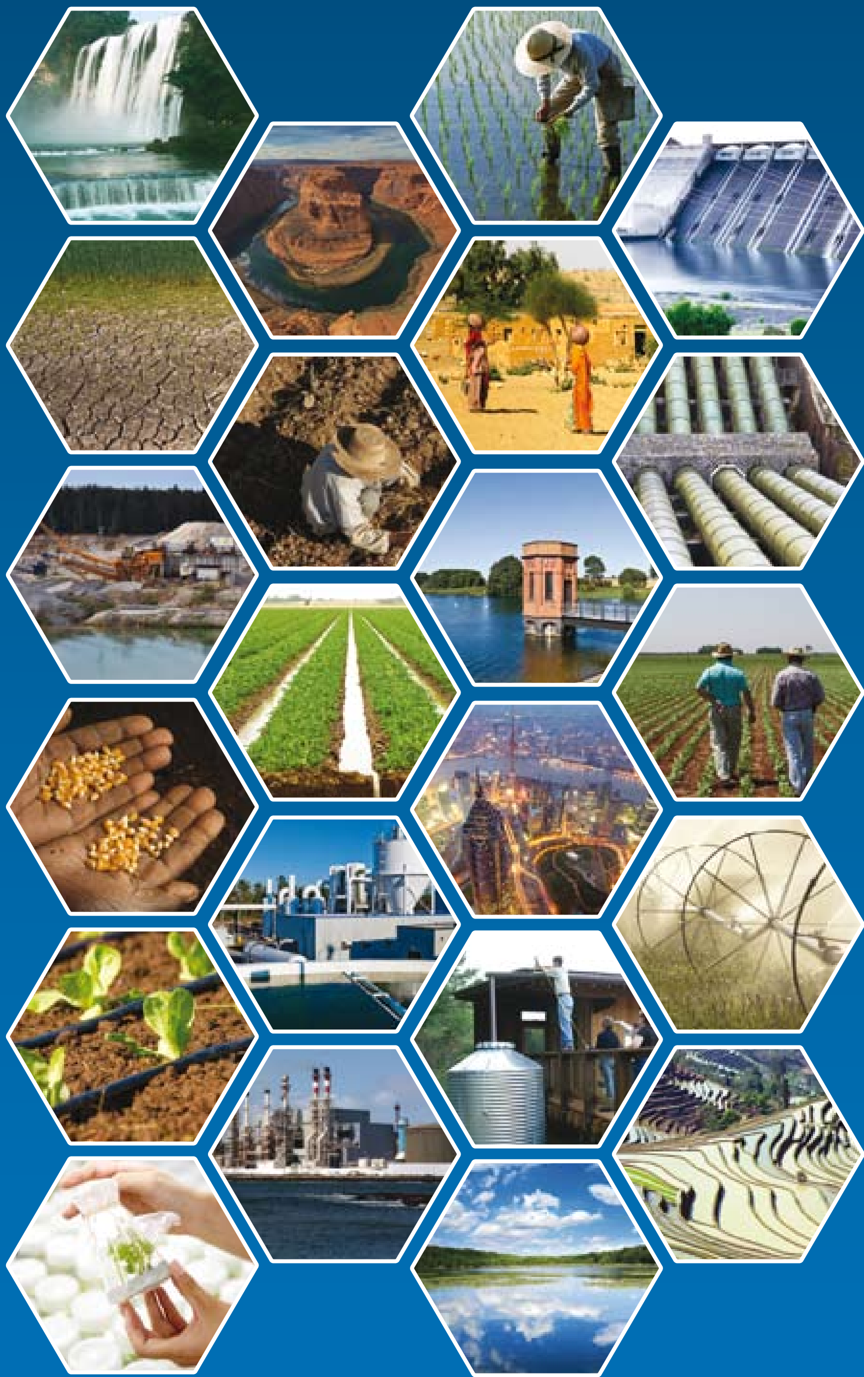
2030 WATER RESOURCES GROUP

Executive Summary



Charting Our Water Future

Economic frameworks to inform decision-making

For more information on this report please use the following e-mail address:
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The 2030 Water Resources Group

The 2030 Water Resources Group was formed in 2008 to contribute new insights to the increasingly critical issue of water resource scarcity. The group aimed to create an integrated fact base on the potential technical levers and costs for reducing water scarcity, with the ultimate goal of advancing solutions-driven dialogue among stakeholders.

The Group consists of a range of organizations from the private and social sectors, which provided the institutional collaboration and counsel needed to tackle this complex topic:

- Initiating sponsorship for the project came from **The International Finance Corporation (IFC),** part of the World Bank Group, which provides investments and advisory services to build the private sector in developing countries. The World Bank also provided substantial input from its experience in the water sector.

- **McKinsey & Company,** a global management consulting firm, provided overall project management, drove the analytical execution and developed the fact base for the report.

- An extended business consortium provided sponsorship, guidance, and expertise. This included: **The Barilla Group,** a global food group; **The Coca-Cola Company,** a global beverage company; **Nestlé S.A.,** a global nutrition, health, and wellness company; **SABMiller plc,** a global brewer; **New Holland Agriculture,** a global agricultural equipment company; **Standard Chartered Bank,** a global financial institution, and **Syngenta AG,** a global agribusiness.

Expert Advisory Group

In addition to the core sponsors, an expert advisory group provided invaluable advice on the methodology and content of this study. The advisory group was composed of:

- **Jamal Saghir,** Director, Energy, Water and Transport, **Abel Mejia,** Water Anchor Lead, and **Michael Jacobsen,** Senior Water Resources Specialist, World Bank Group
- **Anders Berntell,** Director General, and **Jakob Granit,** Program Director, Stockholm International Water Institute (SIWI)
- **Colin Chartres,** Director General, International Water Management Institute (IWMI)
- **Dominic Waughray,** Director of Environmental Initiatives, World Economic Forum (WEF)
- **James Leape,** CEO, **Stuart Orr,** Freshwater Manager, WWF-International, and **Tom LeQuesne,** Freshwater Policy Officer, WWF-UK
- **John Briscoe,** Gordon McKay Professor of the Practice of Environmental Engineering, Harvard University
- **Piet Klop,** Acting Director, Markets and Enterprise Program, and **Charles Iceland,** Associate, People and Ecosystems Program, World Resources Institute (WRI)
- **Mark Rosegrant,** Director of the Environment and Production Technology Division, International Food Policy Research Institute (IFPRI)
- **Michael Norton,** Managing Director, Water and Power Group, Halcrow Group Ltd
- **Pasquale Steduto,** Service Chief, Food and Agricultural Organization, Land and Water Unit (FAO)
- **Peter Börkey** and **Roberto Martín-Hurtado,** Water Team leaders, Organization for Economic Co-operation and Development (OECD)
- **Peter Gleick,** President and **Jason Morrison,** Water Program Leader, Pacific Institute

We thank these advisors for their considerable input, yet the authors alone take full responsibility for the content and conclusions of this report.

