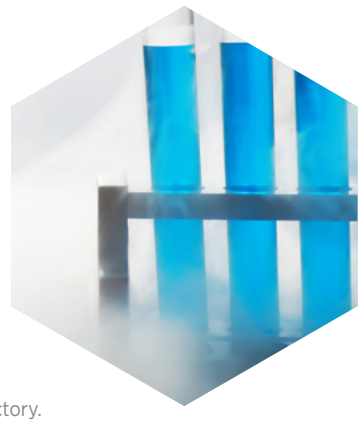
f. Producing models that (in the auditors' estimation) are sufficiently robust to provide evidence of gigaton-scale impact (a key investment criterion).Prime analyzes the ERP of each of its portfolio companies as part of the due diligence process, to ensure that Prime invests only in companies that meet its climate impact threshold. Prime's approach to conducting ERP analyses follows its in-house methodology published in a 2017 report with NYSERDA.

One of the most important findings of this audit is that the ERPs may be underutilized by Prime and by the companies.

KEY TECHNICAL TERMS

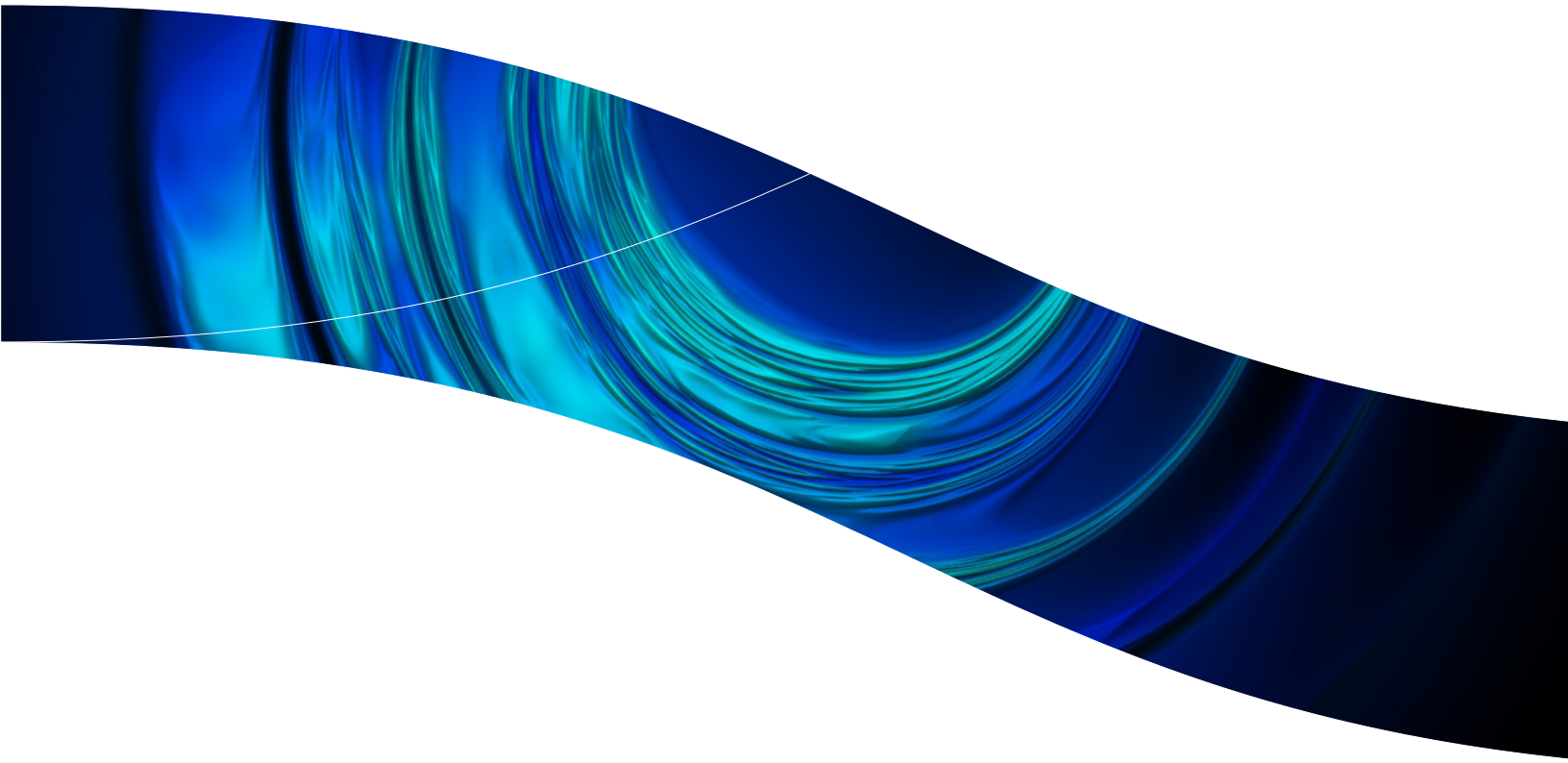
Sensitivity analysis: The practice of testing how certain outputs are affected by changes to certain inputs. For example, a Prime ERP may conduct sensitivity analysis to determine how much emissions reductions would change based on different emissions intensities of a company's product. Sensitivity analysis 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."



