Take a deep breath, as we plunge below the water line to look at the subsea systems which supply our Floating LNG production.

Why do we need to consider the subsea part? Well the subsea part is not just “business as usual”.

In fact, just as Floating LNG is a game changer, so the subsea part has to be re-engineered too:

- Firstly, to take advantage of the new opportunities that come from having the LNG plant right next to the gas reservoirs, instead of hundreds of kilometres away,
- And secondly, to avoid the pitfalls that can come with this new technology.
The context in which I’m speaking is the Browse LNG type developments, with massive offshore infrastructure, long distance subsea pipelines, and onshore LNG plants, being developed instead with Floating LNG.
I believe that these Floating LNG developments can be described as “Smaller, Smarter, More Dangerous”, and I’m going to outline a framework of what I mean by those words, and then give a case study to put some flesh on the bones.
To see how FLNG compares with typical LNG developments, you need to understand that FLNG is small. Prelude is only 3.6 MTPA. Typical fields would require 2 or 3 FLNG vessels. Woodside say they will need 3 for Browse.

Mind you, Exxon Mobil are talking about a 7 MTPA facility for Scarborough, though I think that’s a bit ambitious.

The Shell Prelude vessel is designed for 3.6 MTPA of LNG, but also produces 1.3 MTPA of condensate and 0.4 MTPA of LPG.

For a field with no liquids, the processing equipment on a Prelude-sized vessel could handle 5 MTPA of LNG.

At this point, you may be beginning to see some cracks in the concept of the one-size-fits-all FLNG approach.

Reservoirs are different sizes, and contain different amounts of gas and liquids. It’s unlikely that you can just move an FLNG from one field to another, the processing equipment on board would have to be changed.
Having FLNG close to wells is an enabler
- Allows pipeline heating
- Reduces dependence on chemicals

Shorter distance to wells
- No need for compression or boosting
- Less failure-prone equipment on the seabed
- Slugs and liquid hold-up in flowlines is less of a problem

With remote subsea gas fields, you can’t use some of the new technologies that are available.

For example, big fields like Gorgon and Snohvit use MEG injection to prevent hydrate formation. Conventional developments like these can’t use heated flowlines because the distance is too great and the power losses would be excessive.

With a FLNG vessel close to the wells, you can have electrically heated flowlines, which avoids the problems of handling the chemical MEG.

Another benefit of shorter distances is that new technologies such as subsea compression and pumping and separation are not needed, which means there is less equipment on the seabed which can fail. And that too is smart.
More dangerous?  Well, putting explosive or inflammable things close together is a recipe for disaster. We saw this in the pipeline rupture and fire at Varanus Island, where the narrow pipeline corridor resulted in one ruptured pipeline setting off another and then another.

FLNG vessels are big – very big – and they use air gaps between modules. But putting all that equipment close together increases the risk of escalation. Also, hooking the FLNG up to the subsea system increases the risk.

We’ve also go the issue of technical risk. The previous Shell Australia head Ann Pickard described FLNG as the potential "saviour" of Australia’s LNG industry. She said that FLNG technology represents a way for Australia’s LNG industry to become more cost-competitive in the face of potentially cheaper LNG exports out of the United States and Canada.

She said “The Australian LNG industry has a major problem in general. Floating is the most cost competitive new entrant to LNG in Australia. We do see it as probably the potential saviour of the Australian LNG industry over the next decade or so.” Woodside seem to have bought into that, too.  But is that naïve, for an unproven technology?

Another area of concern is the availability of FLNG systems. Conventional systems have the benefit of long pipelines which act as a buffer and allow LNG production to continue when the subsea system is down. FLNG systems don’t have this buffer. If the subsea system trips, you have to shut down LNG production. Recycling the gas around the process may buy you a bit of time, but eventually you have to shut down. You are totally reliant on a high availability subsea system.
Constraints of FLNG

► Smaller size of FLNG
  • Too small for the big WA fields
  • Browse needs 3!

► FLNG entirely offshore
  • Needs crew offshore (Prelude needs 110 man crew)
  • Needs crew change/personnel transfer

Explain about constraints.
Tell the wolf story.
Explain about constraints.
Tell the wolf story...

Two fur trappers, Jacques and Pierre, were up in the great white north in a quest for wolf pelts, which were bringing in good money back in those days. One night they were awakened by the sound of snarling and growling. They looked out of their tent and discovered that they were surrounded by a vicious pack of wolves. Their hunting gear was out of reach, and so they were basically defenceless. Jacques turned to Pierre and said, “Those wolves look mean and hungry, and there are about fifteen of them and only two of us. I guess you know what that means.” And Pierre answered, “Yeah, we’re rich!”

