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Environmental Investments

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# The electricity transition: 10 years into the game and much more to come

In the last ten years the energy sector has probably seen more changes than in the previous seventy years. A wave of growing demography in emerging economies, tightening regulatory pressures in developed economies, advancements in technology and business models have all supported a long lasting transformation. At the core of the change, is the most intangible form of energy: electricity, the link that connects the future of thermal power plants, car manufacturers in China and your neighbour's investment for solar panels on his rooftop.

2017 also marked Ambienta's tenth anniversary. Over these ten years we have witnessed the emergence of renewables, the return (yes, it is a return) of the electric car and the development of smarter electricity networks. The last ten years have seen some innovations become mainstream while others are yet to realise their full potential. Using electricity as theme, we aim to describe in this newsletter fulfilled promises, ongoing transformations and the next wave of upcoming changes.

# Electricity and the energy industry paradigm: an old laggard is going to take its revenge?

Electricity is not a recent discovery, it is contemporary of many other milestones of the industrial revolution. The steam engine was invented by James Watt in 1765. The first engine suitable for automobiles was patented in 1883 by Gottlieb Daimler and Wilhelm Maybach. The first automobile was sold in 1885. Even before then, Michael Faraday invented the electric motor in 1821 and Thomas Parker built the first electric car in London in 1884.

Thomas Parker (in the middle) and the first electric car, 1884

Despite this almost concurrent origin, today there is about 1.3 billion internal combustion cars circulating in the world and only about 1.3 million electric cars. Generalising this, electricity overall represents less than 20% of global final energy consumption while oil is at about 40%[1] and 1.1 billion people still live without electricity. Why does electricity appear to be a laggard with respect to other sources of energy?

The reason for the apparent underutilisation of electricity compared to other sources of energy is rooted in its technological disadvantage versus biomass and fossil fuel sources. Electricity is not a source of energy or readily available on the planet. Electricity is a form of energy, and a transformation is needed in order to produce it. Once produced, at a cost, energy has been historically hard to store and costly to transport. In history, other forms of energy -such as biomass, oil and other fossil fuels- have been much easier to transport and store.

Energy is ultimately needed to perform a specific job and the nature of that job defines the form of energy required. Heat to make the room temperature comfortable. Mechanical energy to make a stone mill or a wheel rotate. Light to illuminate a road. Humans have learnt how to use and develop technology to transform energy from an available form to the required one.

First we learnt how to use fire, which transforms the chemical energy of biomass into heat. Then to harness energy from a river or wind to move a millstone. In the 19th and 20th centuries, how to use fossil fuels to perform almost all jobs, including electricity production. Fossil fuels had and still have key advantages: their high energy density, their large availability and their ease of use. In particular, energy density is incredibly high. Fossils can store even more than 20 times more energy per unit of volume than a modern lithium-ion battery. Furthermore, they can be easily mined, stored, shipped, and, even more important, traded. On the opposite side, electricity cannot be handled this easily. It needs an infrastructure to be obtained from other sources, to be moved around and even to be consumed. A battery is not a source of electricity and neither truly a storage system, rather it is a device that converts the chemical energy of the cells into electricity. Storage of large quantities of electricity still represents a technological challenge today, 200 years after the invention of the first battery. Technology development concentrated on devices used to transform the chemical energy of fossil fuels into other forms of energy. These technologies are all based on a

[1] *Excluding oil used to generate electricity*


Forbes November 2007 front page

three-stage transformation to obtain electricity from fossil fuels: chemical energy into heat, heat into mechanical energy and mechanical energy into electricity; clearly a complex, costly and inherently inefficient process. Research around electricity focused mainly onto establishing a network and thus to bridge its disadvantages. As a result of all these drawbacks, the adoption of electricity grew at a lower rate than fossil fuels and electricity turned into a laggard. Its usage expanded alongside grid construction, but it was limited to applications requiring small amounts of energy such as lighting and domestic appliances.

Around fifteen years ago things started to change on the technology side. We became extremely good at directly transforming radiative energy from the sun and mechanical energy from the wind into electricity. No longer a three-stage process, but a more efficient single step. Once their technology and costs were better mastered, solar and wind energy started to gain share in the generation mix. This growth was also supported by the increasing regulatory attention to air pollution and greenhouse gases emissions which are a large modern drawback of fossil fuel combustion. Since less transformations are needed to produce electricity and all transformations come with a loss, solar and wind technologies contribute effectively to a more efficient energy system.

