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A NEW ELECTRICITY REGIME FOR QUEENSLAND:

SUMMARY OF WORKSHOPS & PRINCIPLES FOR A NEW REGIME

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Sponsored by The TJ Ryan Foundation

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PURPOSE AND ORIGIN OF THIS PAPER

This report is a submission to the Department of Energy and Water Supply with a view to contributing to the development of a new Electricity Act.

This paper encapsulates the proceedings of two twin events held on 8 September and 20 October 2017 in 111 George Street Brisbane:

- two *Lunchtime Forums* sponsored by the Office of the Queensland Chief Scientist; the first addressed by keynote speaker Alan Pears AM, Senior Industry Fellow, RMIT University; and the second by Dr Matthew Stocks, Fellow, Research School of Engineering, Australian National University;
- followed by two *deliberative workshops* co-hosted by the TJ Ryan Foundation with the support of the Department of Energy and Water Supply; the first addressed by supporting speakers Prof Ian Lowe AO, Michael Gutteridge and Brendan Markey-Towler; and the second by Prof. Simon Bartlett AM, API Australian Chair in Electricity Transmission, University of Queensland and former MP Clem Campbell.

The paper includes two major parts:

- a summary of Mr Pears', Dr Stocks' and Prof. Bartlett's addresses; and
- a set of principles that might guide new legislation, notably the Electricity Act.

Also, a summary of plenary deliberations at the workshops is available and has been published online (http://www.royalsocietyqld.org/initiatives/electricity/) but, given the unstructured nature of the discussions, is not formally part of the submission.

PDF files incorporating PowerPoint slides by Mr Pears, Dr Stocks and Prof. Bartlett are attachments to this submission. Please note that the following is a text-based summary. For the definitive information in their presentations, refer to the slide files.

Disclaimer 1
The views expressed do not necessarily reflect the policy of the Society or the TJ Ryan Foundation.

Disclaimer 2
A financial contribution towards the cost of the events was made by the Department of Energy and Water Supply.

LESSONS FROM THE SOUTH AND PATHS FORWARD: ALAN PEARS AM

Alan Pears, Senior Industry Fellow at RMIT University, has been educated in engineering and teaching. He has been a highly regarded consultant on climate policy, energy efficiency, energy markets and practical design of green buildings, appliances and systems since 1991. He has been a member of the Victorian Government's Expert Reference Panel for development of its Energy Efficiency and Productivity Strategy. He is a prominent media commentator, having written more than 30 articles for The Conversation opinion website.

Key messages

1. State governments play the pivotal roles in electricity. National energy governance and the NEM can play only a limited role.
2. Contemporary national policy is focused on large generators and wholesale supply. Yet many of the levers available to resolve the current tangle lie in the retail market or demand side.
3. Economic, environmental, social and political factors are all leading us towards a low carbon, energy-efficient, diversified and distributed energy network that can respond flexibly to an uncertain future.
4. There is a severe risk to power system security from high penetrations of distributed inverter-connected devices – this risk is not currently being managed.
5. Contingency planning is needed for unexpected closures of large generators, generator failures, variable renewables, new industrial activities, major weather events, etc.
6. Victoria's in-depth review has demonstrated that the deregulated, market-based, 'consumer choice' approach has not delivered efficient pricing and resource allocation, nor equitable and low cost consumer outcomes – and was not designed to work in the emerging energy system.
7. Effective energy policy must drive demand-side energy productivity, 'smarts', storage and renewable energy, as well as large scale solutions for large energy users and appropriate solutions for fringe-of-grid consumers. Drivers of demand, such as buildings, appliances/equipment and major industrial sites must be part of the energy policy agenda.

The following notes are a text-based summary of the slides, supplemented with subsequent discussion with the presenter. For the definitive presentation, including the graphics, referred to the slide file.

The emerging energy context

- Climate response is a fundamental driver. Fossil fuels generate three quarters of Australian emissions and two thirds of global emissions.
- The future will be diverse, complex and quick-moving.
- Future demand for energy and energy services is uncertain – but governments and communities have the power to shape demand.
- There will be much more activity at local and regional levels than in the past.
- Much more energy investment will be 'behind the meter' and modular.
- Queensland's energy agencies, researchers and communities are already driving a lot of innovation.
- There is a tension between the desire for low prices (to satisfy consumers) and the need for high prices (to incentivise investment in new supply capacity). Note

that current high electricity prices are not due to a capacity shortfall but are due to high domestic gas prices, network charges, and the cost of renewable energy incentive schemes.