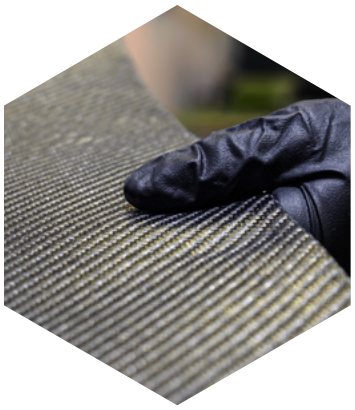
[8] The term "S-curve" refers to a technology diffusion model whereby market adoption follows an S-shaped trajectory.
[9] Here "M" refers to the ultimate market penetration of a given technology, as discussed in a later section of this report.

Beyond these overall strengths and weaknesses, 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. With minimal further investment in modeling standards and formatting, these types of insights could be more easily gleaned from the ERP modeling process. Many of the following recommendations would support a shift in this direction. To support making greater use of the ERP analyses as ongoing management tools, the audit team also sees value in updating the ERPs on a periodic basis (we recommend annually), but doing so through a focused analysis of four to five key parameters.



Summary of ERP Audit Findings: Portfolio-Level Review

1. Do ERP calculations document all assumptions in a consistent manner across the portfolio?



The audit team suggests providing a summary/assumptions tab at the front of each ERP. Putting all of the assumptions in one place in the document would better enable readers to understand the ERP.

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 addition, the models are not generally 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 following information:

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)][10]
- 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. Proojections 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 place in the document 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 in 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.)

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

2. 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 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., International Energy Agency or Environmental Protection Agency) 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

One response to low-quality data sources might be treating the corresponding inputs as key uncertainties and running sensitivity analyses around those inputs.

Because proprietary information from a 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. 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 ERP modelers appear to attempt to secure high-quality data where possible, but the ERPs 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 justifications 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, the modeler should make a practice of checking the CRANE[11] 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. **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 Prime's Investment Team to sign off on such a library so that the members' expert opinion could inform the references selected. For example, the Investment Team may have a view on the growth potential of the electric vehicle 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.

[11] In 2019, Prime turned its in-house ERP methodology into a publicly available, online software tool called CRANE to advance the field writ large. The CRANE tool launched publicly in April 2020 and is free for anyone to use at www.cranetool.org.

