Australia’s Technology Investment Roadmap

bp submission

Discussion paper consultation

June 2020

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1 About bp

bp has a proud history of operations in Australia. We are a foundation partner in the North West Shelf and have helped fuel the country for just over 100 years. bp is the only oil and gas company engaged in the Australian market from well to bowser – from exploration and production of crude oil and natural gas, to refining, marketing and retailing of petroleum products.

A leading global energy company, we deliver energy products and services to people around the world in ways that will help to drive the transition to a lower carbon future. We provide fuel for transport, energy for heat light and power for industry and consumers, lubricants to keep engines moving and the petrochemical products used to make everyday items such as paints, clothes and packaging. bp has been based in the UK for more than 100 years and operates in 72 countries around the world.

bp supports a rapid transition to a lower carbon future because we believe it is in society's, and bp's, best interests. Delaying today could lead to an abrupt, precipitous course-correction tomorrow which could be highly disruptive for business and the world economy. Therefore, bp agrees on the need for the world to move to net zero emissions. This is what Paris calls for in the second half of the century. Technology underpins bp's strategic priorities: it enables today's safe, efficient and reliable operations while at the same time identifying technology developments for future growth.

On 12 February 2020 bp announced a new purpose: to reimagine energy for people and our planet; and set a new ambition: to become a net zero company by 2050 or sooner and help the world get to net zero[1]. Globally, this requires bp to reduce its greenhouse gas emissions by around 415 million tonnes – 55 million from bp's operations and 360 million tonnes from the carbon content of bp's upstream oil and gas production. Importantly, these are absolute reductions. bp is also aiming to cut the carbon intensity of the products it sells by 50% by 2050 or sooner.

The purpose is supported by **ten aims**:

1. Net zero across bp's operations on an absolute basis by 2050 or sooner.
2. Net zero on carbon in bp's oil and gas production on an absolute basis by 2050 or sooner.
3. 50% cut in the carbon intensity of products bp sells by 2050 or sooner.
4. Install methane measurement at all bp's major oil and gas processing sites by 2023 and reduce methane intensity of operations by 50%.
5. Increase the proportion of investment into non-oil and gas businesses over time.
6. More active advocacy for policies that support net zero, including carbon pricing.
7. Further incentivise bp's workforce to deliver aims and mobilise them to advocate for net zero.
8. Set new expectations for relationships with trade associations.
9. Aim to be recognised as a leader for transparency of reporting, including supporting the recommendations of the TCFD.
10. Launch a new team to help countries, cities and large companies decarbonise.

In Australia we are focused on advancing the role of Australian resources in meeting the region's demand for significantly more energy, with fewer emissions. Being part of the bp group enables us to share global expertise, research and development with bp's Australian business partners, customers and community stakeholders.

[1] https://www.bp.com/en/global/corporate/who-we-are/reimagining-energy.html

2 Introduction

On 17 June 2020, the 69th bp Statistical Review of World Energy 2020 was released. This review collects and analyses energy data from 2019 and highlights global energy trends. The latest review shows that carbon emissions from energy use grew by 0.5% in 2019, only partially unwinding the unusually strong growth of 2.1% seen in 2018. The average annual growth in carbon emissions over 2018 and 2019 was greater than its 10-year average. However, renewables contributed their largest increase in energy terms on record (3.2 exajoules) accounting for over 40% of the global growth in primary energy, more than any other fuel. Their share in power generation (10.4%) surpassed nuclear for the first time. The share of natural gas as primary energy was a record high at 24.2%[2]

In 2018, bp released the Technology Outlook, a publication which uses techno-economic analysis to show how the costs of deployment of a range of energy-related technologies could develop out to 2050. The approach considers factors such as investment, operating and fuel costs, capacity factors, and advances in technology including 'learning rates', whereby costs fall as experience is accumulated[3]. Technology has the potential to change the way we produce and use energy to 2050. As an energy company, the challenge bp faces is the ability to meet the demand for energy and keep it affordable, accessible and low or zero in carbon emissions.

While bp has provided the world with energy for light, heat and mobility for more than a century, technology, consumer behavior, the low carbon transition and regulation are fundamentally changing the way that people consume energy, whether through movement of goods and services or demand for electricity.

bp is well known for its participation as a fuel and lubricants provider in the transport sector, and we have discussed the changes we are seeing in this sector, and view of its future, in this submission. Today's transportation sector (air, marine, domestic, rail and haulage) accounts for approximately a quarter of carbon emissions. The way goods and people are transported will continue to change significantly, driven by government policies and technology advancement aimed at decarbonizing the sector.

The changes in mobility are not isolated, energy systems across the board are experiencing disruption as they transition from fossil-fuel-based energy sources to diversified renewable energy sources. This is especially evident in the power sector.

bp considers technology innovation and development in the energy sector to be two pronged. Directionally, these prongs are parallel and have the same overall outcome of achieving a low/zero carbon energy sector, but deployment will be staggered and overlap until the final overall transition.

- First, fossil fuel-based energy requires rapid decarbonization to service the short and medium-term increased demand for energy and meet the challenge of lowering the associated emissions (integrated renewables, fuel switching, CCUS, electrification).
- Second, new sources of carbon-free or carbon negative energy need to emerge and penetrate the current energy system at cost parity (advanced renewables, hydrogen, nuclear).

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2 bp Statistical Review of World Energy 2020; https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/renewable-energy.html

3 https://www.bp.com/en/global/corporate/what-we-do/technology-at-bp/technology-outlook.html

3 Priority technology themes

Many technologies will need to be developed and deployed to respond to this period of transition. At bp, we believe there are five technology themes that can play a game-changing role to 2050. These themes are outcome-based, and technologically agnostic. The themes are interconnected and have dependence with other sectors of the economy, demonstrating the need for a system- based approach to the investment and deployment of technology. Deploying the right technology at the right time requires case-specific assessment that includes parameters including, but not limited to, natural environmental conditions, exiting infrastructure, risk, policy support, technical capacity and capability and value generation.

bp's view on the role of bioenergy technology has been captured in the submission to the ARENA Bioenergy Roadmap consultation and has therefore been omitted from this submission (see Appendix 1).

3.1 Energy efficiency

Energy efficiency is not only about using less energy. Technologies that support efficiencies throughout the value chain are important. Energy efficiency is often under-rated as a means to drive down demand when supply is under pressure. bp thinks of energy efficiency from a value chain perspective - it starts with energy conversion technologies, such as wind turbines and solar panels, and finding ways to make these technologies, that convert raw energy into usable energy, more efficient. It also includes distribution and transmission of energy efficiencies, and technologies that capture heat waste in industrial processes and utilize that heat for other productive uses, or recycling back into the original production process. Applying the principles of the circular economy support how we think about energy efficiency.

The global energy system consists of a diverse range of technologies for transforming and using energy, yet it is the delivery of energy services, such as mobility or heating, rather than the source itself, which drives consumer energy demand. The more efficiently these technologies operate, the less energy is required to deliver the energy services.

3.2 Renewable power

Decarbonizing the power sector is crucial to reducing carbon emissions.[4] At bp, we believe policy levers that accelerate the switch to low carbon fuels and away from high carbon fuels are critical. Renewable power, particularly wind and solar, is already the fastest growing energy source. According to bp's Statistical Review of World Energy 2020, renewable energy posted a record increase in consumption in energy terms accounting for 40% of the global growth in primary energy in 2019[5].

