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Ethylene Industry Worldwide,
Mark Eramo, Vice President Chemical Market Insights, IHS Inc

Moderator

Our next speaker will offer his thoughts on the ethylene industry worldwide. He comes to us from IHS Chemicals in Houston, Texas where he oversees the chemical market insight teams that provide in-depth marketing analysis and nearly 300 and plus techs products. Prior to that, he received his BS in chemical engineering at Cornell University and then spent 12 years in a chemical business with Vista Chemical Company, and 13 years with CMAI where he was responsible for global market advisory services. Ladies and gentlemen, please welcome Vice-president of Chemical Market Insights at IHS chemicals in Houston, Mark Eramo.

Mark Eramo, Vice President Chemical Market Insights, IHS Inc

Thank you. Thank you for the introduction. I was told jumper at the end because of time constraints so I am going to do that, but first before I start, I want to say thank you to Technip for the invitation to share with you our views on the ethylene market. I certainly view these advance having spent some times in the industry as you heard, 13 years with CMAI, I have viewed these kinds of answers, exclusive events, so I certainly appreciate the opportunity to be invited to join all of you and participate, so again thank you Technip for the opportunity.

I will be talking to you about the global ethylene market and our specific outlook. You see the subtitle there: low cost feedstock fuel the next wave of investments in North America and in China. So I will try to focus on that.

First, just 15 seconds on, since I think just chemicals have a kid of a new name in the industry which is about 2.5 year old. I will just try to give you a perspective and help you understand what sits underneath and the better of just chemical today. Again, I spent 13 years with CMAI. In the spring of 2011, we were required by IHS and that was after a series of acquisitions in the chemical consulting space. So CMAI, also now intelliChem which is focused on Latin America, SRI consulting based in California, Harriman Chemsult which was based in Europe, and of course chemical week which actually turns 100-year old next year, a lot of years of experience in-depth in the various brands that you have seen there, expanding our coverage from chemical week which I can tell you about today. It is news and information on what is

happening around the world of petrochemicals, and plastic, and derivatives to the deep market analysis and forecast that goes on in the legacy CMAI teams, Harriman teams and SRI teams. We are here just chemical now and it is really the combination of this legacy brilliance. That is also now connected with a pretty strong brand like CRO on the energy side, global insights on the economic side, in many others companies that are coming underneath, i.e., just umbrella. So, again, I am happy to be here with you today to talk about ethylene.

I would like to start in a conversation, even ethylene is one of the main chemical industry building blocks. I think it is important to view the chemical industry in a successive to be part of an industry that really is a key enabler of modern living. Look around you, on many aspects of our life whether be the medical industry, transportation and construction packaging, food distribution, water distribution, fuels, fuel additives, coatings, resins, the list goes on, and on. There is no doubt that the chemical industry, the technologies and the assets that you contribute to building around the world are in fact the key enablers of modern living, and that is why it makes it so exciting, from the cell phone, the Smartphone that we now use to the cars we drive, the homes we live in. At the end of the day, it is all about making products that enable that modern living, but I would say it is a very serious responsibility that the chemical industry takes on, in continuous to press the envelop in terms of the technology in the advances that enable that modern living to continue to progress.

When you look at the investments across this industry, they seek an advantage either driven by cost and/or the proximity towards the demand centers are, so again one of the key driving forces behind where the investments occur. When you look around, you see demand growth accelerating outside of the developed regions now, it is really the developing world that is accelerating in terms of the demand growth for some of these key basic building blocks, and the strategy that has been developed today do require a complete understanding of the value-chain from the wellhead all the way down to the end-user consumer in the products that have been used to develop what you and I consume in durable and non-durable goods.

So understanding that value-chain is so important that on the front-end of that chain is energy which then relates to some type of feedstock that flows to a chemical plant, is then converted into a derivative, pushed out on stream to a fabricator of some sort and then making a derivable or some semi-finished good that is then sold to you and I as the retail chain. So on the very front-end is again the energy source, but it is such an important part of the cost of what happens in this value-chain, and then on the back-end is the supply demand from the consumer themselves. So you and I drive in the supply side.

