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Massimo Danieli

Managing Director, ABB Power Generation

Dear Reader,

The commitment that underlies Symphony control systems is an island of continuity in the sea of rapid and complex changes sweeping the Power Generation sector. It is the commitment of support from an automation partner that understands the critical importance of balance for customers – balancing acquisition of cutting-edge technology against the need to maximize return on investments already made.

The life cycle management strategy of ‘Evolution without obsolescence’ announced in 2010 for Symphony control automation guarantees continuity for one the world’s largest installed bases of distributed control systems, with nearly 6,700 systems installed worldwide, about 4,700 of them in power generation and water applications.

Since the 2011 launch of Symphony Plus control automation, ABB has delivered or is delivering Symphony Plus solutions (page 5) controlling 50,000 megawatts (MW) of additional power generation across all types of applications in the sector, from conventional thermal to solar and wind.

In addition, many ABB installations have chosen Symphony Plus to upgrade their existing systems, because

‘Evolution without obsolescence’ ensures customers can get needed new technology and features in a product that protects valuable investments in hardware, software, engineering and staff expertise, over the lifetime of a plant.

Continuity is at the heart of this success. ABB’s commitment to the Symphony family includes ongoing development of products that bring greater capacity, higher performance and new functionality to control, I/O, communications, engineering, operations, safety and security.

ARC Advisory Group distinguishes Symphony Plus as the world’s leading distributed control system in the power generation sector, and singles out ABB as the market leader in DCS services, hardware and software for the power generation sector (pages 6-10).

In the five years since Symphony Plus was launched more than 100 products have been released, which clearly demonstrates ABB’s commitment to continuously develop the platform by enhancing its features and functionalities, such as the SD Series of flexible control and I/O products, providing plant automation regardless of an application’s size or physical location.

The system is continuously evolving to meet changing power generation needs from gas and renewables to hydro, solar and wind markets (pages 28-30), while still meeting the requirements of traditional fossil fuel power generation that must become more operationally flexible (pages 22-27).

On top of adding functionality and features to its Symphony Plus control product, ABB has been creating multi-layered cyber security systems (pages 31-32) to detect and deter threats and keep increasingly interconnected systems secure.

And to ensure that customers are getting the most from their plant assets, ABB works hard to develop deep ties with system owners through our service products (pages 14-16) to help them operate their plants more efficiently, reduce costs and plan the best long term operational solutions.

A prime example of ABB’s deep ties with long-term customers is our relationship with companies like Ansaldo Energia, (pages 11-13), which is now building a new multinational profile in the gas turbine sector.

ABB is committed to developing new Symphony Plus innovations that improve the way renewable energy and conventional power generation are integrated into daily life, and which are fully compatible with their predecessors. We hope you enjoy reading this new issue of In Control.

With kind regards,

Massimo Danieli
Managing Director
ABB Power Generation



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Can an automation system last a lifetime?

Certainly.

Symphony® Plus is compatible with all of its earlier generations – Network 90, INFI 90, Harmony, Contronic and Melody – delivering a simple, seamless, low-risk, and cost-efficient upgrade solution for your power or water plant. Whether your running system is 30 years old or newly installed, our industry leading “Evolution without obsolescence” life cycle program ensures new technology and features are always available to help meet changing business requirements, while protecting your valuable investments in hardware, software, engineering, and staff expertise over the lifetime of your plant – from commissioning to retirement.

www.abb.com/symphonyplus

Symphony Plus DCS leader of the power generation market

While prestigious ARC Advisory Group confirms ABB as number one global DCS supplier, Symphony Plus now controls 50,000 MW of additional power since introduction.

ABB has been recognized by the ARC Advisory Group as the global leader in distributed control systems (DCS) and as the number one positioned supplier of DCS.

From the ARC DCS Worldwide Outlook annual study, ABB's leadership position in the DCS market was fully demonstrated by consistently placing first in key global verticals - including energy and energy-intensive industries - and in the DCS service, hardware and software categories.

In particular, ABB's Symphony® Plus - the total plant automation platform for power and water industries - has kept expanding its footprint since its launch in 2011 leading to ABB's ascension to the top position in power generation. The system's flexible automation features, solid competence at integrating electric power infrastructure with automation products, and forward compatibility with previous generations of products are some winning factors in these markets.

Recently, Symphony Plus passed another milestone threshold. Since the introduction, Symphony Plus solutions have been or are being delivered to control 50,000 MW of additional power across all types of generation, included conventional thermal, combined cycle, hydro, solar and wind.

In addition to that, many more ABB installations around the world have chosen Symphony Plus for their existing system upgrades thanks to the 'Evolution without obsolescence' life cycle management policy that ensures any new generation is upward compatible with its predecessors. Through this

strategy, Symphony Plus offers the simplest incremental enhancement of system technology and functionality for its large installed base without compromising previous investments.

In only the last year Symphony Plus has been installed on several landmark projects such as the first phase of the gigantic Wanzhou supercritical thermal plant in China, the Bangladeshi Bhola combined cycle, the Severnside waste-to-energy plant in the UK, Dubai's desalination facility, the impressive photovoltaic plant in Kamuthi, India, and Morgan City's gas-fired plant in the US to name just a few.

Several new products have been recently added to the Symphony Plus family: SD Series DIN-rail mounted control and I/O products, Fast-Ethernet hierarchical plant architectures, device and system integration over a broad range of standard communication protocols, a unified engineering environment for efficient configuration and management of any system component, and many new HMI features supporting fast and effective decision making.

In all, there are nearly 6,700 systems Symphony DCS installations in operation all over the world, about 4,700 of which are in power and water applications.

"Symphony Plus' market acceptance is undeniable," comments Massimo Danieli, Managing Director of the Power Generation business. **"Being recognized as the leaders in the power generation DCS segment reaffirms that the Symphony Plus offering is addressing what the market needs."**

Automation markets and market trends

Automation suppliers must find a way to deliver technologies that can work with both old and new power generation models as extensive changes sweep the sector. ABB is at the forefront of this dramatic evolution, singled out by ARC Advisory Group in 2014 as the top global DCS supplier and market leader in DCS services, hardware and software.

What are the key market drivers and dynamics affecting the change in the power generation industry today? Does it differ from a regional perspective?

Electricity is unique – you can't put it on a tanker and move it from continent to continent, like gas, coal, or oil. It's up to each region to develop its own infrastructure for power generation and transmission and distribution (T&D). It's an important variable in each region – much more so than in other industries, such as steel, or automotive or such, because regions must be self-sufficient, to a large degree.

The situation in power generation markets in recent years has been specific to each region, and the two major observations are:

- Developing Asia has undergone rapid and sustained growth for a very long time. China has had 7-10 percent year-on-year growth in power consumption for many years. This has been unprecedented development, and now China has become a major segment of the worldwide power market. China's economy is slowing down now, but it's still growing at 4-5 percent, and will continue to drive investment in new generating capacity of all types for the next five years at least.
- In developed economies, specifically Europe and North America, there's an entirely different dynamic going on, made up of flat electric demand since

the financial crisis, as well as the adoption of energy efficient technologies and renewable generation. These are greatly reducing the need for new thermal generating capacity, and the trend is that the new capacity that is being added is in the form of renewables.

Based on these trends, what do you expect will be the key challenges facing power generation plant managers?

The convergence of regional and global power generation trends, and the changing dynamics of power generation itself from central block to geographically distributed systems, is creating major new challenges for power sector managers. This is particularly visible in European markets, which have gone the furthest in terms of substituting intermittent renewables for baseload capacity.

The challenge for the existing installed base of generation is it has to be able to interact with this new renewable generation in order to manage the overall grid. Dispatchable generating capacity, which consists of coal and natural gas thermal plants, has to be able to respond to the intermittency of the renewable generation, as well as the behavior of the load itself – which means they have to become more flexible and more responsive. Much more

of existing plant will have to cycle at least daily, so they have to respond faster. Larger portions of what are now base load plants will not be base loaded in the future.

Automation needs to support changing markets:

How can automation best support the revolution that is ongoing in the global power business, in the context of today's fast, challenging and competitive market environment?

The challenge of automation is to address these major changes in our power generation markets: moving from base loaded to cycling operation based on renewable power availability. A new

The challenge for the existing installed base of generation is it has to be able to interact with this new renewable generation in order to manage the overall grid.

plant is probably designed to deal with that kind of operation, but a 15, 20, or 30-year old coal plant was not designed with that mode of operation in mind.

Distributed generation makes managing grid operations much more complex, because there are many more participants, although many of them are small. It's the difference between a

few dozen large power generating units within a control area, and a few dozen large units plus hundreds or thousands of very small units, such as the wind or solar sites that are now also participating.

Grid management becomes greater than just matching generation to consumption. It's further complicated by the implications to T&D infrastructure. For example, most solar generation is attached to the distribution system directly, sometimes at the extreme ends of the grid. Distribution system power flows can be impacted severely by changes in solar generating capacity.

The other kinds of challenges that I hear utilities talking about are the common industry challenges like a greying work force, but in utilities it's a bit more distinct in that they had a very solid skills development model for their plant personnel, a well-defined career path that enabled personnel to develop great expertise at a particular site. This doesn't happen as much anymore, particularly in the fossil-fuel world. Today, career paths are much more open and undefined.

In terms of automation, the trend is towards doing more with less, and reducing Capex in favor of Opex. End users want to add more capability to their systems, but to do it incrementally. It is difficult for them, especially in an older facility, to justify a major upgrade investment or tolerate the risk of a major rip-and-replace upgrade to a plant or an automation system when they don't know what the expected life of the asset is going to be.

In North America, given the kind of incremental improvements end users are looking for, the move from Symphony to Symphony Plus, for example, is much less disruptive than some of the other options available, and this is welcomed by the installed base of Symphony, Harmony and Melody systems.

Your recent report identified a substantial installed base of aging global automation. How will automation trends balance the need to serve this market and yet address the needs of new power generation applications?

What we see in the market is a convergence of automation and safety systems, and a smartening of devices at the edge of the automation system – such as smart and very compact I/O

systems – which are suitable for retrofits and new designs alike. We see much greater use of virtualization to reduce the management work required on IT-like parts of automation systems.

This gives end users much more flexibility in renewing and maintaining their automation systems. It requires more skill to maintain them, but you don't have as many tasks. I would say a lot of automation end users in many industries, including utilities, are tightly constrained in terms of the skilled human resources available at any particular site.

For utilities maintaining a broad mix of traditional and renewable generation, commonality is a big plus. For automation end users this means simplifying their supply chains, and relying more on a reduced set of suppliers for products and services, especially aftermarket services that enable utility staff to focus more on plant and performance, and less on the repetitive tasks of maintaining the automation.

Technology and technology trends:

Following up on your comment that utilities and industries in general are undergoing a generational shift in workforce, can automation help to minimize the expected “knowledge drain” associated with this change in workforce?

Building best practices and continuous improvement into automation systems and management systems to the highest degree possible is crucial going forward. In terms of more integrated plant operations, it is imprudent today for utility companies to expect a lot of manual operations from their operations staff in units that are worth billions of dollars. This is not something people do with 100 percent success, and it is especially difficult when there are a lot of changes in terms of people's roles.

Embedding best practices in the automation is about creating higher levels of operation, integration and automation functionality, so that conforming to procedure is not as reliant on high levels of operator skill, especially for non-routine operations or responding to abnormal situations.



Harry Forbes is a Senior Analyst with ARC Advisory Group, and a co-author of “Distributed Control Systems Worldwide Outlook: Market Analysis and Forecast through 2019.” He holds an MBA from the Ross School of Business at the University of Michigan in Ann Arbor, a BSEE from Tufts University in Medford, Massachusetts, and has over 25 years of experience in manufacturing and automation.

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Where there is less knowledge and experience available, it is wise to first put as much best practice as possible into the automation being used, and then train the person on the system to ensure that the best practices are executed, documented, updated and retained within a system. It becomes part of your operations and is institutionalized where it is needed most, and not just something that only resides in someone's head. Operations also become incrementally improvable, with relative ease.

Additionally, automation is trending to higher levels of integration across a number of industries. Because of this need to institutionalize best practices using automation, and to integrate an array of traditionally separate functions, such as safety, instrumentation, electrical plant and so forth, all of these functions can be brought under the umbrella of a common automation environment.