Turning constraints of FLNG to advantage

- Smaller size of FLNG
  - Allows phased development of larger fields
  - Reduces financial exposure and initial CAPEX

- FLNG entirely offshore
  - Reduces exposure to environmental direct action
  - Avoids onshore protest activity (e.g. James Price Point)
  - Still some risk from offshore activism

- FLNG entirely offshore
  - Less risk of environmental approval delays or native title issues

- FLNG entirely offshore
  - No requirement for WA Domgas

These apparent constraints actually confer some very significant benefits.
- The smaller size of FLNG means there is reduced financial exposure and the CAPEX is lower.
- Being entirely offshore means that protests and direct action are less likely.
- The approvals process may be simpler.
- And it may avoid a requirement for Domgas in Western Australia.
Let’s look at how the smaller size of FLNG allows us to have phased developments.
Smaller size of FLNG
- Allows phased development of larger fields (3 FLNG for Browse)
- Reduces financial exposure and initial CAPEX

For example, a Browse sized field with 3 FLNGs would not have them all coming online at the same time. They would be built and installed in phases, so the initial outlay is only for a single FLNG, not three.

Once the first FLNG is installed and commissioned, it starts generating revenue, so a second and then a third can be brought into service.

The benefit of the phased development is that the financial exposure is far less than for conventional developments, where the entire system has to be built before any LNG can be produced.
Turning constraints of FLNG to advantage

- Smaller size of FLNG
  - Allows phased development of larger fields (3 FLNG for Browse)
  - Reduces financial exposure and initial CAPEX

- Going from MEGA-Project to Mini-MEGA-Project

In effect, we are going from MEGA-Projects to Mini-MEGA-Projects. For brevity, I shall refer to the Mini-MEGA-Projects as Mini-Me.
Turning constraints of FLNG to advantage

- **Smaller size of FLNG**
  - Allows phased development of larger fields (3 FLNG for Browse)
  - Reduces financial exposure and initial CAPEX

- Going from MEGA-Project to Mini-MEGA-Project

$50-60$ billion exposure $13$ billion exposure

Now, although I’m showing Dr Evil and his naughty little clone here, neither type of project is actually evil. But that is not the perception of 4% of the public.
In fact, 4% of the public strongly oppose gas developments, indeed they are ideologically opposed to fossil fuel use and climate change through human activity. This survey by the Australian Petroleum Production & Exploration Association shows that part of the community opposes the type of developments that we are discussing, with a small part in strong opposition. A large part of the community hold the middle ground on these issues. It’s important for oil and gas companies to manage those who strongly oppose them, and also seek the favour of those holding the middle ground. Besides exploration licences and production licences, companies need a “social licence” to operate.
FLNG entirely offshore

- Reduces exposure to environmental direct action
- Still some risk from offshore activism
- Avoids onshore protest activity (e.g. James Price Point)
- Avoids protracted delays (e.g. Corrib)

So taking the activities offshore can reduce the opportunities for protest and consequent delays.
We saw protest at James Price Point, and there have been extended delays at Shell Corrib in Ireland.
First gas on Corrib should have been in 2007
However, there were protests from locals who felt that Shell was not listening to their concerns about an onshore pipeline running past their houses. Jailing them turned the protestors into heroes, and there was a groundswell of support and resistance from the community and the international environmental lobby.
An independent safety review failed to impress as the community had lost confidence in the proponents.
Legal challenges and appeals about the environmental approvals caused further delays, with the onshore pipeline being re-routed.
Turning constraints of FLNG to advantage

- FLNG entirely offshore
  - Reduces exposure to environmental direct action
  - Still some risk from offshore activism
  - Avoids onshore protest activity (e.g. James Price Point)
  - Avoids protracted delays (e.g. Corrib)

- Shell Corrib
  - Mediation failed – “the parties are unable to resolve the differences between them”
  - “Shell has learned, through listening, that you need to go beyond compliance to win the trust of your neighbours”

Despite attempts at mediation, the landowners and Shell were unable to come to agreement.

It’s important to recognise that the 4% who strongly oppose gas developments will not be persuaded by anything we say or do to change their mind. They have to be managed in a way that offends them and makes them seem unreasonable or cranks, because that will distance them from the undecided majority and make them more in favour of our gas developments.

