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**03**|2023 en

## Sustainability



## Sustainable living

## Cooler power electronics



## You read, we listen.

## Sustainability



## Technology



## Buzzword Demystifier



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Many readers will be pleased to notice that from this year we have returned to classic scientific journal page numbering. Hopefully this makes referencing easier for the scientific community.

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# What do you think?

**ABB Review exists to keep you up to date on the latest innovations from the company's R&D labs and its technological achievements. The journal strives to inform the reader in a manner that is interesting, informative and also scienfically precise. Our readership survey is your opportunity to help guide the content that you'll see in future issues of the journal. The short questionnaire starts on the flap of the back cover (page 230). Your input is greatly appreciated.**

Coming up in the next edition: **Detection and analytics**

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EDITORIAL

# Sustainability

Dear Reader,

The need for action on climate change is becoming ever more urgent. At ABB we have placed combatting this existential threat at the heart of our operations, implementing sustainable practices across our value chain.

In its Sustainability Strategy 2030, ABB has pledged to make its own operations carbon neutral by the end of the present decade, while at the same time helping customers reduce their $CO_2$ emissions by 100 megatons.

Besides climate change, ABB's sustainability strategy also focuses on the conservation of resources, safe working practices and social progress.

In this issue of ABB Review, we present a broad range of examples of ABB enabling and supporting renewables, energy efficiency and circularity.

Enjoy your reading,

Björn Rosengren
Chief Executive Officer, ABB Group

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# Sustain-ability

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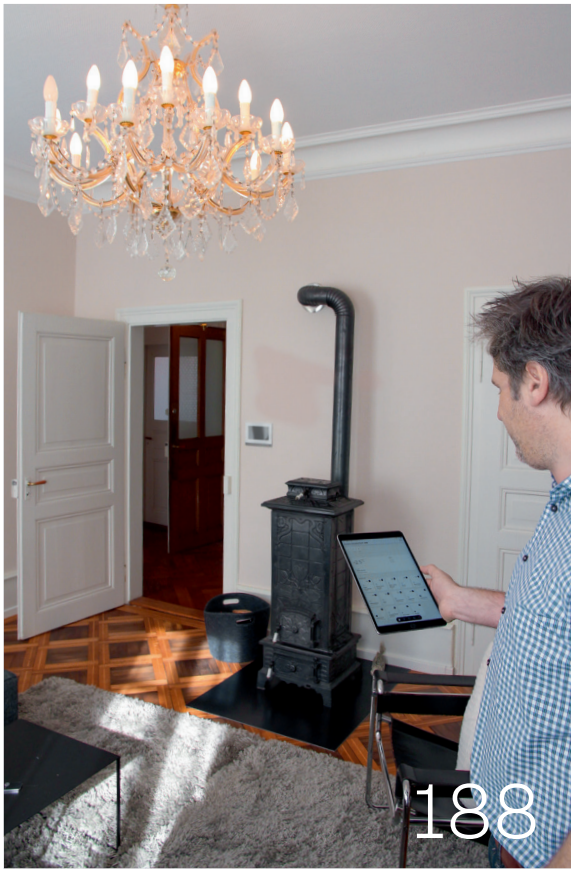
**ABB has pledged to meet the Paris Agreement's Net Zero goal by 2050. The company's Mission to Zero(TM) effort has already delivered a 73 percent reduction in emissions since 2019. It's now actively taking its "leadership by example" approach to customers and across its value chain - as this is where, on average, 90 percent of emissions occur - and helping capture or reduce carbon emissions and waste while increasing productivity. The company reports that many investors see ABB as the "go to company" for sustainable solutions.**



INTERVIEW WITH ABB'S HEAD OF SUSTAINABILITY, ANKE HAMPEL

# Pathway to sustainability

Anke Hampel, head of sustainability at ABB, discusses how the company is using its strengths to pursue a more sustainable economy. Among many other topics, the interview explores why supply chains are key in achieving a low-carbon society, preserving resources, and promoting social progress.


01

01 ABB's view on sustainability is not limited to reducing emissions and waste but spans a broad palette of areas including social responsibility and protecting resources.

## Anke Hampel

Head of Sustainability at ABB

**Anke Hampel joined ABB in 2022. She was previously Global Innovation & Sustainability Director with Tetra Pak, prior to which she was Director of Procurement and led the drive to reduce emissions across the value chain. Before joining Tetra Pak in 2017, Anke Hampel worked in procurement at Procter & Gamble and at Coty.**

**AR** **ABB Review (AR):** ABB and its predecessor companies have since their early years at been the forefront of electrification and hydropower projects, bringing clean electricity into factories and people's homes. In more recent times, ABB has advanced energy efficiency, for example through its variable-speed drives, as well as helping industry cut waste and losses, for example with Industry 2.0.

Is it fair to say that that ABB was delivering sustainable technologies long before sustainability became fashionable?

**AH** **Anke Hampel (AH):** Absolutely. One example that comes to mind is DC power. DC has been around since the earliest days of the commercial use of electricity, but was historically swept aside by AC and relegated to special applications. The recent growth of renewable energy is bringing with it many new DC applications. Photovoltaic panels produce DC for example, as do some wind turbines. Battery storage and clean hydrogen require DC. Likewise, more and more electricity-consuming devices use DC. Variable-speed drives, for example, convert electricity from one frequency to another via an intermediate DC link. Data centers use DC. The vast and rapidly expanding field of E-vehicle-charging revolves around DC. ABB is at the forefront of providing connections between these different forms of generation, storage and consumption. If we can use DC for these connections, we can avoid many of the conversion losses that presently occur. Every time we do a DC to AC or AC to DC conversion, we are faced with losses of 6 to 8 percent.

Furthermore, DC grids offer higher reliability and resilience as they can be independent and secured as islands, eliminating influences of reactive power. They also make better use of resources as cable capacity can be used to the limit as they do not have to deal with reactive power. Beyond this, a DC Smart Grid can further eliminate transmission losses due to the localization of supply and demand.

Even if we don't see such a move to DC networks, ABB is, through its unique position and know-how, taking a lead in the energy transition. Our business and technology decisions have many effects, not just on mitigating climate change, but also on avoiding waste via circular solutions, protecting biodiversity, and water resources, etc. Then there is also the aspect of social progress. Increasing automation and artificial intelligence may be leading to the elimination of some jobs over time, but these technologies are also creating other jobs that require higher levels of education. Our focus is on leading by positive example in our value chains, especially when it comes to human rights, due diligence, and avoiding deforestation.

ABB is, through its unique position and know-how, taking a lead in many aspects of the energy transition.

**AR** In public discussions we often hear about such things as green washing, meaning a company is pretending their activities are green when in fact they are not. What can we do to ensure our achievements are genuinely meaningful?

**AH** This is a very important topic. Greenwashing has a related phenomenon called greenhushing, which means people just stop talking about something to avoid being called out.

Public awareness of sustainability has increased, and with it, the level of scrutiny. Consumers, customers, suppliers and investors have become more aware of the issues and Credible sustainability measures are weighing more heavily in purchasing and investment decisions. People understand that it is time to act and not just talk.

The increased calling out of greenwashing and the development of respective legislation is good for our business. Transparency and scrutiny ensure businesses are creating genuine value and not just making claims.

## Local manufacturing and sourcing reduces the footprint of the value chain.

In this context, when we are talking about emissions, for example, it is important to emphasize that we are not just concentrating on our own emissions, but looking at the entire value chain.

There are many claims out there that a company is achieving net zero, without clarifying that the claim may relate to the emissions of the company itself, and not to the full value chain. It is much easier to achieve an apparent net zero if you ignore the value chain, which is where on average, about 90 percent of emissions occur.

Supply chain decisions and offering smart technology solutions are powerful in improving sustainability.

**AR** ABB's strategy on sustainability does not only relate to interventions in its own operations when it comes to emissions, waste and zero harm, but has broader aspects including environmental, social and ethical responsibility as well as a safe working environment in its entire value chain →01.

**AH** Indeed, by working across the value chain we can act, for example, against unethical working practices. It is not just about expecting others to act in a certain way but, we in ABB need to be a role model and show that it can be done. We are in the process of relaunching our Supplier Code of Conduct which will reinforce our expectations towards our suppliers and, importantly, their suppliers and pre-suppliers.

**AR** How difficult is it to convince people to change the way they do business?

**AH** I think we have reached an amazing momentum in terms of readiness and willingness to drive the changes that are required. Right now, my concern is not principally with awareness or willingness, but in helping industries get started on the road to sustainability.

Sustainability is an extremely complex area. We need to guide customers in recognizing the areas in which changes have the greatest impact and on how to quantify these, for example by measuring carbon emissions correctly. The fruits of these changes benefit the customers of our customers and so on all the way to the end users.

**AR** Indeed. When we supply a piece of equipment, that is a one-time purchasing decision for the customer, but the savings and advantages are reaped throughout the equipment's' lifetime, which could be every day over the next 20 to 40 years.

**AH** Of course, and we also need to think about what will happen at the end of the equipment's lifetime. We need to have a circularity framework that is applied to our product portfolio across all business areas to make sure new products or upgrades are designed with environmental impact and recyclability in mind and that the materials can be and will be recycled at scale.

**AR** Do you have any examples of any measures that we took, to make a product more recyclable?

**AH** Our circuit breakers are a good example. We set about re-designing them, starting with an eco-design mindset. We investigated whether we could replace any content by recycled material. We also looked at how we assemble the breakers, because if they are difficult to de-assemble at the end of their life, this could be a barrier to effective recycling. This would be in the very long-term future as we want these units to have long lives, meaning the ease of disassembly needs to be balanced with the stability and robustness throughout their operating life.

**AR** Circuit-breakers are an area where we already have a high potential recyclability because we use copper and other metals, which are by nature well suited to recovery and recycling.

**AH** Steel, aluminum, copper and then PVC (in that order) are the materials that cause high emissions in our value chain. In all four cases, recycled options exist and we are actively engaging in how to increase our use of these.

Local manufacturing and sourcing is another way to reduce the footprint of the value chain. Sourcing needs to be smart and efficient, and parts should not be shipped further than necessary.

**AR** This is where Factory 2.0 comes in. We, and our suppliers, can produce locally and in small batches because modern manufacturing methods are making it increasingly viable to do so. This creates value locally and feeds back into the local economy - all across the globe.

**AH** Exactly. Modern and precise manufacturing also mean less waste because operations can be steered in a more accurate manner. ABB supplies sophisticated systems and service solutions that support this →02.

Rather than just looking at recycling, we need to avoid the creation of waste in the first place.

**AR** Is it difficult to convince our investors of our sustainability strategy? Is there a risk that they could chose short-term gains over long-term sustainability?

**AH** I don't see a conflict here. We have seen a major shift on for example ESG KPIs (environmental, social and governance key performance indicators), especially in investment funds. Our

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02 Smart manufacturing means it is becoming viable to produce in smaller batches and locally, reducing the transportation footprint. Increased precision also means less waste.


02

investors are very keen to see us meet our commitments and raise our ambitions further.

Many of our investors are telling us that they see us as “go to company” for sustainable solutions. At the same time, we do face a very strong competition and we are far from the only ones to view our purpose and business model based on sustainability and technology leadership.

It is the companies that are not meeting these expectations who are going to struggle with their business.

**AR** Do you have any success stories you would like to share?

**AH** As a company we have demonstrated what a focused approach is able to deliver. Since 2019, we have reduced our own emissions by 73 percent. And that was possible only because everyone was moving in the same direction.

We did this by tapping into our engineering leadership across the company. We used an “all hands on deck” approach in our Mission to Zero™ effort[1].

As somebody who has just recently come into ABB, I am extremely impressed how this has been approached in a consistent manner across all the very different businesses that form part of ABB.

This puts us in a strong position to be able to inspire and support our customers. People are turning to us for help to manage the complex decisions that are required and hence to drive technologies that reduce or capture carbon and avoid wasting resources. One of the great examples I see is the North Sea becoming Europe’s biggest green power plant based on the April 2023 Ostend Declaration →03. This is only possible because different companies and different countries are coming together to jointly make the investments. Collaboration and innovation are key for any successful sustainability intervention.

**AR** Do you have advice for our readers? What should we do in our personal lives to better support sustainability?

**AH** Our greatest personal impact is always going to be in our own area of responsibility. Whether we are at work or in our private lives, we can ask what it is that we can stop doing, or if we can’t stop doing it, seek how we can do it with more sustainable means. This is the three-step approach of reduce, reuse and recycle. Reducing, reusing and recycling are all good, but we should reduce first of all – find ways to consume fewer resources. The best way to protect natural resources is to not touch them in the first place.

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Since 2019, we have reduced our own emissions by 73 percent.

Having done that, we should then reuse what we cannot reduce and finally recycle what we can neither reduce nor reuse. Doing this can sometimes call for creative solutions, and thinking outside the box, not just at home. I am fortunate to meet many of our ABB employees through my engagement as a Climate Fresk trainer[2] and experience their passion and readiness to act. If you have not yet participated in a Climate Fresk workshop, now is the time to reach out and get inspired.

**AR** Thank you for the interview. •

This interview was conducted by Andreas Moglestue, , Chief Editor of ABB Review, andreas.moglestue@ch.abb.com .

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03 The North Sea is on track to become the biggest source of renewable energy in Europe.

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**Footnotes**

1) Mission to Zero™ is ABB's pledge to reach carbon neutrality at its own sites by 2030, while helping customers do the same. See also "On a mission" on pp180-187 of this issue of ABB Review.

2) Climate Fresk is a game-based tool for teaching and raising awareness about climate change. See also climatefresk.org .

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IMPROVING SUSTAINABILITY BY SWITCHING TO ELECTRIC VEHICLES

# Electric switch

As part of its 2030 sustainability strategy, ABB is replacing its over 10,000 mainly petrol- or diesel-driven automobiles, vans and trucks with electric vehicles (EVs).

**Ricardo Koevoet**
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01 ABB is replacing its global fleet of petrol- and diesel-driven vehicles with electric alternatives.

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02 ABB's Terra charger.

As a globally recognized leader in power and automation technologies that enable businesses to improve their energy efficiency and productivity, ABB is committed to sustainable development and has been working to reduce its environmental footprint for many years.

**Replacing the ABB vehicle fleet**
As part of this commitment to sustainability, ABB has embarked on a massive project to replace its existing global fleet of conventionally powered vehicles with EVs →01. The company's fleet comprises over 10,000 vehicles in 62 countries, with an associated annual expenditure of approximately $100 million. ABB has begun implementing this initiative with a special focus on the 24 countries that represent more than 80 percent of its fleet.

ABB's fleet conversion project is part of its 2030 sustainability strategy, which seeks to enable a low-carbon society while working with customers and suppliers to implement sustainable practices across the entire ABB value chain and the lifecycle of its products and solutions. The company is also committed to driving social progress in its communities and with its suppliers.

The decision to convert the fleet to EVs is a significant step towards achieving ABB's greenhouse gas emissions reduction targets. These targets have been validated by the Science Based Targets initiative [1] as being in line with the 1.5 °C scenario of the Paris Agreement. ABB has committed to achieving carbon neutrality across its operations by reducing its emissions by at least 80 percent by 2030. Moving to an EV fleet is essential if ABB's emission reduction objectives are to be achieved.

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By 2030, the whole ABB global vehicle fleet will be electrified.

In ABB, vehicles using an internal combustion engine (ICE) are, for the next few years, allowed only as an exception. This approach means that ABB is moving away almost entirely from traditional petroleum-powered vehicles and toward a more sustainable future. By making this transition, the company is not only reducing its own carbon footprint but also setting an example for other companies to follow. By 2030, the whole ABB global vehicle fleet will be electrified.

**At-home charging**
ABB's fleet conversion project includes the installation of ABB AC Terra chargers and charging infrastructure at ABB locations →02. In many cases, a battery charger is installed at ABB drivers' homes. This measure makes it easy for them to charge their vehicles overnight and ensures they always have a full battery when leaving for work in the morning.

**EV uphills and downhills**
One of the project's challenges is that ABB can sometimes move faster than EV acceptance among drivers, leading to EV range anxiety in some cases. Further challenges include:
- Potential semiconductor shortages.
- The reluctance of governments to offer incentives such as subsidies.
- The immaturity of public charging infrastructure in some regions.

Given the rapidly increasing popularity of EVs in all segments of transportation, vehicle availability can also be an issue.

02

The project presents opportunities in addition to those mentioned above. For example, the encouragement of new product developments in supplier organizations.

**Pilots and policy**

The fleet pilot project started in 2019 and three pilot countries launched in 2020. Careful total cost of ownership analysis was carried out and supplier management and procurement strategy elements were carefully considered.

The company launched an EV policy document in September 2020. The policy makes allowances for ICE-based vehicles, but only in exceptional cases. A detailed stakeholder communication plan was implemented in late 2020 to support the policy launch, transition and go-live. Priority locations for EV infrastructure investment were identified and an agile implementation plan was developed to adapt to the potential impact of the global COVID-19 pandemic, and the consequent supply chain disruption, on availability of both ABB products and EVs.


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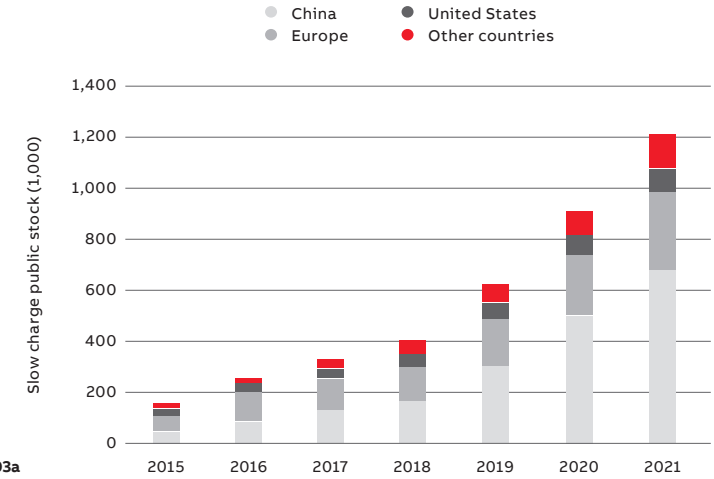


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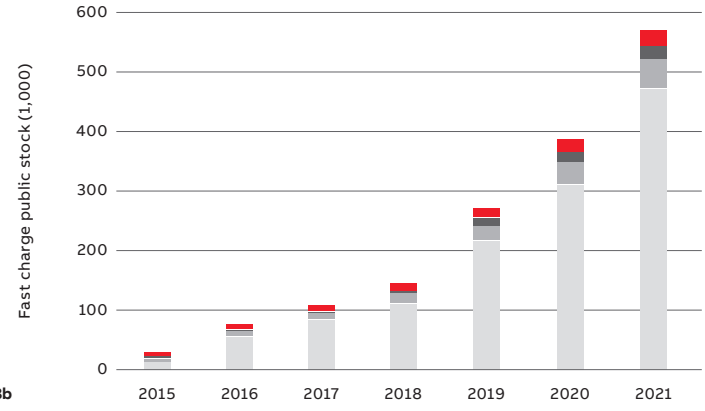


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The UK was chosen to host the first pilot project not only due to the high $CO_2$ footprint of ABB's UK fleet but also the ready availability of vehicles and growing charging infrastructure in the country. Currently, for the UK, 383 EVs have been ordered – and only 26 ICE vehicles.

ABB continuously develops new procedures and guidance based on the experience gained from the UK and other pilot EV projects.

**Sweden and Spain**

EV charging infrastructure varies by country, so strategies for switching to an EV fleet must be adapted accordingly →03.

In Sweden, ABB is making significant strides toward a more sustainable future by converting its local fleet to electric vehicles. Although Sweden was not one of the original pilot countries for this initiative, the local policy for company cars was changed in March 2021. Since then, ABB has ordered 427 EVs and 11 plug-in hybrid vehicles (PHEVs) for its Swedish fleet – and only 5 ICE vehicles.

EV charging infrastructure varies by country, so strategies for switching to an EV fleet must be adapted accordingly.

This transition to electric vehicles is a significant step forward for ABB's sustainability efforts in Sweden. By reducing the number of



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03 EV charging infrastructure is expanding rapidly, but not at the same rate in all regions. Data courtesy of the International Energy Organization [2].

3a Slow charging infrastructure.

3b Fast-charging infrastructure.

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04 ABB sponsors the Formula E racing series.

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05 A custom-made compact Terra DC unit is used in the ABB Formula E-supporting Jaguar I-Pace eTrophy. ABB's experience in EV technology facilitates the move to an all-electric fleet.

petroleum-powered vehicles on the road, the company is not only helping to reduce carbon emissions but is also improving air quality in the country, especially in urban areas.

In Spain, ABB is taking a different approach due to still developing charging infrastructure. In December 2020, ABB decided to replace the Spanish service and sales fleet with PHEVs. By transitioning to PHEVs in Spain, ABB is still making a significant contribution to reducing its carbon footprint. While PHEVs still rely on petroleum for part of their power, they offer significant improvements over traditional petroleum-powered vehicles in terms of carbon emissions and fuel efficiency. Unfortunately, the shortage of semiconductors upset the transition plans: After taking delivery of just over 90 PHEVs in 2021, ABB had to make the decision to take an intermediate step in which the planned PHEVs are replaced by mild hybrid vehicles in the short term. A mild hybrid has a small electric generator that replaces the traditional starter motor and alternator plus a small lithium-ion battery. This variant reduces the fuel consumption and $CO_2$ emissions of ICE vehicles. Full vehicle electrification in Spain will still be completed by 2030, though. In neighboring Portugal, ABB aims to have an all-electric fleet by the end of 2023.

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Formula E provides an ideal test-bed for innovation that positions ABB at the forefront of sustainable technology development.

**EV experience from Formula E**

ABB is no stranger to the world of EVs: the company's association with Formula E motor racing is well-known and ABB has been sponsoring the series since its inception →04-05. Formula E is a competitive racing series that features electric race cars. The series demonstrates the potential of EVs and promotes sustainable mobility. Furthermore, Formula E provides an ideal testbed for innovation that positions ABB at the forefront of sustainable technology development and, ultimately, contribute to a cleaner environment for all.

**Driving sustainability**

Overall, ABB's efforts to convert its global vehicle fleet to electric vehicles and PHEVs are an important step forward for its sustainability efforts. By reducing its reliance on fossil fuels and moving toward a more sustainable future, ABB is setting an example for other companies to follow.

As the world continues to grapple with the impact of climate change, it is essential that companies take proactive steps to reduce their carbon footprints and transition to more sustainable practices. ABB's EV fleet replacement program is one step in this direction. •

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**References**

[1] SBTi, "Ambitious corporate climate action – Science Based Targets." Available: https://sciencebased-targets.org/ [Accessed 28 February, 2023.]

[2] IEA, "Global EV Outlook 2022: Trends in charging infrastructure." Available: https://www.iea.org/reports/global-ev-outlook-2022/trends-in-charging-infrastructure [Accessed 28 February, 2023.]

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THE ELECTRIC GRID IS THE SILENT ENABLER OF A MORE SUSTAINABLE ENERGY SYSTEM

# In grid we trust

As more renewable energy sources are incorporated into the grid, the intermittency of supply and increased system complexity requires the electricity grid to evolve. By modernizing infrastructure and reinforcing the grid to enhance resilience, efficiency and security of supply, a more sustainable energy system is possible.

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Although natural fluctuations in atmospheric $CO_2$ concentrations occuring prior to industrialization are well-documented [1], the relentless increase over the past two centuries due to anthropogenic activity, especially over the last 5 decades, is alarming [2,3] →01. This combined with a predicted growth rate of around 2.05 ppm $CO_2$ annually [2] has propelled policy makers to act. This is reflected in the legally binding treaty: the Paris Agreement and initiatives from the UN's Climate Change Conference (COP26, and COP27) [4-6], that address decarbonization.

While these commitments are laudable, recent studies indicate that not enough is being done. Despite the nearly 3 giga ton decrease in $CO_2$ emissions observed during 2020, due to COVID restrictions, emission concentrations are in line with the pre-COVID trajectory [2,3] →01.

Photo: ©Soonthorn/stock.adobe.com

What more can be done to lower $CO_2$ emissions on a global scale? With more than 80 percent of $CO_2$ emissions derived from the three top sources of global energy: coal, oil and natural gas [7], it follows that switching to renewable energy sources such as solar, wind, geothermal, etc. would enable decarbonization, right? Well, yes,

The electric grid is required to accomodate the new renewable energy generation and distribution reality.

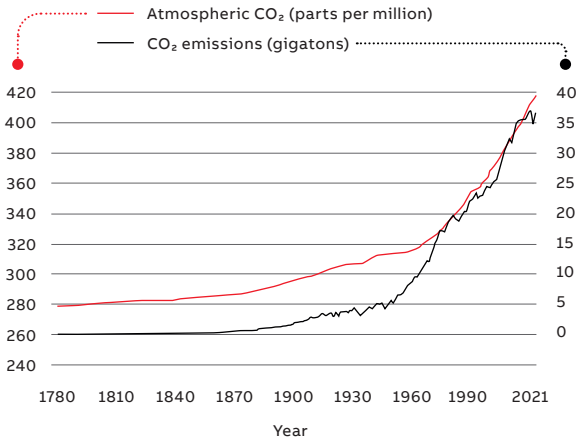
but only in part. The fact might not be dominating the world's media yet, but without reinforcing the electric grid to accommodate this new renewable generation and distribution reality, energy from wind turbines, roof-top solar panels, or electric vehicles (EV) would be unusable. For electricity generation, transmission, delivery and security of supply to be stable, as the electric load increases, a modern reinforced grid is critical. This grid is the silent enabler of a more sustainable energy system. ABB, its partners in industry, and utilities, are examining this massive challenge to provide solutions.

**Remixing the energy mix**

In 2022, the EU presented RePower Europe: a plan to diversify energy sources, and save energy while expanding the use of renewable energy [8]. The goal is to bring total renewable energy generation capacities to 1,236 GW by 2030 or to 45 percent of the energy mix [8].

According to the International Energy Agency, for every Euro invested in renewable sources, more than one Euro must be invested in infrastructure and services to transport the energy produced. There is little value in placing wind turbines where the wind blows strongest – off the coast – if the electric grid is incapable of transporting the energy produced to the populated areas where it is needed [9].

The challenge is to connect these variable energy sources to the electricity grid, transmit the electricity in the necessary form to where it is needed, when it is needed reliably, safely, and efficiently. ABB provides technology and systems to ensure that the electricity grid evolves to a more sustainable energy system or a "decarbonized grid" one that can include distributed energy resources (DER) and efficient storage to handle this new reality →03-04.