Renewable power's fast growth is driven by a combination of technology advances and supportive policies. bp believes the process of deployment will accelerate significantly to 2050. The power sector accounts for over 42% of primary energy demand globally, with greater potential than, transport or heat, for reducing GHG at scale and economically. The sources of electricity are diversifying, with new types and more efficient energy conversion technologies emerging. In 2019, wind energy provided the largest

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[4] bp Energy Outlook 2019, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf

[5] bp Statistical Review of World Energy 2020, https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/renewable-energy.html

contribution to renewables growth, followed closely by solar, the share of renewables in the energy mix rose to 5%[6].

3.2.1 Solar

Solar photovoltaics will continue to grow in deployment and advancement. The solar PV supply chain is dominated by China but is driven by technology innovation and competition for market share. There is significant investment in R&D and new capacity additions indicate a growing industry. There is a strong innovation pipeline aiming to reduce costs across the whole supply chain. Solar technologies such as bifacial modules and single-axis trackers, which can significantly increase energy output for little additional cost, can be deployed at scale in Australia. Advances in smart inverters will allow solar farms to provide ancillary grid services and support reductions in integration costs. The use of digital tools will enable cost and reliability benefits in operation and maintenance. The step change will come in the advancements in materials and cell/module design, which will see silicon PV pushing theoretical efficiency limits beyond 25% by 2025. Expected cost reductions in capex and opex, coupled with improvements in panel efficiency and capacity factors, will easily see the levelized cost of solar energy competing against traditional generation. Australia has an abundance of land and sunshine which can support utility-scale solar PV, at low cost of production. This advantage should support grid-transformation domestically but also should be considered as an export energy, via a hydrogen vector for example. Continued focus on deployment of utility scale solar throughout the country could provide the low carbon power that will flow through to other areas of the economy and support deep decarbonization.

3.2.2 Wind

Wind energy has become mainstream, competitive and a some-what reliable power-generating technology in recent years. Continuous technology improvements have seen a real reduction in costs of production on land, and this is expected to continue. The amount of power that can be extracted from a wind resource is proportional to the area of the circle created by the blades as they sweep through the air (swept area) and the cube of wind speed. As a result, turbine technology has focused on increasing the tower height and increasing the length of the blades, in order to access higher wind speeds and swept areas. The desire to benefit from high speed and consistent resources available at higher altitudes, without the need for conventional heavy structure, has resulted in the development of high-altitude kites and airborne wind technology.

The industry is now focused on improving performance, reliability and overcoming the technical challenges of large-scale offshore installation. Offshore wind (fixed-bed foundation) currently represents a $30bn per annum industry, with a 25% annual growth rate that has been achieved with strong support from governments and industry players. Technology advances, lower costs and accessible finance have driven recent cost reductions. The trend towards larger turbines is expected to reduce costs a further 35% between now and 2030. In the EU, prices are reaching competitive levels through standardization, supply chain optimization and significant opex reduction due to operational learning and advanced data analytics. Australia has the potential to be a major producer of renewable energy from offshore wind due to attractive environmental (natural) conditions, offshore development capability (transferable skills from offshore oil and gas development) and an established and mature electricity market. Australia has the opportunity to adopt this technology fast with government support for initial developments including financing and project development de-risking, and access to the power market.

[6] ibid

Advances in wind power include technologies such as floating offshore wind and high altitude/airborne wind. Airborne wind could potentially provide a step-change reduction in capital costs and it presents the opportunity to access higher quality wind resources over a vast area. These advanced technologies benefit from a strong synergistic effect with multiple emerging technologies such as AI and battery storage.

3.2.3 Storage

Energy storage options, including battery technology, are seeing major advances. Lithium-ion batteries (LiBs), for example, are developing rapidly and are projected to bring down the cost of Electric Vehicles (EV).

Other storage, such as metal-air, solid state and flow batteries, and grid-scale batteries, offer more options for storing power. There is a need for batteries that are capable of being recharged thousands of times, lasting for many years and powering a two-tonne vehicle over miles of terrain, for electrification to make deep cuts in transport emission. In renewable power, batteries play an important role in addressing intermittency.

Until recently, almost half the cost of EVs was attributed to building the battery itself. With recent advances in technology, that cost has dropped by more than two-thirds. That cost reduction, supported by government incentives, may result in the buying, running and fuelling of EVs in Europe being competitive with internal combustion engines before 2050.

One of the challenges with battery storage is capacity versus charging speed. Charging rates for LiBs have remained slow because of trade-offs between how much energy a battery holds and how quickly it can be charged. The battery is either designed for high capacity that will allow it to last longer before recharging or optimised for a fast charging rate.

3.3 Electrification

At bp, we believe that electrification of transport and specific industrial processes is key to reducing emissions. The growth and advancement in renewable power generation, coupled with innovation in storage, presents low cost opportunities to reduce emissions in other sectors of the economy by utilizing renewable power as a source. Electrification technologies include technologies that support and augment the power sector as it transforms to more renewable sourced energy, as well as an energy-switch application in industrial processes (replacement of feed gas) or mobility (replacement of petrol with electricity).

The shift to electric in the transport sector is a global trend but is happening at different speeds in different markets. It will take many years for the full fleet of vehicles and transport infrastructure to go fully electric and this will vary by country. bp's analysis suggests that across most scenarios, in 2040, more than two thirds of the world could still have internal combustion engines (ICE), either as hybrid or full ICE. There will therefore still be a need for liquid fuels, albeit low carbon. In order to meet Paris goals, investments and policies are needed that create incentives that support all low carbon options in the transport sector. bp's view on the role of sustainable biofuels is in the submission to the ARENA Bioenergy Roadmap consultation (see Appendix 1).

3.3.1 Electric vehicles

Electric Vehicles are key to decarbonizing the global transport sector and their numbers continue to grow rapidly, specifically within passenger cars, light-duty trucks (LDTs) and public buses. They remain, however, a very small segment of the overall market. In 2019, the sale of electric cars accounted for 2.6% of global car sales and about 1% of global car stock. According to bp's 2019 Energy Outlook, electric vehicles are expected to grow rapidly, with the number of electric vehicles reaching 350 million by 2040, of which 300 million will be passenger cars, ie. 15% of all passenger cars[7].

Advances in fast-charging batteries (5 min or less), along with accessibility to a nationwide charging network, could speed up the adoption of electric vehicles. EVs can only deliver on carbon savings if the electricity itself is decarbonized. Reducing the carbon footprint of the transport sector is dependent on decarbonisation and transformation of the electricity grid. A ready supply of lithium and cobalt are required to support the development of an EV market. Australia has large proven reserves of lithium.

Several challenges will influence the speed at which EVs penetrate the Australian market:

- The high cost of electric vehicles; and competition with efficiency improvements in ICE technology.
- Access to charging infrastructure. This includes access to charging stations within dense urban areas, and – of most concern in a country as vast as Australia – access to charging stations in remote and regional areas between cities.
- Availability of fast charging.
- Battery degradation, cost and lifetime.

According to the Australian electric vehicle council, 'range anxiety' is one of the main barriers to electric vehicle adoption. Research shows that although financial incentives and local presence of production facilities are positively correlated to a country's electric vehicle market share, access to charging infrastructure is most strongly related to electric vehicle adoption[8].

Governments can encourage the rate of uptake of electric vehicles by providing incentives for industry investment in charging technology, such as co-investment in charging infrastructure. Building a network of charging technology throughout Australia is key to increasing the uptake of electric vehicles. This network should be convenient for both businesses and consumers. Public investment in upgrading the grid will be necessary to enable it to carry the power required, as well as support to encourage breakthrough technologies such as higher–capacity batteries. Focused innovation support and demonstrators across the value chain (battery technology, vehicles, charging and power supply) are essential to ensure the projections for uptake can be met.

