Chevron's Business-Driven Actions on Greenhouse Gas Emissions Management: Gorgon Project and Other Examples

International Workshop on CO2 Capture and Storage
Tokyo, Japan

Arthur Lee

20 February 2006

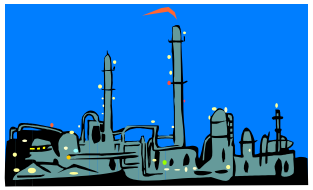
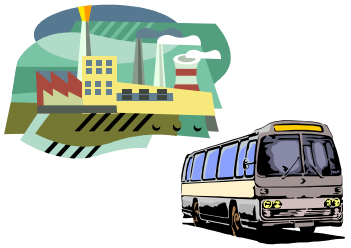
 Corp HES

Business-Driven Actions on Greenhouse Gas Emissions Management

- **Strong Centralized Greenhouse Gas Management**
- **Management Processes and Tools Integrated to Business**
- **Carbon Markets Team**
- **Partnerships**

Importance of Climate Change Issue to Chevron

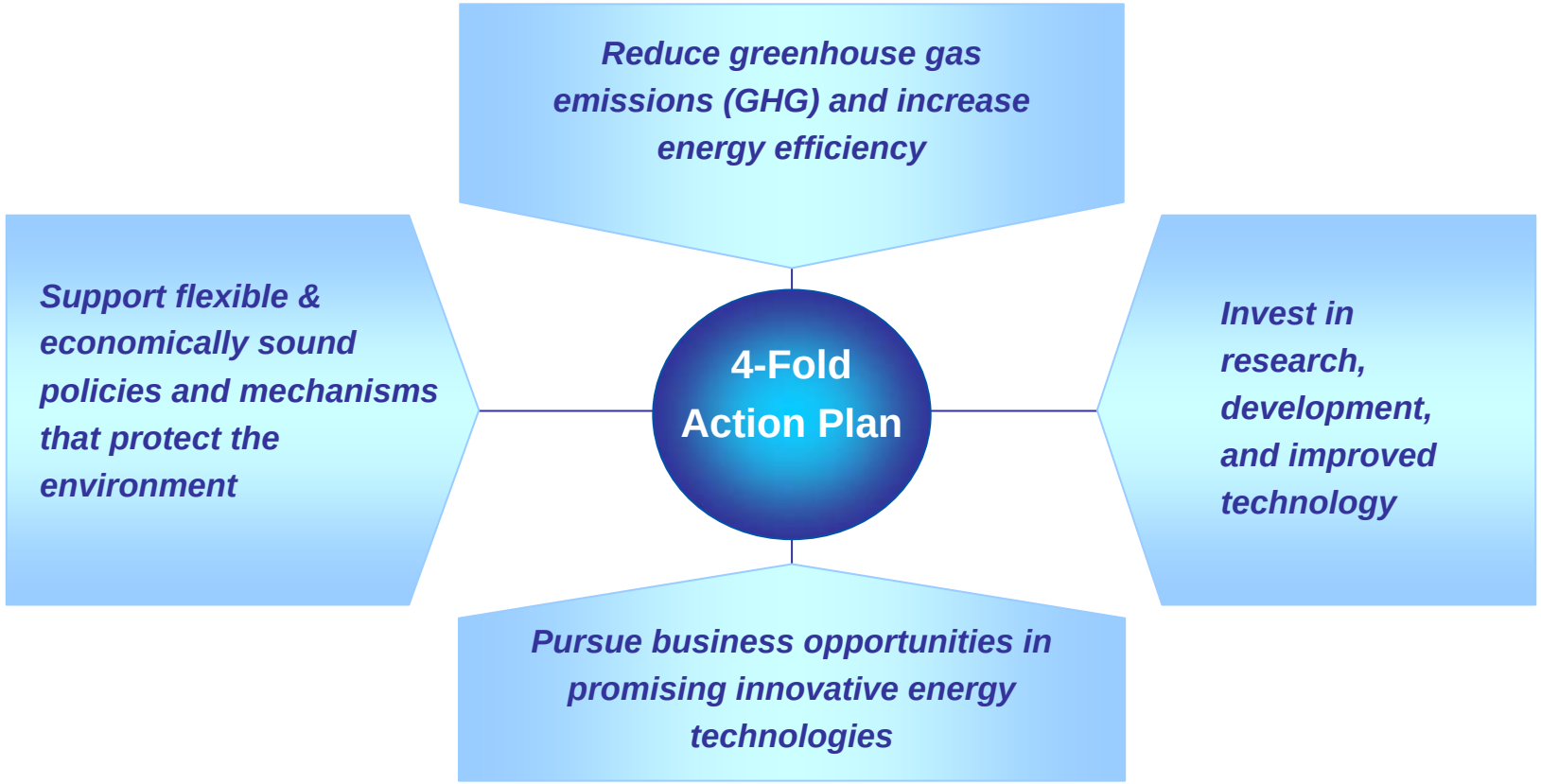
CO_2 and methane emission sources

	Production	Transportation	Refining and Petrochemical Production	End Use
				
Sources	■Combustion and rotating equipment, flaring, venting ■Gas associated with oil production	■Pipelines ■Vessels ■Vehicles	■Heaters ■Boilers	■Customer use of gasoline, diesel, and coal
Emission	■CO_2 ■Methane	■CO_2 ■Methane	■Primarily CO_2	■CO_2

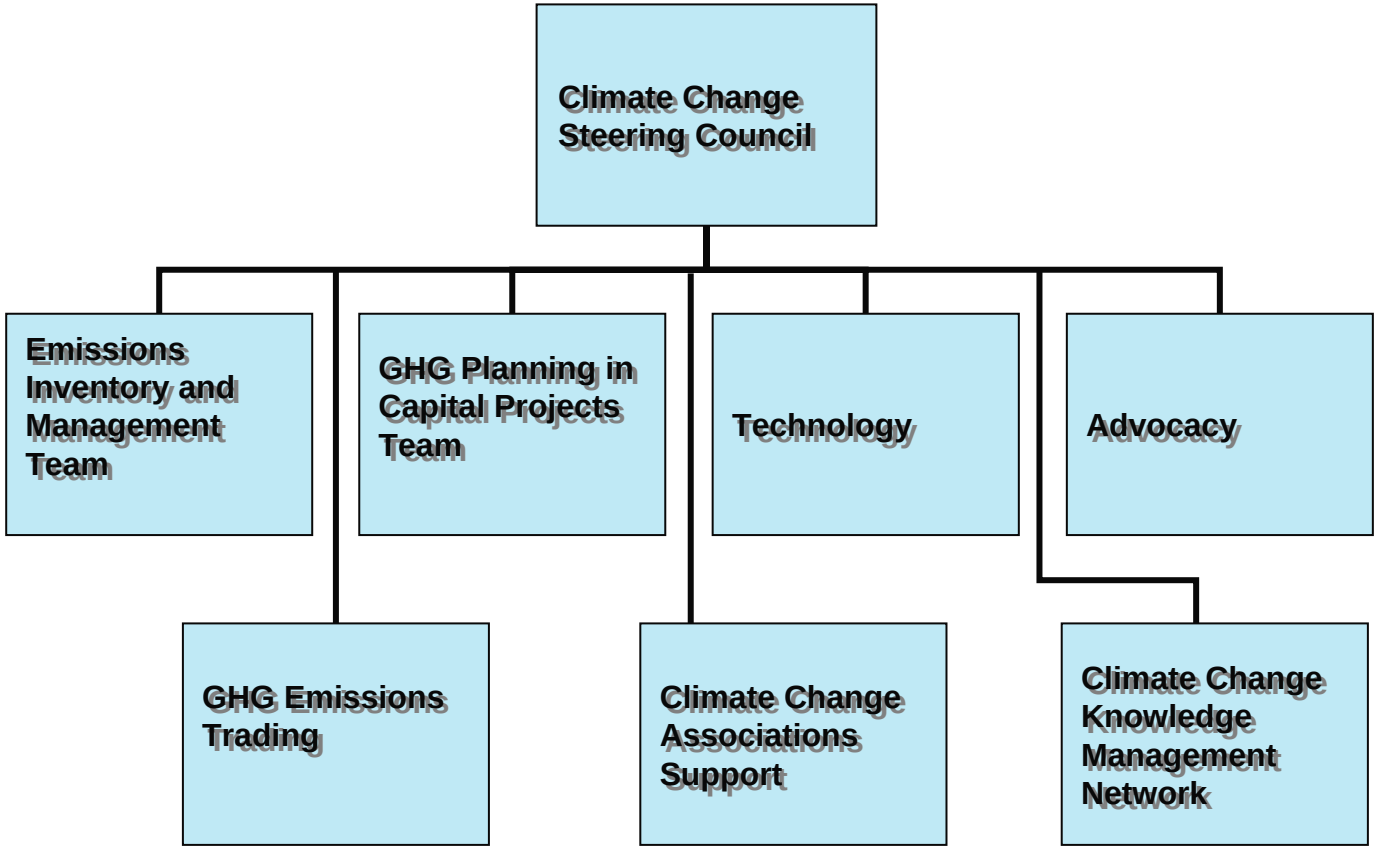
Chevron's Climate Change Position and Action Plan

Position: We at Chevron Corporation are responding to increasing climate change concerns by integrating an action-based approach into our business strategy

