Norconsult in Small Scale LNG
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- **Background**
  - Statoil Rotvoll LNG concept 2000
  - Lyse ROGAS 2004
  - Lysenor Established in 2006
  - Norconsult LNG AS in 2013
  - Merged into Norconsult AS in 2015

- Dedicated company based on the execution small scale distribution in Norway/Scandinavia
- Skangass Small Scale LNG Plant and distribution chain projects
- Probably the most experienced Engineering Consultant within the small scale LNG area in the Nordic region.
Norconsult LNG - Main areas

Norconsult AS has established experience in the onshore gas sector since 2000. Three main areas are:

1) Early phase
   a) Concept, Feasibility and FEED
   b) Permits including National and EU requirements
   c) Business case (financial assessment, logistic analysis, sourcing, contract models)
   d) Sales executives and support

2) Project Execution
   a) Owners Engineer / Project Management
   b) Project Administration
   c) Tender documents
   d) Contracts & Procurement

3) LNG Tank design.
   a) Flat bottom atmospheric full containment tanks
   b) Pressurized Vacuum insulated solutions
Norconsult - Services

- Owners Engineer
- Concept development, Logistic analysis
- EIA process, Permitting applications, Contact with Authorities
- Financial assessments (investments, operations & contract model)
- Tendering process
- Design - Terminals and small scale LNG plants
  - Processes (liquefaction, utility systems, district heating and regasification)
  - Harbors and jetties
  - Storage facilities (tanks and rock caverns)
  - Site selection (geology, soil conditions & infrastructure)
  - Risk analysis
- Safety analysis & HSE
- Third party verification studies
Early phase services

- Environmental Impact Assessment - permitting
- Permit regime support
- Authority meeting support
- Sales Management
- Technical Sales support
Early phase services

- Evaluation of LNG as energy source
- Investment analysis – business case development
- Concept evaluations and development
- Plant or terminal capacity assessments
- Process simulations of plant/terminal
- Site evaluation
- Hazard and risk identification
- Requirements and GAP analysis
- Development of policies, goals and acceptance criteria for HSE and quality performance
- Advisory services related to hazardous materials, major accidents and emergency preparedness
- Technology qualification studies based on international recognised standards
Project execution - construction phase

- Project Management
- Supplier and fabrication follow-up
- Construction management
- Site supervision
- HSE management and follow-up
- Mechanical Completion
- Commissioning
- Final documentation
Detail design

- Philosophies for design, operation & maintenance
- Design documents for all disciplines
  - System descriptions, process and main utility systems
  - Process simulation static and dynamic
  - Sizing of process equipment, piping & layout
  - Fabrication drawings
  - Civil
  - Instrumentation and automation
  - Electro
- Layout and safety
- Infrastructure and interface management
- Assistance in application processes HSE authorities
- Development and implementation of management systems (HSE, quality)
LNG Tank Design

- Tank Design > 30 000m³ LNG - Extensive analyse work
- Civil design
- Follow-up construction at site,
  - Concrete work
  - Steel fabrication
  - Civil work
  - Insulation

- Risavika LNG Plant 30000 m³
- Lysekil LNG Terminal 30000 m³
- Manga LNG Terminal 50 000 m³

- Design code:
  - EN1473
  - 14620 1-5
Specific LNG competence

Design specification

LNG Pressure vessel bunkering terminal design and operation kriteria
LNG Pressure Vessel terminal "standard" design elements.

- Vessel are designed for 8-10 barg pressure
- 500m³ - 6000m³ storage capacity
- High capacity centrifugal pumps for export
- Cold flare (no ignition)
- Vacuum insulated transfer lines
- Dual transfer lines with gas return
- Optional single transfer line
- Optional vaporizers for re-gasification
- No gas compressors
LNG Pressure Vessel terminal "standard" operation elements:

- LNG filled transfer lines during stand-by with boil-off to tank
- Top-spray of receiving LNG tank until pressure equalization
- Bottom filling after pressure equalization
- Gas return to supplier tank
- Optional no gas return. Requires longer time for pressure equalization
- Pump cool down with gas return to tank
- Optional gas export by vaporizers with economizer function for discharge of boil-off gas
- Gas export pressure equal to tank pressure, limited by regulators for e.g grid pressure
- Tank minimum pressure regulated by pressure build up coils for gas export and pump suction head
Specific LNG competence

