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Social Innovation in Energy Whitepaper

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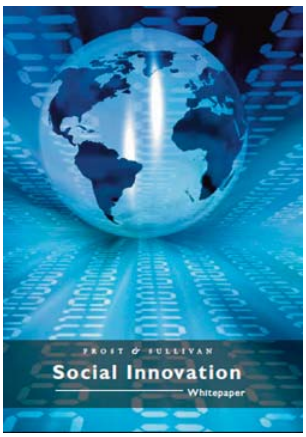
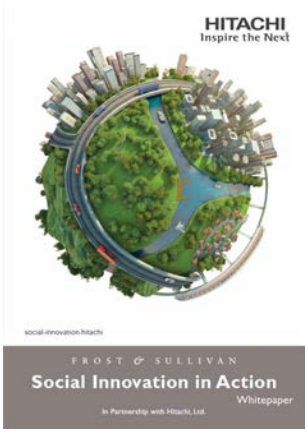
Hitachi Social Innovation





CONTENTS

Introduction 3
- Social Innovation: The Need for Global Change 3
- The Future of Energy: The Need for Innovation 4

Mega Trends & Future of Energy Vision 5
- Introduction & Future of Energy Vision 5
- Smart is the New Green 6
- New Business Models 7
- Connectivity & Convergence 9
- Innovating to Zero 10

Defining Social Innovation in Energy 10
- The need for Intervention and Social Innovation 12
- Social Innovation in Action - Today 13
  - Power Generation 13
  - Smarter Grids 14
  - Energy Management 15
  - Distributed Generation & Microgrids 16
- Social Innovation in the Future 17

Quantifying the Opportunity 17

Hitachi's Unique Contribution 19
- Social Innovation in Energy at Hitachi 19
- Hitachi's role in Renewable Energy 21
- Hitachi's role in Smarter Energy 22

Conclusion 23
- Other Whitepapers on Social Innovation 24

Social Innovation Whitepapers

Hitachi has partnered with Frost & Sullivan to produce research studies on Social Innovation.
Our previous Social Innovation Whitepapers define what Social Innovation is and the key Mega Trends globally which define our future societies.

Access our Website at
http://www.hitachi.eu/en/sib/whitepapers/
to download the Whitepapers in full.

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INTRODUCTION

Social Innovation: The Need for Global Change

The global appetite for energy shows no signs of abating and at the same time the way we generate, manage and consume energy is changing. The Energy sector is a perfect example of an area riddled with challenges brought about by the complexities of the modern world, but ripe for innovation for the betterment of society, businesses, and individuals.

In Energy, the key question is how we will satisfy the growing requirements of a highly connected and power-hungry global population increasingly concentrated in urban environments entirely dependent on vulnerable power grids. And furthermore, how can we deploy innovation to solve the growing challenges of rising energy demand and carbon emissions, while also driving efficiency in transmission, distribution and consumption? And all this at the same time as increasing access to clean, reliable and safe electricity for the world's poorest communities?

"How can we deploy innovation to solve the growing challenges of rising energy demand and carbon emissions, while also driving efficiency in transmission, distribution and consumption?"

In our previous Whitepapers (http://www.hitachi.eu/en/sib/whitepapers/), we defined Social Innovation as "the deployment of technology and new business models to bring about real positive change to the lives of individuals and societies, creating shared value."

By starting from the most critical global mega trends (Urbanisation; Smart is the New Green; Future of Energy; Future of Mobility; and Health, Wellness & Wellbeing), we identified the key element of convergence as absolutely critical to the delivery of Social Innovation. That means convergence of technologies, industries, products and business models, including finance.

Looking closely at the sectors that Frost & Sullivan define as having the greatest need for Social Innovation (Energy, Water, Transportation, Healthcare, Manufacturing, Construction and Natural Resources), we also identified that Social Innovation will represent a market opportunity of more than $2 trillion by 2020.

In this Whitepaper we will highlight the specific mega trends impacting the future of energy, and define what Social Innovation can deliver to the global energy sector. We will take a deep dive into the challenges and opportunities for Social Innovation in energy, as well as quantifying the relevant opportunities and their impact from our extensive research in this market.

"Global energy demand will grow 55% by 2040"

"Smarter and more society oriented innovation is required to overcome the increasing challenges of electrification, energy efficiency and de-carbonisation"

We will also introduce Hitachi and its Social Innovation Business and show how the company has become a visionary global player with a thought leading position in the sphere of Social Innovation, as well as sharing some examples of ground-breaking projects being delivered around the world in the crucial areas of renewable energy, nuclear power, smart grid solutions, energy storage and energy savings and efficiency.

We outline how Hitachi is building for the future using technology led solutions in an efficient, integrated way. This Whitepaper is supplemented by the findings and strategic discussions of the Social Innovation Forum, hosted in Munich, Germany on October 22nd 2015 and co-hosted by Hitachi and Frost & Sullivan.

The Future of Energy: The Need for Innovation

Energy is a key enabler of economic growth, a driver of industrial output and business, and also a crucial ingredient to bringing progress in sectors such as transportation and healthcare. Energy is also a critical factor in guaranteeing access to clean water, sanitation and education in developing countries, as well as bringing essentials such as warmth, light and safety to people's homes. In essence, the security and efficiency of energy is one of the most essential components of improving the lives of individuals while also securing a sustainable and dynamic future for society.

The global energy industry is going through a period of massive change. Environmental pressure, governmental policy and recent changes in patterns of generation and consumption have led to major changes in the global fuel mix and CO2 emissions.

Furthermore a combination of new technology and business model innovation is transforming the way energy is generated, distributed, managed and stored and is delivering a fundamental change in the relationship between consumer and supplier. This is resulting in new opportunities to integrate the increasingly complex elements of the energy ecosystem, bringing together energy infrastructure with sophisticated IT. The future of energy will rely increasingly on digital intelligence and use of data analytics to drive efficiency from generation to consumption.

However, in a world where global energy demand will grow by over 2% per year up to 2020 and a colossal total of 55% by 2040, further innovation is required. Over 1.2 billion people lack access to electricity, and air pollution causes in excess of 7 million deaths per year as a result of air pollution exposure. As the demand for energy continues to grow, smarter and more society oriented innovation is required to overcome these increasing challenges of electrification, energy efficiency and de-carbonisation to facilitate continued economic growth and improve people's quality of life.

Companies such as Hitachi are moving towards delivering innovation to their customers and society as a whole, to mitigate the global energy challenges, and in turn improve quality of life; a trend commonly referred to as Business to Society (B2S). This IT integration capability is set to positively impact the power generation, transmission and distribution and energy efficiency sectors in particular.