Plan: 4-Fold Plan predicated on ***ACTION***

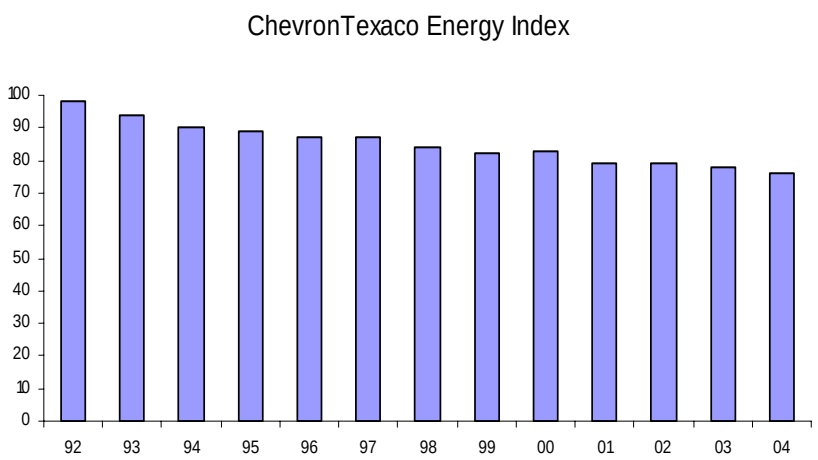


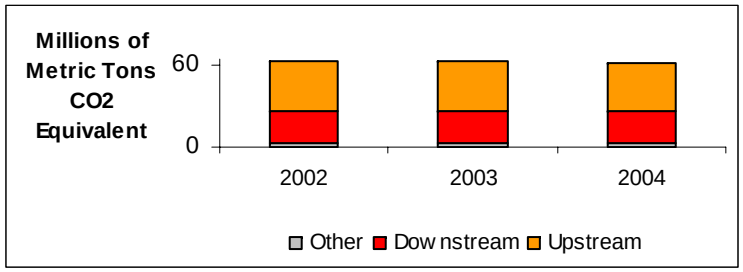
Organization of the Climate Change Steering Council and Supporting Teams



- Additional teams will be added as needed

Actions and Results

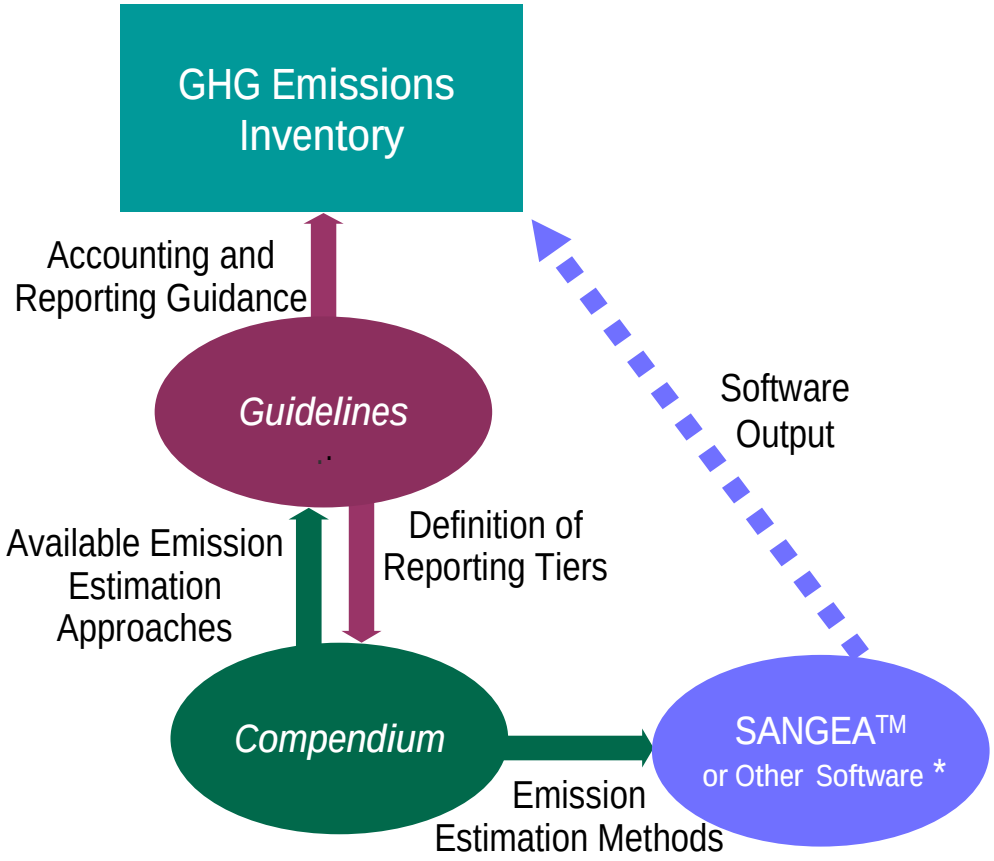




2002, 2003, and 2004 Equity share emissions do not include Chevron Phillips Chemical and Dynegy. Other includes shipping, global power, coal & corp. services

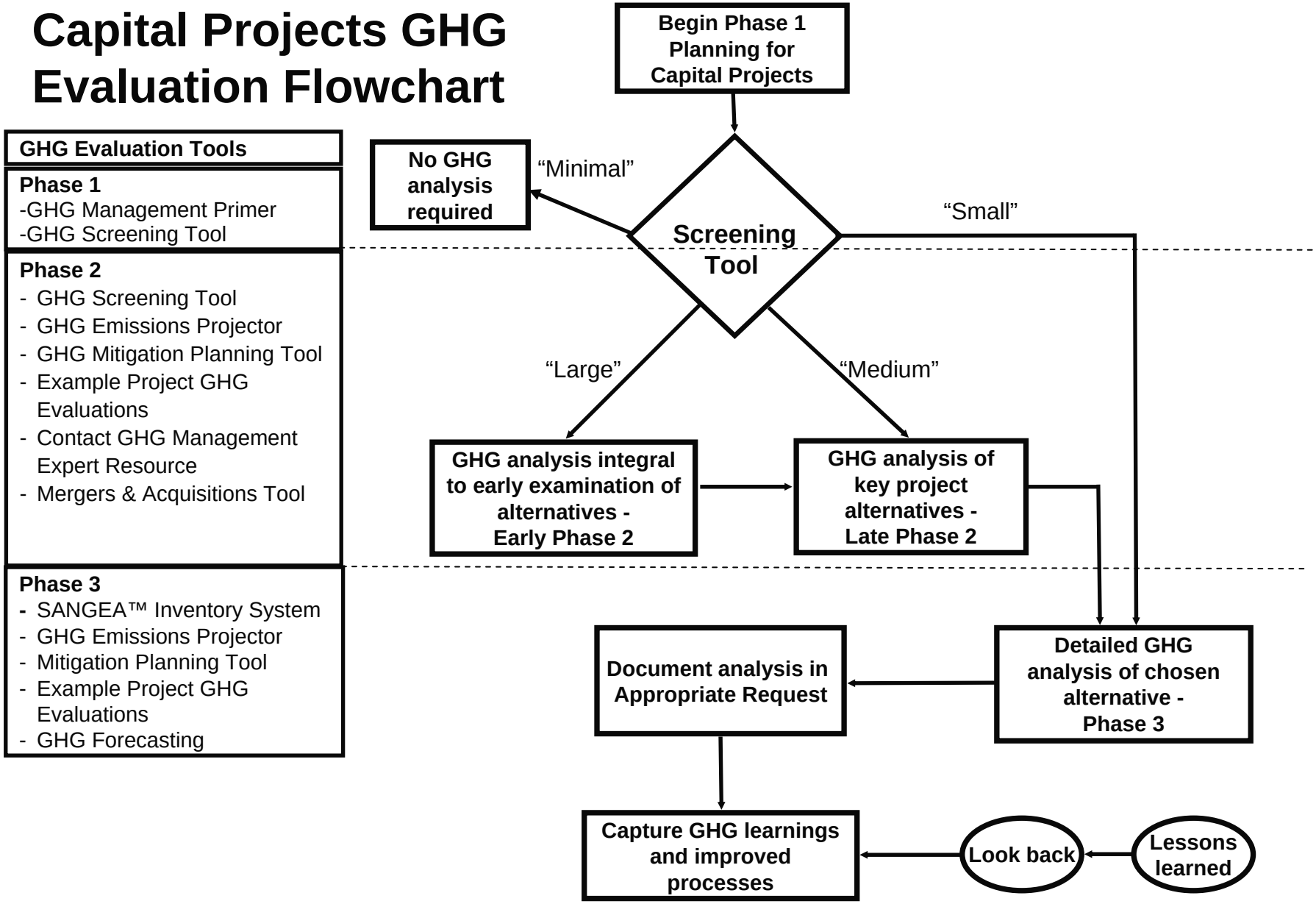
- Greenhouse Gas Emissions Accounting To Become Standardized --CVX SANGEA™ software has role
- CVX Energy Efficiency Improved 24% from 1992. US Refinery Plans an Additional 10% by 2012 via API Commitment to the US.
- CVX OpCos Set Emission Goals for 2005 and Forecast 2005-07
- CVX To Reduce Upstream Flaring/Venting in Nigeria and Angola. F/V is 24% CVX GHG
- Gorgon Project – State-of-art CO2 Reinjection Program Planned in Australia (2-3 million metric tons per yr)

Emissions Inventory Framework: API Compendium and SANGEA™ and IPIECA



*Emission calculations made following Guidelines accounting and reporting procedures and Compendium emission estimation methods.

