



JOGMEC/TRC Long-term R&D Strategy toward 2030

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**Oil and Gas/Upstream Technology Unit
Technology and Research Center
Japan Oil, Gas and Metals National Corporation
(JOGMEC/TRC)**



JOGMEC

JOGMEC/TRC Long-term R&D Strategy toward 2030

"TRC R&D Strategy" (2006)

"JOGMEC/TRC Long-term R&D Strategy toward 2030" (2007)

◆ Mid-term endeavor (5-10 years)

Japanese Government Policy

Targeted Hydrocarbons and Areas

Global R&D Trend

Interview Survey (March, 2007)

Domestic R&D Needs

Questionnaire Survey (March, 2007)

Basic R&D Orientations

- (1) Value Chain Consciousness
- (2) In situ Direct Measurement
- (3) Real-time Control
- (4) Sustainable Development
- (5) Advanced Technology Application

◆ Goals and Roadmap toward 2030

Prioritized Technological Fields 5+1

R&D Elemental Technology

TRC's 10 R&D Core Projects

(1) Maximizing Oil Recovery

Conventional EOR/IOR Technology, Productivity Improvement Technology, Reservoir Evaluation and Modeling Technology

(1) EOR70

(2) Oil and Gas Reservoir Detection and Characterization

Exploration and Reserves Evaluation Technology, Reservoir Characterization Technology, Dynamic Modeling Technology

(2) Reservoir TV

(3) Well Drilling and Field Development

Drilling Technology Improvement and Cost Reduction, Production Facility Optimization Technology Improvement and Automation, Frontier Area Development Technology

(3) Sea-Quest 3000

(4) WD 50

(4) Non-conventional Hydrocarbon Exploitation

Methane Hydrate Development Technology, Oil Sands/Oil Shale/Heavy Oil Recovery and Upgrading Technology, Non-conventional Gas Exploitation and Production Technology

(5) Next-generation Advanced Resource Exploitation

(6) National MH

(7) UHO 20

(5) Effective Utilization of Oil and Gas

GTL Technology Demonstration Project, Upgraded Liquid Fuel Production Technology, Exploitation Cost Reduction Study through Floating System

(8) Next-generation Non-conventional Resource Development

(9) GTL 7

(6) Environment-conscious Oil and Gas Exploitation

CO2 Injection Technology, Methane Bio-conversion Technology, Emission Reduction Technology

(10) Next-generation Oil and Gas Effective Utilization

Action Plans 7+3

Six (6) Prioritized Technological Fields

1. Under **“TRC R&D Strategy”** (2006), five prioritized technological fields listed below were selected and the technological roadmap for 5-10 years was set up to achieve the JOGMEG mid-term goals, in view of changes in the JOGMEC/TRC business environment, global technological trends, technological needs of domestic upstream enterprises, JOGMEC/TRC’s technological strengths, etc.
 - (1) Maximizing Oil Recovery
 - (2) Oil and Gas Reservoir Detection and Characterization
 - (3) Well Drilling and Field Development
 - (4) Non-conventional Hydrocarbon Exploitation
 - (5) Effective Utilization of Oil and Gas

2. In formulating the **“TRC Long-term R&D Strategy toward 2030”** (2007), we have decided to emphasize the five prioritized technological fields listed above until the year 2030 in line with Japan's long-term energy strategy. We have also added the sixth prioritized technological field related to environmental issues in oil-field development, taking into account that environment-related technological development is progressing toward 2030 in view of growing environmental consciousness worldwide.
 - (6) Environment-conscious Oil and Gas Exploitation

3. In order to identify the goals to be reached by 2030 in individual prioritized technological fields, we propose “10 Core Projects”. In line with this, we have set up **“JOGMEC/TRC Long-term R&D Roadmap up to 2030”** while promoting our strategy.



(1) Maximizing Oil Recovery

2010

2020

2030

● **Conventional IOR/EOR Technology**

CO2 flooding field application study *Field application and continuous improvement*

Basic study of air injection method *Field pilot test*

Basic study of gas flooding (asphaltene precipitation, etc.)

