Credit Suisse

SECTOR REVIEW

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Asia Pacific/China
Energy Equipment & Services

Equity Research

China's Renewable Energy Sector

China's next booming sector

- **China is currently confronted with an energy shortage, a rapid increase in its reliance on imported oil and worsening air pollution. We estimate that China's energy consumption will reach 3.5 bn tce (tonnes of standard coal equivalent) by 2020. The government has an aggressive capacity expansion target for renewable energy to mitigate these issues. The NDRC's target implies a CAGR of 36.9%, 46.8% and 18.4%, respectively, for wind, solar and biomass power capacity in 2005-10E, and 19.6%, 7.2% and 18.5% in 2010-20E. These targets imply that renewable energy is likely to become the next booming sector in China.**

- **In the 11th Five Year Plan, the Chinese government increased its commitment to promoting renewable energy. The NDRC asserted that up to RMB1.5 tn (US$184 bn) will be invested in renewable energy by 2020.**

- **We believe feedstock and raw material suppliers will benefit from the rapid expansion in China's renewable energy. We believe Suntech's integrated large-scale production of high-quality PV cells and modules gives the company a stronger bargaining position compared to its Chinese counterparts in the procurement of silicon. Shanghai Electric Group (SEG) has partnered with a technology provider from Germany, Aerodyn, to produce wind turbine equipment in China. JVs with Aerodyn, Ersol Solar and Jiaotong University position SEG well to capture Shanghai and other PRC renewable orders to further increase its power and environmental equipment income.**

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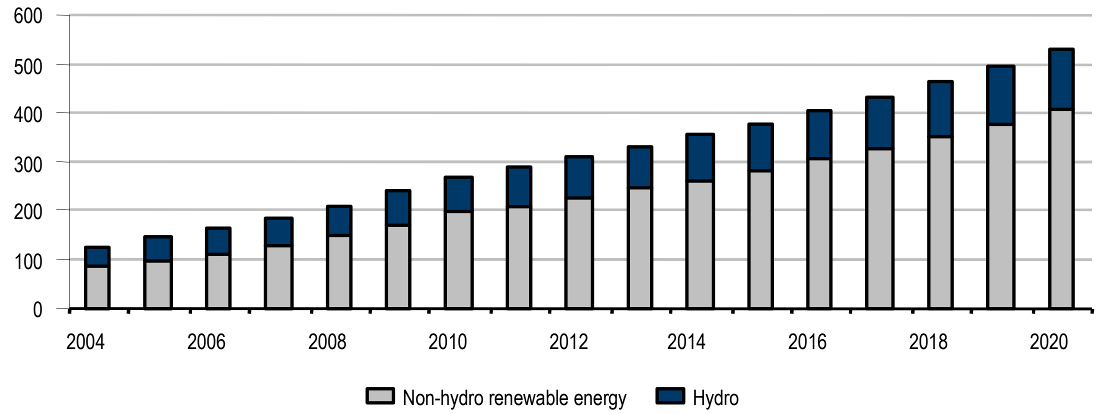
Figure 1: **China's renewable energy**

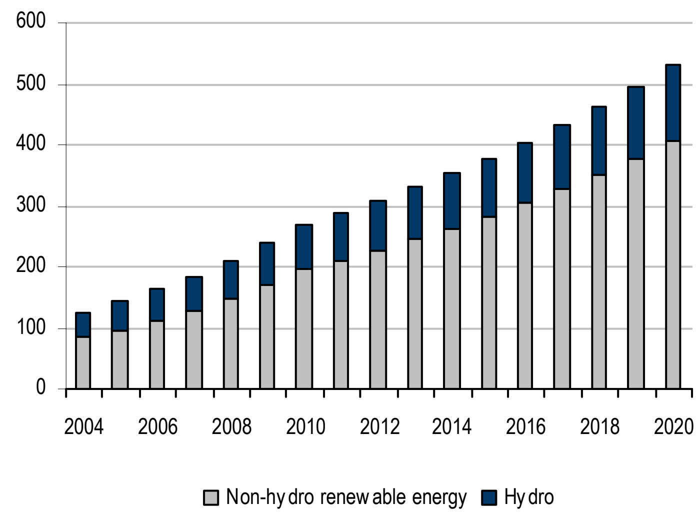


Source: Company data, Credit Suisse estimates

Note: For a list of the companies mentioned in this report, see page 60.

