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Advanced Biofuels Study

Strategic Directions for Australia

Summary Report

14 December 2011

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Background

The Advanced Biofuels Study was commissioned by the Department of Resources, Energy and Tourism, funded through the Australian Centre for Renewable Energy (ACRE), to inform the priorities of the Australian Biofuels Research Institute (ABRI). The Study will also inform the development of the Government's Alternative Transport Fuels Strategy.

This Report summarises findings of the Advanced Biofuels Study, identifies priority pathways for the industry and recommends the role Government should undertake in order to facilitate the establishment of an advanced biofuels (ABF) industry. More detailed research and analysis of ABF technologies, feedstock options and economics is contained in an Appendix, which should be read in conjunction with this Report.

The Report sits in the context of an industry that is still in an early stage of development, with activity to date centred on ethanol and biodiesel production.

Advanced biofuels are defined as liquid fuels derived from sustainable sources of organic matter that do not typically compete with food production, such as wood residues, certain oilseeds, and algae.

Acknowledgements

The Advanced Biofuels Study has been prepared by L.E.K. Consulting with the assistance of a range of organisations and individuals.

We would like to acknowledge the contribution of the CSIRO acting as scientific and technology advisors to the project team, particularly in the analysis of feedstocks, conversion technologies and economics.

We also acknowledge the important role of the ABRI Establishment Council members in providing guidance and feedback throughout the Study.

We appreciate the contribution of domestic and international industry participants in providing data and sharing their perspectives.

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1. EXECUTIVE SUMMARY

Advanced Biofuels (ABF) offer the potential for Australia to build a significant and sustainable new industry which could increase national fuel security, assist in reducing greenhouse gas (GHG) emissions and stimulate regional development.

The opportunity exists for Australia to capitalise on its comparative advantages and start laying the foundations now for what might be an industry of significant future value and scale, providing a substantial proportion of Australia's future fuel requirements.

There is mounting urgency around the world to find affordable and sustainable alternatives to non-renewable transport fuels.

If prices for non-renewable fuels continue to rise, and as the cost of ABF production falls, ABF could become cost competitive within a timeframe as close as 5-10 years.

Once cost competitiveness is achieved, ABF are then likely to form a significant part of an alternative fuel solution.

Given Australia's comparative advantages drawn from its history of expertise in agricultural sciences, its abundance of flat land and sunlight and a climate suitable for growing dedicated energy crops, Australia could become a global leader in ABF.

The development of a large scale ABF industry will, however, require transformative land use change and significant investment.

This Report summarises the findings of a detailed Advanced Biofuels Study, setting out key issues for industry and Government for the establishment of a sustainable ABF industry in Australia over the next 20 years.

It identifies several priority ABF feedstock and conversion technology pathways for Australia, with an emphasis placed on those that produce drop-in fuels, leverage Australia's comparative advantages and are scalable in the long term.

It also raises a number of early stage challenges that will need to be overcome in establishing a sustainable ABF industry.

This includes outlining an initial supporting role for Government in providing signals and a platform that gives the private sector confidence to invest.

The Report recommends 20 specific actions for Government consideration that will help business establish a sustainable market-led ABF industry.

2. AN ADVANCED BIOFUELS INDUSTRY

2.1. Growing Global Momentum

Around the world, momentum is building in the search for affordable and sustainable alternatives to fossil (non-renewable) transport fuels. Growing global demand and increasing costs are contributing to prices for non-renewable fuels that, while volatile, are on the rise. At the same time, the international community is taking concerted action to reduce GHG emissions in order to mitigate potentially devastating impacts of climate change later this century. Countries are investing vast resources and setting ambitious goals as they look for renewable energy alternatives.

There is mounting urgency around the world to find affordable and sustainable alternatives to non-renewable transport fuels

Biomass derived fuels (biofuels) are an alternative on which more and more countries are placing greater emphasis. The United States, for example, has recently mandated that 136 gigalitres (GL) of biofuels must be used in transport by 2022. Europe has also recently mandated biofuels use, requiring that 10% of transport fuel use is renewable by 2020, largely through increased biofuels consumption. Other countries targeting biofuels include India, China, Canada and Brazil, and the level of interest is such that the International Energy Agency projects a five-fold increase in global biofuels production to 2030.

The spotlight is shifting towards ABF because they can avoid many of the drawbacks of conventional biofuels. Specifically, conventional food-crop based biofuels have been criticised for their high use of arable land, negative impacts on world food prices and biodiversity, limited energy yield, and sometimes poor life-cycle greenhouse gas (GHG) emission reduction.

ABF can provide a substantially more sustainable alternative to conventional biofuels

In contrast, ABF can provide a substantially more sustainable alternative as they are based on non-food (i.e. “advanced”) biomass sources, including waste streams (agriculture, forestry, household and industrial) and dedicated energy crops including algae that do not typically compete with food. These sources also offer the potential to significantly lower life-cycle GHG emissions compared to non-renewable alternatives, an increasingly important requirement in a carbon-constrained world.

Countries are therefore not only shifting their focus towards renewable energy and renewable transport fuels, but increasingly to ABF. The U.S., for example, is investing $500m into a major military research project that will see ABF powering a sizeable share of the Navy by 2020; Government support in the order of several hundred millions of dollars has been provided for demonstration and pre-commercial facilities for prospective ABF technologies. Canada is also investing over $400m into ABF research. The IEA projects that advanced biomass will supply more than 50% of the feedstock required for biofuel production by 2030.

Private sector investment of close to $1 billion has been made in Asia where commercial ABF production has been online since 2010. Similar investment activity is underway in Europe, with capacity coming online from Q4 2011. In North America the private sector is actively involved in the development of ABF production with large scale funding arrangements between leading technology companies and major oil companies. In London, an ABF plant is currently being built that will produce commercial quantities of aviation fuel from municipal waste by 2014, with off-take arrangements already in place. ABF are quickly becoming a reality.

2.2. Benefits for Australia

An ABF industry has the potential to offer a number of important benefits to the nation by increasing fuel security, reducing GHG emissions and stimulating regional development

In Australia, interest in advanced biofuels is also rising. This is because an ABF industry has the potential to offer a number of important benefits to the nation.

In particular, Australia faces a growing level of uncertainty surrounding the price and supply outlook for non-renewable fuels. In providing a new and renewable fuel source, ABF could reduce the dependence on these fuels, potentially mitigating risks to Australia's fuel security in the medium to long term.

ABF are also attractive because of the significant GHG emission reduction benefits that they potentially provide compared to their non-renewable counterparts. Refined fuels currently account for c.23% of Australia's total GHG emissions, and cost-competitive, low emission ABF would be an attractive alternative to existing non-renewable fuels.

Developing an ABF industry would also be crucial in meeting specific sector needs. Biofuels represent the only feasible renewable fuel alternative for the aviation sector, and key aviation players are committed to ABF development and adoption. ABF could also be attractive to a number of other key sectors identified in this Report.

A new ABF industry could also be significant in its own right for Australia, providing a competitive industry for the long term future with attractive possibilities to generate economic growth, replace imports and even create exports to supply growing global demand. The latter may range from large scale export activity, through to the regional supply of ABF to meet U.S. Navy refuelling demand.

