Intelligent manufacturing: Targeting better energy efficiency
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Foreword

Intelligent manufacturing: Targeting better energy efficiency
As policy makers, business and society tackle the complex challenges around climate change, industry is increasingly coming under the spotlight. Manufacturing activities account for around one-third of the world’s total final energy demand; as populations continue expanding and living standards continue rising, industrial demand for energy is set to grow further. Targeting better industrial energy efficiency—first and foremost the efficiency of the manufacturing processes at the core of industry—is the most effective lever available to curb industrial energy consumption.

“Intelligent manufacturing: Targeting better energy efficiency” is an Economist Intelligence Unit report that discusses the challenges that industrial manufacturers face as they target better energy efficiency in their manufacturing processes. The research was sponsored by ABB. The Economist Intelligence Unit bears sole responsibility for the content of this report. The findings and views expressed in the report do not necessarily reflect the views of the sponsor. Christopher Watts was the author of the report, and Aviva Freudmann was the editor.

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In February-March 2013, the Economist Intelligence Unit surveyed 317 senior executives, mostly in North America, Asia-Pacific, and Western Europe, on their plans to invest in improving energy efficiency in production processes, the issues they face as they consider these investments, and the factors that are likely to influence industrial energy efficiency in the coming years. This white paper is based on the results of this survey and a comparable survey conducted in 2011. The research also includes a program of in-depth interviews, as well as desk research on developments in industrial energy efficiency.

Around two-thirds of respondents to our survey are executives at director level. Respondents are most likely to have responsibility for finance, strategy and business development, general management, and operations and production. Around 49 percent are from businesses with $500 million or more in global annual revenues. The survey focuses entirely on the manufacturing and power sectors, with manufacturing having the strongest representation.

In addition to the online survey, the Economist Intelligence Unit conducted a program of 16 in-depth interviews with senior business executives and other experts in industrial energy efficiency. The insights from these interviews appear throughout the report. The Economist Intelligence Unit would like to thank all survey respondents, as well as the following executives (listed alphabetically by organization name) who participated in the interview program:

- Steve Schultz,
  Global manager of corporate energy, 3M, US

- R Neal Elliott,
  Associate director for research, American Council for an Energy-Efficient Economy, US

- Satish Agarwal,
  Chief, corporate manufacturing, Apollo Tyres, India

- Ryan Schuchard,
  Manager, climate and energy, BSR, US

- Fengyuan Wang,
  Manager, advisory services, BSR China, Hong Kong

- Hui-Min Tzeng,
  Sustainability manager, Bayer China, China

- Tony Van Osselaer,
  Head of industrial operations, member of the management board, Bayer MaterialScience, Germany

- Daniel Dexter,
  Chief operating officer, CLP India, India

- Gil Forer,
  Global Cleantech leader, Ernst & Young, US

- Urs Herzog,
  Head of energy, Holcim Technology, Switzerland

- John Lindahl,
  Group technical director, Mondi Group, UK

- Dale Harris,
  Chief operating officer, Pilbara Services and Integrated Planning, Rio Tinto, Australia

- Warren Bowden,
  Environment director, Scottish Leather Group, UK

- Thorsten Becherer,
  Director, hygiene manufacturing excellence, Svenska Cellulosa Aktiebolaget, Sweden

- S G Choudhary,
  Chief technology and sustainability officer, Tata Chemicals, India

- Ricardo Mendes,
  Energy director, Vale, Brazil
Manufacturing activities account for around one-third of the world’s total final energy consumption. As the global population continues to expand and living standards continue to rise, demand for industrial goods is set to grow further. Among the numerous challenges around climate change that industry must tackle is industrial energy efficiency — targeting better efficiency of the manufacturing processes at the core of its activities.

This white paper is based on an online survey of 317 senior executives and 16 in-depth interviews with corporate executives and other experts, as well as extensive desk research. These sources provide a backdrop to the discussion of overall trends in industrial energy efficiency, including the drivers of investment in better energy efficiency; the obstacles to investing in efficiency improvements; the ways in which companies are adopting better energy practices; and the outlook for industrial energy efficiency.

Here are the main findings of the research:

**Industry executives say better energy efficiency is critical to their businesses and will be critical in the coming two decades.** Around 77 percent of manufacturers say that energy efficiency will be a critical success factor for manufacturers’ profitability in the next 20 years. This is because of the high cost of energy, but it is also because of volatility of energy prices and concerns about security of energy supplies.

**Growing numbers of companies are seeing energy efficiency as a key part of their efforts to promote sustainability.** Thirty-five percent of respondents say sustainability is a key factor influencing their investment in energy efficiency — up from 26 percent two years ago. In many cases, large companies are promoting energy efficiency in their supply chains to meet their own sustainability commitments.

**More and more firms are investing in efficient lighting, heating, and air conditioning — but the proportion investing in efficient plant and equipment remains static.** Just 39 percent of respondents have invested in more efficient equipment in the past three years, versus 40 percent in 2011. Some industry managers say it is difficult to make a clear financial case for investing in energy efficiency; others say they lack funds for large investments, such as investments in combined heat and power systems.