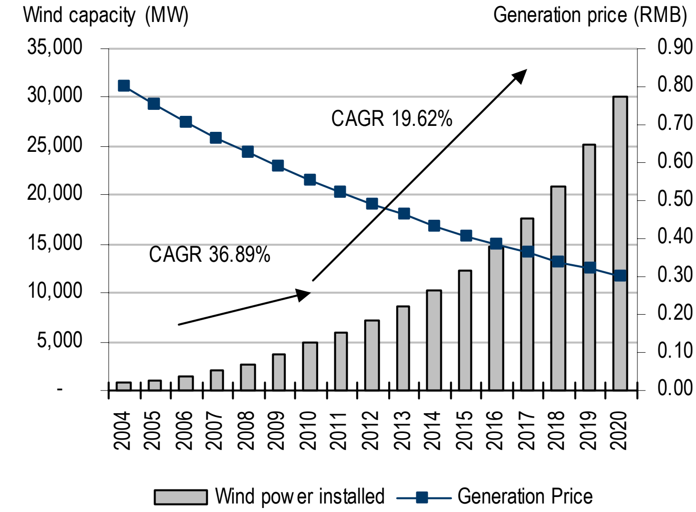
Focus charts

Figure 2: **China's renewable energy**



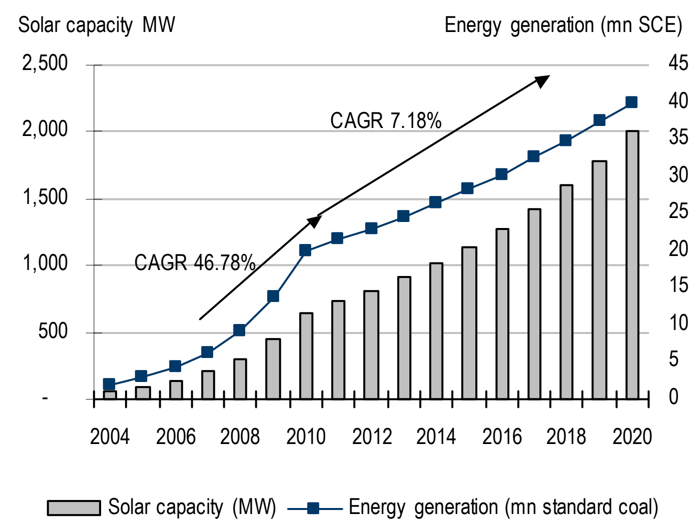
Source: NDRC, Credit Suisse estimates

Figure 3: **Wind power capacity and generation cost**



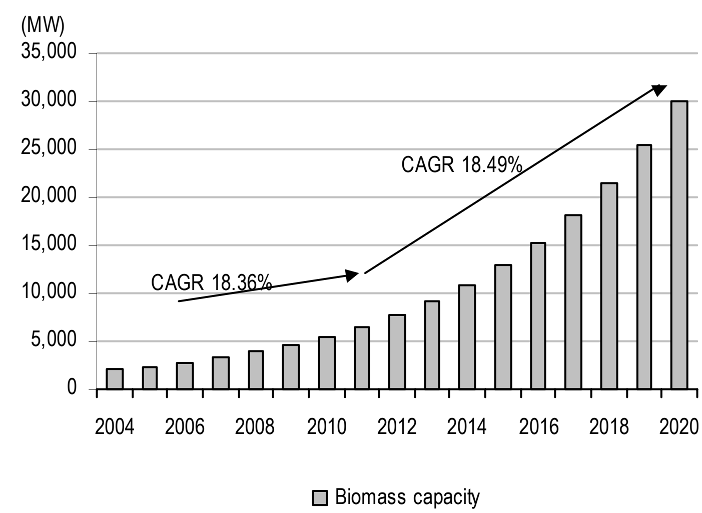
Source: NDRC, American Wind Energy Association (AWEA), Credit Suisse estimates

Figure 4: **Solar power capacity and generation**



Source: NDRC, Credit Suisse estimates

Figure 5: **Biomass production capacity**



Source: NDRC, Credit Suisse estimates

China's next booming sector

Rapid growth in China's demand for energy

China's total energy consumption is likely to exceed the government's targets

We project that China's energy consumption will reach 3.5 bn tce by 2020, compared with the National Development & Reform Commission's (NDRC) target of 2.65 bn tce. We expect energy consumption per GDP to fall by 13.7% in 2004-10E, lower than the NDRC's 20% reduction target. Coal will remain China's primary energy source. We estimate that China's coal consumption in 2020 will represent 58.2% of the country's total energy consumption, down from 68.7% in 2004. Based on forecasts by the State Council Development Research Centre (SCDRC), the NDRC and China National Petroleum Corporation (CNPC) (not listed), we forecast that China's reliance on imported oil will increase from 44% in 2006 to 56% in 2020. The Energy Research Institute's (ERI) forecasts imply that demand for natural gas will increase, outstripping domestic output growth and resulting in higher imports for natural gas. In the bid to reduce air pollution, and with the reliance on coal and oil, China is likely to boost renewable energy development.

China's renewable energy

China's renewable energy sector is set for rapid growth

China is currently confronted with an energy shortage, a rapid increase in its reliance on imported oil and worsening environmental pollution. The government is targeting aggressive capacity expansion for renewable energy in order to mitigate these issues. The NDRC's targets imply a CAGR of 36.9%, 46.8% and 18.4%, respectively, for wind, solar and biomass power capacity in 2005-10E, and 19.6%, 7.2% and 18.5% in 2010-20E. At a 3.1% CAGR in 2005-20, as targeted by the NDRC, the potential growth of hydropower capacity lags behind that of alternative renewable energy forms. Based on these targets, renewable energy is likely to become the next booming sector in China.

Government initiatives

Up to RMB1.5 tn (US$184 bn) is expected to be invested in renewable energy by 2020

In the 11th Five Year Plan (FYP), the Chinese government increased its commitment to promoting renewable energy. The NDRC asserted that up to RMB1.5 tn (US$184 bn) will be invested in renewable energy by 2020, with investment expected to come from international donors and the private sector.

Feedstock and raw material suppliers likely to benefit

We prefer raw material and feedstock suppliers, as well as upstream manufacturers

We believe feedstock and raw material suppliers will benefit from the rapid expansion in China's renewable energy. We believe Suntech Power Holdings's integrated large-scale production of high-quality PV cells and modules gives the company a stronger bargaining position in the procurement of silicon compared to its Chinese counterparts. Shanghai Electric Group (2727 HK, HK$2.775, OUTPERFORM, TP HK$4.50) (SEG) has partnered with a technology provider from Germany, Aerodyn (not listed), to produce wind turbine equipment in China. JVs with Aerodyn, Ersol Solar and Shanghai's Jiaotong University position SEG well to capture Shanghai and other PRC renewable orders to further increase its power and environmental equipment income.