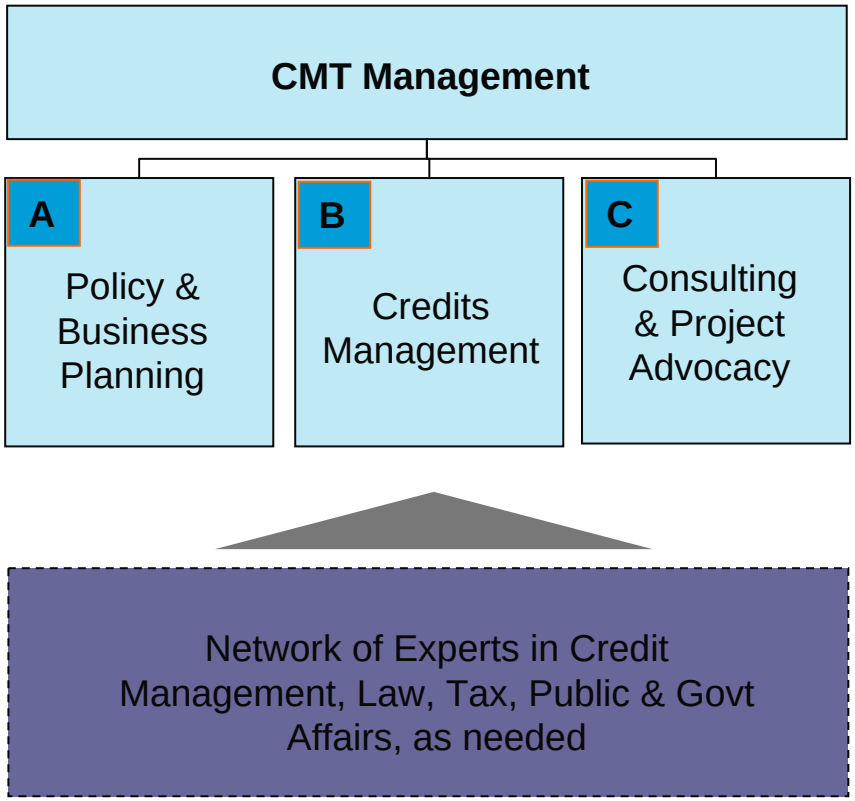
Capital Projects GHG Evaluation Flowchart

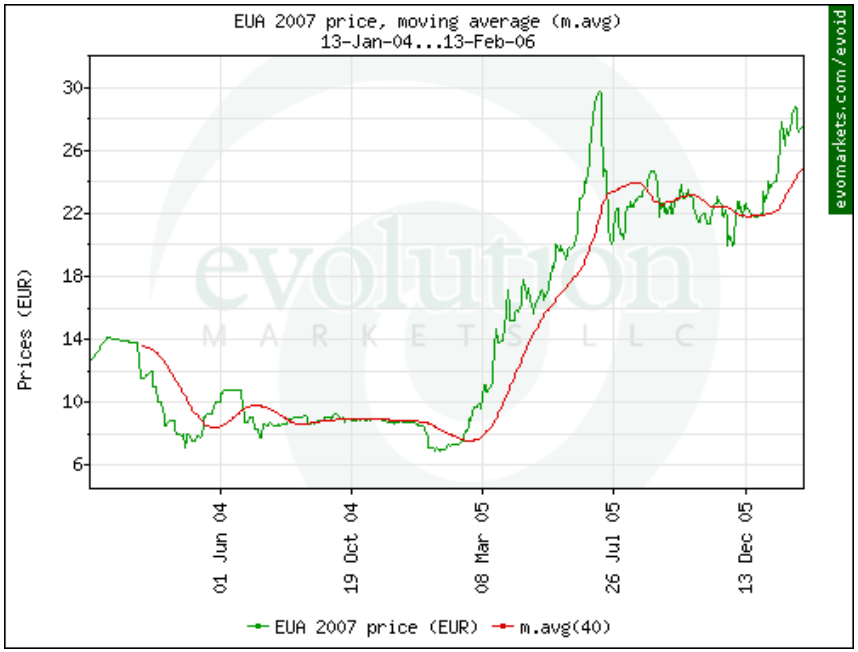


SANGEA™ is a trademark of the American Petroleum Institute

Carbon Markets Team (CMT) Organizational Functions

CMT Organizational Structure





Source: Evolution Markets

SETTING THE SCENE … INCREASING LEVELS OF POLICY DEVELOPMENT

1992 – U.N. Framework Convention on Climate Change

1997 – **The Kyoto Protocol** *(156 nations ratified; US and Australia have not ratified)*

2001 – Marrakech Accords *(Clean Development Mechanism)*

CANADA 2005

(1) Voluntary Agreement with Autos
(2) Regulatory Proposal for Large Sources

EUROPE 2005

EU Emissions Trading Scheme *(impact on CVX operations in the UK and Netherlands)*

UNITED STATES 2005

(1) California Executive Order
(2) Gulf Coast climate damage suit
(3) NE States regional GHG initiative

Int'l Flaring Standard 2004

(CVX's operations in Angola, Nigeria, Kazakhstan, Indonesia)

AUSTRALIA 1995 and 2003

Voluntary Greenhouse Challenge Agreement 2003 (Gorgon)

Climate Change Policy Drivers

G8 Gleneagles Plan of Action on Climate Change, Clean Energy and Sustainable Development recognizes that advances in a portfolio of technologies are critical for the stabilization of greenhouse gas concentrations.

Technology common ground

- G8 nations disagree over the Kyoto Protocol
- G8 Plan of Action is the common ground.

In the transport area, G8 Gleneagles Plan of Action commits the nations to:

- Launch a Global Bioenergy Partnership to support wider, cost-effective, biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent
- Encourage the development of cleaner, more efficient and lower-emitting vehicles
- Promote their deployment by adopting ambitious policies to encourage sales of such vehicles, including public procurement to accelerate market development

Climate Change Policy Drivers

G8 Gleneagles Plan of Action on Climate Change, Clean Energy and Sustainable Development recognizes that advances in a portfolio of technologies are critical for the stabilization of greenhouse gas concentrations.

Technology common ground

- G8 nations disagree over the Kyoto Protocol
- G8 Plan of Action is the common ground.

In the CO2 capture and storage technology area, G8 Gleneagles Plan of Action commits the nations to:

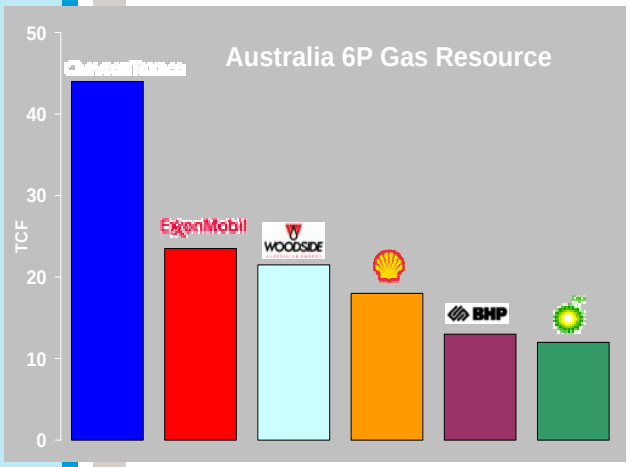
- Acceleration of the development and commercialization of carbon capture and storage (CCS) technology by endorsing the objectives and activities of the Carbon Sequestration Leadership Forum (CSLF)
- Working with the IEA and the CSLF to hold a workshop on short-term opportunities for CCS in the fossil fuel sector, including from enhanced oil recovery and CO2 removal from natural gas production
- Collaboration with key developing countries to research options for geological CO2 storage

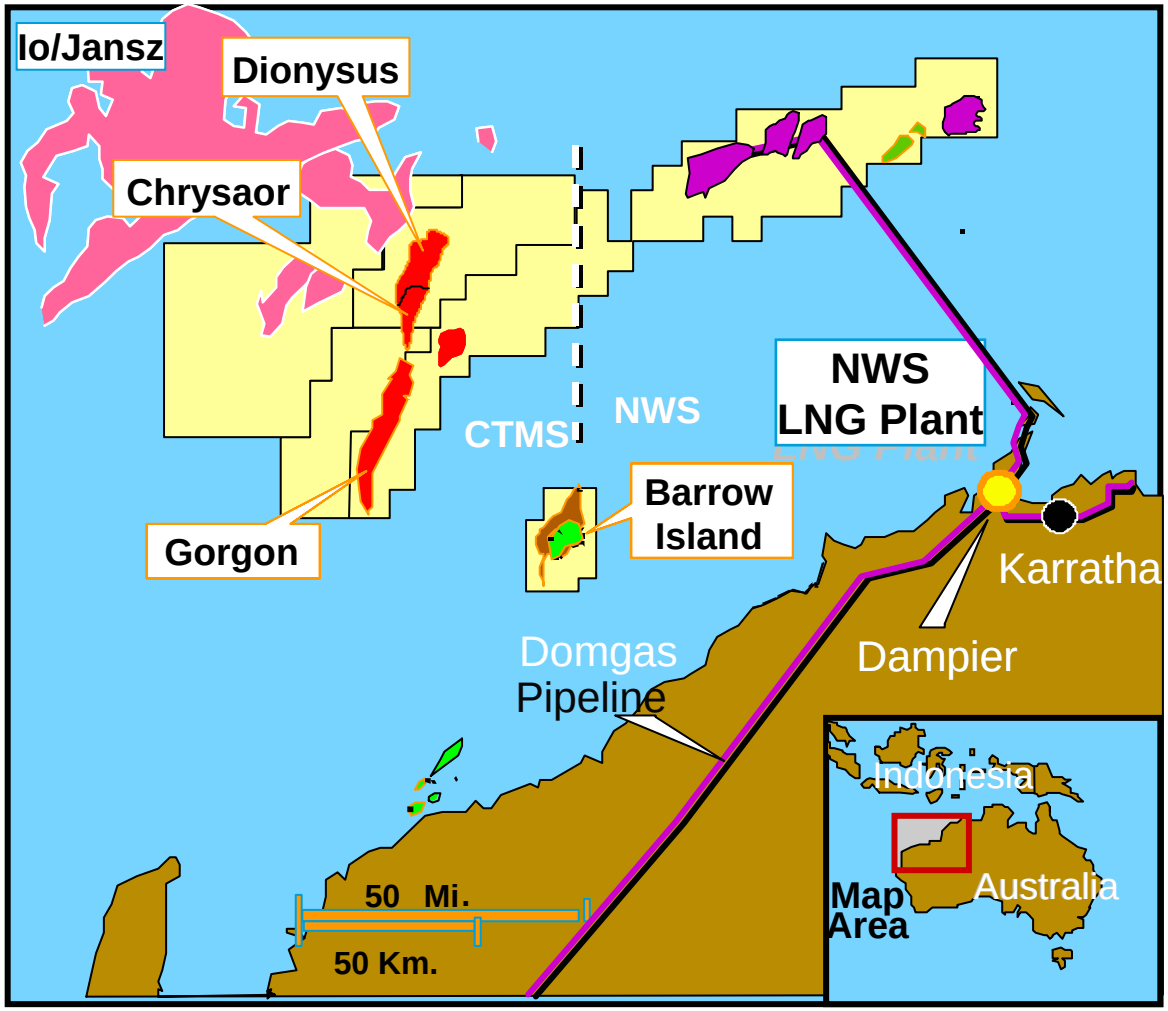
Business-Driven Actions

- Gorgon Project
- Climate Change Related Joint Industry Projects
- Operating Companies' and Business Units' Activities in Support of 4-Fold Action Plan
- "Practical Hydrogen" – Hydrogen Infrastructure Development

