GLOBAL CCS INSTITUTE

Global CO_2 Storage Readiness and Capacity

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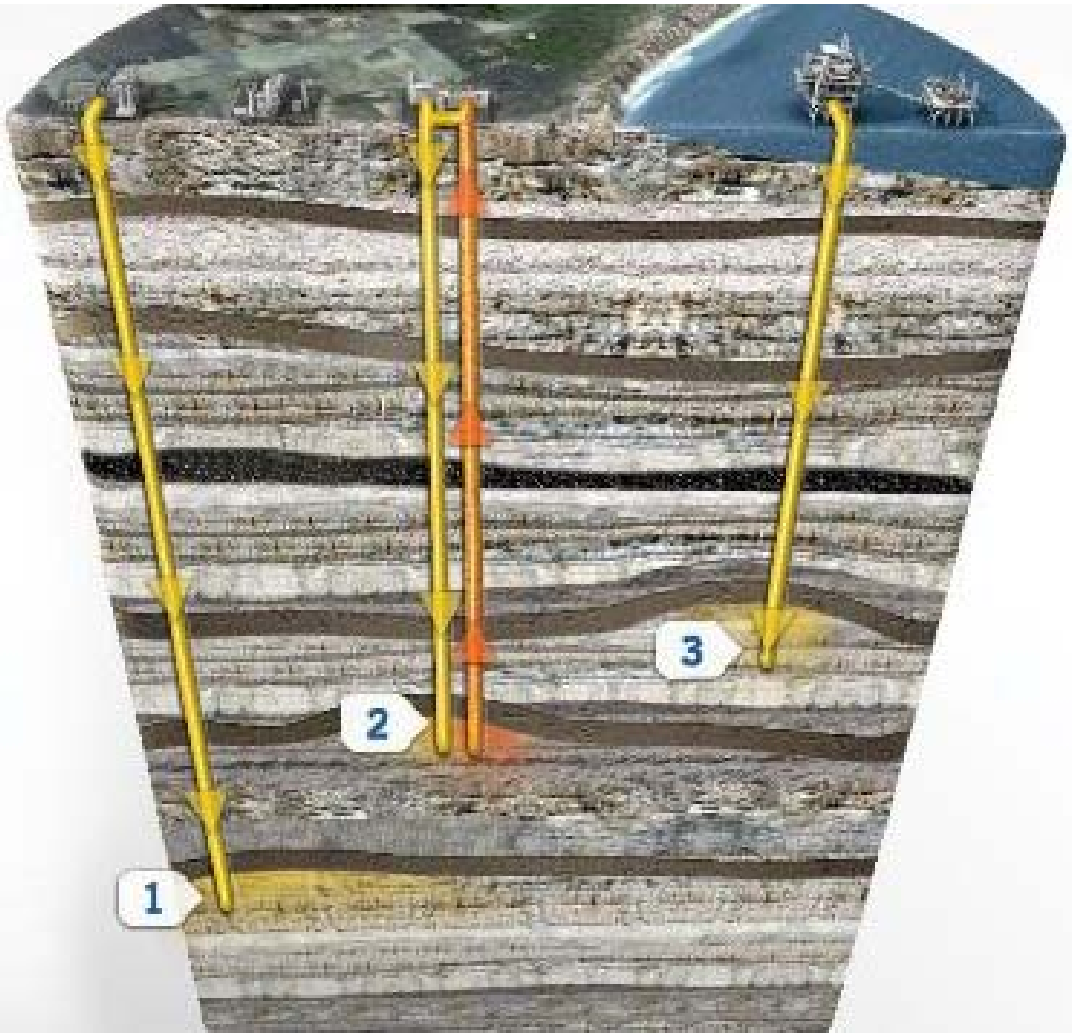
CSLF / CCSA Workshop

Overlooking the Quest Capture facility located at Shell - Scotford, near Fort Saskatchewan, Alberta. Image provided by Shell.