Solar sector valuation matrix

Figure 6: Solar sector valuation matrix

Name	Ticker	Price	Currency	Market cap (local currency mn)	Market cap (US$ mn)	P/E (x) 2005	P/E (x) 2006	P/E (x) 2007	P/E (x) 2008	EV/EBITDA (x) 2005	EV/EBITDA (x) 2006	EV/EBITDA (x) 2007	EV/EBITDA (x) 2008	2006P/E to 2006/08 EPS CAGR	2006EV/EBITDA to 2006/08 EBITDA CAGR
Tokuyama	4043 JP	1675	¥	460,003	3,951	34.1	24.3	19.6	17.0	12.6	9.8	8.2	7.4	1.25	0.69
Wafer Works	6182 TT	42.7	NT$	7,614	233	29.2	25.7	21.6	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.
Sino-American Silicon Products	5483 TT	73.1	NT$	11,133	341	43.3	26.9	17.0	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.	n.m.
Solartron	SOLAR TB	6.65	Bt	1,995	52	12.1	24.6	n.m.	n.m.	7.2	10.1	n.m.	n.m.	n.m.	n.m.
Solon	SOO1 GR	36.06	€	326	409	34.3	22.1	17.2	13.0	16.5	9.8	7.6	5.9	0.84	0.41
Ever-Green	ESLR US	12.97	US$	867	867	n.m.	3,242.5	n.m.	32.6	n.m.	n.m.	41.6	8.2	n.m.	n.m.
Motech	6244 TT	784	NT$	66,206	2,030	29.9	15.4	26.6	n.m.	45.4	27.8	19.1	n.m.	n.m.	n.m.
SolarWorld	SWV GR	52.6	€	2,938	3,685	13.6	9.8	29.2	6.1	28.8	19.4	15.0	12.4	1.65	0.87
Sunways	SWW GR	11.68	€	127	159	20.7	14.2	11.3	6.6	27.5	9.5	6.8	4.1	0.47	0.19
Phoenix Sonnenstrom	PS4 GR	23.15	€	128	160	19.8	15.1	17.2	13.7	19.6	13.7	10.5	8.4	2.97	0.57
SAG Solarstrom	SAG GR	4.44	€	47	58	113.8	32.6	4.9	3.4	14.2	8.4	4.3	3.0	0.17	0.14
Conergy	CGY GR	49.37	€	1,481	1,857	33.1	24.3	9.4	7.1	28.4	19.8	15.5	11.7	3.77	0.79
Solar-Fabrik	SFX GR	11.5	€	97	121	40.6	26.9	12.1	8.9	24.8	8.7	6.5	4.7	0.38	0.25
Q-Cells	QCE GR	70.07	€	2,587	3,244	55.9	35.5	27.8	21.3	32.4	19.0	14.6	11.1	1.22	0.61
Renewable Energy Corp.	R3Q GR	11.1	€	n.m.	n.m.	370.0	75.5	34.5	3.2	n.m.	n.m.	n.m.	n.m.	0.19	n.m.
MEMC Electronic	WFR US	37.94	US$	7,967	7,967	24.0	22.0	18.1	15.4	23.1	14.9	12.1	8.3	1.13	0.43
ErSol Solar Energy	ES6 GR	48.32	€	474	594	69.0	30.2	22.3	12.3	27.6	11.1	7.9	4.7	0.54	0.21
Sunpower Corporation	SPWR US	28.59	US$	466	466	n.m.	114.4	44.1	23.9	1,611.8	12.2	8.7	n.m.	0.96	n.m.
Suntech	STP US	28.85	US$	4,174	4,174	144.9	54.4	30.5	20.8	84.4	42.1	23.3	14.1	0.88	0.58

Note: Companies are priced as at 4 July 2006

Source: Bloomberg, Datastream, Company data, Credit Suisse estimates

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Rapid growth in China's demand for energy

