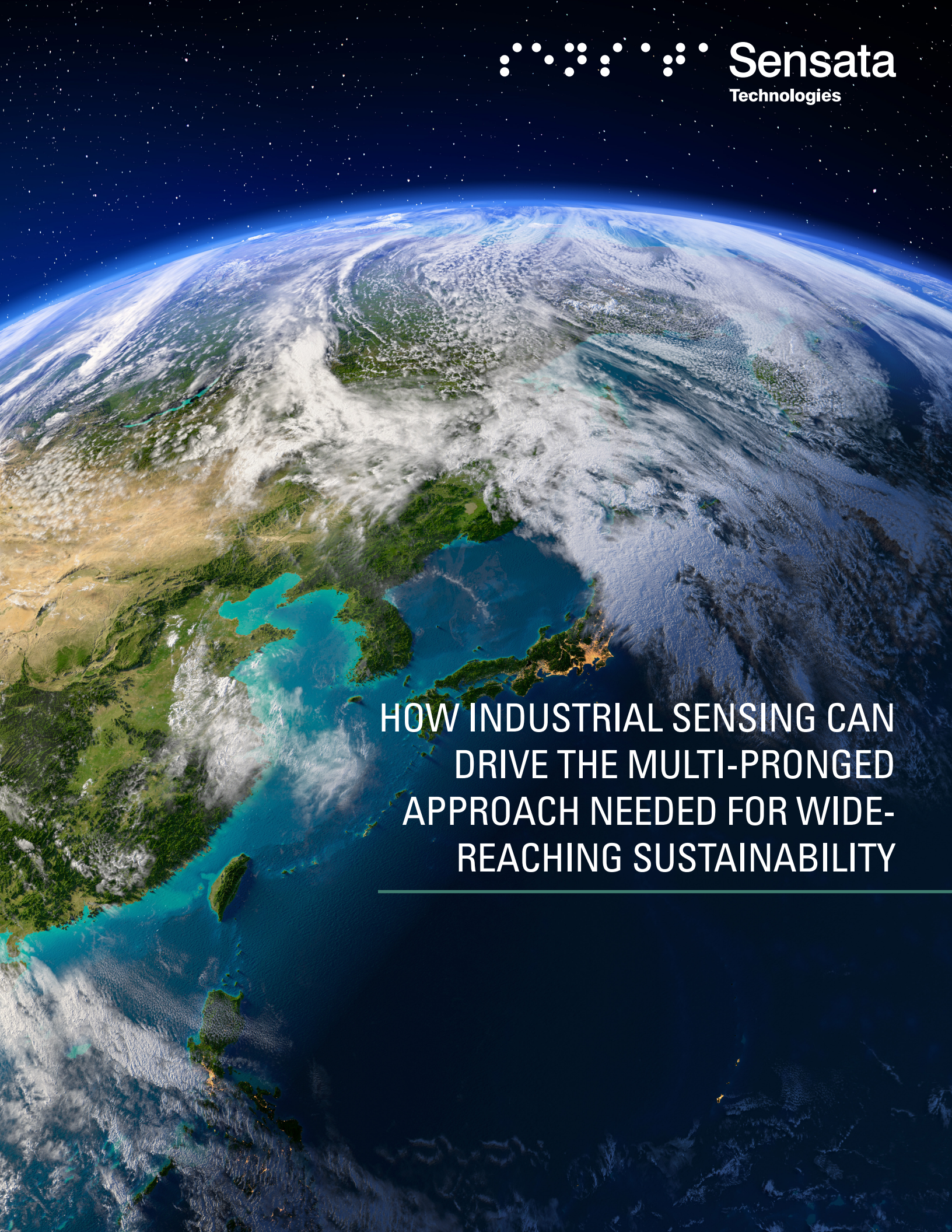


Sensata Technologies

HOW INDUSTRIAL SENSING CAN DRIVE THE MULTI-PRONGED APPROACH NEEDED FOR WIDE-REACHING SUSTAINABILITY

"A full 81% of the world's top companies report on sustainability as part of their corporate priorities, and 90% of companies in the S&P 500 issued a sustainability report in 2021."