The 2030 Water Resources Group also relied on the additional input from more than 300 experts and practitioners of leading scientific, multinational and nonprofit institutions who offered invaluable insights on methodology and detailed input into the regional case studies.

Above all, the active participation of government water resource managers in the various regional studies (Brazil, China, India, and South Africa) brought important thought partnership to the project and helped tailor our contribution to have the most utility to the public sector.

1. Shining a light on water resource economics

Constraints on a valuable resource should draw new investment and prompt policies to increase productivity of demand and augment supply. However, for water, arguably one of the most constrained and valuable resources we have, this does not seem to be happening. Calls for action multiply and yet an abundance of evidence shows that the situation is getting worse. There is little indication that, left to its own devices, the water sector will come to a sustainable, cost-effective solution to meet the growing water requirements implied by economic and population growth.

This study focuses on how, by 2030, competing demands for scarce water resources can be met and sustained. It is sponsored, written, and supported by a group of private sector companies and institutions who are concerned about water scarcity as an increasing business risk, a major economic threat that cannot be ignored, and a global priority that affects human well-being.

Assuring sufficient raw or "upstream" water resources is a precondition for solving other water issues, such as those of clean water supply in municipal and rural systems, wastewater services, and sanitation—the "downstream" water services. Yet the institutions and practices common in the water sector have often failed to achieve such security. A lack of transparency on the economics of water resources makes it difficult to answer a series of fundamental questions: What will the total demand for water be in the coming decades? How much supply will there still be? What technical options for supply and water productivity exist to close the "water gap"? What resources are needed to implement them? Do users have the right incentives to change their behaviors and invest in water saving? What part of the investment backlog must be closed by private sector efforts, and what part does the public sector play in ensuring that water scarcity does not derail either economic or environmental health?

In the world of water resources, economic data is insufficient, management is often opaque, and stakeholders are insufficiently linked. As a result, many countries struggle to shape implementable, fact-based water policies, and water resources face inefficient allocation and poor investment patterns because investors lack a consistent basis for economically rational decision-making. Even in countries with the most advanced water policies there is still some way to go before the water sector is managed with the degree of sophistication appropriate for our most essential resource. Without a step change improvement in water resource management, it will be very difficult to meet related resource challenges, such as providing sufficient food or sustainably generating energy for the world's population.

After careful quantitative analysis of the problem, this report provides some answers on the path to water resource security. It first quantifies the situation and shows that in many regions, current supply will be inadequate to meet the water requirements. However, as a central thesis, it also shows that meeting all competing demands for water is in fact *possible at reasonable* *cost*. This outcome will not emerge naturally from existing market dynamics, but will require a concerted effort by all stakeholders, the willingness to adopt a total resource view where water is seen as a key, cross-sectoral input for development and growth, a mix of technical approaches, and the courage to undertake and fund water sector reforms.

An upfront caveat is warranted. This work delivers—the authors believe—a mosaic of the solution by providing a comparative fact base on the economics of technical measures. We would thus portray it as a starting point, not a comprehensive solution to all water problems. We fully recognize that water is a multi-faceted good differentiated by type of use, quality, and delivery reliability, and thus a complex sociopolitical issue. And, we acknowledge the vast body of economic and political economy literature that has elaborated on such topics. This report does not intend to substitute for that work.

To those familiar with the water challenge, our endeavor might appear daunting, as the quality of the data is highly variable and often uncertain. We fully acknowledge these uncertainties and welcome contributions that can improve this study's accuracy and usefulness through better data. Yet we are convinced that rigorous analysis built off existing data can provide a sufficiently robust fact base for meaningful stakeholder dialogue and action towards solutions.

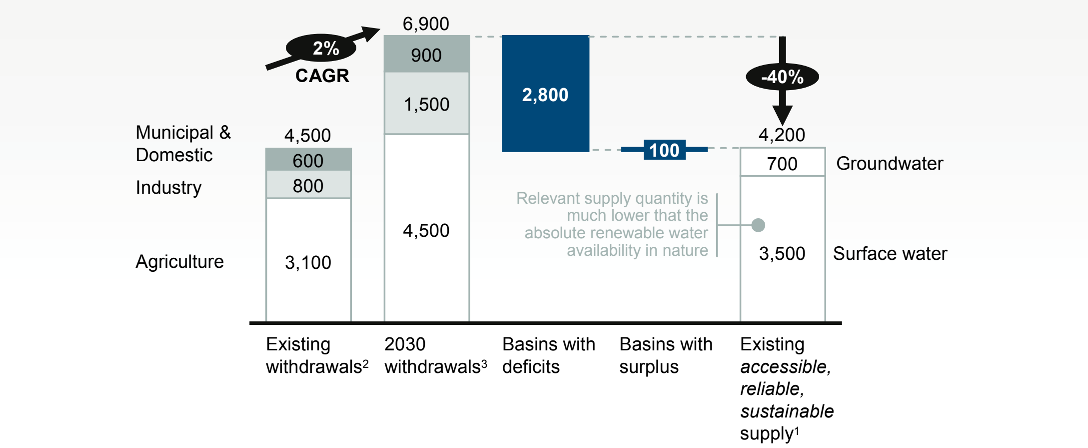
2. Managing our way to scarcity: The challenge ahead

By 2030, under an average economic growth scenario and if no efficiency gains are assumed, global water requirements would grow from 4,500 billion m^3 today (or 4.5 thousand cubic kilometers) to 6,900 billion m^3. As Exhibit 1 shows, this is a full 40 percent above current accessible, reliable supply (including return flows, and taking into account that a portion of supply should be reserved for environmental requirements). This global figure is really the aggregation of a very large number of local gaps, some of which show an even worse situation: one-third of the population, concentrated in developing countries, will live in basins where this deficit is larger than 50 percent. The quantity represented as accessible, reliable, environmentally sustainable supply—a much smaller quantity than the absolute raw water available in nature—is the amount that truly matters in sizing the water challenge.