China will boost outlay on renewable energy

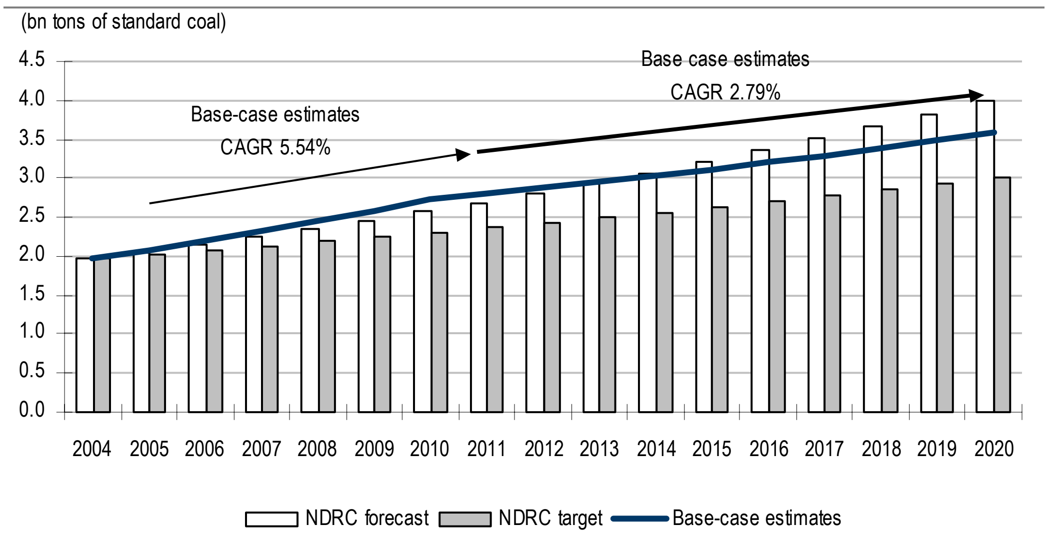
We forecast that China's energy consumption will reach 3.5 bn tce by 2020, compared with the NDRC's target of 2.65 bn tce. We expect energy consumption per unit of GDP to fall by 13.7% in 2004-10, lower than the NDRC's 20% reduction target. The NDRC's 20% target requires the nation either to achieve a coal consumption CAGR of -2% or an oil consumption CAGR of -11% in 2005-10. Given China's historical 17% CAGR for oil consumption and 26% for coal consumption in 2001-04, as reported by the Energy Information Administration (EIA), we are sceptical as to whether China can achieve such a reduction in coal and oil consumption in 2006-10. Coal will remain China's primary energy source. We estimate that in 2020, coal will represent 58.2% of China's total energy consumption, down from 68.7% in 2004. Based on forecasts from the SCDRC, the NDRC and CNPC, we estimate that China's reliance on imported oil will increase from 44% of total national oil consumption in 2006 to 56% in 2020. The ERI's forecast implies that demand for natural gas will increase, outstripping domestic output growth, resulting in higher imports of natural gas. In a bid to reduce air pollution and reliance on coal and oil, China has decided to boost its renewable energy development.

Total energy demand

China's energy consumption will continue to rise in the foreseeable future

Owing to the nation's rapid economic growth, China's demand for energy has experienced a dramatic surge. The NDRC reported that in 2004, total energy consumption was 1,386 mtoe (mn tonnes of oil equivalent), 13.5% of the 10,200 mtoe of global world energy consumption in that year. The NDRC predicted that in the absence of any government effort to curb energy consumption, China's total energy consumption is likely to reach 4,000 mtce by 2020. The NDRC is striving to enhance China's energy efficiency in order to keep the country's total energy consumption below 3,000 mtce by 2020.

Figure 7: **Total energy demand of China**

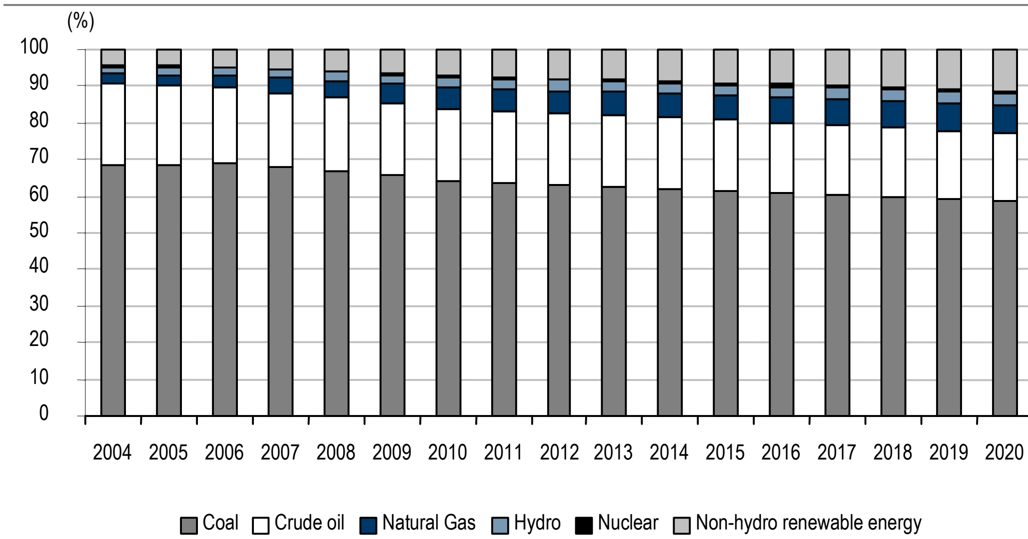


Source: NDRC, SCDRC, CNPC, ERI, Credit Suisse estimates

China's total energy consumption is estimated to reach 3,590 mtce by 2020

We estimate China's total energy consumption by aggregating the estimated consumption for all energy types (coal, oil, natural gas, hydro, nuclear and non-hydro renewable energy). Forecasts for energy consumption of each energy source type are provided separately by the NDRC, obtained from various sources. According to Mr Li Shan Shi, the deputy head of the renewable energy bureau of the NDRC, total energy consumption in China reached 2.22 bn tce in 2005. China's total energy consumption increased at a CAGR of 5.4% between 1995 and 2005, according to Mr Zhou Da Di, head of the energy research institute of the NDRC. The NDRC estimates that China's total energy consumption will increase at a CAGR of 5.5% in 2004-10 to reach 2.70 bn tce by 2010. The NDRC projects energy consumption of 3 bn tce by 2020, which implies a CAGR of 1% in 2010-20, due to the significant energy consumption efficiency gains. Instead, we estimate that China's total energy consumption will reach 3.59 bn tce by 2020, which implies a CAGR of 2.8% in 2010-20 to reflect slightly less energy efficiency gains over the period, compared to the NDRC's estimates. Our estimates are slightly higher than the forecasts published by the World Bank, derived from several studies, which project that China's demand for energy consumption will reach 3.3 bn tce by 2020. Figure 8 shows our forecasts of the composition of China's energy consumption between 2004 and 2020.