3.3.2 E-fuels

E-fuels is an umbrella term that refers to the conversion of electrical energy to gaseous and liquid fuels. If generated from renewable power, e-fuels are considered sustainable fuels. E-fuels use common constituents such as carbon dioxide, nitrogen and water to form chemical compounds that can serve as fuels or feedstock. They could be potential disruptors to the existing liquid fuels space in the long-term, with drop-in fuels such as e-diesel, as long as the power required to produce these fuels is sufficiently low cost.

E-fuels are gaining attention from energy companies, the automotive industry and government agencies, particularly in Europe, as a means to decarbonize the transport sector with fuels which are

[7] bp Energy Outlook 2019, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf

[8] The influence of financial incentives and other socio-economic factors on electric vehicle adoption, Sierzchula et al., 2014 https://doi.org/10.1016/j.enpol.2014.01.043

broadly compatible with existing engines, and distribution infrastructure, and can be stored efficiently and at low cost.

The energy needed for CO2 conversion to liquid fuels, or chemicals, is considerable and would need to come from renewable sources, or directly from concentrated sunlight (solar fuels). The development of efficient and low-cost catalysts is important and has been accelerated, with advances in material science and artificial intelligence. The economic feasibility of e-fuel commercialization remains challenging due to the capital cost per unit of output and power consumption. E-fuels will compete with electrification of the transport sector, especially at the domestic car level, but may be better suited to heavy-hauling applications or replacing conventional fuels used in aviation. E-fuels may be developed as a storage medium of renewable energy, like hydrogen.

A key driver for e-fuels deployment may be to achieve long-term, deep decarbonization of the transport sector - it may be required to support in-market segments less well suited to electrification, such as aviation, marine and long-haul road freight.

3.4 Hydrogen

The race for an advantaged hydrogen supply chain is on! If Australia wants to win this race and secure its competitive advantage the government must act immediately and directly invest in priority demonstration projects, including demonstration-scale hydrogen hubs; and incentivize the development of supply chains needed for prospective hydrogen hubs. This investment will help the industry achieve commercial readiness in the medium-term. Hydrogen is a zero-emission energy carrier that could be used to provide power, as well as fuel for transport and heat, if costs could be reduced to competitive levels.

Hydrogen can be created from renewable power by electrolyzing water or produced by steam methane reformers. Once developed, it can be stored under pressure in caverns, pipelines or vessels. It can be blended into some natural gas networks at levels of up to 10% by volume, without the need for system modification, and used for heat, both domestic and industrial, or power[9].

70Mt of grey hydrogen is produced worldwide today, 90% of which is used in industrial feedstock. Less than 2% of this hydrogen is produced by water electrolysis. Based on a trajectory consistent with net-zero by 2050, global hydrogen demand is forecast to increase. This increase is driven by the emergence of hydrogen as a clean energy vector and development of clean hydrogen markets to support decarbonization in heavy transport and industrial heat.

The ultimate scale and pace of demand growth will depend on the pace of cost reductions (scale-up of technology and cheap renewable power), investment in associated infrastructure, and government support. 'Blue' hydrogen, produced from steam methane reforming of natural gas in combination with CCUS, needs to be scaled up, but longer-term 'green' hydrogen, powered by renewables, will play an important role as we progress towards 2050. Green hydrogen can be produced by electrolyzing water using renewable power sources. Less than 1% of the world's hydrogen is currently produced by this method. BP believes that for hydrogen to make a real difference as a clean energy vector and clean feedstock, both blue and green hydrogen will be required.

Australia's gas industry is well placed to both produce and transport blue hydrogen in the near term as well as support export ambitions for green hydrogen and the development of a new sector. bp is

[9] bp Energy Outlook 2018, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2018.pdf

supportive of Australia's National Hydrogen Strategy released in November 2019, however urgent work needs to be done to ensure the recommendations of the strategy are implemented.

Hydrogen could contribute to decarbonization of many sectors, including transport, heating, lighting and industrial processes. Most hydrogen demand is likely to be in areas where electrification is not technically or economically feasible. Hydrogen's versatility is an important asset and can improve the resilience and flexibility of the whole energy system. Approximately 95% of hydrogen comes from fossil sources with high CO2 emissions. Alkaline Electrolysis (AEL) and Proton Exchange Membrane (PEM) are the two electrolysis technologies which are commercially available today. Solid Oxide Electrolytic Cell (SOEC) and Anion Exchange Membrane (AEM) technologies are currently in development[10].

3.4.1 Hydrogen in transport

Australia's expansive geography means there are large distances to cover with high and growing intercity freight. EVs cannot provide a solution to this challenge as they are disadvantaged for longer routes. As there is no viable alternative for moving freight throughout Australia, such as highspeed rail, there is a heavy reliance on on-road freight movement. This therefore opens demand for Hydrogen powered fleets.

There is also a strong mining and industrial demand, as many customers are looking to decarbonize. Hubs of concentrated demand from mining and agriculture exist in the Pilbara (WA), Kalgoorlie (WA) and North Queensland.

3.4.2 Hydrogen in industrial processes

In most countries and regions, blue hydrogen is the most immediate and cost-effective way to produce hydrogen at scale and begin to build the hydrogen economy. bp believes Australia has a leading role to play to achieve this scale. bp anticipates that by mid-century much of our gas, in combination with CCUS, will be converted to blue hydrogen.

In the longer-term, green hydrogen will grow substantially as the economics of electrolysers and renewable power improve, providing an important form of energy storage for renewable electricity supply. For hydrogen to be green, the domestic power market will need to be either fully decarbonised or coming from curtailed or stranded renewable energy sources.

bp is looking at both blue and green hydrogen projects for the 2020s with specific application of green hydrogen as an input to refining. bp has some global experience utilising green hydrogen in the oil refining process - in 2018, bp's Lingen refinery in Germany conducted a four-week demonstration project, becoming the first refinery globally to produce fuel with green hydrogen. bp's Rotterdam refinery is undertaking a similar project. The use of hydrogen in industrial processes will help bp achieve our net zero ambitions and retain value at existing infrastructure.

Consistent with the Lingen refinery project, there may be an opportunity for bp to utilise green hydrogen for Kwinana refinery in Perth, Western Australia. Local industrial use of green hydrogen can help underpin the commerciality of a local hydrogen industry in support of ultimately establishing an export industry supply chain for Western Australia. bp's Kwinana refinery is currently evaluating the prospect of generating green hydrogen for its desulphurisation process, to supplement its existing hydrogen

[10] bp Energy Outlook 2019, https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf

generation and hydrotreating processes. It currently generates its hydrogen requirements using natural gas via the conventional steam methane reforming process.

A behind-the-meter renewable energy source (e.g. a large solar PV array on site) could enable the production of green hydrogen, allowing the refinery to partially decarbonise its end products, as well as lowering its energy costs from on-site power generation and storage.