At the end of the day, the company as you look around the industry that have long-term success in the chemical industry that have been able to leverage the technology and low cost supply strategy for meeting demand, the ones that have been successful are able to take the right cost with the right products, using the right go-to-market strategies, and those are the companies that had been sustained for years and years and will continue to be the companies that advance this industry in the future.

I mentioned these chemical investments liked to seek and leverage advantage, here again energy in feedstock's make up 70 to 60% of cost in manufacturing chemicals,

that is not news to this crowd. So where you can find that advantage whether be low cost ethylene as I said now in North America or in Saudi Arabia, or in Western Canada, or some other trap feed cycle like coal in Western part of China, you will try to leverage that feedstock advantage in the production of chemicals and plastics; or you will try to locate yourself with proximity to the demand growth without a distinct cost advantage than having that proximity towards a key demand growth is, becomes essential to your position in the marketplace. Trade access is also very, very key when you think demand growth in proximity to the market.

Finally, technology to enable efficient competitive production costs as well as high performance products being first on market and on the technology side, it is also very important. So, when the producers, the people making the investments around the petrochemicals and plastics and end-use world, some combination of these advantages are obviously the best choices, the best situations that have some combination of all three.

So, we will start of taken small comments about the basic building blocks in the industry, look at what is happening from a demand trend standpoint. We will look a bit closer at the impact of energy and look at the shift of new capacity and therefore how their results are changing trade dynamics around the world; and then the profit cycle that is somewhat makes depending on what your feedstock situation is in the industry.

So again, when I look at these key basic building blocks, of course ethylene is the largest of the basic chemical building blocks. As you look over time, this is looking from 2010 to 2020. Basically, ethylene, propylene and methanol are expanding at the most rapid pace, benzene and chlorine at a somewhat more moderate pace. So, by 2020, we expect ethylene capacity to reach nearly 200 million metric tons, methanol will approach 160 million metric tons, and propylene is also accelerating and we believe it will probably reach 140 million metric tons of production. So, significantly sized markets depending on how you look at it as far as the growth in these three key-based building blocks.

From a demand standpoint I mentioned earlier, that the demand for these basic chemicals is also driven by the consumption of durable and non-durable goods, that is what you and I consume every day. So, you can look at basic relationships of strong economic growth around the world will support basic chemical demand growth. The last couple of years, we have seen modest growth around the world in 2012, in 2013, and we are seeing that is suggesting lower consumer spending and we have seen some weaknesses in terms of overall supply demand as a result of that. I mentioned earlier the emerging markets are driving tomorrow's demand growth. China dynamics are changing, we see things shifting in terms of internal focus as far as the demand within China as opposed to the re-export volumes of products that flow in, get converted to durable and non-durable goods and flow back out, but China remains critical for a supply demand standpoint in terms of most major petrochemicals and plastics markets.

When we look at the rise of emerging consumer, this graphic here looks at the ratio of domestic consumption to global GDP. Part of the graphic is, as you see this downward trend in the US and Western Europe compared to a ratio of Brazil, Russia, India and China, the BRIC, common term that has been used to look at the represented developing world if you will. In the key message here is: we do not want

to ignore the absolute size of the US market and European market because they are enormous in terms of their overall consumption capability, is this rapid acceleration as occurring in these developing countries as far as this year size of their domestic consumption relative to global GDP that you must take note of in terms of the rapid growth in basic petrochemicals and plastics. So, as you can see here the forecast from IHS is suggesting, the relative size of the combination of those developing countries will be the same size of US or Europe in terms of this domestic consumption relative to global GDP.

The demonstration of what is happening in terms of the production of basic petrochemicals and plastics, so I should say examples, is let's look at accumulated production growth across the different regions. In this graphic, you are looking at our model of all basic chemicals and plastics. So, if you look at those five building blocks that I have showed earlier on, and you follow the derivatives that are produced, what is happening in this graphic is that we are tracking accumulated production in million metric tons of those basic chemicals and plastics that are produced from those building blocks.

This is a look at the Asia and India marketplace. So from 1990 to our forecast to 2020, we are talking about the production of accumulated 500 million metric tons of basic chemicals and plastics.

You need to compare that to what is happening in West Europe for example and notice the change in the order of magnitude on the scale. A rapid build-up and a nice growth that occurred from 1990 through 2005 before reaching a plateau. But it is only 40 million metric tons. In our forecast through years, it just slowly declines over time because of the competitive situation. It is happening relative to the NAP the feedstock basis from the European standpoint.

