

**Energy Institute International Conference  
September 13-14, 2018  
Hong Kong**

**Keynote Speech: Megatrends and the Energy Transition  
Malcolm Brinded, President Energy Institute**



Good morning ladies and gentlemen...

Asia holds a special place in my heart.

43 years ago, in 1975, I was posted by Shell to the Sultanate of Brunei in Borneo, 2,000km due south of here, where my wife Carola and I lived for 5 years.

As you can see, in parts of Brunei life had not changed much for a while - despite being a wealthy oil producing nation.



Here is my first project in the fabrication yard.

Of many changes in the oil and gas industry since then, safety is the most impressive. Today, this site would be shut down, given its lack of proper PPE and people aloft without scaffolding or harnesses. But in those days, we were too blind to the risks – and I shudder at some near misses I personally experienced during offshore construction.



Apart from that it was a great experience, with young engineers given amazing responsibility.

This was pre-email and even pre-fax. If we really had to, we communicated by telex; pink paper meant an incoming telex from the Hague - to which I would painstakingly draft a reply in big capital letters, for the telex machine operator to transmit. Maybe 1 or 2 telexes per week compared with today's email avalanche!

Here is the largest project I worked on - still there 4 decades later. It was all a terrific opportunity for someone straight out of University.

I would just ask if we give young people today enough early challenge and responsibility?

You might assume the global energy system has been transformed since those 1975 days, but actually it's much less than you'd think.

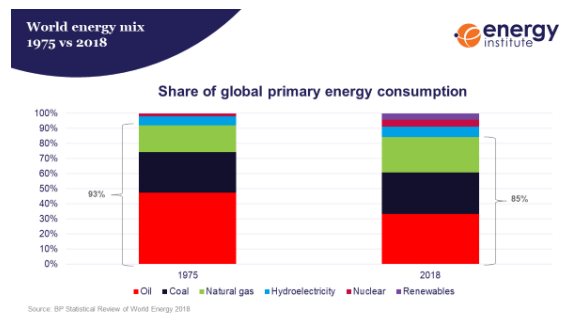


In 1975, coal, crude oil and gas accounted for 93% of the world's energy sources. Neither solar nor wind power were significant.

That is changing very rapidly: indeed the new renewable power of 157 GW added globally in 2017 was astonishingly more than twice the 70 GW of net additions from ALL fossil fuel sources. (source: UN report)

But look – for all that focus on renewables, the overall global primary energy mix in % terms of the total is remarkably little changed from 40 years ago!

Note that 2 and a half times as much energy is consumed now – AND well over 80% of it is still from fossil fuels, because the transition to a low carbon world in transport, heat and industry goes much slower than in power.



What happens in the future depends greatly on Asia - and especially on China. Because corporations here in China are now so massive in the global economy. So let me explore the megatrends that will shape China, Asia - and the world!

I first visited Hong Kong in 1976, and after a year in quiet Brunei, what a shock it was! For here was a booming megacity. It gave me a taste of the challenges of sustained population growth and rapid urbanisation - global megatrends today bringing unprecedented implications.



The pace of this growth in population and urbanisation creates a huge need for *more energy* and *more transport* – which exacerbates the pressing challenges of *climate change* and *air pollution*.



Yet we cannot just press “pause” - as there are still billions of people without meaningful access to energy - and billions more for whom urban transport today means misery, and their health and lives put at risk.

These challenges are existential for individuals and huge for the planet.. But I am an optimist – and believe that humankind has the capability to resolve them. With technological disruption in our energy and transport systems at the heart of those solutions.

Let’s look at the first megatrend...

The world’s population has more than doubled since I went to university - and will hit ten billion in the second half of this century, up from 7.5 billion today.

The best cause is that we are living longer. Globally, babies born now can expect to live over 71 years.

And here in China, average life expectancy is over 76 [source: WHO] - up by an astonishing 32 years since 1960.

Why has this been possible?

Because global hunger has dropped 40% in just 25 years, and infant mortality has halved. And because vaccinations and drugs keep at bay former killers such as polio, TB, malaria and HIV. In short, this astonishing progress is down to major advances in *nutrition and medicine*.

But, enabling these is the sustained increase in global wealth - and driving that has been a huge increase in access to energy.

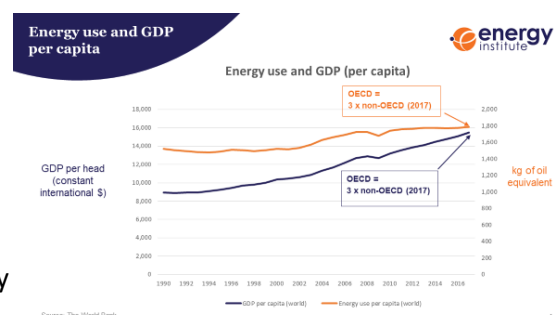
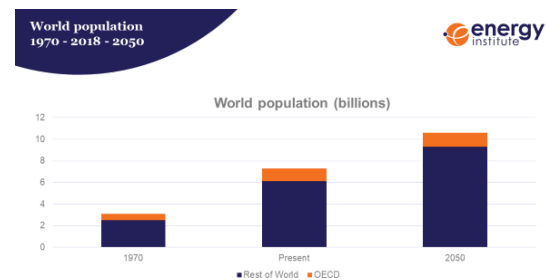
See here: average global GDP per head in real terms is up by 75% since 1990. That means that world average man and woman is effectively 75% wealthier in less than 30 years.

It has only taken 17% more energy per person to drive that 75% increase in wealth. A tribute to energy efficiency improvements.

But such global average data is deceptive, and hides the huge inequalities that persist. So let’s look behind it, at the boxes on the right.

In the rich 36 OECD nations, average wealth per head is still about 3 times that of the 150 non OECD countries, and energy use per head is still 3 times as much.

With energy use per person now falling in the OECD, it’s what happens in those other 150 countries which defines the global future.



Those non-OECD countries will together grow their population by 30% by 2040 – to nearly 8bn people in 2040 – and they will need much more energy - as billions more become middle class consumers of power, heating, washing machines, motor bikes, cars, and air travel.

Indeed by 2040 their increase in energy needs is the equivalent of adding another China PLUS another India to today's global demand [Source IEA World Energy Outlook 2017].

Yet, even then, their per head energy usage will still be less than half that of OECD countries today.

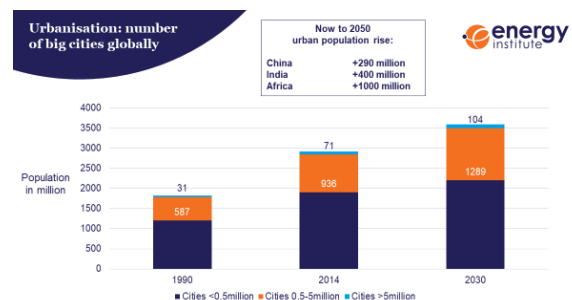
So the wealthy OECD should never deny such advances to the less privileged – and we must never forget the benefits that access to affordable energy delivers:

- It is the bedrock of economic and social development.
- Be it for jobs, food production, clean water, or increasing incomes - energy is essential, but still far from universal .

Finding affordable pathways to provide energy for all is crucial..

