Sevan Floating Powerplant – proposed solution for additional power to Japan

Opportunities for maritime design and technology co-operation in the energy market offshore.

Green Shipping: co-operation between Japan and Norway in the maritime field.

Japan-Norway maritime working meeting 3 June 2015

Presentation content

- Background information
- Sevan Floating Powerplant
- Potential Application in Japan
- Project organisation
- Potential local content
- Summary

Sevan Floating Powerplant - Involved Companies

SIEMENS

Energy Systems
- Powerplant
- Power transmission

DNV·GL

Safety and risk evaluations
3rd party verification
Regulatory compliance

SEVAN marine

Floater design
LNG Loading system
Regas plant
System integration

SEVAN marine

Sevan 700MW Power Plant –
Main Characteristics

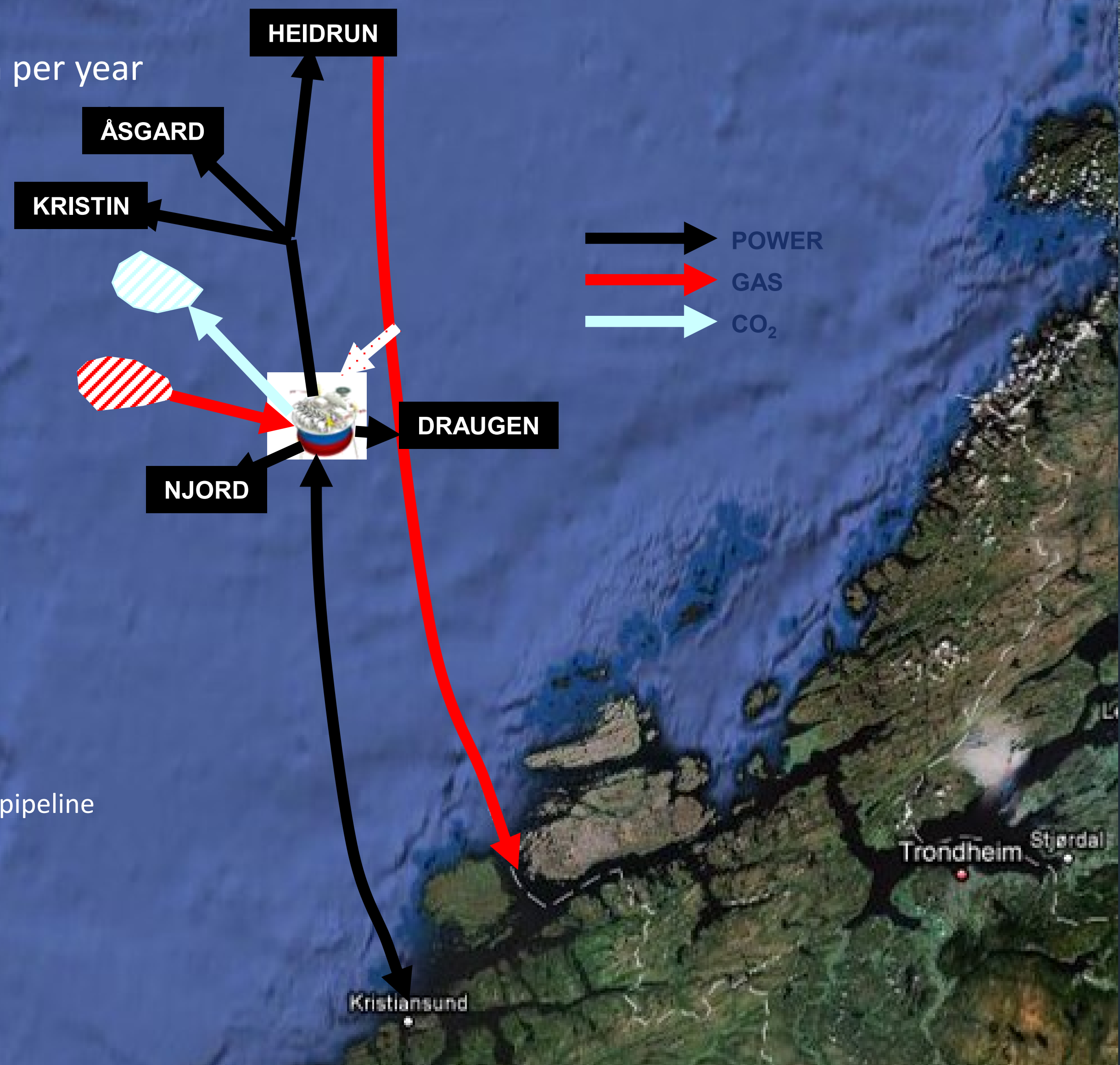
- Based on Siemens Combined Cycle (Gas/ Steam) Power Plant, CCPP
- 700 MW Powerplant configuration:
  - 2 x 350 MW CCPP blocks each consisting of:
    - 5 Siemens SGT800 Gas Turbine generator sets
    - 5 Heat Recovery Steam Generators (HRSG)
    - 1 SST-900 Steam Turbine generator set
- Power rating can be tailored in steps of 70 MW
- Plant electric efficiency ~ 55%
- High Voltage AC or DC Transmission lines to shore