Figure 8: Composition of China's energy consumption



Source: NDRC, SCDRC, CNPC, ERI, Credit Suisse estimates

Responding to the rapidly worsening air pollution, China is looking to boost renewable energy consumption

In response to the country's rapidly worsening air pollution, China is looking to boost renewable energy consumption from 7% of total energy consumption currently to 10% in 2010, according to Mr Li Shan Shi. We estimate that renewable energy will represent 14.8% of total energy consumption in 2020, marginally lower than the NDRC's target of 20%, as our targeted total energy consumption for China by 2020 is higher than that of the NDRC.

We believe that despite China's attempt to enhance utilisation of renewable energy and to reduce air pollution, coal will remain the primary source of China's energy and that the country's reliance on imported oil will rise. We estimate that China's reliance on coal will decrease from 68.70% of total energy consumption in 2004 to 58.52% in 2020. Our estimate is marginally more aggressive than the forecast provided by the World Bank, which projects that China's reliance on coal will decrease only to 60% by 2020. We also expect China's reliance on fossil fuel oil to decrease from 21.80% of total energy consumption in 2004 to 18.6% in 2020. However, our forecast implies that China's dependence on imported oil will increase from 44% to 56% of the country's oil consumption between 2006 and 2020, resulting in 250 mn tonnes of oil to be imported by 2020.

Coal consumption

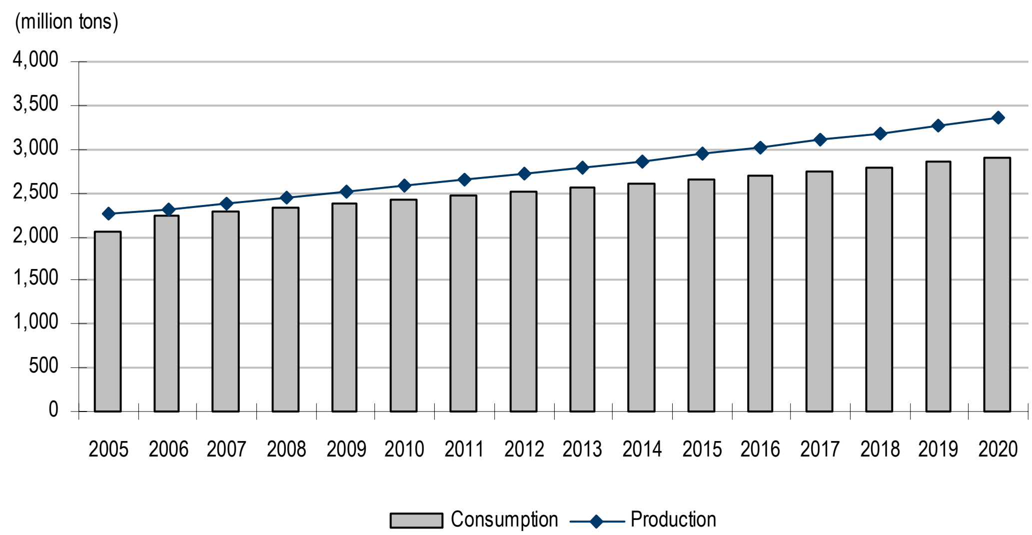
Coal is China's primary source of energy and will remain so in the foreseeable future

Coal is China's primary source of energy and we expect it to remain so in the foreseeable future. According to Mr Li Shan Shi, in November of 2005, China's annual coal consumption had reached 1,870 mn tonnes, a 14.4% increase from the previous year. This accounted for 68.7% of the country's total energy consumption in 2004. Ou Xinqian, vice director of the NDRC, forecasts that China's coal demand will increase to 2.25 bn tonnes in 2006, implying a 9.7% CAGR in 2005 and 2006.

Coal production capacity will be increased in order to meet increasing demand

Mr Pu Hongjiu, vice-president of the China Coal Industry Association, predicts that China's total demand for coal in 2020 will exceed 2.5 bn tonnes, and approximately 1.0-1.6 bn tonnes will be used to generate electricity. In response to the increasing demand, Mr Xu Dingming, director of the energy bureau of the NDRC, stated that the government is targeting an additional 1.1 bn tonnes of coal production capacity by 2020. This implies that China's coal production capacity will increase by around 50% in 2005-20, resulting in a net exportable surplus of 460 mn tonnes by 2020.

Figure 9: **China's coal consumption and production**



Source: NDRC, Credit Suisse estimates

The outlook for China's coal consumption remains strong

We estimate that China's coal consumption will reach 2.9 bn tonnes by 2020, implying a CAGR of 1.8% in 2006-20E. Our estimates fall at the high end of the 2,100-2,900 mn tonne range estimated by Professor Ni Weidou of Tsinghua University. There are two justifications for our aggressive forecasts. First, our estimate of a 1.8% CAGR remains significantly below the 9.7% CAGR in 2005-06 provided by the NDRC and China's historical double-digit coal consumption growth. Second, the 1.1 bn tonnes of additional production capacity reduces the risk of a future supply shortage.

We estimate the CAGR for China's coal consumption per unit of GDP to be -2.7% in 2005-20E. We expect coal consumption, as a proportion of total energy consumption, to decrease from 68% in 2005 to 58% in 2020, or an annual reduction of approximately 1%. Our 1% forecast is more conservative than the NDRC's 3% estimate, as stated by Mr Wang Jiacheng, deputy director of the Industrial Economics and Technical Economics Institute under the NDRC; our forecast of total coal consumption in 2020 is also higher than the official government guidance.