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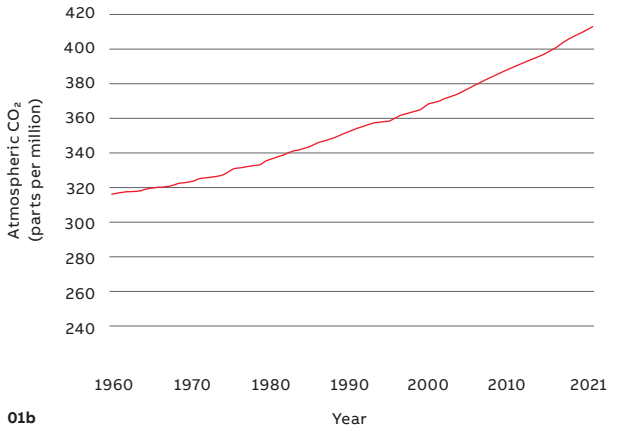


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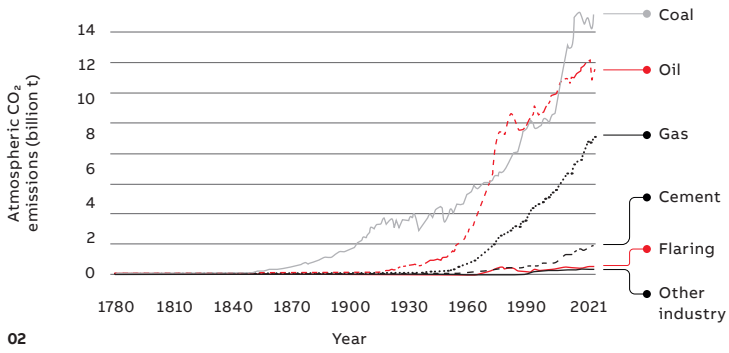


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This requires:

- Grid stability and the need to maintain a stable frequency with variable supply;
- Grid extensions to facilitate electrification, power system resilience and security of supply;
- Grid digitalization and smart monitoring to improve service level, the performance of existing and legacy assets, and efficiency.

**Switching to renewable power**

The electric grid was based on a top-down transmission system, characterized by unidirectional energy flows from large centralized power plants. As renewable power generation grows, big fossil-fuel plants are removed; the grid becomes more decentralized, less stable and prone to voltage fluctuations. Consisting of generation from large solar power plants or wind farms, distributed energy resources (DER), photo voltaics (PV), micro-grids, and a variety of renewable sources are connected to the distribution grid – requiring bi-directional energy and communication flow – a smart network.

While many renewable energy generators convert DC to AC electricity for grid compatibility, conventional gas or coal power plants connect directly to the grid via large synchronous generators (eg, of 50–500 MW) with rotating masses capable of providing inertia in case power demand spikes. Renewables, with lower system inertia and voltage swings, require unique, flexible technology for regulating, controlling

ABB develops technologies that foster integration of renewable energy, improve grid functionality, resilience and stability.

and monitoring to ensure grid stability and resilience – a challenge that demands innovative solutions. For instance, by adding a variety of different forms of renewable energy resources as well as other features, eg, storage, to the grid [10], the electric grid can be decarbonized while resilience is increased; this is increasingly critical as more heating and transportation loads switch to electric.

**Meeting the challenges**

As a global leader in electric products and solutions, ABB develops new technologies and systems that enable the integration of renewable energy resources, improve electric grid functionality, resilience and stability [10-13] →03 to support decarbonization. Collaborating with electricity producers and consumers, for instance, ABB develops improvements for industrial loads, eg, highly efficient motors coupled with drives; technology for green steel production (circuit breakers for arc furnaces and magnetic stirrers); products and solutions for hydrogen production, eg, substations, rectifiers, DC busducts, measuring devices, control systems etc.→04. Focus areas that warrant special attention are:

- Utility integration of renewables with smart grid technology and distribution
- Data centers
- Electrification of domestic loads
- Smart building management
- Connections for e-mobility
- Energy storage systems
- Electrification of factories.

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01 The diagrams show the changes in atmospheric $CO_2$ concentrtions and emissions (measured and calculated) over time.

01a The diagram shows the atmospheric $CO_2$ concentrations, sourced from NOAA and ETHZ, and $CO_2$ emissions, sourced from the Global Carbon Project and Our World in Data, from 1780 through 2021 [2].

01b The mean monthly atmospheric $CO_2$ concentrations measured between 1960 and 2021 at the Mauna Loa measuring station of NOAA. The concentration of 414.72 ppm measured in 2021 combined with the available historical data during the past five decades indicate the need for action to reduce emissions [2].

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02 Illustration of $CO_2$ emissions in billions of tons for various industries from 1780 to 2021. The low levels of $CO_2$ are notable for all industries (eg, wind solar hydrologic and nuclear power generation) except for coal, oil and natural gas [7].

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03 Illustration of a fully electrified city complete with solar power plants (both on- and off shore), production facility for the energy carrier ie, hydrogen, data centers, storage facilities, and smart technology for integration, etc.

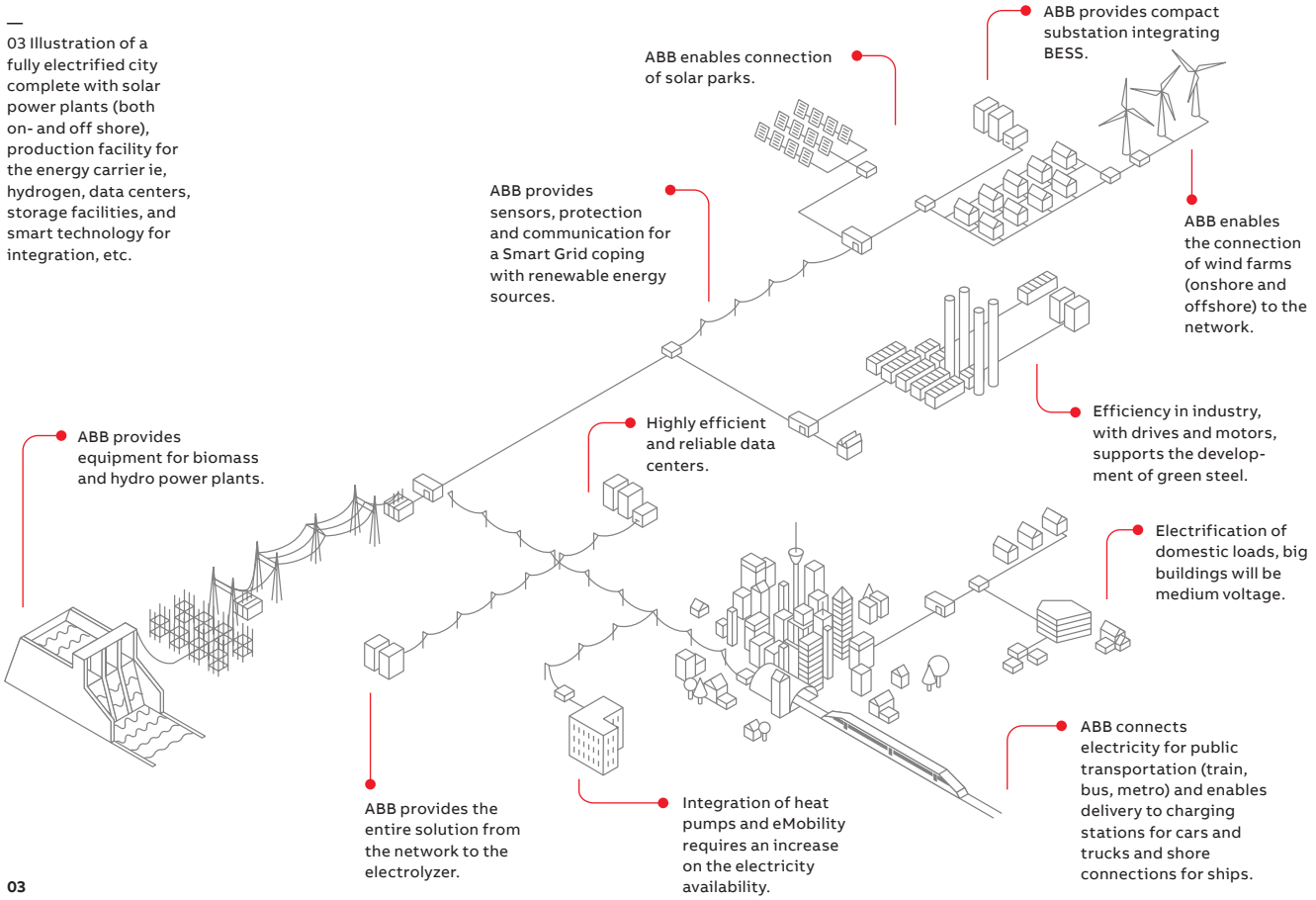
**Integration of renewables with the smart grid**
Despite the rush to develop renewable technology, the integration of the generated energy into the grid is a key concern. For successful integration, components and systems must function flawlessly and simultaneously →04-05. Increased complexity and interdependency can increase risk of disruption; this necessitates innovative technologies for electrification, automation and digitalization. By providing power electronics to convert renewable generated DC electricity to grid-compatible AC electricity; synchronous condensers to support the grid with short-circuit power, inertia and reactive power [12]; and switchgear with advanced digital technology to harness the power of data, ABB is fostering the seamless integration of renewables [13-15].

UniGear ZS1 switchgear delivers reliable protection of generators and transformers as the renewable source is fed into the grid.

For instance, wind parks typically consist of many turbines, each generating a voltage of less than 1 kV; a transformer, to step up to medium voltage (MV) and switchgear, eg, ABB's bespoke modular gas insulated switchgear (GIS) SafePlus, up to 40.5 kV, which can be used to connect with the wind park grid [11]. Larger wind turbines, generating up to 15 MW, connect directly to the wind park network. The electricity is transferred to a transformer substation where the MV is stepped up to high voltage (HV), to reduce losses, for transport to the main electricity grid →04.

Moreover, as the renewable source is fed into the main grid by step-up transformers and MV distribution boards, ABB's UniGear ZS1 switchgear with VD4G circuit breakers [13,14], assures reliable protection of generators and transformers →04, by clearing short-circuit faults rapidly, preventing system and component damage.

In addition to its use in power plants and on- and off-shore platforms for primary distribution (up to 24 kV, 4,000 A, 63 kA) [13], such switchgear can support secondary distribution applications and MV motor control, eg, in utility substations, ships, rail, and a range of industrial applications →04, to maintain a secure power supply. Combined with

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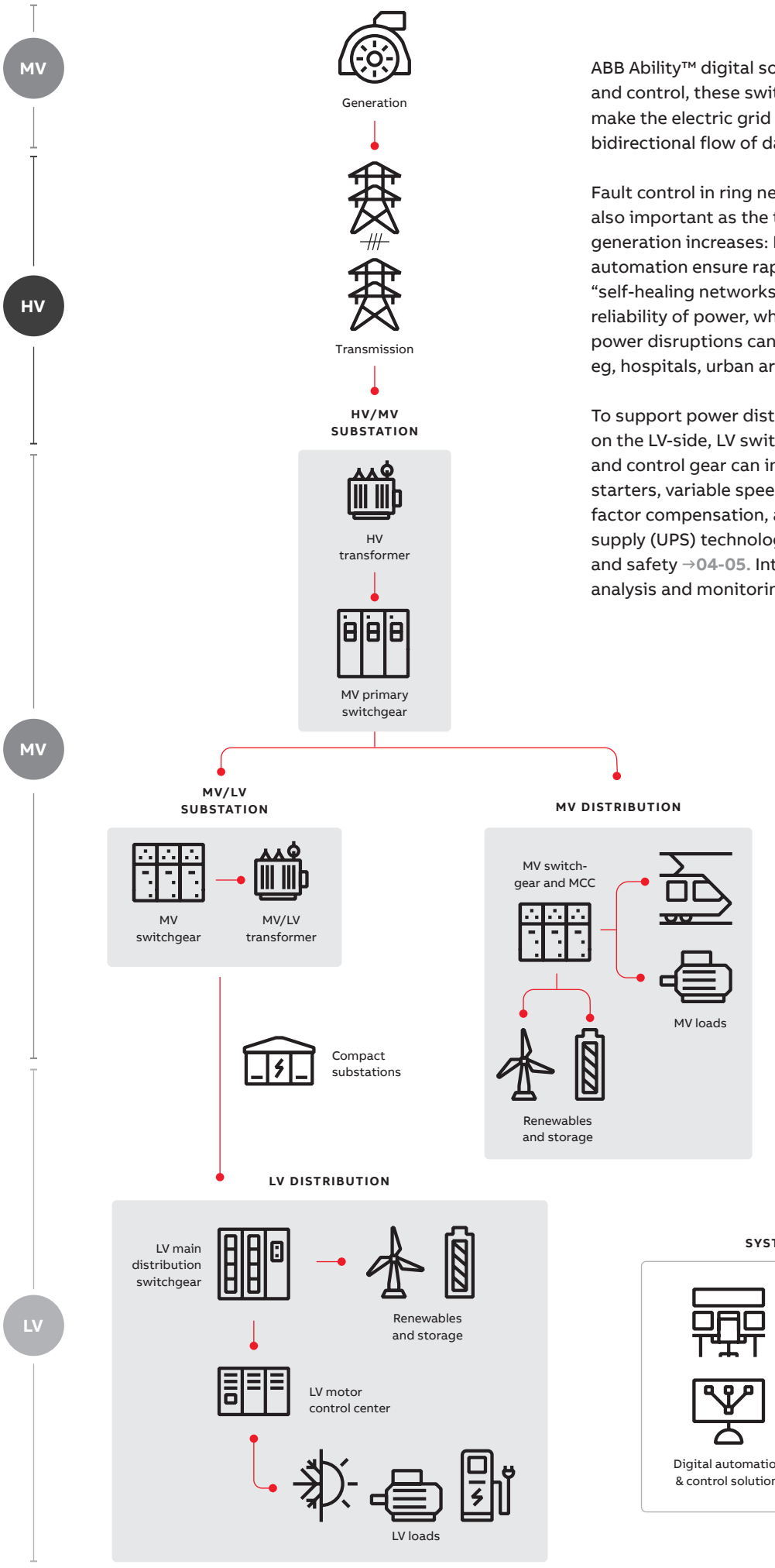
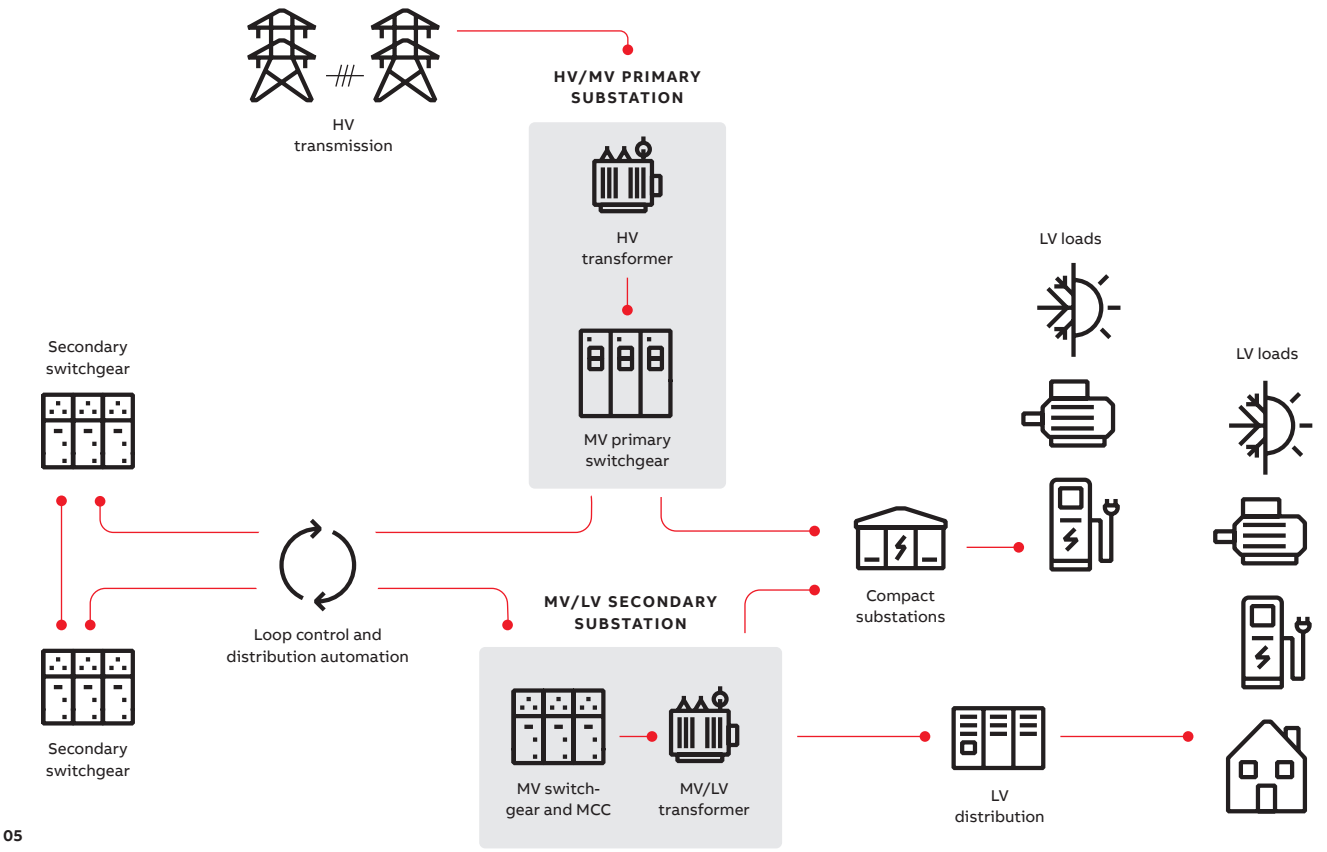



ABB Ability™ digital solutions for automation and control, these switchgear solutions help to make the electric grid smarter by enhancing the bidirectional flow of data [13] →04.

Fault control in ring networks [13-16] →05 is also important as the trend toward distributed generation increases: Here, loop control and automation ensure rapid fault recovery. Such “self-healing networks” ensure continuity and reliability of power, which is so crucial wherever power disruptions can cause severe challenges, eg, hospitals, urban areas, etc.

To support power distribution and motor control on the LV-side, LV switchgear, eg, ABB’s MNS [17], and control gear can integrate feeders, motor starters, variable speed drives (VSDs), power factor compensation, and uninterrupted power supply (UPS) technology for efficiency, reliability and safety →04-05. Integrated data collection, analysis and monitoring for electric systems

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04 This schematic illustrates the holistic approach to the reinforcement of the electric grid, from MV generation to HV transmission, the necessary processes and equipment, switchgear, transformers etc. and digital smart solutions etc. needed until the electricity reaches the load or storage.

—
05 A secondary distribution application illustrating loop control and the so-called self-healing network, which is important for the future of the electric grid as more renewables are added.

provide intelligent control for smarter grid integration, eg, ABB Ability™ Condition Monitoring [17] →04.

**Keeping data centers running**

As the backbone of our digitalized era, data centers are growing in size and power rapidly. They must be continuously "up" and operate sustainably. Behind the scenes, a UPS eg, HiPerGuard MV [18,19], helps keep servers and infrastructure operating smoothly and more sustainably [18]. The UPS converts some of its stored DC power to AC in case a power outage occurs. This allows the data center to run until the disruption is resolved or emergency diesel generators can supply power.

—

By including a smart energy and asset manager, buildings can improve asset utilization, reliability, efficiency and stability.

**Electrification of domestic loads**

In addition to protecting loads in data centers, the electric grid must cope with the need to install greener heating systems, eg, heat pumps. While circuit breakers facilitate the successful integration of heat pumps reliably and safely, eg, ABB's SACE Tmax XT series [20], power needs will increase. Consider an apartment building, with 30 apartments heated by gas, each apartment uses 3 kW electricity, if all 30 apartments switch to a heat pump, each apartment would require 6 kW – or double. Consequently, the building's LV electric distribution network must be reinforced and, at the utility level, more MV to LV substations must be installed →03.

**Smarter energy management**

Efficiency can also be improved by monitoring and controlling the supply and demand of electricity. By including a smart energy and asset manager such as ABB Ability™ Energy and Asset Manager [21], for in-depth analysis, reporting, predictive maintenance and bi-directional communication, buildings can improve asset utilization, system reliability, efficiency and stability[1,2]. Additionally, monitoring and control systems eg, ABB ZEE600, can simultaneously maximize the use of renewable power (roof-top PV) by performing peak shaving of electrical loads, as do EV charging stations – demonstrated at ABB's state-of-the-art factory in Xiamen [22].

**Connections for e-mobility**

With ever more people transitioning to EVs, by 2040, between 340 and 490 million chargers will be needed globally, with home chargers

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**Footnotes**

[1] See also "Sustainable living" in this issue of ABB Review pp. 188–193.

[2] See also "On a mission" in this ABB Review issue pp. 180–187.

06

dominant, This will impact the electricity grid. Infrastructure must be expanded to handle the resulting increased load [23-25] →03-04.

While residential customers might use LV AC charging stations, (taking 12-30 hours to charge with up to 40-80 kWh vehicle battery pack), more customers are switching to DC fast chargers, eg, Terra family of chargers (20 to 180 kW) with an output voltage up to 920 $V_{DC}$, reducing time-to-charge. Despite this impressive capability, even faster chargers would be desirable. As more heavy-duty industrial Etrucks take to the road, multiple super-fast charging stations will be needed to ensure the continuing decarbonization of transportation while improving operational efficiency; ABB provides this and the electric infrastructure needed to deliver this power to connect to the MV network [24,25].

Environmentally benign NIBs are becoming preferable for applications in which weight constraints are unimportant.

**Energy storage**

Ensuring continuity of supply to the electric grid and maintaining stability requires that some renewably-sourced power be stored, but how [26,27] →03-04?

Mobile phones, computers and EVs rely on Li-ion batteries to store energy due to the technology's high energy density [26] →03-04, which features an efficiency between 90 and 95 percent and a discharge-on-demand of 95 percent. But Lithium is flammable, geographically constrained and must be mined for battery production, eg, NMC Li-ion batteries – prompting environmental, safety, cost and supply concerns [26]. Contrastingly, sodium-based batteries (NIBs) are non-flammable, have a ubiquitous source, are environmentally benign and are thus enable a more sustainable electric energy storage system [26]. With 90 percent efficiency, and a high discharge-on-demand, but a low energy density, NIBs are increasingly preferable in many applications – rooftop PV applications – where weight and volume constraints are not important [27].

Despite this trend, HV Li-ion batteries are still relevant for storage in solar power plants: 600 $V_{DC}$, 1,000 $V_{DC}$ and 1,500 $V_{DC}$ [28]. Typically deployed alongside utility-scale solar installations, utility-scale battery energy storage systems (BESS) can match the input DC voltages of the inverters and converters (1,500 $V_{DC}$ input from PV) [28]. Such deployment can stabilize the grid while ensuring security of supply.

To foster sustainability, the production of NIBs with an energy density comparable to that of Li-ion batteries could be advantageous for large-scale grid energy storage [29]: Recently, experts found that high-voltage and high-capacity cathodes provide a means to produce rare earth element-free NIBs to do just that [29].

**Electric modernization of an ABB factory**

By combining smart, connected building energy and asset management systems with electric-powered HVAC systems, storage, and e-mobility connections, ABB demonstrates how to make the electric grid more sustainable, while ensuring stability and reliability. ABB's manufacturing site in Dalmine, Italy , is a low-carbon production site – a Mission to Zero™ site² [30] →06.

Already supplied with 100 percent green energy from renewable sources certified by Enel Green Power, three factory buildings were fitted with 4,000 m² PV panels in 2020 →06. A peak power

06 ABB's 45,000 m² MV circuit breaker and switchgear factory in Dalmine Italy is an example of how to reach decarbonization of the grid by maximizing roof-top solar panels, etc.

of 900 kWp is generated, which provides around 25 percent of the factory's electricity needs. This balances peaks in demand from air conditioning during the summer [30]. ABB Ability™ Energy and Asset Manager now monitors energy consumption to identify inefficiencies and highlight energy saving opportunities: for example, outdoor lighting has been replaced with high efficiency LED lamps, reducing energy consumption by 76,000 kWh per year, which is the energy needed to recharge the growing fleet of electric vehicles.

A modern and reinforced electric smart grid enables a more sustainable energy system and ABB is here to help make this happen.

Despite the significance of steps taken to decarbonize the grid as discussed in this paper, the news media typically highlights only the stars among the renewables: solar panels, wind turbines and EVs. And yet, it is important to keep in mind that without the electricity network, these stars could not shine. A modern and reinforced electric smart grid is required for the connection of these energy sources to their respective loads. ABB along with their partners can help make this happen, thereby enabling a more sustainable energy system.•

**References**


[1] International Panel on Climate Change, "Climate Change 2021: The Physical Basis", *IPCC Sixth Assessment Report*, Available: https://www.ipcc.ch/report/sixth-assessment-report-working-group-i/ [Accessed June 11, 2023.]

[2] R. Lindsey, "Climate Change: Atmospheric Carbon Dioxide", NOAA Climate Website, June 22, 2022, Available: https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide [Accessed June 11, 2023.]

[3] F. Apadula et al., "Thirty Years of Atmospheric $CO_2$ Observations at the Plateau Rosa Station, Italy", in *Atmosphere*, 2019,10, 418, pp. 1-21.

[4] The United Nations, "The Paris Agreement", 2016 Available: https://www.un.org/en/climatechange/paris-agreement [Accessed June 11, 2023.]

[5] United Nations "The Glasgow Climate Pact", *United Nations Climate Change Conference COP 26*, Available : https://www.un.org/en/climatechange/cop26 [Accessed June 11, 2023.]

[6] United Nations Climate Change Conference *COP 27*, Available: https://www.un.org/en/climatechange/cop27 [Accessed June 11, 2023.]

[7] Our World in Data Website "Coal, Oil, and gas where do $CO_2$ emissions come from?" based on Global Carbon Project, Earth Syst. Sci. Data, 14, 4811-4900, Available: https://ourworldindata.org/emissions-by-fuel [Accessed June 11, 2023.]

[8] The European Commission, "REPowerEU: Affordable, Secure, and Sustainable Energy for Europe", 2023, Available: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en [Accessed June 11, 2023.]