SEVAN marine

2008 Initial idea – Electrification of NCS

Example – Halten Offshore power plant

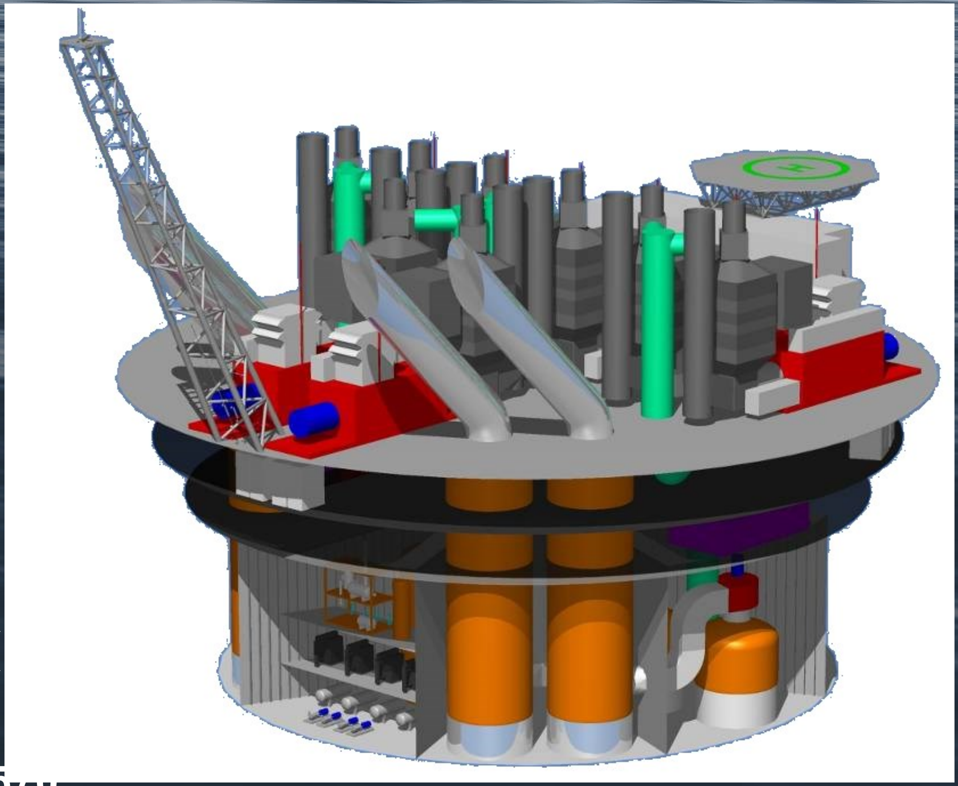
- CO_2 emission reduction 1.1 mill ton per year
  96% of existing emission
- 7% of total CO_2 from NCS O&G
- 2% of total NO CO_2



- Located close to Draugen
- Suggested 450 MW capacity
- Run on gas from undeveloped reservoir or gas pipeline
- Can supply clean power to:
  - Draugen, Heidrun, Åsgard, Kristin and
  - Njord
- Emergency power to grid ashore
- CO2 removal from flue gas onboard
- CO2 pipeline to reservoir for deposit

