ebruary 2023 marked the two-year anniversary of Winter storm Uri, a brutal multiday event that delivered record-setting lows across the US, with prolonged colder temperatures in the Midwest that migrated further south into Texas than anticipated. This event highlighted the impact extreme weather can have on energy infrastructure; in Texas alone, the storm left more than 4.5 million homes and businesses without power and heat.

Already in 2023, colossal storms across North America have left hundreds of thousands of homes and businesses in Texas – and elsewhere – without power, some for more than 10 consecutive days.

On the opposite end of the temperature spectrum, similar challenges have occurred as extreme heat (such as that recently seen in the western US) drive up demand for electricity, straining grid reliability.

With dramatic increases in the number of extreme weather events over the past 20 years – up 83% globally according to the United Nations Office for Disaster Risk Reduction¹ – the need to make energy systems more reliable and resilient has never been greater.

Southwest Gas recognised this need and made the decision to build the Southern Arizona LNG Reliability Facility (Tucson LNG plant) to ensure continued reliability of natural gas service to its customers. According to Laura Nelson, Southwest Gas Vice President of Sustainability and Public Policy, reliability is a key cornerstone of Southwest Gas' sustainability promise to its customers - to ensure natural gas is there when it is needed, whether for seasonal periods of peak demand or during extreme temperature events, such as those seen across the country in 2021, and again in 2023. It is also key to the company's core promoting cleaner energy and providing should the need arise.

In fact, as natural gas production facilities were forced to shut down during Winter storm Uri, daily natural gas prices increased dramatically. In response, Southwest Gas vaporised LNG stored at the Tucson LNG plant for the first time since being placed into service in December 2019. The vaporised LNG was injected into the Tucson distribution system for customer use. Over the course of the event, the facility vaporised more than 10 000 dekatherms. And while daily spot prices for natural gas increased

Ensuring energy reliability, sustainability, and resilience

Ken Erdmann, P.E., Vice President Cryogenic and Storage Technologies, Matrix PDM Engineering, and John Hart, Vice President, Matrix Service Company, provide insight into how the company partnered with Southwest Gas for the engineering, procurement, fabrication, and construction of the Tucson LNG plant. during Winter storm Uri, the supplies Southwest Gas vaporised had been purchased, liquefied, and stored when prices were lower, which saved customers approximately US\$1.5 million over two days during the Winter storm.

At a time when maintaining critical reliability and an inherent ability to withstand the tests of outside forces was crucial, Southwest Gas' LNG plant in Tucson proved its resilience as a reliable energy source during high-impact events.

Indeed, there is no question that infrastructure investments, such as the Tucson LNG plant, are further evidence of the effectiveness and speed at which gas utilities can respond to extreme events that may otherwise disrupt supply and service or increase costs to consumers.



Figure 1. The plant's location in the Sonoran Desert and in close proximity to Davis-Monthan Air Force Base required design features including a lower tank profile, finishing that would blend in with the desert environment, and sun shields and insulation to protect equipment from triple-digit heat.



Figure 2. Southwest Gas and Matrix ensured the facility design would allow for LNG to be delivered by truck initially, with the option to add liquefaction capabilities at a later date.



Figure 3. Temperatures are often triple-digit in the Sonoran Desert, so Matrix and Southwest Gas protected personnel from heat-related injuries and maximised productivity by planning start times when temperatures were at their coolest.

Planning for today and tomorrow

The Tucson LNG plant, which is designated as a peak-shaver, is an operational cornerstone in Southwest Gas' commitment to reliability and social sustainability. This facility helps to ensure natural gas is available to provide for life's essentials, including warm homes, hot water, and cooked meals. To that end, being prepared for potential service interruptions or other events is essential to providing sustainable energy for its customers.

Partnering for success

The project specifications for the Tucson LNG plant included a 2.8 million gal. single containment LNG storage tank, as well as a 65 000 ft³/d vaporisation unit. The facility is the state's first and only natural gas storage facility.

Strategically located on 31 acres near existing pipeline facilities deep in the Sonoran Desert, its location meant giving special consideration to several factors, including:

- Pre-construction environmental studies, as well as thermal radiation and vapour exclusion studies, and other safety analyses to safeguard the area's desert surroundings.
- Careful attention to design features that would allow the facility to blend in with the surrounding environment and take into consideration its close proximity to Davis-Monthan Air Force Base.
- Frequent triple-digit desert temperatures where solutions would be needed to protect equipment, piping, and electrical items, minimise boil-off gas, and ensure there would be no impact to surrounding communities.
- Flexibility in the overall plant design to allow for future addition of liquefaction capability, expansion, or modification.