Access to energy is particularly a chronic rural problem. Perhaps it's one reason why so many move to towns and cities in massive numbers.

Look at the middle column in this global slide. Nearly 3 billion people today live in cities, up 60% in one generation. The top blue slivers show the number of cities of over 5 million people has more than doubled to 71 in that time, and the orange and blue together show we add some FOUR HUNDRED more cities of over half a million people by 2030.



Overall, the world urban population adds one Shanghai *every four months* (source WEO 2017).

This unprecedented urbanisation brings huge stresses.

Here in China, in just 30 years, nearly 500 million people have moved into cities from rural areas, and a predominantly rural country has already become nearly 60% urban. [Source: [McKinsey](#)].

China has tackled this challenge uniquely well, especially in building the necessary infrastructure - with some incredible engineering feats on many fronts, such as high speed railways.....

And this wonderful \$20 billion Hong Kong-Zhuhai-Macau bridge, the world's longest sea-crossing bridge, and a terrific new "umbilical cord" between here and mainland China.

But rapid urbanisation globally brings greater energy demand and adds to climate stresses, and in most countries is triggering dangerously high air pollution levels, and severe transport congestion.





India, has already seen its urban population double in 30 years, to nearly 600 million.

And this isn't just an Asian challenge. If Nigeria's urban population keeps growing at current pace, Lagos would become the world's largest metropolis, home to a staggering 85 million people within the next 60 years (source: [journal article](#) and [Guardian](#)).



This brings huge challenges to provide enough water, sanitation, homes, hospitals, energy and transportation. Yet already the world struggles:

In sub-Saharan Africa over 250mn people live in urban slums.

In Delhi, the level of particulates is over 15 times World Health Organisation limits

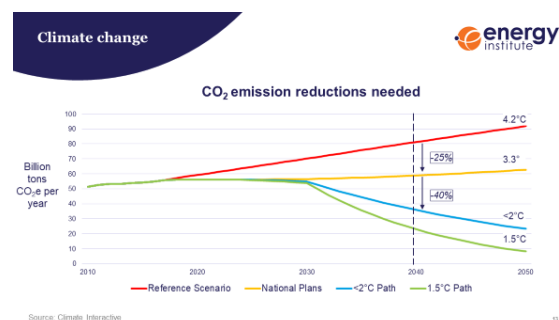
And the huge downsides from lack of infrastructure hit the poor the most.

So providing affordable cleaner energy for the **urban** poor is just as pressing – and as difficult – as for the rural billions.

The third megatrend to focus on is climate change.

This affects us all. From heat records throughout Europe and deadly heat this summer in Japan, to massive fires in Portugal and California, to the continuing Arctic ice retreat.

To be a climate-change denier is the equivalent of being a modern-day 'flat-earther'.



The Paris Agreement at COP 21 was a historic moment – committing to the goal of keeping temperature rises well below 2°C, and striving for 1.5°C. Critics will highlight that it has no teeth – but it was a huge step forward.

The National commitments since made - and shown in yellow - should deliver 25% reduction in emissions by 2040, but need stringent measures to reduce growth in energy demand and decarbonise, everywhere.

This means not only very fast expansion of low carbon power - such as solar, hydro and nuclear - but also massive reductions in the CO<sub>2</sub> intensity of transportation.

But even these pledged carbon reductions are inadequate.

If all nations meet their Paris pledges per the yellow line, it will still leave us tracking for a temperature rise of at least 3 degrees.

We would need an extra 40% reduction in emissions to get to 2 degrees.

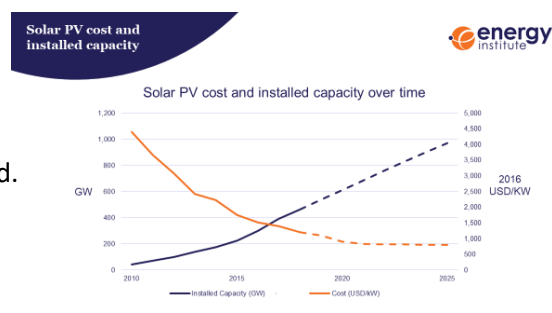
So we need to run much faster. Reducing the carbon intensity of heating and air conditioning as well as of power. Finding low carbon transport solutions not only for light vehicles - but also for freight, shipping and aviation. Tackling emissions from industry, especially from cement and steel, and from agriculture. And finding routes to significant negative CO<sub>2</sub> emissions - requiring large scale carbon capture and storage.

But I said I'm an optimist. And I do think that a 2 degree world is possible.

That's partly because of the astonishing progress made in all types of energy, unlocking new and unexpectedly low cost supplies right around the world.

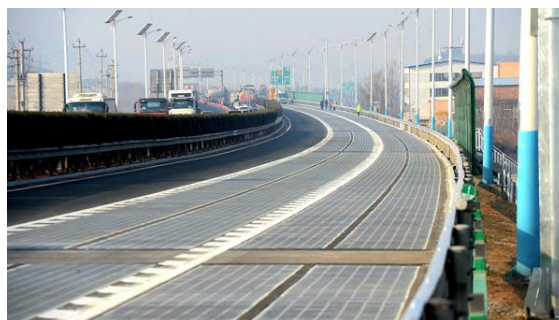
Take solar, where costs are tumbling globally.

The orange line shows Solar PV module costs are down 77% since 2009, driven largely by China and Japan who together installed almost 90 GW between 2014 and 2016 alone (source IRENA 'Renewable Power Generation Costs in 2017')



And as the blue line shows shows, huge capacity growth is predicted globally as the price continues to drop.

Here in China, the state is now the largest investor in solar energy, and driving many innovations, like this trial solar freeway in Jinan, Shandong Province, developed by Chinese company Pavenergy, in partnership with state-owned Qilu Transportation.



Even ahead of solar, onshore wind is now the cheapest form of generation in many countries such as China, but only where space, planning constraints and neighbours allow it.

Avoiding such constraints is offshore wind, where in the UK auction prices have more than halved in just three years - and are approaching grid parity around the North Sea.

This is the UK's current largest offshore wind farm – the London Array.

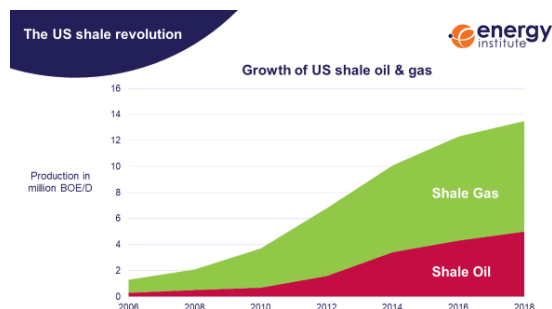
Hornsea Project One will start-up in 2020 as the world's largest offshore wind farm, 70 miles offshore and with a 1.2GW capacity.



Solar and wind both show astonishing cost reduction and growth rates.

But for the energy revolution of our lifetimes, US shale has to be the current winner.

In just 10 years, US shale gas output shown in green increased by a factor 13 and now produces the energy equivalent of over 8 million barrels of oil per day. And shown in red, US shale oil has added another 5 million barrels per day mostly in the last



6 years.

Together, this is a massive and unexpected energy windfall for the US and the world. The equivalent of ALL the current power consumption of India, plus Africa, plus South America combined. Just astonishing!

