

NATURAL GAS STORAGE

NARUC Energy Regulatory Partnership Program

The Public Services Regulatory Commission of Armenia
and The Iowa Utilities Board



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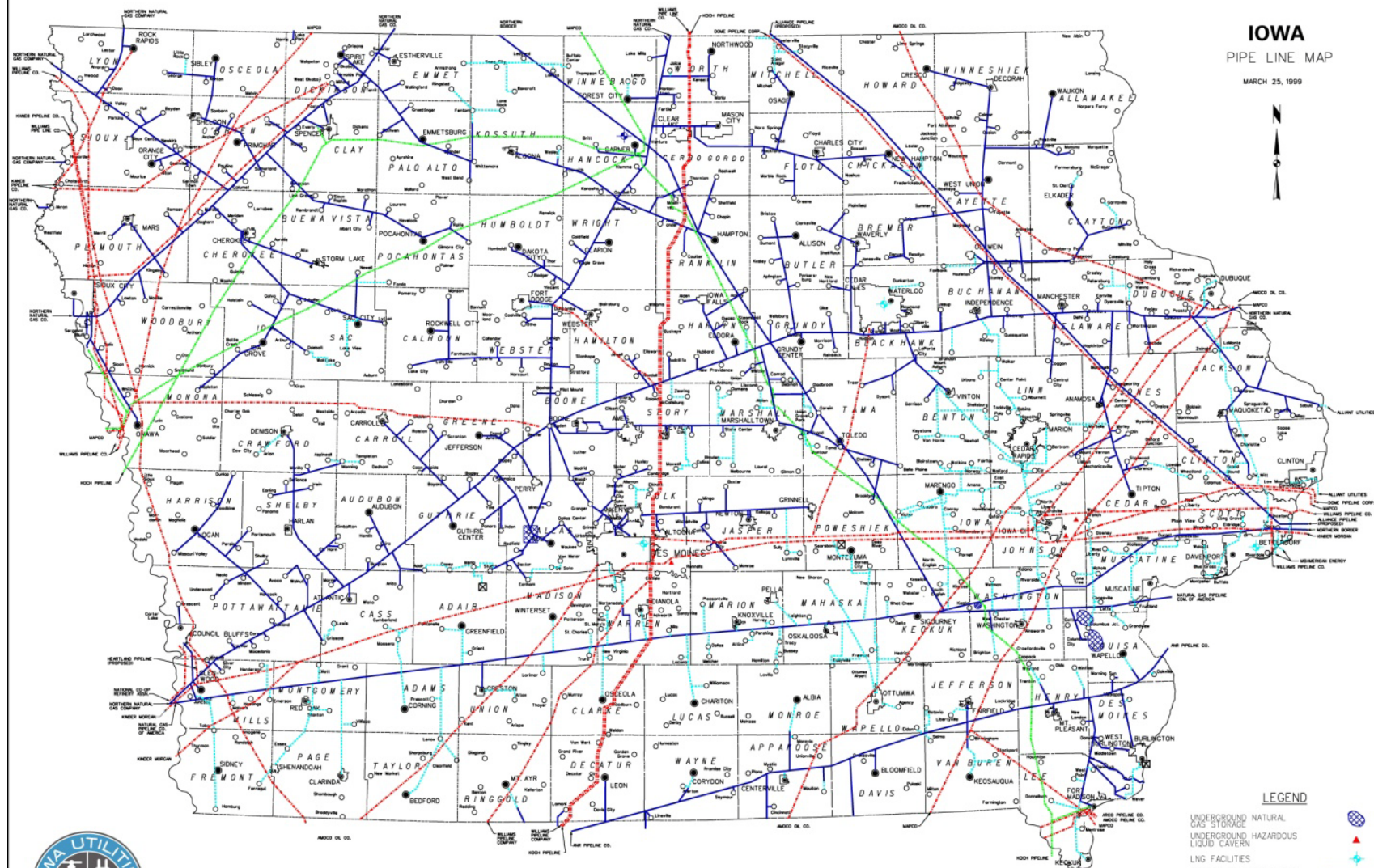
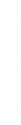
STORAGE FACILITIES

- Historically, almost all storage facilities were part of the interstate pipeline system and owned by an interstate pipeline.
- Main Types:
 - Depleted Natural Gas Or Oil Fields
 - Aquifers
 - Salt Caverns
- 82 Percent are reservoirs in depleted natural gas fields.
- There are only a few storage facilities in Iowa.
- There are four storage facilities three owned by Natural Gas Pipeline Company of America and one by Northern Natural Gas Company.



