ENERGY TRANSITION PARTNERSHIP

ENERGY TRANSITION MASTERCLASS

SUMMARY

13 DECEMBER 2022

Prepared by: AMPERES

AMPERES

About the Energy Transition Roundtables

The Southeast Asia Energy Transition Partnership (ETP) is a multi-stakeholder platform that aims to accelerate energy transition in Southeast Asia and deliver the Paris agreement targets on climate change by bringing together Government Donors, Philanthropies and Partner Governments. The ETP offers a strategic opportunity for multiple actors from government, Civil society and the private sector actors to come together, leverage their expertise and resources to support Governments understand and advance a more ambitious agenda of reform to enable fully the Southeast Asian energy transition.

The Energy Transition Roundtables is a two-year capacity building and networking program that aims to provide an opportunity for the region's energy transition stakeholders – in particular, mid-career policy-makers from identified Southeast Asia countries (Vietnam, Indonesia and the Philippines) and regional level bodies – to engage in an intensive 24-roundtable series on the energy transition.

The roundtables are delivered by the Australian National University (ANU) and Australia-Mekong Partnership for Environmental Resources & Energy Systems (AMPERES), in partnership with: the Institute for Economic and Social Research, Faculty of Economics and Business, University of Indonesia (LPEM UI), the Indonesia Research Institute for Decarbonisation (IRID), Ateneo School of Government (ASOG), and University of San Carlos (USC).

Acknowledgements

The study team wishes to thank the support of the Energy Transition Partnership team in Indonesia, the Philippines, Vietnam and Thailand for their support to the roundtable program: Ms. Sirpa Jarvenpaa, Mr. John Cotton, Mr. Yu Chong Nam, Ms. Praewpan Intapanya, Ms. Maria Fritzie Reyes Vergel, Mr. Aang Darmawan and Mr. Do Manh Toan.

The team also especially thank the experts from the Australian National University who developed and delivered the program: Prof. Frank Jotzo, Dr. Thang Nam Do, Prof. Ken Baldwin, Prof. Andrew Blakers, Prof. Paul Burke, Dr. Bin Lu, Dr. Tom Longden, Dr. Cheng Cheng, Dr. Elizabeth Ratnam, Dr. Lee White, Dr. Emma Aisbett, Dr. Rebecca Pearse, and Dr. Rebecca Colvin.

The team also especially recognises the support of our delivery partners who provided regular guidance, review and discussion: Mr. Tarek Ketelsen (AMPERES), Ms. Nicole Foronda (ANU), Ms. Le Thi Ha Tien (AMPERES), Dr. Alin Halimatussadiah (LPEM UI), Dr. Riatu Mariatul Qibthiyyah (LPEM UI), Mr. Fachry Abdul Razak Afifi (LPEM UI), Ms. Khairunnisa Rangkuti (LPEM UI), Ms. Moekti Handajani Soejachmoen (IRID), Ms. Ajeng Rachmatika Dewi (IRID), Dr. Michael Lochinvar Abundo (ASOG), Dr. Lloyd Bautista (ASOG), Ms. Bernadette Chloe Torno (ASOG), Ms. Janine Bragais (ASOG), Engr. Isabelo A. Rabuya (USC) and Engr. Arben Vallente (USC),

And finally, we wish to thank all the government, civil society and private sector participants who have joined the Energy Transition roundtable program and the Masterclass in particular. Their energy, insight and commitment have been invaluable to the Energy Transition Roundtable team.

ABOUT THE REPORT

This report is a summary of information and discussion of the Energy Transition Masterclass, delivered by ANU speakers to over a hundred participants in Indonesia, the Philippines and Vietnam.

The summary is prepared by Tien Le, AMPERES.

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1 OVERVIEW

The Energy Transition Roundtables is a two-year capacity building and networking program that aims to provide an opportunity for the region's energy transition stakeholders – in particular, mid-career policy-makers from identified Southeast Asia countries (Vietnam, Indonesia and the Philippines) and regional level bodies – to engage in an intensive 24-roundtable series on the energy transition.

Part of ETP Roundtables, the **Energy Transition Masterclass** is a 20-week structured online training program that provides a suite of tailored professional forums (training sessions) to enable the exchange of information, develop leadership among the region's energy transition stakeholders, and endow participants with the latest understanding and tools to accelerate energy transition for both policy and market contexts. The training program was developed by the Australian National University (ANU). Integrated into ETP roundtables that specifically targeted mid-career participants from the government, industry and civil society organisations of Indonesia, the Philippines and Vietnam, the course was tailored to include relevant information and discussion about the energy transition of the three targeted countries and Southeast Asia (SEA) region.

The course was delivered for 113 participants predominately from Indonesia, Philippines and Vietnam via teleconference between March and July 2022. It was highly interactive with a mix of lectures, practical exercises, workshops, and discussions groups delivered via 10 sessions of two hours.

LEARNING OUTCOMES

- **Learning outcome 1:** Understand the key technologies that will enable the transition to a zero-emissions energy system
- **Learning outcome 2:** Engage with the key technological and technical issues that underpin the integration of renewable energy into the grid
- **Learning outcome 3:** Consider the market, regulatory and policy frameworks that underpin the operation and facilitate the transition of the energy sector
- **Learning outcome 4:** Consider the socio-economic issues that will need to be addressed in the energy transition, including bringing a gender lens to the transition
- **Learning outcome 5:** Understand the barriers, challenges and opportunities presented by international renewable energy trade.

COURSE STRUCTURE

No.	Topic	Speaker/Session convener
1	Energy transition: Australian experience in the global context	Prof Ken Baldwin
2	Renewable energy generation	Prof Andrew Blakers
3	Carbon pricing	Prof Paul Burke
4	International renewable energy systems	Dr Bin Lu | Dr Thang Do | Prof Ken Baldwin | Dr Tom Longden
5	Energy storage	Dr Cheng Cheng
6	Operation of electricity grids	Dr Elizabeth Ratnam
7	Energy efficiency	Dr Lee White
8	Trade, investment, and green industrial policy	Dr Emma Aisbett
9	Industry workforce planning and transitions	Dr Rebecca Pearse
10	Social transition	Dr Rebecca Colvin

All session recordings and materials are available **HERE** for self-paced learning interest. Each session includes:

- Reading materials
- Lecture presentation
- Recordings
- Infographic recap

2 SUMMARY OF COURSE SESSIONS

SESSION 1. THE AUSTRALIAN EXPERIENCE IN THE GLOBAL CONTEXT

This session covers:

- Motivation and Trend of the Energy Transition
- Energy generation sources and LCOE
- Enabling Policy
- Energy and Security

The world is undergoing a massive energy transformation. As all economies move towards decarbonising their electricity sector and electrifying all other sectors of the economy, the distributed nature of this new energy system will resemble much more the "internet of energy".

