Carbon Capture, Utilization and Storage (CCUS) Technology Development in China

Dr. Peng Sizhen
Deputy Director-General
The Administrative Centre for China's Agenda 21, MOST

at

2011 CSLF Technical Meeting
May 19, 2011 Edmonton, Canada

Outline of the Presentation

- **CCUS technology policies in China**
- **CCUS R&D activities in China**
- **International Cooperation on CCUS in China**
- **Ongoing capacity building progarmme**
- **Summary of progress and GAP analysis**

CCUS S&T policies in China

- National Medium- and Long-Term Program for Science and Technology Development (2006-2020), State Council, 2006

  "To develop efficient, clean and near-zero emission fossil energy utilization technologies"---highlighted as an important frontier technology

- China's National Climate Change Programme (2007-2010), State Council, 2007

  CCUS technology was included as one of the key GHG mitigation technologies that shall be developed.

- China's Scientific and Technological Actions on Climate Change (2007-2020), 14 Ministries including MOST, 2007

  CCUS technology was identified as one of the key tasks in the development of GHG control technologies in China.

CCUS S&T activities and pilot Projects in China

- Main Government Supported S&T activities
  - Themes and areas Supported by National High-tech R&D Program (863)
    - Post-combustion + CCS research and demonstration
    - IGCC+CCS research and demonstration
    - CO2-Microalgea-bio diesel conversion key technology research
    - CO2 mineralization research
  - Themes and areas Supported by National Key Technology R&D Programme
    - Industrial CCS (iron and steel sector)
    - Oxy-fuel + CCS research and demonstration
    - Full-chain dome (Coal chemical capture + Saline water storage) demonstration
  - Themes and areas Supported by National Basic Research Programme (973)
    - Theoretical research and pilot study on enhanced oil recovery (EOR)

CCUS S&T activities and pilot Projects in China

- Main CO_2 Capture Pilots

Operational:

- China Huaneng Group 3000 t/a capture pilot, Beijing
- China Power Investment 10000 t/a capture pilot, Chongqing
- China Huaneng Group 120000 t/a capture pilot, Shanghai

Under Construction:

- Huazhong University of S&T (HUST) 35 MWt Oxy-fuel pilot, Hubei

Planned:

- China Guodian Co. 20000t/a capture pilot
- Clean Energy Technology demonstration, Lianyungang City

CHINA HUANENG GROUP'S 3,000 T/A PILOT

Huaneng Beijing Gaobeidian Thermal Power Plant, start operation in 2008, CO2 used in food industry

China Power Investment Co. 10,000t/a capture pilot

Location: Hechuan Power station, Chongqing
Technology: Post-combustion capture
CO_2 Capture Rate: >95%
CO_2 Purity: >99.5%

10,000 t/a carbon capture device

Start operation since January, 2010

Huaneng 100kt/a CO_2 capture demonstration in Shanghai Shidongkou Power Plant

Project Entity: Huaneng Shanghai Shidongkou No.2 Power Plant
Location: Baoshan district, Shanghai
Technology: Post-combustion capture + reuse in the beverage industry
CO_2 purity: >99.5%
Start operation since early 2010