And also you can compare that to North America, note the order of magnitude in the scale. We are talking about a rapid growth through about 2000 and reached about 50 million metric tons and look at the way it *plateaued* for a period of about 10 years, which happened to be the 10 years that North America decided to take off in terms of building any new major assets in terms of petrochemicals and plastics. You see the severe dip in 2009 - 2010 as a lot of de-inventorying occurred as crude prices crashed during that time period and then slowly started to recover. Our forecast in the future again is based on the investments that we see coming in basic chemicals and plastics, but again you are not much better than I do in terms of what is progressing through, but now rapidly a growing approach in about 70 million metric tons.

So again, the idea here is to show Asia with steady growth in its production continue investments as a common thin that won't occur, because of the role Asia plays as the manufacturing floor to the rest of the world. So if you think about those durable and non-durable goods that have been provided to consumers all around the world, Asia continues to be the place we believe, at least in this timeframe, will continue to grow at a steady pace. Your contracts a bit, and now North America will recover and starts to provide some of those products as well.

Not to be repetitive, but I made a comment earlier about capacity extension being driven by low cost feedstock's in integration strategies. So, it is the combination of those two things as you look, as the company looks around the world and says: can I

leverage the feedstock position? Am I close to the demand center? Do I have some combination of both? And what would be my position going forward as a result of the location that I select for the investment?

From the cost perspective, a lot of discussions in the last three, four, five years as I spoke at various conferences about green chemicals and about alternative feedstock's beyond crude oil and natural gas. And I liked to use this graphic as a bit of a perspective just to say, you think about those basic chemical building blocks I talked about, you are starting with crude oil and natural gas, these are the hydrocarbon that you are after. These hydrocarbons that provide that value-add if you will, as you move down the value-chain that I showed you earlier, and of course as you all well know, the billions and billions of dollars of significant investments that are going into, taking that barrel of crude oil or the cubic of natural gas in converting that into this high par-value, hydrocarbons then get produced into this durable and non-durable goods that you and I consume.

Do I need to keep my eye on coal and what is happening in coal markets around the world gas? I really need to pay a close attention to China and talk about that a little bit. Do I need to understand biomasses and feedstock petrochemicals? Yes, I need to understand it and see whether that is and where that is going tomorrow. But at the end of the day, I would like to make the point that our product manager, our business manager in basic petrochemicals and plastics, tomorrow when I come in to work, what I want to know is what is the price of crude oil, what is the price of gas, because billions of dollars of investments, and millions and millions of metric tons of production capacity are engineered on what is happening in those two marketplaces, and those are key drivers.

Again, I am not trying to say, don't watch what is happening on coal developments in China and don't pay attention to green chemicals that have been developed, the use of sugar cane for example as a feedstock or whatever the biomass might be, it is also generating feedstock for this industry. But the vast majority of the investments and the vast majority of the chemicals being produced are being driven by these two basic hydrocarbons and it will be the case for the foreseeable future.

As you have seen, I have shown various pictures of this graphic. This is a look in constant 2012 US dollar per million Btu as comparing crude oil in the light blue bars and natural gas, natural gas liquids and also naphtha, so a lot of information. Unfortunately, the reveals are coming across what I wanted, because this is a nice graphic to build slowly rather than show you all at once. But if you start with the blue bars in the background versus the natural gas at the very bottom, that is the spread that is generating this incredible opportunity that is returned to North America, high crude oil and no natural gas. You see the yellow one, it represents ethane prices and the green and red, the propylene which represents NGL and naphtha prices.

If you go back to 2000, all those lines were pretty much trading pretty close to each other, but as crude oil took off and gas dropped off, those things have created this very large spread and that has opened up a variety of opportunities, not only in terms of investments, but in terms of new technologies around the world. I would argue that obviously, the hydro units are being built because of what is happening in the coal product markets. What is happening in China relative to coal is somewhat related to this energy dynamics that is going on between crude oil and natural gas with respect to North America. So these spreads have opened up these opportunities and the

sustainability of these spreads are what, if you will the better been made, we saw the presentation earlier about you pick that one baseline forecast and are you prepared for the variations offered that one baseline forecast? This is a good example of that. So what either brings the crude oil price lower than natural gas price higher, that would change the dynamics that are really unfolding today around the world as far as the investments in ethylene capacity are rather based petrochemicals and plastics capacity.

