



## 25 October meeting Summary of the remarks

### Session 1: The impact of technology

#### 1. Upstream - Enhanced recovery

The first presentation is about the possible impact of EOR (Enhanced Oil Recovery Techniques) in the Orinoco Heavy Oil belt of Venezuela. This country has the world's second largest accumulation of heavy oil: Initial oil-in-Place is 1400 Billion barrels - Bbbl according to PDVSA (Initial oil in place for Canadian Tar/ Oil Sands in Alberta: 1800 Bbbl. The proven oil reserves producible with existing technology in Orinoco are estimated to be 180 Bbbl with a mixed cold/thermal technology(PDVSA). In Alberta, proven reserves (using thermal or mining techniques) are estimated to be 160 Bbbl.

Up until now, only cold production (depletion) without any EOR – Enhanced Oil Recovery – has been applied in the Orinoco... The recovery factor is thus limited to 4-7%. Cold methods cannot be applied in Alberta simply because the oil remains liquid in the ground in Venezuela, whereas oil sands in Canada are solid. The reservoirs have a high rate of permeability (Oligo-Miocene sandstones). Gravity is 8-9 API, viscosity 1,000 to +10,000 cP in situ compared to 10,000-500,000 cP in Alberta.

According to Venezuelan authorities, crude oil production could reach 6 million barrels per day – Mbd - in 2020, of which 4 would be produced in the Orinoco heavy oil belt, which presently (2011) produces 1.2 Mbd.

There is not a single EOR method tentatively applicable in the Orinoco. The choice of method will depend on geology, fluid conditions, economics and industrial constraints.

Thermal methods: if we look at thermal methods, we can have:

- Alternate or Continuous Steam injection (CSS/HASD/CSD):- Recovery factor can reach 10-30%
- Steam-assisted gravity drainage SAGD. Recovery factor can reach 40-50% (but only in thick sand layers of more than 30 m)

Chemical methods (polymers and or surfactants injected with water) can also be used. Recovery factor can reach 20-35% (for viscosity up to 5000 cP). Polymers improve sweeping by increasing the density of the injected water. They can be applied to oil with viscosity up to 5000 cP (discarded in West Orinoco. They were successfully used in Alberta oil sands).

Cold Production by depletion requires many wells. The optimal drilling cost must be found. This technique leaves +92% of the oil in place and requires sand control. The recovery factor is less than 8%. It is difficult to re-use existing wells and difficult to adapt to EOR in the second phase.

Simple thermal (Cycling Steam Soaking / Continuous Steam Drive) techniques boost local recovery factor by up to 50%. However, the average rate is 25-30%. This technique requires many wells, huge amounts of steam and poses the problems of gas availability to generate the heat, expensive surface installations for vapor generation and skilled field operators. It can lead to H<sub>2</sub>S hazards.

Complex thermal (SAGD) techniques can reach a recovery factor of up to 30-50%. This technique can boost recovery factor and sweep larger volumes than the Continuous Steam Drive (CSD). Complex thermal techniques cannot be applied everywhere (sands must be more than 30 m continuous). SAGD poses the same challenges as CSS or CDS (it requires huge amounts of steam (gas availability), needs expensive surface installations for vapor generation and highly skilled operators in the field; it can lead to H<sub>2</sub>S hazards.

Chemical EOR (Polymers and Surfactants Polymers) can theoretically be applied everywhere if viscosity is limited. Recovery factor is on average 20-30%. Additional cost/bbl is likely to be a fraction, i.e. about 1/3 or ½ of the additional cost of thermal techniques for EOR. Although the Polymer Process is proven in Canada, it requires a feasibility study and pilot proof. It is easier to operate at the field level.

- Venezuela has the world's second largest accumulations of oil-in-place, but the currently observed recovery factor is low (depletion method only). Introducing EOR methods is a priority. They will dramatically increase the Recovery Factor and reserves (potentially adding 200-300 billion bbl reserves), but this is an enormous technical and industrial challenge. Huge investment is required: capital, technology and people.
- There is no clear philosophy today: thermal is the natural candidate. Simple methods (CSS and CSD) are proven elsewhere but they bring many disadvantages (H<sub>2</sub>S hazards, shortage of gas, industrial complexity). There is a lack of pilot proof. Chemical is the potential challenger. It is simpler and 50-70% cheaper than thermal but it will probably be restricted to Center-East Orinoco. It needs a lab and pilot proof
- There is a need to launch laboratory tests, studies and pilots in association with fine scale reservoir characterization and simulation studies; optimal EOR methods will vary with geology/reservoir conditions. The typical cost of a chemical EOR pilot: \$50-80 Million. The typical cost of a thermal pilot: \$150-200 Million (the same as a deep offshore exploration well).

