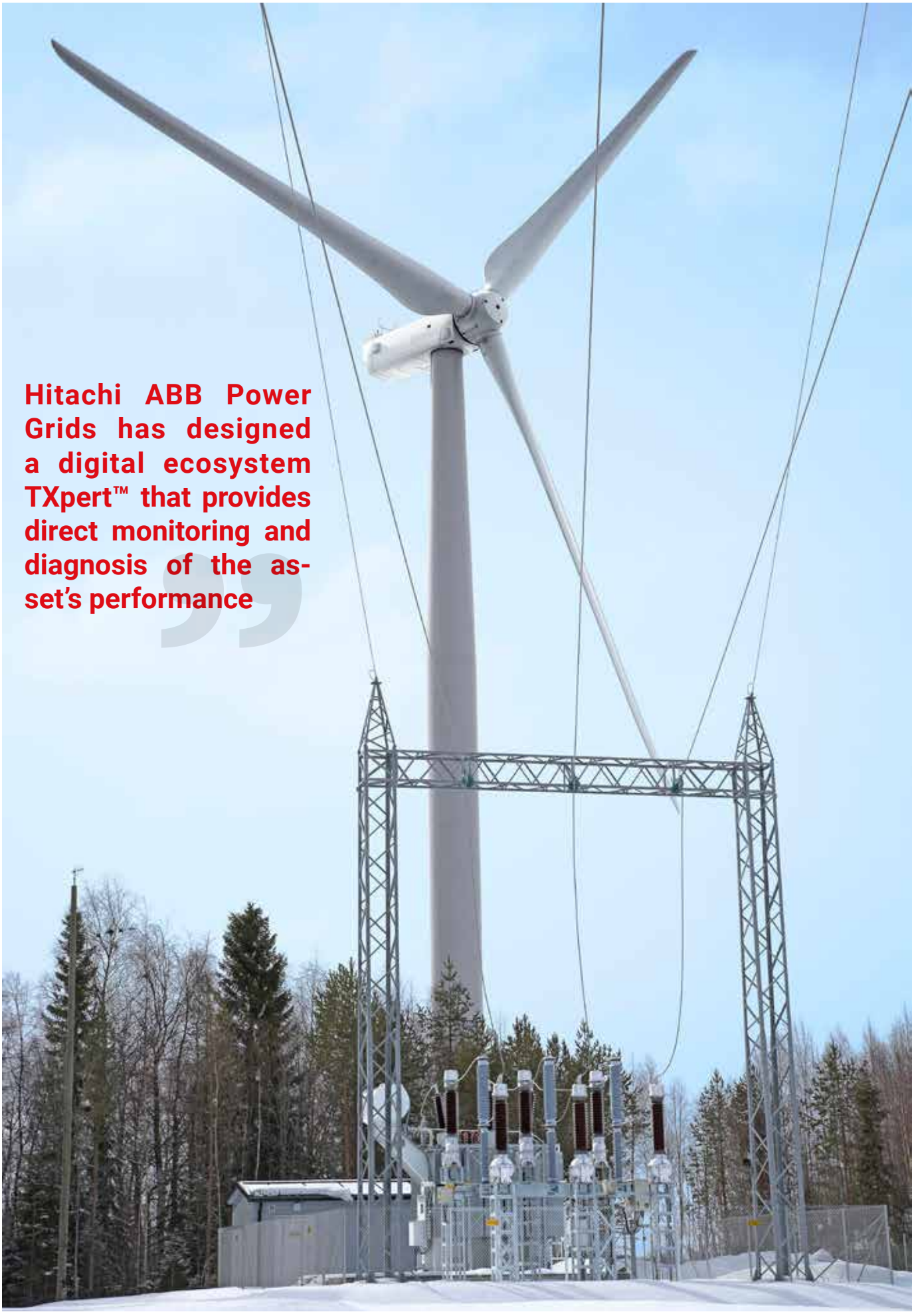

Hitachi ABB Power Grids has designed a digital ecosystem TXpert™ that provides direct monitoring and diagnosis of the asset's performance

Digitalization of renewable resources, the path to a more reliable electrical network

Introduction:

Electricity has become a vital part of everyday life and is required for almost everything we do, and transformers are one of the most critical elements in any power network.

During the life of a transformer, the asset will be subjected to various conditional and environmental stresses, including over voltages, short circuits, emergency overloading, and failing accessories – which can substantially decrease the expected life of the transformer. In addition, many network transformers in service are over 40 years old, which, in combination, creates unpredictability in the assets performance and greatly increases the risk of a costly, unplanned, or catastrophic failure.

As the world leader in transformer manufacturing, services, and asset performance management, Hitachi ABB Power Grids has come up with a solution designed for anyone who needs to do more with less.