A snapshot results here in terms of what creates this advantage on feedstock's is shown here. This is our model for different types of feedstock cracking. This is ethylene production cost, dollars per metric ton for our different models around in the world. So, on the very far left, it is the Middle East ethane, as low as it is, I would even argue that is probably Saudi Arabia ethane. US ethane and then to the far right is South East Asian naphtha where our models are for their. Ethane cracking if you look at the Middle East, US and even Western Canada, you are talking about an advantage based on our forecast for 2013. So these are annualized numbers and assumptions for crude and gas in feedstock's as well as co-product to credits. We set on average ethane cracking which has an advantage that would exceed $600 per metric ton. I mean these are numbers that are just unbelievable. In some cases, numbers are difficult to comprehend. When I used to work and be involved with the Lake Charles cracker there and Lake Charles chose Louisiana, we certainly were not looking at this kind of advantage that is relative to competitive feedstock's as far as ethane cracking. So that type of advantage creates a lot of opportunity in a lot of different ways around the world.

This is just a look at the sustainability of what we think ethane cracking is now. So if you take our forecast and run through these models, again you see in the top lines, the green line and the red line being Western European naphtha and South East Asian naphtha compared to the USA ethane cracking. So there is a sustainable advantage there even that you are brought into low gas, high crude for the foreseeable future. This is our forecast through 2020.

So this energy dynamics in North America is in fact changing and having an impact on the global landscape. The development of low cost hydrocarbons, low cost gas, therefore low cost NGL is bringing in a new wave of investment. Really, it has been more than a decade before we have seen this in North America. This new competitive investment will ramp up production in North America and because of the domestic growth that is occurring in terms of the consumption in North America, the vast majority's products we are going to have to find a home offshore that is changing dynamics for the North American producers. I go back to my Vista days, I would say that 90% of what we produce stayed domestic and 10% were for offshore. That formula would change dramatically. A large percentage of this new capacity that we will produce, we have to find a home elsewhere, not within the North American market because of the growth dynamics that are occurring as we talked about earlier between developed and developing regions.

Pass forward to China, it is limited in terms of its crude oil and natural gas reserves, but a large coal reserve, so the graphic here is showing you in terms of the energy reserves within China coal make a 95% of that. In a very simplistic way, I say coal is to China as natural gas is to North America as far as it is used as a competitive feedstock and a competitive energy source in feedstock source for the development of petrochemicals, especially in the Western regions of China where essentially, you

have stranded coal reserves. How do you get that coal in the market? One way to get it to market is to build chemicals on site there and then move the chemicals to market as opposed to moving the coal to market, and that is what we see starting to happen across the China regions.

Coal technology is not new in China. It has been there a very long time, I would say the products are on the left hand side and are other than some of the things that are now being developed in terms of new technologies as far as going from coal to chemicals, but essentially PVC, ethylene, propylene, methanol, ethanol and ethanol-glycol now being leveraged today in terms of plants that have being put in the ground and try to leverage this low cost coal to chemicals capability within China.

So many projects have been discussed across China. This is a graphic trying to show where the centers are, of the different kinds of projects whether there may be methanol or coal to olefins, whether be glycol or even ethanol, we do not believe that all the projects being discussed will go forward either because of government controls, high capital cost, water availability, or the carbon emission and waste disposal issues, but there are a number of projects that in fact are starting up, are running today and will continue to be built tomorrow.

What we see happening if you step back, we see these three measured demand centers, if you will the production centers in terms of global chemicals between North America, Middle East and China as a focal point for these investments going forward. The strategies are very depending on the region and the country that you are in.

In North America, we have this surge in new investment driven by shale oil and gas, a stagnant domestic growth will shift the focus to export markets.

In the Middle East, we have seen a moderate pace of investment. It continues to increase, but some way moderated. Obviously, seeking domestic and regional supply options along with export capabilities that they have in place.

