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nurturing the future generations for oil and gas industry

IGU
INTERNATIONAL GAS UNION
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Nurturing the Future Generations for the Oil and Gas Industry

Produced by:

TASK FORCE 2

International Gas Union

Chair: Soh Mey Lee, Malaysia

in collaboration with

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Task Force 2
International Gas Union

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LIST OF ABBREVIATIONS

AAGR	Average Annual Growth Rate
ACHE	Association for Continuing Higher Education
ARWU	Academic Ranking of World Universities
Barclays	Barclays PLC
BERD	Business Expenditure on Research and Development
BP	BP PLC
BRIC	Brazil, Russia, India, and China
C&B	Compensation and Benefits
CAPEX	Capital Expenditure
Chevron	Chevron Corporation
Citigroup	Citigroup Inc.
CRC	Cooperative Research Centre
CSR	Corporate Social Responsibility
Daimler	Daimler-Motoren-Gesellschaft
DJSI	Dow Jones Sustainability Index
E&P	Exploration and Production
Encana	Encana Corporation
EU	European Union
ExxonMobil	Exxon Mobil Corporation
GCSE	General Certificate of Secondary Education
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
GHG	Greenhouse gas
GSA	Graduate skills assessment
HR	Human resources
ICT	Information and Communications Technology
IGU	International Gas Union
IT	Information technology
MST	Mathematics, science and technology
NGO	Non-governmental organisation
Nokia	Nokia Corporation
O&G	Oil and gas
OECD	Organisation for Economic Co-operation and Development
Petrobras	Petróleo Brasileiro SA
PMNI	Potential Net Migration Index
R&D	Research and development
ROE	Return on equity
ROIC	Return on invested capital
ROS	Return on sales
S&M	Science and mathematics
S&T	Science and technology
Shell	Royal Dutch Shell PLC
Sinopec	China Petroleum & Chemical Corporation
SJR	SCImago Journal Rank
SME	Small and medium enterprises
Standard Oil	Standard Oil Company (Incorporated)
Statoil	Statoil ASA
STEM	Science, technology, engineering and mathematics

TF2	Task Force 2
TIMSS	Trends in International Mathematics and Science Study
Total	Total SA
UNESCO	United Nations Educational, Scientific and Cultural Organisation
Vodafone	Vodafone Group PLC
Volkswagen	Volkswagen AG
WBD	Women board directors
Woodside	Woodside Petroleum Limited

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CHAPTER 1

INTRODUCTION BY THE TASK FORCE 2 CHAIR

Wisdom from history has taught us that irrespective of the economic cycles, world energy demand continues to rise, driven by wealth creation, urbanisation, and a growing world population. Fossil fuels will continue meet close to 80 percent of the world's energy needs; a figure unlikely to change significantly over the next 20 years.

Natural gas is currently widely used for power generation but the composition of gas in the energy mix for most countries remains relatively low. However, if the Millennium Goal to reach the 1.5 billion people currently without electricity is to be achieved, natural gas, being an abundant and environmentally-friendly energy source, will become an increasingly important source of fuel.

Despite this, the global gas industry is facing mounting challenges. In recent years, both oil and gas discoveries are not only diminishing and dwindling, but are becoming more challenging to find. The industry appears to have reached a point in time where easily extractable, high quality hydrocarbon resources have mostly been discovered. The scenario now is exploring and exploiting more difficult to extract areas, including tapping into unconventional sources such as hydrocarbons that are locked in rock.

In light of this, the industry continues to innovate and push the limits of technology to further drive down costs, enhance economics, and recover more hydrocarbons. These efforts have made it possible for the industry to discover and exploit tight gas resources, deeply buried reservoirs, and deepwater exploration activity. Further downstream, the industry continues to find innovative solutions to deal with CO_2, sour gas, and high sulphur gas, and to find new uses for gas.

As we resolve to meet the insatiable global appetite for energy, we cannot avoid the fact that resources will be found in more remote and difficult locations that demand huge investment and state of the art technologies. Hence, innovation is a key driver for the global gas industry. This is made even more crucial given the increasing importance of environmental considerations.

Innovation means that the industry needs to attract, train, and develop talented people. Given the fierce competition for a limited global supply of talent, the gas industry needs to develop an industry-wide strategic response as a first step to developing a strategic human capital. As it is, many companies are already making individual efforts such as promoting awareness of career opportunities in the industry. However, this has been inadequate to draw sufficient numbers of today's youths to join the industry.

Some studies attribute this to either a lack of awareness and engagement by youths with the oil and gas industry, or misperceptions of the industry as a "sunset" industry or one that is polluting the environment. For example, there is more than a 90 percent drop in the number of students obtaining university degrees in petroleum engineering and geo-sciences since 1982.

Overall, there has been a trend of decreasing enrolments in STEM courses in some countries. Furthermore, those who have enrolled in science and engineering courses will also have career paths in other industries. Hence it is important for the global gas industry to really understand the future generations' career motivations.

While the O&G industry outlook is positive – demand for energy is projected to increase by 50 percent from 2007 to 2035 – only 8 percent of the top 50 most attractive employers to engineering graduates are O&G companies. Hence, it appears that the industry today does indeed suffer from a negative image. The industry also faces an imbalanced gender distribution. Whilst the overall global labour participation rate of women is rising, women still make up less than 30 percent of the workforce at leading O&G companies.

Examining the role that STEM plays in national development, economic growth, and the promotion of societal well-being, STEM assumed centre stage after the Second World War in national strategic thinking for governments and enterprise. The heightened status of STEM was a consequence of the role that it had played in the world wars and associated national production. The consequences included the establishment of national laboratories, the creation of new academic disciplines in STEM education, and the emergence of science and innovation policy as new areas of study.

However, the importance of science in driving industry began even earlier, from at least the last quarter of the 19th century, when the new electrical and chemical industries emerged in Germany, the USA, and the UK. Accordingly, economist Carlota Perez's analysis shows that there have been five Great Technological Surges since the industrial revolution.

By her count, the 4th Great Technological Surge was market in October 1908 by the marketing of the Model T Ford alongside the advent of the internal combustion engine, petrochemicals, and mass production. The 4th Great Technological Surge is still unfolding in the 21st century, for instance with the rise of hybrid cars.

The Cold War arms and space races between 1949 and 1989 heightened the interest of governments in S&T. It became an article of faith that improving science, mathematics, and technology in schools would be essential to achieving future national prowess. A decisive moment came on October 6, 1957, when the Soviet Union launched Sputnik, followed a month later by the satellite hosting space dog, Laika, and in 1961, cosmonaut Yuri Gagarin's orbit around the Earth. To the USA, these events reflected their national failure in S&T education.

As the space race unfolded, the mysteries of the economy became less opaque. The econometric studies of Moses Abramovitz and Robert Solow showed that technological change accounted for some 80 percent of the rise in economic growth. This further emphasised the importance of science education.

Efforts to modernise and improve science and mathematics education percolated beyond North America joining emerging trends in Europe and across the rapidly decolonising world. UNESCO became a champion of modernising S&T. In addition, newly independent countries announced policies for science, and identified science education as a core to their national curricula. The

conditions appeared optimal for ensuring that S&T would play a fundamental role in building nation states and industries, and in the fight against poverty.

The 5th Great Technological Surge in the 1970s saw the eruption of the ICT revolution. This 5th Surge, which may be dated from 1971 with the advent of the Intel 4004 microprocessor, is still in its most powerful stage of innovation and societal change. One only needs to think of the unfolding impact of mobile telephony and the Internet. The ICT revolution has yet to fully unfurl, even as the 6th Surge involving bio- and nano-technologies are taking shape.

The O&G industry itself is essentially synonymous with the 4th Great Technological Surge, and is driven forward and outward across the globe through the power of the 5th Great Technological Surge. Remote sensing and control at three thousand metres below sea level are only possible because of digital technology. The capital investment and technological complexities facing the industry today exceed those of the Soviet Moonshot in the sixties. As a result, the present human capital needs for the industry are growing given the increasing complexity and technological sophistication of the industry.

While technological surges continue to unfold at higher rates, a structural change in demographics, especially in the OECD nations, is also an untimely development. Across the core OECD countries, the countries that have traditionally led innovation, an ageing population is already a hard reality. Additionally, due to the current period of fiscal austerity, investment in education in these countries may potentially suffer setbacks.

In China, it is envisaged that it will soon feel the impact of its ageing populace as a result of its former one-child policy. Even 'youthful' Brazil has started to see the upward shift of its age profile. This ageing trend is also reflected in the current STEM workforce. Eurostat figures show that approximately 42 percent of scientists and engineers are in the '45-64' age group and approaching retirement.

A confluence of the aforementioned factors contributes to the diminishing supply of qualified STEM candidates trickling into the talent pipeline for key STEM industries, including the O&G industry. To address this issue, under the Malaysian Triennium of the World Gas Conference, a special project is undertaken by the IGU under TF2 on "Nurturing the Future Generations". The TF2 project attempts to look for ideas to discuss and adopt, and to think about how the gas industry can address the talent issues for those between the ages of 5 and 30.

The IGU TF2 aims:

- To develop a holistic approach on nurturing future generations to engage and excite the young generations about STEM and energy (the gas industry)
- To ensure that the gas industry will have a deep pipeline of 'qualified' STEM candidates for the gas industry to attract and nurture into talent to achieve the industry's objectives

The approach includes creating awareness and preparedness of the younger generations for the O&G industry and other STEM-oriented careers at all educational levels.

In the past, efforts to halt the decline of STEM education have been undertaken on a sporadic basis by companies, governments, and industry bodies. It has been recognised that the global gas industry needs to make a concerted effort to understand the younger generation's career motivations, build awareness, and manage their perceptions of the global gas industry.

The TF2 study will take a multi-step approach, starting first with an understanding and insight of young generations' perception of the O&G industry. The next step will make an effort to gain some insights into what the industry has so far tried with regard to becoming an employer of choice. The study will also look into efforts of governments worldwide in promoting STEM education and see how STEM education fits into the respective countries' investment priorities.

A critical component of this study will be to gain insights into the younger generation's lifestyles, beliefs, values and interests, so that any strategic engagements to attract talented young people into the sector will have addressed the younger generation's motivations effectively.

The study will also make an effort to assess whether young generations worldwide are presented with sufficient opportunity to gain access to STEM education before finally concluding on whether young people are enjoying STEM, if they are given the opportunity, and why. Over the last decade, general accessibility to education has increased by approximately 20 percent, whilst STEM enrolment at the tertiary level has remained stagnant.

The TF2 project will assess the efforts by academia, industry, and government towards addressing young generations' interests in STEM as well as to develop a strategic approach with recommendations to tackle this challenge of nurturing young generations' interest in STEM and managing their perception of the O&G industry.

This report examines ten countries of varying population size, economic strength and wealth, and maturity of its O&G industry. The ten countries are Australia, Brazil, Canada, China, France, Germany, Norway, Russia, the UK, and the USA. In addition to these 10 countries, Malaysia is also featured to commemorate its role in hosting the 25th WGC

This report highlights the challenges faced by the STEM industries, followed by an examination of major forces which impact the STEM talent pipeline for the O&G industry. Finally, this report recommends strategies and implementation plans to nurture young generation's interest in STEM and to attract future STEM graduates into the industry.

Soh Mey Lee
Chair, Task Force 2
International Gas Union

CHAPTER 2

THE CHALLENGE: AVAILABILITY, INTEREST, ATTRACTION

To plan for the supply of STEM skills to the O&G industry, it is necessary to understand industry demands. Technologies required are both hard and 'soft', with requirements spanning across exploration, production, process, and organisational aspects of operations. In addition, the industry must prosper in conformity with its triple bottom line reporting requirements entailing financial, environmental, and social responsibilities. The industry operates at the technological frontier across climatic and geographic extremes, with high and low environmental footprints. As such, it depends upon the availability of a wide spectrum of skills, including welders and divers; chemists and marine biologists; geophysicists and mathematical modellers; actuaries, economists and accountants; and even ecologists and ornithologists. Petroleum engineers are an essential part of the industry's value chain of processes, but are they not the only key resource.

The O&G industry operates under various business models. In the USA, the industry has been publicly owned since the early days of Standard Oil. BP, the fourth largest company in the world, was originally owned by the UK government but became publicly-traded in the 1980s. Norwegian Statoil is publicly traded with the government holding a majority stake. Publicly listed Petrobras of Brazil is the largest company in the Southern Hemisphere in which the government share is now 64 percent. Russian Lukoil is the second largest O&G producer in the world, and is owned by its managers.

Governments adopting free-market policies (or *laissez faire)* rather than central planning (or *dirigisme*) are likely to respond to O&G industry requirements in different ways. Given the massive size of the industry, it is 'the elephant in the room' and its impact on state finances through taxation, employment, spill over and externalities mean that strong government-industry relations are likely necessities. Balancing the future well-being of society and the O&G industry must thus be a matter for all governments, be they committed to *laissez faire* or *dirigisme* economic policy.

What then does the O&G industry expect of the education systems in the countries where it operates and of the governments responsible for those systems? The twin forces of energy security and economic sustainability mean that governments must take proactive measures towards encouraging the development of STEM skills to sustain future production and growth.

2.1 STEM TALENT SUPPLY

The O&G industry is a competitor for “skilled talents”, drawn from a pool that appears to be stagnant or even diminishing in size. The ways in which these talents are generated and supplied to the industry are complex and involve many feedback loops, some of which are country specific.

It is unlikely that there can be a ‘one-size-fits-all’ approach to addressing the industry’s talent needs. For example, Shell operates in 90 countries and its talent requirements cannot be met by actions taken in its country of domicile alone. On the other hand, Petrobras, a relative newcomer active in 14 countries, has activities that are highly concentrated in Brazil - and thus looks to the Brazilian government to address its talent requirements. Both Shell and Petrobras are active in the O&G industry, while the latter is also the world leader in ethanol from sugar cane production. Their strategies for talent sourcing must necessarily differ. The above differences notwithstanding, it is still possible to draw out some common issues. These concern the changing global demographics, STEM education and its successes and failures, as well as the industry’s public appeal, especially to young generations.

2.1.1 AVAILABILITY OF GLOBAL HUMAN CAPITAL

The world is undergoing demographic changes with relation to the size and proportion of the respective age groups in its population. While world population will continue to grow in the long term, of particular concern is the declining numbers of young generation (age groups ‘0-14’ and ‘15-29’), as well as the steady increase in the proportion of senior citizens (65 and above) in the global population. US Census data suggests that the global population is ageing at a rapid pace. This demographic trend indicates that potential losses and lack of talent supply may arise as issues surrounding the future workforce. The ‘0-14’ age group is experiencing the biggest decline in its proportion of total population, with a projected drop of 9 percent from 2000 to 2050. This drop is followed by the ‘15-29’ age group, which is projected to decline from 26 percent in 2000 to only 20 percent of the world population in 2050. In contrast, the older age groups are projected to experience a significant increase in number. The proportion of those aged 65 and above in 2050 will be more than double that of year 2000 with an increase from 7 percent to 17.

This demographic pattern is replicated across all ten countries analysed in this report.

The aging population trend is driven by two factors: decreasing birth rate and increasing life expectancy. The decreasing birth rate is partly the result of increased mortality rates across nations, which has resulted in many adults choosing to have smaller families. In addition, higher levels of educational attainment and labour market participation amongst women have led to more women choosing to delay starting a family. Increasing life expectancy is the result of advancements in medical technology and increasing awareness of the negative effects associated with unhealthy lifestyles in a society with increasing educational attainment.

Of the countries surveyed, Brazil has the steepest projected decline in birth rate (45 percent) from the year 2000 to 2050. Meanwhile, developed countries will still have higher life

expectancies compared to developing countries, but the life expectancies of Brazil, China, and Russia are expected to show a drastic increase, significantly adding to the proportion of elderly

According to The Stanford Center on Longevity, growth of the working-age population will slow down everywhere. Among the large industrialised economies, only Canada and the UK will experience growth for their respective working-age populations, albeit at slow rates. Countries such as Brazil and China will experience an increase followed by a significant decline in working-age populations in the next 60 years.

2.1.2 STEM INTEREST

As the global population ages and the size of the future workforce shrinks, it becomes critical to ensure the young generations' interests and inclination to STEM are nurtured, to maintain a steady qualified talent pipeline for the industry in the future, particularly when competition for talent from other industries is also steep.

