Longer Term Investments

Energy efficiency

CIO WM Research | 22 November 2016
Alexander Stiehler, CFA, analyst; **Sundeep Gantori**, CFA, CAIA, analyst

- Energy demand continues growing, particularly in emerging markets, due to growing populations, ongoing urbanization and rising wealth levels.
- Energy efficiency helps end-users reduce power demand at source, cutting CO2 emissions and saving resources, making efficiency a key business factor for companies and consumers. The International Energy Agency (IEA) expects the demand for energy-efficient products to grow by 7–8% annually. Investment could reach USD 530bn in 20 years, up from USD 130bn in 2013.
- We see two strong drivers for energy efficiency: a) stricter regulation to protect the environment and secure energy supplies; and b) corporate competition to improve product efficiency. Both offer good long-term opportunities for investors focused on sustainable investing. We expect high single-digit earnings growth rates for our energy efficiency theme.

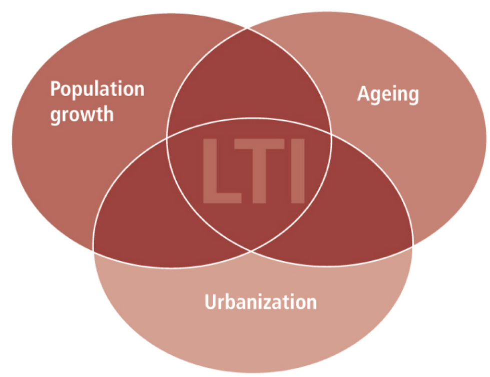
Our view

Urbanization, population growth and an expanding middle class are leading to higher energy consumption. Given the consequences that rising emissions have, energy efficiency is becoming ever more important. An IEA scenario projects that energy consumption could almost double by 2050. The good news is that policymakers have already started to react. The Climate Summit in Paris in December 2015 paved the way for additional efforts to mitigate climate change. Energy efficiency is considered the most effective way to lower energy consumption, and the easiest and generally cheapest way to reduce energy demand and lower CO2 emissions.

While pessimists argue that the recent increase in oil supply and subsequent fall in prices have made the case for efficiency less compelling, energy efficiency is not only about economics or short-term fluctuations in demand and supply. It involves a long-term commitment to addressing global warming and energy security, and so should remain a key priority for policymakers. We also believe the recent US election does not throw a wrench into the works, because regulation is only one driver. Another is corporate competition (payback periods). No manufacturer has an incentive to produce less-efficient equipment, since global peers would then win out in the next bidding.

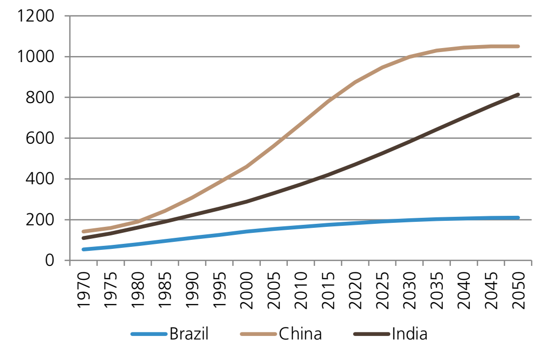
Introduction to the Longer Term Investments (LTI) series

- **The Longer Term Investments (LTI)** series contains thematic investment ideas based on long term structural developments.
- Secular trends such as population growth, ageing, and increased urbanization create a variety of longer term investment opportunities.
- Investors willing to invest over multiple business cycles can benefit from potential mispricings created by the typically shorter term focus of stock markets.



We expect investments in energy efficiency to continue growing. With the industry anticipated to increase in scale (based on IEA estimates of 7–8% annually), we also expect margins to improve, fueling high single-digit earnings growth rates annually for our theme.

Fig. 1: Urban population
1950-2050E, in millions



Source: United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects: The 2014 Revision

Introduction

"Less is more" could be the motto for the coming decades. Energy efficiency is the response to many challenges humankind is facing, such as the much sought-after reduction in the use of fossil energy sources or the lack of storage technologies for renewable energies. Saving energy directly at the source lowers costs, while also conserving resources and cutting back on emissions. The growing pace of urbanization in developing countries in particular (see Fig.1) and global population growth are leading to an increased demand for efficient buildings, transport and equipment. Since 2010, 50% of the world's population living in cities have accounted for a disproportionate 75% of energy consumption and 80% of greenhouse gas emissions. Based on the mentioned underlying trends, the energy efficiency investment theme fits perfectly into our Longer Term Investment series.

Here we examine the regulatory environment and some of the most important product solutions and services that we expect will benefit from energy efficiency investments: i) buildings, ii) industrial processes (including smart grids), iii) IT, iv) transport efficiency, and v) the automotive sector. We think that companies exposed to these end-markets will benefit from the rising demand for energy-efficient products and services.

Regulation and competition as main driver

From an economic perspective, the rule of thumb is that for each US dollar invested in energy efficiency measures, about two US dollars can be saved in investments in electricity supply and up to four US dollars in electricity costs over the life-cycle of a product. A study commissioned by ABB a few years ago revealed that 88% of all companies in the industrial sector regard energy efficiency as the key factor for their business's success in the next two decades. In particular, competitiveness will play a major role for companies with high rates of energy consumption. It is not only aging infrastructure and, in the longer term, rising energy prices that will drive this. Politics and regulation in particular will foster investments in the energy efficiency market. Politicians have long known that energy efficiency is the most cost-effective solution to the challenges posed by energy security and climate change. An impressive example of the effectiveness of energy-efficiency regulation can be seen in the transport sector. In 2015, national standards lowered global fuel consumption by 2.3m barrels per day, or 2.5% of global oil consumption, compared to a scenario with no standards (Source: IEA).

Developed markets (DM)

By 2020, the EU hopes to reduce greenhouse gas emissions 20% compared to 1990 levels, and to boost energy efficiency by the same amount. According to the EU, this is equivalent to turning off 400 power stations. EU countries have agreed to an energy efficiency target of 27% or greater by 2030 (EU summit in October 2014). By 2030, the target is to lower CO2 emissions 40%, and 80–95% by 2050.

The US has set similar targets, as evidenced by the various initiatives introduced since 2000, such as the Global Climate Change Initiative (2002), the Energy Independence and Security Act (2005), the American Recovery and Reinvestment Act (2009) and the National Action Plan for Energy Efficiency (NAPEE). Last year, the US Congress passed the Energy Efficiency Improvement Act of 2015.