MEGA TRENDS & FUTURE OF ENERGY VISION

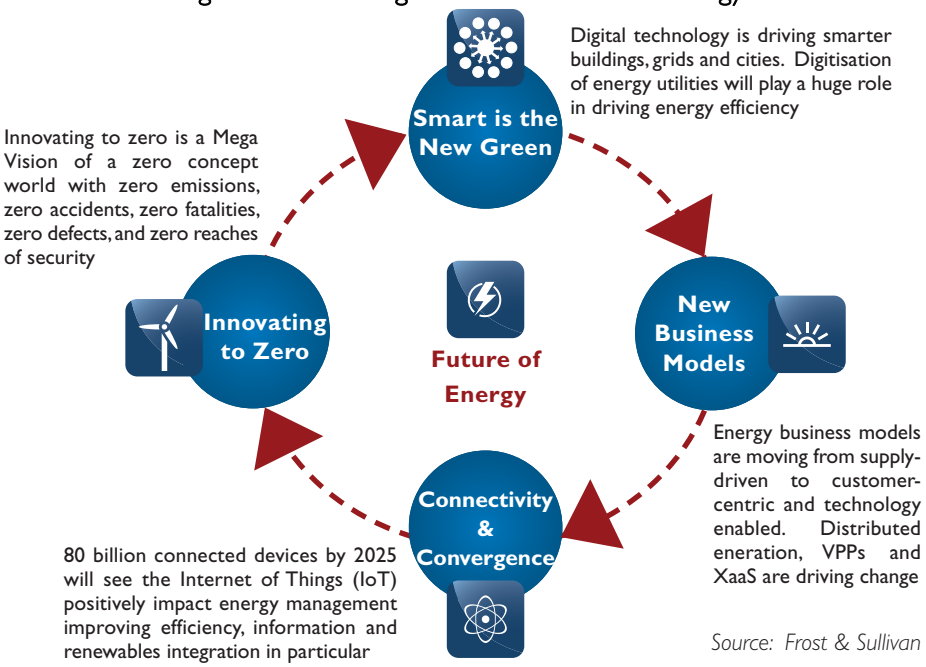
Introduction & Future of Energy Vision

The future of energy is all about integration: That means the integration of an increasingly complex and diverse range of generating assets as the global energy mix diversifies; and the integration and deployment of advanced IT and digital solutions to drive more efficient use of resources.

In particular, the next generation of digitisation will be crucial for enabling growth in renewable energy and driving more efficiency across the energy value chain from generation to consumption. Indeed, the digital transformation of energy utilities has already begun and will be at the core of future energy trends.

This vision is being crafted by the convergence of four main mega trends that are being continually tracked by Frost & Sullivan research teams – Smart technology to drive real energy sustainability; new business models to drive customer centricity; connectivity and convergence to enable valuable data capture and drive innovation and efficiency; and innovating to zero to create the vision and framework for Social Innovation in energy to flourish.

Mega Trends Driving Social Innovation in Energy



Source: Frost & Sullivan

"Accelerated introduction of energy from wind and solar will only be possible through the leveraging of advanced technology and new business models"

Smart is the New Green

We have entered an era where green products and services are increasingly being enhanced or even replaced by "smart" products and services. Smart solutions have a real business case, can typically provide energy and efficiency savings of up to 30 percent, and generally a two- to three-year return on investment. Enabled by the IoT and machine to machine (M2M) communication, smart products are characterised by having intelligent sensing technology. They are increasingly being integrated with internet technologies, which allow the products to react and communicate to changing environments, optimizing operations and improving efficiency.

In energy, digital technology is driving smarter buildings, grids and cities by delivering efficiency gains and also enabling the automated integration of an increasingly diverse range of energy sources.

The global growth in smart meters – one of the key enablers of successful smart grids and the point of connection between customers and the distribution networks – is a great example of this. At the start of 2015 there were around 510 million smart meters installed globally with this number set to increase to 980 million by end of 2020. Approximately half of the smart meters (450 million) will be in China.

In the Energy sector, 'green' and 'smart' are of course intrinsically linked. One of the main drivers of digitisation is the need to cope with growth in renewable energy generation. In Germany, for example, around 30% of electricity is generated from renewables and this will increase to close to 60% within the next 10 years. This growth in renewables – from both centralised and distributed sources – will put huge pressure on grid infrastructure and this can only be efficiently accommodated through digital transformation of the energy utilities.

This is true all over the world and the accelerated introduction of energy from wind and solar photovoltaic (PV) power will only be possible through the leveraging of advanced technology and new business models. Smart technology is also driving the efficiency of transmission and distribution networks, where losses in current grids can be anywhere between 5% and 30% depending on where you are in the world.

Electricity networks will also be massively impacted by the anticipated accelerating growth in electric vehicles (EVs) and the associated charging infrastructure. Frost & Sullivan research data shows that there are around 1.2 million EVs on the roads globally in 2015 with that number set to grow to 6.3 million by 2020 and 12.6 million by 2025.

This is not only a transformational trend in the transport and mobility sector, but it will necessitate the deployment of smart technology to drive energy efficiency and optimise distribution networks as well as changing energy storage business models.

The convergence of EVs with energy management has also paved the way to innovative approaches to saving energy such as the Vehicle to home (V2H) system that can supply electricity from a car battery to a residence for backup or peak power. The power is controlled through data communication processes between the vehicle, an EV charging stand and the home energy management (HEM) system. With the technology now fully available, this type of digitally enabled solution to home energy management is poised to make a massive impact on the way we manage our homes in the next few years.

New Business Models

Next-generation business models will redefine future business propositions and influence future technology and product development. These business models will not only reshape the landscape of the business environment but will also influence industry dynamics.

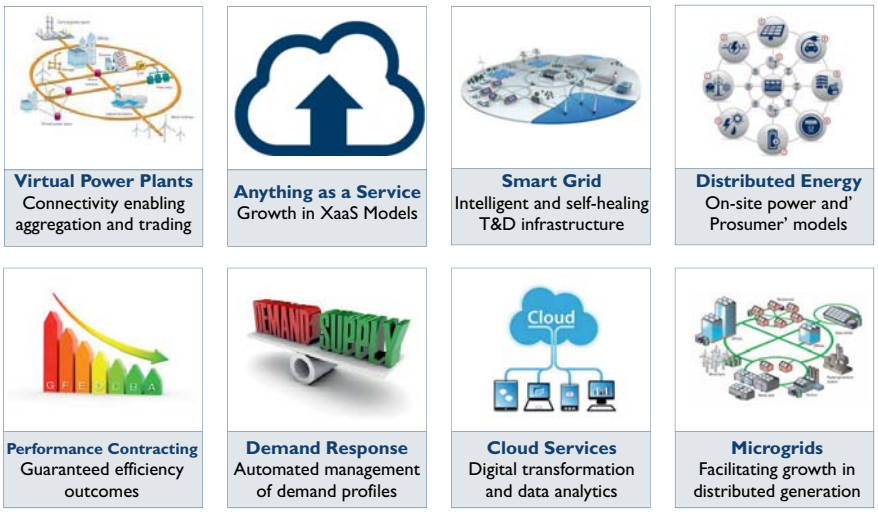
"The next wave of innovation in the Energy sector will be around new business models"

Following a decade of intense technology innovation, Frost & Sullivan believes that the next wave of innovation in the Energy sector will be around new business models. The industry is waking up to the need for a shift from the historically dominant supply-driven models to more customer-centric and technology enabled business models for the next generation of evolution.