> **bp feasibility study into export-scale renewable hydrogen production facility**
>
> The extensive study will help bp and the energy sector better understand the possibilities of using hydrogen to export renewable energy at scale. The feasibility study will deliver a detailed techno-economic evaluation of pilot and commercial scale green ammonia production plants in Geraldton. This will include an evaluation of the different technologies and process configurations required to manufacture green hydrogen and green ammonia.
>
> The potential pilot plant will look to produce green hydrogen, using onsite and/or grid-sourced renewable power. This will then be converted into around 20 kilo-tonnes per annum (ktpa) of green ammonia. Once developed to commercial scale, this is expected to increase to around 1,000 ktpa of green ammonia, targeted at domestic and export markets.
>
> The commercial-scale plant would require around 1.5GW of power. This is expected to be sourced from greenfield renewable power generation, enabling the project to benefit from the advantaged solar and wind resource in the region. Lightsource bp, a 50:50 joint venture between Lightsource and bp, in the funding, development and long-term management of solar projects, will provide and advise on the renewable power solutions.

3.5 Decarbonized gas and Carbon Capture Utilization and Storage (CCUS)

In 2019, natural gas consumption increased by 2%, with the share of gas used in primary energy rising to a record high of 24.2%.

CCUS is likely to play an important role in getting to net zero and meeting the Paris goals at lower cost. The IPCC has set out scenarios in which deployment of CCUS more than halves the cost of limiting temperature rise to 2 degrees. CCUS can achieve deep emissions reductions and is a proven technology, but government support is needed to commercialize and deploy it at scale to ultimately bring down the costs. CCUS offers significant cost and scale advantages over other low carbon options because it enables decarbonization of existing infrastructure. Re-purposing existing infrastructure to distribute decarbonized gas or hydrogen reduces the cost of decarbonizing a range of sectors, including transport, heating and industrial processes, compared to higher levels of electrification or bio-alternatives. Hard-to-abate sectors of the economy, such as LNG, may benefit from utilizing such technology to support producing decarbonized gas. Decarbonized gas is critical in the short to medium term as a firming option for renewable power.

Natural gas has unique characteristics that make it an important part of the energy transition. It is locally abundant, affordable, easily transported, flexible and an energy-rich and efficient store of energy. The combination of renewables and gas supports decarbonization in hard to abate sectors and provides a basis for the development of hydrogen, whether blue or green.

4 Emerging technologies

bp conducts an annual assessment of global disruptive technologies. This assessment results in a Top 20 list of technologies we consider as we pursue our strategic priorities. Below is a snapshot of the 2020 list. Some of these technologies are given strategic priority, such as hydrogen development, while others we continue to watch and assess.

4.1 Top 20 Disruptive Technologies 2020 – bp perspective

- **Autonomous mobility** - vehicles capable of sensing their environment and reacting to it.
- **Circular Economy** - creating value through zero net waste.
- **Hydrogen**
- **Low carbon products** – products derived from bio feedstocks or fossil feedstocks with significantly reduced carbon.
- **Wind energy**
- **Solar Energy**
- **Remote sensing** - the acquisition of information about an object or phenomenon without making physical contact with the object.
- **Cognitive computing** - technology platforms that are based on the scientific disciplines of artificial intelligence and signal processing.
- **Electric mobility**
- **Biorefining** - refining of biomass to energy and other beneficial byproducts.
- **Energy storage** – examples include pumped-storage hydroelectric dams, rechargeable batteries, and compressed air.
- **Quantum** - including quantum computing, quantum communications and quantum sensing.
- **Robotics**
- **Geothermal** - Geothermal energy relates to the extraction of useful heat and/or power from the ground.
- **Power networks** – using grid system capability to transform the legacy power utility model into the future utility model driven by decarbonization, decentralization and digitization.
- **Decarbonized industry**
- **Human enhancement** - technology that augments human capability and performance.
- **Subsurface imaging** – to allow real-time monitoring of CCUS and geothermal and hydrocarbon resources and improved granularity of resource identification and assessment.
- **Agriculture** - increased automation using robotics and sensors to improve the yield of crops, while minimizing the application of fertilizer and maximizing land use.
- **Blockchain**- these technologies make financial markets more efficient and have the potential to radically disrupt and open energy markets by removing intermediaries and allowing for direct interaction between parties.

5 Drivers of change and public investment

The global carbon budget is finite, and running out fast, and the world needs a rapid transition to a net zero energy system. To meet this goal, bp advocates well-designed carbon pricing policies as the most efficient ways to reduce greenhouse gas emissions. It is lowest cost to the overall economy and creates the necessary incentives for innovation, development and deployment of low emission technologies.

At bp, we apply a carbon price assumption of $40 real to all investment appraisal, this results in decision-making and behaviors consistent with our purpose and ambition.

On 15 June 2020, bp announced to the market a revision to investment appraisal long-term assumptions, these broadly reflected a range of transition paths consistent with the Paris climate goals. They include averages for Brent ($55/bbl) and carbon prices rising to $100/teCO2 in 2030. As part of the company's strategic development, portfolio and capital development plans are being reviewed and the long-term price environment view and balanced investment criteria inform this development. Together, these assumptions and criteria create a framework that seeks to ensure investments at bp align with strategy and add shareholder value.

Identifying the point where new technologies approach broad-based economic parity with more emissions -intensive alternatives is critical to understanding the role public investment should play in accelerating technology development and deployment.

bp’s primary approach towards deployment of technology capability is close to the businesses so as to enable businesses to win in their chosen sectors. In recent years, technology has also played a key role in participating in the transition as it develops ie. using technology venturing to access strategic options outside of the core businesses.

5.1 Investment considerations

bp believes the following high-level considerations should feature in the further development of this Roadmap:

- Support for flexible business models to allow for value capture that meets the expectations of the private sector and the public good. There is no preference here, the principle is to support different, innovative financing and management models to secure the outcome on an open, case by case basis.

- A value chain approach to the assessment of technology need and investment. As a global multinational with an ambition to reach net zero by 2050, the deployment of technology across a value chain will be where greatest value can be extracted in short and medium terms. As climate change is a global problem, abatement of carbon from anywhere in the world counts. As such, for investments to be directed to Australia, incentives must be clear and readily available, accessible and not administratively restrictive.

- A systems-based approach to investment. Investment should not simply be into isolated technology but rather administered from an integrated energy system perspective, considering the dependencies that exist between the discussed five priority technologies.

- Consideration of integration technologies. There is a need to consider in more detail the role and investment requirements of integration technologies. The role of integration technologies in supporting grid reliability and flexibility to allow for flow on effects of electrification in the transport sector, for example, will be critical in the medium term and more so in the long-term aspiration of creating a hydrogen export sector.

- Prioritization based on themes or outcomes. bp is always concerned with the picking of technology ‘winners’, however we recommend prioritization based on themes or outcomes to govern the pathways of investment. In principle, the investments should be technologically agnostic and or technologically neutral, with the best technology options canvassed to deliver specific emission reduction outcomes or ancillary function, such as cost reduction.

- Consideration of development timelines. As technology development and deployment takes time, bp is concerned with running an annual Low Emissions Technology Statement. bp supports the development of a Statement but suggests revising this timeline to better reflect the realities of the technology development timeline.

Appendix 1

Australian Bioenergy Roadmap

bp submission

ARENA Bioenergy Roadmap call for submissions

June 2020

Contents

1 About bp

bp has a proud history of operations in Australia, having helped fuel this country for just over one hundred years, and has operations in every state and territory. bp is the only oil and gas company engaged in the Australian market from well to bowser – from exploration and production of crude oil and natural gas, to refining, marketing and retailing of petroleum products.

bp in Australia is focused on advancing the role of Australian resources in meeting the region’s demand for significantly more energy with fewer, and in time, no emissions. Being part of the bp group enables bp in Australia to share global expertise, research and development with Australian business partners, customers and community stakeholders.