Sevan GTW 700 CO_2 capture plant

CO_2 extraction/ compression integrated in hull

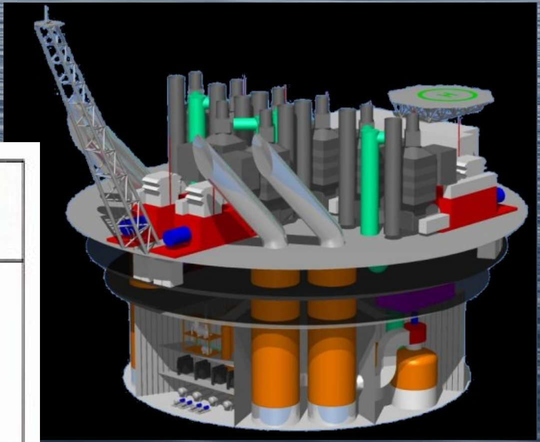


- 90% CO2 capture from flue gas feasible (study with SINTEF)
- Net power capacity after CO2 removal ~ 570 MW
- Net efficiency after CO2 removal is ~45%
- CO2 compression to liquid stage for injection into subsea reservoir .

SEVAN marine

Sevan GTW 700 CO_2 capture plant

Feasibility demonstrated by two SINTEF studies



SINTEF	TECHNICAL REPORT
SINTEF Energy Research Address: NO-7465 Trondheim, NORWAY Reception: Sem Sælands vei 11 Telephone: +47 73 59 72 00 Telefax: +47 73 59 72 50 www.energy.sintef.no Enterprise No.: NO 939 350 675 MVA	SUBJECT/TASK (title) **Offshore power generation with CCS – Phase 2** CONTRIBUTOR(S) Jens Hetland, Hanne M. Kvamsdal, Geir Haugen, Aslak Einbu Quality is assured by Hallvard F. Svendsen and Olav Juliussen CLIENTS(S) Sevan Marine ASA

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RESULT (summary)

This study supports the main conclusion drawn from phase one that a post-combustion CO_2 capture
easily integrated with a natural gas-fired power plant on board a Sevan floating structure – designated
(gas-to-liquid) - intended for offshore operations. The study has been constrained by the Sevan float
SIEMENS modular power system with a net rating of 450 MW_e (with CCS). The net efficiency - after
and compression of the CO_2 (1.47 Mtpa) – is estimated at 45%, thus, implying that the post-combustion
system is accountable for a fuel penalty of 9% points. The study has refined the conceptual design. Mos
the dimensioning height of the absorption columns and the overall performance. The rational behind th
selection is the urgency in making appropriate steps for a quick start. Despite the capture cost, which r
high, the Sevan GTW presents itself as a realistic concept deemed to be within reach today.