Enabled by cloud computing, the energy sector is seeing growth in technology enabled service business models including the concept of anything as a service – or X-as-a-Service (XaaS). Examples include Product as a Service, Energy Savings as a Service and Light as a Service (LaaS). The fundamental shift here is that the product or system becomes part of the service, rather than the historical model where the service is part of the product.

Great examples of XaaS business models can be seen right across the energy value chain. Many leading firms are using cloud-hosted analytics for smart grid applications; Leidos has developed a Smart Grid as a Service (SGS) model to accelerate the roll-out of advanced metering infrastructure (AMI); and the Finnish company Cozify offers a wireless IoT based solution for smart homes that is delivered as home automation as a service (HAaaS).

Business Models: The Next Wave of Innovation in Energy



Source: Frost & Sullivan

Another technology enabled solution is the virtual power plant (VPP), where multiple power sources (such as small CHP plants, solar PV, wind, biogas, generator sets and small hydropower) are integrated into a centrally controlled network. Using connectivity, smart technology and advanced data analytics, VPP concepts are delivering portfolio optimisation across diverse generating assets, as well as aggregation and trading of energy from the virtual capacity. This will totally transform the operating models of both energy utilities and independent power producers (IPPs) in the very near future.

Meanwhile, demand response (DR) models are enabling real-time analysis of customer demand trends and allowing the generation, transmission and distribution infrastructure to react accordingly. Utilities will increasingly invest in innovative technologies and predictive tools to reduce power generation costs as well as grid failures and outages.

The energy value chain will witness an investment of $10 billion in DR programs by 2020, which will incentivise consumers to actively participate for financial benefits while contributing to energy efficiency. New communication technologies and supportive government regulations are imperatives for its integration into the future energy system.

The US is currently by far the leading market in terms of DR, but the United Kingdom, China, Japan and South Korea are rapidly evolving markets where the benefits of DR will help achieve the countries' emission targets while providing cleaner and efficient energy during peak times. A total of 80 GW/year of capacity will be reduced in the US alone with the help of efficient DR programs.

"People will have greater visibility and control over their usage of energy than we could have even imagined a few years ago."

Connectivity & Convergence

As mentioned above, technology is playing a key role in enabling new energy business models, as well as being a major driver of change in the power and energy industry. For example, the penetration of smartphones, connected devices and infrastructure has led to a world of potential exploitation of Big Data, improving energy management and efficiency in the process. With a forecast 80 billion connected devices by 2025, the Internet of Things (IoT) phenomenon is expected to positively impact all aspects of our energy networks from production to consumption.

In the residential sector alone, this will translate to 10 connected devices for every household and about 500 devices with unique digital IDs per square km by 2020.

In fact, the residential sector has the largest potential for demand flexibility and variability across the globe. Almost 50% of the energy required for residential consumption can be shifted to off peak times by deploying DR solutions. Among the attractive benefits are the incentives to energy providers to manage this variability in demand while reducing emissions. It is imperative to note that the role of the connected consumer in the value chain is set to recreate itself as an equal contributor. Indeed, the lack of awareness that currently impedes the pace of deployment is very soon expected to change as the need for sustainable power becomes more acute.

This connectivity has already started to improve the customer experience, for example with new solutions for smart and connected homes where application-based control is converging with connected hardware such as smart thermostats and home energy management systems (HEMS). In Europe alone, there will be over 30 million smart thermostats in homes by 2020. People will have greater visibility and control over their usage of energy than we could have even imagined a few years ago.

Technology is penetrating all forms of energy, and the next wave of development will move towards more automation in the network, and connecting generating assets to grid infrastructure and devices. The emergence of smart grids using digital connectivity to improve the flexibility and efficiency of infrastructure began over 10 years ago, but it is only now with more advanced data analytics and information management that the real benefits are coming to fruition. The connectivity and digitisation are enabling reliability, flexibility, efficiency and sustainability of electricity supply to become a reality for cities and communities across the world.

Regarded by many as the most transformative force in energy, connectivity has the potential to positively impact our lives, as well as our environmental impact, by enabling real-time advanced decision making and using data to drive innovation and efficiency.

Innovating to Zero

By 2020, nearly half of the world's electricity will be produced in emerging regions. Shifting regional and fuel balance will see non-carbon energy (renewables and nuclear) increasing to 38% percent of the total power generation, with this number set to grow further to 44% by 2030.

Companies will shift focus and develop products and technologies that "Innovate to Zero," for example, zero-emission technologies (including wind power, travelling wave reactor (TWR), solar PV, revival of nuclear power, concentrated solar power (CSP), and third-generation bio fuels).

The key difference between the 'Zero' vision and the thinking of the past is the shift towards targeting the complete elimination of the unwanted consequence (aiming for zero) as opposed to targeting incremental change (aiming for step by step improvements). This is a key area where we see the opportunity for Social Innovation business to make bold and visionary change in the world. For example to eliminate energy wastage or to eliminate the existence of communities without access to electricity.

Examples of companies that have set visions to innovate to zero can be seen across a huge spectrum of applications: Shell has a Goal Zero program to target zero harmful incidents; Atos has a zero email initiative to improve staff productivity and satisfaction; Microsoft aims to have zero net emissions for all data centres, offices, software development labs and employee air travel; and Infineon has a Zero Defect Program supported by advanced quality control and compliance.

DEFINING SOCIAL INNOVATION IN ENERGY

Frost & Sullivan previously defined Social Innovation as being about bringing innovation to deliver life-changing outcomes for society and individuals, requiring the convergence of technologies, industries, products, and business models.

"Energy is one of the key industry applications set to realise and enable Social Innovation"

