The Future of Energy

Ladies and gentlemen good evening.

Shravan - thank you for generous introduction

- great pleasure to have opportunity to participate in this program.
- following in footsteps of some great speakers.
- do my best to live up to them.

Energy provides heat, light, communication and mobility that everyone in this room takes for granted. It's fundamental to modern way of life and our very existence today.

If energy is not available in a modern developed democracy it's a political crisis.

Those of you following the news in Australia over the last couple of years will have seen exactly what I meant and a few weeks ago we saw what happens with a one hour power cut in the UK.

Indeed - as our world digitises reliable and secure sources of energy will become ever more important.

In the developing world - energy combined with education is the way in which you lift people out of poverty – it's been true for the last two hundred years and its true today.

To judge by popular press living through period unprecedented change in the energy industry - what some have dubbed the energy revolution.

- So is that true? What is really happening?
- How profound is the change? And how different might the future be ?

Three parts

1. The story so far - going back to 1982 the year I joined the energy industry to today – "energy industry veteran"
    - what's happened? - what's changed?
2. Current projections out to 2050 - based on Paris agreement -'business as normal' projections
3. What policies and technologies might enable a different future from the one we're currently predicting

1982 - year I joined the energy industry oil price was $75/bbl. That would be north of $200/bbl today. The popular view held by all the major oil companies was that peak oil supply would occur by about 2000. Everyone worried that the world was running out of oil.

When it came to climate change the world was more concerned about when the next ice age would occur than with global warming.

And this country had just lived through a decade of intermittent electricity supply - a consequence of industrial action on the part of the nationalised coal mining industry.

Global population was 4.6 billion people and around 2 billion lived without electricity.

Total global energy consumption was 7 billion tonnes oil equivalent.

It was a fossil fuel energy system - fossil fuels provided almost 90% of the worlds energy

Coal had powered the industrial revolutions in Europe and the US - and was just about to do the same for China.

Oil had powered the transport revolution that had made the world mobile and created the modern society that we all take for granted.

If we fast forward to today – what's changed ?

- Global population has increased by 40% to more than 7.5 billion people.
- Energy consumption has doubled to 14 billion tonnes oil equivalent.
- And still more than 1.2 billion people live without electricity.
- And a further 2.9 billion cook with biomass - that's firewood to you and I

Energy poverty condemns millions to darkness, ill health and missed opportunity.

It's Estimated Energy Poverty kills nearly 20 million people a year.

It's still a fossil fuel energy system. Fossil fuels today make up more than 80% of today's energy supply.

So what has changed ? And why despite all the noise and many billions of dollars invested has so little changed in terms of energy supply? And why do so many people still live without electricity?

Two big things have changed :

1. The world is no longer concerned about running out of fossil fuel energy.

- the debate in the oil industry is now about peak demand not peak supply - I'll come back to that later.

- and on current projections there is much more coal and gas in the world than we will ever consume.

2. The world is preoccupied by the threat of climate change induced by CO2 emissions from fossil fuels . It has become the unifying cause of our time - globally more politicians agree on this than on probably any other subject - although there are of course some notable exceptions!!

So given the unity of purpose why is it so difficult to effect change? What's getting in the way ?

Firstly – Scale.

Today energy industry invests around one trillion dollars a year globally and has been doing so for a long time. We live within an energy ecosystem of enormous scale and complexity that has been built up over the last 100 years

Secondly - Demand

Demand keeps on rising. Despite the enormous investment in renewable energy - it has simply failed to keep pace with demand growth - so whilst the percentage of fossil fuels has fallen the absolute numbers keep on rising. Last year the world consumed more coal, more oil and more gas than at any time in its history - and of course more renewables

Demand is driven by population growth - and more importantly a rise in wealth in the developing world - a trend that will continue through the middle of this century.

Xaio Wang story on demand growth .....

Thirdly - Government Policy

In their rush to demonstrate leadership on climate change many governments around the world and particularly in Europe and Australia have pursued disastrous energy policies.

Successive UK governments have been lamentable.

Australian energy policy has created an energy crisis in the country today - and Germany is perhaps the ultimate text book example of how not to do it.

Germany spent Euros 25 bn a year on renewable energy over the last few years, 90% of which consumers paid through a surcharge on their electricity bills, and by 2025 Germany is projected to have spent a staggering Euros 520 bn on the green energy transition.

1.7 million German houses have solar panels - installed at enormous cost subsidised by German taxpayers - that deliver less than 6.5% of German power. Not surprising given the weather most of the year in Germany !!

In wind they have been more successful - but of course wind is not a reliable source of power.

And at the same time driven by politics not economics they have progressively reduced their nuclear program. On current projections the last nuclear power plant in Germany will close in mid 2020's.

The net result is despite hundreds of billions of dollars of investment into renewable energy to reduce CO2 emissions - emissions in Germany are the same as in 2008

I would also note that despite the UK claims to have reduced emissions by 40% since 1990 - if you look at our imports then the real number is about 3% - in our case we've sent the problem elsewhere!!

By contrast the U.S., who never signed up to Kyoto, has not pursued a Federal government interventionist strategy of trying to pick winners to shape their energy future - has seen a significant transformation.

