An industrial perspective of the role of R&D and innovation in frontier gas monetization projects

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3rd Trondheim Gas Technology Conference (TGTC-3). 4th- 5th, June 2014

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Outline

- Technip's credentials
- LNG innovation history
- Innovation within frontier mega projects - FLNG
- Tomorrow's projects and their needs




Technip Today

- With engineering, technologies and project management, on land and at sea, we safely and successfully deliver the best solutions for our clients in the energy business
- Worldwide presence with 40,000 people in 48 countries
- Industrial assets on all continents, a fleet of 35 vessels (9 of which under construction)
- 2013 revenue: €9.3 billion

Energy is at the core of Technip

Technip in Norway

- Technip Norge is a leading EPCI contractor for subsea projects on the NCS
- Main office in Sandvika and Stavanger.
- Spoolbase in Orkanger (Trondheim)
- Norwegian workforce exceeds 600

Technip is also a Norwegian company

Technip is Present Across the Gas Value Chain


Khursaniyah, Saudi Arabia

Oil Field Facilities inc. Shale oil

Associated Gas

Non- Associated Gas

Gas Field Facilities inc. Shale gas

Gas Processing

CO2 Sulphur Water

Methane (C_1)

Onshore Liquefaction

Offshore Liquefaction

GTL

C_3/C_4 LPG

C_5-$_{12}$ Gasoline

C_{5-20} Condensate


Yansab, Saudi Arabia

Ethane (C_2)

Steam cracker (Ethylene)

Petrochemicals
- Ammonia/Urea
- Hydrogen

- Polyethylene
- Polyvinyl chloride…


Qatar LNG


Prelude FLNG


Oryx GTL, Qatar


Phu My Fertilizer, Vietnam

Two projects taking LNG offshore

Prelude FLNG

Petronas FLNG1

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One project in the Russian Arctic

“Using only proven technologies with established effectiveness and reliability”

Yamal LNG

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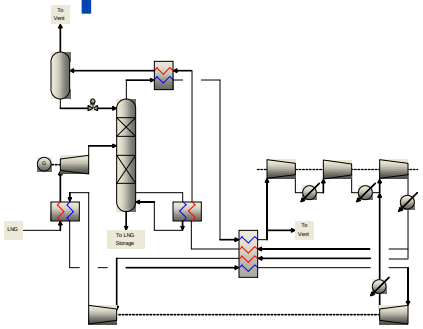
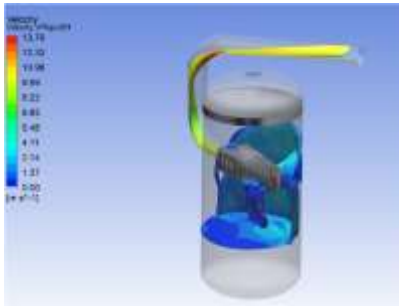
LNG related innovation at Technip