Australia is at the vanguard of this transformation, annual installed solar and wind capacity per capita is increasing faster than any other country. In 2021, over 250W per capita was added in Australia, while the world average was in the order of 25W per capita per year in 2019 and 2020.[1]

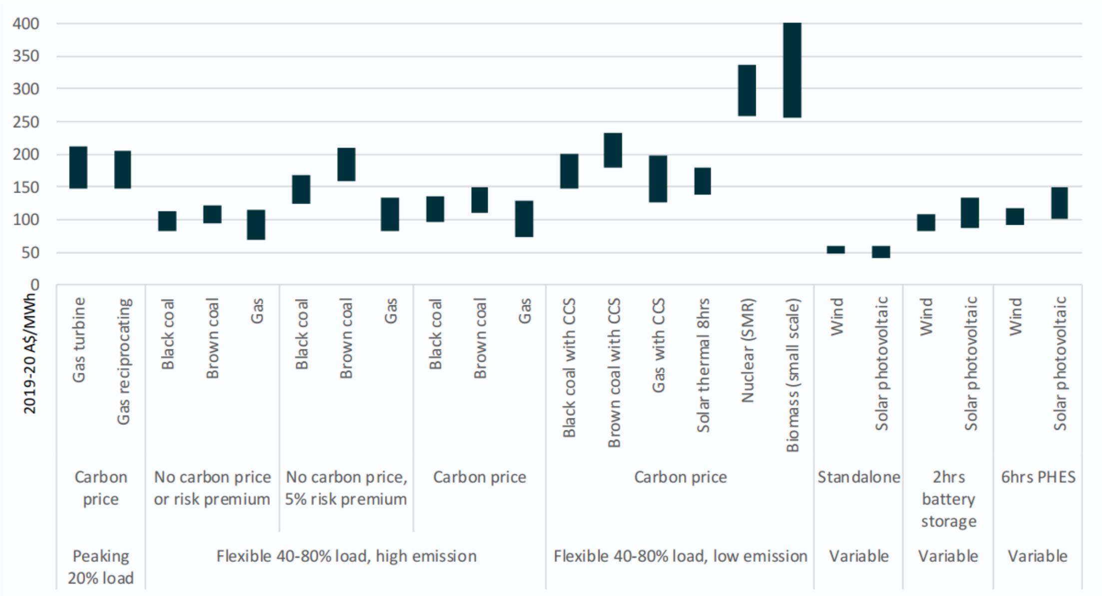
The levelized cost of electricity (LCOE) of solar and wind have been falling at a rapid rate over the last decade and became lower than coal in the recent years. Renewable Energy (RE) penetration on Australia's grid is expected to surpass 50% of total generation in 2025 and parts of Australia's National Electricity Market (NEM) already reach 100% instantaneous

[1] Information and figures used in the sessions' summary were cited from the presentations if not mentioned otherwise.

RE penetration for short time intervals. At these levels of RE penetration, a higher cost is required to cover intermittency through the overbuild of generation capacity, integrating energy storage and modernising network infrastructure. A 100% RE system may add 50% more to the LCOE. In that case, renewable energy will be still more competitive than fossil fuels, even when carbon price and carbon capture and storage are not applied.

Beyond its border, Australia also contributes to about 8.6% of the total greenhouse gas emissions of the Asia-Pacific through the trading of coal, liquefied natural gas, iron ore, and alumina. Australia has the potential to change this reality by replacing conventional carbon-based commodities with green alternatives including RE electricity, hydrogen, and green metals. If the same amount of energy as being exported from Australia to the Asia-Pacific is replaced with hydrogen and electricity, and the same amount of ore is mined and exported, the total renewable electricity required could reach 7,040 TWh/year, which is 27 times of Australia's present electricity generation.

Figure 1 | Calculated LCOE by technology and category for 2020. Source: CSIRO, 2020.



As Australia shifts from a carbon-intensive energy trading nation to a renewable energy trading nation, together with the lessons learnt from pioneering energy transition on its own domestic grids, will help inform energy transformation in ASEAN countries and throughout the world.

Suggested readings:

1. Blakers, A., Baldwin, K., & Stocks, M. (2020). Australia, the global renewable energy pathfinder. The Australian National University.
2. Stocks, M., Blakers, A., & Baldwin, K. (2019). Australia is the runaway global leader in building new renewable energy. *The Conversation*, 25 September, 2019. Available at https://theconversation.com/australia-is-the-runaway-global-leader-in-building-new-renewable-energy-123694
3. Baldwin, K., Blakers, A., & Stocks, M. (2018). At its current rate, Australia is on track for 50% renewable electricity in 2025. *The Conversation*. Available at https://theconversation.com/at-its-current-rate-australia-is-on-track-for-50-renewable-electricity-in-2025-102903

4. Baldwin, K. (2017). Renewables will be cheaper than coal in the future. Here are the numbers. *The Conversation*. Available at https://theconversation.com/renewables-will-be-cheaper-than-coal-in-the-future-here-are-the-numbers-84433

SESSION 2. RENEWABLE GENERATION

The session covers:

- Solar and wind resources
- Impact on land, water and environment
- Energy in ASEAN

In 2020, solar and wind constitute 75% of all global additions in generation capacity. This is because they are decisively cheaper than fossil and nuclear generation. Large-scale deployment of solar and wind reduces both electricity prices and emissions.

Balancing 50-100% solar and wind in an electricity grid is straightforward and low cost. Renewable intermittency can be addressed by (i) diversifying RE generation technologies and blending wind and solar, (ii) deployment of energy storage at scale with pumped hydro energy storage for longer duration storage and batteries for shorter duration storage, (iii) transmission expansion to smooth out both local weather and demand peaks, and (iv) demand side management to smooth the load throughout the day.

ASEAN countries has an enormous solar resource averaging between 1,300-1,600 kWh/kWp annually. Vietnam and the Philippines are exceptional in ASEAN with good wind potential. The technical potential for offshore wind is 178GW and 599 GW in the Philippines and Vietnam. Meanwhile, Indonesia can accommodate an enormous amount of floating solar capable of generating over 200,000 terawatt-hours per year on its calm equatorial inland sea, sufficient to generate all the energy needs of the world.

Figure 2 | 60,000 good sites for off-river Pumped Hydro Energy Storage, equivalent to 2 million Gigawatt-hours, in ASEAN according to an ANU's model.

A model developed by ANU shows 60,000 good sites for off-river Pumped Hydro Energy Storage in ASEAN that could provide 100 times the capacity needed to support 100% Renewable Energy without fragmenting river systems.