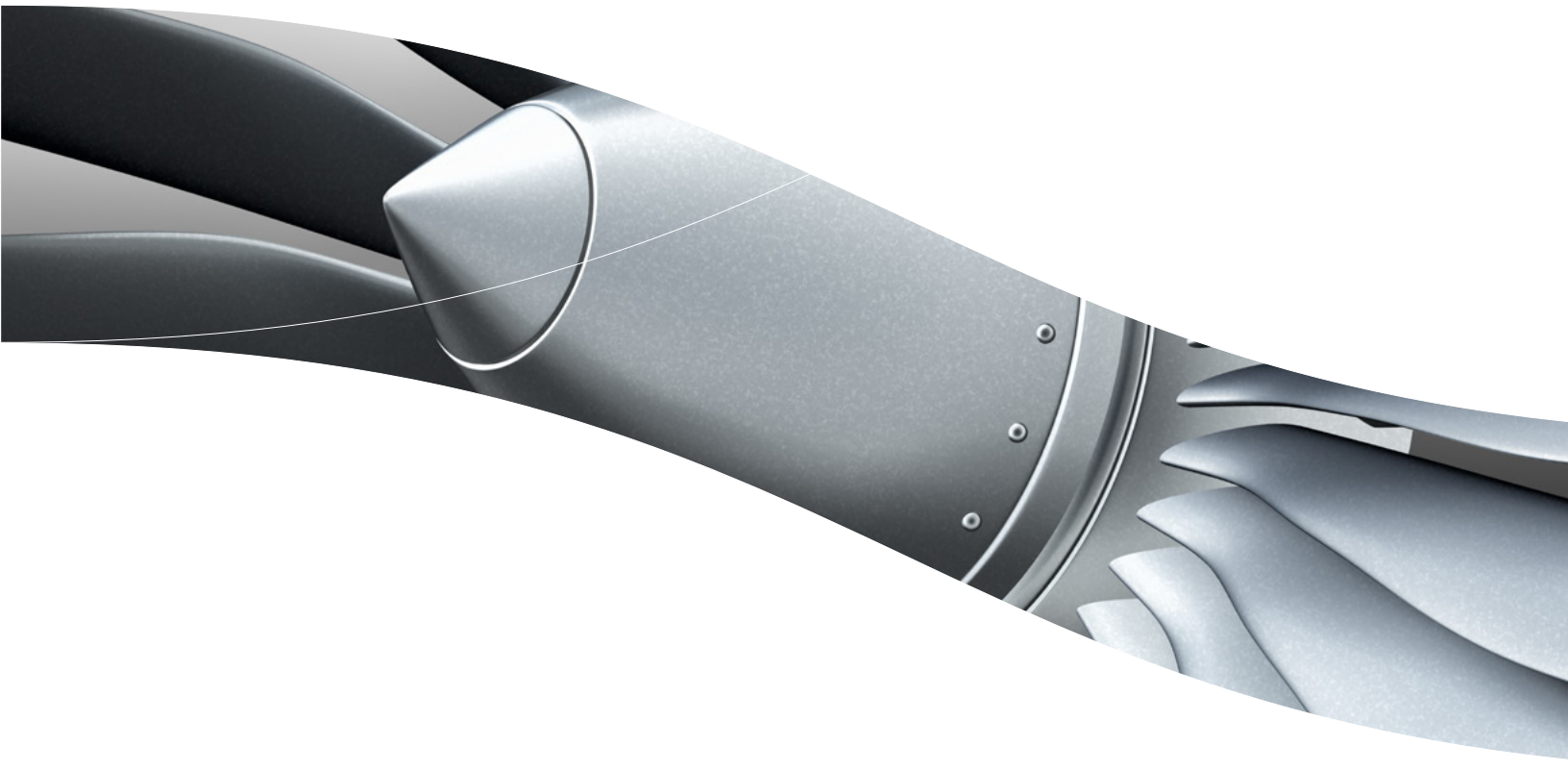
3. Do ERP calculations follow consistent principles in defining target markets?

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 compare 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 the target market is the biggest driver of climate impact for many companies and is also almost always a large driver of uncertainty.

The audit finds that the definition of the 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 ERPs for these companies tend 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, several 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 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. Yet 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 company's expected value of climate impact. 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. 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. Furthermore, the fact that a company's target markets will likely evolve supports the case for updating ERPs periodically (we suggest annually).

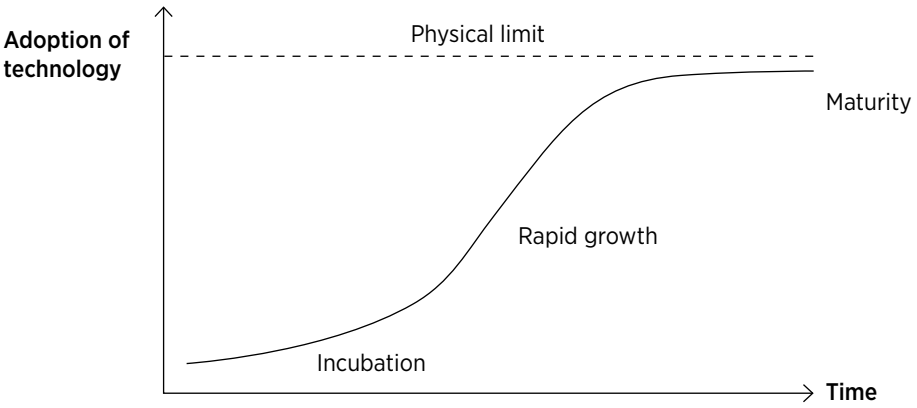
4. **Documentation around target markets should be improved.** Finally, it would be a good practice to ask the ERP modelers to document how and why the target markets were chosen and if there were markets that the modelers wanted to model but for which sufficient data were unavailable. This would allow the Prime team to consider adding new markets to the ERPs if they are updated at a future date.