[9] International Energy Agency, Available: https://www.iea.org/fuels-and-technologies/electricity [Accessed June 11, 2023.]

[10] J. Bonnett, "Dartmouth Engineering study shows renewable energy will enhance power grid's resilience", 2021, Available: https://engineering.dartmouth.edu/news/dartmouth-engineering-study-shows-renewable-energy-will-enhance-power-grids-resilience [Accessed June 11, 2023.]

[11] ABB Website, "SafePlus Gas Insulated Switchgear", Available: https://electrification.us.abb.com/products/switchgear/safeplus-secondary-gas-insulated-switchgear [Accessed June 11, 2023.]

[12] C. Nilsson, "Grid support", in *ABB Review*, 1/2023, pp. 66-71.

[13] ABB Website, "IEC Air Insulated Switchgear UniGear", Available: https://new.abb.com/medium-voltage/switchgear/air-insulated/iec-and-other-standards/iec-air-insulated-primary-switchgear-unigear-zs1 [Accessed June 11, 2023.]

[14] ABB Website, "IEC/IEEE vacuum generator circuit breaker vd4g" Available: https://new.abb.com/medium-voltage/apparatus/circuit-breakers/indoor-CB/iec-indoor-vacuum-circuit-breaker-vd4g [Accessed June 11, 2023.]

[15] ABB Website, "IEC Air-insulated Secondary Switchgear UniSec", Available: https://new.abb.com/medium-voltage/switchgear/air-insulated/iec-and-other-standards/iec-indoor-secondary-distribution-ais-unisec [Accessed June 11, 2023.]

[16] ABB Website, "Loop Control Solutions", Available: https://new.abb.com/medium-voltage/packaging-and-solutions/digital-systems/loop-control-solutions [Accessed June 11, 2023.]

[17] ABB Website, "Fully IEC Certified and Verified Low Voltage Switchgear Assembly", Available: https://new.abb.com/low-voltage/products/switchgear/mcc-and-iec-low-voltage-switchgear/mns [Accessed June 11, 2023.]

[18] ABB Website, "HiPerGuard", Available: https://new.abb.com/ups/systems/medium-voltage-ups/hiperguard [Accessed June 11, 2023.]

[19] A. Tapp et al., "Powering Sustainability" in *ABB Review* 04/2022, pp. 8-13.

[20] ABB Website, "SACE Tmax XT", Available: https://new.abb.com/low-voltage/launches/xt [Accessed June 11, 2023.]

[21] ABB Website, "ABB Ability™ Energy and Asset Manager", Available: https://global.abb/group/en/technology/did-you-know/abb-ability--energy-and-asset-manager [Accessed June 11, 2023.]

[22] ABB Website "ABB Ability™ Electrification Monitoring and Control ZEE600", Available: https://new.abb.com/medium-voltage/packaging-and-solutions/digital-systems/substation-solutions/zee600 [Accessed June 11, 2023.]

[23] T. Swallow, "ABB releases new home charger and critical EV market data", in *EV Magazine*, 2023, Available: https://evmagazine.com/charging-and-infrastructure/abb-releases-new-home-charger-and-critical-ev-market-data [Accessed June 11, 2023.]

[24] ABB Website, "Heavy-duty truck charging", Available: https://e-mobility.abb.com/segments/heavy-duty-truck-charging/ [Accessed June 11, 2023.]

[25] Bloomberg BEF Website, "Electric Vehicle Outlook 2022", Available: https://about.bnef.com/electric-vehicle-outlook/ [Accessed June 11, 2023.]

[26] S. Lilley, "Sodium-ion Batteries: Inexpensive and Sustainable Energy Source", *Faraday Insights*, 2021, Available: https://www.faraday.ac.uk/wp-content/uploads/2021/06/Faraday_Insights_11_FINAL.pdf [Accessed June 11, 2023.]

[27] DOE, Sandia National Laboratory, "Batteries for Grid Storage: New molten sodium batteries operate at lower temperatures using low-cost materials" in Science Daily, 2021, Available: https://www.sciencedaily.com/releases/2021/07/210721120651.htm [Accessed June 11, 2023.]

[28] ABB Website, "Battery Energy Storage Systems BESS", Available: https://electrification.us.abb.com/your-business/oem/energy-storage-solutions [Accessed June 11, 2023.]

[29] H. Hirsch et al., "Sodium-Ion Batteries Paving the Way for Grid Energy Storage" in *Advanced Energy Materials*, 2020, Vol 10 (32), p. 2001274.

[30] ABB Website, "ABB cools its Dalmine Factory with solar power", 2019, Available: https://new.abb.com/news/detail/39309/abb-cools-its-dalmine-site-with-solar-power [Accessed June 11, 2023.]


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01

SMART ENERGY AND ASSET MANAGEMENT MAKES BUILDINGS ENERGY-EFFICIENT

# On a mission

By combining energy management systems with electrification and renewable resource technologies, ABB established the Mission to Zero™ program. Acting as a guiding light, ABB aims to reach net zero by 2030 in their own factory sites, while helping customers and suppliers reach their emission ambitions too.

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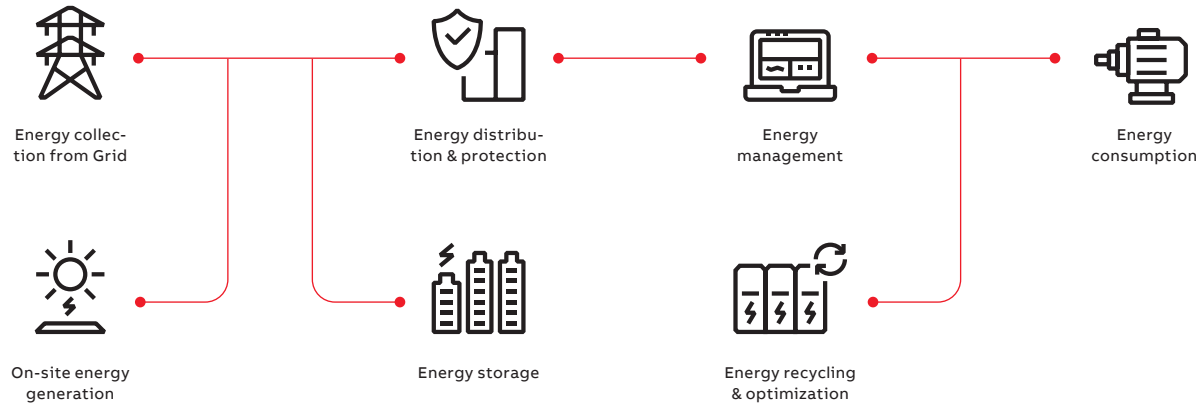
With urbanization and connectivity dramatically increasing over time [1], by 2050 most people will live in cities surrounded by a plethora of connected devices. As such, they will spend around 90 percent of their time inside buildings [2] – buildings that consume around 30 percent of the world's energy production and collectively account for around 40 percent of energy-related $CO_2$ emissions today [3]. Nowadays, around 80 percent of existing buildings are without automation of any kind, while electricity is projected to rise to 30 percent of the energy mix by 2040

Vast amounts of energy could be saved by the electrification and automation of buildings.

[1,4]. Considered together, it follows that vast amounts of energy, $CO_2$, and other greenhouse gas (GHG) emissions could be saved by the electrification and automation of buildings by increasing their energy efficiency, optimizing

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01 ABB's first carbon-neutral facility site at its Busch-Jaeger subsidary in Luedenscheid, Germany is shown.

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02 The overall abstract design of just how the Mission to Zero™ program addresses energy management stages in accordance with ABB's offering.

space occupancy and adding comfort. As part of their sustainability strategy 2030, ABB developed the Mission to Zero™ program, a program to help ABB achieve carbon neutrality by 2030, with strategic partnerships, at their own sites, directly and indirectly, and to encourage their suppliers and help customers in their efforts to reach carbon neutrality too.

**Working toward a carbon-neutral future**
Relying on expertise and collaboration, both in-house and with third parties, the Mission to Zero™ blueprint, developed in 2020 following the success of ABB's light-house project at the Luedenscheid facility in Germany →01, integrates advanced technical and smart digital solutions to reduce GHG emissions →02-03. This is made possible by the vast amounts of accessible, manageable and utilizable data available for sustainable and energy efficient buildings, infrastructure and processes. By combining ABB's energy management solutions, and those

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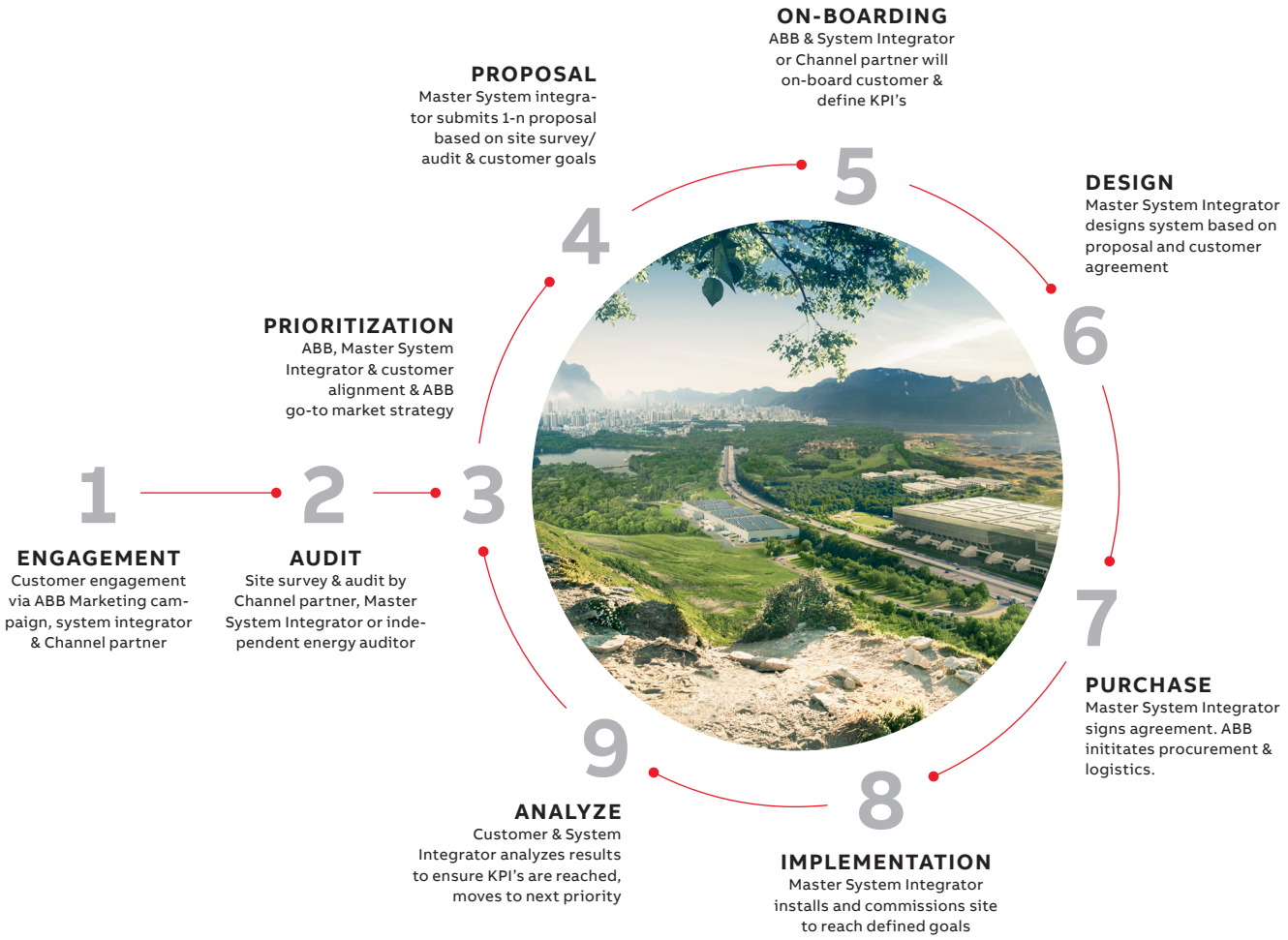
By combining their own capabilitites and expertise with that of partners, ABB helps their customers toward carbon neutrality.

of partners, with electrification, distributed energy resource (DER) technologies and renewable energy sources (solar, geothermal, wind, storage and grid, etc.), customers – ABB factories and external customers alike – are




03

provided with a tailored yet flexible and holistic solution to improve sustainability and efficiency, cost transparency, convenience and well-being for better productivity [1] →02-03.

ABB's approach to building a smarter and more sustainable future includes:

- Energy collection and storage
- Energy distribution and protection
- Energy analysis and optimization
- Energy efficiency

In addition to incorporating ABB's own smart solutions, third party and partner solutions and services are also considered to ensure customers are provided with the best possible solution for their individual sustainability needs. This might include solutions for water conservation and recycling, and even for smart energy management, as well as overall system integration eg, Caverion [5]. By combining the solutions, capabilities and expertise of partners, ABB is better able to bring along their industry-peers and further their customers aims toward carbon-neutral buildings, which is at the core of the Mission to Zero™ program.

ABB developed the Mission to Zero™ program to help achieve carbon neutrality at its own sites by 2030.

03 Mission to Zero™ methodology.

**Applications for a complete solution**
ABB's building applications encompass a wide range of power distribution and protection solutions→04:

- Low voltage (LV) and medium voltage (MV) switchgear
- ABB Ability™, Condition Monitoring for Electrical Systems (CMES)
- Storage systems including BESS[1]
- Building and energy management solutions: eg, metering and ABB Ability™ Energy and Asset Manager →04b
- Heating, ventilation, air-conditioning (HVAC) control products and systems →04c such as ABB Cylon® ASPECT® & INTEGRA™ Building Control as well as the recently released ABB Ability™ Building Analyzer, electrification of heat via heat pumps

ABB's factory in Dalmine, Italy has already been able to reduce $CO_2$ emissions while increasing insight into energy management.

- Use of artificial intelligence (AI) from ABB Ability™ Efficiency AI solution powered by BrainBox AI
- Lighting systems, eg, dimming system based on a digital addressable lighting interface (DALI) and KNX
- Electric vehicle (EV) charging solutions, eg, Terra AC Wallbox and Terra DC fast chargers
- Motors and drives, eg, IE5 SYNRN motors and variable speed drives.

By choosing the right applications in concert with the designed energy architecture →04, customers can benefit from reduced $CO_2$ emissions, energy savings, reduced energy loss, as well as cost savings while fulfilling the requirements of environmental product declarations (EPD) or certificates on their path toward carbon neutrality.

**Lighthouse project demonstrates success**
The proof-of-concept of this approach was demonstrated in 2019 as ABB subsidiary Busch-Jaeger presented its first carbon-neutral industrial site, located in Luedenscheid, Germany →01. Relying on solar power, smart energy management using ABB's OPTIMAX® scalable energy management system and a highly efficient cogeneration plant that features a solar power plant, this flagship site now generates 1,100 MWh annually (albeit this varies according to weather conditions) from a combined heat and power plant (CHP), of 200 kW, 1,250 kW from PV, up to 50 kW of EV charging and has a battery storage with an output of 200 kW and a capacity of 275 kWh, this Mission to Zero™ site saves 744 tons of $CO_2$ annually, depending on the weather conditions in a given year.

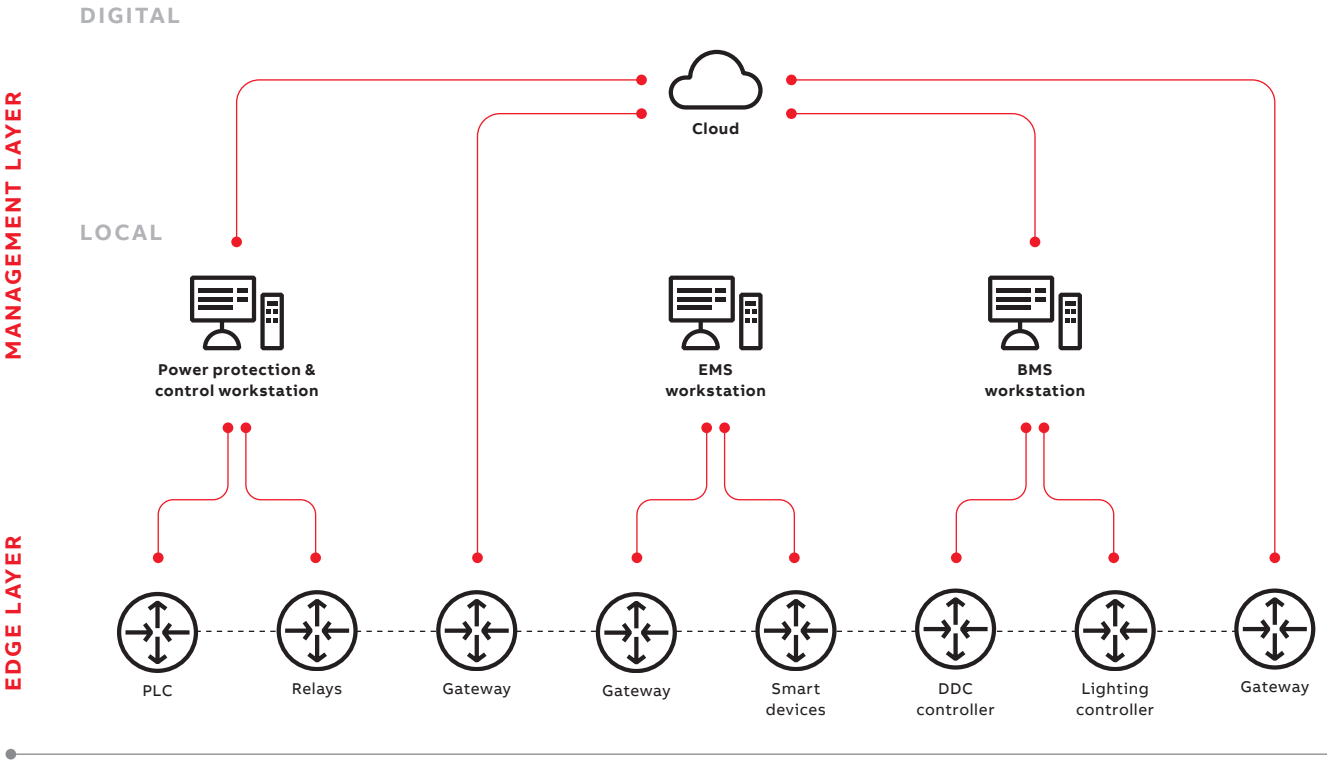
This lighthouse project site demonstrates just how a carbon-neutral and energy self-sufficient ecosystem for industry can result from combining the production data from the Internet of Things (IoT), electrification and buildings. Here, data is gathered from all involved entities, such as utilities, and connected digitally with the data derived from physical entities such as EV chargers, solar panels, or building automation appliances to achieve interoperability. This complete solution results in the ability to optimize energy use and achieve a carbon-neutral ecosystem at this factory.

**Dalmine – the importance of energy transparency**
The Mission to Zero™ blueprint is being successfully applied to other ABB factories as well. A particular highlight is ABB's circuit breaker and switchgear factory in Dalmine, Italy, where Mission to Zero™ efforts have aimed to reduce $CO_2$ and other GHG emissions, conserve resources, and increase visibility and insights into their own energy management →05a. To promote circularity and resource conservation, ABB also evaluated and certified products and processes using life cycle assessments (LCA) and Environmental Product Declarations (EPD). By installing photovoltaics (PV) for power generation and consumption, coupled with smart energy and asset management technology to monitor and assess power use, this ABB factory has been able to generate over 20 percent of its own energy in the summer months, and has reduced $CO_2$ emissions by over 2,200 tons over the past two years.

**ABB's retrofit factory achieves carbon ambitions**
The newest ABB Mission to Zero™ site with completely carbon neutral operations is a factory that produces wiring accessories and material for the smart building market located in Porvoo, Finland →05b. With the total elimination of fossil fuels, this site utilizes almost 100 percent renewable energy derived from a combination of solar and

**Footnote**

[1] Battery energy storage systems (BESS) comprises batteries, a battery management system, an inverter, switchgear, transformer, protection and a control system.




FIELD LAYER

### POWER DISTRIBUTION

**Energy collection**
- Grid connection

**Energy generation**
- Solar panels
- Wind turbines
- Geo-thermal

**Energy distribution**
- MV & LV distribution
- Main & sub distribution

**Energy protection**
- Motor, surge & earth protection

### EV CHARGING

**EV charging**
- AC chargers
- DC chargers

**Energy storage**
- Battery energy storage
- UPS

### ENERGY MANAGEMENT

**Electrical energy metering**
- Main metering
- Sub-metering
- Circuit monitoring
- Smart devices

**Water metering**

**Gas metering**

**BTU metering**

**Fuel metering**

### HVAC CONTROL

**Air-side energy optimization**
- Air handling units
- Supply fans
- Exhaust fans
- Fan coil units
- VAV boxes

**Water side energy optimization**
- Chiller, boiler
- Heat exchanger
- Cooling tower
- Chilled water pump
- Hot water pump
- Heat recovery pumps

### LIGHTING CONTROL

**Natural light optimization**
- Occupancy sensor
- Brightness sensor
- Shades/blinds controller

**Artificial light optimization**
- ON/OFF controller
- DALI dimmer
- Direct dimmer
- Low voltage dimmer
- Timer

### MOTORS & DRIVES

**Energy efficiency**
- Normal fan motors
- Water pump motors
- Chiller motors
- Safety fan motors
- Variable speed drives

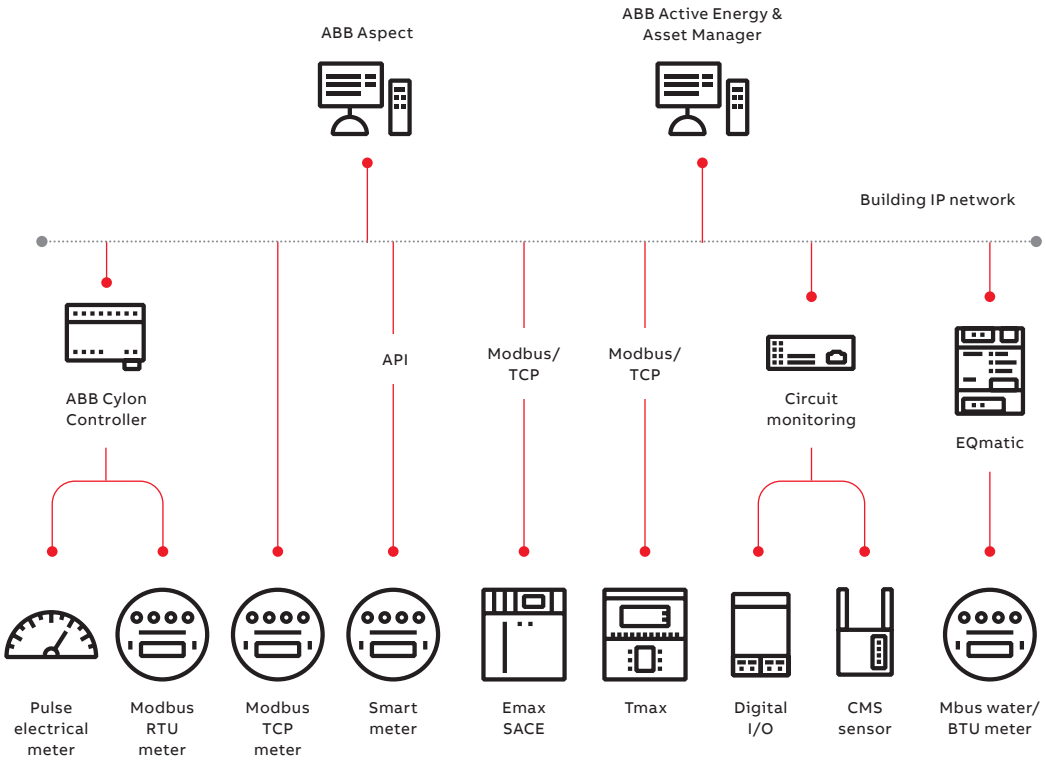
**04a**

04 The combination of state-of-the-art technology and advanced digital solutions, as the architecture schematics shown here illustrate, help customers achieve more sustainable operation.

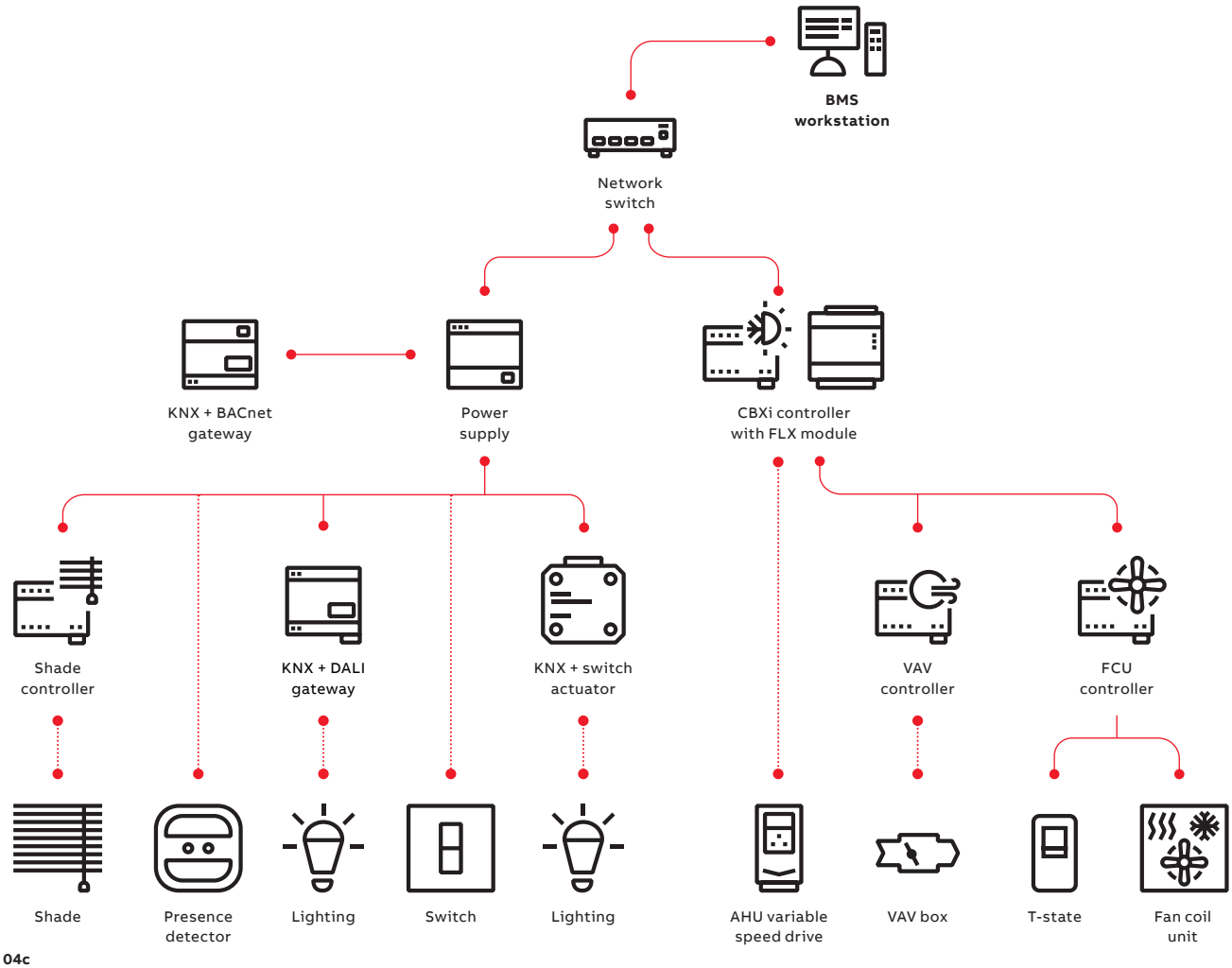
04a Global reference architecture.