Huazhong University of S&T (HUST) 35MWt Oxy-fuel pilot, Hubei

Existing 400kWt Oxy-fuel recycle combustion facility

Features of the 35MWt oxy-fuel pilot

Project Entity: HUST and others

Goal: To set up a full demonstration plant combining carbon capture, storage

Scale: 35 MWt oxy-fuel combustion boiler with 100,000 t/a CO_2 storage

Location: Yingcheng, Hubei Province

Technology: Oxy-fuel combustion + storage in salt mines

Status: under preparation

CO_2 capture rate: > 90%

CCUS S&T activities and pilot Projects in China

- Main CO_2 Storage Pilot/Demo

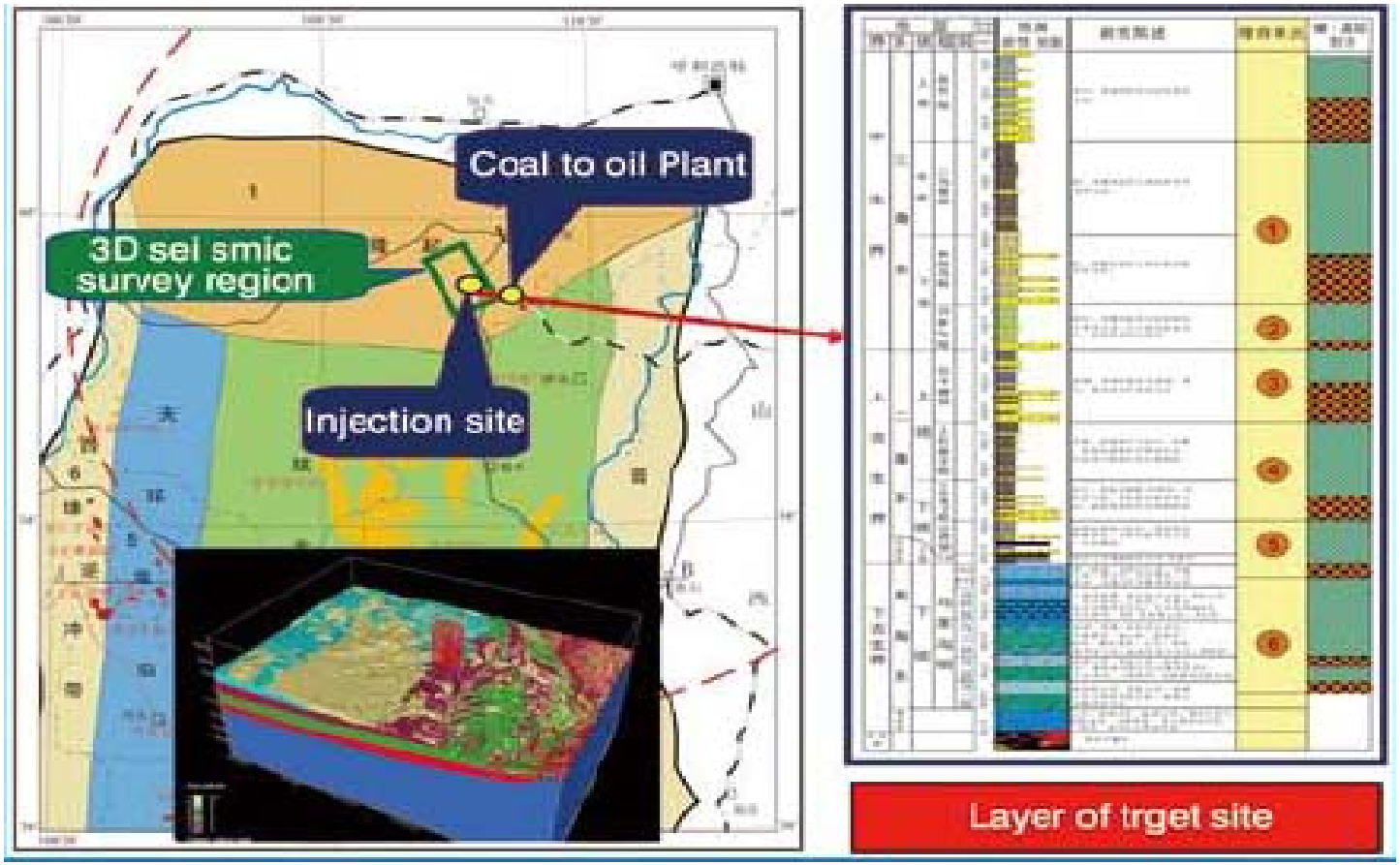
Starting operation

  - **Shenhua 100,000 t/a CCS demonstration, Inner Mongolia**

Features:

Technologies: CO_2 chemical source capture + saline aquifer storage
Injection scale: 10,000-100,000 tons per year
Injection life: for Phase I, 3 years
Target Layer: Deep saline aquifers
Expected Depth: 1000-2500 m
Number of wells: 1 injection well, 2 monitoring well
Implementation Period: On-site injection started in 2010
CO_2 Source: Captured from coal liquefaction plant

Shenhua 100,000 t/a CCS demonstration site and site analysis



Institutions active in Carbon storage study

国土资源部
中国地质调查局
China Geological Survey

清華大學
Tsinghua University

中国科学院武汉岩土力学研究所
Institute of Rock and Soil Mechanics, Chinese Academy of Sciences

北京大學
PEKING UNIVERSITY

中国科学院地质与地球物理研究所
Institute of Geology and Geophysics, Chinese Academy of Sciences

CHINA UNIVERSITY of PETROLEUM, BEIJING

CAEP
环境保护部环境规划院
Chinese Academy For Environmental Planning

中国21世纪议程管理中心
The Administrative Center for China's Agenda 21

CCUS S&T activities and pilot Projects in China

- Main CO_2 Utilization Pilots
  - EOR

  PetroChina's CO2 EOR Research and pilot Injection, Jilin Oilfield

  - ECBM

  China United Coalbed Methane Co. Enhanced Coal-Bed Methane (ECBM) Pilot Project

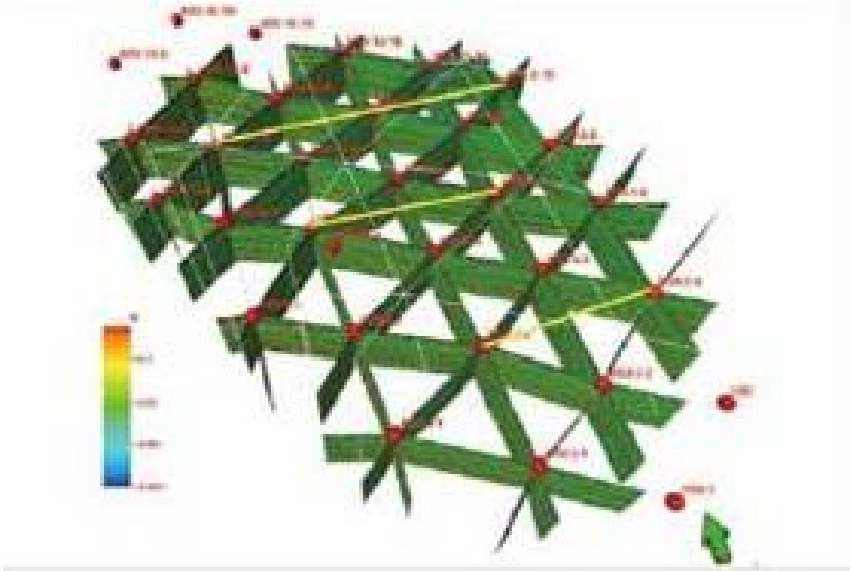
  - CO_2 to Biofuel

  ENN Group's Micro algae Bio-fuel Pilot

  - CO_2 to Chemicals
  - Jinlong-CAS CO_2 Utilization pilot in Chemical production, Jiangsu

PetroChina's CO_2 EOR Research and pilot Injection, Jilin Oilfield

PetroChina EOR Project



Jilin Oil Field CCS-EOR pilot test block well network design

Goal: 0.8-1.0 million tons storage of CO_2 annually (Phase II)

Site: Jilin Oil Field

Technologies: Separation of CO_2 from natural gas + EOR

Status: Phase I has been completed and phase II is in progress

China United Coalbed Methane Co. ECBM Pilot Project

CUCBM CO_2-ECBM Well Site

CUCBM CO_2-ECBM Well Site

Project Entity: China United Coalbed Methane Company (CUCBM)

Goal: Studying and developing ECBM and CO_2 storage technology, testing safety and permanence of CO_2 sequestration.