The education system plays an important role in cultivating STEM interest, and subsequently developing and producing quality STEM graduates for the O&G industry. At the base is primary education; at the top the provision of skills for the industry. To ensure that the economy and the O&G industry in particular, are able to draw on STEM personnel of sufficient quantity and quality, a number of preconditions must be met. Fundamentally, schooling must 'pass', and this success depends critically upon teachers and teaching. Few countries can claim to have solved the problem of teacher supply. Korea, Singapore, and the Scandinavian nations are perhaps exceptional in the high status accorded to the profession. For other countries, this weakness in the formal school system is often corrected by private substitution. For example, Japan's high attainment of science and mathematics expertise is boosted by its massive out-of-school private tuition industry. The lesson from this observation is that an education system which creates and retains excellent teachers and captures the imagination of youth through its curriculum is the *sine qua non.*

The problems facing STEM education have exercised some of the best minds in the world over the last half century. Some recent perspectives are provided by the USA in the National Academies 2007 report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*. The study followed a mounting concern that the USA was in danger of losing its pre-eminence as the world technology leader, as illustrated by the American students' poor science and mathematics achievements. A study for the USA Congress noted that,

> *There is growing concern that the United States is not preparing a sufficient number of students, teachers, and practitioners in the areas of STEM. A large majority of secondary school students fail to reach proficiency in math and science, and many are taught by teachers lacking adequate subject matter knowledge*.

The report, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, followed with the warning that,

The prosperity the United States enjoys today is due in no small part to investments the nation has made in research and development at universities, corporations, and national laboratories over the last 50 years. Recently, however, corporate, government, and national scientific and technical leaders have expressed concern that pressures on the science and technology enterprise could seriously erode this past success and jeopardize future USA prosperity. Reflecting this trend is the movement overseas not only of manufacturing jobs but also of jobs in administration, finance, engineering, and research.

A second and different appreciation of the problem is the report titled *Science Education in Europe: Critical Reflections* published by the Nuffield Foundation. The motivation for this Nuffield report is the EU Lisbon Agenda that demands more of science due to signs of disaffection toward science. A seminal conclusion of the report is "There are shortcomings in curriculum, pedagogy and assessment, but the deeper problem is one of fundamental purpose. School science education, the authors argue, has never provided a satisfactory education for the majority. Now the evidence is that it is failing in its original purpose, to provide a route into science for future scientists. The challenge therefore, is to re-imagine science education: to consider how it can be made fit for the modern world and how it can meet the needs of all students; those who will go on to work in scientific and technical subjects, and those who will not." According to the Nuffield report, the problem does not reside in the raw material (learners) or the factory workers (teachers), but lies within the production process itself. The Nuffield report claims that the curriculum is flawed. Three decades ago, educationist Dennis Lawton argued that curriculum is a selection from the culture of a society, including knowledge, values, and attitudes. The Nuffield report is suggesting that an inappropriate selection has been made.

A new vision for school science that crystallizes the role of school science for future careers in science, and based upon science, is needed. Improving students' interest in science requires that the primary and secondary levels curricula be changed to include more investigative work and experimentation rather than a concentration on the memorisation of rules. Such fundamental questioning notwithstanding, the Nuffield report agrees with the USA assessment that one must ensure science teachers of the highest quality are provided for students in primary and lower secondary school. This is critical due to the fact that attitudes toward science-based careers are formed in schools during the years when individual personality formation occurs. This is a time of intense self-reflection for young people and such attitudes are formed both consciously and subliminally. While family, peers, and broad societal influences and values will always predominate, the curriculum mediated by teachers is the decisive factor in attracting interest in science and mathematics. Motivation by role models, especially parents, may overcome disincentives in the schooling experience, but this cannot be the case for the majority.

The centrality of quality teaching is beyond doubt; what is more problematic is for teachers to be the agents of curriculum change. Curriculum change requires coordinated intervention at every step in the education process – in classrooms, university lecture halls, through education media, and the continuing development of teacher educators and support staff.

In addition to the governments and the academic sector, major O&G industry players have also recognised the importance of cultivating STEM interest amongst the young generations. For instance, Petrobras has shown major concerns regarding the ageing O&G workforce, future attractiveness of the industry, global skills shortages and future supply of human capital for the industry. Unlike the O&G industry in the USA or the UK, Petrobras has been proactive in partnering with its home government to promote a national HR programme, “PROMINP”, designed to meet the future HR needs of the O&G industry in Brazil. The company has also established Petrobras University, which is similar to the 80 year-old Gubkin Russian State University of Gas and Oil with its strong links to Lukoil.

2.1.3 ATTRACTION OF STEM TALENTS TO O&G INDUSTRY

We commence with findings from an interview with a former senior technology manager of BP conducted during the Gulf of Mexico oil spill. It was thought the spill would generate caution, yet his perspective was that the spill “was exciting stuff that has exposed the whole community to a new technology challenge. No one, not even NASA, understands technology under such extremes of temperature and pressure. If anything, the Deepwater Horizon ‘disaster’ would attract, not repel staff to join the industry.”

Nevertheless, public perception towards the O&G industry contradicts with the former BP senior technology manager’s opinions. According to a public poll held annually in the USA, the industry has been ranked most negative image for the last decade. Moreover, the industry has also scored lower than the average in both “Environmental Reporting” and “Risk & Crisis Management” aspects of the Dow Jones Sustainability Index in year 2010.

In the past, the O&G industry had no real difficulty attracting STEM talents as it was prepared to pay the market rate. The environmental movement had some impact in deterring new entrants, but the more recent engagement of NGOs with the O&G industry suggests that there is a willingness to work toward solutions rather than just being oppositional. It is true that HR will always be a prime concern, but while there had been a drop in production of petroleum engineers in the nineties, National Science Foundation figures show that there is a 25 percent increase in production of American petroleum engineers in the last decade. Nonetheless, as the ongoing cross industry war for talent intensifies, the O&G industry faces the challenge of attracting the required STEM skills which are transferable across different industries. Even then, the industry must also necessarily attract the qualified STEM talents who would choose to join the industry with the right attitude. This is crucial given that the nature of the oil and gas industry is such that it takes a long lead time for one to gather the right type and spectrum of experience and expertise before one can necessarily become useful.

A number of criteria have been identified to be critical in retaining technical skills, including positive work culture, fair monetary compensation, and professional development opportunities. In general, the O&G industry performs well in providing its employees with training opportunities. The industry itself is a major site of in-house training. For instance, Petrobras addresses its HR need by collaborating with the government to implement the nationwide PROMINP programme.

The programme provides training through free courses to thousands of professionals ranging from entry level, to middle, technical and higher in 175 categories in O&G and associated fields.

In addition, the company, alongside its relationships with public universities, has also established Petrobras University that offers full accredited degree courses. The company also encourages research through its Petrobras Technology Award scheme founded in 2005. As a result, for the fourth year in a row, Petrobras has been chosen as the 'young person's dream company' in Brazil by a leading market research organisation. As opposed to the industry's overall poor performance in the "Environmental Reporting" and "Risk & Crisis Management" aspects of DJSI, the company has been recognised as setting the benchmark for the "Human Resource Development" aspect.

In the case of Malaysia; PETRONAS took a leading effort to complement the fort's efforts in nurturing STEM interest with the setting up of Petrosains, a science centre with a flavour of the petroleum industry. Visiting children to the Petrosains get to have hands on experience of the industry from geology, to rig, to refinery. Regular outreach activities further promote awareness and education to incite interest and inclination to science education.

Nevertheless, despite investment in providing employees with professional development opportunities, the industry is generally being viewed negatively as an industry which fails to promote work-life balance, especially for women with families. When compared against other industries, the unpredictable and demanding nature of the O&G industry often deters female employees from pursuing strong career in the industry while growing a family. Consequently, the industry's workforce is extremely imbalanced, with over 74 percent of the leading industry players' employees being male. This lack of diversity has also negatively impacted the industry's work culture as perceived by the public.

In short, even though the industry offers extensive professional training opportunities, its attractiveness is smeared by misconceptions of its poor environmental performance and "perceived" dangerous working environment. Prevailing perceptions of a lack of work-life balance, coupled with low workforce diversity, also contribute to the negative public image of the industry, making it a challenge for the industry to attract sufficient STEM talents to fulfil its future needs.

2.2 THE CRITICAL ISSUES

In conclusion, the five major issues that affect the availability, interest and attraction of STEM skills to the O&G industry are:

- Quality of education systems
- Mobility of the highly skilled
- Changing demographic patterns
- Government-industry relationships
- Perceptions and misconceptions, especially relating to environmental concerns & work-life balance

The quality of education systems is essentially a matter for the governments, but as in the Petrobras case, there is proof that corporate-led initiatives can provide efficient, expedient solutions to address the gaps. Generally, O&G industry may intervene with project funding aimed at teacher development and curriculum development, as well as contribute towards public communication of S&T. Whilst potentially important, these will always be marginal. Deliberate action and investment will be needed further down the education pipeline at the higher education level through the agency of industry-owned or supported facilities.

Mobility of the highly skilled has three facets: brain gain, brain circulation and brain drain. The increase in talents represented by 'brain gain' is largely the task of universities and polytechnic institutions. Universities, though increasingly pressurised to earn 'third stream income', remain dedicated to their two main processes of teaching and research. The highly skilled individuals that emerge from these processes move to industry with new ideas and attitudes, and it is this increase in talents that represents the universities' largest contribution to the innovation activities of firms.

Brain circulation is understood as movement of the highly skilled within and between sectors, as well as temporarily across borders. Circulation is an essential element of knowledge transfer because tacit forms of knowledge reside within people, not operator manuals. Restrictions on circulation will harm countries' potential to advance.

The most negative form of mobility is brain drain where the highly skilled talents commit to permanent migration. On the inward side, the USA, the EU, Canada, and the UK have implemented processes to enable the highly skilled to obtain work permit visas. On the outward side, this brain drain creates and maintains serious threat for African development with little sign of amelioration. Reversing brain drain to become brain gain may take generations, for example in the case of Éire. Conversely, it can also happen within a generation, as shown by the return of native software engineers to India, Russia, and the Baltic States.

The O&G industry appreciates the subtlety of these movements and gears its recruitment and retention policies toward industry stability. Ultimately, it is the complex set of conditions in a country which will affect the individual choices regarding where they will sell their skills. These

choices are determined by factors beyond the control of the O&G industry, for example, the immigration and labour laws, which are regulated by the governments.

While the global ageing trend is least amenable to direct O&G industry influence, the changing behaviours and values of the young generations require the industry players to take a different approach towards attracting and retaining talents. In the current digital age revolution, some form of engagement via digital or telephony-based mediums becomes increasingly essential.

The industry also ought to address its relations with the government. In countries where the government holds a majority stake in the O&G industry, the government-industry link is obvious. On the contrary, in countries where the government has no substantial ownership stake, the situation will be different. In the former case, it is possible for the O&G industry to invoke special pleading; in the latter, not.

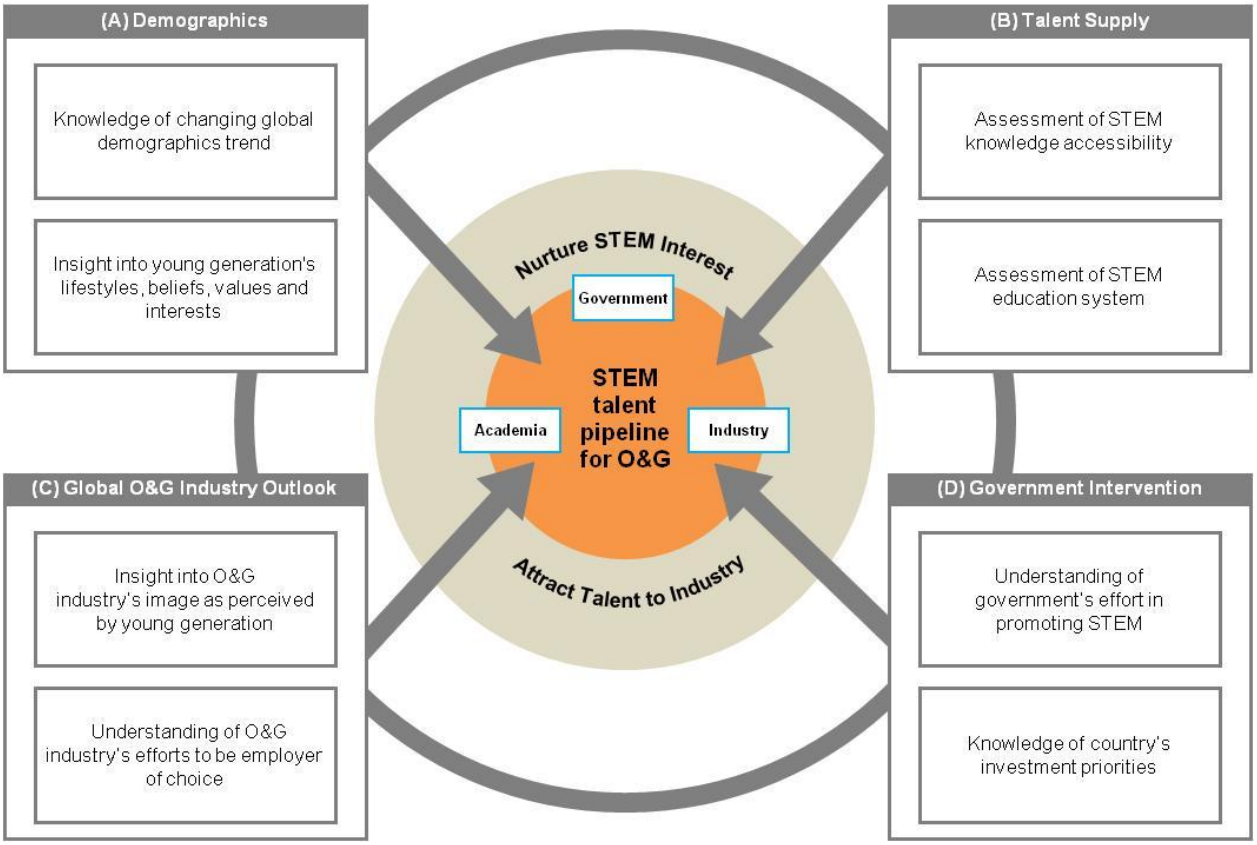
The O&G industry also needs to deal with the public at large. The approach may be different from establishing relationships with the governments, and in principle should be independent of the depth of government-industry relationship. Communications and public relations can assist in improving the O&G industry's attractiveness, especially in correcting the misperceptions.

CHAPTER 3

NURTURING AND ATTRACTION: THE HEART OF THE MATTER

In the previous chapter, we identified the quality of the education system, high mobility, demographics, the extent of government-industry relations, and general perceptions of the O&G industry as the major talent supply issues. This chapter examines the current situation and trends from the perspectives of the four contextual forces – demographics, talent supply, industry outlook, and government intervention - and their interlocking relationships with the three major stakeholders – academia, industry, and government – within the supply and demand equation of STEM talent pipeline.

Figure 3.1 Four contextual forces



Source: *Deloitte Consulting Malaysia (2010).*

Firstly, global demographic trends are assessed as they determine the future availability of talent for the STEM workforce. Demographic trends have pivotal and lasting impacts on the future direction of an organisation or even an economy. For instance, China's economic boom over the past two decades has benefitted from the abundance of young and productive labour. However, the country's "one child" policy has slowed its population growth tremendously, curtailing over 250 million births and setting the country on a path to grow old before it becomes

prosperous. China is bound to face the long-term consequences of labour shortages unless steps are taken to rectify it.

While demographic trends impact the availability of potential talent, education remains as the central force in converting these potentials into competent labour. During the Age of Enlightenment and French Revolution, literacy rose from 25 percent in the 1640s to 70 percent in the 1740s, which in turn led to a surge of in interest in the sciences.

Whilst academia prepares students to enter the workforce, industry players are collectively responsible for attracting graduates. One of the leading determinants of attraction is the public image of the enterprise. Massive layoffs in the O&G industry during the 1980s and 1990s caused the public to view the industry as being cyclical, and inconsiderate towards employees. As a result, many have since avoided the industry when wanting to start a career which provides job security.

With academia and industry players responsible for the supply and demand of STEM workforce respectively, governments are a strategic force in driving both sides of the equation. When John F. Kennedy introduced the Apollo space mission, enrolment rates for bachelor's degree in aerospace engineering and space science peaked so that between 1969 and 1970, 5.4 million out of 6.3 million undergraduates were enrolled in one or more science or engineering courses. Government intervention may be fundamental in steering a nation's direction and priorities.