Suggested readings:

1. Blakers, A., Stocks, M., Lu, B., Cheng, C., & Stocks, R. (2019). Pathway to 100% Renewable Electricity. *IEEE Journal of Photovoltaics*, vol. 9, no. 6, pp. 1828-1833. 10.1109/JPHOTOV.2019.2938882.
2. Lu, B., Blakers, A., Stocks, M., & Do, T. N. (2021). Low-cost, low-emission 100% renewable electricity in Southeast Asia supported by pumped hydro storage. *Energy*, *236*, 121387. https://doi.org/10.1016/j.energy.2021.121387

SESSION 3. CARBON PRICING

This session covers:

- Policy Options to Reduce Emissions
- Taxes
- Emissions Trading Scheme (ETS)
- EU Carbon Border Adjustment Mechanism (CBAM)

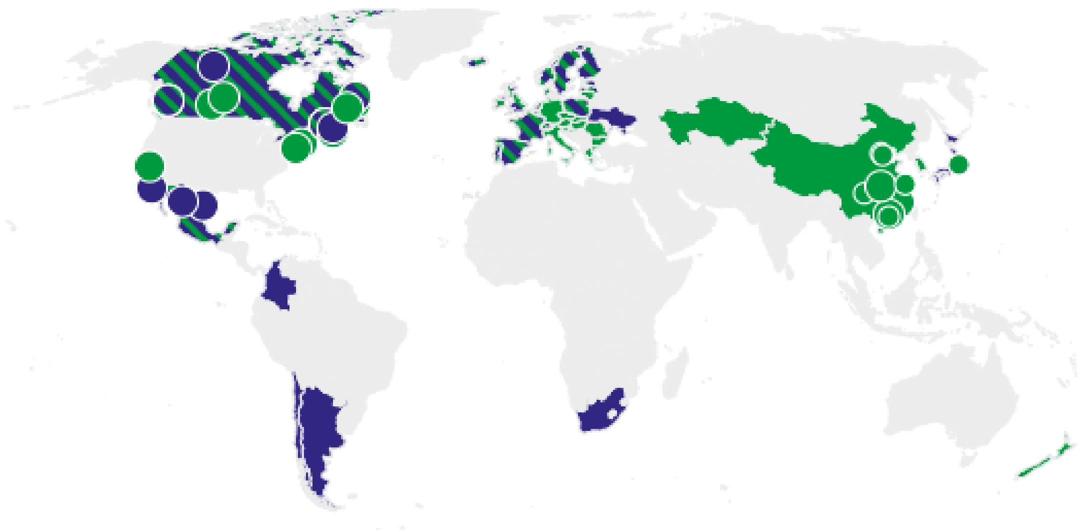
Addressing climate concerns, key countries in the Asia-Pacific have set targets to reach net-zero greenhouse gas emissions, including Vietnam by 2050 and Indonesia by 2060. Carbon emissions have escalated because our economies consider pollution as an externality to the market, i.e., the environmental, social and economic costs of CO_2 emission are not borne by those emitting. Firms and people release pollution without considering the effects on others.

Putting a price on carbon emissions will internalises the environmental and social costs of CO_2 and helps creates an incentive for polluters to invest in abatement options. The simplest form of carbon pricing is a carbon tax. Another type of carbon pricing is emissions trading schemes (ETS) which set a cap on total annual emissions and allow emitters to buy and sell permits as needed. There are also some hybrid schemes that focus on both price (as carbon tax) and quantity (as ETS), such as a carbon tax that is increased or reduced over time to ensure the quantity target is met or an ETS with a price ceiling and/or price floor.

By 2021, 45 nations introduced a carbon tax and/or emissions trading scheme. Countries with a carbon price on average have an annual emissions growth rate that is about 2 percentage points lower. Every additional EUR/tCO_2 in carbon tax amounts to a 0.3% reduction in annual emissions growth. The World Bank recommends a price of at least US$40–80 per tonne of CO_2 by 2020 to be consistent with the 2°C goal, but few countries meet this minimum pricing, and instituting such a price may be difficult in some ASEAN economies.

In Southeast Asia, since 2019, Singapore has enforced a carbon tax of S$5/t$CO_2$-e (US$3.7/tCO_2). The tax rate will increase to S$25/t$CO_2$e in 2024 and to S$50–80/tCO_2e by 2030. Indonesia started to implement a carbon tax of US$2/t$CO_2$e in April 2022 for coal-fired power plants. Vietnam also planned to adopt a domestic carbon trading scheme. The country will start the pilot in 2025 and put it into full operation in 2028. A clear, long-term policy commitment to carbon pricing could help countries accelerate decarbonisation and meet NDC commitments.

Figure 3 | Countries with carbon tax and/or ETS by 2021. Note: Blue: Carbon tax, Green: ETS. Source: Carbon Pricing Dashboard (World Bank, 2022).



Suggested readings:

1. Burke, P., Jotzo, F., & Best, R. (2020). Carbon pricing works: the largest-ever study puts it beyond doubt. *The Conservation.* Available at https://theconversation.com/carbon-pricing-works-the-largest-ever-study-puts-it-beyond-doubt-142034
2. Do, T.N, & Burke, P. (2021). Carbon pricing insights from Vietnam. *Policy Forum*. Available at https://www.policyforum.net/carbon-pricing-insights-from-vietnam/
3. Burke, P. & Do, T.N. (2021). Greening Asia's economic development. *Asian Economic Policy Review* 16(1), 22–39. https://doi.org/10.1111/aepr.12316
4. Do, T. N., & Burke, P. J. (2021). Carbon pricing in Vietnam: Options for adoption. *Energy and Climate Change*, *2*, 100058. https://doi.org/10.1016/j.egycc.2021.100058
5. Burke, P. J., Widnyana, J., Anjum, Z., Aisbett, E., Resosudarmo, B., & Baldwin, K. G. (2019). Overcoming barriers to solar and wind energy adoption in two Asian giants: India and Indonesia. Energy Policy, 132, 1216-1228. https://doi.org/10.1016/j.enpol.2019.05.055

SESSION 4. INTERNATIONAL RENEWABLE ENERGY SYSTEMS

This session covers:

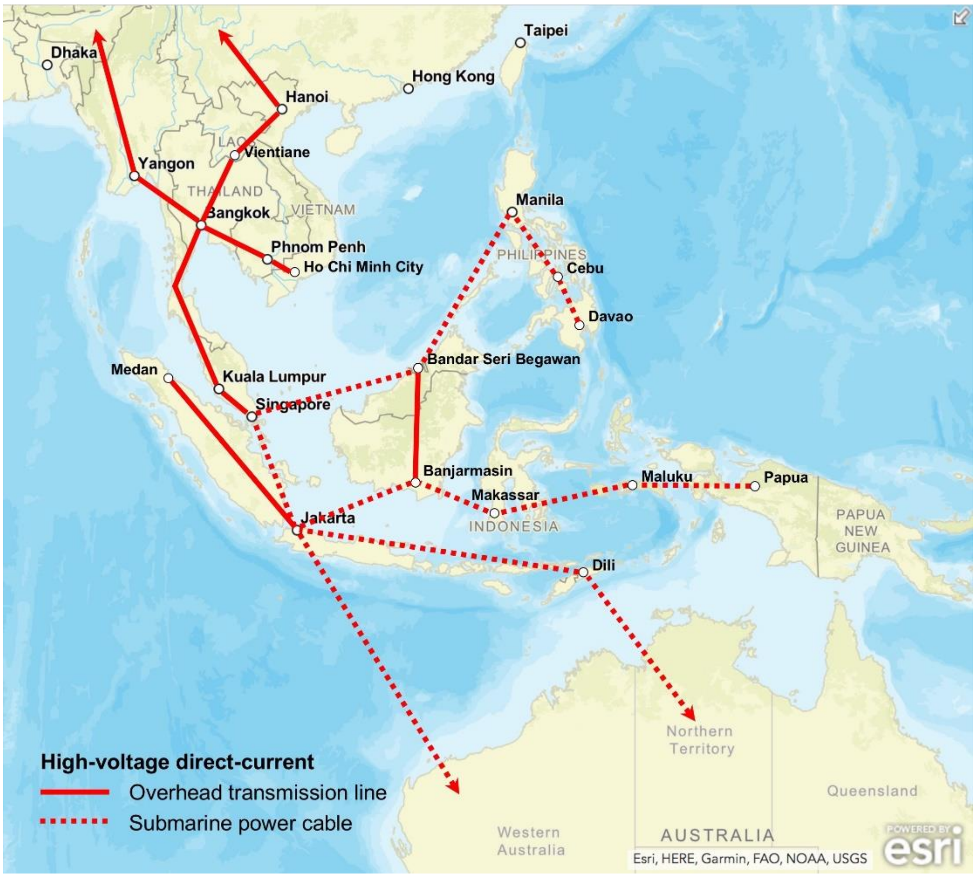
- Electricity Super-grids by Dr Bin Lu
- Cross-border Electricity Trade: The Case Of ASEAN by Dr Thang Do
- Hydrogen Trading Hubs by Prof Ken Baldwin and Dr Tom Longden

