Improving investment outcomes in the research and commercialisation of 'clean' energy technologies within Australia

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ABSTRACT

Clean energy technologies have gained significantly increased investment over recent years within Australia and internationally. However, commercialisation of innovative technologies is always a challenging exercise and the clean energy technology sector faces some particular challenges including competition with well established, low cost and proven fossil fuel incumbents.

Efforts to address these challenges through public policy initiatives, including direct funding of R&D, demonstration projects and price mechanisms have generally no yielded significant investment for commercialisation or deployment activities. Only a history of attractive risk-weighted investment returns will secure sufficient ongoing investment for widespread technology adoption. While such a history is being established, scarce resources may be wasted and prospective deployment opportunities foregone.

The paper presents some initial work to create an analysis framework for financial investors that identifies the most promising clean energy options for R&D, demonstration and deployment in the Australian context. It is intended that this framework help inform both policy makers and private investors about the most prospective clean energy investment opportunities for Australia.

[keywords] clean energy technology, innovation, demonstration, commercialisation, investment

Introduction

Clean energy technologies have gained significantly increased investment over recent years within Australia and internationally. The last two years has seen a global environment of constrained access to capital due to the Global Financial Crisis (GFC) and international climate policy uncertainty. Nevertheless, a range of drivers including volatile fossil-fuel energy production costs, a growing number of national clean energy policies and inflows of private investment have resulted in continued research, development and commercial deployment of clean energy technologies. Overall expenditure on such technologies grew some sixteen-fold from 2001 to 2008 before falling in 2009 (Kerr, 2010). Even with this decline, the world saw greater investment in clean electricity generation technologies than fossil fuel generation in both 2008 and 2009.

However, commercialisation of innovative technologies is a challenging exercise, demanding competitive intellectual property, market access, organisational expertise and access to capital. Furthermore, the clean energy technology sector faces some unique challenges. Unlike other highly innovative areas of the economy such as IT and pharmaceuticals, clean energy technologies must demonstrate technical, operational and economic viability in the face of well established, relatively inexpensive and proven alternatives, in the form of fossil-fuel technologies. The only real disadvantages of these incumbents are possible future supply constraints and consequent uncertainties on future pricing, and a range of adverse environmental impacts, which remain unpriced externalities in our energy markets. As a result, the great majority of current clean energy asset investment is presently driven by supportive policy incentives such as feed-in tariffs, renewable energy targets and other publicly funded support (IBID).

At this time, therefore, two key uncertainties for clean technology investment within particular countries and globally must prevail in order to encourage continued growth in investment – longer-term public interest and continuing support for a more sustainable energy system. However, even if these factors continue to encourage investment, it is not clear whether the technologies and the commercial opportunities that ensue will demonstrate that the investments have been applied optimally or whether, in fact, the public incentives have encouraged unproductive investment. Thus, in the absence of a history of attractive investment returns from the sector, ongoing development of a cleaner energy system remains at risk.

In any country's innovation system, both public and private investment have key roles to play. Experience to date with clean energy, suggests that successful research can require an order more expenditure on development and demonstration, which requires, in turn, another order of magnitude investment for successful commercialisation and widespread deployment. Innovation can fail at any point in this chain. Governments have a key role in R&D and demonstration, yet the scale of investment that appears to be required to address our climate and energy security concerns will almost certainly require major private investment in predominantly market-based economies. Such private investment will be driven by direct corporate (strategic) expenditure as well as participation by financial investors such as mutual funds, banks, venture funds, infrastructure funds and the like

There are two key contexts for driving such private investment – the policy and wider institutional frameworks put in place by national governments to support clean energy; and the internal processes of financial investment decision making. There is ample evidence of the challenges in getting such contexts right. For example, some countries have had very limited success in delivering renewable energy deployment targets due to inadequate policy frameworks. Similarly, the decision-making processes of the financial investment community have been bought into question due to the evident misallocation of capital that contributed to the Global Financial Crisis.

For a relatively small economy like Australia with considerable fossil-fuel energy reserves and currently low energy costs, channelling clean energy investment appropriately will be vital if commercial exploitation is to generate both environmental dividends and investment returns.

