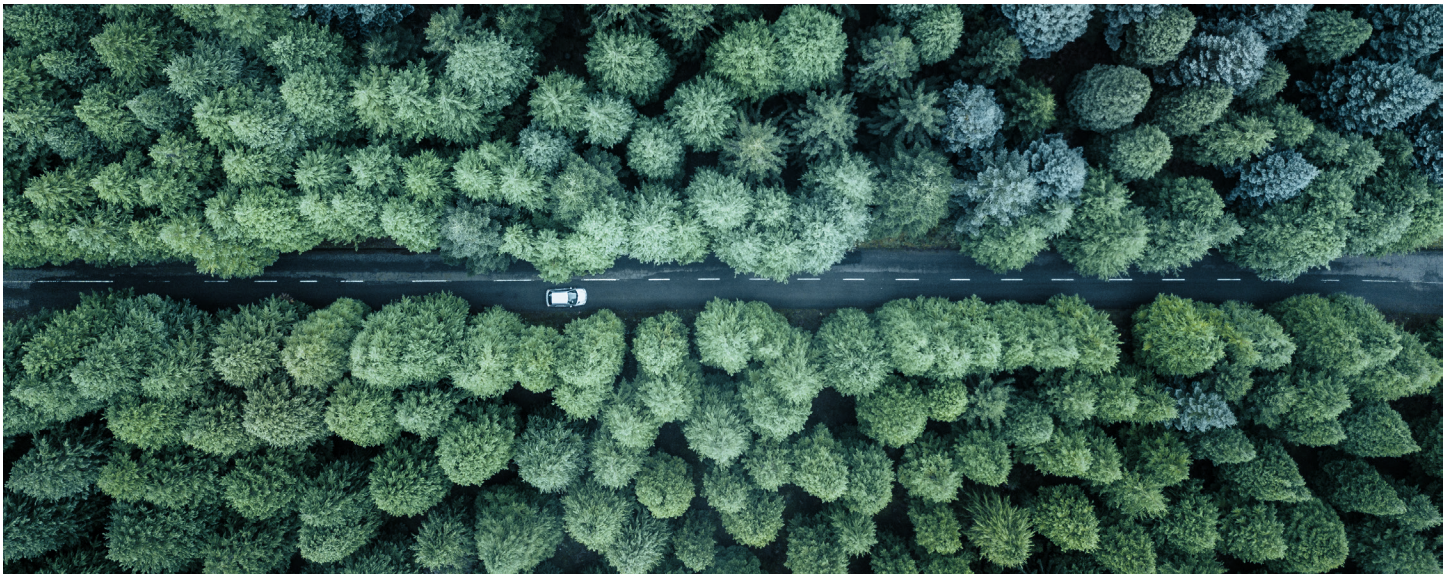
ENERGY SERVICES

THE CAPACITY BRIDGE

ENSURING A RELIABLE, LOW-CARBON GRID WITH AERO-DERIVATIVES

Energy Services LLC

MOVE THE WORLD FORWARD MITSUBISHI HEAVY INDUSTRIES GROUP



IN EARLY FEBRUARY 2022, A WINTER STORM BLEW ICY WEATHER AND UNWELCOME MEMORIES THROUGH CENTRAL TEXAS.

Residents and businesses watched nervously as another winter storm threatened the balance between the generating capacity of its grid and the area's demand for electricity. To their relief, the state's total generating capacity – about 86 gigawatts – held up and remained ahead of peak demand.

The event reminded Texans of a year earlier, when a succession of winter storms crippled the state's grid, cutting power to 4.5 million homes and businesses, and leading to an estimated $195 billion in economic damage. It could have been even worse: Had operators not acted as swiftly as they did to shed load, the grid would have become unstable, taking even more generating assets offline. Sudden trips further reduce the available power and risk potential equipment damage.

Extreme weather events are becoming more frequent at the same time the grid is becoming more fragile. In addition to Texas' winter storms, 2021 brought record wildfires, drought, and flooding, and the third most active hurricane season in recorded history. Yet the Lone Star State's experience was especially poignant, because of the ways it highlighted the threat posed by climate change and underscored the need to maintain reliable on-demand power supplies as we transition to lower- and zero-carbon energy sources. This transition will reshape the power grid. At the same time, it will intensify the need for ample, reliable electric capacity as decarbonization roadmaps call for the electrification of everything from vehicles to home heating.

