Challenge toward Carbon Neutrality of Kushiro Coal Mine(KCM)

September 6th 2023

Kushiro Coal Mine CO., Ltd.
MATSUMOTO Hiroyuki

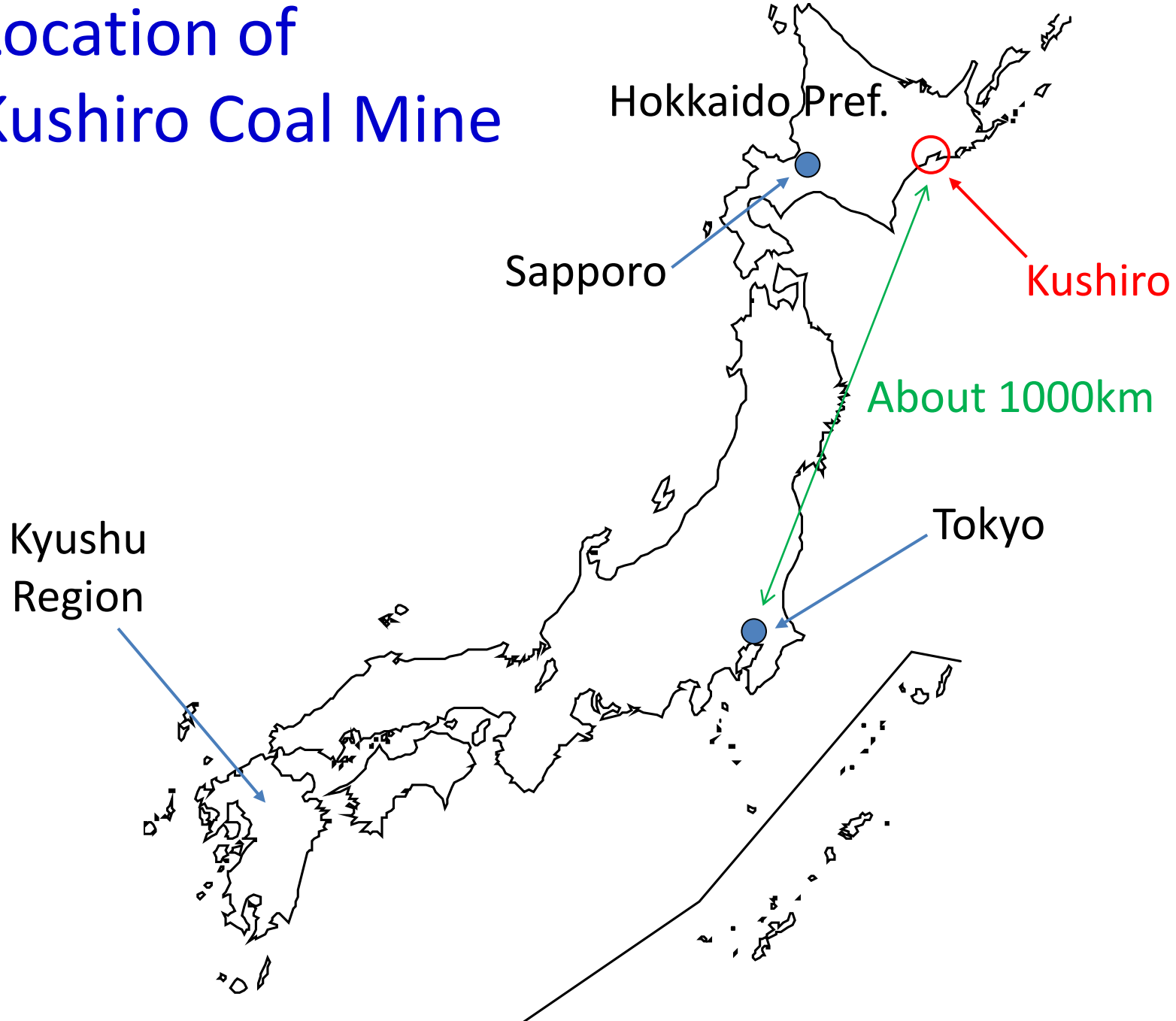
Contents of Presentation

1. Outline of Kushiro Coal Mine (KCM)
   - History and Outline
   - The Training Project on Coal Mining Technology
   - Collaboration between KCM and Kushiro Power Plant
   - Room and Pillar Mining
   - Filling with Fly-ash in Mined Out Area

2. Carbonate Mineralization and Enhanced Coal Bed Methane (ECBM)
   - Field Trial of Carbonate Mineralization in Mined Out Area
   - Field Trial of ECBM
   - Future Plan

KUSHIRO COAL MINE CO.,LTD.