It is hard to understand how fast a technological revolution can affect the existing industry landscape. In November 2007 Forbes titled: “Nokia: can anyone catch the cell phone king?”. We all know it has been caught, overtaken and almost put out of the telephony business. Another main article on that release: “$60 oil? believe it”. It looked an absurdly high price at that time, but in the following 8 months it got up to $150, and since then it has been up and down from $30 to $120. In an industry, such as the energy industry, where investment cycles can be a decade long, it can be even harder.

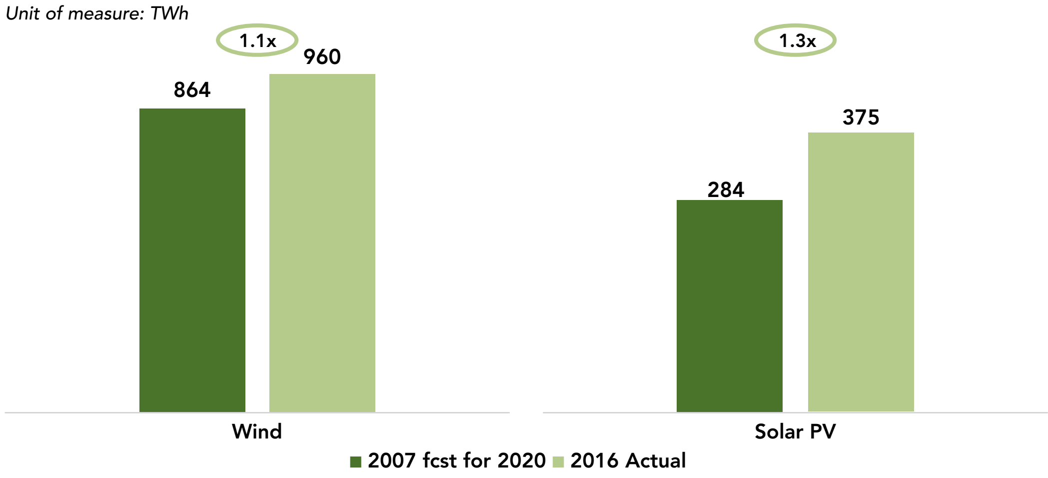
In conclusion, the increased availability of electricity supports its adoption and ability to perform jobs traditionally accomplished through other type of energy. Heating through heat pumps or through electric heating is an established example of this adoption. Electric vehicles exemplify the largest new wave of opportunities where an old laggard type of energy can turn into the new century winner.

## 10 years of innovation: from pioneering technologies to a long-lasting revolution

In the last ten years, a supportive regulatory framework has facilitated the diffusion of electricity related technologies. In 2007 EU leaders committed to the 2020 Energy strategy to reduce greenhouse gases emissions by 20%, increase the share of renewable energy to at least 20% and achieve energy savings of 20% or more. All by 2020. Electricity stands at the core of this commitment, since adoption of electricity based technologies, on both the generation side (i.e. solar and wind) and the usage side, fulfils all three objectives at the same time.

Four major trends are at the foundation of this recent evolution and will continue to play

**Electricity Production: highest forecast for 2020 vs 2016 actual**




Solar and wind development has beaten all 2007 forecasts

in the decades ahead: 1 diffusion of renewable energy; 2 energy efficiency; 3 digitisation of the grid and 4 energy storage development. The impact of first two trends is already very visible, while the second two trends are yet to demonstrate their full potential.

1 Modern renewables such as solar and wind, even if supported by questionable and bumpy incentive schemes, have become the most relevant element of the electricity market from being fairly irrelevant ten years ago. Indeed, solar and wind exceeded anyone expectations in 2007, including those of solar energy associations. In 2016, solar produced almost 1.3x times more electricity than the highest 2007 forecast expected for 2020. Wind 1.1x times. Despite all of the ups and downs, its successes and its bankruptcies, ten years of subsidy driven growth has reduced costs of renewables and has brought them into a mature development phase. The price of solar installation is today 60% below those forecasted. Investments in renewable plants have remained constant in the last five years but installations have grown by 50%. In recent years, several countries have run just on renewable electricity production for entire days.