The TXpert™ Ecosystem is designed with the users in mind, whose job it is to track, understand, protect, and maintain these critical grid assets. With an unmatched return on investment, this solution can identify risks early enough to: prevent unplanned outages; replace time-based with condition-based maintenance; reduce maintenance and operation costs; optimize asset utilization, and enable risk-optimized maintenance schedules. TXpert™ technology can be used both in new transformers and as an upgrade for an existing fleet.

Be prepared for today and for the unknowns of tomorrow with digitalization.

Hitachi ABB Power Grids' power transformers will contribute to the integration of this sustainable electricity into the grid across nine of Mainstream's Chilean projects

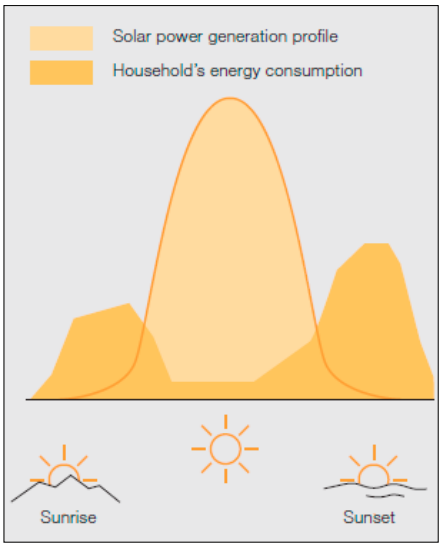

Figure 1. Residential supply and demand curves [1]

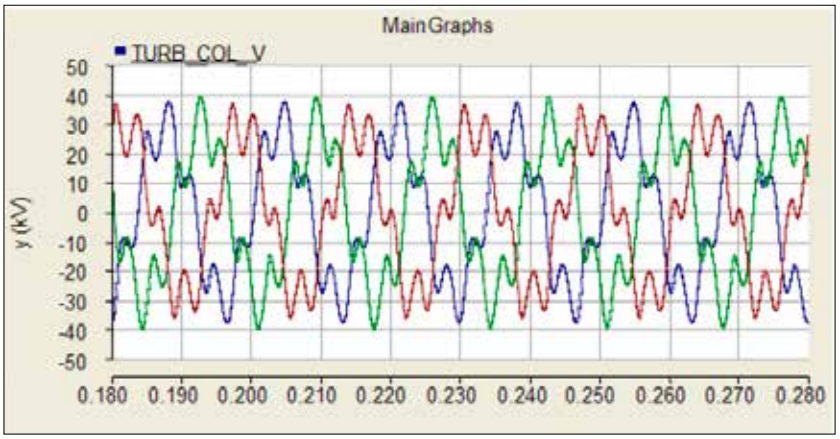

Figure 2. Collector system overvoltages from the wind generation harmonic spectrum [2]

Inka Complex

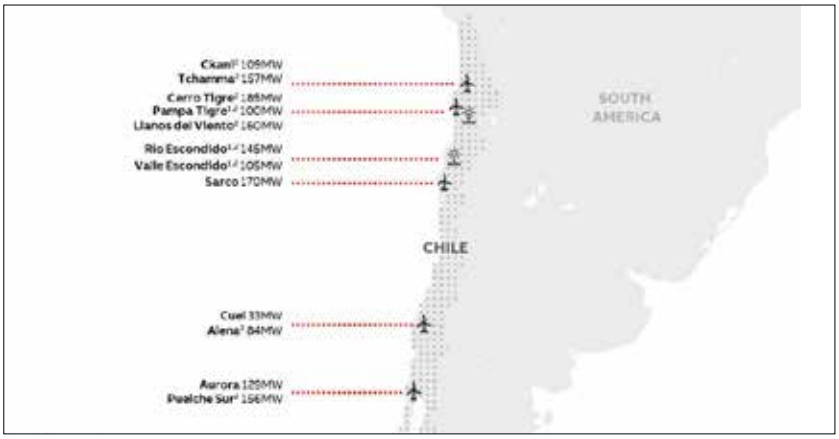

Figure 3. Mainstream Chilean wind projects

Renewable energy performance considerations

Renewable energy generation installations are fast evolving but can still be regarded as a relatively new application area. As a part of this ongoing evolution, they have experienced several design and performance challenges that have not always been fully addressed during the development of the project specifications. These issues have included transient overvoltages, harmonics, transformer saturation, power factor, reactive power, and voltage control.

Hitachi ABB Power Grids has been a major supplier of equipment for renewable power development for many years and has supported customers in this dynamic and highly demanding application area.

To address these challenges, Hitachi ABB Power Grids has designed a digital ecosystem that provides insights for customers to control the variables that influence the state of the transformer. This digital ecosystem provides direct monitoring and diagnosis of the asset's performance, including load and overload cycles that are highly variable in the application of renewable projects; estimation of the transformer life expectancy by observing thermal behavior and monitoring moisture content and gases in the transformer oil; monitoring key transformer accessories such as bushings and on-load tap changer, and centralizing all signals from digitally-conditioned transformer monitoring equipment.