Historically, energy systems have developed as national systems designed, operated and managed at a country level. However, the trade of energy and the trade of electricity has seen an increasing level of connectivity and the growing importance of regional and international energy systems. Renewable energy is an important driver for integration in regional energy systems in the Asia-Pacific through three key aspects: electricity super-grids, cross-border electricity trade and hydrogen trade.

Super-grids are high-capacity power transmission lines using either high-voltage direct current or ultrahigh-voltage direct current power lines. Expanding regional power interconnection with super-grids is essential to allow a higher RE penetration and reliability of the power system.

Developing an Asia-Pacific super grid that connects major cities of the Southeast Asian countries with Australia, India and China can smooth out the power demand and variability of renewable energy in the region. It is proved technically feasible and cost-competitive compared with the scenario where the national systems operate separately. Such super grids would integrate the high wind energy potential areas (offshore Vietnam and Philippines, solar and wind in Northern Australia) with the large load centres of ASEAN. About 50-89% of storage requirement to support a complete renewable power system in SEA is reduced in the Super Grid scenario, due to the sharing of renewable energy resources.

Figure 4 | The Asia-Pacific Super Grid: a high-voltage direct-current backbone in the Super Grid scenarios.



ASEAN countries have explored the potential for regional power trade since the late 1990s, but progress has been limited. To date, power trade has mainly consisted of project-level trade between generation in one country exported for consumption to a neighbouring country (i.e., bilateral trade).

The first multilateral power trading arrangement was the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP). Actual trading has started among Lao PDR, Thailand, and Malaysia since 2017 and will soon further include Singapore.
Under this project, a total of 30.2 GWh of electricity was traded as of August 2020. There are multiple technical, institutional and economic barriers to multilateral and unified trade in the region, such as a lack of unified standards, specifications, and protocols for electricity transmission and distribution. In addition, countries of the ASEAN region place strong importance on energy self-sufficiency as a key ingredient for national energy security which has historically inhibited interest in reliance on energy trade.

International energy trade can also happen in the form of energy-carrying modules, such as hydrogen. To date, almost all traded hydrogen is produced from fossil fuels. With solar and wind now the cheapest form of generation on the planet, there is a potential for hydrogen to be a zero-carbon fuel for electricity generation. Brunei, for the first-time, exported hydrogen to Japan in December 2019; meanwhile, Singapore has signed a Memorandum of Understanding with Chile, Australia and Japan to enhance the cooperation in hydrogen. Low-carbon hydrogen could be produced in renewable rich countries like Australia and exported to energy intensive colder countries with limited domestic RE potential (like Japan, Korea).

Suggested readings:

1. Lu, B., Blakers, A., Stocks, M., & Do, T. N. (2021). Low-cost, low-emission 100% renewable electricity in Southeast Asia supported by pumped hydro storage. *Energy*, *236*, 121387. https://doi.org/10.1016/j.energy.2021.121387
2. Do, T.N. & Burke, P.J. (2022), Is ASEAN ready to move to multilateral cross-border electricity trade?. Asia Pac. Viewp.. https://doi.org/10.1111/apv.12343
3. White, L. V., Fazeli, R., Cheng, W., Aisbett, E., Beck, F. J., Baldwin, K. G., Howarth, P., & O'Neill, L. (2021). Towards emissions certification systems for international trade in hydrogen: The policy challenge of defining boundaries for emissions accounting. *Energy*, *215*, 119139. https://doi.org/10.1016/j.energy.2020.119139

SESSION 5. ENERGY STORAGE

This session covers:

- Why do we need storage?
- Pumped hydro energy storage
- Battery storage
- Hydrogen

Energy storage is inevitable in a 100% renewable power system as the sun does not always shine and the wind does not always blow. Energy storage technologies are available and can be cost-effective, including pumped-hydro energy storage (PHES), battery energy storage systems (BESS) and the use of hydrogen as a form of energy storage.

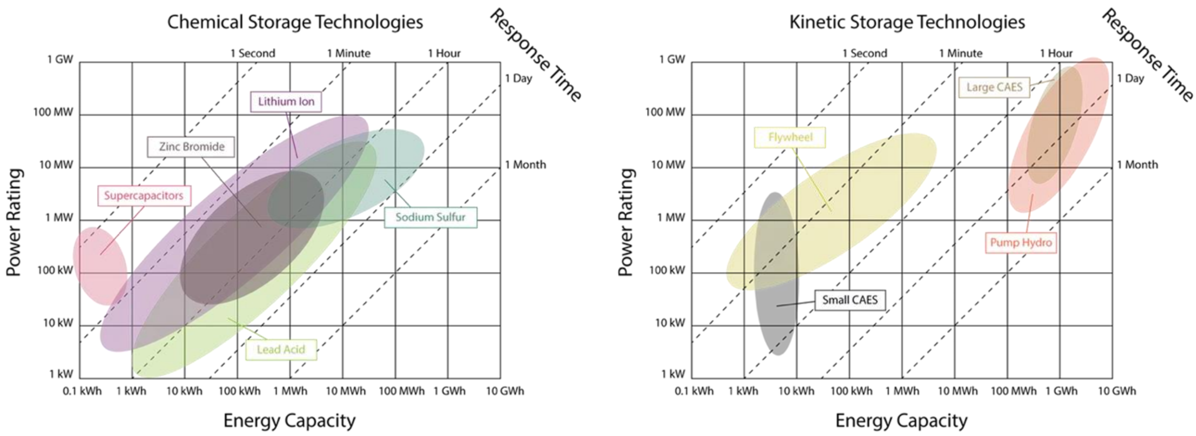
PHES is a long-existing and mature energy storage technology. About 96% of global storage power capacity is in the form of PHES. A PHES system includes 2 reservoirs with different altitudes connected by a pipe or tunnel. Water is pumped from the lower to the upper reservoir when there is spare power generation capacity (e.g., on windy and sunny days) and is allowed to return to the lower reservoir through a turbine to generate electricity when there is a supply shortfall (e.g., during the evening). Many of the existing PHES systems are river-based and often entail environmental and social impacts. However, it is possible to construct an off-river (or closed loop) PHES system that comprises two artificial reservoirs connected by underground tunnels and powerhouses with significantly reduced adverse social and environmental impacts.

