Xi Engineering Consultants
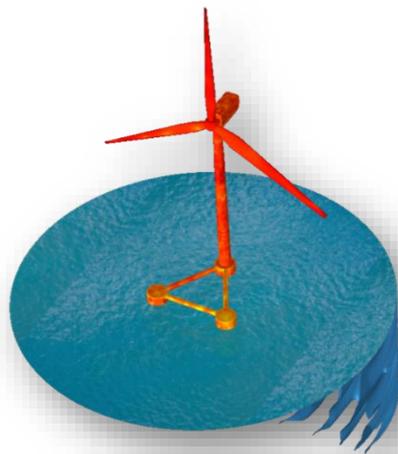
Engineering Support for Offshore Wind, Tidal, & Subsea Energy Systems

Partner with Xi to lower costs, extend asset life, and reduce risk across the subsea cable lifecycle.

At Xi Engineering Consultants, we deliver advanced modelling, simulation, measurement, and digital engineering solutions that help offshore renewable developers, OEMs, operators, and regulators design safer systems, reduce risk, and improve long-term asset performance.

Our team of multidisciplinary engineers combines structural dynamics, underwater acoustics, hydrodynamics, fatigue assessment, environmental compliance, and digital twin technology to support clients across the entire lifecycle of offshore and subsea energy projects.

We work across fixed offshore wind, floating wind, tidal energy systems, subsea generation platforms, inter-array and export cables, moorings, and hybrid marine energy devices, providing accurate, actionable insight from feasibility through to operations, life extension, and decommissioning.

Client Value

- **Reduced risk of failure:** Digital twin–driven predictive maintenance and anomaly detection.
- **Optimised performance:** Multiphysics simulation to extend asset life and minimise downtime.
- **Cost savings:** Informed decisions that cut repair costs, avoid delays, and reduce insurance exposure.
- **Sustainable operations:** Lower environmental impact through accurate modelling and scenario planning.
- **Integrated partnerships:** End-to-end lifecycle coverage through our partner network (SAMS, NeuWave Technologies, ERIKS, Beckhoff, 1StopWind, FloWave).

Unlike traditional consultancies who deliver isolated studies, Xi integrates simulation, measurement, and digital monitoring into a unified technical workflow. This produces faster insights, reduces uncertainty, and builds traceable, evidence-based solutions for complex offshore environments. Our COMSOL-based applications offer something unique in the market: validated physics models that clients can run in-house, without needing modelling expertise or specialist licences.

Our Capabilities

1. **Structural, Fatigue & Dynamic Analysis:** Modelling of turbines, foundations, tidal devices, moorings, and subsea structures to quantify fatigue life, dynamic response, and long-term reliability under wave, wind, and current loading.

2. **Underwater Noise, Vibration & Environmental Acoustic Modelling:** Predictive modelling and measurement of construction and operational noise, including structural-acoustic FEM, distributed source modelling, and 3D propagation mapping for EIA, HRA, and marine licence submissions.

3. **Hydrodynamic, Wave & Current Interaction Simulation:** Analysis of device loading, wake effects, scour risk, mooring dynamics, and fluid-structure interaction, validated through partnerships with FloWave test tank, SAMS, and offshore testing facilities.

4. **Digital Twin Development & Predictive Maintenance:** System-level digital twins integrating structural, thermal, electrical, and hydrodynamic behaviour with real-world sensor data to track asset health, predict failures, and reduce O&M costs.

5. **COMSOL-Based Custom Applications:** Standalone executables for fatigue, thermal, electrical, cable-device interaction, noise mapping, and structural dynamics — enabling client teams to run advanced analyses in-house.

6. **Environmental Compliance & Regulatory Support:** EIA, marine licence, underwater noise assessments, cumulative impact analysis, and standards-aligned reporting for both fixed and floating systems.

7. **Measurement, Monitoring & Diagnostics:** Noise, vibration, strain, pressure, and motion monitoring solutions — from rapid-deploy kits to long-term installed systems with automated dashboards.