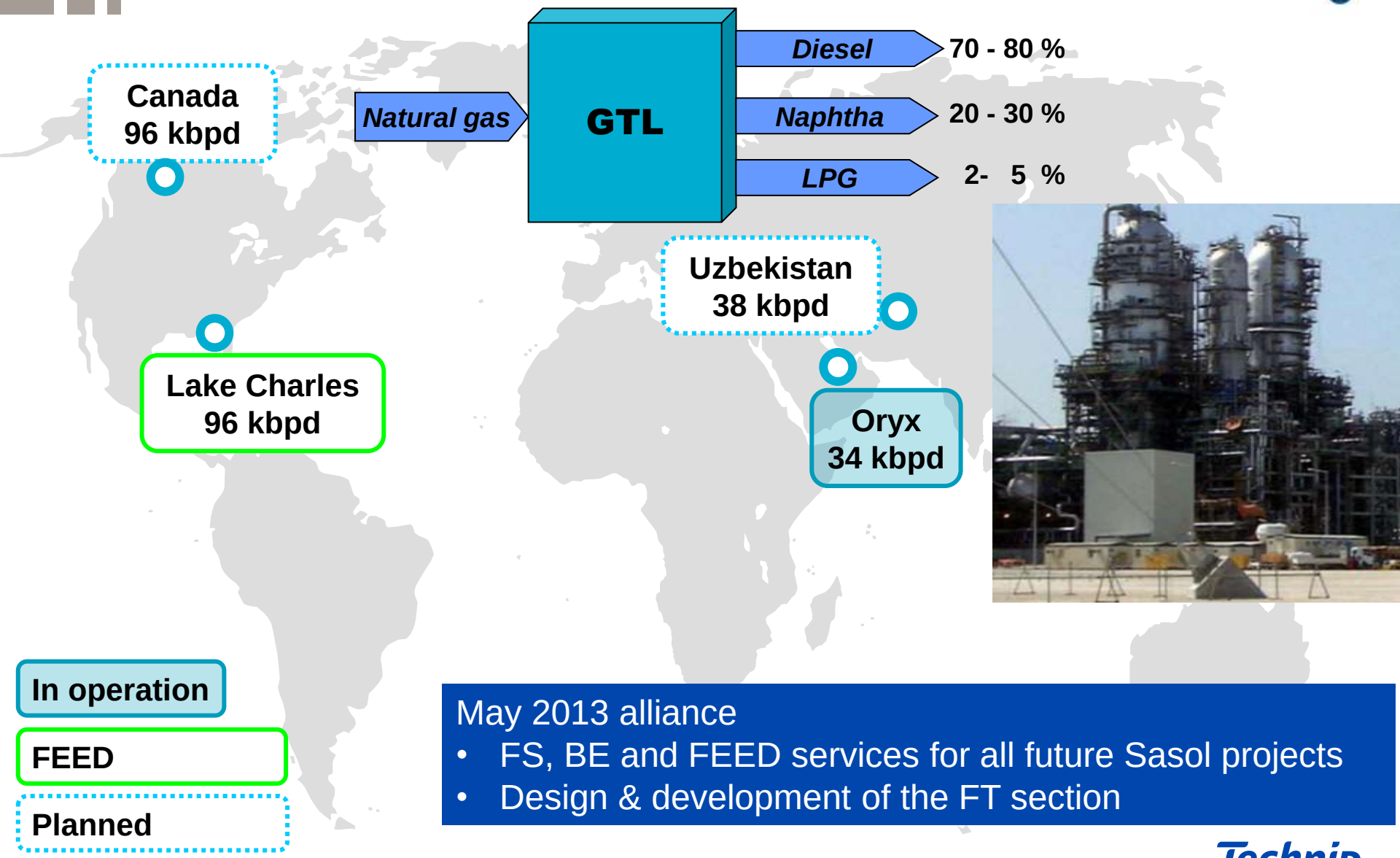
- **Flowsheet development**
  - Cryomax for Gas treatment or Liquefaction
  - Nitrogen rejection from LNG and natural gas
  - High efficiency LNG plants

- **Products developed with manufacturers**
  - Wieland – dual enhanced surface tubes for propane pre-cooling exchangers.
    50% market share in the last 10 years



- **Advanced numerical simulation**
- **FLNG related:**
  - Developments using flexible pipe
  - Cryogenic spill protection

