The CO_2 Storage Resource Management System (SRMS): A Project Maturity Based Classification and Categorization of Storable Quantities

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SRMS Outline

- Introduction
  - Motivation: Historical Studies Commercialization
  - Analogous System: Petroleum Resources Management System (PRMS)
  - SRMS committee activities
- SRMS
  - Categories (storable quantities)
  - Classifications (project maturity)
- Example: Generic Illinois Basin
- Summary

Introduction: SRMS Motivation

Historical Studies

- Early studies had a wide variety of methods and assumptions used to calculated CO_2 storage
  - Total pore volume to mobile water volume, with free phase CO2 or 100% CO2 saturated water
- Recognized that uncertainty in CO2 storage estimates existed due to
  - Data quantity, quality, and type
  - Regional vs. site-specific
- Recognized that well configuration and specific geologic depositional environment (i.e. *the project specifications*) influenced storage estimates

Commercialization

- Commercial scale CO_2 storage projects involve financial, corporate, government organizations
  - provide common terminology and clear definitions needed to classify storage quantities, *the commodity* for storage
- Storage quantities are essential part of all projects
  - provide context for investment and tracking the performance of the investment

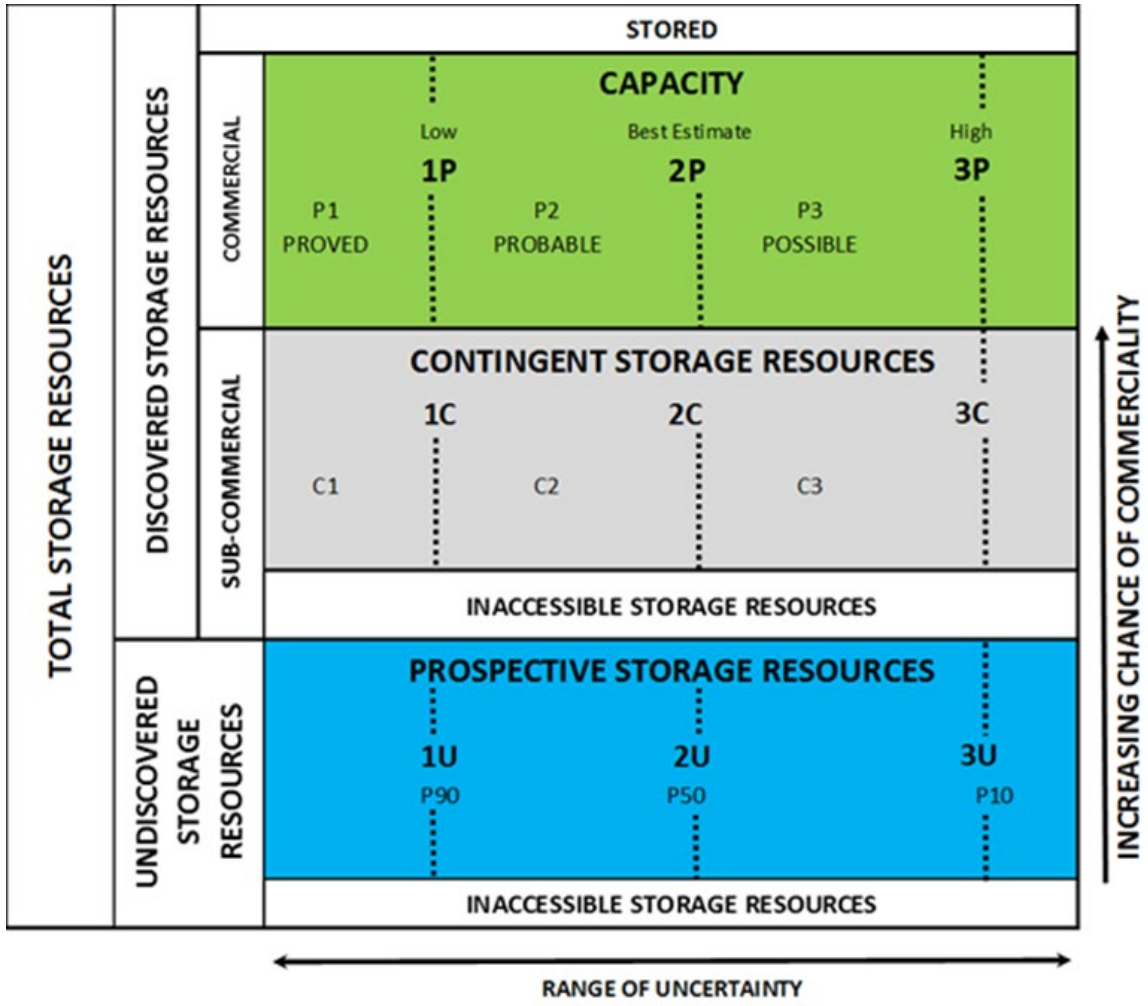
Introduction: SRMS Seed Document (Analogy) Petroleum Resources Management System (PRMS)

