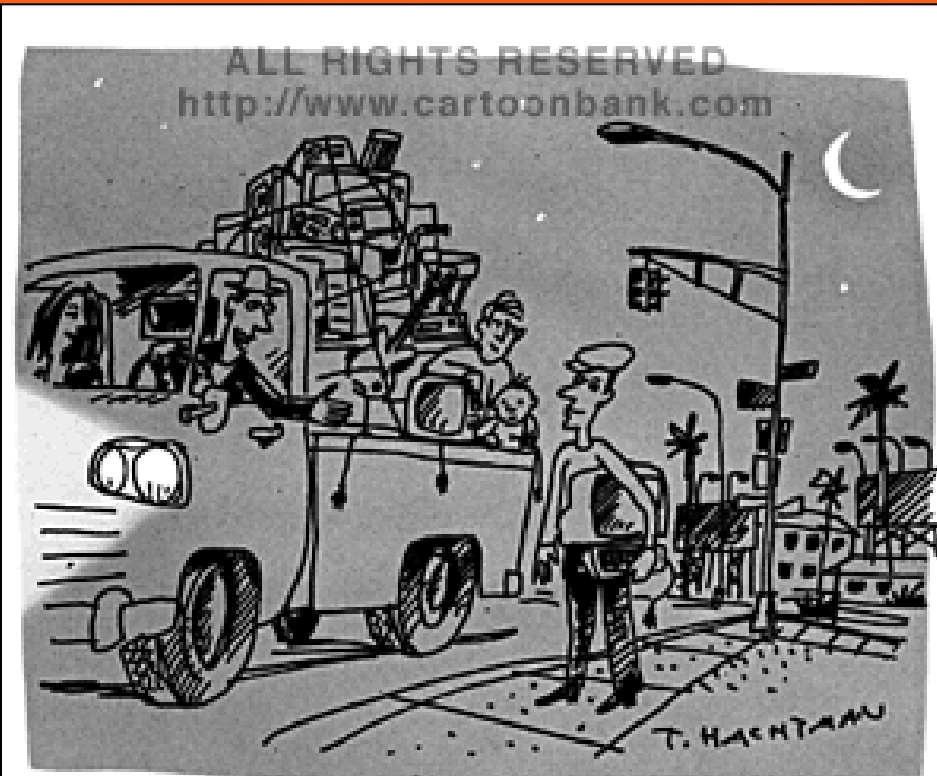


Generation investment in a liberalised electricity market

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*"Get in, Tom—we're goin' to Oklahoma.
Hear tell they got 'lectricity."*

Investment in electricity markets

- Demand for electric power in China is, of course, growing rapidly...
 - ...there is substantial investment in generation and transmission capacity to ensure that supply keeps up with demand.
- As China considers further reforms in the electricity sector, the need to protect and promote on-going investment in generation capacity will naturally be a key priority.
- This presentation will address generation and transmission investment in the context of a liberalised electricity market:
 - How does a liberalised electricity market deliver efficient investment?
 - What policies should we put in place to foster investment?
 - What has been the experience in Australia?