**Although barriers to investment in energy efficiency remain, they appear to be lifting for some companies.** While financial barriers rank top, as they did two years ago, they now appear to affect proportionally fewer companies. Thirty-seven percent say that the lack of a financial case for investment in energy efficiency is an obstacle, for example. Two years ago, 42 percent said this. At the same time, more industrial managers are likely to say that there are no such barriers to investment in better energy efficiency.

**Industry is embracing better practices around energy management.** Even if they are not investing in more-efficient plant and equipment, more companies are tracking, measuring and reporting their energy usage than two years ago. Responsibility for energy efficiency is shifting towards business unit managers and dedicated sustainability and energy executives, which may lead to greater energy savings.

**Regulatory pressure on industry will further intensify in the coming years.** Numerous countries plan energy efficiency regulation to promote better practices and technologies in industry. Fifty-seven percent of survey respondents say that energy efficiency regulation is stringent, up from 40 percent in 2011. Still, 64 percent of executives describe regulation as a benefit rather than a burden.

**Innovations in process design and execution will also promote better energy efficiency in the future.** Manufacturing processes are likely to become more energy efficient as process execution improves. These improvements may be driven by technologies such as intelligent, networked pumps and compressors; improved operational software and applications; and cloud-based super-computing capabilities that enable real-time modelling and control of energy use.

**The key to improved energy efficiency will increasingly lie in software rather than in hardware.** As advances in technology allow better management of equipment and processes, the challenge for industry will be to develop analytics capabilities in order to interpret data and report performance. Over time, it is likely that improvements in energy efficiency will be driven more by software and apps, and less by equipment and plant.
Part I: An expanding role for energy efficiency

Cutting carbon dioxide emissions 35 percent between 2003 and 2007 “was not rocket science,” in the words of Warren Bowden, environment director of Scottish Leather Group in the UK. Rather, he recalls, most of the steps the company took were “easy, low-cost options,” for example installing variable speed drives in place of fixed speed drives. Furthermore, much of the cash the company invested was routine capital expenditure—not extra funds earmarked for energy efficiency measures.

Investments in new technology, such as those at Scottish Leather Group, plus developments in manufacturing processes, have led to declining energy intensity—the amount of energy used to produce a unit of gross domestic product—across industry for some decades. For example, statistics from the Brussels-based European Chemical Industry Council indicate that the European Union’s chemicals sector reduced its fuel consumption by an average 1.7 percent annually between 1990 and 2009, while increasing its output by an average 2.5 percent annually. In all, energy intensity in the sector fell by almost 55 percent during that time.

But there is scope for bigger savings across the board. The Washington-based Alliance to Save Energy says that the energy productivity of US manufacturing industry can be improved by one-third or more by 2035. The Paris-based International Energy Agency (IEA) says industry can cut its energy costs by $3.3 trillion by 2035 (See box: How to save $3 trillion).

Many of the savings are to be found in electric motors and motor-driven systems, which consume 40 percent of global electricity—more than any other single end-use on the planet. The IEA estimates the efficiency of these motors—most of which run in industry—can be improved by some 10-15 percent, equivalent to cutting global electricity use by around 5 percent.

### Box: How to save $3 trillion

The Paris-based International Energy Agency (IEA) estimates that industry can save a cumulative $3.3 trillion in energy bills by 2035 by implementing currently available technologies and practices in manufacturing—by “exploiting known opportunities for economic investment in energy efficiency.”

To make these savings by 2035, the IEA says, investments totalling $1.1 trillion will have to be made in that timeframe. By contrast, the organization estimates that total expenditure on improving energy efficiency worldwide—across power, transportation, industry and buildings—reached $180 billion in 2011.

Which measures would pave the way for these savings? The following, according to the IEA:

- All new manufacturing equipment should have efficiency levels in line with best available technology by 2015;
- Industry should take less-efficient legacy equipment out of service five years earlier than originally scheduled;
- Factories should change manufacturing processes, when applicable to local conditions;
- Companies should implement manufacturing process control and energy management systems in their facilities;
- Factories should adopt high-efficiency electric motor systems.
Industrial energy efficiency as a cost advantage

Most industry executives appear to be aware of the critical role of better energy efficiency, both in their own companies and in the wider economy. Fully 75 percent of executives surveyed for this research “agree strongly” or “agree somewhat” that energy efficiency is a critical success factor for manufacturers today—up marginally from the 72 percent recorded in the comparable survey the EIU conducted in 2011. (Figure 1)

Yet, looking forward over the next two decades, 77 percent of respondents expect energy efficiency to be a critical factor in manufacturers’ profitability—down from 88 percent in 2011. (This fall appears to have been driven in particular by respondents in Western Europe, perhaps reflecting the collapse of carbon prices in the EU.) (Figure 1)

Since the 2011 survey, however, there has been little change in the list of leading factors that executives say will influence their firms’ investment in energy efficiency over the next three years: the price of energy, cited by 57 percent, marginally down from 58 percent in 2011, is at the top of this list. “Energy accounts for 50-60 percent of our manufacturing cost,” says Satish Agarwal, chief of corporate manufacturing at Apollo Tyres in India. “We are bound to improve energy efficiency, because energy is a big cost for us.” Mr Agarwal says the firm has realized efficiencies of around 5 percent over the past two years. (Figure 2)
An expanding role for energy efficiency

Figure 2: The price of energy is the main factor that will influence companies’ investment in industrial energy efficiency over the next three years

Looking beyond the absolute level of energy prices, executives point out that volatility of energy prices is another reason to curb power consumption—not only improving earnings, but improving earnings predictability too. Furthermore, factors such as the Fukushima disaster in Japan in 2011 and political turmoil in the Middle East raise concerns about security of energy sources. “Energy is a major driver for our business,” explains John Lindahl, group technical director at paper and packaging maker Mondi Group. “Not being energy efficient is certainly a disadvantage that can’t be compensated by any other means in the long run.”