For off-river PHES, water needs to be transported for the initial fill. The water loss during operation due to evaporation can be replenished by rainfall. If an off-river PHES system has an altitude difference (or head) of 400 m and generation efficiency of 90%, about 1 Gigalitre will be required per GWh of energy storage.

Australian National University has identified 616,000 good sites for off-river PHES worldwide based on geospatial modelling (http://re100.eng.anu.edu.au/global/index.php). A good site is characterised as a pair of closely located reservoirs with a large difference in elevation and distant from major urban centres or protected areas, and without damming river systems.

BESS is highly complementary to PHES. PHES is optimal for large-scale storage and medium-term energy balancing (hours to weeks) while battery storage provides a faster response and is available in modular form, thus is more suitable for small-scale storage and short to medium energy balancing (second-to-minutes-to-hours). At these shorter time scales, BESS are able to offer a wider range of services to the grid including frequency regulation, system inertia and other ancillary services, as well as short-term ~2-8hour time shifting. In recent years, battery energy storage systems are becoming more and more affordable and have been deployed at scale in power systems, based primarily on the commercialisation of lithium-ion technology for stationary storage applications. As of 2020, lithium-ion batteries account for 93% of BESS deployed for electricity generation.

Figure 5 | Energy storage technologies and response time



Hydrogen is an energy carrier with a wide range of applications. It can store energy generated from renewable sources and be used in sectors that are difficult to electrify such as heavy-duty transport and industry. However, the process of converting RE electricity into hydrogen and then back into electricity suffers from significant efficiency losses which limits the use of hydrogen as electricity storage to a few key niche industries and geographies.

Suggested readings:

1. Blakers, A., Stocks, M., Lu, B. & Cheng, C. (2021). A review of pumped hydro energy storage. Progress in Energy. 3. 022003. https://doi.org/10.1088/2516-1083/abeb5b
2. Blackhall, L., Franklin, E., Sturmberg, B., Glushenkov, A. M. & Ransan-Cooper, H. (2021) “Energy Storage,” In Baldwin, K. G. H., Howden, M., Smith, M. H., Hussey, K., and Dawson, P. J. (eds.), *Transitioning to a Prosperous, Resilient and Carbon-Free Economy: A Guide for Decision-Makers*, chapter, Cambridge, Cambridge University Press, pp. 139–172.
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4. Beck, F. J., Gourlay, D., Lyons, M., & Venkataraman, M. B. (2021). The Hydrogen Economy. In K. G. H. Baldwin, M. Howden, M. H. Smith, K. Hussey, & P. J. Dawson (Eds.), *Transitioning to a Prosperous, Resilient and Carbon-Free Economy: A Guide for Decision-Makers* (pp. 173–200). chapter, Cambridge: Cambridge University Press. http://doi.org/10.1017/9781316389553.011

SESSION 6. OPERATION OF ELECTRICITY GRIDS

This session covers:

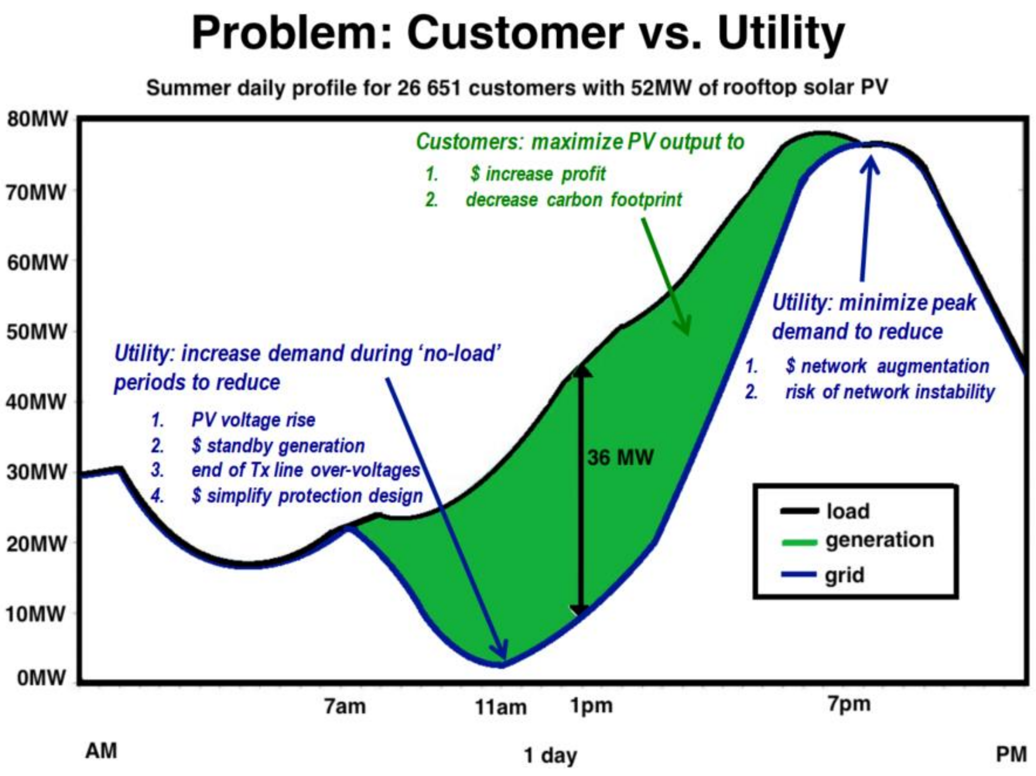
- A single residential system with rooftop solar
- Coordinated residential systems

- New Control Paradigms

High penetration of variable renewable energy will bring many challenges to grid operation. Studies on integrating rooftop solar into the grid in Australia show there are practical solutions emerging that are of benefit to both grid operators and end consumers.

By 2021, there was 810W of solar PV per capita in Australia. As installation of rooftop solar increases, it causes a change in the demand profile. Solar generation reduces the demand for electricity during sunlight hours whilst requiring grid electricity during peak hours and evenings (the duck curve). The duck curve creates a new demand profile for grid operators to manage.

Figure 6 | The duck curve



- During peak solar generation: voltage instability and the need for flexible generation that can be ramped up on cloudy days and ramped down on sunny days.
- During the evening: demand peaks - rise of network instability and peaking generation.

Considering a single residential system, there is a certain time during the day when the electricity generation exceeds the load. The excess can be either exported to the grid or stored in a battery. If net-metering and time-of-use pricing policies are in place, the customer can utilise these instruments to optimise battery operations and maximise their saving. For example, based on the variation in electricity price at different times of the day and solar generation profile, a customer can charge their battery during off-peak times when the price is low and when there is a generation excess, and discharge their batteries during peak pricing times.

A case study of 145 residential customers located in an Australian distribution network shows that applying this strategy would save them 986 AUD annually. Charging and discharging of electric vehicles can be coordinated by a similar strategy. However, the adoption of this practice at a large scale would cause a big problem for grid operators. Power load reversal and voltage rise may happen during the period when all batteries are discharged at a time.

