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Monopoly regulation, discontinuity & stranded assets

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Abstract
Inherent in the design of monopoly utility regulation is an implicit assumption of non-negative load growth and an objective function that guides inter-temporal cost growth at some lower rate, such as RPI-X. While investment error often violates the cost growth objective, historically, population and economic growth could be relied upon to sweat-out overinvestment 'mistakes in retrospect'. But what happens if trend-load growth enters a state of terminal decline from disruptive competition? Unless costs decline the discontinuity would approach the limits of the regulatory design envelope and produce the conditions necessary for a utility Death Spiral, and stranded assets. The 'regulatory compact' makes this a complex area of economics. Zero recovery of stranded monopoly assets is not credible policy. But a normative analysis of economics and law suggests full recovery is not credible either. Remedies span from accelerated depreciation, return of capital and transition bonds. Ultimately, asset stranding remedies are a policy choice, not analytical determinations.

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1. **Introduction**

Inherent in the design of monopoly regulation is a presumption of non-negative load growth along with an objective function that is intended to simulate competitive market dynamics and guide inter-temporal cost growth at some lower rate. This objective function is frequently implemented via Professor Littlechild's classic regulatory prescription, *RPI-X*.[1] But despite best intentions of policymakers, industry regulation can produce unintended consequences (Douglas et al. 2009). For monopoly utilities, if disruptive competition causes aggregate demand to contract then the regulatory mechanics that follow raise prices to offset volumetric losses to meet a regulated revenue constraint. The feedback-loop of rising prices and contracting volumes in the presence of a discontinuity can produce a vicious cycle, known as a *Death Spiral*. Note consumers disconnecting from a network is *not* a pre-condition for a *Death Spiral*. The *necessary condition* is that consumers, in aggregate, reduce system load year-on-year, and the *sufficient condition* is that cost growth is non-negative. At this point, the regulatory framework will approach the limits of its' design envelope. The reason for this is axiomatic; a regulatory outcome of persistent price rises in the presence of falling aggregate demand from disruptive competition produces a *strikingly different* result to equivalent competitive market conditions, where prices fall and assets are written-off (Pierce, 1984).

There is also the more general case of non-trivial demand forecast error and overinvestment mistakes in retrospect – where prior period expectations prove too ambitious and the extent of excess capacity simply overwhelms the stability of tariffs. In either case (*Death Spiral* or non-trivial *mistakes in retrospect*), while regulatory processes are *expected* to allow for recovery of lost revenues in future rate cases – the political economy of such an outcome may well be unacceptable, and this exposes utility shareholders (Kind, 2013).[2]

A potential circuit-breaker for consumers and utility shareholders is asset stranding policy and associated remedies for recovery. Stranded assets arise when sunk costs associated with prior investments will not be recovered because future revenues (via prices, volumes or both) are expected to be significantly lower than assumed when the commitment was made due to materially changed circumstances (Joskow, 1996).

The purpose of this article is to review asset stranding literature from the US where considerable experience exists. Key principles are applied to circumstances where it becomes clear that in the presence of disruptive competition, and after exhausting all options within the existing regulatory envelope including tariff reform[3], a *Death Spiral* has commenced characterised by (i) contracting energy *and* peak demand, and (ii) non-negative cost growth. This article is structured as follows. Section 2 reviews relevant

[1] Professor Stephen Littlechild's 'incentive regulation method' emerged in the early 1980s whereby tariff adjustments were based on a formula comprising annual inflation with a productivity adjustment, expressed as RPI-X. See Littlechild (1983).

[2] In relation to a Death Spiral, Kind (2013, p1) explains that various Distributed Energy Resources (DER) and associated demand programs capture market share which reduces utility revenues. Regulatory processes are expected to allow recovery of lost revenues in future rate cases, but tariff structures generally require non-DER customer to pay for (absorb) lost revenues. As DER take-up rates increase, the cost-recovery structure may require a reversal of cross-subsidies, but the political economy of sharp rate-rises may result in utility stranded asset exposures.

[3] On tariff reform and *Death Spirals*, see Simshauser (2016).

literature and Section 3 extracts key principles from the literature. Section 4 presents a Regulated Monopoly Model and Section 5 explores recovery options. Conclusions follow.

2. Review of Literature

When confronting an episode of stranded assets, policymakers seeking guidance would look in vain to economic textbooks. Even the great regulatory treaties of Bonbright (1961) and Kahn (1970, 1971) are silent on the matter. However, US wholesale electricity market deregulation in the 1990s stranded US$135bn[4] of monopoly generation assets.[5] FERC Order 888[6] allowed *full recovery,* underpinned by three principles; (1) the 'regulatory compact', (2) maintaining power system 'financial integrity', and (3) 'cost causation[7]' (McArthur, 1998). This was different to FERCs *equitable sharing* policy devised during natural gas deregulation, consequently setting-off an intense debate vis-à-vis how stranded monopoly assets should be treated. A wealth of academic literature subsequently emerged. How stranded monopoly assets are dealt with is of vital importance to social welfare but is a complex area of economics for three reasons;

1. Economic theory says nothing of how to treat stranded assets of regulated monopoly utilities (Rose, 1995; Martin, 2001). Moreover, efficiency arguments compete with fairness arguments (Hogan 1994; Baumol & Sidak 1995);

2. Amounts at stake are invariably massive (Tye & Graves 1996; D'Souza & Jacob, 2001; Ritdchel & Smestad, 2003).

3. Remedies[8] are a zero-sum game. When recovered from consumers remedies damage the benefits that emanate from the cause of stranded assets viz. new competitors and technologies (Navarro, 1996; Wen & Tschirhart 1997). When imposed on utilities it produces financial distress as Section 5 later demonstrates.

Industry and consumer advocates will adopt extreme positions of *full recovery* or *zero recovery,* respectively, which is to be expected. Meanwhile policymakers have little in the way of analytical frameworks to assess competing claims (Beard et al. 2003).

2.1 On *full recovery* of stranded costs

Arguments supporting full recovery can be catalogued by (1) efficiency or (2) equity and fairness. From an efficiency perspective, compelling arguments are those that follow Kydland & Prescott's (1977) theory of dynamic inconsistency.

- *On efficiency*

If the legitimate and prudently approved investments of regulated utilities are stranded by *regulatory fiat*, capital markets will interpret policy as opportunistic and heighten the

[4] See Rose (1996) for a summary of the standing estimate undertaken by Ratings Agency Moody's.
[5] Not only were legacy assets expected to be stranded, but also many Power Purchase Agreements forced upon utilities via the PURPA Act.
[6] Federal Energy Regulatory Commission (FERC) Order 888 was enacted 24 April 1996.
[7] Specifically, investment costs should be repaid by those who caused them.
[8] Recovery typically occurs via accelerated depreciation, supra-competitive prices or non-bypassable surcharges.

cost of capital in future regulatory periods. It may produce investment frictions or at the extreme, block investment[9] (Baumol & Sidak, 1995; Douglas et al. 2009; Kind, 2013). Crawford (2014) shows how higher costs of capital might produce future costs that outweigh the benefits of an asset write-off.[10]

Additionally, when competitive threats become plausible utilities are unable to raise their returns – i.e. regulated rates-of-return never reflected asset stranding risks (Baumol & Sidak, 1995; Martin 2001; Woo et al. 2003).

Furthermore, industry reform is unlikely to be successful without the support of affected utilities, (Joskow, 1996). If full recovery is disallowed utilities may resist technical progress and efforts to strand assets (Brennan & Boyd, 1997). Incumbent utilities may attempt to recover inefficient costs through supra-competitive tariffs, ultimately encouraging excess entry which produces tangential inefficiencies (Hogan, 1994). Consequently, FERC Order 888 and full recovery was argued to be sound public policy, noting recovery mechanisms can be structured without distorting competition (Tye & Graves, 1996).

- *On equity and fairness – the 'regulatory compact'*

From a fairness perspective, utility investors make vast financial investments in long-lived assets to serve the public in exchange for a guaranteed rate-of-return. Underpinning this is the so-called *regulatory compact* which can be traced back to 1983.[11]

The regulatory compact is heightened when investments were approved as *prudent* at the time of commitment (Baumol & Sidak 1995; Woo et al. 2003). Regulators frequently force utilities to make sub-optimal investments to meet universal service obligations, policy objectives or mandated environmental schemes that deviate from minimum cost (Hogan, 1994; Navarro 1996; Boyd, 1998; Pagach & Peace 2000; Martin, 2001). Such commitments were undertaken because returns were guaranteed. Economics may not provide a basis for systematic conclusions on matters of equity and fairness, but stranding these asset categories without recovery does present an *'inescapable issue of procedural fairness'* (Baumol & Sidak, 1995, p.843).[12]

[9] This is more than a theoretical possibility and the Dampier to Bunbury Pipeline in Australia provides an interesting case in point. During a period of financial distress in the 1990s, due to the large number of banks involved (and represented in the workout committee), operating and capital works decisions were routinely frustrated.

[10] The financial economics logic of Crawford (2014) is prima facie sound for *zero recovery* (which differs from this article as it focuses specifically on *partial recovery*). However, an implicit assumption underpinning the outcomes in Crawford (2014) is perfect equity capital markets. Conversely, Pagach & Peace (2000) explain that institutional fund managers will quickly discern between historic managerial error and future grid requirements. At a practical level, in the current environment rightly or wrongly (and I would argue wrongly) regulated utilities are viewed as a form of fixed income and thus modelled results in Crawford (2014) would be moderated by the wall of institutional money seeking stable dividend yields (i.e. driven by the current low interest rate environment). Crawford's (2014) modelled results might be more applicable in a high interest rate environment and 'tight' equity capital markets.

[11] Michaels (1995) observes the use of "regulatory compact" formally appears in court and regulatory proceedings from 1983. Rose (1996) notes the notion of a *regulatory bargain* can be traced back to case law in the 19th century (regarding railroad regulation). In his 1972 article, Myers (p78) describes an 'implicit contract' between investors and regulators.

[12] Although not directly relevant to Australia, there is a strand of literature that extends this one step further and classes such regulatory action as a violation of the US Constitution's Takings Clauses of the Fifth Amendment and its application to the states under the Fourteenth Amendment. See Baumol & Sidak (1995), Rose (1996) or Graffy & Kihm (2014) for further details.

Finally, monopoly utilities are known to possess massive market power but regulators have precluded pricing above regulated set-points. It is unfair to expose utilities to downside losses from asset stranding when they were prohibited from raising prices above regulated rates in prior periods (Baumol & Sidak, 1995).

2.2 On *partial recovery* of stranded costs

Arguments grounded in equity and fairness can be deployed by both sides of the stranding debate and because they are subjective can be turned in favour of consumers (Boyd, 1998). For example, it may be unfair to send a regulated monopoly into financial distress given an obligation to supply but it is equally unfair to recover excessive and misguided utility investments from customers, especially future customers (Maloney & Sauer 1998).

Discontinuity *does not* impose costs on monopoly utilities – it exposes inefficient costs and a crucial role of markets is to screen-out inefficient assets and above-market prices (Rose, 1996). Brennan & Boyd (1997) observe that when utilities argue for full recovery in the presence of disruptive competition, they are over-relying on regulation. Those utilities reliant on regulation for protection are often characterised by extensive investment mistakes in retrospect (Graffy & Kihm, 2014).

- *On equity and fairness*

The regulatory compact deserves special attention because it forms a central argument of those in support of *full recovery*. A strict normative economic and legal analysis of the regulatory compact will produce an objective view of what a long term contract between utilities and consumers might comprise, and reveals at least four counter-arguments against full recovery as Navarro (1996), Rose (1996), McArthur (1998), Brennan & Boyd (1997), Boyd, 1998; Graffy & Kihm (2014) and others explain:

1. Individual consumers never agreed to the implicit terms of the regulatory compact[13]. Conversely, utility investors signed up for risky returns (Maloney & Sauer, 1998; Woo et al. 2003);

2. The regulatory compact assumes regulators act as agents on behalf of consumers. This erroneously assumes regulators act exclusively in the public interest but a long historical line of economic literature explains why this is not necessarily the case (Stigler, 1971; Posner, 1974; Peltzman, 1976).