Coal mines targeted for shutdown represent only around 50-100 mn tonnes of coal production capacity

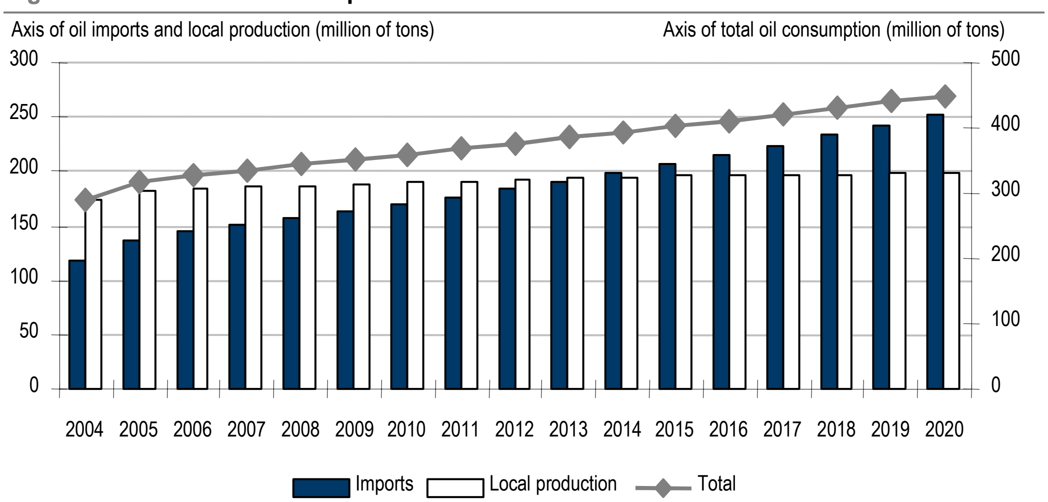
The rise in energy demand has forced China to focus on expanding coal production capacity and exploring new technologies, including renewable energy solutions and coal liquefaction technologies. Consequently, the State Administration of Work and Safety has stated that around 50% of China's coal production originates from mines that do not meet safety standards. Any move by the government to close mines that do not adhere to the existing work and safety standards will reduce production capacity. However, mining companies are taking safety risks in order to take advantage of the current high coal prices by operating in unsafe mines. The *China Daily* reported that 2,157 mines were shut down in 2005. According to Credit Suisse's metals and mining analyst, Trina Chen, the estimated 5,000 mines targeted for closure represent only around 50-100 mn tonnes of annual coal production capacity. Hence, while our estimate of China's coal production capacity may be exposed to some downside risks, we do not believe that the magnitude is significant.

Oil consumption

China's reliance on imported oil will heighten

We believe that China's reliance on imported oil will rise, despite the reduction in oil consumption as a proportion of total energy consumption. The NDRC reported that China's oil demand increased from 290 mn tonnes in 2004 to 318 mn tonnes in 2005, representing a CAGR of 9.6%. The SCDRC estimates that China's 2006 oil consumption will reach 328.6 mn tonnes, with 184 mn tonnes produced locally and 144.6 mn tonnes imported. The NDRC estimates that China's oil demand will reach 500 mn tonnes in 2020, while CNPC predicts that the country's oil consumption in 2020 will reach 450 mn tonnes, with 200 mn tonnes produced locally.

Figure 10: China's oil consumption



Source: NDRC, SCDRC, CNPC, Credit Suisse estimates

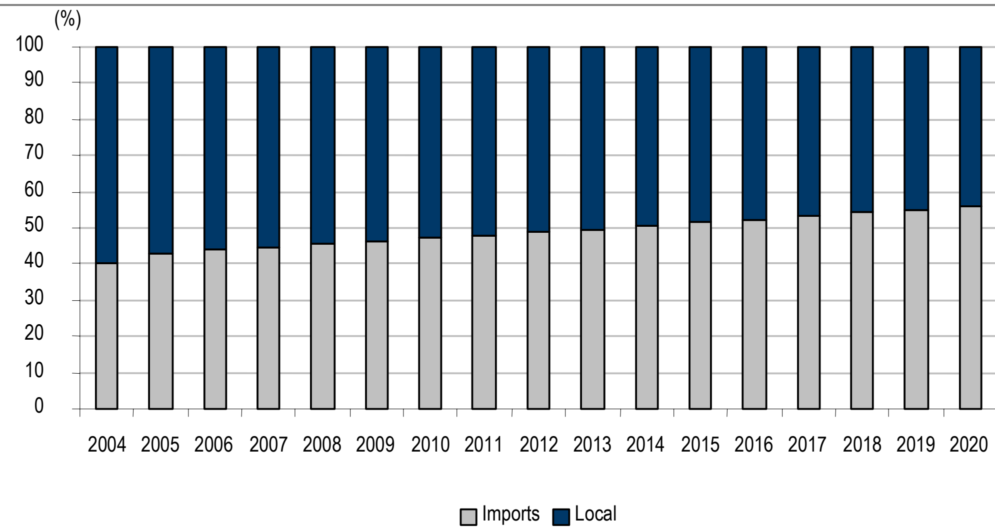
We expect China's oil consumption to reach 450 mn in 2020

Based on the SCDRC's forecast, China's oil consumption will be 328.6 mn tonnes in 2006, with 184 mn tonnes produced domestically and 144.6 mn tonnes imported. In line with CNPC's forecast, we expect China's oil consumption to reach 450 mn in 2020. Our estimates fall within the 400-500 mn tonne range estimated by Professor Ni Weidou of Tsinghua University and are slightly below the NDRC's forecast of 500 mn tonnes. We estimate that China's oil consumption will grow at a CAGR of 2.3% in 2007-20. This represents almost a 1% reduction from the 3.3% growth estimated for 2006. Our estimates assume that China's power shortage will ease in the near future and, thus, that the country's high historical oil consumption growth will moderate.