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2. Net zero on carbon in bp’s oil and gas production on an absolute basis by 2050 or sooner.
3. 50% cut in the carbon intensity of products bp sells by 2050 or sooner.
4. Install methane measurement at all bp’s major oil and gas processing sites by 2023 and reduce methane intensity of operations by 50%.
5. Increase the proportion of investment into non-oil and gas businesses over time.
6. More active advocacy for policies that support net zero, including carbon pricing.
7. Further incentivise bp’s workforce to deliver aims and mobilise them to advocate for net zero.
8. Set new expectations for relationships with trade associations.
9. Aim to be recognised as a leader for transparency of reporting, including supporting the recommendations of the TCFD.
10. Launch a new team to help countries, cities and large companies decarbonise.

1.1 bp’s global bioenergy portfolio

As part of its new purpose to reimagine energy, bp recognizes that the energy mix must evolve quickly, and is investing accordingly.

bp’s global near-term approach is to lower carbon and reduce emissions by reducing operational emissions, improving its products and creating low carbon businesses. Bioenergy, predominantly in biofuels, features in this approach.

bp is involved in a number of bioenergy operations around the world as an operator, an investor and as a developer of technology that can help deliver innovative low carbon fuels.

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[11] https://www.bp.com/en/global/corporate/who-we-are/reimagining-energy.html

One of bp's largest bioenergy projects is bp Bunge Bioenergia, a 50:50 joint venture with US agricultural trader Bunge to create a bioenergy company in Brazil. bp and Bunge have combined their Brazilian biofuels and biopower businesses to create a world-scale, highly-efficient producer of sugarcane ethanol. The joint venture includes 11 biofuel plants in five Brazilian states. It has a total crushing capacity of 32 million metric tons of sugarcane per year. The joint venture can produce 1.5 billion litres of ethanol and 1.1 million tons of sugar. It also generates renewable electricity through its cogeneration facilities – fuelled by waste biomass from the sugarcane – to power all its sites and sell surplus electricity to the Brazilian power grid[12].

bp is also an active participant in the biogas market and has invested to process renewable feedstocks alongside traditional fossil fuel feedstocks to produce diesel at several of its refineries. During 2019 bp continued to scale up co-processing, growing the volume of lower carbon bio-feedstock processed. It is piloting a growing range of bio lubricants and continues to develop new technologies in this area.

bp is also an active participant in the emerging sustainable aviation fuel (SAF) supply chain, having invested in Fulcrum Bioenergy, a company planning to use bp technology (also licensed by bp's partner Johnson Matthey) to convert domestic waste into SAF[13].

bp is expanding its investment in bioenergy and positioning for future growth, with further details about its near-term plans to be announced in September 2020.

1.2 bp Australia's gas, low carbon and bioenergy portfolio

In Australia, bp is involved in a number of low carbon businesses, including:

- bp's strategic partnership with Lightsource bp. The first 200MW solar project in Wellington, NSW is currently under construction – and will supply enough energy to power 70,000 homes and save 336,000 tonnes of carbon emissions, which is the equivalent of taking 121,580 cars off the road.

- bp Australia has commenced a feasibility study into an export-scale renewable hydrogen production facility in Western Australia. The project includes an initial investment from bp of (AUS) $2.7 million with a further $1.7 million being funded by the Australian Renewable Energy Agency (ARENA).

- bp are joint venture partners in the North West Shelf LNG and gas plant and Browse development. The role of gas in reducing emissions in the region is profound, switching can lead to a 50 per cent reduction in some cases[14].

- bp has invested $20 million in Santos' Moomba carbon capture and storage (CCS) project in South Australia. CCS can achieve deep emissions reductions in existing power infrastructure and energy-intensive industries that rely on the use of fossil fuels.

- bp participates in biofuel value chains in New South Wales and Queensland consistent with state bioenergy policies.

[12] http://bpbunge.com.br/

[13] "BP and Johnson Matthey License Innovative Waste-to-Fuels Technology to Biofuels Producer Fulcrum BioEnergy." *BP Global*, www.bp.com/en/global/corporate/news-and-insights/press-releases/bp-and-johnson-matthey-license-innovative-waste-to-fuels-technology-to-biofuels-producer-fulcrum-bioenergy.html.

[14] Iea. "The Role of Gas in Today's Energy Transitions – Analysis." *IEA*, www.iea.org/reports/the-role-of-gas-in-todays-energy-transitions

bp operations in Australia

BP's contribution

100 years in Australia

Australia's 4th largest manufacturer (by revenue, 2018)

Australia's largest oil refinery (Kwinana)

Australia's first oil refinery (1924)

Supplying 24.4% of Australia's fuel in 2018

5,700 employees

1,400 BP retail sites

26 depots and terminals

Supplying more than 75 airports

$1.5 billion direct + $29.4 billion indirect tax (2013-17)

Foundation North West Shelf partner

Invested $3.6 billion in North West Shelf (2008-2018)

Invested $1.44 billion in downstream (2013-2017)

Supplying Qantas since 1920s

Invented Opal low aromatic fuel

2 Introduction

bp welcomes the opportunity to contribute to the development of the Australian Bioenergy Roadmap. bp shares the Australian government's ambition to support technologies that will provide affordable and reliable lower emissions energy.

bp's 2019 Energy Outlook forecast the increasing pace of transition, with renewable energy the fastest growing source of energy, contributing half of the growth in global energy- its share in primary energy increasing from 4% today to around 15% by 2040[15].

bp has a long-established record of investment and development in the bioenergy value chain. Indeed, bp has been producing, trading on international markets, and selling bioenergy to end users for over 30 years internationally.

In Australia, bp is involved in the purchase, blending, storage and sale of:

- ethanol, an alcohol produced from fermented feedstocks; and
- biodiesel, or Fatty Acid Methyl Esters (FAME)— oil produced from a variety of sources such as waste cooking oil, vegetable oils, tallow and canola.

These are blended with conventional fuels (petrol or diesel) for use as motor fuels. The sale of these fuels is predominately to abide by the biofuel mandates in NSW and Queensland.

Prior to changes to the Cleaner Fuels Grants Scheme, bp produced hydrotreated vegetable oil or HVO, also known as renewable diesel, at bp's Bulwer refinery.

Bioenergy is an increasingly important part of a lower carbon energy system and advanced biofuels offer one of the best large-scale solutions to reduce emissions in hard-to-abate sectors such as aviation, marine and haulage.

An Australian bioenergy industry requires well-designed, stable and long-term policy frameworks to incentivize and support investment in sustainable biofuels. In this submission bp will present policy principle considerations and key recommendations for inclusion in the Australian Bioenergy Roadmap.

[15] *Bp Energy Outlook 2019*, p.79 www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf

3 Key policy principles

The following principles should be applied to development of the Australian Bioenergy Roadmap and any subsequent policies:

- **Equity:** ensures a level playing field for all sectors, industries and technologies, provide market signals that engender confidence to investors and detail long-term pathways to guide future investment. Any policy settings and incentives need to be competitive with those in more advanced markets to ensure Australia captures investment and leverages existing proprietary technology.

- **Sustainability**: throughout the value chain, environmental and social considerations should be assessed and verified to ensure that a net positive environmental and social outcome is achieved.

- **Market-based**: policy that uses flexible market mechanisms and outcome-based regulation to deliver efficiencies and liquidity.

- **Technology neutral**: policies should be flexibly designed, outcome based and support access to a range of technology pathways, at pace.

- **Circularity:** A circular economy is based on the principles of avoiding waste by designing it out, keeping products and materials in use, and regenerating natural systems. It builds long-term resilience, generates business and economic opportunities, and provides environmental and social benefits.