A further important factor that influences companies’ investments in energy efficiency is cost-benefit analysis of these investments, including break-even analysis. This factor is highlighted by 55 percent of the sample, down slightly from 59 percent in 2011. Many executives say that early efforts to target better energy efficiency can pay for themselves within weeks. Understandably, the importance of cost-benefit analysis is high in times when funds are less plentiful. (See Part II: Commitment to more efficient plant and equipment remains weak.)

Energy efficiency becomes embedded in sustainability

Survey results indicate that while energy prices and cost-benefit analysis remain top of the list of factors that influence decisions to invest in energy efficiency, the proportions of managers who say these two factors are influential are somewhat lower than they were in 2011. Another factor is gathering momentum as a driver of investment in energy efficiency: a wish to improve the company’s image as environmentally concerned. This ranked third in 2013, named by 35 percent of survey respondents; in 2011 it ranked fourth, named by just 26 percent of managers. For certain, more and more companies—in both developed and developing markets—perceive sustainability as critical to their long-term survival. Many industrial corporations that have carbon emissions reduction goals are embracing both energy efficiency and renewable energy in efforts to meet these goals. Scottish Leather Group is one. “We spent several years improving our energy efficiency. The next stage is the creation of our own renewable energy,” says Dr Bowden, the environment director. “We have moved forward from energy efficiency in its own right; the key message now is sustainability.”

Meanwhile, many large corporations are taking a more active approach to sustainability in their supply chain to reduce their environmental impact and meet their corporate social responsibility commitments—providing more impetus for firms in the supply chain to focus on energy efficiency. Many large companies are requiring carbon disclosure or environmental impact statements from their suppliers; furthermore, “some have started to help suppliers to move by getting energy audits into their factories, and by getting coaching in place,” says Ryan Schuchard, manager of climate and energy at BSR, a consultancy focused on sustainability. “That’s just started; it really is the frontier.”
Part II:
Commitment to more efficient plant and equipment remains weak

In keeping with the expanding role of energy efficiency in industry, more and more manufacturers and power producers are taking steps to improve their energy efficiency, such as replacing less-efficient lighting. Survey results demonstrate that 73 percent of companies have undertaken measures relating to lighting systems to improve energy efficiency in the past three years, up from 67 percent in 2011; that 57 percent have invested in air conditioning, up significantly from 48 percent previously; and that 46 percent have invested in heating, up marginally from 45 percent in 2011. (Figure 3)

Yet results of the survey this year show that a marginally lower proportion of companies have been making investments in plant and equipment to improve energy efficiency than was the case in 2011. For example, just 39 percent of respondents say that they have invested in capital, plant and equipment within the past three years to improve energy efficiency—a figure below the 40 percent reported in 2011. In developed countries, just 32 percent have made such investments. Apollo Tyres in India is one of those companies that has made investments in improving their equipment, including motors and motor-driven equipment such as pumps, compressors, and fans. “These take around 30 percent of our energy in the plants,” says Mr Agarwal. “So that’s a major area for us, and a lot of work goes into improving the efficiencies of our existing equipment.”

And looking more broadly at levels of capital expenditure made to improve industrial energy efficiency over the past year, a similar picture emerges: the proportion of industrial enterprises that have expanded investment in industrial energy efficiency over the past year is stagnant. While the majority (58 percent) of surveyed executives indicate they have increased their investments in energy efficiency in the past year, versus the prior year, a very significant minority (42 percent) say their investments have remained static in the past year, or have fallen. It was the same two years ago. (Figure 4)
Financial obstacles stand in the way

If more firms are investing in better lighting, heating, and air conditioning, why are more not investing in better plant and equipment? The reasons are apparently financial, first and foremost. When asked the two most significant barriers to investment in energy efficiency at their companies, executives are most likely to name a “lack of a clear-cut financial case for energy efficiency investments.” Thirty-seven percent of executives name this as an obstacle; but the figure is down from 42 percent in 2011, suggesting that while it remains the most significant barrier, it is a barrier that fewer and fewer firms are encountering. (Figure 5)

Furthermore, companies appear to demand high rates of return on their investments in improving energy efficiency. According to research by Resources for the Future, a Washington-based think-tank, most plants require measures to offer payback in 15 months or less, corresponding to an annual rate of return of 80 percent or more. That concurs with the views of executives in our interview program: “We look at investment payback of anything less than two years as very good, and more than three years as less attractive,” says Mr Agarwal of Apollo Tyres.

Rates of return depend on many variables—explaining why 68 percent of survey respondents say that arguments for energy efficiency investments must be made on a case-by-case basis. “If you build a new plant, the additional investment in making it energy efficient has a payback of about two years,” says Tony Van Osselaer, head of industrial operations and a member of the management board at Bayer MaterialScience in Germany. “But if you tried to do that at an existing facility, you’re talking about seven to eight years.” The case for investment in energy efficiency is therefore clearer in industries that are growing—and in countries whose manufacturing industries are growing.

