

Categories of hydrocarbon accumulations and sources

	<u>Hydrocarbon source or process</u>	<u>Prominent examples</u>	<u>Description</u>	<u>Challenges or concerns</u>		
Conventional	Conventional petroleum	Fields in Middle East and North Sea	Liquid and gaseous hydrocarbons in porous and permeable sedimentary rocks	Seeming scarcity or depth of undiscovered large accumulations		
Unconventional petroleum	Conventional hydrocarbons in unconventional reservoirs	Sources dependent on fracking	Tight oil	Bakken Formation (Williston Basin, North Dakota); Eagle Ford Shale (Texas)	Liquid and gaseous hydrocarbons liberated from impermeable sedimentary rocks by hydraulic fracturing ("fracking")	Cost of fracturing process; air pollution from fracking engines; disposal of wastewater from fracturing; potential contamination of groundwater resources.
			Shale gas (Conceptually a subset of tight gas, but usually treated as a separate category)	Marcellus Shale (Appalachian Basin); Barnett Shale (Texas)	Gaseous hydrocarbons (largely methane but locally "wet") liberated from shale (an impermeable sedimentary rock) by hydraulic fracturing	Cost of fracturing process; air pollution from fracking engines; disposal of wastewater from fracturing; potential contamination of groundwater resources.
			Tight gas	Austin Chalk (Texas-Louisiana); Niobrara Chalk (Colorado etc.)	Gaseous hydrocarbons (largely methane but locally "wet") liberated from impermeable rocks by hydraulic fracturing ("fracking")	Cost of fracturing process; air pollution from fracking engines; disposal of wastewater from fracturing; potential contamination of groundwater resources.
	Unconventional hydrocarbons	Coalbed methane	Powder River Basin (Wyoming)	Methane adsorbed on maceral and fracture surfaces in coal	Drawdown of aquifers; disposal of associated water.	
		Unconventional hydrocarbons in conventional reservoirs	Tar sands; heavy oil; bitumen; oil sands	Athabasca (Canada) and Orinoco (Venezuela) sands	Viscous dense petroleum in shallowly buried porous and permeable sands and sandstones	Where mined, economic and environmental costs of mining; great energy required for heating tar to liquid state; water sources and wastewater.
			Oil Shale	Green River Shale (Colorado, and with lesser certainty Utah and Wyoming)	Hydrocarbons generated by heating kerogen (pre-petroleum organic matter) in shallowly buried impermeable sedimentary rocks, typically shales.	Economic and environmental costs of mining; energy required for pyrolysis of kerogen; sources of water; impact on air quality.
		Unconventional hydrocarbons	Coal gasification; coal liquefaction	"Town gas" of late 1800s to mid 1900s; modern Shanxi Jincheng plant in China; present proposed plants in U.S. etc.	Indirect synthesis of fuels via chemical reaction of coal with steam and O ₂ , generating H ₂ , CO, CO ₂ and, after further reaction, methane or liquid hydrocarbons	Economic and environmental costs of mining of coal; complexity of chemical processing; water sources and waste water; generation of CO ₂ , a greenhouse gas.
			Methane hydrates; gas hydrates	Ignik Sikumi gas hydrate field trial (Alaska)	Small hydrocarbon molecules trapped in H ₂ O frameworks in permafrost or in seafloor sediments and fractures	Uncertainty as to the extent and concentration of deposits, and as to economically viable recovery technologies.

Sources include Keith et al. (2003), Bartis et al. (2005); Meyer et al. (2007), Toman et al. (2008), Collett et al. (2009), U.S. Geological Survey (2009, 2010), Bjørlykke (2010), Energy Information Administration (2010), and National Energy Technology Laboratory (2012). This table was improved by the comments of Dr. David S. Ortiz of the RAND Corporation.