## Cleantech matters

## **Global competitiveness**

Global cleantech insights and trends report

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## Foreword: Global competitiveness

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The business landscape these days presents a new reality that forces us to face new business, financial, strategic and operational risks. These risks stem from various dynamic market and economic factors and trends, such as the cost of energy, energy security concerns and constraints on natural resources, as well as environmental regulations. In addition, consumer demand for greener products and services, population growth and urbanization, and the purchasing power of the middle class in emerging markets all provide challenges. At the same time, the new reality also presents exciting opportunities that can drive sustainable growth and development. No business or government can afford to ignore either these risks or these opportunities.

The new reality continues to drive the global transformation toward a more resourceefficient and low-carbon economy. Many governments and corporations recognize the need to develop and implement cleantech and sustainability strategies to mitigate the risks and seize the opportunities at both national and global levels.

In the near term, however, cleantech market participants operate in a business environment that is increasingly competitive along a number of dimensions. This report – our fifth annual – explores the theme of global competitiveness, for it can be argued that achieving competitiveness – with existing technologies and within the sector – is the strongest force at work in cleantech today.

First, cleantech must compete with incumbent technologies on an unsubsidized basis. As we observe in our analysis of pure-play

cleantech public companies (see p. 7), the combination of economic recession and diminishing governmental financial support in the US and Europe is taking a toll on financial results. Yet business leaders in a number of the cleantech verticals are coming to the seemingly contrarian conclusion that now is the time to develop a roadmap to the end of subsidies rather than ask for more. They recognize that success depends on driving the efficiencies, innovations and business models needed to compete head-on with traditional technologies.

Then, there is greater competition in the sector than ever before. As cleantech matures, the field has become crowded in many of the industry verticals. With the sluggish economy and waning subsidies, competition has become intense, particularly in wind and solar. While the restructuring occurring in these two industries is painful, stronger global players will emerge from the process. And as we note in our article on solar and wind (see p. 25), the resulting fall in prices for renewable generating equipment is hastening installations and competitive prices for renewable energy in markets around the world.

Countries continue to vie for competitive advantage through cleantech. Over the past year, we have seen significant new national commitments to cleantech, such as China's clean energy and efficiency initiatives under its 12<sup>th</sup> Five Year Plan and Saudi Arabia's US\$100 billion solar development plan. In the report, we focus on Brazil's efforts to promote wind and biofuels to meet its burgeoning eneokrgy needs, enhance energy security and provide economic development (see p. 41). Corporations, too, are increasingly treating their energy strategy as a competitive differentiator. As we highlight in the findings of our global survey of corporate energy executives (see p. 1), the energy mix has become a strategic issue at the C-suite level of billion-dollar corporations, especially given that a considerable – and growing – share of operating costs is spent on energy. Energy efficiency measures and the use of renewable energy by corporations are set to rise significantly over the next five years. In this context, only those corporations with a comprehensive and diverse energy strategy will be able to create a competitive advantage in a more resource-efficient and low-carbon economy.

While the failures sometimes garner more attention than the successes in times like these, it is important to recognize the rapidly emerging cleantech market of stronger players with greater scale, who are better able to compete with industry incumbents on price and performance.

In this report, you will find in-depth articles providing insight into different facets of the cleantech market, interviews with leading cleantech executives, roundtable discussions among key market participants and perspectives from Ernst & Young's global cleantech leaders. We hope that our report proves to be a valuable source of cleantech business insight and a helpful contribution to the ongoing discussion of how to advance the cleantech agenda globally. //

## Table of contents

Billion-dollar corporations prioritize energy mix strategy // 1 Cleantech industry performance: global pure-play analysis // 7 Capital roundtable: key trends in the cleantech value chain // 17 Interview with Paul Ho, Managing Director, Hudson Clean Energy Partners // 23 Solar and wind – more bang for your buck // 25 Interview with Mark Vachon, Vice President, GE ecomagination // 29 Cleantech IPOs: are you ready? // 33 Strategy in a time of uncertain incentives // 37 Industry leader interview with president of ACCIONA // 39 Brazil's clean energy goals // 41 Brazil turns to turbines: Latin America's biggest economy looks to power future growth with wind // 47 Roundtable: Future of transportation // 49 Contacts // 57



## Billion-dollar corporations energy mix strategy

by **Ben Warren**, Global Energy and Environmental Finance Leader, Ernst & Young, and **John de Yonge**, Director of Account Enablement, Ernst & Young Global Cleantech Center



The largest global corporations are meeting the challenge of transitioning to a lowcarbon and resource-efficient economy through proactive energy strategies with C-suite engagement. Improving energy efficiency to mitigate energy cost hikes, increasing use of renewable energy and growing energy self-generation form the foundation of corporate energy strategies worldwide. These are some of the key findings arising from Ernst & Young's recent global energy mix survey of billion-dollar corporations.

### Global energy mix survey

Ernst & Young worked with a market research firm to conduct a telephone survey of executives involved in setting corporate energy strategy at 100 companies with revenues of US\$1 billion or more. Questions focused on energy spend, types of energy consumed, energy strategy formulation and outlook.

The company population was limited to companies in energy-intensive sectors with a balanced distribution around the globe. In the final tally, 72% of the responding companies have revenues exceeding US\$1 billion and another 28% revenues of US\$10 billion or more. Survey respondents are spread among North America (35%), EMEA (35%) and Asia-Pacific (30%). The largest industry groups are diversified industrial products (29%), retail and wholesale (16%) and automotive (9%).

While our survey was conducted at arm's length to ensure the participants' confidentiality and anonymity, respondents who opted to disclose their participation include Celgene, Goodyear Tire & Rubber Company, Arvind Ltd, Marks & Spencer Group and Rete Ferroviaria Italiana SpA. Global survey reveals focus on efficiency, increasing use of renewable energy and growing corporate self-generation

### Key business risks

Energy mix strategy is an integral part of addressing key financial, energy security, brand, regulatory and competitive risks.

- Energy expenditures are becoming a growing share of operational costs as fossil fuel-based energy prices increase and price fluctuations in traditional energy sources impact the bottom line.
- The Fukushima disaster in Japan and political turmoil in the Middle East highlight energy availability risks.
- Increased consumer focus on sustainability is changing how industry leadership is being defined.
- Long-term carbon penalties and license-tooperate risks arise as governments focus on energy efficiency and environmental objectives.
- The new reality of the resource-constrained, low-carbon economy changes the basis of competitive advantage.

Figure 1.

### Survey respondents by country



### High energy costs

High energy costs that are expected to go even higher set the context for the discussion of corporate strategy on the energy mix. For half of our survey respondents, energy expenditures represent 5% or more of operating costs. A smaller but significant subset (22%) report that 20% or more of operating costs go to energy. In absolute terms, this translates into an annual energy spend of at least US\$50 million for 40% of respondents. Nearly a third (27%) spend US\$100 million or more on energy.

The majority (73%) of our respondents foresee their already substantial energy costs rising over the next five years. A large percentage (38%) expect that energy costs will rise by 15% or more during this period.

## Formal energy strategy and implementation plan

Given such high energy costs, it is no surprise that the majority of respondents (70%) have a formal strategy and implementation plan to manage the mix of different energy sources they use. Slightly over half (51%) have a strategy that applies to their company globally; 46% say that energy strategy applies at the country or business-unit level.

#### Figure 2.

Cost of energy

Reliability of

Regulatory

compliance Energy price

volatility/ predictability

energy supply

Carbon emissions

Most important drivers for composition of energy mix

77%

31%

23%

**15%** 

10%

### Energy strategy objectives – respondent comments

"To see how energy costs will develop over the next two to three years and to ensure a high level of [energy] security"

"First, to reduce energy use; second, to increase the usage of renewable energy"

> "To phase out older technology and equipment and replace it with more energy-efficient equipment."

"To help us achieve three targets: reduce energy consumption by 15%; reduce greenhouse gases by 20%; and increase the renewable energy mix by 5%."

Interestingly, 16% of respondents report that their energy strategy isn't limited to their own operations but also extends to their supply chain.

### Energy strategy objectives

Asked to comment on the objectives of their energy strategies, a majority of respondents indicated that cost reduction through efficiency was the primary objective of the strategy. Energy conservation and minimization of carbon footprint followed cost reduction as other key objectives. Many companies have targets to meet a portion of their energy needs through renewable sources with implementation of their energy mix strategy. Ensuring reliability of energy supply is another major objective.

## Key implementation challenges

Respondents identified financing and capital issues related to energy projects as the most important challenges to the implementation of energy strategies:

- Financing and capital issues related to energy mix projects (47%)
- Identifying and accessing government grants and incentives (40%)
- Assessing and selecting technologies (39%)
- Measuring or tracking progress in meeting energy mix strategy objectives (37%)

### C-suite input and oversight

Decision-making with regard to energy mix strategy is not limited to the procurement or facilities management functions but rises to the highest levels of the corporation. For more than one-third of respondents (36%), the CEO makes the final decisions on energy mix strategy. For another 40%, energy mix strategy is decided by the COO, CFO, GM or board chairman.

**Company self-generation of energy** A number of well-known large corporations have launched initiatives to generate their own energy for a variety of reasons. Among them are reducing energy price volatility, increasing security of supply, decreasing costs and meeting carbon-reduction objectives. Examples of corporations with company-owned renewable energy generation include Toyota, eBay, Kimberly-Clark, BMW and PepsiCo.

Our survey suggests that this practice is not yet widespread, but is likely to grow over the next several years. Slightly over half (51%) of respondents report no self-generation at all, and only 20% of respondents generate more than 10% of their companies' total energy needs. That said, one-third of respondents expect to meet a greater share of their energy needs through selfgeneration over the next five years.

### Key barriers – return and risk concerns

Asked why they had opted not to invest in self-generation capacity, survey respondents highlight financial return and risk concerns. The leading reason given is the payback period is too long for such investments, followed by risk considerations and internal rate of return calculations.

#### Figure 3.

### Primary reasons for not investing in self-generation



#### Figure 4.

## Renewables as a percentage of company energy generation

Figure 5.

## Top energy efficiency objectives





Note: response totals exceed 100% as respondents could select more than one option

Such factors as the upfront investment amount, the company's level of experience with energy projects, site availability and technology readiness are relatively unimportant, suggesting that the right financial models could unlock corporate investments in energy generation.

### **Energy efficiency**

Given current energy spending and anticipated increases, reducing energy costs remains the nearly universal primary objective of energy efficiency initiatives. However, important subsidiary objectives include shrinking the company's carbon footprint, limiting exposure to fluctuating fossil-fuel prices and reducing risk related to fuel availability.

Respondents deploy a variety of technologies to achieve their energy efficiency objectives, including energy demand management (47%), building energy management systems (20%), energy-efficient lighting (18%) and building automation (18%). A large majority of respondents anticipate increasing energy efficiency over the next five years – 60% say that initiatives to reduce energy consumption through efficiency will increase, and another 22% say that such initiatives will increase significantly.

### Use of renewable energy

Our energy mix survey examined the use of renewable energy from two perspectives: energy generated by company-owned or controlled assets and energy purchased from outside parties. From either perspective, the survey indicates that renewable energy use among large corporations is set to rise over the next five years from an already substantial base.

Renewables in company energy generation Whether solar, wind, bio-energy or other kinds of renewables, 41% of respondents report generating some form of renewable energy with company-owned or controlled resources. The greatest number of respondents generate power with photovoltaic solar (25%), followed by biomass or biogas generation (20%) and the use of biofuels in company-owned fleets (19%). Wind and geothermal have a 7% uptake.

However, renewable energy still makes up a relatively small proportion of total company generation. Only 11% of respondents say that renewables account for more than 5% of their companies' total energy production.

Although corporate renewable energy generation currently can be said to be wider than it is deep, this looks set to change:

- Across the total survey population, 51% of respondents say that company-owned renewable generation will increase over the next five years.
- Another 16% expect renewable generation to significantly increase.

This suggests that other corporations will experiment with renewable generation in the near future, and companies currently deploying it will become more deeply involved.

#### Figure 6.

## Renewables as a percentage of purchased electricity



#### Renewables in purchased electricity

In contrast to company-owned generation, nearly half of respondents (48%) purchase some amount of electricity generated from renewable sources. In terms of total consumption, this population divides itself into those who consume just a little renewable electricity and those who consume a lot.

Pricing remains a key factor in the adoption of renewable energy. Only 39% of all respondents say they would be willing to pay a premium for renewables, highlighting the importance of achieving grid parity and developing innovative project-financing models.

Nonetheless, as with corporate generation, survey respondents predict growing use of renewables in purchased electricity over the next five years – 59% say that their use will increase or increase significantly.

### **Energy audit issues**

Survey respondents were invited to comment on the key issues revealed in their companies' latest energy audit. Taken together, the energy audit issues revealed the difficulty of implementing a global energy mix strategy. Common challenges highlighted by the respondents include:

- Need to develop a structured approach to meeting energy targets
- A greater focus on implementation of energy conservation programs
- Better understanding of energy usage profile
- Improvement in monitoring and tracking energy metrics
- Understanding of the opportunity to increase the proportion of self-generated energy and renewable energy in the mix
- Better understanding of technology to optimize efficiency and replace aging or low-performing equipment
- Need for energy security in terms of both supply and cost
- Funding and access to capital

### Conclusions

Energy mix has become a strategic issue at the C-suite level of billion-dollar corporations as a significant – and rising – share of operating costs go to energy. While reducing energy costs through energy efficiency measures is often the foremost objective of energy strategy, a number of other subsidiary goals are also driving strategy, such as energy security, carbon reduction and price stability. Regulatory compliance, together with reputational and brand aspects, also plays a part.

Company self-generation of energy and integration of renewables into the energy supply have been implemented at significant rates to meet these ends, with these practices set to accelerate over the next five years. The main barriers to self-generation and use of renewables are mostly related to risk and financial returns, suggesting that adoption could come even faster with financing innovations and increasing cost-competitiveness of renewables. In summary, only those corporations that have a comprehensive and diverse energy strategy will be able to create a competitive advantage in the new world of a more resource-efficient and low-carbon economy. //



## Cleantech industry performance: global pure-play analysis

by **Scott Sarazen**, Markets Leader, Global Cleantech Center, Ernst & Young

In this second year of tracking the performance of pure-play public cleantech companies, we observe significant changes in our annual industry benchmark major drops in valuation and revenues and significant churn from one year to the next in the benchmark constituents. With little or no growth in the major developed economies, waning or uncertain policy supports for clean energy in many jurisdictions as a result of government austerity measures, and an oversupply of solar and wind generating equipment, cleantech is a tough business to be in these days. Yet we also observe new leaders arriving in the marketplace and pockets of resiliency in dynamic cleantech-sector verticals.

Ernst & Young follows pure-play companies – those whose value is primarily derived from clean energy – because they represent the vanguard in the global transition to a resource-efficient and low-carbon economy. This benchmark is an indication of companies driving clean technology and business-model innovation around the world. For this study, "pure-play" companies are defined as those whose clean energy focus is designated A-1 Main Driver (50%-100% of value) by Bloomberg New Energy Finance (BNEF).

The public pure-play population, however, represents only a small part of the overall cleantech population, which ranges from start-ups backed by venture capital (VC) to large private companies and multi-industry Fortune 1000 companies. BNEF designates more than 650 other public companies as having either a considerable (25%-49% of value) or moderate (10%-24% of value) clean energy focus. Our research reveals that nearly 1,400 VC-backed companies worldwide target cleantech markets.

The public pure-play companies provide a gauge of the industry's ability to evolve, adapt and create new market leaders in the face of challenging market conditions. The objective of our benchmark is to provide annual quantitative measurements of the pure-play cleantech population as it evolves – including the number of companies, headcount, revenues, net income, market capitalization and debt – and to offer insights into unique geographic and sector sub-segments.

### Figure 1 2012 benchmark – company additions and deletions

	Bankruptcy, delisted, defunct or	Private, restructured, acquired or	No longer A1; no longer classified as	Total		IPO or new A1 cleantech entity post-	Public company reclassified	Total
	quoted OTC	merged	pure play			merger	as Al	
Deleted companies	32	24	46	102	Added companies	24	98	122
Percentage	31%	24%	45%	100%	Percentage	20%	80%	100%

While our analysis of this universe of public pure-play companies shows a few nodes of growth in some categories, the overall results suggest that a high degree of competitiveness is required to attain growth and a leadership position in this dynamic market.

## New entrants, churn and reconstitution

From 2011 to 2012, the benchmark population of pure-play public cleantech companies shifted considerably. In this year's reconstitution of our list of pure-play companies, we removed 102 companies from the 399 constituents of 2011 and added 122 new ones – a churn of 31%.

A large proportion of the deletions from the company population were a result of financial duress – companies delisting, moving to OTC trading or going bankrupt. Other companies were removed from the list because they were acquired, merged or went private. The majority of deletions, however, came from changes in the clean energy focus classification provided by BNEF. Many companies that had been designated A1 (i.e., deriving 50% or more of their value from clean energy activities) were reclassified as A2, A3 or A4 companies (i.e., deriving less than 50% of their value from clean energy activities).

Similarly, additions to the 2012 universe came mostly from new A1 designations – 80% of the new entrants this year were public companies that received a higher clean energy focus classification from BNEF. The remaining 20% of new entrants were a result of IPOs or were new pure-play companies emerging from a merger or restructuring.