Lessons from Victoria

- Deregulated energy retailing model based on consumer choice has not worked, for reasons outlined in the August 2017 *Independent Review into the Electricity and Gas Retail Markets in Victoria*.
- Victoria's energy legislation is outdated and fails to recognise the diversity and the challenges of the emerging energy system.
- Terms of Reference of Victoria's state regulator are narrow: focus on 'price' not 'cost'; there is a requirement to 'ensure financial viability' of incumbents.
- There is no formal official recognition of emerging energy industries in Victorian legislation or policy: they have no rights, engagement mechanisms or responsibilities. (However, they have rights and responsibilities under the National Electricity Rules and renewable energy legislation).
- Consumer rights mechanisms cannot deal with the diversity and nature of emerging market participants.
- There are currently no coordinated mechanisms to deliver downstream energy efficiency, demand management or the emerging peer to peer trading.
- Victoria was unprepared for the sudden closure of Hazelwood – lack of contingency planning, risks of big, 'lumpy' energy infrastructure failing. 'Lumpiness' of electricity generation and transmission infrastructure is to be expected.

Hazelwood closed because of a compliance notice to remedy workplace health and safety shortcomings. Repairs would have cost more than $400 million. Hazelwood was ~50 years old, well beyond its original design life. Australia's older power stations will all eventually close down.

The seeds of the shortcomings of today's regime were sown during the privatisation of the 1990s. To maximise the sale price (justified on the basis of reducing state debt), emerging competition from renewable energy and energy efficiency was suppressed, prices were raised and weak regulation established. (However, the breaking of the government monopoly on generation to allow private investors to fund new generation, including new renewable generation, was a potentially worthwhile innovation).

The National Electricity Market was designed so that the highest cost generator selected at a given time sets the price for all suppliers. This approach is standard for electricity markets globally. (It now favours gas).

Features of Queensland's system

- Large network, many 'fringe of grid' issues, long supply lines in north and west Queensland challenge maintenance and are vulnerable to extreme weather events.
- Many large industrial loads, mainly resource processing.
- Significant and different renewable energy resources; for example the Kennedy windfarm has an output profile very different from those of NSW wind farms.
- Legacy of inefficient buildings, equipment, industrial plants.

States complement national frameworks

- If national policy and/or governance fail or do not recognise state level issues, state governments carry much of the 'blame' from voters and business.
- Although network regulation is by the Australian Energy Regulator, states have significant powers (e.g. ownership) over networks and retailing; and can own and influence generation.
- States need to maintain expertise and 'hands on' experience to engage and influence at national level.
- States act as 'pilots' so all can learn – e.g. energy efficiency schemes, retailing deregulation, reverse auctions – stakes lower for trialling innovations outside NEM, including trialling by state-based retailers.
- Capture jobs, economic development for state and regional areas.
- States have significant responsibility for infrastructure of all types.

Desirable objectives for future electricity

- Zero carbon (as soon as possible).
- Affordable, safe, reliable access to energy *services*. People want the *services* that electricity delivers, they don't want electricity for its own sake.

To achieve these:

- Minimise the amount of electricity needed to deliver the services that people, businesses, industry need:
  - Energy efficiency and productivity improvement,
  - 'Behind the meter' renewable energy, 'smarts', storage.
- For small consumers (SMEs, households) minimise fixed, wholesale, transmission, network and retail charges.
- For large consumers, minimise wholesale and transmission costs as these matter much more; maximise energy efficiency and 'behind the meter' investment.
- Ensure mix of energy sources + storage delivers energy when and where it is wanted/needed, manage peak demand.
- Ensure grid stability – frequency, voltage, etc. (This objective is incompatible with minimising grid expenditure. As inverter-connected renewable generation increases, and as conventional synchronous generators are progressively retired, the existing grid is severely weakened, resulting in power system instability and wide-scale blackouts (e.g. South Australia) unless there is substantial new investment in the grid including interconnectors and eventually large scale storage.

Issues for supply side

What will happen on the demand side:

- On-site renewable energy, energy efficiency, demand reduction, demand management, storage, shift from gas to high efficiency electric.
- Changes in structure of economy.
- Future of ageing industrial facilities.
- Electric vehicles – bound to come rapidly as soon as they are affordable – yet Australia's power system in unprepared.
- Competition from emerging supply side technologies.
- Large energy storage in networks and stronger transmission systems.
- Wind, solar, bio-electricity.
- Intermediates such as hydrogen, biogas…

- New players – local government, businesses and households facilitated by aggregators, 'smart' solutions, attractive financing packages, peer-to-peer trading, building industry, internet providers, Internet of Things, appliance retailers, etc.