04b An example of the building energy management electric metering architecture.

04c An example of the building energy management architecture for HVAC and lighting.




04b




04c

05a

heating systems via eg, a heat pump, and the use of recycled plastic for the production process. Specifically, 238 MW/yr power is self-generated from a 375 kW PV system; the heat pump system covers 93 percent of the heat needed. Results from this industrial site demonstrate that factories with legacy technologies can be successfully retrofitted in efforts aimed toward carbon-neutral ambitions.

In its first year of operation, this retro-fitted facility achieved a 21 percent increase in energy efficiency and a savings of 636 tons of $CO_2$ emissions. This is a stark demonstration of what is possible when ABB's advanced digital solutions are integrated with state-of-the-art technical solutions. By combining ABB Ability™ History for real-time data gathering and storage, with ABB Ability™ Building Analyzer for near real-time data visualization and third party information systems, data is collected on thermal energy, electricity and water consumption, which has been registered by meters, electrical equipment and production cells →05b. This information is then used for monitoring and analyzing energy consumption, for assessing and optimizing the energy balance and processes. Importantly, this same process can be applied to other factories as well as to homes and even to entire cities.

**Looking at the future through a new lens**

Within the context of recent global geo-political events and economic crises, forming strategic alliances within the private sector is of paramount importance [6]. By zooming out it becomes crystal-clear that there is a need to facilitate the implementation of smart, safe and sustainable energy management technologies, so that their impact at scale can be magnified, for the benefit of all.

A prime example of this amplification effect is demonstrated by the strategic partnership between ABB and Microsoft[2], which was first introduced in 2016. When ABB launched the Mission to Zero™ Program in 2019, the primary objective was to "walk the talk" on sustainability by bringing ABB's own operations close to carbon neutrality, while concomitantly building up a customer-centered commercial offering around decarbonization services. The approach has

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The Mission to Zero™ site in Porvoo, Finland is ABB's newest factory with completly carbon-neutral oprations.

been powered by a broad network of partners, such as Microsoft, across the energy sector and beyond. Since then, Microsoft has been a close implementation partner – one that has accompanied ABB along their journey toward carbon neutrality. Microsoft has supported ABB Ability™ digital solutions with its Azure cloud services and ecosystem. Moreover, since Microsoft launched their Cloud for Sustainability recently, ABB has begun to onboard these products and solutions

05b

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05 Two examples of Mission to Zero™ sites are shown.

05a In addition to reducing $CO_2$ emissions at the Dalmine factory, ABB evaluated and certified products and processes using LCAs and EPD, thereby promoting sustainability overall.

05b The digital solution at the Porvoo site relies on ABB Ability™ History data collected from thermal, electricity and water consumption as well as ABB's technical solutions to reach carbon neutrality ambitions.

Microsoft has been a close implementation partner of ABB, accompanying ABB on its journey toward carbon neutrality.

into the new sustainability-centered ecosystem. Beginning in 2023, ABB will be rolling-out the joint offering within its plants under the umbrella of the Mission to Zero™ program.

The success of the Mission to Zero™ program to date, not only demonstrates ABB's commitment to sustainability and carbon neutrality, it provides a tested means to reach carbon and reduction ambitions in buildings around the world whether they already have some automation or digitalization capabilities or not. By fostering strategic alliances with commercial partners such as Microsoft, Caverion and others, ABB is integrating technologies in an effort to reduce reach energy and $CO_2$ reduction goals at scale – a boon for business and humanity alike – and an important step toward a more sustainable future in an increasingly uncertain world. •

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**Footnote**

[2] See "Perfect Partners" in this issue of ABB Review on pp. 194-199.

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**References**


[1] ABB, "Mission to Zero™ Building Solutions" ABB eBOOk, Available: https://buildingsolution-sebooks.abb.com/view/822880579/ [Accessed June 11, 2023.]

[2] KLEPEIS, N., et al. "The National Human Activity Pattern Survey (NHAPS): a resource for assessing exposure to environmental pollutants", Journal of Exposure Science and Environmental Epidemiology, 11, 2001, pp. 231–252.

[3] IEA, "Global energy use and energy-related CO emissions by sector", 2020, Available: https://www.iea.org/data-and-statistics/charts/global-energy-use-and-energy-related-CO-emissions-by-sector-2020[4] ABB, ELSB red line strategy 2021 [Accessed June 11, 2023.]

[4] European Commission "A renovation wave of Europe, Greening our buildings, creating jobs, improving lives", 2020, Available: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en [Accessed June 11, 2023.]

[5] ABB press release, "Development of carbon-neutral buildings accelerated through ABB and Caverion collaboration", Sept. 8, 2022, Available: https://new.abb.com/news/detail/94574/development-of-carbon-neutral-buildings-accelerated-through-new-abb-and-caverion-collaboration [Accessed June 11, 2023.]

[6] The World Bank. "Global Economic Prospects", June 2020. © Washington, DC, Available: https://openknowledge.worldbank.org/entities/publication/d29e6c95-4753-58e8-b368-d03c78cacab5 [Accessed June 11, 2023.]

INTERVIEW: SMARTER BUILDINGS AND THE ABB ELECTRIFICATION STARTUP CHALLENGE

# Sustainable living

The built environment is undergoing a rapid evolution. ABB Review met with Dirk John, innovation manager and expert at ABB Smart Buildings to discuss the role ABB is playing to incorporate new forms of construction and innovative intelligent technologies to make homes and buildings not just smarter, but safer, more comfortable and sustainable.

**AR** **ABB Review (AR):** Dirk, it seems that every industry has joined in to reduce $CO_2$ emissions on the road to net zero. How can smart buildings help?

**DJ** **Dirk John (DJ):** Currently, buildings account for around 40 percent of global $CO_2$ emissions, annually with about 70 percent of that derived from building operations. This is massive. If we, at ABB, can significantly reduce that greenhouse gas contribution by developing intelligent building solutions to manage energy and assist people in their efforts to optimize, we will contribute toward carbon neutrality – a core focus at ABB.

Buildings account for around 40 percent of global $CO_2$ emissions annually; 70 percent of that is derived from operations.

**AR** What possibilities exist to help people interact with their homes and workplaces in a safer smarter and more sustainable way to address this focus?

**DJ** The increase in connectivity, and advances in the Internet of Things (IoT), have led to a growth in smart technology and automation. This has ushered in a new way of living and working

which necessitates a human-centric design and construction approach [1]. This new demand for convenience, comfort, energy efficiency and product sustainability at home and in the office is driving the demand for more intelligent houses and buildings. Because at ABB we aim to help people live better lives whether at home or work by improving well-being, energy efficiency and cost transparency, it makes sense for us to focus on the human-centric design of smart houses and buildings to create holistic solutions that include greenhouse gas reduction.

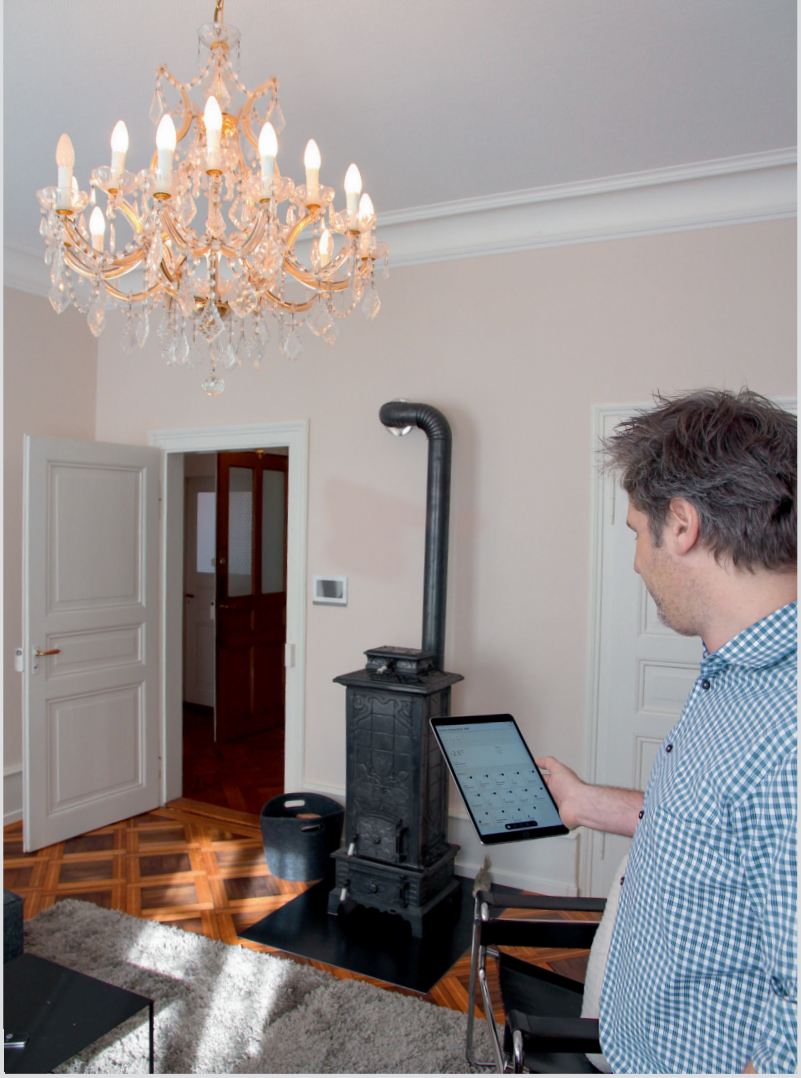
**AR** So, could you provide us with an example of technology that supports the human-centric design principle?

**DJ** Absolutely. ABB's well-established yet first-of-its-kind, i-bus® KNX product range is a good example of technology available for all types of buildings →01; it includes components that cover many applications that make peoples' lives more convenient, comfortable, energy efficient and sustainable. Products range from lighting and blind control to heating, ventilation and air conditioning (HVAC), security, and energy management [2]. Because all devices communicate with one another via a single bus cable installed alongside normal power lines, all electrical functions are interconnected – a boon for building control and human interaction.

**AR** What about industrial or commercial buildings specifically, how does ABB help these customers?

**Dirk John**
Innovation Manager for Strategy and Portfolio Management for ABB Electrification Smart Buildings in Heidelberg, Germany

**After finishing his PhD at University of Karlsruhe, Dirk began his career at ABB in research; he then joined the ABB Smart Buildings as Global Product Manager, working closely with the ABB Ability™ team. He is currently responsibile for "open innovation", mainly driving cooperation with startups, ranging from partnering up to investments.**



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01 ABB-free@home®, shown here in use, is an easy-to-use smart home product that controls blinds, HVAC and door automation for example, thereby providing the customer sustainable comfort and convienence.

—
02 ABB Ability™ Building Analyzer tracks both building data (occupancy, equipment runtime hours, temperatures, and costs) and utilities (energy, gas, water, steam) in real-time and provides actionable insights to help save money while improving energy efficiency, sustainability, and occupant awareness.

**DJ** ABB is not only zeroing in on comfort and convenience for the building occupants, we are also focusing on lowering the building's energy consumption. This will not only help to address carbon-neutral ambitions, it is especially important in today's uncertain energy market. If we consider the dramatic increase in utility prices this past year and future possible trends, it is important for customers to have the best possible control of their HVAC systems, and lighting, since

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Demand for convenience, comfort, energy efficiency and sustainability is driving the demand for more intelligent buildings.

heating and air conditioning alone can account for 20-40 percent of a commercial building's energy costs. ABB acquired Cylon® to support our product range on the building-side, specifically for the effective management of HVAC and lighting. ABB's Cylon® products are scalable and serve a spectrum of connected building energy management solutions for automation and energy control of any size commercial or industrial building [3]. Customers can even prevent up to 20 percent of a building's energy drift annually through continuous monitoring and management of building energy usage →02.

**AR** Since there is clearly much need as well as predicted growth in the commercial building sector [1], why does ABB focus on smart homes in addition to buildings?

**DJ** Let's face it most everyone has a residence of some kind, be it a studio flat or a villa. Our aim is to develop the connective and automation technologies to assist people in their daily lives no matter how and where they reside. What better way is there to do this then by improving design, comfort, security and energy efficiency of home appliances, lighting, blinds, air conditioning and heating and door automation. In this way, the building assists the resident.

**AR** What role does convenience and assistance play in ABB's approach to smart homes?

**DJ** Enhancing total ease of ownership is paramount – IoT elements need to be easy to install, use, understand, and maintain, all in a sustainable way if customers are to benefit. For instance, both

interconnectivity and automation allow users to remotely manage and monitor thermostats, indoor and outdoor lighting, surveillance camera footage, and program blinds with ease.

**AR** Could you provide our readers with an ABB home product example?

**DJ** ABB-free@home® for lighting, blinds, HVAC, and door automation control is a good example of an all-in-one smart home product designed for convenience in addition to comfort, and energy efficiency [4]. It is truly a residential assistant. Control is intuitive, by switch or voice, via tablet, PC or Smartphone, and it can be easily set according to individual personal preferences. Functions can also be managed automatically, according to schedule, temperature and the presence of people, or by the touch of a screen. A very important aspect is the low cost of ownership compared to other electrical installations – this makes it particularly attractive.

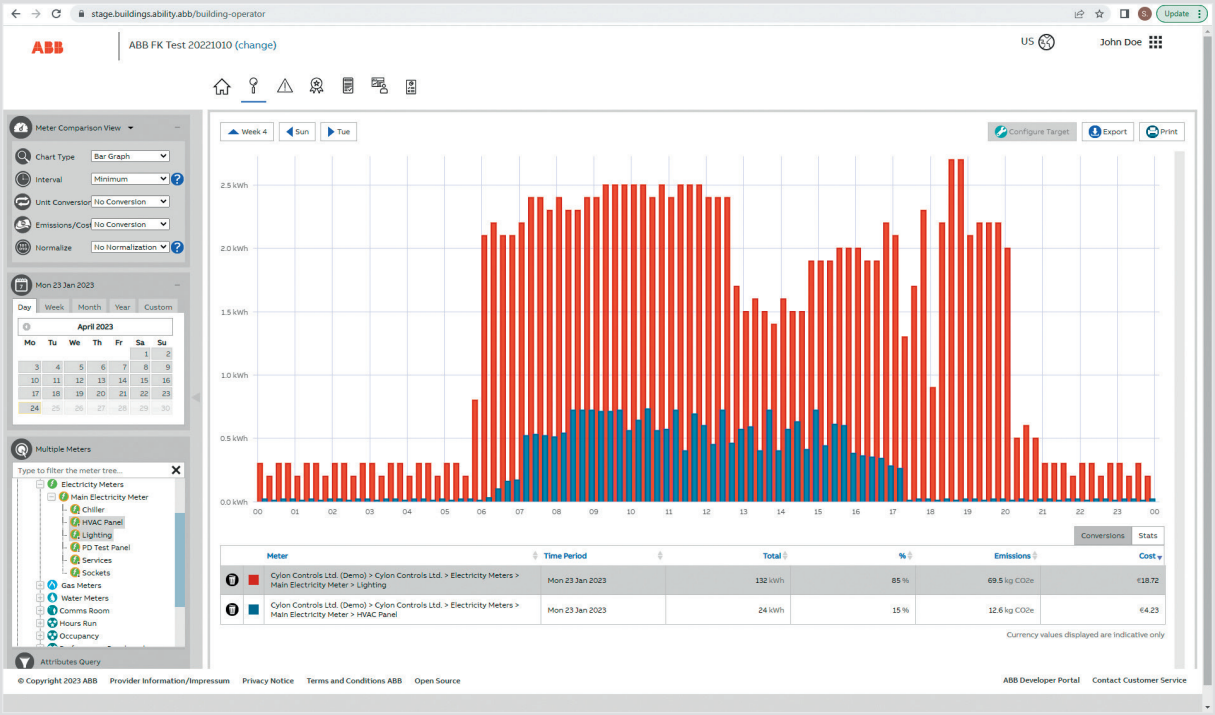
**AR** What about system security and product sustainability?

**DJ** ABB's unique app uses conventional and therefore sustainable operating systems, iOS and Android. After all no one wants to invest in a system that must be replaced in two years. System flexibility and simplicity of design help to ensure ABB-free@home® as a future-proof assistant. It relies on wired or wireless sensors, actuators and sensor-actuator units. And, to lower the security risk, there are a multitude of up-to-date measures for protection, yet configuration and operation are as easy as surfing the internet. It also connects to ABB's MyBuildings Portal which is powered by ABB Ability™ platform for support and is open for partnerships, like we are doing with Samsung and others.

At ABB, our aim is to develop connective and automation technologies to assist people in their daily lives.

**AR** In addition to developing and launching such smart products, how is ABB promoting innovation in this field?

**DJ** One important way is through collaboration. Each year since 2020, ABB has initiated "The ABB Electrification Challenge" for entrepreneurial startups [5]. There are different categories, with Smart Buildings, my focus area, forming one of this year's four challenges. Because the demand for more connectivity is growing in all areas of our lives, we think it is important to work with others to advance human-building interaction for

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03 Representatives from ABB and the 2023 winner of the ABB Electrification Startup Smart Building Challenge, Epishine, are shown. From left to right: Morten Wierod, President of ABB Electrification; Daniel Westling, VP Sales and Marketing, Epishine; Dan Nylén, Lead Integration Engineer, Epishine; Jonas Engstrand, Account Executive, Epishine; Lucy Han, Global Product Group Manager BHAS, ABB Electrification Smart Buildings, and Dirk John, Digital Innovation Manager, ABB Electrification Smart Buildings.

03

customers. The challenge gives us the opportunity to further relationships, through networking, with creative thinkers to foster new ideas – even those we might never otherwise consider.

**AR** What about the motivation for a startup?

**DJ** Clearly a challenge must be beneficial for all parties involved: The winner receives a prize of 30,000 USD, the ability to work with us toward a market entry such as developing a pilot case, interaction with ABB customers, and sessions with Microsoft mentors as well as a 6 month membership in ABB's startup accelerator, Synerleap, which has created more than 200 collaborations, together with 160 startup members from 24 countries. When everything is taken into account, all winners gain success in the market. Even those who don't win, gain valuable feedback from the coaches and jury members and establish bonds, which can help them in the future.

**AR** Can you give an example of a successful candidate from a previous year?

**DJ** Indeed. Mavenoid, a startup located in Sweden, won the first challenge with an exciting business idea. By taking advantage of the feedback and support provided by ABB and its partners, Mavenoid has turned into the ultimate success story. They utilized all the opportunities provided by the Electrification Startup Challenge and have developed a growing business. Today the company provides a scalable support platform for hardware companies [6]. For example, the support platform helps customers onboard, to use, and troubleshoot products. Mavenoid guides users to fix product issues themselves, instead of just deflecting to generic articles or FAQs by combining existing content, input from a support team, and AI. In response to their success, last year ABB Smart Buildings decided to invest into Mavenoid by joining their recent funding round.

**AR** Could you explain to our readers the challenge and the candidate selection process.

**DJ** Certainly, the description of the challenge is released through all the normal media channels with an invitation to apply. A PowerPoint application template is available for download. Once startups submit their applications, the applications are evaluated until the closing date (Feb. 21, for this year). After an initial filtering session, a team evaluates the most promising candidates. These are chosen for a ten day-long virtual challenge; support is provided from ABB's global smart building experts. The best three candidates will be invited to the final event in Berlin where one startup will win the challenge →03. All participants receive feedback from experts because we want each to benefit from the experience, even to reapply later if they don't win in a given year.

—
Each year since 2020, ABB has initiated "The ABB Electrification Challenge" for entrepreneurial startups.

**AR** This year's challenge targeted smart functions, such as smart wiring accessories, to assist the user wherever he or she is located. Can you expand on this?

**DJ** Yes, we decided to focus on the residential application field this year. It is a rather broad field ranging from devices that lower energy consumption needed to power conveniences in a home, such as energy harvesting; through AI and machine learning solutions based on user and room information to control a room; to solutions that combine and integrate different domains with limited user interactions and those that connect with ABB's MyBuildings Portal.

**AR** Why did ABB decide to issue a challenge with such a broad topic area?

**DJ** I can imagine that might seem counter-intuitive. Practically, by targeting such topics we focus on domains that fit well within our product portfolio and are in line with our overall aim to assist people to interact comfortably and conveniently in their residences to achieve greater energy efficiency, security and safety.

Also, from experience, we know that it is important to be expansive in our challenge descriptions. If the challenge is too narrowly defined, we might possibly eliminate candidates who have wickedly creative ideas – ideas that might not have occurred to us. After all, innovation demands freedom to unfold. We also have to consider that our challenge description could be interpreted differently than we have intended by some good candidates.

**AR** Can you give us an example?

**DJ** This year we received, once again, very interesting applications that did not fit in our framework, eg, the definition of a residence. However, some of these applications fit the criteria for other ABB units, in our division, or elsewhere, so we were able to forward the applications to these ABB teams for consideration.

**AR** It sounds like a positive and dynamic experience for all involved, but of course there can only be one winner. Has ABB announced a winner for 2023 yet?

**DJ** Indeed, it has been a valuable experience, all-around, to work with so many innovative startups. One startup however stood out this year. Epishine was announced as the winner of the 2023 ABB Electrification Startup Challenge in the smart building category at the ABB Formula E race event in Berlin. Epishine fits our challenge criteria perfectly. This Swedish company, founded in 2016, develops self-powered sustainable indoor solar cells that power electronics using light. The thin and flexible design, allows the solar cells to be easily integrated into IoT devices to achieve high-level performance and

Epishine, a Swedish company that develops self-powered solar cells, won this year's Smart Building Challenge.

reliability. We, at ABB, are thrilled to be able to collaborate with Epishine this year. And, we will certainly keep in contact with all of our excellent contenders and finalists.

**AR** Thank you Dirk for the interview. •

**References**

[1] M. Chiu et al., "IoT value is set to grow through 2030: Where and how to capture it", McKinsey Website, 2021, Available: https://www.mckinsey.com/capabilities/mckinsey-digital/our-insights/iot-value-set-to-accelerate-through-2030-where-and-how-to-capture-it [Accessed June 11, 2023.]

[2] ABB Website, "ABB i-bus® KNX", Available: https://new.abb.com/low-voltage/products/building-automation/product-range/abb-i-bus-knx

[3] ABB Website, "ABB Cylon® Smart Building Solutions", Available: https://new.abb.com/low-voltage/products/building-automation/product-range/abb-cylon [Accessed June 11, 2023.]

[4] ABB Website, "ABB-free@home", Available: https://new.abb.com/low-voltage/products/building-automation/product-range/abb-freeathome [Accessed June 11, 2023.]

[5] ABB Website, "ABB Electrification Startup Challenge 2023 Smart Buildings", Available: https://campaign.abb.com/ABBElectrification-StartUpChallenge2023/smart-buildings [Accessed June 11, 2023.]

[6] Marvenoid Website, "The Product Support Platform", Available: https://www.mavenoid.com/en/ [Accessed June 11, 2023.]

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01 The quest for peak performance demands collaboration with a shared sense of mission.

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**01**

MICROSOFT AND ABB: ENABLING IMPROVED ENERGY EFFICIENCY IN CUSTOMER OPERATIONS

# Perfect partners

From start-ups to multinational enterprises, industrial organizations are looking to improve energy efficiency with an eye to mitigating rising energy costs and greenhouse gas emissions →01-02. Two companies that are helping businesses around the globe realize this goal are Microsoft and ABB.

Microsoft's cloud and analytics services support ABB in helping customers meet their sustainability goals. They do so through the industrial Internet of Things (IIoT), and through energy appraisals and smart energy management solutions that sustain better decisions on ways to save energy, lower $CO_2$ emissions and boost a company's overall operational efficiency. Among the many areas in which the two companies have made common cause is in optimizing the energy efficiency of motor-driven systems.

Eighty-nine percent of industrial leaders surveyed intend to increase investment in the energy efficiency of their operations.

Sometimes referred to as the "first fuel," energy efficiency is a key piece of the puzzle when it comes to reducing greenhouse gas emissions within industry. Indeed, a recent survey [1] commissioned by ABB found that energy efficiency is a priority issue for executives around the world. Eighty-nine percent of industrial leaders surveyed intend to increase investment in the energy efficiency of their operations in the coming five years, with 54 percent aiming to achieve net-zero emissions in that timeframe. Major steps in this direction have already been undertaken. For example, although worldwide energy demand is predicted to grow, an International Energy Agency (IEA) analysis of nine large countries and regions, including China, the European Union and the United States, found that efficiency standards helped to save about 1,500 TWh in 2018 [2]. This was equivalent to the total electricity generated in 2018 in those countries by wind and solar facilities.

The cooperation between Microsoft and ABB is a case in point. Recently, for instance, Microsoft joined the Energy Efficiency Movement [3]. The Movement, a multi-stakeholder initiative launched by ABB in 2021, is designed to raise

awareness and spur action to reduce energy consumption and combat climate change. Companies are invited to join The Movement and make a public pledge as a way of inspiring others to take action. To date, more than 350 companies have joined The Movement, with Microsoft being one of the largest organizations to join.