Of course, in China, strong domestic investment really focused on reducing import dependencies. So, some of the strategies in China are about self-sufficiency in terms of being as dependent upon imports of all this based chemicals and plastics in order to make the goods that they are making, but there is a shift to look at domestic demand growth as it evolves away from the re-exports to domestic needs.

Other parts of the world, Brazil, surge in demand near term as we see Brazil preparing for the World Cup and the Olympic Games, but a pause in the comperj investment as they assess the American landscape.

We see Europe a bit on a defensive assessment now in terms of the assets that are in the ground how those can be positioned in the future, seeking to add competitive feedstock in idle high-cost capacity.

India having a domestic focus with investments at Jamnagar. High energy is a huge issue from the Indian perspective, remain short of some very key products such as PVC which will continue to grow as far as the major import product in the India marketplace again related to the high-cost energy issue that they face.

So, this graphic here, again stepping a look at specifically at ethylene. I again apologize that this work better as a reveal versus those shown to you all at once. But this is looking at millions of metric tons that have been invested and started up a new ethylene capacity in the various regions that you see there, over the different decades. So the red bars represent the decade of the eighties, the green bars the nineties, the yellow bars the 2000 and then the blue bars the 2010 - 2020. The point here again, you see North American taking in a decade of 2000 - 2010 off. Europe will take the current decade off in terms of new investments, and the other key point here just look at the steady growth in Asia Pacific. So again, Asia is representing that manufacturing floor to the world, wanting to maintain a certain degree of self-sufficiency in terms of its ability to produce ethylene for what it is then turned into durable and non-durable goods, slowly increase in the amount of new investment going across that region.

This next graphic here just shows you for each region what percentage of the total global additions it represented in that time period. So again, from 1980 through 1990, you see that it was relatively evenly spread, and then you are fast forward to the current decade from 2010 to 2020, you really see the dominance of Asia Pacific and that steady growth in Asia Pacific as far as the investments are going into that region. So yes, we are surging again in North America in the current decade representing about 20 % of the global additions, but the investments continue across the Middle East. They continue across the Asia Pacific region as the global ethylene market continues to expand at a pretty rapid rate.

From this list of projects that we tracked in North America. These are the companies that are on the list either advancing some way shape reform. We had various discussions even while I was here throughout conferences that the rate eliminating factor will more likely be the permitting process and the point at which the company can get in line with the different contractors in the availability of resources in order to build these plants. I actually think we will look as to say that there will be some readable increase of capacity, the threat of oversupply becomes some of these other constraints. Assuming a steady growth in the ethylene demand around the world over the next five to ten years, the threat of oversupply is somewhat muted by the fact, there are other factors that would bring this capacity on some readable basis.

So North American ethylene capacity will increase about 45 million metric tons after declining, so we went to a decade of actually shutting down a lot of capacity over plants in North America. It will now surge to that 45 million metric tons by the year 2020.

From a China perspective this graphic here is showing you olefins, non-coal based production, so olefins being ethylene and propylene increasing to about 40 million metric tons by 2017. These are the coal-based olefins projects, ethylene and propylene increasing their capacity to about 60 million metric tons by 2017 representing a little bit more than 20 to 25% of the capacity in China, and again the coal-based olefins capacity in a much lower percentage of the overall global capacity that is based on that coal.

So investment in new capacity way from demand centers obviously will drive exports higher and that is central theme here as you build a certain capacity in China, you are building up for the domestic market, but the more asset you put into the Middle East, now your ramp up capacity in North America, the vast majority of products get

to be turned into a driven and that driven has to find some place somewhere in the world, because the domestic demand growth in those areas are not just fast enough to absorb all their capacity.

So that is the fundamental thing that is occurring here, what we see happening in terms of the different products that are based on ethylene. By 2020, we are suggesting for example that 50% of the ethylene glycol that is produced around the world will be put on a ship and sets some place out for consumption. About 40% of the polyethylene and about 30% of the methanol, and on down the lines. So we see the trade beginning to ramp up so the pressure on logistics system around the world also have to have reinvestments, also have to be expanded in order to handle this new capacity that is coming on stream.