Shell said this about Corrib, but I don’t think they actually learned it. In fact, at the start of the week, Shell’s Australian chairman Andrew Smith put Premier Colin Barnett on notice over his opposition to floating LNG, saying WA risked losing the chance of playing host to the fledgling multibillion-dollar global industry. I don’t sense much listening there, just the arrogance that got them into trouble on Corrib.
Is the tolerance of green activism changing?

► Paul Watson of Sea Shepherd has faced legal action from the United States, Canada, Norway, Costa Rica, and Japan
  • After skipping bail following an arrest in Germany in 2012, Interpol issued red notices requesting his arrest.

► The activist who caused a $314 million temporary plunge in Whitehaven Coal's share price could face 10 years in jail
  • Jonathan Moylan issued a fake ANZ press release claiming ANZ had pulled a $1.2 billion loan because of environmental concerns

► Greenpeace vessel Arctic Sunrise arrested by Russia
  • Piracy charges for boarding the Gazprom drill rig Prirazlomnaya have been downgraded to hooliganism

► Senator Eric Abetz says
  • "With the Greens it is always a case of the ends justifying the means."
Turning constraints of FLNG to advantage

- FLNG entirely offshore
  - Potentially no requirement for WA Domgas
  - Western Australia’s domestic gas reservation policy, instated in 1977, was updated in 2006 and requires LNG Producers to make available domestic gas equivalent to 15% of LNG production from each LNG export project
  - Sales revenue of export gas and domestic gas (15% of total gas production) are approximately $12/MMBTU and $8/GJ

Domgas comprises 15% of LNG production but only gets 8% revenue due to the lower sales price of Domgas.

Another interesting thing from the piechart is that condensate and LPG can generate a large revenue stream in addition to LNG sales.
New subsea technologies for FLNG

Heating of flowlines for hydrate prevention
- Direct electric heating or trace heating or heated water pipes
- Eliminate need for MEG
- Eliminate need for MEG reclamation on FLNG vessel

Why?
- Shell Prelude has 800 m$^3$/day MEG regeneration system to provide buffer storage, collection and regeneration of MEG
- MEG facilities including MEG storage tanks, MEG desalination package, MEG regeneration and MEG booster pumps

MEG module for offshore Brazil application
Rich MEG flow 120 m$^3$/day
300 tonne module

Image: Cameron
New subsea technologies for FLNG

- **Direct Electrical Heating (DEH)**
  - AC current to pipe
  - Field Proven: Single phase required
  - High voltage and power required (100-150 W/m)

- **Electrical Heat Tracing (EHT)**
  - Heating cables between pipe and insulation
  - Pipe in Pipe (PIP)
  - AC three phase power
  - Low voltage, low power (4-30 W/m)
  - Higher safety, less dielectric ageing
  - Qualified wire traces and subsea connectors
  - Allows redundancy

- **Integrated Production Bundle (IPB)**
  - Hot water tubes between pipe and insulation
  - Use spare heat from compression / power generation
  - Use for risers

DEH
AC current to pipe - return through pipe or external cable
Field Proven: NaKika (Shell, GOM) – 5 cases in Norway (Statoil)
New subsea technologies for FLNG

- Electrical Heat Tracing (EHT)
  - Low voltage, low power (4-30 W/m)
  - Redundant trace heating cables
  - Fibre optic for thermal monitoring

The power required is relatively small, and the highest demand is during pipeline warm-up, when the wells are not producing, and the platform power is not needed for processing and liquefaction. When maintaining the temperature, the power demand is less.
New subsea technologies for FLNG

- Electrical Heat Tracing (EHT)
  - Low voltage, low power (4-30 W/m)
  - Redundant trace heating cables
  - Fibre optic for thermal monitoring

<table>
<thead>
<tr>
<th>Maintain temperature above HAT (ca 20°C)</th>
<th>Power required per metre</th>
<th>Overall power required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maintain temperature above HAT (ca 20°C)</td>
<td>4 to 8 W/m</td>
<td>Ca. 50 kW</td>
</tr>
<tr>
<td>Heat up pipeline from 4 to 20°C in 24 hours</td>
<td>15 to 20 W/m</td>
<td>Ca. 120 kW</td>
</tr>
<tr>
<td>Heat up pipeline from 4 to 20°C in 30 hours with 15% of hydrates</td>
<td>30 W/m</td>
<td>Ca. 180 kW</td>
</tr>
</tbody>
</table>

The power required is relatively small, and the highest demand is during pipeline warm-up, when the wells are not producing, and the platform power is not needed for processing and liquefaction.
When maintaining the temperature, the power demand is less.
New subsea technologies for FLNG