This paper presents some initial work to create an analysis framework for identifying the most promising clean energy investment options for R&D, demonstration and deployment in the Australian and global context, having regard to the sources of available investment capital, the nature of available investment opportunities and the challenges specific to innovation in this sector. We first highlight several challenges to successful commercialisation of clean

energy technologies and some of the international and Australian experience to date. The paper then describes the particular context of private financially driven investment for clean energy technologies including measures of success and the limitations of current decision making tools. It then outlines a proposed framework to support better financial investment decision-making in the clean energy space. The intent is that this framework can then be populated with data from companies and projects from within Australia and the region, tested using case studies of real investment opportunities to determine correlation with success and failure, and ultimately applied as a tool to support both policy makers and private investors in improving commercialisation and investment outcomes in the clean energy sector.

Challenges to clean energy commercialisation

Technology innovation is an enormously challenging process involving R&D, demonstration, deployment and commercialisation. Private investors are generally unwilling to risk capital in such endeavours without commitments regarding commercialisation. In the clean energy space where new technologies must compete against well entrenched fossil fuel incumbents, commercialisation will be highly dependent on government policy support. In some countries, high energy prices, significant government policy support and large energy industry participants there is significant private sector R&D and Demonstration. In many others, including Australia, investment in research and development, leading to larger scale exploitation, is generally derived primarily from the public sector – research by universities and other largely publicly funded research institutions such as the CSIRO. Demonstration of promising technologies may be publicly funded, or undertaken by joint public-private investment such as the Renewable Energy Commercialisation Program (RECP) or Low Emission Technology Demonstration Fund (LETDF) (Wilkins, 2008).

However, none of these mechanisms are suitable vehicles to promote large scale private investment. And major investment will only flow when success in research, development and early stage commercialisation are demonstrated. In particular, adequate risk-weighted investment returns must be demonstrated for such deployments to be widespread and economically viable. Appropriate selection of technology and investment opportunity is critical to ensure that scarce resources are not wasted and that the most prospective investment opportunities receive funding.

Figure 1 highlights these issues. While Government funded R&D has grown moderately over the last ten years it has been rapidly overtaken by Corporate and other privately funded R&D. Substantial deployment expenditure on sustainable energy technologies has coincided with the dramatic growth in private sector investment - almost independent of Government's R&D and demonstration funding.

A key question then for Australia, and all countries, is how to maximise their opportunities in the sustainable energy space given their particular circumstances and the changing global context. For example, where might Australia have competitive advantage in technology development given our limited industry capability by comparison with some other countries such as the United State, European Union, Japan, Korea or Taiwan? What might be the right mix of public and private funding for which activities (R&D, demonstration or deployment), and for which technologies? Given such an assessment, how can both policy makers and financial investors maximise the likelihood of successful commercialisation and investment outcomes? These are the key issues which the work in this paper is attempting to address.