This is a look at global ethylene equivalent trade. If you look at the parts that are above the line in terms of net exports, you see the yellow area there in the Middle East, the line blue area there being North America, you see the expansion occurring there. Before I run this graphic back to the 1990s, the net equivalent trade, so the relative height of those bars will be less than 5 million metric tons, and you see that expanding up to almost 30 million metric tons by the year 2020. So the way we run our balances obviously, the net exporters have to balance out with the net importers, you see China there, the red bar at the bottom which continues to grow in terms of ET need for ethylene derivatives. So, this is ethylene equivalent trade, so all the ethylene that is contained in various derivatives there is being traded around the world.

So, another graphic it says for the logistics companies that are moving these products around the world, tremendous opportunity continues to lie ahead as far as they need for more investment.

A look specifically at how the net ethylene exporting countries are around the world. Again, this is net ethylene equivalent trade, it is not just ethylene, but it is some total of the equivalent ethylene contained in the derivatives that are being traded. So, you see US, Canada and then the Middle East countries growing from 2010 to 2020 - 2025 to substantial quantities, and then the NAP based countries around the world that are also net exporters of ethylene derivatives, South Korea, Japan, Taiwan, Singapore, Thailand, really be more in a defensive position in terms of the net trade of these ethylene derivatives. So, ethylene-based derivatives want in fact dominate the trade market as we look forward, because of their low cost competitive position.

Finally, I will talk a little bit of the profit cycle overall market recovery is somewhat delayed because of the slower demand growth that we have seen in 2012, in 2013. Gas-based producers have really seen steady high margins, NAP based producers are really on more and more pressure. So, capacity additions could be somewhat moderated versus the current forecast influenced by capital cost in resource limitations. I commented earlier about readable additions as well that we may see going forward.

Let's have a look on profitability index we run across all of our based chemicals and plastics. The key message there is cyclicality in the industry, so these rose on all these based chemicals and our assumptions for cost and margin profitability going back from 1985 to our forecasts for 2020. We have got a sustained period of high profitability because of the dominance of really the ethane based, the gas-based

chemicals and their profitability that was seen in those chemicals in our forecast for energy to support that going forward. An example of this is shown in our integrated margins for polyethylene comparing the US-based producers cracking ethane or West European-based producers cracking naphtha. If you look historically, the margins were somewhat equal if you will. And then you see that the separation has started in the current 2012 and we predicted that separation will continue.

The other startling part about this is just the sheer size of those margins estimated in this case 45 cents per pound or 900 dollars per metric ton from an integrated ethane to polyethylene producer as seen in the United States. So, tremendous levels of profitability, more pressure on the naphtha side obviously, which is why we are seeing some of the news report that was seen across the European market in terms of plants being handed over, a close look at how we make these units much more competitive.

Trends in ethylene also impact propylene. I am to spend much time on it. It is the slides that you have seen in the deck on propylene, and also on the deck on benzene. And really, the key message there, is that the shift to lighter does impact propylene production, the change in the crude slate in North America will impact aromatics production across North America as refinery responds to that. We have seen the hydro units, we have seen other ways to make propylene. We have got issues in beauty lines so the co-products that we have relied on is not the crackers, they are all being impacted now for a couple of years, that would continue to be the story as this whole picture unfolds and quite frankly, it opens opportunities for new technology developments and opens opportunity for new players in these markets to come up with solutions of how we fill those supply gaps.

So again let me ramp up and I apologize running just a little bit longer, but in terms of conclusion, improving economic fundamentals are expected to enhance the pace of demand growth. Economic Megatrends are shifting demand to the developing world as opposed to the developed world. Unconventional feedstock's are playing a major role in terms of shaping the global industry. High-cost supply is reacting to more competitive pressure in stepping up rationalization or conversion capabilities. Supply demand dislocation increased the need for sound supply chain strategies. The logistics to export these products have to be in place in order to facilitate the investments that have been made upstream in energy and petrochemicals. We are seeing new competitors slowly emerge into the marketplace. The amount of foreign capital that is coming into North America that is interested in some type of position in shale energy where the petrochemicals related is ramping up rapidly and I think that beyond the next wave you may see even more new entrance coming into the marketplace. Unconventional resource owners enter the stage as far as various product offerings. And again, that first point that may leverage success is really defined by assigning the right cost for the right product and the right go-to-market strategies for the chains that you are involved in.

Again, thank you for the invitation to participate.