Top 10 Factors Defining the Future of Energy

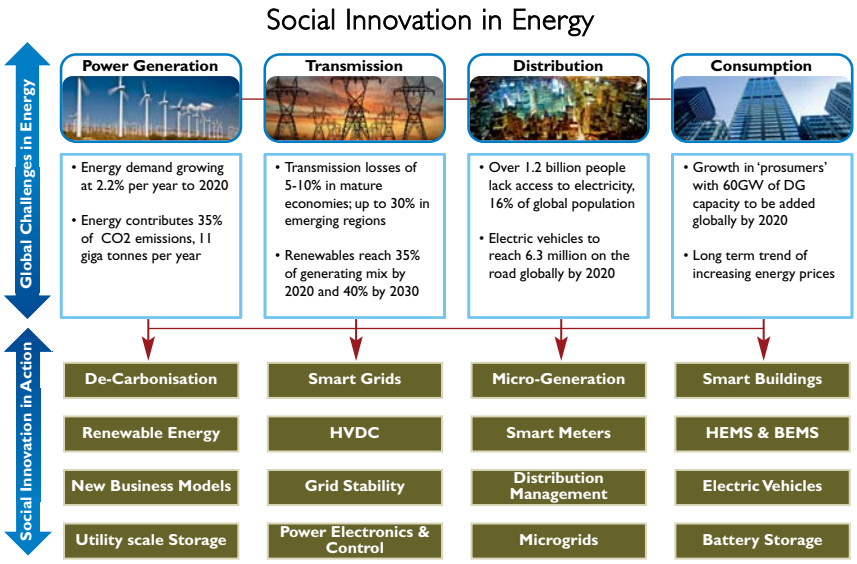
Source: Frost & Sullivan

Whilst technology is impacting and disrupting all sectors, energy is one of the key industry applications set to realise and enable Social Innovation, due to the converging mega trends outlined above and the considerable efficiency and sustainability gains that can be realised as a result. The top energy sector trends that Frost & Sullivan tracks show that the combination of technology advancement and business model innovation are re-shaping our energy future.

Thus, our definition can be directly applicable to the energy sector, by leveraging technology and new business models across the energy value chain to improve efficiency and sustainability. That means optimising resource use, providing safe, secure, reliable and clean power to businesses and homes, and to deliver collective benefits to communities and the wider society.

The most notable conclusion of our research here is that Social Innovation opportunities exist across the energy value chain from generation to consumption. It's all about the convergence of energy infrastructure with digital technology and intelligence to capture data and drive innovation and efficiency.

We will therefore look in more detail at the needs and opportunities for Social Innovation from power generation to the point of use in the sections below.



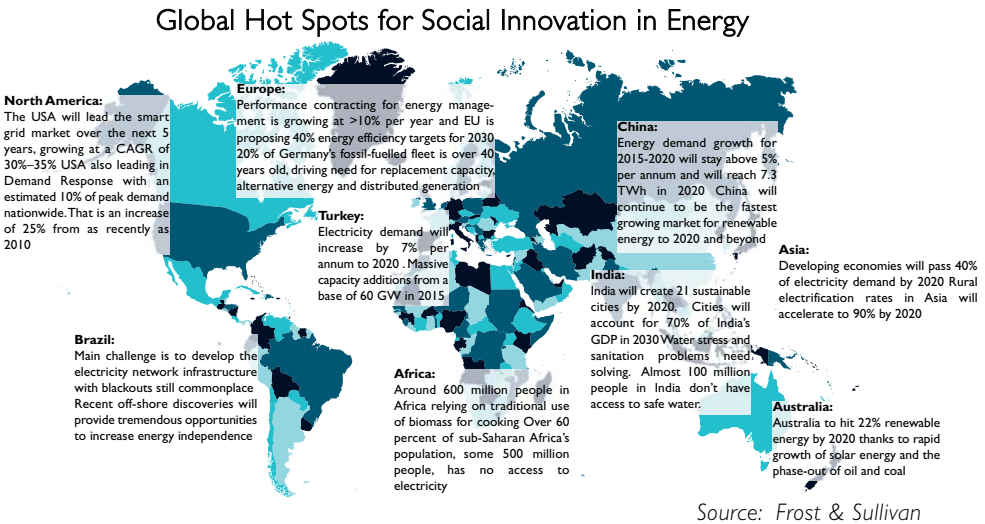
Source: Frost & Sullivan

The need for Intervention and Social Innovation

Social Innovation is essential for cities, communities and companies that want to truly deliver an integrated and sustainable energy vision for the future, by understanding the challenges faced today and offering both incremental and radical innovation to solve these.

As mentioned earlier, the biggest opportunities for improvement will come from the convergence of modern energy infrastructure with advanced IT solutions, all supported by the emergence of new customer-centric business models.

Among the areas most likely to benefit the most from such innovation are emissions and air pollution caused by power generation; access to electricity for remote or developing communities; efficiency of energy networks enhanced by automated and autonomous control; environmental and cost savings for businesses; and connected solutions for homeowners to proactively manage their energy more efficiently.



Source: Frost & Sullivan

By understanding these challenges and the need for intervention, the same principles can then be applied across the energy vale chain from generation to consumption, either individually or collectively, to solve societal challenges with innovation. This can either be a specific solution to improve the efficiency of energy usage within a company for example, or a solution that targets one or several challenges whether specific to one element of the energy network or several.

All of these areas looked at individually will deliver incremental benefits to their respective cities, communities, companies and countries, but if considered cumulatively, there is an extrapolated opportunity to realise through enabling Social Innovation in Energy.

Social Innovation in Action - Today

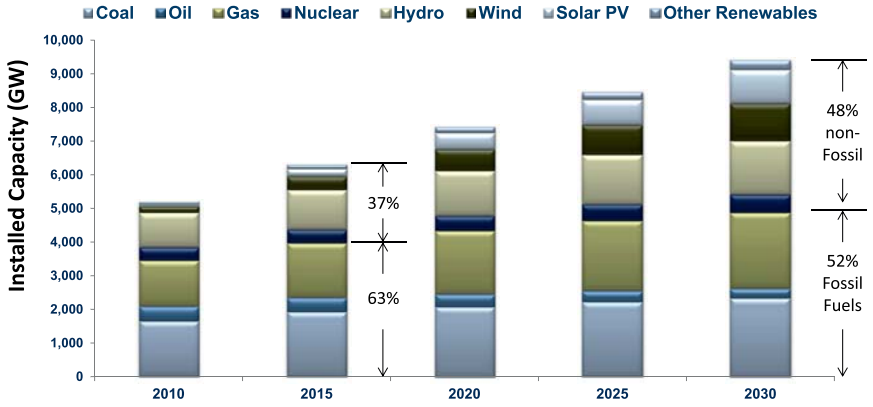
There are several areas where we already see Social Innovation improving energy, across various modes and of differing scales.

Power Generation

With global energy demand set to grow by over 2% per year up to 2020 and a colossal total of 55% by 2040, it is arguable that the greatest innovation need of all is in the area of power generation if this demand is to be met in a sustainable manner.

In the coming years there will be capacity growth in almost all types of power generation. Even fossil-fuelled power generation (coal, oil and gas) will actually grow in absolute terms, albeit at a lower rate than non fossil-fuelled power which will grow its share from 37% of capacity in 2015 to 48% by 2030.

Global Power Generation: Evolution of Installed Capacity by Fuel Type



Note: All figures are rounded. The base year is 2015.

Source: Frost & Sullivan

In emerging markets electricity demand is growing the fastest, driven by industrial growth, population expansion, urbanisation and improvements in living standards. That means solutions need to be found to enable generation to keep up with demand while minimising the impact on the environment. Meanwhile in many of the poorest parts of the world where electrification rates are the lowest, solutions need to be found to bring sustainable local generation to often remote communities.

