



# INNOVATION: THE KEY TO COMPETITIVENESS

Due to changes in the global scenario of energy sources and increased exploitation costs, the Oil & Gas industry needs to continue to focus on pursuing innovation to cope with challenges in the near-future. Saipem has a long tradition in innovation driven mostly by frontier operations; however, a step-change impulse and a new innovation strategy is now necessary, both in scope and intensity, to cope with the current market scenario.

Stakeholders to whom it matters	2016 Highlights	Saipem goals	UN GC Principles	Sustainable Development Goals
	R&D expenditure (million euro) <b>19</b> <hr/> Main technology innovation hubs <b>7</b>	<ul style="list-style-type: none"> <li>Identify or anticipate the trends of the O&amp;G industry requirements</li> <li>Increase investment in technology innovation</li> </ul>		

It is clear that in the current low oil price environment, innovation and technology development are expected to be even more of an effective and strategic leverage to support the restructuring phase of the Oil & Gas industry and this view has been fully endorsed also at Saipem. A strong propensity to change, continuous technological development, adapting new instruments and successful operating methods is in Saipem's DNA. However, the general figure of the Oil & Gas industry has pushed Saipem to do even more than in the past, considering Technology Innovation as one of the founding bases of the new Strategic Plan. In this frame, Saipem has recently decided to renew its own technology innovation strategy based on three main pillars:

- **Technology Development:** applied to tools, equipment and technologies for commercial project execution, integrated systems with a high technological content, technologies licensed by Saipem, etc.;
- **Transformative Innovation:** to change processes and how Saipem works to boost productivity and chase new value propositions, all the while being even more open to the 'ecosystem' and taking advantage of digitalisation technologies;
- **Technology Intelligence:** to scout new technologies within and outside of the Oil & Gas industry to identify disruptive emerging technologies as opportunities to have a high impact on Saipem business.

## SAIPEM'S INNOVATION MODEL

The success of many of Saipem's projects, as well as one of the main sources of the Company's competitiveness, is driven by technological advances. Saipem's technology approach is strongly oriented to projects/services execution. As a consequence of the proximity to the business of most of Saipem's innovation activities, two main types of technology innovation are currently being realised:

- **Research and Development:** activities with a higher innovative content and medium-term target (only these activities are explicitly reported in the balance sheet of the Company);
  - **Technology Applications:** internal development activities close to final deployment and technologically more mature, directly developed in projects/assets and also with clients.
- It is essential to consider both the innovation categories in order to clearly picture Saipem's innovation effort.

**The overall 2011-2016 portfolio** ~€190 mln

In 2017, in relation to the new innovation strategy, overall innovation investments will at least double with respect to the average of the last few years. The main general drivers are cost reduction and/or productivity increase; improved safety and/or operability and environmental protection.

## MAIN TECHNOLOGY CENTRES AND RESOURCES

As Saipem's Technology Innovation is strongly focused on projects and services execution, several centres, close to engineering hubs and operations, are responsible for the execution of most of the activities in different locations.

**People involved on R&D activities\*** ~100

**Main Technology Innovation Centres** 7

(\*) As Full Time Equivalent.

## INTELLECTUAL PROPERTY (IP)

Technological know-how is a strategic and fundamental asset for Saipem and, as such, must be suitably managed, developed and protected. As a consequence, the strategic aim is to address the company's ability to generate commercial and competitive value from IP, more specifically by:

- stimulating the generation of innovative ideas (and developing most of the consequent IP);
- strategically managing the portfolio in order to guarantee the best trade-off between the generation of new intellectual property and containment of the dedicated IP budget;
- using Saipem's IP to gain advantages in operating commercial projects, licensing and establishing technology alliances.

Patents in force

2,308

New patents filed in 2016

36

As a broad strategy, IP is generally developed for internal use in commercial projects in the offshore business, while it is mostly licensed out to third parties in the onshore business.

