



Australian Government

Department of the Environment and Energy

The role of fossil fuels in a significantly carbon constrained world: Insights on the implications for energy security and the economy

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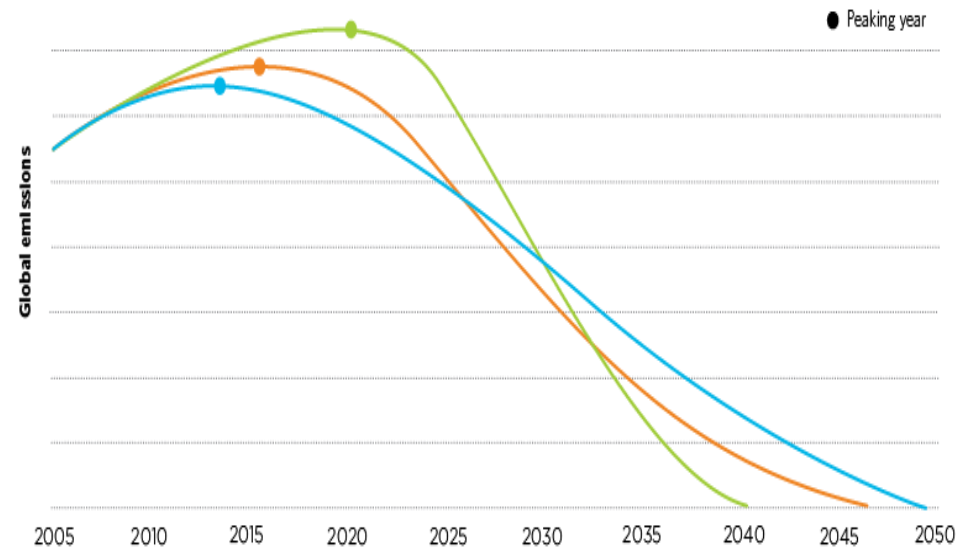


A global energy transformation is underway...

...let's assume the world commits to action on climate change consistent with the objectives of the COP21 Paris Agreement

- Objective – to limit the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the increase to 1.5°C
- To achieve a 50-50 chance of holding global warming to 2°C, global annual emissions need to peak sharply around 2020, fall steeply by 50% before 2040, and be close to net-zero towards the end of this century.

Stylised emissions trajectories resulting in the same cumulative emissions



The role of fossil fuels in the global energy mix as the world transitions to lower emissions

“When one has just tea leaves to guess the future, there is no tool to advance knowledge” - Professor Sergey Paltsev, MIT

- Scenarios based on long run energy projections give “plausible” insights
- IEA, BP and Shell scenarios show a wide range of pathways are available for the world to transition to the emissions reductions consistent with meeting the Paris Agreement’s objective
- Scenarios generally agree that:
 - World population continues to grow
 - The world economy and energy demand continue to grow
 - Energy intensity and carbon intensity decline at an unprecedented rate

The role of fossil fuels in the global energy mix as the world transitions to lower emissions (cont.)

Decomposing carbon emissions using the Kaya identity...

$$\begin{array}{ccccccc}
 \Downarrow & & \Uparrow & & \Uparrow & & \Downarrow & & \Downarrow \\
 \text{Carbon emissions} & \equiv & \text{Population} & \times & \frac{\text{GDP}}{\text{Population}} & \times & \underbrace{\frac{\text{Energy used}}{\text{GDP}}}_{\text{Energy intensity}} & \times & \underbrace{\frac{\text{Carbon emissions}}{\text{Energy used}}}_{\text{Emissions intensity}}
 \end{array}$$

- The role of fossil fuels, will depend on the opportunities available for them to significantly reduce both energy intensity and the carbon intensity consistent with the required trajectory for emissions reductions
- General agreement across projections that over the transition period average growth in the annual demand for gas is positive, and that for both coal and oil is declining.

The role of fossil fuels in the global energy mix as the world transitions to lower emissions (cont.)

But, there are key demand uncertainties for coal, gas and oil...