Today, beyond global accords and national policies, market forces are making clean, renewable power a competitive low-cost reality on a global base. In the last five to six years around 70 countries in the developing world have introduced energy efficiency and renewable energy policies for the first time

**Energy Consumption and Gross Domestic Product evolution in EU**

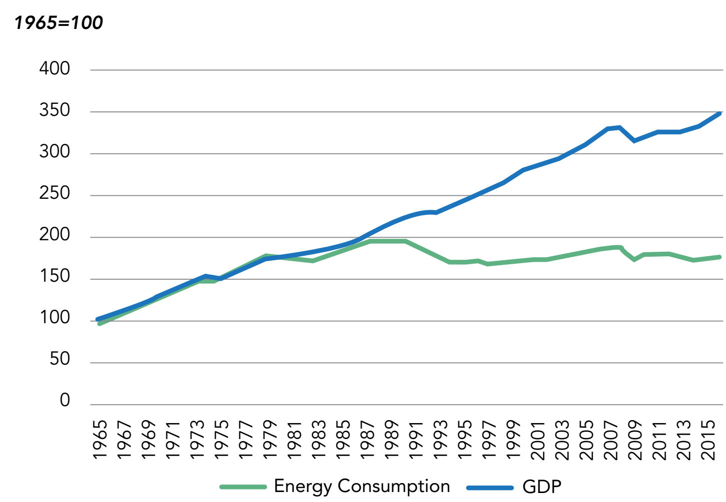


Table 1: Energy transformation efficiencies of representative technologies

| Energy transformation technology | Energy Input | Energy Output | Typical efficiency |
|---|---|---|---|
| Electric generator | Mechanical | Electricity | 95% |
| Electric motor (large) | Electricity | Mechanical | 90% |
| Battery | Chemical | Electricity | 90% |
| Automobile engine ref. Efficiency | Chemical | Mechanical | 45% |
| Steam turbine | Thermal | Mechanical | 45% |
| Gas turbine (aircraft) | Chemical | Mechanical | 35% |
| Simple cycle gas turbine (industrial) | Chemical | Mechanical | 35% |
| LED lamp | Electricity | Light | 25% |
| Incadescent lamp | Electricity | Light | 5% |

ever. New installations have spread globally with roughly 70% of the total 2016 new net installations being built in developing economies.

2 Energy efficiency policies have wiped out the traditional dogma of direct correlation between energy consumption and GDP growth. In the last five years, in a healthy overall global economy, energy intensity (unit of energy per unit of GDP) declined on average by 2.1% per year. Energy efficiency policies alone have been able to reduce total final energy consumption by 12% in 15 years, equivalent more or less to the annual consumption of the European Union. In this respect it is important to notice that very often electricity is more efficient than other technologies (Table 1), therefore its adoption has the potential to provide further efficiencies. The extremely high efficiency of electric motors (>90%) is their fundamental adoption driver when electricity becomes widely available.

The impact on $CO_2$ emissions reduction of these two trends has been remarkable. By 2015 in the EU only, renewables had reduced $CO_2$ emissions by 10% and energy efficiency policies by another 10%, reaching the target five years in advance. We can debate whether public incentives have been spent effectively, but we have to acknowledge the fulfilment of the objectives of a less carbon intensive and a more energy efficient Europe.

3 Digitisation of the grid is a broad concept. It describes the integration of digitally advanced technologies within the existing network, which had only been incrementally modified since its first construction around 100 years ago. Digitization of the grid allows two-way communication between the utility and the network, including its customers, and enables insight, automation and control across the utilities' operations, empowering utilities to improve reliability, availability and efficiency of the grid, and customers to participate in the energy market as producers. The integration of distributed energy sources as renewables has increased the need for this wave of innovation. Nonetheless we have only seen the tip of the iceberg. The share of distributed energy will increase from the current 5% of installed electricity supply to 15% and above by 2025. Furthermore, digitisation of the grid is a key enabler of several value-added services set to enhance grid flexibility and let consumers participate the electricity market. For instance, widespread diffusion of the so called "demand and response" service, will represent a fundamental change for network operators.

**"What is demand response?**
According to the United States of America's Federal Energy Regulatory Commission, demand response (DR) is defined as: "Changes in electric usage by demand side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized."

The network will shift from purely supply-side management fully in control of utilities to demand-side management with consumer participation through the control of demand.