Location of Kushiro Coal Mine



History

Close of Taiheiyo Coal Mine and Establishment of KCM

- 27 Dec, 2001 Establishment of KCM
- 30 Jan, 2002 Close of Taiheiyo Coal Mine Operated from 1920 (2 million ton annually)
- 31 Jan, 2002 Start of Operation of KCM

  0.7 → 0.5 million ton annually
- Nov, 2019 Change of Mining Method from Longwall(L/W) to Room & Pillar

  0.3 million ton annually

Business of KCM

- Coal Mining and Sales
  - Fully Mechanized Longwall Mining →Room and Pillar Mining
- Government Commissioned Training Program
  - Start from 2002
  - Accept the Trainee and Dispatch of Engineer
  - Around 150 Trainees Come from Vietnam, China, Indonesia and Colombia, Annually
- Start up Business
  - KCM Cooperation（KCMC）
    - Crushing Treatment of Oversize Garbage
    - Garbage Collection
    - Operation of Garbage Incineration Facility from 2006
    - Operation of Kushiro Power Plant from 2020
    - Administration of KCM
  - Kushiro Auto Recycle Co.,Ltd.
  - KCM Engineering Co.,Ltd.
  - Kushiro Power Service Co.,Ltd.
- Cooperation Research
  - JCOAL
  - Private Company
  - Institute, University

Number of Acceptance of Trainee

	2002～2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	合計
Vietnam	1,217	82	84	84	74	70	70	140※	345※	70	2,236
China	953	63	56	54	52	56	55	107※	220※	220※	1,836
Indonesia	0	0	10	12	20	19	13	28※	98※	24	224
Colombia	0	0	0	0	0	4	5	10※	38※	21	78
Total	2,170	145	150	150	146	149	143	285	701	335	4,374

※ On-line Training

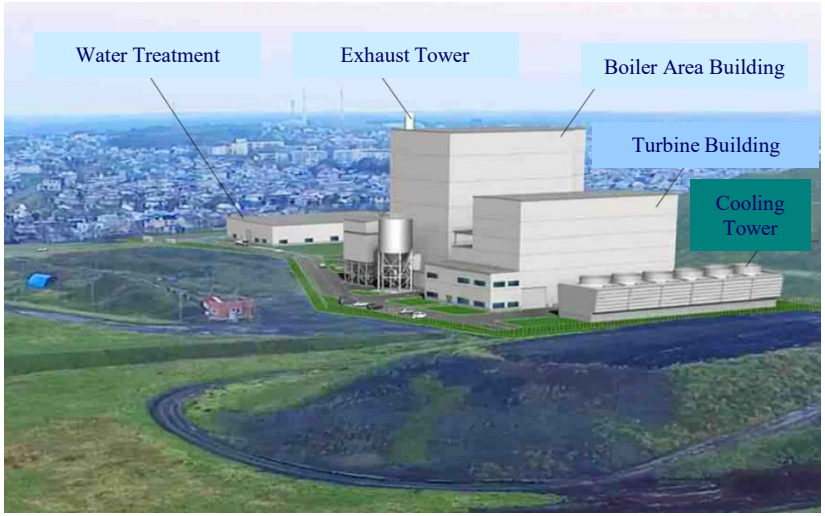
Number of Dispatch of Lecturers（Cumulative Total Number）

	2002～2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	合計
Vietnam	2,414	457	230	169	185	151	162	50	33	100	3,951
China	231	12	4	3	4	4	4	0	0	0	262
Indonesia	44	0	0	0	0	0	0	0	0	0	44
Total	2,689	469	234	172	189	155	166	50	33	100	4,257

2020～2021 On-line Training

KUSHIRO COAL MINE CO.,LTD.

Introduction of Electric Power Plant



- Boiler Type :
  Circulating Fluidized Bed
- Maximum Steam Flow :
  370 t / hr
- Steam Temperature :
  560 ℃ / 540 ℃
- Steam Pressure :
  17.0 MPaG (Heater Outlet)
  3.1 MPaG (Re-heater Outlet)
- Steam Turbine Type :
  Re-heat Condensing Turbine
- Generator Output :
  112,000 kW
- Fuel :
  Coal (70%), Biomass (30%)

Kushiro Power Station Co., Ltd.

Collaboration between KCM and Power Plant

- Provide Strong Industrial Area against the Earthquake and Tunami
- Provide Low Pollution Coal and Local Consumption
- Provide Clean Mine Water as Cooling Water (No Use of Sea Water)
- Receive Warm Drainage Water after Cooling Tower as Coal Preparation Water
- Receive Ash as Filling Materials for Mined out area
- Provide Engineers, Qualified Persons and 3 Shift Workers
- Propose New Training Course of Coal Utilization including Electric Power Plant and Environment for Training Project
- Others