Not necessarily a common system architecture, but rather a common operations framework.

How do you see DCS products evolving to address the needs of the changing power landscape, particularly as it relates to the accelerating growth of renewable power generation?

The trend for DCS is the proliferation of large clusters of small generation units, which need fewer traditional control configurations and more analytical capabilities. The key here is simpler integration, robust alarm management, abnormal situation awareness, remote HMI operation, and more asset performance applications. For renewable generation, DCS must be able to scale to a different kind of plant, because typically these are wind or solar assets that are being regulated pretty much at a unit level.



The challenge for suppliers then is to provide systems that can deal with both large and small generation systems, often at the same time.

Symphony Plus Total Plant Automation:

Symphony Plus was introduced for Power Generation markets in 2011. Over four years, what are your observations regarding its market roll-out and acceptance? How would you explain ABB's success in DCS markets, particularly relating to power applications over this period?

Automation users were from the start very pleased to see the path laid out by the Symphony Plus offering when it was introduced. The fact that ABB committed to support this system offering and to upgrade its products over time brought a collective sigh of relief among utility customers. Since it was very well thought out, the strategy was very much appreciated by the installed base of customers. ABB has delivered on that in terms of upgrades and new products over time, new control form factors and environmental specifications.

For example, the SD series control and I/O products clearly shows that ABB is continuing to invest in this system. It provides features and functions required in new greenfield opportunities, while offering the installed base a path to state-of-the-art equipment. That is a very important message to deliver to power markets, particularly in emerging markets and applications - they have an automation partner that enables them to make incremental improvements to their installations, rather than just providing wholesale "rip and replace" options.

The SD series with its expanded operational capacity in a broad range of operating temperatures simplifies matters for EPCs who are designing the plant, or end users who are trying to maintain it over time - you don't need as much auxiliary equipment for cooling, and over the life of a system it reduces problems and maintenance. I can't tell you the number of "temporary" cooling solutions I've seen applied on control cabinets for months or years at a time. If you can design for passive cooling, those problems disappear for the life of the plant.

Symphony Plus provides a much simpler update path for customers, and that is a big advantage for them. Customers can preserve their investment, while providing a pipeline for improved products, like the SD Series.

Growing in a flat market

Your recent DCS report forecasted five-year flat growth for the DCS power generation market. What would you say are the main strengths of the Symphony Plus DCS to grow in this market environment?

Over the next five years, ARC expects the power DCS market to be right where it is now in terms of dollar value, which is a downward revision compared to what was expected earlier.

The factors driving this are, firstly, the slowing rate of growth in Asia, which had been expanding very rapidly and was kind of the heart of growth in the global power generation market. A slowdown there has a big impact on the overall market. Second is the impact of energy efficiency and technologies like more energy efficient lighting and buildings, and the impact of renewable power generation. Finally, there is the impact of the potential retirement of older thermal coal-fired plants, especially in North America. ARC expects markets to be flat over the next five years, because parts of the fleet that might have been upgraded or retrofitted over that time are probably not going to be.

Regarding Symphony Plus, the evolutionary approach to control design and configuration allows users to maintain and upgrade existing designs relatively easily, which means they can keep and reuse intellectual property that has been embedded in a system design. Another factor is the advanced applications for the power market, and

However, I'd say the biggest single factor of success for ABB in DCS markets are its people, who deeply understand the application of technology to the power generation sector.

For example, a typical fossil fuel power plant unit is probably 500-800 megawatts (MW), versus a typical wind unit that is around 2-3 MW in size. So you are looking at large numbers of small generating units that are similar.

These small generation units have the automation capacity to govern themselves. What is needed at a higher level is visibility in terms of overall unit performance, abnormal situations, alarms, and higher level analytics. This is in contrast to a coal-fired plant, where you need a full automation system supporting the operation of a single very large generating unit.

Automation for the smaller units must be able to scale, but reach out to a large number of sensors that are part of the individual wind turbine's or solar panel's automation package. There is a lot of data to monitor, and the role of higher level advisory systems is more towards analytical functions, alarm and abnormal situation management.

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that is something to keep in mind - you can put a lot of different DCSs in a power plant, but do they have the industry-specific applications, and do you have people who understand how to make them work, and implement these systems successfully? That is certainly

"As an end user you need these two things - five star products and systems, and then industry and application expertise from one single supplier."

something ABB does have, and has maintained for a very long time.

Growth for DCS suppliers is going to be in applications and services, given that owner-operators have limited human resources and domain expertise. They have to spread their experts over more units and plants, and need help to make this work. For Symphony Plus, the capacity to competitively address applications in utility-scale renewables will be a big help in this kind of market, because from a market standpoint, Asia and renewables are the areas that will be growing.

Can you expand on the significance of a one-supplier strategy for automation and electrical systems and other strategies for success in power generation applications? What do power customers appreciate most from automation technology suppliers?

We see end users standardizing on automation solutions at the beginning of a project, which pertains more to greenfield projects. We see them standardizing on technologies, and trying to standardize on their choice of suppliers and also give them broader scope, like a MAC/MEC structure to a project, which ABB refers to as the one supplier strategy for customers.

This kind of approach is now common in a lot of industries. What happens is suppliers are brought on board as a project partner with scope for process automation, field devices, electrical, medium-voltage and low-voltage equipment. They are instructed to procure equipment, design and integrate it. Commercial terms are already set, which orients everybody in terms of the overall project goals.

The future trend is for more integration between power and process automation, and what is unquestionably here today is a smaller number of suppliers with a broader project scope, particularly greenfield projects. By delegating responsibility for a broad scope of supply and integration, such as field devices, automation, LV and MV, electrical equipment, motors, drives, and so on, end users can simplify their supply chain, project processes and schedules.

In return they get a supplier/partner they can rely on with very broad responsibilities, so they don't have to orchestrate a set of suppliers for this part of the project. It simplifies things and by quickening the pace on and off the site, is better for the project.

There is certainly value in the integration of electric system automation with plant automation, but end users cannot generally perceive it, or if they

do they cannot take advantage of it in their existing organizations/practices. This will eventually become a common practice, but it is not at present.

I believe what power customers appreciate most and expect from suppliers is highly reliable equipment and long-term support for that equipment. Secondly, they appreciate industry expertise - that a supplier's engineering and service organizations have the expertise to understand issues affecting their industry, and how various applications can address these issues - that is extremely important.

So I would say as an end user you need these two things - five star products and systems, and then industry and application expertise from the supplier. In DCS markets now, I would say Symphony Plus is a major contributor to ABB's leading market position, and the second factor behind its success is that ABB has always had very strong application capability within the power industry.



ARC Advisory Group is the leading research and advisory firm for industry and infrastructure, covering technology from business systems to product and asset lifecycle management, supply chain management, operations management, energy optimization, and automation systems. For complex business issues facing organizations today, ARC analysts and consultants have the industry knowledge and first-hand experience to help clients find the best answers.

www.arcweb.com/

Ansaldo Energia charts a new course in global power markets

Ansaldo Energia is laying the foundations of sustainable growth in the power generation sector by extending the company's global reach, technological capability and product portfolio. Ansaldo CEO, Giuseppe Zampini, explains how the company is moving forward.



Giuseppe Zampini, CEO of Ansaldo Energia, was born in Belluno in 1946. Working from the outset in the power generation sector, he started his career in 1972 at Progettazione Meccaniche Nucleari, before moving on to Nira Spa where he acquired international experience on specific projects. After these experiences in the field of nuclear power, in 1989 he was appointed to head the Ansaldo Division responsible for energy and steam production plants (cogeneration). Then in 1990/95 he set up and managed Ansaldo Industria of America, acquiring experience in the field of project financing. He joined Ansaldo Energia in 1997 as General Manager, and was appointed CEO in 2001.

China is actually leading activity in global energy markets. As a player it is no longer considered a risk, but an opportunity. How do you see it?

Indeed, China has shown particularly in the past five years that it is one of the main players in the power generation business from the customer point of view, and is also playing a lead role in the production of generating equipment, mainly steam turbines. Perhaps not everyone will know this, but over the past five years China has been the global market leader (50 Hz) for gas turbines rated over

50 MW, with more than 33 GWs worth of gas turbines traded. The second biggest player is the United States. This market is peculiar, since nearly all of the trade involves combined cycle power, and is therefore technologically advanced and high performance. Most of the great players in this sector have drawn up commercial agreements with big local companies in order to take advantage of the massive market potentiality. Ansaldo Energia is also entering this big but complex market with the addition of Shanghai Electric among its stakeholders.

Apart from China, how do you see the development of the gas sector going forward in strategic areas like Africa, the Middle East and the United States?

Natural gas is important now and will increasingly become the fossil fuel of the future, according to most influential market stakeholders. It is ecologically sound and flexible when used as a backup for the growing renewables market, and is therefore gaining its own place as an

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Ansaldo Energia steam turbine

energy source for global power generation. In some areas of the world, the gas price is particularly convenient thanks to the presence of old and new oilfields and the deployment of new extraction technologies (see the initial growth of shale gas in the U.S.). This is facilitating its deployment as a primary energy source for power generation. Mainly, we're talking about the U.S., many African states and almost all of the Middle East.

What new business drivers does Shanghai Electric bring to Ansaldo Energia?

The presence of new international partners within a company always brings a fresh perspective: when we talk about a massive Chinese entity that is operating in China as well as Africa and Southeast Asia, then this perspective can only represent a growth opportunity for us. The technological synergy includes Shanghai Electric's know-how in the production of steam turbines, and Ansaldo's expertise with gas turbines. This will provide new commercial and technological nourishment to Ansaldo Energia, which from now on will be perceived in the market as a really multinational group.

How does the global market change for Ansaldo Energia after the acquisition of Alstom by GE?

For sure this acquisition and the simultaneous asset transfer represents a significant turning point in Ansaldo Energia's long history. Firstly, the technological intellectual property rights and the upgrade of the GT26 gas turbine - the top performing large combined cycle gas turbine - will complete Ansal-

The successful decades-long collaboration between ABB and Ansaldo Energia is supported by shared language, perfectly complementary skill sets and vast experience in the field of power generation.

do Energia's product portfolio and enhance the maintenance market for such turbines. The development and further trade of the GT36 for both the 50Hz and the 60Hz markets will enable Ansaldo Energia to enter for the first time the large size 60Hz gas turbines market, and to shorten the technological gap in the POST F class of latest generation turbines. Lastly, the American-based PSM asset will enable Ansaldo to enlarge its position in the profitable gas turbine service market.

In this context, how important is it for a company like Ansaldo Energia to consolidate strategic partnerships with groups like ABB?

For sure, from the perspective of product enhancement and development, it is vital for our company to count on strategic partners like ABB, who are reliable with respect to new technological challenges, who demand and expect technological excellence and also innovation, in terms of optimizing services and intervention times. Add to that list of essential qualities prompt and punctual problem solving, and last but not least, a partner who can help significantly improve our competitiveness.

Speaking of this, can you provide a brief analysis of Ansaldo's 40-year collaboration with ABB? With particular focus on the four years following the launch of the Symphony Plus DCS?

Extensive experience in the field of power generation, a shared language, perfectly complementary skill sets in both companies, as well as a long-term collaboration represent the major points of strength in this consolidated partnership. Since 1974, we have installed more than 300 gas and steam turbines at more than

150 power plants, accumulating valuable experience in the process. ABB contributed its know-how and Symphony Plus power generation control technology. Ansaldo Energia contributed its know-how as an original equipment manufacturer of plant and machinery, in addition to its dynamic simulation labs for prototype testing and qualification.

Ansaldo Energia's branded gas and steam turbine automation system launched in 2012 is based on ABB's Symphony Plus technology, which features high computational power as well as great flexibility and compatibility with the most advanced communication standards and devices. Scalability and standardization are two fundamental characteristics of this control system, which can be applied in various configurations to all existing models of gas and steam turbines, as well as those currently under development by Ansaldo Energia. The control system provides the "intelligence" to exploit the huge potential of the machinery and power plants, and also to satisfy increasingly demanding flexibility criteria required by the customer and the environment.