The debate focuses on the situation in Venezuela. A lot of new projects are forecast but the production from these new projects will be limited. The environmental consequences are also stressed: clearly some technologies lead to more CO<sub>2</sub> emissions and a risk of H<sub>2</sub>S production. There is an upstream challenge as well as a downstream challenge: which kind of synthetic oil should be produced? (16-20 ° API for most projects, more than 30 ° API – Total).

The problem is not the stability of rules, but the rationality of decision in a very difficult geopolitical context.

## **2. Transport – Electric Vehicles**

The different options are:

HEV: Hybrid Electric Vehicles (with electric motor and optional plug-in)

BEV: Battery Electric Vehicles

REEV: Range Extended Electric Vehicles (option: plug-in)

FCEV: Fuel Cell Electric Vehicles

The number of electric (battery, hybrid, etc.) vehicles sold has doubled between 2009 and 2012, but remains limited (1 million vehicles out of a total of tens of millions). 70% are Prius – Toyota hybrid vehicles, whereas the rest are manufactured by Honda, Mitsubishi, GM, Nissan, PSA, etc.

The future of electric vehicles will very much depend on how fast battery costs can come down, as well as how the cost of batteries can impact the adoption of different electric vehicle options.

Large improvements can be expected in the price of lithium-ion batteries, from \$560/Kwh today to \$163 in 2025. The improvement will come from reductions in material and component costs, reductions in manufacturing costs and technological improvements.

The future of the powertrain market is highly uncertain and it will mainly be driven by regulations, the total cost induced by these regulations and consumer needs. Very strict regulations (less than 10 g of CO<sub>2</sub> per km) lead to a world of Battery EVs and Fuel Cell EVs, while limited regulations (up to 95 g of CO<sub>2</sub> allowed per km) will lead to a world of Hybrid EVs and Batter EVs.

High motor fuel (gasoline / diesel) prices and large improvements in battery costs will lead to domination by Battery EVs, while limited improvements in battery prices will result in domination by Hybrid EVs and Plug-in Hybrid EVs. The transition from Internal Combustion Engines to Electric Vehicles will be driven by these factors; Internal Combustion Engines will remain dominant in the next years, but should nearly disappear by 2050.

### **3. A global view of transport**

Transport consumes 2280 tons of oil equivalent per year or 27% of total energy consumption. Oil products represent 94% (Gasoline 46%; diesel 32%; jet fuel %; fuel oil 7%) of transport needs; Biofuels 2%, Electricity: 1%; Gas – LPG, CNG/NGV and LNG: 1,5%.

Gasoline fuel engines will be slightly improved in the future with new combustion processes, downsizing and or cylinder deactivation, variable compression ratio and variable valve train systems. Diesel-fueled engines will be slightly improved in the future with new combustion processes (HCCI and very high pressure injection), variable compression ratio (VCR) and variable valve train (VVT) systems. Regarding diesel engines, pollutant emissions will be reduced by new technologies: particulate filter, oxidation catalyst improvement, selective catalyst reduction or NO<sub>x</sub> absorber.

New motor technologies are also possible: dedicated engines (natural gas vehicles, dimethyl ether and hydrogen), electric vehicles (batteries and fuel cells) and hybrid vehicles. Fuel consumption of a hybrid-gasoline vehicle could be reduced by 35% (-25% to 50%), while fuel consumption of a hybrid vehicle could be reduced by 20% (-17% to -34%). Potentially significant fuel reductions could also be obtained based on non-engine related parameters: aerodynamics, rolling resistance, energy management and weight reduction) and engine improvements.

In addition to a reduction in fuel consumption due to engine improvements, a reduction in oil consumption will also result from the development of biofuels (second generation through lingo-cellulosic synthesis).

According to the International Energy Agency, alternative fuel consumption could be reduced by 8 Mbd (including 4 Mbd of biofuels) in the “New Policies Scenario” and by 13 Mbd in the “450 ppm scenario” (including 7 Mbd of biofuels).