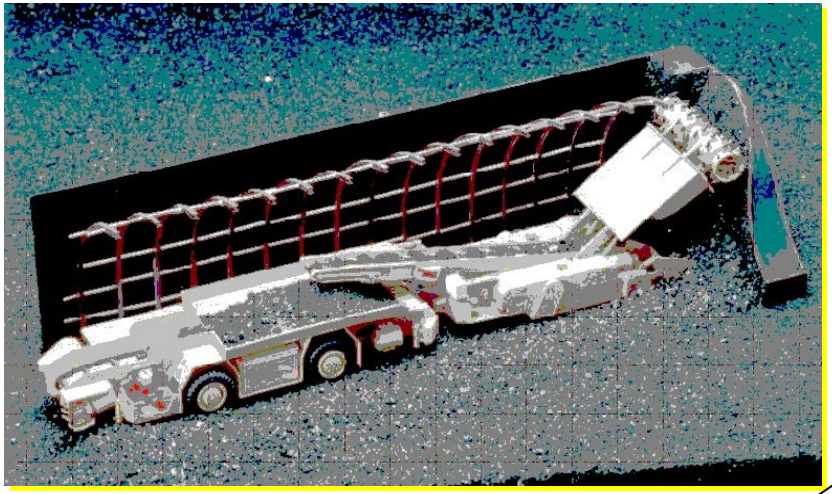
Mining Method(at Present)

- Roadway Heading
  - Combination Continuous Miner and Shuttle Car
  - Room & Pillar Mining
  - 3-4 Units Working Annually

Continuous Miner

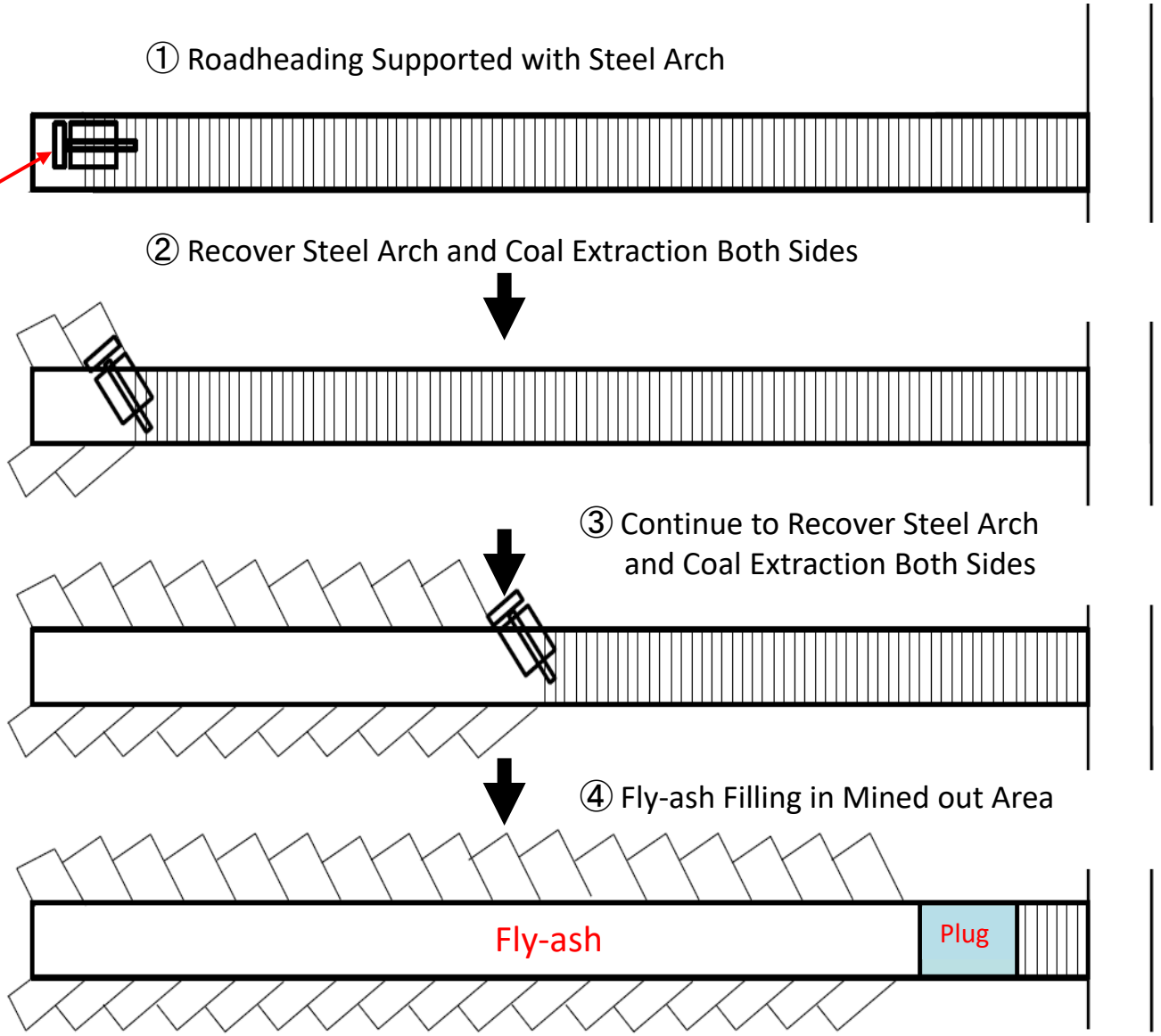
Shuttle Car

Road Heading - Single Entry System



KUSHIRO COAL MINE CO.,LTD.