- Developed to standardize methods used to determine value of the assets of oil and gas producing companies based on projections of future oil and gas production
- Reserves
  - Proved developed producing
  - Proved developed, not producing
  - Proved undeveloped
- Time tested and applied system in the oil and gas industry
- Developed by professional organizations
  - SPE, AAPG, WPC and SPEE
- Supported by financiers, security exchanges, and governments approved

Introduction:
SRMS Committee Activities

- Society of Petroleum Engineers committee formed in 2016.
- Recruited members with storage experience and PRMS experience
- Started with SRMS seed document
- Approved and released by 2017
- Currently completing SRMS Guidelines
- Next, SRMS

SRMS Categories (storable quantities-certainty)

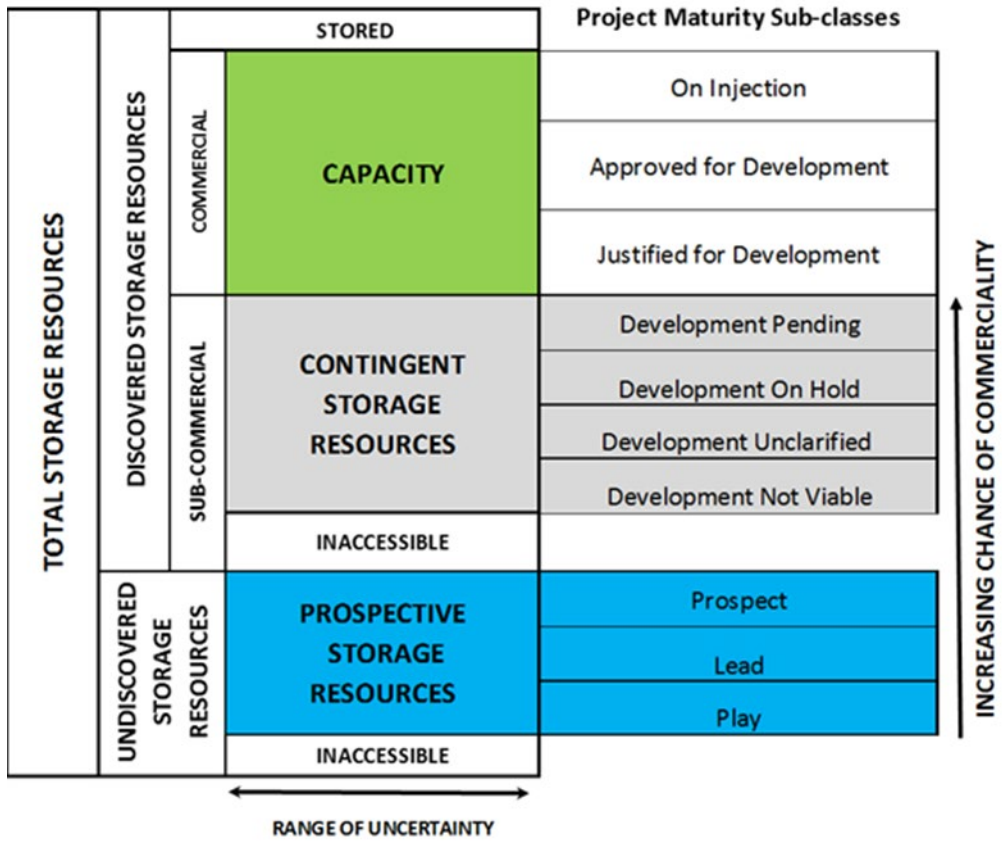


- Low estimate-highest certainty
- Best estimate-most likely
- High estimate –lowest certainty
- Capacity Example
  - Proved Capacity (P1):
  - quantity estimated w/ reasonable certainty (e.g. P90) to be commercial with a defined project within a known geologic formation, operating methods, and government regulations.
  - Probable Capacity (P2)
  - Possible (P3)