● **Advanced Hybrid EOR Technology (Chemical EOR (applied nano-technology), MEOR, Improved Water Flooding, etc.)**

Fundamental research *Small-scale pilot test* *Field application*

● **Productivity Improvement Technology**

Fracturing for carbonate reservoir *Pilot test* *Fracturing optimization study (cost reduction, large-scale fracturing, etc.)* *Field application and continuous improvement*

High-efficiency production system (down hole separator, etc.) *Basic study* *Field pilot test* *Field application and continuous improvement*

Condensate reservoir *Field application and continuous improvement*

● **Oil Reservoir Analysis and Modeling Technology**

Core and Fluid Analysis

Integrated system for property evaluation (INCELA/PVT) *Field application and continuous improvement*

Advanced Core and Fluid Analysis Technology Development

Conceptual design *Design and trial manufacture* *Field application and continuous improvement*

Reservoir Characterization and Flow Behavior Analysis

Multidisciplinary reservoir characterization, VT/HTI analysis, front monitoring *Field application and continuous improvement*

Oil reservoir evaluation and analysis resolution improvement *Field application and continuous improvement*

Advanced techniques for fluid behavior analysis *Field application*

(1)
EOR70

* INCELA: Integrated Core Evaluation Laboratories



(2) Oil and Gas Reservoir Detection and Characterization



● Exploration and Reserves Evaluation Technology

Seismic imaging	Practical application of interactive processing and interpretation system		Field application	Technology diffusion
Multi-component seismic survey	Optimization of data acquisition	Full-wave inversion development	Field application	
Electromagnetic survey	Development of high-resolution sensor	Development of processing techniques	Application to DHI	
Evaluation of DHI technologies (AVO, attribute, geochemical survey, electromagnetic survey)			Development and operation of 3D survey system	
Provision of accurate and high-speed petroleum system analytical tool and accumulation of analytical know-how (Basin modeling, Petrophysical measurements, Geochemical analysis, Sedimentological analysis)				
Evaluation technology for trap and seal efficiency of faults				

(5)
Next-generation
Advanced
Resource
Development
Technology

● Reservoir Characterization Technology

Reservoir characterization	Field application and continuous improvement			
Petrophysical measurement, Geochemical analysis, Sedimentological analysis, Special fluid analysis (Micro-PVT) Pore scale modeling, Gas condensate behavior analysis, Upscaling Geostatistical methodology, Reservoir simulation uncertainty evaluation, Fracture reservoir analysis				

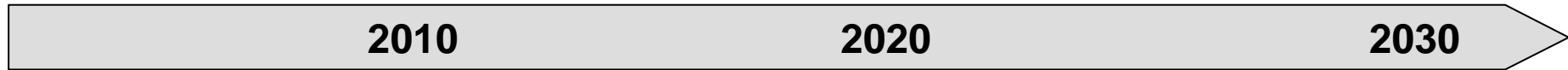
(2)
Reservoir TV

● Dynamic Modeling Technology

4D seismic survey	Feasibility test	4D multi-component seismic survey data processing and interpretation	Field application and demonstration	Integration with electromagnetic exploration
Feasibility test of geochemical method applicability to monitoring		Field application and demonstration		



(3) Well Drilling and Field Development



● Drilling Technology Improvement and Cost Reduction

Engineering Study for Drilling and Completion Cost Reduction, ERD/Well Bore Stability, etc.		<i>Continuous implementation</i>		
Smart Completion	<i>Basic survey</i>	<i>Engineering study</i>	<i>Continuous (in-situ) monitoring</i>	<i>Field application and continuous improvement</i>
Laser Drilling	<i>Quantitative evaluation</i>	<i>Experiment and optimization study</i>	<i>Pilot unit experiment</i>	<i>Filed application and continuous improvement</i>
Drilling Robot Technology		<i>Conceptual design</i>	<i>Prototype development</i>	<i>Practical development and test</i>
New Conceptual Drilling Methodology		<i>Conceptual design</i>	<i>Small-scale experiment</i>	<i>Field application</i>

**(4)
WD50**

● Production Facility Technology Improvement and Automation

Digital Oil Field	Monitoring and automatic measurement elemental technology		<i>Field application and continuous improvement</i>	
Pipeline Maintenance	<i>Engineering study of design and maintenance optimization</i>			
	Advanced Pipeline	Flow efficiency improvement technology	<i>Flow capacity increase</i>	<i>Field application and continuous improvement</i>
Anticorrosion	Monitoring system technology development		<i>Field application</i>	
	Microbial anti-corrosion and corrosive fluid treatment		<i>Field application and continuous improvement</i>	

**(5)
Advanced Next-generation Oil and Gas Resource Development Technologies**

● Frontier Development Technology

MPSO	<i>Conceptual design</i>	<i>Field application and continuous improvement</i>	Advanced offshore development Technology	
Floating Production Storage Offloading System (FPSO)	<i>Floating LNG upgrading for commercialization</i>	<i>Floating GTL application for practical use</i>	<i>Floating NGH application for practical use</i>	
Arctic Area Development	<i>Development conceptualization and element extraction</i>		<i>Elemental technology study</i>	<i>Field application for practical use</i>