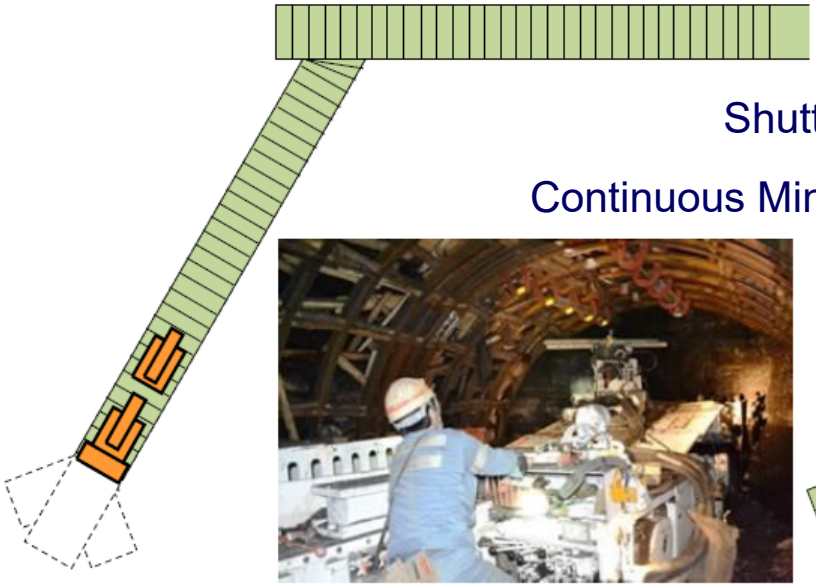
Sequence of Room & Pillar Mining and Filling



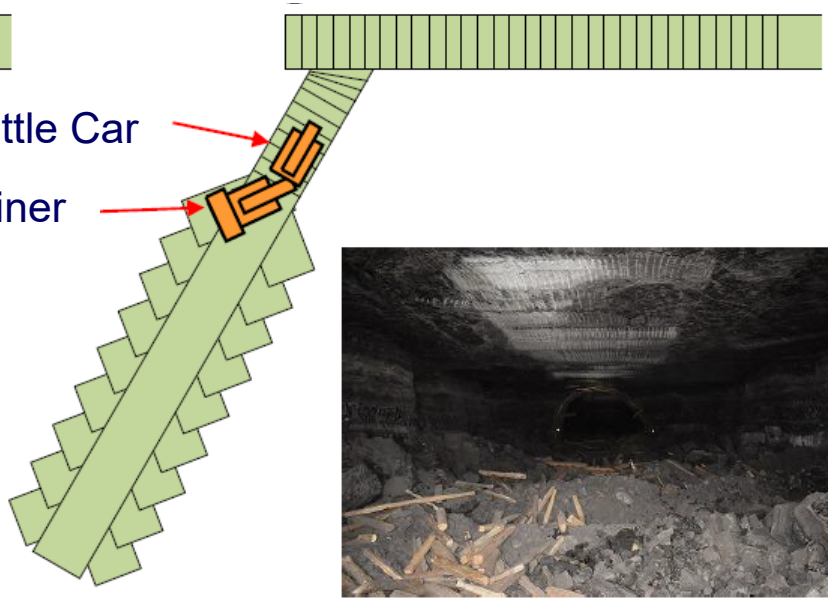
Sequence of Room & Pillar Mining and Filling

Room and Pillar Plan

Outward Mining



Return Mining



KUSHIRO COAL MINE CO.,LTD.

Contents of Presentation

1. Outline of Kushiro Coal Mine (KCM)
   - History and Outline
   - The Training Project on Coal Mining Technology
   - Coexistence between KCM and Kushiro Power Plant
   - Room and Pillar Mining
   - Filling with Fly-ash in Mined Out Area

2. Carbonate Mineralization and Enhanced Coal Bed Methane (ECBM)
   - Field Trial of Carbonate Mineralization in Mined Out Area
   - Field Trial of ECBM
   - Future Plan

KUSHIRO COAL MINE CO.,LTD.