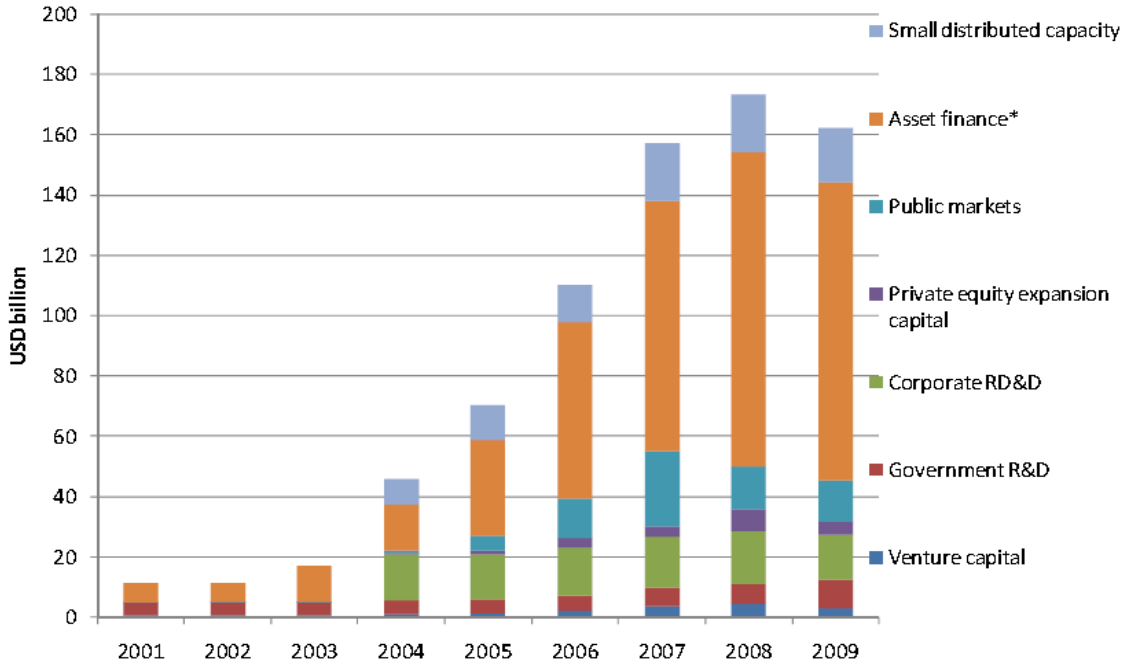


Figure 1. Estimated global clean energy expenditure over the last decade according to participants and activities (IEA, 2010).

Improving financial investment analysis and outcomes

Opportunity meets commercial success in a variety of forms. Commercialisation may take the form of licensing, company formation and growth, joint venture, in-house adoption, deployment or use – replacing or supplementing incumbent products, technologies or companies.

Success may thus be gauged using different benchmarks. Benchmarks for determining commercial benefit include the breadth of diffusion and adoption, market penetration, funding of local research and development, growth of local manufacture, or broader industry spin-offs that lead to industry development which generate jobs. Benchmarks for societal benefit may include lowering of emissions and greater access to, and reliable availability of, lower cost energy.

Simplistically, investment success is easier to measure. Internal rate of return, cash on cash return on investment, project net present value, total revenue or contribution to profit are the success measures of financial and corporate investors globally.

So, in determining a framework for investment in sustainable energy initiatives, it is important to focus on the constituents of the investment community that are relevant. These constituents include corporations (large and small, sector specific such as power utilities or resource companies, and transnational vs local), the public sector (state owned enterprises, universities and research institutions, and governments themselves), and financial institutions (mutual funds, banks, venture funds, infrastructure funds and the like).

Of course, corporate and public sector investors consider investment decisions very differently to financial investors. Whereas a financial investor would assess an investment in terms of size, risk, return and liquidity, a corporate investor may consider these factors alongside the strategic coherence of the investment, whether it is a core business investment or a peripheral one whose objective is to provide competitive information, create future

investment or acquisition options, or to satisfy corporate social responsibility obligations or expectations. A public sector player would heavily weight social benefit and indicators of commercial success such as industry creation, job creation, value added, reduction in emissions, political and public popularity, etc.

The range of criteria applied by corporate or strategic investors, and public sector actors, is so broad so as to exclude considering such investors from this analysis. However, it should be noted that corporate investment far outweighs pure financial investment on a direct dollars invested basis (notwithstanding the fact that the financial backing for corporations to undertake investment activities ultimately derives from the investments in equity and debt by individuals, pension funds, insurance companies, banks and other financial institutions).

This paper presents work in progress to better discern how an informed financial investor might optimally identify, transact and manage investments that will generate above benchmark returns and, in doing so, enhance the exploitation of important new and diverse, minimally polluting, energy technologies. The research applies lessons from private equity and venture capital investment to the diverse mix of the industry's public and private company investment universe. As explained below, the focus of this work is on the financial investment community including mutual funds, banks, venture funds, infrastructure funds and similar.

Investment themes may focus broadly or on specialised sectors. For the purposes of future research, and as a consequence of the complexity of the global energy sector, it is convenient to restrict the focus on stationary energy applications. However, the factors driving innovation and adoption in other energy applications are as, if not more, wide-ranging than those driving the evolution of stationary energy production and distribution.