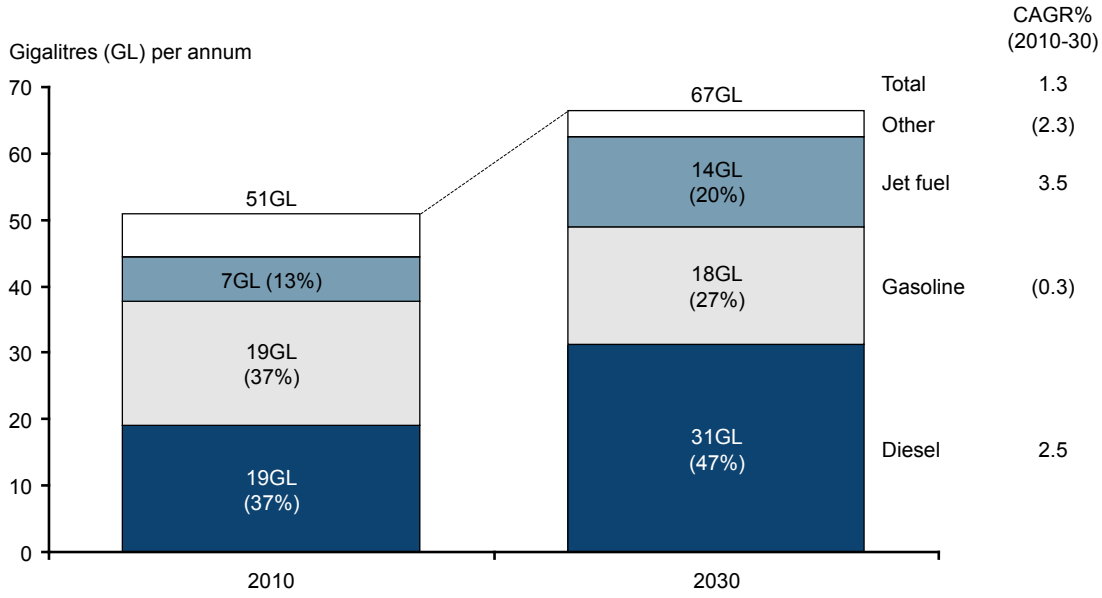
An established ABF industry would also have an agricultural foundation and not be concentrated in major cities. Considerable job creation and new economic activity in rural and regional areas would be another important benefit.

The scope of these benefits is potentially vast. While ABF have not to date featured prominently in the national conversation about alternative fuels, this range of substantial benefits suggests that ABF warrant much greater focus and consideration. The opportunity to develop a new major industry of the future does not often present itself, and as cost competitiveness for ABF may be attainable in the medium term, there are strong merits in acting now to lay the foundations for a sustainable ABF industry.

2.3. Meeting Market Needs

Australia currently consumes 51 gigalitres[1] (GL) of liquid fuels, and this volume is expected to grow to 67GL by 2030 (Figure 1).

Figure 1: Fuel demand in Australia (current versus future)



Source: ABARES; CSIRO; L.E.K. research, interviews and analysis

Note: CAGR = compound annual growth rate

For a number of industry sectors, ABF are an important alternative fuel option, particularly where sector fuel demand is high, and few alternatives to non-renewable fuels exist. These factors, in addition to considerations around ABF suitability and ease of adoption make it possible to identify those sectors likely to benefit the most from the establishment of an ABF industry[2].

They are:

- **aviation** (aviation fuel);
- **defence** (assorted fuels);
- **freight road transport** (diesel);
- **mining** (diesel); and
- **marine** (diesel and fuel oil).

For a number of sectors, ABF are an important alternative fuel option

For the aviation sector, biofuels are the only feasible renewable fuel alternative

[1] One gigalitre (GL) represents 2% of Australia's current transport fuel usage
[2] End-use sector needs are discussed in further detail in *Chapter Three* of the Appendix

Within this group, aviation and defence may more readily take up alternative fuels as these sectors have a smaller number of users accounting for a large proportion of demand. As early adopters they could become champions for an ABF industry. Aviation is already acting as an early industry champion and providing important signals of downstream demand at a time when the ABF industry is still at an early stage.

The production of "drop-in" ABF would potentially offer even more widespread end-user benefits and applications. Drop-in fuels, by definition, are compatible with existing distribution infrastructure and engine technologies, and do not require blending. Drop-in ABF equivalents can be made for aviation fuel, gasoline and diesel, for which the domestic end user market is very large. **Private transport** could therefore also be a key user of drop-in ABF gasoline and diesel.

The cost competitive introduction of drop-in ABF could see ABF ultimately substituting a large share of Australia's current non-renewable fuels, with users potentially unaware they are even using ABF.

Once the economics of the industry are sound, ABF are likely to form a significant part of an alternative fuel solution.

ABF are likely to form a significant part of an alternative fuel solution

2.4. Setting an Appropriate Aspiration

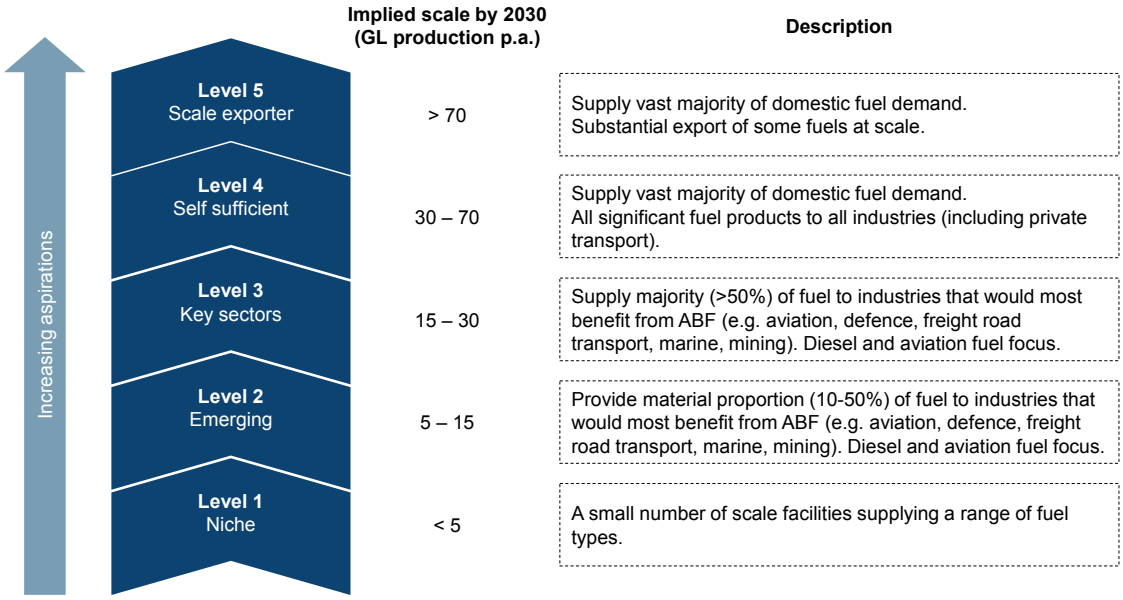
Australia enjoys a number of important comparative advantages when considering the establishment of an ABF industry. It possesses extensive flat land, abundant sunshine and a climate and environment suitable for growing dedicated energy crops. Complementing its natural endowment, Australia has a history of world class expertise in agricultural science, and has demonstrated strengths in natural resource and infrastructure orientated industry development (e.g. mining, LNG). These advantages position Australia well to not only develop a strong local ABF industry, but to also potentially play a significant global ABF role.