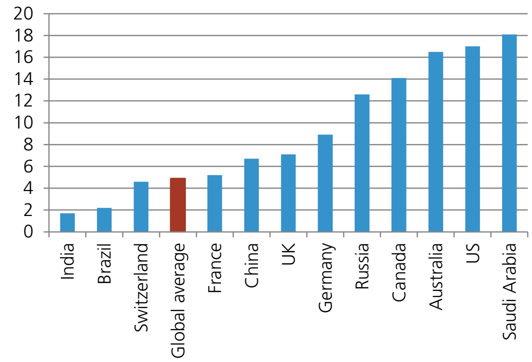
It aims to promote energy efficiency in commercial buildings. Energy efficiency measures are inevitable in the US, since the average CO2 emission per capita is more than double that of most European countries and emerging markets (see Fig. 2). By 2030, the US wants to lower CO2 emissions 26–28%, and by 2050, 80% or more.

It is possible, for example, that the newly elected president and government will reverse previously installed environmental policy, which could lead to less stringent Environmental Protection Agency (EPA) regulation. We are less concerned, however, because energy efficiency is driven not only by the regulatory framework but by competition (payback periods). We highlight two examples of competition-driven energy efficiency potential. The original purchase price of a standard pump represents less than 10% of the total cost of ownership; the primary costs are energy (40%) and maintenance (also around 40%). Energy efficiency thus represents major service-life cost-reduction potential, a considerable selling point for producers opposite global competitors. Energy-efficient motors are another example. Today, motors consume around 28% of all electricity worldwide (in machines, fans, pumps, compressors, etc.). According to ABB, only 10% of all motors are equipped with drives that allow them to adjust their speed, i.e. 90% of all motors run the entire time at full tilt, regardless of how much output is required. ABB's variable-speed drives can reduce energy consumption in motors by 20–50%. Manufacturers have a strong incentive to improve their products' energy efficiency to remain competitive.

Emerging markets (EM)

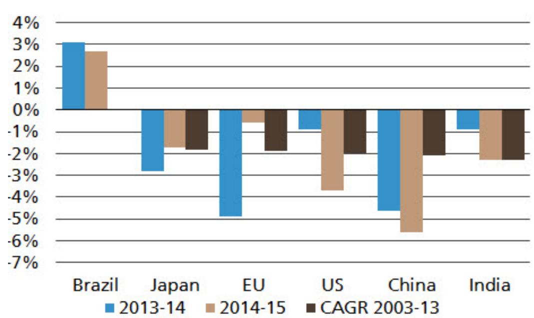
The BRIC nations – Brazil, Russia, India and China – are also making a targeted effort to reduce their CO2 emissions and improve their energy efficiency. In China, for example, CO2 intensity per unit of GDP is to be reduced 60–65% from 2005 to 2030. India wants to lower emissions intensity of GDP by 33–35% by 2030 (base year 2005) and achieve 40% installed electricity capacity from non-fossil sources. India also promotes energy efficiency in industry, transport, buildings and appliances. Brazil wants to lower CO2 emissions 37% by 2025 (base year 2005).

Fig. 2: CO2 emissions per capita
Metric tons



Source: World Bank (latest data 2011), as of November 2016.

Fig. 3: Changes in primary energy intensity for selected countries
Changes in energy intensity (total primary energy supply/GDP => units of energy per unit of GDP)



Notes: It is calculated as units of energy per unit of GDP. GDP is measured in Mtoe per billion 2010 USD using market exchange rates. Primary energy demand is not adjusted for annual temperature changes.

Source: OECD/IEA, 2016: Energy Efficiency Market Report 2016

The country already achieved a 41% reduction to the 2005 level by 2012, so it is aiming to stabilize around the current level. For 2030, Brazil has an indicative target of 43% below the 2005 level, and is also striving for 10% efficiency improvements in the power sector, as well as new energy efficiency standards in the industry and transport sectors. Russia's energy intensity is much higher than the OECD average due to its reliance on heavy industry. One of the country's overriding objectives is to improve heavy industry's energy efficiency. It wants to lower CO2 emissions 25–30% by 2030 (base year 1990). In 2009, Russia already announced plans to cut energy intensity by 44% between 2005 and 2030.

Over the last few years, nearly all countries lowered their energy intensity except for Brazil, which suffered from a recession (see Fig. 3). China achieved the greatest reduction, in two years in a row surpassing the average annual improvement over the last 10 years.

Buildings

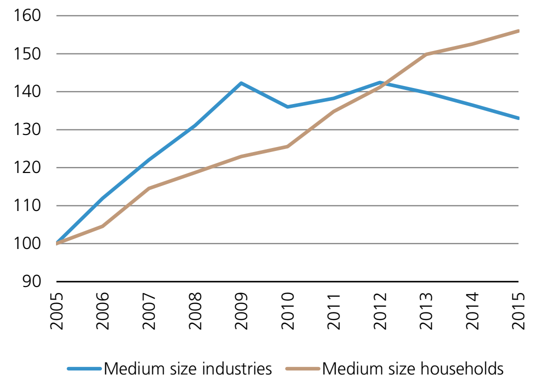
Buildings offer the greatest potential for reducing energy consumption; the buildings segment currently accounts for 40% of energy demand and emits 30% of CO2 emissions (Source: IEA). In developed countries the CO2 emissions are even higher, at close to 40% (Source: EU, EIA). By 2040, the primary energy demand in buildings could increase by another 60%, mainly driven by emerging markets (Source: OECD). The growth is propelled by population and urbanization (more commercial and residential floor space). Based on various forecasts, the amount of energy consumed in buildings could be reduced 30–50% through energy efficiency in the next decades.

On average, a building in the US is used for 50–75 years, and 60–85% of the costs associated with it are operating costs (for fuel, maintenance, and repair, etc.), compared with just 5–10% spent on design and construction (Source: US National Institute of Building Services). This makes energy efficiency a simple way to bring down maintenance costs. According to Ingersoll Rand, energy costs represent 40% of the EU's operating costs. High electricity prices (see Fig. 4), laws that prescribe stricter standards and tried-and-tested technologies at acceptable prices all have a role to play in promoting energy efficiency. The driving force, in our view, is more stringent regulation, not only for old buildings, but also for new ones. As more countries have recognized the advantages of energy-saving investments, demand for efficiency-boosting measures in the construction industry has risen in recent years. Several countries have already introduced building standards and classification instruments to improve knowledge about the sustainability of existing buildings. This provides countries with precise information about the respective building conditions and the need for political intervention by means of control instruments.