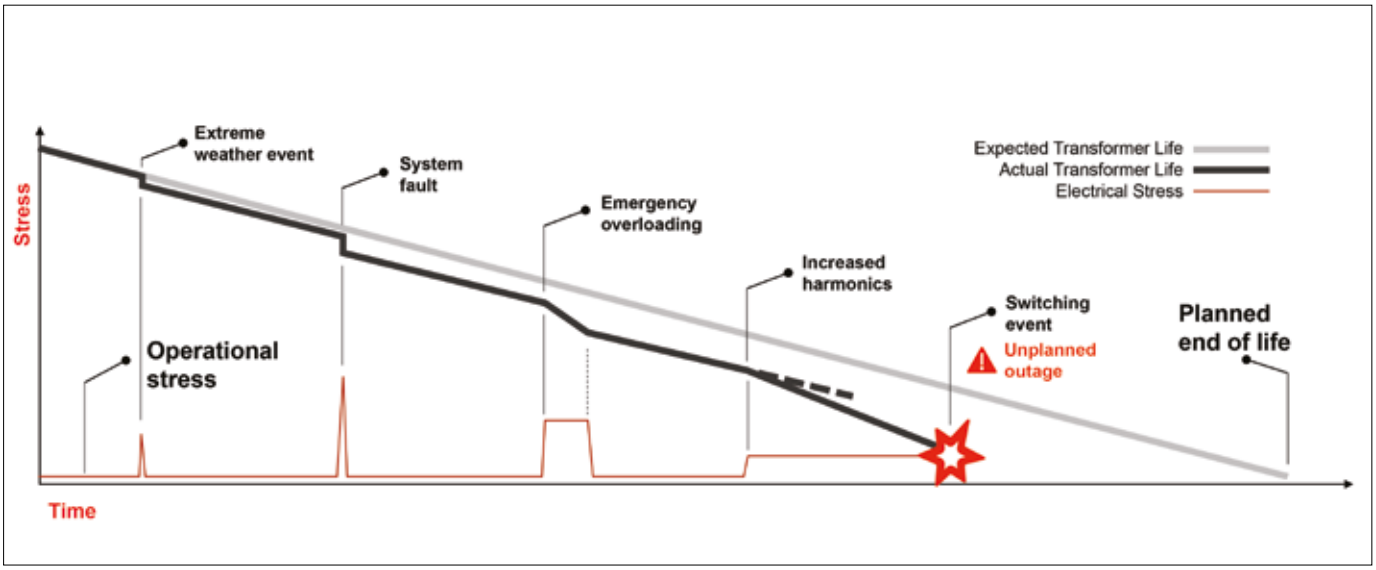

Figure 4. Typical transformer stress events

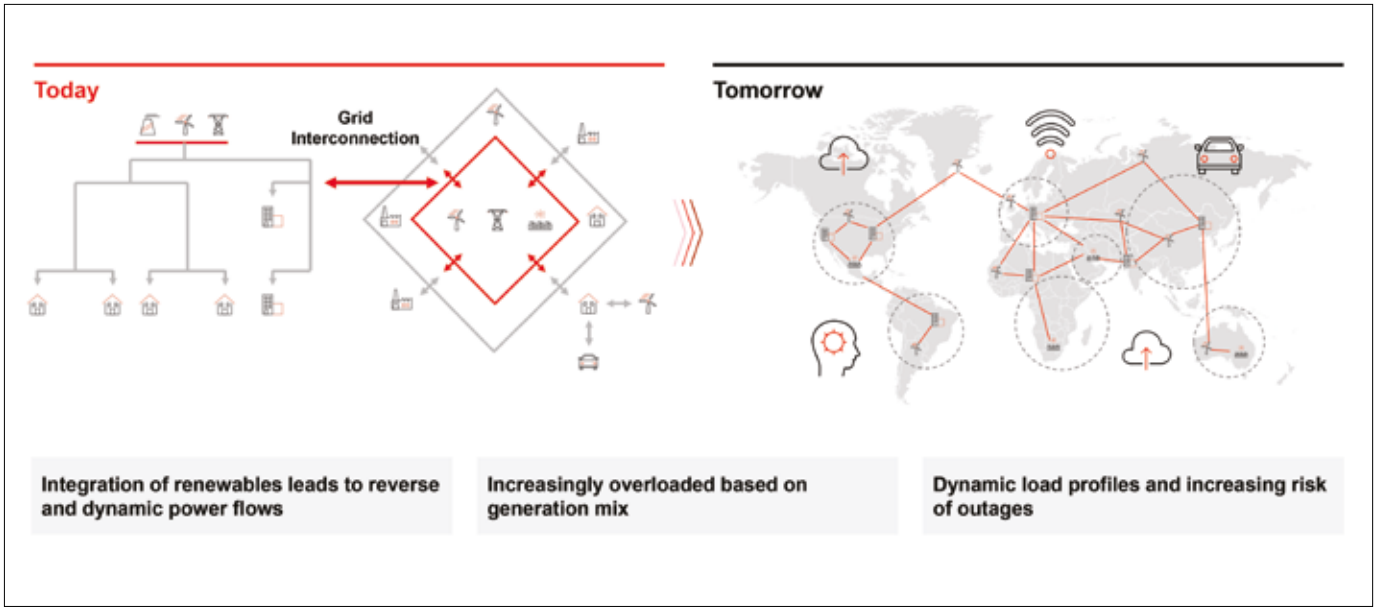

Figure 5. Evolution of future power systems

How is the renewable power industry addressing this challenge?

Mainstream Renewable Power's 1.3-gigawatt (GW) wind and solar platform, Andes Renovables, represents a good example of overcoming these challenges. Hitachi ABB Power Grids' power transformers will contribute to the integration of this sustainable electricity into the grid across nine of Mainstream's Chilean projects using digitally enabled transformers to enhance their operation in this critical application, which will provide electricity for around 1 million people.

"Driving the world with sustainable energy is one of our top priorities, and we are proud to be part of these major projects that will integrate renewables into Chile's electrical grid," said Bruno Melles, Managing Director of Hitachi ABB Power Grids Transformer Business Line. "By deploying Hitachi ABB Power Grids' digital transformers, Mainstream Renewable Power will be equipped to turn transformer health data into actionable intelligence for optimized asset performance and active network management for increased renewables integration – meaning more of this sustainable electricity can reach the end consumers."

Mainstream Renewable Power, a global developer of renewable power based in Ireland, is a major player in Chile's evolving electricity market and, worldwide, has over 16,000 megawatts (MW) of renewable power installed and in planning stages.

Installation of the TXpert™ Hub on transformers enables real-time management and analysis of the data coming from multiple sensors to provide early warnings and recommendations to avoid unexpected downtime

"To achieve our vision of electrifying the world with renewable energy, it is essential that the power our projects generate is always available," said Manuel Tagle, Mainstream Renewable Power Latam. "The power transformers in our wind and solar farms are critical, so this technology must be of the highest quality and designed to never go offline unexpectedly. The digital devices integrated into these transformers will enable us to constantly monitor the health of the transformers and take preventive action before any issues become critical. This remote monitoring is especially important for our systems, which can be isolated and difficult to access."