But – as our Energy Institute Future of Gas report said this year, if natural gas is to have a long-term future - especially displacing coal as we decarbonise - more needs to be done during production and distribution to reduce leakage of methane, a greenhouse gas some 30 times more potent than CO<sub>2</sub> over 100 years.

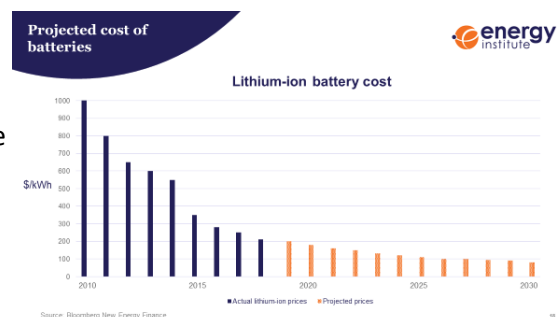
The good news is that this could mostly be done at net zero cost and with available technology.

So: Solar, wind, and shale gas have all shown simply remarkable progress in just a decade.

A key next step in the energy transition will be to radically improve energy storage.

There is a huge prize here, with the global small-scale battery storage market alone estimated to be worth \$250bn by 2040.

The growth in power storage will not be a one-horse race but lithium-ion batteries will likely dominate the EV market, and costs are forecast to continue falling dramatically, as this graph shows.

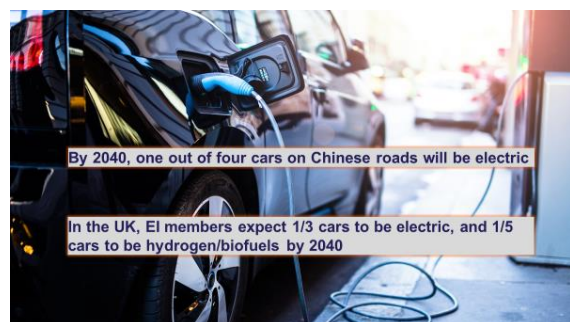


Such dramatic technological progress - across solar, wind, shale and battery technology – are enormous windfalls for the world, and will transform billions of lives in the next 20 years, helping us meet the challenges of population growth, urbanisation and climate change.

Another urbanisation downside is air pollution - the cause of one million excess deaths per year in China alone – and the electrification of vehicles will be a massive, positive transformation to help address this..

China is leading in its response, producing 680,000 all-electric cars, busses and trucks in 2017 – more than the rest of the world combined.

Indeed, the IEA predict that in just over 20 years, 1 in 4 cars in China will be electric vehicles. And in the UK the Energy Institute's members are even more positive, predicting a third of UK cars to be electric by 2040, as well as a fifth to be powered by hydrogen or biofuels.



Such *cleaner* energy technology will be increasingly crucial to meet future demand growth.

Take solar energy where, because of tumbling costs, a three-light household bright solar system in Africa now costs less to buy in just one year than the kerosene bill for one lamp.

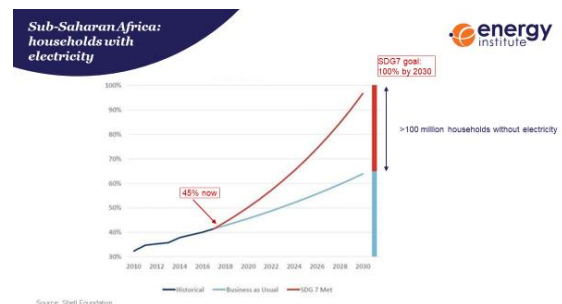
I'm a Trustee of the Shell Foundation, which supports over 50 companies such as D.light – who design, manufacture and distribute affordable solar power products to low-income households in Africa and India.

Yet, despite many great examples, I am surprised at how little money goes into early stage research and development to tackle such big problems – and especially that many innovators cannot attract enough patient risk capital to get smart new ideas developed, piloted and brought to market at scale.



energy institute

So it's clear that we need to do much more to support clean energy technologies at an early stage, by properly focusing research, and nurturing technology-based start-ups. Just look at the challenge of providing access to affordable energy in Africa.



After all the rhetoric of Paris, and the positive blurb about helping Africa – there are still likely to be over 100 million households without access to power in 2030 – that's over half a billion people! What an indictment of a civilised world!

But this is far from an insuperable problem.

To hit the red line on this slide and give everyone in Africa access to electricity needs about \$33 bln over the next 12 years – of which 85% could be normal debt and equity finance, so leaving less than \$5 billion to come from grant. By the way - that's less than half the annual cost of the ice cream eaten in China.....

Just as the energy sector faces massive change, so more generally the world is entering an even more disruptive transition.

This is the so-called 4<sup>th</sup> industrial revolution, where the Internet of Things, robotics and artificial intelligence will not just improve productivity, but permeate the whole global economy from finance and defence to transportation and energy management.

This revolution will transform all our lives and the world of work as we know it.



This is Tesla in California, where robots each do four activities - like welding, riveting, bonding and installing components.



As routine tasks are automated, businesses increasingly employ only those people that really add value: who can reason and create, and who are highly skilled.

Think of farming - as it transforms from widespread low-wage low-skill employment...



...to large scale mechanisation and automation, with far fewer individuals with the technical skills – commanding much higher salaries.

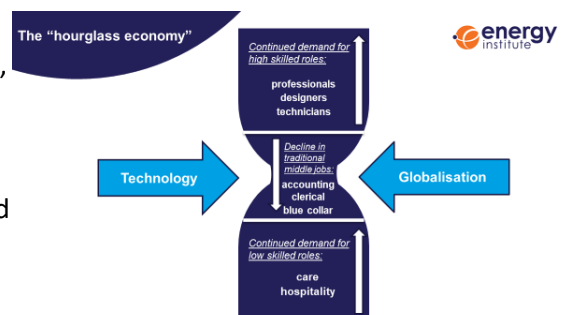
Or take your local garage - where cars need fixing far less often - but now need good electronic and programming skills, and not a large spanner.



This is called the “hourglass” effect on the workforce - meaning major reductions in the number of workers needed with mid-grade skills.

It also places a much greater emphasis on education, training and lifelong learning.

Which is why organisations which support that agenda - such as the City University of Hong Kong and the Energy Institute - play such an important role..



The EI is for people in energy. People who keep the lights on, the gas flowing, the forecourts full of petrol - and who develop the new energy technologies helping us tackle climate change and getting energy to the world's populations.

We're here to help energy be **better understood, managed and valued.**

We work for corporate members, to help raise standards and guidance right across the energy spectrum from oil and gas to smart energy management. Knowhow that is leveraged globally – in 120 countries and counting.

We work for individual members, through academic study to professional recognition, and lifelong learning. Developing the skills they need to do their jobs well.



We support companies to increase their diversity, so that our industry doesn't exclude itself from large parts of the talent pool.

And we work to enlighten the energy transition, so that our Members - with deep, global expertise - can better support evidence-based policy making...

...in contrast to the policy-based evidence-making, prevalent in this world of fake news.