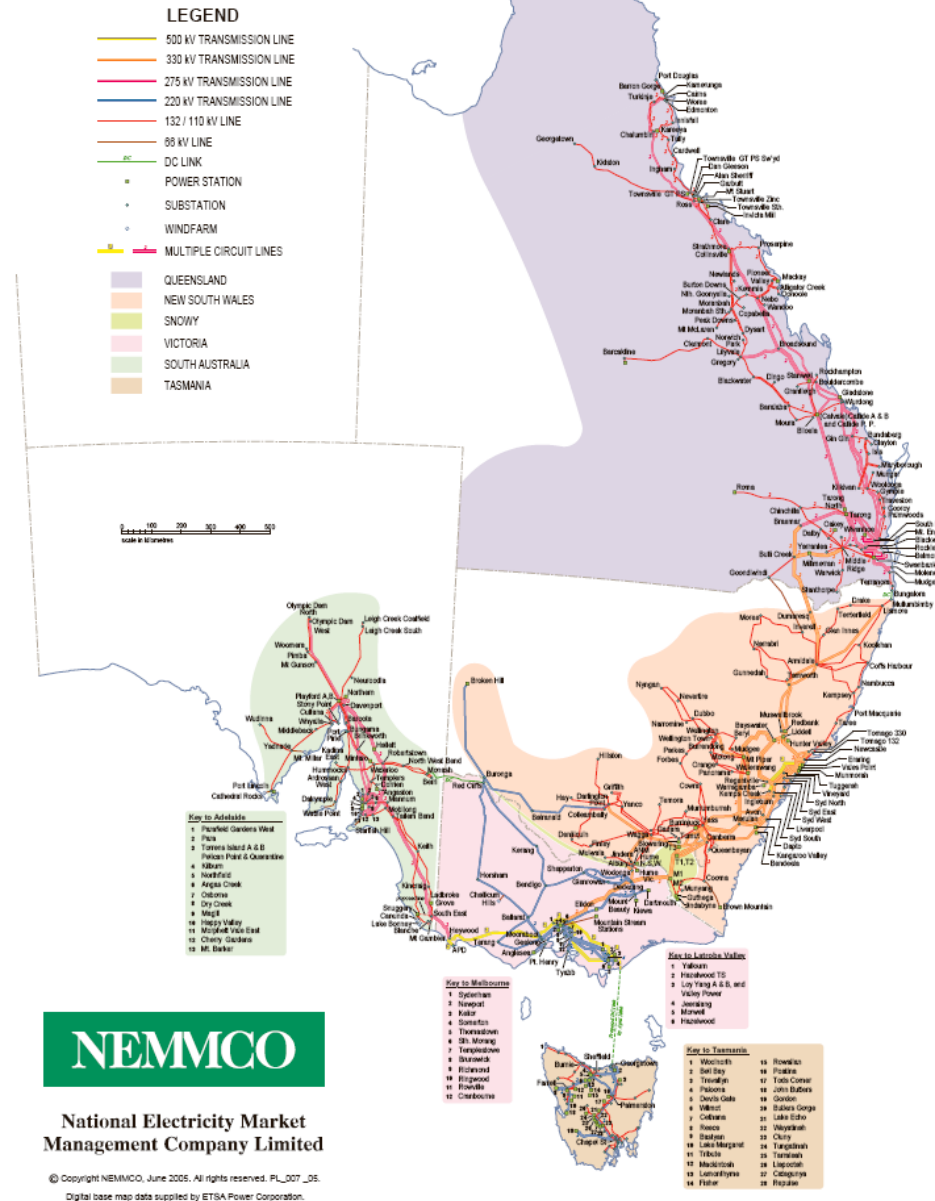
Australia's Wholesale Electricity Market

- First, let's review some of the features of Australia's market:
- Australia's electricity reforms of the 1990s followed a pattern which is now standard in many countries around the world.
- In particular, Australia followed policies of:
 - Vertical separation of generation, transmission, distribution, and retailing
 - Establishment of a wholesale spot market for electricity
 - Focus of regulation on the “natural monopoly” components – specifically generation and transmission.
 - Establishment of new independent regulatory authorities
 - A system operator responsible for the day-to-day operation of the market;
 - An economic regulator, responsible for regulation of transmission and distribution tariffs, and enforcing the market rules; and
 - An independent authority responsible for developing policies for the electricity sector, conducting reviews, and maintaining the market rules.