Fossil fuel	Critical demand uncertainties
Thermal Coal	↑ Economic carbon capture and storage solution
	↑ Penalties for lower quality coal supply/minimum quality standards for power generation
	↓ Switch from coal to gas in power generation
	↓ Renewables capacity additions for power generation
Metallurgical Coal	↑ Penalties for lower quality coal supply
	↓ Increased rate of steel scrap collection
	↓ Materials substitution
Gas	↑ Switch from coal to gas in power generation
	↑ Economic carbon capture and storage solution
	↑ Increased use of gas in transportation
	↓ Energy conservation in buildings and industry
	↓ Renewables capacity additions for power generation
Oil	↑ Higher level of economic activity and disposable income
	↓ Energy conservation in buildings and industry
	↓ Energy efficiency in transport
	↓ Increased adoption of electric vehicles

The continuing need for fossil fuels as the world transitions

It is reasonable to expect that fossil fuels will continue to play a role in the global energy mix...

- The scale of investment is massive if the world is to completely transition away from fossil fuels:
 - IEA WEO 2016 – to achieve an outcome similar to that of the Paris Agreement:
 - USD40 trillion of investment in energy supply is needed to move away from and dramatically reduce emissions from fossil fuel
 - USD35 trillion of investment required for improvements in energy efficiency
- Without major technological breakthroughs the challenges in some sectors of the economy to shift away from fossil fuels are too great:
 - Heavy industry sectors, such as steel and iron production
 - The transport sector with respect to long distance heavy freight, shipping and air.

The implications for energy security and the economy

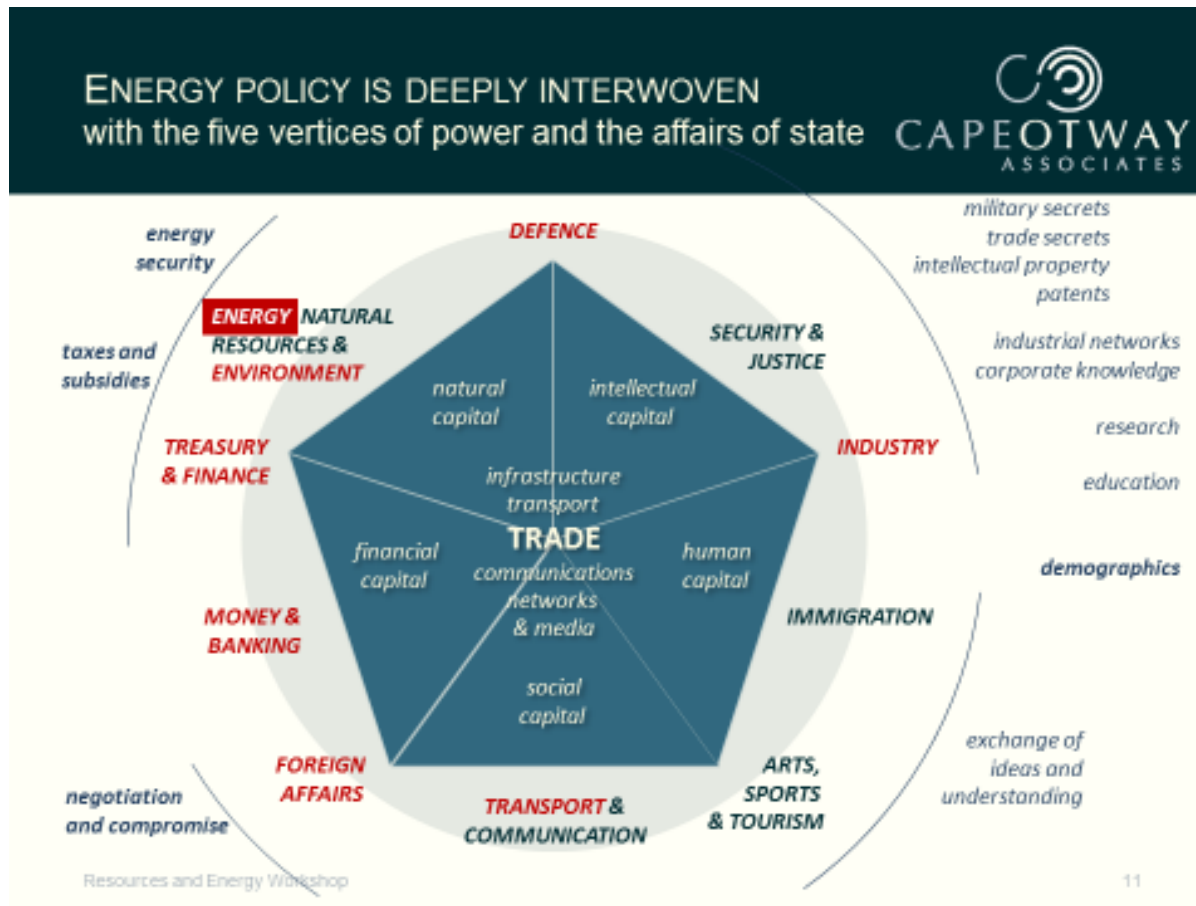
Deriving meaningful insights is not easy, but that doesn't mean it is not useful to try...

