



# **Lighter Footprints submission**

## **Submission to the Committee Secretary Senate Standing Committees on Environment and Communications**

### **Retirement of Coal Fired Power Stations**

Lighter Footprints is a large climate action group based primarily in the Boroondara and Whitehorse council areas of Victoria, encompassing, Box Hill, Kew, Hawthorn, Camberwell, Canterbury, Surrey Hill and some parts of Ashburton, Glen Iris and Burwood, and Federal electorates of Kooyong and part of Chisholm and Deakin.

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Committee Secretary  
Senate Standing Committees on Environment and Communications

## **Retirement of Coal Fired Power Stations**

Thank you for the opportunity to make a submission to the inquiry by the Environment and Communications References Committee into the retirement of coal fired power stations.

This submission is by Lighter Footprints, a group of concerned residents (now close to 2000) from Boroondara and Whitehorse municipalities in Melbourne who came together in 2006 to see what we could do about the serious challenge of climate change. Our community recognises that climate change has been scientifically demonstrated for some years, and the extent of the challenges leads us to be impatient for effective action.

## **Executive Summary**

This report outlines the case for closure of Australia's Eastern States coal fired power stations and presents a view of what a coordinated and comprehensive policy framework would be . The various available technologies that can be incorporated are identified and the impacts considered.

In the assessment of Bloomberg New Energy Finance, solar and wind energy are easily the cheapest form of new generation in Australia.

Good policy will be characterised by a clear-sighted understanding of the present situation and the use of measures that take advantage of current trends and momentum

The measures should be tailored to achieve not only a commercial advantage but to capture the many other potential benefits to be gained by an orderly transition away from coal fired power stations to renewable sources of energy.

## **Introduction**

Lighter Footprints supports the closure of coal fired power stations such as Hazelwood as part of a program to meet Australia's obligations to reduce its carbon emissions under the 2015 Paris Agreement. We do not consider the targets Australia has nominated or the current mechanisms put in place to reduce our emissions are sufficiently ambitious or effective to ensure Australia makes an equitable contribution to meeting the global challenge of climate change. We look forward to Australia's ratification of the Paris Agreement in November.

Australia needs to take a more ambitious and pro-active approach to reducing our carbon emissions. This includes adopting a planned and strategic approach to the closure of all coal fired power stations around Australia starting with the most polluting plant at Hazelwood.

We see the announcement by Engie that it will close the Hazelwood completely by the end of March 2017 as a necessary step in the decarbonization of the Australian economy and a major move towards meeting our obligations under the Paris Agreement. We are very aware of the impact that this decision will have on the workers and sub-contractors employed by the power plant and on communities in the Latrobe Valley dependent on the wealth generated by this plant and welcome the announcement by the Victorian State Government of measures designed to ameliorate the social and economic cost of this decision.

We consider that such closures must be part of a coordinated and comprehensive strategy that ensures that the burden of transition is shared equally by all parts of the Australian community and in ways that capture the economic and social benefits of the move away from coal fired power generation.

## **The case for a planned closure of coal fired power stations**

A planned closure of Australia's coal fired power stations is essential for ensuring that we meet our obligations under the Paris Agreement in a timely and effective manner, with measures that protect the productivity and competitiveness of the Australian economy and ensure a just and equitable transition for Australia's workforce and community in general.

- Electricity generated by coal fired power stations make up around one third of all Australia's carbon emissions. These facilities are thus one of the most important factors putting Australia amongst the highest per capita emitters in the world.
- The owners of these plants cannot be left to make decisions as significant as those relating to closure solely on the basis of commercial considerations or without reference to the actions and interests of others.