IOWA PIPE LINE MAP

MARCH 25, 1999



LEGEND

- UNDERGROUND NATURAL GAS STORAGE
- UNDERGROUND HAZARDOUS LIQUID CAVERN
- LNG FACILITIES
- INTERSTATE NATURAL GAS
- INTRASTATE NATURAL GAS
- HAZARDOUS LIQUID PIPELINES
- ANHYDROUS AMMONIA PIPELINES
- COUNTY SEAT
- TOWN
- GENERATING INDUSTRIAL OR COMMERCIAL SITE



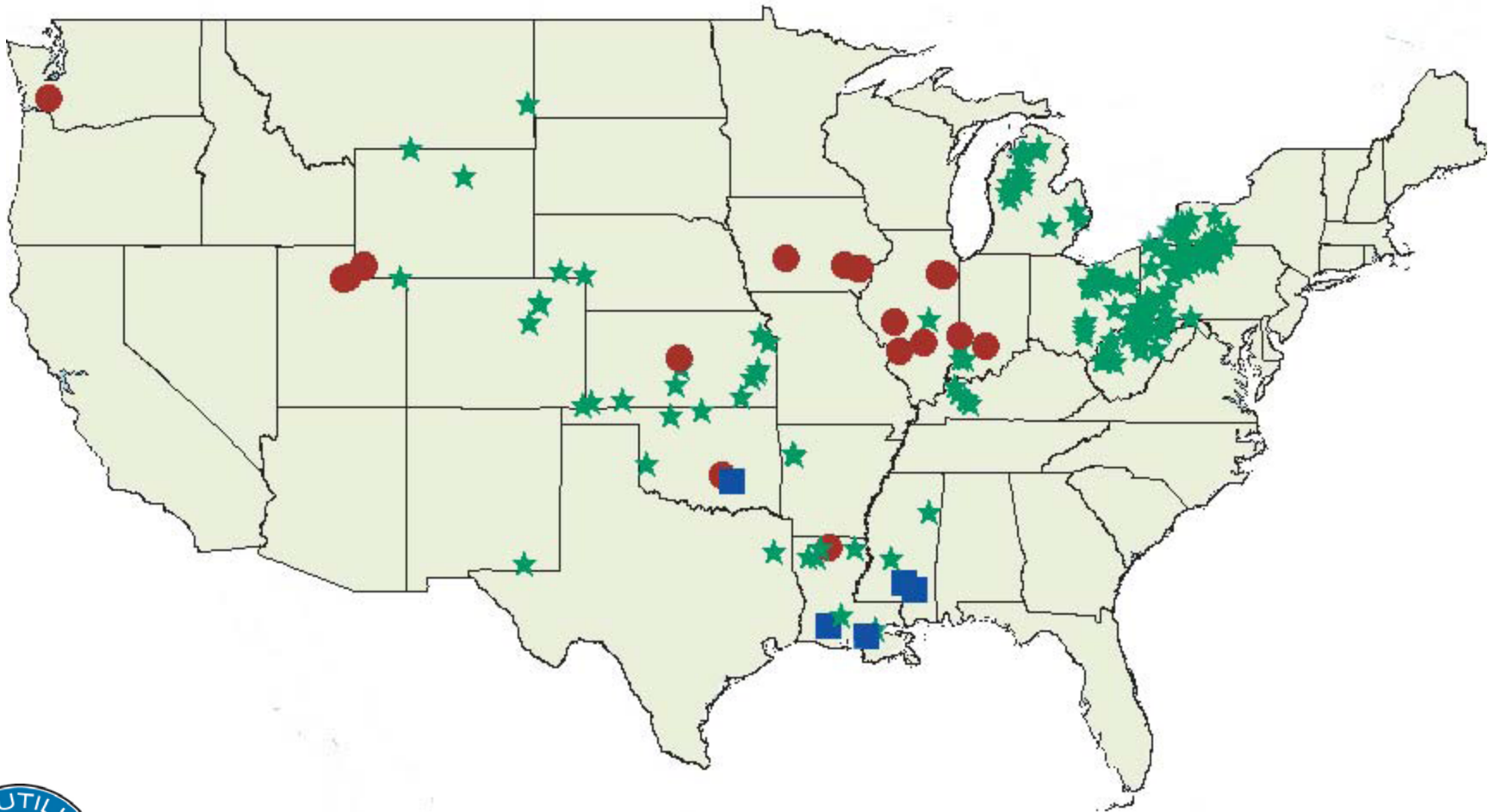
NATURAL GAS STORAGE

Types of Storage Facilities:

- Depleted Reservoirs
- Aquifers
- Salt Caverns



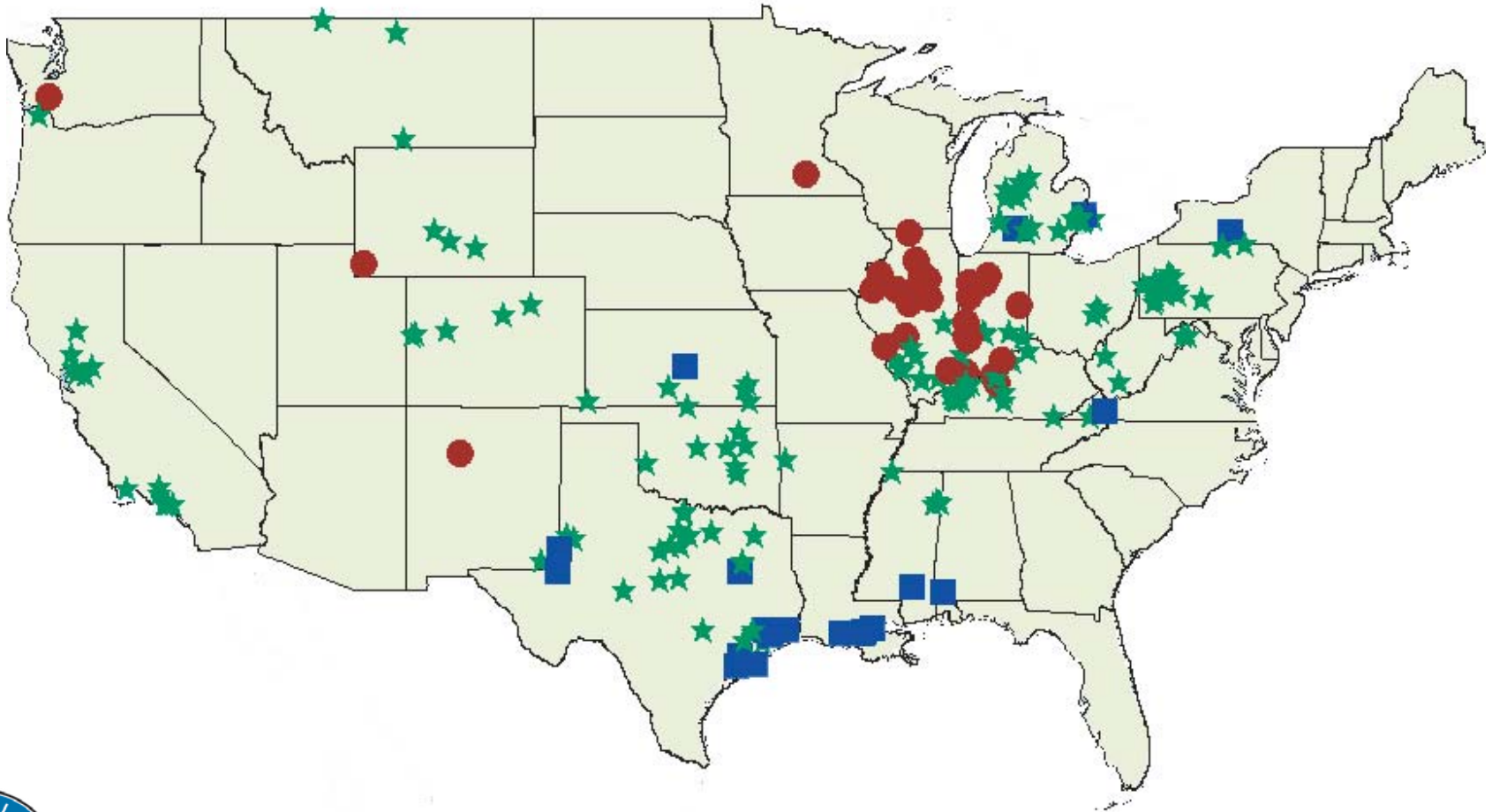
FERC JURISDICTIONAL U.S. STORAGE BY TYPE AND LOCATION



★ Depleted Gas Reservoir ● Aquifer Storage Field ■ Salt Cavern Storage



NON-JURISDICTIONAL U.S. STORAGE BY TYPE AND LOCATION



★ Depleted Gas Reservoir ● Aquifer Storage Field ■ Salt Cavern Storage

DEPLETED RESERVOIRS

- Most prevalent type of storage facility.
- Use depleted natural gas or oil fields that are located close to consumption centers.
- Takes advantage of existing wells, gathering systems, and transmission facilities.
- Widely available.



NATURAL AQUIFERS

- Mostly located in Midwestern United States (including Iowa).
- Suitable for gas storage if water bearing in sedimentary rock formation is overlaid with impermeable cap rock.
- Requires more base gas and greater monitoring of withdrawal and injection performance.



SALT CAVERNS

- Salt dome formation in Gulf Coast states.
- More costly than other two to develop.
- Provide very high withdrawal and injection rates relative to working gas capacity.
- Able to perform several withdrawal and injection cycles each year.



USES OF STORAGE FACILITIES

- Basically two uses: base load and peak load storage.
- Base load storage is used to meet seasonal demand.
- Base load facilities are capable of holding enough gas for long term seasonal demand (usually turnover each year).
- Peak load storage designed for high deliverability for short periods.
- Do not hold as much gas; however, can deliver more than once a year and be injected more than once (Salt Caverns and Aquifers).



GAS IN UNDERGROUND STORAGE

- Working gas: is the volume of gas above the level of cushion gas.
- Measured by working gas capacity and working gas inventory (gas available for delivery to customers).