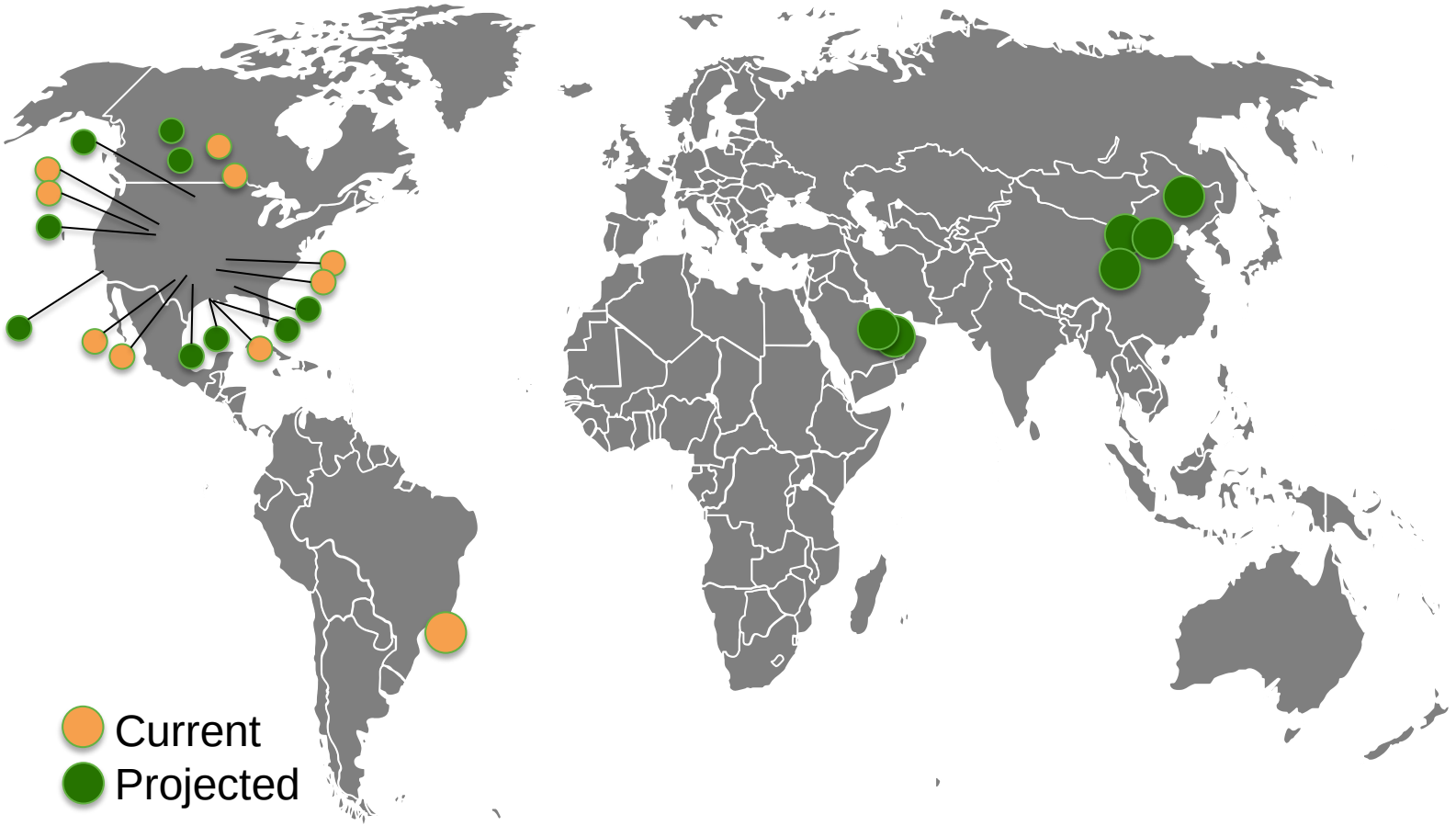
Geological storage scenarios

1. Saline formations
2. Use of CO_2 in enhanced oil recovery
3. Depleted oil and gas reservoirs



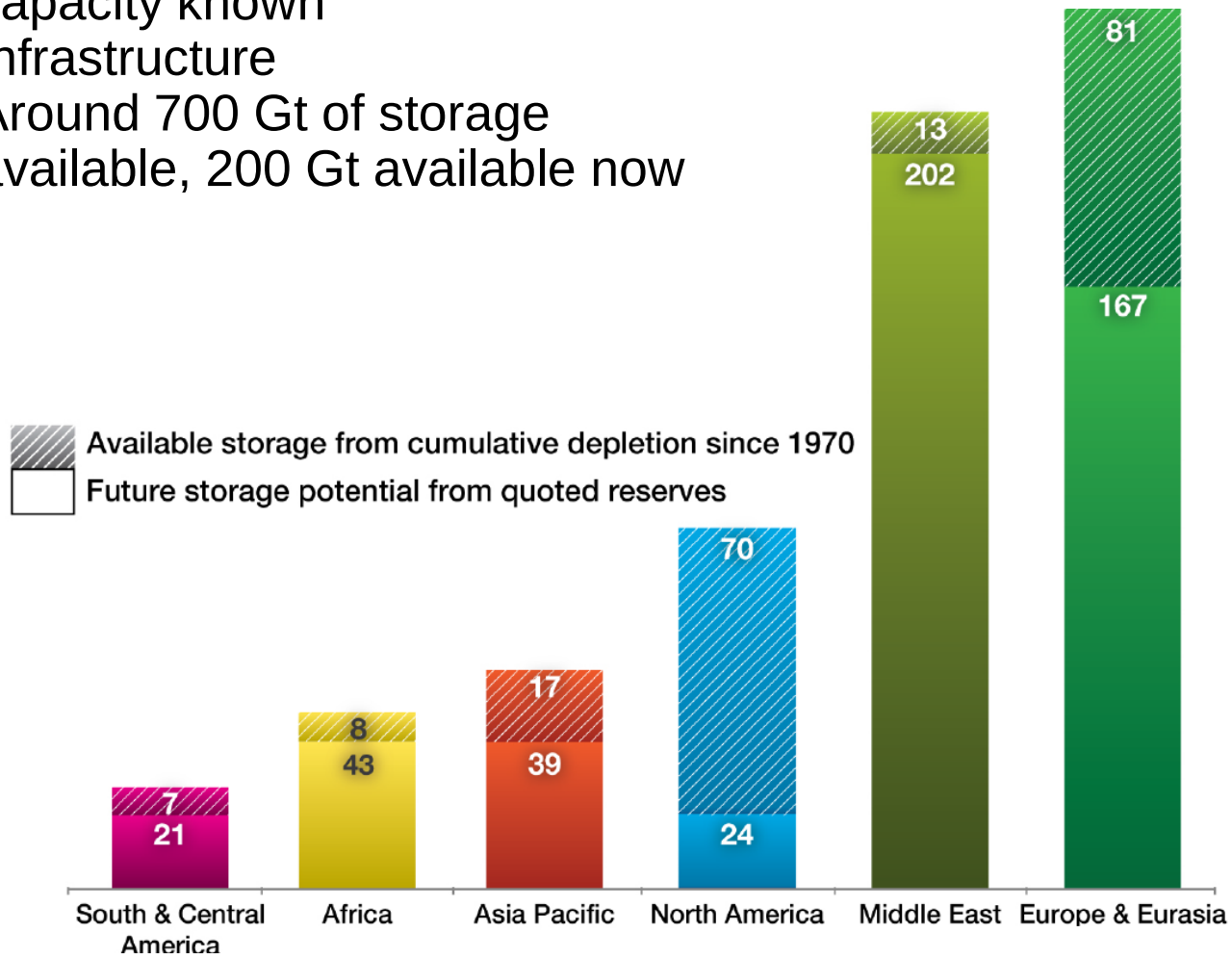
CO_2-enhanced oil recovery: Provides commercial reality

- EOR >100 Mt anthropogenic CO_2 cumulatively injected and stored
- Global CO_2 for EOR demand 140-320Gt (ARI,2009)
- Restricted by CO_2 availability and reservoir type



Depleting - depleted oil and gas fields

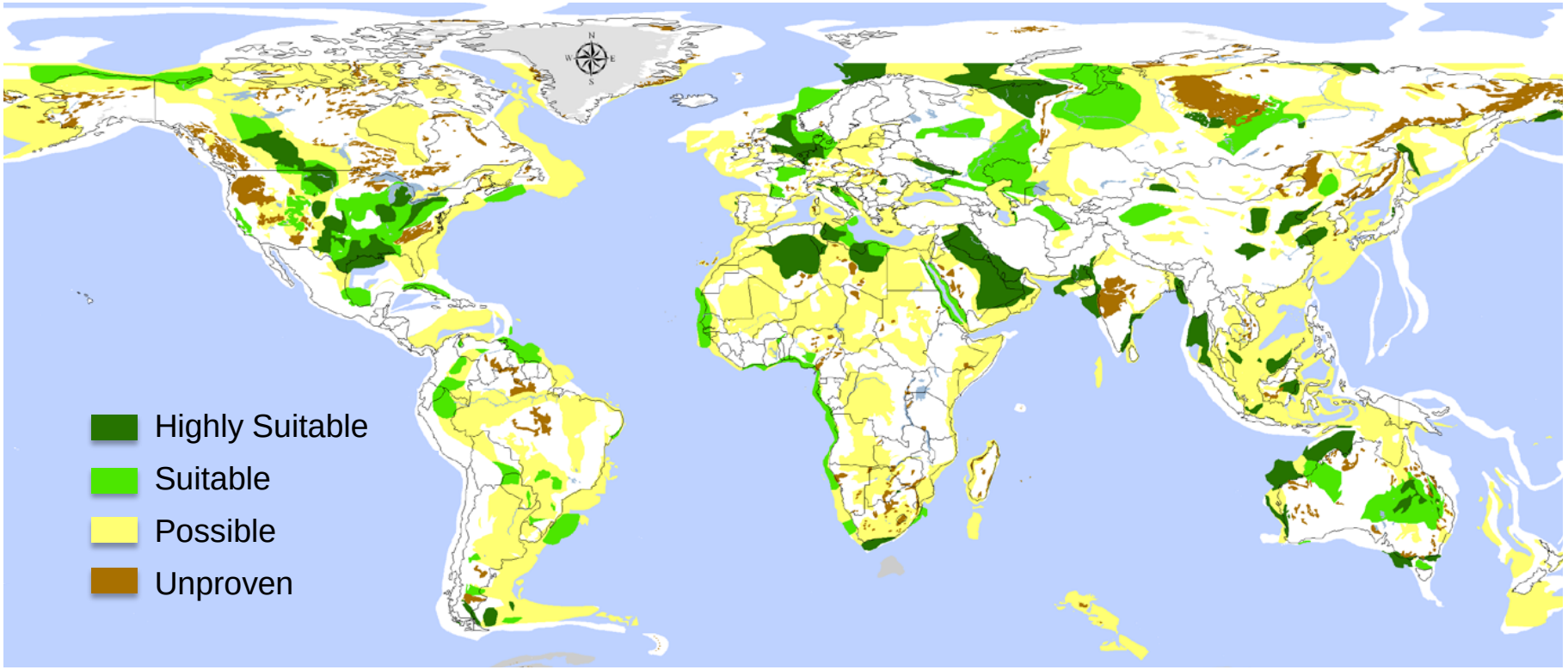
- Globally distributed
- Well characterised proven sites, capacity known
- Infrastructure
- Around 700 Gt of storage available, 200 Gt available now



Modified after: BP Statistical Review (2010)