- The Federal Government has an essential role in providing policy mechanisms to facilitate timely and regulated closures and for ensuring that responsibility for rehabilitation of plant sites is appropriately accounted for in the negotiations surrounding closures. These mechanisms need to be carefully designed to ensure they do not provide a perverse incentive for companies to remain open in anticipation that they will receive payments to close
- An orderly and strategic approach is essential to protecting the interests of local communities and the people working in these plants.
- The Australian Energy Market Operator has a vital role in the coordination of the closures to ensure continuity of energy supplies. They have already identified an excess of capacity within the Eastern States system which enables some station closures without energy security impact.
- Development of a suite of coherent policy measures would provide an opportunity to demonstrate to the international community that Australia is willing to acknowledge its contribution to global carbon emission levels and to take its share in finding solutions.
- A consistent policy approach would assist in exploiting our unequalled renewable energy resources of sun, wind, land and ocean together with an educated workforce to regain the competitive advantage inherent in the availability of low cost energy.

#### *Why adopt an accelerated timeframe?*

It is imperative that we stop putting CO<sub>2</sub> into the air because it either stays there and warms the globe or goes into the ocean and makes it more acidic as well as warmer. Every tonne is another tonne that has to be drawn down and somehow sequestered away in the near future if we are to avoid the undesirable consequences associated with life on an overheated planet.

Evidence of the consequences of delayed action is already with us in the form of heat damage to Great Barrier Reef corals, prolonged inland droughts, heavy insurance payouts for storm damage, and threats to coastal property values from rising sea levels. It is true that Australia acting alone could not hope to turn global warming around but it is assuredly in our national interest to do everything we can, including by positive example, to promote effective international action to combat it. Countless studies caution against avoidable delay in cutting emissions.

Kemp and Jotzo (2015)<sup>7</sup> put the case for urgent action in three succinct dot points:

- Every plausible carbon budget for Australia will involve deep reductions in emissions before 2030, even with relatively modest global climate action.
- If Australia remained on a high emissions economy for an extended period of time, this would create very large adjustment pressures later.
- The longer emissions increase or plateau, the steeper the required reductions – and the harder the task – later on.

The same writers<sup>8</sup> make reference to Austrian modelling in 2013 which found that delaying global action by just five years would require double the marginal cost of abatement to give the same expected temperature outcome. This finding points to a significant difference between current Australian and US intended nationally determined contributions (INDC) in that the Australian targets, 26-28% below 2005 levels by 2030, are the same as the US targets except that the latter are designed to be met five years earlier, in 2025.

The IEA , at the launch of the 2011 edition of the World Energy Outlook, described delaying action as a false economy:

*for every \$1 of investment in cleaner technology that is avoided in the power sector before 2020, an additional \$4.30 would need to be spent after 2020 to compensate for the increased emissions.*<sup>9</sup>

The Climate Council in its report *The Silent Killer: climate change of the health impacts of extreme heat*<sup>10</sup> points to the importance of an accelerated timeframe in combatting climate change. With an increasing likelihood of hot weather and as heatwaves become more severe, there is a serious and growing health threat to many Australians . It notes that:

*... over the past four decades there has been a steady increase in the number of deaths in summer, compared to those in winter suggesting that climate change may already be affecting mortality rates*

*Why predictable and economically efficient policy settings are necessary to achieve an orderly transition*

Jotzo and Kemp put it this way<sup>11</sup>:

*Achieving an orderly transition will require predictable and economically efficient policy settings. If there is uncertainty about future policy settings, investment can stall, as is currently the case with regard to Australia's Renewable Energy Target. Similarly, the carbon pricing mechanism that was in place from mid-2012 to mid-2014 resulted in changes in operational decisions, but probably did not have large impacts on investment decisions because its political future was uncertain.*

*Good policy will be characterised by a clear-sighted understanding of the present situation and the use of measures that take advantage of current trends and momentum*

The fastest, most efficient way to develop and implement good policy is to build on the trends currently taking place and to take advantage of the momentum that is building to bring about change. Significant trends include:

In the domestic market place

Trends in domestic energy consumption include:

- Carbon emissions continue to grow from the major electricity generators<sup>12</sup>.
- There has been a rapid take-up of domestic rooftop solar