Purpose of Fly-Ash Filling in Mined out Area

- To Reduce Stress Concentration on Remaining Area
- To Prevent Gas and Water Emission from Mined out Area
- To Prevent Spontaneous Combustion Due to Air Inflow
- Fly-Ash Disposal

Next Target

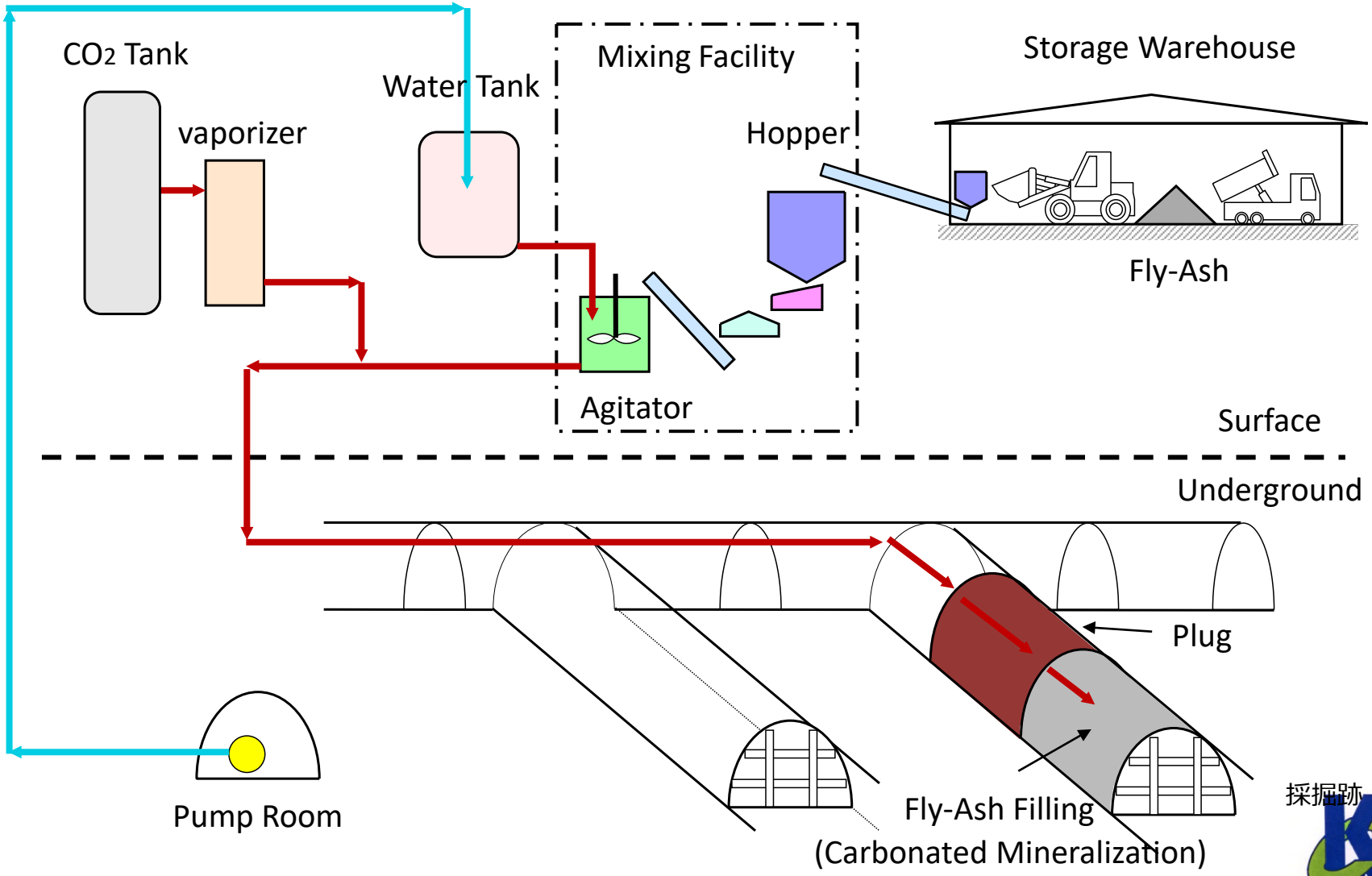
Fly-Ash + Carbon Dioxide(CO_2)

↓

Carbonated Mineralization
($CaCO_3$, $MgCO_3$)

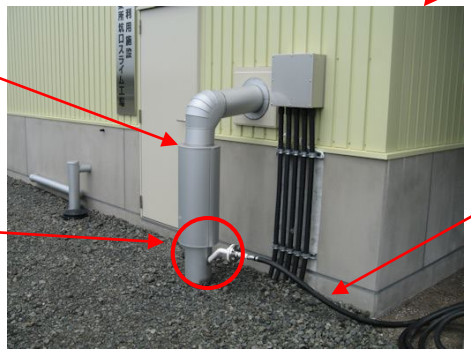
- Increase of Filling Strength
- Stabilization Disposal of CO_2

Diagram of Mixed Flow of Fly-Ash Slurry and CO_2 Gas



KUSHIRO COAL MINE CO.,LTD.