GTL: Sasol alliance

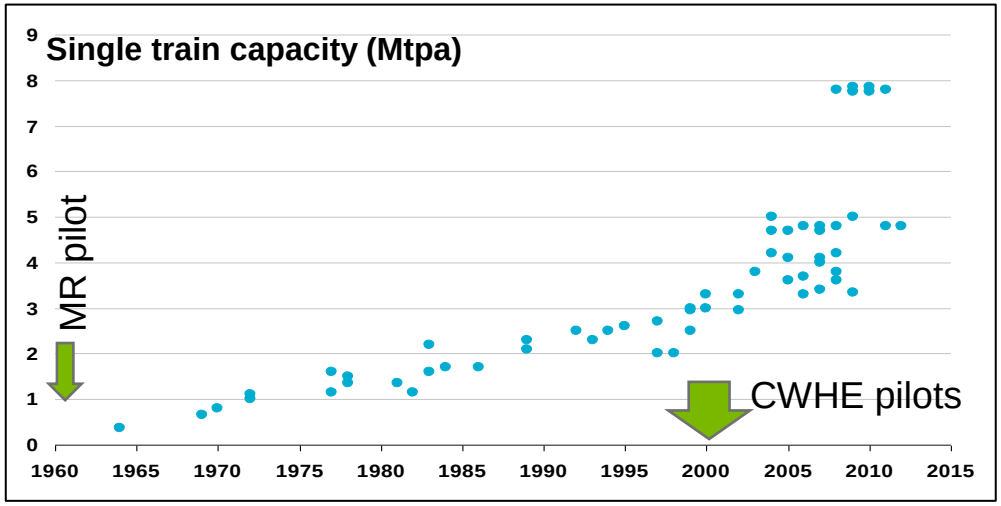


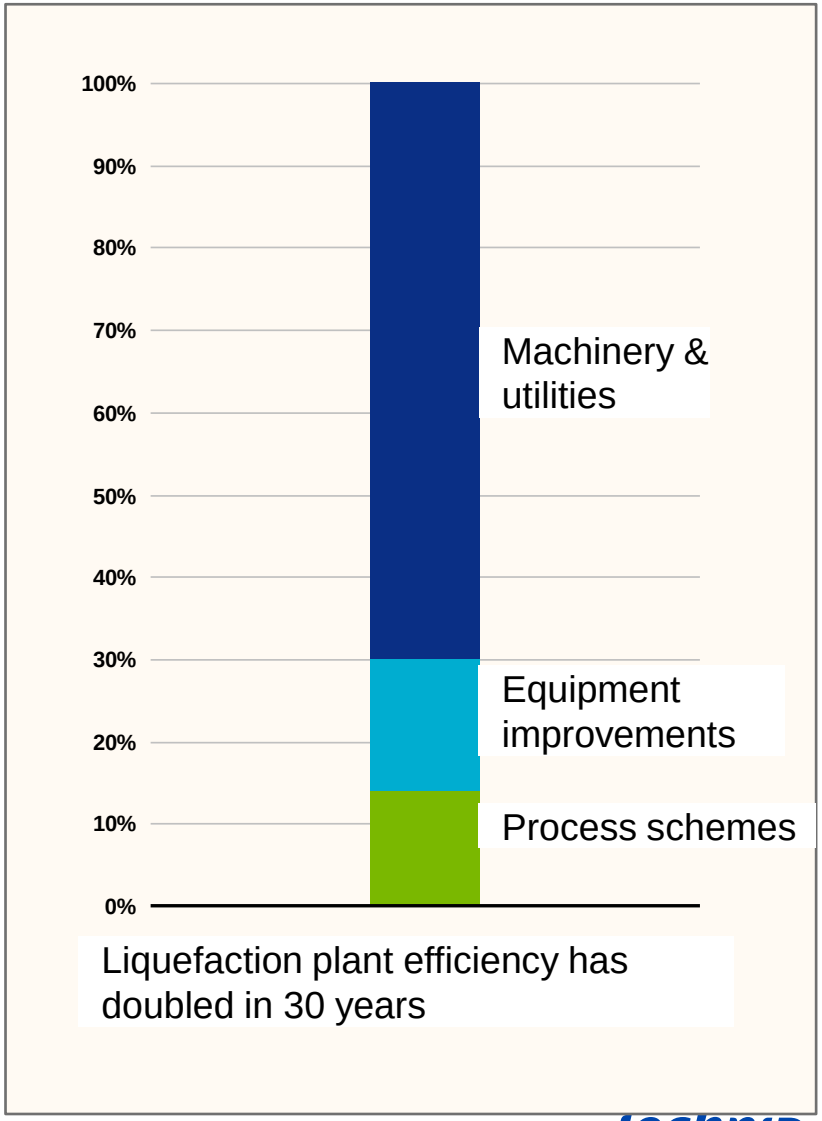
May 2013 alliance

- FS, BE and FEED services for all future Sasol projects
- Design & development of the FT section