- Electricity consumption has declined on average since 2008
- An unprecedented and rapid change in patterns of use for grid-supplied electricity

### Current state of generation equipment and grid

An understanding of what is happening in the generation and supply of energy is essential as a basis for an orderly and strategic transition away from coal fired power stations:

- serving peak demand from centralised power generation will become increasingly uneconomic.
- the average age of Australia's coal power station fleet is over 30 years with some 50-year-old facilities still in service
- the condition of some older plants is unsafe and will require increased maintenance costs
- the closure of coal fired power stations in an orderly manner will make available market capacity for smooth transition to renewables under legislated RET scheme
- there is already surplus capacity in the market as assessed by AEMO<sup>16</sup>
- closures will speed up the process of assimilating operating knowledge with higher renewables penetration and encourage low-emissions replacement generating technologies - e.g. solar thermal

The three major power generators AGL, Energy Australia and Engie Australia have acknowledged the need to respond to climate change in respect of their generation facilities and their key roles in the changes required in the industry. They have published their own considerations.<sup>19</sup>

There is already acceptance of the need to retire the coal fired generators with identification that 70% of coal fired plant is at its end of life. These companies are looking for a plan for an orderly phase-down and shutdown of the facilities.

### *Global trends and agreements*

- reduce emissions in line with Paris Agreement
- key issue is for zero carbon emissions after 2050
- increased renewable energy generation combined with plug-in EVs can allow emission targets to be met at the same time as reducing dependence on foreign oil imports.
- coal mines likely to become uneconomical as world demand for coal contracts under Paris Agreement pressures

### **What does a coordinated, comprehensive strategy look like?**

A coordinated, comprehensive strategy for the closure of Australia's coal fired power stations should

- be evidence based and built upon knowledge and experience gained from similar experiences here and overseas and include the results of consultation with all affected parties
- take a timely , innovative and long term approach to the development and implementation of measures to bring about change which is fair and equitable for affected individuals and communities and ensures the burden of transition is shared by all Australians
- provide leadership by recognising the economic and social potential inherent in the transition away from energy generated by coal fired power stations and towards renewable energy e.g. new jobs, skills and a reduction of adverse health impacts. Long term the cost of electricity is cheaper to the whole community.
- adopt measures that are appropriate to the problem being addressed, take effect in a timely and efficient way and builds upon the skills, knowledge and experience of the people immediately affected by the transition. This is not a “one size fits all” solution but involves many solutions tailored to meet the needs of those at the front line. There will be tension between national consistency and regional variability
- Attitudes within the energy generation community. are changing There is great value to be had in Governments working cooperatively with the owners of coal fired powers stations to develop policies that facilitate systematic and timely closures.

### **Policy Mechanisms to encourage the retirement of coal-fired power stations**

The Australian Government needs to implement a suite of policy mechanisms that promote an orderly transition of the stationary energy sector from coal-fired generators to zero carbon infrastructure within an accelerated but safe time-frame.

The specific measures adopted must build upon the trends already happening and take advantage of the momentum that is building up within commercial and domestic energy consumers to convert to renewable sources of power. The measures should also take advantage of the rich research and innovation that is happening within our research bodies including CSIRO and Universities and within the corporate sector.

These mechanisms need to be clearly and strongly focused on the end game of reducing Australia’s carbon emissions in a timely and efficient manner. We cannot afford to wait for companies to be dragged screaming to the negotiating table. It is in everybody’s best interest not least that of the companies themselves that the Governments adopt a firm, measured and predictable approach to closures. At the same time, care needs to be taken that the mechanisms do not provide perverse incentives for companies to remain open or to seek excessive compensation.

There are already a number of examples that the Government could examine to identify what factors are essential to the success of a transition package and how to design a comprehensive strategy. These include lessons to be learnt from the transition which

occurred following the closure of major industries in cities such as Newcastle and Geelong. The Snowy Mountain Scheme is also a prime example of a huge and successful infrastructure building project.