Australia enjoys comparative advantages including its natural endowments and expertise in agricultural science

The desired scale of aspiration for Australia's ABF production (in GL) should be informed by a range of factors, including policy priorities, technology maturity, anticipated supply and demand, and appetite for investment. Australia's aspirations could change over time in response to new developments and information.

Australia's production of ABF could range from niche production (Level 1: less than 5 GL), to supplying the majority of domestic fuel for key sectors (Level 3: 15-30 GL), or even expanding significantly into scale export supply (Level 5: greater than 70 GL) (Figure 2).

Figure 2: Aspirations for an advanced biofuels industry in Australia



Source: Alchemy Growth Partners; L.E.K. research, interviews and analysis

If ABF are to play a material role in fuel security, GHG reduction and regional development, it will be necessary to aspire to an industry of substantial scale. A 15-30 GL pa industry would see ABF supplying a majority of fuel for those key sectors with greatest need for ABF, and providing a large proportion of Australia's liquid fuel use overall. An industry of such scale would require transformational land use change and significant investment.

Depending on how the industry develops, the feedstock required to produce 20 GL of end fuel could, for example, require as much as c.5-10 million hectares of new crop-based plantations (i.e. an area larger than Tasmania but smaller than the current wheat crop), although other feedstocks may be less land intensive. In terms of investment, it could require more than $50bn in upfront capital. To further put the scale of such an aspiration in perspective, 15-30 GL of production would imply a c.$10-$20 billion ABF industry, amounting to c.1-2% of Australia's 2011 GDP. Such an industry could be as big as one fifth the size of the mining sector, or equivalent in size to the existing automotive, appliance and equipment manufacturing sector.

It is recommended that Government lay the foundations to enable the industry to reach at least an aspiration of level 3 (supplying the majority of fuels to key end use sectors), with the option to proceed to levels 4 or 5. This is not a recommendation to be advanced in the absence of cost competitive ABF, with sound economics being a necessary pre-condition for large scale industry growth. It does, however, inform the type of actions which would be required to build a competitive industry of scale with consequent benefits for fuel security, GHG reduction, industry and regional development.

Government should lay the foundations to enable the industry to reach at least an aspiration of 15-30 GL

3. PRIORITY PATHWAYS

3.1. Criteria for Pathway Prioritisation

There are a number of feedstock and technology combinations that can produce ABF. These combinations are termed "pathways", and there are benefits to industry and Government in identifying those which may currently be most prospective.

For the purposes of the Advanced Biofuels Study, the following criteria have been employed to identify the pathways which are most attractive for Australia:

- pathways which produce drop-in fuels, being those compatible with existing distribution infrastructure and engine technologies, and those which meet the fuel requirements of end users with the greatest need or appetite for ABF, should receive priority;
- pathways that can scale should be preferred because they offer the potential for enhanced fuel security, GHG reduction and regional development; and
- pathways that take advantage of Australia's strong comparative advantages including agricultural science, an abundance of flat land and sunlight, and a suitable climate and environment for growing dedicated energy crops should receive priority.

Figure 3: Considerations for ethanol and biodiesel[3]

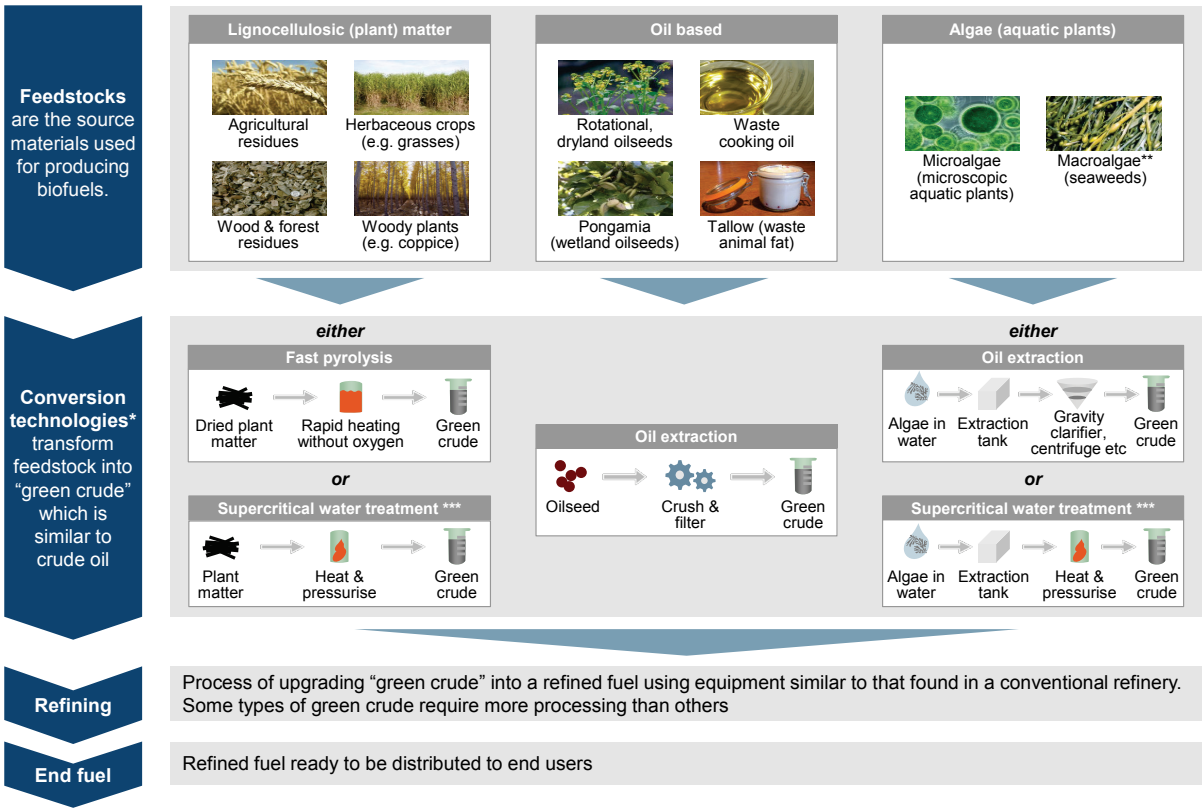
Ethanol and biodiesel have been the leading biofuels in Australia to date, and have played a valuable role in establishing the industry. There is ongoing investment in these conventional biofuels, recognising some current and future demand.