Location: Shizhuang, Qinshui County, Shanxi Province

Technique: CO_2 Storage for ECBM

Current Status: Ongoing, injection test started since April 2010

ENN Group’s Micro algae Bio-fuel Pilot

Features of ENN Group's Micro algae Bio-fuel Demonstration Project

Based on technologies developed by ENN in its Pilot Study, ENN is planing to construct a facility that absorb 320,000 t CO2 a year. The features of the facility is as following:

Goal: **To use microalgae to absorb 320,000 t/a CO_2 emitted from the flue gas of coal-derived methanol and coal derived dimethylether production equipment and to produce bio-diesel and feeds.**

Site: **Dalate, Inner Mongolia**

Technologies: **Third-generation bio-fule technology**

Status: **Under constructionTo be completed in 2011**

CO_2 Source: **Capture from coal-derived methanol and dimethylether production**

Jinlong-CAS CO_2 Utilization pilot in Chemical production, Jiangsu

Jiangsu Jinlong-CAS Chemical Co., Ltd. has built a production line to produce 22,000 tons of CO_2-based poly(propylene(ethylene) carbonate) using CO_2 captured from ethanol plants. This project will use about 8,000 tons of CO_2 per year. Jinlong-CAS is planning to build a new projection line, which is expected to expand to 100,000 t/a in 2016.

Key features:

Location: Taixing, Jiangsu Province

Technology: CO_2 based resin loop reactor

Scale of CO_2 Utilization: 8000 t/a

CO_2 Source: Ethanol Production Plant

Products: highly flame-retardant exterior wall insulation material, leather slurry, biodegradable plastics, etc

CCUS S&T activities and pilot Projects in China

- Full Chain CCUS Pilot/Demonstration

Operational

- Sinopec's 30,000 t/a CO_2 flue gas capture and EOR Pilot, Shenli Oilfield

Under Construction

- Huaneng Greengen 400MW IGCC Power Plant, Tianjin

Planned

- Sinopec's 1,000,000 t/a CO_2 flue gas capture and EOR Demonstration, Shenli Oilfield

Sinopec's 30,000 t/a CO_2 flue gas capture and EOR Pilot

recycling power plant flue gas

absorbing and purifying

inject CO_2 into oil fields

Capture of CO_2 from associated gas

Capture associated gas

Started operation since mid 2010.

Main features of the Sinopec 30,000 t/a Pilot

- **Technologies: Post-combustion+MEA+EOR**
- **Status: Started Operation in 2010**
- **CO_2 Source: Flue gas from the Shengli Power Plant**
- **CO_2 Purity: 99.5%**

Huaneng Greengen Tianjin 400MW IGCC Power Plant

three stages of the GreenGen Project

Project Entity: China Huaneng Group

Goal: To construct a demonstration project of 400 MW IGCC and to capture CO_2 for EOR in the Dagang Oil Field

Scale: 250 MW IGCC (1st stage), 400 MW IGCC + Capture + EOR (3rd stage)

Location: Binhai New Area, Tianjin

Expertise: IGCC + EOR

Construction period: The 250 MW IGCC demonstration power station (Phase I) is to be operational in 2011; the 400 MW (with CO2 capture) demonstration (Phase III) to be finished in 2016.