That backdrop presents considerable challenges to power providers, and one of the key solutions needed to ensure a reliable, resilient, low-carbon grid will be additional fast-responding, flexible, on-demand capacity.

WITH ELECTRICITY, *WHEN* IS AS IMPORTANT AS *HOW MUCH*

For electricity suppliers, having the capacity to meet total demand is not enough. They also need to be able to react quickly when demand changes. That's because the electricity supply must always match demand: Having too much supply on the grid can cause as many problems as not having enough.

Demand for electricity changes constantly. To keep supply and demand in balance, electricity providers have to be able to increase or decrease the amount of electricity flowing into the grid. A drop in the supply of renewable electricity that occurs because the wind isn't blowing or the sun goes down has the same effect on the grid as a spike in demand. In other words, electricity providers need reliable capacity available to make up the difference.

CAPACITY VS. ENERGY

THE TERMS, THOUGH RELATED, ARE FREQUENTLY MISUNDERSTOOD.

CAPACITY

- The maximum amount of electricity a supplier can produce at any given time
- Measured in megawatts (MW)
- Power system resources must meet or equal demand to maintain reliability

ENERGY

- The amount of electricity actually produced over a period of time
- Measured in megawatt-hours (MWh)
- No generator operates at full capacity at all times
- Diverse resources are crucial, including and especially fast-start generators

Different markets build capacity in different ways, but the underlying principle is the same: Supply must always equal demand – when that equation fails, so does the grid.

> ***Balancing reduced emissions and reliability is key to advancing prosperity while reinventing the grid for a clean energy future.***
>
> **– Raul Pereda, President and CEO of Mitsubishi Power Aero LLC and Energy Services LLC**

For all the promise and advances in renewable power sources, renewables can't guarantee readily available output at all times. Until renewable energy sources are able to provide such a guarantee, on-demand aero-derivative power is an ideal way to bridge this capacity gap efficiently and effectively. The presence of such facilities – known as peaker plants – offers the clearest path to increasing the portion of electricity produced by renewables while still maintaining the steady power needed to keep the people in our communities safe and healthy, and to advance human prosperity.

AS RENEWABLES SUFFER FROM INTERMITTENCY, PEAKER PLANTS PROVIDE RELIABILITY

A proposal to build new plants powered by fossil fuels may be the last thing citizens expect to hear when they attend a meeting about building a more sustainable grid in their region. "If you're looking to reduce carbon emissions," they want to know, "why add a plant that burns natural gas?"

In regions such as the United States, the question may stem from the power sector's decades of being required to deliver electricity people can count on. Consistent power can seem like a given, and laypeople may not fully appreciate the challenges a rapid changeover to renewables presents to the grid's reliability and resiliency.

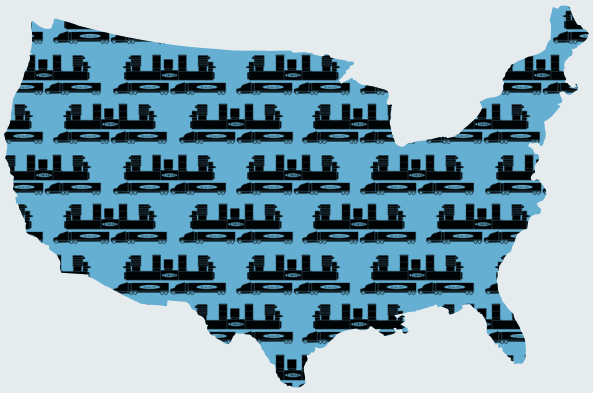
The industry must make use of every opportunity to reduce its carbon emissions rapidly through a combination of sources that maintains reliability and provides the increased capacity needed to decarbonize other sectors of the grid. Alongside renewable energy sources, using lower-carbon fuels can also produce substantial gains. To generate a single kilowatt-hour of electricity, coal produces 2.23 pounds of carbon dioxide emissions. Natural gas produces less than half that amount at 0.91 pounds per kilowatt-hour.

The need for energy security and grid resilience introduces practical hurdles, starting with the intermittency of renewable power. There won't always be enough renewable energy flowing through the grid to power all the homes and businesses that need it for two simple reasons: The sun doesn't always shine, and the wind doesn't always blow. At those times, producers must have the ability to add energy on demand to prevent disruptions to the power supply.

