



Institute for Energy Economics
and Financial Analysis

VPPs in Australia 澳大利亚 虚拟电厂(VPP)实践

Using Distributed Energy Resources (DER) as
flexible resources in the Australian Electricity
Market

使用分布式能源 (DER) 作为澳大利亚电力市场
的灵活资源

Dr Gabrielle Kuiper

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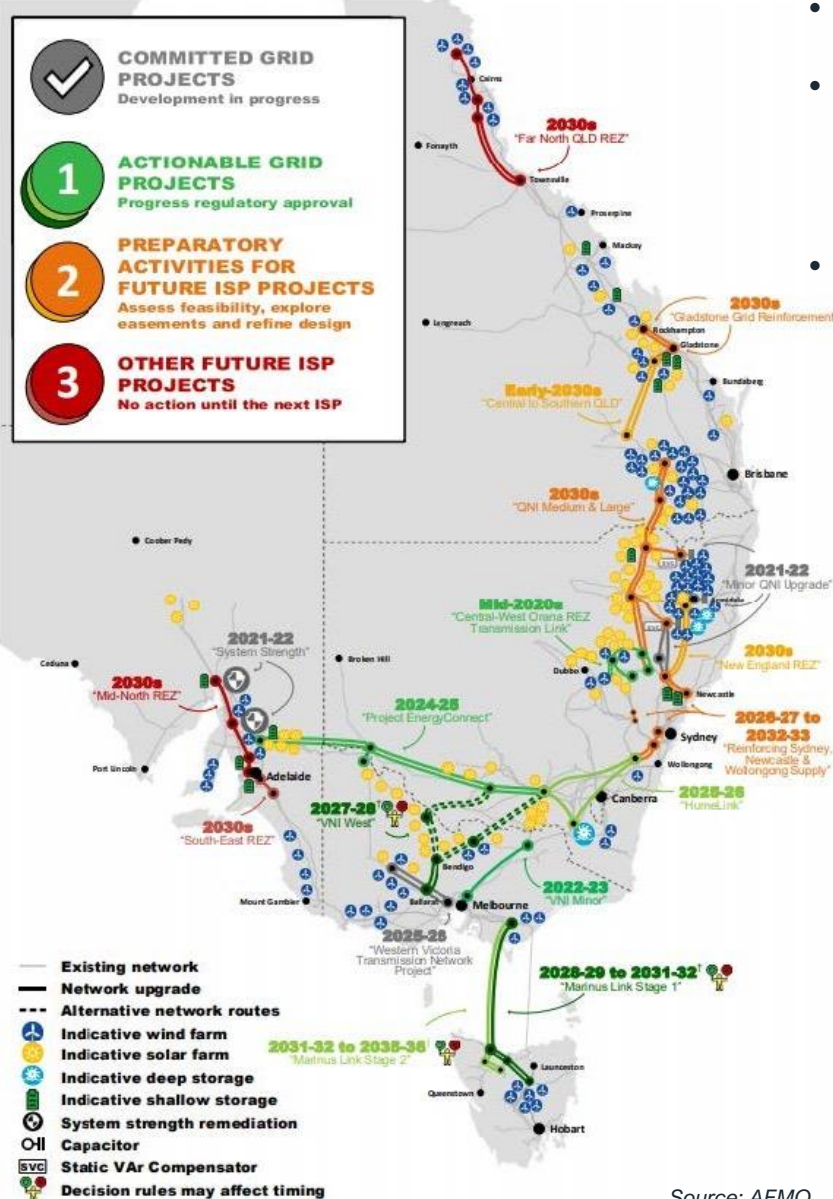




Australia's National Electricity Market (NEM) 澳大利亚国家电力市场



Figure 1 The optimal development path for the NEM



Source: AEMO

- **Wholesale energy-only market 能源批发市场**
- **Market price cap 市场价格上限:** \$AUD16,600/MWh. **Price floor 价格底线:** - \$AUD1,000/MWh
- **Negative prices 负价格: 9% of all trading intervals across the NEM Q2 2023**
South Australia 17% and Victoria 13% in the same period 2023 年第二季度NEM所有交易区间的9%; 同期南澳大利亚州为17%, 维多利亚州为13%