3. No written contract exists with consumers. Therefore the regulatory compact is an illusory construct. Anything not explicitly identified is immediately contentious – the sub-clauses of a regulatory compact are matters for pure speculation (Rose, 1996; Boyd, 1998).

4. The imprecise nature of the regulatory compact is used to argue for full recovery while ignoring the problems of agency in this idealised and hypothetical agreement (Brennan & Boyd, 1997). Specifically, the regulatory compact is used

[13] One Reviewer observed it collides with the requirement for the Explicit Informed Consent of consumers under Australian Consumer Law and the National Energy Customer Framework.

to justify all of the upside and none of the downside inherent in long term contracts (Rose, 1996).

As Beard et al. (2003) highlight, long term contracts always include clauses for contingencies, viz. *price re-openers* in circumstances when prices formed under a long-term contract breach certain limits or when Material Adverse Change clauses are triggered. A normative analysis of economics and law under conditions of long term contract ambiguity, which evidently exist with the regulatory compact, dictates that responsibility tends to fall on the party best able to adapt to the relevant circumstances. In the case of discontinuity it is difficult to argue this is *entirely* the consumer (Rose, 1996; Boyd, 1998).[14]

The obligation to supply is, prima facie, a compelling argument in favour of full recovery and in certain instances will apply to specific investments (Navarro, 1996). However, rarely do utilities flag the risks of such large capital expenditures with regulatory authorities being proposed. McArthur (1998) observes that in hindsight, the regulatory compact argument appears designed to conceal the virtually exclusive role monopoly utilities have in planning national energy infrastructure, and their role in encouraging regulated capital-intensive outcomes.

- *On efficiency*

Efficiency arguments against full recovery commence with the underlying objective of monopoly regulation. The public policy goal of economic regulation is not to protect monopoly utilities from competition. On the contrary, it is designed to protect consumers from monopoly prices (Pierce, 1984; Rose, 1996). Myers (1972) explains ideal regulation forces utilities to operate at competitive levels of investment, price, output and profit with prices set so utilities earn a 'fair return' on investment. Utilities, reliant on the regulatory compact, argue fair returns were also guaranteed. This is true in the short run (viz. for each regulatory determination). The *Hope Natural Gas*[15] case established the 'fair return' principle:[16]

> *The return to the equity owner should be commensurate with returns on investments in other enterprises having corresponding risks. That return, moreover, should be sufficient to assure confidence in the financial integrity of the enterprise, so as to maintain its credit [worthiness] and to attract capital… (FPC vs Hope Natural Gas Co, 320 US591 (1949) at 603).*

Utilities with stranded assets will cite the *fair return* principle. By implication, they are citing the *Hope Natural Gas* case. But the same Court explained regulatory powers have limits and *do not* extend to setting rates that result in positive utility returns, or utility solvency, in the presence of disruptive competition (Graffy & Kihm, 2014). The 1945

[14] Boyd (1998) noted from an efficiency perspective, interpretation of implicit contractual obligations following an unspecified contingency should consider which party can best adapt to, or insure against, risks due to a costly future contingency (this should include considerations of moral hazard). Analyses of how courts and policymakers interpret duties in the franchise relationship with utilities does not mean stranded assets should be fully recovered. Both an analysis of precedent and an economic analysis of optimal contracting suggest partial recovery.

[15] Federal Power Comm'n vs Hope Natural Gas Co (1942).

[16] Myers (1972) explains how Finance Theory mobilises these legal constructs with the fair return being equal to the utility Weighted Average Cost of (debt and equity) Capital.

Market Streetcar[17] case further refined regulatory principles. The San Francisco Streetcar company was incurring losses at a monopoly tariff of 5c in the face of disruptive competition (viz. buses and cars). The firm sought, and regulator approved, tariff increases to 7c. This exacerbated market share losses, demand plunged further, thus producing a *Death Spiral*. The regulator reduced tariffs to 6c and court proceedings were initiated. *Market Streetcar* lost the case and a key regulatory principle was established:

> *…regulation and the fair return principle applies when a utility has monopoly power, not when it is besieged by disruptive competition that it is failing to navigate… If market values decline in response to successful competition, utilities cannot simply look to their regulators to undo the impact of fundamental changes in market forces…" (Graffy & Kihm, 2014, p26-27).*

FERC Order 888, which granted *full recovery*, was widely acknowledged as a regulatory oddity (McArthur, 1998). A long history of policy changes without full compensation exists during episodes of discontinuity (Brennan & Boyd 1997; Martin, 2001; Woo et al 2003, Graffy & Kihm 2014). Boyd (1998) explains that with gas deregulation, FERC reasoned utilities bore considerable responsibility for planning errors and enforced a policy of *partial recovery*.

As is well understood, there is no mechanism to recover stranded assets in competitive markets. Firms incur losses and either adjust their business or collapse (Baumol & Sidak 1995). There is no obligation for policymakers to shelter monopoly utilities from changes in demand for their product. The role of policymakers and regulators is ultimately to stimulate competition (Maloney & Sauer 1998).

2.3 On finance theory, the fair return principle, and *partial recovery*

At the core of the fair returns argument is the ability of the utility to attract capital for future additions (i.e. financial integrity). McArthur (1998) argued that, setting aside the fact that regulation was never designed to deliver a riskless world, failure to deliver full recovery does not automatically translate to a violation of financial integrity. There are two limbs to this line of economics reasoning; investor expectations, and moral hazard.

- *Investor expectations*

Economics and Finance practitioners and academics alike have long been relaxed with the notion that stock investors require higher *expected* returns on companies facing increased risk. However, there is no basis in theory nor empirical evidence to suggest firms *will* earn higher returns as risk increases. They key term is *'expected returns'* – an ex ante concept.[18] Ex-post short run returns can and do deviate substantially from the

[17] See Market St. Ry. Co. v. Railroad Comm'n (1945). Both Rose (1996) and Graffy & Kihm (2014) provide good summaries.

[18] As Myers (1972, p80) explained *…There are several things that the [fair return] principle does not imply. It does not specify returns ex post; it is solely an ex ante concept. The existence of competitive markets does not require that expectations be realised for any asset, or even for all assets over any period of time. Regulators can eliminate unexpectedly high or low rates of return after the fact, but only if they are willing to make the firm a risk-free investment. The principle says nothing about whether regulation should aim to make utilities safe or risky enterprises…*

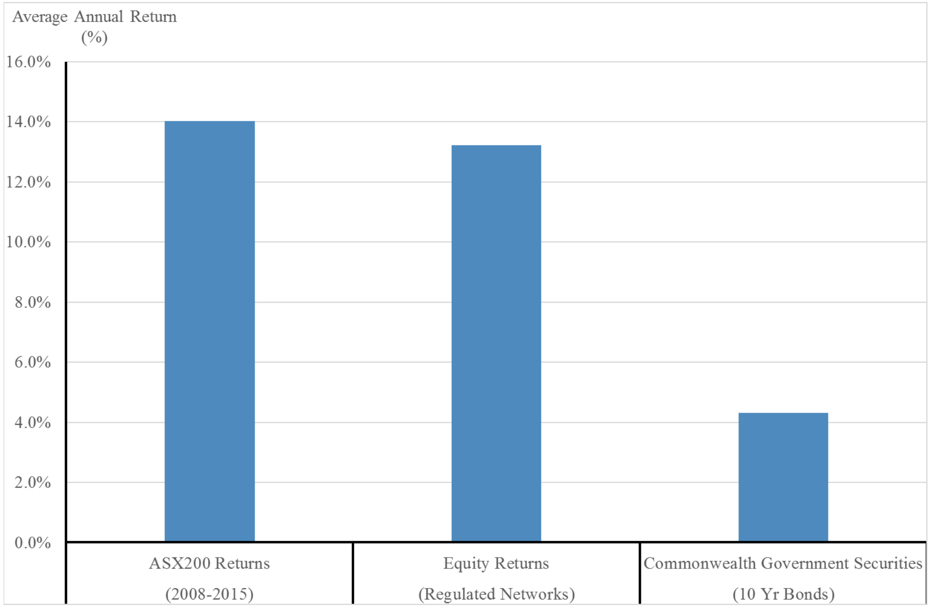
cost of capital in competitive markets.[19] The argument that rising risk should equate to higher ex post returns is simply not correct in theory or practice. Capital markets exist to spread the risk of investment outcomes, including unmet expectations.

There is no *explicit* allowance for the risk of asset stranding contained in regulated rates of return. But the universe of utility risks are not individually catalogued and priced by regulators in determining rates of return and so the relevant question is whether there is an *implicit allowance*. While Rose (1996) observes the risk of changing demand is an inherent market risk of utilities and forms a component of the risk premia contained in their regulated rate of return, Maloney & Sauer (1998), McArthur (1998) & Michaels (1998) solve the question by deduction. If returns were guaranteed under virtually all conditions, bonds issued by regulated utilities would trade marginally above treasury notes, and equity returns afforded to utilities in rate cases would be similarly priced (with extremely low Beta factors, closer to zero than one). However, Maloney & Sauer (1998) and McArthur (1998) observed that bonds traded at 120 basis points above treasury notes over the previous 5-year window while Michaels (1998) explains utility equity returns in the five-year window leading up to FERC Order 888 had been 13.2% per annum vs. S&P500 result of 13.3%.

Contemporary Australian results are similar – the current regulatory allowance for issued debt is 219 basis points over Australian Commonwealth Government Securities[20] while equity returns from 2008-2015 for Network Utilities averaged 13.2% per annum, the ASX200 averaged 14.0% and Government Bonds averaged 4.32% (see Figure 1 and Appendix I).[21] That utility returns are materially higher than government bonds, and virtually equivalent to ASX200 returns raises the distinct possibility that investors are adequately remunerated for business risk, including an implicit pricing of demand and discontinuity risk.

[19] As Myers (1972) explains, the speed at that prices re-calibrate back to equilibrium returns is dictated by the speed of firm entry or exit.
[20] See Australian Energy Regulator determinations for networks over the regulatory period 2015-2020 at http://www.aer.gov.au/networks-p ipelines/determinations-access-arrangements/energex-determination-2015-2020 (accessed Oct-16).
[21] Appendix I provides average annual returns to 2015 for each year commencing from 2006 to 2010. The regulatory framework underwent a significant change in 2006 with impacts applied from about 2008 hence the starting date. However, for completeness two years either side of 2008 (i.e. 2006-2010) have been provided in the Appendix. There is some variation in the result but the substantive point remains – network returns are close or higher than ASX200 equity returns, and substantially above long-dated Commonwealth Government Securities.

Figure 1: **Equity returns: ASX200 & Regulated Networks vs. Govt Bonds (2008-2015)**



Source: JP Morgan, RBA.

Furthermore, Navarro (1996), Pagach & Peace (2000), Woo et al. (2003) and Graffy & Kihm (2014) all note risk-adjusted profits are earned by monopoly utilities – and while it is true that utility tariffs had been "capped", they had also been "floored".[22] In no unregulated industry do inept firms enjoy such a low probability of failure (Michaels, 1995).

Policy frameworks affect utility stock prices, but capital markets determine the cost of capital (Rose, 1996). As Pagach & Peace (2000) and Martin (2001) explain – investors may have an initial adverse reaction to a policy of *partial recovery* but most will quickly discern the difference between bad historic investments and well-founded future investments.

> *…There is the concern that if government does not guarantee cost recovery, this will lead to investor distrust of regulators in the future. But is that distrust such a bad thing? Distrust of regulatory cost recovery commitments is socially desirable if it inhibits imprudent investments. The signal sent to future investors is very important… Boyd (1998, p71).*

Utility investment flows and capital market evidence shows investors discern that difference. D'Souza & Jacob (2000) analysed stock price movements of 18 listed utilities in the US that disclosed stranded assets in their annual accounts during the 1990s. Results demonstrated investors *did not* anticipate full recovery prior to FERC Order 888. By dissecting the classes of stranded assets their analysis revealed stockholders anticipated non-recovery of, on average, 23-24% (i.e. 76-77% recovery). However, the same analysis revealed much higher expectations of recovering forced

[22] Natural disasters may of course produce a short term operating loss.

investment - PURPA Act[23] contract costs had expected non-recovery of 6% (i.e. 94% recovery).