To resolve the grid instability problem, a coordinated schedule solution seeks to retain the consumer benefits of solar battery systems whilst mitigating the emergent grid reliability issues. This solution suggests that a grid operator specifies the battery charging schedule a day ahead, so that they can effectively coordinate multiple distributed renewable energy systems into a mutually beneficial system for both the energy consumer and the grid operator.

Suggested readings:

1. Ratnam, E. L., Weller, S. R., & Kellett, C. M. (2015). Scheduling residential battery storage with solar PV: Assessing the benefits of net metering. *Applied Energy*, *155*, 881-891. https://doi.org/10.1016/j.apenergy.2015.06.061
2. Ratnam, E. L., & Weller, S. R. (2018). Receding horizon optimisation-based approaches to managing supply voltages and power flows in a distribution grid with battery storage co-located with solar PV. *Applied Energy*, *210*, 1017-1026. https://doi.org/10.1016/j.apenergy.2017.08.163
3. Nimalsiri, N. I., Ratnam, E. L., Mediwaththe, C. P., Smith, D. B., & Halgamuge, S. K. (2021). Coordinated charging and discharging control of electric vehicles to manage supply voltages in distribution networks: Assessing the customer benefit. *Applied Energy*, *291*, 116857. https://doi.org/10.1016/j.apenergy.2021.116857
4. von Meier, A., Ratnam, E. L., Brady, K., Moffat, K., & Swartz, J. (2020). Phasor-Based Control for Scalable Integration of Variable Energy Resources. *Energies*, *13*(1), 190. https://doi.org/10.3390/en13010190
5. Salehi, Z., Chen, Y., Ratnam, E., Petersen, I. R. & Shi, G. (2021). Social Shaping of Linear Quadratic Multi-Agent Systems. *Australian & New Zealand Control Conference (ANZCC),* 2021, pp. 232-237. https://doi.org/10.1109/ANZCC53563.2021.9628389

SESSION 7. ENERGY EFFICIENCY

This session covers:

- Impact of energy efficiency
- Types of energy efficiency policies
- Developing tools

Energy is a means and key enabler for economic growth and social prosperity, not an end by itself. We use energy to access the services it provides, such as heating, lighting, cooling, and cleaning. Each of these major types of societal energy uses is subject to inefficiencies in consumption. Energy efficiency focuses on reducing the demand for energy by the improved efficiency in how energy is consumed and is key for a range of aspects in energy transition. This includes keeping overall energy demands from rising steeply as new loads are added due to development and/or increased electrification of sectors and regions; supporting energy users in getting the most out of the services that energy provides with the lowest energy cost; and creating a stock of infrastructure that uses minimal energy to achieve its intended purpose. Improving energy efficiency means reducing energy consumption and GHG emissions while pursuing and maintaining a good-quality life. Energy efficiency also enables universal clean energy access and brings health benefits (e.g. by adopting efficient and clean cooking facilities) and has synergies with many other Sustainable Development Goals (SDGs).

Energy efficiency policies can be classified into regulatory, financial and informational instruments.

Minimum standard regulations such as building codes can reduce energy consumption and avoid carbon lock-in. The EU with decades of experience adopting energy efficiency policies for buildings showed a strong impact of residential building code reform on reducing energy intensity.

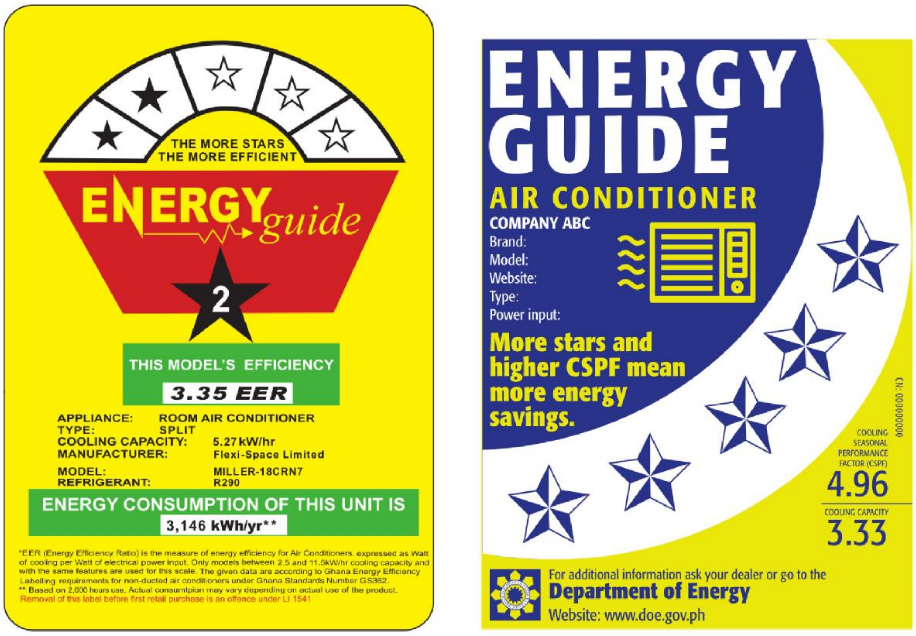
Sufficient data is required when setting a reasonable minimum standard that supports energy goals without imposing a heavy burden on consumers and the country. This can be a barrier in places that do not have a lot of resources for testing and analysis, or do not have a lot of historical data to work with.

Building performance requirements and product standards tend to be strengthened over time. Tracking data is critical for tracking and enforcing implementation of regulations. Without collection/tracking over time of housing stock energy efficiency, it can be challenging to determine what to target for future change, and challenging to understand which existing strategies are most effective. Setting in place mechanisms to collect information on building and product energy efficiency can support future efforts for improvement.

Taxes, subsidy, or grants can be used as **financial tools** to enhance energy efficiency. Nevertheless, a review of the use of those instruments worldwide revealed that finance instruments are not always effective and sometimes are regressive in nature, i.e., people with less ability to pay bear more of the policy cost.

Meanwhile, **information-based instruments**, e.g., energy label and energy certificate can be implemented at low cost and be highly effective in directing consuming behaviour towards EE products. A combination of product standards and labels is popular for electric appliances. Energy performance certificate can be applied for a property. Buildings with high energy-efficiency labels are often valued, sold or rented with a higher price compared to ones with the same characteristics but not certified.

Figure 7 | Energy Label in Ghana and the Philippines



A study of middle-income households in the Philippines and Ghanafound that:

- Consumers care about energy efficiency and are influenced by an energy efficiency label.

- ACs with a higher energy efficiency rating are preferred and so are ACs with a better cooling technology.
- Within the range of existing market prices, the energy rating has a bigger impact on AC choices than the price.
- Higher environmental concern and knowledge increased the value of energy efficiency in the Philippines and, partially, in Ghana.

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SESSION 8. TRADE, INVESTMENT, AND GREEN INDUSTRIAL POLICY

This session covers:

- Renewable Energy Trade, Foreign Direct Investment and Green Industrial Policy: What and Why.
- Trade & Investment Policy for Energy Transition
- EU Carbon Border Adjustment Mechanism (CBAM)
- Certification

Renewable energy trade is the sale of renewable energy between high-producing countries to high-consuming countries. Trade can be in the form of RE electricity or other energy carriers. With high RE potential, opportunities for RE trade are emerging in the Asia Pacific. For example, an onshore windfarm is constructed in Laos with intention to sell electricity to Vietnam. Australia also sees its opportunity to export solar generated power to the Southeast Asian countries where power demand continues to grow steadily.