There is a strong body of prior research on investment decision processes and financial theory – much of this applied to publicly traded stocks where fundamental investment analysis is differentiated from technical analysis through an increased focus on underlying economy, industry and company factors.

In emerging industries with relatively immature actors and unclear market developments, even basic fundamental analytical approaches are inadequate. Investment theory research which is relevant includes aspects related to portfolio and capital market theory, security valuation approaches, market efficiency analysis and derivative valuation (Farrell, 1993). Research related to investment under conditions of uncertainty, the application of behavioural theory (Baker et al., 2004), connection to environmental factors through socially responsible investing (De Graaf and Slager, 2006), and debates regarding fundamental versus quantitative analysis (Gregory-Allen et al., 2009) is applicable to investment decisions in mature industrial and resource markets. However, none satisfactorily address the circumstances of the emerging clean energy sector where there is both an environment of almost infinite combinations of source and nature of technology, stage of development, technological risk, geographic location and political risk, organisational capabilities, prospective growth, public sector support, competing technology, market adoption issues and more; yet also an equally confusing set of choices in funding sources, risk preferences, proximity and availability of funds, investment expertise, vehicle structure, tax regime and competing investment products.

Investors' funds are broadly fungible – they can easily transcend different investment choices and geographic boundaries. In practice, however, funds directed at complex and emerging investment themes (such as infrastructure, exploration, research and development) tend to be locally managed and often locally sourced. Proximity to an investment is presumed to imbue a greater understanding of the risks and potential rewards of an underlying investment.

Energy is a global commodity but its use mix is a function of local availability (compared with competing local resources); local cost; availability of energy distribution infrastructure; economic and social costs of changing the fuel source mix; population and market size, growth and profitability; sovereign and political risk, etc. Thus, one must consider the target geography as a key dimension to consider when evaluating the preferences of investors. Analysts such as Ernst and Young (Ernst&Young, 2014) recognising the importance of country-by-country reviews, conduct on-going analyses of country attractiveness for some aspects of renewable energy – focussing on infrastructure (including market, planning and access to finance) and technology which can provide valuable inputs into an investment decision-making process.

Public policy within a country can play a vital role in attracting private investment. We would argue that the key government role is to create a coherent and comprehensive policy and institutional framework to support private investment. Public policy initiatives that 1) inform prospective investors about prevailing local technology costs and characteristics; 2) provide 'demand pull' (including government intervention and incentives for sustainable energy, as well as other efforts that demonstrate and enhance social and political will); and 3) deliver 'supply push' support (including availability of some publicly funded capital, appropriate planning and energy market frameworks and skills development) would all enhance an economy's ability to attract investment to the sustainable energy sector.

Evaluating Financial Investment Opportunities

Where, in this mix of geographic, market, and technological complexity, would an investor source opportunity and commit capital to generate worthwhile financial and social returns? And how would an investor make rationale investment decisions in this context?

Mandated with a brief to invest funds into sustainable energy projects, an investment manager would survey the relevant landscape to identify that universe of opportunities that firstly, best align with its world view of technology and market trends and secondly, take a regional view of key adoption factors.

The resulting universe of potential investments would then be assessed against four key factors (a) scale of investment, (b) liquidity, (c) return potential and (d) risk. These factors, and their underlying criteria, will determine the attractiveness of an investment for a financially motivated (versus strategically interested) investor.

These factors may be dissected into more detailed criteria in order to discern the characteristics of individual investment opportunities.

An investment process such as this is relatively standard fare. Modelling of public stock investments utilise approaches which are similar in order to make improved asset allocation decisions (Hoyland et al., 2003). Structured approaches to investing in the property mortgage sector have also been postulated (Matsakh et al., 2008). The challenge in optimising investment in the sustainable energy sector is in determining, 1) what are the macro trends and factors dictating attention to certain technologies, sectors or geographic regions (i.e. what factors define a potentially attractive universe of opportunities); 2) what factors comprise the detailed criteria; and, 3) what weightings should be applied to these detailed criteria.