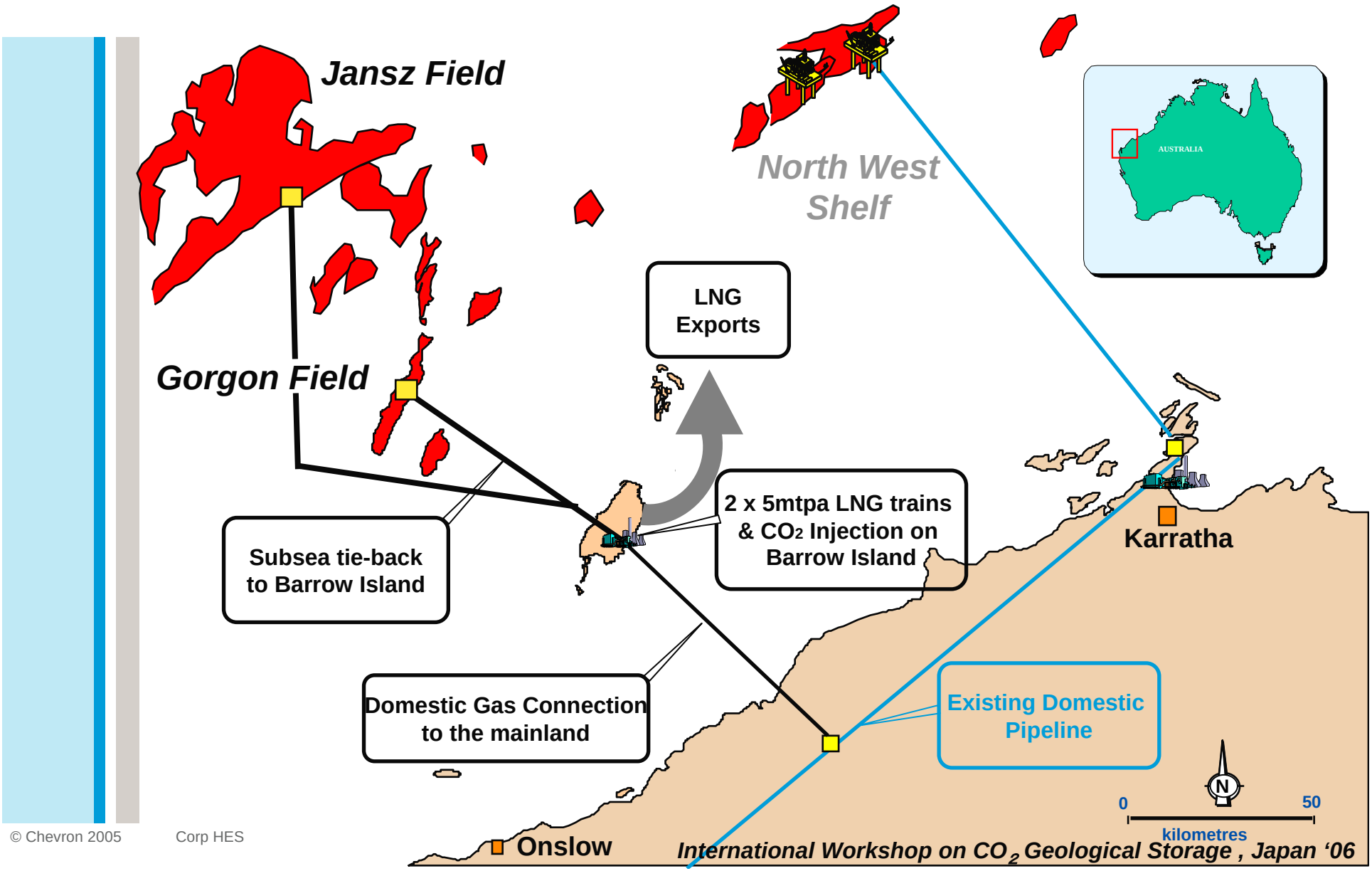
Australia: Vast Resources Offer Clean Fuels Promise and GHG Advances

- CVX is 1/6 Equity Owner in NWS LNG Venture
- CVX is also Operator and Lead Developer of Gorgon LNG with more than 40 TCF in Greater Gorgon area.





Gorgon Development Plan



Greenhouse Gas – the Gorgon commitment

Gorgon CO_2 sequestration will be the largest such project in the world.

It will be managed through:

- Greenhouse Gas Management Strategy
- Environment, Social and Economic Review commitments
- Greenhouse Gas Management Plan
- Environmental Impact Assessment process (EIS/ERMP)

"Greenhouse gas management is part of our business"

GORGON
AUSTRALIAN GAS

Gorgon Gas Development Greenhouse Gas Management Strategy

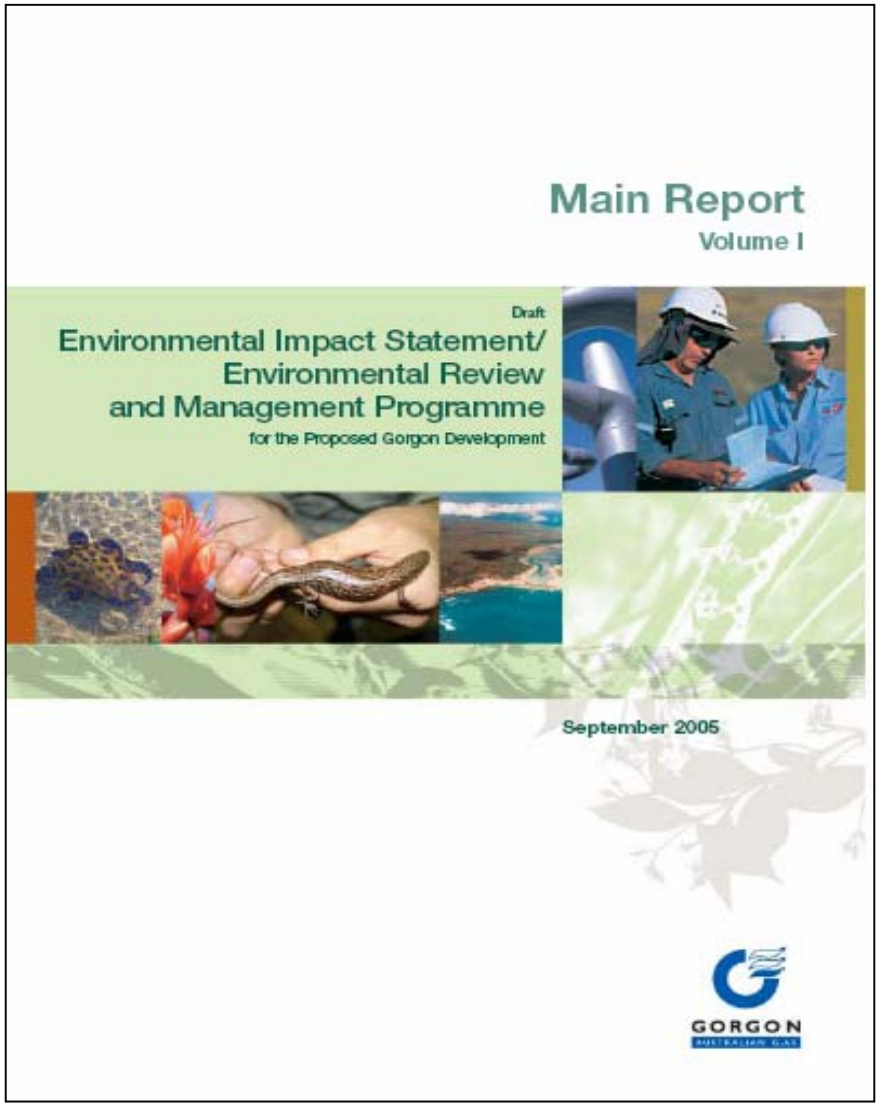
The Gorgon Development Greenhouse Gas Management Strategy for a Barrow Island development is to:

- Demonstrate via lifecycle analysis that a Gorgon gas development and LNG export results in a net reduction in global greenhouse gas emissions relative to other fossil fuel alternatives.
- Design the production facilities to incorporate current best practices in thermal efficiency and greenhouse emission control where practicable.
- Develop a project to re-inject the removed reservoir CO_2 into the Barrow Island Dupuy saline reservoir, unless it is technically infeasible or cost-prohibitive. This will involve:
  - Pursuing a stepwise process to: develop a reservoir CO_2 re-injection project, demonstrate technical feasibility, and ensure costs to the project are not excessive.
  - Selling treated gas to meet domestic gas customer requirements and re-inject the removed reservoir CO_2.
  - Commencing re-injection as soon as practicable after the processing facilities commissioning and start-up process.
  - Implementing re-injection of reservoir CO_2 by installing a single train of injection equipment, sized for the full volume of reservoir CO_2.
- Investigate potential synergies with existing Barrow Island operations and implement measures that minimise greenhouse emissions and enable full use of associated gas production where practicable.
- Pursue projects and opportunities which provide net conservation benefits and enhance greenhouse gas removal from the atmosphere.
- Continue existing funding for greenhouse gas related research and development projects such as CRC's and technological research.
- Review options for funding additional value-added research and development or demonstration projects.
- Pursue potential opportunities for external sale or use of separated reservoir CO_2 as a chemical feedstock or enhanced oil recovery agent.
- Develop a contingency plan that could provide a partial offset for reservoir CO_2 if a sequestration project proves infeasible. Options may include:
  - Maturing alternative re-injection sites that could be developed in the future such as a depleted gas reservoir.
  - Creation of emission reductions or offsets external to the Gorgon gas development.
  - Sequestration opportunities such as forestry.
  - Additional research funding.
- Meet the commitments within the LNG Action Agenda including the revision of the existing Gorgon Greenhouse Challenge Cooperative Agreement.
- Continue to advocate increased use of gas based fuels, in preference to more carbon intensive options, to reduce greenhouse emissions.
- Participate constructively in the development of greenhouse policy at both the State and Commonwealth level.