Renewable energy trade will foster renewable energy cost reduction thanks to the advantage of economy of scale and the reduced need for energy storage. In addition, with diversified renewable sources, the energy system is less vulnerable to climate variability and geopolitical crises.

Foreign direct investment (FDI) also appears in RE generation and transmission assets. FDI helps developing countries quickly meet their financing needs for development of renewables and transmission projects and facilitates access to global market and advanced technology, avoiding energy transition delay and carbon lock-in.

Green Industrial Policy (GIP) comprises sector-targeted policies that support the growth and development of certain industries and technologies, with an aim to further both economic and environmental goals. GIP addresses traditional market failures restricting industry growth (e.g. by using certification schemes to correct imperfect information). GIP also includes funding schemes, subsidies and price guarantees to support the development and acceleration of green technology. A technology-based approach is an alternative where carbon pricing policy faces considerable opposition and barriers to be employed.

Examples of GIP include Green Deal adopted in the EU and South Korea (GIP package), hydrogen strategies introduced in Australia, Japan, South Korea and many other countries, and GIP instruments such as innovation fund that jointly managed by Australian Renewable Energy Agency (ARENA) and Clean Energy Finance Corporation (CEFC).

The EU's Carbon Border Adjustment Mechanism (CBAM) is a trade-related policy and an important climate action instrument of the EU "Fit for 55" Package, which aims to reduce net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.

The objective of CBAM is to reduce carbon leakage occurring when businesses relocate production from countries with stringent emissions policy to ones with laxer constraints to avoid climate responsibility. Under CBAM, a carbon price will be imposed on specific products imported into the EU. CBAM covers carbon-intensive products, including cement, aluminium, fertilisers, electricity, iron and steel. EU importers will have to buy carbon certificates corresponding to the embedded emission intensity of the products at the price of the EU's Emissions Trading System allowances at any given point in time. The cost can be deducted if a carbon price has been already paid in the country of production. As a result, CBAM will level carbon price between the EU and the third country. CBAM will start application from 1 January with a transitional period of three years and full application from 1 January 2026.

CBAM will consequently encourage carbon reduction in countries outside of the EU. However, compliance costs are likely high in the Least Developing Countries (LDCs) where governments, sectors and firms lack the capacity and access to expertise to facilitate verification and compliance. The EU plans to provide LDCs with technical assistance, technology transfer, extensive capacity building and financial support to develop industrial production structures compatible with long-term climate objectives.

Non-EU countries should establish a domestic carbon price mechanism and have an EU-compatible carbon accounting system for verification of actual embedded emissions. Particularly, LDCs should actively consult with the EU for equitable use of the revenue from CBAM.

Suggested readings:

1. White, L. V., Fazeli, R., Cheng, W., Aisbett, E., Beck, F. J., Baldwin, K. G., Howarth, P., & O'Neill, L. (2021). Towards emissions certification systems for international trade in hydrogen: The policy challenge of defining boundaries for emissions accounting. *Energy*, *215*, 119139. https://doi.org/10.1016/j.energy.2020.119139

2. Aisbett, E., Cheng, W., & Beck, F. (2021), Green Industrial Policy and Technology Neutrality: Odd Couple or Unholy Marriage? *ZCEAP Working Paper,* 01-21.
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4. Aisbett, E., & Bonnitcha, J. (2021). A Pareto-Improving Compensation Rule for Investment Treaties. *Journal of International Economic Law*, 24, 1, pp181–202. https://doi.org/10.1093/jiel/jgab006

SESSION 9. INDUSTRY WORKFORCE PLANNING IN ENERGY TRANSITION

This session covers:

- Introduction: Energy as a labour issue
- Best practice policy and lessons from Australia
- Reflections from Southeast Asia

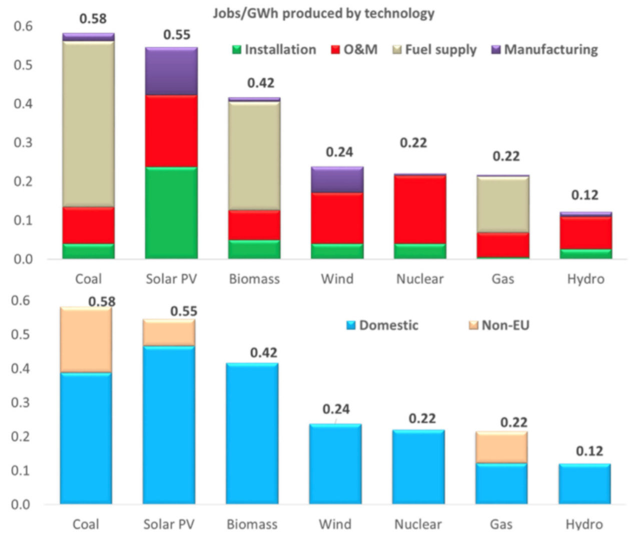
Energy Transition also means a shift in society's workforce. People working in coal mining or coal power plants are losing their jobs while new jobs are created in the renewable energy sector. Coal power station closure takes away coal jobs, which significantly affects the coal workers and their families in both economic and psychological ways. The impact of job losses spreads further to the whole local economy. As seen in Australia, coal towns have been built up over generations. Workers are usually informally trained in a skill set that is difficult to translate to new industries.

Job losses in the coal industry could be made up by new ones emerging in the renewables industry. Considering and improving quality of new created jobs is part of the workforce planning in the new sectors. This means to reduce the precarious conditions in minerals mining for producing solar panels and wind turbines, reduce the exposure to hazardous chemicals of manufacturing jobs, ensuring that the new jobs come with adequate incomes and good working condition.

It is expected that job intensity in RE will be lower than fossil-fuel energy industries. As observed in the EU's renewable energy transition, coal industry creates the highest number of jobs per GWh produced, however, about two-thirds of these jobs are upstream in coal mining and fuel supply. Solar PV creates a comparable number of jobs to coal with two-thirds of these in installation and operations and maintenance (O&M). Hydro creates the lowest number of jobs of any technology half as many as wind or gas.

Renewable industries will open more job opportunities for women compared to fossil fuels, although currently the female proportion remains modest. An IRENA survey showed an average of 32% of women involving renewable energy in 2018. There was a fair gender balance in administrative jobs, whereas the higher-paid STEM (science, technology, engineering and mathematics) jobs were only 28% occupied by women.

Figure 8 | Employment associated with 1 GWh of annual electricity production by technology in 2015.



Broad industrial strategies are recommended for a successful just energy transition. They require a combination of a just transition of the workforce when closing fossil fuel facilities, creation of new decent work and quality jobs, economic diversification to make up the number of job losses and bringing attention to gender equality.

The closure of Hazelwood power station in Victoria State of Australia in 2017 is a good case study that showcased an effective application of these strategies. Victorian state and federal governments initiated many tens-of-millions-dollar packages to support the local economic restructure through re-training, active job-seeking assistance, building new infrastructure, and providing funding for promoting economic growth, business investment and job creation in the wider Valley community.

