# **Continuous Innovation of Technology and Environmental** Stewardship in the Natural Gas and Oil Industry

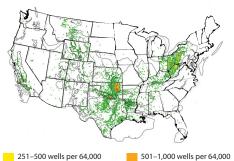
#### DRILLING ACTIVITY IN THE UNITED STATES

January 17, 1844 to December 31, 1899



1-50 wells per 64,000 50-250 wells per 64,000 cres (100 square miles

January 1, 1900 to December 31, 1924



acres (100 square miles)

January 1, 1925 to December 31, 1949 >1,000 wells per 64,000

January 1, 1950 to December 31, 1974



January 1, 1975 to December 31, 1999

January 1, 2000 to January 6, 2011



#### **ENVIRONMENTAL LAWS & REGULATIONS**

acres (100 square miles)

- **1863** PA enacts first anti-pollution law preventing running of tar and distillery refuse into creeks
- **1879** NY mandates plugging of abandoned oil and natural gas wells to prevent freshwater contamination
- 1883 OH enacts law regulating methods of casing and plugging oil and natural gas wells
- 1890 PA enacts first law requiring non-producing wells to be plugged
- **1899** TX enacts law on groundwater protection, well abandonment, and conservation of natural gas

#### **OIL & GAS TECHNOLOGY**

- **1821** First well dug specifically intended to obtain natural gas in Fredonia, NY, by William Hart
- 1839 Marcellus Shale identified and named by NY state geologist James Halls
- **1854** First oil company, Pennsylvania Rock Oil Company, formed by James M. Townsend
- **1858** First shale gas well fracture using gun powder in Fredonia, NY, by Preston Barmore (first petroleum
- 1859 First successful oil well. Drake Well, drilled in Titusville, PA (about 70 ft.)
- **1870** First and largest multinational corporation, Standard Oil Company, founded by John D. Rockefeller and Henry Flagler

#### **ENVIRONMENTAL LAWS & REGULATIONS**

acres (100 square miles)

- 1915 CA enacts well drilling, production, and abandonment law
- **1917** OK expands oil and natural gas regulatory mandate to groundwater protection and well plugging and abandonment
- 1918 Migratory Bird Treaty Act
- 1924 Oil Pollution Control Act

#### **OIL & GAS TECHNOLOGY**

251–500 wells per 64,000

acres (100 square miles)

- **1891** First lengthy natural gas pipeline constructed from wells in central IN to Chicago, IL (120 mi.)
- **1897** First offshore well drilled south of Santa Barbara, CA (455 ft, below seabed)
- 1901 Oil explorer Captain Anthony Lucas drills Spindletop Gusher in Beaumont, TX
- 1905 Oil strike in Glen Pool, OK, heralded as largest discovery of its time
- 1909 H. Hughes Sr. and Walter Sharp introduce Two-Cone Drill Bit, enabling deep boring
- 1911 Standard Oil Company dissolved by Sherman Antitrust Act
- 1917 American Association of Petroleum Geologists founded
- **1921** First horizontal oil well drilled in Texon. TX
- **1921** First experimental use of seismic imaging at Vines Branch, OK

#### **ENVIRONMENTAL LAWS & REGULATIONS**

- 1935 Interstate Oil & Gas Compact Commission (IOGCC) established (OK, TX, CO, IL, NM, and KS)
- **1941** Multiple states enact moratoria on aspects of oil and gas conservation and environmental regulation to support war effort
- 1946 KS Board of Health authorized to regulate oil field brine disposal
- 1946 Bureau of Land Management created by President Harry Truman
- 1948 Federal Water Pollution Control Act (FWPCA)

#### **OIL & GAS TECHNOLOGY**

- 1922 Wildcatter James S. Abercrombie and machinist Harry S. Cameron develop successful ram-type blowout preventer
- **1927** First patent on caustic flooding for improved oil recovery
- **1929** Barite introduced to drilling fluids
- 1929 First controlled directional drilling in Huntington Beach, CA, by H. John Eastman
- 1930 East Texas Oilfield discovered by Dad Joiner
- 1933 Hughes Tool Company develops Tricone Drill Bit
- 1934 First relief well to control a blowout used in Conroe, TX, by H. John Eastman
- 1938 Cooper-Bessmer Integral-Angle Gas Engine Compressor installed in natural gas pipeline

#### **ENVIRONMENTAL LAWS & REGULATIONS**

1953 Outer Continental Shelf Lands Act

1968 Cuyahoga River engulfed in flames in northeastern OH

1969 Santa Barbara oil spill leads to environmental legislation and is the impetus for the environmental law movement in the U.S.