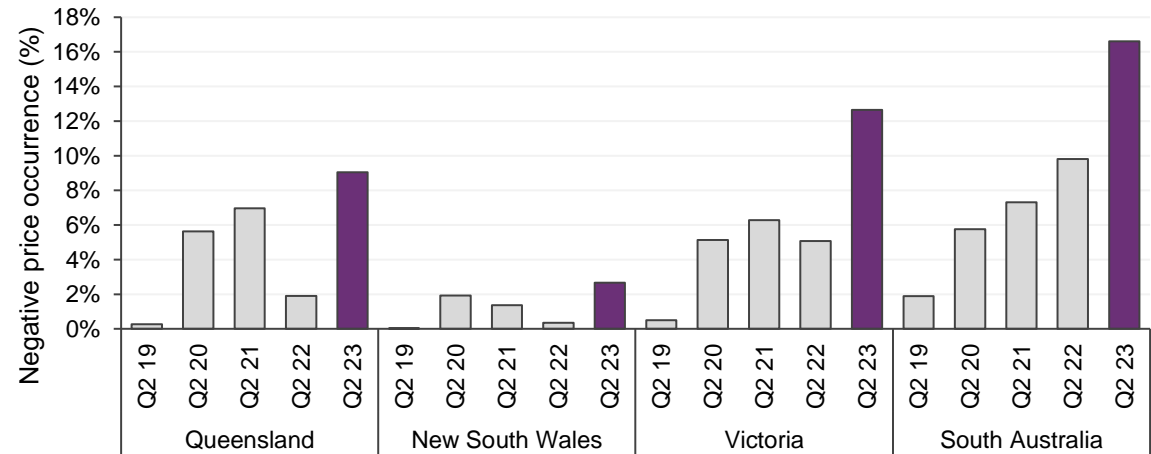
Source: AEMO

- **Deregulated market, typical bill 2022 减少市场管制的2022年法案:**
 - **Wholesale costs 批发费用 (35% of bill)**
 - **Network costs 网络成本 (46% of bill) – revenue-capped Transmission and Distribution**
 - **Environmental costs 环境成本 (8%)**
 - **Retailer and residual costs 零售和剩余成本 (11%)**

Source: AEMC Residential electricity price trends report 2021

Figure 17 Record high Q2 negative price occurrence in all NEM mainland regions

Negative price occurrence in NEM mainland regions – Q2s



Source: AEMO

† The timing of these actionable projects is dependent on decision rules. All dates are indicative, and on a financial year basis. For example, 2023-24 represents the financial year ending June 2024.

DER has already changed Australia's energy system

分布式能源(DER)已改变澳大利亚能源系统



So far 迄今为止:

- \$15+ billion of household investment in rooftop solar alone 仅家庭式屋顶太阳能的投资已超过 150 亿美元
- Over 3.5 million household rooftop PV systems, 17+GW on rooftops 超过 350 万个家庭屋顶光伏系统, 其中屋顶装机容量超过 17 千兆瓦 (GW)
- C&I rooftop PV accelerating (large potential) 工商业屋顶光伏加速发展 (潜力巨大)
- Over 110,000 small batteries 超过 110,000 个小型电池
- Demand response underutilized 需求响应未得到充分利用