So-called smart buildings will be an important way to save energy. Building management systems centralize the building control and manage lighting, heating, ventilation and air conditioning systems in an efficient and well-coordinated way. Fig. 5 shows how energy savings have progressed in Switzerland over the years.

Fig. 4: Strong rise in electricity prices over the last 10 years

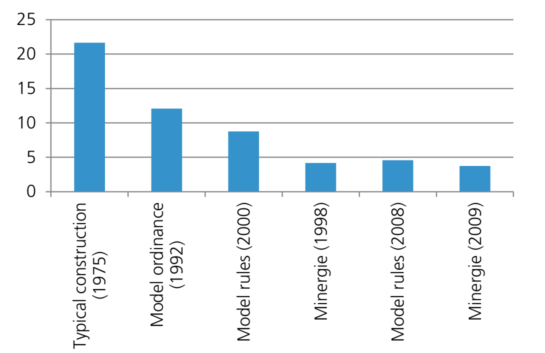
Electricity prices EU27 (indexed to 100 = 2005)



Source: Eurostat as of November 2016

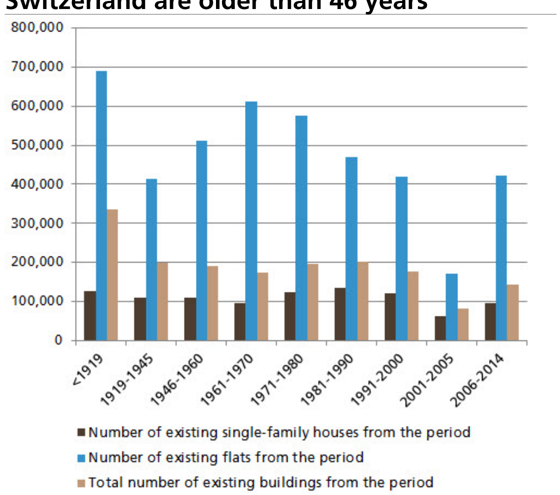
Fig. 5: Progress in energy savings over time in Switzerland

Consumption in liters of oil equivalent per square meter and year



Note: Minergie is a Swiss-registered quality label for new and refurbished low-energy-consumption buildings.
Source: EnDK (Energiedirektorenkonferenz)

Fig. 6: Around half of the existing buildings in Switzerland are older than 46 years



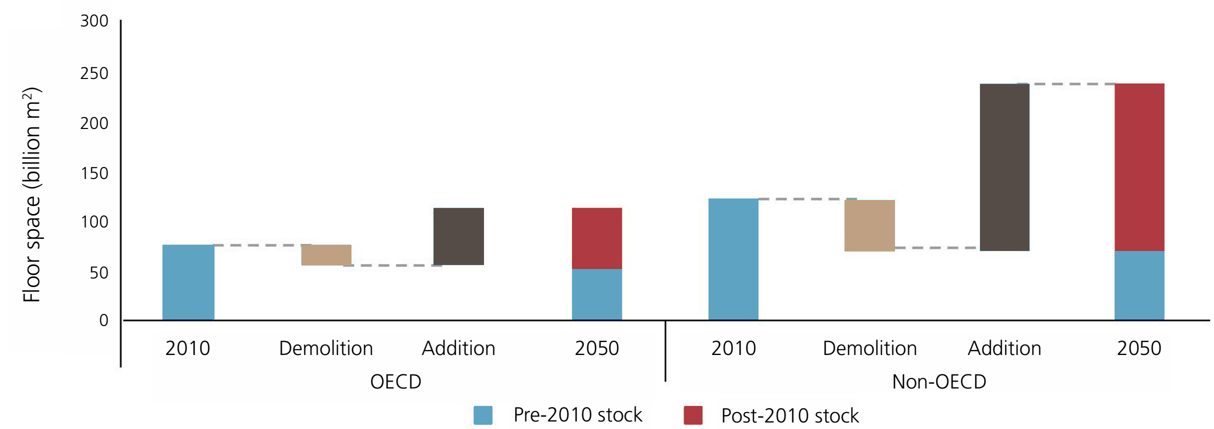
Source: Swiss Federal Office for Statistics, as of December 2015

Trends differ between EM and DM
In EM, the ongoing urbanization trend combined with higher incomes and greater access to technology should drive demand for more energy-efficient buildings. The example of Switzerland (see Fig. 5) indicates what countries can achieve. In stark contrast, the primary challenge in developed markets is the large stock of older buildings (see Fig. 6, example Switzerland). In the EU, 40% of the buildings were built before the 1960s and less than 20% in the last 20 years (e.g. in Germany, the median year of construction is 1969). In the US, the average age of owner-occupied homes is close to 40 years, according to the US Census Bureau. An IEA study shows the big difference between EM and DM. Around 75% of the buildings in OECD countries will still be standing (base year 2010) in 2050, compared to only 40% in non-OECD countries, leading to a sharp rise in new builds. The building stock in non-OECD countries is expected to double by 2050 (see Fig. 7).

Strict regulation the strongest support
Although the payback period for most energy efficiency applications is only a few months (e.g. LEDs, see also Fig. 11) to some years (e.g. insulation), the strongest support for energy efficiency comes from government incentives and regulations. The EU has one of the strictest and most ambitious programs. By 2020, emissions are expected to be cut 29% for residential buildings and 13% for commercial buildings (base year 2008). As a result, the EU expects to lower its energy dependence. On top of that, EU countries should also make annual energy-efficient renovations to at least 3% of buildings owned and occupied by central governments. Other countries also have codes to improve energy efficiency; for example in April 2015, the US Congress passed another bill to promote energy efficiency in commercial buildings. In Emerging Markets, China had significant energy efficiency improvements in residential heating. Compared to the year 2000, China achieved an energy efficiency improvement of 27%. In particular, co-generation (combined production of heat and power) supported this trend. Co-generation boilers provide in the meantime 42% of total heating, up from 26% in 2000. But also building energy efficiency standards for new residential buildings are important drivers. Since August 2010, a 65% building energy efficiency over buildings constructed in the early 1980s should be achieved.

Market opportunity
From an investment perspective, building efficiency includes several end-markets. The range of companies active in this field is broad. Over the next five to 10 years, we expect growth rates of 5–7% a year depending on the segment; the highest growth is in building automation (i.e. systems that control the mechanical and lighting systems in a building), at a good 7%.

Fig. 7: Evolution of building stock between 2010 and 2050



Source: Based on OECD/IEA data (2013): Technology Roadmap, Energy Efficient Building Envelopes, UBS

Industrial processes

ABB estimates that around 80% of energy gets lost between the extraction of the resource (e.g. coal) and the final use of electricity. In the middle, diverse industrial applications are used to transport the energy and to produce end-products (see Fig. 8).