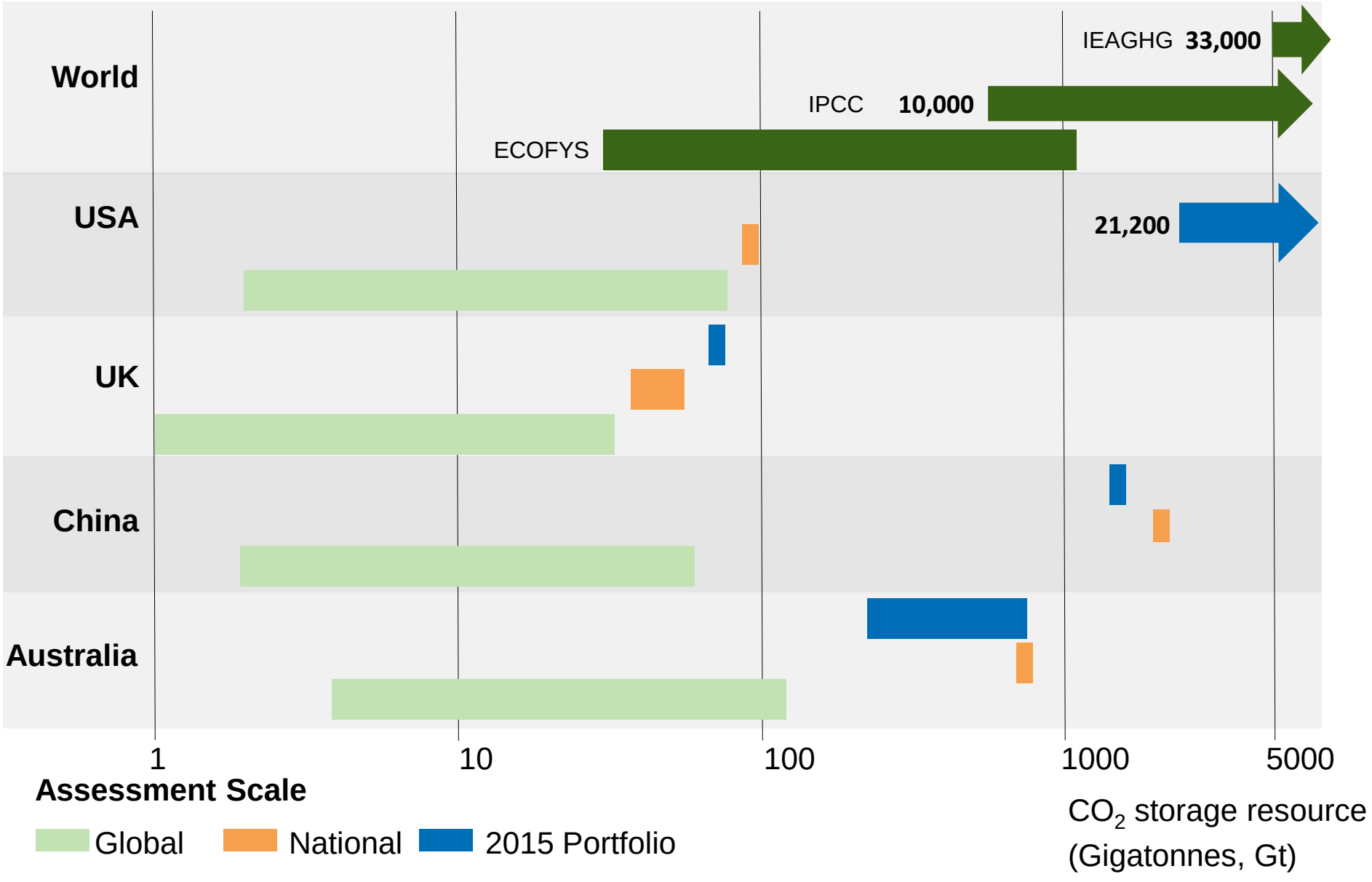
Deep saline formations

- Globally distributed
- Largest potential resource
- Largest variability and least knowledge
- 1000–10,000 Gt /CO_2 + (IPCC)



Modified after: IEAGHG (2011)

Inconsistency in data, methodology and outcomes



Global Storage Portfolio: 2015

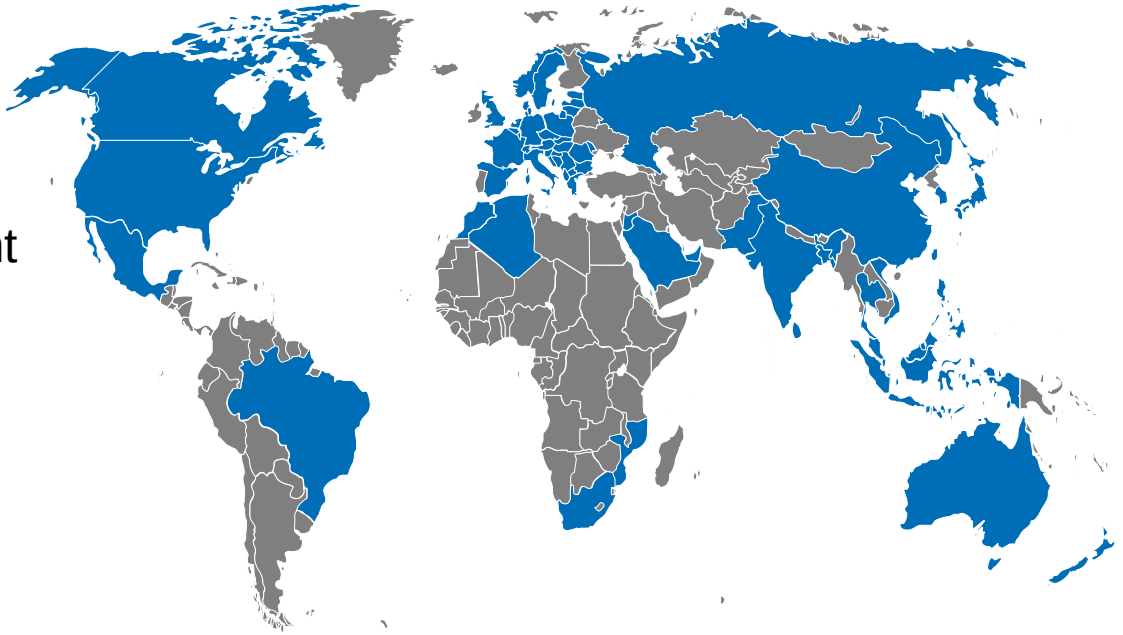
Portfolio outline

Summarises the results from all known publically available, English-language (for now) storage resource assessments worldwide

- Asia-Pacific- fourteen countries
- Americas- five countries
- Middle East- three countries
- EU and Russia- 31 countries
- Africa- four countries