- *Moral Hazard*

On efficiency grounds, a fundamental proposition against *full recovery* is a heightened propensity for moral hazard. Investment mistakes produce the need for asset stranding. Once stranded assets are deemed 'recoverable' there is little incentive to mitigate existing exposures, nor incentives to avoid future exposures. The moral hazard of full recovery is that the most incompetent firms are rewarded the most. And as Michaels (1995) explains, as in economics there is surely a supply curve of stranded assets – the bigger the reward, the more utilities will find. Conversely, efficient monopoly utilities rarely engage in stranded asset debates (Madian, 1997).

Utilities may argue capital programs were approved by regulators as *prudent investments* at commitment. The implication is prudent investments that become obsolete due to technological change should be *fully recovered*. Apart from moral hazard, this ignores a crucial tenet of utility regulation, viz. the *used and useful* principle (Hoecker, 1987).[24] Pierce (1984) explains the *prudent investment test* is a low bar and rarely used in its pure form because it would be unusual for utilities to make blatantly imprudent capital commitments. When *prudent investment* is combined with *used and useful*, more objective screening occurs because the latter does not require a finding of fault as a prerequisite for excluding certain investments (McArthur 1998).[25]

Regulatory approval at the time of investment commitment does not, therefore, form a basis for full recovery. As Navarro (1996), Maloney & Sauer (1998) and many others highlight, regulators have neither the resources, nor responsibility, to create and guarantee investment plans. Regulators review plans and hear arguments of interested parties. Regulators cannot be expected to match the expertise and resources of utilities, nor come close to second-guessing what constitutes a prudent investment program (Douglas et al. 2009).

Regulators may have added their own distortions to routine supply- and demand-side errors of incorrectly selecting technologies, underestimating build costs, incorrectly sizing capacity additions or over-estimating future load growth (McArthur 1998). But mistakes made by regulators approving apparently prudent investments are likely to be a contributing factor, not a primary cause of stranded assets and to say otherwise would be re-writing history (Pierce, 1984). Ultimately, the regulatory system leaves

[23] Public Utility Regulatory Policy Act (PURPA) contracts were long term Power Purchase Agreements (PPAs) that were effectively forced on to utilities by regulatory authorities.
[24] The *'used and useful'* principle can be traced back to a New York Public Service Commission decision in 1922. Hoecker (1987, p.306 – citing N.Y. Pub. Serv. Comm'n 1922) notes the principle established was that …*Consumers should not pay in rates for property not presently concerned in the service rendered unless (1) conditions exist point to its immediate future use, or (2) unless the property is such that it should be maintained for reasonable emergency or substitute service…* This latter condition clearly indicating reserve planning margins form part of the used and useful asset stock. See also D'souza & Jacob, 2001).
[25] Rose (1996, p70) explains that if a regulatory framework were to rely on a *'pure'* prudent investment test, then returns to stock and bond holders would be very low and commensurate with the low risk of stranding. Conversely, a *'pure'* used and useful test would have substantially higher returns to equity and debt holders because they would face stranding risks with no compensation because it is embedded in the rate of return. In practice, most regulatory frameworks employ a combination of both.

entrepreneurial decisions and capital management in the hands of utility management, not the regulator (Madian, 1997).

3. Principles of Asset Stranding

From the review of literature, 10 principles can be established to guide assert stranding policy:

> *Principle #1 – The necessary condition for stranded assets is terminal decline in energy and peak demand in the presence of disruptive competition. The sufficient condition is non-negative cost growth. Under these conditions the regulatory framework will approach the limits of its design envelope and so asset stranding policy needs to come into sharp focus.*

Recall discontinuity and disruptive competition do not impose costs, they expose inefficient costs and an important function of markets is to screen-out above market prices and misguided investments. Wen & Tschirhart (1997) demonstrate from a welfare perspective that allocative efficiency is more important than productive efficiency. Maintaining prices at supra-competitive levels may accelerate entry and intensify a Death Spiral as *Market Streetcar* demonstrated. Regulation, therefore, must not impair the price mechanism. It is essential to identify the line between stable and unstable zones of regulation, and whether discontinuity represents a singular threat or an ongoing wave of disruption (Graffy & Kihm, 2014). If it is the latter, asset stranding policy needs to come into sharp focus.[26]

> *Principle #2 – Zero recovery of stranded assets is not credible policy.*

I have argued previously that economists must approach welfare enhancing reform with the notion that recovery for losers is inappropriate – were it not for such an approach government would not be able to function properly[27] (Simshauser 2009). But I have also argued that when reform shocks constitute large, policy-driven events that breach longstanding expectations and produce an especially uneven distribution and intensity of losses, partial recovery is appropriate (Simshauser, 2009; see also Pasour 1973; Neary 1982; Argy 1999).

Business mistakes should be exposed to losses but there is no serious argument for *zero recovery* of stranded regulated monopoly assets (Pierce, 1984; Navarro, 1996; McArthur, 1998; Brennan & Boyd, 1997; Beard et al. 2003). Some recovery is appropriate, especially where utilities have been compelled to invest as a result of regulation or policy mistakes (Baumol & Sidak, 1995; Boyd, 1998; D'Souza & Jacob, 2001). At risk is the credibility of government policy. Providing stable rules for the market is an important function of policymakers and a pattern of random or capricious changes undermines the credibility of government (Hogan, 1994). As Kydland & Friedman (1976) explain, firms respond predictably to dynamic inconsistency.

[26] As noted earlier, when the future turns out to be substantially different to forecasts prepared in prior periods, the more general case of forecast error and the "weight" of excess capacity arising from overinvestment mistakes in retrospect can also produce tariff instability if there is no prospect of load growth.

[27] In particular, the complexity of measuring economy-wide losses for every policy change is not feasible as transaction costs would vastly exceed likely benefits. Further, delivery of assistance would impair the economic efficiency that a policy measure is trying to drive. See Simshauser (2009 at page 34).

Principle #3 – Full recovery of stranded assets is not credible policy either. Recovery should therefore be partial, and rates of return on stranded asset recovery accounts curtailed (eliminated).

Pierce (1984) noted that if excess capacity was an inevitable result of forecast error, excess costs could be spread across as many consumers as possible and recovered accordingly. However, he also noted price rises that follow won't be tolerated by policymakers because sheeting home monopoly utility investment errors to captive electricity consumers it too great a contrast to the treatment of investment errors in unregulated markets. So while total exclusion of stranded assets has critical defects, so does total inclusion.

Neither regulatory frameworks nor courts have ever provided a complete guarantee of returns (noting FERC Order 888 is a regulatory oddity). Monopoly regulation removes short term risks, but does not guarantee enduring protection from policy change or discontinuity. As McArthur (1998) explained, the shadow of competition never stopped pursuing regulated utilities, even if its image was faint.[28]

A certain level of compensation for stranding risk has been enshrined in the cost of capital allowance afforded to utilities (Wen & Tschirhart 1997; Boyd 1998). Were it not, utility equity returns would trade only slightly above Commonwealth Government Securities and well below ASX200 Equity Returns, yet there is no evidence of this (see Appendix I). Credible policy points to discounted recovery of stranded assets (Pierce 1984; Brennan & Boyd 1997; Hirst & Hadley, 1998; McArthur 1998, Boyd, 1998; Pagach & Peace 2000; Martin 2001; Beard et al. 2003; Simshauser, 2009). Joskow (1996b), who argued for full recovery, also argued utilities are better to accept some discount to full recovery than spend years litigating their position.

Once an asset bundle is stranded and marked for recovery, the rate-of-return applied should be lowered given recovery risk has been eliminated[29] (Pierce, 1984; Madian, 1997). Recall from Section 3.3 that stock investors anticipated some level of non-recovery of stranded assets. Pagach & Peace (2000) found rising equity Betas in the period leading up to FERC Order 888, thus indicating capital markets began to price-in some level of non-recovery (i.e. 23-24%). They also analysed the 7-day and 12-month event windows after FERC Order 888 and found significant positive abnormal returns (i.e. outperformance) by utilities with stranded assets *cf.* the S&P500. FERC Order 888 eliminated the possibility of expected (23-24%) losses, instead providing guarantees over stranded assets. The policy of *full recovery* thus produced a form of economic rent which investors competed away by bidding-up stock prices.

Principle #4 – The 'regulatory compact' is, at best, an incomplete agreement and does not justify full recovery.

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[28] McArthur (1998) also noted the risk of policy change tends to rise when tariffs exceed what competitive markets would otherwise deliver.
[29] This avoids counter-intuitive results in Pagach & Peace (2000).

Viewing the regulatory compact as comprising the upside potential of a long term contract (i.e. *full recovery*) without contemplating the downside represents asymmetric regulation (Michaels 1995; McArthur, 1998). The regulatory compact is incomplete and its sub-clauses are matters for speculation. Because it is incomplete, policymakers can only follow a normative analysis of economics and law with liability determined after devising the welfare maximising position at the time it was created, ex ante. It is difficult to argue competition was an unforeseen contingency[30] or a balanced contract would not have *upper limits* on price increases (Pierce 1984; Rose, 1996; Boyd, 1998; Martin 2001; Beard et al 2003). In the absence of written clauses, courts will follow an economic analysis of law with financial exposures assigned to expected least-cost adapters or those with greatest potential for moral hazard (Brennan & Boyd, 1997). Crucially, *Market Streetcar* illustrated neither regulators nor courts have an absolute obligation to preserve utility solvency under conditions of disruptive competition (Graffy & Kihm, 2014).

Principle #5 – The level of stranded assets is a case-by-case proposition. Each episode needs to be independently valued, and thoughtfully managed.

Unless asset sales are used to produce market-derived results, the most contentious aspect of a program will be the valuation of stranded assets (Joskow 1996b; Hirst & Hadley 1998). Either a 'bottom-up' or 'top-down' administrative valuation method will be requied (Hogan, 1994; Navarro, 1996). It will be necessary for an independent body to determine stranded asset bundles (Madian, 1997). The unique position of each utility means optimal recovery can only be assessed case-by-case (Boyd, 1998; Simshauser, 2009). And if policymakers permit partial recovery it is essential that only sunk costs are included in the calculus (Joskow 1996).[31]

It would be irregular to know precise values at the point of stranding. Uncertainty over future demand and technology adoption means stranding events may turn out to be significantly different. Treatment and recovery therefore needs to be thoughtfully managed. Ongoing valuation methods combined with adjustment mechanisms are appropriate, acknowledging this produces ongoing transaction costs (see Joskow, 1996; Navarro, 1998).

Principle #6 – In the presence of large discontinuities, multiple rates of return are appropriate.

Principle #3 explained regulated returns of stranded assets should be reduced. Conversely, when the risk of discontinuity is non-trivial, an efficient monopoly will curtail investment to avoid stranded assets. Investment required to meet operational constraints that transgress the judgement of the efficient utility can rightly justify higher regulated rates of return or accelerated depreciation (for *marginal* risky assets).

[30] Utilities cannot claim they were unaware of stranding risk – their Commercial & Industrial customers are routinely required to sign long term contracts that outline minimum terms associated with specific utility investments. Regulators encourage (and certainly never prohibit) terms that ensure cost recovery from industrial customers. That utilities engage in such behaviour is strong evidence that they are aware of stranding risks and that cost recovery is not guaranteed (Boyd, 1998).

[31] Pierce (1984) also observed the indivisibility of plant means professional judgement will be required. Apparent over-capacity can be amplified by legitimate scale choice.

Conversely, Pierce (1984) observed the regulated rate of return can be adjusted on a downwards-scale as excess capacity increases.[32]

Principle #7 – A window of opportunity exists for full recovery of risky assets (i.e. avoiding asset stranding). Economic depreciation is a suitable mechanism.