Ideally, a mutually exclusive and comprehensively exhaustive set of factors could be constructed against which an investor's preferences could be applied in order to select the most attractive investments for consideration. Ideally, this could be regression tested against real-world examples to refine the commercial framework and use it as a predictive tool. These stochastic techniques are unfortunately not able to be applied to this "real-world"

problem since the data for such historical testing and assessment are absent. The challenges in predicting commercial performance of this immature industry is illustrated by the different correlations between large publicly traded stocks and the S&P 500 index (measured to be as high as 97%) whereas a blend of small capitalisation stocks (with characteristics somewhat similar to those companies in the emerging sustainable energy sector) demonstrates a correlation to the S&P 500 index of only 78% (Coaker, 2007)

In dealing with technological innovation, in companies that often do not possess scale, robustness or diversity, it is unreasonable to expect significant correlation to financial metrics alone, even if the data did exist. In dealing with established industries such as property or manufacturing or even technology based sectors such as IT or healthcare, an established history of success and failure exists to guide future investment decisions. This is not the case in sustainable energy investment. So, any commercial framework that an investor might apply to the universe of potential investments in the emerging, technology rich, field of sustainable energy innovation must rely on highly qualitative assessments against the selected criteria.

This superimposes analytical risks (for example, imperfect information, information asymmetry, deception or lack of full disclosure by management) and biases (for example, does the assessor have a hidden agenda, a conflict of interest, inadequate knowledge of the subject matter, a non statistically relevant historical bad or good experience) that are difficult to account for and that may skew the investment outcomes. Being aware of such deficiencies could enable operational processes or counterbalances to be developed to improve investment assessment and resulting outcomes through objective data gathering, assessment and analysis.

Proposed Framework for Improving Financial Investment Outcomes

The proposed framework for assessing and managing investments in the sustainable energy sector involves a stepwise process of determining macro investment themes on a sectoral and geographical basis followed by the determination of detailed investment parameters which can be objectively assessed and recorded. These parameters are then weighted based on the investor's preference for risk, exposure and return expectations and assessments made in line with the investor's portfolio requirements. Recognition of the imprecision of the review process, available data and potential assessment errors would then be factored into the decision process. A review of investment performance – both actual investments and broader market performance is tracked and evaluated. The proposed process is presented in Figure 2.