In more mature economies, there are growing problems of peak demand, at the same time as we have underutilised generating capacity. Meanwhile many countries, especially in Europe, have very old power plants that are either inefficient or nearing the end of their lives.

While these two scenarios – between mature and emerging markets – might seem very different, the reality is that the solutions are somewhat similar. In both cases, a sustainable future will rely on a combination of new and cleaner generating assets, as well as better use of capacity by utilising technology that will enable DR solutions to shift peak demand and VPP solutions to intelligently aggregate the growing number of distributed generation sources.

We will see growth in renewables – especially wind and solar, more leverage of natural gas, development of shale gas, the next generation of nuclear power plants and growth in distributed generation using clean energy sources close to the point of use.

Where fossil fuels continue to be used, there are also many opportunities to increase the efficiency and reduce emissions. Examples include advanced air pollution control to reduce NOX and sulphur emissions; carbon capture and storage to keep CO2 out of the atmosphere; and ultra super critical (USC) power plants using advanced materials and new technology to operate at higher temperatures and greater efficiencies.

Smarter Grids

The global need for improvement and investment in electricity grids manifests itself differently in different parts of the world: In Europe and Japan it's all about increasing the efficiency of aging grid networks; in North America it's all about increasing grid reliability, especially in and around dynamic urban centres; and in fast moving and developing regions, it's all about building future-proof electricity grids to efficiently deliver energy to support industrial growth and improving consumer lifestyles.

When this is combined with the global growth in renewable energy and EVs that need to be integrated into the grids, it's no surprise that smart grid technology is a key area of growth and innovation.

The convergence of IT with T&D equipment and sensing technology means that next generation smart grid solutions are creating opportunities for self-healing grids and driving up the last mile efficiency of distribution networks to minimise distribution losses.

The digital transformation of utilities starts with the grids which connect suppliers with consumers by reducing inefficiencies and supporting a more efficient distributed monitoring and control system. But this is not limited to utilities and smart grid technology is also transforming the operations of distribution system operators (DSOs) and even facilitating the growth in prosumers.

In the near future we will also see smart grid technology become a key driver and enabler of global growth in demand response (DR) solutions with DR software using data to drive innovation and efficiency. By altering consumers' demand profiles to fit the needs of an efficient energy system, the entire energy spectrum will result in a more flexible, efficient, less expensive, and lower emission ecosystem.

The same will be true of virtual power plants (VPPs) which are created by connecting a collection of distributed generation sources to form an integrated network. By digitally linking a vast and diverse mix of generating sources – including commercial and residential prosumers – VPP solutions will take power aggregation to a new level and drive 'virtual' generating capacity to take pressure off centralized assets.

"Next generation smart grid solutions are creating opportunities for self-healing grids and driving up the last mile efficiency of distribution networks"

Energy Management

The convergence of technology is also transforming the way energy is managed by commercial and industrial users in their buildings and facilities, many of who can easily achieve energy savings of up to and beyond 30%. Today's energy management trends are also characterised by business model innovation to deliver cost savings, sustainability, flexibility, safety and reliability. In Europe, for example, energy performance contracting markets are growing at over 10% per year, driven by an increasing customer preference for buying 'outcomes' to their energy problems rather than individual products or solutions.

These customer-centric, service-based business models enhanced and enabled by technology, like cloud solutions, will proliferate in the energy management markets. Energy performance contracting, demand response and virtual power plants are transformational changes requiring new business models. Energy savings, lighting, heating and cooling are all seeing rapid growth in XaaS delivery as competitive landscapes are transformed and will represent areas of great opportunity in coming years.

Value propositions based on guaranteed outcomes such as energy savings and business performance—enabled by cloud-based analytics—are driving a move from product based offerings to solutions and services such as cloud-based building energy management systems (BEMS) and factory energy management systems (FEMS). This movement of the management layer to the cloud – combined with advanced data analytics – is creating very significant cost savings for the user, while also facilitating efficiency within and between buildings via remote management platforms.

This will eventually lead to the concept of the 'Internet of Buildings' where intelligent and connected equipment within and between multiple buildings can be fully automated to facilitate optimal decision making over the usage of energy, space and resources across a portfolio of buildings and ultimately smart cities.

Distributed Generation & Microgrids

The traditional energy model of generating electricity predominantly from centralized power plants is changing fast. Distributed generation (DG) will increasingly feature within electricity grids as solutions become more cost effective and new technologies facilitate the transformation.

This growth in DG is responsible for the acceleration of the 'prosumer' model – that is customers that both produce and consume energy. Frost & Sullivan expects that growth in prosumers will lead to over 60GW of DG capacity to be added globally by 2020.

This technology enabled transformation is driving efficiency by bringing power generation closer to consumption. It's also driving innovation in business models and greater collaboration between suppliers, businesses and communities as more customer-centric solutions take hold. For example in Germany – where nuclear power is being phased out – there is a stated government goal to accelerate the role of small scale DG from renewable energy sources close to the point of use.

Distributed generation – facilitated by smarter energy management solutions and grids – will lead to rapid expansion of the number of grid connected devices and assets and drive a new need for innovation to integrate this complex mix. One such innovation area will be microgrids. These are effectively autonomous connected groupings of distributed generating assets and customers that are not connected to 'macro' grids.

Advancements in energy storage technologies and business models are a key enabler of this trend, especially in supporting distributed generation from renewables. The effects are being seen right down to the residential level where home energy storage will facilitate accelerated growth in micro-generation using solutions such as solar PV to increase the flexibility and autonomy of homeowners.

We're even seeing the convergence of EVs with smart and connected homes to bring the EV battery into the home energy storage ecosystem. By 2020, there will be about 20 million residential prosumers in North America alone, alongside strong growth in commercial and industrial prosumers in Europe, as well as strong opportunities globally.

DG is also a hugely significant enabler of rural electrification where renewable energy, hybrid power, battery storage and microgrids are converging to create solutions for electrification in remote and emerging regions.

Social Innovation in the Future

As many of the above business models become more fully established and deployed on a mass scale, Social Innovation provides the opportunity to connect several of the initiatives to improve society and quality of life at a greater rate. In our future of integrated and intelligent solutions for energy – with a less centralised and more customer-centric approach – the automated and autonomous control and management of energy networks will be commonplace all the way down to the increasingly proactive role of the connected individual.

In the section below we have looked in more detail at the specific areas where Social Innovation in energy will make a significant impact on our future and identified the key indicators that can be quantified to define that impact.

"DG is a hugely significant enabler of rural electrification where renewable energy, hybrid power, battery storage and microgrids are converging"

QUANTIFYING THE OPPORTUNITY

In considering the monetary and societal benefit that can be derived from Social Innovation Business in energy, Frost & Sullivan has considered three main areas: the value of the power infrastructure and equipment for delivering clean energy; the value of smart energy infrastructure (ICT solutions) for bringing digital intelligence and efficiency; and the value of the benefits to customers and society.