That's why it's so uplifting to be in Hong Kong, seeing such a vibrant and exciting branch:

from launching this ambitious conference, to supporting Certified Carbon Auditor training, to your Young Professional Network, ensuring the talent of tomorrow has a vibrant forum to discuss the energy concerns of today.

Ladies and gentlemen: The EI serves all the ingenious men and women who want to better understand, and contribute to, the extraordinary energy system on which we all depend.

Thank you for your time today and I look forward to your questions, and to a thought-provoking next two days.



# Global megatrends and the energy transition

6<sup>th</sup> International Conference: meeting the challenges of energy transition through multi-disciplinary collaboration

13 September 2018

**Malcolm Brinded CBE FREng FEI**  
President, Energy Institute



[www.energyinst.org](http://www.energyinst.org)



Brunei, 1975



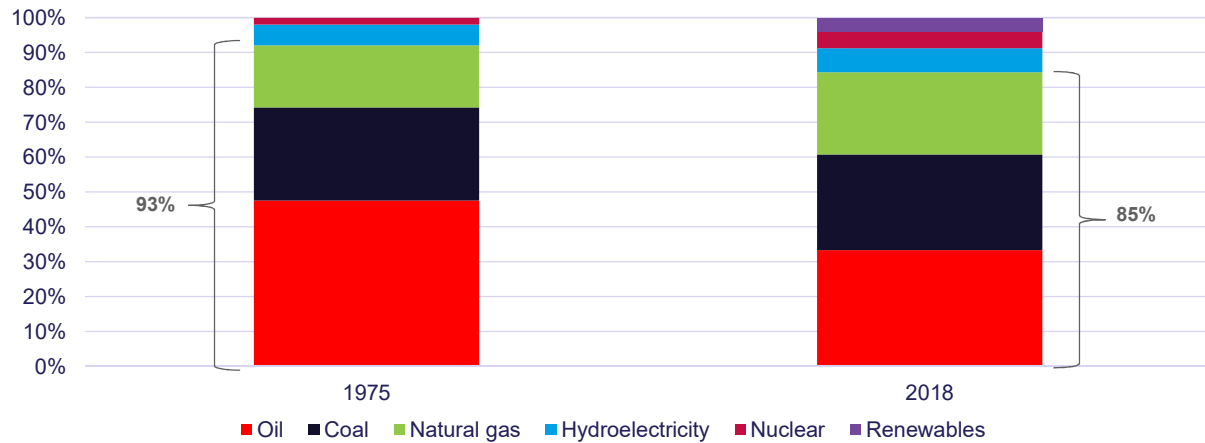




## World energy mix 1975 vs 2018



### Share of global primary energy consumption



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## Global megatrends



### Growth:

- Population
- Urbanisation
- Energy and transport

### Challenges:

- Climate change
- Air pollution

### Technology disruption

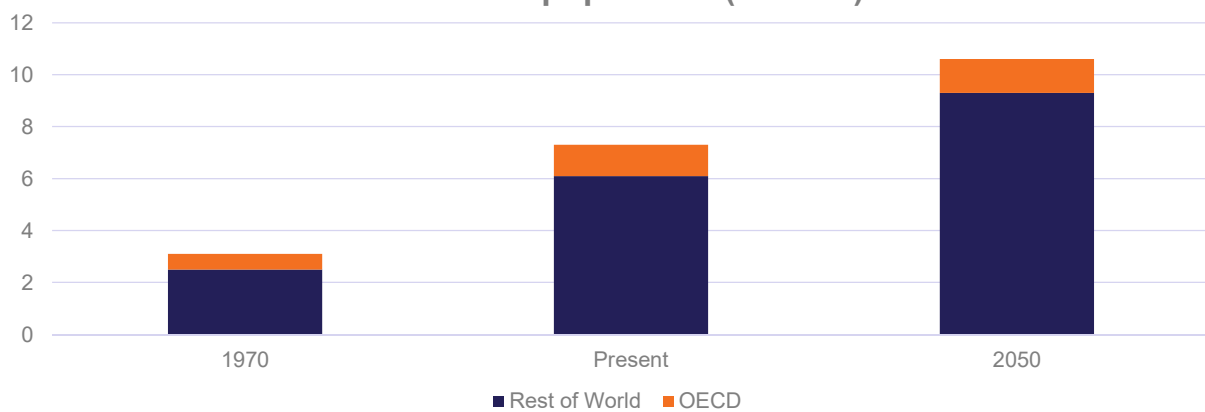


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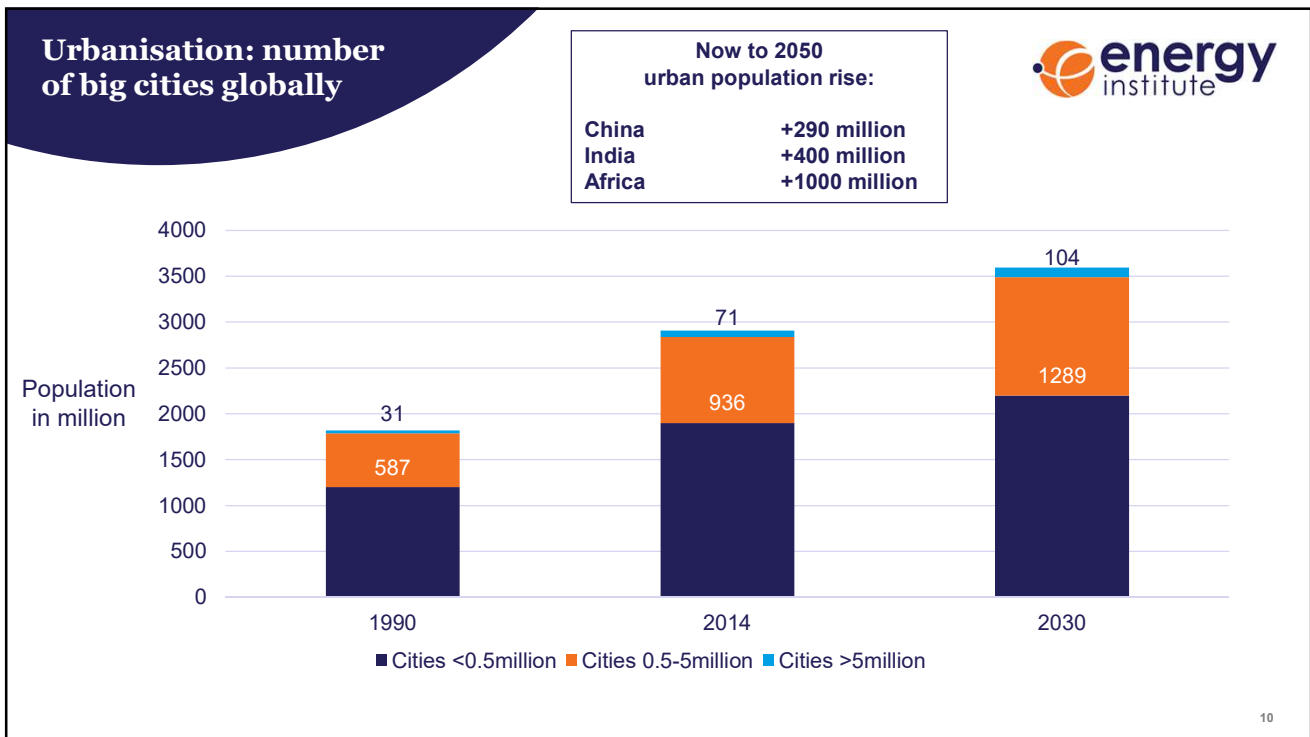
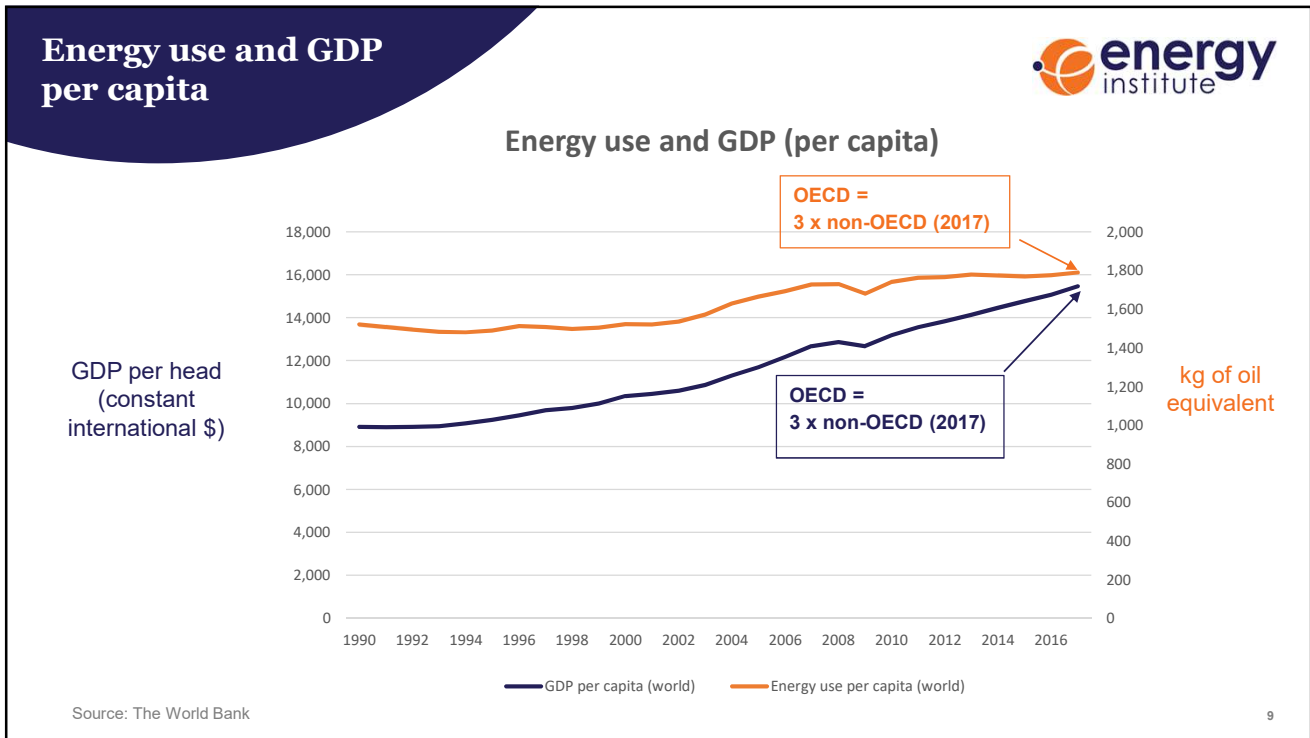
## World population 1970 - 2018 - 2050



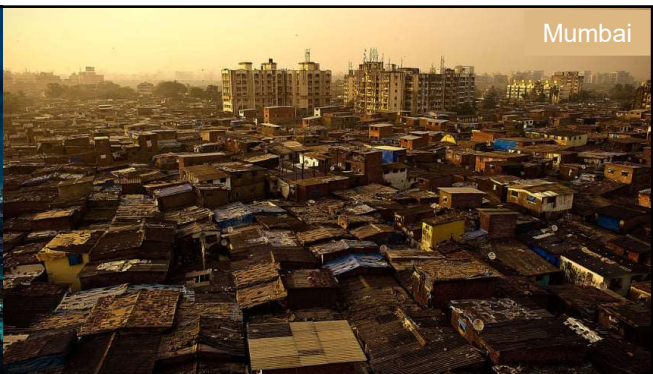
World population (billions)