Exhibit I

Aggregated global gap between existing accessible, reliable supply[1] and 2030 water withdrawals, assuming no efficiency gains

Billion m³, 154 basins/regions



1 Existing supply which can be provided at 90% reliability, based on historical hydrology and infrastructure investments scheduled through 2010; net of environmental requirements
2 Based on 2010 agricultural production analyses from IFPRI
3 Based on GDP, population projections and agricultural production projections from IFPRI; considers no water productivity gains between 2005-2030

SOURCE: Water 2030 Global Water Supply and Demand model; agricultural production based on IFPRI IMPACT-WATER base case

The drivers of this resource challenge are fundamentally tied to economic growth and development. Agriculture accounts for approximately 3,100 billion m³, or 71 percent of global water withdrawals today, and without efficiency gains will increase to 4,500 billion m³ by 2030 (a slight decline to 65 percent of global water withdrawals). The water challenge is therefore closely tied to food provision and trade. Centers of agricultural demand, also where some of the poorest subsistence farmers live, are primarily in India (projected withdrawals of 1,195 billion m³ in 2030), Sub-Saharan Africa (820 billion m³), and China (420 billion m³). Industrial withdrawals account for 16 percent of today's global demand, growing to a projected 22 percent in 2030. The growth will come primarily from China (where industrial water demand in 2030 is projected at 265 billion m³, driven mainly by power generation), which alone accounts for 40 percent of the additional industrial demand worldwide. Demand for water for domestic use will decrease as a percentage of total, from 14 percent today to 12 percent in 2030, although it will grow in specific basins, especially in emerging markets.

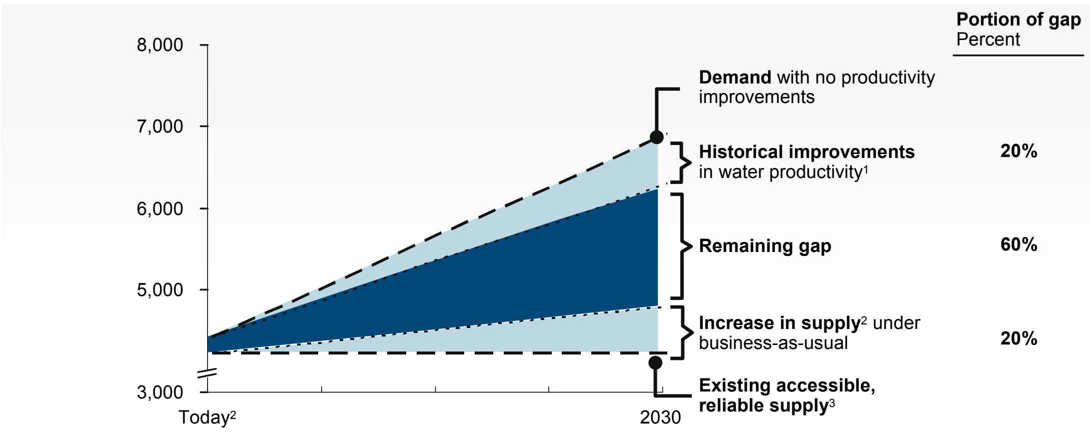
While the gap between supply and demand *will* be closed, the question is *how*. Given the patterns of improvement of the past, will the water sector land on an efficient solution that is environmentally sustainable and economically viable? There is every reason to believe it will not. The annual rate of efficiency improvement in agricultural water use between 1990 and 2004 was approximately 1 percent across both rain-fed and irrigated areas. A similar rate of improvement occurred in industry. Were agriculture and industry to sustain this rate to 2030, improvements in water efficiency would address only 20 percent of the supply-demand gap, leaving a large deficit to be filled. Similarly, a business-as-usual supply build-out, assuming constraints in infrastructure rather than in the raw resource, will address only a further 20 percent of the gap (Exhibit II). Even today, a gap between water demand and supply exists—when some amount

of supply that is currently unsustainably "borrowed" (from nonreplenishable aquifers or from environmental requirements of rivers and wetlands) is excluded, or when supply is considered from the perspective of *reliable* rather than *average* availability.

Exhibit II

Business-as-usual approaches will not meet demand for raw water

Billion m3



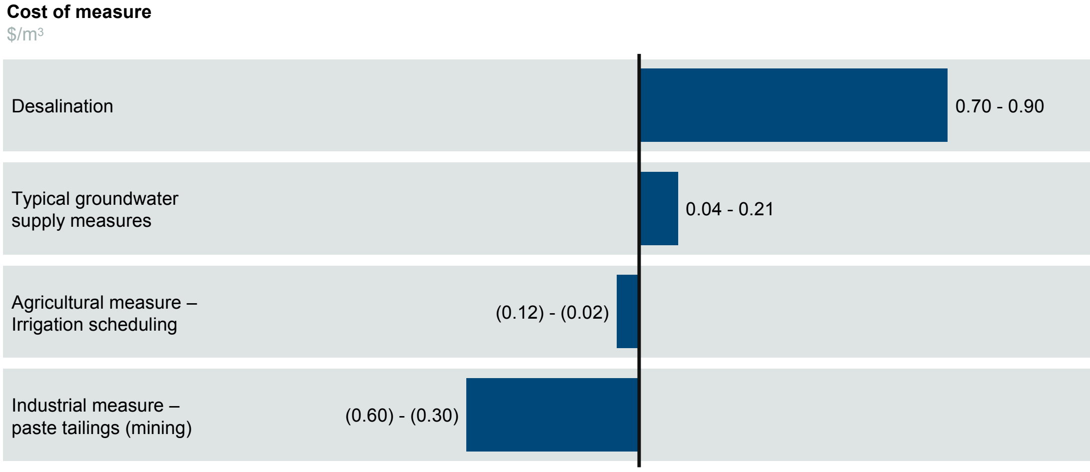
1 Based on historical agricultural yield growth rates from 1990-2004 from FAOSTAT, agricultural and industrial efficiency improvements from IFPRI
2 Total increased capture of raw water through infrastructure buildout, excluding unsustainable extraction
3 Supply shown at 90% reliability and includes infrastructure investments scheduled and funded through 2010. Current 90%-reliable supply does not meet average demand
SOURCE: 2030 Water Resources Group – Global Water Supply and Demand model; IFPRI; FAOSTAT

If these "business-as-usual" trends are insufficient to close the water gap, the result in many cases could be that fossil reserves are depleted, water reserved for environmental needs is drained, or—more simply—some of the demand will go unmet, so that the associated economic or social benefits will simply not occur. The impacts of global climate change on local water availability, although largely outside the scope of this study, could exacerbate the problem in many countries. While such impacts are still uncertain at the level of an individual river basin for the relatively short time horizon of 2030, the uncertainty itself places more urgency on addressing the status quo challenge.

The financial implications of this challenge are also clear. Historically, the focus for most countries in addressing the water challenge has been to consider additional supply, in many cases through energy-intensive measures such as desalination. However, in many cases desalination—even with expected efficiency improvements—is vastly more expensive than traditional surface water supply infrastructure, which in turn is often much more expensive than efficiency measures, such as irrigation scheduling in agriculture. These efficiency measures can result in a net increase in water availability, and even net cost savings when operating savings of the measures outweigh annualized capital costs (Exhibit III).