## TECHNOLOGY INNOVATION IN THE ONSHORE BUSINESS

The focus in the onshore business is on improving overall sustainability of projects through the capacity to design plants with higher performances and availability while integrating them with the surrounding environment. This is reflected in Saipem's innovation effort in the following areas: in gas monetisation, leveraging the strong competences to maximise the efficiency of the complete value chain, in refineries, focusing on the total conversion of oil's bottom of the barrel, and thoroughly

## EXTERNAL COLLABORATIVE EFFORTS

Saipem actively cooperates with several external entities both within and outside the Oil & Gas industry. This allows Saipem to be receptive to crossover technologies. Therefore, increasing efforts in 'Technology Scouting' have been implemented. In this general frame, Saipem has always demonstrated a collaborative approach, leveraging on a broad network of technology suppliers, universities (such as Politecnico di Milano, Universities of Padova, Bologna, Pisa, Urbino, Rijeka, Tulsa, etc.), research centres (i.e. Fraunhofer IKTS), university spin-offs, start-ups, commercial partners, as can be seen by the number of collaborations and Joint Industry Projects (JIPs) between oil majors and field service providers or contractors, activated in the last few years.

Joint Industry Projects since 2013

+60

Collaborations with universities, spin-offs, research centres

+25

investigating the management of CO<sub>2</sub>. More specifically, implementation is proceeding for a multi-year plan to keep the proprietary fertiliser production technology 'Snamprogetti™ Urea' at the highest level of competitiveness. After completion of the development of the novel 'Supercups™' trays, ongoing activities include:

- improving resistance to corrosion and cost reduction through the development of novel construction materials;
- decreasing energy consumption through optimisation of utility systems;
- reducing the environmental impact ('Urea Zero Emission') through highly innovative solutions is under development.

As regards LNG Regasification, the final step of the LNG value chain, Saipem, in cooperation with the 'Politecnico di Milano' university, has explored ways to reduce the consumption of this high energy consuming process. The schemes assessed as viable are mainly based on Direct Expansion, Cogeneration and Organic Rankine Cycle technologies; results achieved show that a significant

## LICENSED PROPRIETARY TECHNOLOGIES

### MTBE + derived techs



42 LICENSED UNITS  
(EcoFuel co-owner)

Refinery/Petrochemistry



134 LICENSED UNITS

+60 REVAMPED UNITS

+66 FORMER MONTEDISON UNITS

Snamprogetti™ Urea Technology

## FOCUS ON ASSET INTEGRITY MONITORING (AIM)

Asset Integrity Monitoring is a broad term for many different applications, methods, technologies and practices, that participate in the life cycle management of any asset.

One of the historical applications at Saipem was in Pipeline Integrity Management (PIM) activities, starting from onshore trunklines transporting oil or gas, typically in the presence of hazardous conditions and then moving towards offshore applications. Saipem's application covers from the early engineering phases (conceptual, pre-FEED) throughout the entire value chain (EPCI, commissioning, operation & maintenance).

Technologies for pipeline monitoring went from punctual monitoring (extensimeter, vibrating wires, Fibre Bragg Grating sensors, etc.) to distributed monitoring, with Fiber Optic (FO) techniques as DAS (Distributed Acoustic Sensing), DTS (Distributed Temperature Sensing) and DSTS (Distributed Strain-Temperature Sensing).

Other recent applications occurred in LNG plants and in maritime infrastructures.

Distributed pipeline monitoring represents the new frontier for the remote maintenance and operation

of pipelines, allowing operators to manage the asset in the safest conditions and making it more efficient, even avoiding expensive and sometime dangerous visual inspections, by monitoring structural strains, displacements, loads, temperatures, pressures, vibrations, flow conditions, pig tracking, gas and oil leakages, intrusions, etc.

For onshore pipelines, Saipem is therefore developing an integrated system for DSTS. The work programme also includes the development of a robotised system for the application of sensors during pipe laying and the definition of the cable containing optic fibres to maximise information on reliability and quality. Similarly, for offshore flowlines and risers, Saipem has developed a DSTS device currently applied on its heat traced Pipe-in-Pipe system, together with a device to install the FO during the prefabrication of line pipes.