The lack of a clear financial case is not the only barrier to investment in improving energy efficiency. The obstacle that is most widespread besides this is a “lack of funds”—which 28 percent of survey respondents describe as a barrier. This is similar to 2011, when lack of funds was also the second most common barrier and was also cited by 28 percent of executives. The particular issue, say interviewees, is the difficulty in securing funds for large projects. “As we ran out of the obvious things to do, we then had to spend more in order to save more,” recalls Dr Bowden of Scottish Leather Group.

This raises the question of capital allocation, as Mr Herzog points out: “In times where you have not so much resources, I feel a certain ‘competitiveness’ for the resources in the sense of, do we allocate capital to something that will save us money, or do we allocate capital to something that will provide growth opportunities?” The answer, it appears, could lie somewhere in between. The challenge for management, believes Gil Forer, global Clean-
tech leader at Ernst & Young, is to understand “how being more efficient can lead you to have a certain competitive advantage in the market and lead to profitable growth,” he says. “To be more resource efficient is not just a game of numbers—it is a strategic imperative.”

Lifting the barriers
Significantly, only 21 percent of respondents cite a “lack of information” as a barrier to investment in better energy efficiency, whereas 27 percent did in 2011, suggesting that efforts to promote energy efficiency are making headway. Still, points out Mr Schuchard of BSR, “in emerging markets there is less information that is locally relevant, that is taking into account the specific local equipment and processes and norms.” Precisely 30 percent of executives in developing regions say lack of information is a problem, just as they did in 2011; just 14% in developed markets say lack of information is a problem, down from 25% previously. This suggests that it is in developed markets that the provision of information has improved in the past two years, and that there is still considerable room for improvement in developing markets.

It is worth noting as well that relatively smaller firms are less likely to say information is a barrier than they were two years ago: just 20 percent cite lack of information as a barrier, compared to 32 percent in 2011. Among other reasons for this improvement, it appears that resources for energy efficiency improvements are being made available to small and medium-sized enterprises (SMEs) (See box: SMEs in the spotlight).

“Customers are a good resource for factories in China to gather information on energy efficient technologies,” says Fengyuan Wang, advisory services manager at BSR in Hong Kong. He points out that in China, local governments have training programs available for factories, and energy service companies—so-called ESCOs—are often willing to provide free support.

Despite the improving availability of information about investment in energy efficiency, gaps remain. For example, 71 percent of survey respondents say that “industries need clearer benchmarks for what constitutes energy efficiency” in their sectors. While high, this level is nevertheless lower than the 77 percent figure of two years ago. This fall could indicate that benchmarking information is becoming clearer, or more widely accessible. Equally, it could indicate that executives feel they have adequate information about their own energy efficiency and need no external data.

Indeed, some executives rely little on external benchmarks, saying that circumstances vary across processes, facilities, regions, and sectors, and that external benchmarks may not be reliable. Consider Mr Agarwal of Apollo Tyres, who says that, “the age of our different plants is different, and therefore the efficiency of our different plants is different,” meaning benchmarks even between different plants within Apollo are of little use. Instead, the company benchmarks individual processes across its plants. Thorsten Becherer, a manufacturing excellence director at Swedish paper maker Svenska Cellulosa Aktiebolaget (SCA), says internal benchmarks are fast and can be tailored. “Internal benchmarking is a key for us to drive continuous improvements in all our sites,” he says.

While the survey findings indicate that some of the barriers to investment in better energy efficiency are lowering, one further finding is that the number of industry managers who say there are no such barriers is on the rise: 26 percent of executives respond to the survey this way, significantly more than the 18 percent who did so in the comparable survey in 2011. While significant, the change appears to be for the most part driven by large firms from North America, possibly reflecting, in part, strong cash balances among US companies.
Apart from improving energy efficiency through investment in more efficient equipment and processes, there is also significant potential to achieve energy savings by improving energy management practices. Some of these improvements may be straightforward. “The guy comes at six o’clock in the morning, switches everything on, and then switches everything off at six o’clock in the evening,” says Dr Bowden of Scottish Leather Group. “But the equipment may not have done a thing all day,” he says. “And it really is as simple as that. You can have the most energy efficient plant on the planet, but if you don’t need to run it, don’t.”

Although there has been no growth in the proportion of companies investing in plant and equipment to improve efficiency, there appears to be growth in the proportion focusing on improving their energy management practices. (See box: Are less energy-intensive companies now behaving like energy-intensive companies?) For a start, more and more companies are making managers responsible for energy efficiency. Executives are more likely now than two years ago to say that responsibility rests with individual line-of-business managers or business-unit heads (25 percent, versus 19 percent in 2011) and with an energy efficiency or environmental health and safety manager (24 percent, versus 20 percent previously). For a case in point, look no further than CLP India: “The CEO has set up a team to look at sustainability and energy efficiency,” comments Mr Dexter. “So there is now a central organization at the corporate level to look at these things.”

The fact that companies are delegating formal responsibility for energy efficiency is significant because line-of-business managers or business-unit heads may be more likely than CEOs to squeeze the most out of equipment and processes for manufacturing.