Risk from competition and innovation:

- Uncertain demand – see above.
- Reduced demand during daytime due to solar generation undermining viability of traditional baseload generators – surplus solar, wind AND storage depresses wholesale prices.
- Need for contingency measures to cover low wind, solar, failure of large generators, shortage of cooling water, etc.
- Financial risk for large projects – the regulatory or investment context may change before a large project is even commissioned. Uncertain profitable operating life given climate change, increasing competition…..
- Financial risk – risk for 'behind the meter' investment is lower than for wholesale energy market investment.
- Power system security risks due to excessive distributed inverter-connected renewables and other devices.

Paths forward at State level

Overriding principle given retail scale technology: Top-down control won't work.

- Mechanisms to monitor, facilitate action, provide feedback, incentivise, regulate to remove poor practices.
- Financing for incremental, modular, decentralised, 'behind the meter' solutions.
- Reverse auction/'contract for difference' agreements on an individual project basis for renewable energy, large storage, grid stability, demand response, energy efficiency.
- Energy Retailer Obligation schemes for demand reduction, storage, grid stability services (examples of existing schemes: Renewable Energy Target, Victorian Energy Efficiency Target, South Australian Retailer Energy Efficiency Scheme, New South Wales Energy Savings Scheme…).
- Programs addressing drivers of demand±:
    - Buildings: use planning schemes, standards for existing buildings (with long term financing); Retailer Obligation schemes; improved data collection/feedback and use to target policy; new financing models;
    - Appliances and equipment: public sector purchasing; incentives for importers, manufacturers, retailers, tradies and consumers; use building energy data to identify faulty, inefficient equipment and drive replacement; improved maintenance practices (linked to better real time data); research and development to improve and model/benchmark performance of custom equipment used in commercial and industrial facilities;
    - Large industrial facilities: develop real time models of process energy flows to support improved operation and maintenance, and to benchmark against best global practice and theoretical energy requirements; financing for transition;
    - Fringe of grid and off-grid consumer programs – reduce subsidies, build local economies.

Peak/daytime demand can be managed with:

- Improved energy efficiency, especially in buildings (building fabric, shading, HVAC, internal heat sources and exhaust systems, etc), retail (especially retail with refrigeration and cooking).
- Demand response and 'smart' management.
- Rooftop and large scale solar.
- Other renewable electricity sources.
- Energy storage (thermal and electricity).

Overnight load seems more challenging:

- Different loads will require different approaches.
- Commercial, residential, SMEs - as above but with more focus on off-peak hot water (heat pumps and tank insulation), stand-by power, switching things off, energy efficiency for continuously operating equipment, etc.
- Energy intensive industries and mining (total under 40% annual electricity but maybe 60%+ of overnight demand) require detailed consideration.

Peak demand is a misnomer and is no longer the driver or main issue. The new issue is *peak residual demand* – after taking into account the generation from solar PV and wind power. In Queensland's case with record amounts of rooftop PV and a large program of utility-scale PV already under construction, the State will soon experience its peak residual demand overnight. Energy storage (batteries or pumped storage) are expensive and the extra cost must ultimately be borne by end users. It would be much better and cheaper to shift energy usage into the daylight hours where it can be efficiently supplied by solar PV. This will need innovative appliances and industrial processes that work harder in the daylight hours and store energy locally for use locally overnight. For example, refrigeration and air-conditioning that freeze ice in the daytime for use overnight.

Tenanted houses and commercial buildings where owners are responsible for the capital outlays but tenants pay the power bills are a challenge but a finance corporation could work around these. States can borrow money at historically low interest rates. Investment in energy efficiency can have short paybacks. With appropriate repayment periods, energy efficiency using loan funds can be cash flow positive from year 1.

PUMPED HYDRO STORAGE: DR MATTHEW STOCKS

Dr Matthew Stocks is a Fellow, Research School of Engineering, Australian National University. He has had more than 20 years' experience in research and development in photovoltaics including high-efficiency solar cell concepts; and in studies supporting high penetration renewables including 100% renewable energy and sustainable transport. From 2000-2012, he was involved in the development, technical transfer and subsequent large scale manufacture of the ANU-invented SLIVER technology.

Key messages

Some 97% of energy storage globally is achieved through storage of water. A large volume of water is not required for pumped storage, differentiating this type of system from standard hydroelectricity generation. Ideally, it would be good to detach the name 'hydro' from 'pumped storage' as the two techniques are very different.