II. LNG innovation history

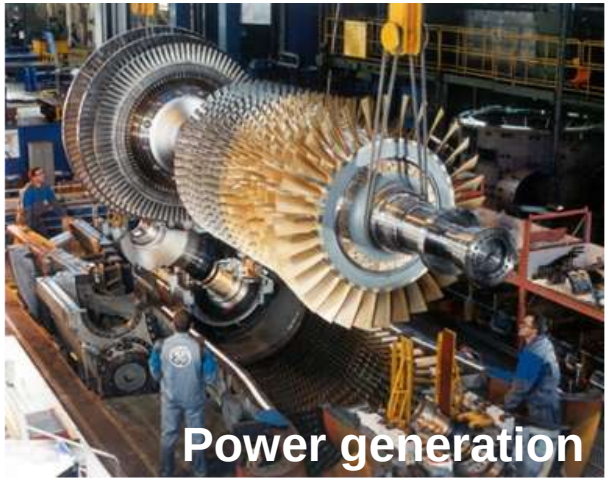
Scale and efficiency … with reliability





The LNG industry borrows and adapts ideas

Mixed refrigerants



Compressor drivers

CO2 removal

Compact equipment

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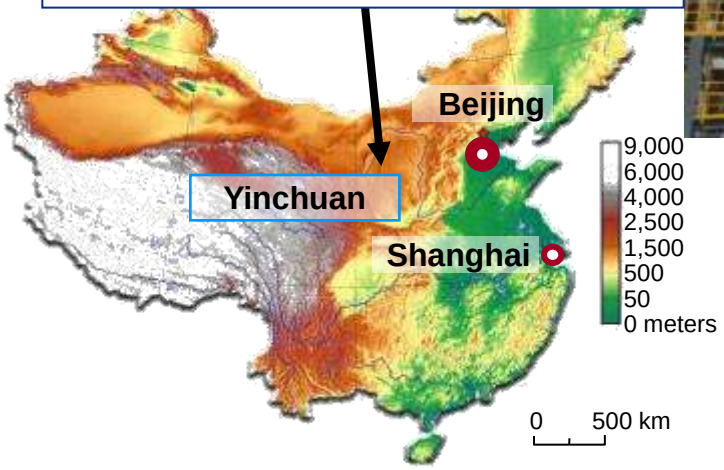
Small scale LNG projects provide opportunities

Innovation α CAPEX^{-1}

Yinchuan City, Ningxia Hanas LNG

- 2 trains x 0.4 Mtpa
- Air Products SMR liquefaction process
- May 2009 – Oct 2011

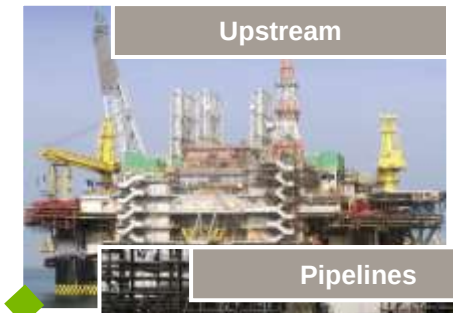


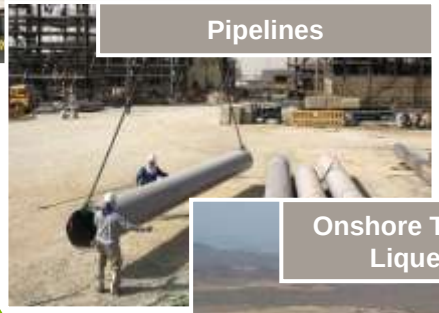
Recent projects, rich in innovation

- Removal of trace heavy components
- Variable speed EM driven compressors
- Nitrogen rejection