**Insights from energy appraisals**

Concretely, key Microsoft and ABB technologies enhance each other's energy efficiency offerings in a number of areas. For instance, by acting on insights gathered from the ABB Ability™ Digital Powertrain Energy Appraisal solution, Swedish flooring manufacturer Tarkett was able to use data gathered from 10 connected motors to improve the motors' efficiency from 80 percent to 95 percent, thus saving 800 MWh per year.

Similarly, an ABB Ability Digital Powertrain Energy Appraisal recently helped Swedish pulp producer Waggeryd to pinpoint places where energy savings could be made. This was accomplished by mounting sensors on the mill's motors to collect and transmit data to the ABB Ability™ Condition Monitoring system. The system analyzes the information to provide key operational equipment parameters and provide early warnings regarding potential trouble that may be developing, for example when a bearing may be trending toward higher vibrations – and possible failure [4].

Key Microsoft and ABB technologies enhance each other's energy efficiency offerings in a number of areas.

To summarize, appraisals based on ABB and Microsoft technologies offer the following benefits:

- Reducing energy waste and costs by identifying energy-intensive applications, finding ways to cut energy waste, and obtaining an estimate of potential cost savings.
- Cutting $CO_2$ emissions, thus helping to meet local environmental regulations and meet the customer's sustainability goals.
- Lowering total operating costs as a result of rapid payback from investing in, for example, high-efficiency motors and drives and the impact on the total cost of ownership of reducing energy consumption.
- Minimal disruption to operations since appraisals are carried out without any impact on a facility's operations. New equipment recommended by the appraisal can be installed during routine maintenance shutdowns, thereby minimizing disruption to production.

**Powering optimization**

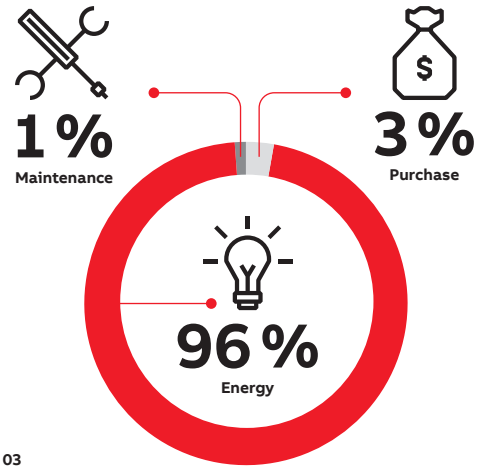
One key area in which ABB and Microsoft are working to enable greater energy efficiency is the operation of motor-driven systems →03-04. Worldwide, there are over 300 million such systems and they account for 70 percent of the electricity consumed by industry [5]. Using Microsoft Azure's platform-as-a-service capability, along with AI and machine learning-based analytics, cloud computing and edge technologies, ABB Ability solutions are optimizing the efficiency of motor-driven systems in a wide array of applications that range from manufacturing and buildings to agriculture →05,[6].

**ABB SUSTAINABILITY GOALS**

By 2030, ABB aims to achieve carbon-neutral operations. ABB has already reduced scope 1 and 2 emissions by some 65 percent versus the company's 2019 baseline, with a full 42 percent reduction in 2022 alone. As part of its overall sustainability strategy, ABB has committed to EP100, an energy efficiency initiative spearheaded by the Climate Group, a non-profit organization that partners with businesses and government leaders around the world on climate action. With EP100, ABB has committed to establishing energy efficiency targets and continuing to deploy energy management systems at the company's sites.

**MICROSOFT SUSTAINABILITY GOALS**

Microsoft has been carbon neutral since 2012. By 2030 it will be carbon negative and by 2050 Microsoft will remove from the environment all the carbon it has emitted either directly or by consumption since it was founded in 1975.

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02 ABB's and Microsoft's sustainability goals.

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03 Total cost of ownership for motor systems.

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04 Replacing an old motor (IE1, 90 kW, running at full load) with a more efficient motor (IE4, 90 kW, running at full load) can significantly reduce losses and energy costs.

Another energy efficiency solution is ABB Ability™ Energy Manager, which is built on a state-of-the-art cloud architecture for data collection, processing and storage. The architecture was developed together with Microsoft to enhance performance and guarantee a high level of reliability and security for industrial assets. This Azure-enabled solution supports the collection and storage of data from ABB devices installed in low- and medium-voltage distribution systems in a wide range of industrial and commercial facilities →06. The solution allows customers to consolidate data from a wide variety of sensors, secure data from edge device to application and apply AI-based analytics to make sense of data and drive smarter decisions about how energy is used. The ABB Ability Energy Manager solution enables actionable insights into energy usage that can reduce electrical costs by up to 30 percent, save up to 40 percent on maintenance costs, improve energy efficiency by up to 10 percent, and save up to 20 percent on energy bills [7]. Azure's compute, storage, security and analytics capabilities have allowed ABB to develop energy efficiency offerings serving a cross-section of industrial and commercial use cases with greater scalability, cyber security and consumption model flexibility.

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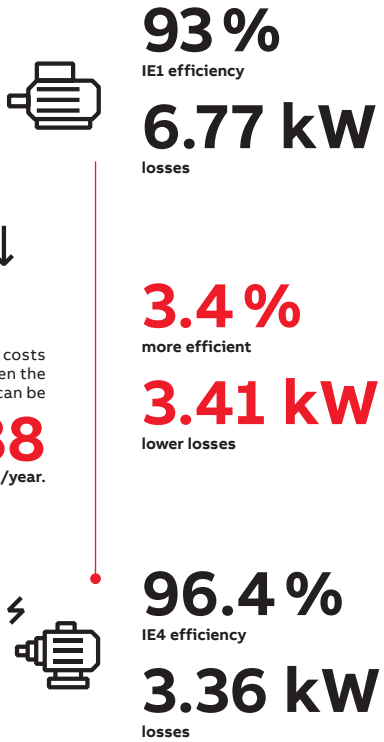
The ABB Ability Energy Manager solution enables actionable insights that can reduce electrical costs by up to 30 percent.

**Toward carbon-neutral operations**

In 2019, ABB launched its Mission to Zero™ program, which seeks to help customers achieve carbon neutrality by leveraging energy management solutions associated with electrification, distributed energy and renewable energy. The initiative aims to "walk the talk" on energy efficiency by demonstrably reducing greenhouse gas emissions across ABB's operations while building up a customer-facing commercial offering around decarbonization services, all powered by a broad network of partners such as Microsoft. Since the program's inception, Microsoft has been a close implementation partner along the journey towards carbon neutrality, supporting ABB Ability digital solutions with its Azure cloud services and ecosystem. ABB is integrating a number of solutions with the recently launched Microsoft Cloud for Sustainability and has begun deployment of these capabilities in its own manufacturing plants under the umbrella of the Mission to Zero™ program.

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The first joint installation is currently underway in the ABB Electrification Smart Buildings factory in Schaffhausen, Switzerland. The project uses building management and other applications on top of the Microsoft Cloud for Sustainability to deliver transparency and automated monitoring and reporting. With the Corporate Sustainability Reporting Directive requiring that companies apply the new rules for the first time in 2024 [8], ABB digital solutions will serve as a key data input and aggregator for automated reporting through the Microsoft Cloud for Sustainability.

**Partnering for innovation**

In 2021, SynerLeap, ABB's global innovation growth hub, began working with Microsoft for Startups to bring the two companies' accelerator arms together to speed up co-creation and scaling. Working with Microsoft and Synerleap, ABB has successfully identified new partnerships and integrated innovation into the ABB Ability portfolio.

Supported by Microsoft, ABB's range of digitally enabled solutions and life cycle services help companies continuously optimize the energy efficiency of their assets, reduce energy consumption, and limit $CO_2$ emissions [9]. As digitization continues to progress, data-driven services will continue to make it easier for companies to achieve their sustainability goals through improved energy efficiency.

Looking to the future, Microsoft and ABB continue to develop and explore existing and potential collaboration opportunities. For example, enabling more accurate, efficient sustainability data collection and reporting within ABB and bringing ABB Ability energy efficiency-focused solutions into Microsoft's Cloud for Sustainability.

Combining ABB's domain expertise in electrification and automation with Microsoft's Azure cloud platform shows how collaboration with a shared mission can create innovative solutions addressing global challenges. •

## PUTTING ENERGY EFFICIENCY ON THE MENU

Backed by Microsoft Azure, ABB is providing the hardware and digital infrastructure for energy resource management at Pure Harvest Smart Farms, a start-up that is pioneering sustainable smart farms for the Middle East. Pure Harvest is an innovator in sustainable agriculture, growing pesticide-free, fresh fruits and vegetables all year.

The start-up constructs the hosting infrastructure for smart farms that provide crops with optimal growing conditions: the right levels of light, water, ventilation, $CO_2$, temperature and nutrients. The business model for the sustainable operation of these controlled environments requires 24-7 operation with full remote visibility of energy resources, assets and electrical system behavior.

To meet these requirements, Pure Harvest uses the ABB Ability Energy Manager to help optimize its IoT-enabled climate and ensure that its greenhouses operate continuously and cost-efficiently. Energy Manager monitors the complete spectrum of energy consumption and electrical distribution assets on the farm, including HVAC and pumps, to maintain efficiency and availability for a healthy harvest, providing real-time data insights that maximize performance and energy efficiency.

Energy Manager monitors the complete spectrum of energy consumption and electrical distribution assets at Pure Harvest.

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05 Pure Harvest uses the ABB Ability Energy Manager to optimize its IoT-enabled greenhouse climate.

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06 ABB's Frosinone plant benefits from an Azure-enabled solution that supports the collection and storage of data from 128 electrical distribution points.


## SUCCESS STORY: FROSINONE, ITALY

**Situation:** Frosinone is a global production hub for ABB's low-voltage circuit breaker technologies. The factory, along with sister plants in Dalmine and Santa Palomba, are Lighthouse Plants, selected by the Italian government as a model for other companies working on digital transformation and Industry 4.0 strategies. With annual power consumption of 9,000 MWh and an energy bill in the region of 1.2 million euros, ABB wanted to explore opportunities for reducing costs and carbon emissions using digital energy management and renewables.

**Solution:** As a first step in its sustainability strategy, ABB implemented a retrofit switchgear upgrade that was connected to the cloud-based ABB Ability™ Energy Manager solution (formerly known as EDCS). The new system was able to monitor more than 120 electrical distribution points at the facility, helping staff continuously improve the site's energy efficiency and power asset management. Advanced algorithms and machine learning helped Frosinone identify hidden drains on the site's energy, as well as calculate the payback period for any investment in new equipment.

**Results:**

**30 percent improvement in energy efficiency**

**Ability to identify and fix energy leaks**

**Reduced energy and maintenance costs**

06

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**References**

[1] ABB. "Accelerating ambition: How global industry is speeding up investment in energy efficiency" Available: https://www.energyefficiencymovement.com/wp-content/uploads/2022/04/ABB-Energy-Efficiency-Survey-Report-2022.pdf [Accessed April 6, 2023.]

[2] IEA. "Energy Efficiency 2021", p. 17. Available: https://www.iea.org/reports/energy-efficiency-2021 [Accessed April 6, 2023.]

[3] ABB. "The future is energy efficient". White paper. Available: https://www.energyefficiencymovement.com/wp-content/uploads/2022/12/ABB_EE_WhitePaper_Motion-Services_011222.pdf [Accessed April 6, 2023]

[4] ABB Energy Appraisal Highlights. Available: https://new.abb.com/service/motion/data-and-advisory-services/energy-appraisal [Accessed April 17, 2023.]

[5] EIA. "International Energy Outlook 2021", p. 12. Available: https://www.eia.gov/outlooks/ieo/ [Accessed April 6, 2023.]

[6] ABB. Pure Harvest smart farms thrive with ABB Ability Energy Manager. Available: https://new.abb.com/news/detail/98882/pure-harvest-smart-farms-thrive-with-abb-ability-energy-manager [Accessed April 17, 2023.]

[7] Microsoft. "ABB Ability Energy and Asset Manager" Available: https://appsource.microsoft.com/en-us/product/web-apps/abb-3963258.abb-ability-energy-asset-manager?tab=Overview) [Accessed April 6, 2023.]

[8] Official Journal of the European Union (16.12.2022Directive (EU)2022/2464 of the European Parliament and of the council, of 14 December 2022.

[9] ABB. "Connecting physical environments connecting people" Available: https://global.abb/topic/ability/en/partners/microsoft [Accessed April 6, 2023.]

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01

FROM PLANTED FORESTS TO PACKAGE – SUSTAINABLY

# Klabin-ABB partnership

Klabin, a leader in the packaging paper and paper packaging segments in Brazil and a world reference in sustainable development, partners with ABB to offer increasingly sustainable products to its customers and to improve operational efficiency in its production process.

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At Klabin – a business with more than 120 years of history and a leader in the packaging paper and paper packaging segments in Brazil – environmental conservation lies at the heart of the company culture →01. In fact, some time ago, the company established itself as a world reference in sustainable development – using economic, social and environmental fundamentals as a guide for its business right throughout its supply and production chain →02.

**The Klabin Agenda 2030**
Reinforcing its commitment to sustainability, the company launched, in 2020, the Klabin Agenda 2030, which has goals based on priority themes to orient performance and growth strategies toward economic development, environmental sustainability and social justice. The Klabin Objectives for Sustainable Development (KODS) form a set of short-, medium- and long-term goals within the Klabin Agenda 2030 that are

Some time ago, Klabin established itself as a world reference in sustainable development.

—
01 Sustainability is an integral part of Klabin's culture. The location shown houses Klabin's Puma unit, which showcases the best in sustainable pulp production technology.

—
02 About Klabin.

aligned with the UN's 2030 Agenda [1]. These goals prioritize the transparency of environmental, social and governance (ESG) aspects that are fundamental to the company and society in general – for example, the use of energy and water, carbon management, availability of wood, waste management and the development of people and communities where the company operates. Compliance with the objectives can be monitored through the ESG panel on the Klabin website [2].

—

The long-standing partnership with ABB started in 1980 and aims to maximize results and optimize resources.

**Four decades of collaboration with ABB**

Klabin's investments in the development of new products from renewable sources are substantial →03. The company's driving force in this area positively influences stakeholders so that they, too, pay attention to the importance of sustainability to the planet's future.

**ABOUT KLABIN**

The largest producer and exporter of packaging paper and sustainable paper packaging solutions in Brazil, Klabin is known as an innovative business and the only one in the country to offer solutions in hardwood, softwood and fluff pulp (chemical pulp made from long fiber softwoods). The company is also the leader in the corrugated packaging and industrial bags markets. Founded in 1899, Klabin has 22 industrial units in Brazil and one in Argentina, responsible for an annual production capacity of 4.2 million tons of market pulp and paper.

The company's management is oriented towards sustainable development, seeking integrated and responsible growth that combines profitability, social development and environmental commitment. Klabin has been part of B3's Corporate Sustainability Index (ISE) since 2014 and, in 2020, it became part of the Dow Jones Sustainability Index, with participation in the World Index portfolio. Klabin is also a signatory to the UN Global Compact and Brazil's National Pact for the Eradication of Slave Labor and actively seeks suppliers and business partners that follow the same values of ethics, transparency and respect for the principles of sustainability.

02

There is no way to go about the advancement of the Klabin Agenda 2030 without the adoption of innovative technologies. Many of the results achieved by Klabin in its quest to offer increasingly sustainable solutions to its customers and to improve operational efficiency in its production processes were made possible by the support of several technology providers that work side by side, delivering tools in line with business needs. One example is the long-standing partnership with ABB, which started in 1980

on the most diverse fronts and in different industrial units, aiming to maximize results and optimize resources through solutions relevant to the reality of the pulp and paper industry.

**Quality control with ABB**

Klabin has 22 factories in Brazil and one in Argentina, producing cellulose pulp, paper, recycled paper, corrugated containers and industrial bags. Some units operate under the most advanced principles of industrial automation, using modern tools that guarantee process optimization. For example, ABB's quality control system (QCS) reduces variations in moisture and basis weight in produced paper and cellulose, allowing uniformity and suitable parameter profiles in both the machine direction (MD) and cross direction (CD) →04. Precision sensing and tight MD/CD control reduce losses and decrease the consumption of raw materials, water, energy and chemicals. Full ABB service support and continuous updates of the latest control algorithms and sensor technology ensures the highest level of performance is maintained. In short, the QCS is a fundamental element in pulp and paper production that directly contributes to the achievement of sustainability goals.

**Distributed control in Klabin**

The QCS fits into the plant-wide ABB distributed control system (DCS) in each Klabin factory. The DCS manages, orchestrates and controls the complex production processes via multiple autonomous controllers distributed throughout the network that communicate and coordinate with each other to perform specific tasks. The automatic control mentioned above, working through the DCS, allows high stability and quality in production processes. Any process deviation is automatically detected and examined by experienced ABB technicians, who can access all relevant data. Such full-time, personalized support for Klabin provides stability during operations and gives peace of mind to machine operators. This level of scrutiny means that typical machine uptime is over 99 percent, which makes it possible to produce a ton of packaging paper in an impressive 29 s.

**Power distribution and motor control**

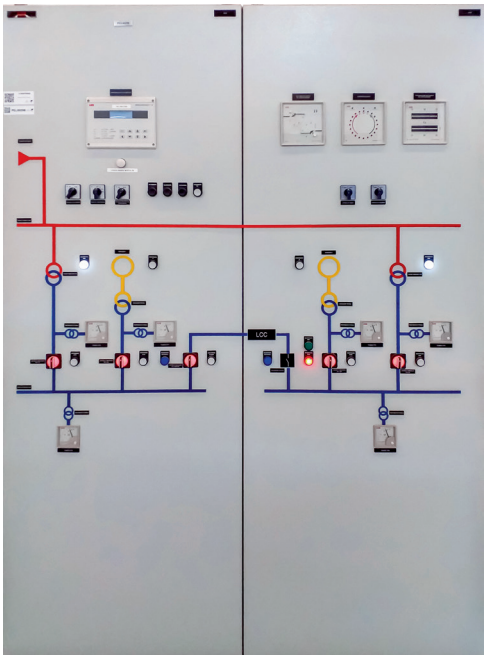
Klabin also uses ABB electrical energy management and power distribution systems that allow for selectivity in resource allocation, comprehensive monitoring and intelligent management of faults →05-06. For example, in Klabin's Puma unit at Ortigueira →01, 03, an energy management system (EMS) brings stability to the network that powers the sophisticated automation infrastructure. Operating directly in the power generation plant, the EMS enables efficient use of electrical power and organizes all relevant data under one umbrella to support preventive maintenance teams.

ABB's QCS reduces variations in moisture and basis weight, allowing uniformity and suitable parameter profiles.

Clean electricity is produced by steam generated by Klabin's black liquor boilers and biomass, which enables Klabin not only to be energy

03


04



05

06

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03
Klabin's Puma unit at the site in Ortigueira, in southern Brazil, is one of the largest pulp projects worldwide.

—
04 Space is limited on the paper machine so only the ABB QCS scanner end column is visible.

—
05 ABB power distribution panel at the Klabin Puma unit.

—
06 ABB gas-insulated switchgear in the Puma water and effluent treatment plant.

self-sufficient at the Puma Unit but also to supply over 800,000 MWh to Brazil's power grid – further promoting sustainability. The EMS facilitates the sale of this excess electricity into the grid on a spot basis to obtain the best tariff.

ABB also supplied multidrives, a coupled control system and electric motors at the Puma Unit (one of the most advanced pulp mills in the world), including for the two new paper machines of the Puma II Project →07.

In Telêmaco Borba, in southern Brazil, an ABB electrical and automation system helped Klabin to expand its paperboard production by 50 percent. Liquid packaging board (LPB) is a specialty of this plant and the installation of the equipment helped Klabin become one of the global leaders in products for packaging liquids. Similar

—

The automatic control, working through the DCS, allows high stability and quality in production processes.


07


08


09

—
07 Paper machine multidrive.

—
08 Automation of handling is an effective way to improve plant efficiency. ABB's IRB 6600, which can deal with up to 175 kg, provides a helping hand here.

—
09 An ABB IRB 6700 robot prepares the paper reels for transport to the customer.

—
10 Klabin's sustainability credentials.

ABB power and automation technologies are at work in other Klabin paper mills, collaborating every day to improve production efficiency, thus making it increasingly sustainable →08-10.

**Continuously improving sustainability**

There are many reasons why the partnership between ABB and Klabin has flourished over the past four decades, moving from a world almost entirely analogue in the last century to the countless possibilities opened up by digitalization and other technologies today. It is noticeable how

—

Klabin moved forward with ABB to seek the innovation and technology essential for advancing sustainable development.

Klabin moved forward decisively with the support of ABB, abandoning obsolete processes that made sense in the past to seek the innovation and technology essential for advancing sustainable development – especially with regard to the reduction of carbon emissions and the rational and strategic use of raw materials and utilities, such as water and energy.

In 1985, the installation of a new continuous digester for the production of unbleached pulp pioneered Klabin's use of a DCS, the first step of digitalization. The supplier was ABB. The partnership of more than four decades with ABB demonstrates, through concrete examples, that the green economy is within reach and is a reality. Klabin will continue to invest in cutting-edge innovative technologies for a more sustainable future, with the support of companies that have the same goals. •

## KLABIN'S SUSTAINABILITY CREDENTIALS

In 2023, for the third consecutive time, Klabin was included in "The Sustainability Yearbook," produced by the international consulting firm S&P Global [3]. With over 7,000 companies evaluated, Klabin is the only one in Latin America in the "Top 1% S&P Global ESG Score" category. In December 2022, Klabin was listed (for the second time) on CDP's Triple-A List (formerly known as the Carbon Disclosure Project), one of the most relevant global sustainability assessments. The company was the only Latin American representative among the 12 companies in the world that have the highest score in the three criteria considered by the entity for action on climate change, forests and water security.

With regard to efforts to reduce greenhouse gas (GHG) emissions, Klabin was one of the first Brazilian companies to have its targets validated by the Science-Based Targets initiative (SBTi). This institution audits actions in favor of decarbonization based on climate science. Klabin's commitment, endorsed by the SBTi, is to reduce by 25 percent, by 2025, the specific GHG emissions of scopes 1 and 2 (own emissions and in purchased energy, respectively), considering the base year of 2019. A further goal is to reduce these emissions by 49 percent by 2035. In addition, Klabin encourages other enterprises to participate in this movement with Impact NetZero, another initiative of Klabin's ESG Agenda, in partnership with Rede Brasil of the UN Global Compact, which seeks to encourage companies to evaluate the adoption of emission reduction targets.

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**References**

[1] United Nations, Department of Economic and Social Affairs, "Transforming our world: the 2030 Agenda for Sustainable Development." Available: https://sdgs.un.org/2030agenda#:~:text=We%20resolve%2C%20between%20now%20and,protection%20of%20the%20planet%20and [Accessed March 26, 2023.]

[2] Klabin, "ASG Panel." Available: https://esg.klabin.com.br/agenda-2030-desempenho-2020-das-metas/ [Accessed March 26, 2023.]

[3] S&P Global, "The Sustainability Yearbook 2023. "Available: https://www.spglobal.com/esg/csa/yearbook/. [Accessed July 2, 2023.]



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PRATEXO CEO DISCUSSES FASTER DEVELOPMENT OF DECENTRALIZED SOFTWARE ARCHITECTURE

# Far-edge future

San Francisco startup Pratexo is helping companies overcome the traditional technical hurdles of complex, edge-to-cloud deployments. The startup's no-code platform significantly accelerates the ability of engineers to design, test, deploy, and manage complex, decentralized software architectures from the far edge up to central clouds. The result is reduced time to deployment, improved security, reduced energy consumption due to improved system efficiency, and the ability to run applications and analytics while disconnected from central servers.

**Blaine Mathieu**
CEO Pratexo
San Francisco

**A former Gartner analyst and founder, CEO/CMO/CPO at public tech giants and startups, Blaine Mathieu is based in the San Francisco Bay area. He is CEO of Pratexo, an edge-to-cloud solution acceleration platform company.**

For more information, visit www.pratexo.com

**AR** **ABB Review (AR):** Pratexo's focus is edge-to-cloud computing – an area that is all about decentralization. To put things in perspective, what's driving the decentralization trend?

**BM** **Blaine Mathieu (BM):** Specific to the electrification space, meaning areas such as grid operations, EV charging networks, and virtual power plants, the drivers include resiliency, flexibility, and a reduction in overall costs via increased system efficiency, along with the ability to potentially sell unused power capacity back to power markets.

But the general trend toward decentralization is relevant to virtually all industrial systems. It's about moving away from monolithic structures and systems towards real-time operations that can only be optimized at the most local level. The last 20 years of IT have been mostly about centralizing computing into the cloud. The next 10 will be about balancing that with a hybrid edge-to-cloud approach – doing the right compute at the right place and at the right level. Accelerating that transition is what Pratexo fundamentally enables.