Other applications of FO techniques are currently ongoing also in the fields of FLNG, SURF, Subsea Factory, ROV systems and others.

Integrity monitoring of assets will generate a huge amount of data that will need to be gathered, acquired, analysed and used for diagnostic purposes by means of the new emerging Big Data techniques, helping Saipem to extract information of greater insight and value.

energy consumption reduction is achievable and these schemes are now available for industrial applications. With a view to reinforcing the traditional Company business of pipeline EPC, a comprehensive programme is in force to improve and optimise several different aspects of the design and construction procedure. A notable achievement in this field in 2016 was the **trenchless solution (Raise Boring)** adopted for the Chinipas slope pipeline crossing (Mexico).

## TECHNOLOGY INNOVATION IN THE OFFSHORE BUSINESS

For the Offshore Engineering & Construction Business Unit, development has focused on subsea fields that are becoming more and more complex and expensive. To make subsea field exploitation economically viable for clients, Saipem has been working on innovative solutions

### RAISE BORING: A TWO-TIME AWARD-WINNING INNOVATION

Since 2003, with the institution of the Innovation Trophy, Saipem has sought to reward employees who bring their innovative spirit, advantages and concrete results to the Company. Since its inception, attention was mostly directed towards technology development. Some of the employee proposals over the years led to Saipem's most important recent successes.

Innovation developed outside of the traditional R&D/technology development efforts was targeted in the last few years by awarding Process Innovations (work tools, work flows, management practices, etc.), in line with the new innovation strategy.

Finally, in 2015, a new special award was introduced for technology innovation to acknowledge the Sustainability value of Company operations.

**In 2016, the Sustainability prize was awarded for the innovations achieved in the trenchless solution adopted for the Chinipas slope pipeline crossing in Mexico.**

This innovation also resulted in the IPLOCA (International Pipe Line & Offshore Contractors Association) 2<sup>nd</sup> place Environmental Award. The grounds of the recognition were 'the design and

construction of the Chinipas Slope pipeline crossing. Based on a geomechanical study, Saipem decided to use a raise borer to avoid a huge visual impact, earth moving, and a steep slope installation'.



**A vital part of our updated strategy will be an enhanced role for technology and innovation in underpinning Saipem's competitiveness and future growth opportunities.**

**Stefano Cao, Saipem CEO**

that can be combined into new Field Architectures, making brownfield debottlenecking, stranded field exploitation and even greenfield developments technically and economically viable, also in deeper water. Indeed, new technologies are moving topside operations onto the seabed and are increasing the distances of subsea production wells from the main infrastructures, heading to the so-called 'Subsea Processing', 'Long Tie-Back' solutions and 'All Electric fields', resulting in an additional reduction in tubular and umbilical items installed subsea and creating significant savings in investment and operating costs (Q see the focus below). But costs can be saved also acting more traditionally on technologies along the operators' supply chain, by innovating the existing products, installation methods and materials.

As an example, the use of Corrosion Resistant Alloys (CRA) or other 'exotic materials' for pipes, spools, valves and ancillary equipment, requires long, cumbersome and expensive welding operations to the extent that they require new joining methods, as was for the 'Internal Plasma Welding' of clad pipes, developed, qualified and successfully used by Saipem on projects in Asia, the Middle East and the Caspian area. Furthermore, the Fusion Bonded Joint is a new joining method for plastic lined pipes fully qualified by Saipem, that restores the continuity of the internal liner during the construction and installation phases of a subsea line, without affecting the laying vessel's productivity. Saipem is very active also in developing and proposing subsea solutions integrating the new, disruptive Thermoplastic Composite Pipe products, which can face