Of course, in the future, the consumption of liquid – especially oil - products will depend on the development of the vehicle population (from 1 billion today to between 2 and 3 in 2050) and unit consumption. Consumption of oil products in the transport sector, which was 43 Mbd in 2009, could reach between 42 and 57 Mbd in 2035.

In the transport field, regulations will be primordial. Too stringent regulations would kill the car industry. Acceptance by the final consumer is primordial.

The maintenance cost of electric vehicles is low. The future of electric vehicles will depend on a potential – if any – breakthrough in battery technology.

The development of the use of LNG as a motor fuel is a very important factor. Fleets of trucks have been adapted to run on LNG (for instance, in California).

## **Session 2: The euro crisis – impact on oil and gas prices**

Did the Euro have an impact on oil prices or is it the other way round?

The yearly European oil bill was on average \$182 dollars between 2000 and 2010, \$488 in 2011 and probably more than \$500 in 2012. In comparison, the Greek sovereign debt is \$370 billion. The Italian import bill is \$55 billion (equivalent to the current annual trade deficit) and the French import bill (more or less the same as the Italian bill) is also equivalent to the French trade deficit.

Oil demand is gradually dropping in the EU: - 12% between 2005 and 2011, - 10% between 2007 and 2011, - 2.6% in 2011 compared to 2010. Gas demand has fallen significantly in 2011 compared to 2010 (-10%). Gas is now out of the market for electricity production, pushed out of production by the development of renewable energies.

The “financial crisis” started in 2007, but the shock occurred on September 15<sup>th</sup>, when the Lehman Brothers filed for bankruptcy, triggering worldwide market panic.

In 2009, the Standard and Poor’s Agency downgraded the Greek debt from A to A-, followed by Spain from AAA to AA+ and then again Greece from A-to BBB+, only three steps above the junk status.

In March 2010, Euro-region finance ministers laid down the groundwork for making emergency loans available to aid Greece. Papandreou hinted that he might seek support from the IMF if EU partners failed to act. In May, Euro-area finance ministers agreed to provide up to 30 billion euros of loans to Greece with the IMF agreeing to put up another 15 billion euros in funds. S&P became the first rating company to cut Greece to the junk status and downgrade Portugal to A-. The Euro-region agreed on a 110 billion-euro rescue package for Greece. Greece agreed to 30 billion euros in austerity cuts over the next three years in exchange for the aid. In May, in a 14-hour overnight session in Brussels, EU finance chiefs, agreed to set up a 750 billion-euro rescue mechanism for countries facing financial distress: the European Financial Stability Facility. Spain, Portugal and Ireland get downgraded (by Fitch, S&P, and Moody’s). Ireland received an 85 billion-euro bailout (Nov).

In January 2011, Portugal's 78 billion-euro debt was bailed out. In May, Moody's cut Portugal and Ireland to the junk status. In August, in the US, the Congress agreed to raise the debt ceiling. The agreement increased investors' demand for U.S. bonds in the days following the agreement, which lowered their yields. However, S & P downgraded the U.S.' credit rating from AAA to AA+.

By mid-September 2011, **European banks began experiencing a shortage of U.S. dollars** as U.S.-based money-market funds began to pull out of European banks as they were worried that the banks were holding too much risky European sovereign debt. This placed European banks at risk of having to pay back their dollar-denominated loans and therefore, **risk defaulting on their debt**. The lack of dollars in European banks increased their borrowing costs.

By the end of the year, major central banks intended to restore market confidence and agreed to pump dollars into the European banking system. However, Spanish bank bailout funds take over three more savings banks. The Fitch Agency cuts Spain to AA- and Italy to A+.

The European Stability Mechanism (ESM), established on September 27<sup>th</sup>, 2012, functions as a permanent firewall for the Eurozone with a maximum lending capacity of €500 billion. It is intended to replace the two existing temporary EU funding packages: the European Financial Stability Facility (EFSF) and the European Financial Stabilization Mechanism.

There is a clear link between the EU economic situation (or the anticipated situation) and the price of oil. The price of oil falls when there is an anticipation of a breakup of the Euro zone and it recovers when the situation improves.