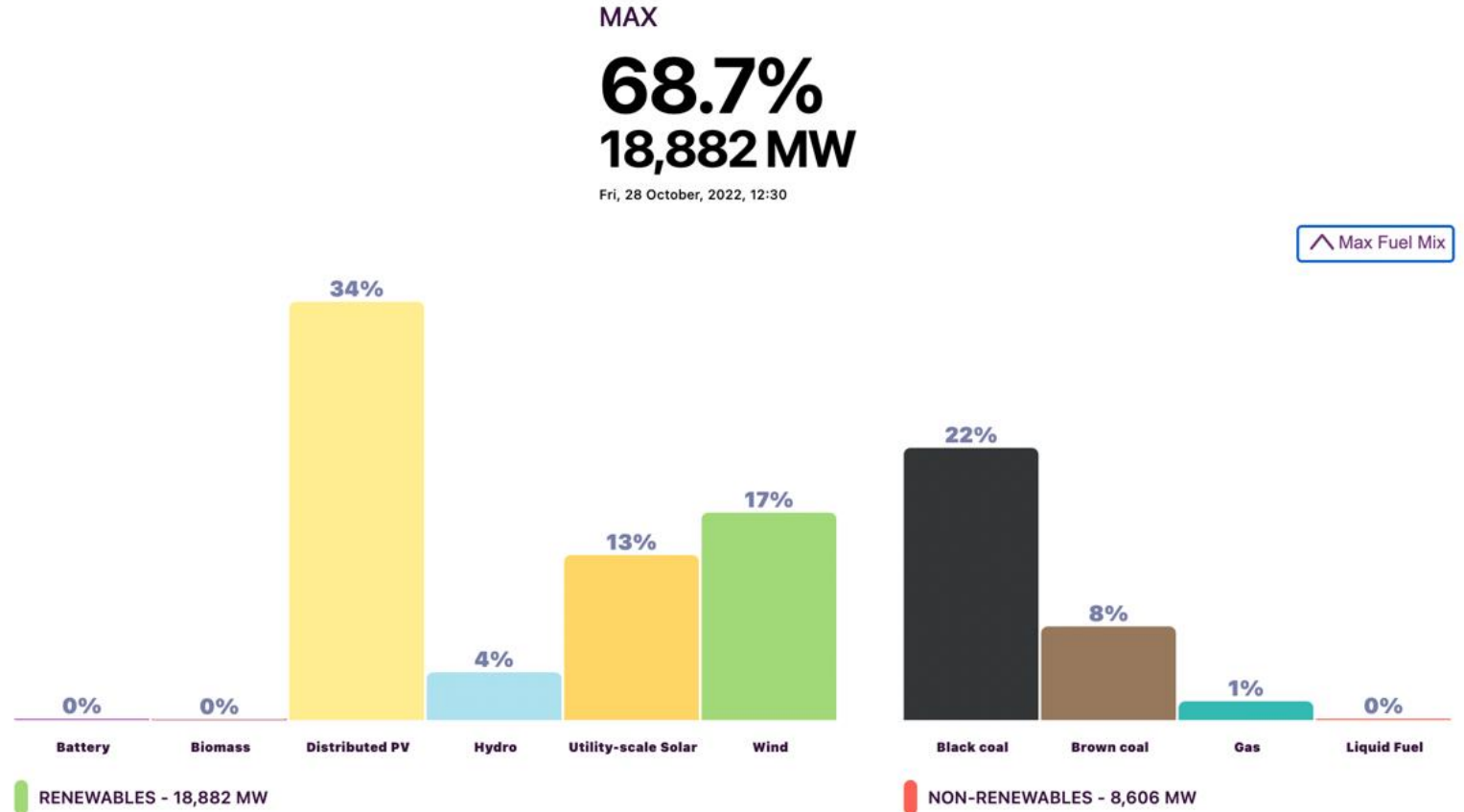
Source: IEEFA

But the benefits of DER are still underestimated

但 DER 的好处仍然被低估

Source: AEMO

Maximum instantaneous renewable penetration in the NEM: 28 Oct 2022
 澳大利亚国家电力市场最大瞬时可再生能源渗透率 (2022 年 10 月 28 日)



Heading for 100% instantaneous renewables by 2025 到 2025 年实现 100% 瞬时可再生能源



South Australia:

74% over the last year
(wind and solar August 2022 –August 2023)

南澳大利亚:

去年增长 74% (风能与太阳能 2022年8月-2023年8月)

National Electricity Market (NEM):

37.5% over the last year

国家电力市场 (NEM) :