- 1970 National Environmental Policy Act, Occupational Safety and Health Act, Clean Air Act, and the U.S. EPA established
- 1972 Noise Control Act
- 1973 Endangered Species Act
- 1974 Safe Drinking Water Act

#### **OIL & GAS TECHNOLOGY**

- 1947 Hydraulic fracturing first used in the U.S. as experiment to stimulate an oil well, Grant County, KS (Stanolind Oil)
- 1947–2011 Kerr-McGee drills first offshore well out of sight of land, Vermilion Parish, LA, with continuous firsts in offshore technology afterward
- 1967 First 3D seismic survey (Exxon) in Friendswood field, Houston, TX
- **1968** First well drilled in >1,000 ft of water by Humble Oil in Santa Barbara channel
- 1968 Oil discovered on Alaska's North Slope
- 1972 Landset satellite used for remote sensing
- 1972 First use of carbon dioxide-enhanced oil recovery, Scurry County, TX

**1970** Founding of

1973 First personal

1973 Arab Oil Embargo

# **ENVIRONMENTAL LAWS & REGULATIONS**

- **1976** Resource Conservation and Recovery Act and Federal Land Policy and Management Act
- **1977** Surface Mining Control and Reclamation Act, Toxic Substances Control Act, and FWPCA renamed Clean Water Act
- 1977 FERC established
- **1980** Comprehensive Environmental Response. Compensation and Liability Act
- 1986 Title III Superfund Amendments and Reauthorization Act
- 1987 Pipeline Safety Act
- **1989** Hazard Communication Standard
- 1989 Exxon Valdez runs aground in Prince William Sound AK
- 1989 GWPC and IOGCC initiate reviews of state oil and natural gas regulatory programs

#### 1990 Oil Pollution Act

### **OIL & GAS TECHNOLOGY**

- 1977 Trans-Alaska Oil Pipeline System completed after three years of work
- 1977 U.S. DOE established
- 1978 First fixed offshore platform >1,000 ft. deep, Shell Cognac
- **1982** First steerable drilling system

## **ENVIRONMENTAL LAWS & REGULATIONS**

- 1999 State Review of Oil and Natural Gas Environmental Regulations (STRONGER) established
- 2001 U.S. House passes legislation opening a portion of the Arctic National Wildlife Refuge to oil and gas drilling; Senate rejects proposal
- 2005 Energy Policy Act clarifies hydraulic fracturing with regards to SDWA
- 2005 DOI opens thousands of acres on the Alaska North Slope for drilling
- 2008 Ten-year moratoria on U.S. offshore oil and natural gas leasing end
- 2010 WY enacts new oil and gas regulations requiring full chemical disclosure for hydraulic fracturing fluid additives
- **2010** Deepwater Horizon oil rig explodes in the Gulf of Mexico, causing largest offshore oil spill in U.S. history
- **2010** San Bruno, CA, natural gas pipeline explosion

#### **OIL & GAS TECHNOLOGY**

- 1995 Mitchell Energy refines hydraulic fracturing coupled with horizontal wells in the Barnett Shale, TX, to recover natural gas
- **1997** Baker Hughes Corporation introduces rotary closed loop drilling system
- 1999 Largest oil discovery in Gulf of Mexico, BP Thunder Horse field (6,000 ft.,1 billion BOE)
- **2006** New seismic recording technique measures hydraulic fracture propagation in unconventional







**2009** Oil price tops \$140/ bbl: Dow Jones Industrial

Average plunges 360 points

2010 World oil demand reaches 87 million bbls/day

2003 U.S.-Iraq War

1990-1991



wellhead pricing, which spurs production

1978 NASA dedicates first solar photovoltaic system, AZ

1980 Iraq-Iran War

wind farm technology used for the first time in CA

1986 Crude oil price collapses

1990 World Wide Web

Persian Gulf War 1991 Drawdown of

Strategic Petroleum Reserve

1997 Kyoto Agreement to limit greenhouse gases

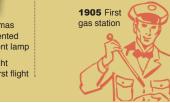


1840 First recorded use of natural gas for manufacturing Centerville, PA

1861-1865

1858-1890 Internal combustion engine

**1897** Thomas Edison invented **1903** Wright



1908 Ford Model-T **1911** U.S. military converts to oil as fuel source

1929 Start of Great

1914-1919 WWI

1939-1945 WWII 1945 World's first nuclear explosion

at Trinity test site, Alamogordo, NM

1958 First commercial nuclear power plant, Shippingport, PA **1958** First integrated

circuit silicon chip 1960 OPEC formed

1960 First large-scale geothermal electric plant, The Geysers, CA

1969 First man walks on