### Global cleantech landscape

Compared to the previous year, the financial results of our pure-play population paint a sobering picture of the cleantech marketplace. While aggregate revenues fell by just 3% to US\$148 billion, net income swung from a positive US\$5.1 billion last year to a US\$6.6 billion loss. Market capitalization fell 41% to US\$143 billion. Although some of the declines can be attributed to changes resulting from the annual benchmark reconstitution, as discussed earlier, the dramatic drop in net income and market capitalization reflects trends across the industry.

Market valuations and net income declines are evidence of the difficulties cleantech companies have had in competing for customers and financing, as well as adjusting to a post-recession economy marked by fiscal austerity. Despite a few large renewable generation and efficiency companies that experienced gains in income, many incumbent wind and solar companies faced losses that brought down the sector's financials over all.

At the same time, debt financing increased, rising 14% to US\$114.8 billion, suggesting that borrowing was making up for some of the losses in net income and fueling continuing expansion in some companies. Total reported industry headcount fell 10% to 457,808 even as the total number of companies in the benchmark increased by 5% to 499. At the same time, the company population became younger, moving from a median 13 years since incorporation to a median of 12. Despite the economic headwinds that are forcing bigger, more established companies to make painful headcount adjustments, emerging companies continue to enter the cleantech universe in significant numbers.

### Asia-Pacific

With 152 pure-play public cleantech companies, the Asia-Pacific region continues to host the largest share of the population, with the pool having expanded marginally from 149 companies. As might be expected, the region also has the highest market capitalization and revenue (see Figure 2). This year, regional revenues of US\$56 billion were considerably larger – by 20% – compared with last year's benchmark. Asia-Pacific was also the only region that had a positive change in median revenue, which increased by 16% compared with last year.

However, Asia-Pacific net income declined due to losses among some of the larger companies in the solar sector. Debt levels in the region increased significantly, rising 73% to US\$59 billion.

Asia-Pacific companies remain the youngest on a median basis – 11 years since incorporation – as a result of new entrants from mainland China, Australia and Taiwan in recent years. The median headcount among Asia-Pacific companies is 457, far higher than in EMEA or North America, largely

### Figure 2 Global public pure-play cleantech companies

	2011	2012	Annual change
Number of companies	399	419	5%
Median age (years)	13	12	-8%
Total headcount	496,311	457,808	-10%
Median headcount	203	214	5%
Market capitalization (US\$ billions)	\$243.2	\$143.5	-41%
Annual revenues (US\$ billions)	\$152.8	\$148.1	-3%
Net income (US\$ billions)	\$5.1	(\$6.60)	-229%
Debt (US\$ billions)	\$100.8	\$114.8	14%

Note: includes public companies designated as clean energy A-1 Main Driver (50%-100% of value) by BNEF, excluding listed investment funds and acquisition vehicles; annual change represents the difference between the 2012 benchmark and the 2011 benchmark in aggregate. The populations of 2011 and 2012 differ as a result of the annual reconstitution process (see sidebar below).

because of the low-cost work force of Chinese manufacturers. Chinese and Hong Kong solar and wind companies consistently placed among the top 10 positions in the region in revenue, net income and debt, with the exception of India's Suzlon, which held the top position for revenue earned in the region.

### Europe, Middle East and Africa (EMEA)

Government fiscal austerity measures in the region, such as reductions in feed-in tariffs in European countries against the last year, have altered the financial dynamics of EMEA companies a great deal.

From 2011 to 2012, the total market capitalization of EMEA companies fell 57% to US\$36 billion, and revenues fell 32% to US\$49.4 billion. Total net income showed losses of US\$3.5 billion – the highest among all regions. European solar- and wind-equipment manufactures faced rapidly falling prices because of global production overcapacity and slackening demand. At the same time, large renewable energy project developers encountered a rapidly shifting regulatory landscape, with cuts to financial supports in Spain, Ireland, the UK and Germany.

Despite the challenging market conditions, the EMEA pure-play population actually grew, increasing 15% to 147 companies. Given the European Union's carbon-reduction commitments and major new cleantech initiatives in the Middle East and North Africa, such as Saudi Arabia's US\$109 billion plan to create a domestic solar industry, new entrants continue to be attracted by the potential of the EMEA market.

### North America

North America's public pure-play cleantech company population numbers 114, down 3%. The region's companies reported mixed results this year, showing US\$3.1 billion in losses in aggregate. However, total revenues grew 30% to US\$30.2 billion, partly due to the new inclusion of high-revenue companies, such as Brookfield Renewable Partners and GT Advanced Technologies, in this year's population and partly to the revenue growth in the energy efficiency sector. Interestingly, despite the drop in the number of companies, the region's headcount actually grew 4% to 72,000 people. This reflects North America's greater diversity in the types of companies represented in its base of cleantech companies compared with other regions, resulting in a smaller impact from the decline in renewables.

While US and Canadian companies were not spared in the broad declines in market capitalization, valuations did not fall as steeply as in Europe; the total market capitalization of cleantech in North America is now almost on par with that of Europe. In terms of median market capitalization, North America's US\$47.0 million exceeds Europe's US\$33.0 million.

Against the backdrop of volatile markets and uncertain policy support, North American companies increased their debt level by 79% to US\$18.4 billion, indicating that this year's benchmark companies have been able to tap into debt markets for expansion or to cover shortfalls. However, median per-company debt levels in the region remain low at just US\$5 million – well below those of other regions.

### Central and South America

The pure-play population in Central and South America is small - just six companies and dominated by large Brazilian ethanol producers such as Cosan. The region's companies have shown relative resilience, and these companies were able to secure a positive net income figure of US\$288 million with revenues of almost US\$12.5 billion. The six companies also have a higher market capitalization, at US\$7.3 billion in 2012, as compared with the five companies that had US\$6.0 billion in market cap in 2010. The median measures for this group of companies are not readily comparable to those in other regions due to the distorting effects of the very small population.

### Country landscape

Further distinctions can be made at the country level (see Figure 3). China and the US make up a first market tier in terms of company population and market capitalization. Like last year, the US has the largest number of companies at 73, while China has the greatest market capitalization value at US\$42.1 billion. China's headcount is also several times larger than that of any other market.

Germany and Canada form the next tier in terms of number of companies, with 42 and 41 pure-play cleantech companies, respectively.

### Figure 3 Global public pure-play company landscape by region







### Figure 4. Cleantech country landscape



Number of company

A third tier is composed of markets with fewer than 30 companies. The leaders in this tier include Australia (28), the United Kingdom (24), France (18) and India (17).

Italy and Sweden join the list of the top 15 countries in terms of number of companies while Spain drops off the list as the result of mergers that reduced its company population.

### Cleantech segments: solar leads decline; pockets of resiliency remain

The solar segment has seen the greatest alteration since last year. While solar continues to dominate the global public pure-play population in terms of the total number of companies (107), people employed (179,500) and total revenues (US\$50.6 billion), other performance measurements highlight the difficult and competitive environment solar companies faced in 2011. Aggregate net income plunged from US\$1.2 billion in 2010 to a US\$6.8 billion loss last year, bringing down the overall figures for cleantech despite some gains in other segments. And the market capitalization of the solar segment has been reduced by almost a third from last year to US\$25.2 billion. But despite its declining financial performance, the number of solar companies actually increased by 5% and headcount grew by 11% – largely the result of new entrants from Asia. Further, consolidation in the solar industry due to declining financial performance is still in the early stages and will likely be reflected in next year's benchmark results.

Wind, the second-largest segment, with 54 companies, showed more resilience in 2011 than the solar segment. The wind segment's revenues remained relatively flat at US\$31 billion, losing just 3% compared to the

Country	Companies	Market cap (US\$b)	Headcount ('000)
United States	73	\$27.2	61.6
China	55	\$42.1	166.5
Germany	42	\$5.8	28.2
Canada	41	\$6.1	10.5
Australia	28	\$0.1	3.1
United Kingdom	24	\$1.1	1.5
France	18	\$1.5	6.2
India	17	\$1.9	14.7
Hong Kong	12	\$4.0	5.3
Taiwan	11	\$8.9	36.0
South Korea	9	\$2.4	1.0
Sweden	7	\$9.7	3.5
Switzerland	7	\$2.1	6.4
Italy	7	\$1.1	4.0
Japan	6	\$1.2	5.8



Bubble volume = cleantech company headcount

Note: Includes public companies designated as clean energy A-1 Main Driver (50%-100% of value) by BNEF; market capitalization data as 15 Feb 2011.



previous year. Wind companies employ some 74,300 workers, a 9% decline that indicates the ongoing restructuring in the wind industry to increase production efficiency and align production with demand. Total net income for wind companies was US\$471 million, a decline of 58% but still positive. As fiscal austerity and competition increase, the financial resiliency of wind companies might yet prove to be short-lived. Debt financing, however, may still shore up the wind segment as wind companies have led other verticals in their ability to attract almost US\$33.7 billion – nearly a third of the total debt in pure-play cleantech. A number of segments show gains in revenue but declines in net income, indicating expanding businesses but eroding margins in the face of fiercer competition and difficult economic conditions. In this category are energy efficiency products, biofuels, renewable energy generation, geothermal and hydro.

One segment stands out for having both revenue and net income growth: biomass/ waste-to-energy, which saw revenues grow by 78% to US\$4.0 billion and net income go from a US\$0.8 million loss to a positive US\$263 million. The financial performance of biomass/waste-to-energy companies illustrates the attractive economics in this segment, which is supported by strong corporate and municipal demand as wasteto-energy becomes a key part of integrated waste management strategies.

The youngest of all the segments in terms of the amount of time since company incorporation is biofuels, with a median of eight years. Water treatment and conservation, although represented by a small number of public pure-play companies, is by far the most mature cleantech segment, composed of companies with a median age of 47.5 years.

## Figure 5 Cleantech segment landscape



Number of companies

### Initial public offerings – China continues to dominate

As 2011 was not the best year for cleantech IPOs, only 22 companies were added to the 2012 pure-play benchmark population through new listings, compared to 38 last year. Nearly half of these offerings were conducted by Chinese companies, which together raised US\$3.8 billion, or 85% of the total IPO equity raised globally over the year (Figure 8). The largest IPO came from the Chinese wind developer and equipment manufacturer Sinovel, which raised US\$1.4 billion on the Shanghai Stock Exchange (Figure 9). An interesting new entrant to the list of countries in terms of cleantech IPO activity, displacing the US from second place, was Poland, with the listing of three biomass and waste-energy companies on the Warsaw Stock Exchange. While the solar segment had the largest number of IPOs (six), companies in the wind segment raised the most capital, at US\$2.8 billion as compared with a little over US\$1 billion in solar. The biggest growth in deal activity came from the biofuels segment, which had five IPOs in 2011, including KiOR and Gevo, as compared to two last year.

Segment	Companies	Market cap (US\$b)	Headcount ('000)
Solar	107	25.2	179.5
Wind	54	30.3	74.3
Energy efficiency products	44	27.7	81.6
Biofuels	38	10.5	49.9
Biomass and waste energy	36	4.8	9.0
Energy storage	36	4.5	18.0
Renewable energy generation	28	23.6	24.9
Geothermal	20	5.0	6.0
Clean transport	17	4.5	4.0
Hydro	15	4.6	1.5
Power and efficiency management services	15	2.0	5.3
Other	9	0.9	3.9



Bubble volume = cleantech company headcount

Note: Includes public companies designated as clean energy A-1 Main Driver (50%-100% of value) by BNEF; market capitalization data as of 9 April 2012.



## Figure 6 Selected top pure-play companies by market capitalization

Company	Market	Cleantech segment	Market cap (US\$b)	Stock exchange
China Longyuan Power Group Corporation Limited	China	Wind	\$6.3	The Stock Exchange of Hong Kong Ltd.
Sinovel Wind Group Co. Ltd.	China	Wind	\$4.8	Shanghai Stock Exchange
GCL-Poly Energy Holdings Ltd.	Hong Kong	Renewable energy generation	\$4.5	The Stock Exchange of Hong Kong Ltd.
EDP Renováveis	Spain	Renewable energy generation	\$4.1	Euronext Lisbon
Cosan Ltd.	Brazil	Biofuels	\$4.0	Bolsa de Valores de São Paulo
Tesla Motors Inc.	United States	Clean transport	\$3.5	NASDAQ Global Select
Sanan Optoelectronics Co. Ltd.	China	Energy efficiency products	\$2.5	Shanghai Stock Exchange
Epistar Corp	Taiwan	Energy efficiency products	\$2.1	Taiwan Stock Exchange
Huaneng Renewables Corporation	China	Wind	\$2.0	The Stock Exchange of Hong Kong
Vestas Wind Systems	Denmark	Wind	\$1.9	OMX Nordic Exchange Copenhagen

Note: Market cap as of 9 April 2012

### Figure 7 Global public pure-play cleantech companies by segment

	No. of companies		Median age	Headcount		Market cap (US\$b)		Revenue (US\$b)		Net income (US\$m)		Debt (US\$b)	
	2012	% change		2012	% change	2012	% change	2011	% change	2011	% change	2011	% change
Solar	107	5%	11	179,486	11%	25.2	-63%	50.6	-4%	-6796	-578%	28.4	-11%
Wind	54	4%	16	74,320	-9%	30.3	-36%	31.0	-3%	471	-58%	33.7	33%
Energy efficiency products	44	5%	20	81,601	23%	27.7	-5%	19.9	55%	603	-28%	6.2	77%
Biofuels	38	15%	8	49,889	-4%	10.5	0%	22.8	47%	-48	-137%	7.5	26%
Biomass and waste energy	36	64%	9	8,974	40%	4.8	30%	4.0	74%	263	526%	3.4	36%
Energy storage	36	-23%	14	18,029	-70%	4.5	-67%	2.5	-67%	-827		1.5	-27%
Renewable energy generation	28	22%	10.5	24,923	8%	23.6	-44%	9.0	5%	1063	-18%	22.5	-4%
Geothermal	20	0%	9.5	5,991	39%	5.0	-4%	1.8	53%	-495	-605%	4.1	78%
Clean transport	17	13%	19	3,971	2%	4.5	2%	0.8	-17%	-382		0.4	85%
Hydro	15	36%	9.5	1,493	-68%	4.6	84%	1.7	235%	-539	-1,248%	6.5	367%
Power and efficiency management services	15	7%	11	5,267	-47%	2.0	-44%	2.3	-23%	41	-39%	0.5	8%
Environment	5	-44%	21.5	2,241	-83%	0.4	-95%	0.8	-94%	-25	-108%	0.1	-93%
Carbon capture and storage	2		20			0.0		0.0		-2		0.0	
Water treatment and conservation	2	-78%	47.5	1,623	-84%	0.4	-96%	0.9	-68%	28	-77%	0.0	-92%

Note: based on analysis of public companies designated as clean energy A-1 Main Driver (50%-100% of value) by BNEF; market cap data as of 9 April 2012. % change compares the difference between the 2012 benchmark and the 2011 benchmark.

### Outlook

As evidenced in this year's analysis, the global population of public pure-play cleantech companies is experiencing dynamic change. We will likely continue to see a cleantech population in flux as consolidation and restructuring continue among solar and wind equipment manufacturers; renewable energy generators adapt to a post-subsidy business environment; market momentum shifts even further in favor of emerging markets; and competition increases across the board.

At the same time, the number of pure-play companies is set for continued growth as new entrants – whether emerging companies or those that increase their focus on cleantech – are attracted by the market opportunities created by resource scarcity and the low-carbon transformation. While global economic conditions will put downward pressure on financial results for at least the near term, new market leaders across cleantech segments will emerge from this period of transition with the scale, efficiency and competitiveness necessary to drive improved performance across all of our benchmark measurements. //

#### Figure 8

### 2011 cleantech pure-play IPOs by market



Note: includes public companies designated as clean energy A-1 Main Driver (50%-100% of value) by BNEF.



Note: includes public companies designated as clean energy A-1 Main Driver (50%-100% of value) by BNEF; percentages may not equal 100% due to rounding.

#### Figure 10

### Top pure-play cleantech IPOs in 2011

Company	Market	Cleantech segment	Stock exchange	Pricing date	Total deal value (US\$m)	Market cap (US\$m)
Sinovel Wind Group Co. Ltd.	China	Wind	Shanghai Stock Exchange	13 Jan 11	\$1,432	\$4,814
Huaneng Renewables Corp. Ltd.	China	Wind	Hong Kong Stock Exchange	10 Jun 11	\$850	\$2,045
Beijing Jingyuntong Technology Co. Ltd.	China	Solar	Shanghai Stock Exchange	8 Sep 11	\$394	\$1,602
Guodian Technology & Environment Group Co. Ltd.	China	Wind	Hong Kong Stock Exchange	30 Dec 11	\$337	\$1,679
Sungrow Power Supply Co. Ltd.	China	Solar	Shenzhen Stock Exchange – Main Board	2 Nov 11	\$215	\$658
Energix-Renewable Energies Ltd.	Israel	Solar	Tel Aviv Stock Exchange	13 Apr 11	\$211	\$32
Ningbo Sanxing Electric Co. Ltd.	China	Digital energy	Shanghai Stock Exchange	15 Jun 11	\$207	\$576
Jiangsu Jixin Wind Energy Technology Co. Ltd.	China	Wind	Shanghai Stock Exchange	6 May 11	\$176	\$836
KiOR Inc.	United States	Biofuels	NASDAQ Global Select Market	23 Jun 11	\$162	\$1,092

Note: Market cap as of 9 April 2012

### Figure 9

### 2011 pure-play cleantech IPOs by segment



# Capital roundtable: key trends in the cleantech value chain



Our annual roundtable discussion among investors and market observers on key cleantech trends covered a range of topics, from technology cost curves to the growing role of emerging markets in investing and innovation, to new financing structures and utility business models.