As a summary, anticipations of a deepening debt crisis across the Eurozone and a resulting recession pushed the oil price downwards. Central-bank largesse (quantitative easing or the promise of keeping rates lower for longer) as a coordinated response to the debt crisis has sent oil prices soaring. This flood of cheap money (along with greater optimism on China's hard landing appearing less likely) has sent investors into hard assets, especially oil. The central banks response to the Euro debt crisis may have **affected oil indirectly**, by raising global growth prospects, which in turn buoy expectations for oil demand. But, speculative positions from non-commercial traders have also been consistently gaining momentum.

One can consider that the 2008 crisis is the result of the oil price increase. Inversely, after 2008, the oil price is the result of the crisis. Some participants do not see a clear link between oil prices and the economic crisis.

It has also been noticed that during the session, the role of OPEC was never mentioned.

## **Session 3: current issues**

### **1. The post Arab Spring**

There are two ways of assessing the post-Arab Spring situation, that Iraq stands as the odd man out, and that the two major issues today are Iran, which we expected, and Syria, which had been frozen for so long that most people didn't pay any attention to it.

Firstly, when you try to measure the consequences of the Arab Spring, the glass seems either half full or half empty, depending on how you look at it.

On the positive side, we have witnessed a succession of regime changes (Tunisia, Egypt and Libya), which were altogether peaceful, except in this last country, but even in the Libyan case, casualties were kept to a low level. The regime change was followed in the same countries by more or less democratic elections. In Egypt, to the surprise of many, President Morsi succeeded after his election in sidelining the army peacefully. In Yemen, transition is in the making, but we cannot yet speak about regime change. President Saleh has bowed to internal and external pressure and has handed out his powers to Vice-President Abd Rabbo Mansur Hadi. Hadi's choice was confirmed by the February presidential election, in which he stood as the sole candidate.

On the negative side, despite altogether successful elections in Libya, where initially, observers lauded the fact that radical Islam didn't prevail, the choice of a Prime Minister proved to be difficult. Tripoli has no control of the situation on the ground. Factionalism is tearing the country apart and as widely expected, militias have refused to surrender their weapons. Women's rights are proving to be a sensitive issue in Tunisia where radical Islamists have gained ground, whereas in Egypt, President Morsi has so far succeeded in maintaining a delicate balance. However, in the absence of any improvement on the economic front, impatience is likely to grow.

In the energy field, delays have to be expected. Any hope that the IOCs might have been seeing a softening of contractual terms have been dashed, at least in the near future. Much needed investments will take time to materialize. Libya's oil production is back to around pre-war levels, at about 1.5mbd, but the message from Tripoli is that no decisions on sweetening terms will be made until the oil ministry and state's National Oil Corp (NOC) carry out a detailed study of existing contracts and previous licensing rounds. This process could take at least a year and any recommendations will need to be approved by a permanent government and the national assembly.

Iraq is the odd man out, as apparent stability could prove to be deceitful. On the surface, one could speak of stability and even of improvement. The same Prime Minister, the Shi'a Nouri al Maliki, has now been in charge for over 6 years, despite his party coming a close second in the 2010 general elections. The level of oil production stood at a record high in September at 3.25 Mbd. Recently, some progress seems to have been made in the dispute over the Federal Oil and Gas Law between Baghdad and the KRG. However, the September 14 agreement between Baghdad and Erbil is only a first step in the right decision and many hurdles remain.

But security is deteriorating and the fact that Tarek al Hachemi, the Sunni Vice president, was sentenced to death in absentia bodes ill for stabilization of the political situation. Moreover, Iraq is likely to be a collateral victim of Syria's sectarian war. The spill-over effect is already apparent; the sectarian split is deepening and is pushing Maliki closer to Iran.

Two hot issues have been feeding market anxiety over recent months, the Iran nuclear crisis and civil war in Syria.

The red line over Iran was pushed back to mid-2013. Two changes have happened on the Iranian nuclear issue. While markets were nervous a few months ago about a potential unilateral attack by Israel before the US presidential elections, the level of anxiety has softened recently, as the red line was pushed back to mid-2013. The military option is not on the table in the very near future, according to Prime Minister Netanyahu's speech at the UN General Assembly in September. The Israeli Prime Minister specified that there would be no Israeli action "*before Iran completes the second stage necessary to make a bomb*" (about

250kg of uranium enriched at 20%), which he estimated, at the current rate of enrichment, *“by the spring or summer of next year”*.