In the context of building an Australian ABF industry of substantial scale in the long term, ethanol and biodiesel pathways are considered less attractive than those that produce refined fuels (e.g. renewable aviation fuel, diesel and gasoline) because:

- end-use applications for ethanol and biodiesel are restricted when compared to refined drop-in fuels (e.g. due to technical performance limitations), limiting scale potential;
- differences with conventional non-renewable fuels (i.e. lack of drop-in compatibility) increase the investment required in separate fuel storage and potentially distribution infrastructure, particularly as volumes increase; and
- Australia is at a comparative disadvantage in terms of infrastructure, technology and expertise to countries with larger, more established, conventional biofuels industries.

[3] The terms 'biodiesel' and 'renewable diesel' refer to two distinct substances. While both are fuels derived from biomass, renewable diesel has greater chemical similarities to diesel and can be used as a drop-in biofuel, whereas biodiesel cannot be used in this way due to important chemical differences.

Figure 4: The advanced biofuels value chain



Source: L.E.K. research, interviews and analysis

Note: * Conversion technologies illustrated for only those pathways identified in this Report as priorities

** Macroalgae can also be processed through fast pyrolysis

*** In this Report, the term supercritical water treatment also refers to conversion processes in 'near supercritical water'

3.2. Feedstocks

Feedstocks can be categorised into three broad groups: lignocellulose (LC), oil and algae (Figure 4)[4]. Each of these feedstock groups has its own distinct attributes, and different levels of ABF fuel production potential for Australia (Figure 5).

A certain amount of LC biomass is readily available in the current production system in the form of agricultural, wood, forest and waste residues. Preliminary evidence suggests that currently divertible quantities could support a significant ABF industry (c. 10 GL) although investments in harvesting, densification and transport infrastructure would be required. New LC crops on the other hand (e.g. grasses, short rotation coppice), may allow much higher volumes of ABF production to be achieved, although these will take time to develop to scale.

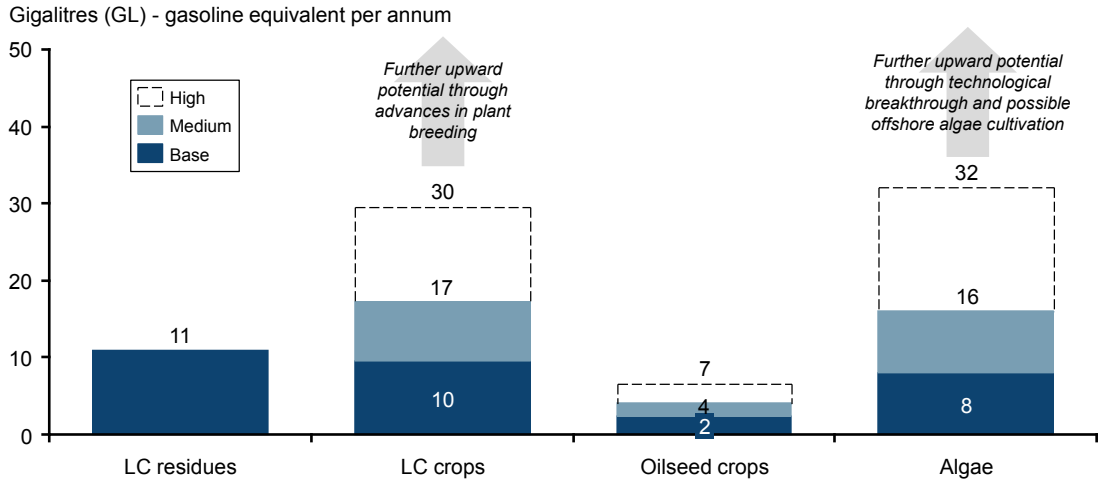
[4] ABF feedstocks and technologies are discussed in further detail in *Chapters Four* and *Five* of the Appendix

Oil based biomass is less available and less scalable, but could be developed relatively quickly, leveraging annual oilseed species such as juncea, camelina and pongamia. Oil-based production systems may also benefit from the ability to easily feed harvested oilseeds into established technological processes.

Algae is attractive as a feedstock as it offers particularly high levels of scalability, as well as substantially reduced land use requirements. Depending on assumptions, production potential ranges from 8 GL to as high as 32 GL.

These different feedstock attributes suggest there is merit in pursuing multiple options, aided by a level of interchangeability among their feedstock groups. It should be noted, however, that only new LC crops and algae appear to offer the long-term scale potential required to meet aspirations higher than level 3.

Figure 5: Scalability of feedstocks: sensitivity analysis (2011E)



Source: L.E.K. research, interviews and analysis

3.3. Technologies

There are a number of potential technologies that can be applied to convert feedstock into ABF, each at varying stages of development, but with many only in the early stages. The most promising technologies for Australia involve the production of refined fuels via oil extraction, supercritical water treatment or fast pyrolysis. These conversion technologies are attractive because they produce drop-in fuels (via green crude); leverage Australia's comparative advantages, and are logistically compatible with the Australian context.

The production of green crude is attractive because it is the renewable equivalent of crude oil, capable of being processed into refined fuel in a similar way to crude oil. The highlighted conversion technologies in Figure 6 can produce drop-in equivalent refined fuels such as renewable diesel, aviation fuel and gasoline.

Employing the criteria for attractive pathways across feedstocks and technologies gives rise to the following priority pathways for Australia (Figure 6):

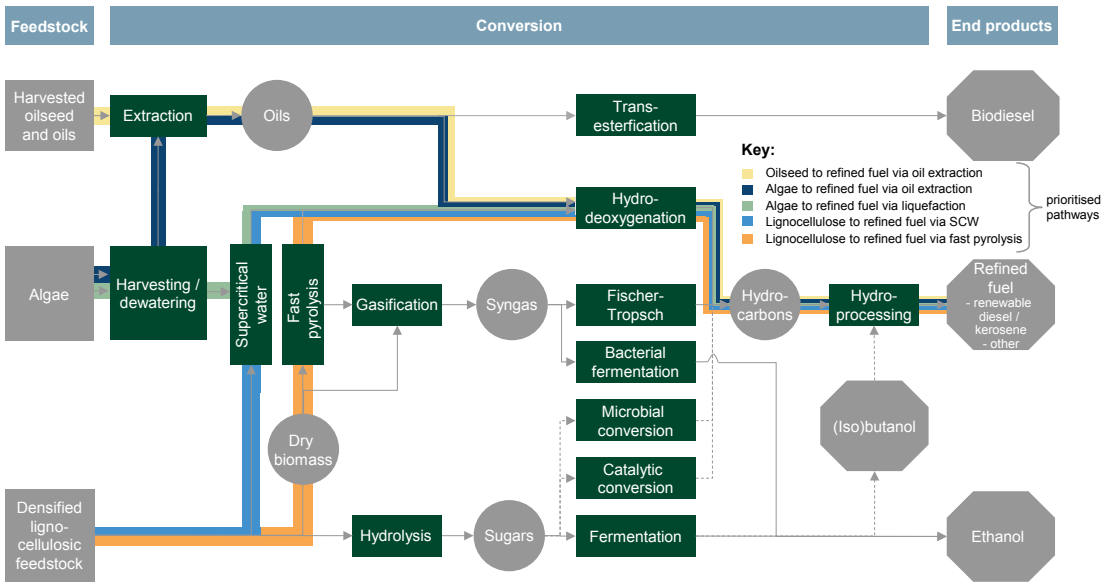
- lignocellulosic feedstocks (including residues such as bagasse, wheat and crop stubble; and new crops such as grasses and short rotation coppice) via fast pyrolysis or supercritical water treatment;
- oilseed feedstocks (such as pongamia and juncea) via oil extraction; and
- algae via oil extraction or supercritical water treatment (or similar processes).