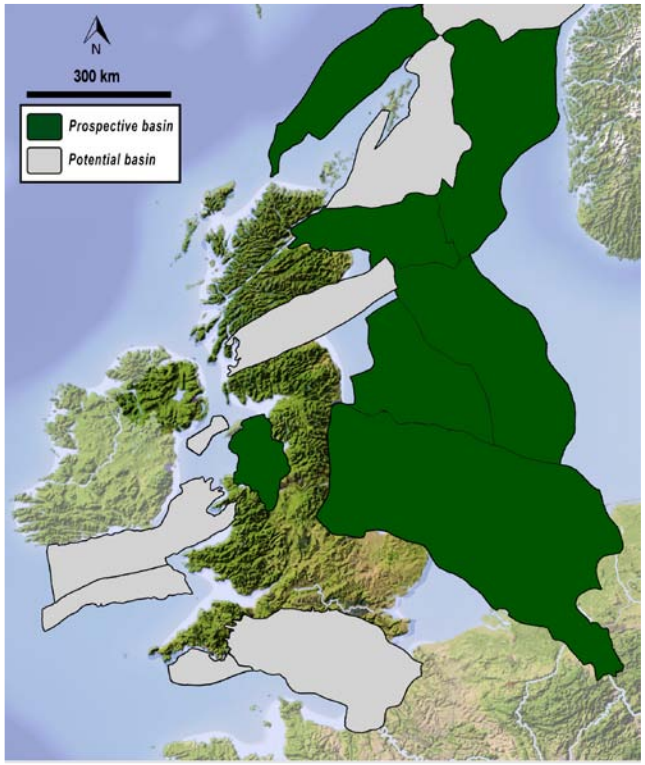
Five key sections

1. Scale of assessment
2. Level of detail
3. Prospective basins
4. Projects
5. CCS Indicators



Countries assessed

Scale and detail of assessment



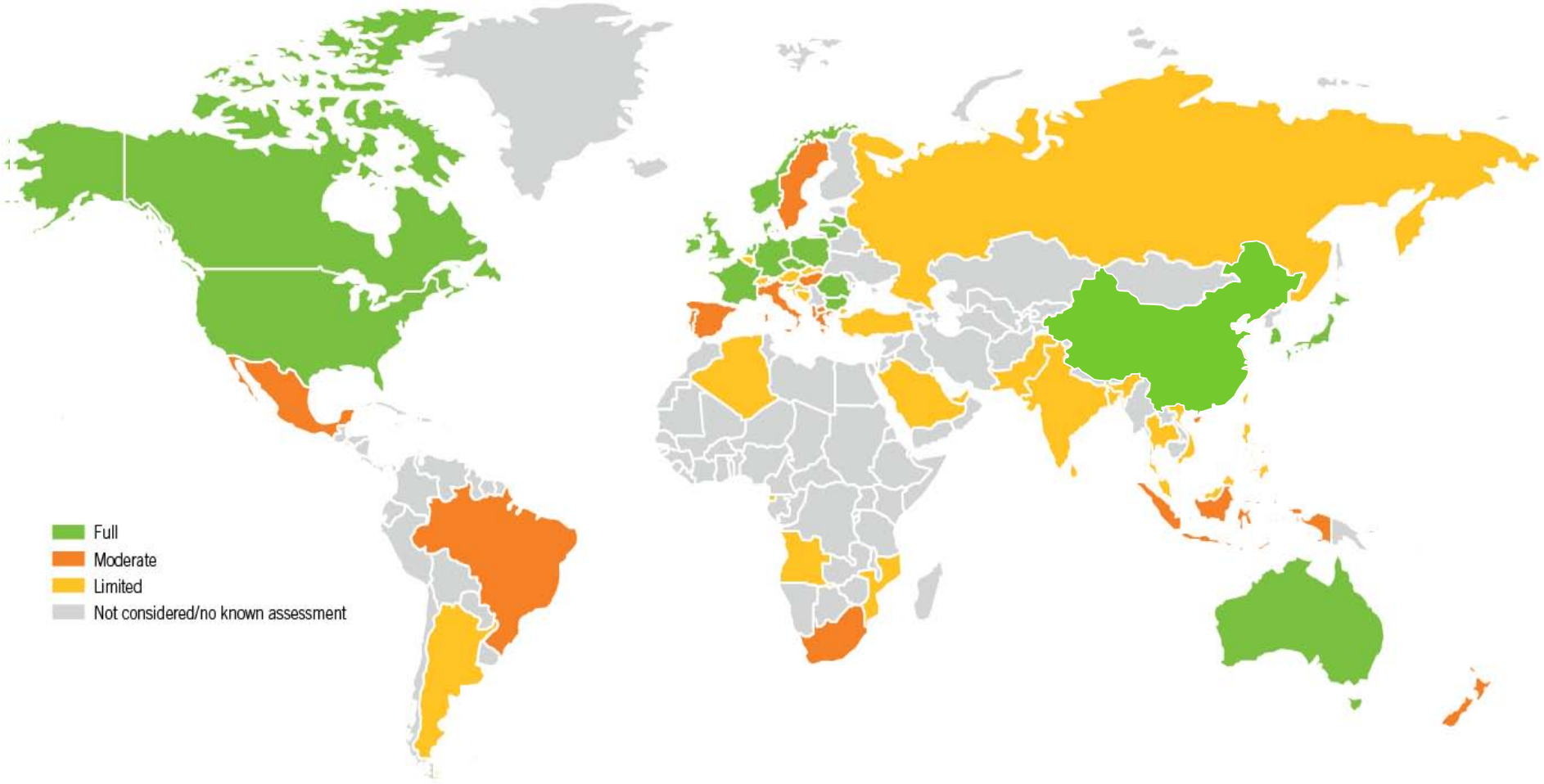
Global Storage Portfolio

Storage Resource Pyramid

Scale and detail of assessment- definitions

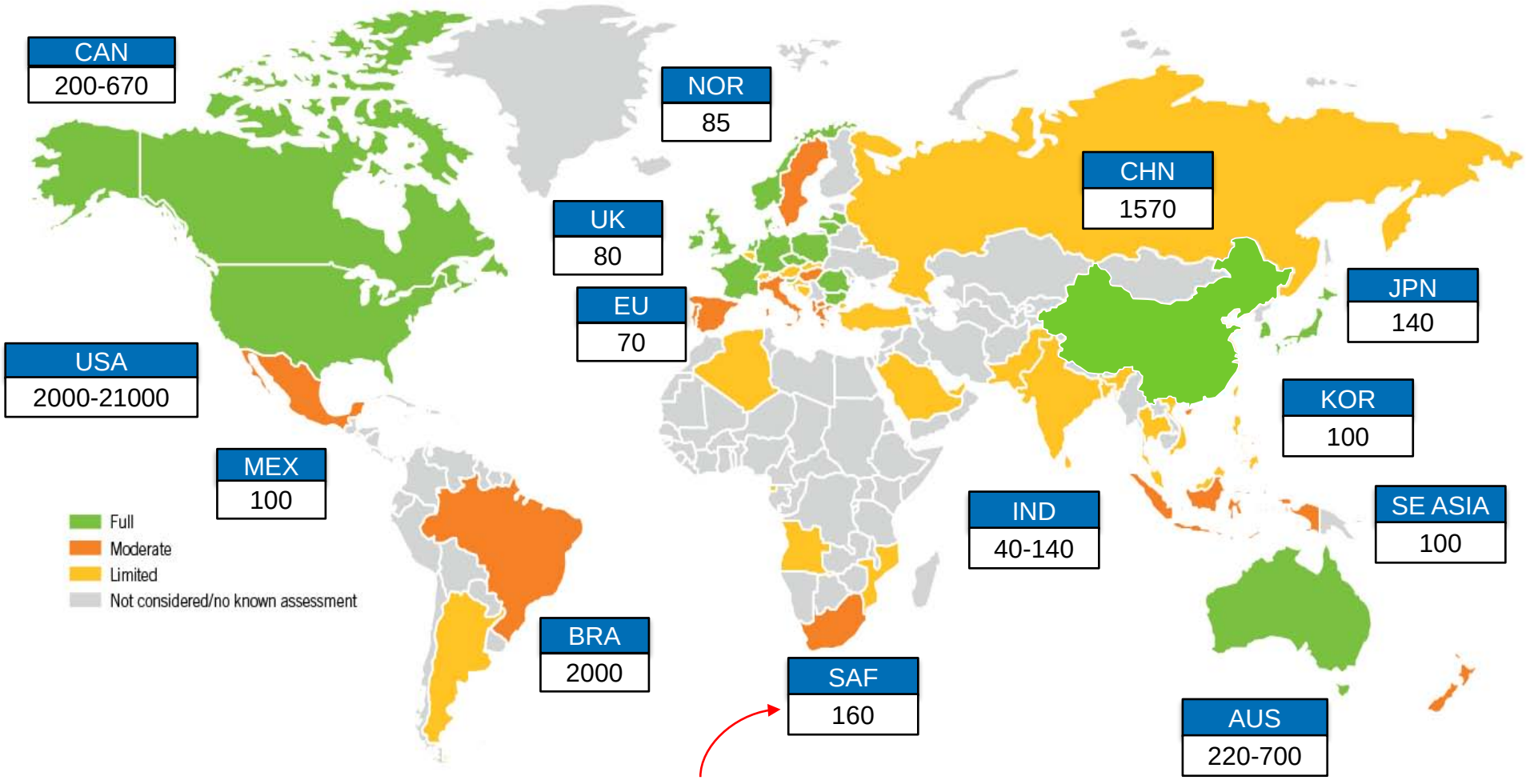
- **Full –** comprehensive assessments (including published Atlases) that cover most or all potential storage basins with accompanying effective resource calculations.
- **Moderate –** national studies/atlases without widespread effective resource calculations; or, partial coverage by state/province/basin scale atlases or detailed assessments.
- **Limited –** more restricted studies, consisting of relevant research into selected basins or sites.
- **Very limited –** minimal or no published research relating to storage potential.

Status of global storage resource assessment



Scale and detail of assessment

Storage resources: 2015



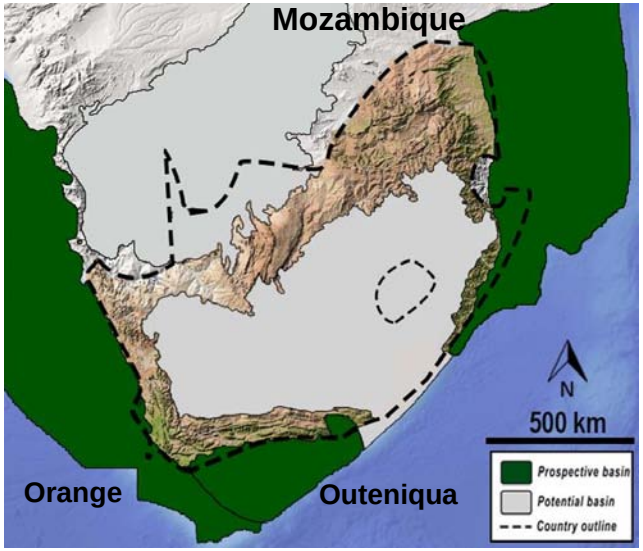
Values from various public sources of information, including national to basin-scale studies to assessments of depleted oil and gas fields only. SE Asia only includes Indonesia (South Sumatra), Philippines, Thailand, Viet Nam.

Prospective basins

- Basins identified as *prospective* have:
  - Previous CO_2 storage potential identified;
  - Proven oil and gas basin; and/or
  - Favourable geology.