Peaker plants represent the optimal solution for an increasingly decarbonized grid. Put simply:

- The best way to reduce the power sector's carbon footprint is to increase the electricity generated by renewables.
- As the share of energy produced by renewables grows, the grid's power supply becomes more intermittent.
- The more intermittent the power supply, the more critical it is to have reliable, fast-response, on-demand capacity to prevent disruptions.
- Aero-derivatives are the best source for reliable, on-demand power because they are designed to start, stop, and ramp in minutes many times a day, unlike traditional power generation infrastructure.
- Aero-derivative gas turbine OEMs have roadmaps in place for aero-derivatives to use 100% green hydrogen, which would make them a zero-carbon source of energy as well.

THE U.S. CURRENTLY RELIES ON 1,000+ PEAKER PLANTS



AERO-DERIVATIVES ARE THE OPTIMAL SOLUTION FOR AN INCREASINGLY DECARBONIZED GRID.

"Balancing reduced emissions and reliability is key to advancing prosperity while reinventing the grid for a clean energy future," says Raul Pereda, President and CEO of Mitsubishi Power Aero LLC and Energy Services LLC.

PREPARATION TO MEET SURGES IN DEMAND

Peaker plants also can help ensure grid resilience when power demand spikes. Baseload power plants are sized to provide the electricity an area needs on a day-to-day basis. Demand is largely predictable – but not entirely. The electrical system must have sufficient generating capacity on standby to respond quickly when demand spikes.

Periods of high demand are sporadic, often amounting to only 200 to 300 hours in a given year (around 3% of total hours). It's possible to estimate the time and severity of these surges with a reasonable degree of accuracy, in part because they are more likely in certain seasons and at certain times of day. But it's impossible to predict precisely how much power will be needed in a particular area at any given moment. Models also can't predict the effects of unexpected events such as forced plant outages and severe weather.

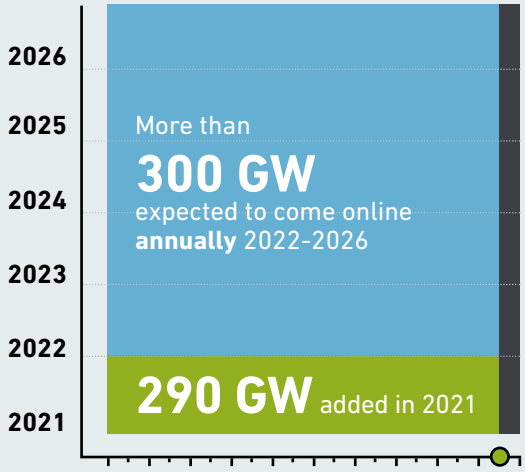
The upshot: Providers can't know exactly when they'll need additional power supply, so they have to keep on-demand power sources at the ready. If power producers' technology can't react quickly enough when called, the grid can't supply the required electricity during those periods, and consumers will experience brownouts or rolling blackouts.

> ***Peakers are like firefighters waiting for the alarm to sound. We pay them to be ready, and when we need them, we know they'll be there.***
>
> **–James Amarel, VP and GM of Energy Services LLC**

Balancing efficiency with reliability requires flexibility. Renewables sometimes make it difficult to match supply with demand because their intermittency creates greater potential for imbalances. We need aero-derivative peaker plants to offset the imbalances in supply and demand introduced by the unpredictability of renewable power.

THE GROWTH OF RENEWABLES

RENEWABLE ENERGY IS **GROWING AT A RECORD PACE:**



95%

OF NEW POWER CAPACITY INSTALLED WORLDWIDE DURING THAT TIME IS EXPECTED TO BE RENEWABLES

Source: International Energy Agency

Flexibility requires a source of power that can scale up quickly enough to provide the right amount when it's needed. That source of power must be ready and available at all times. The United States currently maintains more than 1,000 peaker plants to serve this purpose. "Peakers are like firefighters waiting for the alarm to sound," says James Amarel, Vice President and General Manager of Energy Services LLC, an engineering, procurement, and construction company affiliated with Mitsubishi Power Aero. "We pay them to be ready, and when we need them, we know they'll be there."