How important are DCS systems today for efficient power plant operation?

I would answer that by borrowing a sentence from a famous tire company: "Power is nothing without control." As of today, the flexibility of power plant operations and their reliability in meeting required goals are winning ingredients in the power market. Also, modularity and standardization are vital in a control system, which can be applied – in its different configurations – to all existing gas and steam turbines, including those under development. The distributed control system allows operators to manage flexibility, and provides punctual monitoring of both single machines and fleets. Thus, it is possible to support customers in predictive maintenance and in the management of the power plant.

What technological evolutions do you see in the short-to-medium term in the generation sector?

The millennium that began with filling energy production needs in Italy and in Europe soon met up with the massive and sudden coming of the renewable

energy sector. This forced power plant operators to deal with the need to frequently start and stop generating plants, in order to minimize consumption during pauses. Such procedures were never used before, and since then the term "flexibility" has become the mantra for all power plant operators. Out of this, the prime need for plant operability and reliability was born, as well as the need to measure and verify the consequences of such new procedures on components originally created to operate 8,000 hours per year, in terms of lifecycle decrease. How flexible plant operations should be has been the subject of study for the past five years, which is strictly connected to efficiency enhancement, or consumption

and emissions reduction.

"From the perspective of product enhancement and development, it is vital for our company to count on strategic partners like ABB."

Speaking of research, this past September Ansaldo Energia obtained a 50 MEUR investment loan from the European Bank. Where are you considering investing?

The loan demonstrates how solid our R&D activities are. Not only projects related to flexibility were recognized as valuable and worth financing, but also those related to improving performance in terms of power output and overall efficiency, typical in recent years of efforts in more advanced emerging countries. These are the drivers of innovation where these resources should be invested.

In today's competitive environment, research more than ever plays a strategic role. Can Ansaldo's corporate developments provide new incentive to the idea of Italian excellence in the power industry, through collaboration with other centers of excellence worldwide?

Ansaldo Energia's new corporate assets, our new partners' perspectives and the opening up of new markets are enabling the company to raise its ambitions, to look at new prospects for development even on a large scale, and to

develop new technological platforms. These are massive opportunities for Ansaldo Energia, and all of its partners who are willing to invest in excellence and technological innovation.

We often speak of new power generation, but must never forget what already exists. Service, revamping and optimization of the installed base can be an important opportunity, and perhaps is one more reason to collaborate?

The market is still dominated by factors that penalize and continue to limit the growth of service, such as the ongoing economic crisis that continues to affect all European markets; the global economic slowdown that only in recent months has begun to show signs of turnaround; and the complex socio-economic situations in some large emerging countries (BRIC) where Ansaldo Energia operates. Today we are witnessing some signs of recovery in the demand for maintenance of combined cycle power plants. Starting from February 2016, the service sector, already strategic for Ansaldo Energia, will enjoy new skills and new product lines thanks to the entry of the company Alstom Power Systems Manufacturing ("PSM") based in the U.S. in Florida, which mainly works on after-sales activities generated by other OEMs.

Ansaldo Energia (www.ansaldoenergia.it) is Italy's largest supplier, installer and service provider for power generation plants and components, and a leading international player in power generation markets. Ansaldo Energia has an installed base of about 175,000 MW in single and combined cycle gas turbine, steam, hydroelectric and geothermal plants. The company also has a strategic presence in the nuclear and renewable energy sectors.

A scalable service offering maximizes plant performance and efficiency

Power generation customers face numerous challenges today. Two of the biggest are coping with the impact of renewable energy on power grids, as well as price and cost pressures resulting from flat or declining global electricity consumption and overcapacity.



The changing power model: birth of a new relationship

The impact of renewable generation on the power plant operating model is profound. Many baseload power plants are now operating in more intermittent, adaptable and flexible modes. More peaking or variable modes of operation mean operators have to be able to efficiently modulate the generation process on demand.

Given this changing scenario, the relationship between power generation operators and automation suppliers is moving towards a more integrated, partnership approach, in which suppliers develop deep ties with customers and help them to operate their plants more efficiently, reduce costs and plan the best long term operational solutions.

The changing power generation sector means customers need more than a pure supplier of spare parts, onsite works, repairs, and system upgrades. Today's ABB service offering encompasses long-term pre-packaged standard maintenance contracts with a set of different service options to fit each customer-specific need.

How to better equip plant operators to face new challenges

For power generation plants ABB has developed ServiceGridSM, a comprehensive life cycle service delivery system supporting power generation facilities. ServiceGrid solutions match the operational and maintenance needs of a power generation facility, transforming routine maintenance tasks and freeing resources to proactively focus on power production.

This solution can help extend asset life, complement technical resources, protect financial and intellectual investment and maximize plant reliability. The ABB offering is the collective result of experiences with customers over many years, distilled and condensed into a huge collection of experience and best practices, enabling ABB to help customers improve plant operations by working closely together.

This is really integrated service, a set of contracts with different scopes and purposes. They are prepackaged, and although options can be added to the package, the basic contents do not change, and because they are standardized, ABB can provide the best offering tailored to each power plant to maximize the plant availability and lower overall costs.

ServiceGrid approaches, benefits, and advantages

ServiceGrid is a good example of how ABB can help customers find better ways of operating their power plants, matching service level to their needs, from asset maintenance to ensure steady performance, to asset upgrades that ensure the customer has the latest technology at the best cost, to strategies for better asset operation.

As part of the ABB community, customers receive immediate advantages in terms of planning system investments, improving daily operations, and ensuring protection against unplanned events. ABB service helps customers expand their focus from day-to-day operations so they can better navigate tough markets and difficult issues.

Program services	Core	Select	ProActive	Enterprise
Software updates	✓	✓	✓	✓
Security/anti-virus patch validation status	✓	✓	✓	✓
Web access support	✓	✓	✓	✓
Unlimited product technical phone support (response commitment)	Next business day	4 hours	1 hour	1 hour
Priority one-hour 24/7 technical phone support	○	○	✓	✓
ABB Automation University discount	✓	✓	✓	✓
DCS on-site support	✓	✓	✓	✓
Spare parts and repair savings	★	★★	★★★	★★★★
On-site support savings	★	★★	★★★	★★★★
Customer loyalty offers	✓	✓	✓	✓
Annual installed system life cycle report		✓	✓	✓
Annual usage report		✓	✓	✓
Software upgrades		✓	✓	✓
Remote connectivity		○	✓	✓
Corporate/central engineering support		○	○	✓
Designated support leader			✓	✓
Quarterly report and review			✓	✓
Application/process support			✓	✓
Enterprise-wide report and review				✓
Mid-year on-site review				✓

✓ = included. ○ = available as an option. ★ → ★★★★★ = increasing discount level.

Program options	Core	Select	ProActive	Enterprise
Power plant tuning service	○	○	○	○
Energy efficiency assessment	○	○	○	○
Cyber security patch delivery (monthly)	○	○	○	○
Hydraulic system support and services	○	○	○	○
Turbine control support and services	○	○	○	○
Spare parts spending/consignment program	○	○	○	○
Software evolution		○	○	○
Annual performance and reliability checks		○	○	○
Security services and solutions		○	○	○
Diagnostic monitoring			○	○
Electrical maintenance			○	○
Instrumentation service			○	○
Drives preventive maintenance service			○	○

ServiceGrid, Program levels and services

The assets at a plant are treated differently at different stages of their life cycle. For example, a customer may not want to invest further in a plant, but still would like to keep it operating. ABB Service can help prioritize investments to bring about the best outcomes. Environmental concerns can also make investment decisions more difficult, so the closer a relationship with the customer and the earlier it begins, the better ABB can help the customer decide what is best for his asset.

ServiceGrid delivers these benefits through a comprehensive choice of four different levels of participation - Core, Select, ProActive, and Enterprise Core. These levels provide customers with a series of essential service products for plants that are self-maintaining, have limited budgets or limited running time, but still require services that only an OEM can deliver.

The service products included into ServiceGrid range from software updates and DCS on-site support to repairs and spare parts. Select builds on the Core foundation and increases the extent of ABB's support. It provides a

range of services for customers who want to continue to work on their own but who also want the peace of mind provided by a global OEM. In addition to the products and services provided by ABB in Core, it includes aspects like software upgrades and annual life cycle reports.

The third and fourth levels – ProActive and Enterprise – are premium programs for customers who recognize the benefits of a service partnership with a global OEM. Both levels include all the products available in Core and Select, with the addition of high-value services like a designated technical account manager (TAM), application/process support, and quarterly reports and reviews. ProActive is for customers who wish to partner ABB on a single plant; Enterprise is for companies with multiple sites who want to reap the benefits of ServiceGrid across their entire fleet. A complete range of program options is available for each of the four levels, such as power plant tuning, energy efficiency assessments, cyber security services, and turbine control support and services.

ServiceGrid is structured to deliver five principal benefits:

- Maximize plant performance and efficiency
- Minimize the risk of unplanned and unexpected outages
- Extend the life cycle of ABB products and systems
- Complement the plant's existing technical and service resources
- Protect the customer's financial and intellectual investments in ABB technologies

Please find a ServiceGrid project description on page 16.

Through collaborative life cycle management planning with the customer, ABB can deliver a state-of-the-art solution to maintain customer assets, extend their life time and optimize their performance with new service contract solutions that integrate an entire system life-cycle into a five or 10-year plan. In this case, ABB and the customer look at the installed base over five or 10 years and decide what needs to be upgraded and when. The result is a blueprint of small, seamless upgrades that are done regularly, instead of having to deal with one giant and potentially disruptive upgrade project.

Strategic services concentrate on helping our customers to achieve their business results through collaboration to identify opportunities and implement services for continuous improvement at various steps along the customer's value chain. This result is a long-term, performance-based agreement intended to reduce total lifecycle costs.

ServiceGrid solution delivers maximum reliability to thermal plant in Indonesia

Operators of a 120-megawatt (MW) coal-fired power plant owned by Merak Energi in Banten, Indonesia, needed solid engineering support for their thermal plant to ensure high power availability and reliability for a nearby caustic soda factory with production capacity of 320,000 deadweight tonnes (DWT) per year.



ServiceGrid delivers comprehensive life cycle support services to power generation and water facilities

ServiceGrid delivers service solutions to match the operational and maintenance needs of the power generation and water facility. Through planned delivery, ServiceGrid transforms routine maintenance tasks and frees resources to proactively focus on power production and water treatment. ServiceGrid products can:

- Increase performance and efficiency
- Extend asset life
- Complement technical resources
- Protect financial and intellectual investment
- Maximize reliability

Advanced knowledge of thermal power plant operations was a must, in addition to a capacity to deliver quick responses from qualified engineers to help operators deal with control issues that might arise.

Merak Energi turned to ABB's ServiceGrid solution for energy providers, which delivers comprehensive life cycle support services to power generation facilities. The ServiceGrid Core support level the company chose is an introductory package that provides complete software, product and technical support, professional on-site training, and

access to ABB web support via MyControlSystem and Solution Bank.

ServiceGrid solutions are matched to the operational and maintenance needs of a power generation facility, and come in four program levels and a variety of options. With planned deliveries, ServiceGrid transforms routine maintenance tasks and frees up resources to proactively focus on power production.

Merak Energi selected the 24/7 phone support option for DCS power plant maintenance and operation as a cost effective solution to maintain the power plant's operations. The solution

also includes the latest version of software, security patch and firmware.

Comprehensive ServiceGrid service solutions deliver increased performance and efficiency, extended asset life, complements available technical resources, protects financial and intellectual investment in the plant, and maximizes plant reliability.



Symphony Plus evolution for Te Rapa cogeneration plant in New Zealand

ABB was awarded a contract by Contact Energy Limited, the second-largest electricity generation company in New Zealand for upgradation of ABB's INFI 90 Harmony to Symphony Plus for its cogeneration power plant located in Fonterra dairy factory at Te Rapa, near Hamilton, New Zealand. The cogeneration plant consists of a GT, HRSG and Auxiliary boiler. The plant was commissioned in 1999 and the Te Rapa power plant provides power and process steam to the dairy factory, while excess electricity is exported to the local network.