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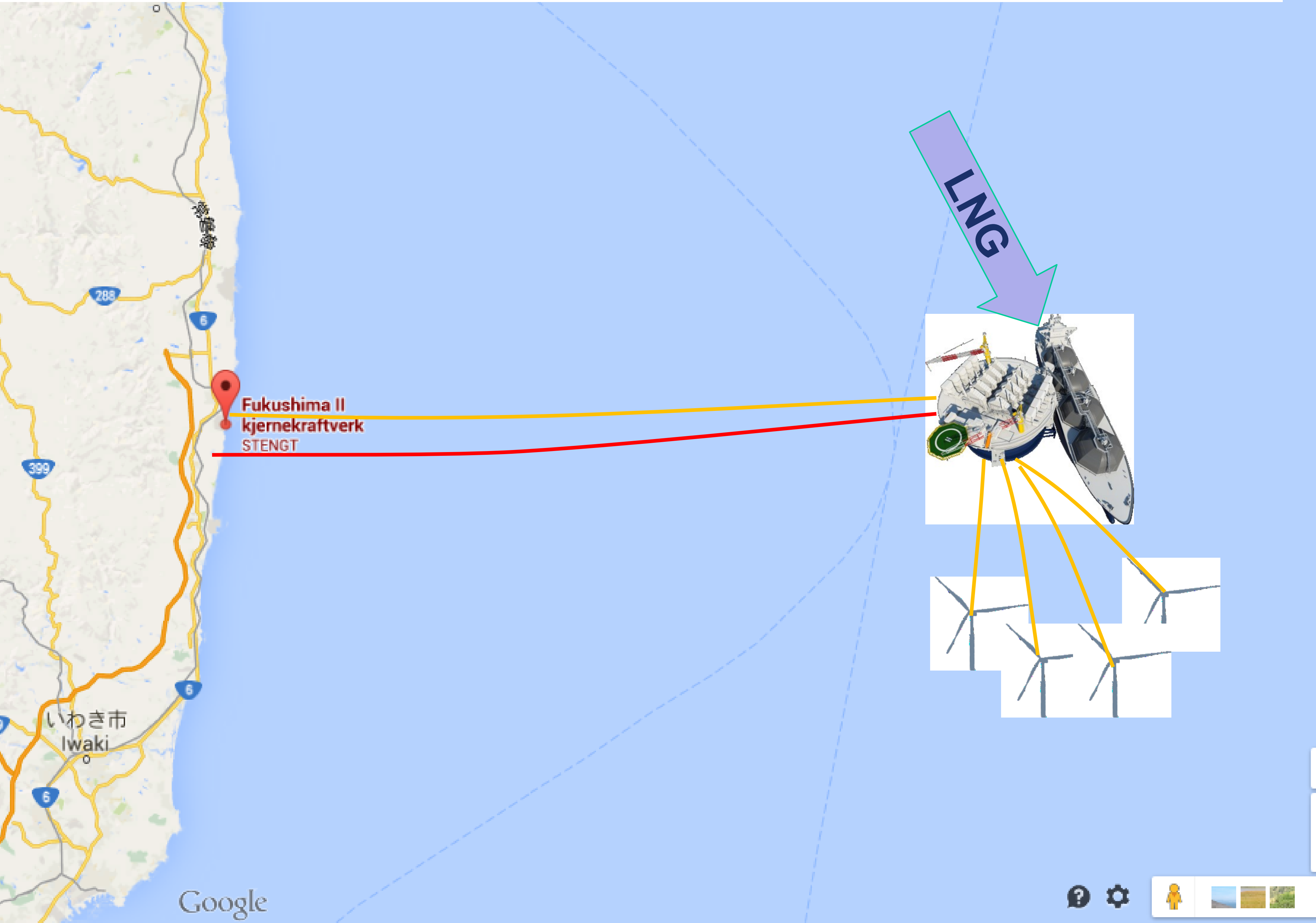
Sevan LNG 700MW fed by imported LNG

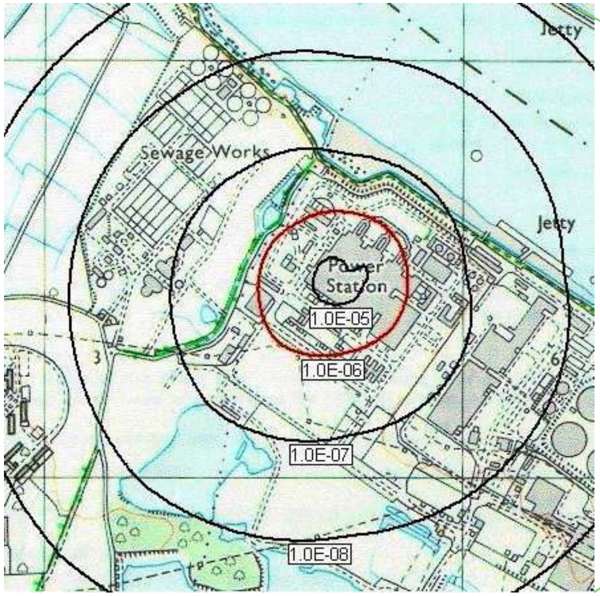
- Gas from imported LNG
- LNG stored in tanks onboard (190 000 - 220 000 m^3)
- LNG re-gasified and fed into gas turbines
- Gas consumption 3,5 mill sm^3/day ~ 5800 m^3 LNG/day
  => 32-38 days of full output from one full unit)