About two thirds of Australia's fossil fuel generators will reach the end of their technical life by 2036 and will need to be replaced. Pumped storage offers a very effective partner to wind and solar generation connected by high-voltage interconnectors to ensure grid stability. Any desired degree of grid stability can be achieved at modest cost by adding more off-river storage. There is no end in sight to reductions in the cost of wind and solar power.

Batteries are very good for storing *power*, but pumped storage is better for storing *energy*.

It is difficult to identify many more opportunities for on-river pumped storage facilities in Queensland. It is easier to achieve large differences in head of pressure with off-river storage and the environmental disruption can be much less.

The minimum practicable storage is approximately one gigalitre, which very roughly translates into 1 gigawatt hour of electricity. This can be achieved with a storage as small as 10 ha or 350 m X 300 m X 10 m deep. Very little water is required compared with a conventional fossil fuel generator.

Dr Stocks' team has identified hundreds of potentially suitable sites in all states outside national parks and warranting investigation. His team is working with Gutteridge Haskins Davey and other consultants to develop cost models. Costings should be available for public release during the first half of 2018.

His personal specialty is demand-supply balance. Is it possible to run an efficient grid with 100% solar photovoltaic and wind? Conventional hydroelectricity with long-term storage is very good for supplying stable electricity, pumped storage for a few days. Snowy 2.0 could run for up to a week which is possibly larger than is efficiently necessary.

A challenge with pumped storage is that invariably, some authority wishes to utilise the lower reservoir for some other purpose, such as flood protection or water supply, which can compromise the smooth efficiency of the system as a backup store of energy.

The proposed Genex plant at the Kidston mine in North Queensland is proposed to build a 250 MW solar farm backed up with pumped storage. However, the transmission line connecting it to the grid (132,000 V) has inadequate capacity and will need upgrading.

A disadvantage of divorcing Queensland from the east coast grid is that the weather systems for each state are localised, and self-sufficiency could cost as much as 30% extra to ensure reliability. There is a negative correlation between South Australia and Queensland in terms of wind speed. Far North Queensland accesses a different weather system, so an adequate interconnector can help to smooth out intermittent supply.

Pumped storage is not a technology of the future; it is available now, although it is not a complete solution to the challenges facing electricity.

If Australia is to meet its Paris obligations, electricity should carry the bulk of the reductions. It is by far cheaper to wring carbon efficiency out of electricity systems than any other major source, and certainly much easier than with vehicles. A sensible aim would be 70% of the carbon reduction budget by 2030.

Dr Stocks named an energy retailer that is permitted by regulation to achieve a 14% rate of return, even though its finance costs only 4%. The company can afford to build solar generation and storage systems itself using offshore finance. Public money is not essential.

QUEENSLAND'S PUMPED STORAGE SITES: PROF SIMON BARTLETT

Prof Bartlett is API Australian Chair in Electricity Transmission, University of Queensland. He has had forty years' experience in the power industry in electricity transmission and power generation in Australia, Europe and Canada. His experience includes planning, design, construction, system operations and asset management and organisational leadership. Past roles include Chief Operating Officer, Powerlink Queensland; Board Director, Electranet SA; Chairman, Australian Power Institute and Deputy Chairman, CIGRE Australia.

Key messages

Pumped storage is an excellent partner for solar and wind renewable energy. It is low (but not zero) in carbon dioxide emissions and also:

Reliable and Secure

- *Stable*: high synchronous inertia and fast frequency response.
- *Flexible*: dispatch and load-following capability.
- *Back-up Storage*: large scale for surplus solar, prevents renewable energy from being 'spilled'.

Affordable

- *Cheap*: perhaps one-tenth the cost of battery storage (in $/MWh).
- *Long Lasting*: 10 x the life of batteries.
- *Low Cost*: lowest cost delivery of new ancillary services.

Pumped storage, if designed correctly, can change rapidly from generation to pumping with very high efficiency. Pelton turbines can wind down or up, changing from zero to full load, within as little as five seconds.

Queensland is likely to need 2000 MW of pumped storage to support a network that is 50% supplied by renewables over 10-20 hours.

The North Queensland Energy Plan indicates that renewable projects underway will more than satisfy North Queensland's demand, but the grid between there and South East Queensland is long and weak. The peak load in North Queensland is 1100 MW, in South East Queensland 6-7000 MW. For a distance of 1500 km, there is not a lot of spare capacity in the transmission lines. The network is untested for transmitting electricity from north to south and will have lower transmission limits unless the grid is reinforced.

Central Queensland has about 4600 MW of coal-fired generation and uses about 1500, but the grid to South East Queensland can barely carry 2000 MW.