In the presence of emerging technology there is limited time for regulators to take remedial action (Crew & Kleindorfer, 1992; Crawford, 2015). Exposed assets can adopt more accurate depreciation methods to minimise stranding episodes. Depreciation methods have long been of interest to economists, dating at least as far back as Hotelling (1925). Under rate of return regulation, choice of depreciation method represents a key input to regulated prices and has a circular reasoning which materially affects how capital costs are recovered (Schmalensee, 1989; Burness & Patrick 1992).

By contrast, in Hotelling (1925) the firm has no control over price or technology and cash flows are fixed regardless of depreciation method selected. Under these conditions, straight-line (accounting) depreciation is shown to be equal to *economic depreciation* only by chance (Hotelling, 1925; Schmalensee 1989; Crew & Kleindorfer, 1992). Economic depreciation can only be measured by the change in the present value of equipment, discounted by its Weighted Average Cost of Capital (WACC).

Principle #8 The recovery of costs should be allocated fairly, viz. ex-ante causation.

Fair allocation of the recovery cost burden, based on *responsibility* and *causation*, is important. McArthur (1998) observed FERC used this approach previously vis-à-vis stranded gas assets with the cost burden matched equitably amongst those responsible. Madian (1997), Hirst & Hadley (1998) and others note this may produce some embarrassment for policymakers and regulators.[33] To be consistent with *Principle #4*, cost allocation should follow a strict normative economic and legal approach. For example, if reliability standards set by authorities produced overinvestment, utilities have a clear obligation (to shareholders) to alert policymakers and regulators to unintended consequences. If authorities constrained the response of a utility, full recovery is appropriate (Brennan & Boyd, 1997). Conversely, utilities – not policymakers or regulators – have a greater capacity to predict demand forecasts and technological change and therefore should be exposed to such dynamics (Pierce, 1984; Graffy & Kihm, 2014). It is an open question as to whether regulators or utilities are better at predicting changes made by policymakers (Boyd, 1998).

Principle #9 – The recovery mechanism selected is important. There are many possible mechanisms, but it is a policy choice, not an analytical determination.

An idiosyncratic characteristic of electricity is that, from a pricing perspective, it has no natural form. Flow (kWh), stock (kW), load volatility and customer numbers are all legitimate pricing mechanisms (Boiteux, 1956; Boiteux & Stasi, 1952; Nelson & Orton, 2013; Simshauser, 2016; Keay, 2016). Woo et al. (2003) observe recovery options

[32] Pierce (1984) also acknowledged this would need to be done carefully due to the risk of unintended consequences (i.e. investment freeze).
[33] This underscores the importance of *Principle #5 (independently valued).*

available to policymakers are extensive. Adding to the recovery matrix is either historic or actual consumption levels – the former better matched with causation (Madian 1997).

Accelerated depreciation was flagged as a potential mechanism. Also possible are supra-competitive prices (Martin, 2001), explicit surcharges (Beard et al. 2003), return of capital (Pierce, 1984) and securitisation (Michaels, 1998). Securitisation involves some authority committing to a once-and-for-all stranding valuation[34], then issuing credit-wrapped transition bonds into capital markets, returning bond sale proceeds to the utility and assigning bond-liability to customers (Pagach & Peace, 2000; Martin, 2001; Ritschel & Smestad 2003).[35]

- *Principle #10 – Recovery must be flexible, equitable, non-bypassable, and time-limited.*

Customer classes selected for recovery liability, and the time taken to recover stranded assets, is also a policy choice – not an analytical decision. Nominal recovery terms of 3-7 years are suggested in order to limit potential damage to reform objectives (Tye & Graves, 1996; Madian, 1997; Hirst & Hadley, 1998) but in practice periods of up to 10-15 years have been used. Finally, a universal principle within the literature is costs should be non-bypassable.[36] As Joskow (1996), Madian (1997) and Martin (2001) explain, power system *exiters* played a role in cost causation – decisions to leave the system should not leave residual customers to cover their share of stranded costs. Ultimately, the recovery task should apply to all historic customers.

4. **Regulated Monopoly Model**

To illustrate asset stranding a 'Regulated Monopoly Model' was constructed to simulate various remedies. Key model outputs include Annual Regulated Revenue Requirement, Tariffs, Profit & Loss, Balance Sheet and Cash Flow Statements and Ratios. Model resolution is annual data over a 10-year time-horizon. Key assumptions (Table 1) are based on parameters typical of an Australian regulated monopoly but could be adjusted for any relevant jurisdiction, and Megawatt hours could be replaced by Megalitres (water network) or Megajoules (gas network). How inputs are used is explained in Sections 4.1-4.3.

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[34] Upfront recovery violates *Principle #5 (recovery needs to be thoughtfully managed)* – upfront mechanisms are very risky for consumers (Hirst & Hadley, 1998; Martin, 2001) whereas utilities are generally advocates for the mechanism (Michaels, 1998; Ritschel & Smestad, 2003). To the extent that this option is pursued, Madian (1997), Michaels (1998), Martin (2001) and Ritschel & Smestad (2003) all observe that funds raised through bond issues should be directed towards redeeming any outstanding loan facilities associated with the stranded assets with any balance repatriated to shareholders – and *not* be made available for utility management to splurge elsewhere "ineptly" as was the case in the US (see especially Michaels, 1998 at page 61).

[35] Michaels (1998) explains that as a financing tool, securitisation can be traced back to 1977 and its intended effect in the stranded asset case is to lower the cost of capital of the recovery target. The first deployment of transition bonds in the electricity industry was in California, where it was used to strand approximately $10bn in generation assets and deliver 10% tariff reduction. As quantitative analysis later in this article demonstrate, the effectiveness of a securitisation program is contingent upon (i) interest rate differentials being greater than debt-tenor differences and (ii) where capital markets have systematically overestimated the risk of utility default on utility bond payments (Ritschel & Smestad 2003). More directly, Michaels (1998, p60) notes that unless capital markets are wildly inefficient, securitization's effect on a utility's cost of capital is likely to be small.

[36] See for example Hogan, 1994; Navarro, 1996; Joskow, 1996; Brennan & Boyd 1997; Madian, 1997; Pagach & Peace 2000; Martin, 2001; Woo et al. 2003; Ritschel & Smestad 2003.

Table 1: **Model Inputs**

Financial Inputs (t=1)				Network Inputs (t=1)	
RPI	π	2.25%		Customer Numbers	1.5m
RPI-X	π-X	1.25%		Avg Household Load	6800kWh
Remain. Asset Life	l	30 Yrs		Total Residential Load	10,072GWh
Net Capital Exp.	C	$400m		Connections Growth pa	1.60%
Operating Exp.	θ	$300m		New Households Load	4200kWh
Transmission Chrg.	ϑ	$275m		Energy Efficiency Effect	0.5% pa
Accounting Tax	$a\tau^i$	30%		3.5kW Solar Takeup Rate	3% pa
Est. Cash Tax	$c\tau^i$	15%		Battry Takeup from Yr 6	3% pa
Benchmark Gearing	D^u/V^u	60%		Solar Self Consumption	2845kWh
Reference Rate	R^u	2.90%		Battery Self Consumption	1581kWh
BBB Credit Spread	S^u	219bps		Residential Sales / Total	80%
Market Returns	Rm	9.40%		Own-Price Elasticity	-0.10
Risk Free Rare	Rf	2.90%		Network Charges / Total	45%

Salient features of the regulated monopoly utility modelled include an opening RAB of $10 billion of which 70% relates to 1.5 million household customers. Total residential load commences at 10,072GWh but decays each year starting at 0.8% and accelerating to 2.5% through a combination of energy efficiency effects (0.5% lost load pa), rising solar PV and battery take-up rates (starting at 0.3% and rising to 2.0% lost load pa). This is partially offset by new connections growth (1.6%), albeit new customers (4,200kWh) are 40% smaller than existing customers (6800kWh). Note that in this stylised example, other variables that may positively impact on load growth (e.g. electric vehicles) are assumed away in order to meet the necessary conditions for asset stranding. Estimated own-price elasticity is -0.10 and benchmark WACC is 6.2%.

4.1 Regulated Monopoly Model: Annual Regulated Revenue Requirement

Determining the Annual Regulated Revenue Requirement (AR_t^i) for network utility *i* in each year *t* involves a building block approach comprising approved Operating Expenses θ_t^i, Return of Capital (i.e. Regulatory Depreciation) δ_t^i, Cash Taxes $c\tau_t^i$, Return on Capital r_t^i and Transmission Use of System charges ϑ_t^i:

$$AR_t^i = \sum\left(\theta_t^i, \delta_t^i, c\tau_t^i, r_t^i, \vartheta_t^i\right) \mid \delta_t^i = \left(RAB_t^i / l_t^i\right) - \left[RAB_t^i \cdot (1+\pi_t)\right] \wedge r_t^i = \left(RAB_t^i\right) \cdot WACC^u \quad (1)$$

δ_t^i is derived by calculating Straight-Line Depreciation (RAB_t^i / l_t^i) where (l_t^i) is average remaining useful asset life of the i^{th} utility at time *t*, then deducting RAB Indexation $[RAB_t^i \cdot (1+\pi_t)]$ – the latter being how price inflation (viz. π_t) is accounted for in the sunk cost recovery process. $WACC^u$ for electricity utility sector, u, is subsequently defined in eq.(4). With Operating Expenses, $\forall t > 1$, θ_t^i escalates at $RPI - X$.

Each year RAB_t^i is rolled-forward:

$$RAB_{t+1}^i = \left[RAB_t^i + C_t^i + \left(RAB_t^i \cdot \pi_t\right) - \left(RAB_t^i / l_t^i\right)\right] \quad (2)$$

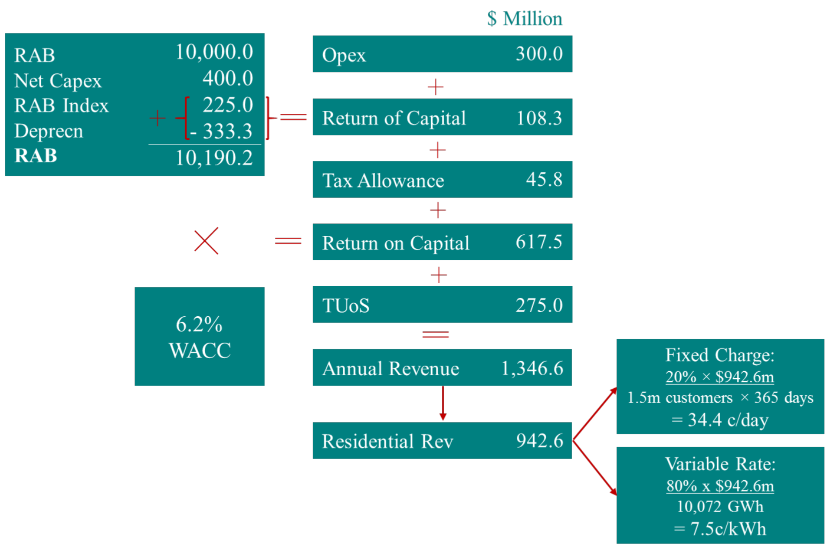
Where C_t^i is Net Capital Expenditure of the i^{th} utility in year *t* (i.e. capital expenditure *less* asset disposals), and (π_t) is the inflation index.

Network businesses have numerous customer segments and multiple tariff designs. AR_t^i is recovered through non-linear tariff structures given expected annual quantities from customer segments:

$$AR_t^i \equiv \sum_{t=1}^{n} \sum_{j=1}^{m} \left(p_t^{kj} \cdot q_t^{kj}\right) \qquad (3)$$

Where p_t^{kj} is the price of the k^{th} component of tariff *j* in year *t* and q_t^{kj} is the relevant expected quantity of component *k* of tariff *j* in year *t*. Note the relevant quantity may be kWh, kW or the number of days in year *t*.[37] Interaction between Table 1 and equations (1), (2) and (3) is illustrated in Figure 2.