ABB was responsible for complete system design, engineering, project management, testing, installation supervision, and commissioning of the upgrade from INFI 90 Harmony Block to the latest Symphony Plus HR Series (Harmony Rack) products.

With ABB's long-standing "Evolution without obsolescence" strategy of upward compatibility with its predecessors, the customer was able to protect their intellectual investments made in their INFI 90 Harmony system. The step-wise evolution approach gave the customer the flexibility to update the system with no change in their logic configuration methods. In addition, human knowledge gained and invested in the existing DCS carries forward as the system evolves, thus reducing resource allocation required by a rip-and-replace alternative.

ABB worked closely with Contact Energy Te Rapa team throughout the entire project phase, starting from planning to testing and commissioning, enabling a smooth execution and a successful completion within a short timeframe of five (5) months. The project was handed over to customer on schedule in June 2015.

With ABB's long standing "Evolution without obsolescence" strategy of backward compatibility, the customer was able to protect their intellectual investments

ABB control solution to improve power plant efficiency in Mexico

Symphony Plus control automation improves plant efficiency, reliability and availability

ABB will supply a Symphony® Plus automation solution for the 320-megawatt (MW) Topolobampo fuel-fired power plant in the state of Sinaloa, in western Mexico.

Mexico's economy has performed well in recent years, chiefly because of its thriving manufacturing sector. Comisión Federal de Electricidad (CFE), the plant operating state-owned electrical utility, is investing in new combined cycle power plant infrastructure.

The Topolobampo plant conversion is in line with the company's desire to both lower emissions from its power generating plants, increase efficiency and reduce operating costs.

The plant is being converted into a dual-fired cycle power plant that will mostly operate with natural gas, instead of heavy fuel oil.

Prior to the plant conversion, ABB had supplied its Procontrol™ P14 control system which will be removed and replaced with Symphony Plus HR Series (Harmony Rack) and Operations hardware and control software.

Based on the positive experience with ABB's control systems, CFE has decided to trust in a long term relationship with ABB for its flagship automation platform.

ABB's scope of supply includes a Symphony Plus distributed control system (DCS) comprising controls, protection and supervision for the plant, human-machine interface (HMI), engineering work stations (EWS), video walls and Optimax plant performance monitoring.

Additionally the scope includes control and protection for an existing ABB gas insulated substation (GIS); soot blower controls and auxiliary systems; and additional process instrumentation, including



transmitters, position switches and analyzers.

"ABB is a trusted and long-term CFE supplier, and plays a key role in this region with our strong local presence and extensive capabilities in power systems, including state-of-the-art control automation," said Massimo Danieli, Managing Director of ABB's Power Generation business, part of the company's Power Systems division. "ABB will provide CFE with a fast, cost-effective control solution."

Symphony Plus is ABB's flagship automation platform for the power generation and water industries. It is one of the most widely-used DCS in these industries, and one of the most reliable and efficient control automation systems available today. Symphony Plus enables plants and personnel to perform efficiently and balance objectives like asset availability, operational reliability and production efficiency with business

goals like asset life extension, carbon reduction and regulatory compliance. S+ Operations is an intuitive, easy-to-use human machine interface (HMI) that leads operators to greater awareness, faster response and better decisions.

There are nearly 6,700 systems Symphony installations in operation all over the world, including about 4,700 in power and water applications.

Symphony Plus maximizes generation for advanced thermal power plant in China

Reducing emissions while maximizing power generation are some of the main advantages of an ultra-supercritical thermal power plant. Wanzhou, a port city at the western end of the Three Gorges region on the Yangtze River, chose this solution to satisfy ever-growing demand for power. With help from Symphony Plus SD Series scalable control and I/O products, the first two units of Shenhua Group's 6-gigawatt thermal power plant are operating commercially.



Wanzhou district is part of the Chongqing municipality and one of China's fastest growing regional economies. Chongqing is a transportation hub and industrial powerhouse that greatly benefitted from the launch of China's Go West initiative in 2001, designed to narrow the development gap between the Eastern and Western regions of the country.

Since then, Chongqing has registered steady GDP growth and in 2013 exceeded China's national average GDP growth by 4.6 percent. The municipality is urbanizing rapidly and its cities expect to host 70 percent of the 30 million population by 2020, which when added to improving infrastructure and enhanced industrialization has created a power deficit of more than 4,000 megawatts.

To deal with electricity shortages and still comply with the United Nations Clean Development Mechanism, the state-owned mining and energy giant, Shenhua Group, invested \$3.77 billion in a power generation and coal storage complex in Wanzhou in 2012. It comprises six ultra-supercritical (USC) coal-fired generators, each with 1,000 MW capacity. These high-efficiency USC generating units are being installed in phases, and are designed to reduce fuel costs and emissions, and provide reliable, low-cost electric power to help eliminate the region's chronic power deficiencies.

Flagship DCS

The first phase comprising two generating units is complete and in commercial operation. For this phase, ABB was awarded

a contract in 2014 to supply its flagship Symphony® Plus distributed control system (DCS) products for power generation.

Symphony Plus monitors, controls and optimizes the entire generation process of the two USC units, including the flue gas desulfurization (FGD) system. The flue gas desulfurization process uses high-tech equipment to remove sulfur dioxide from the exhaust flue gases of fossil-fuel power plants. As environmental protection criteria for power plants in China becomes stricter, the safe and smooth operation of a power plant's FGD system is a very important factor in order to meet regulatory controls and standards.

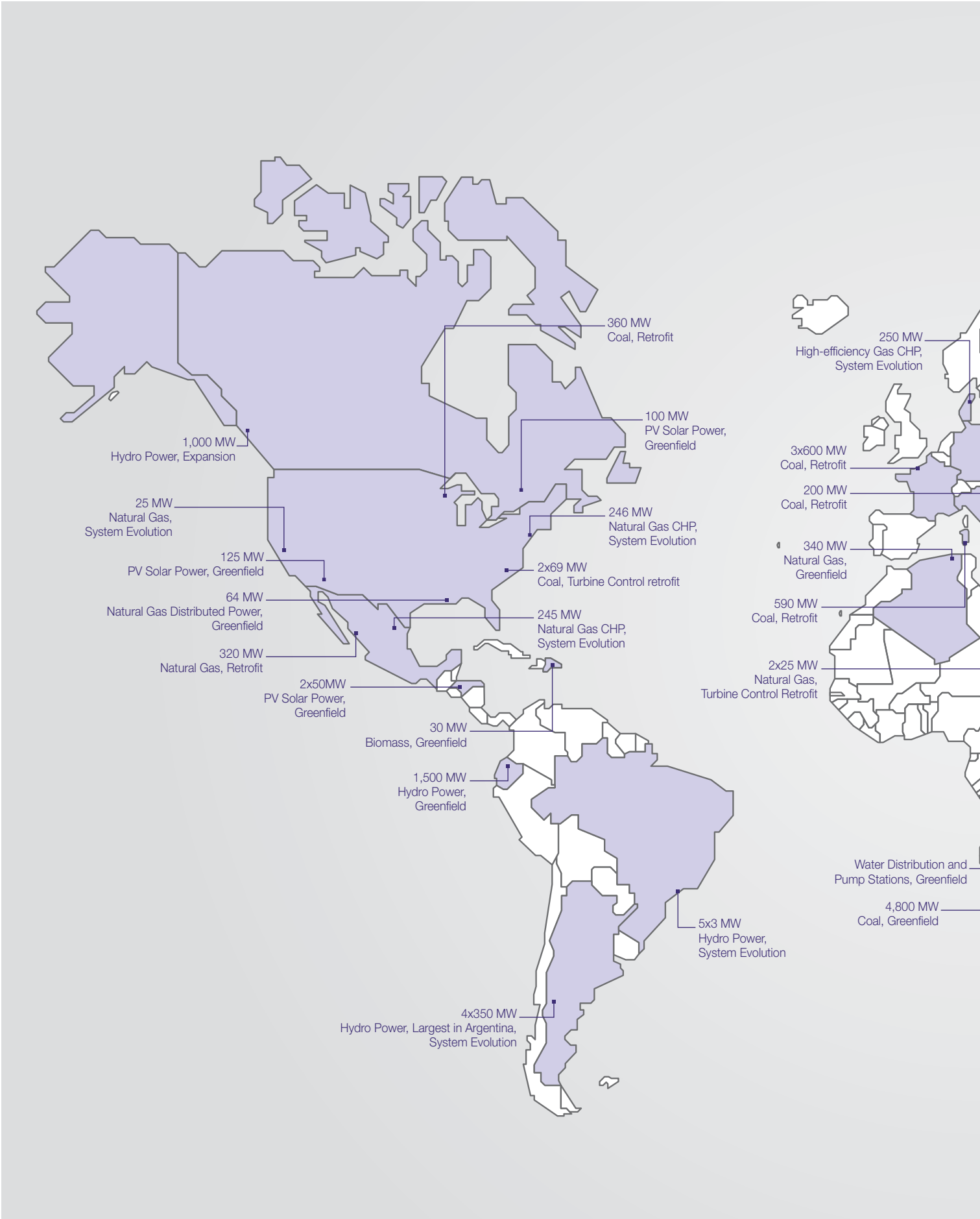
The Symphony Plus solution comprises the latest SD Series HPC800 process controllers and PDP 800 PROFIBUS interface modules, which ensures safe, effective plant operation, high efficiency and ease of operation and maintenance. The system's S+ Engineering tool provides a unified environment for the design and maintenance of the entire control system, including support of the Ethernet communications network, control applications and PROFIBUS devices, and field communications.

Complete plant visibility

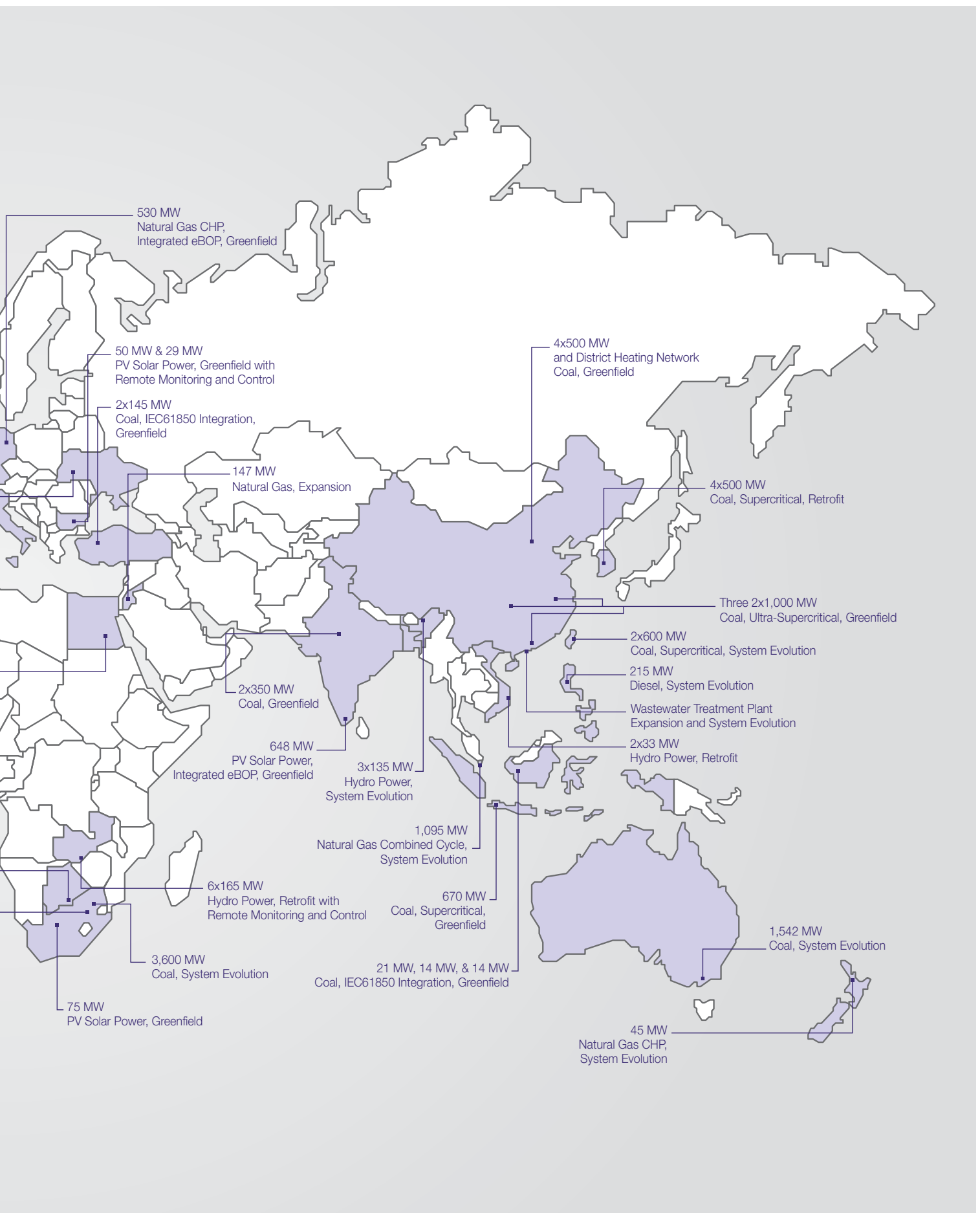
Wanzhou has one of the largest PROFIBUS installations in China. Extensive use of this communications protocol enables reduced cabling, faster commissioning, improved diagnostics, and ensures plant operators are fully informed at all times. The ABB solution also includes S+ Operations human machine interface, which provides Wanzhou operators with complete visibility of plant processes, and oversees both the power generation units and balance-of-plant, greatly reducing management and maintenance costs.

