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Energy System Transformation for a 1.5°C Future

The Revolution Will Be Digitized

Better Data and Advanced Analytics Are Accelerating the Energy Transition

By: Krutarth Jhaveri
Contributors: Charlie Bloch, Frances Reuland, Madeline Tyson, Caroline Ott

STRATEGIC ENGAGEMENT AND ANALYSIS GROUP

Businesses, governments, and other institutions are facing increasing pressure to mitigate the worst impacts of climate change by dramatically reducing emissions in line with the Paris Agreement. However, the strategists, analysts, and decision makers whose actions will shape the necessary market and policy transformations may be challenged to see past legacy modeling approaches and assumptions. These approaches and assumptions capture neither the massive economic opportunities for early movers nor the compounding risks of being left behind.

To strengthen this interface, RMI is releasing a series of insight briefs to help demystify the available tools for 1.5°C alignment, identify critical gaps that require complementary approaches, and highlight emerging opportunities to reinvent the future. **These insights are bound by our assessment that a rapid transition to a low-carbon energy system is not only achievable, but also a source of growth, prosperity, and benefit for all.**

This insight brief explores the role of data and analytics in dramatically accelerating the energy transition and helping limit warming to 1.5°C. This market catalyst is rooted in the exponential growth of data and advanced data science tools that can enable corporations and policymakers to seize economic opportunities in a climate-aligned future.

As decision makers demand better data to drive climate action, solution providers are developing increasingly powerful data applications to meet their needs. Using illustrative examples, we demonstrate how the rapidly evolving global energy-climate-economic data landscape is catalyzing change by increasing transparency, quantifying physical and transition risk, uncovering new value streams, and speeding decision-making.

A Fertile Environment for Fast Action

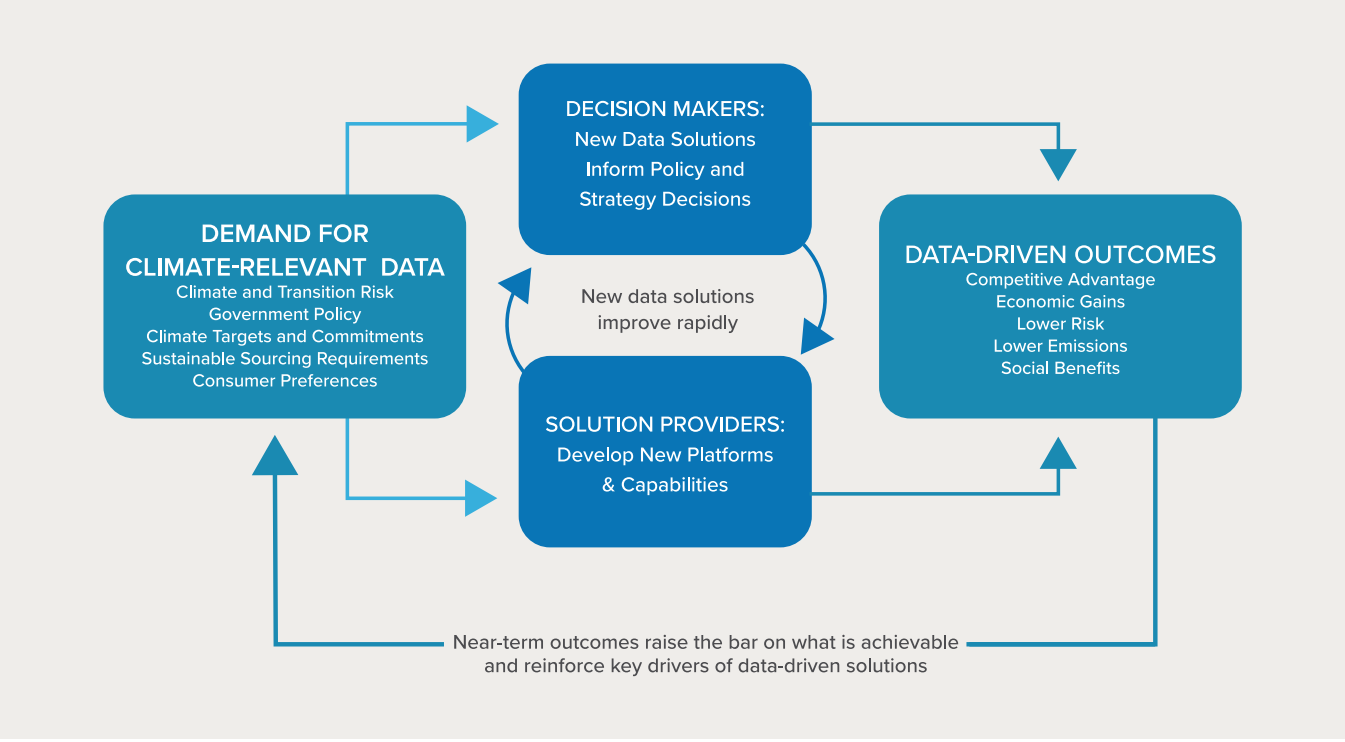
From one-click online shopping to discovering new planets to tracking the spread of global diseases,[1] data's disruptive juggernaut has already transformed various global systems including consumer retail, media, education, and healthcare.[2] This so-called Fourth Industrial Revolution fuses the digital, physical, and biological worlds, and leverages advancements such as artificial intelligence, cloud computing, robotics, and the Internet of Things (IoT) to create the perfect storm for radical disruption.[3] **These forces are similarly driving transformative shifts in the economy and energy system that will play a critical role in rapid 1.5°C-aligned decarbonization.** This is enabled and accelerated through a combination of the increasingly transformative power of data and the ability of solution providers to rapidly meet demand for new data applications.