Figure 2: **Annual Regulated Revenue Requirement**



4.2 Regulated Monopoly Model: Cost of Capital

A crucial input driving results in equations (1) and (3) is the $WACC^u$ for regulated utility firms *u*:

$$WACC^u = \left\{\left(\frac{E_t^u}{V_t^u}\right).\left(\frac{R_f + [R_m - R_f).\beta^u]}{[1 - c\tau_t^i.(1-\gamma^u)]}\right)\right\} + \left\{\left(\frac{D_t^u}{V_t^u}\right).(R_t^u + S_t^u)\right\} \qquad (4)$$

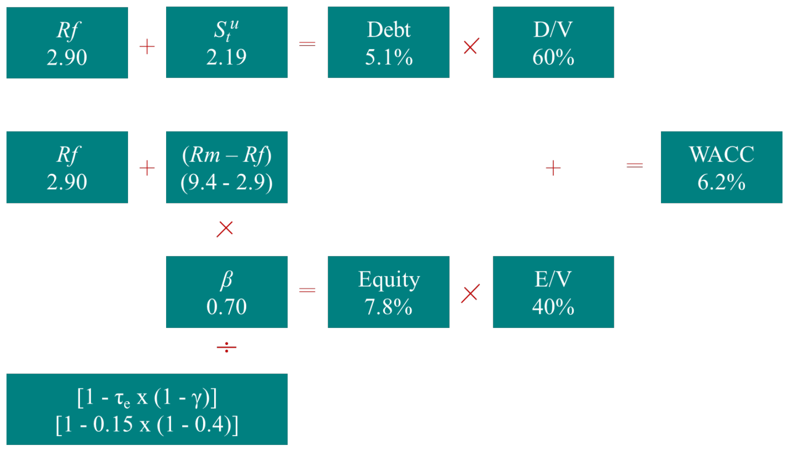
Where:

R_f = Risk free rate of return
R_m = expected market return
β^u = equity beta for the regulated electricity utility firms *u*
E_t^u = sector benchmark value of equity
D_t^u = sector benchmark value of debt
V_t^u = total market value $= (E_t^u + D_t^u)$
R_t^u = reference interest rate (swap rate) in year *t* of regulated utility firms *u*
S_t^u = credit spread given BBB credit ratings of regulated utility firms u in year *t*
$c\tau_t^i.$ = effective taxation rate for the i^{th} firm
γ^u = estimated utilization of imputation tax credits of regulated utility firms *u*

[37] Consequently, the unit price may be c/kWh, $/kW or c/day.

Equation (4) is based on the seminal works of Sharpe (1964) and Lintner (1965) with modifications by Monkhouse (1993) and Officer (1994) to deal with dividend imputation (for those jurisdictions with taxation systems incorporating imputation credits). Its operation is illustrated in Figure 3.

Figure 3: $\boldsymbol{WACC}$



4.3 **Regulated Monopoly Model: Base Case Dynamic Financial Model**

Profit & Loss Statements are set out in a conventional format where Earnings Before Interest & Tax $(EBIT_t)$ and Cash Earning $(EBITDA_t)$ are given by:

$$EBIT_t = AR_t^i - \sum\left(\theta_t^i, \delta_t^i, \vartheta_t^i\right) \wedge EBITDA_t = EBIT_t + \vartheta_t^i \qquad (5)$$

Deducting interest costs and accounting taxes $a\tau_t^i$ from $EBIT_t$ produces underlying Net Profit after Tax $(NPAT_t)$. Accounting taxes $a\tau_t^i$ differ from cash taxes $c\tau_t^i$ due to temporal and permanent differences between accounting and tax treatments of various deductibles from income. In addition, actual debt levels in time *t* for the *i*th firm D_t^i will deviate, sometimes substantially, from sector benchmark D_t^u.

$$NPAT_t = \left[EBIT_t - \left[D_t^i \cdot (R_t^u + S_t^u)\right]\right] \cdot a\tau_t^i \;\middle|\; a\tau_t^i = 30\% \;\forall\, t \qquad (6)$$

Cash Flow Statements follow convention with Net Cash Flow in time *t* (NCF_t) given by:

$$NCF_t = \left[EBITDA_t - c\tau_t^i - \left[D_t^i \cdot (R_t^u + S_t^u)\right] - \rho_t^i - C_t^i - Y_t^i\right] \left|\rho_t^i = \frac{D_t^i}{\left[1-\left(1+(R_t^u+S_t^u)\right)^{-n} / (R_t^u+S_t^u)\right]} \wedge c\tau_t^i = \left[EBIT_t - \left[D_t^i \cdot (R_t^u + S_t^u)\right] \cdot 15\% \;\forall\, t\right]\right. \qquad (7)$$

ρ_t^i is principle repayments on outstanding debt D_t^i for the *i*th firm in time *t*, and Y_t^i is dividends declared and paid to shareholders of the *i*th firm in year *t* (dividends are paid in the year declared). All other variables are as described above.

Balance Sheets comprise working capital ω_t^i which is modelled to match anticipated quarterly outlays associated with cash costs θ_t^i, ϑ_t^i, $D_t^i \cdot (R_t^i + S_t^u)$ and ρ_t^i. Fixed assets are set to RAB_t^i. While the value of Debt D_t^i is initially set at the regulatory benchmark (D_t^i/V_t^i), in subsequent years it provides the mechanism by which cash surpluses or deficits are absorbed:

$$D_t^i = [RAB_t^i \cdot (D_t^i/V_t^i)] \wedge \ D_{t+1}^i = (D_t^i - \rho_t^i - NCF_t + d\omega_t^i) \quad (8)$$

Consequently, Equity E_t^i is calculated as:

$$E_t^i = (\omega_t^i + RAB_{t+1}^i - D_t^i) \quad (9)$$

The Model produces three financial and three credit ratios:

Return on Assets	$EBIT_t/(\omega_t^i + RAB_t^i)$	(10)
Return on Equity	$NPAT_t/E_t^i$	(11)
Running Div. Yield	Y_t^i/E_t^i	(12)
Gearing	$D_t^i/(\omega_t^i + RAB_t^i)$	(13)
FFO/Debt	$FFO_t/D_t^i \mid FFO_t^i = [EBITDA_t - D_t^i \cdot (R_t^u + S_t^u) - c\tau_t^i]$	(14)
FCF/Debt	$(FFO_t - C_t^i - d\omega_t^i)/D_t^i$	(15)

Base Case results from the model are illustrated in Table 2.

Table 2: **Base Case Results (Years 1-7)**

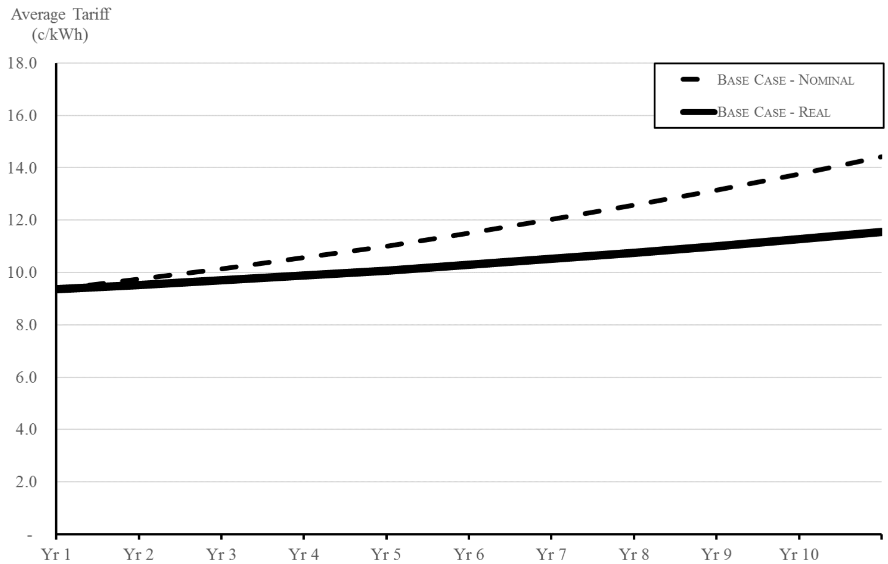
		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7
ENERGY SALES								
Energy Sold (GWh)		10,072	9,990	9,906	9,820	9,732	9,608	9,482
Fixed Charge (c/day)		34.4	34.7	35.1	35.4	35.7	36.0	36.3
Variable Rate (c/kWh)		7.49	7.8	8.1	8.5	8.9	9.3	9.7
Overall Average Rate (c/kWh)		9.4	9.7	10.1	10.6	11.0	11.5	12.0
PROFIT & LOSS								
Revenue		$1,346.6	$1,390.5	$1,435.6	$1,481.8	$1,529.4	$1,578.1	$1,627.9
TUoS		$275.0	$279.8	$284.7	$289.7	$294.8	$299.9	$305.2
Opex		$300.0	$305.3	$310.6	$316.0	$321.6	$327.2	$332.9
Depreciation		$108.3	$122.8	$138.7	$156.0	$174.9	$195.5	$217.9
EBIT		$663.3	$682.7	$701.7	$720.2	$738.1	$755.4	$772.0
Interest		$312.1	$321.0	$329.0	$336.0	$342.0	$346.9	$350.5
Taxation - Accounting		$105.4	$108.5	$111.8	$115.2	$118.8	$122.6	$126.4
NPAT (Underlying)		$245.8	$253.2	$260.8	$268.9	$277.3	$286.0	$295.0
Significant Item - STRANDING		$0.0						
NPAT (Statutory)		$245.8	$253.2	$260.8	$268.9	$277.3	$286.0	$295.0
CASH FLOW								
EBITDA		$771.6	$805.5	$840.3	$876.1	$913.0	$951.0	$989.9
Taxation - Cash		$52.7	$54.2	$55.9	$57.6	$59.4	$61.3	$63.2
Debt - Interest		$312.1	$321.0	$329.0	$336.0	$342.0	$346.9	$350.5
Debt - Principal		$126.9	$137.2	$147.7	$158.6	$169.6	$180.8	$191.9
Capex		$400.0	$407.0	$414.1	$421.4	$428.7	$436.2	$443.9
Dividends *Limit:* 6.0%		$176.6	$175.3	$174.2	$173.2	$172.5	$172.1	$172.0
Net Cash Flow		-$296.6	-$289.3	-$280.6	-$270.7	-$259.2	-$246.2	-$231.6
BALANCE SHEET	Open							
Working Capital	$220.1	$225.1	$230.1	$235.3	$240.6	$246.0	$251.5	$257.2
Stranding Recovery		$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Fixed Assets	$10,000.0	$10,291.7	$10,575.9	$10,851.3	$11,116.7	$11,370.6	$11,611.3	$11,837.2
Total Assets	$10,220.1	$10,516.7	$10,806.0	$11,086.6	$11,357.3	$11,616.6	$11,862.8	$12,094.4
Debt Finance	$6,132.1	$ 6,306.7	$ 6,463.9	$ 6,602.0	$ 6,719.4	$ 6,814.5	$ 6,885.5	$ 6,930.9
Equity	$4,088.0	$4,210.0	$4,342.1	$4,484.6	$4,637.9	$4,802.1	$4,977.3	$5,163.6
RATIOS								
Return on Assets (underlying)		6.3%	6.3%	6.3%	6.3%	6.4%	6.4%	6.4%
Return on Equity (headline)		5.8%	5.8%	5.8%	5.8%	5.8%	5.7%	5.7%
Running Yield to Opening Equity		4.3%	4.2%	4.0%	3.9%	3.7%	3.6%	3.5%
Gearing	60%	60.0%	59.8%	59.5%	59.2%	58.7%	58.0%	57.3%
FCF/Debt *('Modest Positive' = BBB-)*		0.0%	0.3%	0.5%	0.8%	1.1%	1.5%	1.8%
FFO/Debt *(> 6% = BBB-)*		6.5%	6.7%	6.9%	7.2%	7.5%	7.9%	8.3%
Implied Credit Rating		BBB-	BBB-	BBB-	BBB	BBB	BBB	BBB

5. Asset Stranding and Recovery Remedies

Results from the model outlined in Section 4 and presented in Table 2 show an accelerating fall in Base aggregate demand (necessary condition), a 24% rise in RAB (sufficient condition), and thus tariffs rise by 47% (20% real) in aggregate. This is illustrated in Figure 4.[38] It is important to stress stylised model inputs drive these results.