Comprehensive engineering studies (and environmental assessments) have been done for some projects in North Queensland. Tully Millstream was approved for construction. It is based on the original plan for the Cardwell Range hydro-electric power station investigated in 1949 but instead the 72MW Kareeya power station was built at the time.

The best pumped storage sites in Queensland and possibly Australia are:

- Tully-Millstream hydro/pumped storage ~1,000MW.
- Burdekin Falls hydro/pumped storage up to 1,500MW.
- Borumba pumped storage up to 1,000MW and 30 GWh.
- Mount Byron pumped storage up to 2,000MW and 50 GWh.

The Queensland Government built Burdekin Dam – for flood mitigation, irrigation and hydroelectricity – and acquired the land for Tully-Millstream, Borumba and Mount Byron sites 30 years ago. (However, the Tully-Millstream and any other new hydro-electric scheme will raise environmental objections).

Time is approaching when ~1,000MW of large scale storage will be needed in each of North Queensland and South East Queensland for 10–20 hours.
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ARCMESH STRATEGIC NEM INTERCONNECTION: PROF SIMON BARTLETT

The current east coast grid has a deep flaw: its configuration is a horseshoe, lacking a connection between South Australia and Queensland. A high-voltage DC line using structures compatible with the land use is required to allow an alternative supply to both states in the event of an outage in one or the other. A high-voltage transmission line would be easy to build across central Australia and could connect Australia's best solar resources along the way. (Central Australia has 15-20% more solar intensity per square metre than the coast). There are good pumped storage sites in the Flinders Ranges. Modern transmission towers can be designed at half the cost of traditional ones, but this requires innovation.

The route could follow the gas pipeline to Wallumbilla, then to Davenport in South Australia, which is the weakest part of the South Australian grid. This connection would transpose 'inertia' and strong synchronous generation from strong Queensland into weak South Australia.

Also, to the extent that coal will continue to be utilised, the newest and most efficient power stations in Australia are in Queensland and they should be used nationally. A member of the audience confirmed that Queensland coal fired stations are supercritical and it also has 2000 MW of gas plant mainly in the Surat Basin.

ARCMESH is the Australian Renewable Connector, 'meshing' the east coast grid, the longest in the world, 5000 km, nearly always congested with marginal transmission losses up to 40%. The grid operates on a hub and spokes design and if the hub breaks, the power system in the isolated state can collapse as occurred in South Australia. The 2016 blackout in South Australia was largely a consequence of voltage instability (not frequency collapse). Coupled with severe weather and the tripping of wind farms, the interconnector failed. This incident had severe consequences for South Australia.

In summary, an interconnector would turn the east coast spine into a proper NEM grid. It would be the key enabler to link up the most efficient coal fleet (in Queensland) with good sites for pumped storage (in Queensland), modern flexible gas (mostly in Queensland) via first-rate sites for renewable energy, with the most vulnerable part of the NEM grid.

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PRINCIPLES FOR A NEW REGIME

The following principles with accompanying explanations are commended to the Department as a foundation for the next-generation electricity regime in Queensland. These have been derived from expert presentations and deliberative discussion at public events held on 8 September and 20 October 2017 in Brisbane, supplemented with additional later input from the presenters.

Disclaimer 3
Given the depth of expertise of the presenters and the breadth of knowledge of the participants and others who have had an opportunity to review this submission, the following principles are solidly grounded, sufficiently so to justify publication and citing. However, they do not purport to cover as comprehensive a range of topics as would necessarily be included in a new statutory regime. Further research would be required to cover the full suite of potential subjects or to incorporate supporting references.

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FOUNDATIONS

1. *Public interest:* The public interest is paramount

The role and duty of the Queensland Government is to protect and advance the public interest. The public interest does not equate to the interest of the government of the day or the interest of the business sector or any other sector.

The public interest is circumstantial and evolutionary but is not meaningless. A major role of the independent public service is to analyse the meaning of the 'public interest' at a point in time or in a particular field of policy and to advise the government of the day accordingly.

The public interest is not necessarily served by markets which are in essence, a medium for exchange between or with private participants. By their nature, unaided commercial stakeholders cannot be expected to pursue the public interest. Commercial stakeholders will tend to ossify policy and should be kept at arm's length throughout the preparation of any new legislation or policy.

Legislation should specify that the public interest, defined as embodying the principles in this submission, is the overriding purpose of the regime and should instruct all public officers to seek the public interest when making discretionary decisions.