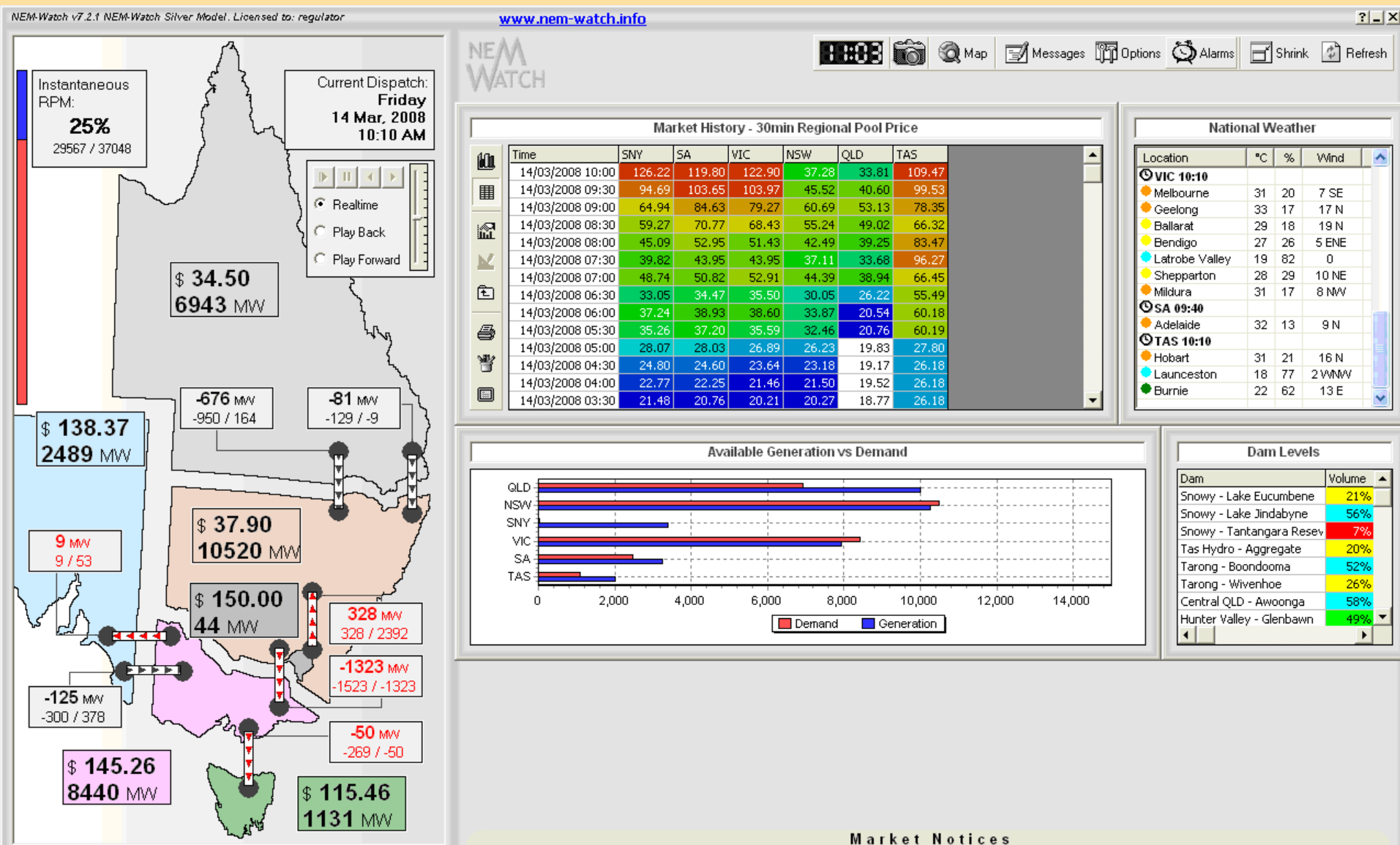
Australia's Wholes

- Australia's "National Electricity Market" involves all the generators and transmission networks in the eastern states of the island of Australia.
- All but the smallest generators participate in the wholesale spot market by regularly submitting their offers to produce electricity to a central computer system.
- A wholesale price is determined every five minutes for each of six different regions.
 - The wholesale market is an "energy only" market (there is no additional "capacity" market)
 - The price ceiling in the wholesale market is \$10,000/MWh

REGIONAL BOUNDARIES for the NATIONAL ELECTRICITY MARKET & COMMITTED DEVELOPMENTS



Market snapshot



Can a liberalised electricity market deliver efficient investment?

- What constitutes efficient investment? To be efficient, generation and transmission investment must be:
 - In the right *amount* (i.e., the right level of capacity, to deliver the efficient level of reliability)...
 - Of the right *type*... (e.g, baseload v. peaking)
 - In the right *location*...
 - At the right *time*...
- In a liberalised electricity market, generation and transmission investment have quite different drivers.
 - Generation investment decisions are entirely private commercial decisions by firms acting in their own self-interest (no role for the state)
 - Transmission investment decisions are made by regulated firms who are – in part - controlled by the decisions and incentive mechanisms established by the regulator (strong role for the state)...
 - Achieving efficient investment overall requires that both generation and transmission investment are efficient.