Reeled installation
- Faster than S-lay or J-lay
- Fabrication is performed onshore
- Controlled environment, off the critical path
- Weld repairs are performed onshore

The Electrical Heat Traced Pipe in Pipe used on the Islay project was installed by reel lay, which offers faster installation than methods such as S-lay and J-lay where pipes are welded together on the pipelay vessel. A completer reel length is fabricated onshore in controlled conditions, and reeled onto the installation vessel, taken out to the field, and unreeled onto the seabed. Lay rates of up to 16 kilometres per day can be achieved with reel lay. The Electrical Heat Traced Pipe in Pipe is qualified for sizes up to 12” which makes it ideally suited for FLNG developments. These don’t have the 40” export pipelines need by the Gorgon and Ichthys type projects. So we can use spare power or waste heat, and use reel installation. It gets rid of the MEG recycling equipment and frees up space on the vessel. It’s like the planets coming into alignment, everything is right for this new technology.
Risks to FLNG from subsea developments

- Risk is higher with FLNG than FPSOs
  - Risk = Likelihood x Consequence
  - Likelihood is higher with gas than with oil developments
  - Consequence of loss of FLNG = $13 billion  
    Shell Prelude
  - Consequence of loss of FPSO = $1.5 billion  
    UIBC 2012 data

Shell statement in Prelude EIS
- After comprehensive studies, model testing and in-depth reviews, 
  Shell’s FLNG design safety is considered equal to the latest FPSO or 
  integrated off shore facility.
Risks to FLNG from subsea developments

The Real Estate for Browse LNG at James Price Point

Image: Woodside
Risks to FLNG from subsea developments

The Real Estate for Prelude

Image: Woodside
Risks to FLNG from subsea developments

The Real Estate for 3 x FLNG
### Case Study – Browse LNG Development

Major gas fields: development status, as of March 2012

<table>
<thead>
<tr>
<th>Field</th>
<th>Basin</th>
<th>Gas Resources tcf</th>
<th>Condensate Resources mbbl</th>
<th>Total Resources PJ</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater Gorgon (including Gorgon, kyUsmitz, Chrysaor, Dionysus, Tyal Rocks West, Spar, Orthrus, Maerad, Geryon and Urania)</td>
<td>Carnarvon</td>
<td>&gt;400</td>
<td>-</td>
<td>&gt;44,000</td>
<td>under construction</td>
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<tr>
<td>Ichthys</td>
<td>Browse</td>
<td>12.8</td>
<td>527</td>
<td>17,179</td>
<td>committed</td>
</tr>
<tr>
<td>Woodside Browse project (including Tansea, Bradnock and Callian)</td>
<td>Browse</td>
<td>14</td>
<td>370</td>
<td>17,579</td>
<td>undeveloped</td>
</tr>
<tr>
<td>Greater Sunrise (including Sunrise and Troubadour)</td>
<td>Bonaparte</td>
<td>5.13</td>
<td>226</td>
<td>8,972</td>
<td>undeveloped</td>
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<tr>
<td>Evans Shoal</td>
<td>Bonaparte</td>
<td>6.6</td>
<td>31</td>
<td>7,442</td>
<td>undeveloped</td>
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<tr>
<td>Scarborough</td>
<td>Carnarvon</td>
<td>5.2</td>
<td>-</td>
<td>5,720</td>
<td>undeveloped</td>
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<tr>
<td>Pluto (including Xena)</td>
<td>Carnarvon</td>
<td>5.05</td>
<td>72.6</td>
<td>5982</td>
<td>In production</td>
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<tr>
<td>Wheatstone</td>
<td>Carnarvon</td>
<td>4.5</td>
<td>-</td>
<td>4,950</td>
<td>under construction</td>
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<tr>
<td>Clio</td>
<td>Carnarvon</td>
<td>3.5</td>
<td>-</td>
<td>3,850</td>
<td>undeveloped</td>
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<tr>
<td>Chandon</td>
<td>Carnarvon</td>
<td>3.5</td>
<td>-</td>
<td>3,850</td>
<td>undeveloped</td>
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<tr>
<td>Prelude (including Concerto)</td>
<td>Browse</td>
<td>2.5</td>
<td>120</td>
<td>3,456</td>
<td>under construction</td>
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<tr>
<td>Thebe</td>
<td>Carnarvon</td>
<td>2.4</td>
<td>66</td>
<td>2,200–3,300</td>
<td>undeveloped</td>
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<tr>
<td>Crux</td>
<td>Browse</td>
<td>1.8</td>
<td>-</td>
<td>2,368</td>
<td>under construction</td>
</tr>
</tbody>
</table>