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There is a range of Government agencies capable of delivering these policy mechanisms.

### *Why aim for Zero Carbon?*

The stationary electrical energy sector is a prime candidate for early decarbonisation. Available and commercially viable technology already exists for the complete replacement of the burning of fossil fuels in this sector by renewable energy in its various forms.

And the costs will be by no means prohibitive. As stated by Jotzo and Kemp:

*The costs of some carbon-free technologies, including solar and wind power, have fallen much faster than expected. For example, large scale solar panel power stations are already only half the cost that the Treasury's 2008 and 2011 modelling studies estimated they would be in the year 2020<sup>1</sup>*

The following references provide indications of the competitiveness of power generation from renewable sources today:

#### Wind Turbines

- The US Department of Energy<sup>2</sup> states that between 2008 and 2013, the levelised cost of energy from onshore wind in good to excellent resource sites declined by more than one-third, falling from USD71 per megawatt-hour to USD45 per megawatt-hour (excluding tax credits)
- Contracts awarded in Australia by the ACT government following auctions in December 2015 and March 2016 provide for the supply of power over 20 years for \$77/MWh and \$89.10/MWh respectively.<sup>3</sup>
- Meanwhile in Europe there is strong development in the harnessing of offshore wind resources, with contract prices in July this year down to USD73/MWh (projects totalling 350MW off Denmark) and in September USD67/MWh for a 700MW Dutch offshore array.<sup>4</sup>

#### Photovoltaics

While Australia leads the world in uptake of domestic (small-scale, less than 100MW) rooftop solar we lag in sixth place behind Germany, Italy, Belgium, Greece and Argentina in total solar (PV and solar thermal) installed capacity per capita.<sup>5</sup> However, there are strong indications that price will not be a bar to growth in large-scale solar in Australia from now on.<sup>6</sup>



- Bids filed with the ACT government this year (2016) for around 200MW large-scale renewable energy capacity showed that solar was already compatible with wind energy with bids spread from \$77/MWh to around \$90/MWh.
- These levels were indicated in a graph presented by Ruoss at the [July] Clean Energy Summit and accord also with estimates by ARENA that project costs were already heading below \$100/MWh.
- In the assessment of Bloomberg<sup>20</sup> New Energy Finance, solar and wind energy are easily the cheapest form of new generation in Australia.

### Energy Storage

Many countries have already committed to filling large percentages of their future electricity demand with renewable energy, and to alleviate concerns with intermittency they will need long-term energy storage in the terawatt-hours range. Grid connected battery storage assists with short term, localised distribution system demand variations. However major opportunities for large scale storage come from pumped hydro systems where installations of up to 500 MW are possible, and thermal storage, usually in conjunction with solar thermal stations.

The State of California in 2013 passed a “Huge Grid Energy Storage Mandate” that required the state’s big three investor-owned utilities to add 1.3 gigawatts of energy storage to their grids by 2020 to assist with grid stability.<sup>17</sup>

### Technology trends

Important trends in technology that must be recognised and built into the suite of policy mechanisms include the following:

- Economic growth has been de-coupling from grid-supplied electricity since 2008
- The levels of peak demand seen in FY 2008-09 will not be seen again until sometime beyond 2035
- Rooftop PV electricity generation reduces the demand for grid-supplied electricity and is forecast to triple over the next 10 years
- 3 GW of wind and 3.4 GW of rooftop solar has been installed in the past ten years
- Homeowners will continue to deploy building envelope upgrades (e.g. insulation and window treatments) for economic and/or energy-saving reasons
- Battery storage will be utilised by homeowners to increase the value from rooftop solar installations in increasing numbers
- Both batteries and solar technologies continue to drop and will encourage further uptake.
- Wave energy and tidal energy are vast, as yet untapped, sources of renewable energy for Australia

*Design of policy measures to capture the range of benefits available from this transition*

Care should be exercised in the design of these measures to ensure that these benefits are captured sustainably, at least cost and by eliminating the potential for competing processes to inhibit desirable outcomes.