Exhibit III

Representative demand- and supply-side measures



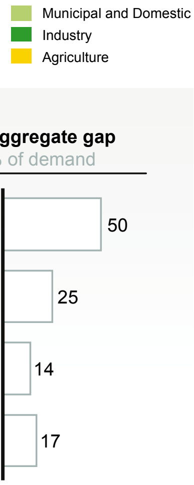
SOURCE: 2030 Water Resources Group

Closing the remaining gap through traditional supply measures would be costly: these face a steep marginal cost curve in many parts of the world, with many of the supply measures required to close the 2030 gap bearing a cost of more than $0.10/m³, against current costs in most cases, of under $0.10 /m³. The most expensive supply measures reach a cost of $0.50/m³ or more. Without a new, balanced approach, these figures imply additional annual investment in upstream water infrastructure of up to $200 billion over and above current levels—more than four times current expenditure.

This picture is complicated by the fact that there is no single water crisis. Different countries, even in the same region, face very different problems, and generalizations are of little help. We therefore conducted detailed case studies on three countries and one region challenged by dramatically different water issues: China; India; South Africa; and, the state of São Paulo in Brazil. (Exhibit IV).

Exhibit IV

Base-case demand, supply, corresponding and gaps for the regional case studies



1 Gap greater than demand-supply difference due to mismatch between supply and demand at basin level
2 South Africa agricultural demand includes a 3% contribution from afforestation
SOURCE: 2030 Water Resources Group

These case studies reflect a significant fraction of the global water challenge. In 2030, these countries collectively will account for 30 percent of world GDP and 42 percent of projected global water demand. They also address some of the main themes of the global water challenge, including:

- Competition for scarce water from multiple uses within a river basin
- The role of agriculture for food, feed, fiber and bioenergy as a key demand driver for water
- The nexus between water and energy
- The role of urbanization in water resource management
- Sustainable growth in arid and semi-arid regions

In each case study, we went to the highest level of granularity afforded by the accessible data, conducting analysis at the river basin or watershed level, and in many cases at the sub-basin level, as appropriate for each study. In each we created a "base case" scenario for water demand and supply in 2030 by projecting the country's water demand to 2030; calculating the expected gap between this 2030 demand figure and currently planned supply; and analyzing the underlying drivers of that gap.

For the countries studied, these 2030 base cases illustrate the powerful impact of macro-economic trends on the water sector.

By 2030, demand in **India** will grow to almost 1.5 trillion m^3, driven by domestic demand for rice, wheat, and sugar for a growing population, a large proportion of which is moving toward a middle-class diet. Against this demand, India's current water supply is approximately 740 billion m^3. As a result, most of India's river basins could face severe deficit by 2030 unless concerted action is taken, with some of the most populous—including the Ganga, the Krishna, and the Indian portion of the Indus—facing the biggest absolute gap.

China's demand in 2030 is expected to reach 818 billion m^3, of which just over 50 percent is from agriculture (of which almost half is for rice), 32 percent is industrial demand driven by thermal power generation, and the remaining is domestic. Current supply amounts to just over 618 billion m^3. Significant industrial and domestic wastewater pollution makes the "quality-adjusted" supply-demand gap even larger than the quantity-only gap: 21 percent of available surface water resources nationally are unfit even for agriculture. Thermal power generation is by far the largest industrial water user, despite the high penetration of water-efficient technology, and is facing increasing limitations in the rapidly urbanizing basins.

São Paulo state's projected demand in 2030 of 20.2 billion m^3 is evenly split between domestic, industrial, and agricultural requirements, against a current accessible, reliable supply of 18.7 billion m^3. Nearly 80 percent of this demand is reflected in the São Paulo macro-metropolitan region, with a projected population of 35 million in 2030. This quantity challenge is compounded by severe quality issues, as even today, low coverage of sanitation collection and treatment means that a significant proportion of São Paulo's water supply is polluted—requiring over 50 percent of current supply to the region to be transferred from neighboring basins.

Demand in **South Africa** is projected at 17.7 billion m^3 in 2030 with household demand accounting for 34 percent of the total. Against this, current supply in South Africa amounts to 15 billion m^3, and it is severely constrained by low rainfall, limited underground aquifers, and reliance on significant water transfers from neighboring countries. South Africa will have to resolve tough trade-offs between agriculture, key industrial activities such as mining and power generation, and large and growing urban centers.

In addition, we supplemented the detailed case studies with insights from other geographies to understand particular challenges (e.g. efficient water use in the arid countries of the Gulf Cooperation Council).

These regional water resources challenges have been characterized, as a base case, by the water resource availability and demand of *historical* climate conditions. Yet, all regions are faced by increased uncertainty in water resource availability as a result of the impact of global climate change. Without taking explicit scientific positions on how climate change will affect any one river basin, we do explore the major implications of climate change projections in some areas—for example, an "average" expectation of climate change for South Africa by 2030 shows a slight decrease in supply and a (more pronounced) increase in crop demand, growing the 2030 supply-demand gap by 30%.

3. Toward solutions: An integrated economic approach to water resource management

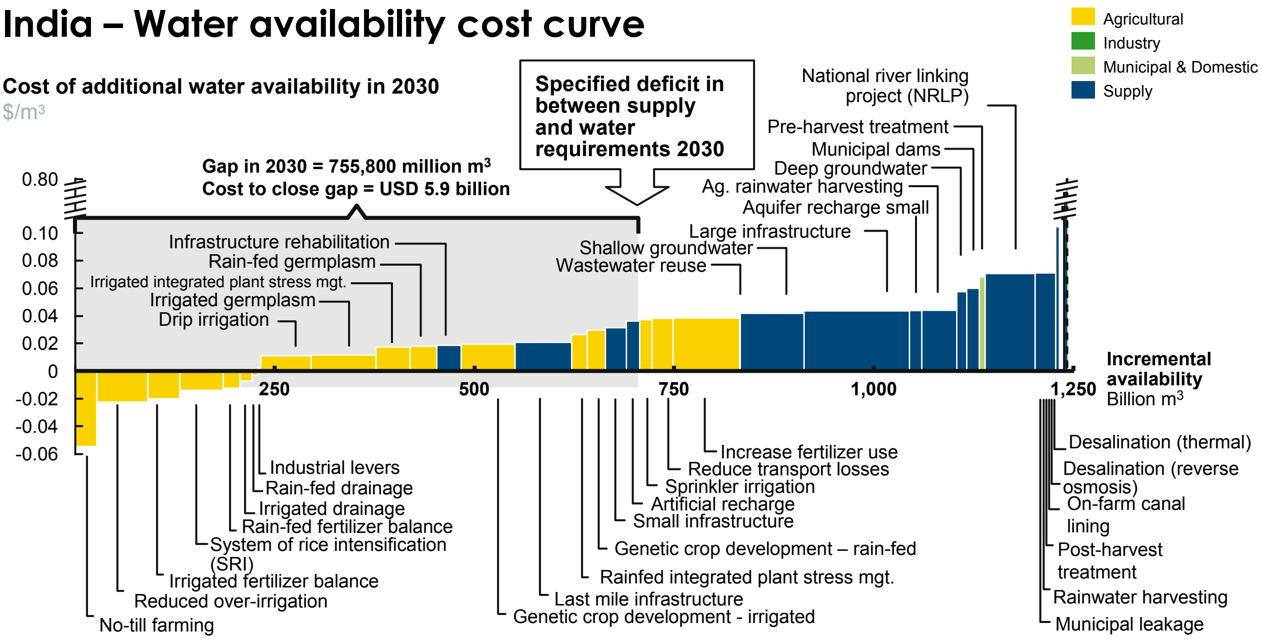
Solutions to these challenges are in principle possible and need not be prohibitively expensive. A solution in a particular basin or country would utilize a combination of three fundamental ways to close the demand-supply gap. Two of these are *ceteris paribus* options and focus on technical improvements, increasing supply and improving water productivity under a constant set of economic activities, while the third is tied to the underlying economic choices a country faces and involves actively reducing withdrawals by changing the set of underlying economic activities. A well-managed sector would identify a sustainable and cost-effective mix of these three solutions.