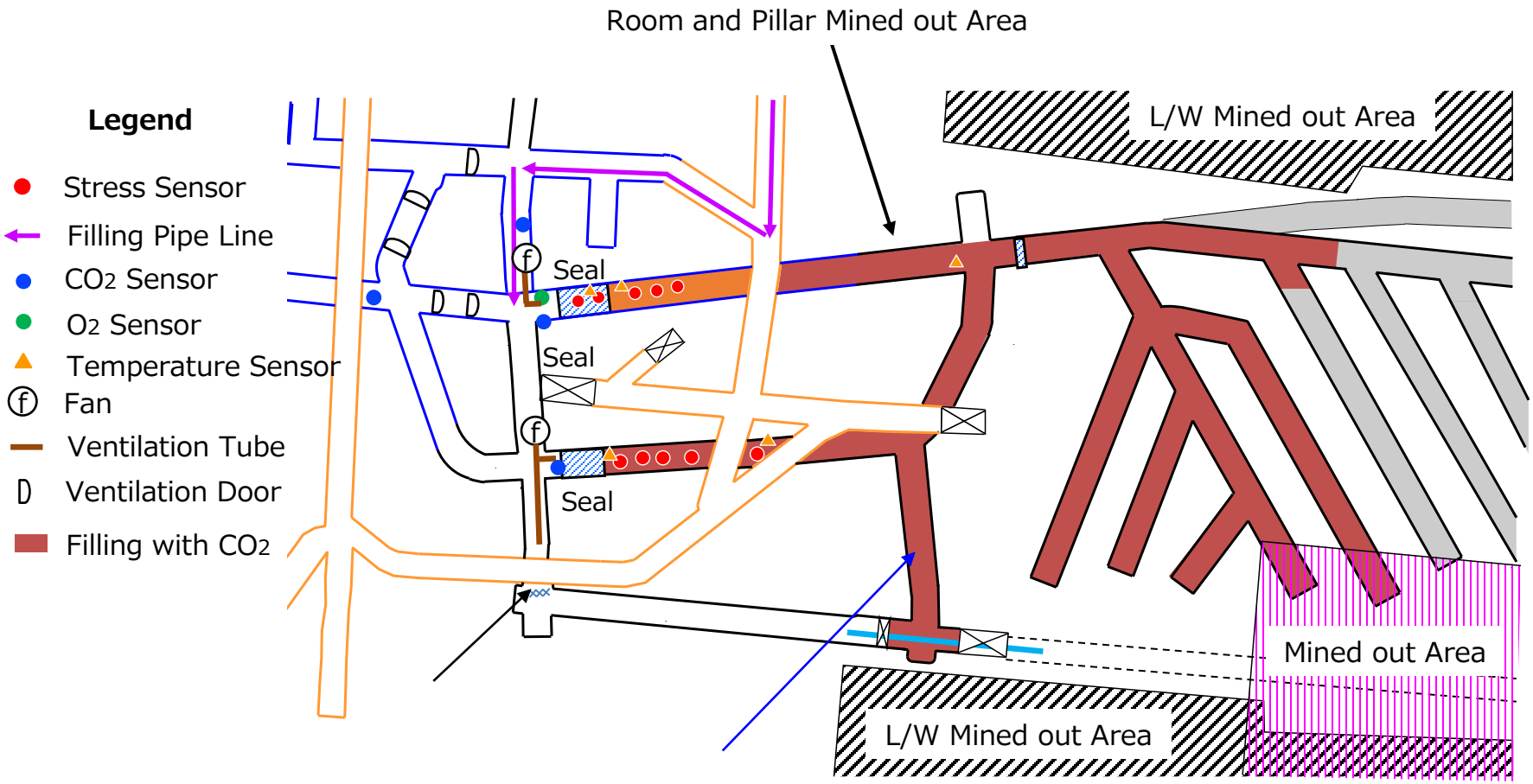
Mixing Facility of Fly-Ash Slurry and CO_2 Gas



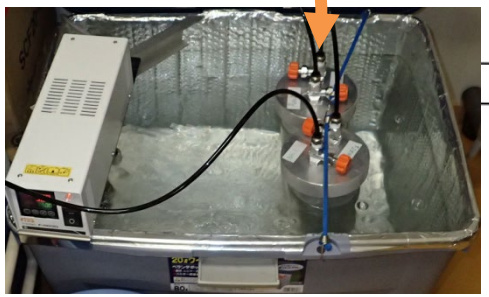
Specification of the Facility of Fly-Ash Slurry Production Plant and CO_2 Gas mixing