After an expert project team vetted potential contractors, Southwest Gas chose Matrix for the engineering, procurement, fabrication, and construction of the facility. Julie Williams, Southwest Gas Chief Operating Officer, believes it is imperative that Southwest Gas and its chosen project contractors maintain a strong partnership from start to finish in order to ensure all goals and benchmarks are met, and Matrix reflected the company's commitment to safety and quality as the engineering, procurement, and construction contractor for the project.

Matrix provided more than 65 years of engineering expertise in designing and implementing complex cryogenic infrastructure and technology, as well as long-standing expertise in storage and terminal construction. In the last five years, Matrix has constructed three North American LNG peak shaving facilities, and is in the process of constructing a fourth. It has also constructed multiple LNG bunkering storage tanks and terminals, along with other sophisticated cryogenic infrastructure for midstream and downstream energy applications and aerospace.

For Southwest Gas, the project timeline was also critical, with expectation that the facility be in-service for the Winter heating season by December 2019. Matrix began engineering and site optimisation in December 2016, with Southwest Gas receiving final regulatory approval from the Arizona Corporation Commission to proceed with the project in January 2017.

While 3D modelling is a common practice to ensure good design, the partnership between Southwest Gas and Matrix, including review of the models at the 25%, 50%, and 100% design

stages by both entities' engineers and project team members, made sure the facility was well designed for proper access, maintainability, operations, plant safety, and potential future equipment and expansion.

The LNG storage tank was kept at a low profile – just 74 ft in height – to address air traffic from nearby

Davis-Monthan Air Force Base and stay within FAA regulations. Tank insulation was increased to minimise boil-off gas, reducing the cost to maintain a full level of LNG and keep the tank ready for service for longer periods of time.

Coolers and air exchangers were increased in size, and sun shields were installed above all major equipment and outdoor electrical panels to protect the facility's components from the desert's frequent triple-digit temperatures. Send-out lines were also insulated to ensure natural gas temperatures did not exceed the allowed limit of 130°F.

Desert temperatures also dictated early morning starts – typically beginning at 5 a.m. – for concrete pours and construction.

Finally, the LNG storage tank, buildings, and other equipment were painted a light tan to reflect the sun's heat and blend in with the environment.

Southwest Gas also brought on their operations team during construction, providing early introduction and familiarity with operations ahead of commissioning and start-up – a critical step to ensuring efficient operation of the facility. Prior to commissioning, Southwest Gas' management and technicians participated in extensive training, which included a review of the property characteristics of LNG, and a detailed examination of regasification, storage, equipment, security, safety, and transportation.

Commissioning began in late spring of 2019, with facility cooldown initiated in early July.

As with any highly complex infrastructure, challenges can also arise, and such was the case with the rotary twin screw compressors initially installed at the Tucson LNG plant when the compressor skid packages failed in September 2019. Matrix quickly installed a temporary compressor while working together with Southwest Gas to design, procure, and install new compressors without interruption to the facility. Williams noted that the way Matrix addressed these issues was an example of the partnership commitment the company looks for in its EPC contractor – taking ownership in identifying the issues and working together to ensure it is resolved.

An energy oasis in the desert

The Tucson LNG plant was officially placed in service in December 2019. Currently, the facility retains ample resources to ensure reliability during times of supply constraint and provides a safe and dependable backup system for customers in Southern Arizona. It also validates Southwest Gas' commitment to environmental sustainability, supporting findings in the American Gas Foundation's January 2021 study² that highlights the critical role natural gas infrastructure plays in building a cleaner, more resilient US energy future.

Highly complex projects such as this one are most successful when there is a true partnership. Williams attributes this success to the fact that Southwest Gas and Matrix came together as one team to complete this monumental project, noting that the owner/operator and the contractor must work hand-in-hand to ensure that the highest quality standards are met, and that local governmental agencies and neighbours, such as Davis-Monthan Air Force Base, are kept informed. **LNG**

References

- 1. "The Human Cost of Disasters', UN Office for Disaster Risk Reduction and Centre for Research on the Epidemiology of Disasters CRED, (2020).
- 2. 'Building a Resilient Energy Future, How the Gas System Contributes to US Energy System Resilience', American Gas Foundation, (January 2021).



Figure 2. When the original compressor skid packages failed during commissioning, Matrix kept the facility operational by quickly installing a temporary compressor as the companies worked together to design, procure, and install new compressors.



Figure 5. The on-site engagement of Southwest Gas' operations team during construction provided early introduction and familiarity, critical to ensuring efficient operation of the facility.