Sustainability is one the central issues facing the planet at this time.

Countries around the globe have each set out aggressive targets to reduce their greenhouse gas emissions – either through the Paris Agreement or through other means, with complementary goals driven by states, provinces, or other local approaches.

That focus on sustainability has also carried into the corporate world, with companies everywhere looking to integrate more earth-conscious choices into their priorities. A full 81% of the world's top companies report on sustainability as part of their corporate priorities, and 90% of companies in the S&P 500 issued a sustainability report in 2021.

This extends to everything – their facilities and buildings, their manufacturing processes, and their products. And in each of those strategies, industrial sensing can play a key role in helping to drive change across a number of pathways.

SMARTER SENSING DRIVES ENERGY EFFICIENCY

Because it does not involve any specific adjustment to end user behavior – other than education around its benefits – the first and most straightforward approach toward sustainability is a push for greater energy efficiency in the categories of equipment already in place.

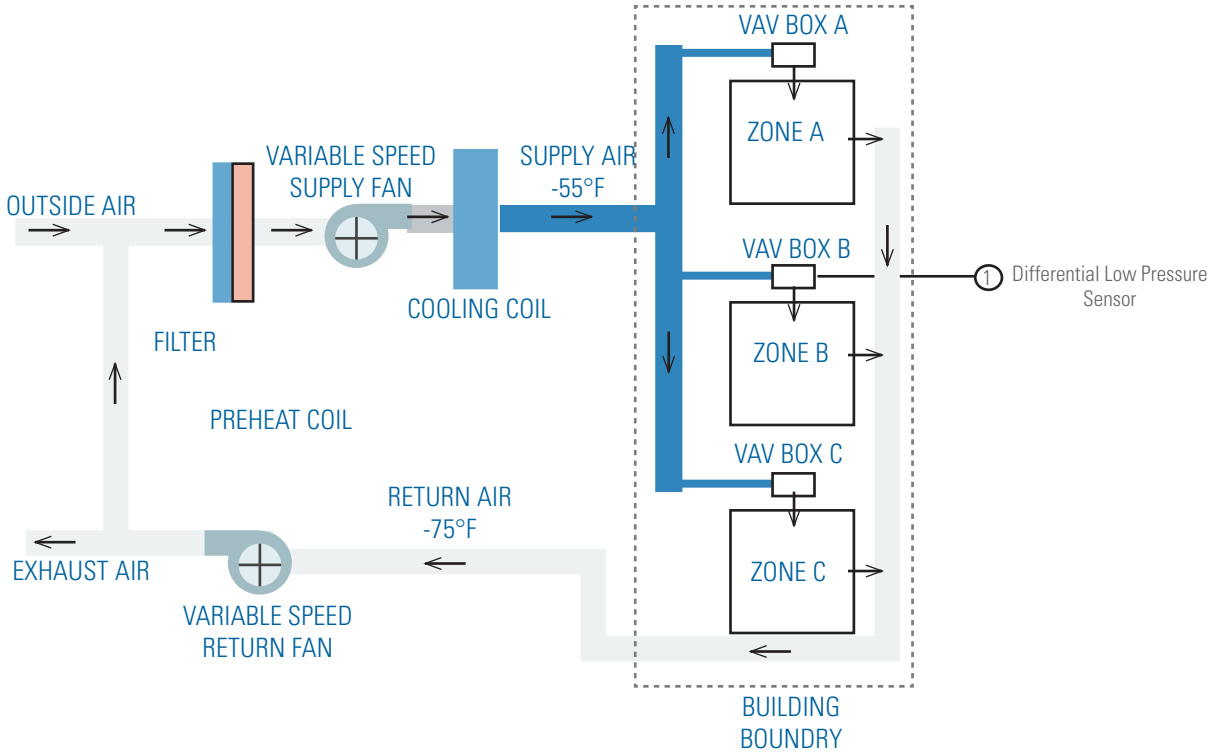
HEATING, AIR CONDITIONING, AND REFRIGERATION

In terms of specific verticals, the most frequently discussed in this context is HVAC - both as it relates to commercial and residential systems – primarily due to its outsized impact on usage. Data estimates from the U.S. Energy Information Administration found that the energy used to cool residential and commercial buildings accounted for a full 10 percent of total electricity consumption.