S G Choudhary, chief technology and sustainability officer at Tata Chemicals in India, explains that the firm has a target to improve energy efficiency by between 1 percent and 2 percent every year, and that responsibility for achieving that target rests with line management. “We take a view that the best people to improve efficiency are the line managers,” Mr Choudhary says, “as they are the ones who are dealing with the equipment and processes on a daily basis.”

Formal delegation of responsibility for energy efficiency is also important because a stronger focus at the operating level allows firms to identify more potential savings. Research by the American Council for an Energy-Efficient Economy (ACEEE), a think-tank in Washington, indicates that “identified opportunities for industrial energy efficiency remained largely the same order of magnitude over the period from 1980 to 2000 in spite of significant realized energy savings in the sector.” Consider SCA: “We thought we would take the ‘low-hanging fruit’ and then run out of opportunities,” recalls Mr Becherer. “But the deeper you look into it, the more potential you find.”

### A focus on energy management systems

Many companies included in this research are adhering to energy planning and management guidelines set out by the Energy Star program, a US-government backed energy efficiency program, or by the ISO 50001 energy management standard. At US manufacturing conglomerate 3M, the group’s global manager of corporate energy, Steve Schultz, says: “We’re working to exceed our publicly stated goal to improve energy efficiency by 25 percent over a 10 year period that ends in 2015. A large part of achieving that is behavior-based activities, which center on the guidelines for energy management that the Energy Star program and the ISO 50001 guidelines give us.”

Indeed, more industrial enterprises now have a company-wide energy management system in place to track and optimize energy use than was the case two years ago, according to survey results. Fully two-thirds (67 percent) of respondents say they have such a company-wide system in place—up strongly from 50 percent in 2011. Mr Schuchard of BSR remarks that tools are becoming available to help companies take control of energy efficiency: “We are seeing better technology for energy efficiency management—software and apps—so it’s becoming easier to manage,” he says.
Mr Schultz explains that 3M is currently working on plans to improve its energy information systems. “We’ve got a lot of meters, and the meters feed information into historical data-gathering systems, but it doesn’t really provide usable information in a real-time manner to people at the factory,” he says. “So we are working to evolve those systems into more information that’s actionable at the time with people who are on the floor of the factory.” The systems at each manufacturing facility will include flat screen monitors with real-time energy data displays. “I think that getting the operators more engaged will be an important aspect of improvement, and giving them the information is key to that,” says Mr Schultz.

Models like that open the way for high-level control systems, or advanced process control systems, that enable plants to run closer to optimum capacity. “Once implemented, you have an ideal energy consumption figure for each facility indicated, because it’s a real-time system,” says Dr Van Osselaer of Bayer MaterialScience. “At any second you compare your current consumption to that ideal consumption.” Such models appear to fit with research by the ACEEE, which concludes: “Increasingly, the opportunities will come less from seeking out individual sources of waste and more from optimization of complex systems enabled by advances in information, communication and computational infrastructure.”

**Box: Are less energy-intensive companies now behaving like energy-intensive companies?**

Executives from energy-intensive sectors (defined as iron and steel, chemicals/petrochemicals, cement, pulp and paper, aluminum, electric power generation, and electric power transmission) and less energy-intensive firms (such as textile producers or computer makers) diverged in the responses they gave in our 2011 survey. But in our 2013 survey, the two groups tend to converge.

Consider the survey questions that appear in this section of the report. These questions concern the behavior and management practices of industrial firms relating to energy efficiency, such as: Do you have a company-wide energy management system in place to track and optimize energy use? Who has formal responsibility for energy efficiency in your organization? Does your company regularly report its progress on improving energy efficiency?

Responses to these questions reveal a convergence between the two groups in 2013, with those in less energy-intensive sectors being the ones that have closed the gap by adopting better practices. This suggests that less energy-intensive firms are adopting better practices around energy efficiency which have been widespread among energy-intensive industries for some time.
Reporting progress
Despite firms’ progress in their approach to energy management, just 36 percent say they have conducted an energy audit across the entire group within the past three years—not much of an improvement on the 34 percent reported in 2011. One reason may be that audits can be costly, especially in remote areas where local resources may be lacking, as is the case in some parts of China. “Firms there are often growing, and the opportunity cost of paying attention to a comprehensive audit is too high,” says Mr Schuchard. (Figure 8)

Furthermore, not all executives find company-wide audits useful. “Energy audits tend to produce high-level information that is hard to convert into practical projects and actions,” says Ricardo Mendes, energy director at Brazilian mining company Vale. “Instead, we conduct engineering analyses of systems with the greatest potential for energy efficiency. These analyses produce more in-depth results, with more potential for conversion into effectively implemented projects.”