In our case studies we focused first on the two technical solutions, and in all cases identified cost-effective solutions to close the gaps calculated in the base cases. Across the four regions under study, these solutions would require $19 billion per annum in incremental capital investment by 2030—just 0.06 percent of their combined forecast GDP for 2030. When scaled to total global water demand, this implies an annual capital requirement of approximately $50 to $60 billion to close the water resource availability gap, if done in the least costly way available, almost 75% less than a supply-only solution.

The challenge in linking these opportunities to close the water gap lies in finding a way of comparing the different options. As a key tool to support decision-making, this study developed a "water-marginal cost curve", which provides a microeconomic analysis of the cost and potential of a range of existing technical measures to close the projected gap between demand and supply in a basin (Exhibit V provides an example of the cost curve for India). For a given level of withdrawals, the cost curve lays out the technical options to maintain water-dependent economic activities and close the gap, comparing on a like-for-like basis, efficiency and productivity measures with additional supply. Each of these technical measures is represented as a block on the curve. The width of the block represents the amount of additional water that becomes available from adoption of the measure. The height of the block represents its unit cost.

Exhibit V

India – Water availability cost curve



SOURCE: 2030 Water Resources Group

For each of the case studies, a basin-by-basin analysis of technical measures was conducted for the base case demand scenario. Then, departures from the base case in the form of alternative supply/demand scenarios were explored. The key findings for these cases are as follows:

Agricultural productivity is a fundamental part of the solution. In all of the case studies, agricultural water productivity measures contribute towards closing the water gap, increasing "crop per drop" through a mix of improved efficiency of water application and the net water gains through crop yield enhancement. These include the familiar technologies of improved water application, such as increased drip and sprinkler irrigation. The full suite of crop productivity measures includes, among others, no-till farming and improved drainage, utilization of the best available germplasm or other seed development, optimizing fertilizer use, and application of crop stress management, including both improved practices (such as integrated pest management) and innovative crop protection technologies.

In India, the least-cost set of levers—those on the left-hand side of the cost curve—is dominated by these agricultural measures, which can collectively close 80 percent of the gap and includes both irrigated and rain-fed crop production measures. In addition to the agricultural opportunity, lower-cost supply measures constitute the remaining 20 percent required to close the gap, delivered mostly through the rehabilitation of existing irrigation districts and the "last-mile" completion of earlier projects such as canals. The total annual cost for the combined set of supply and agricultural levers is approximately $6 billion per annum—just more than 0.1 percent of India's projected 2030 GDP. This analysis does not take into account implementation and institutional barriers, nor the impact on labor markets, GDP or other economic metrics, yet provides the starting point from which to consider approaches to overcome such barriers.

Efficiency in industry and municipal systems is similarly critical. In China, although agriculture still makes up more than 50 percent of the total demand, industrial and urban water uses are the fastest growing (at ~3 percent per annum). China can mitigate this rapid growth in a cost-effective way by instituting aggressive, water-conscious, "new build" programs and enacting water-saving regulatory reforms. If it does so, the cost to fill the gap is negative, implying net annual savings of approximately $22 billion. Most of the cost-saving levers on the left of the cost curve for China are industrial efficiency measures. These have the potential to close a quarter of the gap and result in net savings of some $24 billion. They are distributed among the thermal power, wastewater reuse, pulp and paper, textile, and steel industries. Their savings potential derives from significant savings in energy and other operational expenditures, translating into overall productivity gains. The net capital expenditure to close the remainder of the gap amounts to $8 billion, or less than 0.06 percent of projected 2030 GDP.

Quality and quantity of water are tightly linked. The least-cost solution in São Paulo state has a net annual cost of $285 million (0.04% percent of the state's projected 2030 GDP), a large part of which is in efficiency and productivity measures, while a supply infrastructure solution would nearly double the cost to $530 million per year, or 0.07 percent of GDP. Any approach to solving the state's water management challenges must consider resolving quality issues, both for practical usage reasons and for environmental reasons. Industries can generate significant financial benefit from reducing their water use via levers such as spring-valve installation and sensitivity sensors. Utility leakage reduction can save nearly 300 million m^3. Wastewater reuse for gray-water purposes (such as industrial processes and public works uses) offers roughly 80 million m^3 in new water.

Most solutions imply cross-sectoral trade-offs. South Africa has a balanced solution with cost-effective measures available across supply (which can close 50 percent of the country's projected supply-demand gap to 2030), agricultural efficiency and productivity improvements (30 percent), and industrial and domestic levers (20 percent). Seven river sub-basins are almost entirely dependent on agricultural improvements, while the economic centers of Johannesburg and Cape Town are dominated by industrial and domestic solutions. Almost 50 percent of the levers involve significant savings of input costs, effectively making half of the solution "cost-negative". In the case of industrial levers (such as paste-thickening and water-recycling in mining, and dry-cooling, and pulverized beds in power), up to $418 million in annual savings can be captured from the pursuit of efficiency.