For the major stakeholders, the success in achieving the common objective will depend largely on the careful evaluation of these four contextual forces. These forces have both direct and indirect impacts on the supply and demand of STEM talent. To develop sound strategies in nurturing STEM interest in future generations, it is therefore essential to have a clear understanding of the current state of these contextual forces, and a thorough assessment of efforts undertaken by the stakeholders.

3.1 DEMOGRAPHICS

Demographic trends such as aging population, increase in female graduates, and the emergence of new generations are key influencers to the future composition of the global workforce. The current disproportion in terms of age and gender distributions within the STEM workforce suggests the absence of readiness in tackling such trends. To successfully do so, it is vital that industry players understand the priorities and demands of the largest untapped talent of the future workforce – the younger generations and women.

Current STEM workforce

The STEM workforce is currently feeling the impact of the ageing global population. As 75 million Baby Boomers are expected to retire by 2011, there will be more retirements than incoming supply of knowledge-equipped employees. This predicament is further aggravated by the inability of STEM to attract the young generation or address gender inequities. Eurostat data indicates that approximately 42 percent of scientists and engineers are in the '45-64' age group and are fast approaching retirement age. With slightly over 30 percent in the '35-44' age group, the retirement vacuum will be difficult to fill. The problem is widespread - in Russia's Academy of Sciences, the average age of members is 50. Advanced economies like Canada and Australia also face similar problems. The average age of employed Canadian science and engineering PhDs in 2001 was 46, while the average age of other employed Canadian workers was only 39. In Australia, there will also be a shortage of young engineers in the future. According to Engineers Australia, 70,000 engineers are expected to retire between 2006 and 2011. By contrast, only half of that number graduated from universities during that period.

Gender distribution

In most countries, women make up less than 30 percent of the STEM workforce. China, for example, has nine million women scientists and engineers, making up merely one third of all scientific and technological professionals in China. This is in contrast with the rising labour participation rate of women. Over the past decade, women's labour participation has been steadily increasing at a rate of about 5 percent while there has been a decrease of about 2 percent for men's labour participation. This disproportionate gender distribution is also observed in the O&G industry. Men still make up a majority of the global O&G workforce. Among the countries studied, Norway is the outlier with women comprising 44% of the STEM workforce. Correspondingly, Statoil with 37% female staff, has shown that it is possible to minimise the gender gap in its workforce.

Impact of age and gender trends in the workforce

The exodus of experienced talent has caused an increase in the knowledge succession gap within companies. This talent shortage issue is even more critical for the STEM workforce with its apparent inability to attract women, causing it to lose out on a potential pool of talent to narrow the looming knowledge succession gap.

In particular, one survey revealed that more than 50 percent of respondents believe that the retiring workforce will cause a knowledge and skills gap. An example can be seen in CA Technologies, the second-largest maker of software for mainframe computers after IBM. According to the senior vice-president of CA Technologies, Dayton Semerjian, the average age of mainframe workers is 55 to 60 years old. As noted by Semerjian, “The big challenge with the mainframe is that the group that has worked on it - the Baby Boomers - is retiring. The demographics are inescapable, if this isn’t addressed, it will be trouble for the platform.” IBM, which commands 85 percent of the mainframe market, is also facing the same threat. A lack of engineers skilled in the design, programming, and repairing of mainframes will affect the demand for one of its most profitable products.

Besides the loss of knowledge and skills, the retirement of the Baby Boomers will also lead to an increase in cost. Colin Cadas, the team leader for design technology at engine manufacturer Rolls Royce, calculated that the retirement of a veteran systems engineer will cost the company US$400,000 in the first year alone. Furthermore, a study showed that 40 percent of the skilled labour force will leave the manufacturing workforce by 2010, and this will cost companies between US$50 million to US$100 million. The same study reported that the increase in costs is due to recruitment and training costs, and lost productivity.

Potential future STEM workforce

As the STEM industries face the exodus of Baby Boomers, the need to attract and utilise today’s younger generations (Generation Y and Z) increases. In order to convert these younger generations into potential STEM talent, employers must first understand Generation Y and Z’s manners of thinking, values, learning styles, and career selection criteria – all of which are different from previous generations. To effectively curb the talent supply problem, employers must also make efforts to narrow the gender gap.

Understanding women in STEM

OECD data shows that, compared with men, at least an equal number of women if not more, are pursuing tertiary education in universities. Moreover, women are also more likely than men to get a good degree pass, and are less likely to drop out. This pattern is supported by the higher graduation rates that women have as compared to men.

Gender disparities in education have closed in almost all countries worldwide with the total number of female university students outnumbering males globally. Despite this, women have higher participation rates for all subjects in university except physical sciences, technologies, architecture, building and planning, mathematical and computer science and engineering.

The fact is more women are getting access to quality education and are outperforming men – except in STEM subjects where lower female participation arises from the lack or loss of interest. Reasons contributing to this phenomenon include lack of encouragement, family obligations, lack of networking or mentoring opportunities, and biases against women in science. In an article examining why female students still stuck to traditional subjects, one expert said, “It’s not

just parents, it's career advisers in school who are often detached from the modern reality of these professions and have a distorted idea of what they're like. Even in primary schools, there are hardly any teachers from science-related backgrounds, and few female role models."

For women who were in STEM but then decided to leave, **family obligations** and work-life balance are high among the reasons for quitting. Women often choose early in their careers between being a scientist or a mother. According to another study, more than 70 percent of 450 female scientists and engineers employed at research universities cited family-career balance as the most significant challenge in their career advancement. Another study found that among PhDs, single men and single women had equal participation rates in the STEM workforce. By contrast, married female PhDs are 13 percent less likely to be employed than a married male PhD; this rises to 30 percent for married female PhDs with children.

Additionally, women in STEM faculties receive fewer opportunities from collegial networks to participate in the commercial marketplace. Evidence is seen in the number of patents women in science receive as compared to men. In a study of over a thousand recipients of training grants in cellular and molecular biology, it was found that only 14 percent of female recipients were awarded patents compared with 30 percent of male recipients. In another study on the information technology sector, it was reported that from 1980 to 2005, 93.9 percent of US origin patents were awarded to males.

The **biases and discrimination** that women face are also subtle. Women in so-called masculine jobs are considered to be not as competent as men if their success and performance in that job is ambiguous. In addition, women who have proven to be competent in a masculine job are perceived as less likable.

In addition to explicit discrimination, **implicit biases** also have a negative effect on the participation of women in STEM. Since its inception in 1998, more than half a million people around the world have taken the gender-science implicit association test, with results showing that more than 70 percent of respondents readily associating males with science and females with arts. These findings indicate that across all racial and ethnic groups, both males and females have high levels of gender stereotyping with reference to science.

The aforementioned factors work together to discourage the participation of women in the STEM workforce, and cause women to drop out from STEM-related fields relatively early in their careers as compared to men. Ultimately, these factors contribute to fewer women occupying top positions in the STEM workforce. This is apparent in the academic sector in the USA, where the representation of women as tenured faculty in STEM fields is significantly disproportionate to the representation of men.

The vicious cycle continues – the low percentage of women in STEM translates to a **lack of role models** whom women can look up to for inspiration to participate or continue their careers in STEM. As the demands of a science career become excessive, female students tend to leave their departments at a higher rate than men.

In addition, the low representation of women in STEM signifies a **lack of a critical mass**. An increase in the representation of women in STEM will improve access for women to social networks and important resources. Unfortunately, such an absence of women in the STEM workforce causes women to be more dissatisfied, leading to greater attrition. Results from a job satisfaction survey among tenure-track STEM faculties revealed that women were significantly less satisfied with their work environment as compared to their male counterparts. Female faculty in STEM were more likely to feel that they do not fit or belong in their departments.

Recognising the importance of utilising the female workforce, certain industries have made efforts to be more appealing to women. For example, in the American financial services industry, women make up approximately 75 percent of the entire workforce. In a list of where women want to work, three financial services companies were among the top 10. Barclays, tenth in the list had a 56 percent female workforce as of 2009. The company operates many initiatives to attract and retain women, including entitling new mothers with 52 weeks of leave.

Accenture, a professional services firm, has more than 60,000 women employees accounting for approximately one third of their global workforce. Accenture runs initiatives such as Women's Mentoring Programmes, Flexible Work Arrangements, and Accenture Women's Network.

Understanding Generations Y and Z

Generations Y (1981-1995) and Z (1995-Today) account for 52 percent of the global population. However, to effectively recruit and retain these generations in the STEM workforce, employers will need to understand the learning styles and career motivations of Gen Y and Z.

With the recent entry of Gen Y into the workforce, there are now at least four different generations in the workplace. It is therefore essential for employers to understand and match the different working styles of these generations in order to provide an effective and productive work environment.

In general, there are more distinct differences between the Baby Boomers and Gen Y as compared with Gen X and Gen Y in the workplace. This can be seen in the areas pertaining to work-life balance, the understanding of respect and authority, the use of technology, and employee loyalty.

Gen X and Y prefer more **flexibility and balance** between work and family life as compared to the Baby Boomers. Among the generations, Baby Boomers are the most work-centric, with 22 percent placing higher priority on work over family compared to 13 percent for Gen X and Y. In contrast, Gen X and Y are more likely to be family-centric, with 50 and 52 percent respectively placing higher priority on family as compared to just 41 percent of Baby Boomers.

With regards to the understanding of **respect and authority**, Gen X and Y are more comfortable asking questions and do not feel intimidated by their bosses. They prefer a collaborative and inclusive management style compared to command and control careers. This

is in contrast to the veterans who have a stronger sense of hierarchy and the Baby Boomers who are open to authority figures in the workplace.

In addition, the **use of technology** is another key difference in the workplace between older and younger generations. Focus group discussions revealed that Baby Boomers are not as technologically savvy and do not like computers. In contrast, Gen Y is the leader of technology usage with 90 percent owning a computer and 82 percent a mobile phone. Gen X are also extensive users of technology.

Another important difference between Baby Boomers and the younger generations after them is their loyalty to their company. Baby Boomers are more loyal compared with Gen X and Y. In contrast, Gen X sees current jobs as temporary and as stepping stones for the future. Gen Y is similar in that they can be “here today and gone tomorrow”. According to a survey on differences in generational values, Baby Boomer respondents placed employee loyalty to organisations as the second out of their top ten values. Gen X respondents ranked employee loyalty at eighth place, whereas Gen Y respondents did not have employee loyalty as one of their top ten values. On average, 68 percent of veterans and Baby Boomers preferred to stay with their current organisation as compared to merely 30 percent of Gen X and Y.

Many companies have thus acknowledged the need to create a conducive work environment to attract and retain Gen Y and Z. Nokia for example, has addressed the issue well, as evidenced by the 36 percent of its workforce who are Gen Y, in contrast to the O&G industry where Gen Y only make up 24 percent of the total workforce. In terms of training and development, Nokia integrates three approaches: on-the-job-training, mentoring and coaching, as well as classroom training and e-learning which all appeal to Gen Y. Nokia’s Graduate Programme also gives graduates the chance to rotate between departments, giving Gen Y candidates the opportunity to gain international exposure alongside self-development.

3.2 TALENT SUPPLY

With the younger generations as the primary supply of future talent for the STEM industry, there is a need for the academia sector to rethink its teaching methods and to assume responsibility for nurturing such talent. While introductory STEM education exposes students to basic concepts, solid foundational STEM education and delivery remain essential to nurturing core skills and guiding subject choices for tertiary education.

Accessibility to basic education

According to UNESCO, 84 percent of the world population aged 15 and above is literate. Such a high global literacy rate indicates the population's accessibility to basic education, which implicitly includes the attainment of basic science and mathematics knowledge.

At the pre-school level, 139 million children were enrolled in 2007; a rise of 24 percent since 1999. Similarly, primary and secondary level enrolment accounted for 694 million and 519 million respectively in 2007. This is an increase of 6 and 15 percent respectively from 2000.

While the global education enrolment rate appears healthy, a downward trend is observed in Brazil, Germany, Russia, the UK, and the USA at the primary level, as well as in Australia, Brazil, and Germany at the secondary level.

Introductory STEM education (pre-school and primary levels)

Pre-school and primary levels play an important role in nurturing early interest in STEM among students, where they are induced to enjoy STEM if they are exposed to it at an early age. The increasing enrolment rate at pre-school level hence presents an opportunity to expose more children to STEM. For example in 2008, Curtin University of Technology developed an 18-month project in collaboration with scientists, engineers, and educators to engage young children with science through play, hands-on activities, exploration, and questioning.

On the other hand, STEM education at the primary level forms the foundation for students to pursue secondary STEM education. As such, it is vital at this stage to stimulate students' scientific curiosity, and to encourage critical and creative thinking. Some countries aim to promote such a learning condition focused by teaching STEM subjects separately. In countries where STEM is incorporated into other subjects, emphasis is instead placed on promoting literacy as a whole. This is where equal attention is placed on all general subjects with programmes to link subjects such as science, mathematics, and geography. The highest proportion of time allotted for mathematics, science, and technology learning is recorded at 30 percent in Russia. In France, Norway, and Germany where integrated curricula are practised and little flexibility is offered, approximately 25 percent of the total instruction time is portioned for mathematics, science, and technology learning. In the USA, STEM is included in the curriculum, albeit receiving little attention (29 percent of K-5 teachers reported teaching science for two or less days every week). However in Australia where mathematics, science, and

technology are taught as separate subjects, only 15 percent of instruction time is allotted for these subjects.

Foundational STEM education (secondary level)

Secondary level STEM education is extremely important as this is where students' inclination toward the sciences decreases. Secondary STEM education must play the key role in retaining interest and enhancing performance as students who perform better will likely be more interested to further their STEM education at the tertiary level. Retention and performance of secondary students in STEM are determined by the robustness of the curricula, effectiveness of teaching methods, and quality of teachers.

In Norway, France, Russia, Germany, and Australia, the instruction time allotted for mathematics, science and technology learning has increased as compared with the primary level. In particular, the instruction time allotted for science learning has increased significantly, while mathematics instruction time has declined marginally. Russia's secondary curriculum focuses heavily on STEM education, taking up almost half of the total instruction time. This is mirrored in France, where 34 percent of time is allotted for STEM studies. In contrast, STEM is given less emphasis in Australia, Germany, and Norway.

In general, STEM lessons are conducted through the inquisitive, practical, or theoretical approach. The former two are categorised as a more student-centric approach, whilst the latter is teacher-centric. The distinct approaches are not exclusive and various combinations amongst the three are often practised, such as in Australia where both inquisitive and practical approaches are utilised. While the inquisitive approach is the most common worldwide, many countries have recently revised their STEM curriculum to adopt the **combination of inquisitive and practical approaches**.

Realising the advantages of student-centric activities, many initiatives are underway to promote STEM education through hands-on and real-world projects. An example includes Project Lead the Way (PLTW) in the USA which is targeted at middle and high school students. The project is currently being implemented in two thousand schools across 49 states, with six thousand trained teachers and 175,000 enrolled students. Courses offered through the project utilise research and design software in encouraging students to solve open-ended real-life problems.

According to the Trends in International Mathematics and Science Study (TIMSS) there appears to be no direct correlation between the arrangement of the STEM curriculum and student performance. For instance, Russia, which practises integration of STEM disciplines with other subjects, obtains the highest scores, followed by England and the USA, which teach STEM subjects separately at primary level. Scotland and Norway, both with different arrangements of curricula, achieve scores lower than the TIMSS scale average.

Teachers

Several countries face a looming crisis in the supply of qualified STEM teachers. Australia reported that only a minority of junior to middle school teachers of science had reasonable

qualifications in that field. Similarly, over 30 percent of mathematics teachers in the UK do not possess A-level or equivalent qualifications in the subject. This phenomenon is also observed in the USA where only 8 to 15 percent of its high school teachers are teaching out of their field, and the shortage of highly qualified mathematics and science teachers is projected to reach 283,000 by 2015. This shortage is intensified by the fact that STEM teachers are more likely to leave their profession as compared to teachers of other disciplines.

Initiatives are underway to encourage participation in STEM teaching. For instance, through its California Teach Science and Mathematics Initiative, the University of California Berkeley is encouraging its STEM students to consider teaching as a career. The initiative has successfully raised the number of students in STEM teaching programmes from six to 190 since its implementation. Another effort underway to combat the technology educator shortage is through the setting of minimal quality requirements for prospective teachers. This effort addresses the need of meeting the size of the required workforce, albeit at the cost of teacher quality.

Additionally, professional development programmes are implemented to enhance the quality of STEM teachers. Such programmes include mentoring, classroom observation, shared resources, continuous networking, and learning opportunities. Particularly, induction programmes have also gained popularity in countries surveyed in recent years, resulting in the lower attrition rate of teachers.