In that vein, growing numbers of firms are regularly reporting their progress on improving energy efficiency at either plant level, business unit level, or group level. Sixty-two percent of executives say their firms report progress regularly—a significant rise over the 48 percent level reported two years ago. At 3M, Mr Schultz sends the CEO a quarterly report showing progress towards energy goals at group, business unit and plant level. Many companies, Scottish Leather Group among them, are also publishing their energy performance results in shareholder reports and other external publications. (Figure 9)
Part IV: Promoting long-term efficiency gains

Looking ahead, 67 percent of survey respondents expect their firms to increase their investments in industrial energy efficiency in the next three years—down from the 73 percent level recorded in 2011. Of these, just 9 percent expect a very significant increase of 30 percent or more (down from 13 percent two years ago). More positively, a growing number of companies in Asia-Pacific say they foresee growth in investments in the next three years, with 78 percent saying they will increase spending, up from 71 percent two years ago. (Figure 10)

Given companies’ weak commitment to investing in better energy efficiency, it is perhaps unsurprising that policy makers are pushing hard to promote better energy efficiency in industry in the coming years. Governments appear to be drafting in more and more measures to promote industrial energy efficiency. For example, 63 percent of survey respondents say the government where they are based promotes efficiency standards on industrial equipment and appliances, up from 47 percent two years ago. Fifty-six percent of executives say the government levies taxes on pollution or carbon emissions, up from 38 percent in 2011. Meanwhile, 54 percent of respondents say there are incentives and/or subsidies to upgrade to more efficient equipment, up from 51 percent two years ago—though just 21 percent of respondents say that taxpayers should bear more of the cost of companies’ energy efficiency compliance. (Figure 11)

Policy makers across the globe are also turning to regulation to promote energy efficiency in industry. As a matter of fact, asked to describe legislation and regulation governing industrial energy efficiency in the country in which they are based, 57 percent of executives opt for “very stringent” or “somewhat stringent” in the 2013 survey; in the 2011 survey, the figure was far lower, at 40 percent. Accordingly, the proportion of respondents who describe regulation as “modest, not onerous,” has fallen to 39 percent, from 50 percent previously. (Figure 12)
Regulatory pressure on industry is set to continue intensifying in the coming years. For example, Germany plans a surcharge on energy supplies to companies that do not implement the ISO 50001 standard by the end of 2014; China’s government is launching pilot emissions training schemes in seven locations around China this year, which will extend nationwide in 2015; and India’s Perform, Achieve Trade (PAT) scheme, an energy efficiency certificate program launched in 2012, will progressively be rolled out across industry in the coming years.

Still, despite the growing body of opinion that regulation is becoming stringent, a majority of executives, 64 percent, say that regulation is a benefit. Just 32 percent of survey respondents perceive regulation as a burden. “When governments enter and they set targets for you, the business still struggles with capital allocation—but may be more compelled to do it, if it’s a regulatory requirement,” explains Mr Dexter of CLP India. “The biggest challenge for us is educating the people that intend to regulate us.”

(Figure 13)

Box: Process improvements at Bayer

Improvements in industrial energy efficiency can come from better equipment, better processes or better practices. German chemicals firm Bayer MaterialScience (BMS) is targeting specific emissions reductions of 40 percent between 2005 and 2020. Of these savings, explains Tony Van Osselaer, head of industrial operations and a board member of Bayer MaterialScience, the firm expects around two-thirds from better processes and one-third from better practices.

Already, BMS’ focus on process innovation has led to two notable successes:

− The first is a process the firm calls gas phase phosgenation, based on technology developed by BMS in Germany. Used to produce isocyanates, which are needed in turn to manufacture polyurethane foam, the new process uses 80 percent less solvent than the previous method. As there is less solvent that needs to be evaporated, the new process uses 60 percent less energy.

− The second is a process called oxygen depolarized cathode to produce chlorine, needed for some 80 percent of BMS’ products. The new process uses 30 percent less energy than the old chlorine-alkali electrolysis method that accounts for two-thirds of the group’s entire energy usage. BMS says that if all chlorine production in Germany were to switch to the ODC process, the country would cut its energy consumption by one full percentage point.
Efficiency, IP-style

Besides tougher regulation, advances in technology are also likely to pave the way for further energy efficiency gains in industry. Some advances may enable better process design (see box: Process improvements at Bayer), while others may enable better process execution. The latter are likely to center on sensors and controls, in particular exploiting advances in information and communications technologies, and intelligent manufacturing systems, to improve process control and efficiency. “We see the idea of continuous process optimization as a huge opportunity in the marketplace,” says R Neal Elliott, associate director for research at the ACEEE.

Dr Elliott explains that the ability to capture large amounts of performance data has improved in the past decade, in part because the cost of deploying sensor technology in manufacturing plants has fallen dramatically. Today, there is scope to exploit intelligent pumps that include sensing capabilities or smart motors that are networked. “You achieve continuous process optimization by a combination of deploying sensors, running process simulations and doing closed loop control of the process,” says Dr Elliott. “It’s allowing us to get more productivity, more quality and lower environmental emissions from a lot of existing process technologies.”

Not surprisingly, some industry executives are skeptical. “It’s hard work, day-to-day, to look at your data and to analyze it,” argues Mr Becherer of SCA. “Instead of developing new equipment to give us even more data and confuse us even more, we should have people investigating the data, understanding the losses and driving consumption down,” he says. Indeed, Dr Elliott concedes that, “we’ve gone from the limitation being data in the last decade, to the limitation being to discern signal in the data today.” Accordingly, he believes, industry will need to develop its capabilities in simulation, data mining and others aspects of data analytics.

In time, it’s possible that some of this data analytics capability will rest in super-computers in the cloud, Dr Elliott believes. Networked production systems will be able to feed performance data into cloud-based models in near real time. “Today we have the capability to run models that do real-time process control, and then track the data,” he says. “When they get outside a set of parameters they can then go up to the cloud and run the models on the super-computers in the cloud and then be able to adjust those models that are doing the real-time control of the process.”