So firstly we've looked at the infrastructure and equipment facilitating the cleaner and more efficient generation, transmission, distribution and consumption of energy. This includes investment in things like renewable energy technology, air pollution control and smart grid technology. Frost & Sullivan's ongoing primary research in these areas shows an expected market size of $650 billion in 2020.

Secondly, we've looked at the investment in ICT infrastructure and solutions that facilitate the smarter management of energy in grids, cities and buildings. Frost & Sullivan estimates that this will be worth $102 billion a year by 2020, which is approximately 12% of the total $850 billion that we project to be the total ICT spending by the energy sector at that date.

"An incredible $1.17 trillion is at stake annually by 2020"

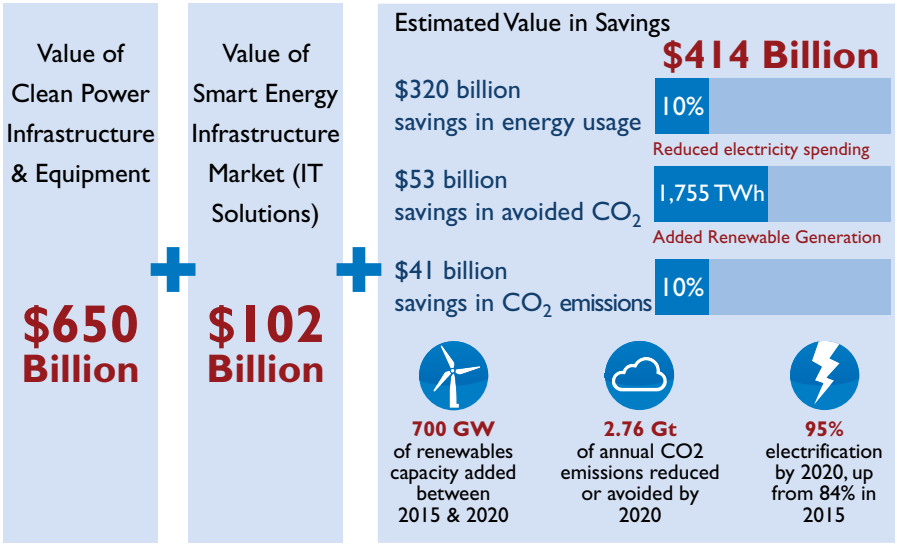
Thirdly – to consider the value of the benefits to customers and society – we have looked at the value of savings that can be achieved through the deployment of Social Innovation in three crucial areas: The value of savings through increased energy efficiency; the value of optimising the generating efficiency of existing assets; and lastly the value of reduced CO2 emissions from the displacement of fossil fuel power with renewable energy.

Frost & Sullivan estimates that total annual global spending on energy is around $6 trillion, of which close to 50% is spent on electricity (equating to approximately 24,000 TWh of consumption).

So global annual spending on electricity is estimated to be around $3.2 trillion, which means it accounts for around 3% of global GDP. This puts customer spending on energy in second place to healthcare in many countries and in some countries in first place. Around 35% of this spending is from residential customers and 65% from commercial and industrial.

This means that even a saving of 10% through better management of energy could translate to cost savings of $320 billion which is of course over and above the environmental benefits. Given that we know that for many customers even a 30% or higher energy saving is possible using advanced technology and energy management, this cost saving impact from Social Innovation is probably conservative.

Social Innovation in Energy – The Value at Stake



= $1.17 Trillion value at stake

Source: Frost & Sullivan

Meanwhile, the global growth in renewable energy between 2015 and 2020 will lead to 700 GW of additional renewable generating capacity according to Frost & Sullivan, translating into growth in annual electricity generation from renewables of 1,755 TWh by 2020.

If we look at this in terms of displacement of fossil fuelled power, then this indicates a saving potential of 1.44 gigatonnes (Gt) based on an average of 0.82 kg of CO2 that is created on average from the global mix of coal, gas and oil based power (source: US Energy Information Administration). Using a carbon price of $37 per tonne (source: costofcarbon.org), this offers a potential annual saving of $53.2 billion.

In turn, more optimised generation efficiency and improving air pollution control has the potential to reduce carbon emissions from traditional power generation by at least 10%. In 2014 there were 32 Gt of CO2 emissions globally, with 35% of this attributed to power and energy (source: International Energy Agency). Reducing the energy proportion of emissions by 10% has the potential to reduce 1.1 Gt of CO2 annually, with the potential to deliver $41 billion of savings when applied to the above-mentioned average carbon tonne price of $37.

Furthermore, whilst monetising the benefit of these significant emission reductions is possible, the real social benefit of these achievements is a positive impact on people's health and even the potential to reduce the 7 million deaths per year owing to poor air quality.

In monetary terms, these combined areas of Social Innovation impact show that an incredible $1.17 trillion is at stake annually by 2020 in terms of market opportunity and benefits to customers and society.

And this is without even trying to quantify some of the enormous benefits such as the social, environmental, health and economic improvements that will be felt around the world by addressing the need to bring electrification to the 1.2 billion people that currently lack access to electricity. Or the improvements in air quality, safety, reliability and security of energy supply that will enable both individuals and businesses to operate more efficiently and sustainably.

HITACHI'S UNIQUE CONTRIBUTION

Social Innovation in Energy at Hitachi

Hitachi – a global pioneer of Social Innovation as a value proposition for over 100 years – has Social Innovation Business at the centre of its mission, values and vision.

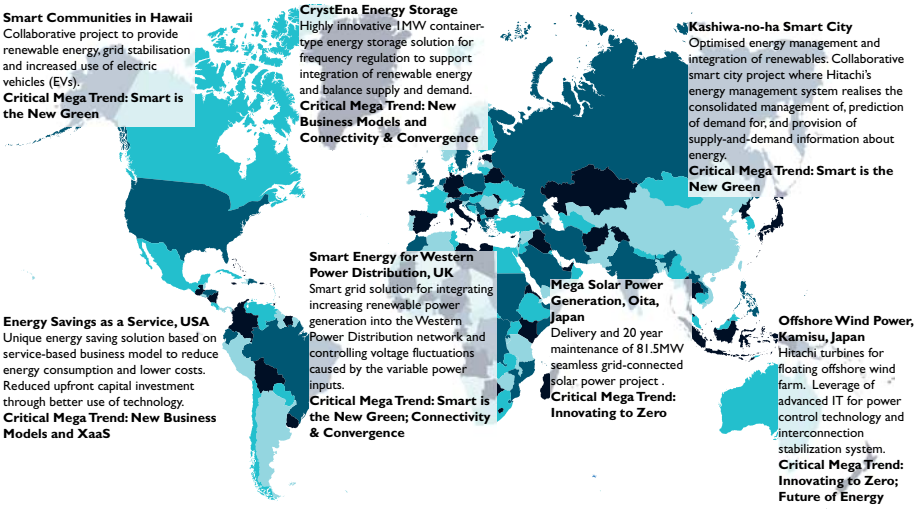
Specific to energy, Hitachi's goal related to Social Innovation is to combine both equipment and social infrastructure with IT and digitisation expertise, operating across the energy value chain from generation to point of consumption. Hitachi also has a vision to subsequently take the same approach into associated converging areas such as water, electric mobility and waste management.