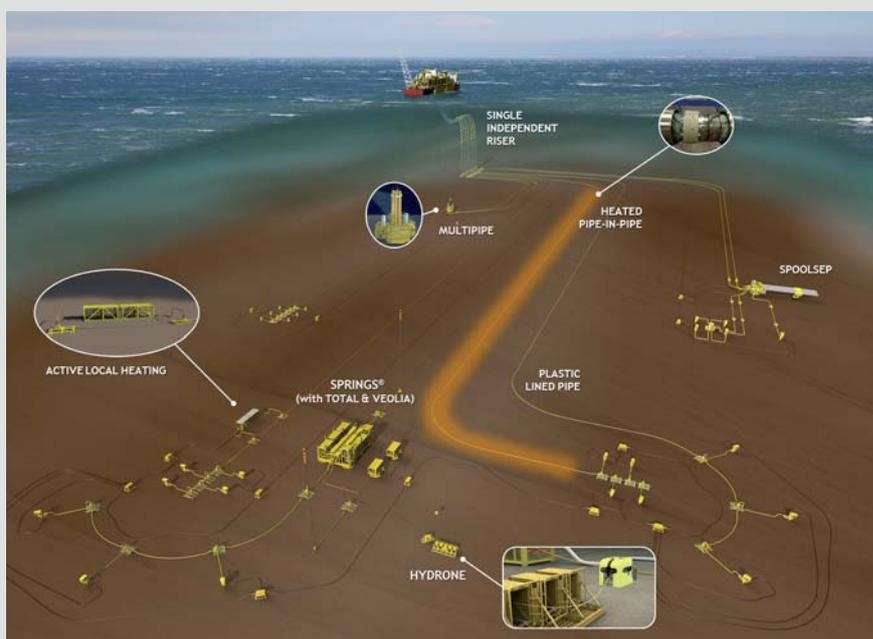
## COMBINING TECHNOLOGIES IN NEW SUBSEA FIELD ARCHITECTURES

### Subsea Processing

'Subsea Processing' means moving surface operations and equipment to the seabed, bringing semi-finished products to the surface. The challenge requires rethinking the industrial structure and supply chain to achieve maturation for standardisation and modularity. The levers are technology and process, and Saipem is getting ready to offer a set of fit-for-purpose subsea solutions called SPRINGS®, Multipipe and Spoolsep.

In 2016, Saipem, Total and Veolia entered into a co-ownership and commercialisation agreement to develop, industrialise and commercialise SPRINGS®, a viable alternative to conventional topside water treatment and injection units by bringing nano-filtration membranes subsea to remove sulphates from seawater. This enhances the economics of oil recovery by eliminating water injection sealines, by saving on topside weight and deck space, easing retrofit in brownfields, especially in FPSOs, and making distant, deep injection wells economical. A pilot unit had been tested subsea. The industrialisation phase and commercialisation programme are ongoing under the leadership of Saipem.

In 2016, Saipem also completed a joint development project on its Spoolsep technology, for the gravity separation of water produced from oil. This solution is characterised by a modular design of the process equipment, making it fit for use with high pressure fluids, ultra-deep waters and its maintenance can be ensured by smaller and less expensive ships.



### Long Tie-Back Solution

To ensure transportation of multiphase fluids in long flowlines and risers, Saipem has industrialised and qualified a new electrical Heat Traced Pipe-in-Pipe fabrication and installation system for rigid J-Lay, that extends the application of the most efficient active heating technology to larger diameter pipes, for even longer tie-back lines. Similarly, Saipem is developing and testing a new, low-cost solution, consisting in a subsea station that can electrically warm up the fluid passing through the pipe, efficiently solving flow assurance problems during production.

## TRANSFORMATIVE INNOVATION 'THE INNOVATION FACTORY'

In June 2016, Saipem launched an innovation lab called 'The Innovation Factory'. Strategic themes defined by management, an agile approach, fast-prototyping, digital enablement, cross-industry open-innovation and, most of all, enhancement of internal innovative thinkers, are the keys to its success.

The 'Innovation Factory' is an idea incubator aimed at testing solutions to address the challenges of the energy sector, by adopting new technologies and methodologies, and at gaining a boost in terms of productivity with the final goal of earning a competitive advantage.