THE GRID OF THE FUTURE REQUIRES MORE ON-DEMAND CAPACITY

Storage mechanisms such as batteries can help bridge some gaps between supply and demand, but only for limited periods of time followed by a lengthy recharging period yielding 1-2 cycles per day. Aero-derivatives can cycle on and off repeatedly and also remain operating indefinitely when needed. Utility-scale storage of energy from wind or solar electricity currently can provide power economically only for several hours, leaving the grid at risk during periods with longer-term needs. The need for fast-responding peaking plants is no longer predominantly driven by seasonal peak loads, but is becoming a regular requirement to respond to loss of energy from renewable sources, primarily wind and solar. As industries become more electrified, ensuring continuous power will become even more important.

Peaker plants with the ability to run on multiple fuels can also enhance the reliability of the grid. For example, Puerto Rico has several 30-megawatt Mitsubishi Power Aero multi-fuel turbines capable of providing power when needed.

FT8® MOBILEPAC® aero-derivative units run efficiently on natural gas, can run on liquid fuel or propane if natural gas is not available or economical, and can be moved to other areas with power deficits. In addition to helping regions meet on-demand energy needs, these units can also be used to replace capacity lost during a natural disaster.

The aero-derivative's ability to ramp up within minutes when the grid demands power makes it an ideal complement to renewables. Aero-derivative technology also helps address

THE GROWTH OF ELECTRIFICATION

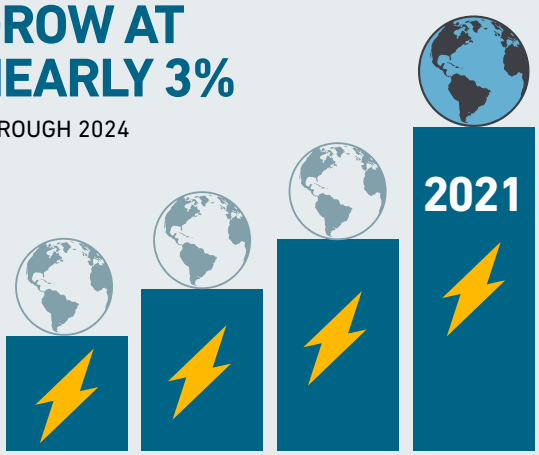
GLOBAL ELECTRICITY DEMAND

ROSE BY 6%

IN 2021 – THE LARGEST TOTAL INCREASE ON RECORD AND IS EXPECTED TO

GROW AT NEARLY 3%

THROUGH 2024



Source: International Energy Agency

producers' growing needs, which are more diverse than ever. Producers must balance various constraints and influences, including available space, environmental and noise requirements, local permitting, political and societal pressures, and the need to minimize costs, among others.

As renewables become more pervasive, the availability of reliable on-demand generation will mitigate the intermittency risk they perpetuate. Adding reliable generation that can supplement renewable energy as needed provides an opportunity to accelerate the speed with which the grid can transition to renewable energy for baseload power. "If you add a 50-megawatt peaker plant to deal with peak demand, you can put in 150 more megawatts of solar," says Amarel.

PEAKERS ARE EVOLVING TO USE CLEANER FUELS

Turbines and fuel technology continue to become more efficient, enabling new plants to produce more power with less fuel, further reducing emissions. Over time, the fuels that power turbines will continue to shift, particularly as green hydrogen becomes more widely available. Peaker plants powered by hydrogen generated from excess renewable energy sources will help bring electricity production to net-zero carbon emissions.

"When we talk about what fuels our aero-derivative gas turbines, we want to make sure that list includes hydrogen," says Pereda. Mitsubishi Power Aero has development

TWO PATHS TO PEAKING PLANTS

BUILD NEW FACILITIES

RETROFIT EXISTING PLANTS

Power producers seeking to bolster intermittent renewable production have two primary alternatives. They can retrofit older plants to produce the flexible, reliable power needed, or they can build new generation facilities. New turbine technologies are becoming more efficient, with units that can produce between 30 and 140 megawatts of on-demand power.