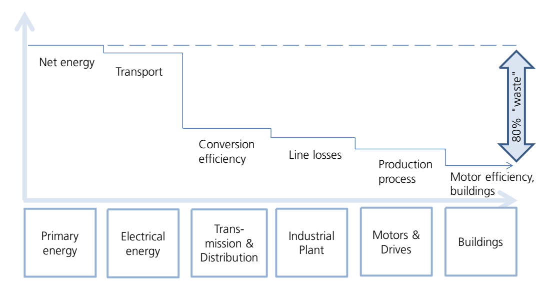
Energy efficiency has not only an immediately positive effect on lowering emissions, but also a positive multiplier effect. For every unit of electricity saved, three units are saved at the power plant as most thermal power plants only have conversion rates of 35% (the rest is wasted). Modern combined cycle gas turbines have conversion rates of 60%, but natural gas accounts for only 20%. Therefore, it is important that the produced energy (electricity) is transported very efficiently. So-called smart grids provide an efficient way to reduce losses and save resources (more about this topic later in the text).

The IEA estimates that, with today's technology, one-third of the energy could be saved (best-in-class approach). The expected payback period would be only three years in OECD countries and five in non-OECD countries. The largest industry sectors in terms of energy consumption are steel production (with 20%), chemical companies (>14%), non-metals (cement, glass, ceramics;13%), and the paper industry (5%).

Given the large number of applications in the industrial sector, there is an equal number of opportunities for increasing efficiency in this area. We estimate that the smart automation industry with current annual revenues of just under USD 150bn is still in the early growth stages. We expect the industry to post long-term mid-to-high single-digit rates on average due to strong growth in industrial software. Due to lower investments from commodity-related sectors, however, we expect the industry to post only low single-digit growth rates in the short term.

Fig. 8: Up to 80% of energy wasted from resource extraction to final use

Capital goods companies can help reduce waste along the value chain



Source: ABB

Smart grids
Smart grids reduce energy consumption and avoid CO2 emissions. They break up the supply-demand relationship in electricity as we know it today. Traditionally, utilities supply electricity from large power plants through transmission and distribution (T&D) networks to end-customers (private or industrial consumers; see Fig. 9). The "upgrade" of the conventional grid to a "smart grid" allows the usage of decentralized, smaller electricity generation resources, e.g. solar panels and energy storage (electric cars). It also enables the grid operator to collect and analyze electricity demand in real time and adjust energy generation accordingly (see Fig. 10).

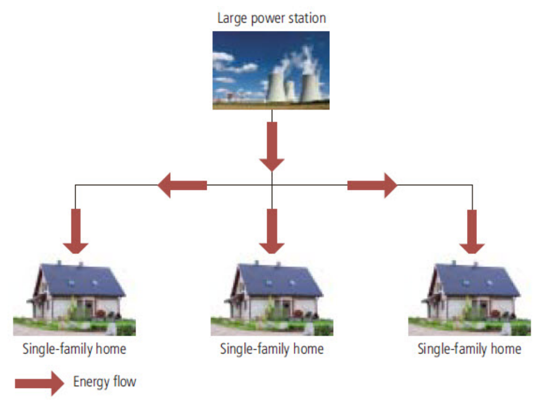
Households can be more than just consumers; they can consume according to their needs, and in future sell back their surplus electricity stored in batteries. This provides both parties (utilities and customers) an advantage and improves energy efficiency; and the ones managing the grid can respond, for instance, to the volatile power generation (wind, solar) by temporarily storing power in batteries that can supply the networks again when required. While traditionally only T&D companies were involved in this sector, we now see more IT companies entering the market. This new infrastructure promotes greater transparency of energy consumption and electricity costs. End-consumers can also adjust their consumption patterns through smart meters. As a result, consumers could adjust air-conditioning systems, for example during peak times, to lower their energy bills, or industrial companies could operate fewer machines if necessary.

On the supply side, utilities can invest less in generation capacities. A second advantage is clearly the better connectability of renewable energies, where we expect strong volume growth over the next decade. A characteristic of these energy resources is unstable generation of electricity. The sun does not always shine, nor does the wind always blow. The power system must be ready to compensate (potential breakdowns). A smart grid could integrate these alternative sources better in the future.

IT applications

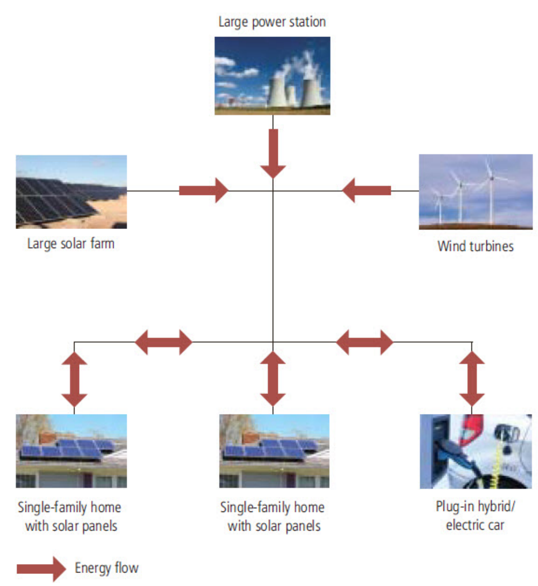
The IT sector provides vast scope for energy efficiency by offering multiple solutions. Software will be at the center of such revolution as we believe when the limits of energy efficiency equipment or hardware is reached, software comes into action to extend the benefits of energy efficiency. Hence, we believe IT is a key enabler of energy efficiency and remains a top priority for investments in the next decade. In the next section, we explain how IT drives energy efficiency based on the three energy end-markets: buildings, transport and industry.