Decision Makers Demand Climate-Relevant Data

Demand for climate-relevant data solutions has been growing in response to policy, market, and economic signals (Exhibit 1). Consumers are willing to pay a premium to align purchases with their values.[4] Investors backing more than $10 trillion of assets are demanding more climate-risk disclosures.[5] Pressure for corporate decarbonization targets and pathway development is growing, with executives from over a thousand companies already having joined the Science Based Targets Initiative.[6] Governments are setting up data exchange platforms such as City Data Exchange (Copenhagen) and SMARTNET (India) to build community networks of action.[7] Supply chain transparency is becoming increasingly critical due to sustainable sourcing requirements.[8]

EXHIBIT 1

The Multiple Benefits of New Climate-Relevant Data Solutions Will Drive a Reinforcing Feedback Loop of Increased Demand and Innovation that Will Rapidly Accelerate the Energy Transition.



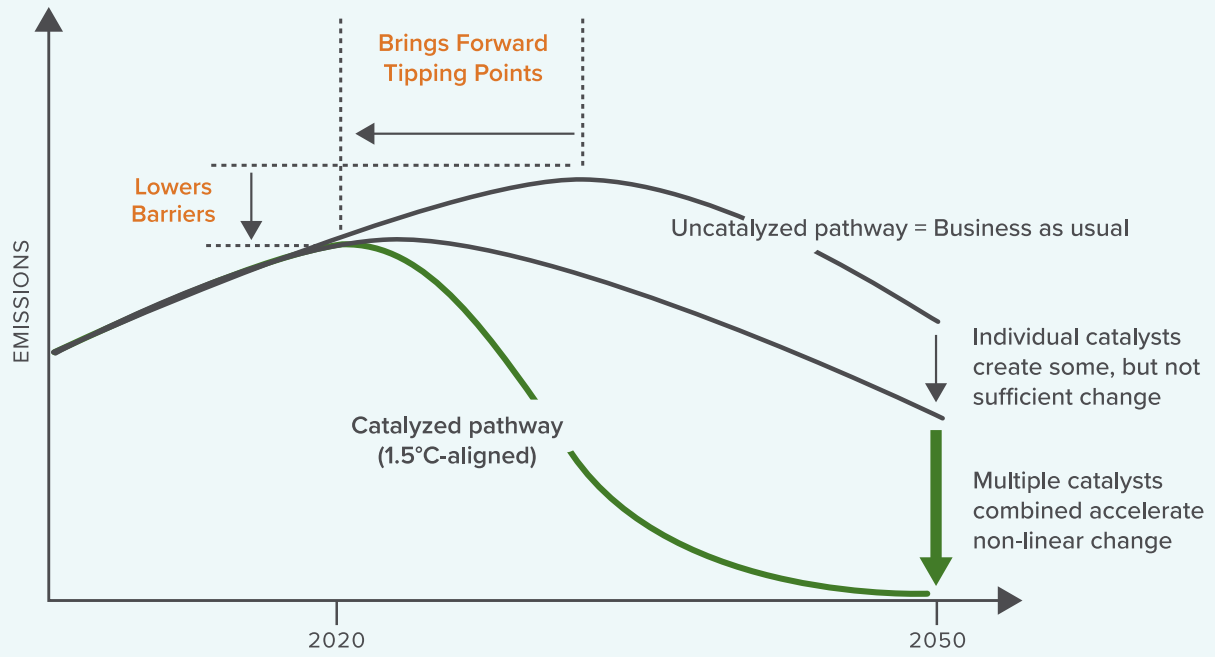
As policymakers, corporations, and financial institutions respond to these signals, data and advanced analytics are enabling bolder action and faster decisions by reducing uncertainty and providing more rapid feedback. Those that leverage data appropriately are better poised to capture the energy transition's economic opportunities through better informed decision-making, reduced uncertainty, and increasingly efficient operations. Those that don't will be exposed to the risks of being left behind.

Market Catalysts for a 1.5°C-Aligned Energy Transition

The energy-economic models typically used to develop long-term climate scenarios don't fully consider the effect of a set of forces that will accelerate the pace of the clean energy transition. These "market catalysts" are often excluded from models and scenarios precisely because of the complexity and uncertainty surrounding their impact on changing systems. However, just as chemical catalysts speed up reactions by lowering barriers and crossing activation energy thresholds, these market catalysts are critical enablers of the pathway to a decarbonized future (Exhibit 2).[9] RMI has identified six such catalysts that we believe are instrumental to a rapid energy transition: data and transparency, finance, technology, business models, education and capacity building, and policy.