Student performance

Across the ten countries studied, students in Hong Kong are the most competent in the areas of science and mathematics with the highest scores in both areas. Conversely, France, Norway, Russia, Brazil, and the USA achieved literacy scores below OECD average.

Canada and Australia are among the countries with the highest science and mathematics literacy scores. This may be attributed to the delivery of STEM education through the inquisitive and practical approach as both approaches place emphasis on the students' understanding of scientific concepts rather than the teachers' delivery of knowledge. Conversely, the "mile wide and inch deep" curriculum in the USA, which promotes acquisition of surface-deep knowledge on a large number of areas, may have caused its students to have lower literacy scores. Similarly, the lack of attention to STEM subjects in the Norwegian curriculum may have led its students to relatively poorer results.

Advanced STEM education (Tertiary level)

STEM education at tertiary level plays the critical role of preparing a sufficient supply of quality graduates to meet industry demand. In seven out of ten countries, only about 30 percent of enrolled tertiary students opted for STEM majors, which has remained consistent from 2003 to 2007. In the case of Malaysia, only 20% of the enrolled tertiary students opted for STEM majors and this has been consistent over the last 5 years. In light of the increasing STEM workforce demand, implementation of attraction and retention initiatives within tertiary education

institutions becomes increasingly important to boost the quantity and quality of STEM graduates.

Perceptions of STEM

The choices made of academic major at the tertiary level are predominantly influenced by the students' perception of the subject and its career prospects. In this aspect, STEM majors are generally perceived as confusing and difficult. For instance in the UK, evidence shows that it is more difficult to achieve good science and mathematics results at both GCSE and A-level as compared to other subjects. In addition, STEM subjects are perceived as difficult due to the structure of the curriculum. Students today have a preference for a less fact-laden curriculum, and a learning environment which allows for the expression of personal opinions, both of which are absent in current STEM curricula.

Students' interest in STEM education also relies on their perception of possible STEM career benefits. Many students have little knowledge regarding the prospects of STEM jobs, and are of the opinion that scientists are boring and eccentric. As a result, most students opt not to pursue careers in STEM. It is interesting to note that such negative views of STEM are more evident in developed economies than developing ones.

Outreach initiatives undertaken to attract and nurture students in STEM have different objectives based on target age groups. Initiatives targeted at pre-school and primary levels students are aimed at triggering interest in STEM at an early age. Those targeted at secondary level students are to prepare prospective students to major in STEM at the tertiary level. In general, there are also initiatives that purely reach out to the public to promote community-wide awareness of STEM.

Specifically, tertiary education institutions encourage student enrolment in STEM through provision of **flexible admission routes**. A notable effort is undertaken by the Russell Group, in the UK, where foundation programmes are designed for students who are interested in STEM majors but lack basic knowledge or qualifications. The programmes are rigorous and aimed at equipping students with the necessary skills, knowledge, and experience. Examples of such programmes include the Interdisciplinary Science Foundation Year Programme in University of Leeds for students enrolled in science, engineering, and mathematics courses without standard admission requirements. The foundation year programmes in engineering, science, and mathematics courses in the University of Manchester and the University of Newcastle are also catered for students who have shown an ability to succeed but lack the necessary qualifications to enter the degree programmes directly.

Financial aid for STEM tertiary education, including scholarships and loans, is also provided as a means to influence students' education decisions and improve educational outcomes. In particular, the awarding of scholarships has gradually shifted from a needs basis towards a merit basis.

There are also **specific scholarships** targeted at international students to promote foreign enrolment and internationalisation of education. Such scholarship schemes encompass exemption of registration and tuition fees, grants for basic learning materials, and travelling and accommodation expenses for qualified international students. Examples include the Chinese Government Scholarship Programmes implemented at Harbin Engineering University in China, the Scholarship Programme of Thales Academia in France, and the Quota Scheme in Norway.

The trend of STEM graduates at the tertiary level from 2003 to 2007 show stagnation, except in the cases of Germany and China where a drastic decline is observed.

Stagnant STEM graduation rates point to the importance of minimising attrition among students majoring in STEM. Retention efforts undertaken by various education institutions emphasise on the provision of **positive educational experiences,** and **conducive learning environments**.

To retain STEM students, tertiary education institutions also focus on **establishing links with industry** that contribute to industry-relevant STEM programmes such as the 23 site IBM China University Partnership Programme. Another similar effort is the collaboration between McGill University in Canada and industry partners (such as 3M Canada, Celestica, General Electric Hydro and Schlumberger).

Quality of STEM graduates

In light of the shift to the knowledge economy, demand for STEM graduates is expected to increase. In the UK, average salaries for graduates in science occupations are already higher than that of those in non-science occupations. However, the unemployment scenario among STEM graduates worldwide paints a different picture. Pure science and applied science graduates in Canada experience a relatively higher unemployment rate, as compared with social science and humanities graduates. In China, graduates majoring in computer science and technology, and information technology also recorded one of the highest unemployment rates from 2007 to 2009. These situations also occur in the UK in the fields of engineering and technology, computer science, mathematical sciences, and physical sciences from 2003 to 2006.

The disparity between workforce demand and supply implies a poor quality of STEM graduates produced globally. This is attributed to the inconsistency in expectation of graduates' quality between the academia sector and industry. Measurement systems (Academic Ranking of World Universities and Quacquarelli Symonds (QS) World University Rankings) focus on the size and eminence of an education institution as indicators of quality. But industry places more emphasis on competencies relevant to the workplace. The persistent global unemployment trend is attributed to the lack of critical employability skills. Recognising the importance of work-relevant skills, academia has implemented initiatives to enhance the employability of STEM graduates. For instance, the Australian Graduate Skills Assessment (GSA) was conceived to evaluate skills of written communication, critical thinking, problem solving, and interpersonal understandings in over 20 universities at entry and exit levels.

3.3 GLOBAL O&G INDUSTRY OUTLOOK

The global industry outlook is promising. Specifically, the increasing focus on E&P activities is shifting the demand for corresponding workforce segments within the value chain. However, the industry is plagued by its negative public image. To compete for a shrinking STEM talent pool, O&G industry players first need to enhance the industry image before making efforts to be an employer of choice. Proactive initiatives to reach out to younger generations are also essential to win the war for talent.

O&G industry future workforce demand

To meet the increasing demand for energy, major O&G industry players are shifting focus to E&P activities, as shown by the higher CAPEX allocated to expand upstream businesses. Conversely, investments in downstream businesses have been either maintained or reduced due to weaker profit margins caused by the increasing price of crude oil and excessive downstream capacity.

As the industry's focus shifts towards the upstream sector, major industry players have also expanded their upstream workforce while reducing the headcount in the downstream sector. On average, Shell, BP, and Total have collectively increased their upstream workforce by 12 percent and reduced their downstream workforce by 11 percent between 2005 and 2009. As a result, demand for certain skillsets in the upstream sector has grown. More specifically, the increasing need is projected to be largely for mechanical engineers, integrity engineers, and chemical engineers, followed by petroleum engineers, and electrical engineers.

O&G industry image

For the last decade the O&G industry has been perceived as the industry with the most negative image. The Dow Jones Sustainability Index (DJSI) that tracks corporate sustainability performance indicates that O&G is perceived as being **environmentally unfriendly and dangerous**. In contrast, the computer industry has consistently been perceived as the industry with the most positive image.

Another factor contributing to the negative image of the O&G industry is the **cyclical nature of the industry**. Drastic layoffs during the bust cycles of the eighties and nineties were widely publicised by the media, causing the industry to be viewed as one which provides low job security.

Industry CSR investment

In an effort to revamp the industry's image, O&G companies are now attaching greater importance to their social and environmental impact, and engaging with local communities more than they used to in the past. However, the industry's CSR effort and effectiveness have been questioned by the critical public whose awareness for societal well-being, fairness, and equality is also escalating.

To boost the industry's image as being environmentally friendly, industry players are working towards **increasing operations' energy efficiency,** and investing in nature conservation. The majority of industry players is actively tracking and reporting a drop in greenhouse gas (GHG) emissions, and upstream hydrocarbon flaring. Industry players have also implemented impact assessments and biodiversity conservation at sites of operation.

Additionally, industry players are also **contributing to society** by providing education opportunities to underprivileged children, improving communities' health and safety, and encouraging local economic development. Most education initiatives are implemented in rural areas to provide children with access to basic education. In addition, to assist countries with high mortality rates due to a lack of healthcare, industry players are providing essential facilities, training medical personnel, and organising health awareness campaigns. In terms of stimulating local economic development, initiatives include job creation for the locals, and assisting in business start-ups.

While industry players engage and invest in CSR, the genuineness and effectiveness of these CSR initiatives are often questioned by the public. Some social investments made by O&G companies have been viewed as a means to **garner a local competitive advantage**. CSR investments have also been described as merely **public relations stunts**. Consequently, media-friendly projects such as donating medical equipment or helping to construct a new hospital may be given higher priority by the companies as compared to slow local capacity-building or the training of village nurses. The industry's CSR initiatives have often been observed as having **little participation by local beneficiaries**, whilst failing to address the root causes of community problems.

Further evidence of the negative impacts of CSR is illustrated by the **social effects on local communities**. For instance, Shell's relationship with the Nembe community via its operations and community development programmes has resulted in commercial conflicts.

Industry efforts to become "employer of choice"

In addition to revamping the industry image through CSR efforts, being an attractive employer is essential in maintaining a sustained competitive advantage. Recognising that STEM skills are transferable across different industries, O&G industry players have taken various efforts to be "employer of choice" to compete for limited STEM talent. The most commonly practised talent attraction and retention strategies include the provision of competitive reward packages, career development opportunities, and healthy work cultures.

The Compensation and Benefits package is one of the top three factors considered by employees when deciding to work for current employers. In addition, increases in salary or bonus is also one of the top three actions required for retention. As such, realising the intensity of the cross-industry war for talent, major industry players have consistently improved their C&B packages to attract and retain the necessary STEM workforce. On average, there has been a 40 percent increase in the average salary per O&G employee between 2005 to 2009.

Insisting on more for their own development, today's global talent has higher expectations for professional training and development, good references for future careers, and leaders who support employee development. Within the O&G industry, provision of technical training is the most frequently practised career development initiative, followed by implementations of job rotation and mentorship programmes. Enhancement of technical skills remains as the main emphasis among industry players.

People have a fundamental need to contribute to an organisation's success and to see the tangible results of their work. Acknowledging that the organisation's achievement and culture depend largely on **empowering employees** in decision-making, Total creates employee dialogues in all setups from the non-OECD countries. Negotiations between employees and management have produced a number of major agreements, such as the one reached in 2006 on equal opportunity, and the accord signed in 2007 on aid for small business start-ups, acquisitions, and expansions. Other major players, including Shell, Statoil, and BP also conduct annual or bi-annual employee surveys to gauge job satisfaction and gather employee opinions on improvement areas.

Organisations have also started to recognise **diversity** in the workplace as a strategy to maximise the productivity, creativity, and loyalty of employees. For instance, Shell has implemented the Diversity and Inclusion framework to promote diversity among its workforce. The framework stresses the values of visible differences such as age, gender, ethnicity, and physical appearance, as well as underlying differences such as thinking styles, religion, nationality, sexual orientation, and education. Initiatives practised under the framework include education offerings and recruitment targeting top talent across diversified groups.

The majority of the industry players are also of the opinion that **work-life balance** is either very important or important to their employees. Nevertheless, compared with other industries, employees in the O&G industry do not think that the industry has successfully cultivated a work culture which promotes work-life balance, in particular for women with family. Due to the unpredictable and demanding nature of the O&G industry, female employees are often doubtful of the feasibility of maintaining a strong career in the industry whilst growing a family.

Industry efforts in reaching out

Although the industry continues to bloom, its future talent supply is negatively impacted by the continuous drop in STEM interest by younger generations, as indicated by the stagnant STEM enrolment rate at the tertiary education level. Realising the urgency in reversing this trend, O&G industry players are taking proactive measures in reaching out to the young generations through organising awareness and support programmes, easing accessibility to STEM education, providing career exposure, and carrying out extensive recruitment efforts. In addition, industry players have also ventured into social media as a channel to reach out to younger generations.

To achieve the ultimate objective of enlarging the talent pool for the industry's workforce, industry players are organising programmes to raise public awareness on the importance of

STEM. Additionally, industry players are also providing assistance and support in STEM education through strengthening the competency of teachers and the interest of students.

Mirroring the efforts taken by academic institutions to encourage STEM enrolment rates at the tertiary level, O&G industry players are also providing **scholarships** to boost the future STEM workforce. The majority of scholarships are offered to students pursuing degrees related to the industry, such as petroleum engineering or geophysics.

In addition to offering financial assistance for tertiary education, industry players also provide **internships** to expose students to a future career in the industry. Many companies have used internships as a means to identify outstanding candidates for future permanent positions.

Social media has become a powerful platform for interaction with social networking now accounting for 11 percent of the total time spent online in the USA. Facebook, Twitter, YouTube, and blogs are the top social media networks with the highest number of users. Young adults between 18 and 29 of age are the heaviest users of social media.

Three quarters of Fortune 100 companies use Facebook, YouTube, Twitter, or blogs, with Twitter being the most heavily utilised at 65 percent. Whilst nearly 75 percent of O&G professionals see value in using social media, corporate-wide endorsement of these tools continues to lag. Only 11 percent of social media adoption is driven by the executive suite, with the greatest concern being the “limited ability to control or provide a secure environment”.

Industry associations play a critical role in promoting society’s awareness and interest in O&G. Apart from taking up the responsibility of communicating to the public the industry’s economic performance, industry associations also execute prominent initiatives including the organisation of events, sponsoring financial incentives for education, and the publication of career information.

As the global workforce continues to decrease, companies are competing within and across industry boundaries for the best talent. Talented employees are likewise searching for opportunities across industry boundaries, often applying their learning from one industry to careers in another. Consequently, the intensity of the talent war has prompted all industries to take similar efforts to attract and retain their workforce.

Negative public image remains as the biggest challenge faced by the O&G industry in attracting STEM talent. A well-planned joint effort between the industry players is essential to tackle this challenge, with emphasis on initiatives to become more responsible corporate citizens. While the industry offers lucrative monetary rewards, poorly perceived work culture deters required talent, women in particular, to enter the industry. Moving forward, industry players ought to position themselves as a competitive and attractive employer by understanding the evolving needs of young generations and by engaging the public proactively.

3.4 GOVERNMENT INTERVENTION

Government intervention acts as a catalyst in bridging scarce talent supply and aggressive industry demand. Governments are in a strategic position to stimulate both industry growth and human capital development as part of national agendas. Through well-crafted national plans centred around financial incentives, human capital development, and strategic partnerships between industry and academia, the process to close the supply and demand gap can be further directed and accelerated.

Driving STEM as a national agenda

Recognising the looming crisis of an imbalanced demand and supply of STEM talent, most governments have been making STEM development a part of their national agendas. This is reflected through the efforts to establish national STEM plans by governments in Australia, Brazil, Canada, China, and the UK. The majority of national STEM plans focus on stimulating industry growth, developing human capital and fostering collaborations between key stakeholders.

To encourage industry growth and collaborations between stakeholders, governments have been focusing heavily on boosting R&D activities; thus increasing the demand for STEM talent. On the other hand, to strengthen the supply of STEM talent, governments have been placing emphasis on raising public awareness, and enhancing education to promote the development of STEM talent.

Stimulating STEM industry growth

Active participation by industry players is essential to stimulate industry growth. In order to encourage industry players to invest more in STEM establishments, governments are providing the necessary assistance through financial incentives and business support.

R&D has been regarded as a key driver in enhancing the necessary knowledge and technology for the industry. In order to promote more R&D activity and to stimulate industry growth, governments globally are contributing to the industry through the provision of **tax reliefs and financial grants**.

Specific to STEM, attractive R&D tax incentives are effectively influencing investments made by the private sector. Countries such as Australia, Canada, France, the UK, and the USA have attractive R&D tax regimes. Not only do these governments offer tax credits, R&D grants are also offered. For instance, the National Competitive Grants Programme (NCGP) in Australia has seen a total of 1,438 proposals awarded US$537 million.

With the exception of Germany and Russia, other countries have offered favourable tax treatments to ease the burden of R&D expenditures and to encourage investment in R&D. In particular, France has one of the most generous R&D tax incentives in the world due to its multiple tax reforms over the years. On the other hand, Germany does not have tax incentives

for R&D, but is in the midst of developing such programmes to encourage participation from the private sector.