III. Innovation within a frontier mega project - FLNG

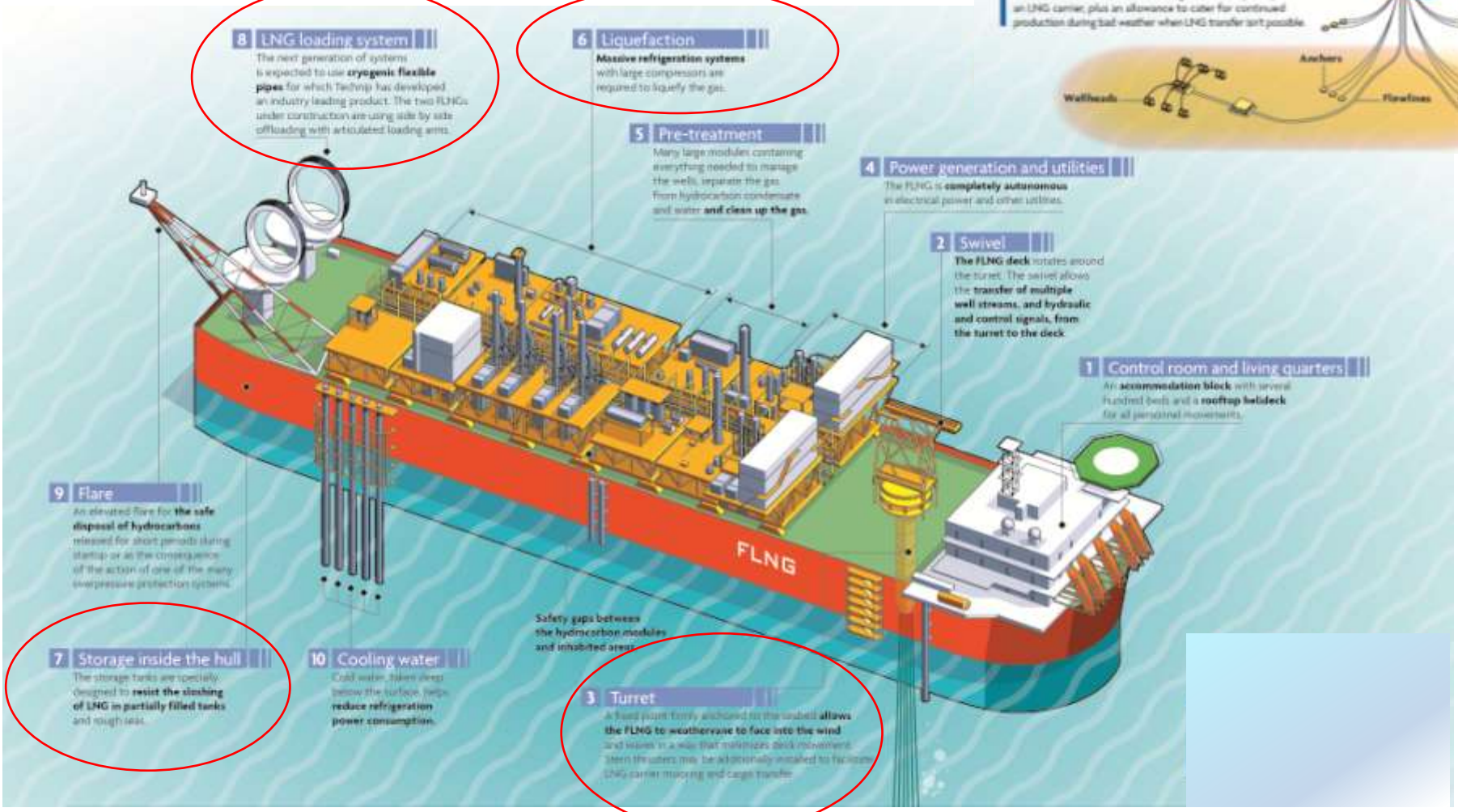
FLNG - mega projects with innovation





The LNG Supply Chain

FLNG – principle innovations



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… From Onshore to Offshore…

Onshore LNG

FLNG

LNG Plant

FPSO

FLNG

- **Deck space management and module congestion**
- **Multiple deck levels including in the hull**
- **Weight control, centre of gravity and liftability of modules.**