- Country-specific
  - Relative to other basins

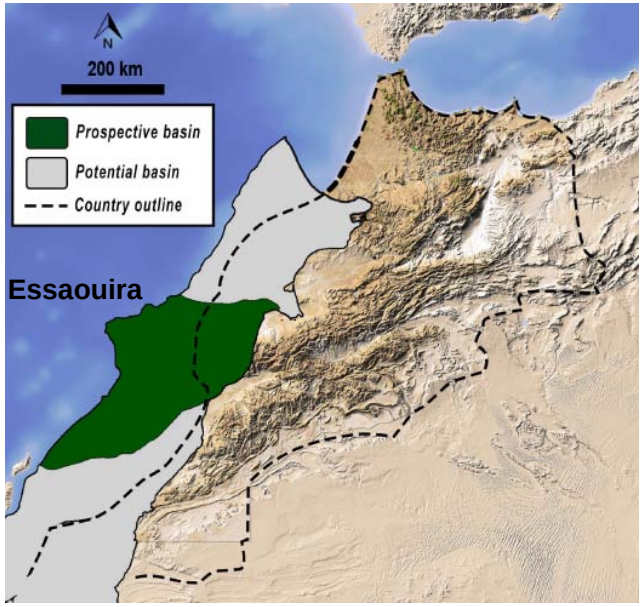
Prospective basins: South Africa and Morocco



Status: Moderate

Estimated resource ($GtCO_2$)	Resource level	Resource Calculation Method
162	Theoretical	Volumetric using storage efficiency factor and probabilistic modelling.
Viljoen et al. 2010		

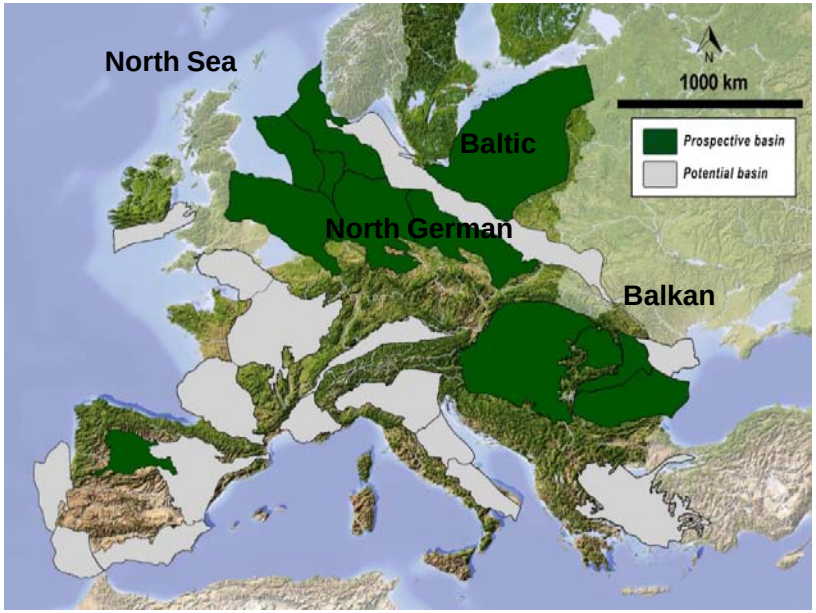
- Each country has a single national study
- Mainly offshore
- Limited data
- Minor R&D



Status: Limited

Estimated resource ($GtCO_2$)	Resource level	Resource Calculation Method
0.6*	Theoretical	Volumetric
*onshore basins only		
Martinez et al. 2013.		

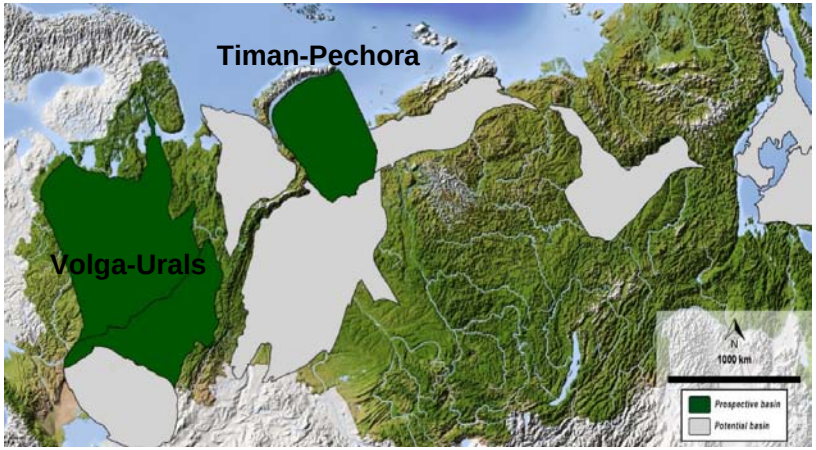
Prospective basins: Europe, UK, Russia



Status: Full

Estimated resource ($GtCO_2$)	Resource level	Resource Calculation Method
72*	Theoretical	Volumetric calculation using storage efficiency factor.
*Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, France, Germany, Greece, Hungary, Italy, Latvia, Lithuania, Luxemburg, Netherlands, Poland, Romania, Slovakia, Slovenia, Spain.		
Vangklide-Pedersen 2009		

- Multiple, multi-scale assessments
- North Sea largest potential
- Extensive R&D

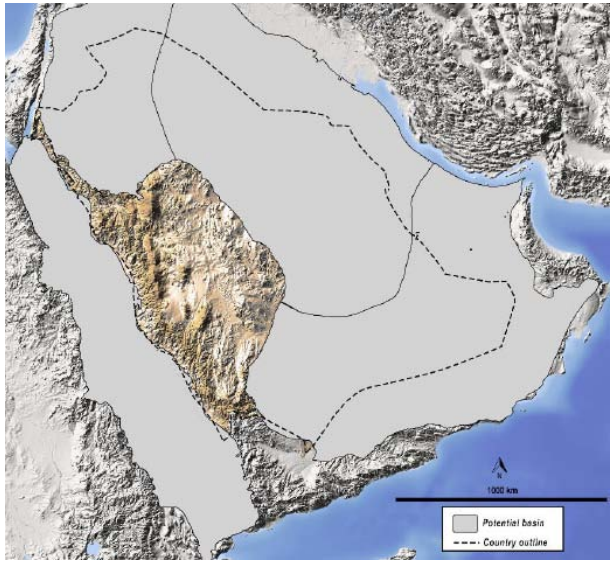


Status: Very Limited

Estimated resource ($GtCO_2$)	Resource level	Resource Calculation Method
6.8*	Effective	OO/GIP with standard CO_2 reservoir conditions and recovery factor.
*CO_2-EOR/DOF		
Sidorova 2014		

- No national studies
- Extensive oil and gas, CO_2-EOR
- Very limited R&D

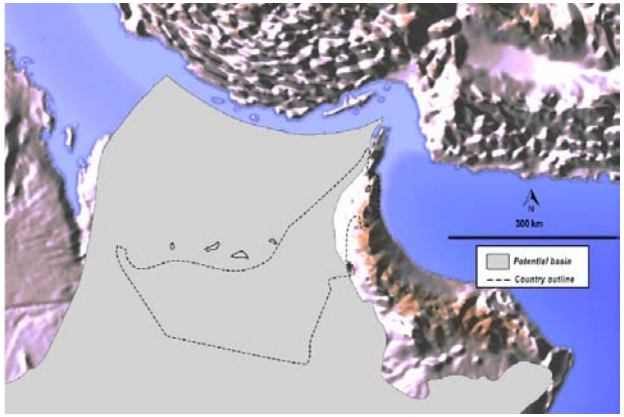
Prospective basins: Saudi Arabia and UAE



Status: Very Limited

Estimated resource ($GtCO_2$)	Resource level	Resource Calculation Method
5-30*	Theoretical	OOIP; assumes generalised standardised CO_2 replacement value.
*CO_2-EOR only		
IEA 2015		

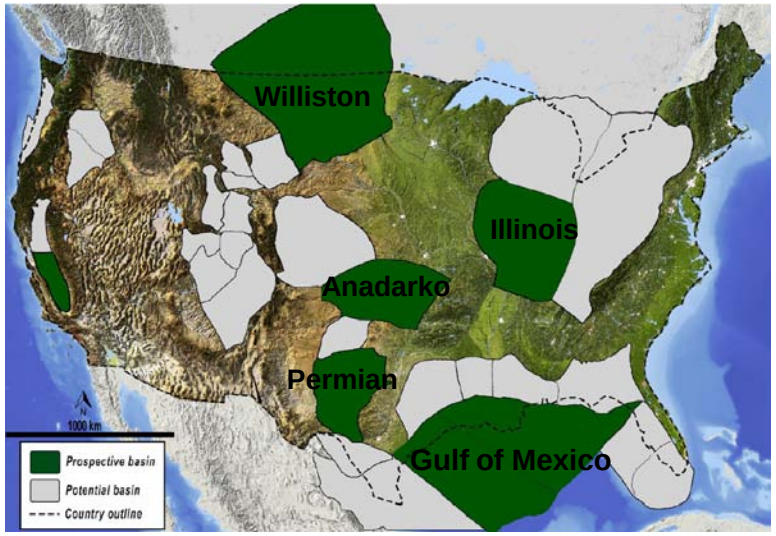
- No national studies
- Extensive oil and gas, CO_2-EOR
- Very limited R&D
- **Commercial project**