8. **Engineering Design & R&D Support:** Simulation-driven design development, prototyping support, validation studies, and optimisation of next-generation offshore wind, tidal, and subsea renewable technologies.

Innovation Beyond the Lifecycle
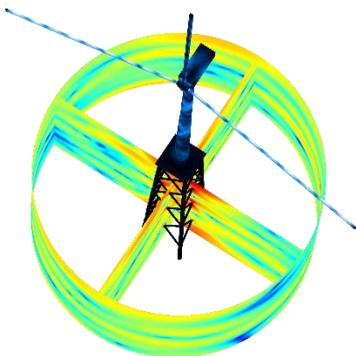
- **R&D & Prototyping:** Multiphysics models to test new technologies, layouts, and installation methods, with integration of real-world data for true validation and reliability.

- **Integrated system modelling:** assess interactions between system components and environmental factors, identifying risks and optimising asset performance

- **Custom COMSOL Multiphysics Applications:** Provide standalone tools that deliver digital twin outputs - from fatigue life prediction to induced voltage and thermal analysis - in formats you can directly use.

Who We Work With

Xi Engineering Consultants' capabilities apply across the entire marine energy ecosystem - turbines, foundations, moorings, dynamic cables, subsea structures, supporting infrastructure, and environmental interfaces.

Offshore Wind (Fixed & Floating)

- **Fixed-Bottom Foundations:** dynamic & fatigue modelling of monopiles, jackets, and gravity bases to optimise design and reduce lifetime risk.
- **Floating Platforms:** stability, mooring, and motion simulation for spars, semi-subs, TLPs, and barges to validate performance under wind–wave–current loads.
- **Wind Turbine Systems:** structural/acoustic FEM and vibration diagnostics to prevent drive-train failures and ensure compliance with acoustic standards.
- **Inter-Array & Export Cables:** thermal–electrical–mechanical modelling to reduce failure probability and optimise burial or protection strategies.
- **Offshore Construction Noise:** predictive piling and vessel noise modelling for EIA, HRA, and marine licence compliance.

Tidal & Marine Energy Systems

- **Tidal Turbines:** hydrodynamic, vibration, and fatigue modelling to increase reliability in high-current environments.
- **Support Structures & Foundations:** seabed interaction, scour, and structural stability analysis to minimise installation risk.
- **Array Design:** wake and flow interaction analysis to optimise energy yield and reduce device-on-device loading.
- **Novel Marine Devices:** acoustic and dynamic source-term generation to support permitting and technological validation.
- **Environmental Interaction:** marine mammal risk modelling using species-weighted noise and exposure mapping.

### Subsea Renewable & Hybrid Devices
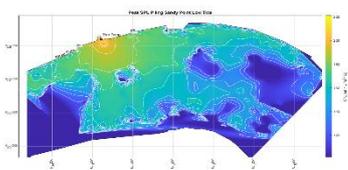
- **Subsea Hubs & Substations:** structural, thermal, acoustic modelling to ensure safe operation and reduce environmental impact.
- **Energy Storage & Conversion Modules:** Multiphysics stress, fatigue, and thermal assessments for battery, hydrogen or power-conditioning systems.
- **Hybrid Power Systems:** integrated modelling of power, comms, and control bundles to improve reliability and reduce installation complexity.
- **Autonomous System Infrastructure:** vibration, power, and comms modelling for AUV/ROV support systems to ensure robust long-term operation.
- **Environmental Noise Mitigation:** barrier design and propagation modelling to minimise ecological impact.

Cables, Moorings, & Power Transmission
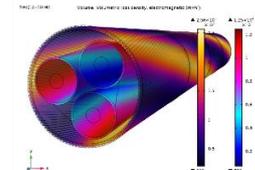
- **Dynamic Cables:** fatigue, tension, and bending analysis under platform motion to extend cable life and avoid failures.
- **Static Cables:** burial, thermal loading, and seabed interaction modelling to support safe routing and installation.
- **Interconnectors & HV Links:** system-level modelling to ensure electrical/thermal stability and support planning consent.
- **Mooring Systems:** tension dynamics, fatigue, and failure-mode analysis to ensure floating structure stability.
- **Grid Resilience Applications:** redundancy and system-response modelling to improve long-term reliability.