4. Putting solutions into practice: New dialogue among stakeholders

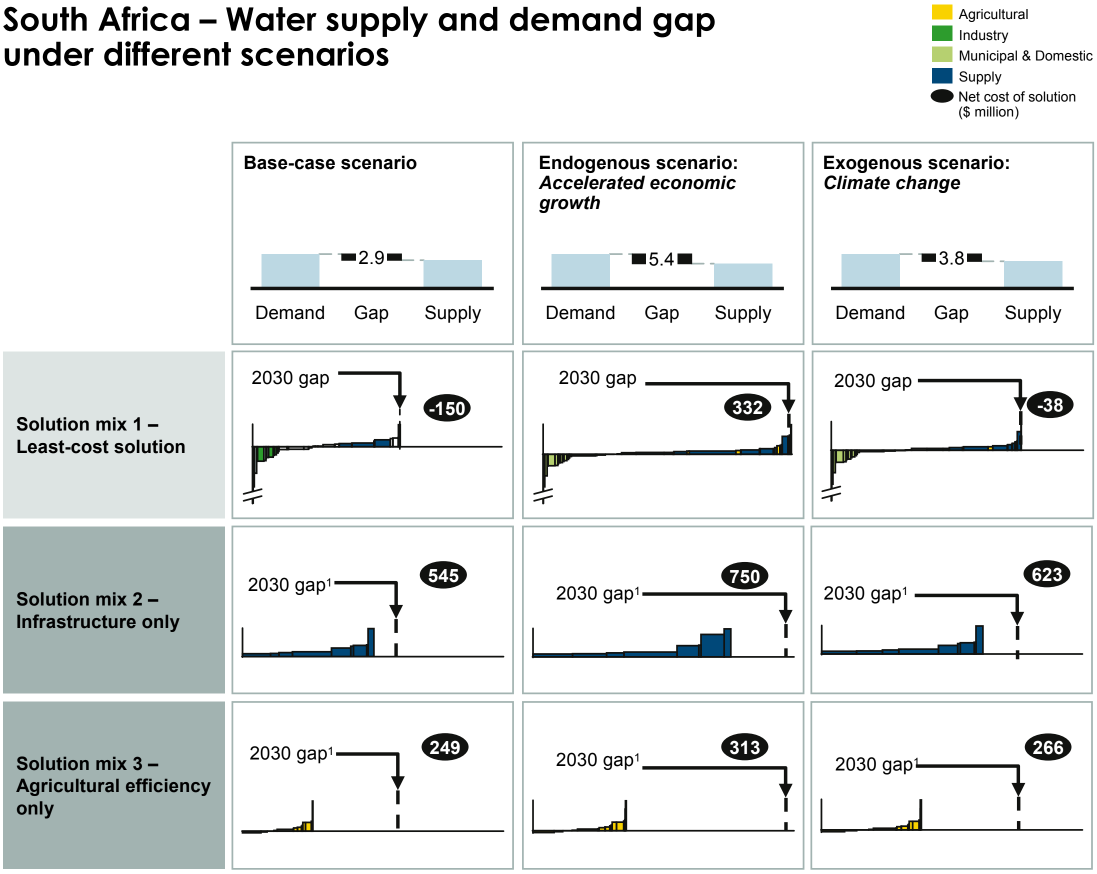
Knowing the least-cost portfolio of technical solutions that will close a country's "base-case" water gap is a significant step forward. On the way towards real change however, the technical options of new supply or better efficiency must be compared to additional options to shift the set of underlying economic activities away from the most water-intensive ones, recognizing that growth in energy, agriculture, and manufacturing have real implications for the water budgets of river basins and countries. The reverse is also true: planning for water must be integrative with directions of the whole economy, whether explicitly constrained by water considerations or not. Using an iterative process, governments and other key stakeholders in a given country can create a matrix of options from which to chart pathways of development that balance water supply and demand.

The tools developed in this report, including the cost curve and gap models, can help provide critical insights for those engaged in transforming a national water agenda. In such a transformation effort, the first step in applying these tools is to construct a set of future scenarios that represent relevant choices facing the country—these might include, for example, the water demand implications of rapid agricultural development; or those of reduced water availability a result of climate change. A scenario approach is chosen because it allows decision-makers to separate the problem of choosing an appropriate mix of economic activities, something that can only partly be planned and that is subject to large number of economic considerations, from ensuring that those economic activities are sustainable. For each scenario, a cost curve can then be constructed. Each cost curve can be used to define a set of technical solutions—a solution mix—such as the least-cost set of solutions, or the infrastructure-only set of solutions. A full suite of options, with the water costs associated with them, is therefore laid out for decision-makers to compare and discuss (Exhibit VI).

In choosing scenarios, and to some extent the technical measures to close the gap projected under any one of those scenarios, the trade-offs decision makers will face go well beyond the issue of water: they will need to consider everything from the impacts on growth and jobs (including geographic distribution), to the implications for trade and geopolitics. A decision cannot be

Exhibit VI

South Africa – Water supply and demand gap under different scenarios



1 The solution is insufficient to close the entire gap. Additional measures are required.
SOURCE: 2030 Water Resources Group

taken solely on the basis of the quantitative water calculations described in this report, but the tools presented here will make the critical elements of those trade-offs more transparent and will define the boundaries of discussion well beyond the confines of the traditional water sector.

If all stakeholders are able to refer to the same set of facts, a more productive and inclusive process is possible in developing solutions. There are, of course, additional qualitative issues that need to be addressed, including institutional barriers (such as a lack of clear rights to water), fragmentation of responsibility for water across agencies and levels of government, and gaps in capacity and information. While the quantitative tools discussed here will not in themselves address these challenges, they *can* help highlight those areas where institutional reform or capacity-building are most needed in order to close the water deficit cost-effectively.

Because this process weighs a broader set of benefits and policy decisions against the technical costs of closing the gaps, each stakeholder group will have different angles and interests to keep in mind. It is by balancing these angles that a shared solution can be developed.

Each group of stakeholders can derive specific planning benefits and insights from using this approach, addressed in turn below.

Tools for policymakers

Policymakers will want to assess whether the cost curve can reflect either the difficulty of implementing a technical solution which along with other secondary impacts will inform their policy choices; they will want to understand the impact specific water policies may have on the adoption of measures; and will want to understand which types of policies may change the adoption economics. Accordingly, three refinements of the cost curve approach can help policymakers understand how to mobilize solutions.

First, the measures on the cost curve can be **classified according to factors** influencing their ease of implementation, such as low institutional capacity, policy and cultural barriers, and the high number of stakeholders from whom action would be needed (Exhibit VII). Solutions that are in principle technically feasible may face one or more of such barriers, which—while not easily quantified in financial terms—are nevertheless very real for those charged with encouraging implementation. Policymakers can use the cost curve to understand the financial trade-offs implied by different levels of commitment to tackle such implementation barriers.