去年增长37.5%

Source: OpenNEM

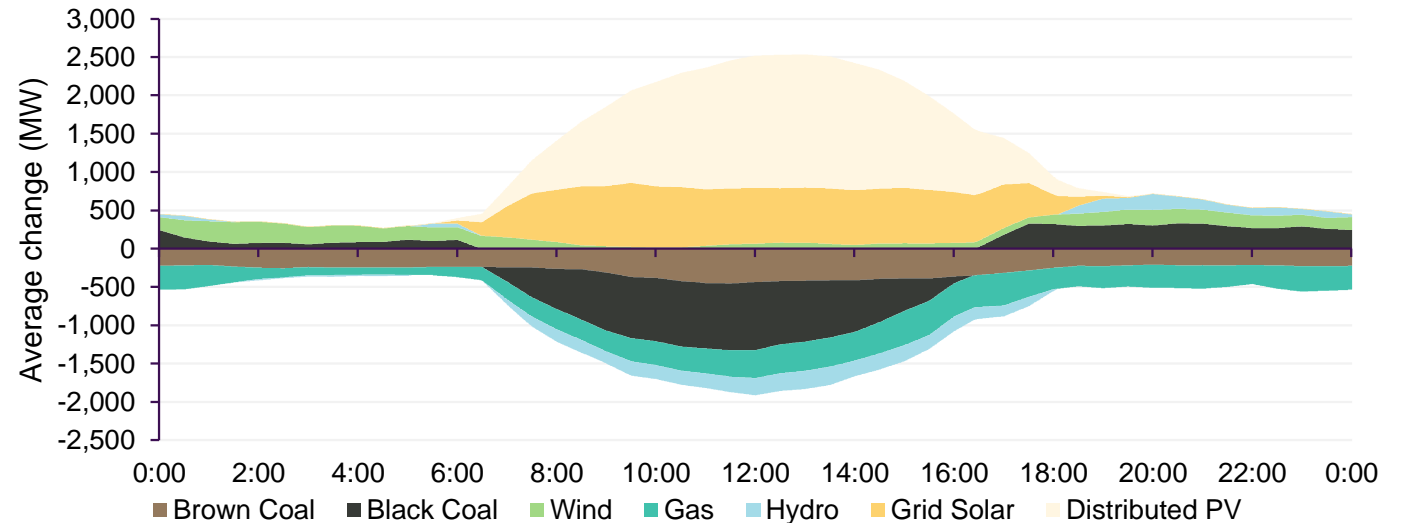
With variable renewable generation, demand must become more flexible to match supply

随着可再生能源发电的变化, 需求必须变得更加灵活以匹配供应

Current middle-of-the-day solar abundance 目前的午间太阳能丰度 (abundance)

Figure 25 Large daytime drops in thermal and hydro generation as solar output increases

NEM generation changes by time of day – Q1 2023 vs Q1 2022



Dynamic operating envelopes: a necessary first step

动态操作范围：必要的第一步



Set dynamically 动态设置:
1-5-minute intervals,
24 hours in advance

1-5分钟间隔，提前24小时



Needs regulatory support 需要监管支持:

including through consistency in APIs for
information sharing – still a work in progress

包括通过 API 的一致性实现信息共享仍在开发中

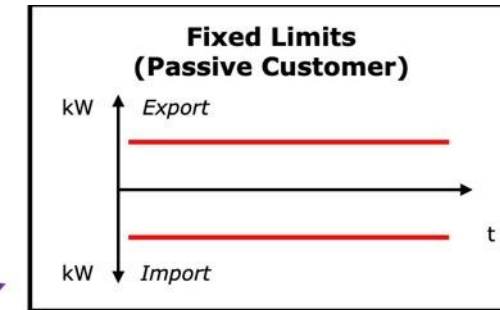
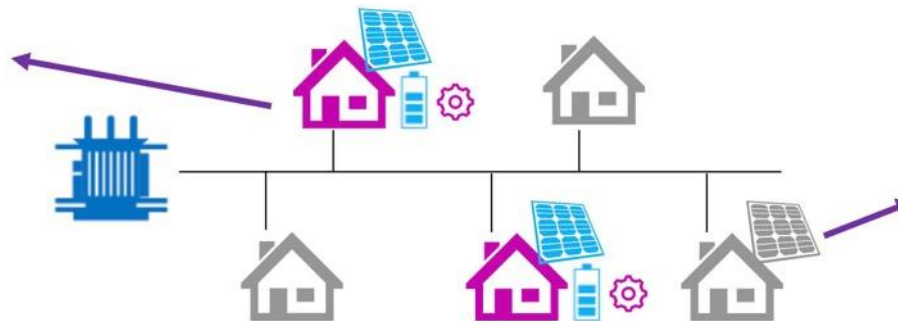
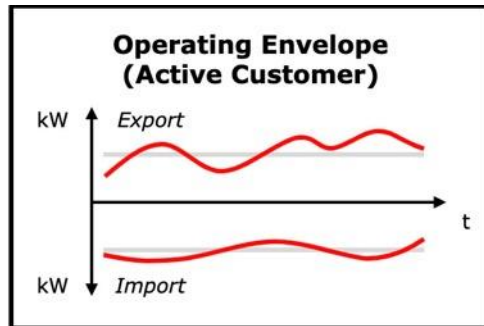