Marine & Coastal Infrastructure
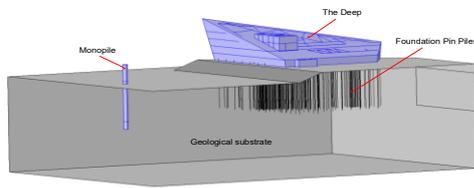
- **Ports & Harbours:** vibration, structural, and acoustic assessments for offshore support bases and quayside operations.
- **Research Facilities:** instrumentation, modelling, and validation for wave tanks, test beds, and offshore R&D platforms.
- **Aquaculture Systems:** mechanical/acoustic modelling for feeding, lighting, and monitoring systems to reduce operational risk.
- **Coastal Landfalls:** nearshore hydrodynamic and noise modelling to support cable landings and HDD projects.
- **Defence & Security:** modelling of secure comms and subsea sensor arrays to ensure high-reliability operation.

Operations, Monitoring & Asset Integrity

- **Structural Health Monitoring:** measurement + digital twin systems to assess fatigue, vibration, and real-time loading.
- **Predictive Maintenance:** ML-enhanced diagnostics for turbines, tidal devices, cables, and moorings.
- **Failure Forensics:** root-cause diagnostics using simulation-informed digital twin replay.
- **Construction Monitoring:** real-time noise and vibration measurement to maintain compliance during critical operations.
- **Decommissioning:** scenario modelling for safe removal, re-use, or adaptation of offshore assets.

Telecommunications & Data

- **Fibre-Optic Systems:** thermal and mechanical stress modelling for deep-water fibre links to ensure safe installation.
- **Industrial Data Networks:** system integrity modelling and interference/noise diagnostics for subsea comms.
- **Integrated Power/Data Systems:** Multiphysics validation to ensure reliable operation of embedded sensor networks.

Oil, Gas, & Legacy Infrastructure

- **Rigs & Platforms:** vibration, noise, and umbilical stress modelling to extend asset life and improve reliability.
- **Subsea Production Systems:** riser/umbilical fatigue and dynamic interaction modelling for improved uptime.
- **Brownfield Tiebacks:** structural and flowline modelling to validate integration with legacy assets.
- **Decommissioning Support:** modelling to plan safe retrieval, cutting, or repurposing of subsea assets.

Lifecycle Services

Xi helps clients look beyond individual cables and instead optimise the entire subsea system. By combining advanced Multiphysics modelling, fatigue analysis, and digital twin development, we enable better decisions across design, layout planning, installation, and lifecycle management.

With the added option of bespoke, standalone COMSOL applications, clients can run their own analyses without needing in-house licenses for modelling software. This system-level approach is a key differentiator, helping extend asset life, reduce failures, and lower lifecycle costs.

Planning & Feasibility

- Early-stage system modelling & feasibility analysis
- Underwater noise predictions for construction & operation
- Tidally driven flow and wave–current interaction modelling
- Concept optimisation and fatigue hotspot identification
- EIA/HRA-ready outputs and regulatory support

Design & Engineering

- Multiphysics modelling (structural, electrical, thermal, acoustic, hydrodynamic)
- Foundation and mooring system design support
- Structural–acoustic FEM and distributed noise source modelling
- COMSOL app development for client-side use
- Prototype validation support through testing or field data

Installation Support

- Pre-installation risk modelling
- Vessel dynamics & weather window analysis
- Cable/device interaction during lay or deployment
- Real-time monitoring for piling, drilling, and marine operations