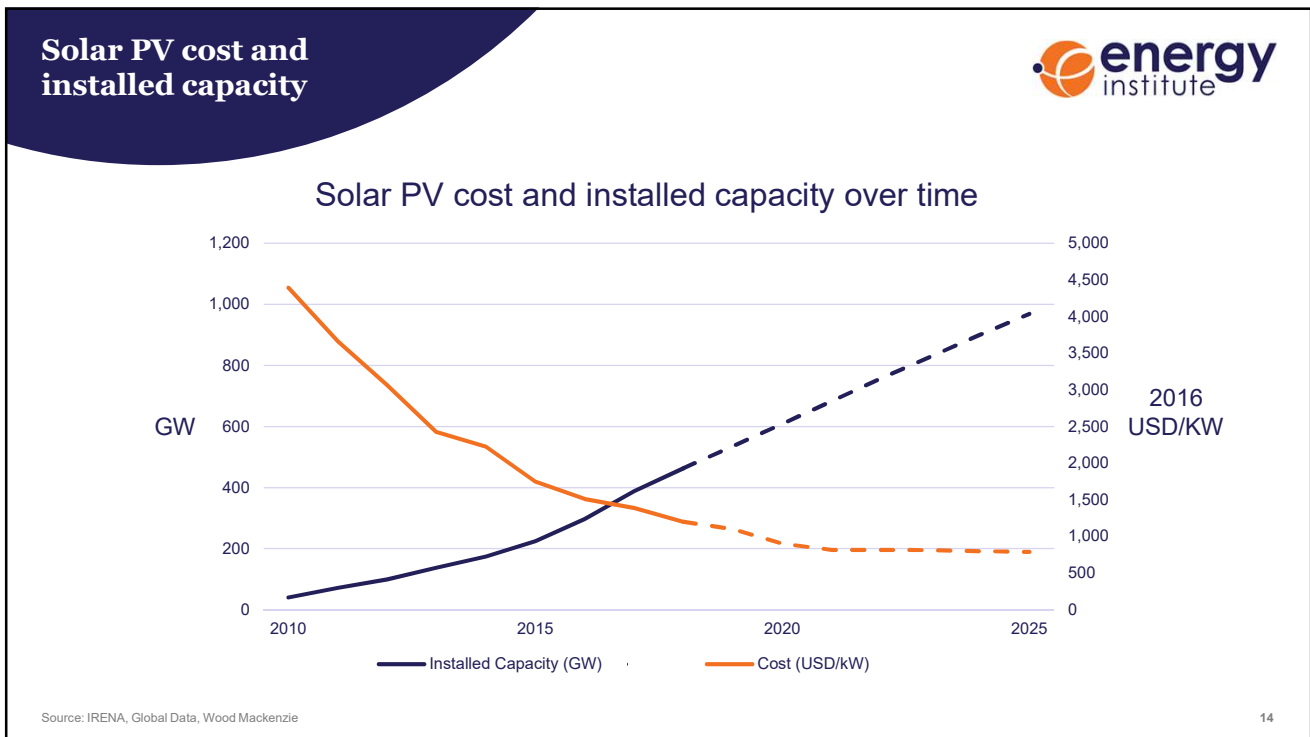
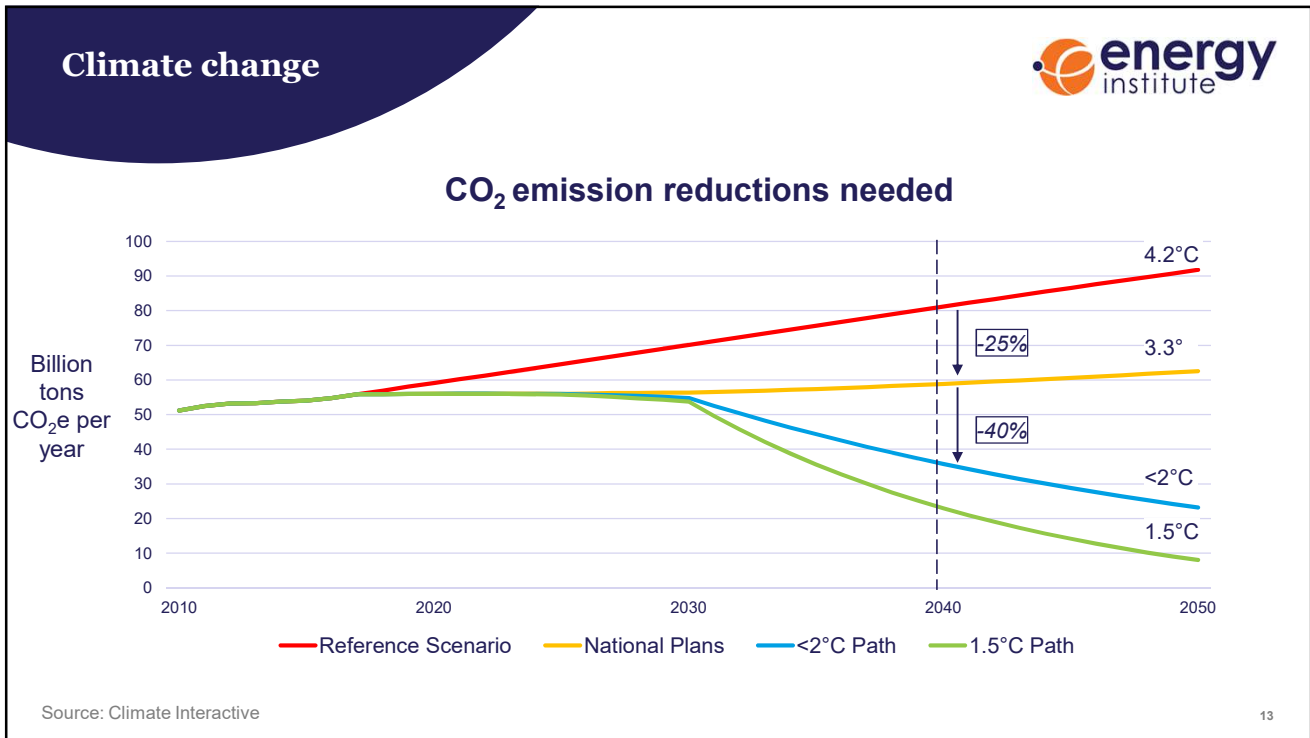
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