Paul Oen
Gorgon Area General Manager

Created on 25/06/2003 11:12 AM DOC ID: 030650006 rev 0

EIS/ERMP



EIS/ERMP - Combined federal state environmental assessment

Public release 12th September

Followed by a ten week public comment period

Environmental approval mid 2006

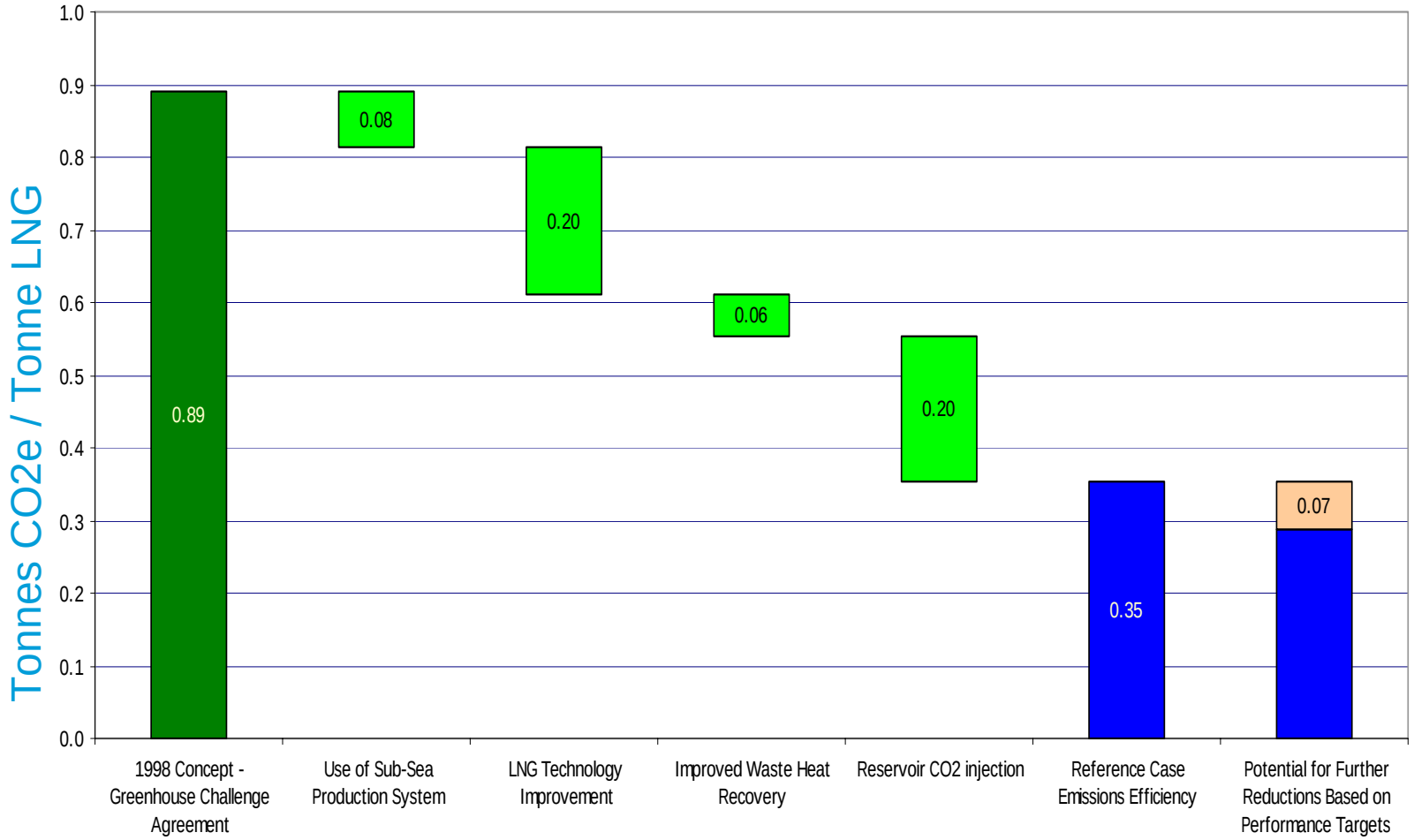
Qualifiers on Commitment to Inject Reservoir CO_2 13.1.1

To ensure the efficient use of capital resources, CO_2 injection is planned to be implemented using injection equipment sized to handle the expected rate of reservoir CO_2 removed from the incoming gas stream to the gas processing facility. Venting of reservoir CO_2 will be required during commissioning, periods of maintenance and equipment downtime associated with the injection equipment or for reservoir constraints. Full redundancy in the CO_2 injection system to eliminate venting as a contingency, cannot be justified given the impact on project financial viability.

In the unlikely event that the proposed CO_2 injection should prove technically infeasible or cost prohibitive, such as if it is determined that a large number of additional injection wells are required, the Gorgon Joint Venturers will consult with government with the intent of maximising the injection of CO_2 within the commercial constraints of the Gorgon Development.

At any time the Joint Venturers consider that the injection of reservoir CO_2 represents an unacceptable risk to the environmental values of Barrow Island, or a safety risk, then CO_2 injection operations would be suspended and the remaining reservoir CO_2 vented to the atmosphere.

Greenhouse Gas Emissions - Efficiency Improvements 13.3.1

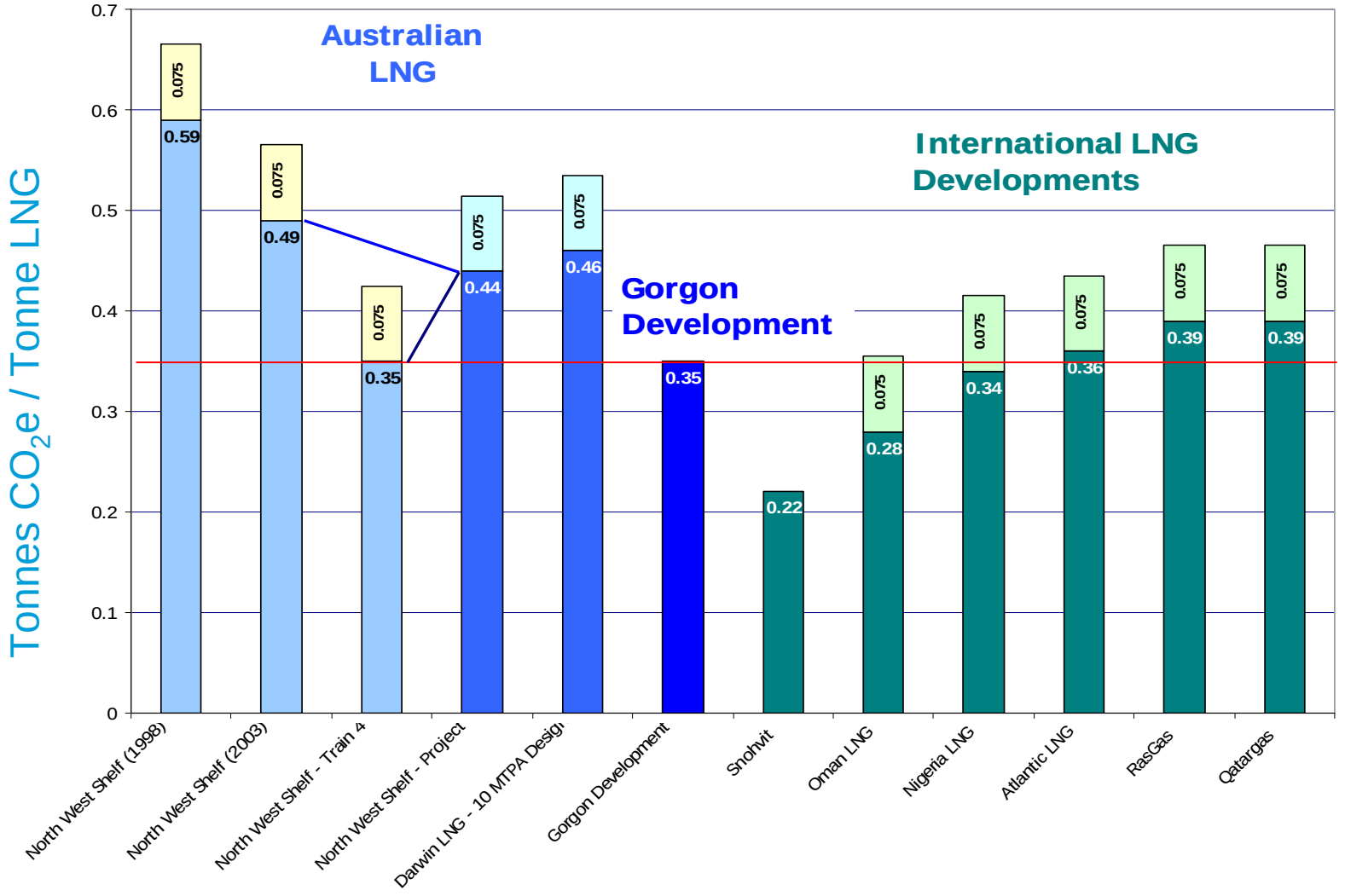


Predicted Annual Emissions 13.3.4

Emissions Source	LNG Processing TPA CO_2e	Domestic Gas Processing TPA CO_2e	Island Infrastructure Support TPA CO_2e
Gas Turbine – Gas Processing Drivers	1 612 000	Nil	Nil
Gas Turbine – Power Generation	1 287 000	200 000	60 000
Fired Heaters	71 000	28 000	Nil
Flare – Events	60 000	Minor	Nil
Flare – Pilots	2 000	Minor	Nil
Fugitive Emissions	Less than 1 000	Less than 1 000	Nil
Transport	Nil	Nil	10 000
Diesel Engines	Less than 300	Minor	Minor
Reservoir CO2 Vented	500 000	180 000	Minor
Total	**3 534 000**	**409 000**	**70 000**