CO2 emissions in the US have fallen by almost 15% since 2005 as cheap gas - enabled by technology revolution in the oil and gas industry, the advent of fracking and shale gas - has replaced coal in their energy mix.

In transportation successive legislation has mandated ever increasing efficiency in the automobile sector.

The U.S. hasn't signed up to Paris but they will probably do better than most other developed economies in reducing carbon emissions over the next few decades as the world's most efficient capital market combined with the world's most technologically enabled economy deals with the problem with minimum "help" from the government.

Fourthly - Physics

Simply put fossil fuels are a fantastic source of energy

If you were going to design a source of energy from scratch you'd design fossil fuels.

- They're cheap - relative to anything else
- They're abundant and readily available
- They're reliable
- They're secure and easy to handle

So if it wasn't for the fear of climate change – no-one would be looking at other forms of energy today.

Turning now to the future - what are the projections looking forward ?

Energy consumption is forecast to increase by another 35% by 2050 as the world's population increases to more than 9 billion people and almost everyone gets access to electricity.

Assuming that governments implement their Paris commitments current projections for the energy mix in 2050 are :

- Gas 28%
- Oil 27%
- Coal 23%
- Renewables <10%
- Biofuels and waste 10%
- Nuclear 5%
- Hydro 2%

So even after governments spending billions of dollars of taxpayers money pursuing renewable or clean/green energy policies we're still left with a fossil fuel economy with fossil fuels making up almost 80% of the total energy mix and we will **not** have achieved the objective of limiting CO2 emissions to the extent that world scientists can declare we've mitigated the risk of catastrophic climate change.

What might be wrong with our projections ? Or perhaps how do we make them wrong and what is it that could make a difference ?

Let me start with transport and mobility.

Many of us who have been in the energy industry a long time feel that we may finally be approaching a tipping point when it comes to electric vehicles for personal use. In particular battery technology has finally evolved to the point where electric vehicles are viable.

All of the major automobile manufacturers are now aggressively pursuing the mass production of electric vehicles and over the next few years almost all of the mainstream automobile manufacturers will have a family saloon electric vehicle on the market

I believe many people in the room this evening will probably own an electric car within the next 5 -10 years - some of you probably already do.

It’s a change that's been driven by technology advances and consumer demand - not a government mandate - much as with this (iphone) manufacturers have come up with a product that consumers want - although today at a price many will not be prepared to pay - but that will change as prices
fall over the next few years

Having got to this point politicians are of course now rushing to issue mandates mostly with no idea what the consequence of those mandates will be.

This transition starts small - last year some 1.5 million electric vehicles were sold globally. To put that in context in the world’s two largest markets U.S. consumers bought 18 million vehicles and Chinese consumers 21 million. Total worldwide sales last year were about 85 million cars.

But over the next decade or so the transition to EV is going to create some interesting challenges for both the resource industry and the energy industry.

Most countries and most governments are completely unprepared for the transition that is being contemplated.

First on the resource side if, as predicted electric vehicle sales get to 30 million cars by 2030, it will increase demand for copper by more than 2m tonnes -in a global market of 23m tonnes - it equates to a new copper mine every couple of years - when today there are no new mines under construction.

It’s even more challenging when you look at metals for batteries.

The two key metals today are cobalt and nickel - the world consumes 100,000t cobalt/year - 70% from the DRC and half of that from one Glencore mine.

Using current battery technology cobalt demand is forecast to rise by 30% by the mid 2020’s. In the case of nickel we will need an additional 1mt in a global market of 2.5mt.

These are the types of challenges that the Chairman of Glencore, one of the world’s largest producers of copper, nickel and cobalt, is only too pleased to have !

The challenge to the energy industry is greater.

Not only will people need the infrastructure to be able to charge their cars - but think about the demands on the grid. We all get home from the office at 6-7pm and plug in the car to recharge overnight. The power demand surge will be astonishing.

It will make the old joke from the 70's and 80's about the power surge at 6pm when everyone puts the kettle on look rather tame.

National Grid recently acknowledged that as it currently stands the average UK street could handle no more than 3-4 cars charging at any one time!!

Not only that but where is the extra power required going to come from?

In many places it will come from fossil fuels mainly gas and coal - because they're available and cheap.

Difficult to see at least over the next decade or so how the EV revolution is going to do much with respect to climate change and CO2 emissions. What we gain on the swings we'll probably lose on the roundabouts. But it will make an enormous difference to air quality in many of the world's major cities and to the health of many people.

All of the challenges of the EV revolution are surmountable with technological development and investment but they are certainly going to take time. It's a lot harder to transition the world to EV than it was to go from fixed line to mobile phones. But it will happen - probably faster than many pundits are forecasting.

Over time it will have major implications for the oil industry. Most people in the industry now see demand for oil peaking in the late 2030's.
I suspect that date will only come forward as EV penetration accelerates and hybrid vehicles take on increasing market share.

And we need to put it context - the world consumes around 100mmbbls of oil every day and less than 50% is used for cars. The remainder is petrochemicals, jet fuel, heavy diesel, and marine fuel. So whilst demand may well peak it will probably be a long plateau followed by gradual decline.