Generation investment in a liberalised market

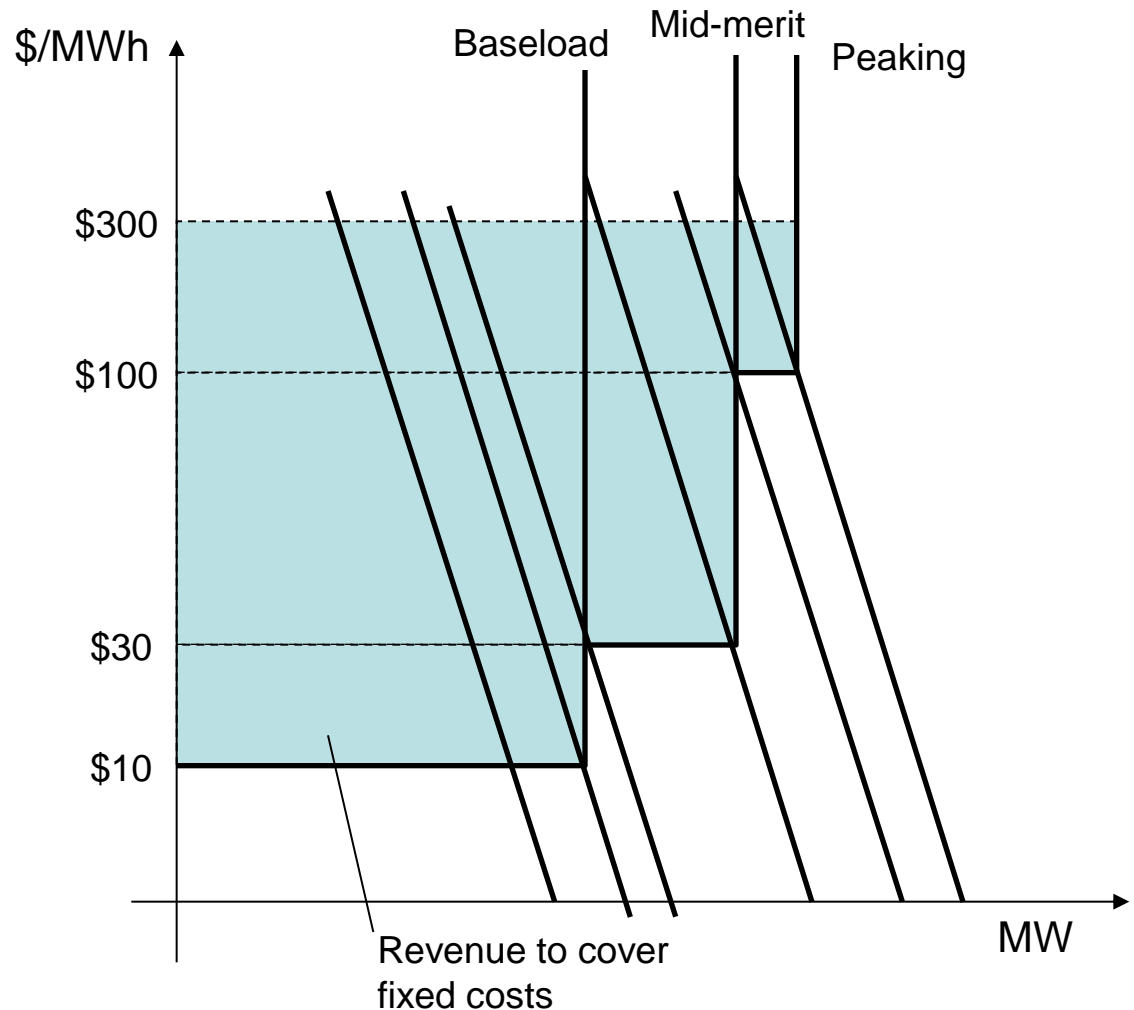
- Generation investment in a liberalised market is (in principle) a purely commercial decision, undertaken by firms to exploit an opportunity for profit that arises in the market, independent of any government input or direction.
- A decision by commercial firms to invest in or expand generation capacity will depend on factors such as:
 - The forecast price the firm expects to receive for its electricity output – both on the spot market and on the forward or contract markets.
 - The availability of and price of key inputs, especially fuel (coal, gas), both on the spot and on the forward or contract markets.
 - Non-discriminatory access to transmission network capacity to transport the power to load centres
 - A degree of trust or assurance that any necessary complementary transmission investment will be made and there will be no competing non-commercial generation, or inefficient transmission investment in the vicinity.
 - A degree of transparency and trust in the stability of the market rules and likely future developments (such as emissions trading schemes)

Price signals in an energy-only market

- In a liberalised electricity wholesale spot market, the spot price at a given location is determined by a central computer which takes into account all of the supply and demand offers and bids in the market and the physical limits of the transmission network.
- Under certain conditions, this wholesale market yields a spot price which precisely reflects the marginal cost of an additional unit of electricity at all times and in all locations in the market.
 - This only arises if, amongst other things, (a) the market is sufficiently competitive; and (b) the physical limits of the transmission network are correctly reflected in the central computer “dispatch algorithm”.
- But, in an energy-only market, how does a generator which is offering its output at marginal cost cover its fixed costs of operation?
 - A: In a liberalised wholesale market the spot price varies over time. A generator receives revenue to cover its fixed costs when the spot price rises above its variable costs of production.