Exhibit VII

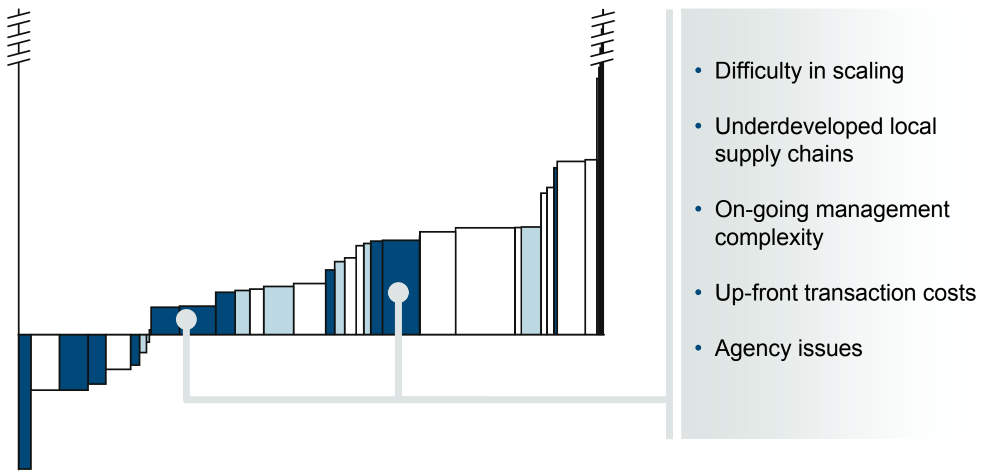
Managing implementation challenges with the cost curve – an illustration

ILLUSTRATIVE

Relative implementation challenges: High / Medium / Low

Cost-curve color-coded to manage implementation challenges

Examples of implementation challenges



SOURCE: 2030 Water Resources Group

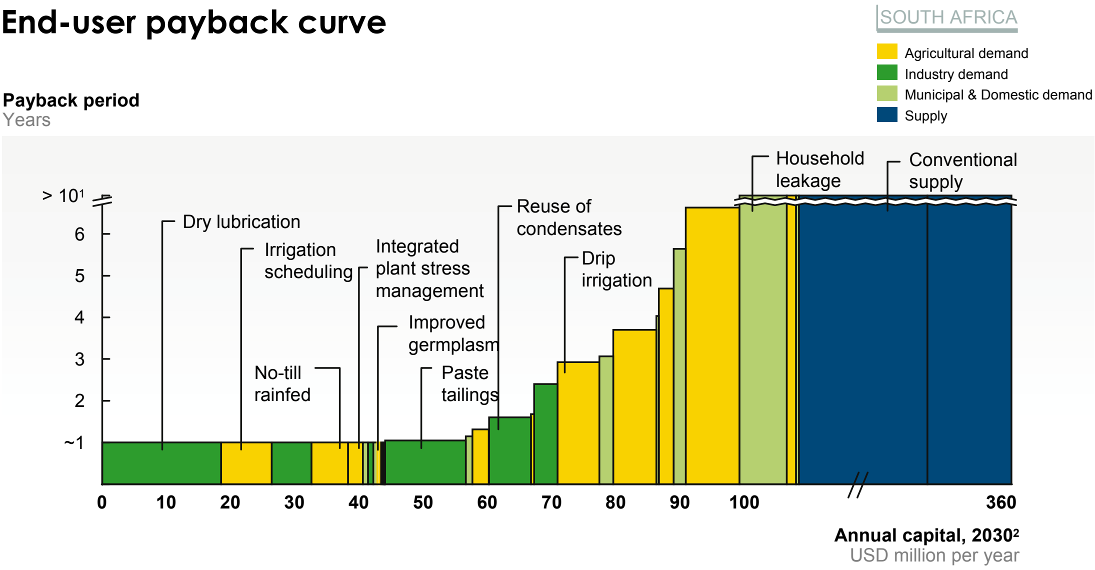
In China and India we grouped the levers, independently of economic "sector", according to whether their adoption required few or many decision-makers, taking this as one illustration of "ease of implementation" from a public policy perspective. The result of such an exercise can help to quantify the costs of not pursuing certain sets of measures. The exercise exposed the reality that a solution made up only of those measures which required the action of a few central decision-makers would come at significantly greater cost than a solution incorporating all available measures, including those whose adoption would require changed behavior from millions of farmers and industrial or domestic water users. Avoiding these "more complex" levers and applying only the "less complex" levers would require an additional $17 billion a year in capital costs in India, while in China the full gap could not be filled at all using supply measures currently within reach—a high price for forestalling the institutional and organizational reforms needed to enable the least-cost solution. This is just one illustration. The real value of classifying levers in this way is as an aid to collaboration with the very policymakers who must make the difficult trade-offs on the path the water resource security, and who will have deeper and more nuanced views of what the barriers to implementation might be.

Second, policymakers can construct **scenarios to assess the impact of policy decisions on water demand**. A policymaker will want to know how a country's projected water supply-demand gap would change when specific policy measures are enacted, or if greater-than-expected economic growth were achieved. The cost curve can reflect a range of different policy and growth scenarios. For example, a number of studies suggest that reducing energy subsidies in India—which currently allow farmers to pump groundwater at very low cost—would reduce crop production, which would in turn lower irrigation water needs. An assumed 5 percent decrease in irrigated crop production would reduce water demand by 8 percent—both straightforward calculations—but our analyses show the actual cost to close the resulting gap would be reduced by 10 percent. This is to be weighed against the reduced output in crops and the corresponding reduction in economic activity. An ethanol boom in Brazil would double the demand for water for agriculture in São Paulo state, and increase the size of the state's supply-demand gap from 2.6 to 6.7 billion m^3. As a consequence, the cost to close it would also double if relying upon the most efficient solution, and increase even more if supply measures only are prioritized.

Third, a "payback curve" can be developed to **quantify the economics of adoption for end-users**. The costs of measures to close a country's water supply-demand gap as seen by the end-user can be quite different from those perceived by government. The payback curve, a variation of the cost curve, can help (Exhibit VIII). It shows how long it will take for an investment to bear fruit, allowing comparison with the end user's expectations: a low-income farmer might need his money back in less than 3 years, whereas an industrial water user has more flexibility. Making financials more transparent can help policymakers distinguish between those measures that need an extra push, and those that, on paper at least, are financially attractive to the end-user. In India and China, for example, almost 75 percent of the gap could be closed with measures offering payback time of 3 years or less. São Paulo state, on the other hand, relies heavily on supply and efficiency measures that are not yet sufficiently attractive to adopters—86 percent have payback times above 5 years.

Exhibit VIII

End-user payback curve



1 Measures with no payback (i.e. only negative cash flows) also shown as > 10 years
2 Does not include financing cost
SOURCE: 2030 Water Resources Group

Pathways for the private sector

Governments are not the only stakeholders that matter, nor are they the only ones that need help managing water decisions. We outline a path forward for five specific private sector players who can contribute to water security solutions.