Michael Liebreich Chief Executive Bloomberg New Energy Finance

CLEANECH

Moderator Gil Forer Global Cleantech Leader Ernst & Young



### Gil Forer: What has changed over the last year across cleantech segments and globally?

Michael Liebreich: Today brings better costs and efficiencies, particularly in wind. Demonstration projects are also moving beyond experiments.

Sure, the bloodbath on the solar supply side is bad news for investors in assets with decimated valuations. The real story, however, is the dramatically and permanently reduced cost of equipment, which is good news for installers. As Foxconn gets into manufacturing and the Chinese scale up silicon manufacturing, this curve of 18% to 19% will continue. It's Moore's Law.

Our analysis also shows that wind turbines now yield far more than before. In fact, between 1984 and 2010, wind farm yields grew to 34% percent from 22%. The first 7% experience curve gain - the price per kilowatt hour of turbine capacity - stems from longer blades, better electronics, better power conversion and taller towers, just as wind turbine prices fell at 7% per doubling. Thus, cost reductions and performance increases add up to a 14% experience curve for wind, not 7%. So for a 100-megawatt wind farm, that price is a turbine cost indicator. And the press and politicians totally missed it.

Moreover, a lithium ion battery price crash looms for the same reason solar crashed in 2008 – far more investment on the supply

side than the electric vehicle industry can absorb. EVs are limited by consumer behavior, range anxiety and subsidy levels, resulting in battery overcapacity. Also, LEDs are coming of age.

Finally, many next-generation fuel demonstration plants are hitting proper scale. They're no longer lab experiments on kitchen tables, but real plants. Learning from those demos will follow, along with talk about the next set of plants, which will be much more competitive with gasoline prices, without subsidies.

Stephan Dolezalek: New this year are perceptions lagging reality as they concern costs, more interest in LED and storage and a looming retrofit boom. Solar panel prices have fallen to levels far below those





**Mark Fulton** 

Managing Director and Global Head. **Climate Change Investment Research & Strategy** Deutsche Bank

transformat





Brian Bolster Managing Director and Head of Alternative Energy/Cleantech Investment Banking Goldman Sachs

anticipated by the markets. So while we focus on negative European tariff developments and continued economic woes, we've overlooked how cheap some technologies are and will become. But beyond lower solar panel costs, with US\$2.60-a-watt installed prices in Germany, the balance of systems has also come down dramatically.

Add in rising oil prices, which could again rejuvenate cleantech or drive economies further into the ground, and it's impossible to know if this is good, bad or indifferent. Other uncertainties stem from technology learning curves and how much manufacturing scale will push prices to rational levels.

So with solar, most assumed we'd reached the scale required to drive costs down. But higher manufacturing supply in China and elsewhere over the last 18 months has pushed prices through the floor. The press completely missed that.

As for segment moves, massively more money and time are spent on power storage on the heels of more wind and solar power. Though the storage learning curve is a few years away, the increased attention and research on storage is starting to tilt the learning curve in the same direction. This is a game changer because it enables dispatchable wind and solar power. Moreover, LED or solid state lighting is rapidly following that same curve despite the US undoing the incandescent light bulb ban.

Finally, we're entering the enterprise software phase for lighting, HVAC retrofits or whole-building energy. Costs have fallen enough with sufficient deployed nodes so that managing those intelligently may suddenly produce a much higher return than was possible even two years ago. This other accelerator was dependent on first driving hardware prices down.

#### Gil Forer: What has the impact of emerging markets been?

Stephan Dolezalek: We see the increasing importance of investment in and innovation by developing countries. We need to rethink the developing world as the growing world and G8 countries as non-growing countries.

Stephan Dolezalek

Leader, CleanTech

Managing Director and Group

VantagePoint Capital Partners



Country development banks are fueling big changes. Flush capital in China, India, the Middle East, maybe even Brazil, will help scale technologies there, so they will own these technologies. The resulting balanceof-power shift will push many of us into the middle of that battle, which dwarfs efforts in private finance. Thus, pension assets are shifting toward countries with greater political certainty and political support for new infrastructure assets. This further exacerbates the movement of capital from the US and Europe.

*Mark Fulton:* Incentives occur in many different forms. Beyond feed-in tariffs and tax equity is a huge amount of cheap debt from global development banks, including Chinese state banks.

So while we focus on falling costs, the supply buildup and the whole cost-cutting push, many technologies globally are at end phase and still require some government support. Brazilian wind, for example, wouldn't be possible without BNDES [National Bank for Economic and Social Development] financing.

*Michael Liebreich:* To Stephan's point about developing vs. developed, many smaller markets are putting in interesting volumes. The Ukraine's solar installations of 200 megawatts are nothing compared to Germany's. But just seven years ago, that was Germany's market. This reflects a much larger shift in overall capital flows. I reckon we're in a prolonged recession because in 2004, the developed world spent roughly US\$200 billion on oil and gas. That flowed back to European luxury goods and investment in America then. Now, our US\$800 billion spend returns to Asian manufactured automobiles and investment. We're losing financing capital of up to US\$800 billion per year. That has a huge macro effect.

So Mexico, Chile, Kenya, South Africa, India, other parts of Southeast Asia, Thailand and Vietnam are now markets. Add in North Africa, Morocco and Egypt, and it's significant. Since these countries are not primary manufacturers of renewable equipment, they benefit from cheap supply and huge competition.



### *Gil Forer:* What is your assessment of the cleantech investment climate?

*Mark Fulton:* The continued and accelerated squeeze between policy incentives and cost reductions, between investment and deployment, is altering the playing field. What's new is the accelerated pace.

US incentives are under severe pressure amid pushbacks in other markets. Feedin tariffs are being cut aggressively. Meanwhile, uncertainty persists in the capital markets. That leaves an investor skittish about the next two to three years. So banks, fund investors, pension funds and insurance companies view cleantech as more uncertain, short term. Investors want to ensure financially feasible projects. They're very careful about where they place their bets, particularly linked to incentive changes versus costs. Thus, project financing must be planned very carefully. That's pushing cleantech companies to fine-tune incentives, to accelerate them and to be in the best markets at levels nearing commercialization.

But the strategic investors, corporations and development banks with potentially deep pockets are charging ahead.

Banks are also exploring the securitization of the project-debt market. Debt markets still account for roughly 70% of project finance. That's where the action is. So a better way to reach debt markets for better liquidity and rates on renewables would be significant.

In the medium term, risk aversion will shift toward a good, balanced risk-adjusted return.

In the US, as a result of grant programs, several years of projects were able to monetize much of their tax, some at fairly attractive cash yields. So this year, I'm hopeful that we'll see the entry of US and Canadian retail investors to provide equity financing for wind and solar projects.

These very attractive yields may drive down costs even further because of the cheaper cost of equity. For example, Canada's Brookfield Asset Management merged its renewable power fund's hydro and wind assets into its Brookfield Renewable Power subsidiary. Many consider that asset a good comparable for future vehicles. This year, some companies may follow. It will probably begin in wind. But more scale in the solar sector and projects coming on line and yielding cash will open up previously unavailable pockets of capital.

**Brian Bolster:** Between oversupply and current demand, the market isn't acting irrationally as it considers allocating capital for solar and wind. But capital for new technologies falls in four buckets: government and development banks, strategic investors, public equity and private equity.

Views among private and public equity are linked. If the public equity market and strategic investors aren't there to provide an exit, private equity gets skittish. The biofuels and biochemical markets are an interesting example. For many of our companies that IPO'd over the last two years in biofuels and chemicals, it's too early to know if investments were successful because twoto three-year time horizons are required. But the public market has lost patience and sold them off. As a result, in that sector, the private market is getting more selective.

Interestingly, at the same time, strategic investors are getting more aggressive.

*Michael Liebreich:* Amazingly, financings keep getting done. Last year was a new record. But there's far more risk aversion. It's a very discontinuous period. So incumbents are fighting back.

The era of large-scale subsidies is over; it's gone. Distortions, regulatory constraints and bottlenecks will always exist. But the idea that a wind farm can earn 75% of its money from renewable obligation certificates and one-quarter from electricity sales makes it unbelievably politically risky. Around 40% is much more reasonable. So subsidies will be much lower, approaching the tenths, if not the hundredths of a percent level.

Generally, there's a lot of nervousness. Look at Greece, Iran and uncertainty around nextgeneration biofuels technologies. Or the US election. Less risk aversion is unlikely.

This perception that the industry is subsidy dependent – the fight to retain subsidies by policymakers and non-specialist investors and the assertion that survival is impossible without subsidies – enormously increases risk perception. The industry has to get serious, grow up, and understand that subsidies are transitional and minor and must be justified monthly and by sector. There are no free lunches. The industry would do itself a favor to take this onboard. Don't fight that trend – go with it and lead it.

*Gil Forer:* How can we unlock or create the right breakthroughs to enable capital flow from the sidelines into investment?

*Michael Liebreich:* What would unlock capital? Many with a Western and investorcentric view see the industry rushing out of control, particularly in countries where it is difficult to make money. So they ask, "How do we advise our clients how to play this?" Because a Chinese turbine with BNDES financing doesn't help Western investors. But the interesting, though boring, story is a shift in utilities. More Warren Buffetts and money created, more sources, buckets – private and public – now own infrastructure. This shift from traditional pension fund ownership of power infrastructure in a utility, or a bucket with layers of management and many assets, is huge.

Now, suddenly, utilities lack balance sheets. Bundled assets differ from utilities in their speciation. Old ones are stressed as lucrative revenue is siphoned off to rooftop solar while new, ruthless, strict, agile utilities – so-called "infrastructure funds" – are slowly replacing them, be they a bundle of solar or solar and wind assets or coal-fired, fossil fuel power stations. The traditional generator business model will explode. The utility, the distribution-transmission grid operator, may protect it. But investors wouldn't want to own any fossil-fuel generating capacity in that scenario.

A pension fund considering maintaining energy sector exposure can put money in revenue-losing fossil generators or utilities with big capital requirements and falling yields – or new investment vehicles holding clean assets.

Today, nobody cares about yield, just capital protection and inflation. So wind farms yielding 7% put them in Danish Government bond territory. But liquidity is the issue. You can sell Danish Government bonds quickly. But not a wind farm.

*Mark Fulton:* Pure renewable energy infrastructure funds exist. Many have renewable parts in their mandates beyond PE to operating infrastructure. So they can hold renewable projects. But a massive, mature, renewable infrastructure fund launch hasn't happened. The long-term development of this infrastructure asset class and rising interest in infrastructure plays by investing institutions globally versus very low bond rates are promising.

After the venture capital and private equity stages, these are infrastructure plays. Good stable assets performing well in long-term contracts should be very attractive to infrastructure investors, meaning pension funds, insurance companies and high net worth individuals. But risk aversion prevails. Those "in the know" – corporate insiders and developers – get it. Another interesting financing structure is energy service agreements. These help overcome barriers to the retrofit market to finance energy efficiency projects without incentives or subsidies. However, to reach commercial breakevens, digging into project finance is critical.

The middle ground could offer infrastructurestyle returns with lower risk and decent longterm contracts and yields. Some portfolio holdings must be longer term. Bigger institutions do asset-liability modeling. That means long liabilities must match long assets. Pension funds have long liabilities, so they need assets with a decent yield.

### *Gil Forer:* How are utilities reacting, and what is their future?

Stephan Dolezalek: Utilities are stuck in the paradigm of providing expensive peak power to customers who on a net metered basis essentially pay nothing. So if utilities overcharge for connection fees, that same customer moving to solar rooftop panels will add battery storage to self-serve through the peak. Add an EV, and connection charges in this market will drive them completely off-grid.

Which begs the question: can demand response be more valuable than gas peaking plants? That financing equation is very interesting. It's more valuable to the utility and cheaper to implement. Sufficient volume to manage intelligently is critical. But if used as a substitute for gas peaking, this crosses over to the smart grid.

Today, some utilities are seeing close to 50% of their most lucrative customers switch to solar. It's similar to the experience of telecoms, supplying landlines over the cellular switch. They began forcing connection charges. Today, many utilities are waking up to this reality through connection charges – because they are getting stuck.

*Michael Liebreich:* It has been an acid-test period for smart grid companies. Stimulus funds were launched in 2008, so 2009 to 2011 was a golden period for smart grid companies to find utilities, get regulatory approval and create programs. It was like

a slot machine – the money just came out. With stimulus funds largely spent now, that scenario is no longer the case. Hardware costs have fallen sharply, but companies must now be able to get real clients for real technologies. Some will manage it domestically or go overseas or won't make it. A reality crunch is coming.

I don't have a landline. It took me 10 years from my first mobile to forego a landline. When will utility customers say, "With these batteries, we're better off off-grid"? There's an ignition point, linked to demand response. Today, marketing and integrating the option make sense.

**Brian Bolster:** Certain US utilities are illprepared for the upcoming revolution.

A utility's eroding rate base, rising costs and falling returns are not attractive to investors. Moving power from A to B with aging infrastructure requires more capital – not counting energy efficiency improvements. This utility must invest more for a basic standard of service. In tandem, customers use less power, resulting in higher fixed charges with lower usage. The result will either be higher prices or lower returns.

I would not want to be a utility in California now. The state is relatively isolated from an interconnection perspective, so it's not easy to wheel power into California. Add in a high solar and EV penetration, some wind, the economics of solar, plus smart grid issues, and executives accustomed to a central station model – producing and shipping power in a very straightforward way – are facing a very different world.

### *Gil Forer:* What do you expect in the coming 12 to 18 months?

*Mark Fulton:* We will increasingly return to a more normalized investment scenario as risk aversion falls and investors pursue wellbalanced risks and returns. That suits both the renewable and the energy efficiency markets, which will attract investors, even with the liquidity premium.

But this will occur in markets and geographies with subsidies at 30%, not 70% levels. Investors will still favor markets with TLC: transparency, longevity and certainty. **Brian Bolster:** As oil prices rise, interest in the so-called "biomass conversion" – biomass to fuels or to chemicals – will rise. Oil prices are moving in the right direction.

Several companies will try to scale up those technologies. Successes will generate excitement in the capital markets. Also, this year, solar will start to rationalize itself, buoyed by trade disputes. *Michael Liebreich:* A bias against innovation and risk-taking, linked partly to career risk for portfolio managers, will persist. We face a few difficult, nervous and jumpy years, until roughly 2014, when things become blindingly obvious to the dumbest of the dumb – that certain things work and some don't; that some are cheap and some traditional companies are in trouble. A tectonic-plate shift will follow. But not this year. Stephan Dolezalek: Everywhere, globally, the pace of change is accelerating. It's odd that the country that was all about pioneering is now afraid to take risks. Not taking risks stems from a massively conservative view at a time when the single most important thing is to change rapidly. While we fail to take risks, much of the game simply moves elsewhere. //



## **Interview** with **Paul Ho,** Managing Director, Hudson Clean Energy Partners



Hudson Clean Energy Partners is a leading private equity firm formed to make private investments in the dynamic and high-growth clean energy industry. Global in scope, Hudson is dedicated to investing exclusively in renewable power, alternative fuels and smart technologies in sectors that include wind and solar, biofuels, biomass, hydroelectric, geothermal, energy efficiency and storage. *Ernst & Young:* How do you see uncertain or declining incentive or policy supports for renewables in developed markets affecting project developers' strategies?

*Paul Ho:* No doubt it impacts them negatively, both in the US and in Europe. On the US side, the impending expiration of the wind production tax credits at the end of the year and uncertainty about their renewal is creating uncertainty in the industry, making any long-term project planning very difficult. The Solyndra debacle has hamstrung the DOE in its loan guarantee programs. Unfortunately, although clean energy is not at the very top of the policy agenda of either of the two parties in this election year, that has not stopped some from using it as a political tool.

The same goes for Europe. Retroactive cuts to the solar PV feed-in tariff in Spain, for example, jeopardized existing investments in renewable energy assets and set a terrible precedent for future investments in the country. When governments unilaterally change the laws of the game mid-way, they are seriously undermining investors' confidence in those markets. But such actions are the rare exception rather than the rule.

For developers with a one-region strategy, there is not much that they can do – they just have to wait it out or try to push projects through before the rule changes. In the US, developers are accelerating completion of projects this year so that they can qualify for the expiring PTC [Production Tax Credit]. In Southern Europe, it is unclear whether the scale-back is temporary or permanent, but developers are putting projects in the pipeline on hold, not willing to invest more without knowing the parameters of the prospective regulatory landscape. We believe that a good strategy is for our portfolio companies to diversify our investments across multiple jurisdictions, even continents, to mitigate the regional or country-specific risks. That is what we are doing in our portfolio companies in wind and solar development. In this case, even if some markets are shut down, our portfolio companies can still divert resources and capital to geographical regions where market conditions remain attractive.