Commissioning the first 2,000 MW of this landmark project marks the first step towards resolving Chongqing municipality's power shortages, and providing the added power needed to pursue more sustainable local development.

Total plant automation: across all



segments around the world



Future automation technology trends

The goal of automation is to build flexible production systems that can cope with the sequences of operations that result from very diverse tasks – from making cars to making pretzels, piping water through networks or generating power. Automation products currently do this very well, but the future is beckoning.



Future automation products will focus on the best ways to deal with dynamic requirements springing from a tightly integrated and more complex working environment. The first outliers of this new industrial revolution are already with us, driven by technical breakthroughs like Big Data, and the Internet of Things, Places and People.

The interconnected world these systems are promising to deliver have set in motion big changes in the automation sector, and ABB is striving to make the best possible use of well-proven innovations for its automation customers, including the power generation sector.

Strategic technology trends are defined as having potentially significant impact on organizations in the short term, three to five years. Today, those trends fall into two broad camps – internetization and Big Data generation.

Internetization

This category of strategic technology involves moving beyond proprietary communication systems and software

to create the information technology that connects the components of the processes inside the plant. The basis of this new internet-based technology is found in the intranet of old DCS technology, which collectivized internal processes to improve operational performance and efficiency.

Once, IT was considered to be software design, and suppliers provided certain software in a certain way. Today, it means Amazon, it means Google, it is the new IT defacto which implies the cloud, lots of data and users altogether, moving beyond the boundaries of machines and sites, and the technology that enables this is the basis of Google and Amazon.

This encompasses mobile computing, for example, as well as the Internet of Things (IoT), cloud/client architecture, risk-based security and self-protection systems and web-scale IT (the industrial Internet).

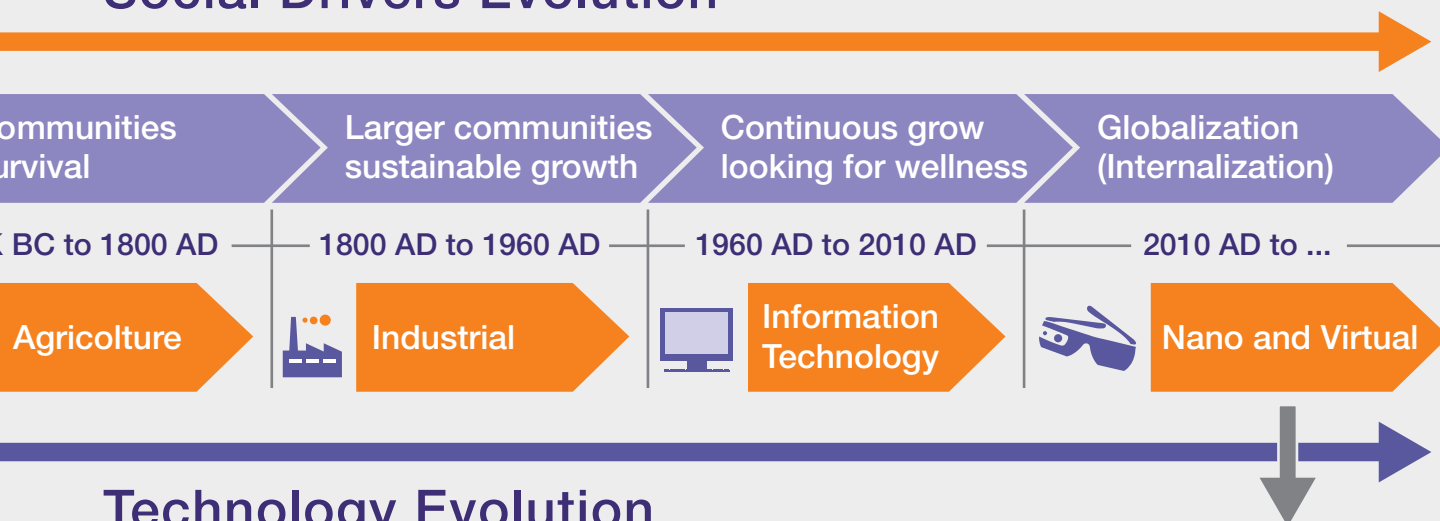
Smart phones and wearable devices are part of a broader computing offering that includes connected screens in the workplace and in public spaces. The

Internet of Things will only get bigger, driven by the expanding capabilities of user-oriented computing. Embedding this technology more deeply in our daily lives will create touchpoints for users everywhere, creating the foundation of digital business.

Mobile computing and cloud computing will continue to converge and lead to the growth of centrally coordinated applications that can be delivered to any device. Apps that effectively combine intelligence and storage with client devices will benefit from lowering bandwidth costs. Coordination and management will be based on the cloud. Enterprise applications will use multiple screens, and exploit wearables and other devices to deliver an enhanced and more effective user experience.

The Internet of Things is about web-based communication and data, meaning users can put parts of a process where you like, it doesn't have to be there physically in a given location. Internet connections today are developing rapidly and in unexpected ways, which demands close attention to se-

Social Drivers Evolution



Technology Evolution

Internet connections today are developing rapidly and in unexpected ways, which demands close attention to security.

curity, and careful thought about how to use and pull maximum value from this technology.

This will necessitate more innovative forms of risk-based security assessment and protection. Since 100 percent secure solutions are not feasible with open architecture, more mainstream and sophisticated methods of risk assessment and mitigation from a process and tool perspective will be implemented.

Security-aware application design, dynamic and static application security testing, and runtime application self-protection, combined with active context-awareness and adaptive access controls will all be absolutely necessary.

This is what the web-scale IT requires, and what technology stalwarts

like Amazon, Google and Facebook are already doing. Evolution toward web-scale IT as commercial hardware platforms will embrace these new models, and cloud-optimized and software-defined methods will become mainstream.

The speed of this transition to the Internet of Things will depend on the willingness of the market to embrace them, but as of now automation suppliers like ABB are fully ready to move in this direction.

For example, Symphony Plus technology basically creates connections between the components of a process and translates this into information technology for use inside the plant. This was the boundary of control technology as of five or 10 years ago.

The Internet of things is simply the same things applied on a much wider scale, which is of course to collect information from a lot of devices, each of them becoming more and more intelligent and developed with more features and functionality, pushing the boundaries and expanding the conversation of control automation systems.

Yet they are still keeping the conversation centralized, and cooperating together in the way of pre-IoT distributed control systems, but on a much wider scale and not necessarily physically present in the plant, but perhaps at some point via servers in the cloud.

This type of functionality would enable power trading, for example, and is very useful in terms of anticipating fuel and power costs, which works very well for renewable generation especially.

IoT functionality could also provide key market intelligence that can be significantly useful for renewable operations. For example, in a year there are

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many days in which the sale price of a megawatt of power is basically negative, and generating plants lose money each time they sell power. There is value in being able to forecast, in connecting to information about weather, for example, so operators can use this data to anticipate what the price of their product might be.

Automation partners like ABB need to show how automation innovations will bring about more effective results, rather than just unveiling a new technology that does something different. For example, traditional power generation

terly comfortable with flexibility, and able to cope with small wind or hydro generation, or at the other end of the scale with gigawatt-sized generating units. Similar agile development methods enable organizations to deliver the flexibility needed to make digital business work. The rapidly changing demands of digital business require computing to move away from static to dynamic models.

Vast pools of structured and unstructured data from both inside and outside the organization will be continuously generated, making advanced analytic capability essential. It is wise to remember

Software-defined infrastructure and applications have created, for example, a Symphony Plus ecosystem that is utterly comfortable with flexibility, and able to cope with small wind or hydro generation, or at the other end of the scale with gigawatt-sized generating units.

operators in thermal and nuclear sectors are carefully looking for ways to make their operations more efficient and effective, such as finding new ways to deal with inventories.

At the same time, customers who embrace new technologies and innovations don't necessarily translate this enthusiasm into requirements for their automation system. They expect automation suppliers to anticipate them, and assume you are using the latest and best technology available in order to make their investment work optimally.

As far as the Internet of Things is concerned, enabling the technology is just the first step. The critical issues of data and information protection and plant security mean making this technology work in the real world for a power plant is something that will need to happen very carefully.

Big Data

The second strategic technology trend lies in the generation of Big Data, which involves software-defined infrastructure and applications (the ecosystem), context-rich systems, advanced, pervasive and invisible analytics, smart machines and 3D printing.

Software-defined infrastructure and applications have created, for example, a Symphony Plus ecosystem that is ut-

terly comfortable with flexibility, and able to cope with small wind or hydro generation, or at the other end of the scale with gigawatt-sized generating units. Similar agile development methods enable organizations to deliver the flexibility needed to make digital business work. The rapidly changing demands of digital business require computing to move away from static to dynamic models.

The combination of analytics and an understanding of context will usher in smart machines. Advanced algorithms will lead to systems that learn for themselves, and act based upon their learning, leading to autonomous vehicles, advanced robots, virtual personal assistants and smart advisors.

Finally, the cost of 3D printing will decrease over the next three years, leading to a rapid growth in the market for these low-cost machines, and industrial use will continue to expand rapidly. 3D printing is a viable and cost-effective way of reducing costs through improved designs, streamlined prototyping and short-run manufacturing.

We are already using Big Data every day. Anyone who is computer literate knows how to buy an app, and people are becoming more and more aware of the information around them, how to access it, search through it and share it. Big Data will similarly provide answers, and analytics a way forward.

Big Data can help deploy a system and provide the step-by-step, context-

driven decisions. For example, one area that is really supported by this technology is software restoration.

People today download and restore software systems in a few minutes, and not many remember how painfully difficult it once was to install software on a computer. Technology has appeared that enables you to upgrade components in the field without stopping the plant, and can provide continuous, automatic upgrades without the operator even realizing it.

Symphony Plus technology is at this point in terms of technical capability now, which means operators can have an infrastructure that is local or remote. In either case, technology is headed towards the capacity to add new information and expand the ecosystem of a specific application to include new features and functionality, without disturbing what is already installed.

Conclusion

Automation suppliers like ABB must be able to show customers how innovations will improve efficiency and operations and save resources. It is much more effective than simply talking about the latest multiprocessor technology, for example, because it demonstrates how innovations touch the business and improve it.

Showing a customer how it is possible to commission a machine remotely because all conductivity is based on the Internet demonstrates innovation's value by underscoring its flexibility – the capacity to circumvent remote locations, political conditions, disturbances, etc.

This is the direction control automation is moving towards - extraordinary flexibility, ease of operation and state-of-the-art cyber security.