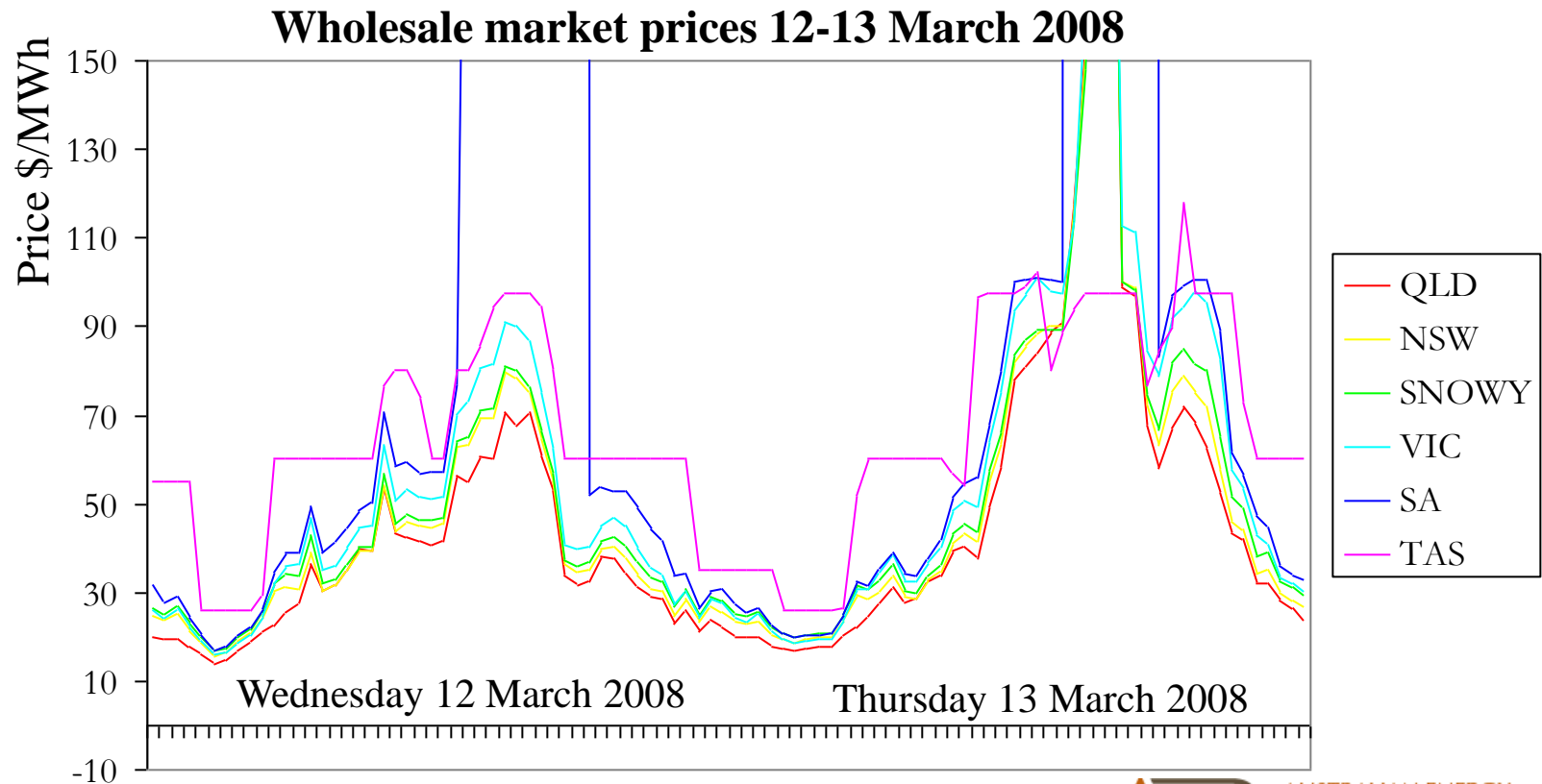
Price signals in an energy-only market

- The proportion of time the price spends above a given price level determines the rewards to different types of generation investment (baseload, mid-merit, or peaking).
 - This determines the overall mix of generation.
- In an energy-only market the price must on occasion rise to a high level to allow even the generator with the highest variable cost to cover all its fixed costs.



Price signals in an energy-only market

- Prices in the Australian wholesale spot market are relatively volatile and occasionally go very high.



Price signals in an energy-only market

- In principle, an efficient wholesale market could signal at each moment the efficient marginal cost of supply of an additional unit of electricity at each location...
 - In turn, this would signal to investors the need for an *amount* of additional generation capacity, at the time when that capacity is needed,
 - and, through the variation in price over time, sends the correct signals to investors regarding the *type* of generating plant that is needed.
- But the price in the wholesale market (at least in an energy-only market) must be allowed to rise to quite high levels.
 - In Australia the price cap on the wholesale market was originally set at \$5000/MWh but was subsequently raised to \$10,000/MWh.
 - In Australia there has been some on-going concern that Australia's energy-only market would not yield a sufficient amount of generation investment in a timely manner, or that the investment would be distorted towards baseload, or towards peaking plant.

Forecasting future supply/demand

- Since generation investment must occur prior to realising spot prices it is not out-turn or actual spot prices which determine investment, but forecasts of *future* spot prices – over a period of 3-10 years or more.
- Future spot prices are primarily determined by the supply/demand balance. How can potential investors can forecast the long-term supply/demand balance over the next 3-10 years?
- In Australia, the system operator is responsible for collecting and reporting on future forecast changes in supply (e.g., capacity additions, planned outages) or in demand (peak demand trends) and to make that information available to market participants to assist them in forecasting future prices...
 - This is published annually in a document known as the “Statement of Opportunities”
 - There are “last resort” powers the system operator can use to purchase more capacity if forecast reserves are too low.