- **Innovative**: the Australian bioenergy sector is slow in transitioning from first generation biofuels and FAME biodiesel (Fatty Acid Methyl Ester) to more advanced fuels. There is an urgent need to move from a first-generation biofuel market to supporting next generation advanced biofuels including renewable fuels.

4 Key recommendations

11. The bioenergy roadmap should articulate broad economy wide market mechanisms.

12. National policy should supersede state-based mechanisms with the same policy objectives.

13. Any obligation with regards to bioenergy should be applied to the whole value chain, this includes production, sale, distribution and end users.

14. Policy design should encourage heavy industry and logistics operators to use low carbon fuels.

15. Sustainable aviation fuel (SAF)
    - The policy framework supports the development of an international approach to the use of SAF.
    - Technology neutrality is encouraged to help ensure efficiency in the market achieving compliance.
    - SAF should be counted as a low carbon fuel in regulated emissions trading and/or offsetting schemes.
    - Policy should also support consumer-led initiatives that promote the use of SAF.

16. For advanced biofuel technologies where technology risks are still relatively high, the policy design should support additional transitional support mechanisms to provide greater certainty on investment decisions.

17. Policy design must foster innovation by being technology neutral and incentivizing technology investment decisions

18. Excise rate reductions as an incentive mechanism to encourage the production of bioenergy, in particular domestically manufactured renewable diesel; and imported biofuel products.

19. Promote the export of domestically produced bioenergy through alignment with international sustainability accreditation on feedstocks.

20. Feedstocks:
    - The policy design should support a broad range of feedstocks.
    - A bioenergy roadmap must ensure feedstock is sustainable including a minimal indirect land use change (ILUC) impact.
    - Accreditation on feedstocks should be aligned with the EU and International Sustainability & Carbon Certification (ISCC), supporting international consistency and markets.
    - Consistent with the current treatment of biodiesel feedstock, international feedstocks should be eligible for use in local manufacturing.

21. End-of-life plastics
    - Domestically produced fuel sourced from an end-of-life plastic feedstock should be treated as a renewable fuel and therefore eligible for reduced excise rates.
    - Policy should be developed that encourages a circular economy and drives industry to extract calorific value from waste.

5 State government biofuel policy design

As a fuel wholesaler and distributor in Australia, bp is subject to the biofuel policy mandates set in Queensland and NSW. The Queensland and NSW biofuel mandates were introduced to encourage growth of a biofuels industry in the respective states and aimed to encourage investment in regional areas in new or advanced biofuel technology.

The policy design of the mandates has been faced with a number of implementation challenges, including:

- A limited number of biodiesel and ethanol producers;
- lack of customer uptake of the products;
- federal excise concession settings which have limited the importation of alternate ethanol or biodiesel products.
- The potential under these settings to divert feedstock from the food to fuel value chains, for example wheat being diverted for use as ethanol feedstock.

Despite ambitious intent, the policy design has struggled to achieve the policy objectives, with neither state realizing any significant increase in private sector investment in bioenergy since the introduction of the mandates, except for some smaller producers working towards producing market level volumes of biofuel in Queensland.

However, the fuels industry has invested significantly in biofuels related infrastructure to support the terminals and logistics supply chains, and at retail sites. Despite significant investments, consumer uptake continues to be a barrier to achieving compliance with the ethanol mandate.

Many consumers in both jurisdictions, especially NSW, choose to purchase premium fuels instead of ethanol blended fuels. Compared to other fuel options, the cost differential of E10 is historically insufficient to encourage consumers to switch products.

Coupled with this is a lack of understanding of the use of E10 in the community. An E10 educational campaign was introduced by the NSW government in partnership with the NRMA called 'Fuel for Thought', but industry saw little change in consumers' buying patterns following the campaign.

The Queensland government's campaign, 'E10 Ok' preceded the commencement of the ethanol mandate and led to slightly higher sales of E10 in Queensland as compared to NSW, however consumers also continue to choose premium unleaded petrol (PULP) or regular unleaded petrol (RULP) – whichever is available – over E10.

In 2016 the ACCC observed in a regular petrol monitoring report that the NSW biofuels mandate is costing NSW motorists up to $85 million per year in fuel costs[16].

Contributing to these challenges are federal excise concession settings which have limited the importation of a variety of alternate ethanol or biodiesel products, which has limited consumer choice, maintained less competitive prices of existing products and in-turn prevented the development of a competitive local market.

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[16] ACCC, 2016, *Report on the Australian Petroleum Market September Quarter 2016*, www.accc.gov.au/system/files/Report%20on%20the%20Australian%20petroleum%20market%20September%20quarter%202016.pdf

This lack of a competitive local market has led to sub-optimal outcomes for supply security, quality of product, market structures and cost of product, that has ultimately disadvantage consumers.

In its 2015 report “*Ethanol Mandate – options to increase the uptake of ethanol blended petrol*”, the NSW Independent Pricing and Regulatory Tribunal (IPART) concluded that a large beneficiary of the NSW mandate was the single producer and dominant supplier of ethanol in NSW[17]. There is a significant lack of competition in NSW as volume fuel sellers must purchase ethanol to comply with the mandate, and there is little prospect of competition from imported ethanol in the foreseeable future, given the Australian Government’s concessionary excise arrangements for local ethanol producers.

bp recommends the bioenergy roadmap articulate broad economy wide market mechanisms and a national policy approach that supersedes state-based mechanisms with the same policy objectives. A consistent national approach would support greater market liquidity.

Recommendations:

22. The bioenergy roadmap should articulate broad economy wide market mechanisms.
23. National policy should supersede state-based mechanisms with the same policy objectives.
24. Any obligation with regards to bioenergy should be applied to the whole value chain, this includes production, sale, distribution and end users.

6 Markets and technology

6.1 Decarbonising the transport sector

As a company that has for more than a century been focused on keeping the world moving, bp is focused on the challenge to significantly reduce emissions while meeting the growing global need for mobility. Transport accounts for around a quarter of carbon emissions from the combustion of fossil fuels. This contribution will need be significantly reduced if the world is to achieve net-zero emissions.

bp analysis suggests that while electric vehicles will account for 15% of all passenger vehicles by 2040, half of all cars in Europe, and over two thirds in the world, could still have internal combustion engines (ICEs) by 2040[18]. It is important therefore to identify cleaner and more efficient fuels and lubricants, increase the use of biofuels and improve the efficiency of ICEs.

It is also important to consider that electrification may not be commercially or technically feasible in many parts of the transport sector, including long-distance haulage, shipping and aviation, or in certain geographies.

Decarbonization in the transport sector will require a range of technologies including biofuels, ‘e-fuels’ and green and blue hydrogen, as well as making use of developments in the broader mobility transition such as autonomous vehicles and shared mobility services.

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[17] IPART NSW, 2015, *Ethanol Mandate - Options to Increase the Uptake of Ethanol Blended Petrol*, p. 75 www.ipart.nsw.gov.au/files/sharedassets/website/trimholdingbay/final_report_-_ethanol_mandate_-_options_to_increase_the_uptake_of_ethanol_blended_petrol_-_may_2015.pdf

[18] *Bp Energy Outlook 2019*, p.47 www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf

It is not possible to predict the energy mix with precision, so policies must be developed that support a range of technologies. Stable yet adaptive policy, technology development, and competition should determine the technology mix.

6.2 Freight and logistics

Australia's reliance on heavy vehicles and road transport logistics is a key opportunity in Australia's bioenergy roadmap.