$$1P = P1 \qquad 2P = P1 + P2$$
$$3P = P1 + P2 + P3$$

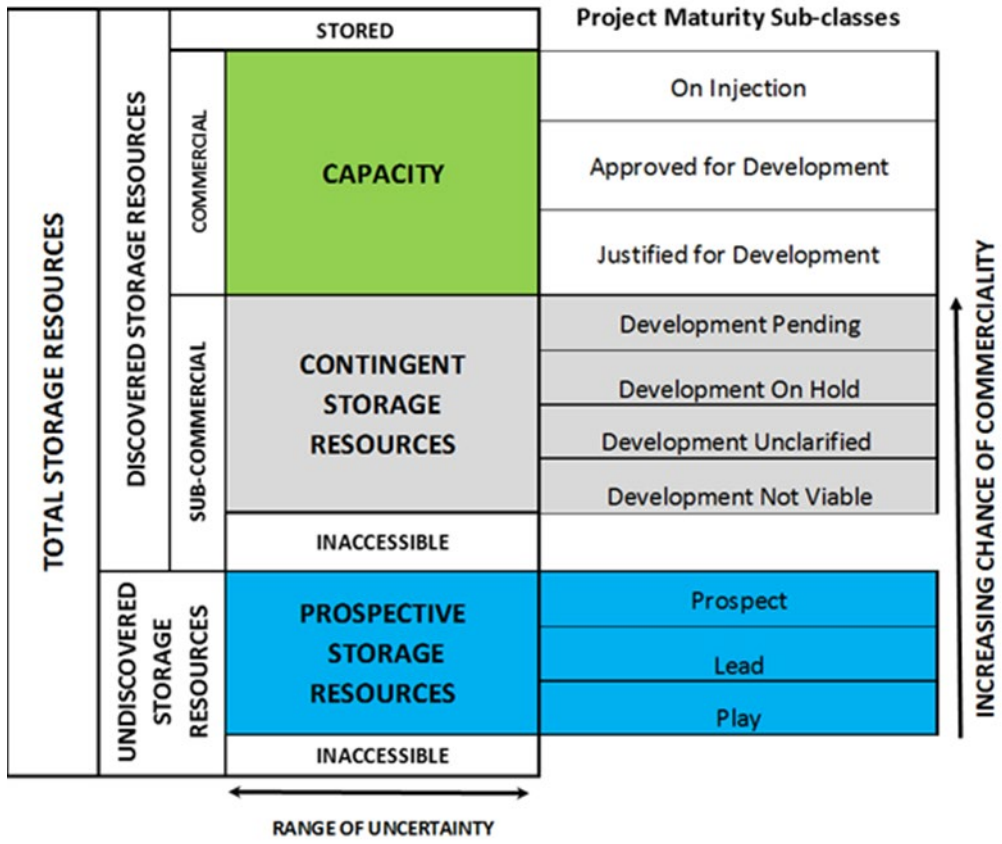
SRMS Classifications

- Based on maturation of a project
- Major classifications
  - Discovered vs. Undiscovered
  - Commercial vs. Sub-commercial
- Capacity:
  - Discovered and commercial
- Contingent Storage Resources
  - Discovered and sub-commercial
- Prospective Storage Resources
  - Undiscovered



SRMS Classifications: Capacity

- **On Injection:** development project is currently injecting and storing CO_2.
- **Approved for Development**: All necessary *approvals have been obtained*, capital is committed, and implementation of the development project is underway.
- **Justified for Development**: Implementation of the development project is justified on the basis of reasonable forecast commercial conditions at the time of reporting, and there are *reasonable expectations that all necessary approvals/contracts will be obtained*.



SRMS Example:
Illinois Basin Generalization

Example SRMS Application
Pre-Storage Assessment: General Knowledge

- Basal sandstone
  - Outcrops and subcrops
  - Crosses two countries, and eight States
  - No known minerals; natural gas storage
  - Few wellbore penetrations
  - Extensive caprock
  - Deep: greater cementation lower p&p

“1995” Study: $250k

- Objective: storage potential, proximity to sources
- Volumetric approach
  - Pore volume replacement
  - Single value
- Boundaries:
  - Perimeter: State lines; Fresh water
  - Depth: Minimum-density of CO2; maximum-low p&p
- Outcome: General Geographical area for a site
  - Estimate: 800 Gtonnes (single value)
  - Classification: **Prospective** Storage Resources-**Play**.
  - The categorization of the estimate is **3U**