2. *Sustainability:* Policy should steer towards a sustainable system

The *National Strategy for Ecologically Sustainable Development* 1992 (NSESD) is Queensland Government and national policy, although it has been widely overlooked in recent years. With its more recent international equivalent the *Earth Charter*, these provide a starting point for contemporary energy policy that can be consistent with emerging international law and policy.

The NSESD stipulates:

- a path of economic progress that does not impair the welfare of future generations
- equity within and between generations
- recognition of the global dimension
- protection of biological diversity and the maintenance of ecological processes and systems.

Legislation should embed sustainability through all its statutory and other processes. For example, Queensland's town planning regime should be recalibrated to embed sustainability and energy efficiency into planning schemes and development assessment. This can be achieved through mandatory provisions in the electricity legislation.

3. *Self-reliance:* The **Queensland Government is sovereign**

Almost all of the tools to establish a new electricity regime, including the capacity to operate generators, but excluding management of the National Electricity Market (NEM), lie within the jurisdiction of the Queensland Government. The government should not wait for national policy to crystallise but rather can contribute pro-actively to reforming the NEM. Participation in the NEM can be in Queensland's benefit through equalising some fluctuations in demand and supply, and in selling surplus power interstate.

Given Queensland's geography, it can easily become an Australian leader in developing an intelligent electricity network.

Given Queensland's public ownership of generation and other pivotal assets, crafting a new regime that will satisfy multiple public policy objectives will be easier than in the States that have more extensively privatised their systems.

Privatisation of large-scale electricity infrastructure is antithetical to a flexible, reliable and affordable regime. Privatisation of natural monopolies has a miserable record in Australia and internationally. The promises of lower prices and better service for consumers have failed to materialise. It is extremely difficult to establish an adequate regulatory regime for natural monopolies, for reasons well understood in economic theory.

Privatisation has been justified in part by the false assumption that ownership and regulation can readily be separated; and that public interest objectives can be achieved through regulation. Tenure or ownership, however, is a more powerful and simpler tool. Unlike regulation, it is direct and contractual rather than indirect and coercive. Privatisation that creates a business or government enterprise under commercial imperatives introduces corporate incentives that too easily become misaligned with the public interest.

There is no particular reason for the government to avoid operating facilities requiring large capital expenditure. The statutory authority and the government-owned corporation have an honourable history in running large facilities on a semi-commercial basis. Given appropriate public interest instructions, they can combine the public-good functions of government with the operational efficiency of corporations.

Private investment of itself is not necessarily objectionable: private investment in demand management, energy efficiency and behind-the-meter renewables is a democratic and decentralised form of private ownership that can be steered towards these objectives.

A large number of the tools available to government (including custodial management of assets, contractual agreements, staff appointments, budget allocations and suasion) can be conducted under the royal prerogative and do not require statutory powers, or require only simple enabling clauses.

4. *Energy efficiency:* Demand management is the cheapest form of generation

All other objectives will be aided by intensive demand management. As demand is capped or suppressed, pressure on transmission and distribution infrastructure and generation capacity eases. It also reduces *total costs* to consumer, even though it may not reduce the *price per unit* of energy. The contemporary focus of energy policy on low 'price' instead of low 'cost' undermines energy efficiency and smart management.

Demand management can be highly cost-effective for governments, business and consumers alike. At least initially, while there is much low-hanging fruit, demand management is by far the cheapest form of 'supply'. Energy efficiency is comparable in scale to renewable energy in its capacity to contribute to a low carbon future. Modern technology can capture waste heat with only a small gradient. The 2003 National Framework for Energy Efficiency estimated that Australia's carbon dioxide emissions could be reduced by 30% using existing technology with payback times of less than four years.

Firms are not necessarily aware of the extent of leakage within their business processes or of the savings to be gained, partly because electricity is commonly a small portion of their costs, partly because of organisational inertia. Energy efficiency cannot be left to industry. Legislation should mandate reporting and organisational engagement by the larger firms (well beyond tick and flick auditing) and facilitate firms' understanding of their energy flows. Government should make information freely available. Legislation should provide for an 'efficiency levy' for large users, contrary to traditional practice of offering discounts for large users (discourages efficiency). Putting a price on waste is a thoroughly orthodox economic instrument.

Financing of efficiency improvements within public enterprises can be a fiscally prudent approach by government. Efficiency measures for homeowners and business enterprises can have short payback periods so may not require public finance but may require mandating in legislation, particularly for residential rental property or commercial buildings where tenants capture the savings when landlords install capital improvements. Legislation should also specify a coordinating role for government and should overhaul the building code.