Through the 'Innovation Factory' cross-functional collaboration is constantly at work since the incubator currently hosts 30 young Saipem talents, representing different professional backgrounds, who are developing strategic topics identified by the top management.

### Projects of the programme in 2016

6

The 'Innovation Factory's' agile approach requires the company management to decide quickly whether to implement a prototype presented by project groups or to abandon it, thus avoiding endless studies and economic efforts. A few proof of concepts have already been conceived and checked directly in the field with

interesting results. The monitoring progress within the Factory is entrusted to senior sponsors who are aware of the needs of the company and its strategic guidelines.

The goal of the Innovation Factory is to collaborate with universities, research centres, start-ups and cross industry players, all the while adapting the best practices already successfully implemented in other sector domains at Saipem where Industry 4.0 is already in place and producing good results.

### IDEA INNOVATION CHALLENGE

As another new initiative in the field of Transformative Innovation, the 'Idea Innovation Challenge' (IIC) was launched in 2016 seeking to create new innovative ideas through collaboration and knowledge sharing with people, by adopting typical crowd-sourcing tools. The IIC aims to involve all Saipem people in the innovation process asking them to propose their own ideas for the resolution of real and precise business challenges.

The launch of the first Idea Innovation Challenge, sponsored by the Drilling Business Unit, proved to be very successful: several new ideas were proposed involving innovators from around 20 countries. Some ideas are now under development at the company and after this pilot test further challenges will be launched in the near future.

the combined requirements of hot, corrosive and highly pressurised fluids and reduce the total cost of ownership of some tubular subsea equipment.

Material technologies play a master role also in unlocking subsea field development projects in ultra-deep waters. Composite materials, and nano-materials in the future, can be the answer in case of high pressure inside and/or outside the production facilities, especially if combined with a change in design to the overall subsea systems. In this direction, Saipem's 'Single Independent Riser' (SIR) is a qualified technology designed to improve fatigue behaviour and to extend the application range of a riser far beyond a water depth of 3,000 metres, also by making use of new materials. In addition to these efforts, Saipem has recently established a new milestone in the oil service industry with the installation of two gas export Free Standing Hybrid Risers (FSHR), measuring 19 inches and 20 inches at a water depth of 2,200 metres.

The increased scope of work of seabed equipment and operations is leading subsea fields to a higher complexity and the consequent need to inspect, monitor, maintain and repair the subsea facilities. By extending the life of the fields, operating costs will be as important as capital expenditure; this means that subsea systems and infrastructures with high availability will be rewarded. Client operations will also benefit from another Saipem innovative solution called 'Hydrone': a permanent subsea infrastructure mainly composed of a new hybrid ROV/ AUV for 'Life of Field' (LoF) management services as an extension of Saipem's EPCI offering.

All subsea intervention technologies developed by Saipem (i.e. Innovator ROV, SiRCoS sealine repair system, ultra-deep and ultra-shallow trenching systems, etc.) have benefited from the experience gained in executing challenging subsea intervention works. In particular, the new Innovator 2.0, delivered in 2016, is based on 20 years of continuous design improvement and it sets the highest standard in the industry in terms of technology development for a Work Class ROV system.

On this basis, the new 'Hydrone' concept, now subject to a development and industrialisation programme, evolved from such a system, integrating AUV (Autonomous Underwater Vehicles) functionalities and innovative automation advanced features, suitable for performing all types of inspection and light intervention operations for long durations without any MSV (Multi Service Vessel) support.

As LoF service covers all the ages of a field, Saipem is continuously conceiving and delivering subsea engineered solutions for the installation, commissioning, operation, maintenance, repair and decommissioning of 'Subsea Production System' (SPS) and SURF equipment. A clear example is the 'Emergency Pipeline Repair System' (EPRS) service, a comprehensive LoF approach 'in order to be prepared' to repair damaged sea lines. Another example is the 'Asset Integrity Monitoring' service that requires new monitoring technologies and equipment, currently under development at Saipem, based mainly on fibre optic sensors, to be applied to SURF and 'Subsea Factory' equipment.