Current status: Phase I Under construction

Greengen at Phase III completion (effect drawing)

International S&T Collaboration on CCS

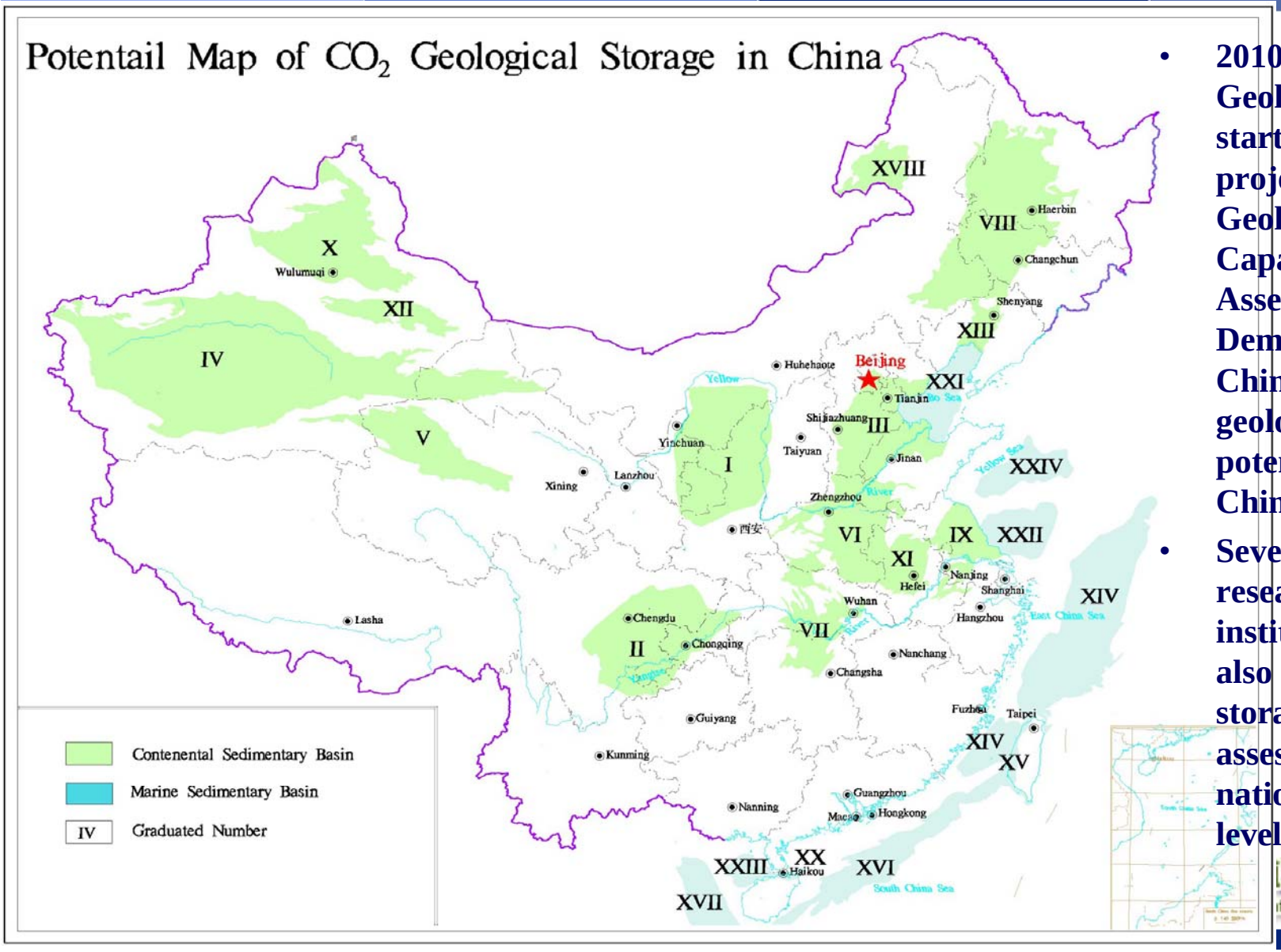
- **Bilateral scientific exchanges and cooperation conducted with European Union, Australia, Italy, Japan, the United States, etc.**
  - **China-EU NZEC Cooperation Phase I**
  - **China-Australia CO_2 Geological Storage Project (CAGS)**
  - **Sino-Italy CCS Technology Cooperation Project (SICCS)**
  - **Etc.**
- **Exchange and cooperation under CSLF, MEF and other international framework**
- **Promote the development of CCUS technology in some extend:**
  - **Info of Newest technology advancement and trends**
  - **Building capacity**
  - **Support preliminary researches, incl. techno-economic evaluation, preliminary assessment of storage potentials, etc.**