EXHIBIT 2

Market Catalysts Can Help Accelerate the Energy Transition onto a 1.5°C-Aligned Pathway.



Capturing Climate *and* Economic Benefits

The digital age has created a fertile environment for corporate and policy decision makers to harness the energy transition in ways that simultaneously benefit businesses, customers, society, and the climate. Increasingly, much of the existing business, consumer, and social data we encounter can help quantify energy-related carbon emissions and reduction potential. Exhibit 3 provides a framework characterizing some of the most compelling applications of climate-relevant data that straddles business, policy, and climate decision-making.

EXHIBIT 3

A Simplified Framework for Climate-Relevant Data Applications and Key Decision Makers

Climate-Relevant Data Applications

Target setting and pathway development
Identify and set emissions reduction targets and develop climate-aligned pathways

Product differentiation/sustainable procurement
Foster market creation for low-carbon products with increased supply chain transparency

Business intelligence
Inform climate-smart decision-making around asset management, organizational strategy, and operational efficiency

Reporting and accountability
Comprehensively identify and report where emissions are occurring, and hold emitters accountable

Risk management
Evaluate and align portfolios with climate-safe pathways

New business models and technologies
Enable new technology solutions and business models to further accelerate decarbonization pathways

Decision Makers Driving Demand

Policymakers
National and subnational

Financial Institutions
Asset managers, insurers, lenders, investors

Corporations & Industry
Companies, OEMs, suppliers, vendors, distributors

Consumers
Institutional (B2B) and individual (B2C)

A few illustrative examples of these applications follow, highlighting how decision makers across sectors and geographies are leveraging enhanced data analytics to capture climate-aligned opportunities in the energy transition.