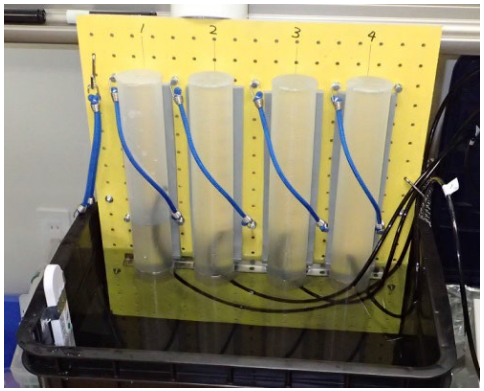
- **Fly-Ash Slurry Production Plant**
  - Fly ash Storage — 800m^3
  - Hopper in Storage — 5m^3
  - Hopper in Facility — 15m^3
  - Feeder — 20t/h
  - Vibrating Screen — mesh size 25mm
  - Agitator — 3.2m^3
  - Flow Rate — 0.5-0.6m3/min
- **CO_2 Gas Mixing**
  - Liquefied CO_2 Tank Capacity — 9.7t
  - CO_2 Gas Holder Capacity — 2m^3
  - Vaporizer Capacity — 400kg/h
  - Gas supply Pressure (Primary Pressure) — 0.7MPa
  - Safety Device
    - Liquefied CO_2 Tank Safety Valve — 2.24MPa
    - CO_2 Gas Holder Safety Valve — 1.08MPa
    - Piping Safety Valve (Liquefied) — 2.99MPa