“2000” Study: $1.0M

- Objective: storage potential, site screening
- Volumetric, GIS approach
  - Natural gas storage analog
  - Single Value
- Boundaries:
  - Perimeter: Oilfield structures only; Fresh water
  - Depth: Minimum-density of CO2

- Outcome:
  - Estimate: Structures-6 Gtonnes (single value)
  - Classification: **Prospective** Storage Resources-**Prospect** *(Increased certainty of geographical area for a site)*
  - The categorization of the estimate is **2U**

“2005” Study: $1.0 M

- Objective: storage potential, site screening
- Volumetric, GIS approach
  - Efficiency: displacement, and net geologic attributes
  - High, medium, low values (E= 1-4%)
- Boundaries:
  - Perimeter: Oilfields and regional dip; Fresh water
  - Depth: Minimum-density of CO2
- Outcome: General Geographical area for a site
  - Estimate: Structures-6 Gtonnes; Basin- 25-100 Gtonnes
  - Classification: **Prospective** Storage Resources-**Prospect**.
  - Categorization:
    - 1U-25 Gtonnes
    - 2U-50 Gtonnes
    - 3U-100 Gtonnes

“2010” Study: $10 M

- Objective: site selection/ well drilled
- Simulation of single well
  - 3,000 tpd maximum at the site
  - 8,000 tpd maximum simulated injection rate of the geologic unit
- No management commitment
- 25 yr facility life at maximum site CO_2 emission rate

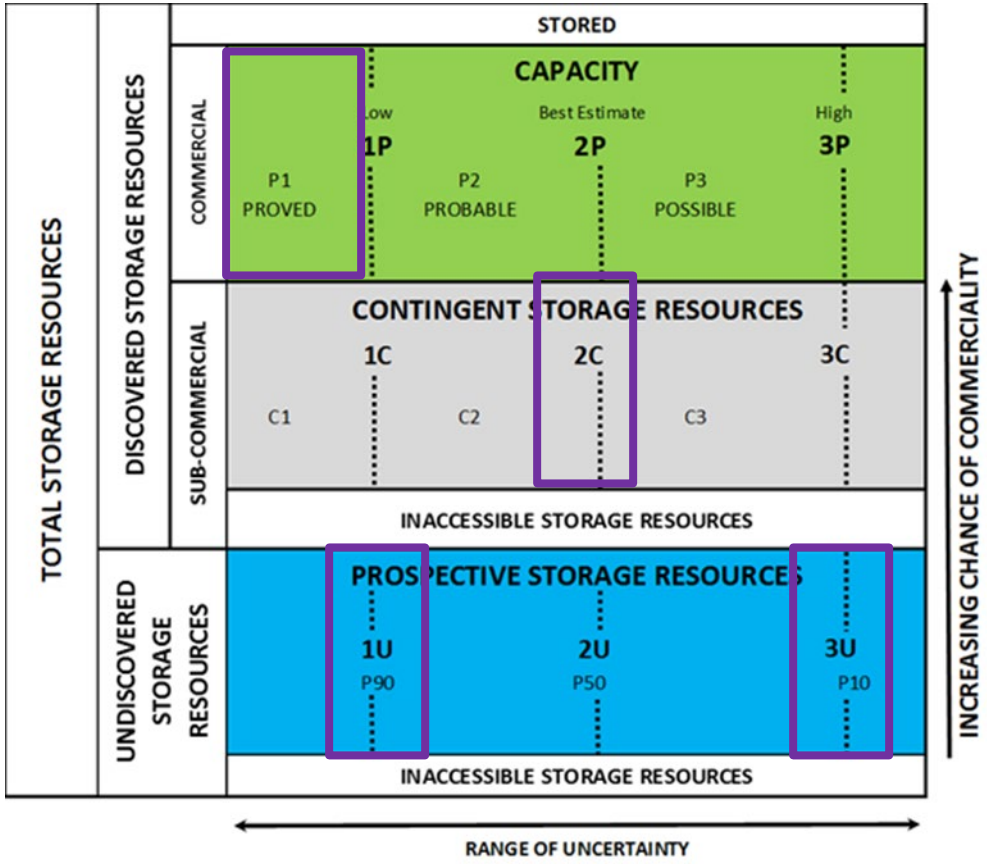
- Outcome (upon active injection)
  - Estimate: 70.0 Mtonnes
  - Classification: **Contingent** Storage Resources-**Development Pending**
  - Categorization: 2C (neither optimistic or pessimistic)