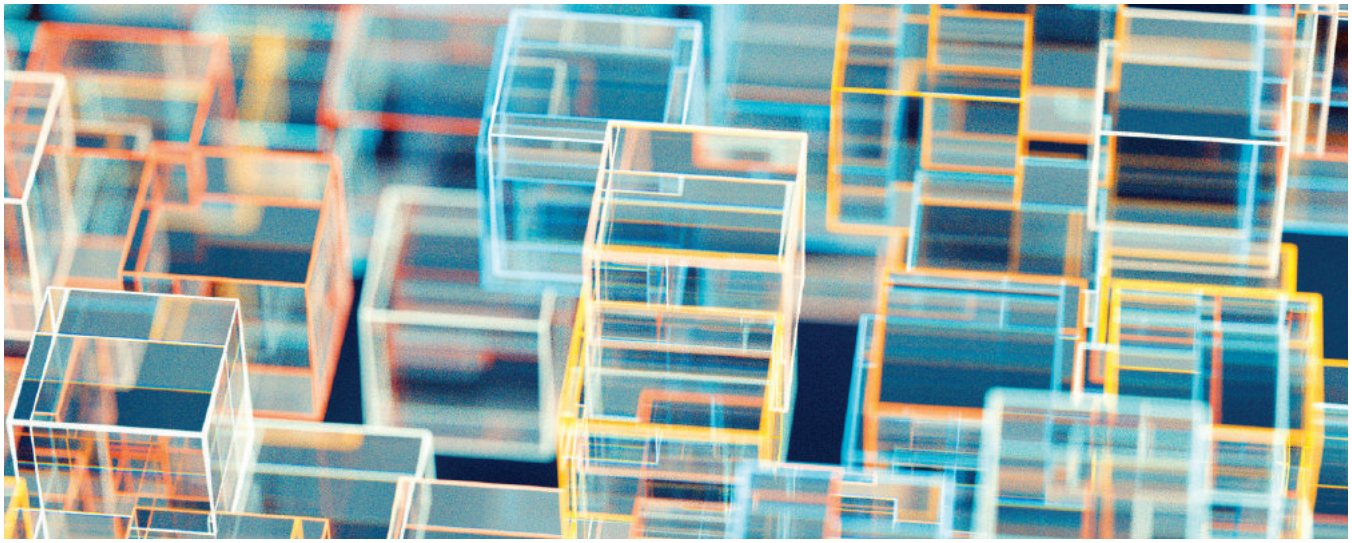
Tesla: Driven by Big Data and Machine Learning

In 2020, Tesla became the world's most valuable automaker, with a market value currently exceeding $500 billion. Tesla's strategic advantage comes not just from its efficient electric drivetrain technologies and advanced battery systems, but also from its ability to collect and process vast amounts of data to continually improve its products and enhance customer experience.

By analyzing vast amounts of data collected from its cars (driving speed, mileage, vehicle location, and other performance metrics) via machine learning algorithms, Tesla is able to quickly improve its vehicle system and driving outcomes.[10] It also uses vehicle data and connectivity to provide product improvements (fixing overheating issues) and implement new features (adding self-driving capabilities) through wirelessly transmitted software updates.[11] Through these Over the Air (OTA) updates, Tesla precludes the need for customers to bring in their car for certain types of services—saving servicing costs, customers' time, and emissions by avoiding hundreds of thousands of vehicle miles driven.

Scaling Fast

The global EV market is expected to exceed $1 trillion before 2030, a compounded annual growth rate of almost 20%.[12] Bloomberg New Energy Finance predicts that EV sales will rise to nearly 60% of the global auto market and will reduce emissions by 2.75 gigatons of CO_2 per year by 2040.[13]



Sustainability Linked Loans: Rewarding Transparency

Sustainability linked loans (SLLs) are instruments that connect financing to sustainability key performance indicators (KPIs). Data transparency is the key enabler here. A company's sustainability KPIs, which can be specific (e.g., greenhouse gas emissions reductions) or broad (e.g., environmental, social, and governance targets), must be measured, reported, and validated. Those that achieve their sustainability targets benefit from favorable interest rates from participating lenders, whereas those that don't receive higher rates.[14]