The isobutanol to aviation fuel pathway was considered and was deprioritised at this stage in an Australian context as the pathway typically builds on conventional ethanol infrastructure, where USA and Brazil currently have a comparative advantage.

Given the potential scalability of algae and new LC feedstocks, and the land efficiency of algae, pathways based on these feedstocks warrant particular emphasis.

In addition, it will be important to continually monitor the developments of the "next generation" of ABF. These technologies use microorganisms to biologically produce substances similar to refined fuels (e.g. direct diesel production), reducing the need for refining. Such breakthrough technologies offer fascinating potential, but are not considered in detail here, as they remain largely in the early stages of development or are further from integration into a full drop-in fuel production pathway.

Figure 6: Prioritised ABF pathways

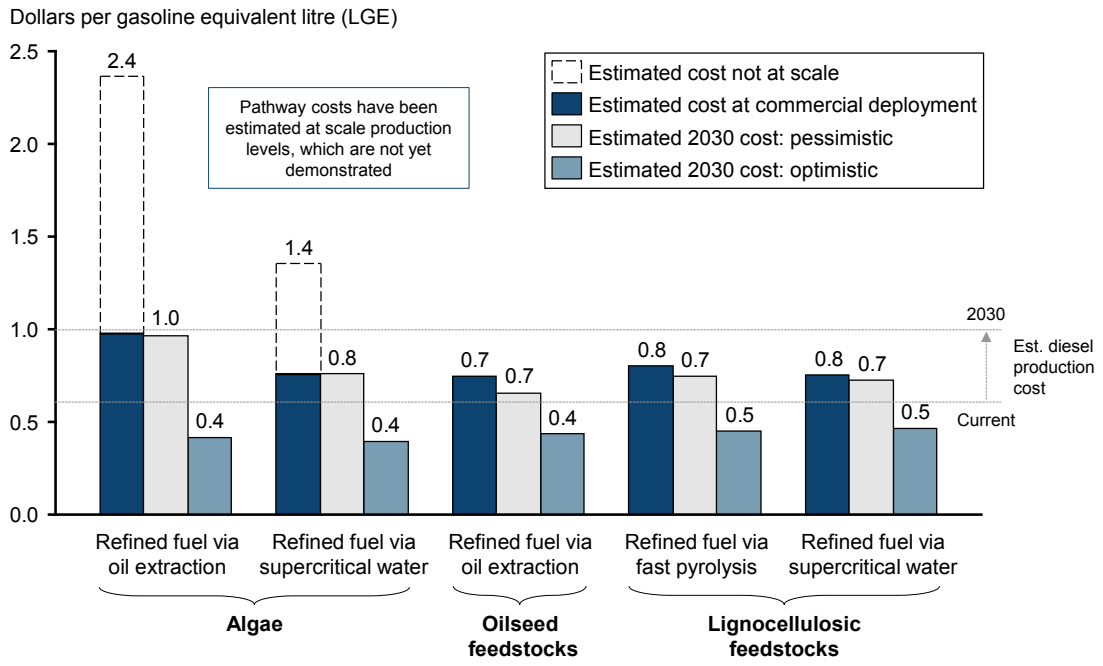


Source: L.E.K. research, interviews and analysis

3.4. Cost Competitiveness

Estimated production costs at commercial deployment, based on demonstrated costs and research calculations, show that ABF are not yet competitive at current non-renewable fuel prices (Figure 7). Some pathways will benefit significantly from economies of scale resulting from larger facilities at commercial deployment, compared to cost estimates based on current demonstration scales[5].

Figure 7: Cost reduction potential of prioritised pathways



Source: ABS; L.E.K. research, interviews and analysis

Note: Pathway costs have been normalised for energy content into a standard measure based on a litre of gasoline

While ABF are not yet cost competitive, they will be in the future. The timing of when ABF will become competitive with non-renewable fuels is uncertain and will depend upon:

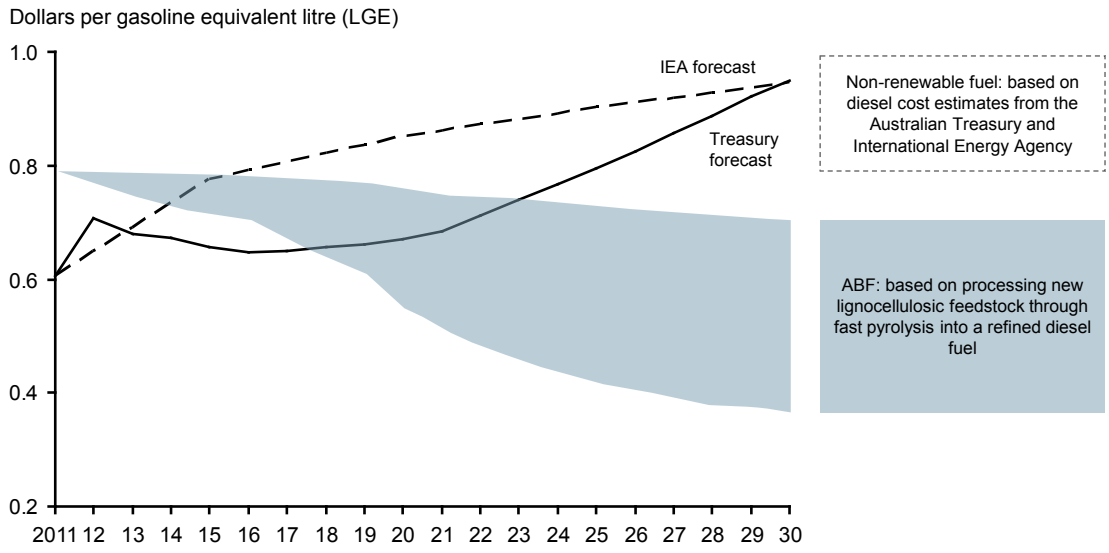
- the speed of technology breakthroughs and accumulating knowledge leading to cost reduction potential;
- the roll out rate of new feedstock cultivation and resultant improvement in feedstock costs;
- the rate of increase in non-renewable fuel prices; and
- ABF cost competitiveness with other alternatives (e.g. electric vehicles).

[5] The economics of ABF production are discussed in further detail in *Chapter Six* of the Appendix

Estimates from an analysis of the most mature of the priority pathways suggest ABF could become cost competitive within a timeframe as close as 5 - 10 years. ABF are likely to be more competitive over the longer term (Figure 8).