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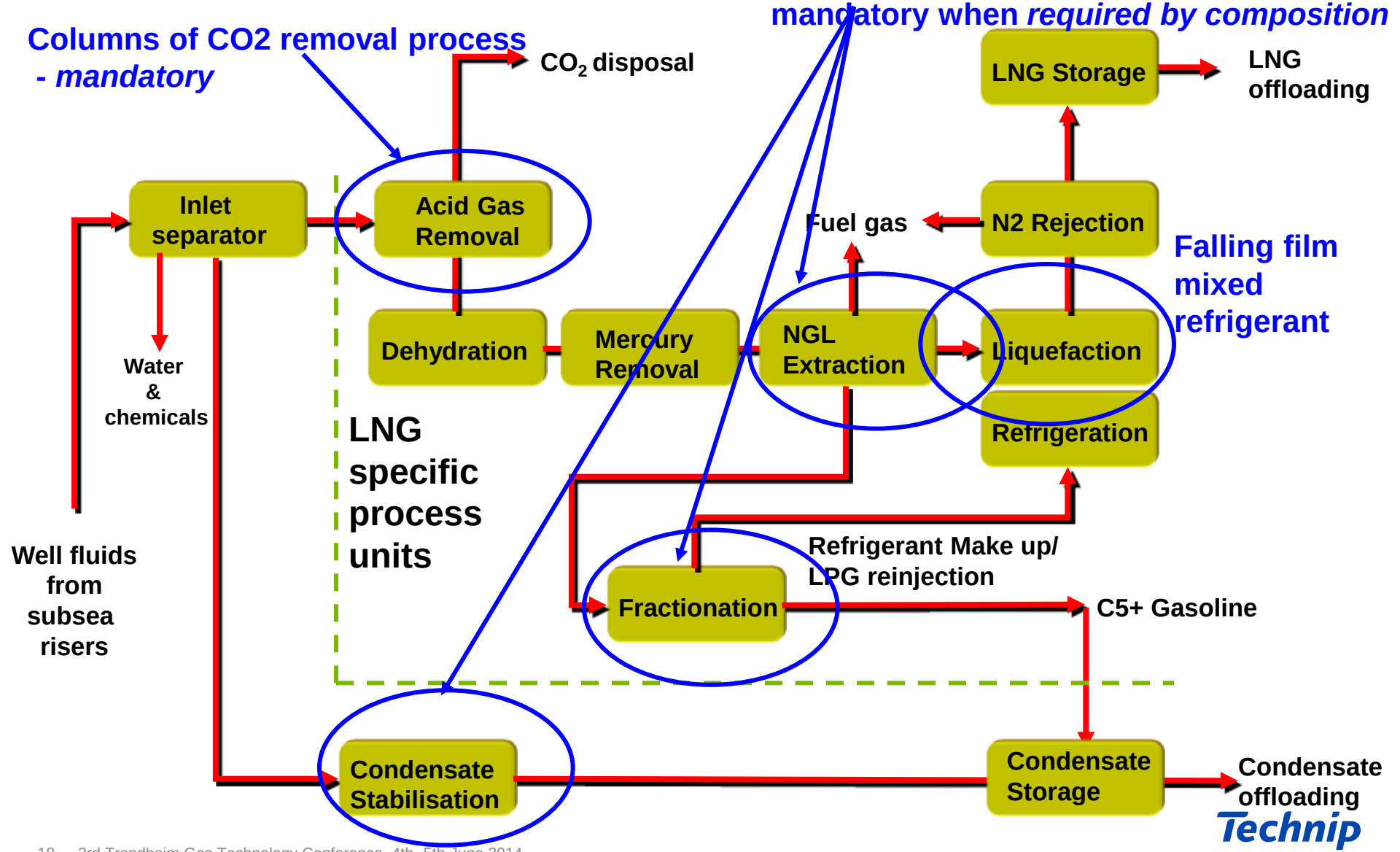
… designing for motion

Columns for condensate stabilisation/ NGL removal/ fractionation/ N2 rejection mandatory when *required by composition*



N2 and DMR Liquefaction Processes

	N2	DMR
Efficiency of liquefaction		✓
Availability of equipment at large scale		✓
HC refrigerant inventory/ inherent safety	✓	
Motion sensitivity	✓	

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Refrigerant Compressor Drivers

- **Steam turbines**
- **Electrical motors**
- **Aeroderivative gas turbines**

			RB211	PGT25+G4	LM6000	Trent 60	LMS100
ISO power (MW)			33.2	33.6	44.8	51.6	100
References	**Onshore**	Power generation	✓	✓	✓	✓	✓
		Mechanical drive	✓	✓	✓ (*)	✓	
	Offshore	Power generation	✓	✓	✓		
		Mechanical drive	✓	✓			

Mechanical design

- **Equipment and piping loads generated by motion**
- **HSE design**
- **Maintenance**
- **Salt and humidity from the marine environment**
- **Early site dates for hull equipment**

Many critical challenges can only be discovered during detailed design & fabrication

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Construction strategy borrowed from FPSO‘s…