SLLs allow financing to align with sustainability targets, encourage corporate target setting, incentivize corporations to achieve their targets, and illustrate another way in which climate mitigation can be profitable. Companies from across power, industry, buildings, and transport sectors can leverage SLLs to reinforce sustainability's place in their business strategies. Belgian chemical company Solvay, US power company NRG Energy, South African auto company Motus Holdings, and Dutch conglomerate Philips have all successfully borrowed using SLLs. The release of Sustainability Linked Loan Principles in 2019 by a group of leading market associations underscores the rapidly growing value that institutions (both borrowers and lenders) see in SLLs.[15]

Scaling Fast

The global SLL market grew from $5 billion in 2017 to $137 billion in 2019,[16] and is expected to continue its rapid growth as new standards and disclosure requirements are formalized.[17]

Shenzhen: Delivering Efficiently

Given that freight transport is a major culprit for urban air quality problems, congestion, and excess energy use and emissions, government leaders at all levels increasingly seek to replace internal combustion engine freight vehicles with electric logistics vehicles (ELVs). In Shenzhen, a city in southeastern China, an innovative telematics-based data framework has helped unlock data-driven policymaking. This made the city a leader in achieving exceptional ELV fleet growth and charging infrastructure deployment—ELVs grew from 300 in 2015 to over 70,000 in 2019.[18]

Shenzhen's data platform provides clarity on how ELVs and charging infrastructure are operating. Pairing vehicle utilization metrics with strong stakeholder engagement allows for improved planning and policy evaluation according to observed market needs. For example, consistent metric collection on vehicle days of operation and driving distances reveals how electric trucks and minivans are utilized compared with each other and their combustion vehicle counterparts, directing local policymakers where to site charging infrastructure and how to incentivize ELV use. Subsequent policy interventions and improvements in technology led to a 25% increase in daily driving utilization of ELVs. Additionally, data and metrics based on actual vehicle use patterns are being used to inform infrastructure and land-use planning.

Similar demonstrations of improving logistics through big data are happening across the globe. German logistics company DHL launched its Smart Truck and MyWay initiatives to optimize its last-mile delivery operations, which sometimes exceed 50% of total delivery cost. Through these economically driven efficiency measures, DHL decreased vehicle miles driven and fuel consumption (and therefore emissions) while boosting customer service. These improvements rely on volumes of road traffic, weather, GPS, and real-time traffic data to chart an ideal shipment sequence and route.[19]