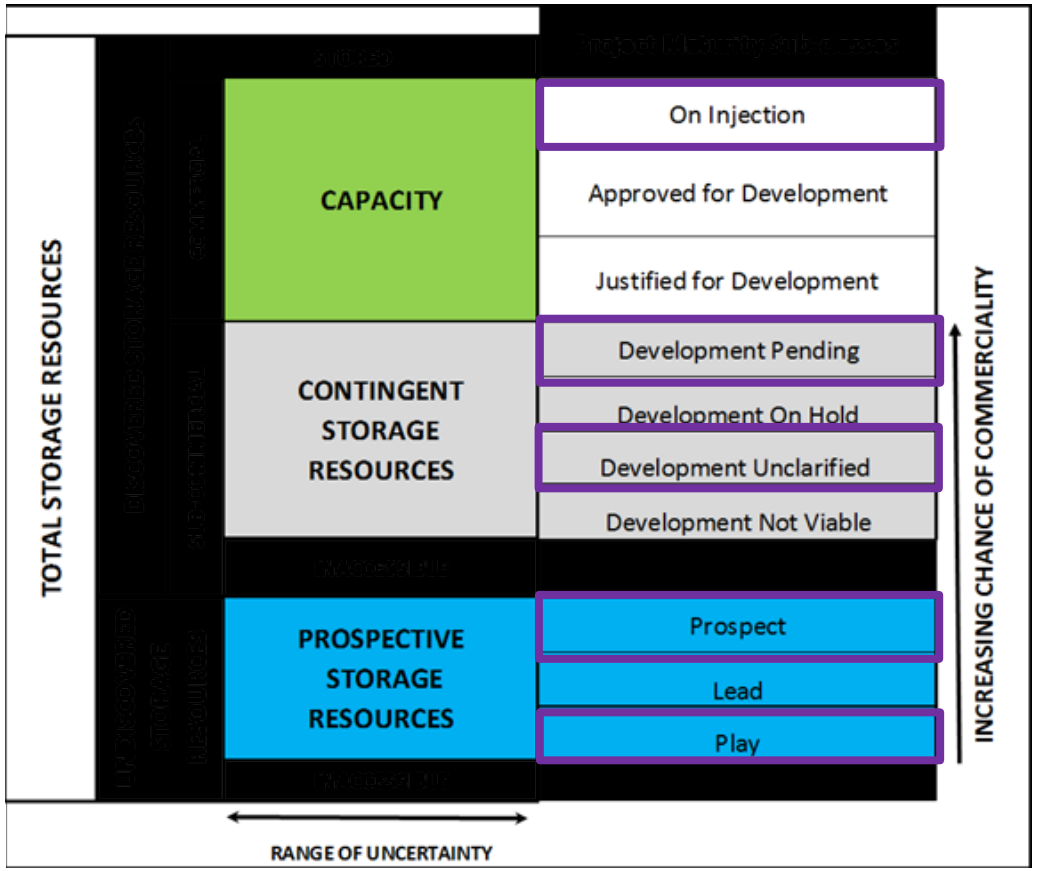
“2015” Study: $50 M

- Objective: project economics and permit acquired
- Equipment and infrastructure purchased: 1,000 tpd
- Management commitment: 3 years
- Permit acquired for same rate and duration

- Outcome (upon active injection)
  - Estimate: 1.0 Mtonnes
  - Classification: **Capacity** – **On Injection** (*No other management commitment to project expansion*)
  - Categorization: **Proved Developed Injecting** (P1)
  - Classification of remaining storage resource: **Prospective Storage Resources-Development Unclarified**

Example Summary





Study Year	Storage Quantity/ Classs/Category	Method	Comment
1995	800 Gt / Contingent Play	Volumetric	
2000	6.0 Gt / Contingent Prospect	**Structure**, natural gas storage analog	
2005	6.0 Gt / 25-100 Gt / Contingent Prospect	GIS, volumetric, **regional dip**	Consistency amongst RCSP
2010	70 Gt / Prospective Development Pending	Simulation	Site selection well drilled
2015	1.0 Gt / Capacity: On injection	GIS, volumetric, regional dip	Active injection with existing facility, permit, and management commitment

SRMS Expected Outcomes

- Standardized terminology and definitions similar to an established and familiar resource assessment methodology
- Different assessors or stakeholders have a methodology to follow to make effective comparisons between projects.
- Elimination of challenge to commercial storage
- Reduce financial risk associated with estimates of storage

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