**AR** How does this relate to sustainability initiatives?

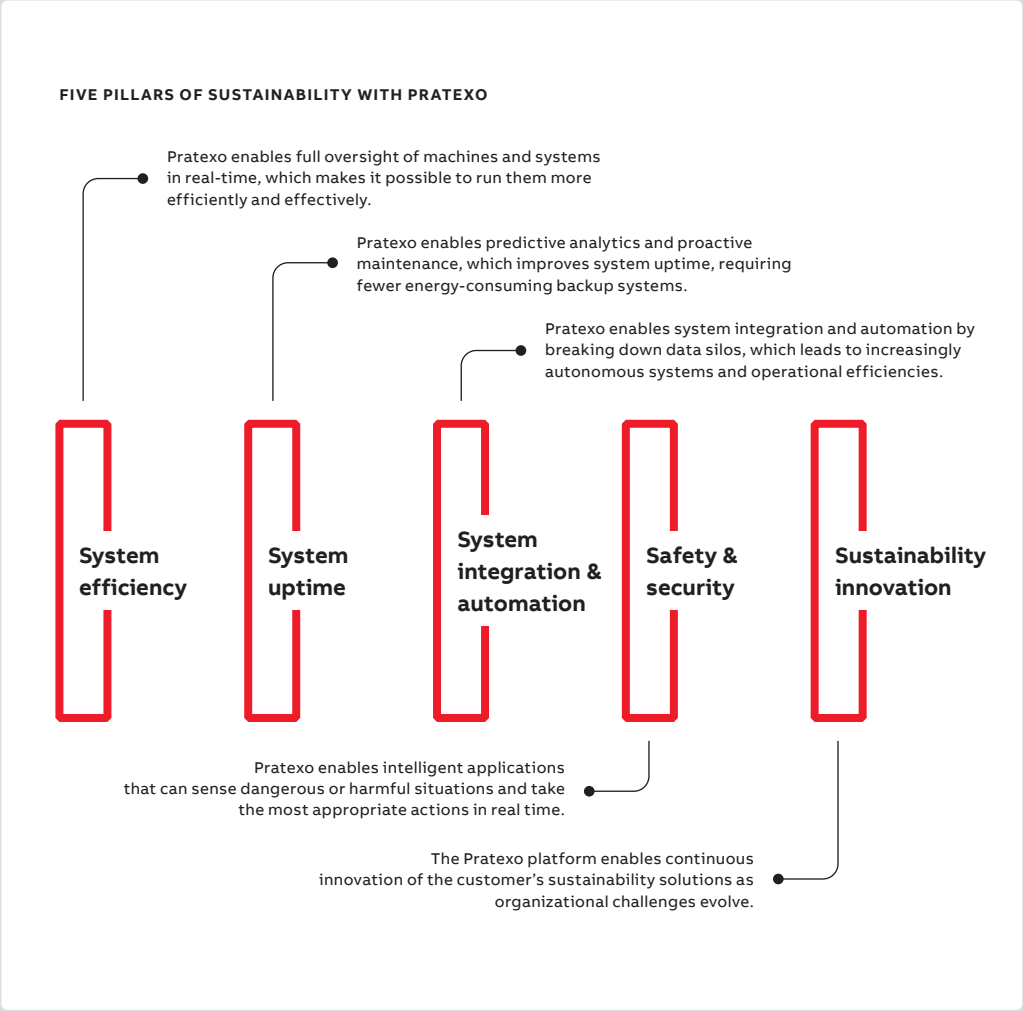
**BM** There is a direct relationship →01, and we are definitely seeing more market pull from this area. More efficient, available, and safe systems are the foundation of most sustainability programs. That precisely mirrors the value that decentralized systems, running in real time and adjusting to rapidly changing circumstances, can provide. Since we focus particularly on improving the operations of industrial and infrastructure systems, we have positioned Pratexo as a Catalyst for Sustainable Change.

**AR** Companies are facing the double challenge of balancing a steadily increasing level of data creation and rising system complexity, while driving their transformation from basic analytics towards real-time, highly efficient, autonomous system control. How does the Pratexo platform support customers in this evolution?

**BM** Pratexo's goal is to help companies deploy software solutions faster and with lower project risk by giving them the tools to overcome the traditional technical hurdles of complex, edge-to-cloud deployments. The Pratexo Studio is what enables this: our no-code platform significantly accelerates the ability of an architect or engineer to design, test, deploy, and manage complex, decentralized software architectures from the far edge up to central clouds. The Studio builds, deploys, and configures complex multi-tiered architectures via a drag-and-drop interface to quickly create hyper-connected networks that enable data collection, advanced analytical processing, and real-time applications at scale. The result is reduced time to deployment, operational continuity in the event of central server disconnection, and a more secure, reliable way to manage distributed systems, including power grids, EV charging networks, distributed manufacturing operations, and many other areas of industry and infrastructure.

**AR** In practical terms, what do these capabilities mean for software architects and solution developers?

**BM** It means they can get projects designed, tested, live, and in the field in a fraction of the time it would otherwise take. As a proof point: Pratexo now has a global framework agreement in place with the Cognizant IoT group. The reason is, as one of their most senior leaders told us a few




01

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01 Edge-to-cloud systems can have a significant effect on sustainability.

—
02 Software modules are dragged into Pratexo Studio. Lines indicate integration points. In the background, the system checks dependencies, writes install scripts, and develops integrations in real time.

—
03 Based on data types defined in the Studio, Pratexo automatically creates a streaming data simulator that can be used to test systems before physical deployment.

months ago: "What you demonstrated in 10 minutes would have taken a team three months to do."

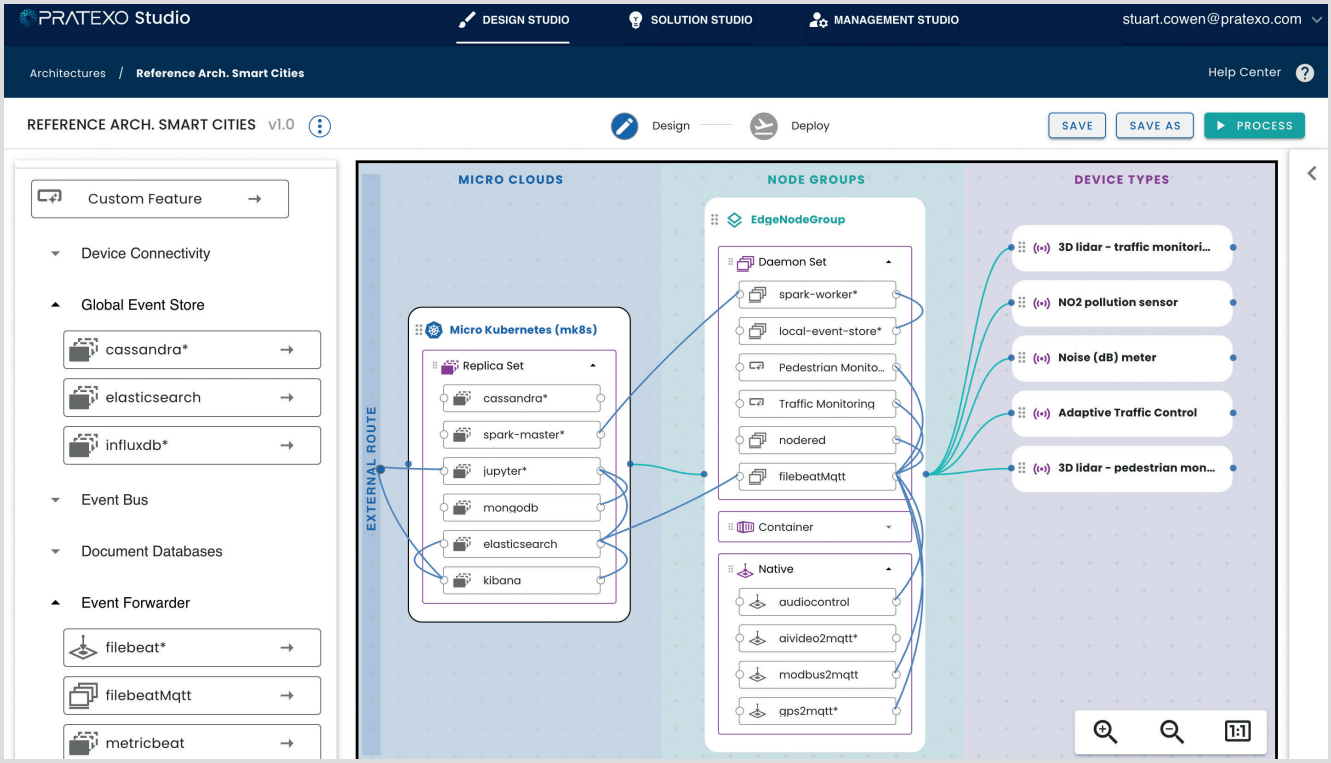
This is also the fundamental reason why Pratexo won the ABB Electrification Startup Challenge back in May 2022. While most entrants were able to create a compelling vision and slide deck over the 10-day period of the Challenge, Pratexo was able to use its platform to stand up an actual smart grid simulator running advanced analytics in real time, on top of a micro cloud connected to real sensors and devices. That's what is possible with a platform like this.

—
Pratexo's goal is to help companies deploy software solutions faster and with lower project risk.

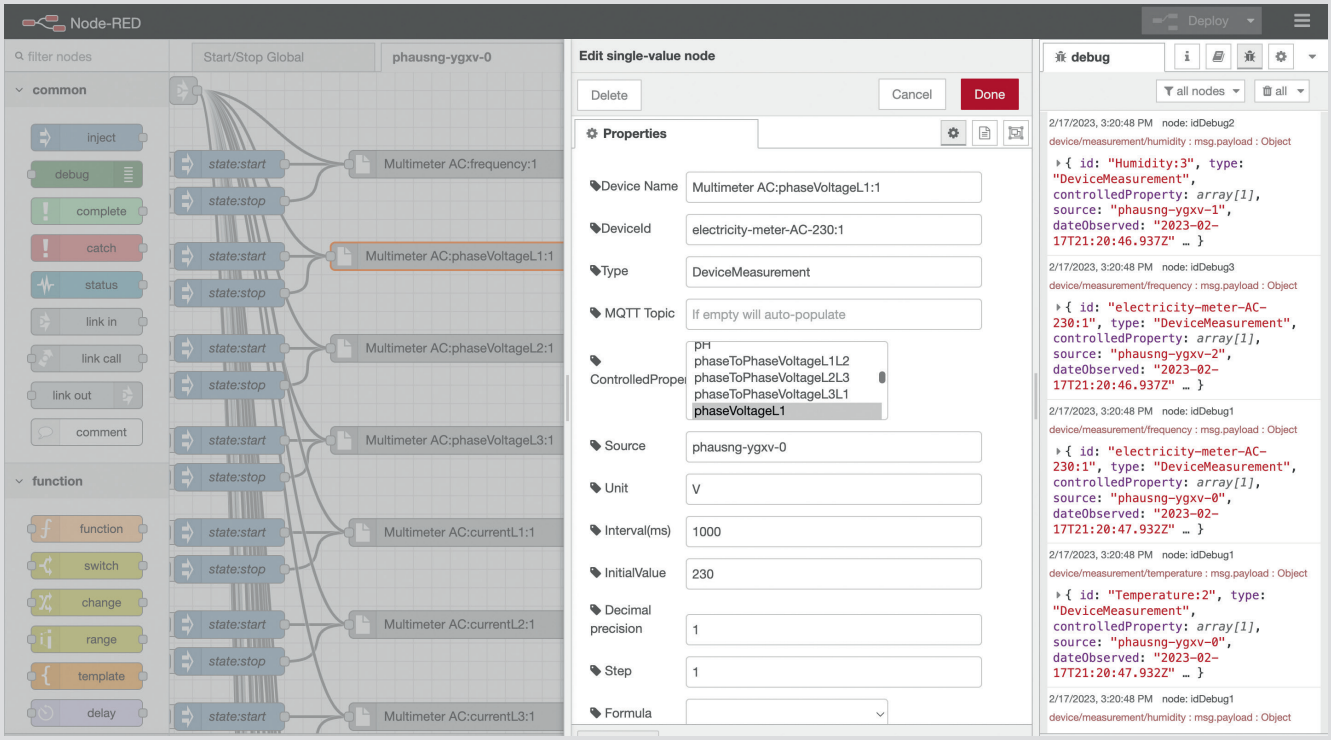
**AR** How does Pratexo Studio work?

**BM** In the first step, the architect begins to define the sources of data and associated software components that are necessary to support the analytics and applications that end-users will benefit from →02. They can decide where each component needs to be deployed, perhaps on each compute node running at the system's edge, or maybe onto a Kubernetes-based micro cloud that runs across a set of compute nodes. This has the advantage of being able to run advanced applications and analytics locally, even if the system is disconnected from central clouds or servers – which is often a requirement for mission-critical systems.

Of course, these solutions can also be deployed all the way up to central hyperscaler clouds – after all, this is what edge-to-cloud computing is all about! In fact, before any software is deployed to physical environments, Pratexo enables the deployment of a digital twin of the system to a virtual environment in the cloud to begin simulation and testing before a single hardware device or compute node is provisioned →03. Pratexo is


PRATEXO Studio
DESIGN STUDIO
SOLUTION STUDIO
MANAGEMENT STUDIO
stuart.cowen@pratexo.com
Architectures / Reference Arch. Smart Cities
Help Center
REFERENCE ARCH. SMART CITIES v1.0
Design
Deploy
SAVE
SAVE AS
PROCESS
Custom Feature
Device Connectivity
Global Event Store
cassandra*
elasticsearch
influxdb*
Event Bus
Document Databases
Event Forwarder
filebeat*
filebeatMqtt
metricbeat
MICRO CLOUDS
NODE GROUPS
DEVICE TYPES
EXTERNAL ROUTE
Micro Kubernetes (mk8s)
Replica Set
cassandra*
spark-master*
jupyter*
mongodb
elasticsearch
kibana
EdgeNodeGroup
Daemon Set
spark-worker*
local-event-store*
Pedestrian Monito...
Traffic Monitoring
nodered
filebeatMqtt
Container
Native
audiocontrol
aivideo2mqtt*
modbus2mqtt
gps2mqtt*
3D lidar - traffic monitori...
NO2 pollution sensor
Noise (dB) meter
Adaptive Traffic Control
3D lidar - pedestrian mon...
1:1

02


Node-RED
Deploy
filter nodes
Start/Stop Global
phausng-ygxv-0
common
inject
debug
complete
catch
status
link in
link call
link out
comment
function
function
switch
change
range
template
delay
state:start
state:stop
Multimeter AC:frequency:1
Multimeter AC:phaseVoltageL1:1
Multimeter AC:phaseVoltageL2:1
Multimeter AC:phaseVoltageL3:1
Multimeter AC:currentL1:1
Multimeter AC:currentL2:1
Multimeter AC:currentL3:1
Edit single-value node
Delete
Cancel
Done
Properties
Device Name
Multimeter AC:phaseVoltageL1:1
DeviceId
electricity-meter-AC-230:1
Type
DeviceMeasurement
MQTT Topic
If empty will auto-populate
ControlledPrope
pH
phaseToPhaseVoltageL1L2
phaseToPhaseVoltageL2L3
phaseToPhaseVoltageL3L1
phaseVoltageL1
Source
phausng-ygxv-0
Unit
V
Interval(ms)
1000
InitialValue
230
Decimal precision
1
Step
1
Formula
debug
all nodes
all
2/17/2023, 3:20:48 PM node: idDebug2
device/measurement/humidity : msg.payload : Object
{ id: "Humidity:3", type: "DeviceMeasurement", controlledProperty: array[1], source: "phausng-ygxv-1", dateObserved: "2023-02-17T21:20:46.937Z" … }
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device/measurement/temperature : msg.payload : Object
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2/17/2023, 3:20:48 PM node: idDebug1
device/measurement/humidity : msg.payload : Object

03

device, sensor, network, compute resource, and cloud agnostic. We don't provide infrastructure – we enable the rapid deployment and management of solutions on top of infrastructures.

**AR** How does a customer get from an architecture design to a finished solution?

**BM** Some companies can take an edge-to-cloud architecture that the Studio deploys and very quickly begin building solutions on top of it. But many benefit from additional support. Pratexo does this in two ways. First, we have developed what we call 'Solution Frameworks' that provide a kick-start towards implementing highly customized solutions on top of the Pratexo platform. Currently, we have solution frameworks for integrated system monitoring and alerting, and one for root cause analysis expert systems. We are now in the process of developing further solution frameworks.

Second, we have a professional services group that collaborates closely with our clients and partners to either take a Solution Framework and complete the necessary customizations, or to develop a complete solution from scratch that is accelerated by the platform. Whether it starts with a Framework or not, this approach is powerful because it is almost impossible for out-of-the-box solutions to meet the very specific needs of each customer and use case. Over time, we definitely see third parties such as systems integrators and engineering, procurement and construction companies (EPCs) also being able to use our platform and Solution Frameworks for their customers – which explains our partnership with Cognizant that I mentioned earlier. Finally, we are excited about close partnerships with OEMs and solution providers like ABB that are working on wrapping more complete solutions around their equipment offerings, some of which may be delivered as-a-service. This is the basis of much of our current work and ongoing discussions with teams at ABB.

—

Pratexo enables the deployment of a digital twin to a virtual environment in the cloud to begin simulation and testing.

**AR** Although Pratexo is still a startup, does the company already have customer success stories?

**BM** Yes! A great example is Hallingdall Kraftnett (HKN), an innovative Norwegian power grid operator that is seeking new ways to improve and safeguard its efficiency and system uptime →04. Like all operators, HKN is faced with power spikes and rapid changes in demand – particularly based on the large loads placed on the Norwegian grid for recharging electric vehicles, which make up the majority of cars on their roads today. While this influx of EVs is helping Norway lead in some measures of sustainability, grid operations are hampered by dark data, which is data that is not actually used to drive operations. Operations are also hampered by inadequate communications between remote substations and prohibitive cloud computing costs. The company operates thousands of substations

04

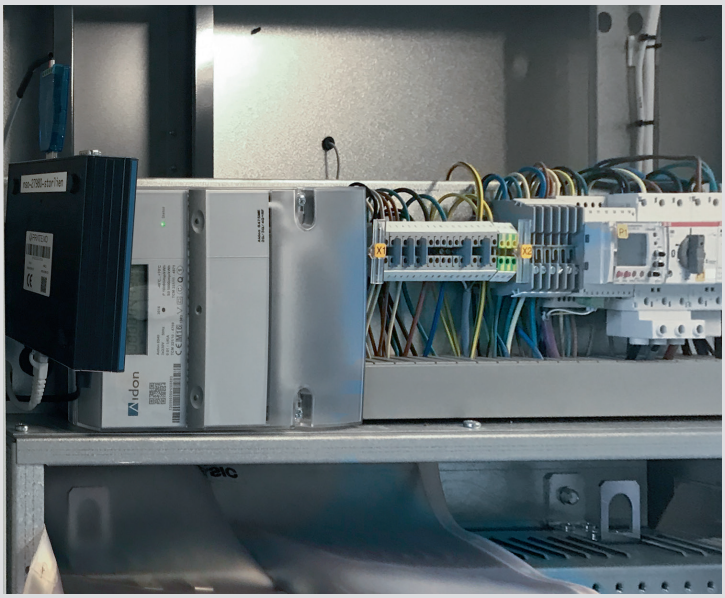
—
04 Norwegian power grid operator HKN is seeking new ways to improve its uptime.

—
05 HKN and its partner grid operators are deploying edge nodes at each substation.

05a A remote HKN substation.

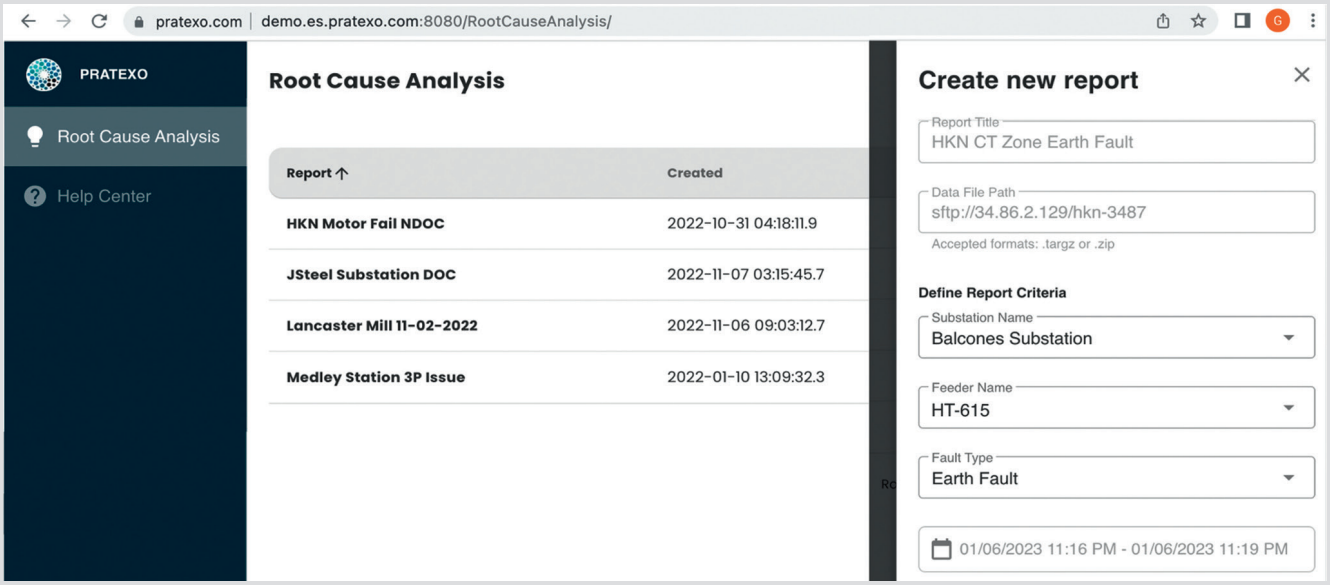
05b The black industrial PC mounted on a DIN rail in the substation is outfitted with Pratexo software that ingests data from a PLC and additional sensors in real time.


05a




05b

Photo fig. 04: Hallingdall Kraftnett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PRATEXO
Root Cause Analysis
Help Center
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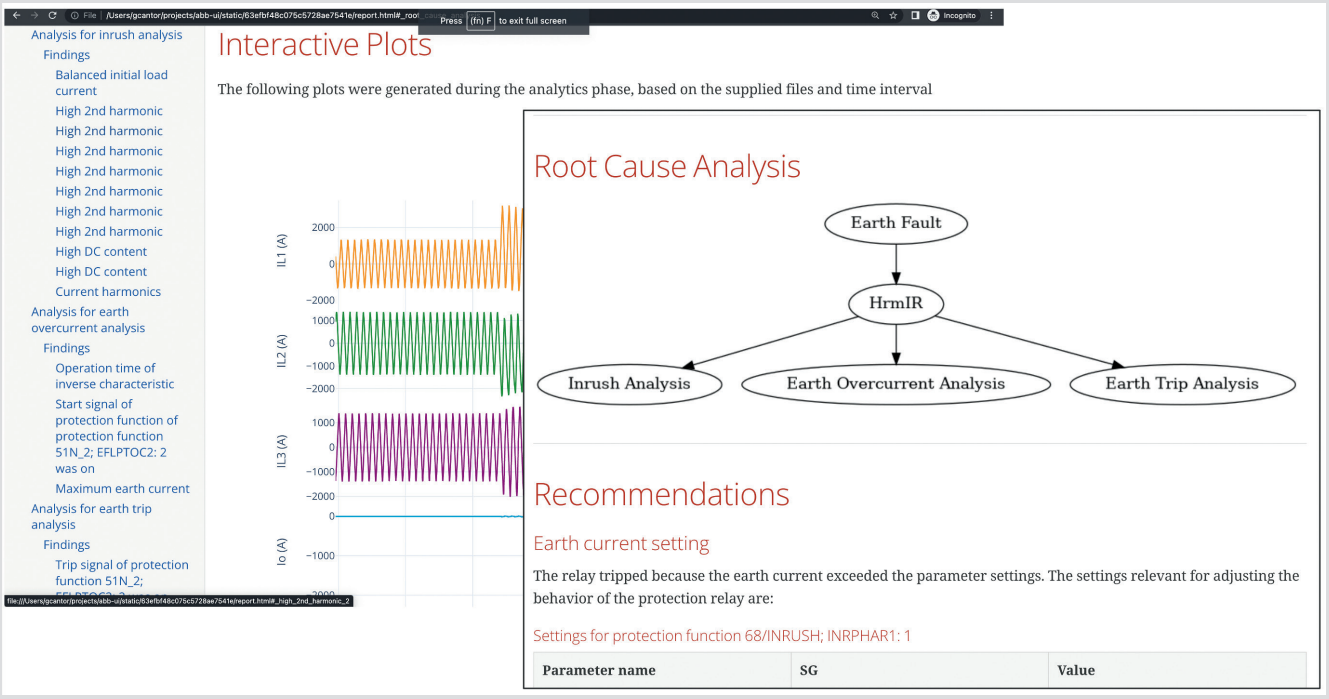
JSteel Substation DOC
2022-11-07 03:15:45.7
Lancaster Mill 11-02-2022
2022-11-06 09:03:12.7
Medley Station 3P Issue
2022-01-10 13:09:32.3
Create new report
Report Title
HKN CT Zone Earth Fault
Data File Path
sftp://34.86.2.129/hkn-3487
Accepted formats: .targz or .zip
Define Report Criteria
Substation Name
Balcones Substation
Feeder Name
HT-615
Fault Type
Earth Fault
01/06/2023 11:16 PM - 01/06/2023 11:19 PM

06


Analysis for inrush analysis
Findings
Balanced initial load current
High 2nd harmonic
High 2nd harmonic
High 2nd harmonic
High 2nd harmonic
High 2nd harmonic
High 2nd harmonic
High 2nd harmonic
High DC content
High DC content
Current harmonics
Analysis for earth overcurrent analysis
Findings
Operation time of inverse characteristic
Start signal of protection function of protection function 51N_2; EFLPTOC2: 2 was on
Maximum earth current
Analysis for earth trip analysis
Findings
Trip signal of protection function 51N_2;
Interactive Plots
The following plots were generated during the analytics phase, based on the supplied files and time interval
IL1 (A)
IL2 (A)
IL3 (A)
Io (A)
Root Cause Analysis
Earth Fault
HrmIR
Inrush Analysis
Earth Overcurrent Analysis
Earth Trip Analysis
Recommendations
Earth current setting
The relay tripped because the earth current exceeded the parameter settings. The settings relevant for adjusting the behavior of the protection relay are:
Settings for protection function 68/INRUSH; INRPHAR1: 1
Parameter name
SG
Value

07

—
06 Operational data is ingested into the Root Cause Analysis Expert System. Parameters are presented to domain experts to filter specific analytics.

—
07 Rich interactive plots provide detailed visualizations of data. A root cause analysis graph details the analytics path taken to derive a report. A recommendation section provides guidance on how to remediate an issue.

that collectively generate many gigabytes of data every hour – far more than could be pushed to a central cloud.

HKN and its partner grid operators are deploying edge nodes at each substation →05. They have also grouped certain nodes into regional micro clouds that are able to share compute resources, bringing the power of cloud computing down to the grid edge. For the first time, the massive amounts of data the machines in each substation are generating – including legacy PLC data and data from ABB sensors and equipment – are being analyzed, and events processed, in real time.

Now that the platform is in place, new solutions and analytics are easily provisioned. This includes microphones with an associated algorithm that can listen for the sound of a partial discharge (PD) at each substation in order to alert maintenance teams more quickly than otherwise possible using typical manual inspection protocols. Future use cases are focused on improving the physical security of remote operations. No longer are all these systems and solutions stuck in silos.

**AR** Pratexo is working with ABB to create a type of expert system. How will this support decision making?

**BM** This is an exciting project for Pratexo. One of the Solution Frameworks we used at the ABB Electrification Challenge was our Root Cause Analysis Expert System Framework →06-07. The purpose of this Framework is to accelerate the decision-making capability of human experts in their quest to understand why complex systems of machines fail or do not run optimally.