Status: Very Limited

Estimated resource ($GtCO_2$)	Resource level	Resource Calculation Method
5-25*	Theoretical	OOIP; assumes standardised CO_2 replacement value
*CO_2-EOR		
IEA 2015		

Prospective basins: USA and Canada



Status: Full

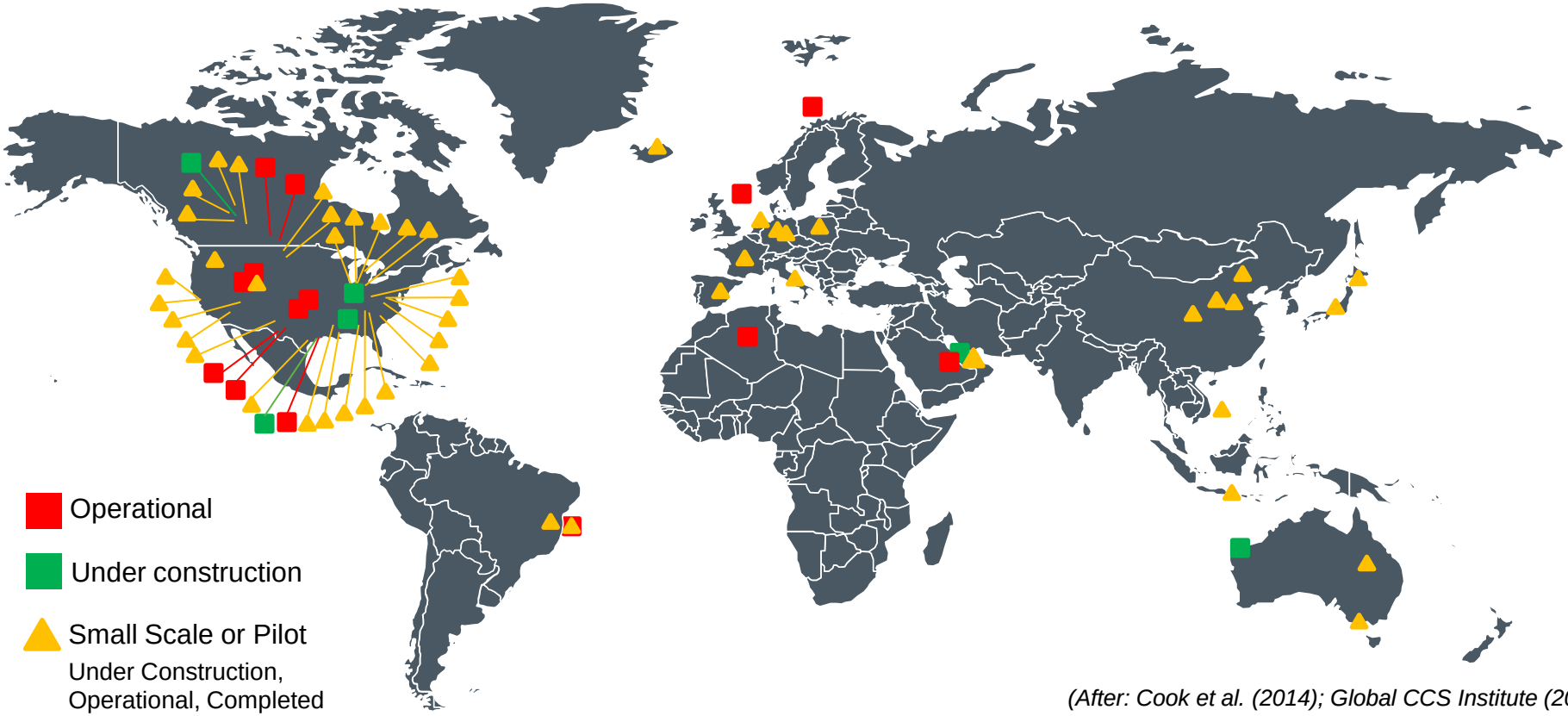
Estimated resource ($GtCO_2$)	Resource level	Resource Calculation Method
2,367-21,200	Effective	Volumetric using storage efficiency factor and probabilistic modelling.
US DOE NETL 2015		

- National and detailed studies
- Site-scale analysis
- Onshore
- Oil, gas, CO_2-EOR
- Extensive pilot, commercial and R&D

Status: Full

Estimated resource ($GtCO_2$)	Resource level	Resource Calculation Method
198-671	Effective	Volumetric using storage efficiency factor and probabilistic modelling.
US DOE/NETL 2015		

CO_2 injection projects



(After: Cook et al. (2014); Global CCS Institute (2015)

- Technical, legal and regulatory barriers overcome
- Scientist, engineers, technicians, suppliers, regulators work together
- CCS can happen here

CCS Indicators

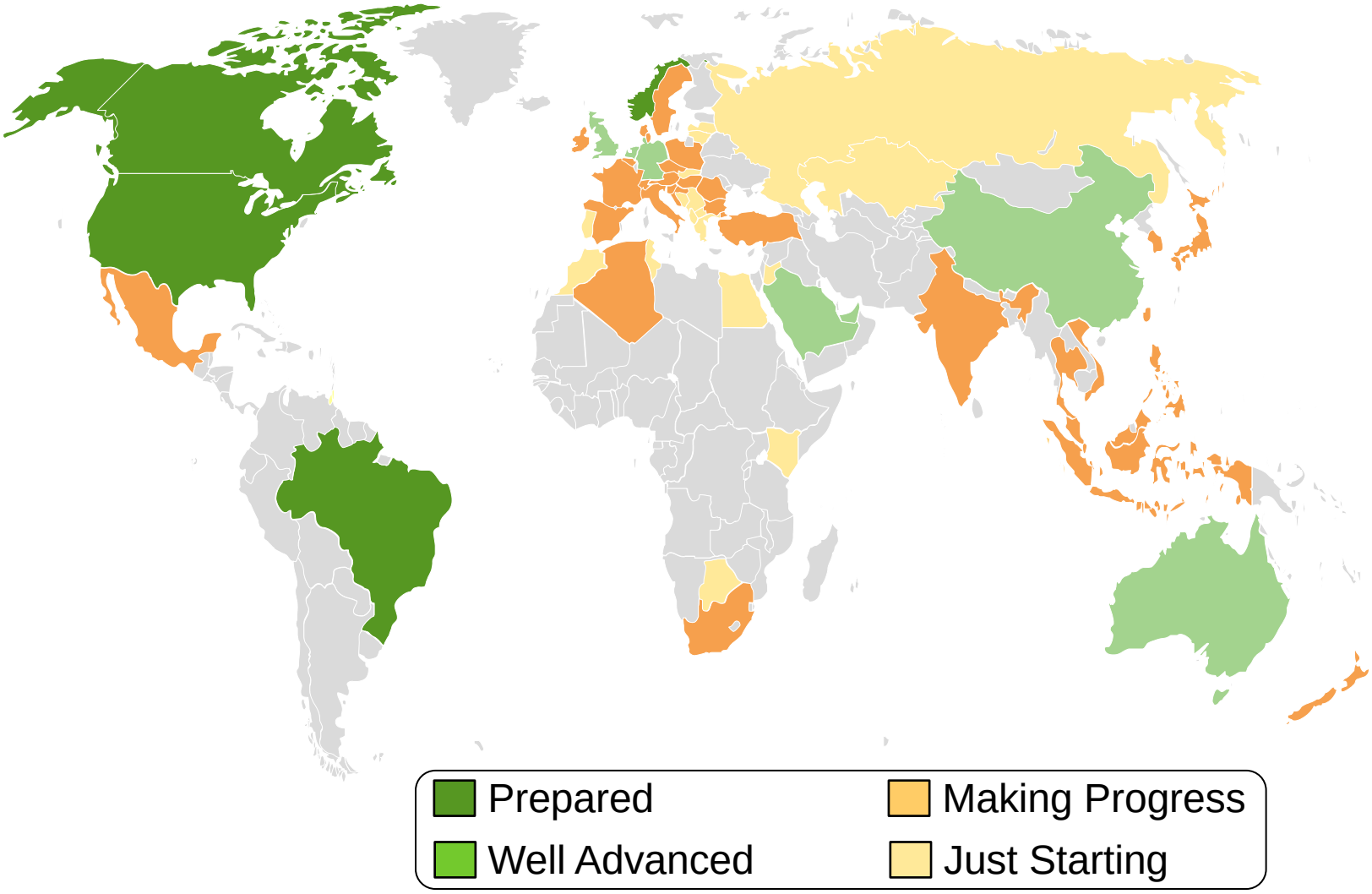
Summarises the results of the three 2015 indicators