Courtesy: Geoscience Australia
Case Study – Browse LNG Development

<table>
<thead>
<tr>
<th>Reservoir</th>
<th>Gas (Tcf)</th>
<th>Condensate (MMbbl)</th>
<th>CO₂ Content</th>
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</thead>
<tbody>
<tr>
<td>Torosa</td>
<td>8.5</td>
<td>159</td>
<td>8%</td>
</tr>
<tr>
<td>Brecknock</td>
<td>4.0</td>
<td>144</td>
<td>8%</td>
</tr>
<tr>
<td>Calliance</td>
<td>3.0</td>
<td>114</td>
<td>12%</td>
</tr>
</tbody>
</table>

Remoteness of Browse Basin from Existing Infrastructure

Challenging Access

Courtesy: UWA Subsea Technology 2013 Team 1
Perspective view of Scott Reef from the west.
The coral atoll Scott Reef is located in 500 m water depth on the edge of the continental shelf.
Note the deep channel with steep sides between the two reefs.
This concept is unlikely to get environmental approval. But it has the singular benefit of being the most cost-effective way of developing these reserves.
$150 million study for Browse LNG DTUs
Paul Howes of the Australian Workers' Union described the decision by Woodside to shelve the LNG project at James Price Point as “the great Australian rip-off”. Rita Augustine of the Jabirr Jabirr tribe was in tears as she spoke of feeling let down and deeply saddened that benefits from the project appeared lost to her people. She said “These people who were protesting were selfish towards our people, even the protesters that came from overseas. It had nothing to do with them. It is not their country.”
The central processing facility Samsung Heavy Industries will build for Ichthys will cost $2.26 billion.

The pipeline for 889 kilometers gas transmission costs $1 billion

The onshore LNG plant near Darwin including two LNG trains with a capacity of 4.2 million tons per year each costs $15 billion.

The Ichthys subsea facilities cost $2 billion.
Case Study – Browse LNG Development

Challenging Reservoir

Courtesy: UWA Subsea Technology 2013 Team 1
Case Study – Browse LNG Development

Challenging Environment

Courtesy: UWA Subsea Technology 2013 Team 1
We came up with 3 development concepts: The first option is Subsea-to-shore directly tie-back to onshore terminal. This option provides flexibility while minimising CAPEX by eliminating the need of offshore processing facilities. One of the major issues of this solution is flow assurance issue. These issues would be controlled from the shore terminal which is the main challenges to the concept. Option B is using Offshore processing facility concept similar to the first concept, but instead of having control and say MEG distribution from shore, this will be supplied from the platform. Any solution which involved chemical treatment is easier to be implemented using a topside. In addition, condensate processing could be done on this facility & transferred to FPSO. Whilst the processed gas from this processing facilities could be exported to either the James Price Point, Karratha or possibly tie in to Inpex Ichthys pipeline. We also considered the use of fixed platform for processing located at the shallow water.

FLNG reduces the number of elements in the supply chain: no offshore platformFPSO, pipeline to onshore plant or onshore infrastructure required. Whilst it potentially saved the infrastructure cost; the risk and technology associated with this solution would be incorporated in cost calculation.

Option A Standard industrial solution is by MEG injection to prevent hydrate plugging in the flowline.

Option C This is a novel concept that currently being built by Shell for Prelude Project.
Explain about reservoir boundary, planned location of sweet spots
Phased development
It should be noted that Torosa South is the most difficult reservoir to develop. By this sequential the development, we could do more studies on the best technology to develop Torosa South.
Case Study – Browse LNG Development

- NPV = $31.78B, IRR = 6.87%
- NPV = $27.46B, IRR = 5.78%
- NPV = $35.03B, IRR = 10.53%

Arrow shows the Start of Production

Cash flow

No data available for the diagram.
At first glance, it’s similar to Prelude.

But there are some significant differences.

The single umbilical on Prelude is recognised as a single point of failure, so dual umbilicals are used to each drill centre.