The digital ecosystem can also be implemented in existing fleets of transformers. CountorGlobal, Peru, identified the presence of gases in the oil of one of their transformers, an indication of a potential failure in the near future. With this insight, the customer could decide when to replace the transformer in order to maintain the transmission of energy and securing the reliability in the network.

How are digital transformer technologies revolutionizing the renewables power industry?

Transformers are exposed to many "stress events" throughout their lives. Research published by CIGRE found the benefits of transformer monitoring has the potential to deliver a 75 % reduction in repair costs due to early detection, 60 % reduction in revenue loss due to unanticipated problems / outages, 50 % reduction in risk of catastrophic failures [3] and annual cost savings up to 2 % of the price of a new transformer [4].

Renewable power generation is set to play an increasingly important part of most countries' infrastructure. However, the Collector Step Up Transformer can be a single point of failure for wind or solar farms. Transformers can now be equipped with the TXpert™ Hub

TXpert™ Ecosystem is based on the experience of more than 10,000 transformer assessments, and it is an ideal platform for the digitalization of either single transformers or the whole fleets

(CoreTec™ 4 units), enabling real-time management of their condition and analyzing data coming from multiple sensors to provide early warnings and recommendations to avoid unexpected downtime. These smart sensors include tap changer, bushing, and DGA monitoring for tracking key indicators of a potential problem inside the transformer.

It is also possible to monitor the transformer parameters remotely, providing service engineers and subject matter experts from anywhere in the world with the key information needed for maintenance planning, ensuring that these critical assets are always available.

The TXpert™ Ecosystem is, however, much more than individual devices or products. Built on the experience of more than 10,000 transformer assessments and world-leading domain knowledge, the TXpert™ Ecosystem provides customers with an open, scalable, and manufacturer-agnostic platform for digitalization of either transformers or whole fleets with a complete suite of products, software, services, and solutions.

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[1] ABB review 2-2015, article *"A bright future"*

[2] ABB Renewable energy design considerations

[3] *Guide on Economics of Transformer Management*, CIGRE, Technical Brochure 248

[4] P. Boss, P. Lorin, A. Viscardi, et al., *Economical aspects and experiences of power transformer on-line monitoring*, (2000), CIGRE Session

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