Other than through the provision of financial incentives, governments also play a critical role in encouraging industry growth through **establishing business incubators and technology parks**. Business incubators are where new businesses are housed for a fixed period and provided with various services to help them grow, while technology parks offer a quality premise for businesses to commercialise their research. A business in an incubator would typically move into a technology park once it has established itself.

Generally, both business incubators and technology parks offer comprehensive facilities and services. For instance, Australian Technology Park (ATP), governed by New South Wales Government's Redfern-Waterloo Authority, offers a wide range of benefits to the Park's tenants, including world-class conference and exhibition centre, extensive optical fibre and wireless network access points, and recreational facilities.

Within the business incubators, the predominant type of business is in the high-technology sector. In particular, China's government is highly involved in the organisations, strategies, and funding for the incubators as compared to the USA which only supports business incubators through funding.

The success of technology parks can be indicated by its operational efficiency, financial performance, research and technology transfer, and business development. Operational efficiency is reflected by the number of start-ups and subsequent failure rate, while financial performance and business development are shown by the total revenue and number of new jobs created, respectively. Similarly, extensiveness of research and technology transfer within a technology park can be measured by the number of patent applications.

Developing STEM human capital

Investment in human capital development is essential to cultivating a STEM literate society and for sustaining the supply of STEM talent. Successful human capital development hinges on raising public STEM awareness, promoting STEM education, and creating favourable working environments to meet the demand of the STEM industry.

Public awareness and understanding of STEM is fundamental to the nation's economic competitiveness and social well-being. To raise public STEM awareness, many governments engage the public through **national science weeks**, where scientific activities and events are held. One of the largest national celebrations of science is UK's National Science and Engineering Week (NSEW), which is has been an on-going effort since 1994. Fully funded by Department for Business, Innovation, and Skills, the NSEW has been very successful, with a 55 percent increase in number of registered events from 2004 to 2009. 65 percent of school children surveyed responded that they would like to attend another NSEW event.

Australia's National Science Week has also become a major national celebration of science, engineering, and innovation, incorporating over one thousand events and reaching out to over one million Australians. It includes community-based events and activities through the use of science centres, museums, universities, science personalities, research centres, professional organisations, and schools. Similar science festivals are also held in Canada, China, Norway, and the USA.

Besides national science weeks, governments also invest in science centres or museums as an effort to enable the public exploration of science. To achieve the objective of promoting public STEM awareness, science centres strive to provide ease of accessibility, high quality visitor experiences, and value-adding programmes.

Following the initiatives implemented to engage the public, most science centres and museums have achieved an increase in number of visitors and gained recognitions. This implies that these centres or museums have successfully increased public STEM awareness.

In addition to raising public STEM awareness, governments have also implemented STEM education initiatives as a result of discovering STEM incompetence among younger generations. For instance, Americans have been ranked 21st out of 30 in science literacy and 25th out of 30 in mathematics literacy among students from developed countries. Recognising that American students are not showing progress, the US government has launched Educate to Innovate to improve the student participation and performance in STEM.

Similarly, there is also a steady decline in mathematics ability of Norwegian students in the higher education sector. This trend implies that the education system in Norway is facing difficulties in developing student competence in MST, leading to a potential quality shortage that will become a barrier for innovation. Hence, to strengthen the teaching of MST, Norway introduced A Joint Promotion of MST.

The focus of both Educate to Innovate and A Joint Promotion of MST is on improving student competencies in STEM through the comprehensive development of curricula, educators, students, and collaborations with private sectors. The ultimate goal is to better prepare students to meet the demands of the STEM workforce.

Another approach by governments to encourage students in taking up STEM is through **promoting the prospect of STEM careers**. The UK has launched a science and maths integrated communications campaign to inspire students to take up science and mathematics subjects through the promotion of exciting careers in STEM. The campaign reaches out to younger generations through career case studies on popular national youth radio stations, youth websites, and in youth magazines. In addition, this campaign also reaches out to parents, teachers, and career professionals to encourage and advise students to pursue science and mathematics as their post-16 options.

Improving STEM education alone is not sufficient in developing the STEM talent supply. The greater issue here is the mismatch of STEM being taught in school and STEM in the real world. Specifically, to develop a sustainable STEM workforce pipeline, the US Department of Labour (DOL) has provided grants to increase the capacity of community colleges in providing training to develop the skills required by industry. The DOL has also recognised the need for One Stop Career Centres to promote, attract, and prepare disadvantaged youth and displaced workers for STEM careers. Each centre receives a total grant of US$2 million.

The governments can also establish favourable work environments for the STEM workforce. In particular, **ease of migration** is critical in attracting foreign talent and has been recognised as a good avenue to complement national efforts in decreasing workforce shortages.

Recognising the importance of international mobility of human capital in science and technology, there have been various initiatives to attract foreign talent. Governments have offered **work permits** such as France's Scientific Permit and Germany's Alexander von Humboldt Professorship to enable foreign researchers to carry out research in universities and institutions in the host countries. In addition, there have also been efforts to **attract foreign students** who may later join the workforce of the respective countries. For example, both Canadian and Norwegian governments permit foreign students who attained credential in their countries to apply for jobs upon graduation.

To embrace **diversity in the workforce**, the Norwegian government implemented a quota for women on company boards. Companies need to meet the quota of having 40 percent women on company boards. As a result of this implementation, there are now a number of databases established for talented women and the creation of a "Female Future" training programme that companies could send their employees to.

As an effort to promote **work-life balance**, the US federal government introduced a telework policy. With teleworking, an employee is allowed to complete most of their duties outside of the traditional office setting. Similarly, France's legislation recently lowered the working hours per week to 35.

Countries such as France and Germany have **raised the retirement age** in their countries to 62 and 67 respectively, while the USA does not have a mandatory retirement age. The German government has also implemented "Campaign 50 Plus" which provides wage subsidies to employers who employ people over age 50.

Fostering strategic partnerships for STEM

Governments play a key strategic role in initiating collaborations between stakeholders to achieve the common goal of addressing disparity between the demand and supply of STEM talent. A merging of resources increases the capability of attaining success in STEM programmes, as compared to entities working independently.

Collaboration to improve STEM education

There have been joint efforts to improve STEM education such as the Massachusetts Intel Mathematics Initiative. Intel, the Department of Elementary and Secondary Education, Massachusetts district schools, and teachers of mathematics collaborate to improve the preparation and ongoing professional development of math and science teachers through intensive 80-hour courses. The US government's Educate to Innovate campaign has also encouraged partnerships between industry and academia to collaborate in national projects promoting STEM. These partnerships have demonstrated good response and support from both the public and private sector in the nation's effort to boost STEM education. One such example is the National Lab Day.

Another collaborative effort to improve STEM education is the E-learning Model School Project, a partnership between HP and China's Ministry of Education to enhance education by providing technology-based education resources, distance learning, and improved teacher training in middle schools. The University of Western Australia and the Government of Western Australia Department of Education have also taken collaborative efforts to improve science teaching in secondary schools.

In addition to collaborations to improve STEM education, governments have also initiated collaborations to stimulate industry growth. For instance, the Australian government provides funds for industry and universities in setting up the Cooperative Research Centre (CRC) to increase scientific innovation in the country.

A similar effort is the **research bonus programme** offered by the German government to encourage researchers to work with the industry. This programme allows universities and research institutions to obtain a bonus amounting to 25 percent of the amount of the contract awarded by SMEs when they collaborate with SMEs to carry out R&D.

Another successful initiative is Norway's OG21 – Oil and Gas in the 21st Century whereby Norwegian companies work together with researchers and academia to sustain oil and gas growth in the future.

As part of national plans to establish STEM policies and investment priorities, governments have offered attractive financial incentives and business support to boost STEM industry growth. At the same time, efforts are also underway to increase appeal of STEM through public awareness, national STEM education enhancement, and creation of favourable working environment for STEM industries. Though initiatives have shown positive results, efforts by the governments to bring various stakeholders into collaborations are absolute musts in order to fully overcome the growing disparity between the demand and supply of STEM talent.

CHAPTER 4: STEM TALENT PIPELINE FOR OIL AND GAS THE CHALLENGE: AVAILABILITY, INTEREST, ATTRACTION

The issued faced by the O&G industry need to be addressed in order to overcome the talent supply challenges which have been identified for each of the four contextual forces, namely: demographics, talent supply, global O&G industry outlook and government intervention contextual force.

Within the demographics contextual force, it is apparent that the emergence of a new generation has brought with it new career selection criteria and learning styles. In order to attract graduates of this generation, O&G organizations need to understand and create a working culture and environment which promote these values.

The talent supply contextual force reveals the need to address students' negative perceptions towards STEM subjects and career prospects. This is particularly pertinent at the secondary school level, as their positive inclination towards science decreases during these years. As such, focus should be placed on students between 13 to 17 years of age to retain their interest in STEM as those are their "formative years".

The global O&G industry has also had a persistent negative industry image which needs to be revamped in order to attract talent. The industry needs to make its CSR investments transparent to the public in order to show its genuine effort in contributing to the betterment of the world. In addition, the O&G industry is perceived by a significant portion of employees as having poor work-life balance. This issue needs to be tackled as it is a repelling factor to young generations who want to work to live and not live to work.

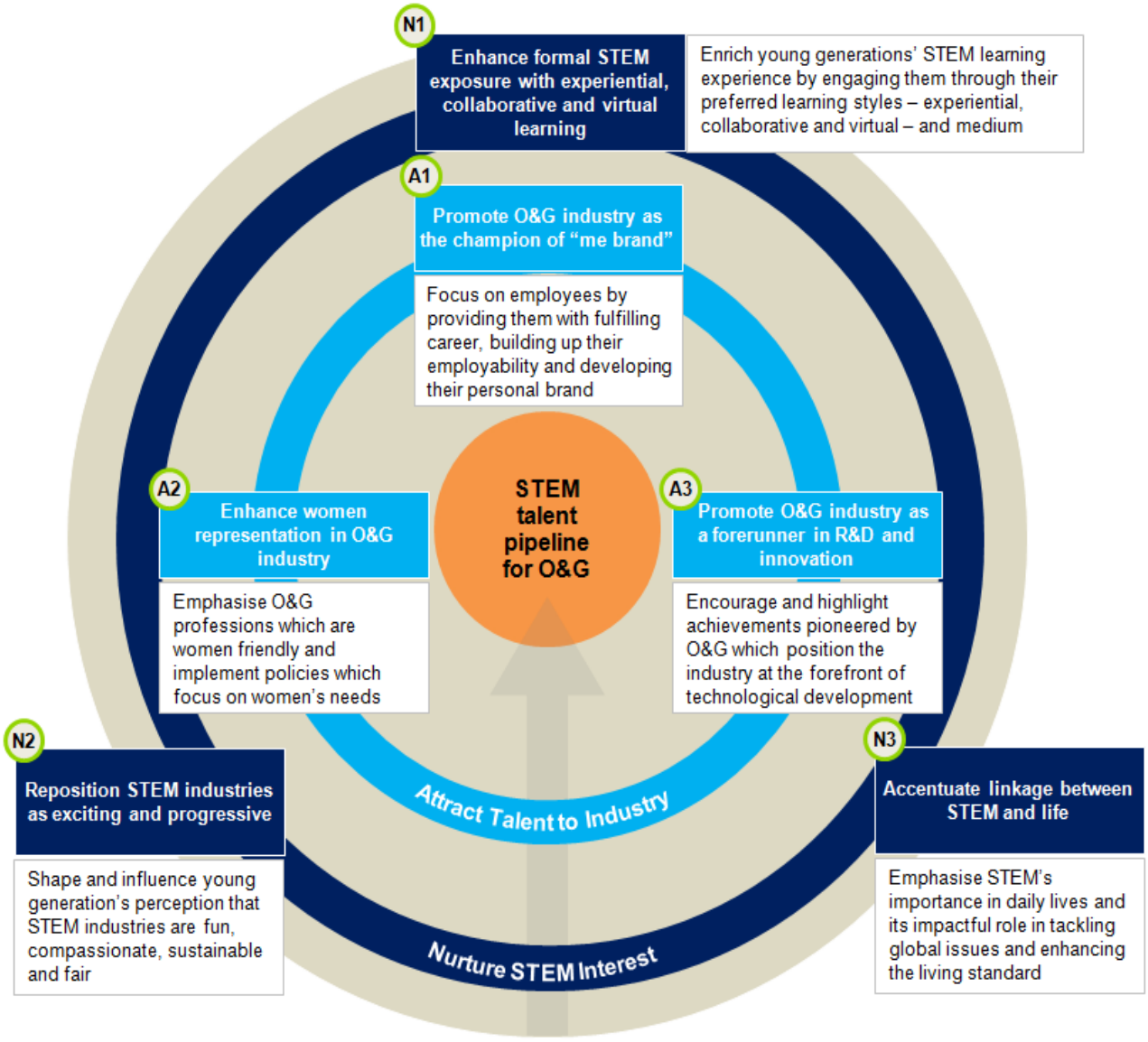
Last but not least, one of the key issues discovered in the **government intervention** contextual force is the lack of coordinated initiatives between key stakeholders. This is a critical issue to address as cooperation between all stakeholders is essential to ensure successful implementation of initiatives designated towards improving the quality and quantity of STEM workforce. Additionally, governments also need to improve education systems towards becoming more robust in order to produce STEM graduates with skills which are more relevant to the industry.

By targeting all of these key issues, this chapter delineates the strategies tailored to *nurture* STEM interest amongst the young generations, and subsequently to *attract* them to the O&G industry.

Strategies framework

To ensure a sustainable STEM talent pipeline for O&G industry, first and foremost, the STEM talent pool needs to be enlarged. Three strategies (N1, N2 and N3) are designed with the objective to nurture STEM interest amongst the young generations. With the level of STEM interest increased, O&G industry will then need to be able to attract these STEM talents to the industry by executing another three other strategies developed (A1, A2 and A3).

Figure 4.1 Strategies to nurture STEM interest and attract talent to O&G industry



STRATEGY N1

Enhance formal STEM exposure with experiential, collaborative and virtual learning

The techno-economic paradigm that characterises the ICTs, the 5th technological revolution, involves workplace, social and educational changes. In particular, the young generation have different expectations of the education process of which they undergo and have their own preferred learning styles.The changing world has transformed Gen Y and Z's learning and communication styles to be vastly different compared with those of previous generations.

The digital shift mainfests in four ways: the first and most obvious is the shift from analog to digital forms of communication that allow for extensive signal processing and underpins the Internet. The second and third are shifts from tethered and isolated forms to mobile and connected forms. The new mantra is to be online, anywhere, always. The fourth and last is represented in the emergence of Web 2.0 on which previous consumers are now content creators.

The evidence for the changes in learning behaviour are readily apparent, with students showing a strong increase in their use of e-learning and collaborative forums in schoolrooms and online. Over the short space of four years the number of students taking at least one online course has more than doubled.

This Strategy recognises that while governments bear the prime responsibility for 'getting schooling right,' the O&G industry should not stand back and wait, if not hope, that the situation will rectify in the immediate term.

Instead it is suggested that the O&G industry should seize the unique moment when new technologies and social forms have coalesced to give individuals considerable power in shaping the information content that impacts upon their lives. The upcoming Generation Y and Z are a wired generation of individuals whom are curious, open to experimentation, and change. Their attitude to the new media and modes of communication might be summed up in a parody of Descartes' maxim: "I connect, therefore I am."

Learning through innovative technology

A number of innovations are combining to change the way we communicate and learn.

Mobile telephony, Web 2.0 and lightweight, low power hand-held devices are technologies that enable the paradigm shift in the young generation's preferred learning styles. These are experiential and collaborative, and make extensive use of virtual worlds.

The perfection of tablet and personal computers and their rapid adoption has shaped youth's life and stimulated the growth of mobile learning. Three million Apple iPads were sold in the first 80 days of its launch and competing devices from Samsung and others have helped to grow the market, which brings the success of mobile phone Apps. Tablet PCs are seen as game changers and the future of the computing world.

A third major innovation is that of crowdsourcing among which Wikipedia is the best-known example, even if its founder does not agree with such categorisation. Wikis are collaborative websites that permit asynchronous communication and group collaboration across the internet. Variously described as a composition system, a discussion medium, a repository, a mail system, and a tool for collaboration, Wikis provide users with both author and editor privileges.

Students may use Wikis collaboratively to create classroom valuables for their own use. Examples would be study guides, glossary, or personal work portfolios. They may be given the authority to participate in each other's learning through peer review, peer editing, and note sharing. It is also possible to complete group work on the wiki, to interact with other classmates, engage in mock-debate, sharing of reviews on movies, books and TV shows, and this applies globally.