Such capabilities could signal a shift of focus away from major process equipment to the software and controls that operate the equipment—meaning that plant and equipment could be optimized more quickly for better performance and better energy efficiency. “We are going to see, in my estimation, increasing value coming from what we have traditionally thought of as intellectual property-type investments and less from investments in physical assets,” concludes Dr Elliott.
In an effort both to improve cost competitiveness and to meet sustainability commitments, many industrial manufacturers across the world are targeting better energy efficiency. The benefits of improved energy efficiency are clear, both in terms of financial impact and in terms of environmental impact. Yet, for the time being, companies appear reluctant to invest in more efficient plant and equipment.

The experiences and viewpoints of executives and other experts interviewed for this report provide a number of insights into trends in investment in better industrial energy efficiency:

– **Energy efficiency is increasingly perceived as a critical element of sustainability management, as well as of cost management.** Industry managers continue to understand the importance of energy efficiency in driving the company’s financial performance, but now it appears that sustainability is growing as a factor behind industry’s approach to energy efficiency. This may signal a turning point, with energy efficiency moving higher up the list of managers’ priorities.

– **Companies are focussing on better energy management practices but are not yet matching this commitment with cash investments.** Firms appear to be implementing basic measures to improve energy efficiency, and adopting better energy management practices, rather than growing investment in more efficient equipment. In time, however, the sharper focus on energy may well lead to more investment in plant and equipment.

– **Regulation is spreading fast, and appears set to promote better energy management practices and drive investment in more efficient equipment.** Those companies that are already complying with the spirit of these regulations—for example, by acting in accordance with the ISO 50001 standard—find it beneficial. Embracing these regulations may provide impetus to industrial manufacturers’ efforts to target better energy efficiency.

– **Sensor technology will increasingly allow continuous process optimization, based on intelligent equipment networked with cloud computing capacity.** In the future, it is very likely that the energy efficiency value in industrial process technology will lie more in software, apps, and other intellectual property, and less in the physical industrial hardware itself.
What are your organization’s global annual revenues in US dollars?

<table>
<thead>
<tr>
<th>Revenue Range</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>$500m or less</td>
<td>51%</td>
</tr>
<tr>
<td>$500m to $1bn</td>
<td>16%</td>
</tr>
<tr>
<td>$1bn to $5bn</td>
<td>19%</td>
</tr>
<tr>
<td>$5bn to $10bn</td>
<td>5%</td>
</tr>
<tr>
<td>$10bn or more</td>
<td>9%</td>
</tr>
</tbody>
</table>

What are your main functional roles? Choose up to three.

- Finance: 56%
- Strategy and business development: 49%
- General management: 21%
- Operations and production: 12%
- Marketing and sales: 7%
- Risk: 7%
- IT: 5%
- Customer service: 4%
- Supply-chain management: 3%
- Procurement: 2%
- Information and research: 2%
- Human resources: 1%
- R&D: 1%
- Legal: 1%
- Other: 2%

Which of the following best describes your job title?

- Board member: 2%
- CEO/President/Managing director: 6%
- CFO/Treasurer/Controller: 23%
- CIO/Technology director: 2%
- Other C-level executive: 16%
- SVP/VP/Director: 19%
- Head of business unit: 2%
- Head of department: 29%
- Manager: 2%
- Other: 0%

In which region are you personally based?

- Asia-Pacific: 31%
- Western Europe: 30%
- North America: 25%
- Middle East and Africa: 8%
- Latin America: 1%
- Eastern Europe: 1%

Do you have responsibility for, or influence over, either of the following?

- Corporate finance, treasury management, investment or asset management: 53%
- Corporate strategy or business development: 47%

What is your primary industry?

- Manufacturing: 52%
- Power & utilities: 48%
In the country in which you are based, how would you describe legislation and regulation governing industrial energy efficiency?

- Very stringent: 16%
- Somewhat stringent: 41%
- Modest, not onerous: 39%
- Non-existent: 4%
- Don’t know: 0%

Do you have a company-wide energy management system in place to track and optimize energy use?

- Yes: 67%
- No: 32%
- Don’t know: 1%

In the country in which you are based, what types of laws and regulations does the government use to promote industrial energy efficiency? Select all that apply.

- Efficiency standards on industrial equipment, appliances, etc: 62%
- Taxes on pollution or carbon emissions: 56%
- Incentives and/or subsidies for upgrading to more efficient equipment / appliances: 54%
- Incentives to switch to renewable energy: 45%
- Requirements for environmental impact statements or audits: 45%
- Codes for energy efficiency of buildings: 41%
- “Green IT” codes (energy efficiency standards for IT equipment): 35%
- Carbon cap-and-trade programmes: 27%
- Other, please specify: 0%
- No legislation in place: 2%
- Don’t know: 0%
Over the next two decades, energy efficiency will be a critical factor in manufacturers’ profitability.

Energy efficiency is already a critical success factor for manufacturers.

The argument for energy efficiency investments must be made on a case by case basis.

Industries need clearer benchmarks for what constitutes energy efficiency in their sectors.

Taxpayers should bear more of the cost of companies’ energy efficiency compliance.