Since the Challenge, we have been working with experts at ABB to create Expert System Solution Modules that run on the Framework. These Modules contain the custom data ingestion extensions, rule sets, algorithms, and reporting templates used by the Expert System Framework and are specific to each type of machine/asset or set of machines.

These expert systems can be run either in forensic – meaning retrospective – mode, or potentially in real time, streaming mode and can be run anywhere from a micro cloud on the far edge, near the machines in question, up to central clouds. The results include detailed analytics of what could potentially be causing machine faults. Although this project is still in early development with ABB, we are very confident about its ultimate value in the market.

—

Microphones with an associated algorithm can listen for the sound of a partial discharge at each substation.

**AR** Any final thoughts on Pratexo's collaboration with ABB?

**BM** Since ABB's SynerLeap innovation growth hub introduced us to ABB in early 2022, it has been a true pleasure to work with the individuals and teams there. In addition to the specific projects I've mentioned, we now have half a dozen discussions ongoing with other groups at ABB, and we truly look forward to accelerating more innovative and sustainability-oriented projects with our partner in the years to come. •

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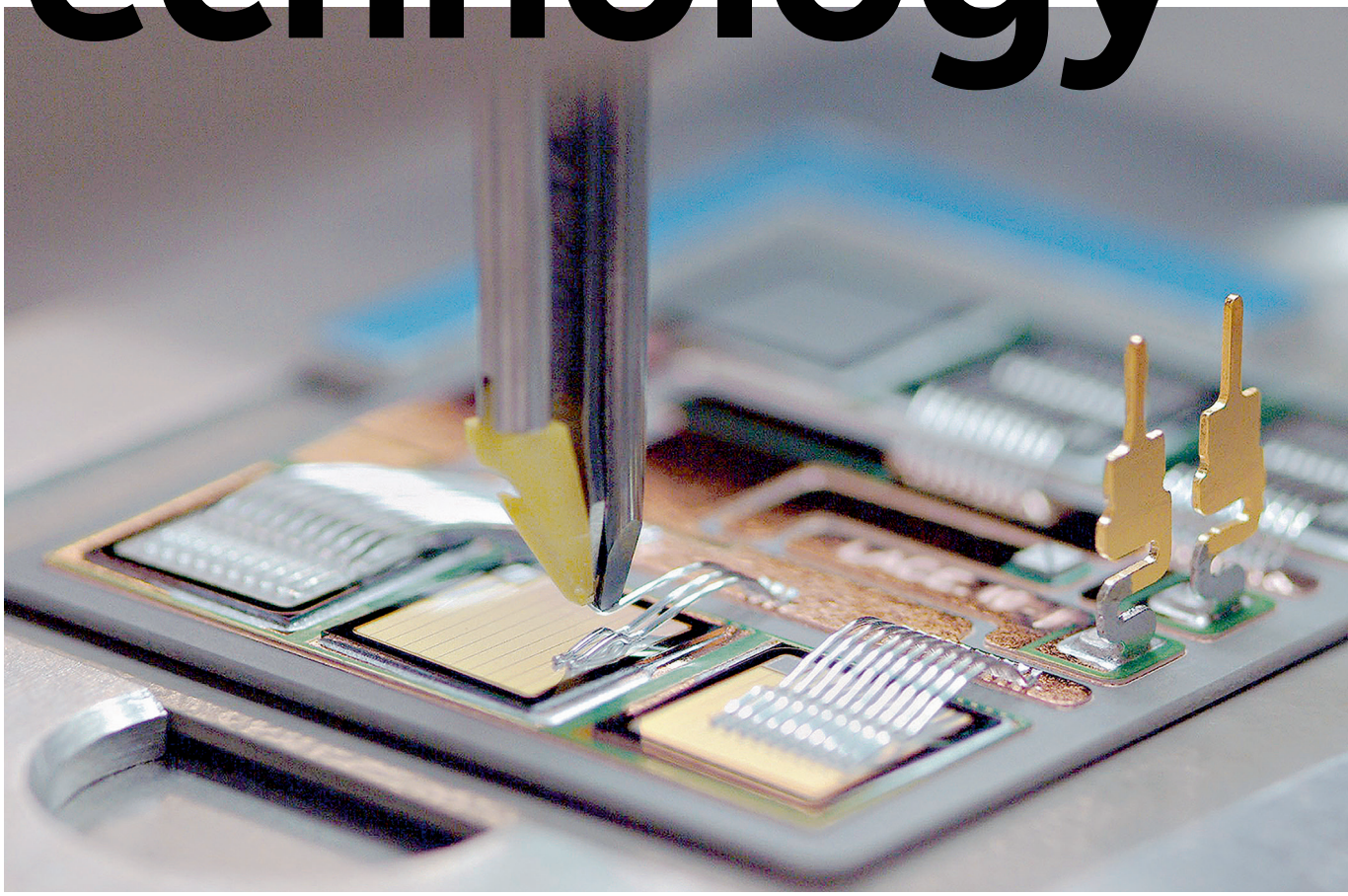
# Technology



**Efficiency gains are one of the most powerful tools for improving performance, profitability and sustainably. In the following section, ABB Review explores how right-sizing plants and components during the design phase leverages their performance.**




HOLISTICALLY OPTIMIZING HYDROGEN PRODUCTION PLANTS DURING PLANNING

# Sizing matters

01

A crucial link in the hydrogen fuel chain is the electrolyzer plant. Decarbonization is driving a surge in the number of such facilities but sizing them is not easy. ABB's new tool helps make fast, accurate design decisions regarding plant configuration to significantly reduce hydrogen production costs.

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Hydrogen, the simplest and most abundant of all molecules, holds the potential to help solve one of the most complex problems the world faces today: climate change. Hydrogen is an energy-efficient fuel, clean and storable and – after many years of stop-start progress – has picked up unprecedented momentum, driven by the urgent need to decarbonize society. Substantial investments are being made to achieve this goal.

Hydrogen fuel technology is advancing rapidly, propelling efforts to scale up production to the magnitude needed to satisfy a world striving for "net zero" →01[1].

**Optimizing hydrogen plants during construction and operations**

As hydrogen production plants (HPPs) grow in size and complexity, enterprises may struggle to construct new plants that are both commercially viable and tailored to a specific use-case. For a successful HPP, considerations such as desired plant capacity, equipment specification, variation in hydrogen demand and fluctuations in renewable energy supply must all be taken into account at an early design stage. Factors that may complicate these considerations, however, are the fast-changing technology landscape, the lack of expertise of many new entrants and the multidimensional nature of optimization endeavors.

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For a successful HPP, many factors must all be taken into account early in the design phase.

These aspects are particularly relevant when specifying the key elements of an HPP. When planning a new facility – or upgrading an existing one – the designers must decide on

- Electrolyzer type, size and capacity
- Storage tank volume and vessel pressure parameters
- Throughput capacity of a compressor unit
- Presence and size of an electric battery.
- Type and capacity of (renewable) power sources.
- Electricity cost model: flat, time-of-use (ToU), spot market or tailored power purchase agreement (PPA).
- Regulatory requirements and subsidy schemes
- Hydrogen demand profiles (distribution and amount) to be supplied.
- Energy source mixes and the consequent greenhouse gas profiles.

All these aspects are to be considered and, ideally, optimized for a financially sound project. The levelized cost of hydrogen (LCOH) is an important measure here as it includes all operating and depreciated capital costs combined to determine the production cost of 1 kg of hydrogen.

In other words, sizing an electrolyzer plant is a nontrivial task that requires much detailed know-how. ABB has developed a tool that assists planners and HPP operators in this undertaking: the HPP Sizing Tool.

**Fundamental principles of the HPP Sizing Tool**

Both simplicity and accuracy were major guiding principles in the design of the HPP Sizing Tool: Only limited input is required by the ABB personnel working in conjunction with the customer concerned. If a requested input is unavailable, the tool recommends a typical value. Reliability is obtained by operating on actual project data and using calculations based on tailored optimization models run in the background. Detailed technical and financial models are used to choose configurations that ensure total cost is minimized.

The tool presents the user with a graphical overview and comprehensive numerical insights of all relevant aspects of the proposed optimized

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01 Large-scale hydrogen production and storage facilities will become an ever more common sight. In this artist's impression, the electrolyzers are the black objects.

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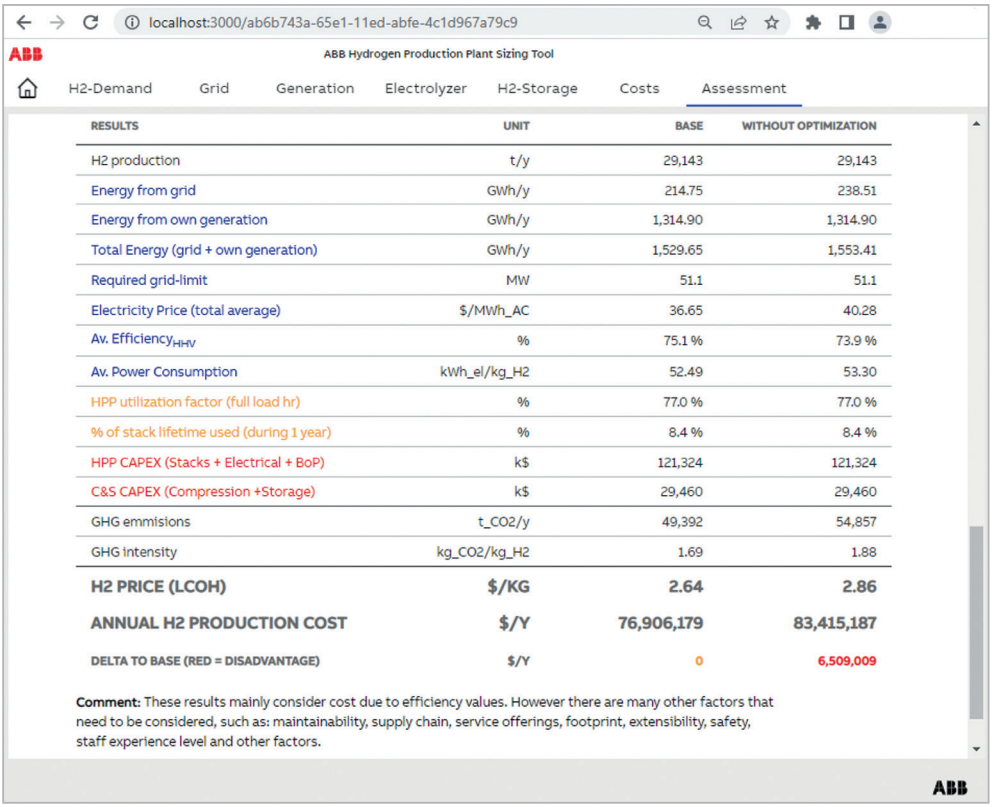
**Footnotes**

[1] See also "Carbon neutrality and net zero" in this issue of ABB Review pp. 228–229.




02

A digital twin capability allows alternative scenarios to be easily constructed, manipulated and compared.

plant →02. CAPEX and OPEX are considered, and a digital twin capability allows alternative scenarios to be easily constructed, manipulated and compared. The model overview and required input parameters of the sizing tool are shown in →03. Two quite different example scenarios highlight the tool's flexibility.

**Example: sensitivity analysis of an industrial hydrogen production plant**

The first example involves an industrial partner who wants to produce large amounts (up to 40,000 $Nm^3/h$ – normal cubic meters per hour) of hydrogen to be used in the production of, for instance, ammonia, cement, or steel. Most of the energy needed is secured via a PPA for 150 MW of renewable energy; the rest is supplied from the grid under a ToU tariff. Twelve alkaline electrolyzer (AEL) modules and hydrogen storage facilities at 250 bar have already been decided upon →04. ABB ran an HPP analysis on the project, resulting in the following:

- The PPA covers 83 percent of the total electricity consumed annually; the remainder comes from the ToU tariff.
- The overall LCOH is $2.75/kg hydrogen due to the competitive PPA price and high plant utilization of 77 percent.
- The greenhouse gas signature is 2.1 kg $CO_2$/kg of hydrogen produced.

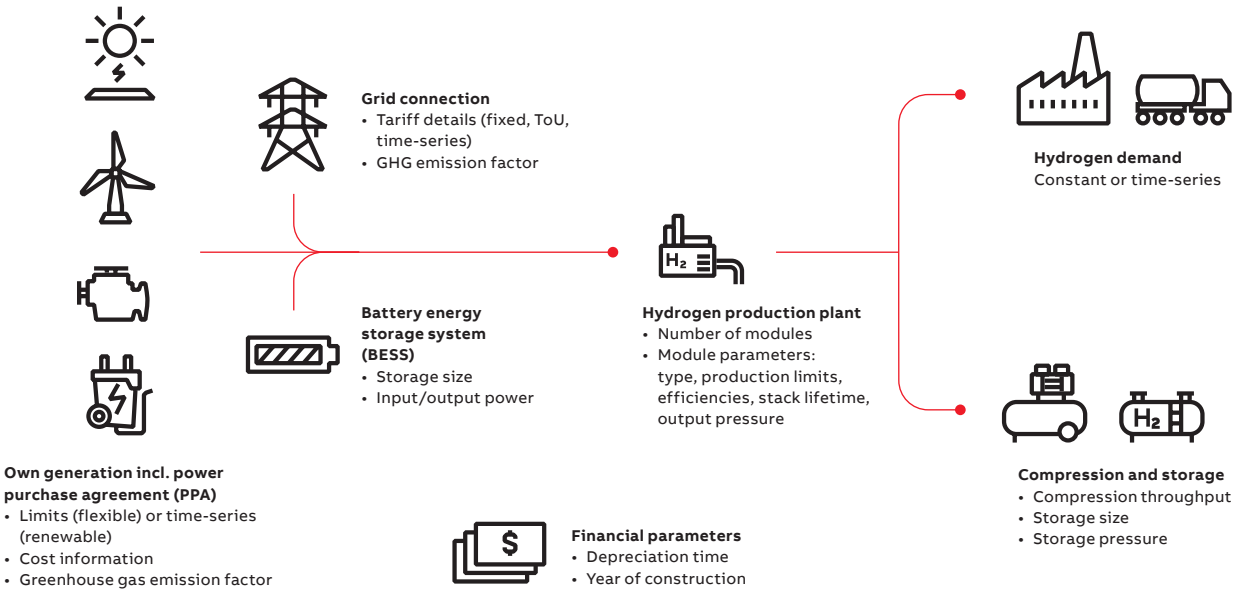
The sensitivity analysis conducted by ABB identified the impact of various levers for further reduction of the LCOH →05. The main levers are (in order of significance):

1. Lower electricity price in the PPA.
2. Utilize more efficient electrolyzer modules.
3. Increase the PPA quantity (and thus reduce the more expensive ToU volume) while ensuring that all the energy ordered can actually be consumed.
4. Lower electricity prices from the grid.

Other factors might be more significant in projects that are not dominated by electricity costs, such as: financial parameters (eg, depreciation time), initial CAPEX of the HPP, number of modules or stack lifetime, water price, or the size of compression and storage. For each specific project, the analysis gives a good indication what aspects to look at for further overall cost optimization.

**Example: optimization analysis of a trailer filling station**

A customer wants to supply hydrogen to fill three to four trailers daily with 1 t of hydrogen each. Power comes partly from a directly connected wind park (9 MW peak output) and the rest is

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02 Sample output from the ABB HPP Sizing Tool, comparing two scenarios.

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03 Model overview and required input parameters of the HPP Sizing Tool.

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04 High-volume hydrogen production example.

purchased on the spot market. The customer preselected a supplier of two 2,000 Nm³/h polymer electrolyte membrane (PEM) modules and decided on a reasonable size of hydrogen storage and compression →06.

The initial calculation of the customer case with this 4,000 Nm³/h PEM plant resulted in an LCOH of $5.45/kg of hydrogen, only half of which comes from the electricity cost, due to the low plant utilization of 36 percent. Taking this base case, ABB used the digital twin to calculate various scenarios with stepwise improvements. The results are shown in →07 and can be summarized as follows:

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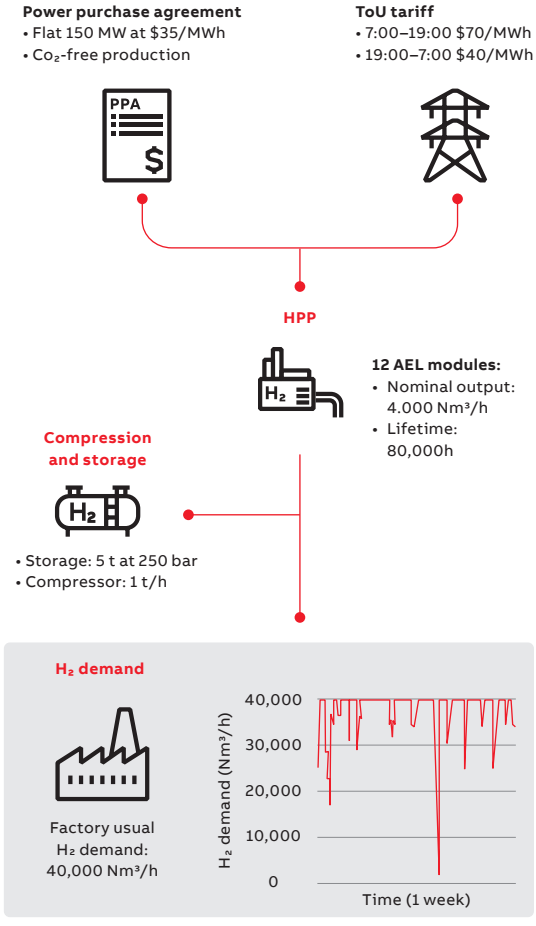
ABB used the digital twin to calculate various scenarios with stepwise improvements.

- Using ABB OPTIMAX as an energy management system reduces the electricity cost significantly by selecting better setpoints to benefit from low-cost energy and higher efficiencies of the nonlinear plant efficiency curve.
- Reducing the number of electrolyzer modules from two to one – ie, cutting capacity to 2,000 Nm³/h – lowers the fixed cost significantly, but has the disadvantage of increased operational cost and lost module redundancy.

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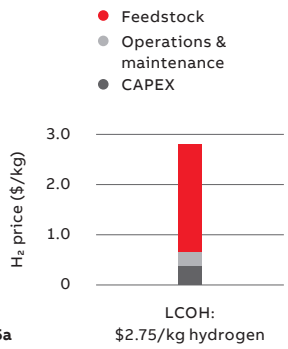
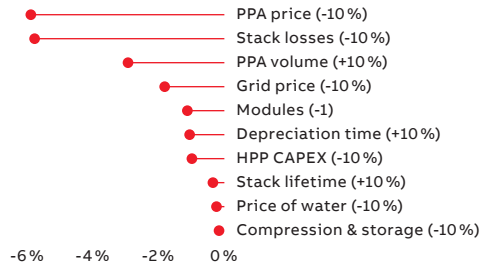



**05a**




**05b** Effect on LCOH

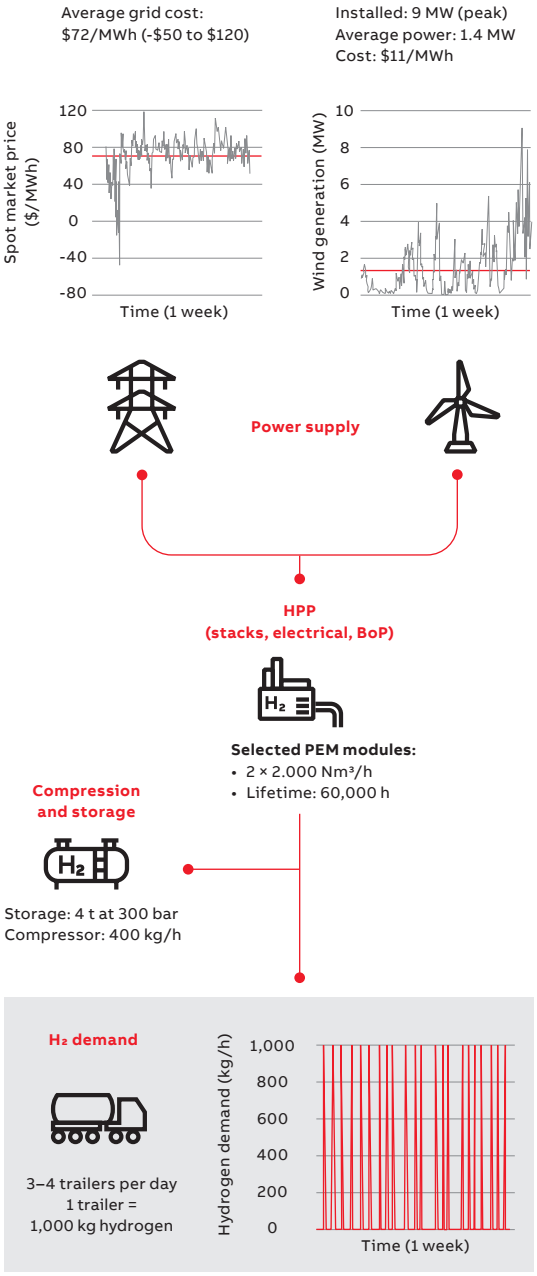
- Optimal sizing of compression and storage reveals that reducing their size (and CAPEX) by around 50 percent brings a benefit greater than the small disadvantage on average electricity cost increase.

Further, a scenario using two slightly smaller alkaline electrolyzer modules, with a total capacity of 3,000 $Nm^3/h$, was calculated. This change reduces the electricity costs (due to higher efficiency at nominal production) and stack replacement costs (due to longer lifetime).

## The sensitivity analysis identified the impact of various levers for further reduction of the LCOH.

The disadvantage of the larger – and thus more expensive – total plant is more than compensated for by reduced average electricity price due to increased flexibility to produce more when prices are low. Compression and storage capacities were enlarged again to maximize this advantage.

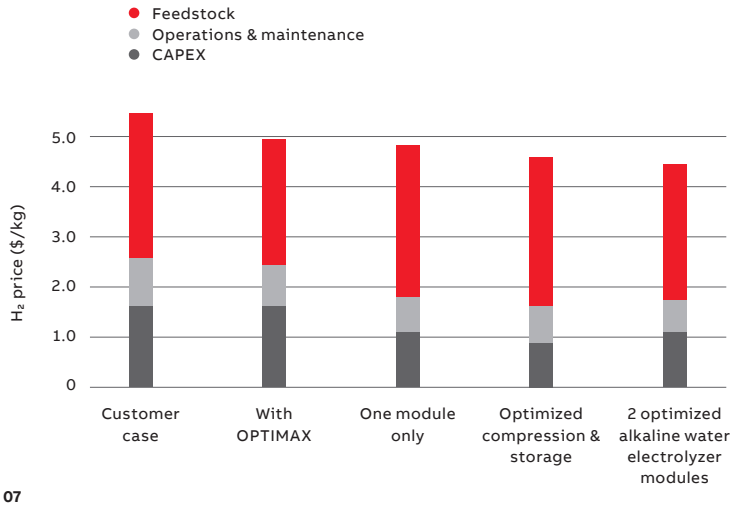
Overall, the final ABB layout proposal offers the plant operator the following benefits:




**06**

- Annual savings of $1.14 million, unlocked by the overall reduction of the LCOH by 18 percent (to $4.50/kg from $5.45/kg). The savings come from reductions in electricity cost (9 percent) as well as CAPEX and OPEX (30 percent each).
- Reduced greenhouse gas emissions (8 percent) by consuming less energy overall and using grid energy when its green content is higher.
- Guaranteed supply of the hydrogen demand, even with failure or maintenance of one of the modules.

These benefits can fully be unlocked during operations when using an EMS system like ABB OPTIMAX.




07

LCOH, the tool uses very detailed models of fixed costs (CAPEX, OPEX). For plant efficiency, non-linear models are employed. These models are crucial for the operational setpoint optimization that ABB OPTIMAX does in the background to determine accurate variable costs. The results are used for discussion with the industrial partner or dedicated consulting activities. The specific customer case can be revisited any time to update parameters according to ongoing project planning as laid out in →03. The tool can be used to respecify existing plants as well as set up new ones.

Together with the expertise of the ABB sales and consulting team, the HPP Sizing Tool supports ABB's partners in making the right investment decisions on their way to decarbonization and switching to a low- or zero-carbon hydrogen production regime →08. •

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05 Results of sensitivity analysis.

05a Base case result.

05b Sensitivity analysis. The corresponding percentage reduction in the LCOH caused by a 10 percent beneficial movement (eg, a decrease in the PPA price or an increase in PPA volume) of each factor is reflected the bars of the chart. For the modules, the change is not a percentage but a move to a system with one module fewer.

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06 Trailer filling station example.

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07 Different scenario optimizations by the HPP Sizing tool for the trailer filling station.

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08 The Sizing Tool ensures that the producer has the facilities needed to deliver the hydrogen required.

**Making the correct investment decisions**

The HPP sizing tool is an ABB Web-based tool for the benefit of electrolyzer projects in early concept and planning phases. The tool takes

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The HPP Sizing Tool supports ABB's partners in making the right investment decisions on their way to decarbonization.

the actual project data as input and offers appropriate default values when data is missing. For accurate calculation of the project-specific

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NEXT GENERATION LOW VOLTAGE DRIVES WITH ADDITIVE MANUFACTURING OF COOLING DEVICES

# Cooler power electronics

Thanks to additive manufacturing, ABB developed a three-dimensional vapor chamber that enables power extensions of high-speed low voltage (LV) drives to higher current ratings, higher switching frequencies, and the improved reliability of heavy duty drives.

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Advances in the ability to control electric voltages have enabled innovations in a plethora of products from electric motor drives to solar inverters. To manage this process efficiently, safely and reliably, not only are high-performance power electronics needed, their cooling is critical. This is especially true for the high-speed, LV drive market. In the past few years, vapor chambers have emerged as particularly interesting cooling devices for handling high heat flux in power electronics and for extending the applicability to air cooling. Ever poised for innovation, ABB set about exploring this possibility.

**Missing offering**

Having analyzed markets, ABB determined that customers' power electronics needs converge toward a demand for higher power density and reliability; this hinges on the ability to cool these products efficiently. While such demands can be satisfied with water cooling systems, there is a conspicuous product offering gap for air cooling beyond a certain power density →01. Clearly, not every customer can accept the inconveniences and high cost of pumped water cooling systems as an alternative to air cooling. Thus, ABB decided to fill this unsatisfied demand. Relentless R&D efforts invested into thermal management spurred the development of ABB's novel power electronics air cooling technology.