Sevan 700MW FSRU/ Power Plant – Located Offshore Fukushima



Benefits of Offshore LNG Terminal/ Power Plant – Negligible risk to public

- Personnel Risk to third party is typically controlled by exclusion zones, reducing both probability of and consequence of major hazard scenarios.
- Offshore LNG import terminals will typically impose negligible risk to third party when located out side major shipping lanes.
- Specific site locations should bee evaluated by Quantitative Risk Assessment to verify the suitability of the site.
- *Ref: DNVGL LNG QRA GUIDELINE, TN 16*



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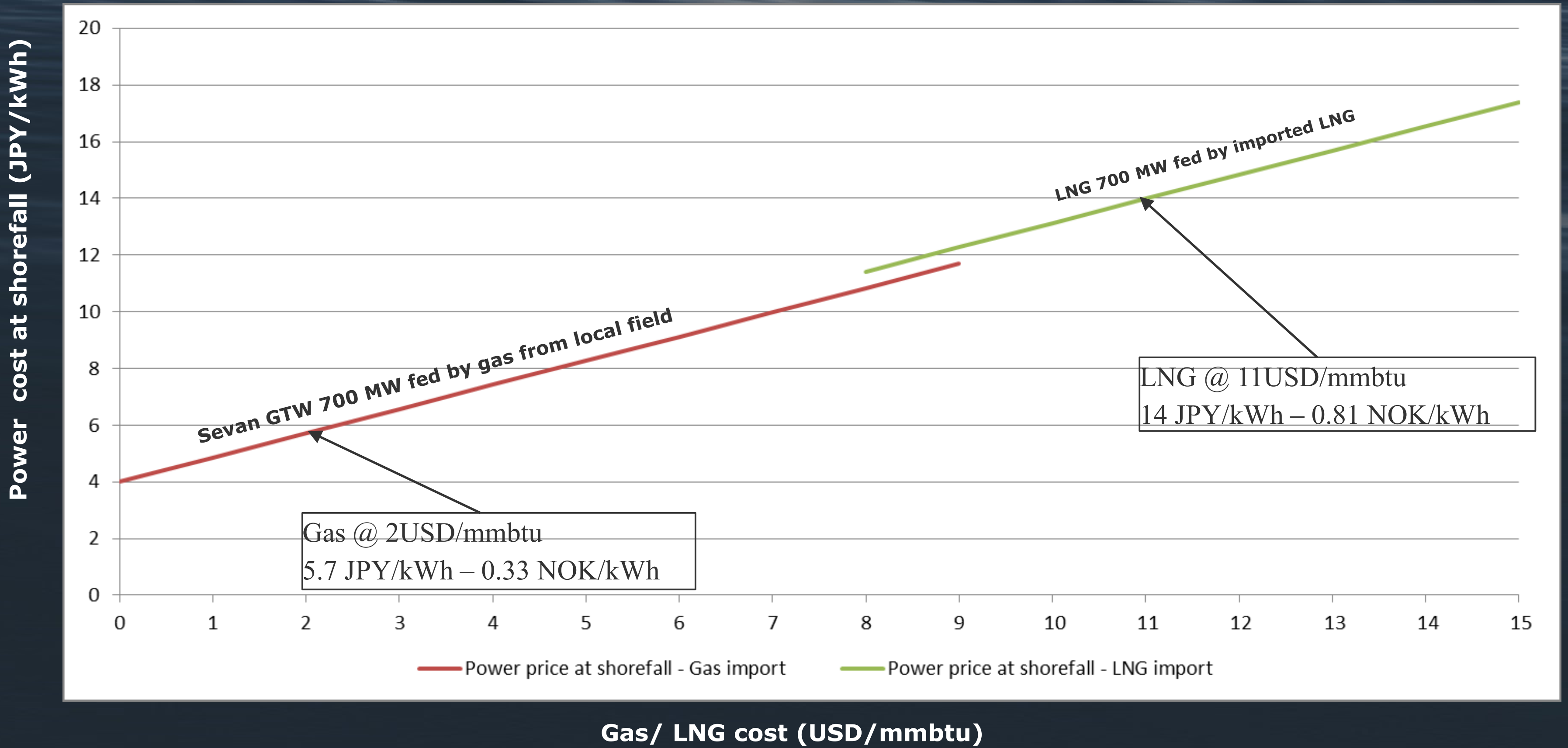
Sevan 700MW Power Plant – Alternative gas feed solutions
Indicative power cost at cable shorefall