5. *Governance:* Competition is a shallow foundation

Reforms of the 1990s along the east coast were based on the principle of competition between private suppliers. Within the discipline of economics, the theory of competitive markets was developed in the era of a craft economy, very different from today's globalised economy with large corporations exercising market power.

Further, electricity is not simply a consumer good but a complex system ('complex' in its scientific sense) that should be modelled as a network according to the principles of systems dynamics. For any complex system, collaboration and coordination are also needed.

Over-reliance on competition *for its own sake* as an organising principle tends to lead to fragmentation, a risk of creating monopolies or oligopolies, undue profit-taking and inability of government to achieve public policy objectives which are diverse and change from time to time. Privatisation makes continual adjustment difficult.

The principle of competitive neutrality is particularly regressive when applied on a 'one size fits all' basis. By forcing government-owned enterprises to act as if they are privately financed (an artifice, as government can always borrow money more cheaply), this principle has encouraged gold-plating of networks beyond what is necessary in the emerging distributed regime. Coupled with a pervasive determination to keep expenditure off state budgets, national policy has arguably been driven by accounting techniques rather than engineering and sustainability objectives.

Given the complexity of the electricity system, its public-good characteristics and the degree of reliance of the entire economy upon electricity, a high level capacity to coordinate across sectors is required to optimise the system and to achieve the endorsed objectives. Only the State Government can fulfil that role, although the Australian Government also has an essential role in coordinating the National Electricity Market, given the existence of the latter.

Counter-intuitively, given modern technology, distributed systems can achieve private investment and market competition more effectively than centralised systems dominated by large corporate stakeholders. In an era of rapid change, distributed solutions are better on most criteria: they can be quick to implement, flexible and low risk. They allow rapid response to innovations, can be rolled out incrementally, and can earn cash flow quickly. Legislation should empower consumers and democratise the regime.

OBJECTIVES

Five objectives have been identified: low emissions, reliable, flexible, affordable and localised. Not all these can be granted equal priority in every element of the system; for example, 'affordability' can be in tension with 'reliability'. These objectives are listed in loose order of priority.

1. Low emissions objective

As climate change accelerates, emissions policy will prevail over most other considerations. Governments will be exercised to respond. The sooner that the transition to a low emissions environment is launched, the easier and less expensive it will be. Potential investors (public and private) in infrastructure, plant and equipment must be given clear emissions signals to avoid creation of stranded assets and waste of public and private investment capital.

Legislation should provide for a price or shadow price on carbon emissions by taxing waste, without waiting for a national trading scheme, which is likely to be complex, indirect, slow to implement and expensive in terms of transaction costs.

Concern over emissions and also over Australia's vulnerability in supply of petroleum will drive electrification of transport. Legislation should facilitate this transition, by such measures as certifying access to charging facilities.

2. Reliability objective

Security of supply is vital for a modern economy. Security requires resilience to natural disasters and changing climate; adequate investment in quality assets; orderly retirement of assets nearing the end of their lives; close attention to synchronous and non-synchronous sources; and independence of undue pressure from commercial participants. In a modern electricity-dependent economy, blackouts are intolerable for manufacturing industry and some critical public facilities such as hospitals, schools and research institutes.

Legislation and policy should facilitate the establishment of pumped storage, which offers reliability and can operate sustainably indefinitely.

Technology is moving quickly, and 'synthetic inertia', smart management, energy storage and many other options to maintain grid stability and reliability are emerging. Instruments to deliver reliability should be designed to support ongoing innovation, not impede it.

3. **Flexibility objective**

Given the cluster of rapidly changing forces in operation, including the rapid increase in public awareness of the shortcomings of the current regime, the Queensland Government should develop a system that is resilient to changes in national policy; receptive to emerging technologies; accommodates the aspirations of homeowners to be both independent and green; and capable of incremental adjustment through policy (government retains necessary levers). Contingency strategies will be needed to ensure that energy services can be provided in the face of unforeseen shocks such as extreme weather events or unexpected failures of large generators or interconnectors.

Flexibility is a two-edged sword. Legislation should avoid increasing the cognitive load on home-owners and small business. For example, citizens should not be required to choose between competing purveyors of an un-differentiated product touting complex contracts, as in retail competition within the grid.

However, complexity in the underlying network is inevitable and will increase as technology places more tools in the hands of participants.

Flexibility will be aided by a statutory framework for a distributed system.