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Vapor chambers have emerged as particularly interesting cooling devices for handling high heat flux in power electronics.

**Two-phase cooling**

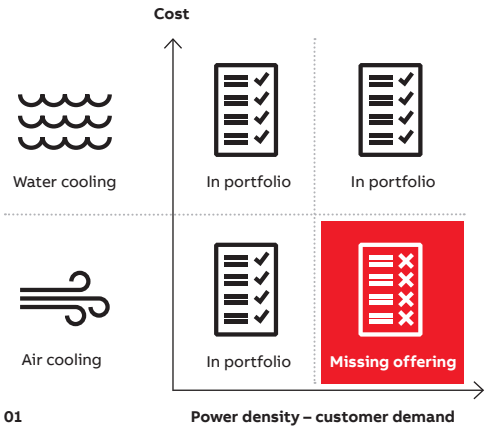
Heat-pipes are ubiquitous heat spreading devices used to cool a variety of equipment, such as the central processing unit (CPU) of your laptop [1]. They can be shaped into a one-dimensional flow as in →02, or into two- or three-dimensional heat spreading forms known as vapor chambers. The working principle is based on the evaporation, circulation and condensation of a working fluid contained inside the heat-pipe – a two phase cooling process. The evaporation absorbs the heat from the component to be cooled, the circulation, achieved through capillary and/or gravity forces, spreads the heat and the condensation, transferring it to the cooling medium, which is usually ambient air. Such vapor chamber features caught ABB's attention. The question became: Could vapor chamber technology be used to cool power electronics, which must dissipate kilowatts inside LV drives.

Historically, heat-pipes were developed to cool electronics, capable of dissipating some 150 W at 85°C and 6 W/cm². In contrast, ABB required a technology to dissipate some 4,800 W at temperatures between -15°C and 110°C and a heat density of 40 W/cm², a tremendous challenge. Working together with suppliers, ABB set out to upgrade the traditional heat pipe technology to meet this new challenge.

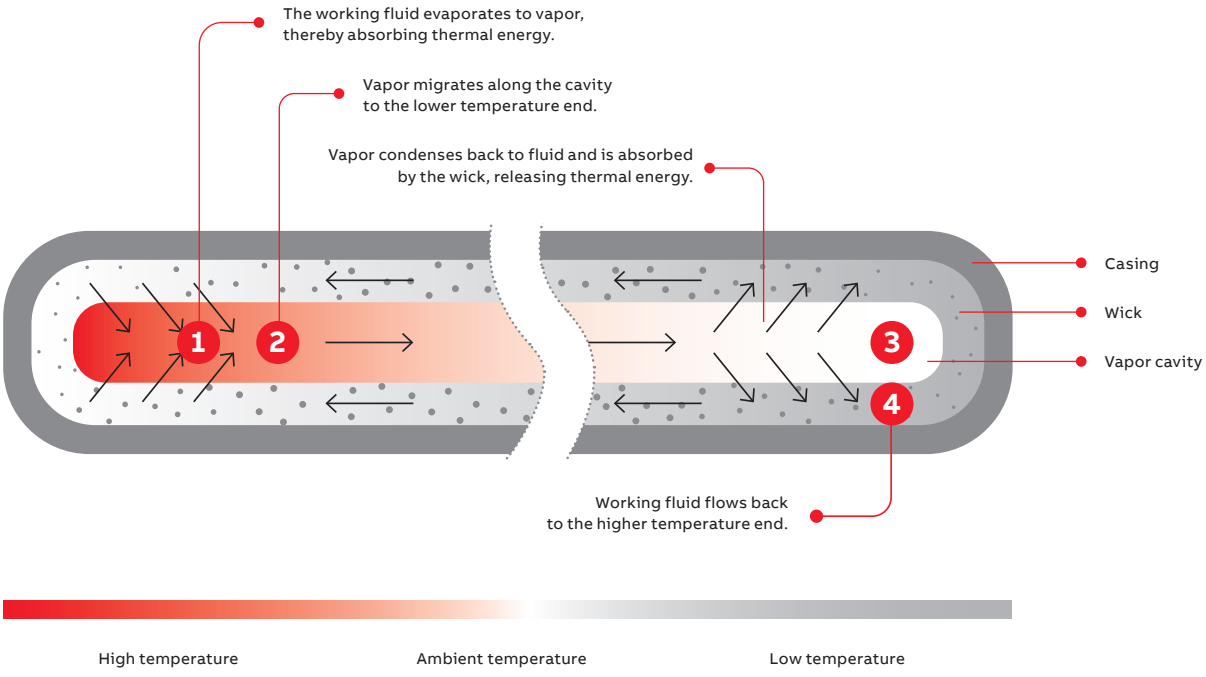
While the product gap could be filled, partly, for lower-end drives in terms of power density using a traditional heat-pipe technology, up-scaling such technology is limited to about 1,800 W. Thus, for higher-end LV drives, ABB decided to develop an original solution with the help of additive manufacturing.

**Printed vapor chamber technology**

Despite offering well-known advantages such as the ability to produce lightweight components and complex geometries, additive manufacturing has limitations, eg, the production of thick, dense (non-hollow) parts, post-processing, and surface finishing. And, yet one important benefit stands out: additive manufacturing supports ideation; it frees the imagination of product designers.




01 Missing cooling offering is presented in terms of power density and cost.

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While vapor chambers are used to spread heat from a source to a sink, they are essentially thin walled containers filled with a fluid: from a construction point of view they are the perfect match for an additive manufactured solution. Traditional vapor chambers, manufactured with state-of-the-art methods such as stamping,

ABB required a new technology that could dissipate some 4,800 W and a heat density of 40 W/cm² for use in LV drives.

machining, soldering and bonding, are necessarily a compromise between different constraints, while additive manufacturing allows each physical process to be optimized, eg, evaporation, internal fluid circulation, condensation and air-heat transfer, without impacting the other processes.

Often labelled as a high-cost production method for prototype-development exclusively, additive manufacturing is coming of age. Owing to the careful optimization of machine parameters eg, laser paths and focus, powder selection, supportless designs and post-processing elimination, vapor chambers can now be printed at a competitive cost. For instance, ABB chose to print the vapor chamber with an aluminum alloy, AlSi10Mg, a lightweight, solid and relatively low cost powder for metal 3D printers →03.

ABB also devoted attention to the geometry of the air fin design because this is where the heat transfer bottleneck usually occurs in traditional air coolers. Thanks to the design freedom that comes with additive manufacturing, ABB used triply periodic surfaces. Such fin geometry has been shown to significantly improve heat transfer within the range of air velocities that are used to cool ABB products [2,3]; this is accomplished by maximizing the air-heat transfer with a minimal drop in pressure.

**Seeking superior cooling performance**

To evaluate the cooling function of the printed vapor chamber, ABB compared the hotspot thermal resistance inside a LV drive for a standard heatsink, the best performing vapor chamber manufactured by state-of-the-art technology, and ABB's new technology →04. ABB's 3D printed vapor chamber yields a thermal resistance that is 30 percent lower than the standard heat sink, and 17 percent lower than the best performing traditional vapor chamber.

Defined as the temperature increase of the heating component relative to the cooling air divided by the heat losses, thermal resistance does not depend on heat losses for a standard heat sink, but it does for vapor chambers. A typical U-shaped curve is produced due to the variation of the working fluid's thermo-physical properties with temperature. Initially, the internal circulation of the fluid improves as the heat losses increase, then a broad plateau is reached, which represents the heat load variation, until a condition called dry-out is established. At this level, the circulation of the liquid phase can no

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02 Heat pipe/vapor chamber thermal cycle is illustrated [1].

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03 ABB's additively manufactured vapor chamber is shown with the notable triply periodic surfaces, which can be pictured as an array of fins with wavy features in the three-dimensional space.

longer cope with the vapor production rate. Importantly, ABB's vapor chamber technology did not reach the so-called dry-out condition →04. In contrast, dry-out did occur above 1,200 W for the traditional market-best vapor chamber tested →04. The superior performance of ABB's technology is noteworthy as it could lead to significantly longer product life since power modules could operate at lower temperatures, higher current or switching frequency, due to the higher heat load handling capability.

**Availability of alternative working fluids**
Because the working fluid impacts vapor chamber performance, ABB evaluated how four different fluids impact thermal resistance →05. Acetone, a commonly used working fluid, was initially tested and found to be the best performing fluid. However, acetone is flammable, so ABB also investigated nonflammable alternative fluids, prioritizing those that are nontoxic and characterized by an acceptable Global Warming Potential[1] (GWP); Fluor-based refrigerant fluids (HFC, HFO) are nonflammable and nontoxic, and can also help maintain a low working pressure; this should be minimized to lower the mechanical resistance requirements. Therefore, two fluor-based fluids with GWPs equal to that of $CO_2$ (the reference gas) were evaluated: R1233zd and R1336.

Moreover, another flammable fluid was tested: Hexane, to determine if an even lower pressure fluid could achieve a better performances than that of acetone. A comparison shows that R1336 is the best-performing alternative fluid, for applications that require a nonflammable cooling fluid, even though it displays a 7 percent increase in the thermal resistance compared to acetone →05.

**Temperature and pressure cycling resistant**
In contrast to CPUs of computers, most of ABB's power electronic products, such as LV drives, must be able to operate flawlessly in extremely harsh environments, eg, in ambient temperatures ranging from -40°C to 50°C and experience large temperature cycles, which can negatively influence product life. Thus, ABB investigated the influence of temperature cycling on the thermal resistance →06 to establish the reliability of the newly printed product for use in ABB's product LV drives. By dipping the vapor chamber 500 times, alternatingly between two liquid baths; one maintained at -15°C and the other at +110°C, and measuring the thermal resistance of the uppermost and lowermost base plate before and after each of the cycles, ABB ascertained the impact of temperature cycling on their product. Because no significant differences were observed, these results support the use of the printed vapor chamber in LV drives.

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Because additive manufacturing supports ideation, ABB set out to explore utilizing this method for vapor chambers.

Another noticeable advantage of ABB's cooling device is that the working fluid: acetone, does not freeze at the extremely low temperatures (down to -40°C) typically encountered in power electronics applications. Conversely, standard market vapor chambers made of copper use

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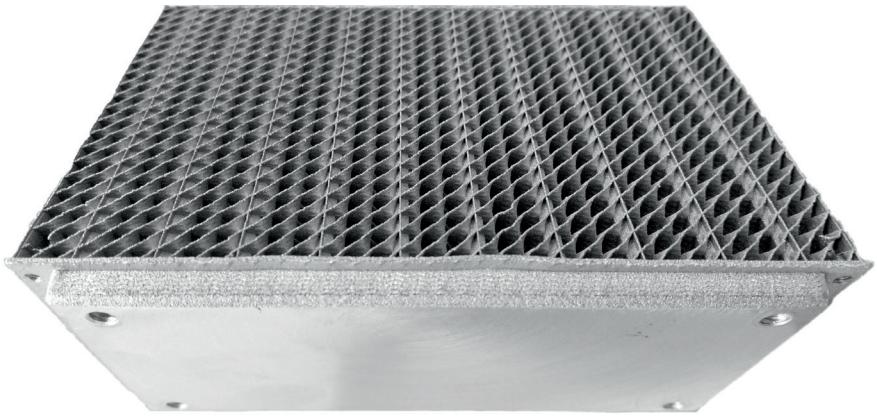
**Footnote**

[1] GWP refers to the total contribution to global warming resulting from the emission of one unit of a gas relative to one unit of the reference gas, $CO_2$.



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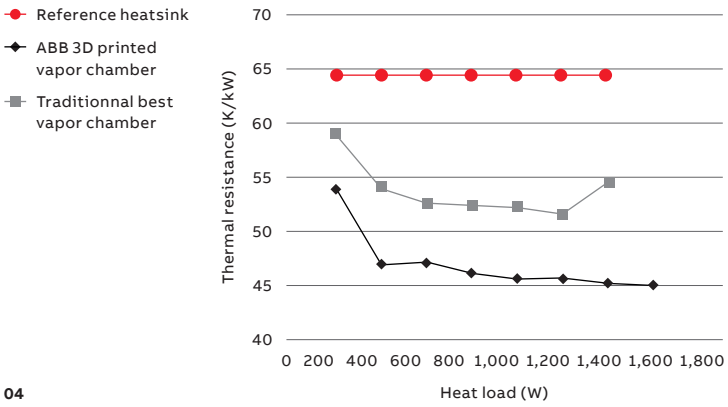


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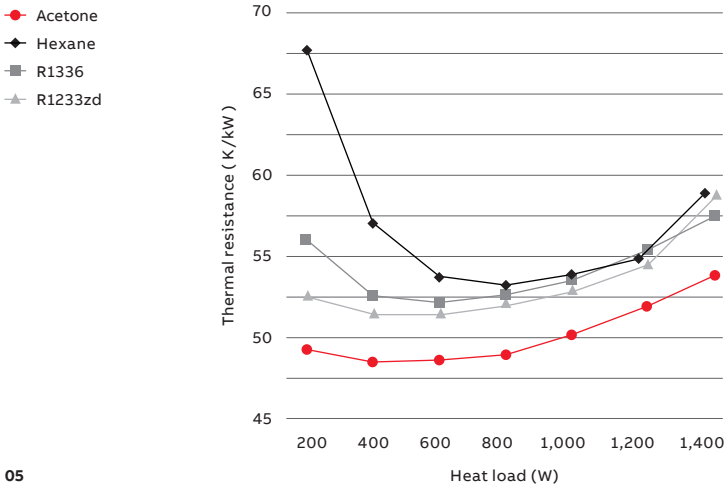


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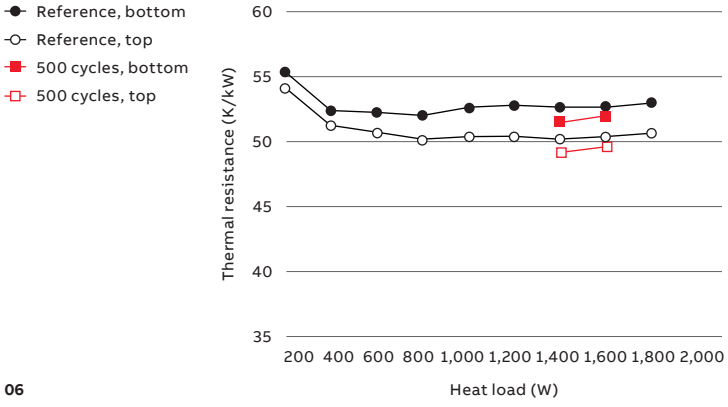


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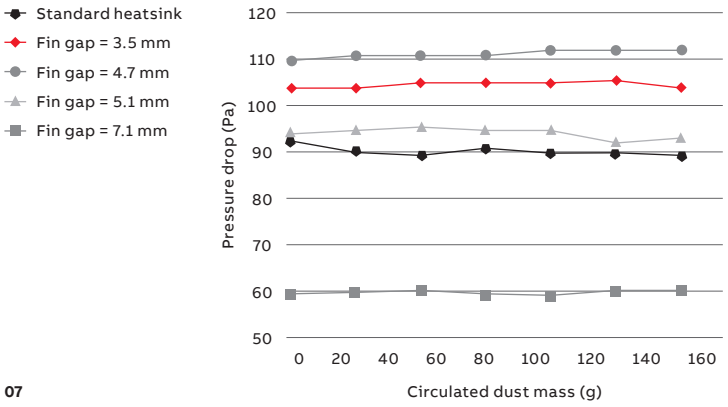


07

water as a working fluid; such a construction can lead to ice formation, bulging and mechanical damage to the vapor chamber.

**Meeting clogging requirements**

In industrial applications, ambient air is often loaded with dust particles that can reduce the cooling performance of vapor chambers due to the clogging of fins. To test clogging's impact, ABB evaluated the effect of dust-filled air on chamber performance →07, specifically, the influence of dust clogged fins (for vapor chambers printed with triply periodic fins) on the cooling air pressure drop. Using ASHRAE stan-

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Test results rigorously support the use of ABB's printed vapor chamber to cool power electronics, efficiently and reliably.

dard dust, typically used in filter fouling tests in accordance with ANSI/ASHRAE standard 52.2 – 2012 6.2, particulate concentrations of 100 mg/m³ were injected inside a closed-loop air tunnel and circulated through a standard heatsink and four different 3D printed vapor chambers. After 150 g of dust had been circulated, amounting to six hours of air circulation, representing several years of use, the pressure drop for all prototypes remained essentially unchanged. These results indicate that the ABB vapor chamber is no more prone to clogging than the standard heatsink – a meaningful result.

**Economic considerations**

The aforementioned test results rigorously support the use of ABB's printed vapor chamber to cool power electronics, efficiently and reliably. But what about cost – additive manufacturing is expensive and mainly applicable for low-volume production, right? Well, yes and no. Thanks to the specifics of vapor chamber geometry, ABB was able to develop special parameters that increased the printer productivity and decreased the part production cost. Additionally, ABB reduced post-processing to a minimum by designing the part without the need for supports, minimum roughness and with maximum flatness; this obviates the necessity of using expensive wire-EDM and CNC milling machines.

Higher production volumes give the printshop higher negotiation power with raw material suppliers too, resulting in lower raw material prices compared to small volume "retail" prices. With the state-of-the-art process, a 4-laser

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04 Comparison of thermal resistance versus heat load.

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05 Influence of various working fluids on the thermal resistance, which impacts performance of the ABB vapor chamber.

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06 Influence of temperature cycling on the ABB vapor chamber thermal resistance.

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07 Influence of particulate clogging of the fins on the four different vapor chambers with increasing fin gap sizes specially printed for this test, and the standard heatsink.

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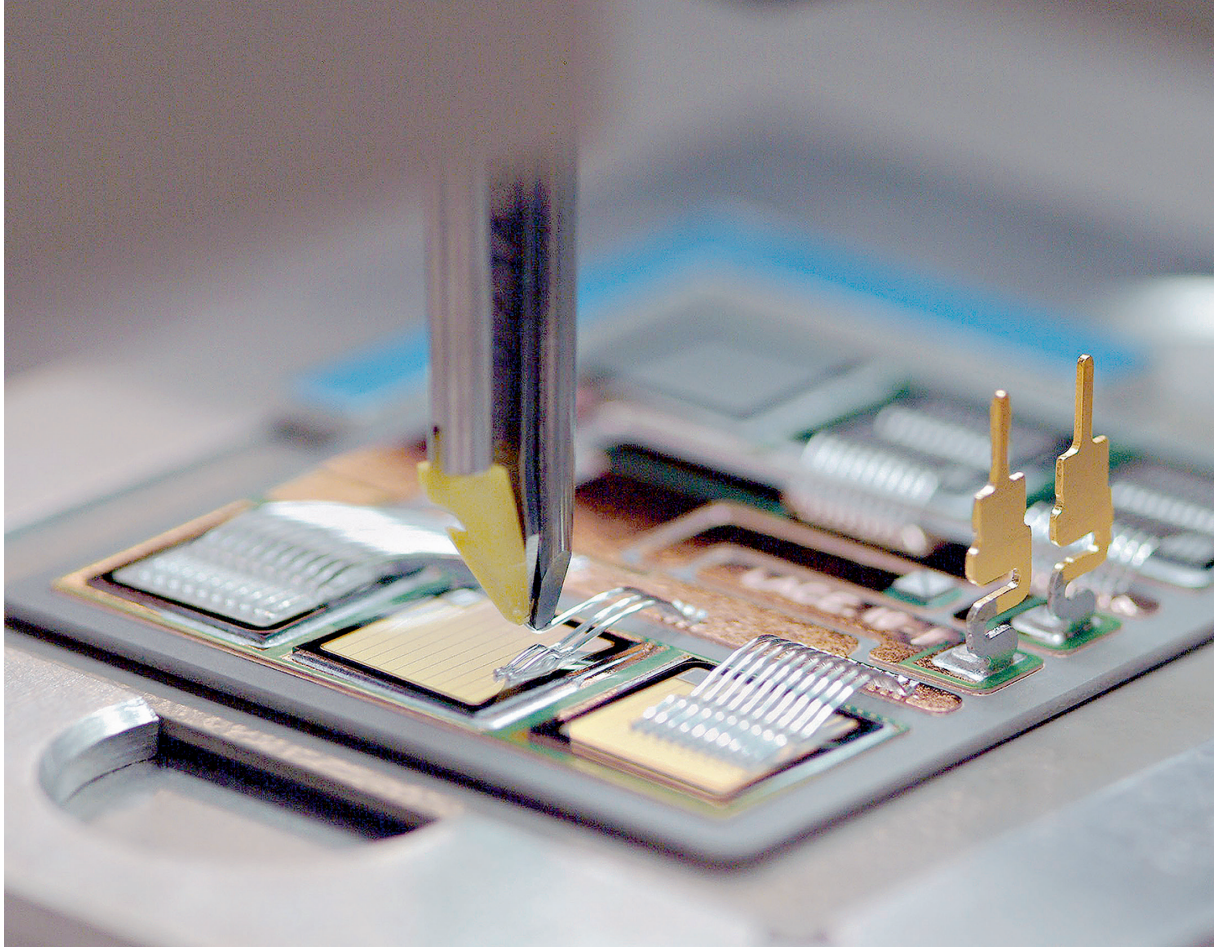
08 Power electronic semiconductors, shown here, are an essential component of LV drives in addition to CPUs and GPUs.



**08**

machine is capable of printing about 3 to 4 tons of heatsink product per year, or 10 to 50 thousand pieces, depending on size. By using an AlSi10Mg alloy and fast parameters for additive manufacturing, costs per kilogram are generated that are an order of magnitude higher than for extrusion, laser welding or skiving depending on the production region and part geometry. However, weight impacts cost too; 3D printed parts are lightweight – weighing 7 to 10 times less than parts manufactured conventionally.

Moreover, additive manufacturing is a rapidly developing field where production efficiency and cost are continuously improving. New, so called "area printing" additive manufacturing machines allow a 10 times faster printing speed. Together

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ABB's new 3D printed vapor chamber demonstrates superior performance compared to standard technologies.

with further design advancements aimed at reducing part weight, such modifications will cause a dramatic shift in the air cooling industry. For the first time, printed heatsinks will not only be smaller, lighter, and better performing, they will be able to price-match existing extruded heatsinks; this transition is anticipated to occur within the next two to four years.

To unleash the full potential of power electronic semi-conductors →08, more efficient and reliable cooling is essential. Despite having conquered the CPU and graphic processing unit (GPU) markets over the past two decades, two-phase heat transfer via the use of copper-water vapor chambers is limited. Scaling-up such technology (by increasing the volume and heat load) for use in LV drives is possible only up to a point: A level exists beyond which power and reliability requirements cannot be satisfied simultaneously. Taking-up this challenge, ABB developed an original vapor chamber solution with the help of additive manufacturing. Not only is this new technology more affordable than ever, it demonstrates superior performance compared to standard technologies, thereby meeting power electronic customers' cooling needs today and tomorrow. •

**References**


[1] Zootalures and Offnfopt, CC BY-SA 3.0: https://creativecommons.org/licenses/by-sa/3.0, via Wikimedia Commons, https://commons.wikimedia.org/wiki/File:Heat_Pipe_Mechanism.svg [Accessed Sept. 22, 2022.]

[2] M. Khalil, et al., "Forced convection heat transfer in heat sinks with topologies based on triply periodic minimal surfaces", *Case Studies in Thermal Engineering*, Volume 38, 2022, pp. 102313.

[3] J. Iyer, etal., "Heat transfer and pressure drop characteristics of heat exchangers based on triply periodic minimal and periodic nodal surfaces", *Applied Thermal Engineering*, Volume 209, 2022, pp. 118192.


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BUZZWORD DEMYSTIFIER

# Carbon neutrality and net zero

Carbon neutrality and net zero are related terms that both refer to an organization's greenhouse gas emissions. Yet, the two terms are distinct and differ in several ways.

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**Carbon neutrality**
Carbon neutrality is achieved when an organization finds ways to eliminate or neutralize its carbon emissions. The neutralization of unpreventable emissions takes place via carbon offsets. Removal of $CO_2$ from the atmosphere is an example of carbon offsetting, as is the replacement of oil heating by a district heating system with lower emissions. For these carbon offsets to be credible, it is important that the avoidance of the emissions can be clearly attributed to the specific project and would not have occurred otherwise.

**Net zero**
Net zero is a newer, more precise and more demanding term. In contrast to carbon neutrality, net zero strongly focuses on emission reductions. To achieve net zero, an organization needs to reduce all its direct and indirect emissions as far as possible throughout the value chain. The remaining emissions that are hard to abate need to be physically removed from the atmosphere through carbon removal technology. Carbon removal technology includes methods that capture carbon directly from the air.

The Science-Based Targets initiative (SBTi) has established a net-zero standard – based on which, organizations can set targets that align with the goals of the Paris Agreement toward "curbing global temperature rise to well below 2° C above pre-industrial levels and pursuing efforts to limit warming to 1.5° C" [1]. Organizations committing to the SBTi must define a near-term target to achieve rapid emissions reductions. They may also define a long-term target in line with the

> An organization that sets a long-term SBTi target must achieve net zero by 2050.

net-zero standard. An organization that sets a long-term SBTi target must achieve net zero by 2050 by the latest, as set out in the Paris Agreement.

**Emissions reduction is key**

While the concept of carbon neutrality has been around for a long time, net zero is increasingly important. Net zero directly links an organization's emissions reduction efforts to the overall reductions that society needs to make to achieve the aims of the Paris Agreement. Additionally, by focusing on emissions reduction, net zero has gained broad credibility. Carbon neutrality, on the other hand, could theoretically be achieved exclusively by purchasing carbon offsets without any actual emission reductions. Therefore, carbon neutrality aspirations must be combined with solid emissions reduction targets to remain credible. •

By focusing on emissions reduction, net zero has gained broad credibility.

**Reference**

[1] SBTi, "Ambitious corporate climate action – Science Based Targets." Available: https://sciencebased-targets.org/ [Accessed 28 February, 2023.]

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READERSHIP SURVEY 2023

# You read, we listen.

Because reader perception and satisfaction and inputs are important to chart the future course of ABB Review, we offer regular readership surveys to gather your inputs. Your opinion matters to us so you are invited to take part in this short, 12 question, survey. We thank you in advance for your time and effort.


—
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- ☐ Food & beverage
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- ☐ Automotive manufacturing
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