There are two CO2 injection wells for disposal of CO2. On Prelude, the 7% CO2 is simply vented to atmosphere.
Manifold: B01
• Phase 1 (6ea)
  Slot - S01,S02,S03
  • Phase 2 (3ea)
  Slot - S01,S02,S03
  • Phase 3 (3ea)
  Slot - S01,S02,S03

Manifold: B02
• Phase 1 (6ea)
  Slot - S01,S02,S03

Manifold: B03
• Phase 1 (6ea)
  Slot - S01,S02,S03
  • Phase 4 (1ea)
  Slot - S04

Injection Wells
• Phase 1 (2ea CO₂ Injection wells)
Water depth: 290 m

Manifold: T03
Phase 4 (2ea)
Slot - S01,S02
Phase 5 (1ea)
Slot – S03

Manifold: T02
Phase 3 (2ea)
Slot - S01,S02

Manifold: T01
Phase 2 (6ea)
Slot - S01,S02,S03,S04,S05,S06

Injection Wells
Phase 2
(2ea CO₂ injection wells)

Field Layout: Torosa – North

Injection pipeline
Flowline
Umbilicals
Spare slot
Manifold
Production A-tree
Injection X-tree
PLET
UTA
SDU
Riser base + SSIV
Production pipeline

20/10/2018

Subsea Developments for FLNG Production
Torosa South

Uses the FLNG vessel from the depleted Calliance field.

Drilling and production from inside the reef will not be permitted, so all drilling takes place from outside the reef, and outside the reservoir, using deviated drilling to reach in from the wellheads to the reservoir itself. This will need directional drilling with a reach of 6 or 7 kilometres, which is on the edge of current technology, but should be easier in 15 years time.
### Case Study – Browse LNG Development

![Image](INTECSEA)  

**Subsea Developments for FLNG Production**

**20/10/2018**  

**WorleyParsons Group**

<table>
<thead>
<tr>
<th>Year</th>
<th>Field</th>
<th>Concept</th>
<th>Subsea</th>
<th>FLNG</th>
<th>topsides</th>
<th>Process</th>
<th>Costs</th>
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</thead>
<tbody>
<tr>
<td>2018</td>
<td>Browse</td>
<td>Underway</td>
<td>N/A</td>
<td>N/A</td>
<td>Open</td>
<td>N/A</td>
<td>N/A</td>
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<td>2019</td>
<td>Browse</td>
<td>Underway</td>
<td>N/A</td>
<td>N/A</td>
<td>Open</td>
<td>N/A</td>
<td>N/A</td>
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<td>2020</td>
<td>Browse</td>
<td>Underway</td>
<td>N/A</td>
<td>N/A</td>
<td>Open</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Courtesy: UWA Subsea Technology 2013 Team 1*
Case Study – Browse LNG Development

Brecknock Gas Field Reservoir Zone “Assumed” Schematic
(Modified from statoil’s snorre gas field development)

Carbon Sequestration

 Courtesy: UWA Subsea Technology 2013 Team 2
Case Study – Browse LNG Development

Project Economics Key Figures

**CAPEX** - $46.16B Total Project Cost
- FLNG -$42.92B
- Subsea -$3.24B

**OPEX** - $440M per FLNG vessel annually
including fuel, staff, transport assistance

**NPV**<sub>10</sub> $35.03B
**IRR** 10.53%

Parliamentary Enquiry CALDWELL/METCALFE/ BP - FLNG proposal will likely result in an internal rate of return of somewhere between 12.5 per cent to 13 per cent and that the onshore project would likely have returned somewhere around 11.5 per cent
The Shell Prelude development
- Single umbilical – single point of failure
- 9% CO2 vented up flare stack – 2.3 MTPA

SSIVs at riser base, 4 12” flexible risers
The South Sea Bubble was the first stock market crash, and it peaked and crashed in 1720.
The South Sea Bubble
- 1718-1721
- The first stock market crash

Sir Isaac Newton, celebrated here on the British pound note, was an early investor. Fortunately, he got out early, making a small fortune.
The South Sea Bubble

- 1718-1721
- The first stock market crash

However, when he saw that the stock price was still going up, he reinvested heavily just before the market collapsed. And he lost a large fortune.

He’s reputed to have said “I can calculate the motion of heavenly bodies, but not the madness of people.”

I think the FLNG market is overheated for two reasons:
Firstly, the South Sea Bubble effect. Everyone is trying to get on the bandwagon. Eventually the market will stabilise with a “horses for courses” approach to conventional developments and FLNG.
Secondly, FLNG is being used as a lease retention strategy. In Australia, companies can’t just sit on reserves and not develop them. If they don’t bring them to production, they need to explore the lease by seismic or drilling, or carry out development studies. I think that some FLNG studies are being carried out just to hold onto the lease, until the company is ready to develop the field.
Subsea Developments for FLNG Production

- Smaller, Smarter, More Dangerous
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