Operation & Monitoring

- Digital twin development & integration
- Predictive maintenance for turbines, tidal devices, cables, and moorings
- Long-term monitoring (noise, vibration, strain, motion)
- Fault diagnostics and performance optimisation
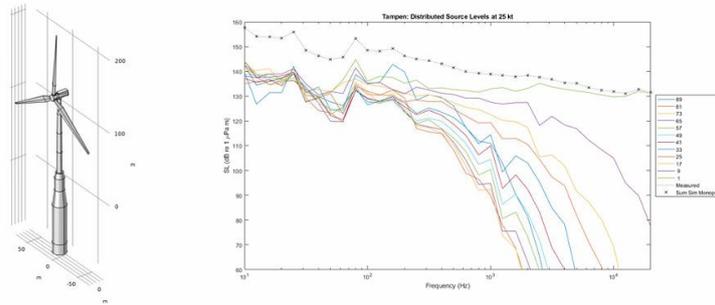
Repair & Life Extension

- Failure forensics
- Fatigue reassessment
- Repair strategy modelling
- Life extension and repowering support

Decommissioning

- End-of-life digital twin modelling
- Retrieval and repurposing scenario analysis
- Environmental compliance support

Case Studies

1. Floating Offshore Wind: Underwater Noise Modelling

Challenge

Developers and regulators required accurate, depth-resolved underwater noise source models for floating offshore wind turbines (Kincardine, Hywind Scotland, Hywind Tampen) to support environmental assessment, reduce uncertainty in EIA/HRA, and demonstrate compliance for planning consent.

Solution

Xi developed structural–acoustic FEM models calibrated using high-quality field data, working collaboratively with ORE Catapult, the Scottish Association for Marine Science (SAMS), and JASCO Applied Sciences. We produced depth- and frequency-resolved source terms for use in regional propagation models, delivering more realistic marine mammal impact predictions. This improved regulatory confidence, reduced consenting risk, and supported clear, defensible environmental evidence for project approval.

2. Subsea Substation: Operational Noise Mitigation

Challenge

A subsea substation required noise mitigation to protect local whale populations and demonstrate compliance, while avoiding costly design changes or operational limits.

Solution

Xi developed structural–acoustic models, designed noise barriers, and validated effectiveness using propagation modelling and experimental methods. The result reduced environmental risk, supported regulatory acceptance, and allowed operation without significant redesign — saving time and cost for the project.

3. Tidal Energy: Fatigue & Acoustic Modelling (MeyGen)


Photo tweeted by Atlantis Resources

Challenge

New tidal turbines faced unknown fatigue and acoustic behaviour, with no measured noise data available. The developer needed evidence-based predictions for environmental approval and to de-risk early deployment.

Solution

Xi simulated vibration, fatigue loading, and hydrodynamic response under tidal flow, and generated robust underwater acoustic source terms for propagation analysis. This provided the client with compliance-ready environmental evidence, reduced uncertainty in device performance, and supported safer, more cost-effective rollout of the turbine technology.

## 4. Offshore Wind Construction: Piling Noise Assessment
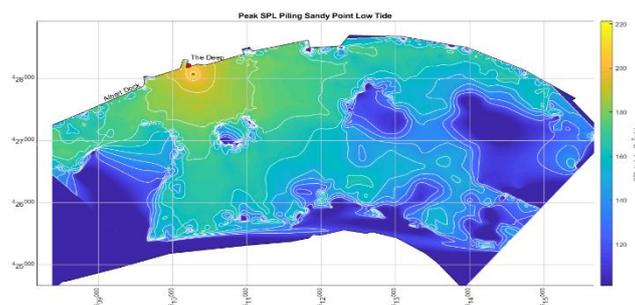
Challenge

Developers needed to predict piling noise levels and species-specific impacts to secure marine consent, minimise delays, and plan mitigation for sensitive areas.

Solution

Xi delivered predictive piling noise modelling, species-weighted impact maps, and scenario analysis to support mitigation planning. This reduced consenting uncertainty, enabled targeted marine mammal protection measures, and prevented construction delays by providing defensible evidence for regulatory approval.