*Ernst & Young:* We've seen wind turbine and solar equipment prices falling. What's going to be the market outcome of this and what are the pros and cons?

Paul Ho: The pro is that the renewable energy cost curve is continuing to decline faster and more dramatically than people ever thought it could, which is a good thing. For example, the cost of solar photovoltaic modules has fallen by 75% since 2008. Wind capital costs are also trending down. The softening of demand due to the global economic slowdown has shifted leverage to the buyer. At the same time, equipment manufacturers want to keep their factories running, especially after rapid production capacity buildups in recent years, so they are willing to sell at marginal profitability or even at a loss in some cases. That's good from a consumer and project developer standpoint, assuming the same power purchase agreement (PPA) pricing, because with lower marginal costs you can improve your own project equity return.

From a manufacturer's standpoint, it's a negative, obviously. We are expecting a lot of capacity consolidation and the survival of only the fittest. The weaker companies are already falling by the wayside. Having a strong balance sheet and access to capital is key to survival. While the next couple of years will be challenging, we think the current supplydemand imbalance is a cyclical swing that will correct as the industry continues to consolidate and mature.

## *Ernst & Young:* Switching gears, what do you see as the prospects and drivers in the biofuels market?

*Paul Ho:* On the surface, the prospects for the biofuels market are attractive because this market is largely driven by the price of oil, which has remained relatively high. So until there is viable technology to synthesize low-cost natural gas into liquid fuel at moderate scale, or people use more natural gas vehicles, the biofuels outlook is fairly robust, particularly given the continued geopolitical uncertainty in the Middle East. Some people are even finding ways to make use of lower-cost waste feedstocks to make biofuels and, therefore, are insulated from grain price volatility.

The undercurrent, though, is that the US Renewable Fuel Standard that replaced the blenders' tax credit for ethanol and biodiesel (which expired at the end of last year) as the main regulatory support driver for biofuels is seen by many industry participants as too stringent. Under this standard, a certain amount of advanced biofuels must be blended into mainstream fuels, yet there is simply not enough production to meet the statutory requirement. Advanced biofuels production capacity has not come online as guickly as anticipated a few years ago. As a result, blenders are forced to pay a penalty even though they can't find the advanced biofuels that they need. There is a risk that the law may be challenged, which could really impact the viability of the biofuels industry, at least until the advanced biofuel technologies have scaled up economically.

*Ernst & Young:* Speaking of advanced biofuels, are companies focused on advanced biofuels technologies succeeding in raising the capital they need to scale up production?

**Paul Ho:** The venture capital providers have been very supportive and have invested huge amounts of capital, but the private equity providers are generally not willing to put money to work in the space because there is still too much technology or scaleup risk. But surprisingly, some biofuels companies have been able to skip the private equity stage of their funding and go directly from venture capital to an IPO, much like some technology companies.

While companies would normally need some track record of profitability before going public, to date a half dozen or so newgeneration biofuel companies have been able to go public without any track record of profitability at all. Some of the investors are really biotech investors who are comfortable with this scenario. That IPO window, though, seems to have been narrowed significantly due to some recently pulled IPOs.

The addressable market is huge. If things pan out, these public companies will have tremendous production cost advantages. But the problem so far is that not a whole lot of these companies have been able to live up to their promises and achieve their scale-up milestones.

## *Ernst & Young:* What about strategic money for biofuels? Is there a parallel with biotech here as well?

**Paul Ho:** Yes, given the lack of private equity money and the needed check size getting to be in the hundreds of million dollars to build out the first commercial-scale plant, many biofuels companies are turning to the equivalent of the big pharmas in the energy space – big oil companies who are willing to fund a significant portion of the scale-up.

Some companies are trying to position themselves as more than just biofuel companies, but as biochemical or even environmental or pharmaceutical companies, because their engineered organisms are able to synthesize molecules in such a way that you can make different end-products out of them. In these cases they actually do pair up with the big pharmas. In essence, these advanced biofuels companies are replicating what the small biotech R&D shops did in terms of borrowing the balance sheet of the bigger players to validate their technologies.

## *Ernst & Young:* Looking out over the next five years, what markets do you think will yield the most interesting investment opportunities?

**Paul Ho:** I believe that the US market will continue to be attractive, particularly in solar development. The solar investment tax credits are in place at least through 2016, and the cost of PV is expected to continue to fall during this time period. There is a lot of industry support, a lot of utilities willing to sign PPAs, and a lot of developers continuing to build viable projects. Not only will the US market gain from efficiencies in installation practices, but financing and customer acquisition costs are also falling, opening up new sales channels in the residential market.

Northern Europe is still very robust. These countries have a very firm commitment to the EU's 2020 renewable energy target and are fiscally sound.

We are also positive on selected Latin American markets, particularly Brazil's hydro, biomass and wind sectors. Chile is also an attractive market given its highpriced power and robust economy.

China has emerged as a leader in the global clean energy market, second only to the US in 2011 with total investment of US\$45b. From a developer's perspective, China is hard to break into as a foreigner because the big state-owned enterprises are so dominant. However, we think China is going to continue playing a crucial role in the manufacturing value chain, as well as in project development. It is hard to beat China's low cost of capital and scale, particularly in the basic manufacturing areas like wind turbines and solar panels. Although consolidation is imminent, we expect successful Chinese value chain companies to continue to increase their global market shares. Unknowns include exogenous factors, such as political intervention by way of trade barriers, antitrust issues and national security concerns related to the electric grid.

But overall, from a clean energy investor's standpoint, the current market malaise provides a unique opportunity to invest at a lower point of the cycle at attractive valuations in many areas. For those who have conviction about the clean energy market and a good read on potential winners, this is a great time to invest. //

## Solar and wind – more bang for your buck

by **Angus McCrone**, Chief Editor, Bloomberg New Energy Finance



Renewable energy – nice idea, but expensive, intermittent, unreliable and immature; better to give our consumers and industries the cheapest electricity we can, by sticking to tried and trusted generation technologies, such as nuclear, coal and gas.

That is a widely held view. Since the economic recovery from the 2008–09 recession started to stumble, it is a line that is increasingly heard from politicians and members of the public.

Ironically, just as that opinion is being voiced more often, the factual foundations supporting it have been crumbling. Renewable power was certainly expensive and immature 10 years ago, but its competitiveness has changed significantly in the last four years – brought about by a combination of technological improvement, economies of scale in manufacturing and low-cost Asian production.

The transformation has further to go, however, and it has not applied to all renewable power technologies. Small and large hydroelectric, for instance, is a mature sector and remains broadly where it has been for decades – competitive with fossil fuels. Geothermal is also mature and can be one of the cheapest forms of generation in the best locations. Wave and tidal technologies are still costly, with dozens of rival devices at the prototype or pilot stage, vying for what could be a big market in the future. Biomass and waste-to-power are types of generation with a wide range of costs per megawatt-hour, depending on the feedstock used and the size of the plant. Offshore wind has seen costs

increase recently, as projects have moved into deeper water, but like solar thermal, or CSP, it has the potential to improve costcompetitiveness in the next decade.

The big changes have occurred in the two renewable power technologies that have attracted by far the biggest shares of investment over recent years – onshore wind and solar photovoltaics (PV).

Between them, onshore wind and PV accounted for some US\$220 billion of the US\$240 billion invested in renewable power and fuels capacity (excluding large hydro) in 2011, according to figures from the Bloomberg New Energy Finance database. By comparison, the amount invested in fossil-fuel generation, including replacement capacity, was US\$302 billion last year.



Onshore wind farms vary from the singleturbine projects of one or two megawatts to the world's largest, such as the 600MW Cogealac installation in Romania or the 782MW Roscoe Wind Farm in Texas. PV has even more size variation, from large-scale plants such as the 85MW Montalto di Castro complex in Italy to rooftop installations of just three, two or even one panel on residential rooftops from California to Sydney.

Looking at PV first, because it shows the most striking shift in price-competitiveness in recent years, the cost of a solar module has been in long-term decline since its invention in the 1950s. But in the mid-2000s, this trend stopped for a while. The German, and then Spanish, subsidy programs for PV were so popular that there was severe excess demand in the industry, affecting the cost of everything from polysilicon raw material to ingots, wafers, cells, modules, inverters and installation.

Then, after Spain's generous feed-in tariff expired in the third quarter of 2008, the industry switched suddenly from excess demand to excess supply. Huge amounts of new production capacity, particularly in China, came on stream, and even though world demand was still rising, supply was increasing much more quickly.

Since that third quarter of 2008, the average price of a PV module has fallen by 75% – and the reduction in the calendar year 2011 alone was nearly 50%. This is not quite the same as the cost of generation, since that also includes the expenses of development and installation, operation and maintenance. Nevertheless, according to Bloomberg New Energy Finance's levelized cost-of-energy model, which compares the competitiveness of different generation sources, PV electricity fell by between 20% and 26% – depending on the exact technology used – in the year ending the fourth quarter of 2011.

Nonetheless, PV remains significantly more expensive than coal- or gas-fired generation as a way of producing wholesale electricity. Even if the gap is narrowing, it is still more than twice as costly, on average. However, there are three important factors to bear in mind. The first is that there is also the carbon cost of gas and coal power. This is not imposed on the power sector in many countries, and even where it is, as in the European Union, market prices of carbon credits appear to be much lower than the real cost of the emissions to the planet.

The second is that PV's competitiveness is expected to continue to improve as the technology matures. Bloomberg New Energy Finance forecasts that the utility-scale system cost of PV, including balance-of-plant, will fall from an average of US\$2.65 per watt in 2011 to US\$1.44 per watt by 2020. Meanwhile, the costs of rooftop installation are also likely to decline sharply, as panels become easier to link up and teams become more efficient at installing them.

The third, and most significant, factor is that even if the cost of PV power remains well above the wholesale price of electricity, in many countries it is already competitive with the retail price of electricity. This means that households and small businesses will save money if they install PV on their rooftops and use it to generate a part of their own power. This is the case even without subsidies.

According to our calculations, by 2012 this point had already been reached in some countries in Europe where electricity is costly, such as Denmark, Germany, Italy and Spain, and in Australia and Brazil. By 2015, with further cost improvements, it will also apply to France, Israel, Japan and many states of the US.

In onshore wind, the cost shift has been quieter and more subtle. As with PV, there was a period (in this case, up to the first half of 2009) in which wind turbine prices actually increased as demand ran ahead of supply.





However, since then, turbine prices per megawatt have fallen steadily – from  $\leq 1.21$ million, to  $\leq 0.93$  million in the first half of this year, and  $\leq 0.91$  million for turbines already ordered but not due to be delivered until the second half of next year. These figures are given in euros, not dollars, since Europe is a bigger manufacturing center for turbines than the US is. But the decline in dollar terms would be similar – between 20% and 25% since early 2009.

The same levelized cost-of-energy model as used for PV shows that the cost of generating electricity from onshore wind fell 9% in the year ending the fourth guarter of 2011, edging its cost per megawatthour closer to that of combined-cycle gas turbines and coal-fired power stations. The analysis of Bloomberg New Energy Finance suggests that wind farms in the best locations are already competitive with coal and gas generation, even without subsidies or carbon prices, and that by 2016, this will be the case with average onshore wind projects worldwide. Similar factors will be at work as in PV, particularly improving technology, with bigger and bettersited turbines, low-cost manufacturing, particularly in Chinese factories, and efficiencies in operations and maintenance.

With these improvements achieved, or in sight, why aren't champagne corks popping in the renewable energy sector? One reason is that the same industry changes that have fueled the cost improvements in onshore wind and PV have been painful for manufacturers and their finances – so much so that in 2011, there was a string of bankruptcies in the solar supply chain, and clean energy share prices plunged 40%.

Even more important is that while the long term looks very promising for renewable power, the short term appears uncertain and even troubled. The subsidies that have helped take onshore wind and PV to the brink of competitiveness are under pressure in both Europe and North America, as governments respond to the continuing distress of consumers and businesses four years after the start of the recession. And while prospects for both coal and nuclear power stations look bleak in developed economies, shale gas discoveries in recent years have strengthened the appeal of gasfired generation – in the US, in particular.

From 2012 onward, it looks like the growth of renewable power will be led not by the European Union or North America, or even by China, which has been by far the largest investor in wind in recent years, but by what used to be called in the sector the "rest of the world."

India was the country that saw the sharpest percentage rise in renewable energy investment in 2011, up 62% to US\$12.3 billion, and Brazil was another strong player, with a 9% rise to US\$7.5 billion. From Morocco to South Africa, Japan to Mexico, electricity sectors are preparing to make step-increases in renewable power investment – often after carefully absorbing the lessons from Europe and North America on how to ensure the greatest deployment at the lowest cost to the consumer. //

## Interview with Mark Vachon Vice President, GE ecomagination

*Mark Vachon*, a 29-year GE veteran, Corporate Officer and member of GE's Corporate Executive Council, leads ecomagination, GE's business strategy that has invested more than US\$5 billion in cleantech research and development and generated US\$105 billion in revenues through 2011.

shakeout. Survivors will be well positioned on the other side.

GE's strength, broadly, is to drive down the cost curve while driving up quality and reliability. We've done it in wind and are confident we can do it in solar too. We are committed to the space and, therefore, plan on being one of the winners left standing when it all shakes out.

*Ernst & Young:* GE's growth in wind is an example of how the ecomagination strategy has been a success. What lessons were learned from the effort?

*Mark Vachon:* This is hard work. But ecomagination works because it is more than a sustainability initiative. Interestingly

enough, something like two-thirds of sustainability-based programs will fail. And the reason they will fail is that there isn't an economic imperative there. GE has always been unapologetic that ecomagination is a business strategy with a commercial foundation. Through ecomagination, we can deliver increased efficiency based on environmental design requirements.

We bring to the challenge great leadership in environment, health and safety compliance. We don't talk about that a whole lot. But we have done some great things in all of these areas. Another strength of ecomagination is that it brings a portfolio of real solutions that have a significant environmental value proposition for our customer base. And there are not a lot of customers or companies that have that third tier of opportunity.

*Ernst & Young:* There have been big changes in the US renewable energy marketplace over the past year. How has GE responded?

*Mark Vachon:* To start, the elimination of the production tax credit (PTC) accelerated orders, which in the near term has been fabulous. We will book record sales this year in wind, in part because of that credit. The downside is that the big sales this year point to a slowdown in 2013.

More broadly, in both solar and wind, overcapacity and the retreat of incentives will lead to a shakeout. Would we prefer a smoother industry performance? Yes, but in some respects, the company with the strongest technology and healthiest balance sheet will be best able to withstand the In terms of lessons, efforts like ecomagination cannot be led from the environmental, health and safety (EHS) department. They have to be led by the CEO. For us, Jeff [Immelt] led and supported ecomagination from the very beginning. Those factors are the reason ecomagination has been successful.

## *Ernst & Young:* Looking ahead into the next year or two, will there be any changes to ecomagination in terms of focus on R&D or investment?

*Mark Vachon:* The level of resource commitment won't change. GE has a public commitment to spend US\$10 billion from 2010 to 2015 – that's double the prior five-year period. Geographic priorities will continue to shift. I have been in the role a year and a half, and I have spent most of my time outside of the United States, whether in China, Australia or Canada. In the US, one of the macro dynamics is the natural gas revolution. This is creating consternation, of course, as a threat to renewables. But it's also a huge opportunity. Europe remains a focus – particularly as a regulatory leader. And we will focus on Brazil too.

### *Ernst & Young:* How is the natural gas rush affecting your business?

Mark Vachon: Given our commitment to renewables, it may seem counterintuitive, but the gas boom has the potential to be positive. Last year, we announced our Flex 50 gas turbine, which was developed using technology borrowed from our aviation business. If you fly planes, you know the importance of flexible capability. Being able to power up a jet engine and then throttle back is similar to the challenge facing a utility that has to ramp up a turbine in less than 30 minutes to pump out significant megawatts. This is a perfect solution to help balance out generation when the wind dies down and wind turbines stop spinning. The shift away from other fossil fuels that aren't as clean as natural gas will be really important too.

### *Ernst & Young:* As you travel, what are the key issues in other markets?

*Mark Vachon:* It varies by region. In Germany, when you decide to exit nuclear, you get a huge generation challenge that will probably result in more distributed energy. When you look at Australia, we believe the pricing of carbon will hold there, even as the government changes, and that means more renewables.

In China, it is all the above with coal at the center and a growing commitment to renewables and nuclear. We will certainly do some experiments in electric vehicles and continue to push renewables there. But, if we can get the gas mix there up substantially, that will help them. That's certainly part of Beijing's 12<sup>th</sup> Five Year Plan.

In Brazil, you'll find more biofuels as a mix of priorities. In Canada, the challenge is how to manage the oil sands and other resources in an environmentally sensitive way. Here in the US, with shale gas, the question is, how do we manage the water challenges associated with that while tapping into an amazing resource.

## *Ernst & Young:* How have the financial crisis and economic recession altered concerns around climate change, renewables and efficiency?