Advanced process engineering
Process simulations

- Aspen One Engineering

Includes

- Process modeling analysis and design tools integrated in Hysys
- Optimization of process designs
- Equipment sizing for layout and weight estimates
- Flare System Analyzer, including PSV sizing
- Depressurisation modelling
- Dynamic simulation for support of design and operational challenges
- Natural gas acid gas cleaning templates for rigorous design
Onshore LNG

- Small/Mid scale LNG production terminals
  - Pre-engineering work for system layout and equipment capacities
  - Input to environmental impact studies (Air, water, noise)
  - Contractor technical specification
  - Support for Design basis
  - Specification for vendor quotes / Cost estimates

- LNG Regassification plant
  - Pre-Engineering and cost estimate support
  - Equipment sizing
  - BOG calculations and modelling
Specific LNG competence

Logistic chain and delivery sensitivities
Advantage of Monte Carlo Simulation

- Tests test-feasibility of a supply chain in an early stage
- Determines efficiency, lead time, capacities in new production lines
- Detects lack of cost effectiveness in processes
- Test capacity limitations in a logistic chain
- Test demands for back-up systems
Simulation of Logistic Chains

- Vessel frequency, waiting time, berth occupancy, use of infrastructure
- Conflicts

- Capacities, Lead time, Production
- Silo filling, max/minimum level, required capacity

- Required capacity
- Required capacity, waiting time, no of trucks

- Vessel frequency, waiting time, berth occupancy, use of infrastructure
  Conflicts
Calendar time vs. quantities
Specific LNG competence

HMS and Risk Management
Risk Management

The society we live in is in constant change and is growing ever more complex, global and open. As a result, society’s vulnerability is also increasing. This means that risk assessments, preventive measures and emergency response are becoming increasingly important elements for all players – from public authorities to private businesses.

Norconsult has been involved for a long time in work to create a safe and well-functioning society.

We provide advice within:

- Working environment assessments
- Emergency preparedness
- HSE control systems
- IT security
- Quality Management Systems
- Risk Management
- Technical safety
- Monitoring
HSE and Risk Management in development phases

- Development of policies, goals and acceptance criteria for HSE and quality performance.
- Hazard identification and risk assessments.
- Risk Analysis
- Development and implementation of management systems (HSE, quality).
- Design reviews and layout reviews
- Assistance in application processes towards HSE authorities.
- HSE management and follow-up in construction projects.
HSE in Construction and Commissioning

- HSE management and follow-up in construction projects.
- Hazard identification and risk assessments at site
- Risk Analysis
- Inspections and audits
- Accident/incident investigation.
- Advisory services related to hazardous materials, major accidents and emergency preparedness.
## REFERENCES: Early phase

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<td>Liquid Biogas</td>
<td>VEAS AS</td>
<td>Permit applications, Technology qualification Tender documents and evaluation</td>
<td>2016</td>
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<td>Liquid Biogas</td>
<td>Biokraft AS</td>
<td>Permit applications,</td>
<td>2016</td>
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<td>Project Management</td>
<td>Naturgass Nord AS Norway</td>
<td>LNG supply chain concept study LKAB</td>
<td>2015</td>
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## REFERENCES: Project Management

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<td>LNG Plant</td>
<td>SLNGaz, Canada</td>
<td>Owners Engineer complete chain 2x450 000 ton/year production 50 000 m3 LNG storage</td>
<td>2014</td>
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</table>
| LNG terminal Lysekil           | Skangass AS                 | Project Management  
Design LNG storage tank - 30000m3  
Full containment storage tank                                                                                                                                                                          | 2013 |
| Höegh LNG FPSO                 | Höegh LNG AS                | Technical and management services in Clients organization. Follow-up of engineering contractor.                                                                                                                  | 2012 |
| LNG Base load plant, Risavika  | Skangass AS                 | Technical and management services LNG production plant capacity: 300 000 tons/year  
Design LNG storage tank - 30000m3  
Full containment storage tank, site prep and jetty.                                                                                                                                                | 2010 |
| LNG terminal, Øra              | Skangass AS                 | Project Management. 6500 m3 storage capacity based on vacuum insulated pressurized tanks with gasification, truck loading and bunkering                                                                         | 2011 |
## REFERENCES: Project Management