**(3)
Sea-Quest 3000**



(4) Non-conventional Hydrocarbon Development



● Methane Hydrate Development Technology

MH Resource Assessment Technology

Assessment of MH resources offshore Japan *Prospect map of MH resources offshore Japan* **Development of drilling rig specialized for MH** *Prototype*

MH resource assessment technology **Integrated MH field modeling technology** *Field application*

Research on MH accumulation mechanism (MH system) **Exploration technology for non-sand reservoirs**

Development & Production Technology

Production method for MH resources offshore Japan **Advanced methane recovery technology** *Field application*

Onshore production Test *Offshore production test (1st)* *Offshore production test (2nd)* *Offshore pilot plant/pilot test* *MH Production system on-stream*

Offshore MH drilling, completion & production technology **Offshore MH production system**

Preliminary feasibility study of MH field **Feasibility evaluation of MH field offshore Japan**

Environment Impact Assessment

Monitoring technology for potential environmental impact *Field application*

Environment impact prediction technology *Comprehensive environmental impact assessment technology*

HSE for MH development

(6)
National MH

● Oil Sands, Oil Shale, Heavy-oil Recovering and Upgrading

Asphaltene behavior study *Field application*

Vaporex SAGD *Field test* *Field application*

Technology development for applying CO2 flooding and air injection to oil sands recovery **Progressing air injection and fire flood method, electrical afterheat method, cold-production technology improvement** *Field application*

Smart completion for high temperature required for oil sands recovery *Field application*

Application of advanced seismic technology to oil sands, heavy oil development *Field application*

Oil sands upgrading technology (using supercritical water) *Study on oil reservoir reforming Study* *-> Field application*

Advanced hybrid oil shale development (improved surface retorting, high-efficiency subsurface retorting)
Basic study *Bench test* *Small pilot test* *Demonstration pilot test* *Field application*

(7)
UHO20

● Non-conventional Gas (CBM, Tight Gas, Shale Gas, Deep Natural Gas, CO2 Concentrated Natural Gas) Development and Production

CBM (ECBM, Fracturing, etc.) *Application of conventional oil field technology* *Field application*

Tight gas, Shale gas *Application of conventional oil field technology* *Field application*

Deep Natural Gas *Deep water drilling and completion/production system elemental technology* *Field application*

Exploitation of Natural Gas Containing High Concentrations of CO2

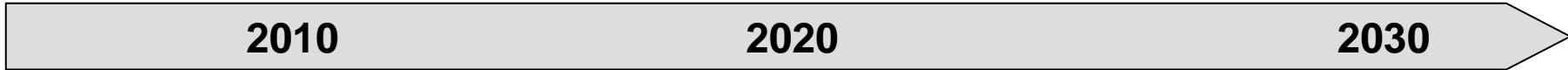
CO2 non-separation *Basic study* *GTL production technology* *Offshore GTL plant technology* *Field application*

Microorganism-utilizing reforming *Basic study* *Pilot experiment in actual field* *Demonstration test* *Field application*

(8)
Next-generation
Non-Conventional
Hydrocarbon
Exploitation



(5) Effective Utilization of Oil and Gas



● GTL Demonstration Project

Demonstration plant construction and operation

Commercialization 1

Commercialization 2

● Advanced Liquid fuel Production Technology

Commercialization 3

A-ATG

Commercialization 4

D-CPOX

Commercialization 5

Commercialization 6

● Possibility of Using Floating System to Reduce Development Cost

Commercialization 7

Floating LNG improvement and commercialization

Floating GTL

● NGH Chain Verification Study

NGH production technology

NGH transport ship development technology

Re-gasification technology

NGH lorry transportation experimental study

Field application

Floating NGH

● DME Fuel Utilization Technology

Development of utilization facilities

Field application

Infrastructure development technology





(6) Environment-conscious Oil and Gas Exploitation



● Production Enhancements by Utilizing CO2

CO2 injection (flooding) study *Field application*

Enhanced coal bed methane recovery (ECBM) *Field application*

● CH4 Bio-Conversion

Microorganism-utilizing in-reservoir methane regeneration *Basic study* *Small-scale pilot test* *Field application*

● Emission Reduction Technology

H2S removal *Basic study* *Small-scale pilot test* *Field application*

Down hole separation of produced water *Basic study* *Small-scale pilot test* *Field application*

Non-treatment produced water injection *Basic study* *Small-scale pilot test* *Field application*

CO2, associated gas injection to aquifer *Basic study* *Small-scale pilot test* *Field application*

Drilling waste treatment *Basic study* *Small-scale pilot test* *Field application*