*Mark Vachon:* We believe in climate science. At GE, we made that decision seven years ago and have been acting on it since. Yet, in the broader community, what you find is those who want to keep pounding the climate change science drum are losing credibility. That's because they're pounding the drum, but are not acting.

Our belief is: let's get busy with the answer. Whether you believe in climate change or not, resource efficiency is a classic business productivity focus that has always been relevant. Customers are very interested in that conversation no matter what their take on climate change. To the extent that climate change can lay a heavy burden of "saving the world" on a conversation, we lose time and we lose focus on real solutions to real problems. When I was in Brussels a few weeks ago, meeting with the EU Commissioner of Environment, they were saying the same thing. They have the same market focus as GE on energy efficiency. So I think if there has been a shift away from climate change and toward efficiency, it would have happened even without the economic downturn.

*Ernst & Young:* Another effect of this crisis has been the retreat of government leadership on some energy and environment issues. Have we seen a shift in the role business must play?

Mark Vachon: Yes, business increasingly needs to be the leader. That's about innovating and delivering solutions that speak to the reality of constrained resources, regardless of government engagement. We are planning on very little government role. That said, this will cycle over time. In five years or so, the momentum may have returned to the government.

*Ernst & Young:* The market difficulties of the past few years have meant a shortage of capital and the need for new funding models. How do you see the capital drought playing out in the energy space?

*Mark Vachon:* We play in this space through Energy Financial Services, which does a lot of project financing. In this area, I think the opportunities will be fewer and more focused near term, but we will still play there. We do equity investing as well, and we will continue to do it. We've also developed a competency in crowd sourcing new innovation in this energy space through the ecomagination Challenge. Our role there will continue to identify and cultivate new ideas.

More importantly though, there is huge pent-up demand for later-stage financing among venture-capital-financed energy start-ups. The phone calls that are coming in to us are increasingly voluminous and desperate. I think there is going to be a bit of a crash on some of the stuff that has received early funding, but that can't find mid-stage capital. There's certainly going to be a lot better deals, and I think corporations such as GE will be natural potential partners. But in considering acquisitions, we will be very selective.

Beyond money, I would also say we have a real ability to help develop these ideas through a phase of reducing their technology risk, and also help debug their business models. Through our ecomagination Challenge, we help accelerate innovation by providing a bit of money and actually working with our partners to get them to scale faster.

*Ernst & Young:* Given instability in the Mideast, we've returned to a time of heightened anxiety around oil supplies, as well as renewed worries about nuclear in the wake of Fukushima. What are you seeing among your clients in terms of energy strategy?

*Mark Vachon:* Talking about this globally, it's a challenge to move individual wedges of the total pie of energy use in any short period of time. But looking at what's in motion, I think gas will take a bigger share in time. Renewables will continue, if not as robustly as in the past. Nuclear will certainly go sideways for a while.

Stepping back a bit further, thinking about the long term in our lifetimes and our children's too, the world will continue to be based on fossil fuels.

So at GE, through our ecomagination strategy, we're looking at how we help manage that reality in terms of extraction, distribution, utilization, re-use. We're at work on the innovations and technologies that we can apply to make this as environmentally productive as possible. //





## Cleantech IPOs: are you ready?

by **Heather Sibley**, Global Cleantech Assurance Leader, Ernst & Young



Initial public offerings (IPOs) are increasingly on the cleantech radar screen. Driving this interest are waning sources of traditional venture capital (VC) and government funding in some parts of the world, and economic growth in others. For vital working capital to fuel growth, boost production, expand internationally and bring promising new technologies to market, many cleantech firms are considering IPOs.

In mature markets, cleantech firms are looking to IPOs to offset shrinking subsidies as governments pare down debt and trim essential services. Spain, for example, temporarily froze new renewable-project incentives in January to cut a tariff deficit amid 23% unemployment. For similar reasons, Germany is slashing feed-intariffs up to 30%, prompting protests and outcries from cleantech companies. The US, likewise, may let the production tax credit for renewable energy sunset. Such subsidies have thrown a lifeline to many early-stage ventures. But with yawning budget deficits in many countries, subsidies are a hot button issue.

Drivers of demand for public equity in the bustling economies of China and Brazil, by contrast, include funding a healthy alternative energy appetite to meet rising industrial, commercial and consumer demand. China is increasingly focusing on energy efficiency, renewable energy and water. Two of the world's top ten venture-backed IPOs in 2011 were Chinese cleantech companies, prompting their peers to consider public offerings. Worldwide, more than two in three IPOs in 2011 were in emerging markets, according to Ernst & Young's Venture Insights, led by Chinese wind-turbine maker Dalian Sinovel Wind. Cleantech company expansion to the high-growth markets of Asia, Africa and South America is also fueling the fresh capital search.

Finally, many VC-backed companies sit on the cusp of commercialization. Over the last seven or so years, VC firms have invested substantial sums in thousands of cleantech companies. There are currently 1,400 private cleantech companies around the world that have raised US\$27b in venture capital to date, according to Dow Jones VentureSource. But because VCs rarely fund the costly commercialization phase of cleantech, many of them seek an exit and management seeks a new source of capital through an IPO.



Ernst & Young has tracked some 40 cleantech companies in IPO registration globally as of April 2012, but feedback from our clients suggests that there are many more looking for a public listing opportunity. With just 34 cleantech-related IPOs raising US\$6.2b in 2011, down from 52 transactions worth US\$13.3b in 2010, there is likely scope for a rebound with the right market conditions.

But the relative youth of many cleantech firms means they often lack the infrastructure, systems or teams to meet heightened public market scrutiny and investor expectations. For cleantech company executive teams considering an IPO, the key question then becomes: are you ready?

### Transformational shift

Indeed, the leap to an IPO is neither easy nor intuitive. Rather than a step change to meet interim milestones – often the VC or government-reporting route – IPO preparation requires a major shift in mindset among management, staff and investors. In other words, the road to an IPO is a transformational journey, not a one-off transaction.

This shift requires management to step back and review plans, processes and people at a very high level. Compliance is, of course, part of the picture. But only with a holistic, long-term and global vision can companies meet basic shareholder demands with a strong, flexible and enduring foundation for long-term growth.

### Start early and embrace change

"Change" is the operative word when preparing for an IPO – for management, businesses, operations and the corporate culture. And true change takes time. So an early start allows management to engage staff in fine-tuning business models and processes, to secure buy-in and initiate a true metamorphosis.

The IPO should be viewed as a first step in a long journey toward market leadership. Instituting measures to serve more demanding investors sets the stage for delivering on the pre-IPO promise of real and enduring growth in today's increasingly challenging environment. An IPO today means being subject to public scrutiny during a time of slowing global growth, political turmoil, macroeconomic instability, fierce competition, talent shortages and market volatility. Pre-IPO goals should address and invest in these new realities. Leading companies can prosper through innovation, cost-competitiveness, global expansion and operational agility

Because shareholders demand more rigorous compliance and guidance than private investors, thorough due diligence of a company's operational framework and financial and legal constructs in the early stages is imperative. Areas that may merit review include tax structures, compensation plans and business processes. By building a strong but flexible due diligence infrastructure founded on strong internal controls, financial reporting policies and corporate governance principles, management can assess risks, measure exposure and plan ahead for a variety of scenarios.

Sufficient lead time should be allotted to build a watertight legal, financial, technological and risk management infrastructure; to address key financial and reporting issues (including stock-option issuance, revenue recognition practices and segment-reporting processes); and to establish realistic guidance and forecasts. In particular, it is important to understand the key IFRS or US GAAP issues unique to a given cleantech vertical and the implications for the business. For example, whether wind, solar or electric vehicles, each cleantech segment has different sales practices and value-chain interactions that must be addressed in public financial reporting.

By operating like a public company while still private, a company can give its current investors an opportunity to weigh in on drafts of quarterly and annual filings and press releases and prepare to pose and respond to challenging queries early. It also provides an opportunity to test whether the company can close its books and prepare its financial reporting within regulatory time limits but without the risk of a public misstep.

Thorough, timely preparation for an IPO does not guarantee success. But it is an indicator. Companies that beat the market after an IPO typically implemented critical organizational changes as much as two years before going public, according to a recent Ernst & Young study.

### Create experienced, focused teams

Perhaps one of the most important pre-IPO steps is assembling the right management team. Choosing and investing in seasoned C-suite executives with both public company experience and deep industry knowledge help ensure a smooth IPO journey and organizational success in the years that follow. Because shareholders will seek answers and a vision from the CFO or CEO, fortifying these roles demands particular attention. Executives would also be wise to instill the prerequisite public-company skills in finance, accounting, sales and marketing, R&D and operations teams.





New board expertise should, likewise, comprise a broad mix of strategic planning, industry knowledge, compliance, governance, compensation and risk management skills, as well as previous experience in business development through organic growth or mergers and acquisitions and raising money from the public markets. The board's size, structure, quality and depth should also align with the post-IPO company's strategic goals.

To guide the company through this critical IPO preparation stage, a thoughtful selection of advisors, including attorneys, underwriters, auditors, transaction specialists and business-process experts is crucial. A strong and integrated advisory team can help management create new financial controls, design performance metrics, prepare accurate forecasts, implement disciplined reporting procedures that meet public market standards, and close the books within reasonable time frames. Given the relative newness of the public cleantech sector, selecting a team of the right advisors may involve looking to those with analogous experiences in other industries, such as leasing, structured finance and so forth.

### Take the long view

The IPO is a daunting, exhausting undertaking. But it is only one step in a long value-creating journey. To avoid distraction and keep an organization on point, IPO preparation should be tackled much more like a marathon than a sprint – slowly, thoughtfully and diligently. A watchful eye on the finish line through robust planning, accurate expectation-setting, smooth, swift operational execution and overseeing the continuity of day-to-day operations lays a strong foundation for better management, stable operations and accelerated growth in the years that follow.

The growing interest in IPOs among cleantech companies reflects the maturation of the industry – companies are ready to move to the next phase of growth and seeking the financing source to take them there. But to create enduring value, and to create a track record of successful public equity financings, it is important for the current wave of cleantech companies lining up to go public to be ready for a successful IPO transformation. //

## Strategy in a time of uncertain incentives

Paul Naumoff, Global Cleantech and CCaSS Tax Leader, Ernst & Young LLP

Michael Bernier, Tax Credit Investment, Advisory Leader, Ernst & Young LLP



Decisions concerning large, often irreversible investments in long-term renewable energy assets generally depend on bankable longterm visibility into asset utilization and prices received for asset outputs. Thus, conventional wisdom suggests that changes to cleantech incentives, such as subsidies, grants and credits, should be handled in a predictable way.

But after the global financial downturn, it's not so simple. Many governments around the world, particularly in more mature economies, must pare down debt and implement painful austerity measures. Against this backdrop, government financial support of renewable energy programs is politically charged, rapidly changing and rife with uncertainty. Over the last year, Spain, for example, froze all new support for renewable projects overnight in the face of unexpectedly high tariff costs and budget deficits. Similarly, the UK's solar feed-in tariff (FIT) rates were cut in March 2012. Neighboring Ireland also announced plans to remove FIT subsidies for offshore wind power. Portugal eliminated licenses for new renewable projects as an International Monetary Fund bailout precondition. Meanwhile, debate raged in Germany over proposals to limit solar photovoltaic (PV) capacity to one gigawatt. In the US, the 1603 Treasury Grant Program expired at the end of 2011, and policy debate has swirled around the question of extending the federal Renewable Electricity Production Tax Credit for wind. And across the world, 300 of China's 728

solar PV makers halved output or shuttered operations after the country's National Development and Reform Commission Energy Research Institute urged Chinese manufacturers to cut output. Finally, Israel's Public Utility Authority said it would trim solar power FITs by 22%.

Such rapid changes and murky visibility deter decision-making. An investment in a new market where expected subsidies evaporate can generate significant financial losses. Conversely, late arrival in a new or growing market could result in missed, potentially lucrative opportunities and an uphill battle to increase sales. Throw in the massive capital investment necessary for clean energy infrastructure, sometimes lengthy regulatory approval requirements and other moving parts that must fall



into place, like supply chains or additional funding, and it's no wonder that even intrepid entrepreneurs delay decisions or pursue other opportunities to avoid risk. So how does one build a 20-year cleantech business plan amid shifting annual incentives?

The key to long-term success lies in a broad and deep analysis of possible outcomes through a decision tree that tracks likely impacts from root system to branches. The complex interplay between regulatory changes and market opportunities demands sophisticated scenario and strategic planning based on a company's resources, competitive advantages and goals amid emerging and sometimes mercurial global opportunities. Indeed, smart movers may find a world of opportunity in uncertainty and position themselves strongly for the long haul.

Imagine that a pure-play wind turbine maker publicizes plans to curb US production because sales projections are unclear as a result of legislative uncertainty. Such poor visibility already crimps purchases because wind turbines must be ordered months, if not years, in advance. The turbine maker's early retreat is thus motivated by preemptive cost savings and loss avoidance. It is based on signs that are either unclear or point to reduced demand for wind turbines as sentiment shifts toward legislation that may not favor the wind sector.

But if visibility improves or new pro-wind programs emerge, the company is illequipped to meet a rapid rise in turbine demand. By retrenching at that particular time, the turbine maker risks losing the market to competitors, either those with big balance sheets and the resources to wait it out, or pure-play manufacturers aggressively seeking new orders.

Alternatively, the turbine maker could stay in the market and slash prices to trigger demand. Short term, this strategy might help it grow market share and perhaps unseat other pure-play competitors – particularly low-cost manufacturers that can ill afford to erode margins further. But in the long term, these tactical moves would better position the turbine maker for a potential turnaround. This scenario has played out time and again, both in the wind and other renewable energy sectors.

As one can see, there is no simple strategic approach. Questions to pose amid such uncertainty include:

- Does one manufacturer's retrenching open the door to another, both to capture and keep market share from the departing company, even if it returns in the future?
- Will profits suffer if this pure-play absorbs shipping costs for turbines manufactured abroad?
- How will yet another company's slashing prices to sustain demand impact profit margins across the industry?
- Does leaving this market weigh on the pure-play's relationship with key suppliers for its other factories?

Every player operates under particular circumstances and should thus pursue a tailored, company-specific strategy. This means that multiple players will often follow fundamentally different strategies. And each company's action or inaction impacts its competitors' risks and opportunities globally, often with less than obvious correlated results. So, like a chess game, each strategic action (or inaction) should be planned two to three steps ahead. This exercise is applicable around the world.

Cleantech investment decisions are often grounded in the long-term visibility of cost saving or revenue-generating drivers like grants or feed-in-tariffs for asset procurement and pricing services and products. But today's regulatory uncertainty is settling in as the new normal. Against this backdrop, quick and strategic responses to bimonthly rather than every 10-year macro drivers open the door to once-in-a-lifetime opportunities. Broad, deep and thoughtful scenario analysis, planning and action will set apart astute and nimble cleantech companies both today and tomorrow. //

## Industry leader interview with president of Accona

Interview with **Carmen Becerril**, President, ACCIONA Energy

ACCIONA Energy, the energy division of the ACCIONA Group, is a world leader in renewable energy. Its mission is to demonstrate the technical and economic viability of a new energy model based on sustainability.



### *Ernst & Young*: What are the key drivers of ACCIONA's 's energy business?

*Carmen Becerril:* Most important, we consider a government's commitment to renewables, whether it needs new energy and if its policy is stable and good. Building renewables is capital intensive, so access to funding and the cost of capital are critical to our success. Conversely, regulatory uncertainty is the most troublesome risk when we consider a market.

This is why so many equity funds are drawn to Germany right now. There is very little technological risk in wind – or solar, for that matter. Given Germany's track record of support for renewables, there's little worry that regulations will change over the coming decade. Of course, because the risk is lower, the return on the investment is lower there than elsewhere.

### *Ernst & Young:* Yet in many developed markets, public subsidies and regulatory support for renewable energy are declining. Is this affecting your strategy?

*Carmen Becerril:* With the financial crisis and political shifts in many developed markets, it's been tricky for renewables.

But I'm not at all negative about the prospects: there have been many events that support the case for renewables.

We have been concerned with all the conflict in the Middle East and North Africa. We have seen Fukushima. Oil prices have been increasing again. In Europe, gasoline prices are nearing new highs. At the same time, the technical maturity of several technologies – particularly wind and solar photovoltaic (PV) – is lowering investment risk.

Overall, the International Energy Agency (IEA) predicts that renewables will grow by 58% from 2009 to 2035. This outpaces the increase expected for any other energy type, whether coal, oil, natural gas or nuclear.

In OECD countries, the IEA expects that 89% of the increase in energy capacity over the next 25 years will come from renewables. Oil and coal are going to fall. Renewables will cover nearly all the new demand, along with some nuclear and new natural gas capacity. Globally, it's clear there is a strong long-term growth opportunity to develop renewables.

### *Ernst & Young:* How does the outlook vary by region?

*Carmen Becerril:* In Europe, subsidies have been reduced in the past year. And the US has become one of the more difficult markets for the moment. But the rest of the world is moving ahead. Some non-OECD countries, particularly developing economies, are beginning to focus on developing renewables. They are designing regulatory frameworks, or at least beginning to sign contracts or power purchase agreements, of a quality that ensures project financing. In the near and medium term, Asia and Latin America are really open to renewables. Further out, Africa has enormous potential.