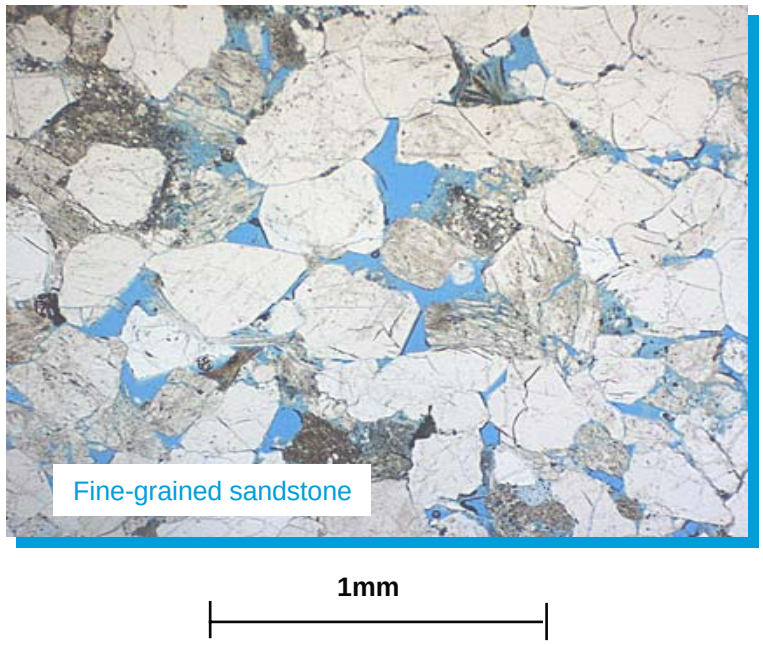
EIS/ERMP also contains estimates of emissions during construction and decommissioning

Greenhouse Gas Emissions – Comparative Benchmarking (LNG) 13.3.6



Reservoir CO_2
Setting the scene 13.4

- Expected gas composition of reservoir CO_2 (99% CO_2)
- Experience with CO_2 injection
- Assessment of CO_2 injection sites (Central East Coat)
- Geology of Barrow Island
  - Stratigraphy
  - Structure
- CO_2 behavior in the subsurface
  - Phase behavior of CO_2
  - Trapping mechanisms
    - Solution trapping
    - Residual gas trapping
    - Mineralogical trapping
    - Large-scale geometric trapping
  - Injectivity/tortuosity compromise
  - Baffles and Barriers
  - Operational Phase
  - Post Operational Phase



CO_2 Injection Development Concept 13.4.2

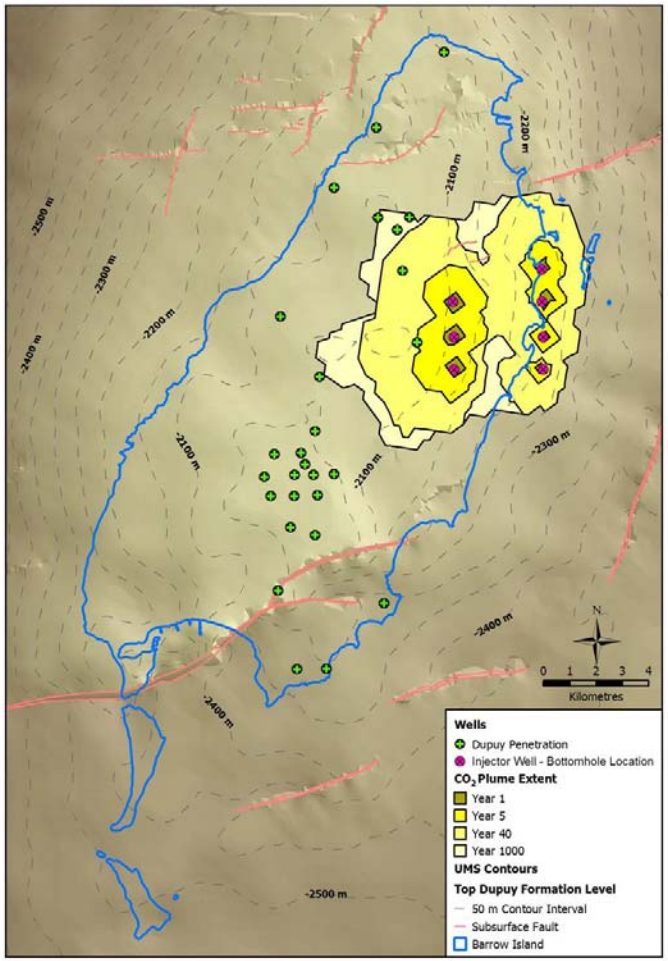
CO_2 compressors and pumps integrated into gas processing facility