Through it's long history in producing products, systems and solutions for the energy sector, Hitachi is a global leader in areas including renewable energy, nuclear power, air pollution control, T&D equipment, smart grid solutions, energy storage and energy savings. It focuses on technologies and solutions to increase the efficiency, stability and security of both conventional and renewable energy generation, as well as smart grids where Hitachi deploys its IT expertise for the balancing of electricity supply and demand.

Through its focus on Social Innovation, Hitachi is supporting the digital transformation of utilities to drive energy efficiency and optimal integration of renewables. By utilising its extensive expertise from generation to consumption, Hitachi is building a sustainable energy efficiency business on a complete portfolio of products and systems all enabled by digitisation. That means using data and bringing intelligence to drive innovation and efficiency, as well as software solutions to bring to life new business models such as virtual power plants (VPPs) and demand response (DR).

The company is also using its project management, advanced IT solutions and creative business models – such as energy saving as a service – to deliver energy efficiency solutions to cities, industries and businesses through the application of autonomous, decentralised IT systems for energy control.

Hitachi Social Innovation Projects: Examples of Convergence, Collaboration and Societal Impact for Energy



Source: Frost & Sullivan

The uniqueness of the Hitachi contribution in the energy sector comes from its vision to put society first and look to the future where there will be continuing convergence of infrastructure, technology and new

Hitachi Live Example:

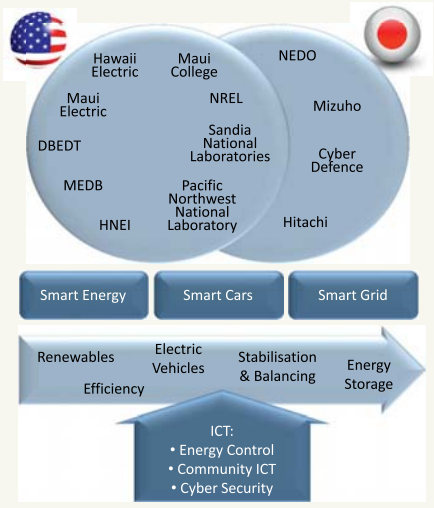
"JUMPSmartMaui initiative creates smart communities in Hawaii"

The JUMPSmartMaui initiative addresses the need to tackle Hawaii's high dependence on oil for energy and transportation. The State has relied on fossil fuels for over 90% of its energy and transport and has increasingly suffered from rising prices.

Through the collaboration of multiple stakeholders, the initiative focuses on energy and transportation infrastructure and the application of autonomous, decentralised IT systems for energy control.

JUMPSmartMaui will deliver 25% renewable energy by 2020 and 40% by 2030, as well as maximising electric vehicle (EV) penetration, stabilising grid infrastructure and improving community ICT and mobility to enhance the quality of life of residents.

Customer Benefit: Improving quality of life by connecting transportation with renewable energy.



Hitachi's focus on Social Innovation will enable it to focus on the sustainability, reliability, safety and efficiency of the generation, transmission, distribution and consumption of energy.

Given that the future of energy is all about integration (as discussed earlier) this will put Hitachi in a great position to thrive in that future world by making a positive difference to businesses, society and individuals.

Hitachi's role in Renewable Energy

The broad area of renewable energy is a great example of an industry where Hitachi's Social Innovation offering combines core products and infrastructure (such as wind turbines), critical enabling technology (such as energy storage) and the IT skills for driving optimisation, control and integration.

In the wind power area Hitachi has focused heavily on offshore wind turbine technology where it can make a big impact to both future energy security and carbon reduction in a high growth segment focused on large turbines. The company has a 2MW wind power generation system that is deployed most commonly in floating offshore wind farms that are well suited to deep sea locations or areas where the ocean floor topography is challenging. It is also in the latter stages of developing a 5MW system. Hitachi has also integrated advanced IT into its power control technology and interconnection stabilization system to enable easier monitoring and efficient operating of the offshore wind farms.

An example of the company's success in this field can be seen from its offshore wind power project in Kamisu, Japan which uses Hitachi turbines for a floating offshore wind farm, including the leverage of advanced IT for power control technology and its interconnection stabilization system.

But Hitachi's activities in renewable energy are not restricted to wind power and the company plays a very significant role in the solar power sector. In particular Hitachi specializes in high quality long-term operation and maintenance (O&M) services – including inspection and maintenance, remote monitoring and trouble shooting – and high precision monitoring of PV module failures combining semiconductor theory and cloud services. An example is the mega Solar Power Generation project in Oita, Japan where Hitachi has taken responsibility for the delivery and 20 year maintenance of a 81.5MW seamless grid-connected solar power project.

Hitachi is also a global leader in energy storage technology. Storage is a key enabler of new energy business models such as prosumers, distributed energy networks and virtual power plants as well as being a critical component in ensuring stable grids and renewables integration.

Hitachi Live Example:

"CrystEna: Energy Storage Solution for Frequency Regulation"

Advancements in energy storage technology are a crucial driver and enabler of stability and flexibility in power grids. This is especially true as we witness rapid growth in the integration of renewable energy into both centralised and distributed power grids.

Hitachi has developed a highly innovative 1MW container-based energy storage solution based on lithium ion (Li-ion) battery technology. CrystEna is a modular high speed response solution to provide frequency regulation that integrates the battery, PCS, control system and air cooling into a containerised unit.

CrystEna has already shown very positive results in North America where it's been utilised for power grid stabilisation and promotion of renewable energy installation. It can be quickly and easily deployed to keep up with rapid addition of clean energy to drive a more sustainable energy future.

Customer Benefit: Enabling environmental improvements through efficient integration of renewable energy and enablement of stable power supply.

As such it's a core element of Social Innovation and Hitachi's 1MW container-based CrystEna solution is an excellent example of a customer friendly storage solution to accelerate the transition towards renewable energy and a lower carbon future.

The modular design, easy installation and connectivity make CrystEna an optimized solution for frequency regulation in ancillary services. It also has the flexibility to change the control software and battery configuration so it can be deployed in other applications such as peak shifting and DR.

Hitachi's role in Smarter Energy

The smart grid is another example of an area where energy infrastructure will continue to converge with IT to create a great opportunity for Social Innovation. In this space Hitachi again combines core products and infrastructure (such as transformers and switchgear), critical enabling technology (such as HVDC transmission) and the IT skills for delivering fully flexible intelligent energy networks and grids.

In the smart grid arena Hitachi is in a great position to drive a better, more efficient and sustainable future for the transmission and distribution (T&D) of electricity. As well as being a global leader in the supply of core T&D equipment, the company leverages the capabilities of the communications and control technologies required to build advanced metering infrastructure (AMI) and ensure stable and secure electric power systems. This use of IT expertise is critical to balancing supply and demand in the future and highlights the critical role that Social Innovation will play in driving a more efficient energy future.