- Storage
- Policy
- Legal and Regulatory

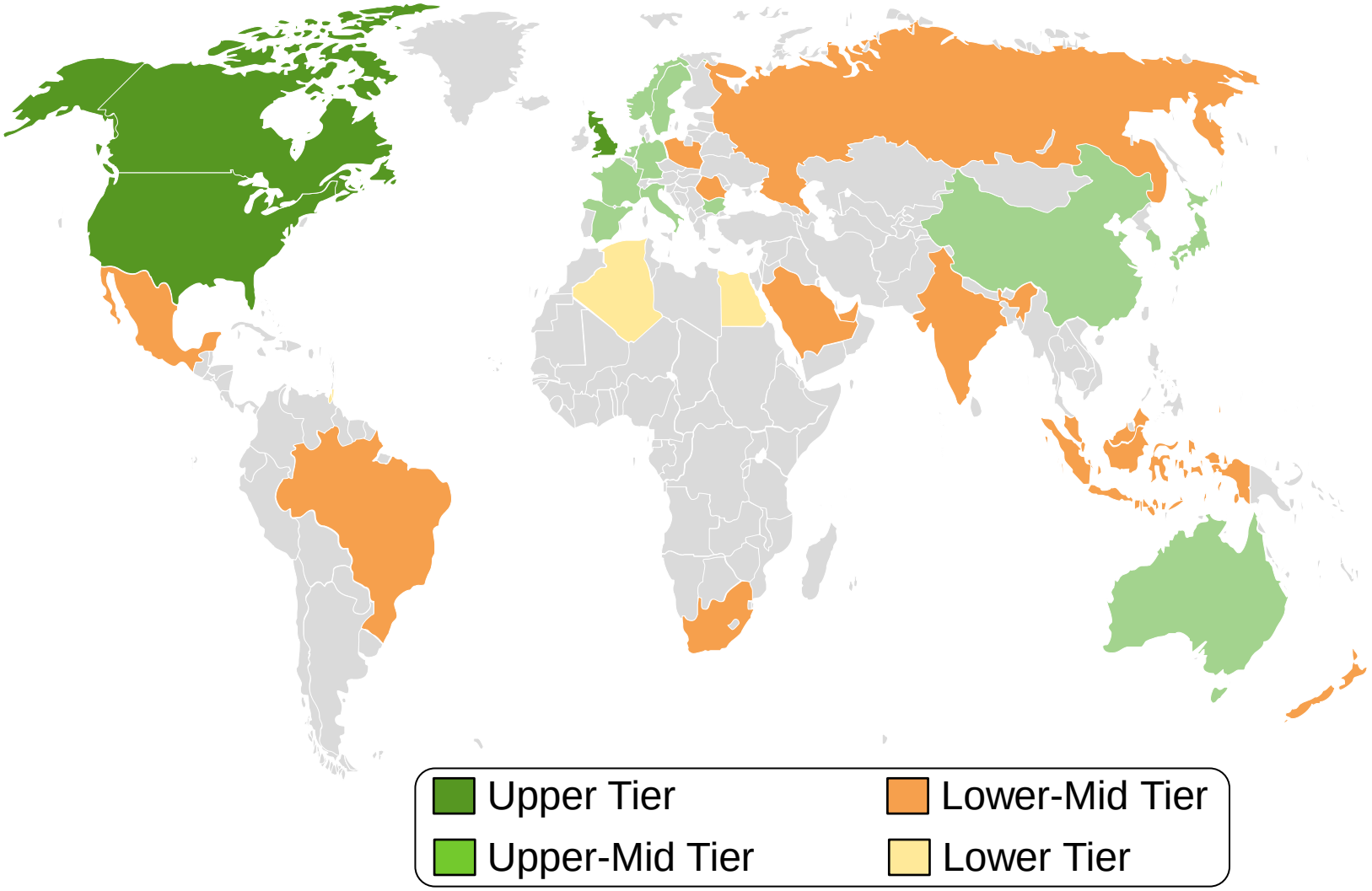
- Detailed quantitative/ qualitative assessments
- Drawing from the extensive Institute database and publically available data

- Can be used to gauge the ‘CCS Readiness” or the ability to deploy a CCS project today

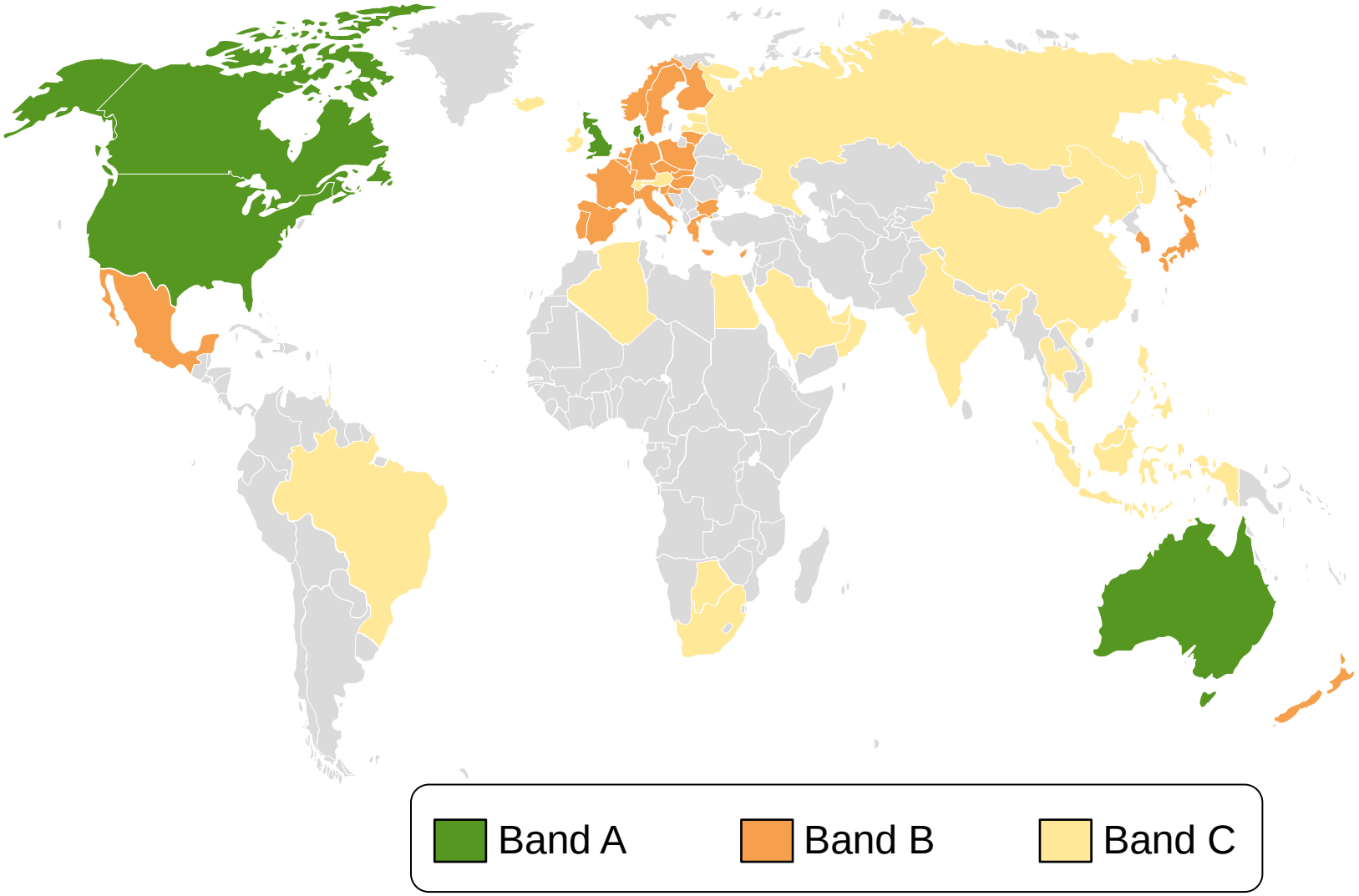
CCS Indicators - Geological Storage Readiness