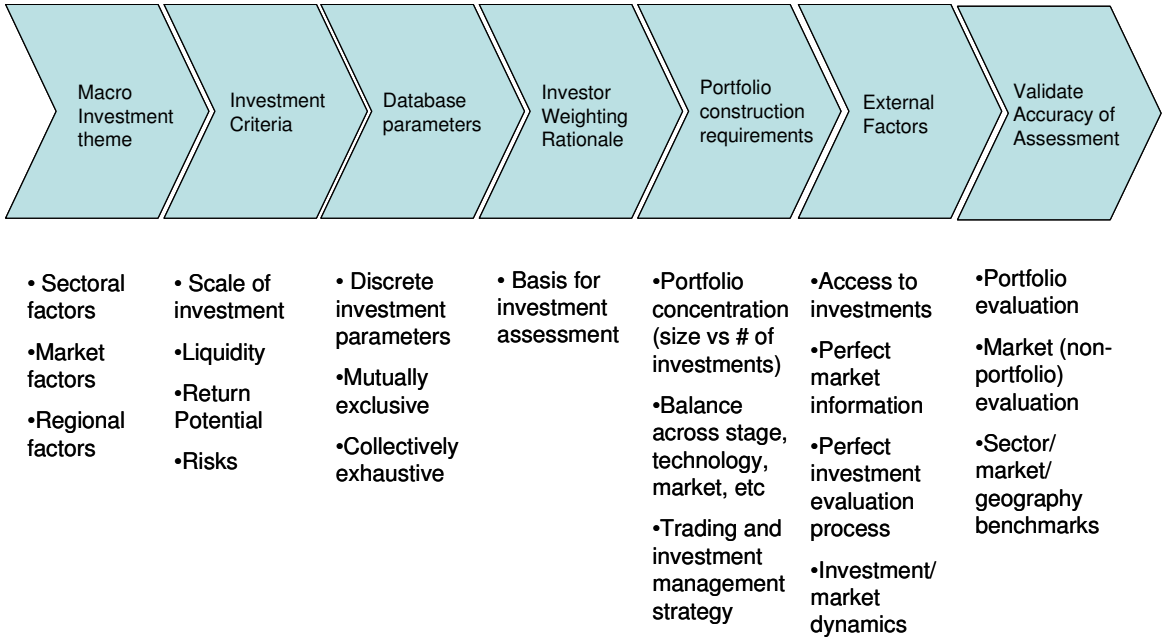
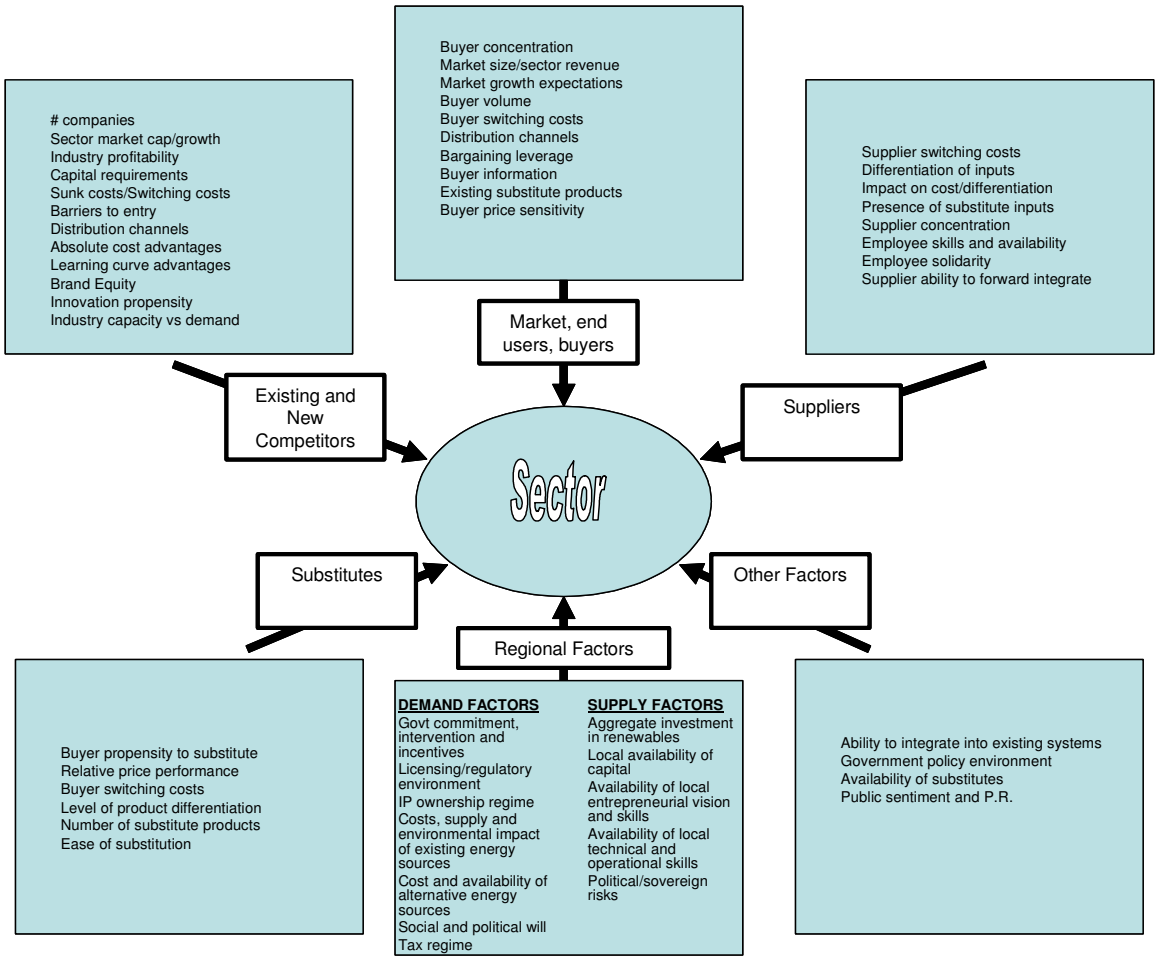