Fig. 9: Conventional electricity grid
Energy flows in only one direction



Source: Nomura, UBS

Fig. 10: Smart grid
Energy flows in many directions



Source: Nomura, UBS

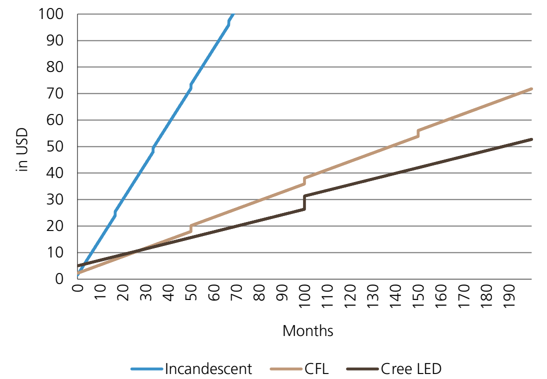
IT applications in buildings

Renewables including LED: We believe ongoing advances in semiconductor technology are changing the way we consume and preserve energy. The two major areas powered by technology include renewables like solar and LED. Solar cells, a kind of semiconductor material, are one of the greenest technologies to generate energy with a low carbon footprint. With falling polysilicon prices and subsequent reduction in assembly and system management costs, the leveled cost of solar power has become very attractive. While costs are a primary driver of investments in renewables like solar, the carbon intensity of electricity generation is an equally important factor. On these metrics, solar's carbon intensity measured for every kWh is only a fraction of fossil fuels like coal or oil. LED is another development driven by the advancement in semiconductor technology, where falling prices coupled with a favorable carbon footprint are driving incremental investments. Currently, a quality LED bulb is available for as low as USD 4-5, driving not only increasing adoption by consumers but also from the public sector. Fig. 11 shows the lifetime payback time of LEDs compared to compact fluorescent (CFL) and incandescent bulbs. We expect LED market growth in USD of around 10–15% annually until 2020.

Cloud computing: The relevance of cloud computing is significant to the energy efficiency of buildings because IT infrastructure related investments typically account for one-fifth of enterprise capex and the ongoing cloud revolution will change the way enterprises and consumers access IT. Various studies highlight that enterprises could reduce their carbon emissions by more than 50% if they migrate their data storage operations to the cloud. According to NIST, US Department of Commerce, cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. Fig. 12 shows the cost breakdown of a traditional data center. The shift to cloud processing and storage significantly cuts these costs including on electricity.

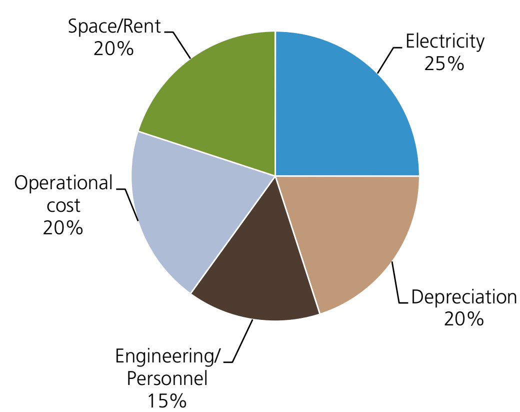
Other technologies: We refer to all the remaining technologies as building management technologies which are primarily computer-based control systems installed to monitor the functioning and the energy consumption of electrical and mechanical equipment of a building. The need for building management technologies is driven by the inability of conventional buildings to communicate and intelligently manage the vast amount of data generated and available in a building. A few technology-driven building management developments include smart security and surveillance including biometrics, smart metering, flexible telecom cabling, predictive fault detection, and smart monitoring systems.

Fig. 11: Payback time of LEDs compared to CFL* and incandescent bulbs



Note: *CFL = compact fluorescent light
Source: UBS

Fig. 12: Cost breakdown of a traditional data center



Source: UBS (2014 data)

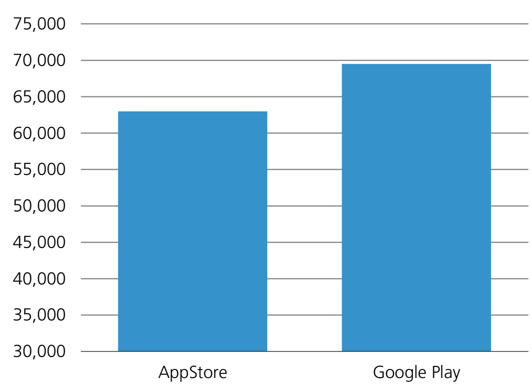
IT applications in transport

Video-conferencing and telecommuting: The way we travel and communicate have been reinvented by advances in networking technologies. Video conferencing and telecommuting are among them. An AT&T report highlights that by adopting these technologies, US and UK businesses can not only save billions of dollars but also cut nearly 5.5 million metric tons of CO2 emissions by 2020, equivalent to the annual GHG (green house gases) from over one million passenger vehicles. Telecommuting, an arrangement in which employees are allowed to work outside the office, either from home or other locations, is another positive development driving GHG emissions lower. By connecting to a virtual private network and cloud-based applications, telecommuting is becoming increasingly attractive to enterprises. According to a US federal study, an average US resident spends 264 hours every year for commuting to work and telecommuting can reduce such travel and save energy in a few cases.

Apps: The progress in smartphones and other hand-held devices has forced us to multi-task throughout the day and made us digital omnivores. Use of the Global Positioning System (GPS) in both inbuilt devices and smartphones is the biggest way technology provides energy efficiency in transport by optimizing routes and creating alerts for fleet management. Anecdotal evidence suggests that GPS can not only significantly reduce travel time, but also cut fuel consumption by a quarter. While GPS is widely used in developed markets like the US and Europe, EM offer the biggest upside given the low GPS penetration. Meanwhile, the growing trend of service sharing through mobile apps should also impact transport as ride sharing and taxi sharing apps become more popular in the future (see Fig. 13).

Other technologies: The other technologies that can drive energy efficiency in the area of transportation include electric vehicles, and e-commerce or shared economy services. Electric vehicles mainly use electric motors with electrical energy stored in rechargeable batteries. According to a US government study, the greenhouse gas emissions of electric vehicles are around 40% lower than those of conventional vehicles. With global electric vehicle (EV) penetration at less than 1%, the rising costs of internal combustion engines and the falling costs of EVs, coupled with government subsidies and regulations, should fuel EV adoption. Meanwhile, the increasing popularity of e-commerce should boost the energy efficiency of transport as consumers travel less to purchase items and e-commerce providers leverage an efficient warehouse and logistics platform. Several studies highlight that e-commerce energy consumption is up to one-third below that of the traditional brick-and-motor retail model.

Fig. 13: Travel related apps available on smart device platforms



Source: Apple, Google, UBS as of December 2015

IT applications in Industry

Internet of Things (IoT): IoT refers to a network of connected devices where everyday objects are linked to a network, constantly sending and receiving data. The concept can be best explained by the photo in Fig. 14; with IoT, users can remotely control connected devices like thermostats or refrigerators. While an interesting development for consumers, the opportunity in the manufacturing industry is huge. The ability to connect virtually any equipment or product with sensors or smart tags allows companies to run intelligent networks and machine-machine interaction. Machines that can predict failures and trigger maintenance automatically save considerable time and energy. The same is true for automatic alerts to logistics teams about unexpected changes in production or material shortages. Various industry studies indicate that IoT can reduce energy consumption by 5-25% depending on the extent to which IoT devices are used in the manufacturing process. For more details, please refer to our other Longer Term Investment theme on *Digital Data*.