China's dependence on imported oil will increase from 44% in 2006 to 56% in 2020

Based on our estimates, China's dependence on imported oil will increase from 44% in 2006 to 56% in 2020, reflecting a CAGR of 4.05%. With local oil production expected to grow from 184 mn tonnes in 2006 to 198 mn tonnes in 2020, we expect China to be importing around 250 mn tonnes of oil by 2020. Our estimates for the size of China's imported oil in 2020 are consistent with those of the NDRC.

Figure 11: **China's oil import**



Source: NDRC, SCDRC, CNPC, Credit Suisse estimates

Natural gas

The NDRC reported that natural gas accounted for only 2.8% of China's total energy consumption in 2004

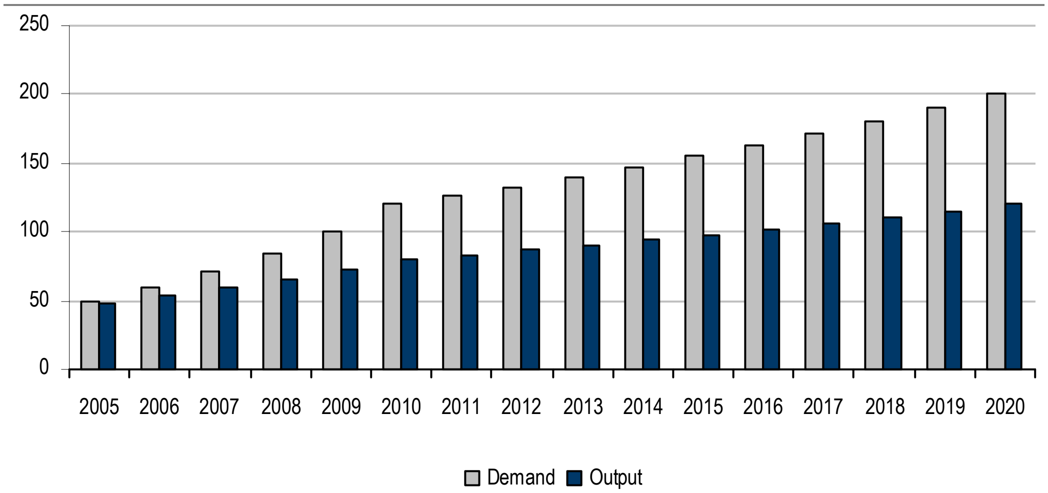
The Chinese government is striving to reduce the nation's reliance on coal and oil, which is likely to lead to higher demand for natural gas. The NDRC reported that natural gas accounted for only 2.8% of China's total energy consumption in 2004, significantly lower than the world average of 24.2%. The ERI predicts that China's natural gas demand will increase at a CAGR of 10.3%, resulting in total consumption of 200 bn cu m by 2020. Given the drastic increase in demand, we believe that local production is likely to fall behind, implying that China's imports of natural gas will increase.

However, competitive bidding for LNG is already pushing up international LNG export prices. The PRC government's plan to build a second West-East gas pipeline and Russia's announcement of the construction of two gas pipelines transmitting gas to China reflect ongoing PRC government efforts to secure additional fuel supplies to meet with rising energy demand growth. In the bid to reduce air pollution and the reliance on coal and oil, China is likely to boost renewable energy development. China's plan to build 12 LNG terminals on the east coast and in the south may therefore be amended.

The demand for natural gas is set to grow dramatically

Ms Liu Xiaoli of the NDRC estimates that China's demand for natural gas will reach 120 bn cu m in 2010 and 200 bn cu m in 2020. This corresponds with the ERI's estimates. The aggressive growth is ascribed to China's aim to reduce its heavy reliance on coal and oil. The Shanghai Municipal Energy Research Society indicates that China aims to increase the share of natural gas in electricity generation significantly from 2.8 bn KWh in 2000 to 285 bn KWh in 2020. However, a lack of gas supply may reduce this target or delay its attainment.

Figure 12: **China's natural gas consumption and output**

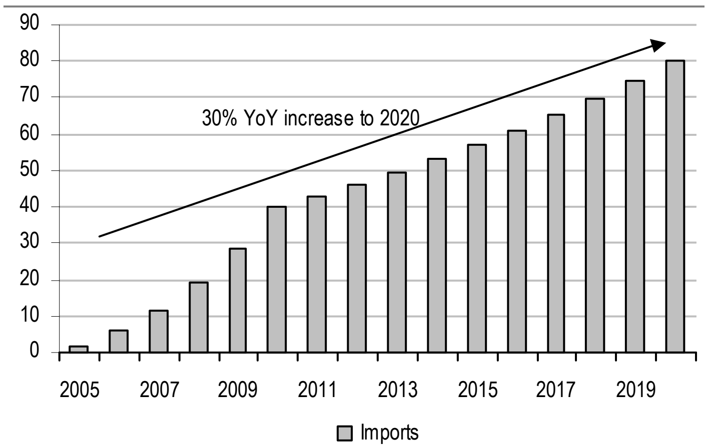


Source: ERI, Credit Suisse estimates

China's imports of natural gas will increase from 6 bn cu m in 2006 to 40 bn cu m in 2010 and to 40 bn cu m in 2020