Contract/forward market

- Since the wholesale spot price is so volatile most generators (or their financial backers) will be reluctant to invest on the basis of the forecast spot price alone
 - instead they will want to “lock in” the electricity price they will receive in the future by selling a large proportion of their output in advance on the “forward” or “contract” market.
- Policy makers can foster investment by encouraging the development of a liquid forward or contract market – ideally with contracts available for several years into the future.
 - Stability, transparency in decision-making and confidence in the market framework can all facilitate investment by reducing the risks of entering into longer-term arrangements.
- In Australia there is an active hedge market, particularly between generators and retailers.
 - There have been some concerns that the bulk of the contracts that are traded are relatively short-term (one-three years).

Efficient location signals

- As we have seen, in principle an efficient wholesale spot market, combined with a forward market, could deliver the right amount of generation investment, and the right type of investment, at the right time...
- But does an efficient wholesale spot market also send the correct signals to investors regarding the right *location* of investment?
 - In principle a market with different electricity prices at each “node” on the network (so-called “nodal pricing”) could send the correct signals of the marginal cost of transmission constraints at each moment in time.
 - Australia does have some price differentiation by location (6 regions) but does not have nodal pricing – instead, the prices are required to be uniform in each region – which may distort location decisions.
 - In addition, nodal pricing gives rise to the need for mechanisms for hedging price-differences across locations.
 - Australia only has an imperfect mechanism for hedging price differences known as inter-regional settlement residues.
 - There are concerns (but not yet hard evidence) to suggest that some investment has been at the “wrong” location.

Market power

- A wholesale spot market will only send efficient signals for investment if the prices correctly reflect the marginal cost of supply at all points in time...
- But if there is market power, the spot price might be distorted away from marginal cost
 - (usually a generator with market power will raise price above marginal cost but there are some circumstances where it might pay a generator with market power to lower price below marginal cost)
- A spot market where the market price is largely distorted by market power will send inefficient signals for investment
 - Could lead to over-investment.
- In Australia there is clear evidence that some of the larger generators occasionally exercise market power. This has probably induced some additional entry, probably of peaking generation, but not to the extent of requiring intervention.

Non-commercial investment

- An efficient private commercial generator may still not choose to invest even if the spot price or forward price is high enough if it fears that there is a risk of further investment on a non-commercial basis driving the price down.
 - In Australia there is a concern that state-owned generators do not have to earn a commercial rate of return – and that they have incentives to expand (to meet the demands of politicians, say) even when it is not profitable to do so.
 - In principle, this could have a “chilling effect” on private investment.
 - In Australia the observation has been made that the state with the most state ownership (NSW) there has also been the least private investment in generation – leading to calls for further privatisation of state-owned generators.

Interaction with transmission investment

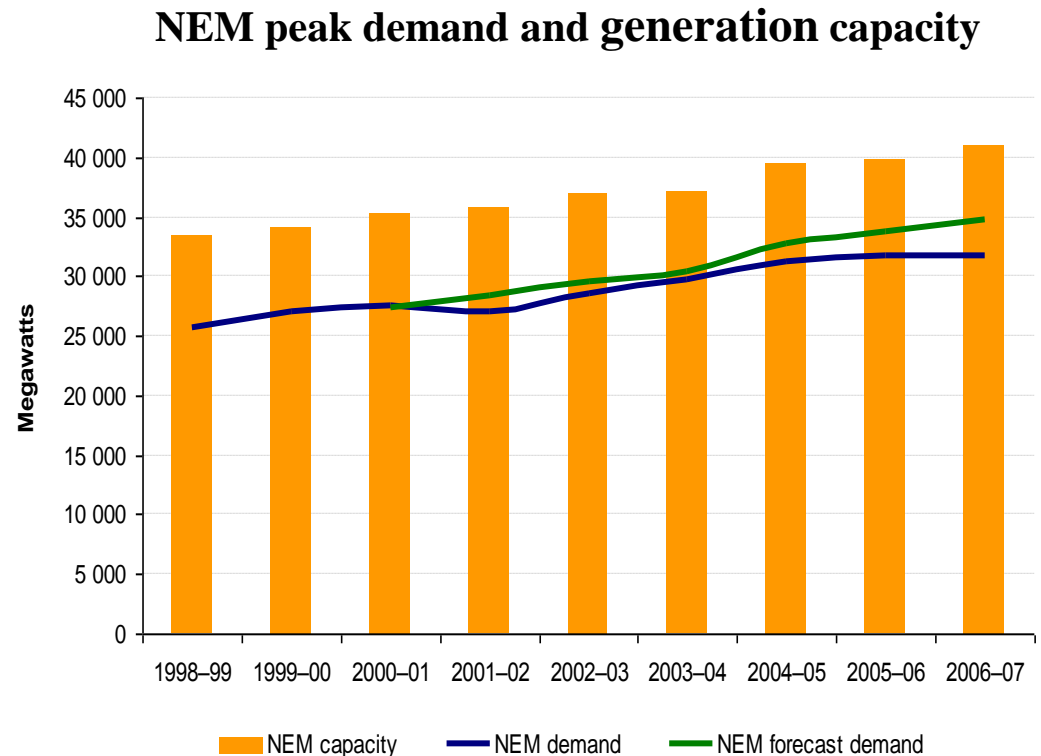
- Efficient generation investment also requires access to and efficient investment in the transmission network.
- Where the grid owner operates generation of its own, there arises a risk of discrimination in favour of its own generators.
 - In Australia, transmission and generation have been fully separated...
- Transmission investment is both a substitute and a complement for generation.
 - In some cases it is efficient for generation to locate far from a load centre. In this case associated transmission investment may be necessary to bring the power to the load centre (in this case transmission is a *complement* to generation)
 - In other cases it is efficient for generation to locate close to a load centre. But for generation located close to a load centre, an expansion of transmission to that load centre may make that generation unprofitable. (in this case, transmission is a *substitute* for generation).
 - It is important for transmission investment to be in the right place at the right time and in the right capacity.