**Core projects
(1) – (10)**

- (1) EOR70:** Recovery factor over 70%
- (2) Reservoir TV:** Visualization of oil and gas reservoirs
- (3) Sea-Quest 3000:** Deep-water project (depth of 3,000m and more)
- (4) WD50:** 50% cost reduction in drilling and completion
- (5) Next-generation advanced resource development:**
Oil and gas resource development project utilizing state-of-the-art technologies (IT, robotics, nanotechnology, biotechnology, etc.)
- (6) National MH:** Methane hydrate production offshore Japan
- (7) UHO20:** Extra heavy oil upgrading project (on-site upgrading to 20 API gravity degrees and higher)
- (8) Next-generation non-conventional hydrocarbon exploitation:**
Development of next-generation resources, such as extra heavy oil and coal bed methane (CBM)
- (9) GTL7:** Implement seven or more Japan GTL commercial projects
- (10) Next-generation oil and gas effective utilization:**
Next-generation technology project inducing gas-field development (next-generation GTL- and NGH-chains)

Three Additional Action Plans

In addition to the seven action plans of “*TRC R&D Strategy*” (2006), three action plans have been set up considering that:

- (1) a powerful technical development structure that covers a wider technological range toward 2030 is required;
- (2) a specific and effective research implementation program on R&D items newly added to the roadmap should be plotted out; and
- (3) a project conception that contributes to the increase of ratio of development of oil resources under Japanese companies’ interest to the entire crude oil import should be concretized.

<Action Plan No.8>

Intensify intellectual cooperation with R&D institutes concerned, as the foundation of the core projects.

<Action Plan No.9>

Implement trend surveys essential for promoting the core projects.

<Action Plan No.10>

Implement steady step-by-step field demonstration for realizing the core projects.

[Reference] Seven (7) action plans of “*TRC R&D Strategy*” (March, 2006)

- (1) *Upgrading the Expertise of JOGMEC/TRC’s Personnel*
- (2) *Technological Support Program for Oil and Gas Exploration*
- (3) *Synergetic Program for Inter-industrial Technologies for Oil and Gas Exploitation and Utilization*
- (4) *Cooperation with Universities*
- (5) *Cooperation with Participants of Overseas Training Program*
- (6) *Retaining Technological Consultants*
- (7) *Establishment of Intellectual Property Management System*

**Intellectual Cooperation with R&D Institutes Concerned,
as the Foundation of the Core Projects**

Promote intellectual cooperation on both “organization” basis and “personal” basis, by intensifying cooperation with R&D institutes concerned having world-class strength so as to utilize the synergy effect, and by intensifying the networks of researchers involved in various JOGMEC projects, respectively.

**(1) Frontier Center for Energy and Natural Resources
(the University of Tokyo)****(2) National Institute of Advanced Industrial Science and Technology
(AIST)**

- a. Information Technology Research Institute (ITRI)
- b. Measurement Frontier Research Division

(3) National Maritime Research Institute (NMRI)**(4) Japan Agency for Marine-Earth Science and Technology
(JAMSTEC)****(5) Value Creating Human Networking**

- a. Invited lecturers
- b. Trainees of JOGMEC overseas training program



The technological development plan can be implemented correctly only when a wide range of advanced technologies are incorporated. Therefore it is essential to collect a variety of information about related technological trends both from Japan and overseas. In line with this, the technological trend surveys related to promoting the ***Core Projects*** are to be implemented on:

- (1) total energy system toward 2030 (zero-emission oil and natural gas development)
- (2) non-conventional resource development toward 2030
- (3) remote area resource development toward 2030
- (4) effective use of natural gas inducing resource development toward 2030
- (5) inter-industrial resource development toward 2030



Step-by-step Steady Field Demonstration for Realizing the Core Projects

Summarized below are TRC's concrete activities for the next 5-10 years, focusing on five instances out of the prioritized R&D projects. These instances essentially require steady field demonstration.

(1) CO2EOR

	2007	2008	2009	2010	2011	2012
CO2EOR		Pilot test on actual oil field				
	Basic research, study, engineering, analysis and evaluation					

(2) Deepwater

	2007	2008	2009	2010	2011	2012
Deep-water project (MPSO)	Conceptual design		Field application, continuous technical review			Commercialization



Step-by-step steady field demonstration for realizing the Core Projects

(3) GTL

	2007	2008	2009	2010	2011	2012
GTL	Detail design of demonstration plant					
		Construction of demonstration plant				
			Operation of demonstration plant			
					Commercialization	

(4) Methane Hydrate

	2007	2008	2009	2010	2011	2012
Methane hydrate	On-shore production test					
			Off-shore production test			

(5) Heavy Oil

	2007	2008	2009	2010	2011	2012
Heavy oil (heavy-oil upgrading technology)	Technology survey					
		Basic experiment				
			Study for field application			
					Semi-pilot	
						Pilot verification