Learning in virtual reality

Web-based virtual worlds have become a new platform to engage the young generation by combining fun and learning beyond the limitation of reality, examples being NASA's Virtual Lab and Game-based simulations for medical students at Imperial College, London.

Two exemplars that have garnered significant user bases are Second Life and Game for Science. According to Wikipedia, Second Life, which is now 8 years old, has 20 million registered users who make use of Linden Labs' open source software to create and animate their avatars.

Advanced industrial and post-industrial societies enjoy high standards of living underpinned by the versatility of the energy provided by the global oil and gas energy. At the same time they fear the consequences of the loss of their lifestyles of warmth in winter, cool living environments in summer, affordable food, international travel, pharmaceuticals and synthetics. This is within the spectre of environmental degradation and climate change. The O&G industry is fully aware of these contradictions: witness the smart rebranding of BP as 'beyond petroleum' and its successful engagement with green NGOs. 2010 saw the industry, at least in the OECD's eyes, endure a loss of image through the Gulf of Mexico disaster, increasingly revealed as a consequence of poor decisions. In France there is a wave of antagonism toward 'flacking' with draft legislation to outlaw the practice before the National Assembly. Climate change is commonly identified as one of the main Grand Challenges facing humanity going forward, so that clean, renewable energy is now the hottest agenda item, the more so post-Fukushima.

In some locations the new energy frontier is presented on a vast scale, such as oil shale in Alberta or the South Atlantic Tupi fields off Brazil, where the promise of riches attracts investors and staff alike. Elsewhere, however, the pull to the industry requires more active intervention and it is to this that we now turn. The task for O&G industry is to reposition itself as exciting, and progressive, and as responsible and accountable.

In short, **Strategy N1: Enhance formal STEM exposure with experiential, collaborative and virtual learning** focuses on learning through innovative technology and virtual reality.

STRATEGY N2

Reposition STEM industries as exciting and progressive

Our analysis of successful repositioning strategies leads us to advise on two thrusts, one that focuses on crafting a new value proposition through orchestrated branding, the other that drives this proposition by leveraging on major spectator events with diversified themes.

Successful image promotion is a key element in attracting, developing and retaining staff. Hence, a strong marketing campaign remains as the key catalyst in revitalising an industry's image.

This marketing campaign is structured around two major thrusts. The first thrust is social media are leveraged to engage with the public and create strong and positive brand recognition due to their increasing popularity. The extent of use of social media among Fortune 100 companies is now widespread, with the majority of companies using at least one social media platform – 88 percent of companies in Europe, 86 percent in the USA and 50 percent in Asia-Pacific report the use of at least one such channel. Twitter is the most popular with 82 percent of Fortune100 companies reporting weekly use, followed by YouTube with 68 percent of companies reporting monthly use, and 59 percent of companies reporting Facebook usage averaging 3.6 posts per week. Corporate blogs are not utilised so frequently with 36 percent of companies making regular monthly usage.

The second thrust is global events with high media exposure are supported to reposition and elevate brand awareness.

Orchestrated branding

The U.S. Army provides a telling example of orchestrated branding. Recruiting is critical to the success and long-term viability of any industry, especially so for the defence industries. The U.S. Army, in particular, needs about 80,000 high quality recruits a year to keep pace with a 20 percent annual turnover rate. Having missed its recruiting target in 1998-1999, the U.S. Army embarked on an elaborated and focused marketing campaign to engage youth in order to convince them of the value of a military career and has developed a range of media including the U.S. Army Toolkit, games, television ads and mobile apps.

The U.S. Army is a pioneer in utilising game technology to appeal to the digital generation. As youth's opinions of organizations and decisions about career are formulated from age 13 to 17, the 2002 free game "America's Army" aims to engage and attract potential hires.

The U.S. Army has also used social media as information dissemination channels to focus on personalising the profession and projecting soldiers as valuable resources. Key purposes include: sharing personal army stories and experiences through blogs, photographs, and videos; providing parents with an avenue to connect and seek answers; introducing various

education and career options, including attractive C&B packages; disseminating accurate information to alleviate fears of the industry.

The U.S. Army appointed marketing communications agency McCann Worldgroup to conduct focus groups to determine key influencers of the soldiers and hire prominent filmmakers and original musical score composers, and produced three television ads, using real soldiers as actors. It also appointed digital ad agency MRM Worldwide to produce digital online videos to transition from public awareness to public engagement of the U.S. Army.

Leverage on major events with diversified themes

Global events such as Olympic Games, motor racing, golf, and football have attracted millions of viewers. In fact, the number of viewers of the major global sports and entertainment events of the last decade all show upward trends: Olympics up by 21 percent; the FIFA World Cup 23 percent, Oscar awards by 30 percent over two years; F1 motor racing by 1 percent even as the recession has bitten into disposable incomes.

Among the major O&G industry that serves as a model for engagement with the public through STEM promotion is the Shell Questacon Science Circus, established in 1985. The Science Circus is a partnership between Shell and The Australian National University (ANU) anchored on Canberra's Questacon, a programme of the Federal Government.

The Circus aims to promote and encourage an interest in science. It is based on a cadre of science graduates bringing lively presentation of science to town and schools across Australia who conduct science show performance for students and provide professional development workshop for teachers.

The Circus has been experienced by over 2.1 million visitors over 25 years and has inspired two generations of children with over 7,700 school visits. In 2008-09 the circus visited over 500 schools, with the participation of more than 86,000 visitors of whom over 90 percent are primary and junior secondary school students and their families. The outreach has joined with over 4,100 teachers in 270 workshops. In addition the Circus has taken science to 90 indigenous communities.

In short, **Strategy N2: Reposition STEM industries as exciting and progressive** emphasises on utilising orchestrated branding and leveraging on major events with diversified themes.

STRATEGY N3

Accentuate linkage between STEM and life

The third strategy is to nurture the future generation of employees via daily exposure to themes embedded in pop culture, skilfully utilised to broadcast the significance of STEM in tackling global issues.

Pop culture has arisen in tandem with urbanisation and the development of electronic media. Microelectronics has made the individual the focus of marketing attention offering audio and video content, anywhere, anytime. Television and video games, combined with ever more powerful handheld devices offer novel ways of reaching youth.

Employment of pop culture

A number of TV series exploit public fascination with medical science and forensics, notably emergency room and diagnostic themes as in *Grey's Anatomy* and *House*, and the various manifestations of Crime Scene Investigation (CSI).

The crime drama CSI follows a team of forensic scientists to investigate and resolve crimes using forensic evidence, and is ranked first in the June 2005 Nielsen Rating with an average viewership of 16 million a night. Multi-platinum singing sensation, Justin Bieber, guest starred in one of the CSI episodes to garner viewership of 20.9 million. The episode drew a high 2.3 rating among teen girls, earning it the second most watched show of the timeslot. Other pop stars invited to star in the show to attract viewership include P. Diddy (13.8 million) and Taylor Swift (20.9 million).

The Autopsy of a Murder, a production of the Montreal Science Centre and QCSI, a multi-player game produced by Questacon, (Australia's National Science and Technology Centre) allow players to virtually investigate and solve crimes using real legal science. Descriptions of evidence, investigation tools and techniques are provided to guide players through the investigation. Similar concepts have been adopted and developed into games for the Wii and X-box consoles. For instance, the CSI games developed by Ubisoft sold approximately 2.4 million copies from 2003 to 2006 and the number of copies sold increased by 46 percent to 3.5 millions of copies in year 2008.

The impacts of these newly created participant bases are evident through elevated interest in forensic science study. The demand for forensic science courses in Wales has seen a 200 fold growth in higher education courses on forensics since 1991 from 2 to 400. Biochemistry and chemistry majors grew by 33 percent over 5 years in Wartburg College, Iowa, while enrolment for forensics courses nearly doubled over 1999 to 2004. Susquehanna University in Selinsgrove has developed a "Science in Motion" programme for secondary science teachers, including science experiments with a "CSI" theme.

In a nutshell, **Strategy N3: Accentuate linkage between STEM and life** emphasises on showcasing the industry through pop culture.

STRATEGY A1
Promote O&G industry as the champion of "me brand"

Today's young generations are more self-centred as compared to their parents. As determined in the previous chapter, Gen X and Gen Y, especially the latter, are less loyal to their employers as compared to Baby Boomers. Consequently, to attract and retain these young talents, O&G industry players ought to understand and provide them with values they desire. The O&G industry needs to promote itself as the champion of the "me brand", with the young generations being the brand.

Career enhancement opportunities

Young generations are more focused in building up their employability and continue to seek to improve their professional image. Professional services firms are particularly successful in providing the young generations the opportunities to achieve these goals, as proven by the fact that they monopolise the top spots in both Universum's "World's Most Attractive Employer" and Business Week's "Best Places to Launch a Career" rankings. The "World's Most Attractive Employer" rankings are determined by Universum's global talent attraction index, results compiled from 12 of the world's largest economies – for companies they would ideally like to work for. The index is calculated according to the preference of those going to graduate soon, companies that are top-of-mind employers and to what extent, and the companies that have a competitive advantage in the "War for Talent".

Social intranet

On top of career progression opportunities, young generations also desire to work within flatter organisations and to be engaged in social and collaborative environments. They want to be treated as valuable team members and want their ideas and creativity to be encouraged and appreciated. Various leading global firms have successfully fulfilled this desire by establishing social intranet within their organisations. The main objective of social intranet is to encourage open communication, thus giving all employees a sense of belonging and an official platform to be involved in company-wide decision making.

Employee empowerment

In addition to providing professional development opportunities and encouraging open communication, to further strengthen themselves as the champion of "me brand", the O&G industry players also ought to empower the young generations by addressing their individual needs and fostering trust. Google and SAS, the number one companies to work for in 2007 and 2010 respectively according to Fortune Magazine, empower their employees via the following four focus areas. Due to their continuous effort in investing in their people, both companies' voluntary turnover rate is as low as 2 percent.

In short, **Strategy A1: Promote O&G industry as the champion of "me brand"** focuses on positioning the O&G industry as one which fulfils the young generations' desire by providing them with what they want: career progression, sense of belonging and empowerment.

STRATEGY A2

Enhance women representation in O&G industry

Today, women have surpassed men in academic performance. At least an equal number of women, if not more, are pursuing tertiary education in universities compared to men. Furthermore, it has been shown that women have higher graduation rates compared to men. Nevertheless, a study shows that of the total number of women graduating with a first degree in science, engineering or technology, only 27 percent will pursue a career in these fields, as compared to 54 percent of male graduates.

As stated in Chapter 3, with the exception of Norway, a majority of the countries studied, including Australia, Canada, France, Germany, Russia, UK and USA, have less than one fourth of their STEM workforce made up by women. The same pattern is observed in major O&G industry players' workforce, where women make up less than 40 percent of the total workforce.

Elevation of women status and representation

Given the fact that the number of women graduates is increasing, the O&G industry should tap into this talent pool for future resources. To do so, as a whole, the industry needs to make an orchestrated effort towards enhancing women representation in the industry, particularly in elevating the status of women in their organisations. Such action has been taken by numerous Fortune 500® companies, with the percentage of corporate positions held by women increasing.

Moreover, the link between gender diversity and business outcomes is evidenced in the performance of companies with a more robust mix of women and men in senior management.

In addition to individual companies' effort, governments have also adopted gender diversity as national agenda to boost economy. In 2003, Norway introduced legislation that mandates 40 percent of female representation on all corporate boards of public companies, which subsequently became law in 2008. As a result, the female representation on boards has risen from around 6 percent in 2002 to about 40 percent, and the number of women board members in Norway has almost doubled over the same period of time. Similar to the pattern observed in the financial performances of Fortune 500 companies, higher gender equality, indicated by higher gender gap index, leads to higher GDP per capita.

Consequently, meritocracy and representation should go hand-in-hand. When an organisation values women and men equally, the gender balance should be the same at the bottom, in the middle, and at the top. The fact that it currently isn't indicates the presence of systemic barriers that interfere with progress for the women employees, resulting in a waste of human capital. Hence, to encourage women to continue developing their careers in O&G, industry players should implement innovative talent management programmes such as career customisation for their employees, particularly women employees.

Career customisation

Today, a career should no longer be a straight climb up the corporate ladder, but rather an undulating journey of climbs and lateral moves. In contrast to the more limited options provided by the corporate ladder, the corporate lattice makes it possible for employees to customise careers – to the benefit of both the individual and the company. This adaptive model of career progression is able to offer employees career-long options for keeping their work and personal lives in sync and employers the long-term loyalty of their best and brightest talent.

Recognising the emergence of corporate lattice model, O&G industry players should customise different career paths for employees, particularly female employees. According to Deloitte research in the USA, only 17 percent of households now have a husband in the workforce and a wife who is not, down from 63 percent in previous generations. Non-traditional families are putting pressure on existing workplace models of career progression originally structured to match the mainstream rhythms of the traditional two-parent, single-income household of the past.

Moving away from traditional career trajectories which do not fit women's lives, Deloitte's Mass Career Customisation (MCC) makes it possible to depict career-life choices and associated trade-offs, while recognising that an individual's career choices change over time. The O&G industry should utilise the MCC framework to acknowledge the fact that their female employees' levels of commitment towards career change as life priorities change according to personal life stages. For instance, during the early stage of their careers, women prefer a fast-paced job along with a heavy workload. However, when women just enter the stage of nurturing their family, they may want a slower-paced job with less workload to adjust to the new family life.

In conclusion, **Strategy A2: Enhance women representation in O&G industry** focuses on increasing the critical mass of women employee within the industry by elevating the status of women and providing them with flexible career paths with enhanced work-life balance.

STRATEGY A3
Promote O&G industry as a forerunner in R&D and innovation

Gen Y and Z grew up in the digital world and rely heavily on digital technology. Due to exposure to rapid transformation of technologies from a very young age, they are drawn to and are extremely savvy at adapting to cutting-edge technologies. Consequently, to attract STEM graduates, it is critical for the O&G industry to promote itself as a forerunner in R&D and innovation. The fundamental measure in achieving this is to foster favourable landscape for R&D activities to create a high-tech work environment.

Financial investment in R&D

Leading ICT industry players such as Microsoft, Nokia, and Samsung have been investing heavily in their R&D expenditures. In 2005, as a whole, the ICT industry spent about 2.5 times as much on R&D (US$ 130 billion) as the automotive sector, and more than triple the amount pharmaceutical sector spend on R&D.

It is evident that O&G industry players also invest in R&D. However, the amount of investment in R&D varies across O&G industry players. The 2009 UK R&D Scoreboard reports that Shell invested £890 million on R&D, or 0.3 percent of revenue. Petrobras is the second largest spender at $820 million on R&D annually, around 2.8 percent of revenue, reflecting the massive technological challenges of extracting oil from 4km below sea level. The leading O&G industry equipment suppliers (e.g. Expro International) also spend approximately 2 percent of turnover on R&D, but this is still a modest amount compared with the extraction companies such as BP at £414 million.

Hence, it is pivotal for every O&G industry player to invest heavily in R&D as a business necessity: to secure and convert product in a safe and environmentally responsible manner. This is consistent with US Energy Information report that continued investment in R&D programmes is required in the discovery, development, and deployment of future technologies breakthroughs as well as the advancement of current O&G technologies. Whether one is designing an extraction and conversion process, or dealing with an extreme event such as the April 2010 Deepwater Horizon loss, technological innovation through R&D is central; resolving the spillage into the Gulf of Mexico demanded solutions beyond any experience, including that of NASA engineers.

Furthermore, O&G has the opportunity to portray the industry as one of the technology frontiers that will stretch human ingenuity to its limits. “Schadenfreude” should be displayed with care, but the Fukushima meltdown and associated brake on investment in nuclear power stations can only increase demand for safer alternatives, of which petroleum gas is the most viable in the immediate future.

Specialised research parks

Research parks are works in progress, with numerous models around the world, ranging from the Isis Innovation at the University of Oxford through to Yokosuka Research Park (YRP) in Japan. The latter is a “triple helix” that brings together universities, industry and government into a synergistic knowledge creating relationship. Some of the organisations affiliated with YRP include Japanese Ministry of Internal Affairs and Communications (MIC), National Institute of Information and Communications Technology, Keihin Electric Express Railway Co. Ltd., Fujitsu, and Sony Ericsson. The research park’s main focus is to support the interchange of research between industry, government and intellectuals. These stakeholders hold symposium to present outstanding R&D achievements, with the objective of revitalising research activities within the ICT industry.