Scaling Fast

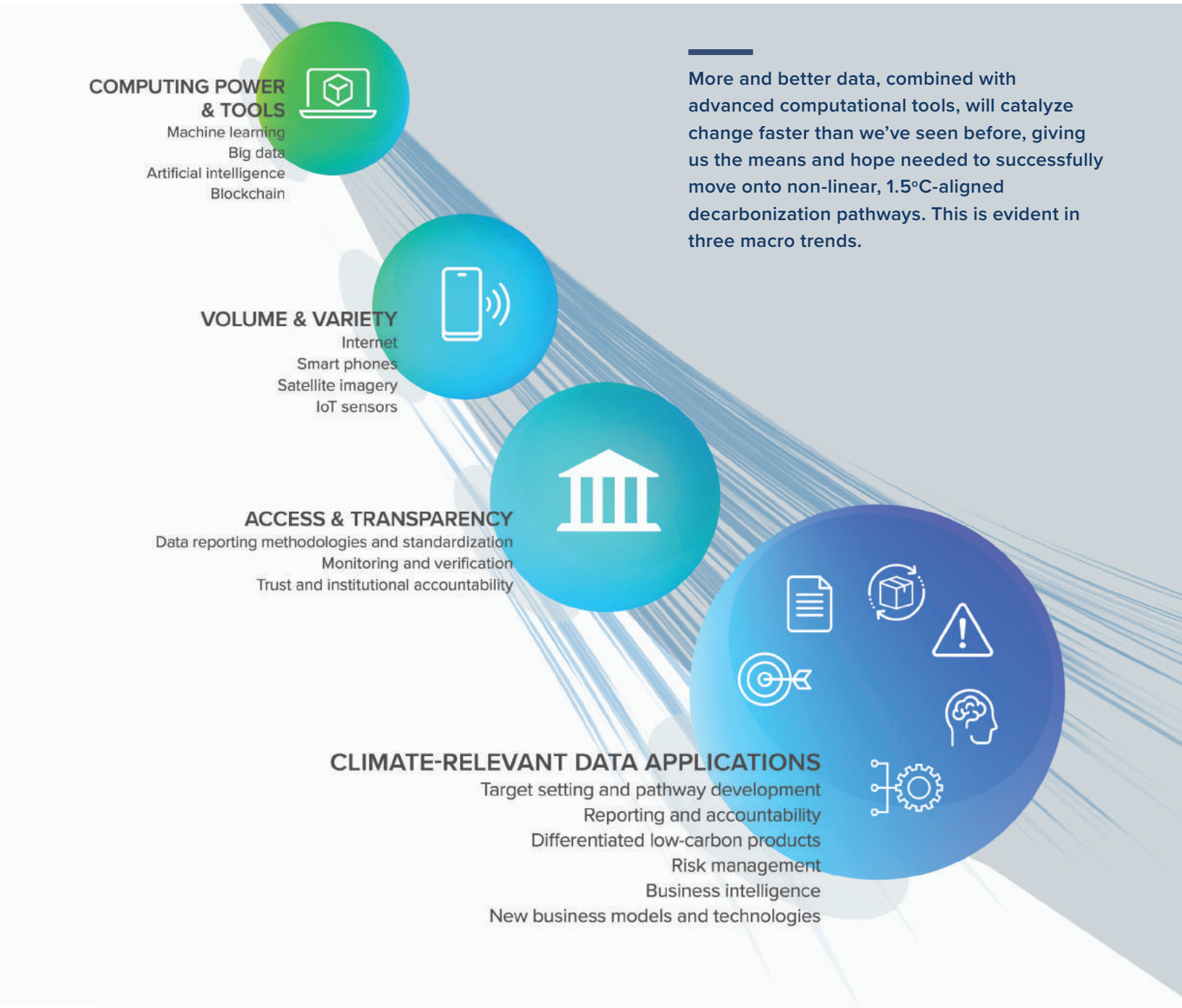
100% electrification in Shenzhen by 2030 will cost-effectively achieve 6 megatons of CO_2 emissions reduction;[20] light- and medium-duty freight vehicles account for 1.5 gigatons of CO_2 emissions globally.[21]

The Transformation Is Just Heating Up

As illustrated above, the evolving landscape of climate-relevant data applications is already transforming the energy system. Simultaneously, rapid proliferation of data and advances in computational capabilities are unlocking new opportunities for policy design, corporate action, and consumer choice to reduce greenhouse gas emissions (Exhibit 4).

EXHIBIT 4

The Data Boom, Complemented by Breakthrough Advances in Technology, Has Unlocked a New Suite of Opportunities for Business and Climate Value Creation.



More and better data, combined with advanced computational tools, will catalyze change faster than we've seen before, giving us the means and hope needed to successfully move onto non-linear, 1.5°C-aligned decarbonization pathways. This is evident in three macro trends.

1. Volume and Variety: Bolstered by technology breakthroughs like the internet, smartphones, satellite imagery, wireless connectivity, and Internet of Things (IoT) sensors, we have more data available to us today than ever before. It is estimated that from 2015 to 2017, humans created nine times more data than in all prior years.[22] New data collection methods and increased awareness of the climate challenge have significantly broadened the types of climate-relevant data being gathered across the entire economy, from energy production to end use, as well as the granularity of data available from rapidly proliferating sensors. These data streams include satellite monitoring of major point sources of CO_2 and methane emissions, near real-time vehicle usage data, supply-chain tracking of carbon-intensive materials, and more.