Needs some funding 需要资金:
but relatively small e.g. <1% revenue
for SA Power Networks - \$32m cf
\$3.9b 5-year revenue

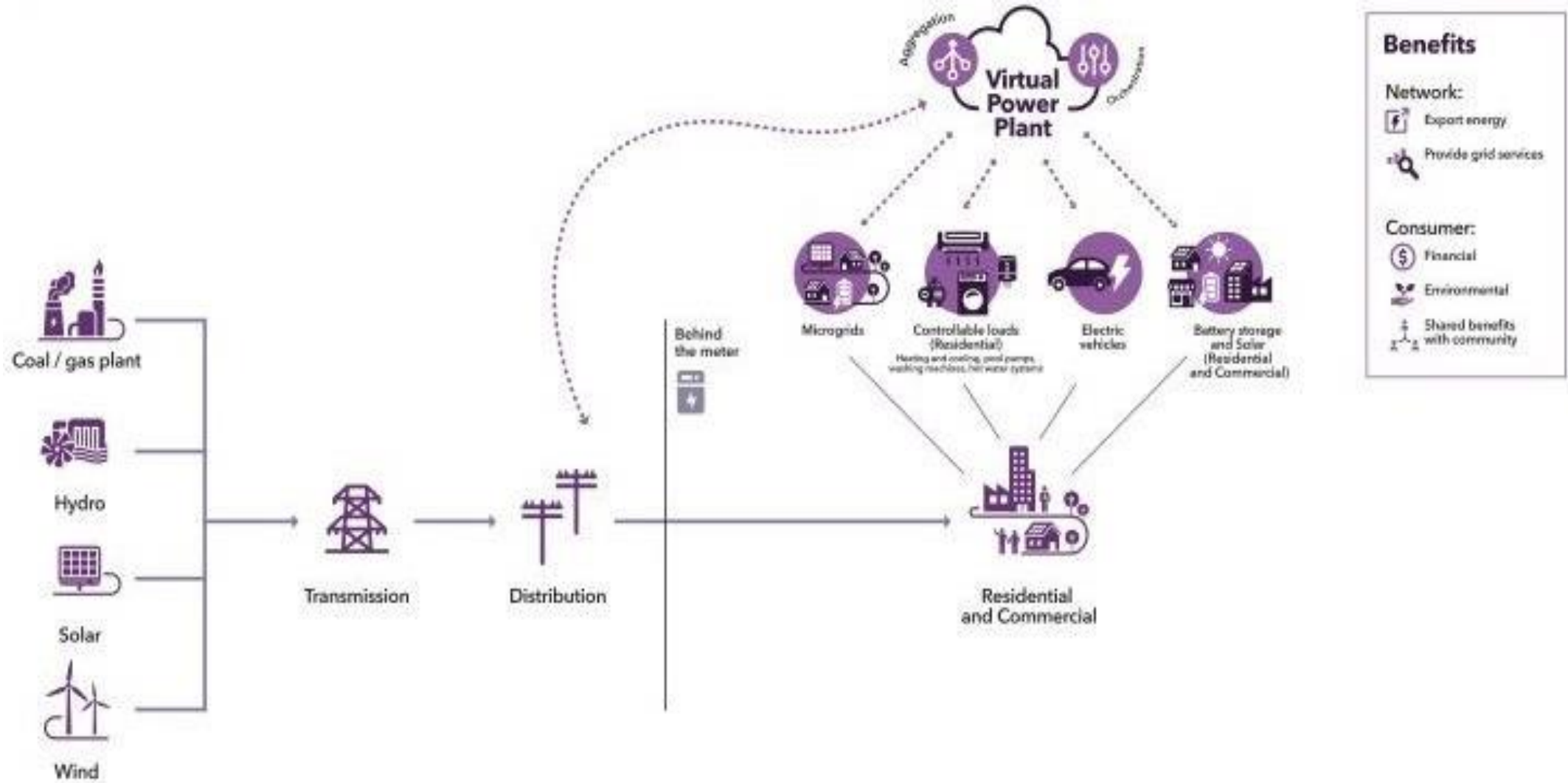
相对较小，例如 <1%的SA Power
Networks 的收入为3200 万美元 对
比五年的39亿美元

Allowing DER to play a greater role in energy markets and the grid 让分布式能源在能源市场和电网中发挥更大作用

Source: IEEFA



What is a Virtual Power Plant? 什么是虚拟电厂?