## *Ernst & Young:* What are the factors that make the US market particularly challenging?

*Carmen Becerril:* In the US, renewables face two challenges. First, the price of natural gas is historically low, at under US\$3 per million BTUs. Second, the PTC will end in December 2012. The situation makes it nearly impossible to plan new investment if the projects aren't going to be completed before year-end.

At ACCIONA, we are finishing our last development in the US until we know more about the resolution of the PTC and other incentives. And while we have several nice developments in the pipeline, it will be impossible to finalize them until policy is clearer. We have to be confident that, after the elections, the new government, whether Democrat or Republican, will review these issues and redefine the framework to promote new investment.

### *Ernst & Young:* You note that the rest of the world is moving ahead – what is driving the adoption of renewables?

*Carmen Becerril:* Locally sourced energy reduces dependency on imports, improves security and stimulates the economy. Renewables do all this, and they also

add the benefit of being clean, with little environmental impact. Price stability is another strength for renewables. The rapid rise and fall of oil prices is very stressful for economic growth, particularly in emergingmarket economies. Yet renewables offer steady, or even falling, pricing over the span of decades. This is also one of the reasons we see big companies, in addition to utilities, investing directly in renewable energy capacity for their own use. They want to ensure long-term price stability.

Ernst & Young: As you mentioned, natural gas prices are low and are projected to stay low as shale gas from the US and other markets comes on line. What is your perspective on the impact of low gas prices on renewable energy development?

*Carmen Becerril:* There is a need to replace aging coal power plants in the US. Yet, because of environmental concerns, it's nearly impossible to think that new coal will be built. Low-cost natural gas is seen as a good replacement. But it is also important to have a mix of energy sources. In this sense, renewables and natural gas can complement each other, with wind and solar delivering low-cost, green energy and natural gas stepping in to help smooth out the irregularity of their output.

While climate change concerns have receded as a priority because of the financial crisis and economic recession, the issue has not gone away. Public opinion, government policy and companies all still have it on their agendas. There's a clear understanding that we have to do whatever we can to prevent more than a two-degree rise in average global temperatures. Yet the door to avoid such a two-degree change is closing fast.

Natural gas is part of a balanced mix. And where it replaces coal, there is a real emissions reduction. So it will be part of new capacity. Renewables will also be a very significant part of new power capacity. I'm sure we will recover commitment to climate change concerns, especially as we see the trajectory beyond a two-degree change. This is not the world we can leave for our children or for future generations.

## *Ernst & Young:* What are the most important new innovations that ACCIONA is bringing to market?

**Carmen Becerril:** In wind, one of the most important is our work to develop floating structures for offshore wind. Today, most offshore wind is built on foundations; this limits the depth where turbines can be built and raises prices. We are exploring how to create floating turbine structures to tap wind resources on sites such as the Spanish coast, where depths exceed 50 meters. We are also working on very large turbines, including a six-megawatt design that we hope could be deployed either onshore or offshore.

In solar, we're already a leading developer of concentrating solar thermal (CST) energy, which uses the sun's heat to drive a turbine. We've built 64 MW of CST in Nevada and another 200MW in Spain, and we hope to add 50MW more there this year. We're refining these technologies as we develop the projects, improving the design of parabolic mirrors and other systems to boost the output of the plants.

We're also exploring storage technology. Hydrogen, as a storage medium, could be generated by using wind or solar energy to split water molecules and then converted back into energy when needed.

## *Ernst & Young:* Looking ahead, what are the most promising technologies to watch for?

**Carmen Becerril:** Given its technical maturity and low cost, wind will continue to dominate renewable energy growth for some time to come. Watch for more technical progress in solar. PV is falling in price so quickly that it will match the price of wind fairly soon.

And for CST, there is great promise in energy storage and for improved performance. This technology cannot work in every market, but in sunny regions, it promises to have a very strong role. It's already easier to store, in the form of thermal energy. That increases its value, because it can then produce power 24 hours a day, not just when the sun is shining. //

## Brazil's clean energy goals

Wind and biofuels will boost its already sizeable renewable energy sector

Daniel Maranhão, South America/Brazil Cleantech Leader, Ernst & Young



Famous for its verdant rain forest and sunsoaked beaches, Brazil is less well-known as a superpower of renewable energy.

Yet, that's what it is. Coursing across its electrical grid, 83% of the nation's power comes from renewable sources – one of the highest levels of any large economy. On its roads, Brazil's cars and trucks are powered by fuel that contains a fifth or more of plantderived ethanol – a higher share than in any other major nation. All together, about 45% of Brazil's total energy is drawn from water, biomass, wind or renewable sources. In the US, that figure is 12%.

It's an impressive feat. Yet Brazil's planners recognize they'll have to repeat the success, and then some, as energy supplies are stretched. The population is expected to rise by 15 million this decade, to 205 million. By 2030, Brazil will be the world's fourth largest economy, after China, the US and India,President Dilma Rousseff has predicted.

Brazil is also attracting growing international attention. As host to a series of global events, including the World Cup in 2014 and the Olympics two years later, Brazil is racing to modernize and green its economy. This June, Brazil hosted the United Nations Conference on Sustainable Development, or Rio+20, as it's come to be known. The event marked the 20<sup>th</sup> anniversary of the United Nations Conference on Environment & Development (UNCED), a landmark meeting recognized as the birthplace of subsequent national and multilateral clean energy programs. Commenting on the influence of Rio+20 on Brazil's economic agenda, President Rousseff recently wrote in *The Economist*, "We should all move to a more environmentally sustainable economic model ... Rather than being a cost, this can open new opportunities for investment and employment within countries, as well as more co-operation between them."

Brazil's demand for primary energy supplies will grow by roughly 60% this decade. By 2020, for example, the share of homes with washers will grow to 75% from 64%. Air conditioners, relatively rare in this tropical country, will soon be in one-third of homes, up from just one in five a few years ago. And the number of TVs per household is expected to grow to 1.71 from 1.37.

### Key points

- Brazil is on track to become the world's fourth largest economy by 2030 and aims to meet rising energy demand by expanding a long-established commitment to renewable sources.
- With new sources of hydropower constrained, wind power has become a top priority and is on track to grow sevenfold to 22GW by 2020.
- Already the world's number two producer of ethanol, Brazil's rising vehicle ownership will help spur ethanol output to grow by 10% per year this decade.
- Long term, Brazil's ethanol producers may find export potential in the US, which dropped tariff barriers to ethanol imports last year.
- As Brazil's conventional petroleum sector booms, competition is growing for many of the human resources, raw materials and capital goods that renewables developers will also need.



Overall, per capita power consumption in Brazil stands at 560 kilowatt hours (kWh) per year, one-eighth that of the US.

Meeting this demand, while sticking to a pledge to lower national greenhouse gas emissions by about one-third by 2020, will require investments on the order of R\$190 billion (US\$123 billion), according to an energy plan recently published by Empresa de Pesquisa Energética, or EPE, a unit of the Ministry of Mines & Energy. Of this, some R\$100 billion (US\$64 billion) will go toward renewable projects not yet contracted, with 55% targeted on large hydropower and the remainder toward wind, biomass and small hydro. For all the promise of Brazil's renewables, no energy outlook would be complete without acknowledging the country's petroleum sector. Already largely self-sufficient in terms of fossil fuel demand, the nation's broader energy outlook has been transformed in the past few years by the discovery and pending development of huge offshore oil and natural gas reserves. By 2020, these so-called presal – or "pre-salt"– reserves are expected to boost Brazil's effective domestic oil supplies by 77%. For renewable energy markets, the ripple effect of Brazil's oil boom may be resource constraints, whether in the form of shortages of engineering talent or costly construction materials. Developing the pre-sal fields, some have estimated, will absorb some US\$250 billion in investment in the coming decade. The scale of this expansion has triggered worries within the oil sector about a shortage of engineering, construction and professional skills, which are also key areas for wind and hydro developers.

Below, we focus on the outlook for wind power and biofuels, which are expected to lead Brazil's renewables investment.

### Brazil wind generation – cumulative capacity (MW)

#### Cumulative capacity (MW)



### Wind

While large-scale hydropower development continues – the 11.2 gigawatt (GW) Belo Monte on the River Xingu in the Amazonian state of Pará is slated to come online in 2015 – planners are intent on diversifying Brazil's generating capacity to include wind. Indeed, green as Brazil's grid may be today, there's growing consensus that needs exceed the potential of new hydropower.

Demand is expected to grow steadily, and national energy plans call for additions of more than 60 GW of generating capacity through 2020. Though wind provides less than 1% of electric supply today, the plan could take its share up to 7% in short order.

Despite estimates of total wind energy potential of some 350GW, just 1.5GW was online by the start of 2012. That total is expected to more than double to 3.2GW this year, before accelerating to 8.2GW by 2016. Come 2020, the total should hit 22GW, according to the Brazilian Wind Energy Association.

**Geography.** The bulk of Brazil's new wind projects are slated for the Nordeste (northeast) region. Thanks to the fortunate combination of flat land and windy coastal breezes, the region is estimated to have 75GW of wind potential.

Accordingly, the Nordeste is emerging as the epicenter of Brazil's fast-growing wind industry. Prior to 2012, the region was Source: Brazilian Wind Energy Association

home to 47 complexes with a total of 839 MW of capacity. Another 49 complexes are under construction and 129 more are licensed.

**Financing.** Wind farm development in Brazil has, to date, been done via an auction model, in which project developers bid for long-term contracts. The relatively large size and long tenures of these deals make it easier for developers to benefit from economies of scale and to commit financial resources.

The result? Wind energy in Brazil now ranks among the cheapest in the world. The latest bids in 2011 came in at under US\$55 per MWh, down nearly 70% from the earliest bids in 2004.

The main source of debt financing is Brazil's development bank, the state-owned National Bank for Economic and Social Development (BNDES), which typically cofinances wind projects by partnering with private capital sources. In the Northeast, for example, BNDES co-invested US\$2.3 billion in funding for projects in 2011. Private partners pitched in another US\$3.9 billion to finance a total of 863MW of new projects. In the rest of the country, BNDES added US\$1.6 billion to US\$2.3 billion in private funds to finance 479MW of new capacity.

"The market remains highly dependent on BNDES," says Lucio Teixeira, a director in Ernst & Young's São Paulo office. "Some players are also looking to international credit agencies for support." Private banks, he adds, are also a minor funding source.

**Deals.** The growth of Brazil's wind sector has sparked a round of acquisitions during the past year, as newcomers look to establish strategic entry.

During 2011 and early 2012, for instance, CPFL Renovaveis has committed R\$2.5 billion (US\$1.3 billion at current exchange rates [1 BRL = 0.491526 USD]) to build a portfolio totaling eight wind farms with a total capacity of 808MW. During the past year, Copel has been consolidating its holdings in the wind space, buying out partners in four wind projects to aggregate nearly 100MW in total capacity.

Mergers and acquisitions (M&A) will continue to gain momentum, Teixeira says, both to drive consolidation and as a source of reinvestment capital. Some project developers have opted to sell operational wind farms and use the funds to capitalize new projects. "In that sense, M&A are becoming a source of project funding," says Teixeira.

### In that sense, M&A are becoming a source of project funding

**Manufacturing.** While still small by global standards, Brazil's nascent wind industry has lured a growing list of the who's-who of global wind players. Alstom, FürhLander, Gamesa and Vestas have built manufacturing facilities in Brazil. Enercon, GE and Siemens are also scaling up Brazilian operations.

Increasing demand for turbine sub-systems, components and related design and installation services, is helping homegrown players to scale up. WEG is emerging as a major domestic supplier of electronic components. Tecsis has grown into the world's second largest manufacturer of turbine blades.

### Growing pains and other

**uncertainties.** If the rise of wind power in Brazil is all but inevitable, its pace and increasing sophistication may be constrained in the near term by human resource limits. Shortages of windspecific technical skills, as well as general engineering and construction manpower, are emerging as other energy sectors heat up and compete for top talent.

"In some areas in the south and northeast, where wind is growing fastest, local labor and infrastructure are being prepared to meet the demand," says Teixeira. "Some companies have to train the workers and build basic access road links in order to develop their plans." Transmission constraints may also slow development. There have been recurring problems linking proposed wind developments to transmission lines. The Government is considering a program that would make power contract auctions a predictable annual event. Such a move may ease the planning of long-term transmission development and capacity additions, according to a Pew report.

### Biofuel

Brazil's green transformation of its vehicle fleet ranks as one of the most successful such efforts ever. Sparked by the Mideast oil shock of the early 1970s, Brazil initiated an ambitious Programa Nacional do Álcool, or National Alcohol Program, known today simply as proalcool, calling for ethanol to substitute for a fourth or more of every gallon of gasoline sold. Since then, carmakers have equipped vehicles to handle ethanol blends of up to 85%.

Three decades on, the result is that Brazil has achieved the world's highest penetration of biofueled vehicles. Overall, ethanol accounts for about 40% of the fuel that Brazilians pump into their cars, according to the World Resources Institute. In the US, the comparable figure stands at just 3%.

**Supply.** Thanks to vast tracts of sugar cane, Brazil has emerged as a global leader in ethanol production, trailing only the US in total production.

Yet in 2011, Brazil's ethanol output retreated dramatically. Prices for sugar on international commodities markets hit a 30-year high, diverting much of the raw material needed by ethanol plants. Compounded by a period of underinvestment and weak harvests, Brazil's total ethanol output contracted by nearly onefifth in 2011. The shortfall forced Brazil to import corn ethanol from the US.

Imports are likely to continue over the next two or three years as immature cane crops come into production and processing capacity is switched back to ethanol. This year, growers may see improved incentives to do so, as the global outlook for bumper crops of cane, sugar beets and related crops has led to predictions of falling prices for sugar through 2012.

If raw cane is available, "Many Brazilian producers have the ability to switch production between ethanol and sugar quickly," says Renato Gennaro, a São Paulobased partner at Ernst & Young.

Brazil has taken both temporary and long-term steps to trim demand and improve industry oversight. Brasília has temporarily lowered the minimum share of ethanol blended into gasoline to 20% (known as E20), down from 25% (E25). In early 2012, the national fuel supply was averaging 20% to 22%.

Officials also made an administrative shift by bringing the ethanol sector under the jurisdiction of the state petroleum agency, Agência Nacional do Petróleo (ANP) while

### Brazilian ethanol production (2011-2011)

#### Thousand barrels per day



expanding the role of state-owned oil producer Petróleo Brasileiro, better known as Petrobras, in ethanol markets. The moves will help steer much-needed capital into the industry. "Investment in ethanol capacity has lagged," says Gennaro. "To meet future demand, additional funding will be necessary."

In the long term, potential exports offer added incentive for Brazil to boost investment. A long-standing barrier to sales to the US fell on New Year's Day 2012, when Washington ended decades-old subsidies of US corn ethanol while also curtailing longstanding tariffs on imported ethanol.

**Outlook.** Biofuel production, including a small but growing share of biodiesel, is expected to expand by 9.7% annually in the decade through 2021, according to Pike Research, with ethanol output reaching 61 billion liters per year. This volume is likely to exceed domestic demand by that time, Pike predicts.

But much depends on just how big demand for road fuel becomes, given that Brazilians are hitting the highways in growing numbers. Vehicle ownership is expected to roughly double to 56 million over the next decade, raising the rate of vehicle ownership from 150 vehicles per thousand habitants to more than 250, according to EPE.

Netting out the effects of the additional vehicles, a return to the E25 standard and potential exports, EPE predicts that ethanol demand will nearly triple to 73 billion liters per year by 2020 from 27 billion today. Source: EIA, International Energy Statistics; USDA

In any scenario, demand growth will be sizeable. Meeting this need represents an opportunity on the scale of R\$100 billion (US\$55 billion) in investment in the decade ahead to construct plants, pipelines, ports and related infrastructure, EPE estimates.

**Deals.** Since mid-decade, a series of consolidations has concentrated roughly 40% of market share among a half dozen ethanol producers. And further consolidation is likely, given that the remainder of the market is supplied by hundreds of smaller-scale entities, many of which are family owned and relatively inefficient.

Ethanol makers face an obstacle course of coming challenges. Market dynamics are pointing toward rising ethanol prices because global oil prices are headed higher over the near and long terms. Pressure is also rising for ethanol producers to get away from using sugar, which remains in demand as a food commodity, and convert





to inedible raw materials, such as sugarcane bagasse. The biotechnology to convert the woody, difficult-to-process agricultural waste remains costly, however.

The technology has advanced far enough that global energy players are beginning to stake out positions in Brazil. For example, The Hague-based Royal Dutch Shell unveiled plans to invest US\$1.6 billion in a biofuel project with its Brazilian partner, Cosan, which currently operates the world's largest sugar-cane processor. The two companies share a minority stake in Codexis (US), a leading producer of the advanced enzymes used to convert farm waste into ethanol. The move is part of a broader Shell-Cosan joint venture, dubbed Raizen, which plans to spend US\$7 billion to boost Cosan's ethanol capacity by 50%.