Within an HVAC system, pressure and temperature sensors play a key role in maintaining optimum temperatures while also reducing energy usage as much as possible.

To deliver heat, the system must have a heat source, such as a boiler, and to provide cooling, the system must have a cooling source, such as a chiller or cooling tower. The heated or cooled water – or other medium - is pumped throughout the building to air handling units or terminal units (or other similar equipment), where it transfers energy with air from the ventilation system before it recirculates to the heating or cooling source. The conditioned air is then delivered to the room.

Updated system designs – such as variable air volume layouts – also allow for a more efficient cooling of space compared to traditional systems. In a variable air volume design, the system maintains the air supply at a constant temperature while individual zone thermostats vary the flow of air to each space maintaining the desired zone temperature. This is unlike a constant volume system that maintains a constant volume of airflow to the space but changes the temperature of the air stream in response to space temperature changes.



The energy savings in this system design are driven by a reduction in fan usage, as they are often utilized at less that full capacity. It also results in reduced compressor wear and fan noise. While the specific energy savings of VAV systems vary based on a number of building and climate factors, some studies have found energy savings of 20-40 percent compared to constant volume systems.

Some of the same efficiencies present in HVAC systems also tie into other refrigeration settings, such as home appliances. Both systems utilize compression and evaporation of refrigerants to produce the cooling effect. It is critical that the refrigerant evaporator and condenser temperatures are managed carefully to ensure the equipment operates properly. Many of these appliance applications also demand effective relay and motor protection designs.

POWER GENERATION

Portable power generation is another area where equipment designs have continued to move in a more efficient direction. Portable generators – as well as mobile equipment which incorporates that functionality, such as highway equipment - typically use a combustion engine to provide power to their user.

While the combustion engine obviously is not new technology the way engineers are moving the technology forward is by creating a more efficient system that consumes less fuel and provides a higher output. In many designs, high-temperature sensors are used to monitor the exhaust gas recirculation system to reduce emissions and maximize fuel economy.

NEXT-GEN CONCEPTS AND ELECTRIFICATION

But beyond these use cases where incremental improvements in existing platforms are improving sustainability, smart sensing technology is also helping to support more disruptive technologies, such as those fueling the ongoing wave of electrification taking hold in a variety of industries.

Because battery technology is significantly impacted by temperature, sensors which optimize power draws and charging are a crucial part of this sea change in equipment design. This has implications in passenger and commercial vehicles, public transportation, and industrial vehicle and material handling applications.

Other disruptive categories – such as hydrogen power, carbon capture, and more – will continue to push toward sustainable outcomes, supported by the backbone of sensor solutions.

SMARTER METERING DECREASES USE

Smart metering technology also plays into the core "reduce" principle which has been at the forefront of sustainability messaging for decades, making a far-reaching impact.

Wide-reaching distributed networks carrying water and natural gas to homes and businesses naturally have countless points where leaks could occur. And the fact that most of the network is accessible only underneath streets and other infrastructure – making regular checks or maintenance impractical – creates the ideal environment for sensor and smart metering technology which can be monitored remotely without the need for on-site access.

PRESSURE SENSING INCORPORATED INTO GAS METERS

Natural gas is the primary heating source for approximately 50 percent of homes in the United States, and its use in residential and commercial sectors accounts for 26 percent of total consumption. It is also the largest driver of household energy use in the European Union, accounting for more than 31% of total residential energy consumption.