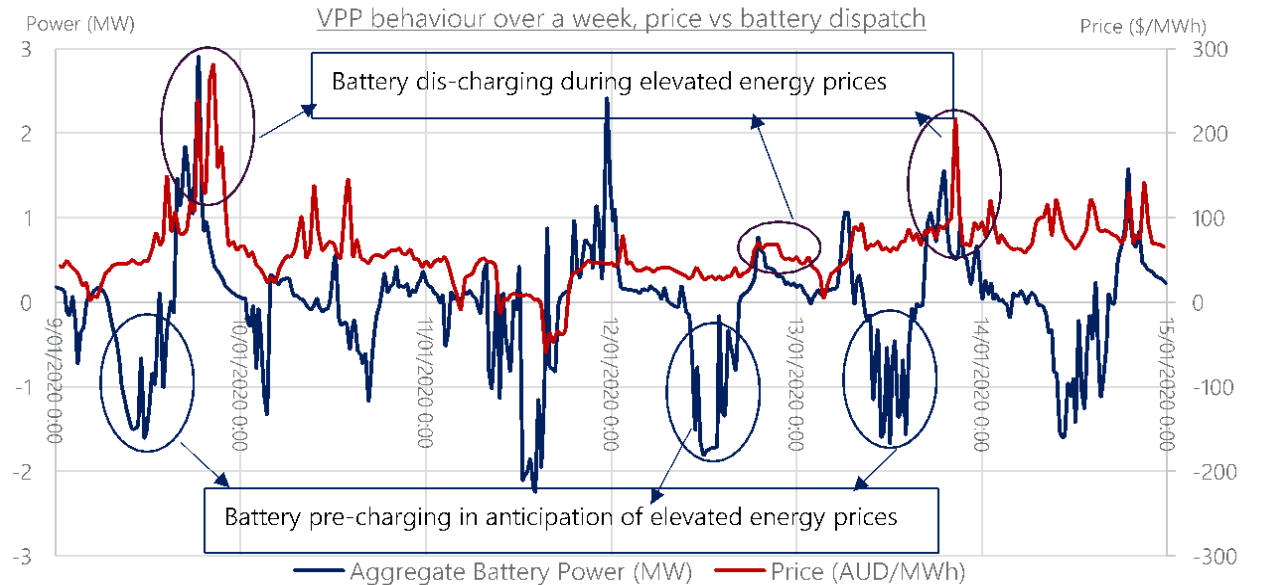
Findings of AEMO Virtual Power Plant trials

AEMO 虚拟电厂试验结果



- Can provide FCAS, energy and assist with minimum system load 可以提供频率控制辅助服务 (FCAS) 所需要的能源, 并协助最小系统负荷
- Only battery participants at this stage (not other DER) 现阶段仅限电池参与者 (不包括其他分布式能源)
- Forecasting challenges (up to 42% different from actual on an hour ahead) 预测面临挑战 (与提前一小时的实际情况相差高达 42%)
- AEMO needs for visibility, forecast-ability, dispatchability – system security challenges if VPPs scale AEMO 对可见性、预测能力、调度能力的需求——如果 VPP 规模扩大, 系统安全将面临挑战
- *Participants view: too many requirements, too costly* 与会者观点: 要求太多、成本太高
- Consumers: overall satisfaction to date is high, but some value opaque 消费者: 迄今为止总体满意度较高, 但部分价格不透明
- Need for consumer protections – especially for switching 需要保护消费者——尤其是转换方面

Figure 5 Energy response for SA VPP – 9-15 January 2020, behaviour over a week





Margins are currently thin 目前利润微薄

But 但是:

- Retailers will need to harness fleets of DER to be profitable 零售商需要利用分布式能源实现盈利
- The future is harnessed VPP and DER-centred retailing 未来零售电力将重点利用虚拟电厂和以分布式能源为中心
- Endorsed by Origin Energy's [announcement](#) in February 2022 of a 10x increase in VPP – 205MW to 2000MW in 4 years 获得 Origin Energy 2022 年 2 月发布的认可公告, 虚拟电厂增加 10 倍——4 年内从 205兆瓦增至 2000兆瓦