Listed below are some of the many potential benefits that should be recognised and catered for in the design of policy mechanisms:

#### Direct benefits from renewable energy plants

Renewable energy sources typically require only 3% of the water requirements of coal and gas thermal stations. This will continue to grow in importance as climate variation continues. Existing plants may face the need for large capital expenditure to avoid escalating costs of supplying water to their cooling towers. These benefits will include the avoidance of damage associated with the environmental impact from opening of new mines - e.g. loss of farming land, water quality impacts'

A significant point to make is in relation to gas fired power generation. There is a tendency to turn to gas as older and less efficient coal stations face closure. Further capital expenditure on this fuel is not to be encouraged in our view due to the very short term nature that this would bring. Although less carbon intensive than coal it still faces the same future of not being viable into the future beyond 2050. Following this path could give false hope of an easy solution and detract from the focus on reducing toward a zero emissions scenario.

#### Health and Safety Impacts

- heat impacts from rising global temperatures
- potential for bush fires to initiate spot fires leading to catastrophic mine fires
- health impacts from coal dust particles

In failing to meet emissions standards .....recognised and adopted around the world the generators are not accepting the full cost of meeting their obligations to the community for safe power generation.

#### *Lessons to be learnt from the past*

If we proceed with a strong renewables building plan adopting a strategic approach such as was done with the Snowy Mountains Hydro-electric Scheme we will be better placed than if we simply go with a market based ad-hoc approach with competing agendas and un-channelled effort. A multitude of benefits can arise for the community as was the case with the Snowy Scheme. These include the development of the new skills to build and maintain a new energy system, the creation of service industries to assist and the potential for a research base for new energy technology paths into the future.

Failing to follow this path and ending with a skills shortfall or absence could not only increase our system running costs but put the security and reliability of the distribution system at risk.

#### *Using existing Government agencies and arrangements to deliver policy mechanisms*

The National Electricity Market Objective calls for the market to operate in the “long term interests of consumers”, not the profits of the existing industry. The capacity excess combined with the RET are driving lower prices, while the RET is encouraging the installation of the kind of generation capacity we need in a low carbon future, which is clearly in the long term interests of electricity consumers.

## **Conclusion**

The potential closure of Australia’s coal fired power stations is a complex problem involving a broad approach in implementation of a solution. The basis for closure must be seen not just from a CO2 emissions reduction need but also from the perspective of jobs creation and the maintaining of our international competitive position.

The former provides the time-line with the now-ratified Paris Agreement in effect which mandates 2050 as the date for global emissions from power generation to reach zero. Economic development and growth of opportunities for new skills in displaced workforces provide a perhaps more urgent focus. Staying ahead of the closure timetable with jobs development will ensure continued high standards of living and political stability.

#### References:

- <sup>1</sup> Jotzo, F. and Kemp, L. (2015), Australia can cut emissions deeply and the cost is low, Centre for Climate Economics and Policy for WWF-Australia: 4
- <sup>2</sup> US Department of Energy, Utility-Scale Wind  
<http://apps2.eere.energy.gov/wind/windexchange/utility-scale-wind.asp>
- <sup>3</sup> Parkinson, G. [CWP wins ACT auction, to press go on 260MW wind project and micro-grids](http://reneweconomy.com.au/cwp-wins-act-auction-to-press-go-on-260mw-wind-project-and-micro-grids). *Renew Economy*. [Online] 4 March 2016 <http://reneweconomy.com.au/cwp-wins-act-auction-to-press-go-on-260mw-wind-project-and-micro-grids-21029/>
- <sup>4</sup> Vorrath, Sophie Offshore wind costs fall 22% in six months as EU auctions drive competition. *Renew Economy*. [Online] 2 November 2016  
<http://reneweconomy.com.au/offshore-wind-costs-fall-22-six-months-eu-auctions-drive-competition-87009/>
- <sup>5</sup> Australian Energy Council. Renewable Energy in Australia: Fact Sheet. August 2015: 3
- <sup>6</sup> Parkinson, G. Plunging cost of big solar in Australia. *Renew Economy*. [Online] 29 July 2016  
<http://reneweconomy.com.au/2016/plunging-cost-big-solar-australia-74247>
- <sup>7</sup> Kemp, L. and Jotzo, F. (2015), Delaying climate action would be costly for Australia and the world, Centre for Climate Economics and Policy for WWF-Australia: 3
- <sup>8</sup> Kemp and Jotzo (2015): 14

