

Transitions in electricity systems towards 2030

An IChemE Energy Centre Green Paper

Effective policy to combat climate change needs to be shaped by three guiding observations: firstly water, energy, food, and other natural resource systems are all inter-connected and must be considered together; secondly global poverty and inequity must be addressed to ensure communities are less vulnerable to the impacts of climate change; and thirdly understanding that these issues of scale, dynamics and uncertainty across the broad socio-economic-environmental-technical sphere requires comprehensive system-analytic tools to demystify their complexity and support decision-making.

The power sector will be pivotal to transitioning to a low-carbon economy. This transition demands significant changes to current electricity systems. It requires a reduction in carbon intensity through a shift to low-carbon generation, improving energy efficiency in the sector, and a decline in electricity demand. IPCC modelling of mitigation approaches, that result in stabilising emission levels between 430 and 540 ppm CO₂, envisage that approximately 80% of generation in 2050 is supplied by low-carbon sources such as renewable energy, nuclear power, and fossil fuel plants with carbon capture and storage (CCS) technology. By 2100, fossil fuel generation without CCS should become obsolete. The question remains of whether the power sectors in individual countries are seeing the changes necessary to transition to a low-carbon energy system. As fossil fuel generation capacity can operate for decades, capacity that is currently being constructed has an impact on future emission levels. Policies and market incentives can both enable and inhibit change.

Current trends and installation rates in Australia, China, India, Malaysia, Singapore, South Africa and the UK were examined in order to determine what the electricity system in these countries is likely to look like towards 2030. Any real effort to mitigate climate change must be a combined and coherent international effort, thus cross-comparison of policy frameworks between countries must be carried out. In order to facilitate the cross-comparison of each of these countries, their electricity systems, policies and contribution towards mitigating climate change, were analysed using our *condensed principles of rational energy policy*.

Condensed principles of rational energy policy:		Australia	China	India	Malaysia	Singapore	South Africa	UK
E	Evidence-based – Policies must be evidence-based and communicated in a transparent manner							
N	Negative emissions – Policies should unambiguously aim at an absolute reduction in anthropogenic CO ₂ emissions							
E	Energy efficient – Energy efficiency should be pursued wherever possible							
R	Renewable energy – Policies should lead to the deployment and grid-connection of renewable energy							
G	Governance – Governments must avoid policy reversal or change, and honour standing policy commitments							
Y	Years ahead – Long-term policies are essential to provide long-term investor confidence							
Overall								

Conclusions

1. Emphasis on stimulating economic growth is evident in all countries



Climate change mitigation efforts are almost exclusively implemented if they are in-line with economic objectives. In Australia, environmental measures such as the carbon tax were repealed in part because they were believed to hamper international competitiveness. Chinese economic growth was hindered by a dependence on foreign energy imports, leading the nation to promote low-carbon energy sources to diversify its electricity mix. Malaysia's fuel-switching is driven by the desire to increase export earnings as a large LNG exporter.

2. Energy security concerns promote the diversification of the electricity mix



China and Singapore are net importers of energy, and are investing in LNG terminals in order to diversify their supply of natural gas. China is also investing in infrastructure to overcome domestic transportation bottlenecks, and is promoting renewable energy generation. The Malaysian government is diversifying its generation mix to coal and hydropower to continue exporting its natural gas resources. India has long term ambitions to increase the proportion of both nuclear and renewable energy in its electricity system as a way to exploit domestic resources and limit the dependence on energy imports.

3. A key driver of capacity expansion and improvement is shortages in electricity supply



China and India expect electricity demand to continue increasing as access to electricity increases and demand from industry grows to fuel growth. Both are investing in new generation capacity, as well as in the transmission grid in order to reduce transmission losses and improve security of supply. This is also critical in India, where transmission losses are in the range of 20-30% of electricity generated. South Africa's economic growth is hindered by widespread blackouts. It is thus imperative that new capacity is constructed quickly. As South Africa has large coal reserves, coal-fired generation is likely to increase.

4. Private sector investment is key to expanding electricity generation and fuel infrastructure growth



State-owned companies control the majority of electricity generation in China, India and South Africa. As national capacity targets in India are missed, the private sector is seen as necessary to increase investment in transmission infrastructure and generation capacity. South African Eskom is also facing financial difficulties and thus private sector procurement programmes have been launched to increase investment in renewable, coal-fired and gas-fired energy sources. The central government in China is promoting greater private sector investment to move away from its traditional government-led model.

5. There is a lack of long-term planning beyond 2030 in the electricity sector



Except for the UK, few countries have energy policies beyond 2030. Australia's Renewable Energy Target for 2020 does not specify which renewable energy sources should be installed. A lack of coordination in both India and Malaysia has created uncertainty for investors. Singapore has an overcapacity in the system and thus limited targets for generation. The South African approval process for capacity targets has faced delays, thus investments are still based on old plans. China has detailed 2020 renewable energy targets, but has not outlined its installed capacity for thermal generation.

At the 21st Conference of the Parties (COP21), the Paris Agreement was adopted. This will come into effect in 2020, empowering all countries to act to prevent average global temperatures rising above 2°C. Solving the climate challenge is a whole world problem, and a problem that can't be solved by working in alone. The IChemE Energy Centre calls on all countries of the world to work together to ensure we apply rational energy policies.

Acknowledgements

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