“If history is any guide, energy scenarios overestimate the extent to which the future will look like the recent past... The need for low-emitting technologies will shift the current technology mix, but the exact contribution of particular technology and the timing of this shift depend on many economic and political variables... [S]cenarios are unlikely to be successful at producing precisely definitive estimates, but they can be used as a qualitative analysis of decision-making risks associated with different pathways. We should recognize the energy system is complex, interconnected and affected by economic drivers.”

S. Paltsev (2016). *Energy Scenarios: The Value and Limits of Scenario Analysis*.

The implications for energy security and the economy (cont.)

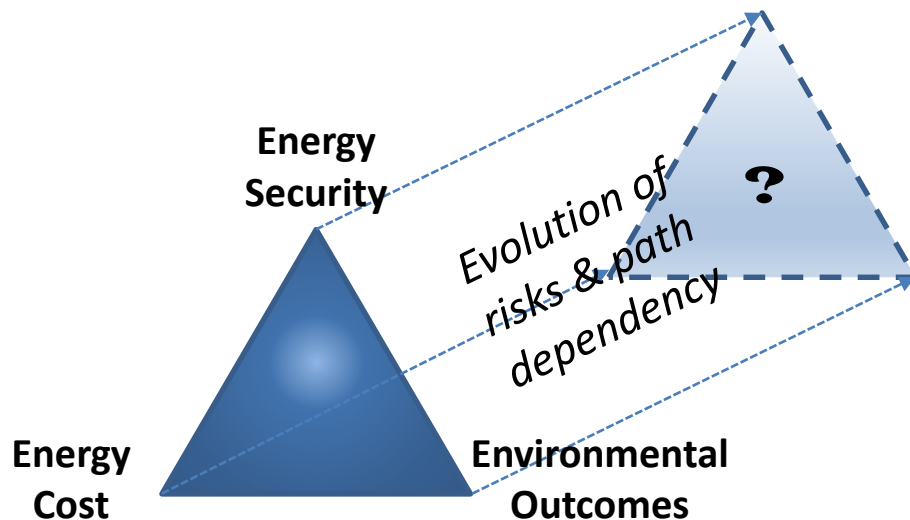
Each country's energy policy cannot be treated in isolation from other policy considerations...



The implications for energy security and the economy (cont.)

Ultimately, the role of fossil-fuels in an economy will depend on how they stack up against other energy options over time...

The Energy Policy Trilemma



- The extent that a country may reduce fossil fuel use will depend on its objectives with respect to energy security, the cost of energy and the environment
- Energy options will be assessed in term of their inherent trade-offs relating to the trilemma and their contribution to reducing energy intensity in the economy and the emissions intensity of energy
- The problem is dynamic involving evolving risks and path dependency, including with respect to energy options.

In conclusion

- There will be a continuing role for fossil fuels even under policies consistent with the ambitions set out in the Paris Agreement – a mix of energy options will need to be adopted
- How investment relating to fossil fuel use and supply is affected during such a transition depends largely on the trajectory adopted by the world for achieving the Paris Agreement's goal
- From our current vantage point, given the uncertainties about the trajectory for reducing emissions, it is important not to generalise about how the energy security and the economy of individual countries may be affected over coming decades. But it is likely the smoothness of the transition will have a bearing on both
- Instead, we need to appreciate the complexity of the interrelationships between both energy policy and climate change policy and the other 'affairs of state' facing each economy, and the impact these will have on their distinct trade-offs between energy security, cost and environmental outcomes as characterised by the Energy Policy Trilemma.