Interaction with transmission investment

- But transmission investment decisions are made by a regulated firm and are subject to the control of the regulator.
 - How can we create incentives for a regulated transmission company to invest in the right place at the right time and in the right amount?
 - Designing a mechanism for efficient incentives of a transmission company is difficult (I am not sure this problem has been solved anywhere).
 - At least we can promote transparency in the process of making transmission investment decisions.
- In Australia:
 - a new national transmission planning body is being established who will be responsible for recommending upgrades to the national transmission network (thereby resolving conflicts and boundary issues which exist)
 - All transmission investment must be subject to a cost-benefit test, known as the “regulatory test”, which aims to prevent inefficient or non-commercial transmission investment (which could threaten commercial generation investment)

Australia's experience

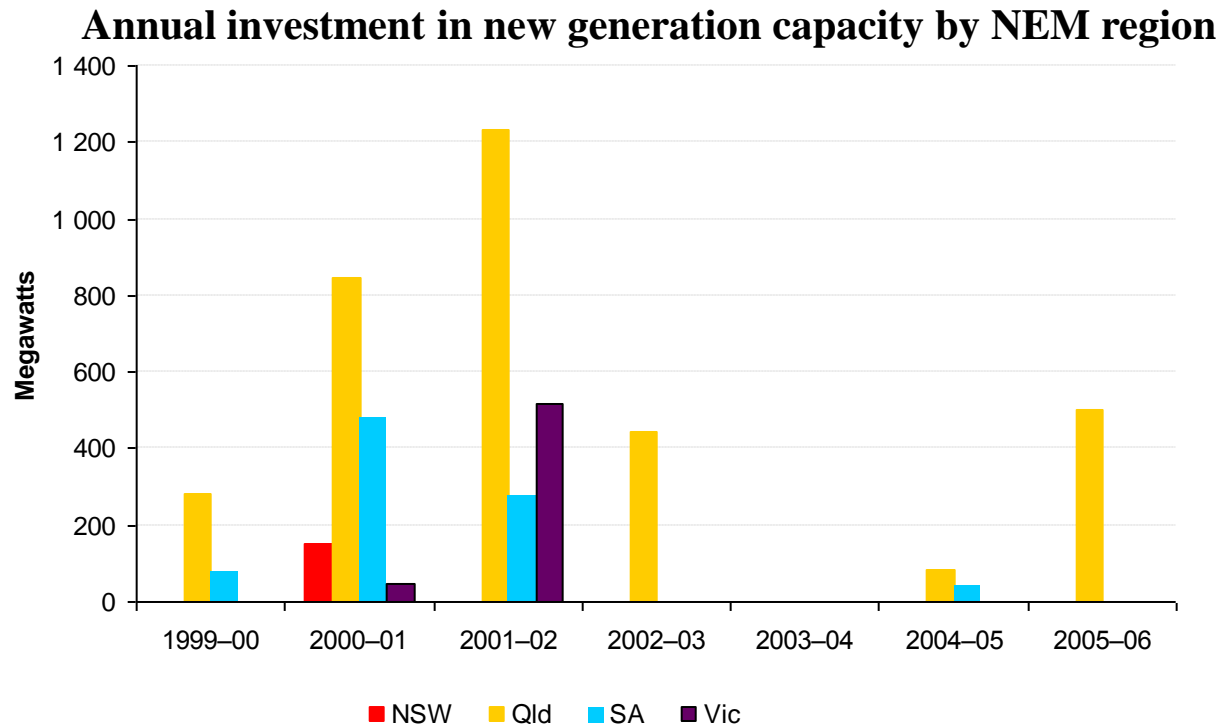
- Overall, what has Australia's experience been with investment?
- As we can see, there have been material additions to the generation capacity since the market started in 1998.
 - Average growth rate of 2.6% in capacity over this period
 - The investment has occurred in sufficient time to eliminate forecast supply/demand imbalances.