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<td>Norgips AS</td>
<td>Skangass AS</td>
<td>Project Management/Municipality engineering Vacuum insulated LNG tanks. Plasterboard plant</td>
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<td>Uddeholms</td>
<td>Skangass AS</td>
<td>Project Management/Municipality engineering Vacuum insulated LNG tanks. Steel tool manufacturer</td>
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<td>Glava Askim</td>
<td>Skangass AS</td>
<td>Project Management/Municipality engineering Vacuum insulated LNG tanks. Glass Wool production</td>
<td>2011</td>
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## REFERENCES: STUDIES AND REPORTS

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<td>Gibraltar LNG terminal</td>
<td>World Fuel Services Europe INC</td>
<td>Concept Study receiving terminal, 12000 m3 LNG storage tank, 21000 Nm3 / hour regasification capacity</td>
<td>2015</td>
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<td>Sundsvall Logistiknav</td>
<td>Sundsvall Logistikpark AB, Sweden</td>
<td>Localization study LNG terminal with risk assessment.</td>
<td>2014</td>
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<td>Sept Iles HUB</td>
<td>SLNGaz Inc. Montreal</td>
<td>Logistic analysis and Cost estimate LNG distribution HUB with 30 000 m3 storage</td>
<td>2014</td>
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<td>LNG terminal</td>
<td>Norrgasol AB, Sweden</td>
<td>LNG Terminal cost verification Storage volume 30 000 m3</td>
<td>2014</td>
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<td>LNG Terminal Helsingborg</td>
<td>Helsingborg Havn, Sweden</td>
<td>Concept cost verification with construction budget for LNG terminal storage capacities 500 m3 to 15000 m3 on vacuum insulated and full containment tanks</td>
<td>2014</td>
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<td>LNG Terminal Vyborg</td>
<td>Cryogas Russia</td>
<td>FEED LNG Terminal storage capacity 30000 m3 full containment atmospheric LNG tank.</td>
<td>2013</td>
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<tr>
<td>TTI Oven 2</td>
<td>TTI Tyssedal</td>
<td>Pre-Feasibility LNG terminal with 12000 m3 full containment tank</td>
<td>2013</td>
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<tr>
<td>LNG terminal Narvik</td>
<td>Naturgass Nord</td>
<td>Initial localization report including risk assessment for different locations.</td>
<td>2013</td>
</tr>
<tr>
<td>Høegh FPSO and LNG</td>
<td>Høegh LNG AS</td>
<td>New technology qualification for LNG cool-down on floating facilities</td>
<td>2012</td>
</tr>
<tr>
<td>LNG process evaluation</td>
<td>Høegh LNG AS</td>
<td>Evaluation and verification of process data and performances including sensitivity analyses.</td>
<td>2009</td>
</tr>
<tr>
<td>Mosjøen Aluminium</td>
<td>Bechtel/Gasnor</td>
<td>Technical support</td>
<td>2007</td>
</tr>
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</table>
Reference project – LNG supply chain over Narvik to LKAB

Client: Naturgass Nord

- Norconsult LNG services:
- Project Management
- LNG Logistical analysis
  - Early phase
  - Final solution
- LNG Sourcing review
- Narvik LNG Terminal concept review
- Permitting process start
Reference project - SLNGaz Bécancour

Pre FID phase - Natural gas liquefaction (LNG) plant in Bécancour. Capacity 500 000 t/year with storage of 50 000 m3.
Reference project, Risavika LNG plant

Risavika 1998: Shell refinery
Risavika 2004
Risavika 2010: Skangass LNG liquefaction plant