ABF could become cost competitive in the next 5 - 10 years

Figure 8: Production cost scenario (non-renewable fuels versus ABF)

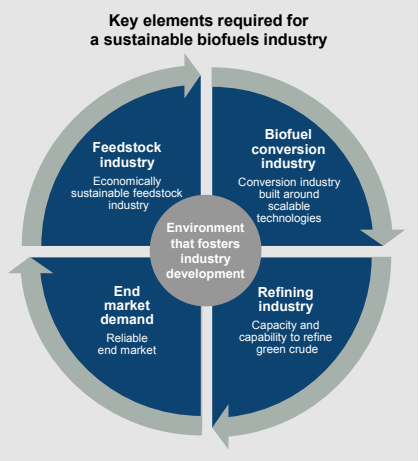


Source: IEA; Australian Treasury; ACCC; AIP; L.E.K. research, interviews and analysis

4. MEETING CHALLENGES: ESTABLISHING THE ABF INDUSTRY

4.1. Challenges to ABF Industry Formation

While the attractions of ABF are high, the sector faces a range of challenges.

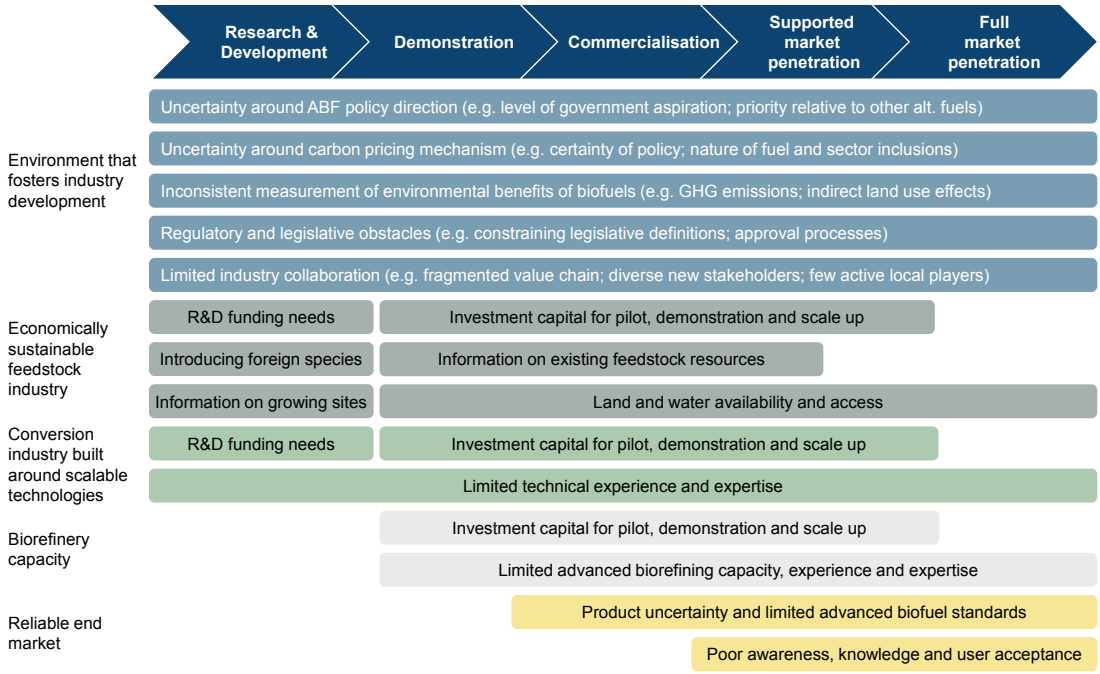


Unlike some industries which can be developed through sequential stages, ABF requires concurrent development of all stages in the supply chain. At present, insufficient feedstock is being produced, in part because conversion technology and refinery infrastructure are not yet available; at the same time refinery capacity is not being developed, in part because feedstock supply is not certain.

There may also be particular challenges relating to the local refining of green crude in Australia. Currently, there are both technical and economic limitations in the ability of domestic refineries to process green crude. This is due to the need for existing refineries with the appropriate infrastructure (e.g. hydrocracker) and willingness to process (or "biorefine") green crude, or the need for ABF-specific refineries. Bulwer Island, for example, is currently the only refinery in Australia with the technical capability for refining green crude. As a result, green crude will need to be exported for refining from most locations around Australia in the absence of significant further local investment in refining capacity and capability.

Exploring ABF industry elements further, it is clear that a number of challenges will need to be overcome in order to develop an Australian ABF industry (Figure 9).

Figure 9: Challenges facing the Australian ABF industry



Source: L.E.K. research, interviews and analysis

4.2. Government's Role in Facilitating ABF Industry Formation

The formation of an ABF industry will rely on Government willingness to meet some of the early stage challenges

Given the nature of ABF industry challenges, the propensity of the private sector to invest is doubtful without Government involvement. It is a central proposition of this Report that the formation of an ABF industry will rely on Government willingness to meet some of the early stage challenges and provide the signals and a platform for gaining investor and stakeholder confidence to invest. Such Government involvement is based on the premise that if the industry becomes cost competitive it will provide valuable fuel security mitigation, GHG emission reduction and regional and industrial development benefits over the medium to long term. The private sector will ultimately be responsible for realising these benefits, and it is the market that must drive activity, but this Report contends that Government has an initial supporting role to play.

Government has already commenced an involvement in the industry. Funding has been provided for ABF through the Second Generation Biofuels R&D Program, and will be provided through the Australian Biofuels Research Institute (ABRI) when ABRI is established. As a result, several ABF pilot projects are underway. A concessionary excise regime for biofuels is also in place, providing some incentives for biofuels consumption.

4.3. Principles for Government Involvement

In considering areas for action, Government involvement should be consistent with a set of guiding principles:

- it should be focused on removing the key barriers that constrain industry development (Figure 9);
- it should only address barriers that would not otherwise be overcome in the absence of Government participation;
- it should be flexible in order to adapt to change in the face of considerable uncertainty;
- it should retain options to minimise risk; and
- it should set policies to provide the capacity to adjust support as developments unfold.

While uncertainties remain, Government should encourage the industry to develop a focussed portfolio of options drawn from the most preferred pathways identified earlier.

By focussing on identified ABF pathway priorities, Australia has an opportunity to leverage comparative strengths, maximise future scalability, meet key sector needs, and produce fuels that can be used with existing infrastructure and equipment.