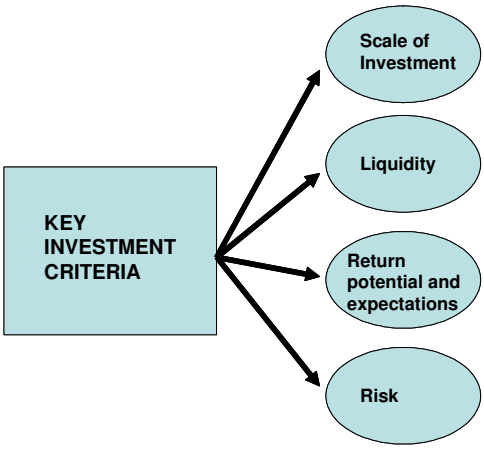
Figure 2 – Proposed Investment Evaluation Process

The underlying factors underpinning each part of the process are described below.

Determine Macro Investment Themes



Establish investment criteria



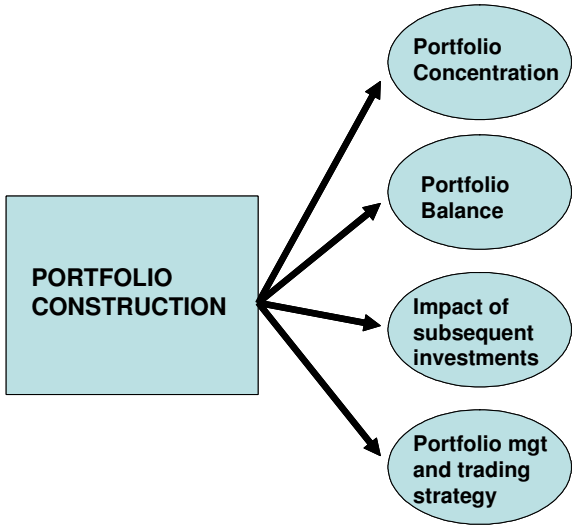
Establish (mutually exclusive and collectively exhaustive) assessment parameters for Investment Criteria

Scale of investment	Liquidity	Return Potential	Risk
Total expected investment Timing of expected investment Equity/debt mix Availability of non-dilutive capital Application of funds	Volume and value of equity (if traded) Number and likely interest of counterparties (if not traded) Time to maturity and stable cashflow Likely liquidity profile when mature Time to liquidity (operational or technological maturity, market)	Anticipated strategic value Value to acquirer Value of assets Market positioning Ability to deliver future value Market value (NPV) Value creation potential Organisational capital	Likelihood and impact of: - external risks (competition, market preferences, etc) -internal risks (management, product failure) -technological limitations -financial market events -funding limitations

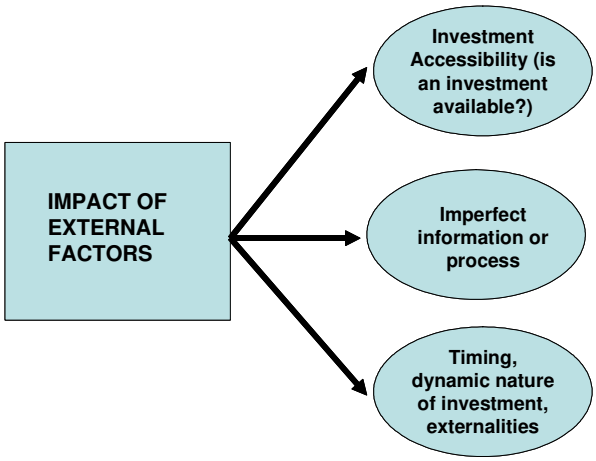
Determine weighting rationale

Weighting rationale is based on preferences of different investors and investor style. Venture investors will have defined guidelines for investment size (as a function of fund size), typically work with fixed, relatively long-term (10 year) fund lives and limited liquidity and target relatively high internal rates of return while being prepared to take large single-investment risks (which are managed through development of a balanced investment portfolio). Exchange traded funds have defined individual investment size guidelines, require strong underlying liquidity, benchmark-linked returns and modest investment risk. Hedge funds are opportunistic with relatively loose guidelines regarding individual investment size, liquidity requirements, and investment maturity. They are generally able to execute moderately risky investments with relatively high returns.