2. Access and Transparency: The difficulty in connecting individual actions and decisions to their incremental greenhouse gas emissions makes climate change an inherently difficult problem to address.[23] Digitalization, new reporting mechanisms, and public pressure, however, are all playing critical roles in democratizing data by improving transparency and accessibility. This is crucial to enabling data-driven decision-making. Improved data transparency informs choice, increases accountability, reduces uncertainty, and strengthens market mechanisms. Better access to a variety of metrics related to greenhouse gas emissions, physical and financial risks, and asset utilization can help decision makers make more robust decisions and protect against risks. Together, access and transparency will play a lead role in uncovering climate mitigation opportunities and pathways that have so far been obscure.

3. Computing Power and Tools: An exponential increase in processing power (more than one-trillion-fold in the past six decades), combined with advances in analysis tools and methods, has created new capabilities to usefully interpret data.[24] Machine learning, big data, artificial intelligence, and blockchain, cornerstone technologies of the Fourth Industrial Revolution, have allowed us to securely transfer, analyze, and transform massive amounts of diverse data into actionable insights. Their use helps eliminate inefficiencies, reduce time-to-market for technology solutions, improve transparency, reduce uncertainty, and quantify risk, all of which enable more decisive and targeted decisions.

Solution Providers Raise the Bar

As shown in Exhibit 1, this rapidly evolving data landscape and growing demand from decision makers is driving solution providers, including data curators, analysts, developers, researchers, and entrepreneurs, to collect, process, analyze, and present data in novel ways. These emerging platforms are rapidly expanding the climate solutions space for decision makers who aim to transition their portfolios and responsibilities toward a prosperous, low-carbon future. They also reinforce the tremendous potential to shift to a new paradigm where emissions reductions are increasingly synonymous with profitable business strategy and economically sound policymaking.

The earlier examples highlighted how organizations are using existing data capabilities to capture new opportunities in the energy transition. Below, we illustrate how solution providers are leveraging new data-driven approaches to deliver ever-more-powerful tools that allow decision makers to identify and execute strategies for profitable climate-aligned action.

WattTime and Climate TRACE: The More You See, the More You Can Do

WattTime—a California-based non-profit and RMI subsidiary—leverages data transparency, smart connectivity, and machine learning to reduce emissions related to electricity use.[25] The company's Automated Emissions Reduction (AER) technology uses real-time grid data on power plant emissions to synchronize the usage of connected smart devices with times of clean energy generation, thereby lowering emissions. The platform's full potential, however, lies in its ability to enable a variety of other applications such as low-emissions electricity rate structures, electricity-related carbon accounting and reporting, regulatory compliance, and demand-response program integration. This provides a striking example of how identifying multiple potential use cases helped support an altogether new data collection platform.

Following on this approach, WattTime recently co-founded Climate TRACE—a global collaboration to bring unprecedented transparency to all human-caused greenhouse gas emissions using state-of-the-art satellites and artificial intelligence. The initiative was named one of *Time* magazine's Best Inventions of 2020.[26]

Cervest: Science-backed Climate Security Tools

Cervest—a London-based data and analytics firm that assesses climate risks—seeks to democratize climate knowledge and tools to equip policymakers, enterprises, and consumers in their decision-making.[27] The idea was prompted by evaluating climate risks to farms in Ghana, and now applies to all types of natural and built assets, such as power stations and hotel chains. Cervest combines open access data (e.g., asset locations, weather and climate pattern data, and emissions data) with advanced computational tools and statistical science techniques to develop asset-level climate risk signals. These signals span from extreme temperature and precipitation to wildfire.

Cervest also de-silos risk signals; in the company's view, near-term, physical damages should not be wholly separate from adjacent risks. For example, its approach allows hotel owners to understand impending flood risk to their properties, while also assessing the longer-term risks to the energy, water, and waste systems to which their buildings are connected. By providing more granular quantification of asset-specific climate risk, the platform also empowers policymakers and financial institutions to make better informed policy and investment decisions. Aided by a partnership with the Alan Turing Institute, Cervest harmonizes across multivariate data sources, offering solutions to complex climate security questions that society will increasingly face.