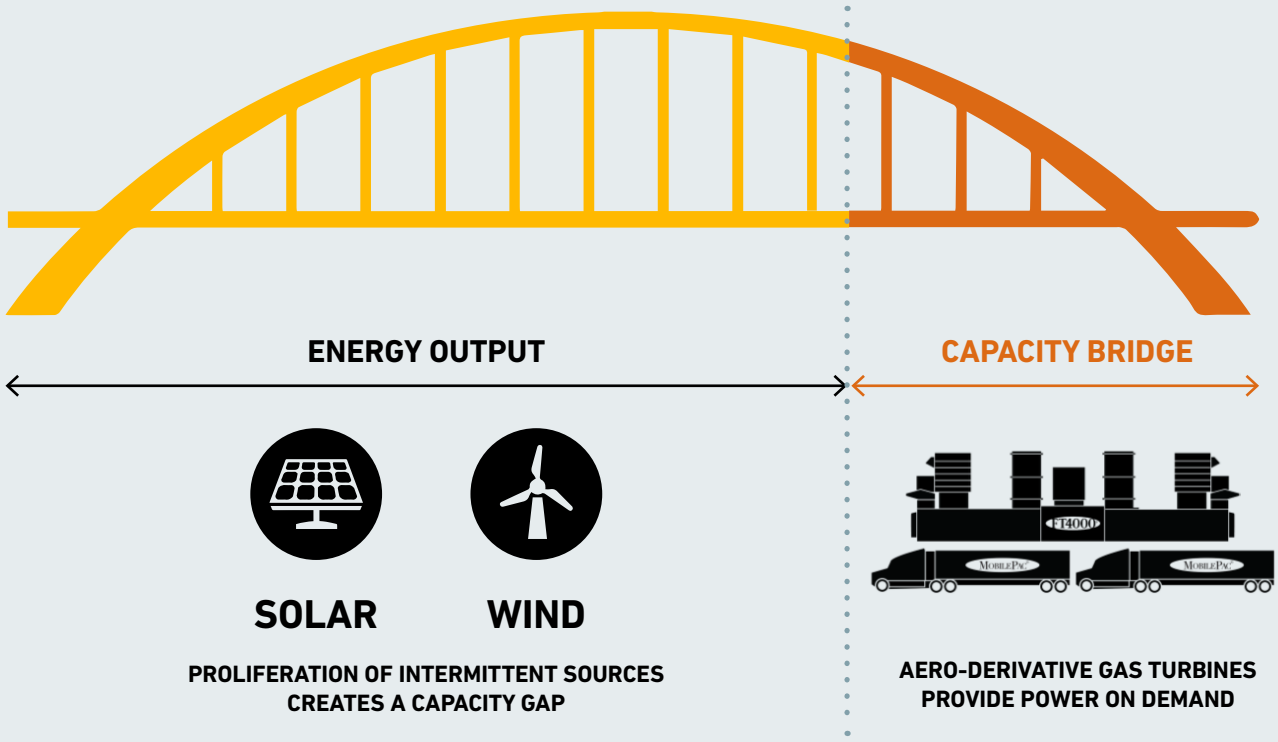
Because fuel supply, capacity requisites, and weather vary by region, the more flexible a solution is, the better it can support a given power producer's requirements. In some cases, meeting demand during an emergency may be the priority, or moving generation equipment to where it's needed is what's invaluable; in other instances, installing more renewable energy sources while maintaining grid stability is imperative.

Last year during the peak summer season in Mexicali, Baja California, five newly installed Mitsubishi Power Aero FT8® MOBILEPAC® aero-derivative units delivered the power needed with 99.5% availability. Three additional mobile units were installed at the same site this spring to meet demand for summer 2022.

In 2021, Energy Services restored one of the four gas turbine units at the City of Pasadena's Glenarm Power Plant to commercial operation to expand capacity ahead of summer demand. "This project is an outstanding example of how we can help leverage existing resources to accelerate the timetable for renewable power implementation," says Amarel. "Restoration projects like this often have the fastest return on investment, are relatively quick to implement, and often improve emissions and efficiency. They bridge the energy gap of today's grid challenges."

PIVOTAL ROLE FOR NATURAL GAS

BY BRIDGING SUPPLY AND DEMAND GAPS, PEAKER PLANTS DEMONSTRATE THE VALUE OF NATURAL GAS AS AN ECONOMICAL, AVAILABLE ENERGY SOURCE TO SUPPORT RENEWABLES.



plans in place to modify its FT4000® SWIFTPAC® and FT8® MOBILEPAC® units to operate using 30% hydrogen by 2025 and 100% hydrogen by 2035.

The broader transition to hydrogen will take time. Until net-zero technologies and related infrastructure are ready, aero-derivative gas turbines will play a key role by making it possible for producers to bring more renewable energy sources onto the grid.