New sources of revenue needed 需要新的收入来源

- e.g. allowing aggregated residential participation in the Demand Response Mechanism 例如, 允许居民集体参与需求响应机制
- Payments for distribution network services 分销网络服务付款

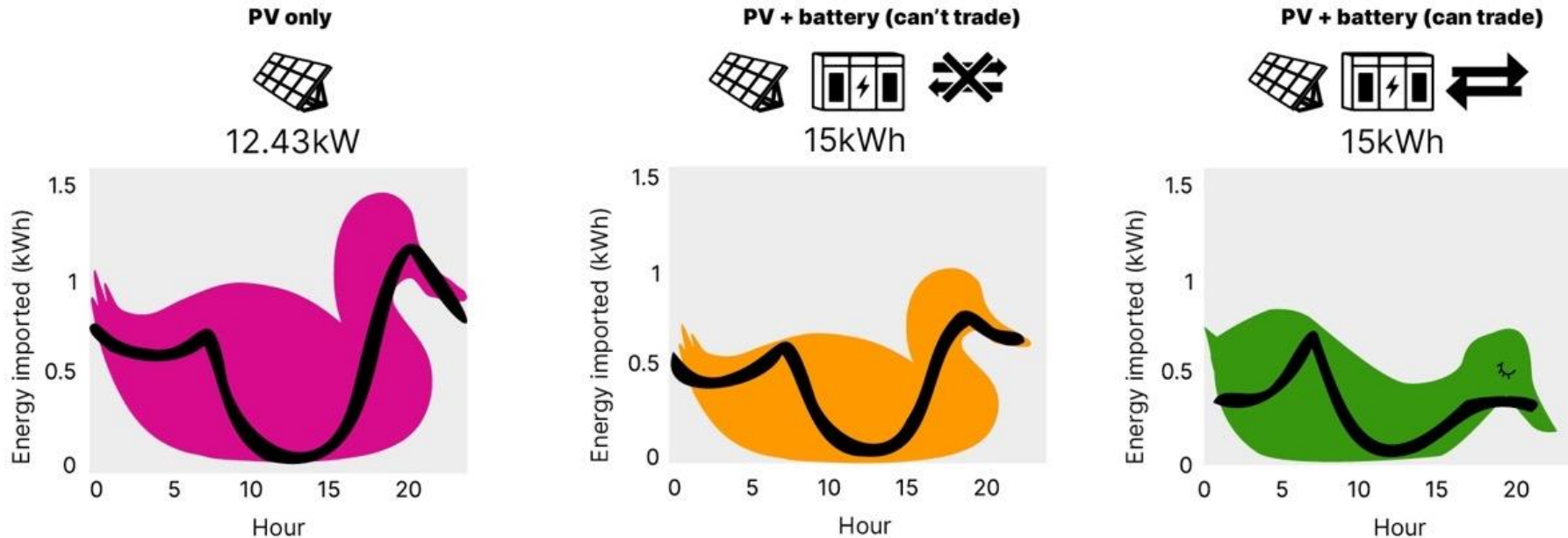




Rooftop PV + batteries puts the duck to sleep 屋顶光伏+电池 (“让鸭子睡觉”)

Import from wider grid

For the average household in the modelled suburb



Based on ITP Renewables modelling

IEEFA



- Reduce wholesale market peaks and price volatility 减少批发市场高峰和价格波动
- Alleviate minimum demand challenges 缓解最低需求挑战
- Reduce network peaks – more efficient utilization 减少电力网络高峰——更有效地利用
- Alleviate ramping issues 减轻调节问题

But need smart regulation and market design 但需要明智的监管和市场设计

- Put dynamic operating envelopes in place 制定动态运营范围
- Provide open and transparent information on network constraints 提供有关电力网络约束的公开透明信息
- Support managed EV charging and then V2H and V2G 支持托管电动汽车充电，并支持V2H和V2G
- Make it easy for VPPs to participate in wholesale, demand response and FCAS markets
让虚拟电厂VPP 轻松参与批发、需求响应和 FCAS 市场
- Allow DER to provide network services – through real-time pricing or auctions or other methods
允许分布式能源DER提供网络服务——通过实时定价或拍卖或其他方式



Thank you 感谢聆听!

IEEFA Guest Contributor
Dr Gabrielle Kuiper



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