5. Underwater Noise for HVDC Cable Installation
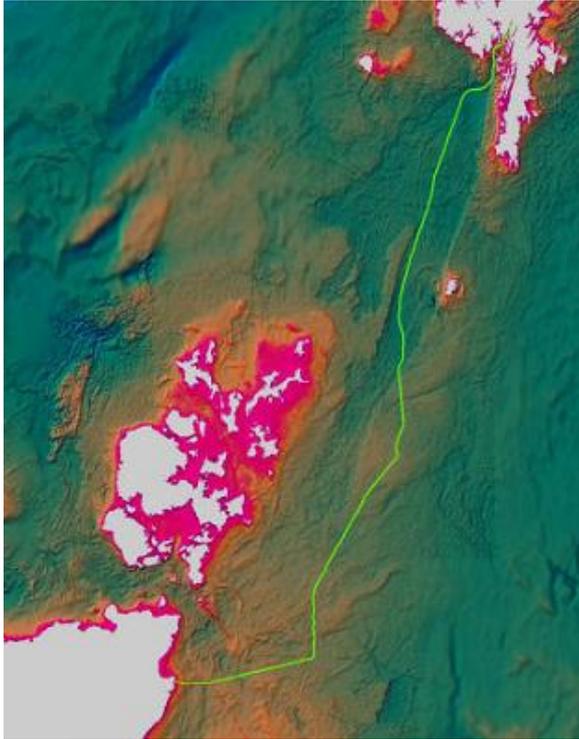
Challenge

A 260 km-long HVDC submarine cable link to the Shetland Islands required buried route design and cumulative underwater-construction noise assessment (trenching, rock-placement, vessel operations) to meet regulatory requirements, mitigate marine mammal risk, and secure planning consent.

Solution

Xi partnered with Scottish Association for Marine Science (SAMS) and the client, SSE Networks' engineering team to model 3D sound fields from seabed to surface, incorporating all major construction activities. We produced species-weighted exposure maps and noise mitigation scenarios. This allowed the client to optimise installation methodology, reduce consenting risk, and avoid costly redesigns — delivering both regulatory confidence and commercial savings.

Why Xi Engineering Consultants?

- **Digital-first engineering:** simulation + measurement + digital twins
- **System-wide perspective:** turbines, foundations, devices, cables, and environment
- **COMSOL apps & digital twins:** unique client-side modelling capability
- **Cross-sector partnerships:** SAMS, FloWave, NeuWave, ERIKS, Beckhoff, 1StopWind
- **Regulatory & standards expertise:** IEC, ISO, BS, DMRB, OSPAR
- **Cost, risk, and time savings** through accurate, scenario-driven modelling
- **ISO 9001 certified,** with rigorous QA and traceability

Example Outputs

- Feasibility & concept development reports
- Structural–acoustic FEM & distributed noise models
- Hydrodynamic and fatigue simulations
- Digital twin dashboards & predictive maintenance tools
- COMSOL-based engineering apps
- Marine noise impact & mitigation reports
- Construction monitoring dashboards

Standards & Frameworks Referenced

Xi delivers in alignment with leading international standards and industry guidance, ensuring compliance, safety, and best practice across the full asset lifecycle. Examples of the standards we reference and apply include (but are not limited to):

- **IEC 61400 series:** wind turbine & acoustic standards
- **DNVGL offshore & floating wind guidance:** structures, moorings, fatigue
- **ISO 18405 & BS 5228:** underwater acoustics, noise & vibration
- **Eurocodes & DNV fatigue standards:** structural and mechanical integrity
- **IEC 60287 / CIGRÉ:** subsea cable thermal & electrical performance
- **EIA, HRA/AA, JNCC & Marine Scotland:** environmental and marine licensing frameworks
- **ISO 9001 & ISO 19650:** quality and information management

This standards-driven approach assures our clients that every project is delivered to internationally recognised benchmarks for reliability, safety, and sustainability.

Core Capabilities

Advanced modelling, measurement, and digital engineering for offshore wind, tidal, and subsea systems. Expertise includes structural and fatigue analysis, underwater acoustics, hydrodynamics, digital twins, dynamic cable modelling, monitoring systems, regulatory compliance, and bespoke COMSOL applications to reduce risk and optimise asset performance.

- 71122 — Engineering related scientific and technical consulting activities
- 71200 — Technical testing and analysis
- 74901 — Environmental consulting activities
- 71121 — Engineering design activities for industrial processes
- 71129 — Other engineering activities n.e.c.

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