Australia should pursue a focussed portfolio of options drawn from the most preferred pathways

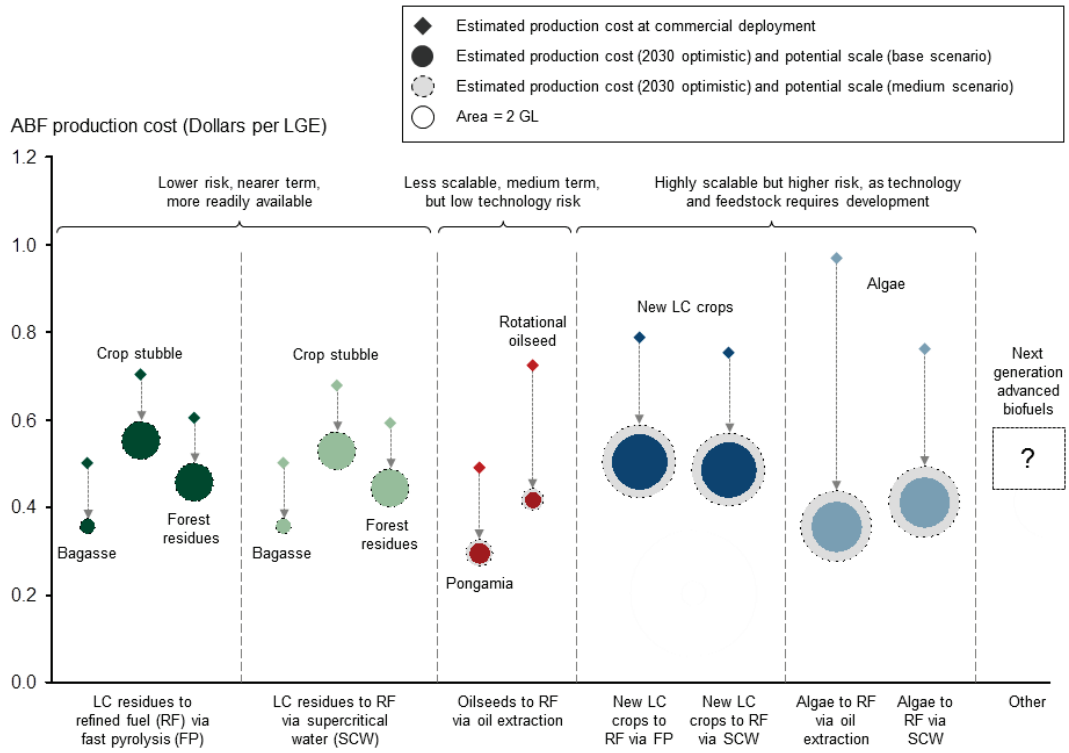
By diversifying across a portfolio of feedstocks and technologies within these pathways, Australia has an opportunity to mitigate high levels of uncertainty and associated risks. A sound portfolio approach will likely comprise:

- a number of smaller, near term, commercially prospective choices, with the objective of building capacity and capability, demonstrating viability, and catalysing feedstock production; and
- several foundation stones for a number of bigger, potentially more transformative outcomes.

For example, as illustrated in Figure 10, a mix of less scalable and more commercially viable options such as existing residues (e.g. bagasse), through fast pyrolysis and supercritical water treatment could be complemented by larger, more transformational options such as algae and new lignocellulosic crops – with only the latter two feedstock options appearing to offer high levels of scalability.

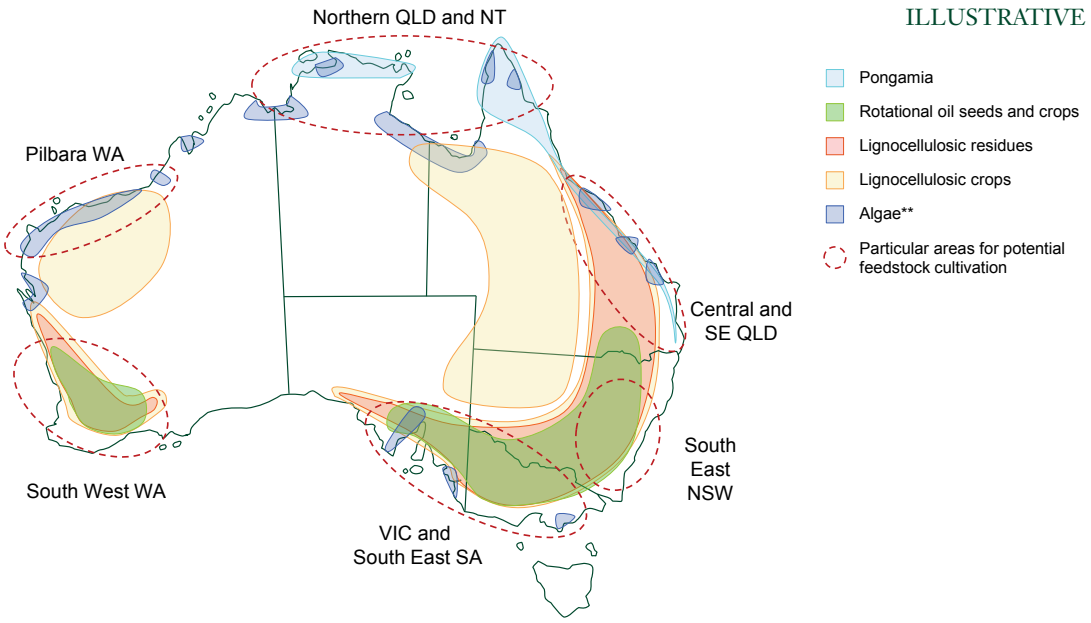
Government may also wish to consider opportunities to diversify ABF activity across multiple regions. Potential feedstock growing regions are distributed across the States and Territories, and a number of regions could have a role to play (Figure 11). It is likely, however, that some regions and feedstocks will develop ahead of, or in place of, others.

Figure 10: Different pathway costs and scale



Source: L.E.K. research, interviews and analysis

Figure 11: Potential feedstock growth regions*



Source: CSIRO; ABARES; L.E.K. research, interviews and analysis

Note: * Development in only a very small proportion of these growing regions would be required
** There may be additional areas for algae production over and above those marked on the diagram

Finally, in supporting ABF, Government should look to capture opportunities which build on, or generate, global comparative advantage for Australia. This may include:

- leveraging agricultural science and other expertise;
- using available natural endowments; and
- generating expertise in global areas of need.

Australia should look to capture opportunities which build on, or generate, global comparative advantage

4.4. Specific Actions

There are a number of specific actions that the Government should take as it looks to facilitate the establishment of an ABF industry with long-term potential. These will complement the actions of commercial enterprises and help to accelerate the development of the industry.

In the short-term (0-2 years), these actions should help to mobilise ABF industry participants, establish ABF as part of the renewable energy and transport fuel agenda, and remove roadblocks. At this early stage, Government is likely to have a key supporting role to play.