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. Yet Prime's current approach to modeling potential climate impact in ERPs does not capture this difference.

4. Do ERP calculations follow consistent principles in defining the S-curve[12] 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 will follow an S-shaped curve, following the Prime-NYSERDA methodology. The figure depicts a conceptual S-shaped adoption curve. Empirical evidence shows that many successful products follow 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 use the parameters of historical diffusion curves. However, identifying appropriate companies analogous to 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.

Across the portfolio, three out of 12 ERPs use common parameters for terms k and x (k = 0.7, x = 10 years). A scan of the literature on technology diffusion curves found that the k parameter (slope steepness) often falls between 0.155 and 0.933.[13] 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%.

Determining the value of each of the S-curve variables is one of the most challenging aspects of creating an ERP. It is important to provide justification and documentation of the variables selected for the model.

[12] Also called "logistic curves," "diffusion curves," or "technology diffusion curves."
[13] Christophe Van den Bulte. "New Product Diffusion Acceleration: Measurement and Analysis." *Marketing Science.* Fall 2000. Vol. 19, No. 4.

Likewise, Prime's ERP methodology prescribes setting M at 100%, since ERPs are intended to model *technological potential* rather than the market share of a specific company. However, only four of 12 ERPs reviewed set M = 100%. Part of the tension between the approach recommended in the Prime-NYSERDA methodology and the approach actually adopted in many ERP models may be that many of the ERPs define markets so broadly 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.

Prime should consider establishing either one standard set of diffusion curve parameters, based on 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 the modeler's subjective understanding of a company's trajectory and/or analogous companies/technologies. The latter practice is employed by one of Prime's peer investment funds. 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 occur, but in these cases the modeler should document a rationale in the ERP model.

Prime should consider establishing either one standard set of diffusion curve parameters, based on 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 the modeler's subjective understanding of a company's trajectory and/or analogous companies/technologies.

5. Do ERP calculations follow consistent principles in assessing uncertainty? Given the hindsight of five years, are there any lessons learned about how to effectively handle uncertainty in ERP calculations?

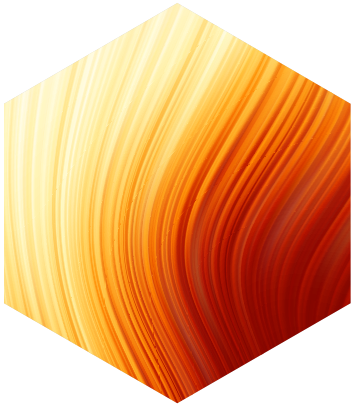
Most of the ERP models use a consistent modeling approach in that they all follow the Prime-NYSERDA methodology and model technical potential, and they use an S-shaped curve to project market penetration. Most of the ERPs have two or three scenarios ranging from conservative to upper bound. These alternative 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 ERP models 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 ERP models 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 most of the parameters in the respective models that are important as climate impact drivers or that involve a lot of uncertainty. None of the ERPs provide any narrative discussion of their findings, identify which parameters have the biggest impact on the ERP, or explain which of those parameters face the greatest 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.

There is little consistency in how the ERP models 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.

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 an opinion and/or require the expert input of the company leaders or the Investment Team. In this area, the audit team believes more communication between the ERP modeler and Prime's Investment Team would be appropriate, as discussed further below.