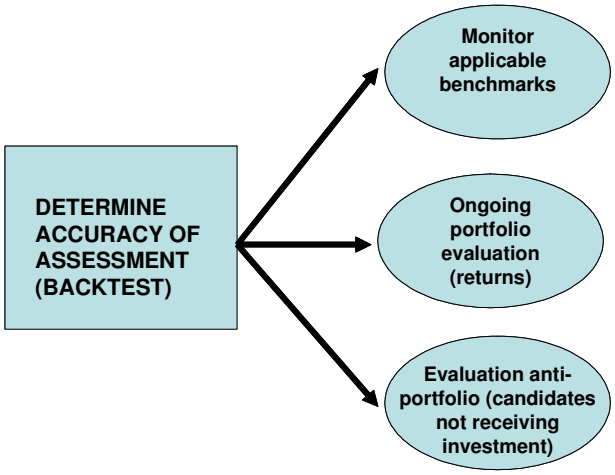
Establish requirements of portfolio construction (Brands et al., 2005)



Establish Impacts of external factors



Determine accuracy of assessment



The framework described is still under development but highlights the complex, interconnected issues that might need to be addressed in order to effectively evaluate an applicable universe of potential investment opportunities by comprehensively identifying factors that will influence investment returns. Unfortunately, the impact of individual factors cannot be determined a-priori. However, by taking a comprehensive view of the most important issues impacting business, technology and investment outcomes, the prospects for successfully generating superior investment returns will be improved. Systemic improvements will, in turn, lead to increased investment in those assets which are most deserving. Investment performance, in concert with public policy intervention, will direct additive investments across the range of technologies and life-cycle stages (from research to development to commercialisation) that society requires.

CONCLUSIONS

A great deal of investment takes place based on ad-hoc or flawed investment criteria or no established investment criteria at all. Much of this investment is lost as a result of technology, market and company failure and a substantial proportion delivers below market average returns.

These difficulties are amplified by the complexity of the emerging clean-energy sector – with inadequate performance history, massive choices in technology and operational platforms, uncertain regulatory environments and challenges from cheaper well-established substitutes. Government assistance (particularly in Australia) has failed to attenuate these problems.

Improved investment outcomes in the renewable and sustainable energy sectors will lead to a greater volume of capital available for investment and, consequently, better commercial outcomes for technology developers and those who deploy new energy initiatives.

This paper has presented a thematic approach to investment in the sustainable energy sector. This approach, informed by a deep evaluation of critical investment parameters according to a structured process, is intended to improve investment returns and therefore enhance outcomes in terms of deployment of new energy sources, with the consequent benefits of improved environmental and societal outcomes.

Our approach incorporates underlying intellectual property, organisational, market and investment factors impacting this investment success; the identification of government and NGO initiatives which encourage (directly and indirectly) applicable research and commercial exploitation of particular areas of renewable energy and energy efficiency initiatives; a suitable commercial and investment framework to apply to the above programs (given variations in investor capacity, preference and appetite) and evaluation of selected identified successful research and commercialisation outcomes. It is hoped that this framework can help inform government and industry about the most prospective clean energy investment opportunities for Australia leading to both improved investment outcomes and greater proliferation of such technologies with desirable economic and environmental dividends.

Policy makers should support external investment in commercialisation and deployment without creating distorting market-based incentives resulting from ideological or vested-interest support for particular technologies or companies. Policy should facilitate a coherent and comprehensive institutional framework that will encourage financial investors to successfully generate returns here in Australia. It's a global competition and investment will flow to those places that have the most coherent, secure and prospective investment environments.

The investment community must improve its performance and use of information in order to avoid misallocation of resources and poor early investment outcomes which might cause delays in exploiting emerging technologies and benefiting from better environmental outcomes.

Much remains to be done, and the future direction of research will involve distillation of relevant macro indicators to direct broad investment themes, refinement of the investment criteria and commercial framework, population of a suitable database of investment opportunities and assessment of correlation between investment criteria and actual performance using case studies.

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