Industrial software: Despite the dominant presence of the manufacturing industry, the amount the industry spends on software accounts for only 8% of the overall software industry. However, software's role in driving energy efficiency cannot be underestimated as it not only helps track manufacturing activities with poor energy efficiency but also - thanks to its predictive power from big data analytics - provides a future road-map on energy consumption. One example of this is the effectiveness of supply chain management software in managing inventories in the value chain. Supply chain management (SCM) software refers to programs that provide oversight of materials, information, and finances as they move in a process from supplier to manufacturer to wholesaler to retailer to consumer. According to industry leaders, firms with locations worldwide can reduce their warehouse costs by around 25–30% with an effective SCM software installation.

Other technologies: Other technologies in the industrial segment mainly refer to the use of upcoming technologies like drones and 3D printing. While these technologies are still in the nascent stage, we foresee that increased usage will not only reduce costs but save energy by reducing time-to-market and removing redundancies. We have addressed these topics in detail in our other Longer Term Investment report, *Automation and Robotics*.

Transport efficiency

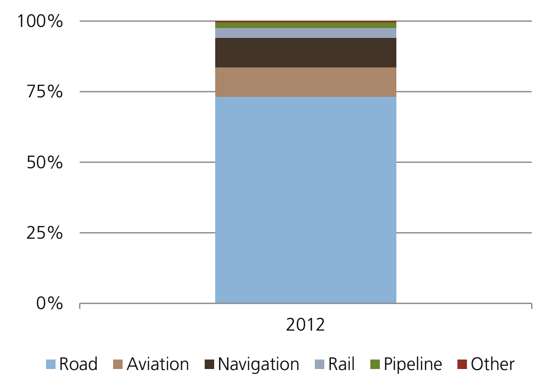
The transport sector is responsible for 30% of energy consumption. Within this sector, road vehicles alone consume three quarters of the energy used (see Fig. 15). Over the last few years, the transport industry's share has gradually increased and, considering that demand rises with spending power in EM (see Fig. 16), energy efficiency is a key factor to limit further growth.

Comparing the fuel consumption per passenger per kilometer, it is quite obvious that trains and buses are much more energy efficient for

Fig. 14: Internet of Things enables remote handling of consumer and industrial operations

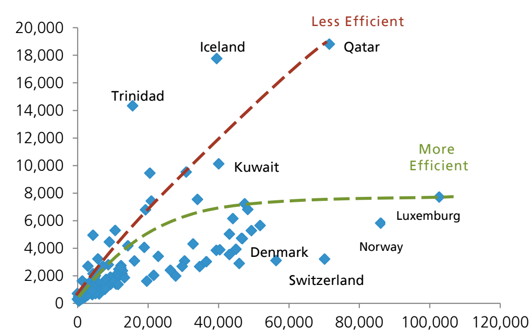
Source: Dreamstime

Fig. 15: Transportation fuel by end market
Road transport dominates the theme



Source: OECD/IEA 2015 Railway Handbook 2015 (elaboration by Susdef based on IEA 2014)

Fig. 16: Transport energy demand increases with spending power
x-axis (horizontal) USD GDP/capita, y-axis (vertical) energy demand in ktoe



Note: ktoe = kiloton of oil equivalent
Source: World Bank
http://data.worldbank.org/indicator/EG.USE.PCAP.KG.OE

passenger transport than cars or aircraft (see Fig. 17). Rail is among the most environmentally friendly transport option.

Considering the continuing urbanization in EM, we expect rail to gain market share over the next few decades (see also our Longer Term Investment theme about *Mass transit rail*). Based on studies in Japan, a country with a dense railroad network and high-speed trains, the inflection point in overall efficiency regarding time and expense is between 800 to 1,000 kilometers for rail versus air. Above 1,000 kilometers distance, traveling by train is too long.

Since 2000, we have also seen a structural trend in the US with trains substituting truck volumes. We expect this trend to continue, first because rail inter-modal (e.g. train and truck) transportation is on average 15–25% cheaper than trucks based on the longer length of haul, and second it is more fuel efficient. Also, highways have been getting more crowded. As such, some shippers have started to switch to the cheaper alternative.

Buses are another option in passenger travel. Several factors support this segment, which is similar to rail. In Europe, one full bus can replace 30 cars; this number rises to 55 in the US. Not surprisingly, buses have become among the fastest growing long-distance means of transport over the past few years in various countries. Buses also benefit from urbanization in emerging markets. Without rail infrastructure, many workers travel by bus to work. China, for instance, is the largest market for buses and is also the biggest producer of buses globally.

Market opportunity

We believe railroad and bus operators are well placed to benefit from the energy efficiency inherent in transporting people and goods with lower emissions and congestion. The main drivers are urbanization in emerging markets, more crowded highways in developed markets, and growing consumer awareness of how to reduce $CO2$ emissions. Market growth depends on the region and several other factors such as a) the development of volumes; b) productivity gains/cost performance of operators; and c) inflation, which has an impact on pricing. In the past decade, US railroads, for instance, achieved exceptional EPS growth, outperforming the S&P 500 Index. Over the last two years, their performance faltered mainly due to lower volumes from the commodity sector (coal, oil, frack-sand, etc.). In the long term, we believe the structural trends will prevail, though in the short term low oil prices could act as a hindrance.

Automotive

While the automotive sector is characterized by a strong capacity for innovation and the constant reduction in consumption per kilometer, the increase in energy consumption and CO2 emissions resulting from the massive rise in demand in developing countries has more than offset these efficiency gains (with strong economic and population growth having led to a rising demand for cars).

Similar to other sub-sectors, energy efficiency developments in the automotive sector are mainly driven by tighter regulations. All important regions have laid out their road-maps to lower fuel consumption and thus CO2 emissions. The incentive for governments is massive, given that only 18–25% of the energy in gasoline reaches the wheels in an average vehicle (based on the US Department of Energy). For electric cars, the ratio is much better, with around 60% of energy conversion from the grid going to power at the wheels. However, the amount of CO2 saved depends heavily on the type of electricity that charges the battery and on transmission losses (see Fig. 8, ABB analysis).