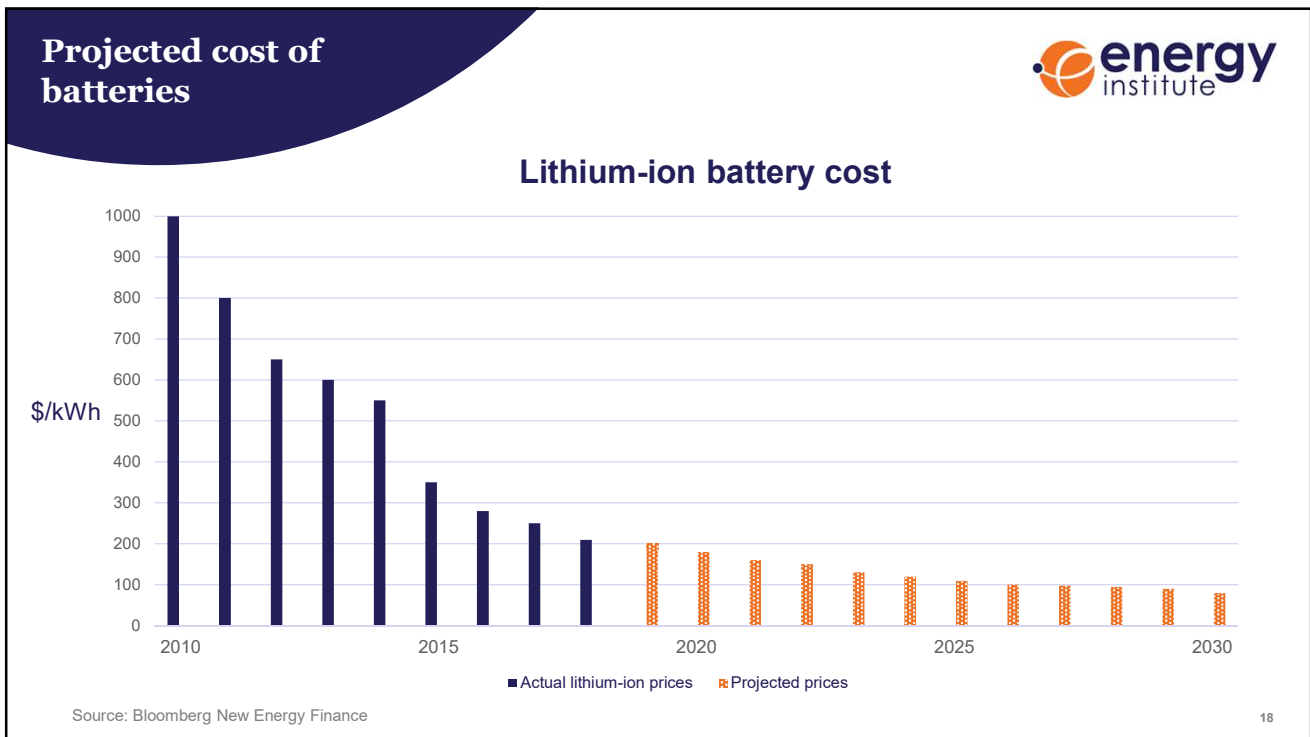
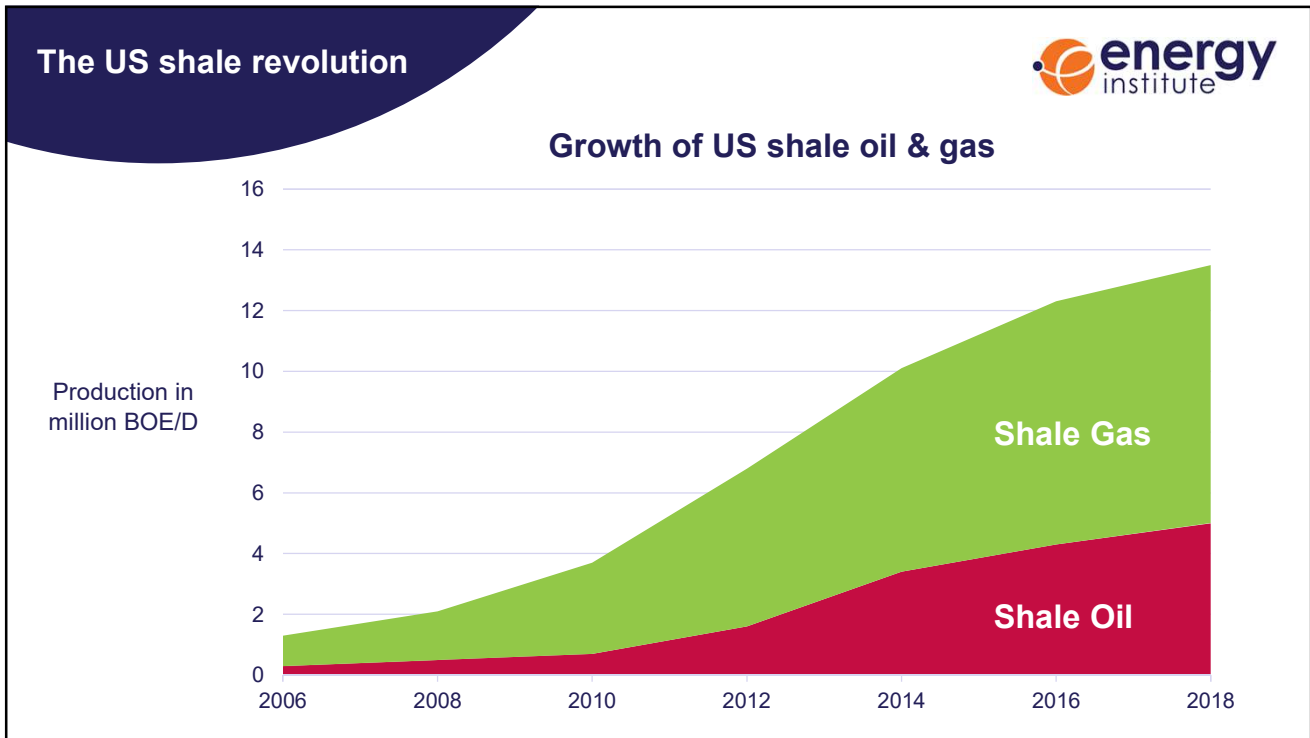