Petrobras, an O&G industry player, has also successfully created a world-class technological park for energy research, the Thematic Networks. The executive manager for Petrobras' Research and Development Center (Cenpes), Carlos Tadeu da Costa Fraga commented on the Thematic Networks: "We part from the principle that, based on strong investments made in the physical infrastructure and in qualification, conditions of excellence will be created to develop daring R&D projects in Brazil and to generate a significantly larger amount of innovations." As a result “Petrobras will be able to perform assays at domestic institutions that in the past it had to hire foreign companies to do." Currently, the Thematic Networks has 50 networks dedicated to different themes now bringing together 80 R&D institutions.

This type of collaboration proves to be mutually beneficial to all parties involved. The research institutes involved receive funding, while the private companies are able to gain easier and cost efficient access to research facilities and academicians. Additionally, cost efficiency can be achieved through joint funding on similar research by several private companies.

Journal publications

In addition to investing heavily in R&D activities, O&G industry should also emulate the Pharmaceutical industry’s effort in promoting the caption of independent peer-reviewed journals further to promote research, analysis and new findings. Presently there are nine petroleum and another five gas-related journals indexed to the Thomson Reuters *Web of Knowledge.* According to SJR, an indicator which measures a journal’s impact, influence or prestige, O&G industry has yet to publish journals which are as impactful as those of Pharmaceutical industry.

Furthermore, there are organisations affiliated with the pharmaceutical industry such as the Fogarty International Center of the US National Institutes of Health that provide complementary journal subscriptions to individuals, government, and universities to further promote journals related to the pharmaceutical industry.

Partner to attain green technology

As environmental issues such as global warming, climate change, and ozone depletion concern younger generations, the O&G industry needs to position itself as a viable partner in attaining

green technology. Presently, the DJSI shows the O&G industry as being perceived by the public as environmentally unfriendly. Additionally, the industry's collective investment in non-hydrocarbon energy is still behind others.

As a result, the industry needs to take a more aggressive role in contributing to the development of the green energy sector. This is in line with the public's growing interest in green energy. According to a 2009 environmental survey conducted by Gallup, 30 percent of the respondents are of the opinion that the government should decrease the monetary support and incentives for O&G producers, while 77 percent urge the government to increase its financial support to alternative energy sources.

Furthermore, on top of being environmental friendly, previous development of green technology has also proved to be cost effective. For instance, advances in coal bed reservoir research have successfully turned coal bed methane from safety hazard to reliable energy resource. This resource now accounts for over five percent of the US gas production and six percent of gas reserves.

In conclusion, **Strategy A3: Promote O&G industry as a forerunner in R&D and innovation** emphasises on showcasing the industry as a leader in advanced technologies by cultivating an environment which encourages R&D activities and positioning the industry as a viable partner in attaining green technologies.

CHAPTER 5: TAKING ACTION: IMPLEMENTATION PLAN

Strategies for nurturing talent and then attracting it to the O&G industry were presented in Chapter 4. These strategies are designed to enhance the human resource pipeline going forward. They were crafted with the recognition that the O&G industry, a STEM-based industry, not only faces the drift of younger generations away from STEM, but also the additional perception of being held accountable for environmental impacts and climate change.

The O&G industry is central to both world economic growth and the set of 'Grand Challenges' that governments around the world have recognized as occupying centre stage. The Grand Challenges coalesce around the themes of:

- Energy, Food and Water security
- Health (including ageing and infectious disease)
- Environment
- Climate change

It is immediately obvious that the oil and gas industries straddle these Grand Challenges: they generate energy, fertiliser, and emissions, as well as the feedstock for fabrics, plastics and pharmaceuticals. Oil and gas are the ultimate Promethean gifts that humanity cannot do without.

The task of TF2 is to provide workable initiatives for accessing the human resources needed to secure the future of the O&G industry. We have shown that the strategies for doing so fall into two broad, but necessarily overlapping areas, namely Nurture and Attraction.

Nurture is primarily concerned with growing talent in STEM, whilst **Attraction** seeks to capture this talent.

These two strategic approaches are critical to support building a strategic human capital base for the global gas industry, which is addressed by Task Force 1. Once attracted to join the industry, only then can TF1 undertake the necessary steps to build and develop young talent in to strategic human capital needed by the industry. Given that skills in the O&G industry typically take a longer lead time to develop, it is of paramount importance for the industry to do more to retain talent.

In short, before the industry can convincingly build strategic human capital for future sustainability, it must first understand the symbiotic relationship between **Nurturing** STEM interest in future generations, **Attracting** the young generations with key employability skills to join the O&G industry, and Developing young talent into strategic human capital and retaining talent for the industry's future benefit.

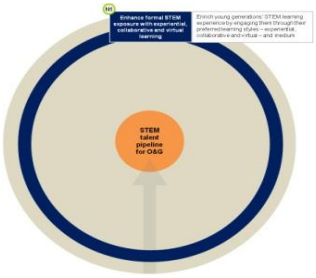
The difficulties outlined in relation to **Nurture** encompass demographics, curricula, teacher education and supply, and gender bias.

It is recognized that inertia is a characteristic of education systems worldwide, and that it is only shock that can trigger significant change. Such shock may arise from abrupt political change or an external threat. The former might be found in countries that have undergone the journey from central planning to market economics, and the latter would be evident under conditions of actual or low intensity warfare. As yet there is no evidence of a shock that is driving change in education systems, despite abundant evidence that all is not well in schooling.

Curriculum content and pedagogy in science bears little relation to science in practice, and this alone may account for the stagnation of STEM enrolments at the tertiary level. Too much of school science is still concerned with the celebration of 18th and 19th century genius, especially in chemistry, the basis of the O&G industry. This is why we offer three bold strategies to break the logjam. In essence school science must play 'catch-up' with society, as much as under-developed economies seek strategies to emulate those of more industrialised countries.

STRATEGY N1

Enhance formal STEM exposure with experiential, collaborative and virtual learning



RECOMMENDATION N1.1

Put learning "into the hands" of young generations

INITIATIVE N1.1.1

Embed educational apps into formal school curriculum

The above examples suggest that consideration be given to developing apps that augment the school curriculum and take it into new areas. This would be a complement to already existing services such as the iTunes University (iTunes U) that operates on Apple's portable platforms. iTunes U already offers in excess of 350 000 lectures and visual resources from around the world.

The challenge to O&G industry is to

- Invest in a number of apps that will capture the imagination of school students in all countries
- Collaborate with academia to ensure contents developed for apps are comprehensive and in line with formal school curriculum – focus on science in action, not science as history

- Ensure that apps allow engagement and collaboration between users from any location and at any time

INITIATIVE N1.1.2

Formalise hand-held devices as learning media in classroom

There is some controversy as to the actual rate of adoption of mobile telephony and the Internet in comparison with earlier radio and TV. Be that as it may, the existence of the mobile and Internet user base has allowed for the explosive growth of social media networking to comprise some 500 million subscribers in the five years since the launch of Facebook. This user base serves to power the demand for easier to use handheld devices such as tablet computers that go beyond being mere electronic books. The take up of tablet computers in schools has been rapid as shown by the quick emergence of support websites such as iPad in Schools.

It is suggested that O&G industry contemplate the following:

- Establish a fund to supply hand-held devices to students
- Commission the development of app-based content for inclusion into the mainstream curriculum
- Development online training programmes for educators to be proficient in using hand-held devices as teaching tools

INITIATIVE N1.1.3

Wire up informal learning environmental

Learning opportunities are now available as never before, 24 hours a day, 365 days a year, at the touch of a (soft) button. In addition to reaching students through the formal school curriculum, it is possible to push content in a non-intrusive way as is already happening in museums and art galleries that are supplementing their portable audio guides with apps for mobiles.

This suggests a number of possible interventions for O&G industry to:

- Install tablet kiosks with features such as audio presentation, opinion poll, comment section, and “like” and “re-tweet”, to allow instantaneous interaction between students’ hand-held devices and exhibits
- Customise and “push” science updates to students based on their areas of interest

RECOMMENDATION N1.2

Go beyond the limitations of reality

INITIATIVE N1.2.1

Pilot affordable access to learning environments virtually

Imperial College London has created a game-based simulation for undergraduate medical students where they can interact with virtual respiratory therapy patients in order to build their skills.

It is suggested that the O&G industry could:

- Construct virtual versions of STEM learning environments (e.g. science labs, science centres, museums) to overcome the security, financial, and geographical barriers to actual on-site field trips
- Establish a network of STEM professionals to produce contents for the virtual world
- Set up a fund to supply targeted schools with facilities to support virtual environments

INITIATIVE N1.2.2

Initiate global role-play simulation (RPS) events

Role play in education has a history as long as education itself. A contemporary example of RPS development is to be found at an online website Fablusi that hosts RPS software with applications across the areas of Nursing, Literature, Politics and Ethics, Strategic Thinking, Interactive Language Learning, Human Resources and Personnel, and Institutional & Organisational Management. Fablusi P/L seeks to partner with organisations that have a RPS need, and enters into cost sharing agreements depending on the nature of the work. Partners include the US Army and universities in Canada and Australia.

The O&G industry could:

- Partner with established virtual reality game companies to pilot a game that allows users to deal with the complexities of decision-making with regard to sustainable energy use, and possibly O&G industry exploration
- Organise global inter-school RPS competitions centred around solving STEM-related quests in virtual worlds

Once operational these initiatives should be launched through extensive marketing campaigns on major media platforms.

INITIATIVE N1.2.3

Broadcast real-time STEM-related events

Two STEM events that received extensive media coverage were the 1969 landing of Eagle on the moon and the 1994 impact of the Shoemaker-Levy comet on Jupiter. Since then we have witnessed video broadcasts of the tsunamis that devastated Indonesia, Thailand and Japan. Science and the natural environment fascinate the public. The science community has a long history of seeking to enhance communication with the general public for educational purposes.

The O&G industry recognises the huge task it faces to win and retain public confidence and can build its credibility through the promotion of public communication of S&T.

Initiatives that could be explored include:

- Recruiting dedicated media taskforce to coordinate and produce broadcasts of real-time global STEM events, such as knowledge sharing sessions, lectures, seminars, and explorations
- Soliciting sponsors to fund the production of these real-time STEM events broadcasts
- Organising events, such as meet up sessions, invention competitions and voting polls, to increase forum's traffic and interaction amongst forum users, and rewarding competition winners and active users
- Attracting attention by breaking news exclusively on forums
- Enriching discussions by providing industry's points of view and insights
- Engaging government and industry players to sponsor forum events financially

RECOMMENDATION N1.3

Stimulate young generations to own and contribute knowledge

INITIATIVE N1.3.1

Formalise wikis as learning media in classroom

The website Educational WIKIS hosts numerous examples of how the wiki idea may be used in school situations. The examples span all areas of the curriculum and come from around the world, from Argentina to Hong Kong, from the USA to New Zealand.

It is suggested that O&G industry should:

- Support efforts to set-up wikis as a critical learning component for each STEM class by posting assignments and solutions, coordinating group discussions, holding open Q&A sessions, and sharing students' self-created learning materials

- Provide extra incentives, such as tangible rewards, and public recognition, to students who contribute to the class' collective learning

INITIATIVE N1.3.2

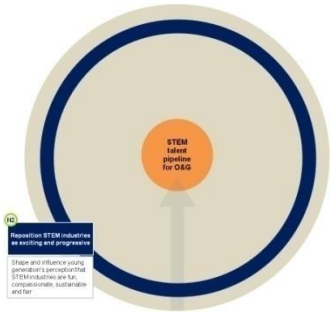
Leverage on existing public platform

Whilst dedicated and suitably customised media platforms are ideal there exists a scope to make use of existing channels. Such an approach offers a cost effective and immediate means of influencing debate and attitudes. To this end, the O&G industry may:

- Engage STEM professionals to upload materials on public wikis to stimulate discussions

- Enrich contents on public O&G websites (e.g. "itsnotmagicitsscience.com" portal).

STRATEGY N2
Reposition STEM industries as exciting and progressive



RECOMMENDATION N2.1

Strengthen value proposition through orchestrated branding

INITIATIVE N2.1.1

Adopt and promote consistent global positioning statement

The examples of the US Army and Ford serve to emphasise the importance of honing a credible and powerful global positioning statement. The medical profession markets the physician as a person who relieves human suffering, instead of a person who receives attractive monetary rewards. It is worth unpacking what it is that makes Petrobras such an attractive employer in Brazil, where competition for industry positions is high and perquisites significant.

A truly visionary *GPS* must make sense to individuals, transcend negative imagery, and create resonance. "Life is a gas" or "Energy is life" are two straplines that might encapsulate such thinking.

We advocate two major initiatives:

- Craft a global positioning statement that focuses on the inspirational and optimistic aspects of O&G industry instead of practical benefits of being a STEM professional

- Develop a public relations “tool kit” which includes the global positioning statement and punchy “taglines” and guides on how they can be used effectively in establishing institutional identity

INITIATIVE N2.1.2

Launch global marketing campaigns

The next step will be to launch the global marketing campaign. This requires an appropriate organisational structure and resources, leadership, and a good sensing of timing. The lessons of multi-channel marketing should be carefully applied. In particular attention should be given to the possibilities that social media offer to initiate a viral marketing campaign. Viral marketing has had major successes in sport, personal products, media and fast foods, as well as consumer electronics. The proposed initiatives are to:

- Form a representative committee to plan for funding, logistics, and other aspects of coordinated, multiyear marketing campaigns
- Coordinate a strong brand position through a variety of communication channels and messengers, and provide dedicated supporting resources
- Develop and utilise viral marketing strategies

INITIATIVE N2.1.3

Utilise social media

As previously noted, Facebook claims about 500 million active users who spend 700 billion minutes on its website every month. This connection should be used to reach out to people. The above viral marketing is one examples of how O&G industry might reach its target pool. Social media are now as much a reality as mobile telephony: the connected generation is actively creating content and seeking out new experiences and information. No major company can afford the failure to understand this new channel and incorporate it into its strategies:

- Form a social media team which focuses solely on establishing company’s footprints in the social media space by actively managing presence
- Urge employees to be ambassadors of company’s social media pages by promoting the pages within their own network

RECOMMENDATION N2.2

Leverage on major events with diversified themes

INITIATIVE N2.2.1

Establish a STEM event management organisation

Globally, broadcasts of major entertainment events continue to draw increasing numbers of television viewers. For instance, The Super Bowl in the USA is a massive sport event which drew 111 and 106.5 million viewers on 2011 and 2010 respectively. This presents a readily available platform for STEM industries to leverage on to reach out and "sell" STEM to large audience.

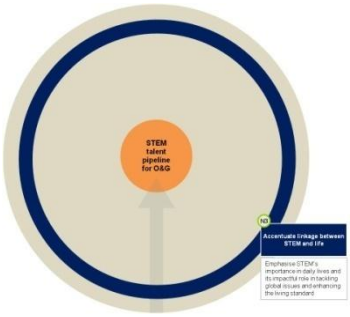
Another example is Spanish bank, BBVA Bancomer that has decided to be a major sponsor of the Spanish Football League until 2013 to promote its trademark and services.

Among the tasks required of the event organisation will be to:

- Create a recognisable STEM road show, or science camp, which includes activities such as exhibitions, competitions, performances, workshops, record-breaking feats, charity benefits, auctions and celebrity galas
- Invest in extensive marketing efforts in order to increase media coverage, attract the world's attention and transform the road show into a global trademark event anticipated yearly
- Organise media fests for teachers and students
- Collaborate with high-profile global events (e.g. Formula 1, Olympics Games, World Cup, Academic Awards) and customise the road show's contents according to the events (e.g. science behind movie making for Academic Awards)
- Set up a sponsorship body to sponsor events
- Garner support from governments and local residents (e.g. mobilisation of Singapore city for the Formula 1 race)

STRATEGY N3

Accentuate linkage between STEM and life



RECOMMENDATION N3.1

Employ pop culture

INITIATIVE N3.1.1

Produce STEM-themed TV shows and video games

A UK youth volunteering charity surveyed 1,000 youths to understand what motivates young people into volunteering. The top issues included terrorism (63 percent), war (63 percent), poverty (61 percent), famine (56 percent) and climate change (54 percent). Efforts to use STEM to tackle these issues have been highlighted in various forms of pop culture. Pop culture is powerful, pervasive, and able to transcend cultural and language divides.