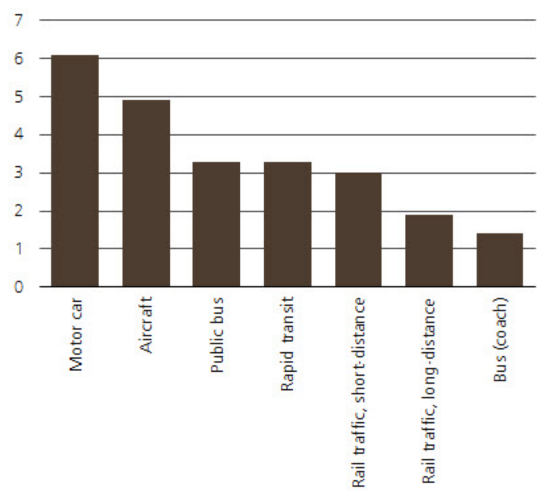
We believe that automotive suppliers of engine technology that improves fuel consumption should benefit from stricter regulations globally. Downsizing has been a hot topic in the automotive industry in recent years.

Reasons for downsizing are technical progress, regulation, increasing energy prices (at least in the longer term) and cost reductions through reduced raw material use. This means reducing engine size through efficiency enhancements, while the capability remains the same (for example, improved engine control, use of turbochargers, reduction of internal friction through the use of smoother materials, reduction of moving masses). Recently, the automotive industry introduced "right-sizing," which aims to fit the right engine size to the right cars as small engines for large cars could result in even higher consumption at high speeds.

Turbochargers can help solve the dilemma of losing output when engine capacity is reduced because they increase the power or the efficiency of an engine. Intake air is compressed by a pump and a turbine driven by the waste heat from the exhaust or newly electric turbochargers. This process helps to improve thermal efficiency and reduce pumping losses as air is pushed into the cylinders. As a result, more air is available for fuel combustion and the engine is able to deliver more torque at lower engine speeds. Growth rates are particularly high for gasoline cars, where penetration is still low (see Fig. 18). The result is lower fuel consumption.

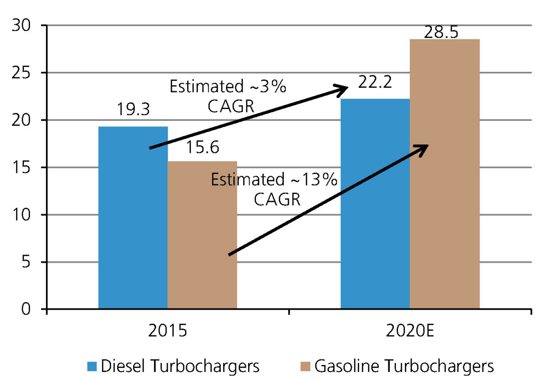
New developments in tires can cut rolling friction at low speeds by up to 10%; at higher speeds this drops to 5%. A reduction of 10% translates into a 1–2% reduction in fuel consumption (Source: US National Research Council). Stop-start technology, whereby the engine cuts out when the vehicle is stopped, can cut fuel costs by up to 25% in city traffic, depending on how it is used.

Fig. 17: Trains and buses are among the most efficient transport alternatives
Consumption of petrol equivalent in liter per 100 passenger km



Note: Motor car 1.5pers./motor car; passenger load for the other alternatives: bus (coach) 60%, rail traffic long-distance 50%, aircraft 71%, public bus 21%, rail traffic short-distance 28%, rapid transit 19%
Source: Airbus and Heinrich Böll Stiftung: ALOFT An Inflight Review, as of May 2016

Fig. 18: Light vehicle turbocharged systems growth by market
In millions of turbos



Source: BorgWarner (as of January 2015), UBS

Emission targets cannot be met without electrification
The EU envisaged 130 grams/km of CO2, China 160 grams/km by 2015, and the US around 155 grams/km by 2016 (see Fig. 19). These targets are achieved by improving the diesel and gasoline-powered combustion engine via developmental technologies (e.g. downsizing). However, the EU's 2020–21 targets of 95 grams/km of CO2 and potentially 68 grams/km by 2025 definitely make a technological shift to electrification necessary. We are convinced that the road to electrification of vehicles is well paved.

The commercial success of electric cars will develop in two phases, in our view. In the first, we will see a gradual increase in hybrids, which are a combination of combustion and electric engines. This phase serves more as a laboratory for the industry to improve technological know-how in terms of batteries, drivetrain and electronics. In this phase, full-electric vehicles will remain a niche product.

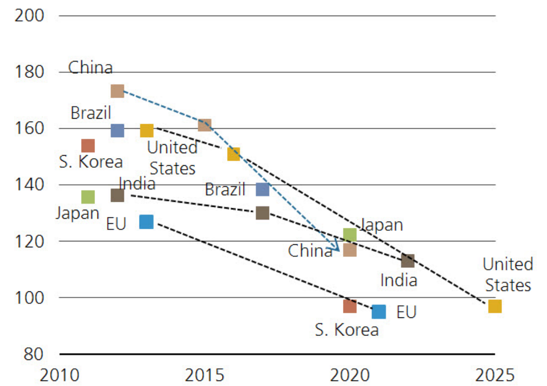
In the second, we see a roll-out of full-electric vehicles, whether they are battery or fuel-cell powered, occurring for consumers' everyday driving needs. Given the high costs, we expect the number of full-electric vehicles to increase from 2020 onwards, supported by a more favorable regulatory framework, technological advances, and possible (financial) incentives from governments around the globe.

Air and sea
Thus far we have focused on the automotive sector, since road vehicles alone consume 77% of the energy in the transport sector. Nevertheless, the other two major transport sub-sectors, air and sea, warrant some discussion. Similar to cars, planes have also increased efficiency.
Today's planes need 70% less fuel than 40 years ago and 20% less compared to 10 years ago, according to IATA. The shipping industry, which accounts for only 10% of transport energy demand but carries 90% of world trade, has improved over the last few decades, but not as much as planes and cars. According to the Danish Shipowners' Association, energy efficiency has improved by 20% since 1970.

Market size and valuation

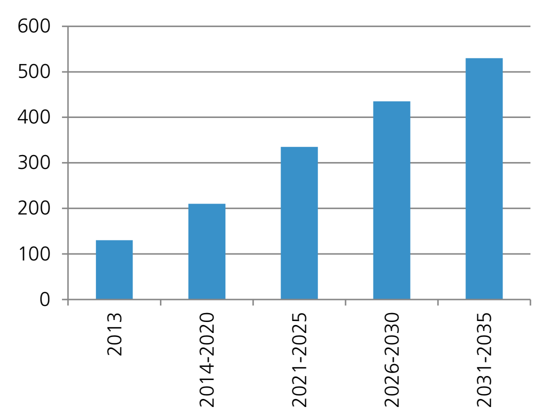
There is no standard definition about the energy efficiency market. Our approach is similar to the IEA's, which defines energy efficiency investments as additional expenditure made by households, firms and governments to improve the energy performance of their energy-using equipment. The IEA, using a bottom-up approach, calculated an annual spending of around USD 130bn for 2013; it expects spending of some USD 210bn annually during 2014–2020, reaching USD 530bn by 2035 (see Fig. 20). In our analysis, we found that compared to other forecasts from independent consultancy companies these estimates are rather moderate.