CCS Indicators - Policy

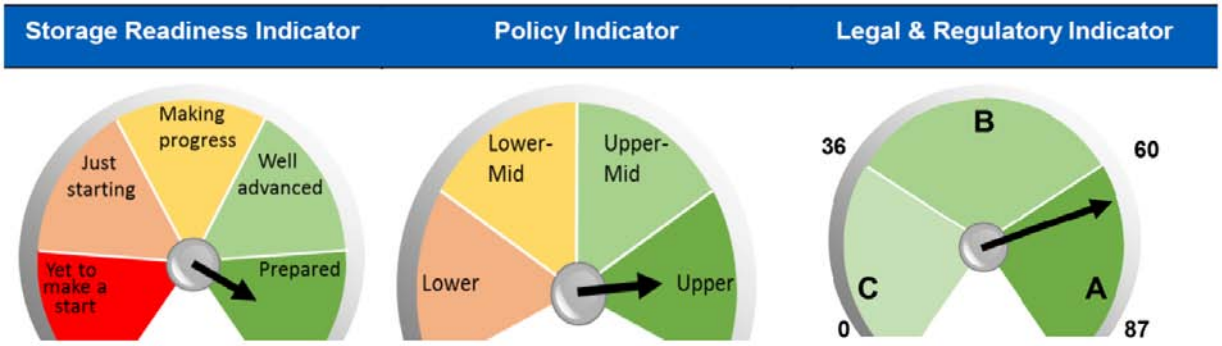


CCS Indicators - Legal and Regulatory

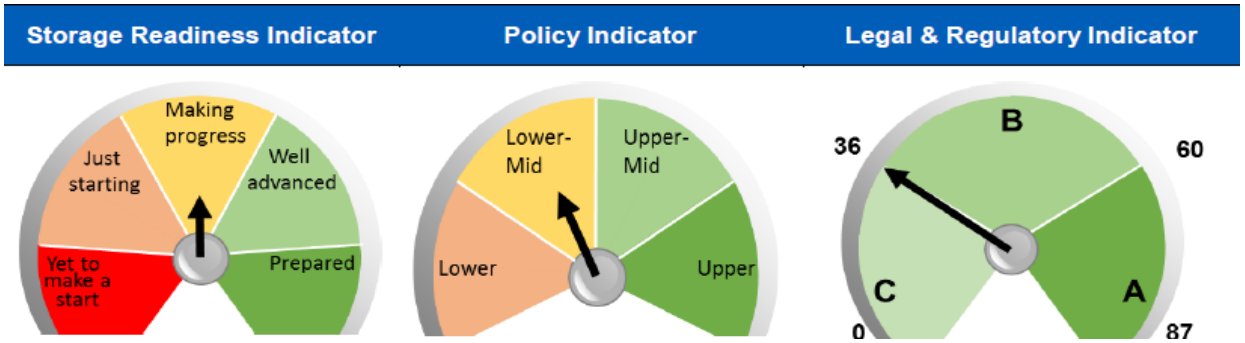


CCS Indicators: Examples

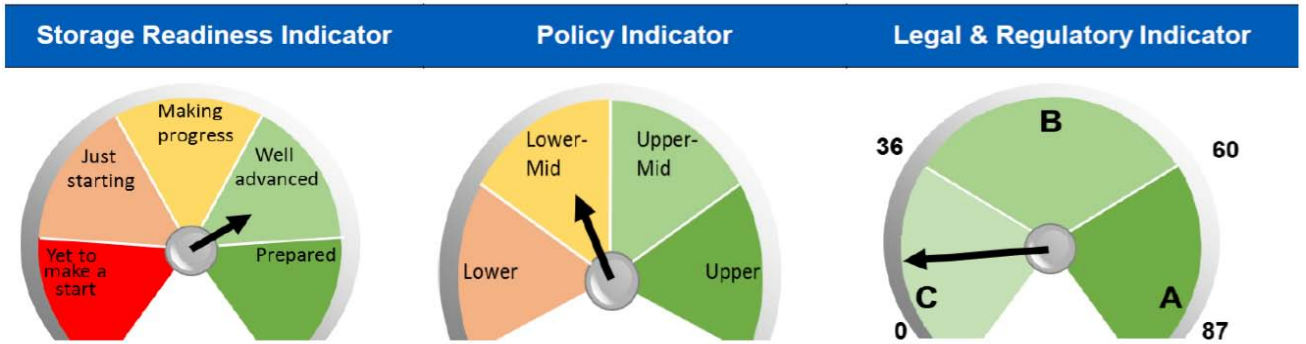
CANADA



MALAYSIA



UAE



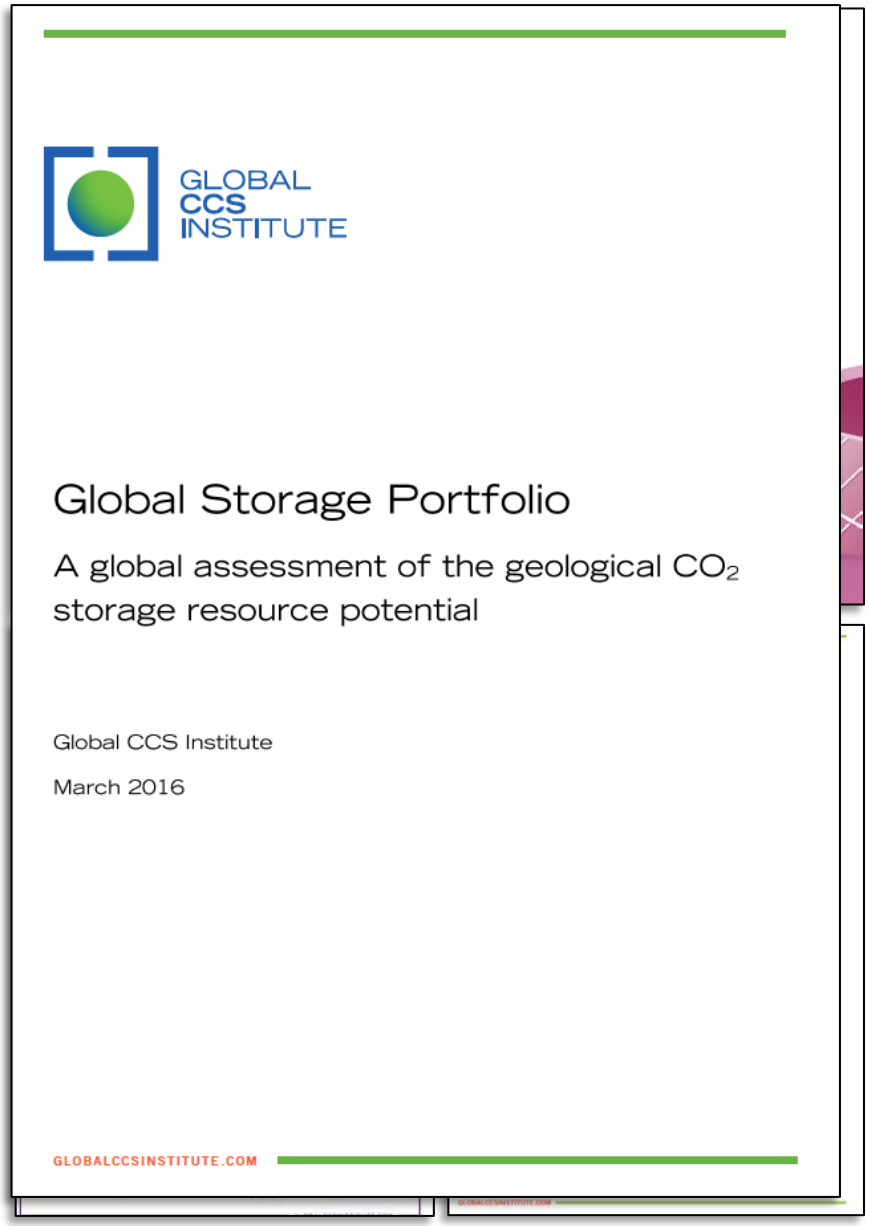
Conclusions

- **Substantial storage resources are present** in most key regions of the world.
  - Most of the largest emitters have vast quantities of available pore space
  - Need more exploration for suitable sites, securing depleted fields and infrastructure

- **Reliable methodologies** to determine and classify regional storage resources are available.
  - But need an international standard, agreed terms.

- The level of resource assessment undertaken and the availability of characterisation data is **highly variable across regions**.
  - Cannot get a ‘global’ assessment and cannot be compared

Global CCS Institute Publications



Storage Portfolio is a Member-only exclusive

- 'Living' document
- Key database
- Full report is available online at the Institute's Members Portal.

CCS Indicator documents

- Storage, Policy and Legal/Regulatory available as public documents.
- All publications here:

www.globalccsinstitute.com/publications

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