4 The future prospects of storage would merit a paper in itself. Despite being under strong attention in the recent years, modern energy storage technologies are still in their infancy. At both utility and residential scale, the volumes of installed capacity are minimal. Storage technologies for electric vehicles have developed and are now growing with vehicle volumes (especially in China), but are still irrelevant from a global energy balance perspective. Nonetheless, energy storage has the potential to bring the grid to the a next level of efficiency and effectively balance the volatility in the demand and supply of electricity. The decrease in costs and its efficient integration in a digital grid are the challenges for the next decade.

The theme in all these changes in the energy landscape is clearly electricity. Electricity generated from solar and wind minimises energy loss and eliminates carbon emissions linked to fossil fuels combustion – electricity that is very efficient in producing torque through the electric motor of a car.

The number of businesses, companies and products influenced by these trends is enormous, almost infinite. A wide range of opportunities is opening up for investors. Along the grid, from generation to usage, equipment manufacturers, physical asset managers and technology or software developers, will all contribute to shape this long-lasting revolution.

# Looking for the right spot within a shifting investment landscape

From an investor perspective, the investment landscape has been both complex and dynamic in recent years. The global trends towards renewables and energy efficiency, the integration of storage technologies and the effects of digitisation are reshaping the value chain. Once profitable, safe and resilient segments are now seeing contracting margins. New services or products have emerged. The foundations of the traditional electrical utility business model have been shaken by the rapid growth of decentralised generation. Revenues have been shrinking because of both energy efficiency and competition from independent producers; margins have decreased along with the decreasing economic viability of large power plant fleets. European utilities took the hit first from the effects of this transition, but eventually the impact of growing distributed energy will be felt everywhere. To further complicate this changing scenario, regulation is also shifting to try to grant a smooth transition to a new energy paradigm.

Distributed generation: rooftop solar panels in Australian suburbs

Foto © zstockphotos/123rf

The electricity sector's risk-reward equation has changed and will continue to do so. Investors of all asset classes are now trying to adapt in response and to find their own way to successful investments. From a private equity investor perspective several lessons can be learnt from experiences in adjacent asset classes.

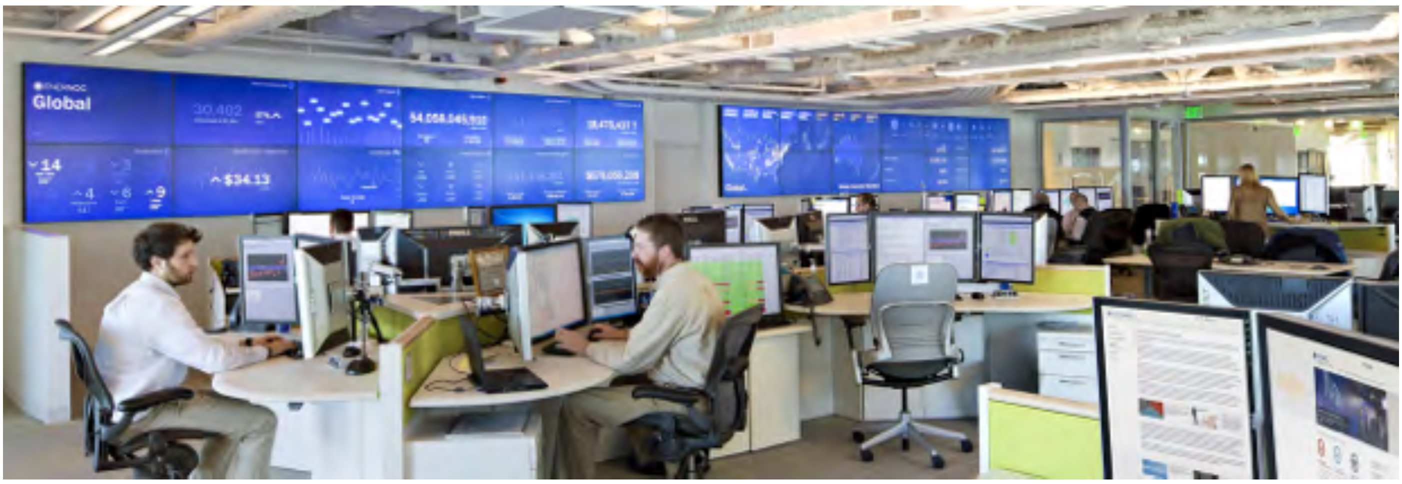
Innovative technology investments in this sector require patient capital, with the possible exception of software companies. Venture capitalists fuelled the enthusiastic first pioneer years of the renewables and power related technologies with billions of euros invested in so called “cleantech”. According to recent MIT research, only half of the $25 billion invested from 2006 to 2011 has returned to investors. The report highlights several issues that led to this loss. Working the kinks of new science requires time, usually more than the three to five years’ timeframe preferred by VCs. Physical technologies are expensive to scale into mass production, much more expensive than software companies, the usual VC targets. Indeed, VCs returned more than 3x the money when they invested in software companies in the cleantech sector.