International S&T Collaboration on CCS

Site visit in Italy

CAGS website

Ongoing capacity building programme--Storage Capacity Assessment in China



- **2010, Chinese Geological Survey started a Key project called CO_2 Geological Storage Capability Assessment and Demonstration in China to assess the geological storage potential of CO_2 in China**
- **Several other research institutions had also conducted CO_2 storage potential assessment at national or local level.**

Ongoing capacity building programme--CCUS Technology Roadmap in China

- started earlier 2011, expected to be finished within the year;
- lead by the Administrative Centre for China's Agenda 21 (ACCA21) under MOST
- aiming to guide CCUS technology development to year 2030;
- more than one hundred CCS experts involved at the moment, which had been divided into four sub-working groups focusing on
  - CO_2 Capture technology
  - CO_2 Utilization technology
  - CO_2 Storage technology
  - Supporting Environment
- questionnaire survey conducted among different stakeholder groups to facilitate;

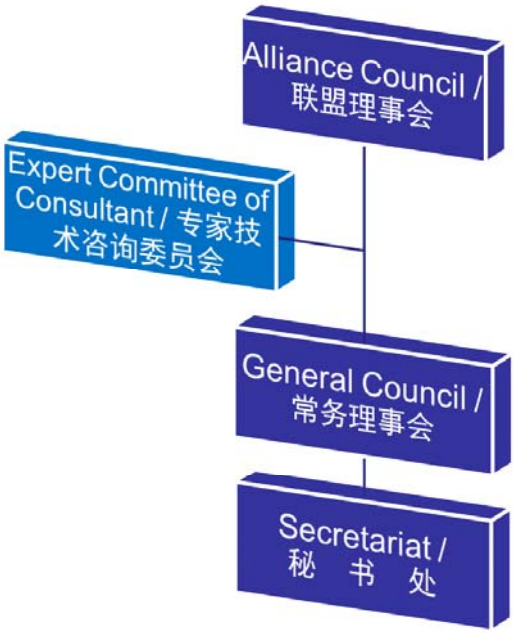
Ongoing capacity building programme-- China Strategic Alliance on CCUS Technology Development

Capture

27

Utilization and Storage

10+9



中国华能 CHINA HUANENG
中国国电 CHINA GUODIAN
中国石化 SINOPEC
中国石油

Total 46 companies, universities and institutes

Summary of the Progress on CCUS Technology Development in China

Although China started CCUS R&D activities relatively late, China has made concrete progresses:

- Guided and supported by the government, Chinese enterprises and research institutions have conducted researches covering the whole CCUS technology chain and main technology directions (Post-, Pre- and Oxy-fuel combustion CO_2 Capture)
- Chinese Enterprises have been actively involved in CCUS R&D, now play the leading role
- China has achieved remarkable progress in certain aspects, e.g. the Huaneng Shanghai Shidongkou 120,000 t/a CO_2 Capture demo is one of the biggest demos that are operational worldwide
- China has conducted some innovative researches focusing on CO_2 utilization, e.g. the algae bio-diesel, etc.

However, Main Gaps

- **Lack of comprehensive CCUS technology development Planning and government supported full chain large scale CCUS demonstration in China,** *e.g. national or regional CCUS Development Plans, EU flagship, Australia flagship, etc.***;**

- **Lack of Financing**

- **Much less attention and resource paid on CCS related supporting environment, such as regulatory/environmental impact/safety/risk management/standards research, comparing to those on "hard-technology"**

Q & A

Thanks!