Assumptions: Average power production 600MW
50km HVAC connection to shore
Investment depreciated over 30 years at 10% IRR



Cooperation with Massachusetts Institute of Technology

Collaborators

Newport News Shipbuilding
A Division of Huntington Ingalls Industries

SEVAN
marine

THE UNIVERSITY of WISCONSIN
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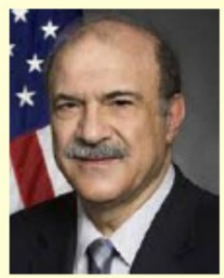

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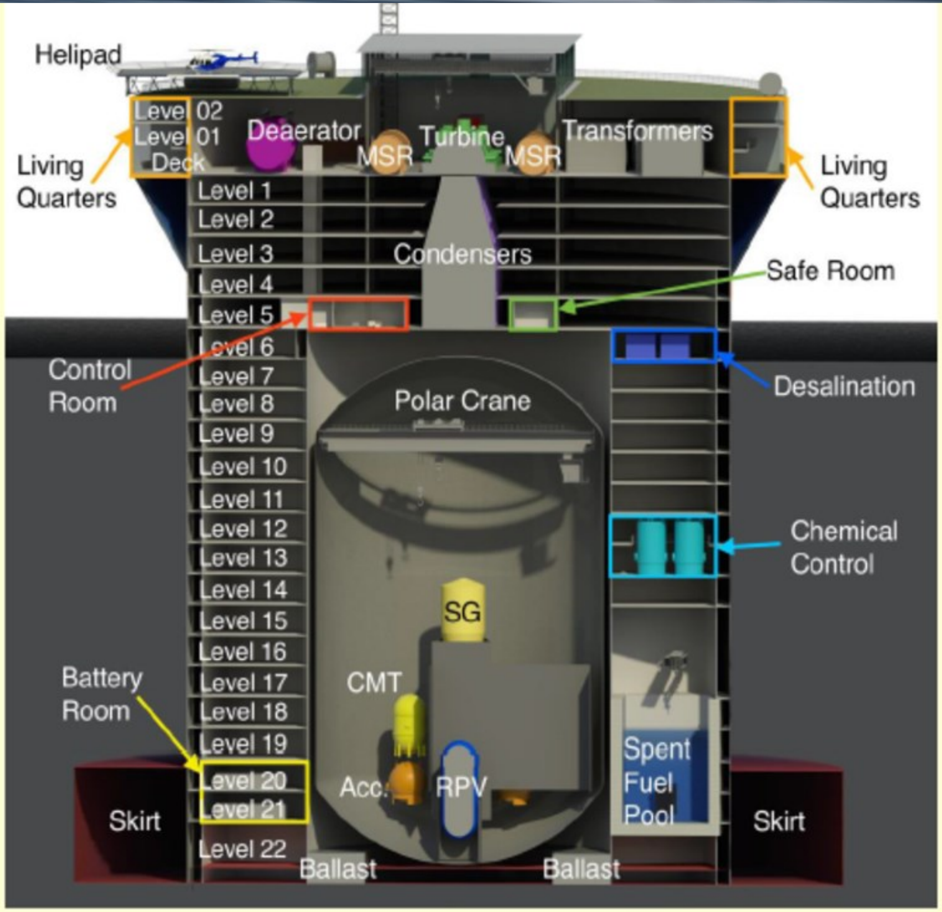
Offshore Floating Nuclear Powerplant (OFNP) based on Sevan design

- All safety-critical components are in water-tight underdeck compartments
- High deck enhances security
- Minor maintenance at sea; major infrequent (~10 years) maintenance in centralized shipyard
- Operate in monthly or semi-monthly shifts with onboard living quarters (oil/gas offshore platform model)



- Flexible refueling (12-48 months); spent fuel stored in pool designed for up to plant lifetime, with passive decay heat removal system
- Includes desalination units + condensate storage tank for water makeup

We make the (floater) world go round