Separately, Petrobras Biocombustivel, the biofuel subsidiary of state-owned Petrobras, has announced plans to invest US\$2.5 billion to boost production of sugar-cane ethanol and biodiesel in the five years through 2015. Petrobras has also inked joint-venture efforts with GE (US) to design and build the world's first commercial-scale ethanol-fired turbine power plant and is working with Novozymes (Denmark) to commercialize advanced methods of converting sugar-cane bagasse to ethanol, as well. In coming decades, Brazil faces the challenge of delivering more energy, more quickly, to more people than ever before. Wind power, while still small, is off to a fast start, thanks to an innovative auction policy that has spurred both domestic and foreign investment in the sector. Meanwhile, Brazil's biofuel sector will benefit from a period of consolidation and reinvestment.

Managing growth poses a challenge, however. Brazil's burgeoning fossil fuel sector is likely to compete for many of the human and physical resources sought by renewables developers. Indeed, given the underlying growth of Brazil's population and economy, developing basic resources – from educating engineers to developing raw materials and manufacturing capacity – may prove to be the greatest category of barriers facing public planners and private energy investors.

Given past success with hydroelectric power and biofuel, Brazil has built a precedent for success with renewable energy. Coupled with a manifest need for new energy supplies, Brazil is a good bet to achieve even greater, greener energy goals. //

## Brazil turns to turbines: Latin America's biggest economy looks to power future growth with wind



*Elbia Melo*, Presidente-Executiva, Associaçao Brasileira de Energia Eolica (ABEEolica)

Elbia Melo has led ABEEloica, the Brazilian Wind Power Association, since September 2011. A PhD in production engineering, Melo is a specialist in electricity markets regulation. Previously she was Director at CCEE (Brazilian Wholesale Market) and served as Chief Economist at Brazil's Ministry of Mines and Energy (2003-2006). *Ernst & Young:* What were the most important developments in the Brazilian wind industry over the past year?

*Elbia Melo:* Brazil's current wind industry began in 2004 with the introduction of PROFINA, a set of reforms and incentives to encourage wind energy. The initial goal was to introduce the technology, to learn and to see future growth. The learning process has been rapid. In the last few years, we've been seeing wind prices bid at much less than half the first bids back in 2004. In fact, nowadays, wind is the second lowest-cost source of electric power in Brazil, after hydro-energy.

### *Ernst & Young:* What factors are driving the costs down?

*Elbia Melo:* In 2009, we started to buy wind power via open auctions in competitive markets for terms of 20 years. The approach has been very efficient and has attracted large-scale investment. The healthy competition has led to highly competitive bidding. The price in the most recent round fell to about R\$100 (US\$55) per megawatt hour.

### *Ernst & Young:* How do technical issues play a role?

*Elbia Melo:* Windmills continue to improve, delivering more energy at a lower up-front cost. The second factor is that our wind resources have proved better than we expected. When we launched PROFINA, we modeled the capacity factor of our wind plants at 32%. In operation, we're finding the figure is closer to 45%. Each turbine that produces more power lowers the cost of power over its lifetime.

### *Ernst & Young*: Who are the key suppliers and project developers?

*Elbia Melo:* There are about a dozen major equipment vendors operating in Brazil. These include the big players from Germany, Spain and the United States. As yet, there's no major Brazilian turbine supplier, though sub-system vendors are evolving quickly.

In terms of project developers, we have a strong share of Brazilian players. We have a new breed of Brazilian investors, such as Renova e Bioenergy, that invest only in renewables. There are newcomers entering from the world of private equity as well, such as Santander, and Patría Bank through ERSA, which recently bought stakes in companies that invest in wind power.

Then we have the traditional investors, the sorts of players that have invested in hydro plants in the past, who see wind as a new opportunity. These include private companies, such as CPFL and EDP. And lastly, we have conventional public companies, such as the state utility, Eletrobrás.

### *Ernst & Young:* What are the chief sources of capital finance?

*Elbia Melo:* BNDES, the Brazilian Development Bank, is the dominant source. The terms of these wind investments are generally too long for private banks to bid on competitively. Likewise, for foreign investors, the long tenors and foreign exchange issues raise risks. That leaves BNDES as the main funding source.

### *Ernst & Young:* Is Brazil's grid resilient enough to handle the growth of variable wind energy?

*Elbia Melo:* At just 0.9%, wind makes up a small share of our total supply, so we have a long way to go to hit any limits. In Europe, there are networks handling up to 25% or 30% of wind. We have seen some minor problems making local interconnections, so that new wind farms are linked to the grid when they begin to operate. In future auctions, we hope to alter terms to lower this risk.

*Ernst & Young:* Are there any risks of regulatory change or public opposition to the growth of wind power?

*Elbia Melo:* The bulk of the changes are behind us: first came the PROFINA reforms of 2004, then the auctions and long-term contracts starting in 2009. Nowadays, the market doesn't think there's a need for major changes. Public support is high, too. Generally, wind projects have been centered in poorer areas, which invite the investment, the jobs and improved power supplies.

## *Ernst & Young:* What is your outlook for the Brazilian wind industry in the coming year?

*Elbia Melo:* We're in a great position. Brazil's wind resources have been estimated at 300GW – roughly three times our total grid capacity today. We need to add about 6GW per year. Yet new sources of hydropower are limited, and thermal plants – whether natural gas or biomass – are costly to build and fuel. Wind offers the capacity and best price to meet this demand. We are working to introduce 2GW per year in the auction. This number is a breakeven to maintain the industry. //



## **Roundtable:** Future of transportation





Moderator Scott Sarazen Markets Leader, Global Cleantech Center Ernst & Young

The pursuit of low-carbon and resourceefficient technologies to reduce fossil fuel use for transportation is one of the most intensive areas of investment, research and development in cleantech today. There are two broad categories under which all the commercialized technologies can be grouped: biofuels and electric.

Biofuels are designed to replace petroleumbased fuels with fuels derived from organic matter, food crops (e.g., corn, soybeans, sugar cane), in the case of firstgeneration biofuels, and non-food crops (e.g., agricultural waste, switch grass, corn stover), in the case of advanced biofuels. This latest generation of biofuels carries the promise of a low-carbon fuel source that can be produced domestically and simply dropped into the existing fuel supply infrastructure.

Electric technologies replace internal combustion engines (ICEs) with electric drives powered by batteries or fuel cells. Electric drives provide greater efficiency than their ICE counterparts, zero direct emissions and the opportunity to power transportation with renewable energy when electricity from sources such as solar, wind and hydro are used to recharge batteries or generate hydrogen for fuel cells.

### Trends and opportunities in aviation biofuels, battery electric vehicles and fuel cells

Both biofuels and electric technologies face challenges related to market adoption, price competitiveness with traditional technologies and achieving commercial scale. To gain insight into the current state of these technologies, we interviewed a group of leading executives who offered observations from their unique vantage points on the market for clean transportation.

For biofuels, we spoke to Jonathan Pardoe, head of fuel management for Virgin Atlantic Airways, Ltd., and Dr. Emma Harvey, the company's head of business sustainability. Aviation is a promising market for advanced biofuels because of the high level of fuel consumption in the industry and the attendant sustainability concerns.

For a perspective on battery electric vehicles, we interviewed Arun Banskota, president of eVgo, a subsidiary of NRG Energy that offers a network of electric vehicle charging stations in Houston and the Dallas/Ft. Worth area along with fixed-price charging plans.

Andreas Truckenbrodt, CEO of Automotive Fuel Cell Cooperation (AFCC), provided insights into fuel cell technology. AFCC is a joint-venture private company owned by Daimler AG, Ford Motor Company and Ballard Power Systems to develop fuel cell stacks for automotive applications. //

# Electric vehicles



*Interview* with **Arun Banskota**, President of eVgo, NRG

*Scott Sarazen:* Let's open with a discussion on the current state of electric vehicle transport and the critical challenges hindering greater adoption for these technologies.

*Arun Banskota:* From my perspective, 2011 was really the first year of the new generation of electric vehicles. Despite Fukushima, despite all the supply chain issues that resulted, there were still 18,000 electric vehicles sold between the Chevy Volt

## Aviation biofuels





Policy



Fuel cells



*Interview* with Andreas Truckenbrodt, Chief Executive Officer, Automotive Fuel Cell Cooperation (AFCC) Scott Sarazen: What do you think about the current state of vehicle fuel cell technology, and what are some of the main barriers preventing a wider level of adoption at this point?

Andreas Truckenbrodt: The technology in the vehicles is ready for the customer. They are such great vehicles to drive because they have all the benefits of the electric drive, but they are not restricting you in range, acceleration or performance.

The first fuel cell vehicle prototype we had was in 1994, and since that time, we have provided many solutions to the problems of the earlier systems. We might not be able yet to drive 600,000 miles like a diesel with a current fuel cell engine without having to replace a part, but for making customers happy with these vehicles as regular cars, the technology has matured.

Continued on page 55

*Interview* with Jonathan Pardoe, Head of Fuel Management, and **Dr. Emma Harvey**, Head of Business Sustainability, Virgin Atlantic Airways, Ltd.

Scott Sarazen: Where do you see the current state of technology in aviation biofuels? What are the technological barriers or other challenges that may be limiting widespread adoption of these technologies?

*Emma Harvey:* Virgin has been involved in biofuels for a few years now. In 2008, we were the first to conduct a commercial test flight using a biofuel mix in one of our engines. It was quite pioneering because, until that point, there was widespread skepticism within the industry that it was technically possible to fly a commercial aircraft using a biofuel blend.

A lot of work since than has focused on getting the fuels right from a sustainability standpoint to avoid repeating some of the unintended consequences created by the production of early-generation biofuels. This led Virgin to be a founding member of the Sustainable Aviation Fuel Users Group and to participate in the Roundtable on Sustainable Biofuels (RSB), which is the leading independent, multi-stakeholder standards group that sets rigorous criteria for sustainability for fuels.

The next stage is getting to commercial viability and scale. Compared with other biofuel uses, aviation transport demand is currently still relatively small. So far, there are greater policy and other incentives to create scale in ground-transport fuels. The performance criterion for aviation biofuels is different from ground transport, so they are also technically more difficult to produce. And we are also still very early stage with some of the aviation biofuel biofuel technologies.

Continued on page 53

### Electric vehicles

### Interview with Arun Banskota, President of eVgo, NRG

#### Continued from page 49

and the Nissan LEAF. This significantly exceeds the 6,000 hybrids sold in the first year the Prius came to market.

Another thing that is very noticeable to us among our EV-charging subscribers is the absence of buyer's remorse. Every one of them is very excited about driving an electric vehicle. They enjoy it, they talk about it with their friends, families, relatives, you name it.

The barrier is more mindset than it is technology. When we do surveys of people going into the Houston or Dallas auto shows, we find that only 5% to 10% of respondents say they would be willing to consider an EV for their next auto purchase. But after they visit us at the show, sit in one of our EVs and learn about our charging network, the number of people who say they would consider buying an EV in their next auto purchase jumps to 55% to 60%.

And putting those together – the fact that EV buyers are happy with their vehicles and that exposure to EVs changes consumer attitudes – the biggest barrier we have to overcome is really the general lack of awareness about the form and functionality of these vehicles.

Scott Sarazen: Are you saying that the technology is mature enough for a larger-scale rollout – that no technology breakthroughs are needed at this point?

*Arun Banskota:* I think what you will see is much more incremental change rather than dramatically disruptive change.

Take DC-charging hardware as an example. We are the largest purchaser of DC chargers in the US and have extremely good visibility into the state of the technology – both the technology roadmap and the cost roadmap. Much of the technology in the chargers is not new – it has been borrowed from other applications. Yet there are a lot of different companies making incremental changes, and just how far that technology has come in the last six or seven months is, to me, pretty amazing. I would say something similar on the battery side. Battery technology has been with us for such a long time. With the economic scale that we are seeing now in all the different battery applications, I think we're going to see prices dropping to anywhere from US\$1,000 per kilowatt hour down to maybe US\$600 or US\$500 per kilowatt hour. And I think we have a very good line of sight in it going down to US\$350 or maybe even US\$300 per kilowatt hour. So again, is that disruptive or is that incremental? I would say more incremental.

But what is also going to happen is that EVs are going to be the catalyst for taking us into a lot of different areas of business that were almost untouched before, whether vehicle-to-grid technologies, vehicle-tohome technology or second-life battery applications. So, in fact, you're going to see a lot of different businesses come out of the EV space.

This is the disruptive part because suddenly, you're going from a car, which has always been looked upon as a cost in terms of getting people from one place to another to possibly becoming a revenue source, which would be a huge change both in technology applications and mindset and you name it. EVs do open up all these kinds of possibilities.

### *Scott Sarazen:* What about wireless charging? Do you think wireless is necessary for a much greater expansion capability or opportunity for EVs?

*Arun Banskota:* We are very aware of all the wireless technology that is being developed. I remain more skeptical right now because I'm assuming there's going to be a significant pricing premium. But again, things are changing so fast that if we talk one year from now, I might have a different mindset.



*Arun Banskota:* I think it's really four factors.

First of all, I think a lot of people really enjoy driving EVs. From a performance perspective, they're quiet and acceleration is very good. There's also a lot of technology in these cars, which the technology enthusiasts appreciate. You push the start button on a Volt, and something like 14 million software codes start running, versus 10 million in an F-15 fighter aircraft.

Another is purely cost. And I think the challenge here is, again, awareness. For example, Bloomberg compares the Volt and the LEAF with the Toyota Prius hybrid and Ford Fusion gasoline and other cars. And it shows you that on a five-year cost of ownership, the LEAF, even at US\$3-a-gallon gas, is already the cheapest form of transportation. But how many people buy a car looking at all three factors – your maintenance cost and your sticker price and your fueling cost?

When we talk with our subscriber base, we find that quite a number of them are, in fact, doing exactly that. These are consumers who actually have running five-year and seven-year spreadsheets and are looking at all of the different numbers and telling me that's the reason they're buying an EV – because it's the cheapest form of transportation.

But third, which is very interesting, a segment of our subscriber base finds the zero emissions aspect of the vehicles appealing. By and large, they are fairly well-educated people, a lot of them in the technology and health industries. I don't think they are buying just for that, but the fact that this is a feature of EVs certainly may make the decision to buy an EV that much easier.





And finally, there is a small segment of the population that feels very strongly about energy security. But again, it tends to be one more good reason for them to buy an EV among all the other different factors.

#### Scott Sarazen: Are EVs close to economic cost parity with traditional ICEs at this point?

*Arun Banskota:* Absolutely. And again, it's a mindset that needs to be changed, more than anything else. You're going from just looking at the sticker price to looking at the total cost of ownership. In some ways, frankly, that may be a bigger value than we think, for people to change the way they think about something.

Scott Sarazen: The recent discoveries and extraction of so much shale gas and shale oil have had a considerable effect on fuel supplies and pricing. What do you see as the potential impact on electric vehicles and clean transport as a whole?

Arun Banskota: I think any time you see such a huge disparity in pricing geographically, something is going to happen. So you look at the US, with gas at US\$2 to US\$3 per million BTU, versus Europe, where it is around US\$8 to US\$9 per million BTU. And then you go to Asia, especially Japan, where you're even looking at US\$12, US\$13 per million BTU. It's a huge disparity and that kind of disparity is not going to last long.

So several things are going to happen. First of all, there's going to be much more use of gas in this country to soak up the excess supply. You've already started seeing some coal-to-gas switching at power plants. You've already started to see some higher energy-using industries moving back to the US, even high energy-using industries like aluminum. And I even hear people talking about some fertilizer factories coming back to the US, which would have been unthinkable some years ago. I think you are probably going to see some LNG exports although they probably will not be very large.

It is definitely going to give a boost to the use of natural gas vehicles. I personally think this will be more the case in mediumduty and heavy-duty vehicles than in lightduty vehicles. But I think we are going to see increased gas usage among light-duty vehicles as well.

So there really are a variety of ways that excess gas is going to get soaked up. And the price gap between the US and Europe and Asia is not going to last forever.

Setting up aluminum mills or fertilizer plants that run on natural gas takes a little bit of time. My personal guess, after being in the energy industry for all these years, is that we're probably looking at a maximum of three to five years before both the excess supply and the huge disparity in pricing among the different continents disappears.

Scott Sarazen: What do we need from the Government? And looking forward, how does the EV ecosystem survive in a non-subsidized world?

Arun Banskota: The best incentive the Government has provided so far is the US\$7,500 tax credit. And if that could be something that could be cashed at the time of the auto purchase, it would be an even better accelerator of consumer adoption because consumers are still looking mainly at sticker price. And when you reduce the sticker price by US\$7,500, it is a huge boost. When we talk with policymakers, we clearly understand the constrained state of government finances. Among the things we really push for are incentives that really cost little or no money, in fact – HOV-lane access, for example. In any of the large cities, where most EVs are being bought and driven, HOVlane access would clearly be of premium value. They were, in fact, originally built to encourage fuel efficiency and are today largely underutilized. And so to us, giving HOV-lane access to single-driver EVs is the best use that you can make of the lanes besides, obviously, having multiple people in the same car. Providing three to five years of free access to EVs would provide a huge boost to EV adoption.

Preferred parking is another perk that can spur adoption. For example, at LAX airport, EV drivers can park in the closest lots for free, something that normally costs US\$60 a day.

Even financially constrained governments, whether cities or munis or states, can offer these kinds of incentives for EV adoption.

Scott Sarazen: How close do you think we are for this ecosystem, these business models, to stand on their own?