BOX 1: Initial Victorian government Latrobe Valley transition policy initiatives.

Note: This is not a comprehensive list of all programs and projects initiated under the Victorian Government's announcements

1. $22 million in support services for affected workers, including financial and emotional counselling, education and training programs; support in identifying new business opportunities; the establishment of a Worker Transition Centre (in partnership with the Gippsland Trades and Labour Council) and an expansion of the Back to Work program that assists business in the Valley (Andrews, 2016a).
2. $20 million to fund the establishment of a new Latrobe Valley Authority (LVA) to lead work on economic transition strategies (Ibid.)
3. Establishment of an Economic Growth Zone, including the local government areas of Latrobe City Council, Baw Baw Shire and Wellington Shire (Andrews, 2016b). This package consisted of two major components — a $50 million Economic Growth Zone to encourage businesses to re-locate to the Valley via financial incentives such as stamp duty concessions and fee reimbursements to be administered by the LVA, and $174 million for a Community Infrastructure & Investment Fund to finance local infrastructure projects (Andrews, 2016b; Gordon & Priess, 2016).
4. Energy efficiency upgrades: $5 million has funded energy efficiency upgrades to 1,000 homes of low-income and vulnerable Valley residents (ABC, 2016e).
5. Morwell Hi-Tech Precinct: $17 million was allocated to the development of an innovation precinct in Morwell through collaboration between Federation University, Federation Training, Morwell Tech School, the Victorian Government and Fujitsu (Andrews, 2016c). The precinct is intended to focus on the energy, food and fibre, health and professional services industries, and expected to create 80 jobs in its construction and hundreds of fulltime hi-tech jobs in the future (Ibid.).
6. Redundancy scheme: $20 million was allocated to a scheme to encourage older workers from the remaining operational power stations to take redundancy

packages, thus providing opportunities for younger Hazelwood employees (Anderson, 2017).

7. New Energy Jobs & Investment Prospectus: $500,000 and 1 full-time-equivalent employee over 2 years to develop tools to encourage investment in small, medium and large scale renewable energy projects — including an investment prospectus for large scale renewable energy projects outlining local workforce, resource and infrastructure availability, and support for local business owners to assess potential savings from solar system installation (Victorian Government, 2017).
8. Gippsland Line Upgrade: In addition to the package, a $345 million upgrade to the Gippsland Rail Line is being undertaken, creating a project office located in the Valley and an expected 400 jobs (Noonan, 2017b).
9. Worker Transfer Scheme: A $20 million Latrobe Valley Worker Transfer Scheme (described in Part 2.4, below) was established via an agreement between labour unions, the Victorian government and electricity generators, announced on the 10th May, 2017.
10. Public housing upgrade: $7.8 million will be invested in the upgrade of 224 public housing properties, creating 80 construction jobs and including the use of more efficient building supplies and utilities to reduce energy bills for tenants and overall environmental impact (LVA, 2017).
11. GovHub complex: the construction of a new GovHub office complex in Morwell is scheduled to begin in 2018 and to be completed in 2020, creating 100 jobs (Noonan, 2017a). Once completed, the site is expected to be a base for up to 300 staff, including 150 public sector jobs with positions advertised in the 12 months from the announcement to enable local job-seekers to apply (Ibid.) The site will serve as the head office for the Earth Resources Regulation staff responsible for mine rehabilitation and regulation (Ibid.)

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1. IRENA (2019), Renewable Energy: A Gender Perspective. IRENA, Abu Dhabi.
2. Cass, D., Connor, L., Heikkinen, R., Pearse, R. (2022). Renewables & rural Australia. A study of community experiences in Renewable Energy Zones in NSW and the case for more equity and coordination of the clean energy transformation, *Sydney Environment Institute and Australia Institute.*
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SESSION 10. SOCIAL TRANSITION

This session covers:

- Social considerations in the energy transition
- Theory and practice of energy transition justice
- Impacts on stakeholders

A social transition is inevitably happening with the transition to clean, renewable energy systems. Recognition and consideration of these social changes in energy transition planning would help resolve conflicts with stakeholders who see themselves as the losers of the transition and ensure benefits of the transition are shared across all segments of society.

Social changes are consequences of:

- **Closure of established industries:** Workers in fossil fuel industries face the fear of unemployment and livelihood uncertainty as the industries are being phased out. Some may choose to migrate and seek new opportunities elsewhere. Key beneficiaries of the phase-out industries often lobby for slowing down the transition and/or compensation schemes for industries closure. Social changes also happen with the rehabilitation of the mined land for new purposes of the community.

- **Emergence of new industries:** Development of new solar and wind infrastructure will boost the local economy and create new livelihoods, both directly by employing the local people in the projects and indirectly by driving demand for hospitality services in the local areas.
- **Changes in landscape:** Landscape is changed with the presence of new infrastructure, including not only wind turbines or solar panels but also new transmission lines. The changes in landscapes can affect local livelihoods, drive migration and settlement, and further interact with how people value nature and amenities provided by the landscape before power infrastructure is built. The conversion of land for renewable generation could also impact the provision of environmental services. This has implications for local people's accessibility to the land and these services before and after the projects.

Investigating energy justice from four perspectives: distributional, procedural, recognition and restorative will uncover many nuances and insights into energy justice in a specific context.

- **Distributional justice** concerns who and how much cost and benefit of the changes are distributed across the populations. The objective is to ensure that some people do not receive an inordinate share of the burdens or are denied access to the benefits. For instance, in building new wind power projects, landholders and surrounding neighbours may all bear the burden of having the new infrastructure. A payment scheme based on proximity to the wind turbines is better to ensure a fair distribution rather than based on the land property right. Benefits could be distributed to a wider community through community funds and shareholding opportunities.
- **Procedural justice** concerns who are included in energy decision-making processes and seeks to ensure that energy procedures are fair, equitable and inclusive of all who choose to participate. Being informed is a basic level of public participation. Highest level of participation is seen when the final decision making is placed in the hand of the public.

Figure 9 | IAP2's Public Participation Spectrum.

IAP2'S PUBLIC PARTICIPATION SPECTRUM

iap2 international association for public participation

The IAP2 Federation has developed the Spectrum to help groups define the public's role in any public participation process. The IAP2 Spectrum is quickly becoming an international standard.

INCREASING IMPACT ON THE DECISION

	INFORM	CONSULT	INVOLVE	COLLABORATE	EMPOWER
PUBLIC PARTICIPATION GOAL	To provide the public with balanced and objective information to assist them in understanding the problem, alternatives, opportunities and/or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution.	To place final decision making in the hands of the public.
PROMISE TO THE PUBLIC	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision. We will seek your feedback on drafts and proposals.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will work together with you to formulate solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.

- **Recognition justice** means understanding of historic and ongoing inequalities, and prescribes efforts that seek to reconcile these inequalities.
- **Restorative justice** is about using government or other intervention to either avoid distributional, recognitional, or procedural injustices, or to correct for them.

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1. Sovacool, B. K., & Dworkin, M. H. (2015). Energy justice: Conceptual insights and practical applications. *Applied Energy*, *142*, 435-444. https://doi.org/10.1016/j.apenergy.2015.01.002
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