<sup>9</sup> International Energy Agency\_Media release [Online] 9 November 2011  
<http://www.iea.org/newsroom/news/2011/november/the-world-is-locking-itself-into-an-unsustainable-energy-future.html><sup>10</sup>

<https://www.climatecouncil.org.au/silentkillerreport>

<sup>11</sup> Jotzo, F. and Kemp, L. (2015), Australia can cut emissions deeply and the cost is low, Centre for Climate Economics and Policy for WWF-Australia: 19

<sup>12</sup> Australian Conservation Foundation

[https://d3n8a8pro7vhmx.cloudfront.net/auscon/pages/716/attachments/original/1465199065/29.02.16\\_ACF\\_Big\\_Polluter's\\_Report\\_2016\\_final.pdf?1465199065](https://d3n8a8pro7vhmx.cloudfront.net/auscon/pages/716/attachments/original/1465199065/29.02.16_ACF_Big_Polluter's_Report_2016_final.pdf?1465199065)

<sup>13</sup> [http://energy.unimelb.edu.au/\\_\\_data/assets/pdf\\_file/0018/2035116/Five-Years-of-Declining-Annual-Consumption-of-Grid-Supplied-Electricity-in-Eastern-Australia.pdf](http://energy.unimelb.edu.au/__data/assets/pdf_file/0018/2035116/Five-Years-of-Declining-Annual-Consumption-of-Grid-Supplied-Electricity-in-Eastern-Australia.pdf) for details)

<sup>14</sup> American Economic Review 101 (August 2011): 1649–1675

<pubs.aeaweb.org/doi/pdfplus/10.1257/aer.101.5.1649>

<sup>15</sup> The Medical Journal of Australia

<https://www.mja.com.au/journal/2011/195/6/mining-and-burning-coal-effects-health-and-environment>

<sup>16</sup>

[http://dea.org.au/news/article/the\\_mining\\_and\\_burning\\_of\\_coal\\_effects\\_on\\_health\\_and\\_the\\_environment](http://dea.org.au/news/article/the_mining_and_burning_of_coal_effects_on_health_and_the_environment)

<sup>17</sup> <https://www.greentechmedia.com/articles/read/california-passes-huge-grid-energy-storage-mandate>

<sup>18</sup> Doctors for The Environment Australia in expressing their concern with health effects for coal quote an international report<sup>14,15</sup> stating:

*The impacts of six pollutants (sulphur dioxide [SO<sub>2</sub>] nitrous oxide [NO<sub>x</sub>], volatile organic compounds, ammonia, particles at less than 2.5 microns [PM<sub>2.5</sub>], and particles less than 10 microns [PM<sub>10-2.5</sub>]) are estimated on human health, agricultural yield, visibility, accelerated depreciation and human recreation. Air pollution concentrations are related to human illness and death and the economic loss estimated.*

They concluded:

*Coal fired power generation was found to produce damages from 0.8 to 5.6 times its value added. In other words, the damage caused is worth at best 80 per cent of the net value of the industry and at worst 5.6 times greater.*

Of great concern among harmful pollutants are the particulates that can penetrate deeply and lodge in the lining of the lungs and cause inflammation. The smaller particles pass through the lining to enter the blood stream and cause disease, predominantly inflammation of blood vessels leading to obstruction in other parts of the body such as, for example, the brain, causing stroke. A number of these toxic substances may be carcinogens.