*Arun Banskota:* I think we have certainly proven that the infrastructure can stand on its own. Here at eVgo, we do not receive a single dollar of subsidies from any source, and we've been building the infrastructure in Houston and Dallas to Ft. Worth. And now we've announced rollouts in Washington, D.C., and Baltimore and a US\$100 million infrastructure investment in California. So we certainly believe we're proof that infrastructure can stand on its own.

On the EVs, I'm guessing it will be three to five years before the Government can do away with the tax credits. //

### **Aviation biofuels**

*Interview* with Jonathan Pardoe, Head of Fuel Management, and **Dr. Emma Harvey**, Head of Business Sustainability, Virgin Atlantic Airways, Ltd.

#### Continued from page 50

Jonathan Pardoe: Yes, one of the things that have prevented the widespread adoption of biofuels for aviation has been the rather slow take-up by certain suppliers because of the incentives to focus on ground fuels. In response, Virgin and the other airlines have pushed the market to let it know that we are serious – we do want biofuels or other sustainable fuels on our aircraft.

Another issue is that to get the fuel into use, it has to successfully pass a significant number of highly vigorous tests because as an aviation company, we're very heavily focused on safety. You have a backup for the pilots, for the brakes, for the navigation system, but there is no backup for the fuel. Because of that, there has been a lot of concern about the potential impact of using alternatives to traditional oil-based products. This is why all those tests are done to ensure the new fuel meets or exceeds the existing specification for jet fuel. All this data must then be independently evaluated and approved by fuel experts who sit on the fuel panels, such as ASTM and Defense Standard, before the fuel can be used commercially.

The approval process is starting to move faster due to lessons learned in prior approvals, but it's still reliant on a lot of support from original equipment manufactures (OEMs), users and the military to get the testing done, and this is becoming increasingly difficult in the current economic situation.

### Scott Sarazen: Could adoption of biofuels by the military help to solve some of these problems of scale? There is significant interest among the military in the US.

Jonathan Pardoe: The US military has done a lot of very valuable testing in the past, but the budget may be more constrained going forward. They have tried out many different fuels, and they are becoming one of the driving forces behind getting some of those fuels approved. They have been looking at all different types of fuel that can reduce their reliance on oil, which started with examining coal and the Fischer-Tropsch process, but increasingly, they have pursued far more sustainable alternatives. Largescale adoption by the military, I think, could truly help provide a significant change in the willingness of investors to support sustainable aviation fuels.

Scott Sarazen: What about fuel specification and performance standards? Although this may be more of a road-fuel issue, we have heard from many of our biofuel clients that greater predictability in fuel demand would be extremely helpful for securing financing.

*Emma Harvey:* Virgin works closely with the Carbon War Room, a leading nonprofit entrepreneurial organization focusing on commercial solutions for the climate change problem. In the last couple of years, it's been focused on the renewable jet fuel space. The organization recently undertook a worldwide analysis of new suppliers for jet fuel, and the results were published toward the end of last year. You can find the publication at www.renewablejetfuel.org.

Having done this market analysis, there is greater transparency into who the suppliers are, where they are located and what kind of feedstocks and technologies they are using – and what ability they might have to scale.

And I think the next step in this conversation is what we can do as a buyer, along with other airlines, to signal our interest and to signal demand. It's still early days in that sense. We are considering how best to contribute to the development of the market in terms of how we can offer a clear message that when fuel is produced of a certain type, in a certain location, we will buy it at agreed volumes.

### *Scott Sarazen:* In what ways do you provide those market signals?

*Emma Harvey:* One good example is our recent partnership with LanzaTech. One of the reasons we decided to partner with this organization is that it's got an exciting new



technology that converts carbon monoxide gas waste streams – from heavy industrial facilities like steel manufacturing – that are typically flared directly into the atmosphere as CO2. LanzaTech's technology captures that carbon monoxide and, by way of a microbe-based process, converts it into ethanol. Then, via a second-stage process with one or more partners, the ethanol can be converted into jet fuel.

LanzaTech chose to start its production in China, which is attractive to us as it is a region where we can uplift fuel. We also liked the fact that it was based on a waste stream and not agricultural feedstocks. We are still potentially interested in agricultural feedstocks if they meet the RSB standard, but we like the fact that this new technology avoids some of the controversies around land use and water and food competition.

Additionally, we liked the fact that the organization had already done some lifecycle analyses and was coming up with results suggesting between 50% and 60% reductions in carbon compared to kerosene. Also LanzaTech uses an abundant, affordable waste stream as the feedstock, which means they can produce fuel that's on par with kerosene prices. This is crucially important to us, given our sensitivity to fluctuations in fuel prices.

Finally, the organization also has outlined a clear development pathway, so it's working toward having commercial quantities available by 2014.

To go back to the broader point, we can signal the market through direct partnerships, such as the one with LanzaTech. We could also potentially work collectively with other airlines to identify the bigger demand, but the problem with that is we start to get into the territory of competition law. We're not allowed to discuss the specifics of deals with other airlines. It is mostly done on a one-to-one basis at the moment.

A lot of this work is evolving and is still in a development phase, but it's really encouraging to see how much recent collaborative activity there is toward innovative, sustainable aviation fuels. The EC is quite heavily involved in a



biofuels program for aviation at the moment, through its Flightpath initiative. And there is, of course, the work of the Carbon War Room. In fact, across the industry, there are a lot of really good minds active in this space, though we're not quite there yet in terms of the financing solutions.

*Scott Sarazen:* So let's follow that thread and talk about economics. What's driving you to be in this space right now, and what are the economic challenges as you're thinking about your fuel portfolio?

Jonathan Pardoe: There are many reasons why we're pursuing this. As a fuel buyer and a parent, I'm very keen on the sustainability aspect, but also I'm very keen to keep our costs down. I try to balance my desire to reduce the airlines' impact on the environment for the benefit of future generations, while providing travel at a financially competitive price.

And thinking ahead further, I'm very keen to make sure that we have supply security when jet fuel from traditional sources may become harder to get. We keep hearing concerns about the future availability of oil globally, so it's very important that we have a long-term strategy. Financially, it has to make sense too; we have to be sure the alternative fuels we select don't cost so much that we can't operate competitively.

*Emma Harvey:* I'm really very motivated to get sustainable solutions for powering aircraft – that's what drives me. But I also know that has to be done in a commercially viable way. We have been approached by some early-stage suppliers who are offering fuel to us at vastly elevated prices, and that is just not possible as it stands. Ours is such a lean industry that our business model can't support that.

While we want to do whatever we can to encourage this new market to develop in the right way – providing both sustainable and commercially affordable fuels – we are not in a position to finance or invest directly, nor can we subsidize it by paying massively elevated prices for the fuel. Scott Sarazen: Given Virgin's concerns related to sustainability, energy security and price volatility, at what point do you think a cost premium might start to make sense so that you have a substantial percentage of your fuel portfolio from biofuels?

**Emma Harvey:** At the moment, we're not even talking about paying a premium because we're so sensitive to fuel prices. We're looking to stimulate the market by providing demand signals – saying we're here to buy at these volumes, and if you can produce it, we guarantee we will buy it. And we hope that this will help suppliers to attract the funding they might need to scale up. We're also focused on encouraging the right policy environment to incentivize the production of sustainable aviation fuels.

Jonathan Pardoe: Yes, to work for the aviation industry, biofuel prices need to be at par with conventional jet fuel prices. Hopefully, biofuels will be disconnected from jet fuel pricing in the future. It would be good to see any alternative fuel being priced on its own merit and based upon its own production costs. Our expectation is that we will realize economies of scale that bring the price of biofuels below that of traditional jet fuel.

*Emma Harvey:* One of the other key pricing factors for any biofuel we might choose is the feedstock. When a feedstock is very closely linked to the commodities market, and the price of that feedstock is quite high and can fluctuate dramatically, then it is going to be more challenging to meet our needs for a fuel that's either at a par or below the cost of traditional jet fuel.

Scott Sarazen: Returning to fuel standards and the potential need for disruptive change, Jonathan, how comparable is the energy density in the best-in-class biofuels to conventional aviation fuels?

Jonathan Pardoe: Depending on the fuel, we're getting very close to where we need

to be. In some cases, the alternative fuel is an improvement over existing jet fuel, actually providing more energy per weight. The issues we saw in the early biofuels are fading as these products become indistinguishable from traditional jet fuel.

Scott Sarazen: Are these biofuels completely drop-in? Do they require any modification of on-board systems or new airport infrastructure?

Jonathan Pardoe: These fuels are set to be entirely drop-in solutions. When I look at the best-of-class fuels, they've all been thoroughly tested, and none of them has had any detrimental impact on engine performance or problems within the tanks. Many early concerns, such as the potential for increased microbiological contamination due to the use of bio-products or the effect of mingling conventional and biofuels, have proven unfounded.

Safety is our highest concern, so we will continue to push for rigorous checks and to support the ASTM process, which analyzes fuel data and independently certifies fuels for commercial use. But the biofuels will be able to drop into every system without any impact upon the operation of the aircraft.

Similarly, we should not need to set up two separate supply lines into airports, one for biofuels and one for traditional ones, as was first feared. This is because once the fuel is approved and certified as jet fuel by all the relevant bodies, then there would be no technical reason to refuse to use the same infrastructure.

So the next thing is cost, and then availability.

*Emma Harvey:* The biggest challenge for the whole industry at the moment is really the financing. How do you get the investment into the early-stage players and get them through the development stages and up to commercial production of sustainable aviation fuel? To answer that question, we also need the right policy environment to properly incentivize the production of the right kinds of fuels. // *Interview* with **Andreas Truckenbrodt**, Chief Executive Officer, Automotive Fuel Cell Cooperation (AFCC)

#### Continued from page 50

In reference to barriers and challenges, there are two main elements. The first is on our side and that is cost. The other is the hydrogen infrastructure. It is also important to point out that when we talk about the application of fuel cells to the transport sector, we see it starting with passenger cars. We also see buses as extremely interesting applications and delivery vans, as well.

But in order to make the other applications affordable, we believe that we need the volumes that the passenger cars will generate.

Scott Sarazen: On durability, do you envision that anticipated technology advancements will minimize the potential for the components to degrade? Or do you think that the solution is driving the component costs down while also having an efficient way to change out the stacks?

Andreas Truckenbrodt: The number one challenge is cost. We always have a threeargument problem – we have to optimize cost, performance and durability – all at the same time.

Unfortunately, they are not working in the same direction. As an example, one of the key elements of a fuel cell stack is the catalyst, and that's made from platinum. One of the key drivers to reduce cost, therefore, is to develop a catalyst that needs less platinum. But unfortunately, if we reduce the platinum content too much, both performance and durability go down.

One of our R&D activities is to work with different catalysts and different ways of applying those catalysts to the membrane. We are trying to develop solutions that do not lose performance or durability, but with less platinum.

Interestingly, one of our goals – and we know we are on the path to achieving this – is to use no more platinum in the fuel cell stack than in your current car. Most people don't realize that platinum is used in today's exhaust catalysts. Scott Sarazen: You said fuel cells are a great application for passenger cars, buses and vans. But you didn't mention larger-class, over-the-road trucks – are there load limitations to be considered with fuel cells?

Andreas Truckenbrodt: With trucks it is far more difficult because they need a lot of power, and that means they have to carry a lot of hydrogen. There is no generic limitation of the fuel cell technology as such, and even the space that would be required to occupy the stack and the system would be okay.

But it's not that easy yet to package hydrogen in a vehicle in the space that typically is provided for energy storage. Hydrogen is a beautiful fuel because it's so light, but it requires a lot of volume. It is just a storage issue, not a technological limitation.

Regardless of the vehicle size, fleets are an excellent application for fuel cells as they typically drive in a defined area. This means that one central hydrogen station would be sufficient. You would not need a fully developed hydrogen network to cover the area.

We also believe, however, that it's not enough to focus on fleets only. They are important to get the technology launched, but at the end of the day – and this applies to battery electric vehicles too – if we want to make an impact in terms of reducing emissions and all the other benefits of these new technologies, we must make them mainstream technologies and not something that only a few early adopters embrace.

This means we have to make sure the product meets the average driver's needs and not only the special needs of fleet customers. We won't meet the target volumes in the fleets, and we need those higher volumes to get the costs down.



Scott Sarazen: Beyond technology or infrastructure, what about business models? What other businesses or business models need to be in place for this technology to realize greater adoption?

Andreas Truckenbrodt: From a business model perspective, fuel cells are quite different from batteries because, with the battery, you have a very expensive component of the vehicle that lends itself to models where you might think about selling the car and leasing the battery – and paying it off through the reduced cost of operations over time. This approach is not applicable to fuel cells because, at production volumes, it is expected that the cost of the fuel cell vehicle and power train will be lower than the cost of a battery-power train.

For the hydrogen infrastructure challenge, an interesting group of stakeholders are the fuelstation operators. They see a constant decline in their traffic because cars are getting more efficient, and if battery electric vehicles take off, people would charge at home and not go to a fuel station at all. So we see an increasing interest from station operators because they understand that if they can sell hydrogen, they will get repeat customers, which will support their other retail operations.

## Scott Sarazen: What is the expected range per fill for what might be considered a standard fuel cell car?

Andreas Truckenbrodt: With our B-class, which is the smallest fuel cell vehicle out there, we have a range of 350 miles or so per fill – which is pretty good already.





### Scott Sarazen: So let's transition to economics. Is there an expected price premium for fuel cell drive vehicles as compared with a traditional ICE?

Andreas Truckenbrodt: The goal is for fuel cell technology to achieve cost parity with current incumbent technologies. And in order to make it a success, we must reach the mainstream customer who cares that it drives as well as his current car and doesn't cost more.

We are still in the prototype phase, so current costs reflect the low volumes. But we expect to get to the start-up commercialization phase in the 2015-20 time frame, when we assume volumes in the 100,000 vehicles-per-year range. There are a lot of studies by the US Department of Energy and others that suggest it is possible to reach our target costs at those volumes with fuel cells.

There are four major elements to realizing our cost targets. The first is to ramp the volume up. That has some limitations because for platinum, even if you increase the volume significantly, the price doesn't go down much. But there are other components for which higher volumes cause a really steep decrease in cost.

The second element in cost reduction is focused on optimization for high-volume manufacturing. We are using materials and technologies that the automotive industry has never used before. That's the reason we have set up our manufacturing colleagues right next to our engineering colleagues here in Vancouver, to ensure close interaction between them.

The third element is suppliers. Suppliers are of course crucial, but the problem is that we are dealing with component suppliers who are not automotive suppliers at the moment. They may be big chemical and materials firms, but they are not automotive suppliers. So there is a need to establish different relationships and get them up to speed with our processes and standards. The fourth element, which I intentionally put last, is technology. There will be technology advances – in the catalysts, in the membranes and in the hydrogen-tank systems – that will over time make the fuel cell drive train cheaper. Technology advancement is an important step, but it won't be sufficient without the other steps laid out.

## *Scott Sarazen:* So now let's talk about fuel economics. How does gasoline compare with hydrogen?

Andreas Truckenbrodt: Currently, the price for a kilogram of hydrogen, which equates to approximately 60 miles of range, is something like US\$8 to US\$10. If you translate that into miles per gallon of gasoline, the cost is approximately equivalent to driving a combustion engine car for 60 miles. What you pay for the gasoline output is what you pay for the hydrogen output.

But there are many studies, by the Department of Energy and others, which suggest the target for the cost of a kilogram of hydrogen will be between US\$2 and US\$4 at scale. That would mean that even if the price of gasoline were to stay where it is today, hydrogen would be more economical. And if you assume that the cost of gasoline is going up, as all of the automotive industry does, then hydrogen can be a very costattractive fuel.

Scott Sarazen: What do you think is the role of governments in the development of the fuel cell? And how are you planning your business so that you're ready for the time when it needs to stand on its own?

Andreas Truckenbrodt: Worldwide, every government we talk to tells us there must be an end to subsidies in the foreseeable future – that this technology must become self-sustainable from an economic perspective because they cannot subsidize it forever. We have to be able to provide a product that, when the subsidies go away, cannot be more expensive than the competition. That is why everything we do is driven by getting the cost down quickly.

The second group of people who are struggling with the cost issue is the suppliers, and this is quite natural with the volumes still low. We are expecting them to make significant investments in research and product development before the returns come. There are suppliers who believe in this technology. They are willing to invest and support the development for a while, but even for them, of course, it has to become self-sustaining eventually.

So what is the role of the government? The role of the government at this point is to provide subsidies to vehicle buyers and to make sure that the infrastructure is developed. We see a good approach in California, for instance, where they subsidize part of the investment and early operating costs of hydrogen stations. When these stations are fully utilized, they will be profitable businesses. Europe is also pursuing the infrastructure development in a joint effort between government and industry.

Besides these subsidies, the second role of government is to provide the right rules, regulations and frameworks such that the right technologies are supported. The third role is in the area of standards. This may sound trivial, but it is still not necessarily clear, for example, how you measure one kilogram of hydrogen. Yet this must be established so that it can be priced and marketed.

The fourth role of government is to have the political will to support this technology. And lastly, there is the opportunity to fund more of the fundamental research in areas where the industry would not necessarily invest. //

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