One of Carbonate Mineralization Field Test Sites

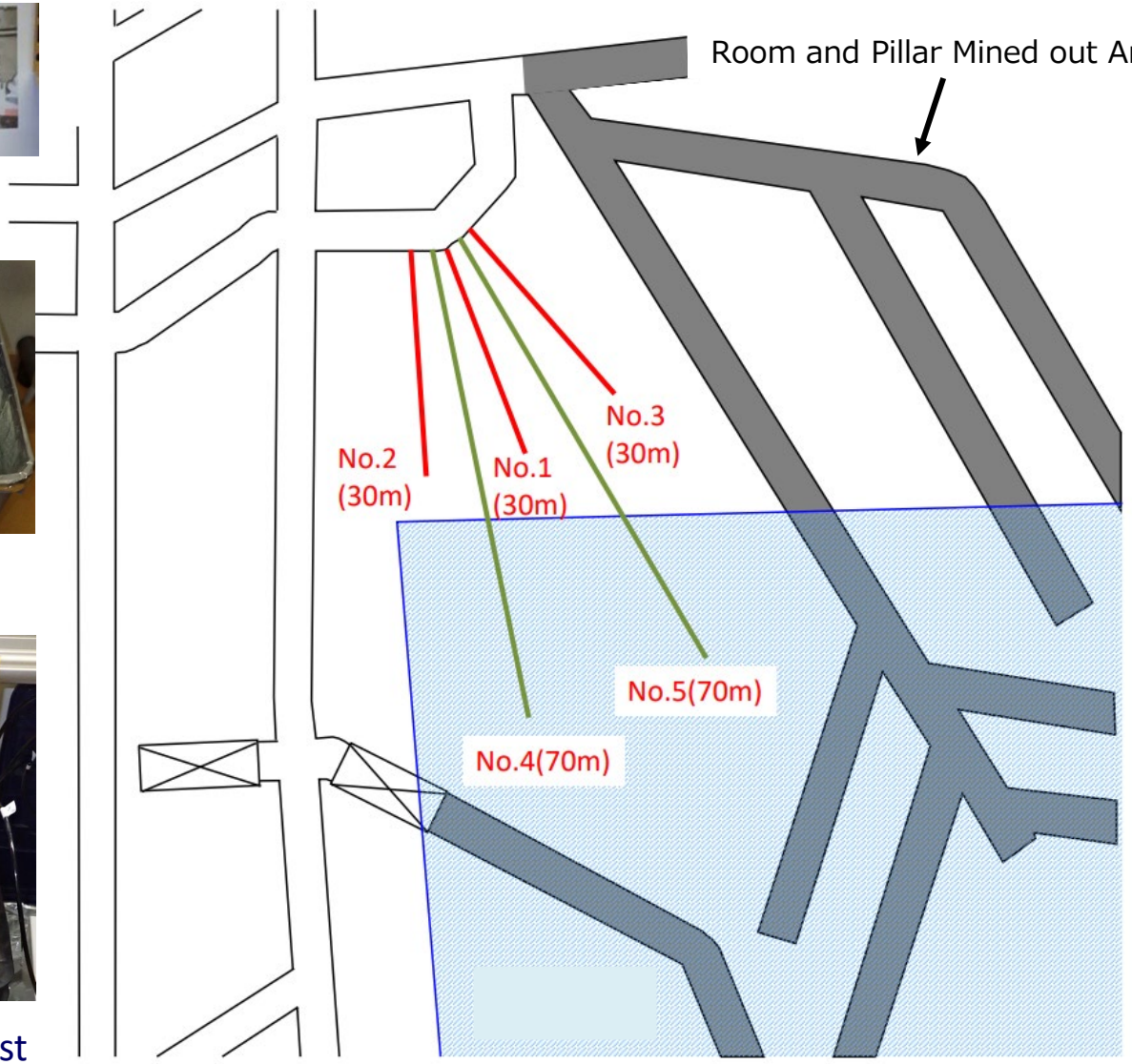


One of ECBM Field Tests, Boring Sites Layout





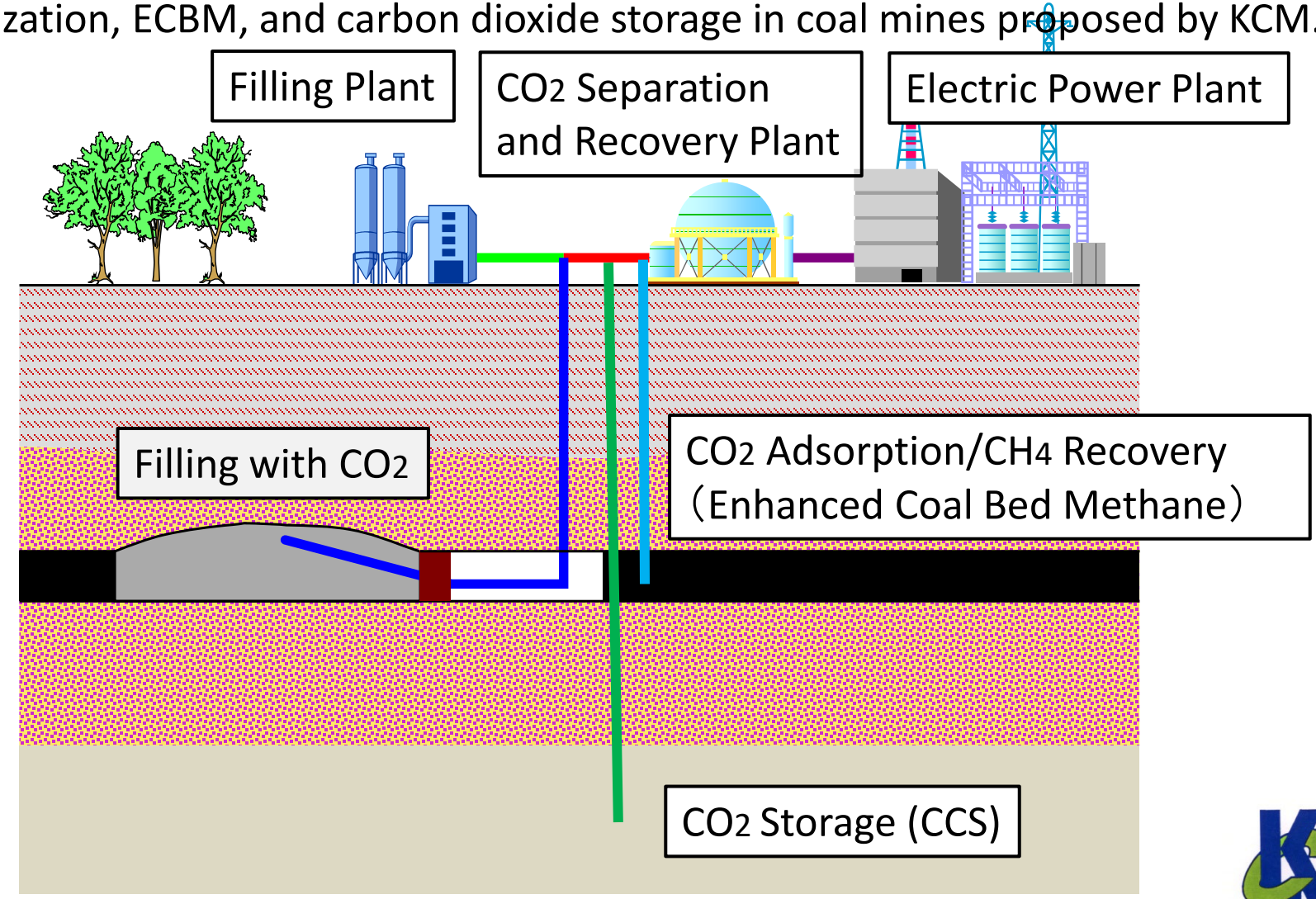
Methane Gas Reserve Test



KUSHIRO COAL MINE CO.,LTD.

Future Vision

Based on the needs of coal-producing countries, the future vision of carbon dioxide mineralization, ECBM, and carbon dioxide storage in coal mines proposed by KCM.



Thank you for your attention

KUSHIRO COAL MINE CO.,LTD.