4. Affordability objective

Inexpensive power bills are an essential ingredient to a competitive commercial sector, especially manufacturing, and to a quiescent electorate. It is the total bill, not the price per unit of electricity, that matters in the emerging energy system, where more efficient use and smart management can cut energy costs. High fixed charges are regressive and undermine the effectiveness of pricing signals to drive rational behaviour. Price signals if structured systematically should be used to influence supplier and consumer behaviour and investment while maintaining equity. Policy should eliminate opportunities for gouging by commercial participants. Markets should be conceptualised as a tool to deliver public policy rather than a vehicle for private profit. Undue private profit by commercial participants is generated at the expense of other participants. Markets require shaping and steering.

While crude, top-down 'command and control' regulation can be inefficient through high transaction costs, poorly designed 'light-handed' regulation can also be inefficient through exploitation and distortion of outcomes.

5. **Localisation objective**

Decentralisation of generation, if systematic, planned and implemented in conformity with the other objectives, can significantly reduce transmission losses (which are a waste to all concerned) and can improve flexibility and consumer sovereignty.

Localisation is a two-edged sword. As demand side investment expands, a stronger level of central coordination will be required to ensure that decentralisation does not degenerate into chaos. The Queensland Government cannot delegate any of its constitutional responsibilities to local government or the private sector. 'Localisation' should not mean delegation of regulatory powers to private certifiers, or light-touch performance-based regulation.

Local government has large unrealised potential to partner with the State in achieving localisation, acting as a locus for innovation, aggregating individual consumers into community-scale projects and implementing building and town planning objectives. Legislation should facilitate township-scale projects (like geothermal projects at Thargomindah and Winton) by local government. Legislation should avoid obstructing local government's general power of competence in Queensland in relation to electricity.

Legislation should prescribe standards for building, town planning, system installation and connection to the grid. Legislation should enable local governments and consumers to exercise their entrepreneurship and creativity, but within a strong statutory framework.

DISSENTING VIEWPOINT

During editing, there emerged a dissenting viewpoint that could not easily be reconciled with the consensus view. The dissenting view sees greater benefit in national coordination compared with State-level independence.

Features of the dissenting viewpoint include:

1. It is not necessary for individual states' energy legislation to accommodate all aspects of system governance. The National Energy Rules are available and regulate the east coast network.

2. So long as Queensland remains within the NEM (and this submission does not argue otherwise), the National Electricity Rules, national renewable energy legislation and the national regulators of transmission and distribution will prevail over state systems.

3. State control over feed-in tariffs, reverse auctions and so on will inevitably be uncoordinated (by definition).

4. Given the appetite of private investors for investment in infrastructure so long as sovereign risk is acceptable, there is no longer a case for state investment in generation.

The difference between the consensus view from the forums and the minority view expressed in the subsequent editing hinges on the scale at which the principle of localisation is to be applied, and the respective role to be assigned to each level of government. The current regime is characterised by inherent contradictions, such as the establishment of a national grid (in the name of coordination), but the atomisation of generation (in the name of competition – breaking up natural monopolies). The dissenting viewpoint does not reconcile those tensions.

The August 2017 *Independent Review into the Electricity and Gas Retail Markets in Victoria* addressed the principles of coordination and competition. It is recommended that the Queensland Government commission a comparable review.

CONCLUSIONS

The electricity regime is ripe for reform. The Queensland Government will be expected by the community and business to develop a system to achieve multiple policy objectives and avoid the present perceived dysfunction.

Participants in twin events held late in 2017 conceived of a regime that achieved all of the desirable objectives outlined above. However, this will not happen by accident. A coherent system can be achieved only by insightful policy analysis within the Queensland Government that crosses disciplines and sectors and takes advantage of Queensland's sovereignty in nearly all elements of any electricity regime.

It is recommended that the Department of Energy and Water Supply establish an Advisory Panel of independent, external experts to advise it on the preparation of new legislation. This panel should not include any representatives of the regulated industries, but such entities should be invited as observers to present on specific agenda items as the panel works through the regime.

It is recommended that this panel be funded to commission additional expert research to confirm or otherwise the substance of this submission; and facilitate good-faith consultation with the community and industry. It is recommended that this research include a review of the merits of coordination versus competition as an organising principle, comparable to the Victorian review into retail markets.

The imperatives of strengthening coordination and reducing waste are sufficiently unambiguous to justify recommending that the Department of Energy and Water Supply establish an Energy Efficiency Secretariat of public servants with secure tenure from a range of disciplines to develop a roadmap and coordinate the capacities of all sectors in applying the above principles, concurrently with developing the new legislation.

The Royal Society of Queensland and the TJ Ryan Foundation are willing to assist the Government to the best of their ability in identifying sources of knowledge as well as publishing non-partisan information and analysis free of commercial or partisan bias.

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