7 injection wells drilled from 2 or 3 drill pads

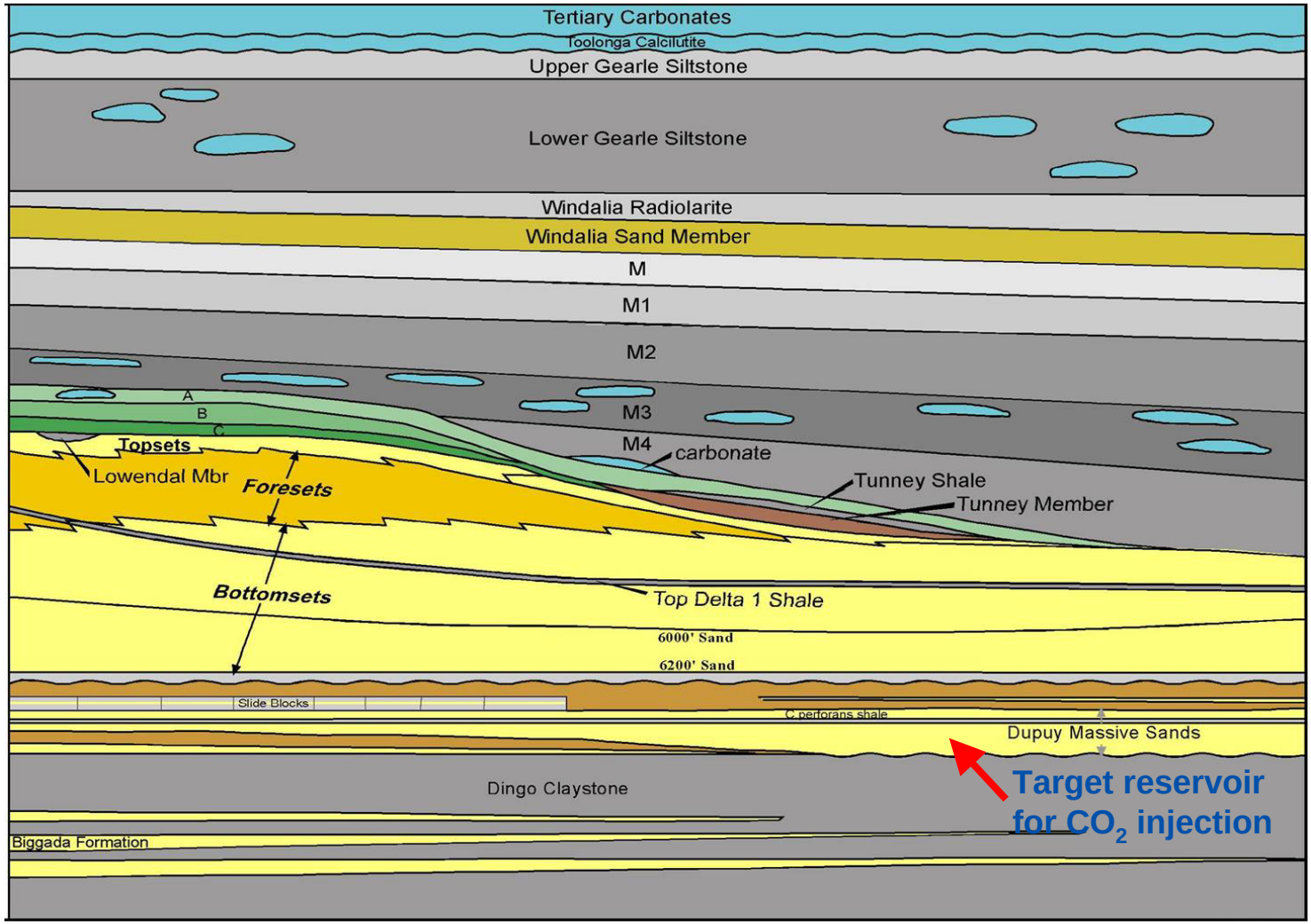
CO_2 pipelines

Fit for purpose monitoring program

Commitment to make data from the ongoing monitoring available to the public

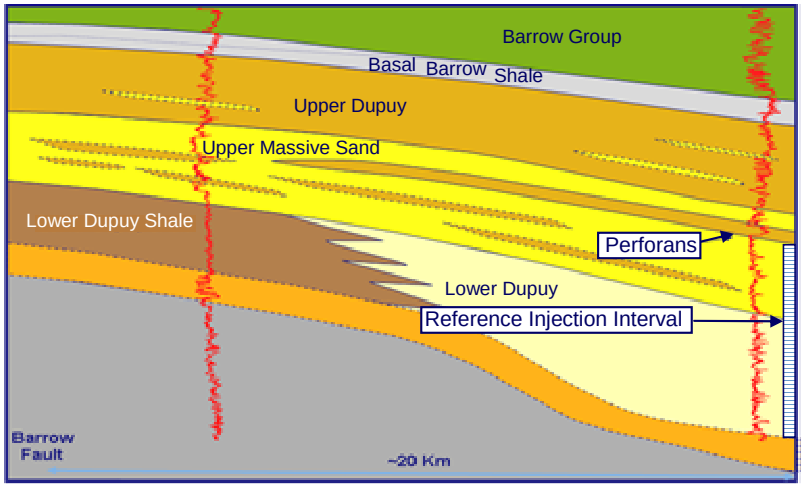


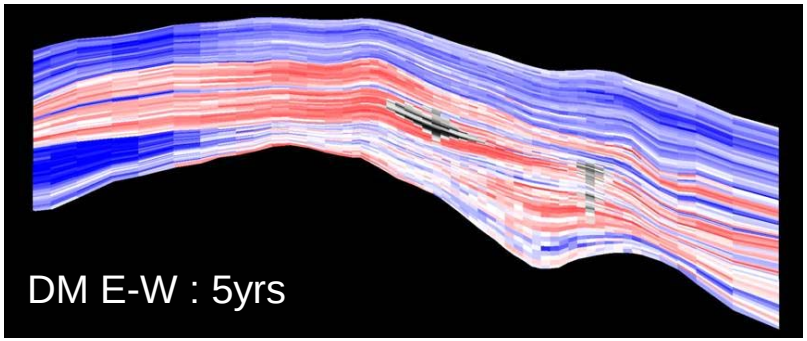
Barrow Island Stratigraphy
13.4.3

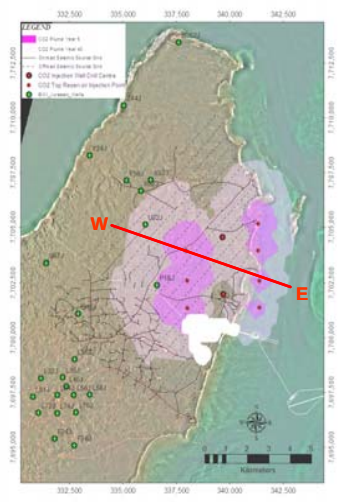


Reservoir Simulation
13.4.5

- Reservoir Simulation
  - Single injection well simulation
  - Full reservoir simulation
    - Pressure field
    - Displaced formation water
  - Deviations from simulation predictions
    - High permeability layers
    - Down dip migration
    - Existing wells







CO_2 Injection – Long Term Responsibilities 13.4.11

The JVs believe that existing statutory regulation & Common Law provide appropriate mechanisms for managing liabilities associated with CO2 injection

The Gorgon JV proposes that its day-to-day involvement with the site continue after the cessation of injection operations

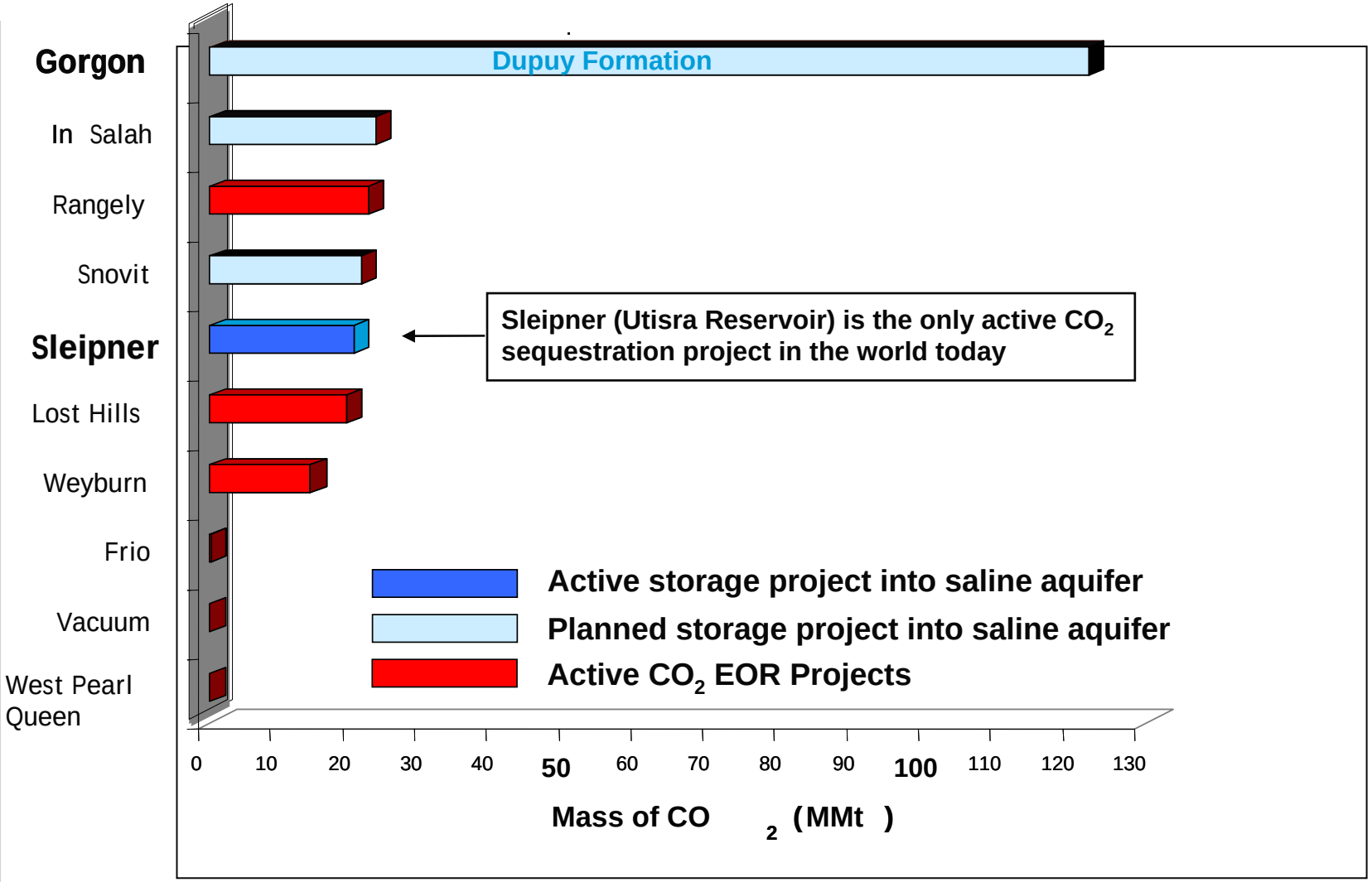
- The Post-Injection Phase would end once agreement was reached with government that the closure criteria for the site had been met

Reference to the Draft Regulatory Principles

Prior to site closure, government would need to be satisfied to a high degree of certainty that:

- Future land use objectives defined at the time of project approval have been met
- The residual risks of leakage & resulting liabilities are acceptably low
- The ongoing costs associated with the site are acceptably low or are otherwise appropriately managed

Comparison of Global CO_2 Re-Injection Projects



 Corp HES

Linking the Gas Value Chain

Forging strong links all along the gas value chain is critical to the commercialization of the significant volumes of remote natural gas resources throughout the world.