Symphony Plus architecture evolves to meet the challenges of a changing power and water automation landscape

ABB Symphony control architecture has been around for more than 30 years serving traditional distributed control system applications like industrial and power plants – large installations in well-defined geographical locations. Symphony Plus has evolved in recent years to meet new control requisites arising from the big changes that are taking place in markets such as power generation.

There are nearly 6,700 Symphony distributed control systems installed in plants around the world, which makes it one of the most widely deployed process automation systems around. The Symphony Plus family launched in 2011 is ABB's automation solution for power generation and water networks, and continues to be widely used in process industries.

The Symphony Plus SD Series portfolio was launched in 2012 and enhanced in 2014 and 2015 to broaden the Symphony portfolio to meet new challenges in conventional and renewable power plants and water networks, focusing on distributed applications and SCADA architectures.

The power generation landscape has been changing dramatically in recent years, evolving from traditional thermal and large hydro installations, which mostly required a DCS automation architecture for a large power plant in a single location. Automation monitored and controlled processes through a local area network-based architecture, using proprietary protocols over well protected networks.

Increasing use of alternative generation sources such as solar photovoltaic, concentrated solar power systems, wind and biomass are spreading the

power generation process over a very large area. Distributed installations can still generate hundreds of megawatts (MW) of power, but instead of doing it in a square kilometer of space, they may do it over hundreds or even thousands of square kilometers.

From localized automation to distributed control

In these cases the traditional automation architecture based on small local areas of control no longer work. Distributed generation still needs the processing power of traditional DCS, but delivered by a large number of intelligent devices, like smaller controller or remote terminal units (RTU) spread over a very wide area. All of these components must exchange information with a remote control center where operators can monitor and take action when needed. In many cases, distributed devices may also need to communicate with each other to coordinate and synchronize the execution of specific control and supervisory tasks.

This means automation in the power generation sector is moving beyond the challenge of controlling a large process in a small area, with large amounts of data generated locally at high speed, to the challenge of networking together a large number of data sources connect-

ed over an open and less reliable and secure network infrastructure.

Water automation and renewable generation is all about SCADA

The water networks industry and renewable power generation have very similar control challenges, and the evolution of the Symphony Plus control architecture serves both applications equally well.

Water network automation mostly applies to water transmission and distribution networks - big pipelines that carry water over long distances and branch lines piping it to residential customers. District heating, from the automation perspective, is very similar to water distribution.

These types of applications are basically networks of pipelines and pumping stations. In the case of transmission networks, pumping stations are large installations, each one comparable to an individual plant. In district heating and water distribution networks, a large number of much smaller pumps manage the steam or water flow in the pipelines. The equipment control demands are different in the two scenarios, with large

Continued on page 26

pumping stations requiring a small but complete DCS as opposed to the small distribution pumps being controlled by a local compact control unit. In both cases, however, the distributed nature of the application will require the water network automation solution to deliver remote supervision and control and data acquisition over long distances. This is the definition of a SCADA application.

Compare water network scenarios with renewable power generation applications, like solar fields and wind farms, and the similarities are immediately apparent: in both cases, pieces of equipment with limited automation needs are distributed geographically, and need to exchange data with a control center, and occasionally between themselves.

Traditional components, designed to address high processing power demand such as the flagship SD Series HPC800 controller, remain in ABB's Symphony Plus portfolio to serve conventional power generation and process industry demands, but a very powerful controller is not the right answer for the challenge of distributed systems.

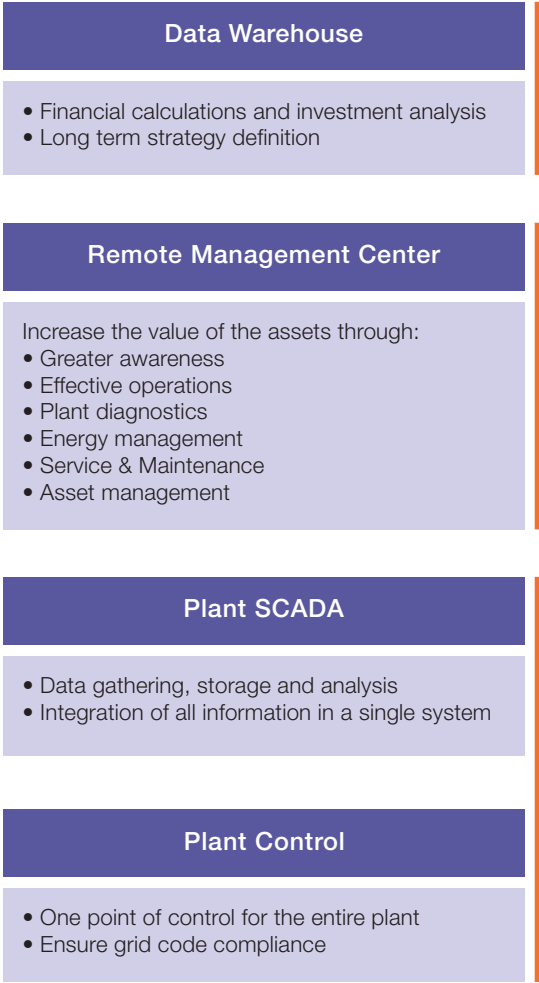
ABB therefore introduced a scaled-down controller, the SD Series SPC700 controller, a compact solution which, in addition to delivering performances suitable for the distribution of processing power, is perfectly compatible with the HPC800 and can be deployed in harsh environments with higher ambient temperatures and in the presence of corrosive agents.

SCADA: Secure, reliable and timely communication is essential

Communication is probably the greatest challenge of distributed power generation control systems. They must ensure data is moving over long distances, and is readily available to operators who, in the event of an emergency, will have to be able to make decisions and take immediate actions, such as blocking water supply from a polluted well.

While, in traditional power generation, DCS normally uses proprietary protocols that bring together devices belonging to the same family, renewable power and water automation systems are very frequently built up by bringing together pre-existing equipment and instrumentation from multiple suppliers.

As a consequence, there is huge demand for open communication solutions that enable Symphony Plus to integrate



into a single platform data from very diverse sources, from meters to remote terminal units or, in the case of water networks, analytic devices that provide data on water quality.

Addressing that challenge, ABB has developed a new family of Symphony Plus communication interfaces ideal for distributed systems. These modules can bring into the Symphony Plus platform data coming from any intelligent source, so the application owner has instant access to data from any source, ABB-supplied or otherwise, at their fingertips.

These new communication modules can be used to expand existing Symphony Plus HR Series (Harmony Rack) systems or earlier generation Symphony Harmony or INFI 90 rack systems, just as other SD modules.

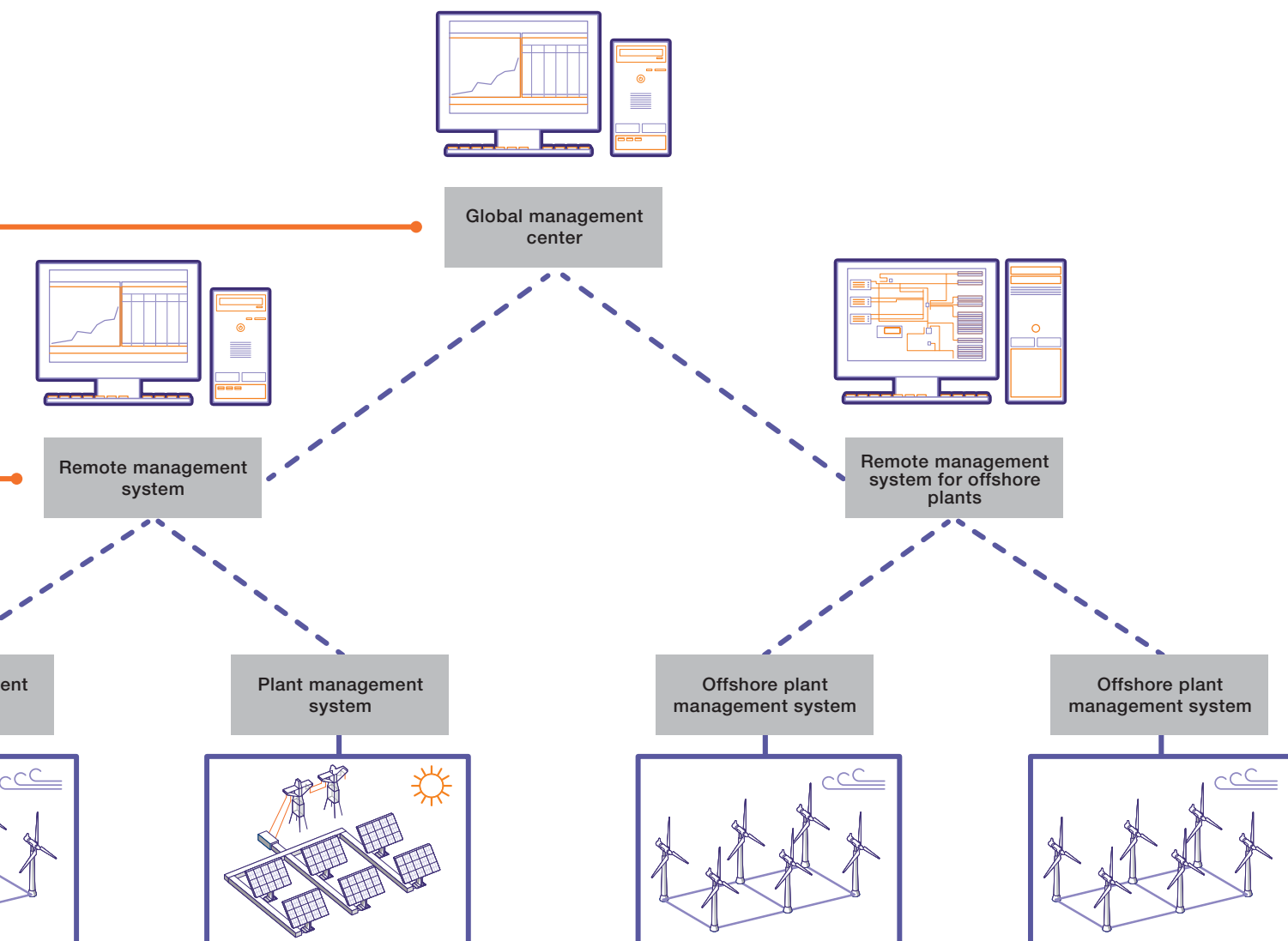
The other challenge of moving beyond the boundaries of traditional DCS is that data is no longer moving within a local area network, isolated from the rest of the world. Instead, business

critical data is now travelling out in the world, and since these are often critical infrastructures, data security is vitally important in distributed systems.

ABB has invested a huge effort to build essential cyber-security features into the Symphony Plus architecture so it can robustly defend against cyber security attacks, in an environment which is by nature more exposed and susceptible to security intrusions.

Remote operation and maintenance

Very often, renewable generation owners are small and independent operators without the financial resources of traditional power generation conglomerates. To serve this market, ABB can provide remote monitoring, maintenance, data analysis and performance reviews of all customer systems from remote ABB operations centers. The service is managed directly by ABB, which can connect remotely to all customer installations.



This is basically a cloud service offered under a “Software as a Service” (SaaS) contract, where ABB’s remote control room substitutes itself for the customer’s operation center. The customer decides what level of service they need, ranging from basic supervision and some monitoring of the amount of power produced, etc. ABB offers customers a library of specific KPIs, which are set up to collect and analyze large amounts of data and from this, develop data indicators that tell operators exactly how their systems are performing.

The automation journey continues

In the future, it is reasonable to expect some consolidation in the renewable segment, as smaller operators join forces to create larger entities, which might require larger control centers that can provide precise overviews of more and more complex operations.