While it still falls into the category of fossil fuels, the combustion of natural gas emits about half as much carbon dioxide as coal and 30 percent less than oil, as well as far fewer pollutants, per unit of energy delivered. Despite the many benefits of natural gas as compared to oil or other fuel methods, natural gas does present a safety concern due to its flammability.

As natural gas is distributed through its network, any leakage could cause a fire or explosion. Also, if buildings and homes become over-pressurized, that strain on piping and appliances inside could create a risk to future leaks and be the cause of fire and explosion. Even as many industry sources look forward to a hydrogen-driven heating network for even cleaner energy, the same principles of monitoring pressure for leaks will still apply.

Applying pressure sensors at nodes throughout a natural gas distribution network is a practical and cost effective approach to mapping and monitoring an areas network, with smart meters identified as a prime location.

Since many meters are already designed with wireless communication technology to monitor usage for billing purposes. By adding additional pressure sensors, utilities will be able to map pressure in their network in real time. This allows them to monitor the network for potential leaks, or even trigger remote shutoff valves in the meter to protect the building in case of an overpressure event.

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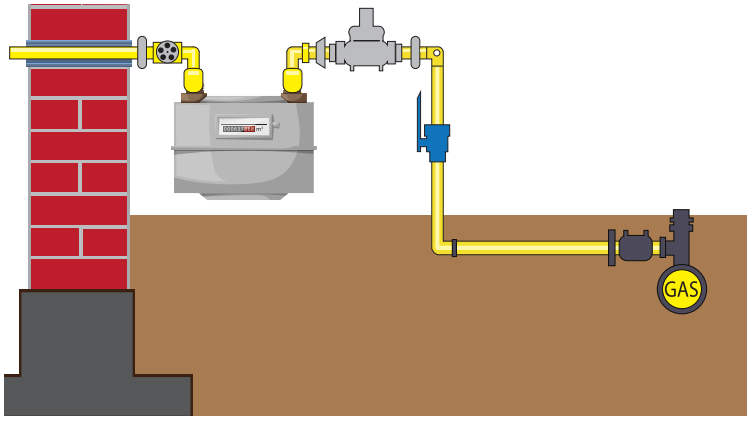


IDENTIFY LEAKS IN WATER DISTRIBUTION NETWORKS

In a similar fashion, sensor technology can also be deployed into water distribution networks. Whereas the use of natural gas helps reduce the potential for global warming, a more efficient water network helps to reduce strain on river basins and reservoirs everywhere.

While water resources continue to move through the water cycle in a variety of ways, the availability of water in specific areas continues to be a concern – with scarcity in many parts of the world continuing to become more acute.