Upstream

Liquefaction

Shipping

Regasification

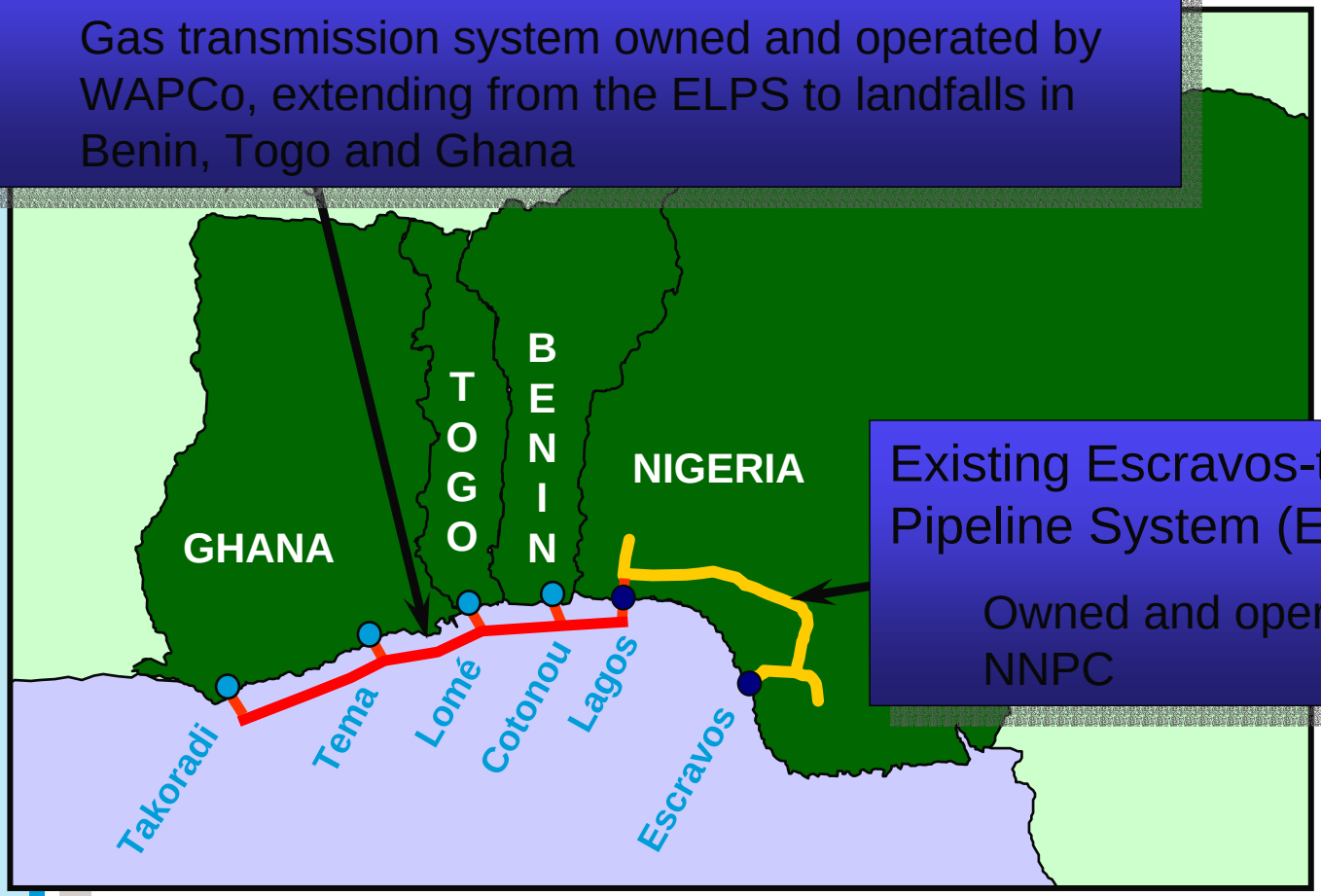
Marketing & Pipelines

Power

West African Gas Pipeline
Nigeria to Ghana

West African Gas Pipeline (WAGP)

Gas transmission system owned and operated by WAPCo, extending from the ELPS to landfalls in Benin, Togo and Ghana



Existing Escravos-to-Lagos Pipeline System (ELPS)

Owned and operated by NNPC

Climate Related JIP Involvement

Partial List …

- CO2 Capture Project
- CO2CRC
- IEA Weyburn
- MIT Carbon Sequestration Initiative
- WestCarb (DOE Regional Partnership)
- Global Gas Flaring Reduction Partnership
- Industry Consortia: API, IEA, IPIECA (chairs Climate Change Working Group), CO2NET

Chevron Energy Solutions – Energy Efficiency, Solar Power, and Fuel Cell Project (Northern California)

Chevron Energy Solutions - Solar Photovoltaic Installation (Public Library, City of Richmond, CA)

Darajat Geothermal Expansion

- 110 MW Expansion of Darajat geothermal power project
- Will help meet electricity demands of Java, Madura and Bali, where supply shortages are anticipated
- Will help Indonesia avoid more than 400,000 tons per year of CO2 emissions
- Darajat's geothermal resources are abundant, clean, renewable.
- Resource operated by Chevron Energy Indonesia Ltd (CTEI)

Chevron Technology Ventures

Find, Launch, and Grow New Energy Technology Businesses

- Add new intellectual capital and organizational capability
- Create options in disruptive technologies
- Augment core R&D
- Add value chain extensions
- Adding a new operating sector

Hydrogen Business Unit

Emerging Energy Business Unit

Molecular Diamonds LLC

Venture Capital Equities

Technology Ventures: Renewable Energy Systems

Solar Mine project in the Midway-Sunset heavy oil field

Renewable energy systems integrated into oil field operations

Nerefco Project, Rotterdam refinery

Advanced Batteries

- The power behind hybrid vehicles
- COBASYS has completed construction of an NiMH Battery Plant

- COBASYS signed a cost-sharing contract to continue the development of NiMH batteries under the sponsorship of the U.S. Department of Energy's FreedomCar initiative

New Manufacturing Facility
Springboro, Ohio

Practical Hydrogen - Navigating the Transition

Public - Private partnerships play a central role

Today → Transition Stage → Future

R&D →

Demonstration projects

Specialized stationary power applications

Prototype fleet and energy infrastructure systems →

Distributed economic hydrogen-based energy & transport systems

Petrochemical

- **Test bed for new component technologies**
- **Community interaction, outreach, and education**

- **Sufficient size and complexity**
- **Cost-efficient - leverages the existing energy grid**

U.S. DOE Hydrogen Fleet & Infrastructure Demonstration & Validation Project

- 5 year project to showcase practical application of H2 technology. Chevron is consortium leader and fuel supplier; Hyundai-Kia Motors the vehicle supplier; and UTC Fuel Cells will supply the FC stacks
- Develop and demonstrate safe, convenient, reliable H2-based distributed power generation, FCVs and vehicle fueling infrastructure
- Educate key audiences about H2 as potential fuel for transportation and power generation
- Sites and fleet operators: HATCHI, SoCal Edison, AC Transit and U.S. DOD
- Fueling for up to 32 H2 FCVs
- Integrated Codes & Standards, Education & Outreach Plans

Opportunities in Early Markets for Hydrogen

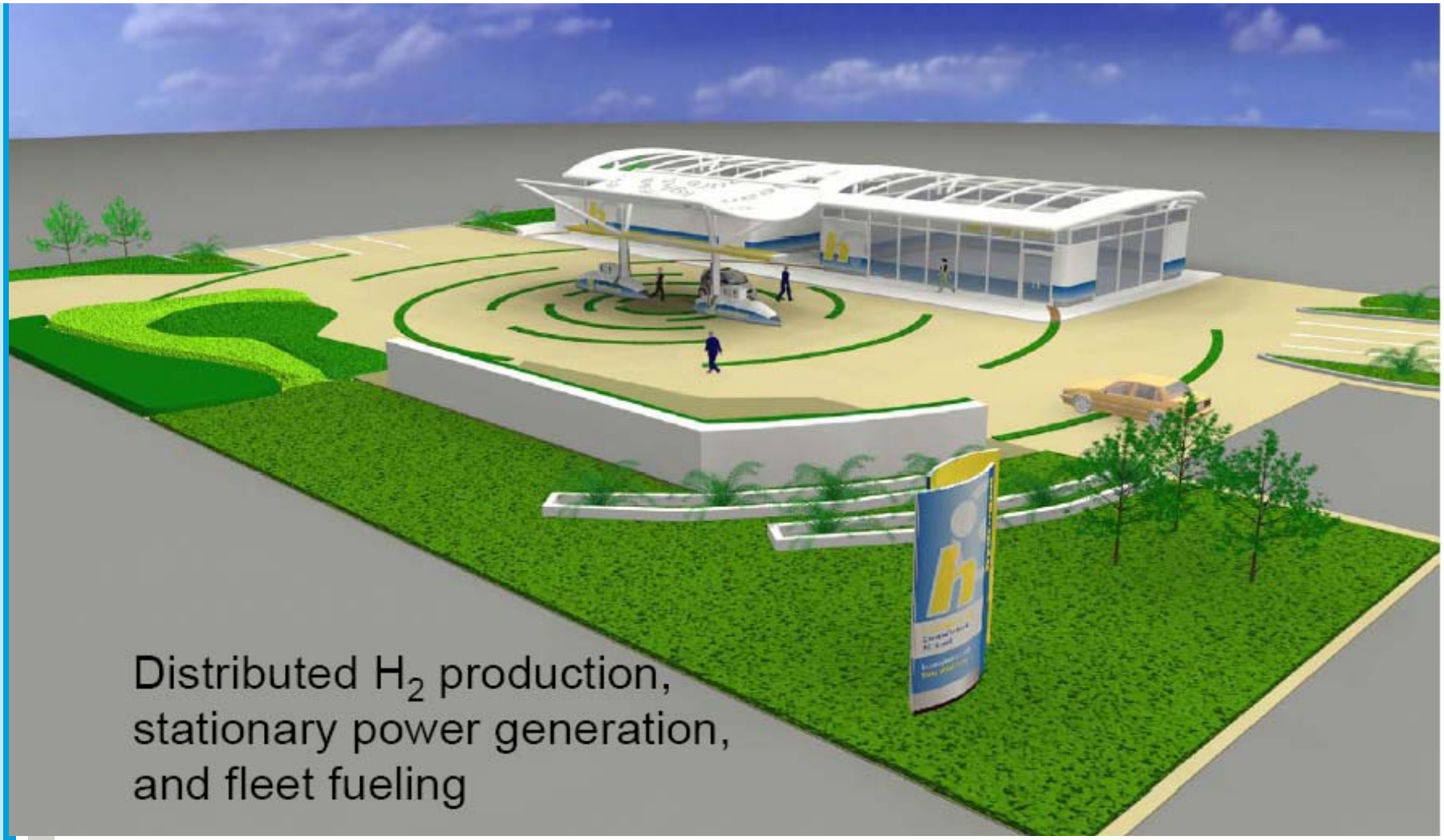
High-Quality
Distributed Power

- Fuel cell installation in Bellaire, TX and San Ramon, CA

Vehicle Fleets

- AC Transit Fuel Cell Bus Program
- US Department of Energy Project

The Hydrogen Highway: moving to the next phase



The Hydrogen Highway: moving to the next phase (18 February 2005)

Chino, California

Hydrogen Fueling Dispenser

Unveiling at Chino, California

Groundbreaking at Orlando, Florida

Business-Driven Actions on Greenhouse Gas Emissions Management

Strong Centralized Greenhouse Gas Management

- Executing the Four-Fold Action Plan
- Climate Change Steering Council

Management Processes and Tools Integrated to Business

- Carbon management systems integrated into business planning
- Multiple emissions-reducing project activities

Carbon Markets Team

- Centrally coordinates trading and credit activities worldwide

Partnerships

- Key opportunity areas to address technology and business development