Large or small, traditional generation or renewable, customers want to get as

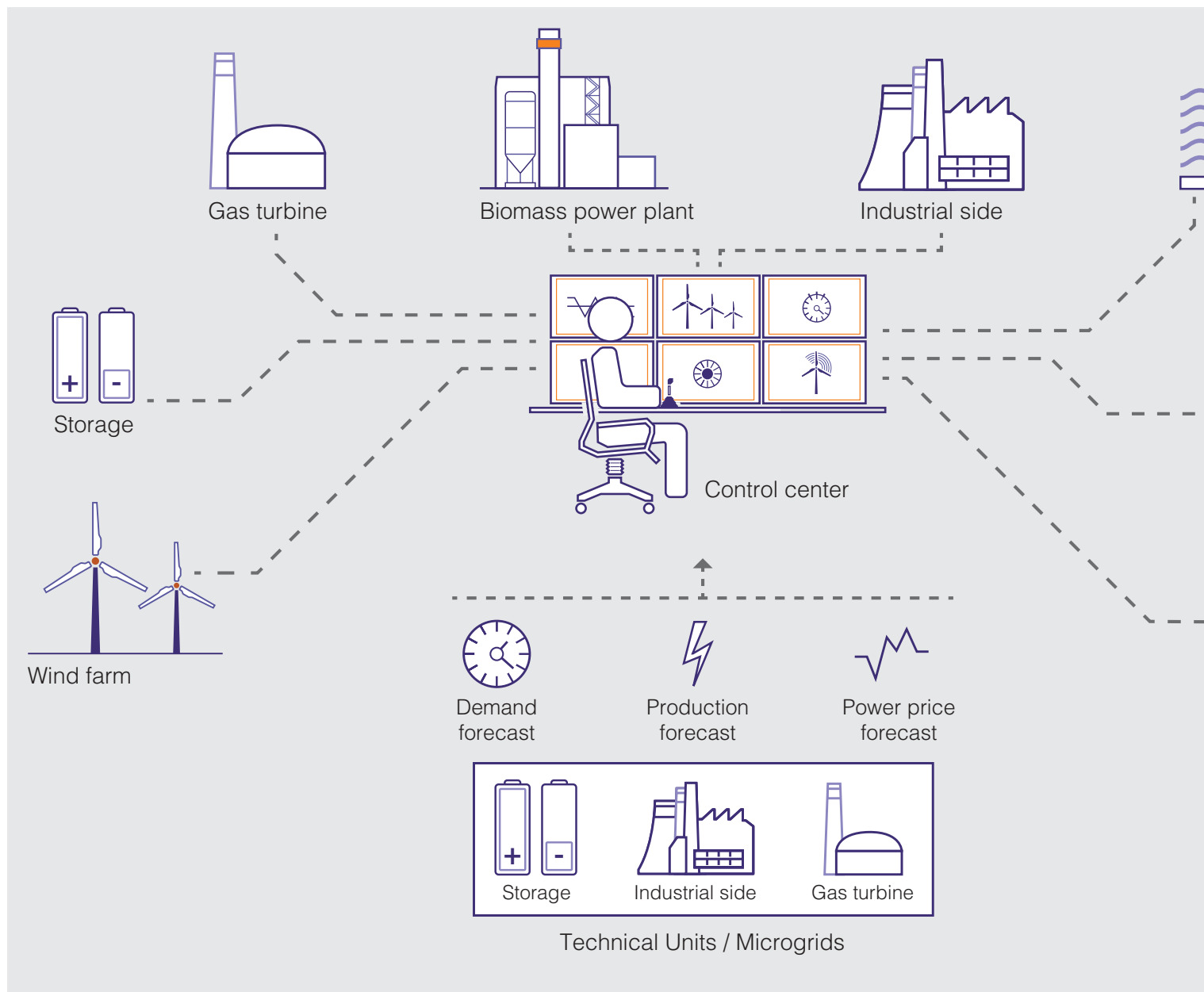
much life and power from their plants as possible. They want automation systems that will operate for several decades, be supported by spare parts and tune-ups over that time, and which will not simply be erased and the investment lost when the time comes for change.

ABB’s challenge as an automation supplier is to continue evolving Symphony Plus in a way that will provide useful new features to the installed base, without asking customers to radically change the technology they already have and know.

Traditional thermal power generation is not predicted to grow much in more developed countries, but renewable generation will, while thermal systems are continuing to expand in developing countries, some of which are also rapidly developing renewable generation capacity. Symphony Plus must be ready to serve a divergent power generation market and its different segments.

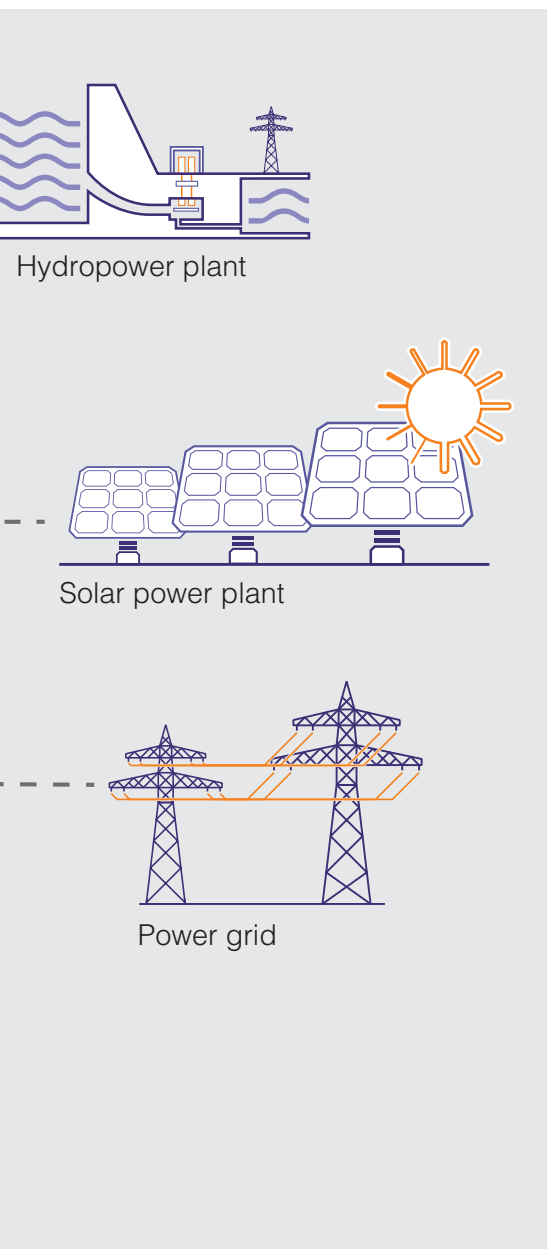
The push coming from renewables

will likely continue to drive ongoing changes in control system architecture. ABB’s task is to provide technology capable of accommodating the changes at work in the power generation sector with directly relevant features, like cloud technology, enhanced security, remote control, data analysis, in systems that are as simple and easy to operate as a smart phone app.



Symphony Plus solutions for renewables and virtual power plants

In an era of global transition to more renewable sources of energy, demands for increased cost efficiency, improved environmental compatibility, and better, more flexible plant operations are prerequisites for maximizing total power plant performance.



Hydropower plant

Solar power plant

Power grid

Modern power plants need modern control systems

In fact, these demands apply to operators of conventional power plants as well, who now require efficient load flexibility in order to deal with fluctuating and intermittent supplies from renewable energy plants, such as wind farms and solar power plants, to the national power grids. The ability to respond quickly and cost-effectively to rapidly changing load requirements is now crucial for power generators.

The new generation of control systems must achieve total plant automation by providing a system platform that increases energy efficiency, improves engineering productivity, and supports more effective, flexible and reliable plant operation with an enhanced

energy and maintenance management strategy. The remote monitoring of process information in real-time is an important prerequisite for economical and operational stability.

Symphony Plus for Renewable Power Plants

Grid codes

Electricity generators are legally obliged to comply with stringent network code requirements particular to each country of operation. Also known as 'grid codes,' they specify the technical conditions and processes required for generator compliance with all aspects of planning, connection and operation.

The essential grid code factor is the requirement to ensure renewable plant control is designed so the plant can provide similar grid support functions as conventional power plants.

Symphony Plus for Renewables addresses these requirements with its newly developed hardware platform (SD I/O) and controller (SPC700), which provides the necessary computational power and communication protocols to ensure proper monitoring and control of the plant. Dedicated control logics for wind and solar installations ensure plant compliance with grid codes, while maximizing power production at all times. Active power and reactive power control, steady-state voltage and power factor are some of the key control logics integrated into Symphony Plus.

Beyond grid codes

Symphony Plus for Renewables has been uniquely developed to integrate generation and electrical infrastructures (substation, capacitor banks, STATCOMs, etc.) into a single monitoring and control system for the power plant. The integration of the process power plant and the substation automation systems results in higher levels of availability, operator visibility and operational reliability.

Using standard protocols, such as IEC 61850, Modbus TCP and IEC 104, the number of control systems across a plant and the complexities associated with the engineering, installation and commissioning of individual control systems are both reduced. Information can be seamlessly distributed to con-

trol operators, maintenance engineers and plant engineers via a common database management system.

Having all assets integrated into a single control system is essential to the optimization of wind power plant production.

Optimization of plant production

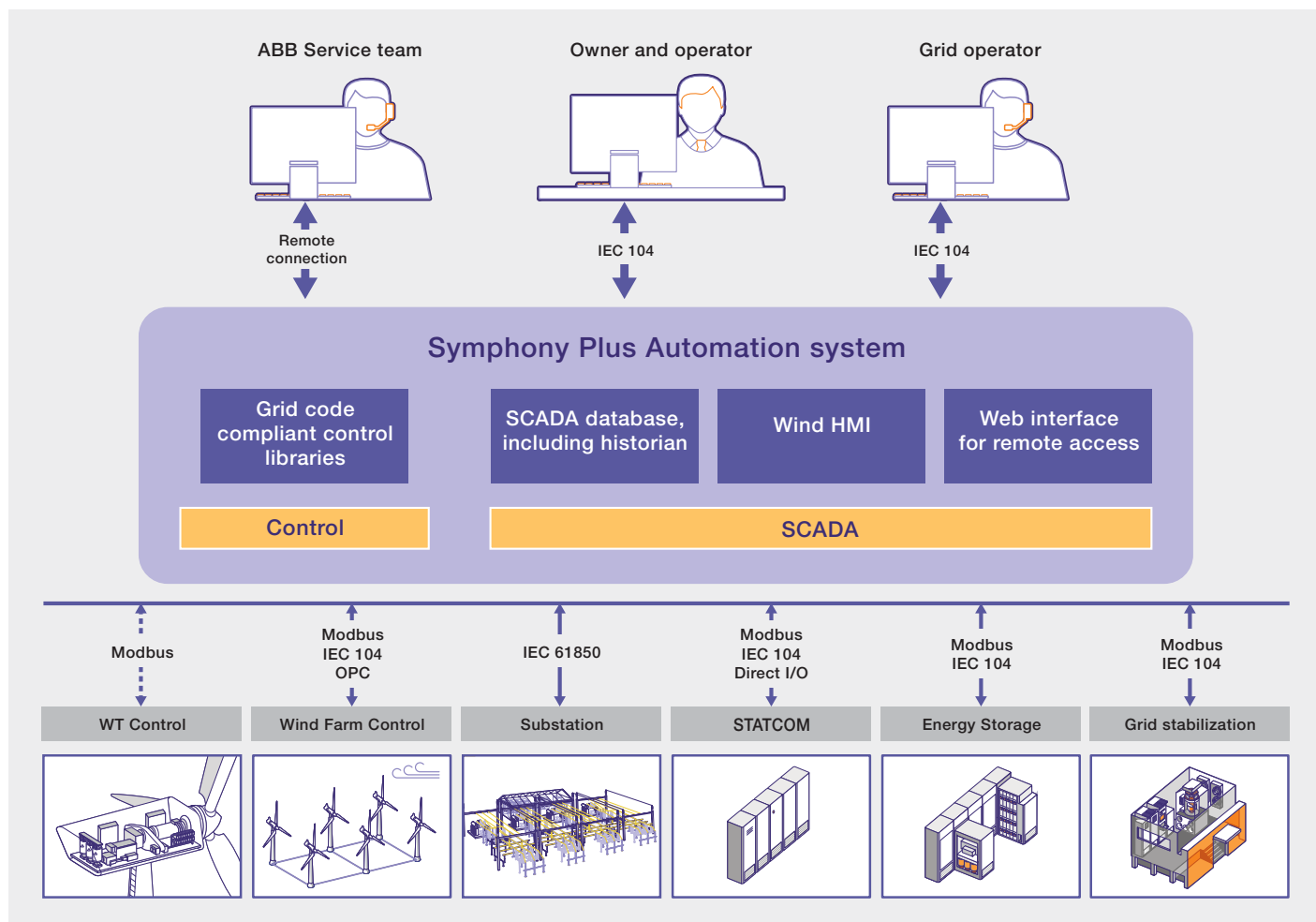
Continuously monitoring both the individual output of each wind turbine asset and the cumulative output of the wind farm involves collecting large amounts of operating data, like wind speed/direction, rotor speed, and interpreting this in line with production data, such as active/reactive power. This data supports decisions to ensure each turbine as well as the farm as a whole are operating effectively and at optimal efficiency, and enables modulating the output of the turbines to meet the required loads.