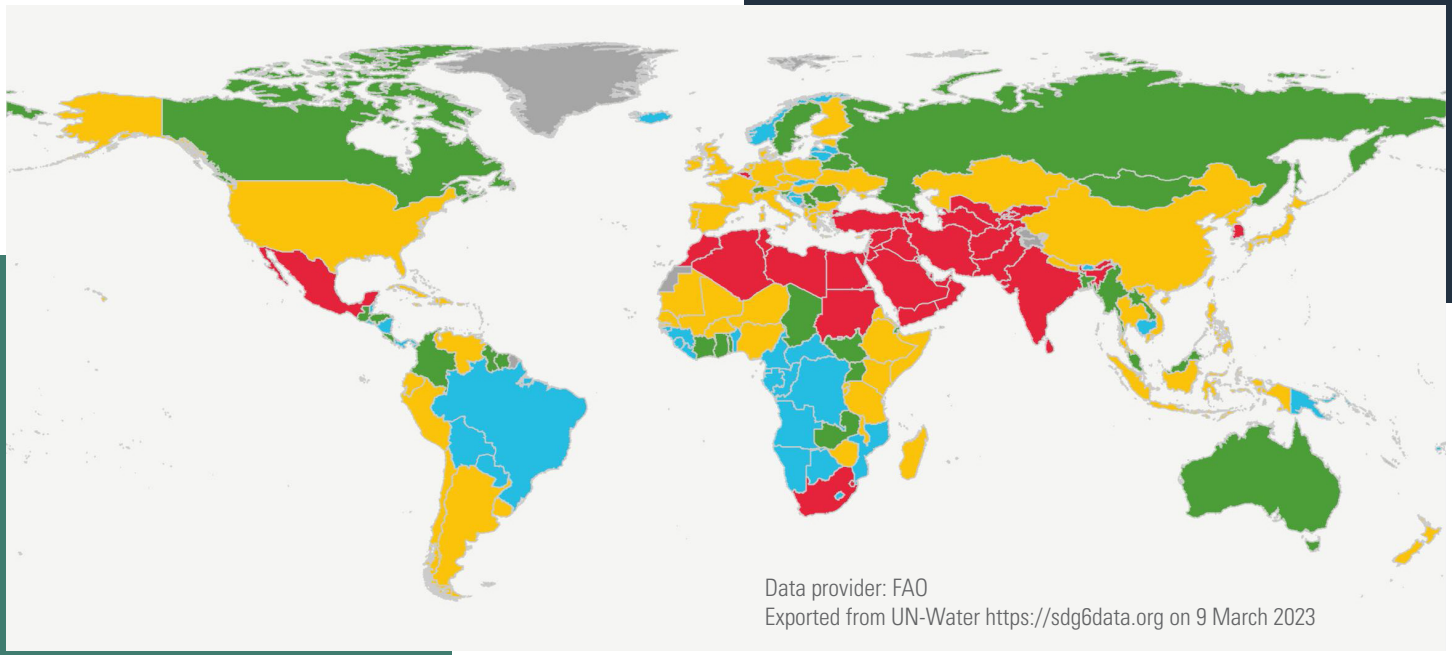
According to the United Nations, 2.3 billion people live in water-stressed countries, with roughly a third of those people living in countries listed as high and critically water-stressed.

Level of water stress: freshwater withdrawal as a proportion of available freshwater resources > Overall (%) > Total

Legend

Freshwater withdrawal as a proportion of available freshwater resources (%)

- 44.01-3,850.5
- 6.66-44.01
- 2.7-6.66
- 0-2.7
- Data not available



With populations around the world continuing to grow, this problem is likely to only continue to worsen in the coming years. By 2025, two-thirds of the world's population may face water shortages at least part of the year.

One of the largest challenges that water distribution networks and water utilities face is "non-revenue water" or the loss of water throughout their network not captured in what customers are billed for. Combining water from leaks in pipes, joints, and fittings along with apparent losses from metering inaccuracies and unauthorized consumption, this non-revenue water accounts for 30-50% of the water input into the distribution networks.

By incorporating pressure sensors into the network – either at the water meter, fire hydrant, or other nodes throughout the distribution network – utilities can identify where leaks may be present and ensure that the water which enters the distribution network is not lost before it reaches its destination – resulting in reduced draws from rivers, reservoirs, and other water sources.

Pressure sensors can also be used in a similar fashion at the individual homeowner level, identifying issues where leaky valves or outlets are wasting water within the home itself.

"By 2025, two-thirds of the world's population may face water shortages at least part of the year"

SENSORS ENABLING CLEAN ENERGY PLATFORMS AND ELECTRIFICATION

Across a variety of sectors, different clean energy platforms are helping to serve the increased demand for electrical power, in keeping with the U.S. goal of working toward a carbon pollution-free energy sector by 2035.

LARGE-SCALE SOLAR INSTALLATIONS

One of these areas of growth is in solar power. While the growth of household solar equipment has continued – 8% of U.S. homeowners say they have installed solar panels – larger-scale solar installations are making a more significant impact on the grid as a whole.

Utility-scale solar farms have a total capacity of 68 gigawatts nationwide - enough to power 15 million homes – according to the industry group American Clean Power. Often placed at locations where other uses are less practical (such as desert areas, or even former landfills), they demand a sensor-driven mindset where continual human interactions are not needed.