[38] Table 2 focuses on the results for Years 1-7 but the model extends to Year 10. In Year 10, RAB is $12,406m or 24% higher than Year 1. Similarly the Year 10 overall average rate (tariff) is $13.8c/kWh which is 47% higher than the Year 1 result.

Figure 4: **Base Case Tariff Trajectory**



A bottom-up asset re-optimisation process is feasible but the nature of the present exercise is better served by an administrative ‘top-down’ approach. As Rose (1996) explains, it is frequently tariffs, not assets, that are stranded. To analyse various remedies, and to ensure tractability of modelling results, a stable overall average rate of 7.5c/kWh (real) has been targeted at the end of a 7-year stranding recovery period (*cf* 9.4c/kWh in Year 1).

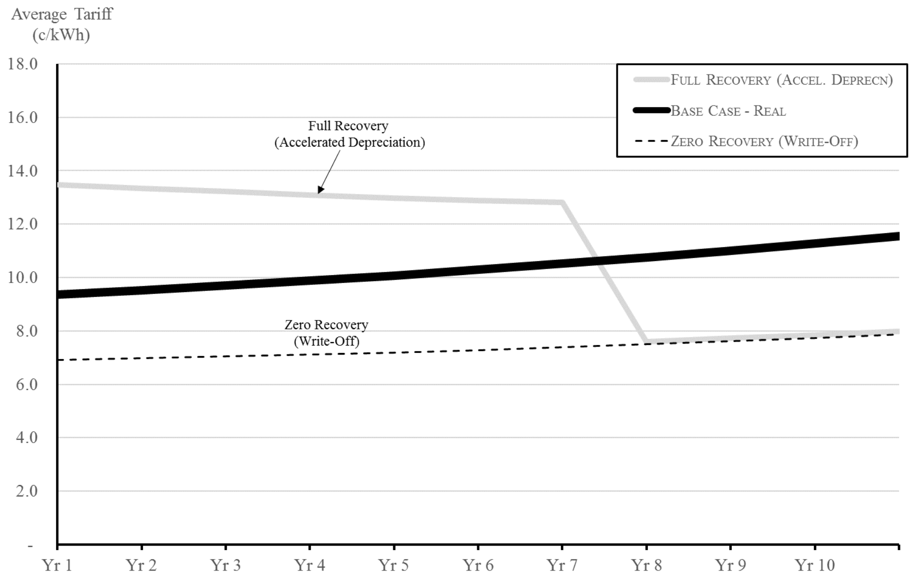
In order to meet this objective the Model drives $RAB^{i}_{t=1}$ down until the ‘average rate tariff’ equals 7.5c/kWh in Year 7. The difference between $RAB^{i}_{t=1}$ before and after the simulation is the total value of *Stranded Assets.* The Model derives Stranded Assets of $4,709.1 million (47.1% of RAB_t). In all subsequent scenarios, only two variables alter from base assumptions in Table 1. In any stranding event:

- capital markets will react. β^{u} is assumed to increase from 0.7 to 0.9 (i.e. $WACC^{u}$ increases from 6.2 to 6.7%). However, credit spread S^{u}_{t} is held constant for reasons which become apparent in Section 5.4; and
- rational firms will (materially) curtail forward Capex – from $400m to $150m pa.

5.2 **Full Recovery vs. Zero Recovery**

Figure 5 presents tariff trajectories under extremities of *Full Recovery* and *Zero Recovery*. Full Recovery involves accelerated depreciation over a 7-year window with tariffs rising from 9.4c to 13.5c/kWh. Conversely, tariffs fall to 6.9c/kWh with Zero Recovery. Both scenarios meet-up in Year 8 at 7.5c/kWh. These two scenarios can be thought of as the ‘book-ends’ of all plausible scenarios given $4,709.1 million in stranded assets.

Figure 5: **10-year tariff trajectory – Full Recovery vs No Recovery (no elasticity, constant dollars)**



5.3 Identifying the Investment-Grade Threshold

From a purely practical perspective, for policymakers one problem with Zero Recovery is the magnitude of financial distress. Table 3, extracted from the Model, shows Year 1 financial position. Results are produced for three scenarios – Base, Zero Recovery and a *Threshold* case.

Table 3: **Financial Position**

	Profit & Loss Statement		**Base**	**Zero Recovery**	**Threshold**
1	Revenue		$1,346.6	$993.4	$1,289.4
2	TUoS		$275.0	$275.0	$275.0
3	Opex		$300.0	$300.0	$300.0
4	Depreciation		$108.3	$57.4	$93.8
5	EBIT		$663.3	$361.0	$620.7
6	Interest		$312.1	$312.1	$312.1
7	Taxation - Accounting		$105.4	$14.7	$92.6
8	NPAT (Underlying)		$245.8	$34.2	$216.0
9	**Significant Item - STRANDING**		$0.0	-$4,709.1	-$1,339.9
10	NPAT (Statutory)		$245.8	-$4,674.9	-$1,123.9
			$0.0		
	Cash Flow				
11	EBITDA		$771.6	$418.4	$714.4
12	Taxation Cash		$52.7	$7.3	$46.3
13	Debt - Interest		$312.1	$312.1	$312.1
14	Debt - Principal		$126.9	$126.9	$126.9
15	Capex		$400.0	$150.0	$150.0
16	Dividends		$176.6	$0.0	$79.1
17	**Net Cash Flow**		-$296.6	-$178.0	$79.1
			$0.0		
	Balance Sheet	**Opening**	**Close**	**Close**	**Close**
18	Working Capital	$220.1	$225.1	$225.1	$225.1
19	Fixed Assets	$10,000.0	$10,291.7	$5,383.6	$8,716.3
20	Total Assets	$10,220.1	$10,516.7	$5,608.6	$8,941.4
21	Debt Finance	$6,132.1	$6,306.7	$6,188.1	$5,931.0
22	Equity	$4,088.0	$4,210.0	-$579.5	$3,010.4
		$10,220.1	$10,516.7	$5,608.6	$8,941.4
	Ratios				
23	Return on Assets (underlying)		6.3%	n/a	n/a
24	Return on Equity (headline)		5.8%	n/a	n/a
25	Running Yield to Opening Equity		4.3%	n/a	1.9%
26	Gearing	60.0%	60.0%	110.3%	66.3%
27	FCF/Debt *('Modest Positive' = BBB-)*		0.0%	-0.8%	3.5%
28	FFO/Debt *(> 6% = BBB-)*		6.5%	1.6%	6.0%
29	Implied Credit Rating		BBB-	Distress	BBB-

With Zero Recovery, the $4,709.1m stranding event (Table 3, Line 9) produces an unambiguous episode of financial distress measured by credit metrics (lines 26-29). In the *Threshold* case, the Model reverse-engineers an asset write-off value that sends the benchmark utility to the edge of investment-grade credit (i.e. BBB- rating). Doing so identifies the maximum non-recovery value that will not disrupt the financial integrity of the benchmark utility during a stranding episode.[39] The relevant binding metric is *FFO/Debt > 6%* (line 28), which drives the stranding amount to $1,339.9m (line 9). This

[39] A utility does not become moribund just because it loses an investment-grade credit rating. However, in my experience the loss of an investment grade credit-rating does result in credit-support triggers (with debt providers key suppliers) being activated which in turn substantially impairs the performance of an organisation (i.e. managerial distraction), and is particularly disruptive if ongoing investment is required.

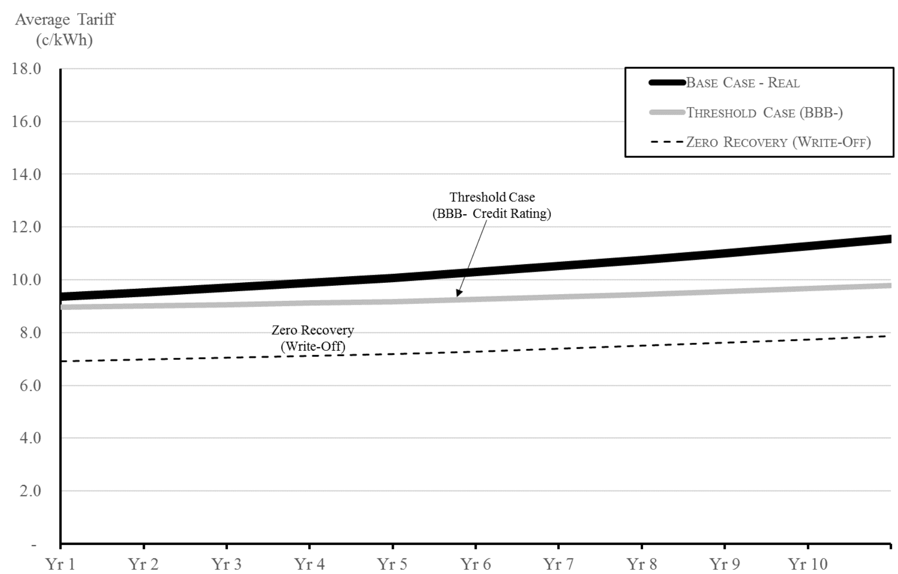
means the recovery amount is $3,369.2m (i.e. $4,709.1m – $1,339.9m) as outlined in Table 4.

Table 4: **Summary of Asset Stranding**

Opening RAB	$10,000.0	
Stranded Assets (7.5c/kWh) ψ^i	$4,709.1	47.1%
Non-Recovery Amount (BBB-)	$1,339.9	28.5%
Stranding Recovery Amount φ^i	$3,369.2	71.5%
New RAB	$5,290.9	52.9%
Net capex	$150.0	
Indexation of Revised RAB	$119.0	
Straight-line depreciation	-$176.4	
Closing RAB	$5,383.6	

Figure 6 illustrates the tariff trajectory for the Threshold case (*cf.* Base and Zero Recovery cases).

Figure 6: **Tariff Trajectory for Base, Write-Off & Threshold case (*no elasticity, constant dollars*)**



5.4 Partial Recovery: Return of Capital vs. Transition Bonds

Figure 7 presents a comparison of two partial recovery remedies with a 71.5% recovery rate per Table 4. Recall the recovery amount was determined in a step-wise process driven by (i) the level of assets stranded to meet 7.5c/kWh, and (ii) the level of (partial) stranded asset recovery that ensures investment grade credit is maintained. To be clear, this process may appear an analytical outcome but in practice would be a matter of intense debate.

In order to derive AR_t^i for the Return of Capital case, let ψ^i be the value of Stranded Assets of the i^{th} firm and let φ^i be the Stranding Recovery Amount and z be the number of years over which it is recovered. Equation (1) is thus modified as follows:

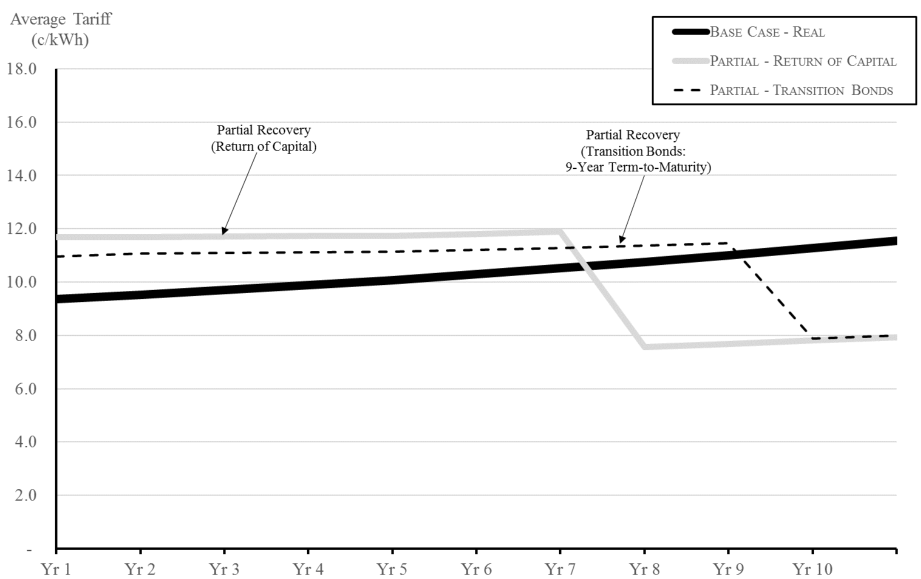
$$AR_t^i = \sum\left(\theta_t^i, \delta_t^i, c\tau_t^i, r`_t^i, \vartheta_t^i, \varpi_t^i\right) \mid r`_t^i = \left(RAB_t^i - \psi^i\right) \cdot WACC`^u \wedge \forall\, t \leq z, \varpi_t^i = \left(\varphi^i \div z\right) \quad (16)$$

Note $r`_t^i \neq r_t^i$ due to a policy-driven change in β^u and the reduction in RAB_t^i arising from ψ^i.