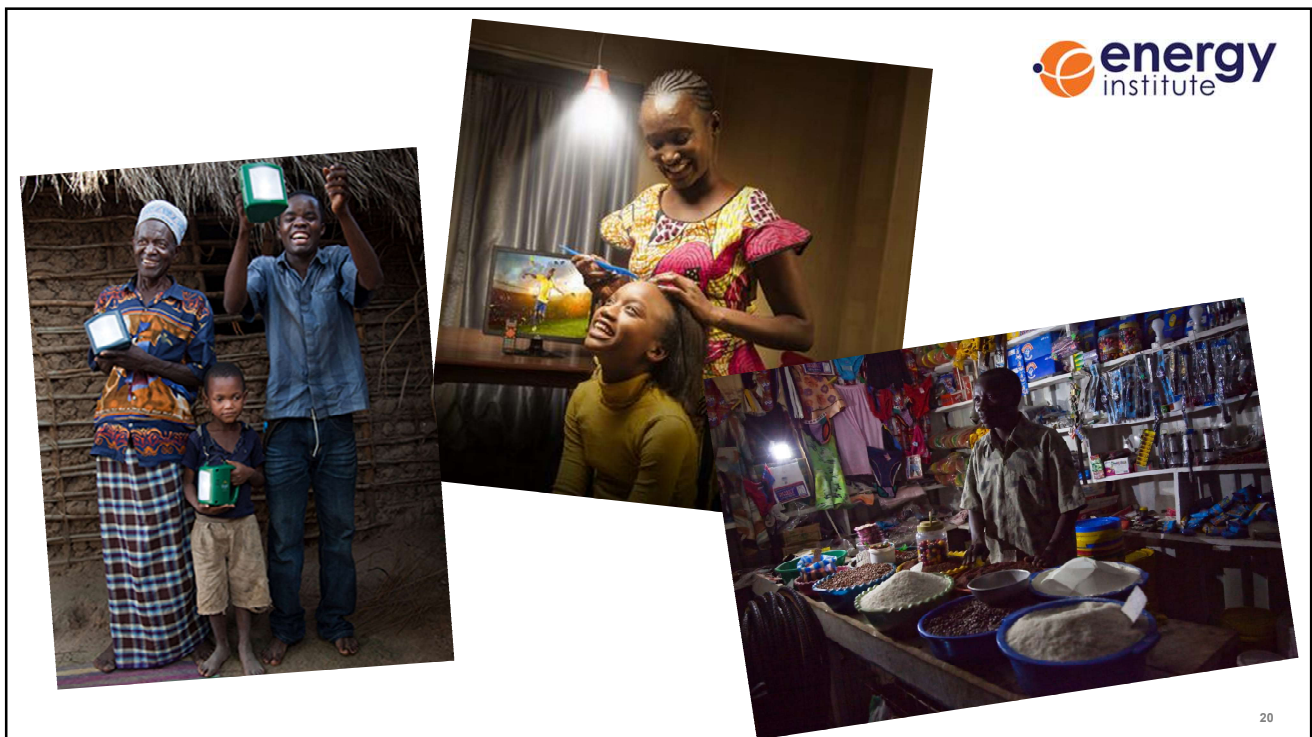






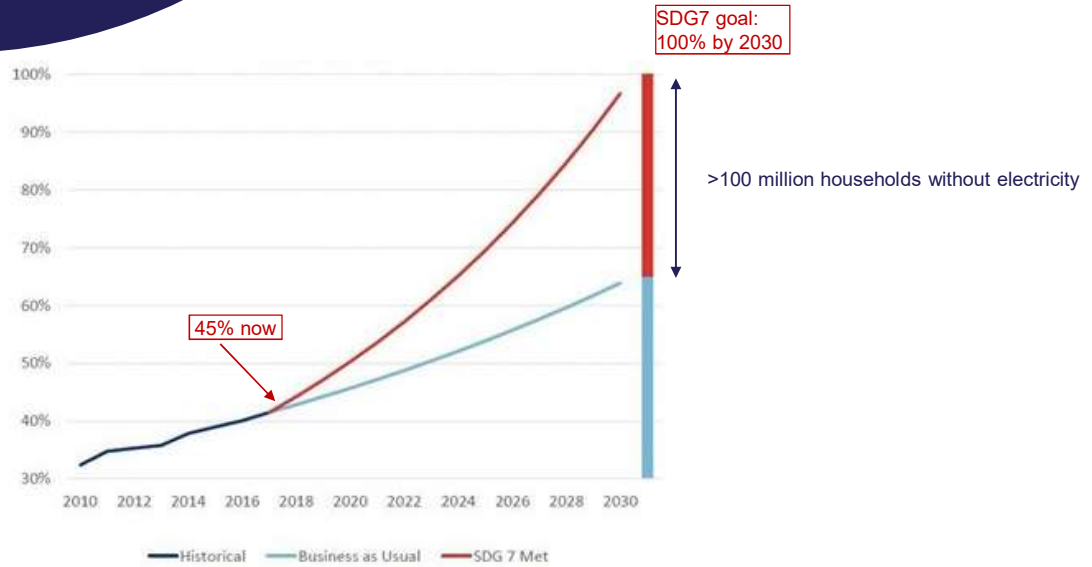






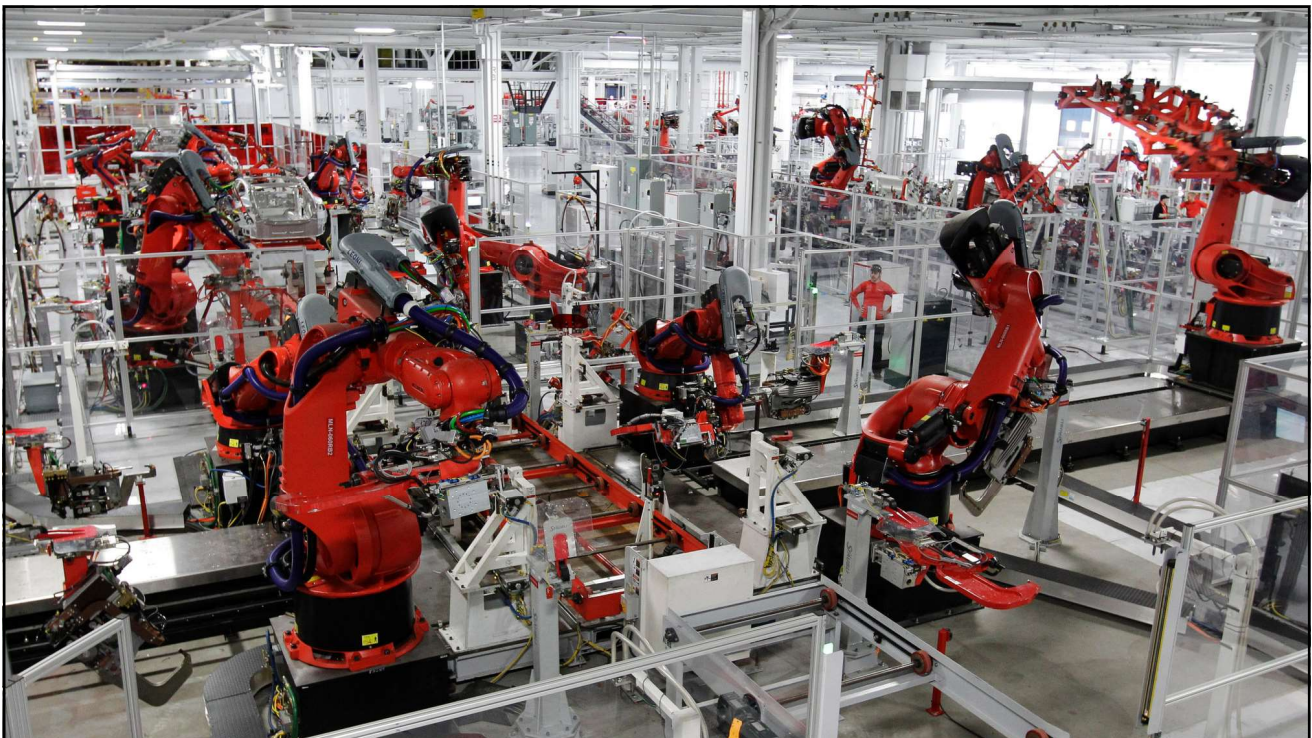


## Sub-Saharan Africa: households with electricity



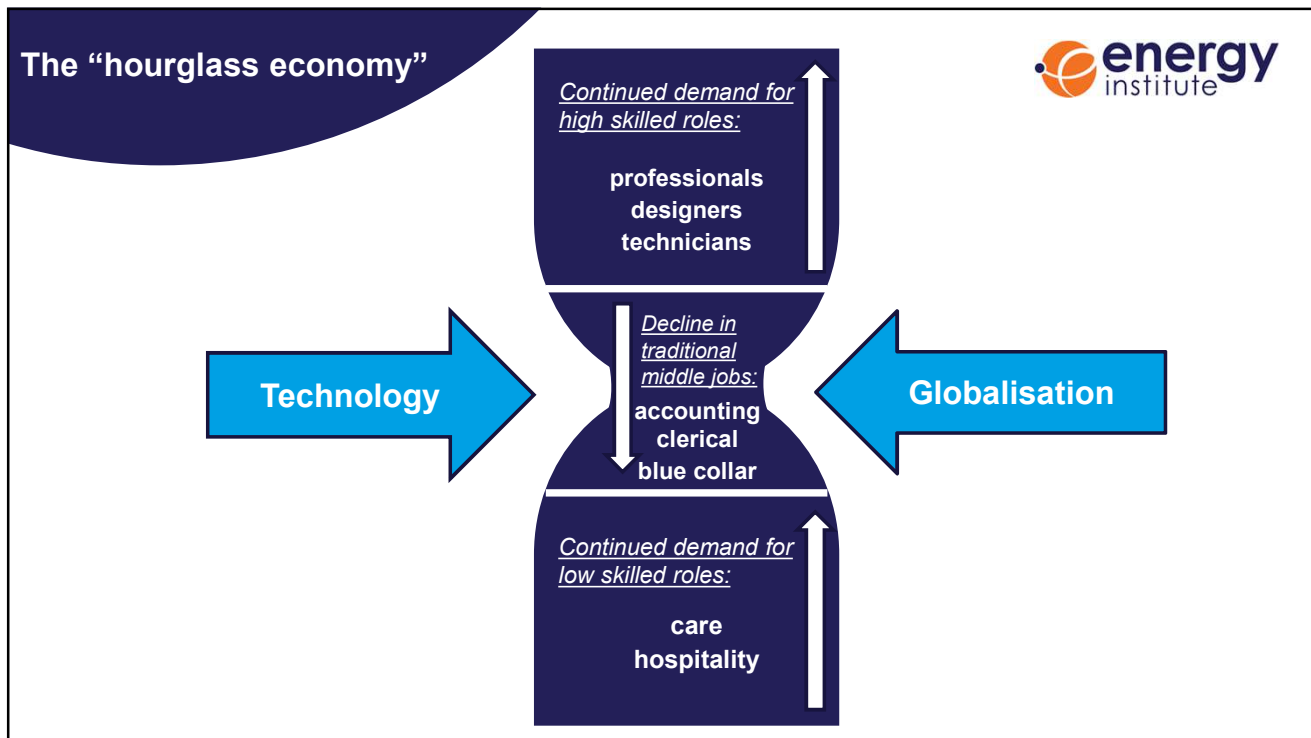
Source: Shell Foundation

21









**Role of the EI**

That energy is better **understood, managed** and **valued**.

- **Better understood:** by raising standards and good practice
- **Better managed:** by developing skills and competence
- **Better valued:** by advancing knowledge and understanding

26