Circulor: Dematerializing and Decarbonizing

Sustainable and ethical sourcing of materials is a long-standing challenge for corporations. Circulor—a UK-based company focused on supply chain transparency—provides traceability-as-a-service to verify responsible sourcing, bolster recycling, and improve efficiency. This helps solve for the once near-impossible task of tracking materials and individual product components across complex global supply chains.[28] The novel business model leverages the power of blockchain and other supporting digital technologies by creating secure, verifiable, and dynamic digital identities of materials as they pass through various supply chain processes—all without the need for physical checks at every stage.[29]

Circulor tracks a wide range of metrics, including associated emissions, water footprint, and ethical factors such as child labor. This level of granular and accurate data on material characteristics can boost accountability throughout the supply chain, from the mine all the way to the material's disposition or next application (if recycled). The platform underscores the connected business and environmental values of building more robust and resilient systems enabled by data: reducing liability risk by better managing high-risk materials, identifying inefficiencies along the supply chain, tracking and reducing emissions, and reducing new material extraction by promoting recycling. Already, this platform has seen early applications led by governments (e.g., Rwanda) and corporations (e.g., Volvo, Mercedes-Benz) to transparently track metals like cobalt (used in electric vehicle batteries) and Tantalum (used in smartphones and laptops).[30]

Opportunities to Leverage Climate-relevant Data

Decision makers can accelerate the adoption and use of climate-related data solutions and begin to capture the economic and emissions reduction potential they unlock by focusing on the following opportunities:

Policymakers at all levels should leverage data to set specific and quantitative targets and adopt frameworks that require greater tracking and transparency of climate-relevant data. Clearly defining their assumptions and plans to limit emissions within a given timeframe (e.g., nationally determined contributions or science-based targets) encourages both government agencies and private-sector actors to develop the data and analytic tools to quantify emissions and develop reduction strategies. Mandating disclosures from corporations and financial institutions on physical and transition risk can help bolster demand for new carbon transparency data solutions. Adopting climate-aligned public procurement strategies such as the Green Public Procurement initiative by the European Union can stimulate growth and transparency of low-carbon supply chains.[31]

Better data also allows policymakers to track progress, demonstrate tangible benefits from their actions, and quickly adapt to changes in the system. Additionally, it can help policymakers synchronize and align climate efforts with other priorities such as public health, social welfare, job creation, and equity.

Corporations can seize profitable decarbonization opportunities while significantly reducing climate-related asset risk by incorporating relevant data, targets, and risk metrics into strategic decisions. Participating in the Science Based Targets Initiative or following recommendations from the Task Force for Climate-Related Financial Disclosure can help companies align with industry standards and gain access to valuable guidance, tools, and communities of practice. Internally, supporting these targets by adopting data-driven metrics and practices (e.g., internal carbon pricing, sustainability linked compensation) and rigorously tracking progress will allow corporations to get ahead and minimize the risk of getting left behind in the transition.

Digital data solutions can also significantly enhance supply chain transparency and accountability or the development of shared decarbonization roadmaps with value chain partners. Beyond incremental opportunities, better leveraging data on consumer behavior, product performance, and life-cycle emissions can enable companies to offer differentiated products and services that provide both greater value and lower emissions.

Financial institutions can reduce physical and transition-related investment risk and uncertainty as they redefine their portfolios for climate alignment. This includes risks posed to all types of financial institutions, including lenders, asset managers, insurers, and reinsurers. The financial upside presented by the energy transition is massive ($26 trillion in economic benefits through 2030[32]) and institutions can position themselves to capture large economic gains with the help of data and analytics. Going beyond financial metrics and including climate-related risk metrics (a growing area for solution providers) when making portfolio-level investment and divestment decisions will enable robust decision-making, allowing financial institutions to capture new opportunities and avoid pitfalls.

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22830 Two Rivers Road
Basalt, CO, 81621 USA
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