In order to derive AR_t^i for the Transition Bond case, let b_t^i be the annual cash flows associated with Transition Bonds issued with a tenor of y years and coupon I^i in order to finance Stranding Recovery Amount φ^i. Equation (16) is thus modified to:

$$AR_t^i = \sum\left(\theta_t^i, \delta_t^i, c\tau_t^i, r`_t^i, \vartheta_t^i, b_t^i\right) \mid b_t^i = \left[\frac{\varphi_t^i}{\left[1-\left(1+I^i\right)^{-t}/\left(I^i\right)\right]} + \left(\varphi_t^i \cdot I^i\right)\right] \forall\, t \leq y \quad (17)$$

Figure 7: **Return of Capital vs Transition Bonds (*no elasticity, constant dollars*)**



The Return of Capital case establishes a stranding account which is recovered over a 7-year window at the rate of $481.3m pa. This would be levied as a non-bypassable fixed charge[40], viz. in Year 1 the (average) fixed charge increases from 34.5c/day to 123.9c/day, while the variable rate reduces from 7.49c/kWh to 4.9c/kWh.[41] In Year 8, the tariff resets to 34.9c/day and 6.6c/kWh (i.e. an overall average rate of 7.5c/kWh in real terms).

[40] If the fixed charge was a uniform rate to all customers, it would adversely impact smaller users and thus the tariff design used here may well need to be adjusted to suit certain other policy objectives relating to consumer segments (e.g. pensioners).
[41] To be clear, the variable rate decreases from 7.49c/kWh to 4.9c/kWh as a result of asset stranding. The daily fixed charge increases from 34.5c/day to 123.9c/day as a result of the recovery mechanism.

The Transition Bond case involves issuing $3,369m (i.e. φ^i) of fully amortising 9-year bonds, enhanced via a government wrap, with a coupon of 1.75% per equation (17). Bond payments via customer contributions would be met by raising fixed charges from 34.5c/day to 110.5c/day while the variable rate is reduced from 7.49c/kWh to 4.9c/kWh.[42] In Year 10, the tariff resets to 34.6c/day and 7.2c/kWh. Note in stranding cases, the model limits the running yield with surplus cash used to repay debt:

$$if\left(\varphi^i \geq 0\right), \forall\, z, y, Y_t^i / E_t^i \leq 6\% \qquad (18)$$

5.5 Comparison of Scenarios and Demand Elasticity Effects

Figure 8 presents all six scenarios. The Threshold case does not meet the objective of 7.5c/kWh – its purpose was to derive the financial integrity limit based on 'regulated benchmark' gearing.[43] As noted earlier, *Zero Recovery* and *Full Recovery* provide the 'bookends' of policy options for a $4,709.1 million asset stranding, while Partial Recovery methods provide examples of recovery options for a given recovery ratio (71.5% recovery in this instance). There are numerous credible alternatives bounded by these solutions. The scenarios all converge at 7.5c/kWh in Year 7 (or 9). Crucially however, this assumes inelastic demand.

Figure 8: **Comparison of Scenarios (no elasticity, constant dollars)**

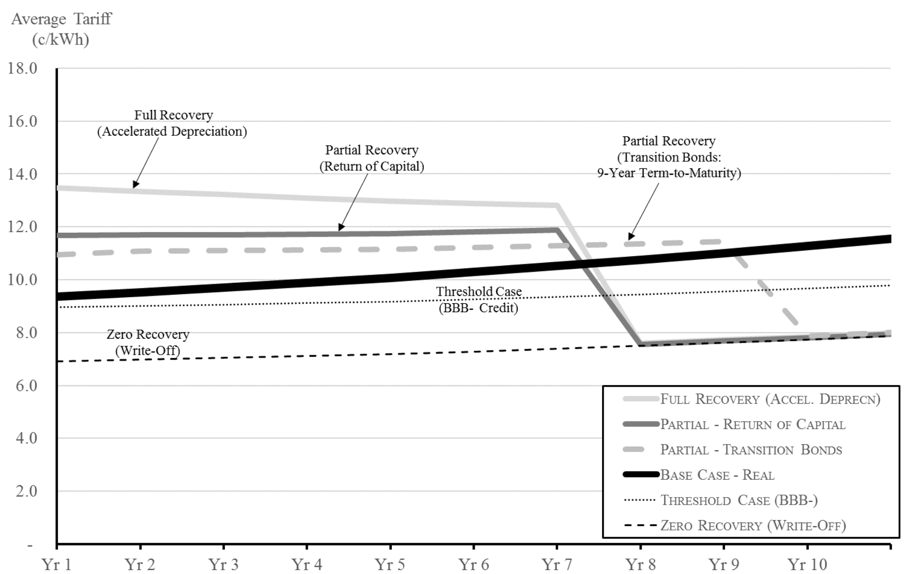


Figure 9 relaxes the inelastic demand assumption. Note the trajectory of all scenarios change slope – rising tariffs reinforcing the *Death Spiral* in Years 1-7(9) before falling and stabilising in Year 8(10).

[42] As with the Return of Capital case, in Year 1 the variable rate decreases from 7.49c/kWh to 4.9c/kWh as a result of asset stranding while the daily fixed charge increases from 34.5c/day to 110.5c/day as a result of the recovery mechanism (in this instance, the Transition Bonds).

[43] In practice, regulated entities in Australia gear their balance sheets beyond the regulated 60% benchmark (viz. 70-75%). Consequently, the non-recovery amount envisaged in this article would probably still result in financial distress to a regulated entity. However, above benchmark gearing is a managerial choice.

Figure 9: **Comparison of Scenarios with elastic demand (-*0.10, constant dollars*)**

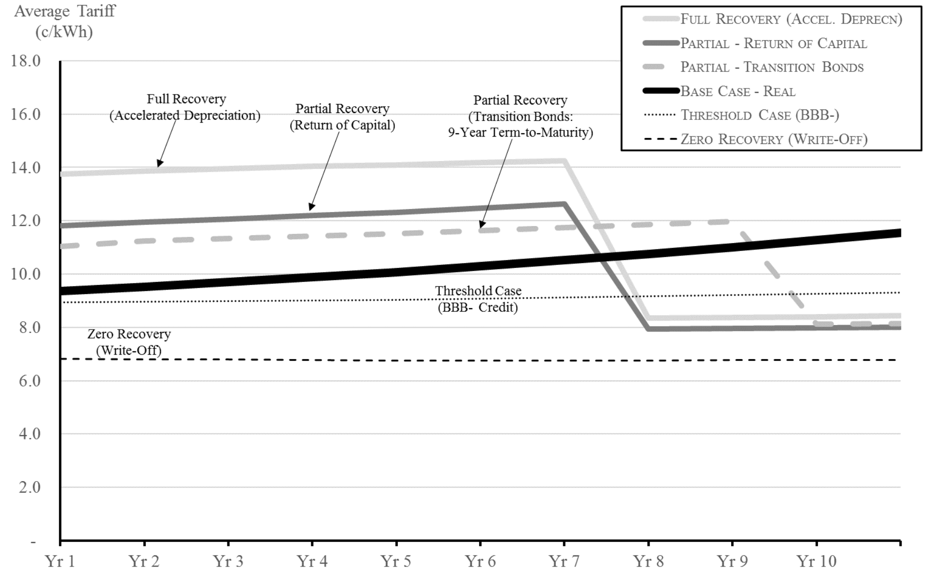


Figure 10 illustrates tariff trajectories with own-price elasticity set to -0.15, and Table 5 includes the financials using the Return of Capital Case as illustrative.

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Figure 10: **Comparison of Scenarios with elastic demand (*-0.15, constant dollars*)**

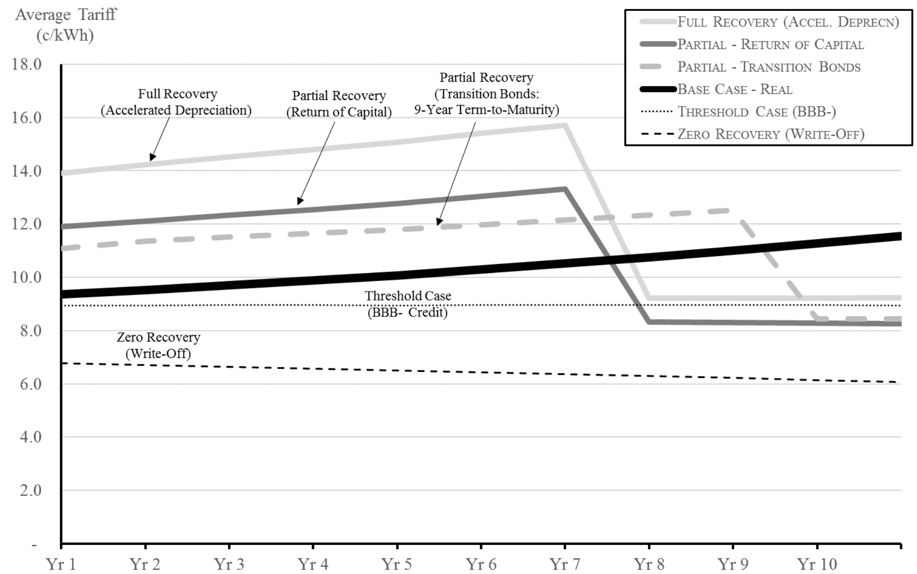

Table 5: **10 Year Financial Position: $4,709m Asset Stranding, Return of Capital: $3,369m**

		Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10
ENERGY SALES											
Energy Sold (GWh)		10,072	9,990	9,906	9,820	9,732	9,608	9,482	9,351	9,218	9,080
Fixed Charge (c/day)		123.9	122.3	120.8	119.3	117.8	116.4	114.9	34.9	34.7	34.6
Variable Rate (c/kWh)		4.9	5.1	5.4	5.6	5.8	6.1	6.3	6.6	6.9	7.2
Overall Average Rate (c/kWh)		11.7	12.0	12.2	12.5	12.9	13.2	13.6	8.9	9.2	9.6
PROFIT & LOSS											
Revenue		$1,474.7	$1,499.9	$1,526.3	$1,553.3	$1,581.1	$1,609.5	$1,638.6	$1,187.1	$1,214.9	$1,243.5
TUoS		$275.0	$279.8	$284.7	$289.7	$294.8	$299.9	$305.2	$310.5	$315.9	$321.5
Opex		$300.0	$305.3	$310.6	$316.0	$321.6	$327.2	$332.9	$338.7	$344.7	$350.7
Depreciation		$57.4	$64.4	$72.1	$80.4	$89.4	$99.2	$109.6	$121.0	$133.3	$146.7
EBIT		$842.3	$850.4	$858.9	$867.2	$875.3	$883.3	$890.9	$416.9	$421.1	$424.7
Interest		$312.1	$305.9	$294.7	$281.9	$267.4	$251.3	$233.6	$214.2	$210.9	$207.0
Taxation - Accounting		$159.1	$163.3	$169.2	$175.6	$182.4	$189.6	$197.2	$60.8	$63.0	$65.3
NPAT (Underlying)		$371.1	$381.1	$394.9	$409.7	$425.5	$442.4	$460.1	$141.9	$147.1	$152.3
Significant Item - STRANDING		-$4,709.1									
NPAT (Statutory)		-$4,338.0	$381.1	$394.9	$409.7	$425.5	$442.4	$460.1	$141.9	$147.1	$152.3
CASH FLOW											
EBITDA		$899.7	$914.8	$931.0	$947.6	$964.8	$982.4	$1,000.5	$537.8	$554.3	$571.3
Taxation - Cash		$79.5	$81.7	$84.6	$87.8	$91.2	$94.8	$98.6	$30.4	$31.5	$32.6
Debt - Interest		$312.1	$305.9	$294.7	$281.9	$267.4	$251.3	$233.6	$214.2	$210.9	$207.0
Debt - Principal		$126.9	$130.7	$132.3	$133.0	$132.6	$131.0	$127.9	$123.3	$127.6	$131.6
Capex		$150.0	$152.6	$155.3	$158.0	$160.8	$163.6	$166.5	$169.4	$172.3	$175.3
Dividends *Limit: 6.0%*		$231.1	$149.2	$139.1	$130.7	$123.8	$118.5	$114.7	$54.8	$57.0	$59.5
Net Cash Flow		$0.0	$94.7	$124.9	$156.2	$189.0	$223.2	$259.2	-$54.2	-$45.0	-$34.7
BALANCE SHEET	Open										
Working Capital	$220.1	$225.1	$230.1	$235.3	$240.6	$246.0	$251.5	$257.2	$263.0	$268.9	$274.9
Stranding Recovery		$2,887.9	$2,406.6	$1,925.2	$1,443.9	$962.6	$481.3	$0.0	$0.0	$0.0	$0.0
Fixed Assets	$10,000.0	$5,383.6	$5,471.7	$5,554.9	$5,632.6	$5,703.9	$5,768.4	$5,825.2	$5,873.6	$5,912.7	$5,941.4
Total Assets	$10,220.1	$8,496.5	$8,108.4	$7,715.5	$7,317.1	$6,912.5	$6,501.2	$6,082.4	$6,136.6	$6,181.6	$6,216.3
Debt Finance	$6,132.1	$ 6,010.1	$ 5,789.8	$ 5,537.7	$ 5,253.8	$ 4,937.6	$ 4,588.9	$ 4,207.5	$ 4,144.2	$ 4,067.5	$ 3,976.7
Equity	$4,088.0	$2,486.4	$2,318.7	$2,177.8	$2,063.3	$1,974.9	$1,912.3	$1,874.9	$1,992.4	$2,114.0	$2,239.6
RATIOS											
Return on Assets (underlying)		9.9%	10.5%	11.1%	11.9%	12.7%	13.6%	14.6%	6.8%	6.8%	6.8%
Return on Equity (headline)		-174.5%	16.4%	18.1%	19.9%	21.5%	23.1%	24.5%	7.1%	7.0%	6.8%
Running Yield to Opening Equity		5.7%	6.0%	6.0%	6.0%	6.0%	6.0%	6.0%	2.9%	2.9%	2.8%
Gearing	60%	70.7%	71.4%	71.8%	71.8%	71.4%	70.6%	69.2%	67.5%	65.8%	64.0%
FCF/Debt *('Modest Positive' = BBB-)*		5.9%	6.4%	7.1%	7.9%	8.9%	10.2%	11.8%	2.9%	3.3%	3.8%
FFO/Debt *(> 6% = BBB-)*		8.5%	9.1%	10.0%	11.0%	12.3%	13.9%	15.9%	7.1%	7.7%	8.3%
Implied Credit Rating		BBB	BBB+	BBB+	BBB+	BBB+	BBB+	BBB+	BBB	BBB	BBB

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6. Conclusion

Under what conditions should policymakers consider asset stranding policy? It would appear that the *only* necessary condition is a terminal decline in energy (kWh) and peak (kW) demand arising from a discontinuity and the sufficient condition is non-negative cost growth. These are the key ingredients of a *Death Spiral*, and under these conditions the regulatory framework will approach the limits of its design envelope. Consequently, it is of utmost importance for policymakers to establish whether disruptive competition is a singular event with transient impacts or the start of a pattern of disruption in which demand contraction is enduring (Graffy & Kihm, 2014). If it is the latter, then the long term interests of consumers and shareholders will be best served by dealing with stranded assets as expediently as possible. There is the more general case of manifest load forecast error and associated overinvestment mistakes in retrospect which, if material enough, can produce conditions equivalent to a *Death Spiral*.

If conditions persist and policymakers, regulators and utilities fail to act, ongoing price rises can be expected to further damage residual demand, investment by disruptive rivals will be above the efficient level, and shareholder losses greater than they need be. Ultimately, if utilities and regulators make it onerous to remain connected to a network, disruptive rivals will help customers sever that connection (Graffy & Kihm, 2014).

Stranded regulated utility assets is a *relatively* new branch of regulatory economics. Experience with necessary conditions is limited throughout the 120+ year history of utility services. Early contributions to literature commenced in the US during the 1980s but no crystalising path emerged. FERC Order 888, which granted full recovery, *was contentious* and sparked an expansive literature. That literature, including important contributions in applied finance, has helped to close some of the gaps in my opinion.

In this article, 10 principles were extracted from the review of literature. Central to these is that there is no serious argument for *zero recovery*. The behaviour of regulated monopoly utilities is constrained by policy and regulation, and they are compelled to invest to meet universal service obligations. But neither are there credible arguments for *full recovery*. The regulatory compact is an incomplete agreement. As Michaels (1995) explained, why would a rational end-user be party to an agreement that offers virtually no protection to price rises and exposes users to being a cash-cow of their utility? Ultimately, stranded assets should be assessed on a case-by-case basis, with recovery based on a normative analysis of economics and law, and an 'ex ante causation' approach. An independent panel would be necessary to adjudicate each episode. And, recovery mechanisms should be time-limited and non-bypassable.

This article explored an applied example. Given stylised input assumptions, results demonstrated the $10bn utility had limited tolerance for *Zero Recovery* ($1.34bn) before triggering the credit rating constraint. Conversely, to meet the tariff objective stranding $4.71 bn of assets was necessary. The difference between these two figures ($3.37bn) was deemed the recovery amount. This translated to a partial recovery ratio of 71.5%. Coincidentally, US equity capital markets anticipated a similar stranding recovery ratio during the 1990s prior to the announcement of FERC Order 888. In the model, recovery was structured over a 7-year (Return of Capital) or 9-Year (Transition Bond) window.

From a political economy perspective, a challenging aspect of asset stranding would be Year 1 tariff increases associated with recovery mechanisms. Context is everything. In prior periods tariffs will have been increasing – were they not it is doubtful asset stranding would be necessary. Return of Capital increased tariffs by 23.9% (10.8% at the retail level) while Transition Bonds produced a 16.4% increase (7.4% retail). Conversely, at the end of the recovery period tariffs were 28% lower than the Base Case (17% in real terms), and, on a stable trajectory given the elasticity estimate of -0.10. Moreover, the benchmark utility could sustain investment grade credit throughout, and following, the recovery period.

As an absolute general conclusion, this article has showed how an asset stranding policy *can* be done. It does not show how it *should* be done. Stranding remedies were deployed using a top-down approach with an objective function of an (implied 'efficient') tariff rate, a stable trajectory, and a binding regulatory benchmark of 'investment grade credit'. It is to be acknowledged that the contention associated with determining such an objective function was dealt with seldom and lightly; in this article, the model had 3 knowns (viz. $10b RAB, 7c/kWh target tariff, BBB- credit rating threshold) and 1 unknown (asset stranding amount). In practice, there will be 1 known (RAB) and 3 unknowns (tariff, financial tolerances, stranding amount). Clearly, this is an area for further research.

Another issue not dealt with in this article is tariff reform. To the extent that tariff structures do not reflect underlying system costs, there will exist a disconnect between cost, price, demand and investment. Asset stranding is not a solution to such problems and therefore should not precede tariff reform in the presence of apparently unstable prices and demand. Additionally, the top-down approach and objectives included certain constraints, and at one level produced an asymmetric result. Stranding policy may well benefit from a coincident shift from a Regulated Revenue Cap to a Regulated Average Price Cap; if utilities are to be exposed to the (downside) risk of lower demand, they should also be exposed to the (upside) risk of higher demand. If nothing else, this should help eliminate any pressure to inflate the WACC. Ultimately however, the approach, objectives and constraints are all policy choices.

Australia's regulatory framework once contained an ability to 'optimise' a RAB but this was removed in 2006. At the time, policymakers were concerned with under-investment, sharp rises in peak loads and the relative infancy of regulated infrastructure investments as an asset class in Australia competing for scare equity capital resources. Removing 'optimisation' from the regulatory toolkit was intended to facilitate expansion. Conditions have changed significantly. Australia has one of the highest uptake rates of rooftop solar PV in the world, which has dramatically altered load flows. But conditions also remain uncertain. Take-up rates of battery storage, and of electric vehicles, remain unknown. At sufficiently high take-up rates – battery storage (combined with solar) would have the effect of reducing energy and peak demand thus meeting the necessary condition. But at sufficient take-up rates, electric vehicles would add load back to the system. Consequently, the present exercise is academic, not prescriptive.

Regardless, consumers and utility shareholders have little to lose from the presence of an asset stranding policy. If it is ever invoked, it will presumably represent a circuit breaker, giving utilities some breathing space to reorganise their affairs as consumers change their preferences. Conversely, under sufficient conditions the absence of asset stranding policy can be expected to, and needlessly, damage shareholders, consumers and welfare.

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Appendix I – Equity Returns

Calendar Year	DUE Security Price	DUE Dividend Paid	DUE TSR	SKI Security Price	SKI Dividend Paid	SKI TSR	AST Security Price	AST Dividend Paid	AST TSR	Networks Average Stock Index	Networks Average Dividend Paid	Networks Average TSR
2006	2.65	0.22	26.0%	1.67	0.15	8.8%	1.29	0.11	9.6%	1.87	0.16	14.8%
2007	2.69	0.24	10.3%	1.90	0.17	24.5%	1.17	0.11	-1.1%	1.92	0.17	11.3%
2008	1.58	0.25	-32.0%	1.25	0.18	-25.0%	0.92	0.00	-21.5%	1.25	0.14	-26.2%
2009	1.70	0.19	19.6%	1.33	0.13	17.0%	0.91	0.03	2.1%	1.31	0.12	12.9%
2010	1.59	0.19	4.7%	1.12	0.13	-5.8%	0.86	0.03	-1.7%	1.19	0.12	-0.9%
2011	1.67	0.17	15.8%	1.36	0.10	30.0%	0.93	0.03	11.1%	1.32	0.10	18.9%
2012	1.98	0.15	27.8%	1.65	0.10	29.1%	1.11	0.03	22.1%	1.58	0.10	26.3%
2013	1.90	0.16	4.2%	1.61	0.11	3.9%	1.25	0.03	14.7%	1.59	0.10	7.6%
2014	2.31	0.16	30.0%	2.11	0.11	38.2%	1.33	0.05	10.6%	1.92	0.11	26.3%
2015	2.28	0.17	6.2%	1.92	0.12	-3.2%	1.49	0.09	18.1%	1.90	0.13	7.0%
Approx YoY	-1.4%	5.6%	4.2%	1.5%	6.0%	7.5%	1.5%	3.3%	4.8%	0.1%	5.2%	5.3%

	Average Annual Return (Calendar Year to 2015)		
Calendar Year	Networks	ASX200	10-Yr CGS
2006	5.2%	5.3%	4.6%
2007	6.9%	3.8%	4.5%
2008	13.2%	14.0%	4.3%
2009	13.8%	8.5%	4.1%
2010	16.8%	9.8%	3.9%