Along with a variety of electrification components – such as contactors and relays - reliable position sensors are one of the most critical components of large-scale solar installations. For efficiency, these panels are also designed to track the progress of the sun across the sky – generating up to 25 percent more power than a similar stationary installation.

Since the sun's movement across the sky is predictable from day-to-day and from season to season, the panels' movement can be programmed in directly. As the panels themselves are large and subject to hot, dusty conditions they typically need a geared motor for precise movement, which in turn requires multi-turn absolute encoders. Should there be a power outage during tracking, it is important that the encoder can maintain information about its current position, so that when power is restored, it can move directly to the correct position without having to follow a homing sequence.

WIND TURBINES CONTINUE LEADING RENEWABLE PUSH

Wind power is also a major part of the clean-energy portfolio. According to IEA data, wind power globally generated 1,870 Terawatt-hours of electricity in 2021, which was more than almost all other non-hydroelectric renewable power sources combined. This represented a 17 percent increase compared to 2020 figures, and was led primarily by the expansion of wind power in China, the United States, and Brazil.

Similar to solar installations, industrial wind turbines also leverage strong position sensing technology to generate clean energy. However with turbines, these movements cannot be programmed into the system in advance because of the unpredictability of wind conditions.

These turbines must measure the conditions constantly, and be designed to adjust both the overall direction of the turbine, as well as the tuning and adjustment of the pitch of the blades themselves in relation to the direction and strength of the wind.

Two of the most critical areas for correct operation of a wind turbine include "yaw angle" – or the direction of the turbine relative to the wind direction - and blade pitch.

Most modern wind turbines can rotate the blade around its major axis, which adjusts the pitch or "angle of attack" of the blade's leading edge relative to the wind speed. This is analogous to a sailor being able to trim the sails of the sailboat in order to increase the speed of the boat. Because of their size, a significant amount of motor gearing is required to adjust blade pitch and yaw, making them ideal applications for multi-turn encoders.

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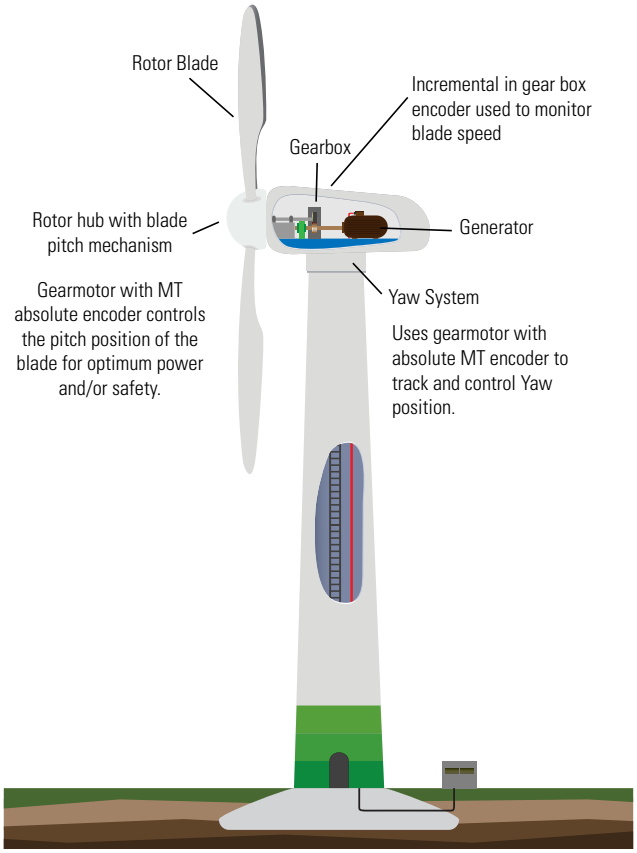

HEAT PUMPS ELECTRIFY HVAC

The growth of heat pumps is also continuing the shift of energy consumption away from fossil fuels – such as oil or gas-fired boilers – into an electrified footprint.