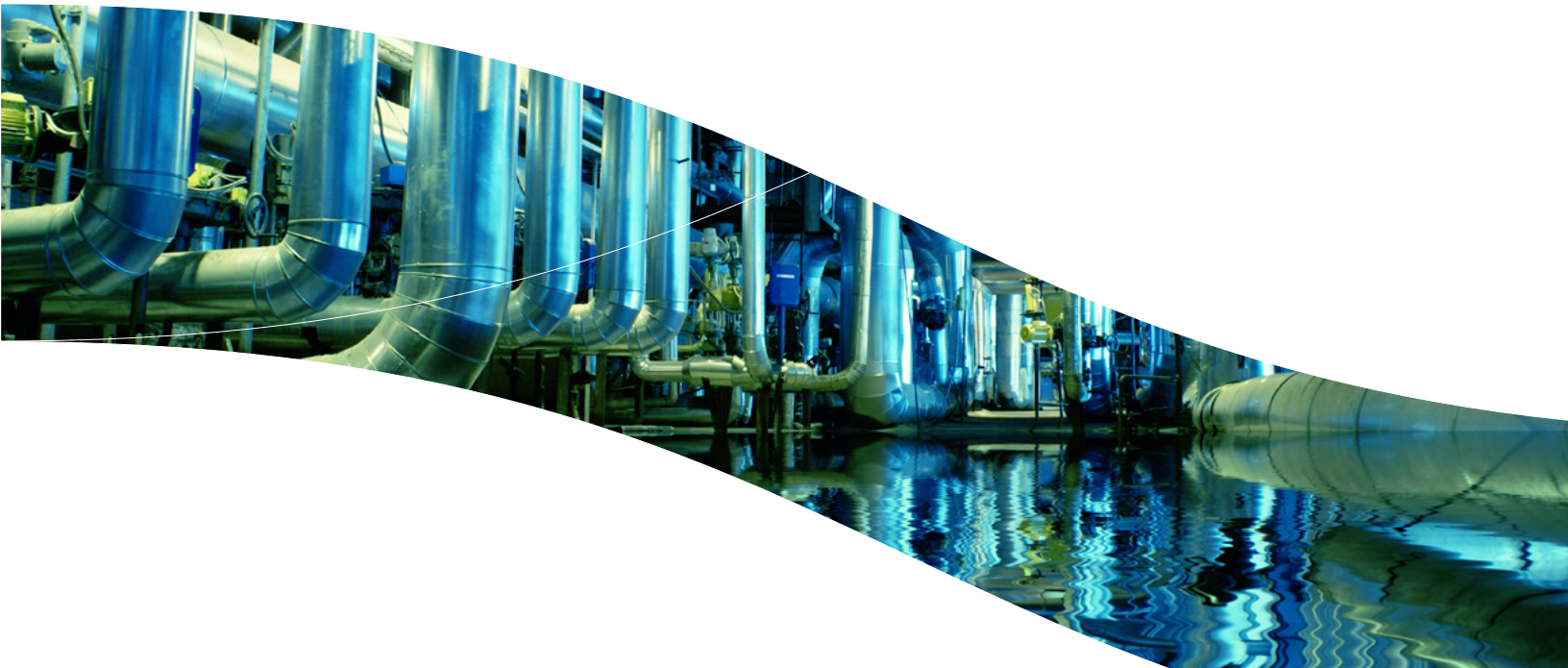
The ERPs appear to be used almost exclusively to determine whether the company/technology has the technical potential to exceed Prime's gigaton threshold. With a marginal amount of further effort, the ERPs could become much more useful management tools, particularly with respect to their role in assessing 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 select 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?"



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.

Furthermore, certain companies in the portfolio have ERPs that show at least one possible scenario in which the company generates net increases in emissions. In one case, the risk of additional emissions would arise from an endogenous technology and/or operational failure. In another, that risk 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 open 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 should 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.



6. 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?

Prime's ERP methodology provides a useful framework and set of guiding principles for ERP analyses and has helped to standardize the ERP approach. 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. Now that Prime has five years of ERP modeling under its belt, an addendum to the methodology in the Prime-NYSERDA report could be developed for Prime's internal use 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. We think four areas are critically important to robust and useful ERPs, and we believe Prime can improve on these areas without much effort.

1. **Scenario construction** – As described above, 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. The audit team recommends establishing a process whereby the ERP modeler, the company, and the Investment Team select the key parameters 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 articulated, "We spend our time on what we trust the least."

2. **Defining target markets** – While the Investment Team, Prime Board members, and the Prime-NYSERDA methodology broadly agree that the ERPs should model an upper-bound technical potential and that this is operationalized by setting M = 100%, defining the target market is not always straightforward. Defining target markets is especially challenging for platform technologies because there are often data limitations or simply a desire not to overcomplicate models unnecessarily. The audit team thinks that the current approach of modeling only a sub-set of markets is practical, although if the ERP models markets that are unlikely to be reached until a late phase of the company's development, then some kind of 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. The rule of thumb seems to be that the market should be defined as wherever the product is technically viable, but markets vary in their complexity and accessibility. Here again, the expected value analysis may help normalize the analyses.

3. **Diffusion curve parameters** – Clearer guidance and more standardization should be provided for diffusion curve parameters. Providing ERP modelers with 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 ERP analyses.