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To what extent do you agree or disagree with the following statements? Please select one in each row.

- Over the next two decades, energy efficiency will be a critical factor in manufacturers’ profitability: 43% agree strongly, 34% agree somewhat, 20% neither agree nor disagree, 2% disagree somewhat, 0% disagree strongly, 0% don’t know.
- Energy efficiency is already a critical success factor for manufacturers: 34% agree strongly, 42% agree somewhat, 18% neither agree nor disagree, 0% disagree somewhat, 0% disagree strongly, 0% don’t know.
- The argument for energy efficiency investments must be made on a case by case basis: 31% agree strongly, 38% agree somewhat, 20% neither agree nor disagree, 10% disagree somewhat, 0% disagree strongly, 0% don’t know.
- Industries need clearer benchmarks for what constitutes energy efficiency in their sectors: 32% agree strongly, 39% agree somewhat, 22% neither agree nor disagree, 6% disagree somewhat, 0% disagree strongly, 0% don’t know.
- Taxpayers should bear more of the cost of companies’ energy efficiency compliance: 8% agree strongly, 19% agree somewhat, 23% neither agree nor disagree, 35% disagree somewhat, 21% disagree strongly, 0% don’t know.

With regard to which of the following has your organization undertaken measures within the past three years to improve energy efficiency? Select all that apply.

- Lighting systems: 73%
- Air-conditioning: 57%
- Heating: 46%
- Water use: 46%
- Capital, plant and equipment in our factories: 38%
- Insulation of our buildings: 36%
- A company-wide energy audit: 36%
- New products or services for our customers: 23%
- IT stock: 16%
- Other, please specify: 2%
- We have not undertaken any energy efficiency measures within the past three years: 4%
Over the past year, how much, if at all, has your company’s investment in industrial energy efficiency changed over the previous year?

<table>
<thead>
<tr>
<th>Change in Investment</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>More than 50% increase from previous year</td>
<td>1%</td>
</tr>
<tr>
<td>30% - 50% increase from previous year</td>
<td>7%</td>
</tr>
<tr>
<td>10% - 30% increase from previous year</td>
<td>22%</td>
</tr>
<tr>
<td>1% - 10% increase from previous year</td>
<td>29%</td>
</tr>
<tr>
<td>Static – no change from previous year</td>
<td>39%</td>
</tr>
<tr>
<td>1% - 10% reduction from previous year</td>
<td>1%</td>
</tr>
<tr>
<td>10% - 30% reduction from previous year</td>
<td>1%</td>
</tr>
<tr>
<td>30% - 50% reduction from previous year</td>
<td>1%</td>
</tr>
<tr>
<td>More than 50% reduction from previous year</td>
<td>0%</td>
</tr>
</tbody>
</table>

How do you expect your company’s investment in industrial energy efficiency to develop over the next three years?

<table>
<thead>
<tr>
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<tbody>
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</tr>
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<td>30% - 50% increase from current year</td>
<td>28%</td>
</tr>
<tr>
<td>10% - 30% increase from current year</td>
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</tr>
<tr>
<td>1% - 10% increase from current year</td>
<td>31%</td>
</tr>
<tr>
<td>Static – no change from current year</td>
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</tr>
</tbody>
</table>

What are the main factors that will influence your company’s investment in industrial energy efficiency over the next three years, in your view? Select up to three.

- The price of energy: 57%
- Cost-benefit analysis of each investment, including break-even analysis: 55%
- A wish to improve the company’s image as environmentally concerned: 35%
- Pressure from customers and/or shareholders to reduce costs: 29%
- Corporate best practice in my industry: 24%
- National energy legislation and regulations: 22%
- A wish to foster innovation in manufacturing processes: 15%
- Expectation of tighter regulations governing energy use and/or carbon emissions: 12%
- Local energy legislation and regulations: 11%
- Pressure from non-government organizations and/or energy activists: 6%
- Other, please specify: 0%
Who has formal responsibility for energy efficiency in your organization?

- Chief executive officer: 32%
- Chief financial officer: 3%
- Head of sustainability: 5%
- Energy efficiency or environmental health & safety manager: 24%
- Individual line-of-business managers or business-unit heads: 25%
- Other, please specify: 7%
- Nobody has responsibility: 3%
- Don’t know: 1%

What, if any, are the main barriers to investment in industrial energy efficiency in your organization? Select up to two.

- Lack of a clear-cut financial case for energy efficiency investments: 37%
- Lack of funds: 28%
- Lack of information about energy efficiency options: 21%
- Insufficient commitment by senior management: 17%
- Unclear who is responsible for such investments: 5%
- Other, please specify: 2%
- We have no such barriers: 26%
- Don’t know: 0%

Does your company regularly report its progress on improving energy efficiency, for example as part of its annual report?

- Yes: 62%
- No: 38%
- Don’t know: 1%

In your view and on balance, is industrial energy efficiency legislation in the country in which you are based currently more of a benefit or a burden to your industry?

- A benefit: 64%
- A burden: 32%
- Don’t know: 4%
Contact us

ABB Ltd
Corporate Communications
P.O. Box 8131
CH-8050 Zurich
Switzerland
Phone:  +41 (0)43 317 71 11
Fax:    +41 (0)43 317 79 58

www.abb.com/energyefficiency