Source: AER State of the Energy Market 2007

Australia's experience

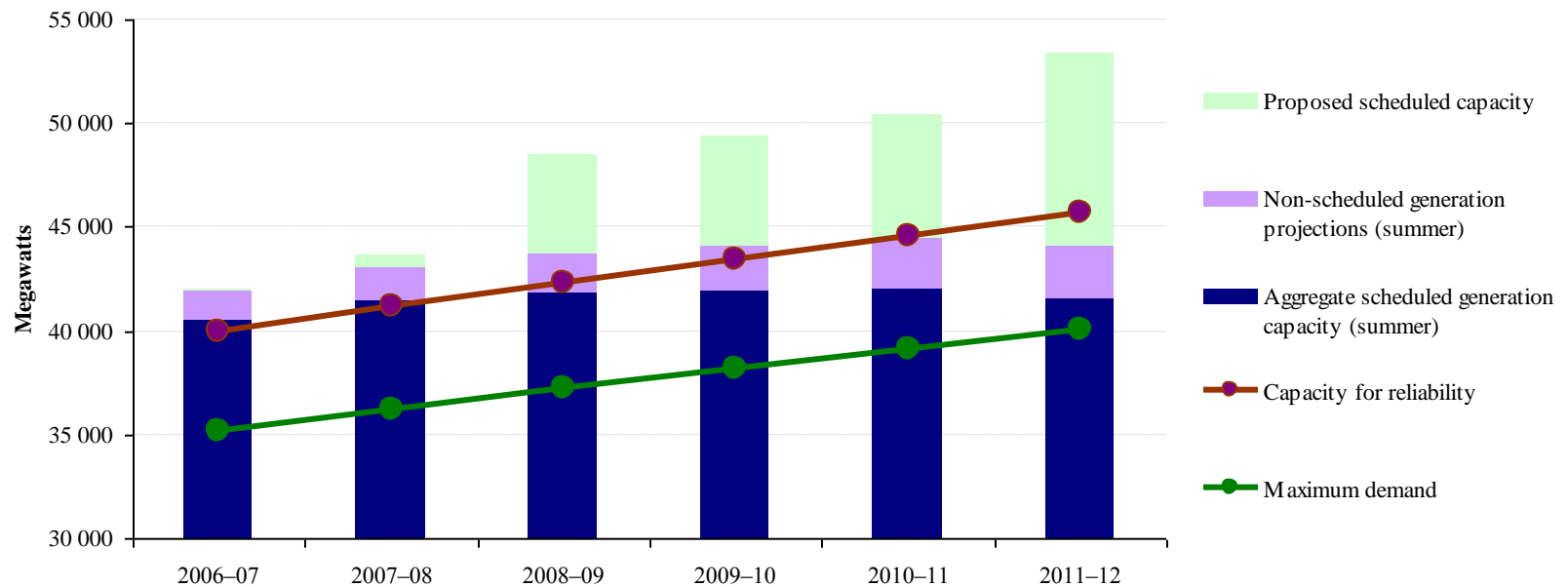
- The amount of capacity added has varied widely from one state to another, as would be expected due to differences in growth rates, access to fuels, and different local prices.



Australia's experience

- Further, on the basis of the plant that has been proposed, the outlook for the next five years looks acceptable...

Demand and capacity outlook to 2011-12



Conclusions

- In theory a liberalised electricity market can, under certain conditions, deliver efficient generation investment – that is, investment of the right amount, of the right type, in the right location, at the right time.
 - However, this assumes that the electricity market is sufficiently competitive, and the spot price is not artificially constrained, and that other complementary investment occurs at the right time and in the right place.
- Although demand is not growing as rapidly as China, in Australia adequate generation investment has occurred in a timely fashion.
 - Although longer-term forecasts have on occasion signalled a potential shortfall of supply, investment has occurred in time to meet the demand.
 - To date, there is no evidence of a particular bias in the type of generation (i.e., baseload versus peaking) that has occurred.
 - Some concerns have been expressed about generator location decisions but this has not been subject to a detailed study.

Conclusions

- A range of policies are likely to be necessary to facilitate efficient generation investment, including policies to:
 - Ensure that the spot price correctly reflects marginal cost of supply at all points in time and all locations. This could involve:
 - Ensuring the spot price can rise to high enough levels
 - Ensuring there is sufficient competition in the spot market
 - Ensuring that there are the correct signals of transmission congestion.
 - Facilitate transparency of the supply and demand balance and to facilitate forecasting of the wholesale electricity price on a national and regional basis.
 - Encourage efficient transmission investment decisions, or to enhance the transparency of future transmission investment paths and to prevent inefficient transmission investment.
 - Facilitate the development and liquidity of the forward/contract markets.
 - Ensure the commercial operation of state-owned plant (e.g., “competitive neutrality” policies or privatization).
 - Enhance competition (e.g., horizontal structural separation).