Consequently, O&G industry should prioritise on:

- Produce a variety of TV shows (e.g. drama series, reality show, documentary) and video games which cater to different groups of audience with different interests – emphasising on the significance of STEM in daily lives
- Feature interesting and memorable characters, and their professional and personal lives to portray the excitement of being involved in STEM industries and their contributions towards the world
- Incorporate latest “hot” topics or trends which young generations are interested in into story lines
- Integrate global issues which young generations are concerned with and how STEM contributes to the solutions
- Allocate budget to promote TV shows and video games produced in the similar way as other Hollywood blockbusters or best-selling video games

INITIATIVE N3.1.2

Engage popular celebrities

The final initiative in our Nurturing theme draws on the phenomenon of role models and the power of individuals to influence us. An example of the use of role modelling is the Global Rice Science Partnership (GRiSP) aims to lift 150 million people out of poverty by 2035 by deploying rice’s genetic diversity to increase rice production. Photos and videos of researchers are uploaded on Flickr and YouTube to create awareness and enhance knowledge in the area.

It is suggested that O&G industry:

- Feature popular celebrities periodically as guest stars or spokespersons for STEM-themed TV shows and video games to act as influential role models for the young generations

STRATEGY A1
Promote O&G industry as the champion of "me brand"

RECOMMENDATION A1.1

Promote O&G industry as the place to launch a career

The objective of this recommendation is to advertise the O&G industry to university STEM graduates as the ideal place to launch a life-long career. In order to achieve this objective, the industry ought to market itself as an industry which is exciting, progressive, and responsible. This is in line with younger generations' preference to work for companies that are socially aware and care about the world. As stated in Chapter 3, 68 percent of a survey's respondents refuse to work for employers that are perceived as not socially responsible.

On top of this, to further promote the O&G industry as the place to launch a career, industry players need to market the professional growth opportunities they provide. Professional services firms succeed in advertising their development and training programmes, for instance, KPMG's Audit Fundamental in Madrid and Accenture's Core Consultant School in Chicago.

INITIATIVE A1.1.1

Adopt and promote consistent global marketing statement

A consistent global marketing statement is essential for any industry which aims to reposition itself. As an example, professional services firms have consistently branded themselves as places which are well-known and recognised internationally, and help their employees to be more employable in the future. Hence, the O&G industry should place a high priority on:

- Forming a **marketing committee** to plan for funding, logistics, and other aspects of coordinated, multiyear marketing campaigns
- Craft global marketing statement which emphasises the industry as **exciting**, **challenging**, **highly mobile globally**, and **impactful towards the world**
- Market industry values such as **progressive**, **socially responsible**, **environmentally friendly**, **caring**, **transparent** and **honest**
- Set up **full-time resident or permanent task forces** to implement initiatives related to each marketed industry value

INITIATIVE A1.1.2

Market professional growth opportunities

O&G industry players should emulate the professional services firms' efforts in showcasing their offer of professional development opportunities. Specifically, O&G industry players with their own private training institutions, for instance, Petrobras ought to leverage on the establishments during their marketing and recruitment campaigns. The areas of actions that should be given attention by O&G industry include:

- Showcase **structured professional trainings** (both technical and soft skills), **exposure through global mobility**, and **vast career opportunities and paths**
- Utilise an **industry-wide platform** (e.g. the IGU website) to link and coordinate individual companies' efforts

RECOMMENDATION A1.2

Implement global branding campaign with clear "me" value propositions

This recommendation aims to brand the O&G industry as one which cares for the employees by "selling" the "me" value propositions. The O&G industry needs to empower younger generations by addressing their individual needs, including the desire to be involved in the organisation's decision-making process. As stated in Chapter 3, young generations are dismissive of hierarchy and titles; they work well in fluid environments which encourage collaboration.

Another initiative of the global branding campaign is to provide sense of meaning in jobs. Today's younger generations want a fulfilling purpose and bigger meaning in life than just the normal consumer experience. They want to work for companies which have positive impact on the world.

INITIATIVE A1.2.1

Establish social intranet within organisations

Social intranet has emerged as a popular tool to increase employee engagement via open communication. For instance, 60,000 global employees of Oracle, a global business software and hardware systems company, are able to share, comment, and rate innovative ideas for new company products on their social intranet, Oracle Connect. A leading consulting firm, Booz Allen Hamilton, has also launched its social intranet, Hello, which contains more than 4,700 collaborative websites created by its employees, of which 56 percent work remotely. Hence, the O&G industry should:

- Incorporate social intranet as part of company's work culture, infrastructure, and support system, where interaction and discussion within the organisation are promoted regardless of department and hierarchy

- Ensure that upper management participate actively on social intranet by “listening” to employees, addressing their concerns, and providing updates on company’s performance objectively

- Create smaller communities on social intranets based on employees’ diverse interest or nature of work to provide them with a sense of belonging

INITIATIVE A1.2.2

Provide sense of meaning in jobs

It has been shown by a UK youth volunteering charity survey that today’s young generations are more concerned with the global issues as compared to their parents. Over 50 percent of the youths surveyed expressed that they are motivated to help tackle the issue of terrorism, war, poverty, famine and climate change. Consequently, it would be vital for the O&G industry to:

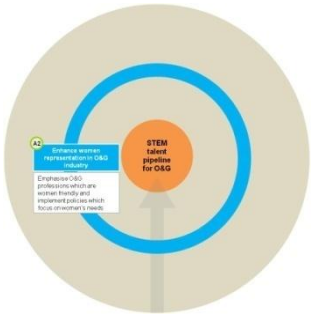
- Sponsor and link company operations with philanthropic and environmental activities

- Establish dedicated teams to plan, coordinate, and execute local community development projects in order to ensure that the real concerns are addressed and bribery is eliminated

- Provide opportunities to employees via sponsorship to work for causes

STRATEGY A2

Enhance women representation in O&G industry



RECOMMENDATION A2.1

Elevate the status of women in O&G industry

This recommendation's objective is to attract women to the O&G industry by showing to them that the industry does pay attention to women's needs, and strives to increase their representation and status within the industry. O&G industry players need to provide additional incentives catered for women's needs. For instance, Scripps Health, one of the 2010 Working Mother 100 Best Companies, offers child care and tutor services to their employees' children in addition to job-sharing, telecommuting and flexitime policies.

In addition to additional perks, the O&G industry also needs to build influential women role models in order to attract more women employees into the workforce. For example, the Malaysia-China-Asia Pacific Women's Economic Summit was held for the purpose of showcasing exceptionally successful businesswomen role models in order to inspire women to participate and excel in the economic arena, promoting respect to women, and disseminating information on the importance of women human capital.

To further showcase the organisations' efforts in elevating the status of their women employees, female representation in upper management also needs to be increased. As stated in Chapter 3, the percentage of female involvement in Fortune 500 companies' upper management has been increasing. Some governments have also mandated a pre-determined portion of the upper management to be occupied by females in order to encourage gender equality.

Last but not least, women in the O&G industry should also have opportunities to network with each other. With increased interaction with and support from others, female employees within the industry are more likely to stay in their jobs.

INITIATIVE A2.1.1

Provide additional incentives for women

Various leading global companies have practised this initiative to show their appreciation and understanding of the female employees. For example, benefits provided by the Boston Consulting Group, a leading consulting firm, include 12 weeks of paid maternity leave, unlimited monetary reimbursement and number of attempts for in vitro and other fertility treatments, fully subsidised back-up child care, lactation rooms in every office, and provision of nursing aids.

Areas of action for the O&G industry include:

- Provide additional perks, such as nurseries, allowance for children-related expenditures, to show the company's understanding of female needs

- Offer referral awards as a means to establish critical mass of female workforce by encouraging more recommendations of qualified females

INITIATIVE A2.1.2

Build influential women role models

In order to elevate the status of women in the O&G industry, successful female O&G professionals should be featured to inspire other women in advancing their career in the industry. It has been shown that featuring female scientists in TV programmes such as CSI has led to a change in children's images of scientists. 50 percent of the study's participants drew a female when asked to draw a scientist – a sharp contrast to another research conducted in 1996. Hence, the O&G industry should:

- Form a panel of female STEM elites to be industry role models who have managed to accomplish career and personal lives successfully

- Organise regular meet-up sessions to share with students in person how professional success can be achieved in the industry while maintaining a successful personal life

INITIATIVE A2.1.3

Increase female representation in upper management

Following the national gender equality agendas mandated by various governments, O&G industry players ought to increase female representation in their upper management in order to show their appreciation for female talent. As mentioned in Chapter 4, there is a positive relationship between a greater mix of gender in upper management and financial performance. Consequently, the O&G industry should prioritise on:

- Mandate that a fixed percentage of upper management should be reserved for female employees to establish a distinct career path in management for women

- Increase the number of IGU task forces headed by women

INITIATIVE A2.1.4

Provide networking opportunities for women

To leverage on and retain the existing women workforce in the O&G industry, networking opportunities ought to be provided for them to interact and support each other. It has been stated in Chapter 3 that a lack of networking and mentoring opportunities is a major factor which causes a low proportion of females in the STEM workforce.

The area of action that the O&G industry should take is:

- Set up an O&G community for women network as a platform for female O&G employees to interact and support one another's career

RECOMMENDATION A2.2

Promote career customisation

The objective of this recommendation is to provide women employees in the O&G industry with career flexibility in accordance to their personal lives. It is evident that female's commitment towards career fluctuates more greatly according to personal life stages as compared to their male counterparts. Indeed, the majority of women have nonlinear or discontinuous careers. Hence, O&G industry should take this into consideration in customising career paths for their employees, women employees in particular.

INITIATIVE A2.2.1

Customise career paths for female employees

As mentioned in Chapter 3, family obligations and work-life balance are the main factors which cause women who are already in the STEM pipeline to eventually leave. They often have to choose early in their careers between being a successful employee or a mother. It has also been shown that more than 70 percent of 450 female scientists and engineers surveyed in a study cited family-career balance as the most significant challenge in their career advancement. Consequently, to attract and retain women workforce, O&G industry players ought to utilise the MCC framework to customise different career paths for each individual employee, particularly women employees. The areas of actions include:

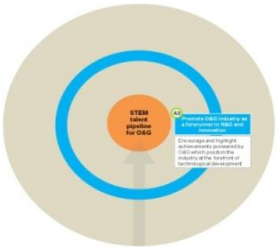
- Acknowledge female employees' levels of commitment towards career change more drastically as compared to men as their life priorities change according to personal life stages

- Design different career paths, as opposed to a standard path, for employees, with particular emphasis on women, by considering their work and current life priorities in tandem

- Provide additional support, such as financial aid for graduate school and professional training opportunities, to female employees who wish to focus on career development again after establishing their families

STRATEGY A3

Promote O&G industry as a forefunner in R&D and innovation



RECOMMENDATION A3.1

Foster a conducive environment for R&D activities

This recommendation's objective is to create a favourable environment to stimulate and sustain growth of R&D activities. One of the main initiatives to achieve this objective is to establish an industry-wide R&D fund. A close example of such fund is the Victoria – Israel Science and Technology R&D Fund (VISTECH). The fund's aim is to support joint commercially focused R&D projects between Israeli and Victorian companies, mainly in the fields of life sciences, nanotechnology, and environmental technology.

Moreover, O&G industry players should also collaborate with prestigious tertiary education establishments to create a R&D environment which is beneficial to both parties. As stated previously in Chapter 4, via the collaboration, the education establishments involved will receive the funding needed, while the industry players are able to gain access to research facilities and expertise.

In addition to setting up research funds and collaborating with the academic sector, to further foster a favourable environment for R&D, O&G industry players should also market their achievements in R&D aggressively. As elaborated in Chapter 4, presently, as compared to other industries such as pharmaceutical, the O&G industry still lacks publications that are perceived as impactful to the world.

INITIATIVE A3.1.1

Establish industry-wide R&D fund

Since the outcomes of R&D are useful for all the players in the O&G industry, it is in the best interests of players to establish an industry-wide R&D fund. O&G industry could learn from the VISTECH, of which activities include promoting and marketing the benefits of R&D collaboration, matching companies in one state seeking a partner in the other, facilitating the identification of specific projects or collaborations and contributing up to 50 percent of the joint eligible R&D costs. The areas of actions that O&G industry should prioritise include:

- Set up a central fund management body to coordinate, source for, and pool financial resources
- Increase individual organisations' annual budgets allocated for R&D activities
- Liaise with governments to provide tax reliefs for R&D funding

INITIATIVE A3.1.2

Collaborate with prestigious tertiary education establishments

Numerous collaboration efforts between industry players and tertiary education have been established in other industries. For instance, Google, Microsoft, and Sun Micro Systems have collaborated with UC Berkeley in setting up the Reliable, Adaptive, and Distributed Systems (RAD) lab to help launch another revolutionary online company such as eBay Inc. Consequently, it would be critical for the O&G industry to prioritise on:

- Partnering with academic institutions and government to set up research parks specifically for R&D related to O&G technologies
- Providing research grants to fund R&D in academia
- Assigning industry professionals to work with academics

INITIATIVE A3.1.3

Market O&G industry's R&D achievements

While O&G industry players have successfully developed cutting-edge technologies to provide sustainable energy resources to the world, they also need to be more proactive in showcasing these achievements to the public. For instance, in the pharmaceutical industry, new findings in medical research, such as treatments for HIV, are widely publicised and attract the public's attention. Hence, O&G industry should:

- Increase the frequency of publication of journals
- Provide complimentary subscriptions to journals
- Organise or attend industry seminars, and visit universities, to present the O&G industry's latest technological developments

RECOMMENDATION A3.2

Position O&G industry as viable partner of green energy

The objective of this recommendation is to expose the public to the O&G industry's effort in pioneering cutting-edge technological developments to build sustainable future. Currently, oil and gas have been pitted against green energy. The industry is generally perceived by the public as being detrimental to the environment.

Henceforth, it is crucial for the O&G industry to play a more active role in the green energy crusade. As existing players in the energy sector, O&G companies are in the position to support

the development of green energy. In order to do so, the O&G industry ought to establish public-private partnerships to invest in and promote feasibility of green energy.

INITIATIVE A3.2.1

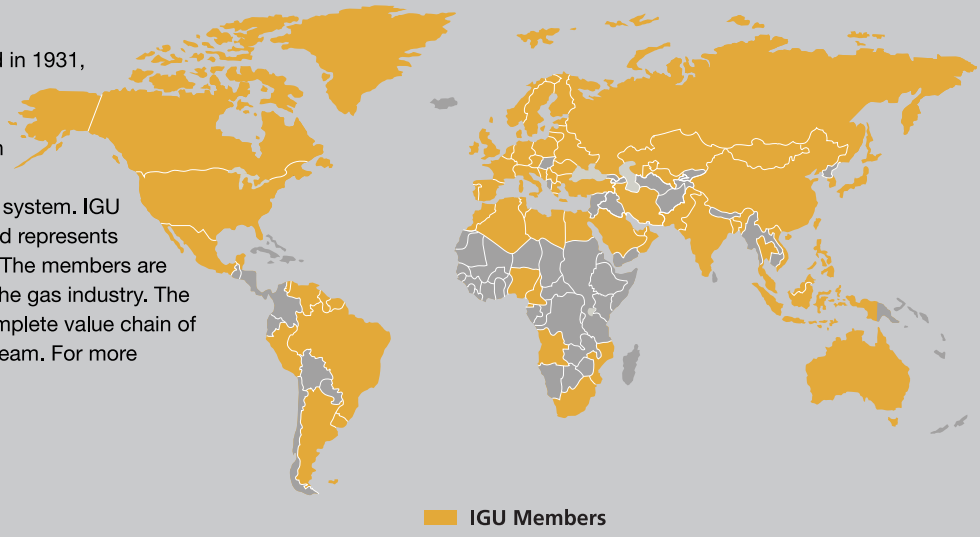
Establish public-private partnerships to invest in and promote feasibility of green energy

To further emphasise its role in supporting the development of green energy, the O&G industry should establish public-private partnerships to coordinate its investment and promotion of green energy. While the investments could be in place, O&G industry players need to ensure that their efforts are also promoted and made known to the public. The areas of actions the O&G industry should pay attention to include:

- Setting-up specific committees to form partnerships with different sectors to catapult green energy research
- Produce TV shows, documentaries, online videos or short clips which capture industry achievements in technological development of green energy
- Launch global marketing campaigns to create awareness of the O&G industry's partnership with green energy players
- Engage mass media to promote the O&G industry's effort and investment in green energy

IGU

The International Gas Union (IGU), founded in 1931, is a worldwide non-profit organisation promoting the political, technical and economic progress of the gas industry with the mission to advocate for gas as an integral part of a sustainable global energy system. IGU has more than 110 members worldwide and represents more than 95% of the world's gas market. The members are national associations and corporations of the gas industry. The working organization of IGU covers the complete value chain of the gas industry from upstream to downstream. For more information, please visit www.igu.org.



IGU
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