Short of a retrograde energy policy or wholesale changes in consumer behavior, reliability will be non-negotiable every step of the way. For the decarbonization transition to work, electricity must be available every time you flip a switch.

[FT4000®, FT8®, SWIFTPAC®, and MOBILEPAC® are trademarks owned by and used with permission of Mitsubishi Power Aero LLC.]

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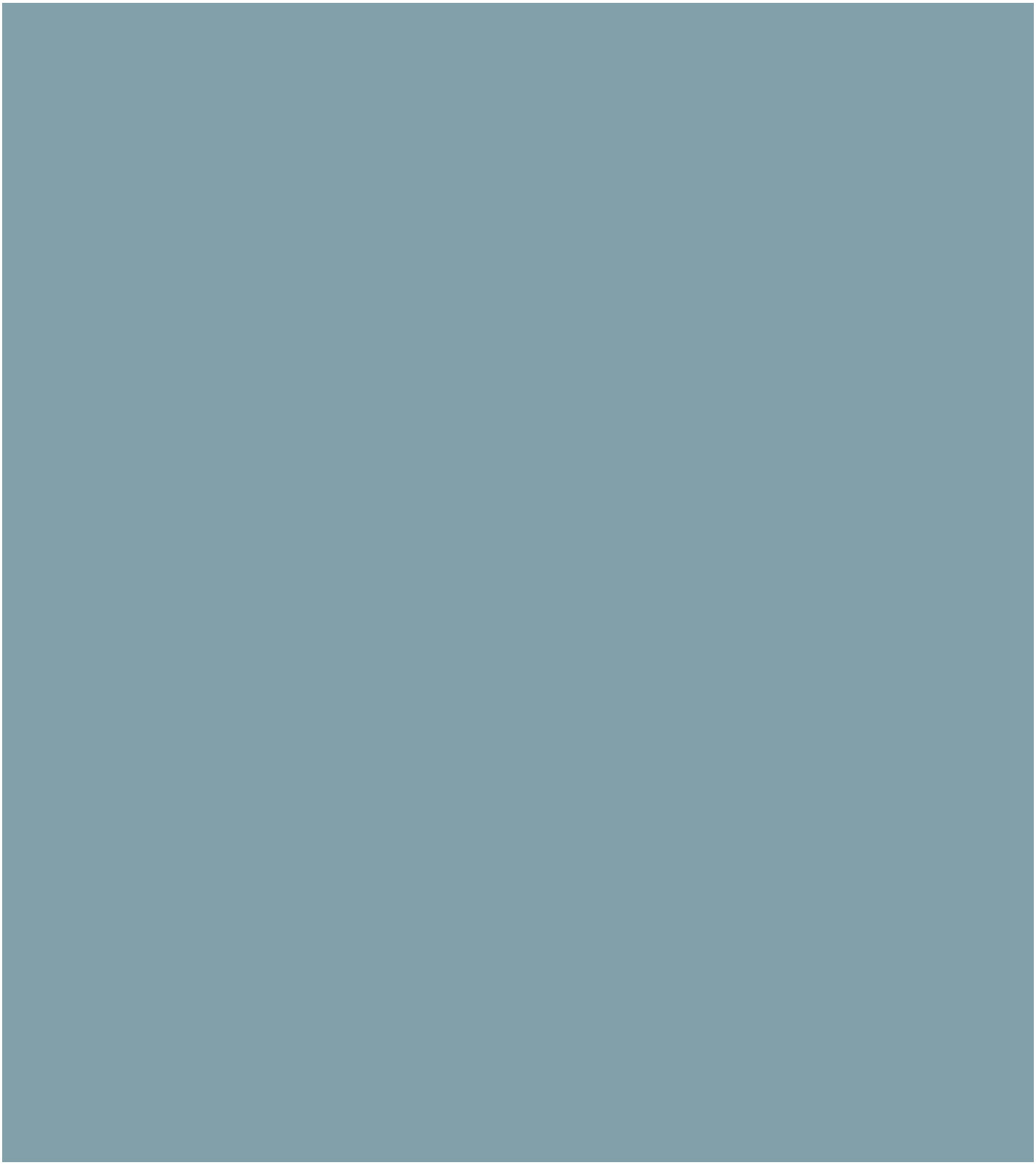

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