There is no safe level for particulate pollution. The burden of disease is proportional to the level of exposure. These findings are the same in all communities throughout the world.

It is important that government policy incentivise investment in lower-emitting technology while at the same time ensuring that older, less efficient and reliable power stations are removed from Australia's energy mix.

AGL will not build, finance or acquire new conventional coal-fired power stations in Australia.

*By 2050, AGL will close all existing coal-fired power stations in its portfolio.*

- Energy Australia

*We have to find an industry-led, government supported solution for modernising generation in Australia, and that requires orderly, managed retirement of the oldest plants in the fleet.*

*This would have the double benefit of making space for renewables, so if you have a situation where supply exceeds demand, you need to retire the older fleet to make way for renewables.*

- Engie Australia

Internationally, ENGIE has announced:

- A halt to building any new coal-fired power stations
- Closure of its 1 GW Rugeley coal-fired power plant in the UK
- Increased installed capacity of renewable energy sources by 50 per cent worldwide between 2009 and 2015
- A target to double its renewable energy generating capacity in Europe by 2025
- Its aim for a 10 per cent reduction in its CO2 emissions from its power generation and associated heat generation activities by 2020.

Engie also recently announced the closure of its Hazelwood brown coal fired generator in Victoria.

<sup>20</sup> Bloomberg New Energy Outlook 2016

<https://www.bloomberg.com/company/new-energy-outlook>

**Bloomberg New Energy Outlook 2016**

### **Exec Summary - NEO**

Cheaper coal and cheaper gas will not derail the transformation and decarbonisation of the world's power systems. By 2040, zero-emission energy sources will make up 60% of installed capacity. Wind and solar will account for 64% of the 8.6TW of new power generating capacity added worldwide over the next 25 years, and for almost 60% of the \$11.4 trillion invested.

- Weaker fossil fuel prices are unlikely to recover greatly-

- Wind and solar keep getting cheaper and cheaper for development, financing and operation.
- Solar will be least cost technology by 2030
- Non OECD countries will see greatest take-up - China and India leaders by 2020, the SE Asia and Middle East thereafter.
- In the **OECD**, electricity demand fundamentals continue to look weak as economic and population growth fails to keep up with falling electricity intensity. This trend, coupled with higher renewables penetration, means that power systems will increasingly need to reward system services such as demand response, battery storage, interconnectors and control systems that work along with traditional firm capacity to help match supply with demand. Around 336GW of this 'flexible capacity' is added in the OECD, and 938GW globally, to 2040.
- By around 2027, new wind and solar gets cheaper than running existing coal and gas generators, particularly where carbon pricing is in place
- Over the next 25 years, **electric vehicles** will provide 2,701TWh of additional electricity demand, to reach 8% of world consumption, 25% of the global car fleet by 2040,
- **Small-scale PV** reaches socket parity in all major developed economies and by 2020 and over 10% of global generating capacity will be small- scale PV by 2040,
- In only a handful of countries do we see material uptake in new gas-fired power as a transition fuel.
- Despite retirements, **coal** generation remains almost flat to 2040.
- **Gas' role** as a 'transitional fuel' appears overstated outside the US as it accounts for just 16% of global generation in 2040,

World **power sector emissions** peak in 2027 at 13,728Mt as China's economic slow-down limits global emissions growth in the near term. However, despite \$9.2 trillion of new clean energy investment worldwide, equating to \$370bn per year, power sector emissions will still be 5% higher in 2040, as progress in the EU, US and China is offset by steep emissions growth in India and SE Asia. To bridge the gap to a two-degree emissions trajectory, we would need another \$5.3 trillion, or \$212bn per year, over the next 25 years