Agricultural producers and other agricultural value chain players. Food production and the water it requires are a key part of the water challenge. Food self-sufficiency in countries with rapid population and income growth will become an increasing challenge. Some 70 percent of the world's water use is in agriculture—with the implication that farming plays a very important role in ensuring water is available for all uses. The agricultural water solutions shown in the cost curves address both the water challenge and the food challenge, and represent the full suite of existing techniques and technologies that can improve agricultural productivity. The magnitude of the potential impact of these solutions on both challenges should motivate farmers, other agricultural value-chain players (e.g. food processors), and policymakers to jointly address their implementation. In India, where agriculture plays the most important role in the least-cost solution, aggregate agricultural income could increase by $83 billion by 2030 from operational savings and increased revenues, if the full potential of agricultural measures is mobilized. In South Africa, where agriculture contributes 30 percent to the least-cost solution, the aggregate potential is $2 billion. Though we have focused on measures that can be implemented geographically close to production, the opportunity exists to reduce losses and therefore "save" water and other inputs throughout the value chain.

Financial institutions. There is wide agreement that water has suffered from chronic under-investment. Financial institutions are likely to be an important actor in making up this shortfall. The cost curves provide such institutions with transparency on the financial costs and the technical potential of measures in the long run to close the water supply-demand gap, as well as on the barriers to their adoption, thus helping them construct credible investment theses—particularly important at a time when credit is hard to find. Investment opportunities span all sectors—the measures that in aggregate require the most capital in each country are municipal leakage reduction in China, and water transfer schemes in São Paulo and South Africa. In India, drip irrigation offers potential for lending and equity investments alike: our analysis implies that the penetration of this technology will grow by 11 percent per year through 2030, requiring increased manufacturing capacity and credit for farmers.

Large industrial water users. The nexus between water and energy, and between water quantity and quality, is at the heart of the water challenge, as we have seen in China and Brazil. Industry faces a potential spiraling challenge of decreasing water resources and increasing pollution, both requiring increasing energy. These issues are particularly relevant to large industrial users such as metals, mining, petroleum, and energy companies, who face both a water and an energy challenge. The transparency provided by the demand and supply analysis and by the cost curves on where such companies' exposure to the risk of water scarcity is greatest, and what their options are to mitigate the risk, will assist them in making the case for investing in water efficiency solutions. In South Africa, for example, the basins with the largest gaps are also the centers of industrial water demand: In the Upper Vaal, where industry makes up 44 percent of demand, the gap is 33 percent, in Mvoti-Umzimkulu (where industry is 25 percent of demand) 46 percent. In such cases, the risk of water scarcity may affect the choice of technology, pointing towards potential measures such as dry cooling and fluidized-bed combustion in power generation, and paste tailings in mining.

Technology providers. Innovation in water technology—in everything from supply (such as desalination) to industrial efficiency (such as more efficient water reuse) to agricultural technologies (such as crop protection and irrigation controls)—could play a major role in closing the supply-demand gap. Also, many of the solutions on the cost curves developed for each country imply the scale-up of existing technologies, requiring expanded production on the part of technology providers. The cost curves provide a framework that technology providers can use to benchmark their products and services for an estimate of their market potential and cost-competitiveness with alternative solutions. Membrane technology, for example, is still 2-3 times more expensive in China than traditional treatment technologies. As the need for high-quality water treatment increases, specifically for potable or high-quality industrial use or re-use, low-pressure membrane technology could develop a market potential of up to 85 billion m^3 by 2030, 56 times its volume in 2005.

Construction sector. A renewed interest in efficiency and productivity does not mean that supply measures do not have an important role to play, as we have seen in Brazil and China. The construction sector will need to continue to deliver that large-scale infrastructure. The cost curves provide transparency on where such infrastructure is most needed, and where alternative solutions may prevail. In South Africa and Brazil, for example, supply infrastructure makes up some 50 percent of the gap. Even in India, where the share is only 14 percent, the required annual investment still amounts to $1.4 billion per year.

5. Unlocking water sector transformation

Business-as-usual in the water sector is no longer an option for most countries. The beginnings of change are under way and there is good reason to believe that water will be an important investment theme for public, multilateral and private financial institutions in the coming decades. Although affordable solutions are in principle available to close the projected water supply-demand gaps for most countries and regions, institutional barriers, lack of awareness, and misaligned incentives may stand in the way of implementation, across both the private and public sectors. Overcoming these barriers will require persistent action and, in many cases, an integrated agenda of water sector transformation.

This report is founded on the belief that developing a fact-based vision for water resources at the country or state level is a critical first step in making a reform agenda possible. This vision will help identify metrics, such as the supply-demand gap, or the potential of different measures, that can help to measure progress. It will link cost and economic data to water resource data—including environmental requirements—a step which is essential to manage the water challenge. Without such a vision, it will be difficult for leaders to gain support for more rational management decisions on water resources. Because of the cross-sectoral nature of the analysis, linking such a vision to action requires high-level energy and support, and commitment from the most senior decision-makers in the country. In countries with sufficient resources, existing institutions can be empowered to produce the data needed to inform such visions. In countries with limited resources to manage their water sectors, developing this data should be a high priority for those seeking to assist.

Having created the fact base and gone through the process of describing the options available, policymakers, the private sector and civil society will need to come together to put into practice a transformation towards sustainability. The fact base can provide crucial guidance for this process at several levels.

For example, an understanding of the economics of the chosen solution will help decision-makers come to a rational design of the economic regimes within which water is regulated. In this regard, there is considerable experience on the way market mechanisms can help efficient use of water by businesses and cities. Further, identifying the barriers to adoption, and the implementation challenges inherent in the measures described on the cost curve, will help leaders focus and improve the institutions needed to champion and implement reforms. The cost curve also provides a benchmark of existing technologies and their cost to deliver additional water, providing guidance for investment in technology hubs, research and education to unlock future innovations in the water sector. Such innovation will be critical in generating new options and reduce costs of provision.

By demonstrating which measures have the greatest impact in delivering solutions, a robust fact base can also spur focused financial investments from the private sector as a key engine for reform. A number of approaches exist, from public/private water financing facilities, to public projects that create the space for private financiers to scale-up their investments, to innovative, microfinance solutions for end-users. Policymakers, financiers, conservationists, farmers, and the private sector need to cooperate to develop and promote innovative financial tools to ensure those willing to improve their water footprint are given the opportunity—and capital—to do so.

In many cases large individual water users have a big role to play in managing demand. Government policy can help align industrial behavior with efficiency objectives, forming a key component of a reform program. It is critical to ensure incentive design emphasizes the value of water productivity—for example through clearer ownership rights, appropriate tariffs, quotas, pricing, and standards—and at the same time recognizes the impacts such incentives can have on the companies' profitability. A fact base on the economics of adoption and on the real potential of efficiency measures in such sectors can help identify and prioritize the right regulatory tools for action.

* * *

The case for prioritizing country-wide changes in water resources management has never been as strong. We have seen that the challenges that lie ahead are considerable for many countries. But we have also provided evidence that none are insurmountable.

We hope the information presented in this report further enriches the global debate, and provides policymakers, business stakeholders, civil society and public users with the tools they need to unlock the full potential of a sustainable water economy.

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