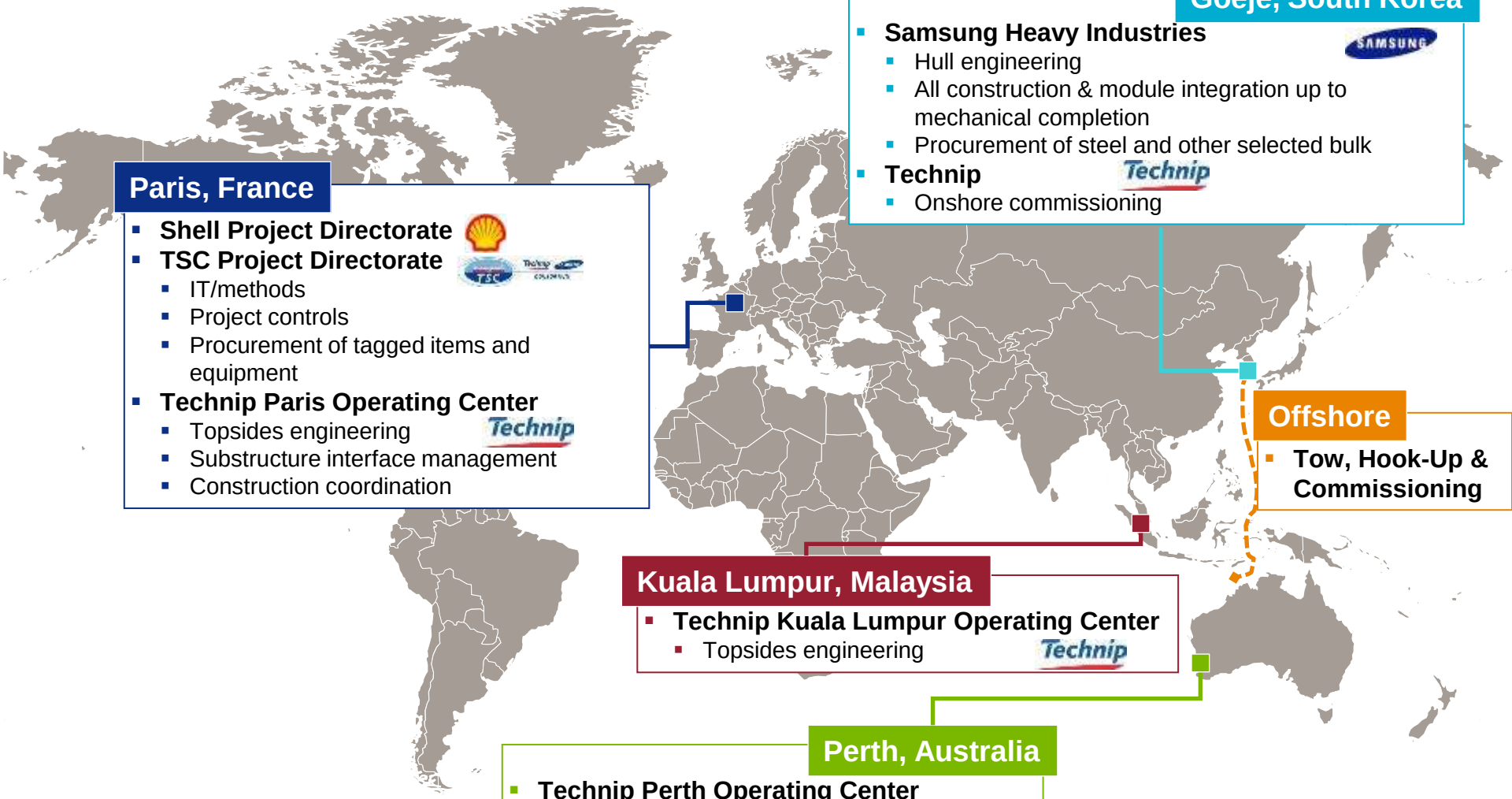
At twice the size

Shell Floating Liquefied Natural Gas Contracts

TSC: Technip Samsung Heavy Industries consortium

- **Master Agreement** **2009**
  The design, construction and installation of multiple FLNG facilities over 15 years
- **Generic FLNG FEED** **2009**
- **Agreement to strengthen FLNG collaboration** **2012**
- **Prelude FLNG**
  - **FEED** **2010**
  - **EPCI** **2010**
    Contract under which the FLNG would be built when the project received the final investment decision
    - **Notice to Proceed** **2011**
    - **Hull steel cut** **2012 Oct**
    - **Topside steel cut** **2013 Jan**
    - **Hull launch** **2013 Nov**

Prelude EPCIC Execution Plan



Goeje, South Korea

- **Samsung Heavy Industries**
  - Hull engineering
  - All construction & module integration up to mechanical completion
  - Procurement of steel and other selected bulk
- **Technip**
  - Onshore commissioning