Investments in physical assets demonstrate the double-edged power of incentives, that can make an investment remunerative, beyond its merits, but also turn it into a failure in case of rapid regulatory changes. Developers, utilities and Transmission & Distribution players are now partnering up with infrastructure and pension funds to let the latter invest directly in physical assets, even with no incentives, while developers free up cash for future investments. This trend is likely to continue and further expand.

The acquisition of EnerNOC, the US leading demand response provider, by Enel, demonstrates the shift in the electricity value chain paradigm described above. Enel is the Italian incumbent electrical utility and the largest renewable power plants operator in the world. This acquisition can be considered as the boldest cross-border transaction made by an Italian industrial player in several years. Enel has acquired a heavily loss-making company for approximately $300m that, since its listing in 2007, has always struggled to deliver financial results despite significant revenue growth. Through the acquisition of EnerNoc, Enel has set a fundamental milestone in its move down the value chain closer to the consumer, entering into a future of direct management of customer-owned energy assets.

From a private equity investment perspective, it is not easy to find the correct risk-reward profile. Timing of enforcement of new regulations, shifting profit pools, emerging new services and new pricing structure (from cost-for-kWh to a cost-to-serve) all contributes to a perceived increase in risk in the space. In our view, the best approach to navigate this is to follow the basic underlying trends and narrow it down to a simple list of opportunities:

- **Critical grid components:** the grid will evolve to enable further expansion of electricity usage and integrate distributed generation. In this context all critical components and solutions (SW+HW) required to cope with increasing complexity of the grid are likely to benefit of growing demand.
- **Electricity adoption enablers:** electricity will represent a preferred type of energy due to the penetration of renewables and is likely




EnerNOC control room

to be adopted to perform jobs where it was not the preferred type of energy in the past. Heat pumps for heating purposes, electric cooking devices (even in rural or remote areas) or electric mobility solutions are examples of technologies benefiting from this increased availability of electricity. Indeed, they provide a more efficient technological alternative to previous technologies.

- **Operation, maintenance and energy efficiency service providers for renewable assets and other related technologies:** recurrent revenue models to support, maintain, and improve the increasing number of consumer-owned small energy producing assets are likely to expand significantly. Increasing solar panel efficiency will drive further penetration. The first repowering wave on wind power plants is just starting in Europe and it will spread in the next five to 10 years to other pieces of equipment (i.e. residential solar). Complexity of services will expand and will drive emergence of larger service providers with capillary service capabilities and broad technological know-how spanning from energy to telco and ICT.
- **Measurement and data-driven automation solutions providers:** data is at the base of a digitally enabled grid or energy system. Data is the key element required to enable rapid or even real-time decision making about energy consumption and production patterns. To make this possible, measurement devices will spread and penetrate further beyond the consumer's door to increase granularity of information. Measurement devices will not be limited to electricity but increasingly integrate information from other sources. The measurement devices will include (as they already have in certain applications) communication capabilities to allow automation and remote management. Full solutions providers will emerge as large meter manufacturers strategies already demonstrate.
- **Value-added energy management services at consumer level:** as previously described, the role of consumers in the energy value chain is increasing. Today consumers act as energy producers (so called prosumers) and they are beginning to participate in the energy market side by side with utilities. Consumers of all dimensions will rely on third party capabilities, primarily through software platforms, to offer flexibility services to the grid, to buy or sell energy during the day, to offer storage capabilities to third parties or simply to require energy efficiency services and consulting. Integrated software solutions will rapidly become a standard, first for industrial and commercial clients and later for residential clients.

Most of the opportunities ahead lie in the convergence of the energy, telco and ICT industries. Any successful player set for long-term value creation will have to embrace and dominate this mix of competencies. Some players will succeed, others will fail, while some might even enjoy temporary profit expansion in regulatory protected niches, but ultimately the electricity transition will impact them as well. Ambienta will keep monitoring this trend and look for attractive investment opportunities in this broad and rapidly changing industry.

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