Now that Prime has five years of ERP modeling under its belt, an addendum to the methodology in the Prime-NYSERDA report could be developed for Prime's internal use 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.

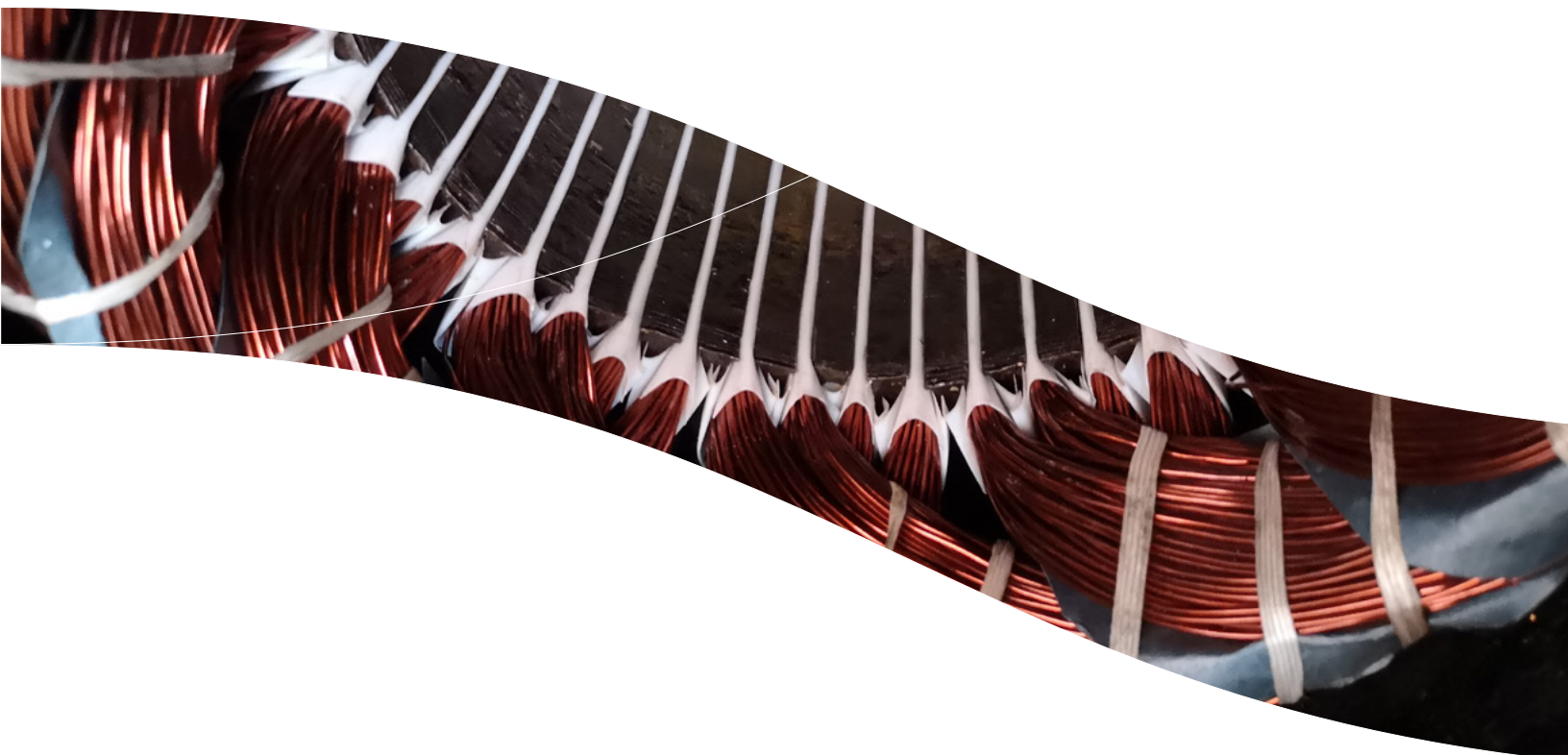
Guiding principles, or at least a clearer process, for determining which parameters to test through the scenarios and any additional sensitivity analyses would help the ERPs to generate more consistent, transparent, and useful insights.

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 reduction 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 is often 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 important given the high level of uncertainty in these indirect pathways.