Responsible for:
Site preparation, tank design, jetty design, Project Management

Production capacity: 300 000 tonnes/year
Reference project, Risavika LNG plant

- LNG production capacity of 300,000 ton/year
- Delivers gas to local grid
- Delivers LNG to small scale terminals by ship
- Facilities for filling of road tankers
Reference project - LNG Plant Elnesvågen

Naturgass Møre - Elnesvågen LNG plant

Client: Naturgass Møre AS
Project Manager: Hege Olimb
Start-Completion Date: 2007
Client’s Representative: Olav Gamlem, tel +4770175559, olav.gamlem@naturgassmore.no
Key Project Features:
- Design pressure at landfall is 40-45 barg.
- Capacity of Pre-treatment, 90,000 tons LNG/year and Liquefaction 30,000 tons LNG with an option on further expansion of two additional train.
- Process availability of 95% per year is required. Design of the plant shall be based on 30 years operating life time.

The LNG plant to be located at Elnesvågen on the Møre coast. Feed gas to be supplied from Ormen Lange field.

Project Management
Preparation of system specifications of LNG terminal and plant.
Authority/official requirements
Invitation to tender, technical/commercial evaluation of tenders
Contract negotiations until award notification
Reference project – Gibraltar terminal concept.

Gibraltar LNG terminal concept

Client: World Fuel Services Ltd
Project Manager: Hege Olimb
Start-Completion Date: 2015
Norconsult Contact Person: Hege - Olimb
Client’s Representative: Mr. Ed Glossop, tel +44 7702 819805, eglossop@wfscorp.com

Key Project Features:
Technical data:
Storage volume: 12,000m3
Tank type: Full containment circular concrete outer and steel inner storage tank
Tank operating pressure: max 280 mbarg
Process equipment: BOG compressors, LNG vaporizer, low pressure ground flare, fiscal metering, gas analyzing
Regasification capacity: 21,000 Nm3/h
Ship unloading capacity: 200 - 1000m3/h
Ship bunkering capacity: 200 m3/h
EN norms & requirements: Fulfils EN 1473/EN 14620
Location size: 88m x 51 m (4488m2)
Reference project - Lysekil LNG hub

- Norconsult LNG services:
  - Project Management
- Storage capacity of 30,000 m$^3$
- Process including:
  - evaporators
  - regulating and control system
  - safety systems
  - import pipeline
  - truck loading
  - quay facilities
  - bunkering
- Design Code:
  - EN1473
Reference project - LNG-HUB Sept-Îles study

- Client: SLNGaz Inc.
- Norconsult LNG services:
  - Project Management
  - Cost estimate
  - Logistical analysis
Reference Project – Cryogas LNG terminal

Cryogas - LNG Tank Concept study

Client: JSC Cryogas
Project Manager: Hege Olimb
Start-Completion Date: 2013
Norconsult Contact Person: Hege Olimb
Client’s Representative: Kravchenko Vyacheslav, tel 7(812) 324-48-01, kravchenko@cryogas.ru
Key Project Features: The full containment tank including process equipment to fulfil the standards EN 1473 and EN 14620.

On behalf of Cryogas, Norconsult has performed an concept study including cost estimate and execution schedule. The scope of work for the study comprises of the FEED delivery of LNG storage tank including complete process installation on the tank ref. PFD figure. The LNG storage tank is based on a full containment tank with an operative storage volume of 26 000 m³. The LNG storage tank will be outfitted with piping, instrumentation and equipment to safely perform the following main functions: import of LNG from LNG plant, export LNG from tank to ship, ship bunkering and truck loading cost estimate and the FEED report.
Reference project - Øra LNG terminal

Schedule: 2008 - 2011

• Storage capacity of 6,500 m³
• Process including:
  • evaporators
  • regulating and control system
  • safety systems
  • import pipeline
  • truck loading
  • quay facilities
  • bunkering

• Design Code: EN13645
• Norconsult LNG services: Project Management
Reference project - customer terminals

• Services:
  • Project Management

• Storage capacity: 2x127m³ + 1x180m³

• Process including:
  • evaporators
  • regulating and control system
  • safety systems

• Design Code:
  EN13645