- Cushion gas: is the volume of gas needed as a permanent inventory in a storage reservoir to maintain adequate reservoir pressure and deliverability rates throughout the withdrawal season.



FERC JURISDICTION

- Prior to 1994, interstate pipelines owned all of the gas flowing through their systems, including gas in storage.
- Interstate pipelines had exclusive control over the capacity and utilization of their storage facilities.
- FERC Order 636 required that storage facilities be operated on an open-access basis.
- This means working gas capacity (that above cushion or base gas) was required to be available for lease to third parties on a nondiscriminatory basis.



USES OF STORAGE HAVE CHANGED

- Today other storage facilities are owned and operated by local distribution companies and independent operators.
- Open access has allowed storage to be used other than for backup supply and to supplement seasonal supply.
- Storage now used by marketers and speculators as prices change.
- Storage used in conjunction with financial instruments such as future and options contracts.



NON-TRADITIONAL USE OF STORAGE

- Meet regulatory obligation to ensure supply reliability at lowest cost to ratepayer.
- Avoid imbalance penalties and facilitate daily nomination changes, parking and lending services.
- Ensure liquidity at market centers to help contain price volatility.
- Offset reduction in traditional supplies relied on to meet winter demand.
- Increase the comfort inventory level of working gas.
- Offset the growing summer peak impacts from electric generation by injection in shoulder months.
- Support electric generation loads.



QUESTIONS?



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