What is new is the domestic reaction to the economic crisis in Iran, as the Rial has devaluated by about 75%. After long denying that sanctions had any impact, Iran’s Supreme Leader has qualified them recently as *“brutal”*. We have to be careful not to make too much of the recent demonstrations in Tehran, but the fact that the Bazaar, which was until now considered as in support of the regime, closed its doors should not be overlooked.

As we know, the economic situation in Iran is not bound to improve. Europe has just tightened sanctions further and it remains to be seen under which conditions the US will renew waivers for countries that continue to import Iranian oil. Our understanding is that quantities might be reduced by 20%.

In case of a closure of the Strait of Hormuz, 11 Mbd will be stuck in the Gulf. Only a small fraction of the Iraq production (Kirkuk – Ceyhan pipe line), a part of the Saudi production (5 Mbd – through the Petroline to Yanbu) and part of the Emirates production (through the new pipe line through Fujairah) can avoid Hormuz.

The Syria black box: there seems no end to Syria’s descent into ever bloodier conflict and chaos.

Although a minor oil and gas producer, Syria is widely perceived as a keystone in the geopolitical structure of the Middle East. Dislodge it and the balance using opposing forces could be quickly lost.

In the ebb and flow of fighting, neither side has gained a decisive advantage that would suggest an early resolution to the crisis. Using guerilla tactics, the rebels have brought increasing parts of the countryside and some border posts under their nominal control, and continue to hold on in some parts of Damascus and Aleppo despite heavy weaponry and air power employed by the Assad regime. Casualties are rising by the day.

For the time being, there is no end to this civil war in sight. Syria could easily enter a period of prolonged sectarian fighting and political chaos reminiscent of Iraq after 2003, and the longer it lasts, the more likely it is that the most radical elements in the rebellion will take the lead. The risk of the conflict spilling over into the wider Middle East helps explain US and European reluctance to intervene.

There is another question, which is rarely put into the open: *“can the Gulf countries remain immune to this general upheaval?”* So far, the answer has been yes, but how long can it last and is the story the same in sparsely populated Qatar as in Saudi Arabia, where King Abdullah has been buying social peace while steadily, but some would say too slowly, reforming the country? Of course, the answer to the question depends partly on how long King Abdullah takes to implement this slow process. It also depends on how smooth the transition to the next generation will be. Two Crown Princes have successively passed away and the choice of Prince Salman as the new Crown Prince was largely expected. However, the question now in people’s minds is who, when the time comes, King Salman will eventually choose as the Crown Prince and whether it will be a personal choice or the result of a consensus within the Allegiance Committee. This transition will take place in the context of a much more open society, thanks to an increasingly educated population, with large access to information and hence, more sensitive to the winds of change that blow outside the country.

And what about Kuwait, the first country in the region to have introduced direct elections back in the early 1960’s, but where Parliament is more successful in blocking government action than in being proactive, and which has a sizable Shi’a minority?

What is the US policy and how is it perceived in the region? We all have in mind the tragedy that occurred in Libya with Ambassador’s Stevens’ death and the demonstrations triggered by an odious Islamophobic

video, “The Innocence of Muslims”, which was posted on the net early in September. The president who will be elected in two weeks’ time – this is just before the Obama election on November 6th; ndr - will face huge challenges in the Middle East, and it is no surprise that this region has taken the lion’s share of the last presidential debate earlier this week.

To conclude, the “fear premium” that is driving up the price of oil is here to stay. The size of this premium will fluctuate according to two interacting variables; (1) the level of perceived threat of a supply disruption and (2) the level of the market’s supply cushion.

## **2. The quest for a new energy mix in Japan**

The Fukushima nuclear disaster forced Japan to rewrite its energy policy from scratch due to the collapse of nuclear safety myth. After several months of intense crisis responses, the preparatory work has started. An overall majority of public comments sent to the government have preferred the zero-nuclear option. The Innovative Strategy for Energy and Environment chose zero-nuclear in the 2030s driven by “energy democracy”. This strategy could be modified in favor of or against nuclear energy, depending on the political situation in the future. The energy reality of Japan may give a longer life to nuclear energy than currently assumed.