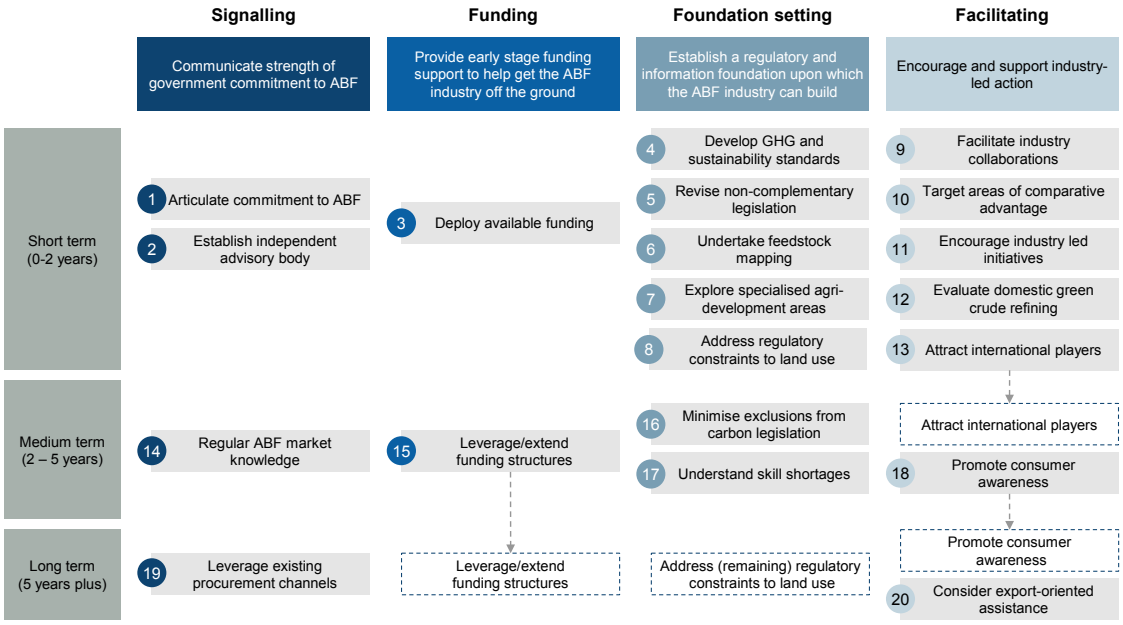
In the medium term (2-5 years), these actions should help to drive a portfolio of pilot and demonstration initiatives, with adjusting emphasis as knowledge grows and the most prospective ABF technologies and feedstocks emerge.

In the long-term (5 plus years), the private sector will be taking an increasingly strong lead, as market certainty and conditions conducive to ABF improve, allowing larger scale investments to be made, and supporting the entry of commercial quantities of ABF into the market.

Specifically, there would appear to be an opportunity for Government to focus its activity in four key areas, recognising different mechanisms for Government involvement (Figure 12):

- **Signalling:** communicating the strength of ongoing Government commitment to ABF;
- **Funding:** providing early-stage funding support to help get the ABF industry off the ground;
- **Foundation setting:** establishing a regulatory and information foundation upon which the ABF industry can build; and
- **Facilitating:** encouraging and supporting industry-led action.

Figure 12: Specific Government actions



4.4.1 Short Term (0 – 2 Years)

1. **Articulate commitment to ABF**: Articulate the nature of government commitment to ABF (via the Alternative Transport Fuels Strategy). This will improve certainty for potential investors
2. **Establish independent advisory body**: Ensure there is an independent body to act as a trusted advisor to ARENA, government and industry, building on existing structures (e.g. ABRI). This will provide a single point of reference to guide and validate ongoing Government involvement in the ABF industry
3. **Deploy available funding**: Deploy available funding (via ABRI and other agencies and programs) to support advanced biofuels R&D and particularly pilot and pre-commercial stage activity. This will provide a boost to companies that are developing solutions within the preferred ABF portfolio of pathways. This may also include investment in flagship projects that could catalyse industry activity
4. **Develop GHG and sustainability standards**: Develop national GHG and sustainability verification methods and standards. This will improve the certainty of relative benefits regarding the environmental performance of ABF
5. **Revise non-complementary legislation**: Undertake a legislative and regulatory audit to identify and address non-complementary legislation and revise accordingly. This will reduce barriers and disincentives that may exist to invest in ABF
6. **Undertake feedstock mapping**: Commission detailed mapping of feedstock resources, leveraging existing information (e.g. via ABARES or CSIRO). This will help to identify the best areas for feedstock and downstream industry investment
7. **Explore specialised agri-development areas**: Explore the means of addressing the establishment of specialised agri-development areas. This will speed up the process of improving feedstock performance via plant breeding and, potentially, genetic modification
8. **Address regulatory constraints to land use**: Address land use zoning and planning constraints (e.g. at regional and local levels). This will support pilot and pre-commercial stage land use activity in the short term, and enable ongoing industry growth in the long term
9. **Facilitate industry collaborations**: Facilitate collaboration across the ABF value chain domestically and internationally. This will help industry participants form collaborations and benefit from knowledge sharing
10. **Target areas of comparative advantage**: Further identify areas of the advanced biofuels value chain where Australia should aspire to take a leadership role (e.g. agronomy, algae pond design). This will help Australia to position itself for lasting comparative advantage
11. **Encourage industry led initiatives**: Encourage appropriate industry led initiatives to drive biofuels activity and uptake (e.g. Sustainable Aviation Fuel Users Group). This will help industry efficiently drive the biofuels agenda
12. **Evaluate domestic green crude refining**: Assess barriers to local green crude refining and the case for government intervention. This evaluation will be necessary if domestic refining capacity is to be built

13 **Attract international players**: Explore opportunities to attract key international ABF players to Australia. This will provide Australia with access to best practice technologies and expertise, and help position Australia within the global ABF value chain

4.4.2 Medium Term (2 – 5 Years)

14 **Update ABF market knowledge**: Provide a regular (e.g. biennial) update on ABF economics and technologies to inform the market and government priorities. This is necessary due to the high level of uncertainty around feedstock and technology development

15 **Leverage/expand funding structures**: Leverage and potentially expand existing initiatives and structures to ensure ARENA, CEFC and other clean energy funding vehicles can explicitly support ABF development, including:

- investment in a portfolio of ABF R&D activity;
- capital funding assistance for ABF demonstration and pilot projects (e.g. grants, loans, loan guarantees); and
- commercialisation support as new elements of the ABF industry are established

16 **Minimise exclusions from carbon legislation**: Consider the case for minimising exclusions from carbon legislation, to create a more level playing field. This will provide incentives to adopt lower carbon emissions consistently across all end user industries

17 **Understand skills shortages**: Undertake an audit to determine labour and technical skills shortages. This will provide industry with an accurate perspective of a necessary input required for investment

18 **Promote consumer awareness**: Work with industry to address issues of consumer awareness and attitudes as larger volumes of ABF start to approach the market. This will be needed to ensure there is sufficient 'pull' of ABF products by potential end users, and that sustainability concerns are addressed

4.4.3 Long Term (5 years plus)

19 **Leverage existing procurement channels**: Consider opportunities to leverage Government procurement where consistent with cost and strategic requirements (e.g. through Defence). This will help to create pull through ABF demand

20 **Consider export-oriented assistance**: Consider the need for export-oriented facilitation and assistance, in the absence of domestic green crude refining capability. This will need to be consistent with existing Government policies and trade obligations, and may help support the upstream local industry until sufficient volume of output is developed to support downstream investment in refining infrastructure

5. CONCLUSION

ABF offer the potential for Australia to build a significant and sustainable new industry which could increase national fuel security, assist in reducing GHG emissions and stimulate regional development.

This report identifies a number of promising feedstock and technology pathways, as well as key challenges that will need to be addressed if Australia is to lay the foundation for a sustainable ABF industry of scale.

The recommended actions above provide a measured way for Government to facilitate industry development and optimise the potential for ABF to offer substantial benefits to the nation in the medium to long term.