Fig. 19: Internal combustion engine vehicle productivity gains – historical and envisaged
CO2 emissions in grams/km



Source: ICCT as of October 2016

Fig. 20: Average annual investment in energy efficiency in the New Policies Scenario*
In USD bn



*Note: The New Policies Scenario includes policies in place and those announced, and is the IEA's central scenario
Source: IEA World Energy Investment Outlook 2014 (Special Report), UBS

Risks

We see political risks as the biggest challenge to our energy efficiency investment theme. As identified throughout most sub-sectors, we think stricter regulation is one of the most important driver for energy-efficiency investments. The recent US election could be a risk to the theme due to Trump's comments about reversing environmental policy, possibly leading to less-stringent EPA regulation. A significantly looser regulatory environment could hurt companies exposed to the respective end-market. Another factor that can hurt investments is tight government budgets, which can affect spending in government-owned commercial buildings. The IT-specific risks include frequent communication or service outages that defeat the purpose of energy efficiency as backup plans not only prove to be expensive but are also energy inefficient. And there are also security concerns about cyber threats regarding building automation, electric cars, cloud computing, etc. (see also our Longer Term Investment theme about *Security and Safety*). While energy efficiency is a structural theme, we do not rule out short-term cyclicality given the underlying exposure to cyclical sectors like automotive, capital goods, IT and transportation, which are heavily dependent on economic development.

Oil price impact limited
In the current environment of low oil prices, we expect investors to raise questions about the impact of oil prices on energy efficiency. We believe the impact is very limited as a) electricity prices have hardly been affected (see Fig. 4); b) more energy consumption due to lower fuel costs enhances the need for energy efficiency as it increases CO2 emissions (e.g. in the transport sector); c) no country has changed its regulations due to the low oil price, and all of them are sticking to their energy efficiency targets (the COP21 Paris summit in December 2015 and resulting strong commitment from all big countries is a case in point); and d) due to the current low interest rates, energy efficiency projects look attractive, because project financing costs are low. Also a case in point is that the global energy intensity (amount of energy used to produce one unit of GDP) improved by 1.8% in 2015, surpassing the 1.5% achieved in 2014 and 0.6% seen in the previous decade (Source: IEA, Energy Efficiency Market Report 2016). This happened despite the sharp correction in the oil price.

Link to sustainable investing

We view "Energy efficiency" as a sustainability-themed investment that fits in our sustainable investing (SI) framework. Energy-efficient products and services help to mitigate one of the most complex challenges humankind faces, namely climate change. Several other of our Longer Term Investment themes like "*Water scarcity*"and "*Clean air and carbon reduction*" are also linked to this challenge, and reducing energy use serves to bring improvements in these areas as well. Energy efficiency combats climate change in two ways: First, simply put, the less energy used, the fewer emissions produced. Second, cost-effective energy efficiency achieves these environmental benefits at low cost, and thus can reduce the economic costs of achieving climate policy goals. (Source: "EPA: A resource of the national action plan for energy efficiency," Sept. 2009). The need to invest in energy efficiency in the coming decades is not slowing: a growing population, ongoing urbanization and rising wealth levels contribute to this structural trend. Two of the most important drivers for the theme are stricter regulation and corporate competition to improve product efficiency (the more efficient products are, the shorter the payback period for them). As a result, energy efficiency is becoming a key business factor for a growing number of companies and consumers.

Impact investing angle

According to scenarios from the International Energy Agency, energy efficiency increases are required to mitigate climate change. These increases could account for more than 40% of the reductions needed to keep the increasing global average temperature within two degrees Celsius by the end of the century. USD 560 billion in financing to achieve efficiency objectives are already pledged by major economies around the world, leaving a significant opportunity to tap these commitments by identifying and co-investing in implementation. Impact investing opportunities can be found in direct deals supporting commercial banks in making loans for energy efficiency projects, new technologies reducing energy consumption commercially, industrially and residentially, and energy service companies that identify and perform retrofits or new project, as well as innovative materials companies. From a project finance perspective, impact and financial returns can be achieved by working with technology providers to retrofit commercial and private buildings and public infrastructure, and funding upfront project costs which are paid back via energy performance contracts with the building's owner.

Investment conclusion

Energy is crucial for our society. It is in the products we consume every day and it drives our economy. Global demand for energy is rising, and in some regions supply is tight and environmental issues are becoming problematic. Energy efficiency helps us face these challenges. Politicians in many countries have long recognized that energy efficiency offers cost-effective solutions.

We regard improved energy efficiency as an opportunity to limit the demand growth for energy. Based on IEA forecasts, the market for energy-efficient products and services will grow by mid-to-high single digits over the next two decades. It is becoming a key business factor for an increasing number of companies. We see the biggest potential in:

- **Industrial processes** – grid (expanding and modernizing), and industry (efficient motors, gears, and robots);
- **Smart buildings** – building automation, more efficient lighting, heating, ventilation and air conditioning systems;
- **Transport and automotive sectors** – lower consumption by cars; the "urban trade-down" from private cars to public transport (increased use of rail and bus) and generally more efficient transportation of goods;
- **IT, cloud computing**, **Internet of Things** and **app-related business models**.

There are already many companies that base their business models on energy efficiency. Hence, our theme should see above-average sales and earnings growth in the decades to come.

Appendix

Terms and Abbreviations

Term / Abbreviation	Description / Definition	Term / Abbreviation	Description / Definition
2011E, 2012E, etc.	2011 estimate, 2012 estimate, etc.	A	actual i.e. 2010A
bn	Billion	Capex	Capital expenditures
COM	Common shares	E	expected i.e. 2011E
EPS	Earnings per share	EV	Enterprise value = market value of equity, preferred equity, outstanding net debt and minorities
GDP	Gross domestic product	p.a.	Per annum (per year)
Shares o/s	Shares outstanding	UP	Underperform: The stock is expected to underperform the sector benchmark
CIO	UBS WM Chief Investment Office	x	multiple / multiplicator