The first phase (crisis response phase) after the nuclear disaster (March 11<sup>th</sup>) included rolling blackout (March 14<sup>th</sup>), emergency imports of LNG and fuel oil (through the year), a 15% cut in power consumption (May 13<sup>th</sup>), a precautionary shutdown of Hamaoka nuclear plants (May 15<sup>th</sup>), a forced power cut (July 1<sup>st</sup>) the introduction of energy supply-demand stabilization measures (August 15<sup>th</sup>, the implementation of a Nuclear Damage Liability Facilitation Fund (September 12<sup>th</sup>).

The Preparation Phase (July 2011 - Sept 2012) saw a review of Renewable Energies, the vote of the Purchase Law (23 Aug 2012), the issuing of 4 Fukushima investigation reports (from February 28<sup>th</sup> to July 23<sup>rd</sup>), the introduction of the Nuclear Regulation Authority Foundation Law (June 20<sup>th</sup>), the Stoppage of all nuclear plants in Japan (May 5<sup>th</sup>), the Restarting of Old nuclear plants (July 1<sup>st</sup> & 15<sup>th</sup>), the announcement of the three energy scenarios (June 29<sup>th</sup>) and publication of Public comments on the above scenarios (July 2<sup>nd</sup> - August 12<sup>th</sup>).

The Implementation Phase (July 2012 - ) started with implementation of feed-in tariffs (July 1<sup>st</sup>), the definition of an Innovative Energy Strategy (September 14<sup>th</sup>), the endorsement of the strategy by the cabinet (September 19<sup>th</sup>), the setting up of the Nuclear Regulation Authority (September 19<sup>th</sup>), introduction of the Carbon tax (Oct 1<sup>st</sup>) and preparation of the framework for green development (end of the year).

The decision-making Body for the Innovative Strategy for Energy and the Environment (September 14<sup>th</sup>, 2012) is the Energy and Environmental Council founded by the Cabinet on 7<sup>th</sup> June, 2011. The Minister for National Policy is the chairman and seven other ministers are members.

The main contents of the Innovative Strategy are mobilization of all possible policy resources to enable zero operation of nuclear plants in the 2030s. The guiding principles are ① Strict application of 40-year limitation rules, ② Restart after safety assurance given by the Nuclear Regulation Authority, ③ No new or additional construction of nuclear plants.

The targets for 2030 are power (-10% vs. 2010 level), total energy (-19%) and renewable energies (3 times), -The Framework for Green Development Policy for concrete implementation (by the end of 2012).



Future Flexibility or Ambiguity: although endorsed by the Cabinet, the text was treated as an attachment to the cabinet decision below. This treatment and the wording of the cabinet decision leaves room (flexibility or ambiguity) for this strategy to be substantially reviewed in future. [Cabinet decision on September 19<sup>th</sup>, 2012]. The Government will execute its energy and environmental policies flexibly by (1) taking into consideration the “Innovative Strategy for Energy and the Environment”, (2) having responsible discussions with local governments and the international community, (3) gaining understanding of the people and (4) conducting continuous reviews and re-examinations.

The government proposed three energy scenarios for public comments on June 29<sup>th</sup>, 2012 (as below). Scenario 1 shows 0% nuclear, 35% renewable and 65% fossil fuels, Scenario 2 shows 15% nuclear, 30% renewable and 55% fossil fuels, Scenario 3 shows 20 – 25% nuclear, 25 – 30% renewable and 50% fossil fuels.

The strategy set forth by the government seeks out zero nuclear in the 2030s, which could effectively be interpreted as Scenario 2. The success of the strategy will be at risk in the following situations: (1) disappointing speed of the increase in renewable energies (e.g. battery technology bottlenecks), (2) extreme increases in oil and LNG prices due to geopolitical upheavals, (4) consumers’ resistance to the rising energy bills due to high feed-in tariff, (5) excessive burdens of negative international trade balance on national economy,

It is too early to predict a precise trend of the energy mix transition; however, the nuclear share will decrease at a slower pace than that assumed in the strategy.

### **3. The situation in the US**

Oil consumption is declining in the US – as in all OECD countries. The decrease is sharp. Inversely, there is a strong increase in liquid production. US production could increase from less than 8 Mbd now to more than 12 by 2020. Development of shale oils (oil in source rocks produced by fracking) will represent a large part of the increase in production. Production from deep offshore, NGL production and biofuels will also develop.