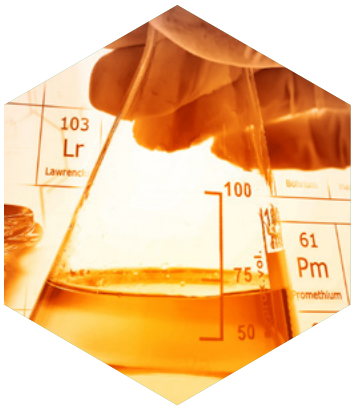
7. How does use of ERPs in the decision-making process compare with leading peer investor organizations, including with respect to handling uncertainty?

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 conduct some kind of ERP modeling. Please visit the full impact audit for more information.

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 and selecting S-curve parameters. 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 the expected value analysis could be a useful addition to Prime's analysis that should not require much additional modeling effort.



8. Are the ERP calculations at sufficient arm's length from the Investment Team? Are any internal organizational improvements recommended for ERP calculations?



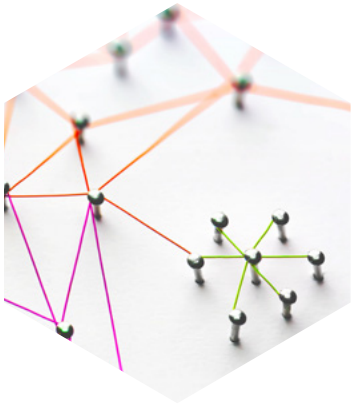
Prime's Partnerships Team is responsible for conducting ERP analyses before investment, with the goal of separating the assessment of climate impact potential from more traditional steps in the diligence process. Based on the audit team's review, the ERP calculations are clearly conducted at arm's length from the Investment Team. The ERP modelers appear to have more dialogue with the company leaders than with the Investment Team, which is appropriate since the companies are experts on their products and their markets. In the view of the audit team, however, 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, Prime's 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 climate impact, and this could help the Investment Team and companies actively manage these drivers.

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, 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 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. 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.

9. Does Prime's approach to assessing investment additionality[14] 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 "additionality test" in the additionality assessment the Partnerships Team prepares for every company it considers for investment. This includes more information on the circumstances of the funding round in question, and a survey from its Investment Advisory Committee, which is made up of leading clean-tech and renewable energy investors. Among other things, a subset of this group opines on whether the company in question would be likely to secure sufficient investment from conventional sources of capital 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. However, none of the peer organizations interviewed conduct specific analyses to assess investment additionality. In this sense, Prime's approach represents best practice. 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 audits.

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 investment from Prime. These are companies that the Investment Advisory Committee has 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.

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

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. In reviewing the ERPs, we learned a tremendous amount about the companies and "what needs to be true about the world" for them to succeed. The ERPs are 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 Prime's internal use to further guide the ERP modelers on areas where the audit has identified consistent opportunities for improvement. This document could provide guiding principles for key elements of ERP modeling such as standardized diffusion curve parameters, standardized reference cases for common sectors, standardized approaches to target market definitions, and protocols for formatting and presenting assumptions and citations, and it could incorporate many of the recommendations that follow.

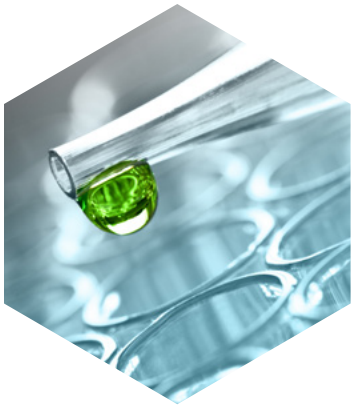
3. Use CRANE at various steps in the diligence process and ERP development.

The auditors determined that Prime should not substitute CRANE for its internal ERP modeling at this time, but we do see a few discrete ways in which Prime could take advantage of the excellent work being conducted with CRANE.

- First, 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.
- Second, CRANE could be used in early stages of pipeline review to provide "back of envelope" calculations on the climate potential of a company. With a few basic inputs, running a scenario in CRANE takes less than five minutes.

4. Standardize diffusion curves.

Diffusion curve parameters vary greatly across the ERPs. Prime should consider establishing either one standard set of diffusion curve parameters based on 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. 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. Prime could take the GHG emissions reduction 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 on 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. 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. Because investing in a company that has the potential to create additional emissions introduces 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. 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.

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. 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 fo 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

These main forward-looking assumptions could be updated regularly. 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 for many years, 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.
- 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. 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.

9. Adjust some process and ownership protocols.

- 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 how the target market(s) should be defined.
- 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 Analyst or Impact Modeler position.

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