An example can be seen in the UK where Hitachi Europe Smart Cities Energy Group has deployed an innovative smart grid solution (based on voltage control) for integrating increasing renewable power generation onto the Western Power Distribution network and controlling voltage fluctuations caused by the variable power inputs.

Another example is the Bonneville Power Administration (BPA) in the USA where Hitachi has established a wide-area grid stability project using grid control technology to prevent outages caused by grid faults. The solution uses real time data from the grid to suggest improvements in reliability and efficiency.

The smart grid is also another area where Hitachi's vision is to provide solutions across the energy chain from transmission (such as gas circuit breakers, high voltage transformers and HVDC transmission), distribution (such as substations and distribution management systems), microgrids (such as energy management systems and storage), and to the final consumer.

Hitachi Live Example:

"Energy Savings as a Service for AT&T"

The Energy savings as a service solution developed by Hitachi Consulting is based on the model of providing guaranteed energy saving outcomes to customers. It brings together a combination of Hitachi's skills in technology, consulting and out-sourced services to deliver a customer-centric XaaS solution for optimised energy management and cost savings.

Through Hitachi Consulting's approach, all energy saving initiatives are funded through service fees based on tangible, provable and measurable savings. This frees up capital for the customer to finance initiatives from its existing energy budget, generates long-term energy and cost savings, and significantly reduces the need for upfront capital outlay by the customer.

Hitachi has been delivering energy saving as a service for AT&T since 2013, delivering approximately 35% savings for the client compared to its previous monthly energy costs. The entire management of AT&T's energy has been outsourced to Hitachi Consulting (including energy utility payment), thus allowing the company to save costs, improve efficiency and sustainability, and of course increase its focus on its core business.

Some examples of where significant savings have been achieved already include motion sensor and motor replacement, lighting retrofit, and lighting controls, sensors and external LED lighting.

The impact of the work by Hitachi Consulting to reduce energy consumption for the customer was recognised immediately and confirmed with Hitachi winning the AT&T Supplier Sustainability Award in 2013.

Customer Benefit: Reduced energy consumption and rapid savings of both energy and cost.

At the downstream (customer) end, Hitachi uses Big Data and data analytics to deliver optimal leverage of meter data for improved energy solutions for commercial and even residential consumers. It also brings a comprehensive customer-centric service offering for smart energy management through the use of service business models and advanced technology to deliver energy savings as a service. This model – based on providing guaranteed energy saving outcomes to customers – can typically deliver over 30% savings in energy consumption.

CONCLUSION

Social Innovation in Energy is poised to deliver a future where sustainable, reliable, safe and efficient energy is available to everyone across society and business. Based on the core elements of technology and new business models to bring about real positive change, our research for this Whitepaper has found that the opportunity for Social Innovation in Energy is enormous and we believe that energy is one of the most compelling areas for Social Innovation Business. It is a truly global phenomenon, with many different regional opportunities to make a real difference to people's lives, whether it's bringing electricity to parts of the world where infrastructure is limited, reducing global carbon emissions, or driving economic growth by enabling businesses to be more efficient.

We have also identified that in a world driven by connectivity and convergence, true Social Innovation in energy is an enabler of a better future. A future where individual elements such as transport, water, sanitation, retail, security, education and healthcare are increasingly coming together – with energy – to enhance people's lives and improve sustainability in communities.

Enabled by the digital transformation of the energy sector and powered by connectivity and convergence, we will see a future where Social Innovation facilitates the integration of higher levels of renewable energy, creates smarter and more reliable grids, and delivers customer-centric business models such as virtual power plants, distributed generation, demand response and XaaS. We'll see consumers – both commercial and residential – taking more control over their energy usage than ever before to manage their costs while also increasing convenience, efficiency and sustainability.

Hitachi is already leading the way globally in this vision of Social Innovation in Energy. From a position of strength in energy equipment and infrastructure, it is now leveraging its advanced IT capabilities to support the digital transformation of energy utilities, facilitating the creation of smarter grids, bringing energy to the centre of smart city solutions, delivering energy savings contracts and bringing innovative products and solutions to fast moving areas such as energy storage.

"Hitachi is already leading the way globally in this vision of Social Innovation in Energy"

With energy demand set to continue growing and environmental pressures getting ever stronger, we have identified a $1.2 trillion annual impact from Social Innovation in Energy by 2020. That's the combined impact of investment in clean power equipment and social infrastructure, the smart energy infrastructure to bring digital intelligence to energy networks, and last but by no means least the estimated savings in energy consumption and carbon emissions.

We've also identified the priceless benefits of Social Innovation across global society that will be felt by addressing the need to bring electrification to the 1.2 billion people that currently lack access to electricity, as well as improvements in air quality, safety, reliability and security of energy supply that will enable both individuals and businesses to operate more efficiently and sustainably.

With energy infrastructure converging with advanced IT solutions, the players in the future energy world that will make the biggest impact are those that can bring innovation to all elements of the energy ecosystem from generation to point of use. That means using collaboration, data and intelligence to drive innovation and efficiency in areas such as portfolio optimisation, energy aggregation and trading.

Companies like Hitachi are driving a better future for Energy and are set to benefit from enabling the core requirements for Social Innovation across the energy value chain: enabling cleaner and more efficient generation and distribution; changing behaviour and patterns from the energy users; saving energy and money at the point of use; fostering smart policies and governance; delivering private sector investment in technology and infrastructure; and bringing the digital intelligence to deliver the more integrated energy future.

It is these technological advances in particular that enable Hitachi to deliver Social Innovation in Energy, through utilising the technology to improve society and quality of life.

Other Whitepapers on Social Innovation

Following our recent work to define and quantify the global impact of Social Innovation [http://www.hitachi.eu/en/sib/whitepapers], this document is part of a new ongoing series of Whitepapers on Social Innovation in specific industries. We are continuing the theme of drilling more deeply into critical industry sectors, while maintaining the crucial themes of connectivity, convergence and cross-sector impact of Social Innovation to bring real improvements to infrastructure and to society.

We have recently completed a Whitepaper on Social Innovation in Transportation and Mobility [http://www.hitachi.eu/en/sib/whitepapers] and will next be undertaking a detailed analysis of Social Innovation in Healthcare.

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ABOUT HITACHI, LTD.

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society's challenges with our talented team and proven experience in global markets. The company's consolidated revenues for fiscal 2014 (ended March 31, 2015) totaled 9,761 billion yen ($81.3 billion). Hitachi is focusing more than ever on the Social Innovation Business, which includes power & infrastructure systems, information & telecommunication systems, construction machinery, high functional materials & components, automotive systems, healthcare and others. For more information on Hitachi, please visit the company's website at http://www.hitachi.com.

Social Innovation microsite:
social-innovation.hitachi

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