'Wake effects' can account for several percent of a wind farm's total power losses, depending on layout, compared with non-wake, free-stream wind conditions. To maximize power production and revenues by overcoming the wake effect, Symphony Plus studies the aerodynamic interaction between turbines. A powerful online optimization engine also boosts the active power of each turbine to maximize power production of the entire plant, while reactive power control minimizes overall losses in the collector grid.

Remote Monitoring and Virtual Power Plants

The remote monitoring capabilities of modern automation systems present both individual plant operators and those managing power plant portfolios with a high level of plant operating visibility. Remote systems provide dynamic decision-making tools to help operators optimize plant availability, detect any abnormal functionality and ensure that energy efficiencies are being maintained. The benefits from improved operation and maintenance regimes and reduced operating expenditure improve business profitability.

Continued on page 30



Symphony Plus remote diagnostics is a key functionality that calculates and forecasts the condition of assets based on overall working conditions during their lifetime. This provides greater awareness of plant conditions, and dramatically improves the maintenance process and its effectiveness. Condition-based maintenance, or predictive maintenance, minimizes costs associated with asset maintenance, and drives down the overall levelized cost of renewable energy.

Owners or operators of large numbers of solar and wind power generators increasingly need to create virtual power plants (VPPs). Centralized remote monitoring of VPPs enables energy production from geographically remote power plants to be accumulated and aggregated. This facilitates participation in the power purchase market, improved load balancing and optimization of on-site electrical production and consumption.

Symphony Plus remote monitoring, integration of forecasting and portfolio-wide power management ensures optimal operation of VPPs via the

backbone of a central control and optimization system. This system connects decentralized assets, and provides real-time optimization of operations and planning.

Scalability, redundancy and high availability are crucial features of Symphony Plus that comply with the needs for extension of VPP operators. Real-time calculations and flawless response times via communication channels are key properties of Symphony Plus that support renewable energy trading in various markets, including the ancillary service market.

The key function that makes Symphony Plus a stand out control automation solution is its capacity to optimize dynamically, in real-time and intraday, the running costs of an entire portfolio of plants. It uses a mathematical optimization program to distribute overall schedules to individual units, taking all current restrictions and disturbances into account. Moreover, the instantaneously incoming balancing power calls are converged with individual schedules to provide the optimal set-points for all technical units.



Integrated security

Industrial control systems meet sophisticated cyber menace - ABB helps customers create multi-layered cyber security systems to detect and deter threats and keep increasingly interconnected systems secure.

The buzz

Cyber security continues to be a very hot topic in the media. At one point, 2011 was widely described as the year of the "Mega Breach," featuring cyber-attacks that scooped up the personal information of hundreds of millions of people worldwide. Then in 2013 more than a half-billion identities were compromised, surpassing all previous years. The escalation continued in 2014 with some very high-profile companies suffering security breaches, including Target, Home Depot, JP Morgan/Chase, etc. By 2015, it was clear that not even the U.S. Government was completely capable of protecting personally identifiable information (PII), when the Office of Personnel Management announced social security numbers and other details of more than 20 million federal employees had been stolen.

According to security software maker Symantec's Internet Security Threat Report (ISTR Vol 20 April 2015), while breaches continue to rise year over year, attention in the internet security commu-

nity is "beginning to shift from just what was being ex-filtrated to increasing the emphasis on the methods and tactics being employed." Attackers are moving faster, and their techniques are becoming more deceptive and stealthy. While the majority of malware is still non-targeted and just looking for low-hanging fruit, there is also growth in more focused attacks and advanced persistent threats which are much harder to detect and defend against.

A skilled and patient opponent

While the majority of media and criminal cyber attention is still outside of the industrial sector, there are clear indications that all is not quiet within our industry. In the U.S., the Industrial Control Systems - Cyber Emergency Response Team (ICS-CERT) has reported and investigated hundreds of incidents in each of the last several years. Moreover, the internal data shows some disturbing trends. While the energy sector has been targeted with the highest percentage of attack incidents, the number two target

has been the critical manufacturing sector, some of which were from control systems equipment manufacturers.

Recently, the ICS community has had to deal with targeted malware attacks such as Havex/Dragonfly and Black Energy. These may utilize some traditional malware techniques, along with more sophisticated approaches such as fake websites with download links to industrial control software, also known as 'watering holes'. In a few cases, even the web sites of actual industrial control product providers were infected! The latter was likely accomplished via an email campaign, where selected executives and senior employees at the target companies receive emails containing a malicious PDF attachment, also known as 'spearfishing.' Employees remain the easiest way for hackers to breach internal systems, via infected email downloads or mass storage devices.

Continued on page 32

While the recent activity has not resulted in widespread outages or general damage to industrial systems, there is evidence that detailed information about these systems was collected and returned to the perpetrators. Also some of this malware seems to be aimed at quietly establishing backdoors in the infected infrastructure, allowing cyber attackers to return and reuse stolen information at a later date. Connecting the dots between such realities points to disturbing conclusions.

A transformed industry

While power facilities may have always been somewhat vulnerable, this was perhaps less clear because systems tended to be more isolated and more diverse than today. The industrial sector has gradually shifted from proprietary systems to common technologies like Windows OS and standard TCP/IP networks, which has opened opportunities for malicious actors already experienced with these platforms. There were perfectly good reasons for making this transition, but now the shift requires cyber protection systems that previously weren't considered. This protection should be multi-layered, including security that is not just built around systems, but also physical infrastructure and human awareness.

According to ICS-CERT, a summary of data from 2014 showed that out of the total number of incidents reported, roughly 55 percent involved advanced persistent threats (APT), or sophisticated cyber attackers. This is significant because a decade ago the notion that ICS would be of interest to hackers was just theory. After some actual infections by worms like Slammer and Conficker, the issue was viewed by many as consequential due to the use of common operating systems and networking technology.

Today it is clearly understood that hackers from various nation states as well as cyber criminals are not only active in our segment, but are growing in sophistication as they attempt to gather information and establish footholds inside industrial control systems. The industrial community is no longer unaware and has set about the challenge of securing these systems on which much of our critical infrastructure relies. Governments are moving to establish regulations and metrics, but the speed and effectiveness of our response to these challenges still requires increasing attention.



Commitment to a secure, defense-in-depth approach

At ABB, cyber security is beyond the hot topic of the day. The matter of protecting our employees, our organization and the integrity of our products is a foundational responsibility which helps protect our customers and their operations. This requires a systemic approach involving our information systems, our product development teams, project engineering resources and on-site service personnel.

The protection of the Internet of Things, Services and People's (IoTSP) interwoven systems of information technology and operational technology is central to the company's Next Level strategy. With more than half of ABB's products related to software, the company and its thousands of software developers, commissioning engineers and service personnel recognize the vital importance of integrating cyber protection across the life cycle of systems. To manage our approach to cyber security across the enterprise, ABB has established a Group Cyber Security Council and cyber security teams at unit and division levels to ensure that security controls and best practices are shared across the company.

No single solution can keep increasingly interconnected systems secure, so ABB works with customers to create a defense-in-depth approach where multiple security layers detect and deter threats – if, where and when they may arise. ABB is active in cyber security standardization efforts through many external initiatives, and participation with groups such as International

Electrotechnical Commission (IEC) and the International Society of Automation (ISA). ABB has also joined the Industrial Internet Consortium (IIC), and is working together with global companies, groups and universities to accelerate the secure adoption of the IoTSP.

ABB is committed to meeting this security challenge through continuous participation with industry stakeholders as a responsible partner. Our project and service teams are diligently working to ensure the ongoing security of the systems delivered and deployed at our customer's sites. With the solid support of senior management, dedication on the part of every employee and valuable coordination with the customers we serve, ABB remains focused on improving industrial control system cyber security in every detail.

Security and protection is a fundamental part of ABB product development, and is consistently evaluated and improved.

Symphony Plus SD Series expanded



Latest SD Series products include an expanded range of HART enabled high-level (i.e. 4-20 mA DC) Analog I/O modules (AIØ2, AIØ5, AOØ2, and AOØ5), mixed I/O channel (4x (AI, AO, DI, DO)) Analog Drive modules (ADØ1 and ADØ2), a short circuit detection and protection Digital Output module (DOØ2) and vertical column mounting bases (VBSØ1-xxx).

Together with the existing portfolio, the SD Series consists of a flexible and scalable control and I/O suite that works across the entire control landscape and delivers total plant automation regardless of application type, size or physical location. For more on SD Series, go to: <http://new.abb.com/power-generation/symphony-plus-sd-series>.

+ Advantages

- Green, energy-efficient design consumes less power and delivers significant energy savings
- Withstands extreme operating conditions and eliminates the need for costly cooling systems
- Smart device integration provides greater process visibility from fewer components and less cabling
- Compact modular design with more than 50 percent higher density than typical DCS solutions
- Flexible vertical mounting facilitates easy design and implementation of field marshalling requirements
- Based on field-proven technology for easy expansion and investment protection

S+ Conversion Tool for PGP 1.0

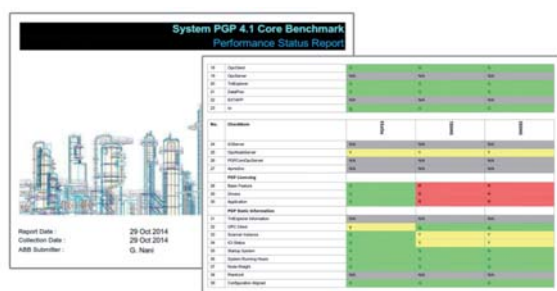
Converting existing systems to the latest S+ Operations technology is a service provided by ABB to end-customers. When customers evolve heritage ABB operator stations to S+ Operations, they expect a smooth and cost-effective conversion. Now the S+ Conversion Tool for PGP systems can be accessed on an ABB server through a web client interface.



+ Advantages

- Reduced conversion time and engineering development
- Reduced troubleshooting effort and project delivery costs
- Service typically uses automatic conversion tools to read the heritage system's configuration source files, historical process data, alarm and event files, and execute automatic conversion
- The tools store converted files for further deployment on the S+ Operations target system by engineers

PGP Benchmark and Fingerprint 1.0



The PGP Benchmark and Fingerprint are the first in a series of Health Check Services that ABB is developing. Health Check Services are non-invasive services based on state-of-the-art software tools which simplify complex diagnostics and reporting. Health Check Services are used for both improving and maintaining system performance.

+ Advantages

- A comprehensive diagnostic analysis of the Power Generation Portal (PGP) system
- Performance, configuration and life cycle parameters are read from the installed system and compared to requirements and best practices
- Non-optimal system states and settings are automatically identified
- The Benchmark report provides a quick overview of system status
- The Fingerprint report presents evaluated findings and detailed recommendations for improvement

ABB is a leading provider of integrated power and automation solutions for conventional and renewable-based power generation plants and water applications. The company's extensive offering includes turnkey automation, instrumentation and control systems supported by a comprehensive service portfolio to optimize performance, reliability and efficiency while minimizing environmental impact.

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Can automation be flexible and sustainable?

Absolutely.



The newest addition to the Symphony® Plus family, SD Series is a portfolio of completely scalable control and I/O products that work in any environment, delivering total automation for power and water plants regardless of application. It has a scalable architecture and has been developed to enable easy device and electrical integration. Its modular design, compact footprint, and low energy consumption needs make it an eco-efficient solution ideally suited for new installations, upgrades or expansions.

new.abb.com/power-generation/symphony-plus-sd-series