Heat pumps work by extracting heat from the surrounding air, ground, or water and transferring it to a refrigerant coolant. The coolant is then compressed - which significantly increases its temperature - and transferred to the location designated for heat. Heat is then extracted by either running air or water over the hot coolant.

In the past, heat pumps had been used primarily in air conditioners and freezers, but now they are being used increasingly for residential and commercial heating and to heat domestic hot water. Heat pumps are more efficient than traditional electric heaters because they use electricity to operate the compressor, pump and fans as opposed to a resistive heat source. A study from Northeast Energy Efficiency Partnerships (cited by the U.S. Department of Energy) found that in colder areas of the U.S, heat pumps could deliver annual savings of more than 6,200 kilowatt-hours compared to oil systems.

For heat pumps to operate properly, their program logic controller (PLC) needs temperature sensor inputs from multiple locations throughout the system. Depending on the purpose of the heat pump, these could include temperature readings of outdoor air, indoor air, and refrigerant at multiple locations.

Sales of heat pumps globally increased 15 percent in 2021, with 190 million units in use accounting for 10 percent of cooing worldwide. Those figures are set to expand even further in the coming years, with significant investment in a variety of countries – led by European nations France, Italy and Germany, as well as the United States, Japan, and China.

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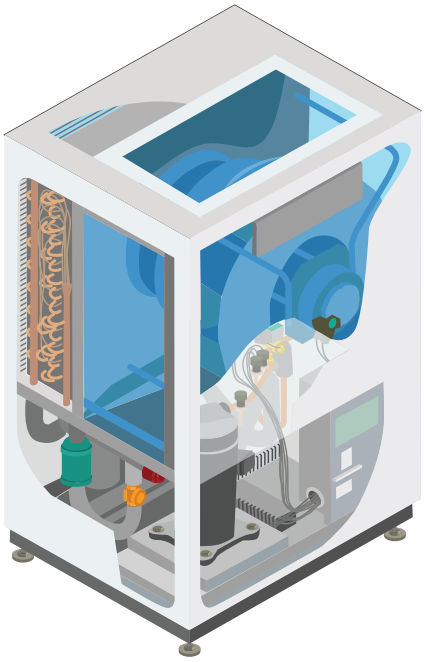

GLOBAL SUSTAINABILITY EFFORTS LEVERAGE CONTINUED TECHNOLOGICAL GROWTH

"The stated goal of the agreement is to achieve a more than 80 percent reduction in HFC consumption by 2047, which is expected to avoid up to 0.5 °C increase in global temperature by the year 2100."

The trend across all of these efforts is the ongoing push toward smarter, more sustainable solutions through the use of additional sensor applications, which are helping to create sea changes in the way problems are addressed.

One example of this is the transition of HVAC systems from hydrofluorocarbon (HFC) refrigerants to hydrofluoro-olefins – which have a far lower impact on global warming than their counterparts - through the Kigali Amendment to the United Nations' Montreal Protocol.

While these new coolants carry and A2L designation - meaning they are slightly flammable – new sensor technology designed to monitor leaks in that type of system allows for the industry to pursue the switch toward the new class of refrigerants. The stated goal of the agreement is to achieve a more than 80 percent reduction in HFC consumption by 2047, which is expected to avoid up to 0.5 °C increase in global temperature by the year 2100.

This type of global approach remains the model for how the world can identify a significant global sustainability issue and react to it.

No one change will allow for the full measure of sustainability improvements needed over the next decades. But smarter sensing will play a critical role in helping create a more sustainable future – driving continuous improvements with today's technology while supporting new technologies which will continue to shape the years to come.

ABOUT US

Sensata Technologies is one of the world's leading suppliers of sensing, electrical protection, control and power management solutions with operations and business centers in twelve countries. Sensata's products improve safety, efficiency and comfort for millions of people every day in automotive, appliance, aircraft, industrial, military, heavy vehicle, heating, air-conditioning and ventilation, data, telecommunications, recreational vehicles and marine applications. For more information, please visit the Sensata website.

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