Paris, France

- **Shell Project Directorate**
- **TSC Project Directorate**
  - IT/methods
  - Project controls
  - Procurement of tagged items and equipment
- **Technip Paris Operating Center**
  - Topsides engineering
  - Substructure interface management
  - Construction coordination

Offshore

- **Tow, Hook-Up & Commissioning**

Kuala Lumpur, Malaysia

- **Technip Kuala Lumpur Operating Center**
  - Topsides engineering

Perth, Australia

- **Technip Perth Operating Center**
  - Subsea engineering & installation
  - Support for regulatory requirements
  - Offshore Hook-Up & Commissioning support

IV. R&D and innovation needs for tomorrow's projects




What is the next technological break-through for FLNG?

- **Improved ROI – larger capacities, economies of scale, lean gas**
  - High power density refrigerant compressors and drivers
  - Compact processing, with gas pre-treatment offering opportunities
  - Improved availability - High amplitude LNG loading system
  - High capacity gas swivels
- **Improved safety**
  - Tandem offloading
  - Improved reliability, lower maintenance
- **Rough sea FLNG**
- **Deepwater FLNG**

Major breakthroughs will result from the operational feedback from the first FLNG's

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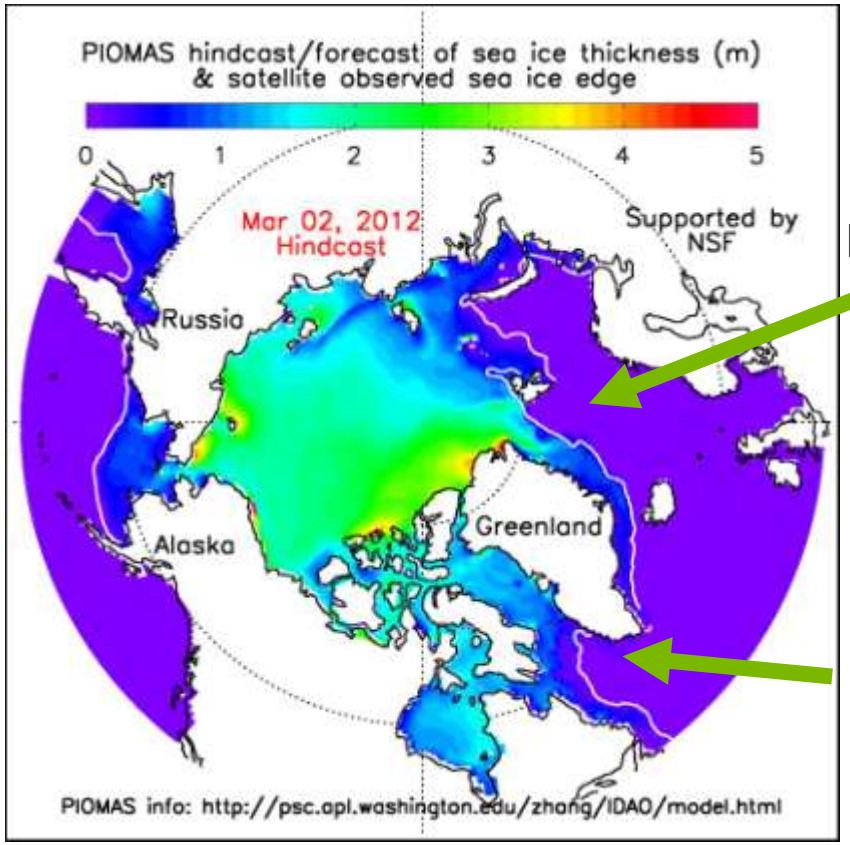
Winterized FLNG as an ultimate goal?

- **Yamal LNG has come after 100 LNG trains onshore**
- **How many FLNG's before we're ready for Arctic FLNG?**

- **Compact processing**
- **Low staffing**
- **High reliability**
- **Compact HVAC**
- **etc**



Barents Sea

Greenland

Conclusion

- **Major operators need to lead major developments**
- **EPC contractors can cross fertilize and drive implementation**
- **Suppliers have a key role**
- **Small scale LNG enables innovation**
- **Research organisations can contribute to all of the above**

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