Let me now say a few things on the future projections for power.

Here the world is faced with a paradox. On one hand we want low cost secure supplies of electricity. In many places best option on price and security is fossil fuels

On the other hand desire to limit CO2 emissions and progressively decarbonise energy mix. Today global power supply comes from:

- 39% coal
- 23% gas
- 16% hydro
- 11% nuclear
- 7% renewables
- 4% oil

At one level we appear to be making significant progress. Over the last few years more than ⅔ of all power additions globally were renewable - mainly solar - particularly in China. And the cost of renewables has fallen significantly over the last 10 years to the point where in some areas they are genuinely competitive with fossil fuels.

And yet renewables still only account for around 7% of total power supply - and as I said earlier more than a billion people still live without electricity.

In many instances we're confusing the desire to reduce CO2 emissions with desire to build a renewable energy system. They're not the same thing.

Given the current limitations of renewable technologies, they're intermittent and we have yet to crack energy storage at scale, the best way to tackle CO2 is to understand the cost of carbon abatement curve and invest along it.

Recognise that a ton of CO2 eliminated is a ton of CO2 eliminated, whether it's achieved through efficiency improvements, clean coal technology, solar PV or wind.

Today despite the Paris agreement we continue to see the massive misallocation of resource at a global level.

Why we're building a nuclear power plant at a cost of abatement of $150/t CO2 while India continues to build sub-critical coal fired power plants - based on 1970's design rather than modern super-critical coal fired plants that are more expensive and where the cost of abatement would be less than $5/t CO2.

And why is Nigeria denied the opportunity by the World Bank to build modern HELE coal fired power plants and instead relies on a grid that is too heavily dependent on renewables. This means it fails all the time so everyone has a back-up generator powered by diesel – one of the highest polluting ways of generating power.

So how should governments and policy makers think about the problem ?

Firstly

We need to focus on cost CO2 abatement - maximum CO2 reduction for minimum cost - be agnostic to technology and don't try to pick winners - a tonne of CO2 abated is a tonne of CO2 abated.

Clean coal in S.E. Asia and Africa - probably the biggest technology opportunity to reduce CO2 emissions globally in the near term. Most of S.E. Asia for a long time to come will be dependent on coal fired power. They should be both encouraged - and **required** - to shut down old coal fired power plants and to replace them with the latest HELE technology available that has a cost of CO2 abatement of $15-25/t.

Much greater focus on energy efficiency is also needed. Our own government has finally woken up to this.

Typical cost abatement <$10/tonne CO2 – it's the one area where governments really can make an impact - to be fair many have been effective in driving up the fuel efficiency of the world automobile fleet. They've been much less successful in driving efficiency in domestic power consumption.

Secondly

I believe it's time to introduce a carbon tax in the western democracies - they can afford it and they caused problem - > 50% all global emissions from US and Europe same basis China<15% and India <5%

We can debate whether the tax is at the point of production (ie paid by companies) or at the point of consumption (paid by consumers) but ultimately it will be the consumer who pays.

It's designed to change behaviour - a well designed tax can make a big difference in demand and the revenues used to further invest in CO2 emissions reduction.

Thirdly

Governments need to play to their natural advantages

Gas for coal - wherever it's cost competitive. That change in the U.S. has done more to change the trajectory of CO2 emissions in the U.S. than anything else.

If you have oil and gas infrastructure use it for carbon capture and storage -CCS in this country using the existing infrastructure in the North Sea would be far cheaper than Hinckley point or almost all of the offshore wind farms built to date.

Canada 1GW CCS reinjection into old oilfields

If you have access to low cost wind resource or long days of bright sunshine then of course you should take advantage of it - renewables are important where they are genuinely competitive. Costs continue to fall – they should play an important part in a diversified energy portfolio - large scale photovoltaic solar - biggest technology opportunity in 2H 21st C

In the case of nuclear – we should be clear it's a role for governments - costs, risks and liabilities are too great for the balance sheet of even the largest private sector companies - as EDF has demonstrated.

Fourthy

As we go through this transition governments should seek to build diversified and balanced energy portfolios

Japan 2050 - 25% clean coal, 25% gas, 25% nuclear, 25% renewables

What does this all mean for climate change ?

Depends where you start on the spectrum -climate change denier or Armageddon just around the corner. I suspect most people are like me - somewhere in the middle.

Need to take action - but measured and proportionate to the risk.

Important to recognise progress.

Rate Growth CO2 emissions slowed over last 4-5 years driven by :

a) Slowdown rate economic growth, mainly in China as its phase of rapid industrialisation comes to and end and becomes a more consumer driven economy

b) Increase in energy efficiency - particularly in the world's developing economies.

c) Cheap gas from the shale gas revolution replacing coal.

d) And renewable energy beginning to offset some of the energy demand growth

I am an optimist. Pace of technology development will continue to accelerate and cost of technology deployment will continue to fall and the world will learn from the mistakes of the last two decades and will gradually get the allocation of resources right.

Ladies and gentlemen I'm going to stop here - thanks for listening and I'd be delighted if we can have a lively Q&A.