Renewable diesel is a drop-in replacement for petroleum-based diesel, it is an interchangeable substitute for conventional petroleum-derived hydrocarbons, meaning it does not require adaptation of the engine, fuel system or the fuel distribution network. This has been corroborated by two major manufactures of heavy-duty engines and trucks, Volvo Trucks North America[19] and Mack Trucks[20], which have approved the use of renewable diesel fuel in all their diesel engines.

Policy design should encourage heavy industry and logistics companies to use lower emission modes of transport. As it stands, most logistics operators will choose the most economical and efficient way to move freight. It is important to encourage a change in behaviour, where the emissions intensity of a journey would be given appropriate weighting relative to cost and time.

Recommendation:

25. Policy design should encourage heavy industry and logistics operators to use low carbon fuels.

6.3 Aviation

Globally Air bp fuels more than 6,000 flights every day and supplies fuel at around 900 locations in over 50 countries.

The volume of jet fuel used by bp alone presents an opportunity to make a material reduction in greenhouse gas emissions over the lifecycle of fuel by using sustainable aviation fuel (SAF) in place of regular jet fuel.

In 2016 bp was the first operator to start commercial supply of SAF through an existing hydrant fuelling system, at Norway's Oslo airport. bp SAF has been supplied at 16 airports worldwide across three continents – including in Norway, Sweden, France and in the US. Air Transport Action Group (ATAG) statistics show that over 240,000 commercial flights had been made on sustainable aviation fuel by May 2020.

SAF is made by converting sustainable material such as certain vegetable oils, recycled cooking oil or solid household waste to a high-quality synthetic product which is then blended with regular jet fuel. It can drop straight into aircraft and is approved for use in jet engines with no technical changes to aircraft necessary.

SAF gives a reduction of up to 80% in CO_2 emissions depending on the sustainable material used, production method and the supply chain to the airport.

The development of SAF has been incentivised by the aviation industry's own emissions targets. The International Air Transport Association (IATA) is aiming for zero growth in carbon by 2020 and a 50%

[19] https://www.volvogroup.com/en-en/news/2015/dec/news-151323.html
[20] https://www.macktrucks.com/mack-news/2016/mack-trucks-green-lights-renewable-diesel-fuel/

reduction in carbon emissions by 2050, when compared to 2005[21]. The UK aviation industry aims to reach a net zero-carbon target for 2050. To achieve this the industry will employ more efficient aircraft and increase use of SAF and offsets.

Achieving the industry's long-term low carbon goals could ultimately require close to 100% SAF in long-haul flights. Scaling the production of SAF up to this level will require collaboration with aviation regulators to support this effort and long-term policy certainty. This will enable the necessary investment into commercial production, alongside continued research, to improve the technologies.

Many of the SAF production technologies are immature, but bp believe the best way to make them viable is a stable long-term policy framework that gives confidence for investors to back these projects.

- In such an international industry, increased fuel costs in one country or region may lead to tankering and increased emissions from aircraft taking on board more fuel than necessary to reduce the need to refuel in those countries or regions with mandates. Care needs to be taken to avoid such situations.

- Technology neutrality is encouraged to help ensure efficiency in the market achieving compliance. bp sees this as a temporary measure until there is stability of supply at scale.

- Fuel suppliers are the most obvious point of obligation for policy compliance, as aggregators of fuel demand. However, other points of obligation could be considered as a mitigation for market distortion and CO_2 leakage due to fuel tankering, for example to obligate airports to ensure a defined portion of fuel at their airport to be SAF, with the incremental cost shared between all users of the airport through landing fees, or similar.

- The cost of SAF is typically higher than that of conventional biofuels for ground transport due to tighter quality specifications. Therefore, bp supports policies allowing SAF to be on an equal footing with other biofuels. bp supports SAF to be counted as a low carbon fuel in regulated emissions trading and/or offsetting schemes.

- For advanced biofuel technologies such as gasification, pyrolysis and electro-fuels where technology risks are still relatively high, bp supports additional transitional support mechanisms to provide greater certainty on returns on investment.

Recommendations

26. Sustainable aviation fuel (SAF)
    - The policy design supports the development of an international approach to the use of SAF.
    - Technology neutrality is encouraged to help ensure efficiency in the market achieving compliance.
    - SAF should be counted as a low carbon fuel in regulated emissions trading and/or offsetting schemes
    - Policy should also support consumer-led initiatives that promote the use of SAF.
27. For advanced biofuel technologies where technology risks are still relatively high, bp supports additional transitional support mechanisms to provide greater certainty on investment decisions.

[21] https://www.iata.org/en/policy/environment/climate-change/

6.4 Marine

bp Marine supplies most of the major marine bunker fuel ports around the world, offering various grades of fuel oil, marine diesel, or gas oil.

Marine fuels is a large and complex global industry, and bp Marine has a presence in more than 50 ports around the globe.

As the shipping industry looks to rapidly decarbonise by 2050, low-carbon fuels, such as biofuels, will need to become commercially available. Additionally, it is expected that the International Maritime Organisation (IMO) will make changes to the International Convention for the Prevention of Pollution from Ships (MARPOL Convention) requiring lower carbon emissions in the short term.

bp Marine is currently supplying biofuel for use in ship bunkering in Rotterdam and is actively exploring expanding this into other jurisdictions through its supply portfolio.

Although, like most sectors, there are technical and logistical issues that need to be resolved before biofuels can be introduced at a larger scale in the shipping sector, there is interest in progressing low carbon fuels from both the fuel and shipping industry.

Volumes of marine fuel sold in Australian waters are lower than larger shipping ports such as Rotterdam and Singapore, however Australian policy settings should be conducive to biofuel usage in marine fuels as demand from the shipping sector continues to rise.

6.5 Mining

bp is a major supplier of energy to the Australian mining industry, offering various fuel sources including natural gas, liquified natural gas, aviation fuels, lubricants, motor spirit and diesel.

A recent McKinsey & Company report indicates that the mining industry is currently responsible for up to 7% of the worlds GHG emissions, much of which is scope 3, or coming from indirect emissions[22].

The mining industry made significant progress towards reducing their GHG emissions footprint, but these levers have largely represented fixed plant equipment that utilise electricity or gas as a feedstock. This is evident in the industry's move towards a renewable electricity source such as solar or wind energy.

Mobile plant and equipment such as haul trucks, that predominately run off diesel, have largely remained unchanged, and whilst the mining industry has identified low carbon solutions such as electrified or hydrogen fuelled trucks, these alternatives will not be available in the short term due to:

- Technological and economic restrictions of the production and use of hydrogen;
- Availability of OEM equipment;
- The high cost of replacing an entire fleet of heavy equipment before end-of-life.

bp is actively working with over 10 mid to large scale mining companies across Australia to find an interim solution before hydrogen and electrification becomes practicable.

[22] "Climate Risk and Decarbonization: What Every Mining CEO Needs to Know." *McKinsey & Company*, www.mckinsey.com/business-functions/sustainability/our-insights/climate-risk-and-decarbonization-what-every-mining-ceo-needs-to-know

Unlike most sectors, mining is unique in that some biofuels can be rolled out immediately, such as renewable diesel. It is also logistically simpler due to the natural clustering of minerals and metals resources, typically across four geographical locations including the Pilbara, Gold Fields, Hunter Valley and Bowen Basin.

The barriers to the mining industry transitioning to biofuels are the same as the barriers in other sectors:

- Unavailability of locally produced biofuels in the quantities required has been a consistent blocker since the abolishment of the cleaner fuels grant scheme in July 2015.
- Globally sourced biofuels are incentivised to be imported into California or the European Union, rather than Australia.
- Biofuels, in their current state, are largely uneconomic in comparison to conventional fossil fuels.

6.6 Technological advances

It is vital that policy not only keeps pace with technological advances but drives it, and investment in advanced biofuels should not be discouraged by current policy that favours first generation biofuels. If policy development is unable to keep pace with technological advances, policy must be developed in support of technical neutrality and with the necessary flexibility to enable emerging fuel technology. This is relevant to all areas of policy including tax and environmental policies.

For example, when the reduced excise rate for biodiesel replaced the cleaner fuels grant scheme in July 2015, renewable diesel was not included as producing second-generation biofuels in commercial quantities is a relatively recent development.

Renewable diesel, also known as hydrotreated vegetable oil or HVO, is a second generation biofuel made from organic biomasses; the production process makes renewable diesel chemically identical to petroleum diesel and meets the same ASTM specification (D975), but with 80% less greenhouse gas emissions and better cold storage properties than traditional biodiesel.

Renewable diesel and biodiesel are currently treated separately under the excise scheme based on their different manufacturing processes. However renewable diesel has been identified as holding a much greater potential to reduce carbon emissions than conventional biofuels (such as biodiesel) in the joint ARENA and CEFC report *Biofuels and Transport: An Australian opportunity*.

bp supports policy reform to reduce the excise rate on domestically manufactured renewable diesel, as per the treatment of first-generation biodiesel. bp believe there exists a clear policy rationale for a change in Australian policy to similarly encourage renewable diesel.

The extension of the biodiesel excise tariff to renewable diesel could be achieved through updating the definition of biodiesel under the existing excise tariff framework (subsection 3(1) of the Excise Tariff Act 1921).

Recommendations

28. Policy design must foster innovation by being technology neutral and incentivizing technology investment decisions.
29. excise rate reductions as an incentive to encourage the production of bioenergy, in particular domestically manufactured renewable diesel; and imported biofuel products.

7 Opportunities - Export markets

In recent years the production and trade of biofuels has increased as policy settings around the world have matured and focused on reducing emissions through incentivising the production and use of biofuels. Traditionally trade has been in ethanol and biodiesel as they are the most established biofuels, however the trade of second-generation biofuels, including renewable diesel is increasing.

Promoting the export of domestically produced bioenergy, especially advanced biofuel, would stimulate the domestic bioenergy market and have broader positive impacts on the Australian economy.

The promotion of this could be supported through ensuring trade-related measures are flexible; and through alignment with international sustainability accreditation on feedstocks.

bp has extensive experience trading bioenergy within mature and complex market-settings globally, including:

- The European Union's Renewable Energy Directive (RED II) which overlays various European countries renewable quotas and mandates.

- The United States Renewable Fuel Standard (RFS) which works alongside state regulations to encourage the use and production of biofuels, including the California Low Carbon Fuel Standard (LCFS), which is one of the first low-carbon fuel standard mandates in the world and is probably the most developed mechanisms to encourage decarbonization of the energy supply chains.

Recommendations

30. Promote the export of domestically produced bioenergy through alignment with international sustainability accreditation on feedstocks.

8 Resources

8.1 Feedstocks

Feedstocks that are scalable as well as sustainable will be required for the industry to meet its low carbon goals. Sustainable biofuel production must consider impacts on land use, food production and sensitive environments and human rights.

bp prefers waste and residue feedstocks where they are available and cost effective. This includes waste cooking oil and end of life plastics.

However, bp supports all feedstocks that have a certified carbon reduction and minimal indirect land use change (ILUC) impact, including e-fuels produced from renewable power and CO_2 and low-ILUC risk vegetable oils.

Accreditation on feedstocks should be aligned with the EU and International Sustainability & Carbon Certification (ISCC), supporting international consistency and markets.

Consistent with the current treatment of biodiesel feedstock, international feedstocks should be eligible for use in local manufacturing, as Australia does not have the necessary volume of local feedstock.

Recommendation

31. Feedstocks:
    - The policy design should support a broad range of feedstocks.
    - A bioenergy roadmap must ensure feedstock is sustainable including a minimal indirect land use change (ILUC) impact.
    - Accreditation on feedstocks should be aligned with the EU and International Sustainability & Carbon Certification (ISCC), supporting international consistency and markets.
    - Consistent with the current treatment of biodiesel feedstock, international feedstocks should be eligible for use in local manufacturing.

8.2 Circular economy

One of bp's objectives is to deliver renewable, low carbon energy without the need for agriculture to switch from food production to feedstock. bp's refining technology and engineering team are working with bp refineries to transform waste into high quality fuel using renewable carbon sources.

bp recommends that fuel domestically produced from an end-of-life plastic feedstock is treated as a renewable fuel and therefore eligible for reduced excise rates, similar to the treatment of biodiesel and ethanol.

Policy should also be developed that incentivises a circular economy and drives industry to extract calorific value from waste. This would help the development of a viable biofuel market and would support Australia's national waste policy.

A circular economy is based on the principles of avoiding waste by designing it out, keeping products and materials in use, and regenerating natural systems. Where it is no longer possible to reuse an item in its current form, using enhanced, chemical or mechanical ways to recycle it into a new product should be used. The most optimum form of this is closed loop recycling, where materials are brought back to an equal or comparable level of quality.

For example, bp is helping commercialize Fulcrum technology that converts household rubbish into fuel for transport. bp has an agreement with Fulcrum BioEnergy, to use bp and Johnson Matthey (JM) technology in the Sierra BioFuels Plant located in Nevada, US to convert approximately 175,000 tons of household garbage into approximately 11 million gallons of biojet fuel each year: equivalent to the fuel needed for more than 180 return flights between London and New York.

The world needs to use its scarce resources in radically new ways; moving from a 'take, make, waste' approach towards one in which materials are re-used, recycled, repurposed and redirected to extend their purposeful life for as long as possible.

In Australia 6 million tonnes of plastic is produced every year, 50% of which is single use plastic. Up until recently, waste recyclers have exported waste to avoid the cost of processing waste locally. Since 2018, the crackdown on exporting waste to China means waste must be processed close to the source.

The technology to convert waste plastic into fuel exists, and small-scale projects are already in progress in Australia, but the capital expenditure required to scale up to market level production is expensive. Government support for the market scale development of infrastructure to convert end-of-life plastics back into fuel would support investment decisions while the market is developing. Financial support would be short-term and aimed at offsetting some of the up-front capital costs.

The process of converting end-of-life plastics into fuel at commercial levels requires a sustained and consistent amount of good-quality feedstock to function effectively. Plastics must be collected, sorted and cleaned in advance of the process. There is a strong market for clean plastic, currently $400/tonne[23]. Like many advanced biofuels, at current production levels the cost of the feedstock makes most projects uneconomical.

An Australian government led waste recovery scheme that works with local government collection and processing of end-of-life plastics for use as renewable fuel feedstock would provide a practical solution to problems with processing waste onshore and provide access to a clean feedstock for fuel processing.

Recommendations

32. End-of-life plastics:
    - Domestically produced fuel sourced from an end-of-life plastic feedstock should be treated as a renewable fuel and therefore eligible for reduced excise rates.
    - Policy should be developed that encourages a circular economy and drives industry to extract calorific value from waste.

[23] https://www.sustainability.vic.gov.au/Business/Investment-facilitation/Recovered-resources-market-bulletin