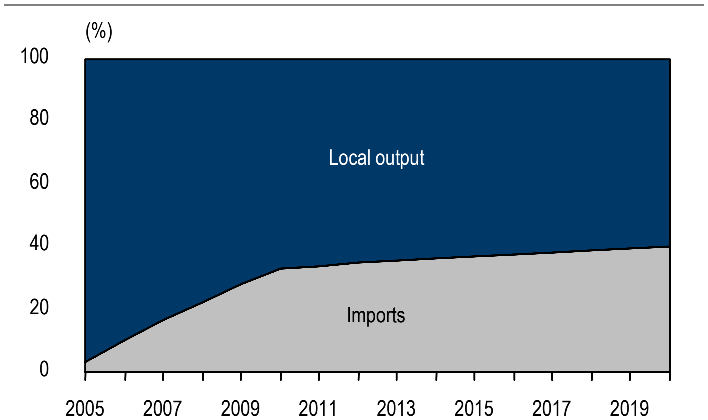
The ERI projects that China will require RMB220 bn (US$27 bn) investment by 2020 in order to expand its natural gas production and distribution capacity. The ERI estimates that production capacity will only grow from 48 bn cu m in 2005 to 80 bn cu m in 2010 and to 120 bn cu m in 2020. The shortage of natural gas supply is expected to increase from around 6 bn cu m in 2006 to 40 bn cu m in 2010 and to 80 bn cu m in 2020. Consequently, China's import of natural gas is likely to increase from 3% of the country's natural gas consumption in 2005 to 33% in 2010 and to 40% in 2020.

Figure 13: **Imports of natural gas are set to grow**



Source: Credit Suisse estimates

Figure 14: **Proportion of natural gas imported**



Source: Credit Suisse estimates

China is expected to increase its hydropower utilisation rate from 30% of available resources in 2005 to 75% in 2020

Hydropower

The NDRC has stated that, in the next 20 years, China will seek to develop its hydropower resources in order to increase its utilisation rate from 30% of available hydro resources currently to 75% by 2020. China's hydropower projects will be concentrated on the development of the Jingsha River, Yanglong river, Dadu River, Lancang River, Huang River, Wu River and Nu River. In addition, China aims to promote the development of small hydropower projects in suitable areas.

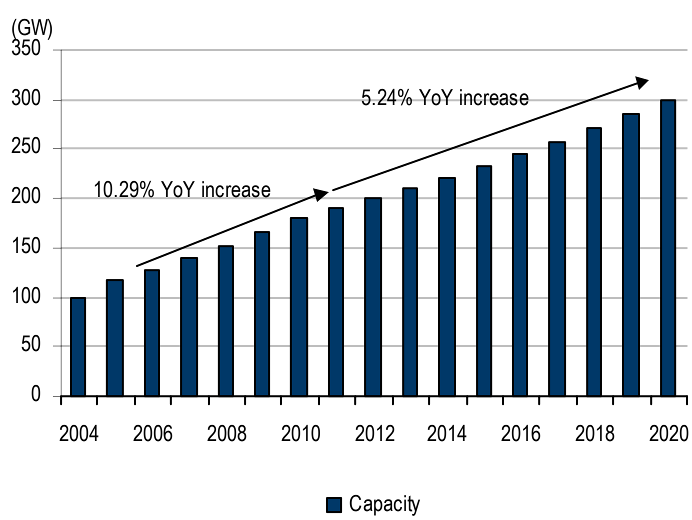
In 2006, 16% of China's electricity output will be generated using hydropower

In 2004, total installed hydropower capacity was 100 GW, generating 328 bn KWh of electricity. Xinhua news agency, reported that in 2005, 16.5 GW of additional hydropower capacity was installed, resulting in total capacity of 116.52 GW, which generated 395.2 bn kWh of electricity (16% of China's total electricity output). However, even at 116.52 GW installed capacity, this represents only around 30% of the 400 GW of total hydropower resources available in China, as forecast by the NDRC. With around 70% of available resources unexploited, the potential for future expansion is still large.

300 GW of hydropower will be installed by 2020

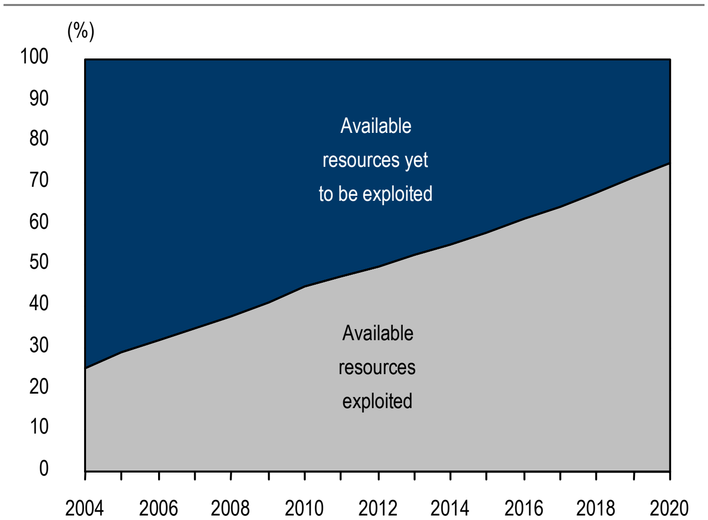
The NDRC has stated that hydropower installed capacity will reach 180 GW by 2010, and 300 GW by 2020. Thus, China's hydropower capacity is set to increase at a CAGR of 9.1% and 5.2% between 2005 and 2010 and 2010 and 2020, respectively. These targets imply that by 2010, China would have exploited 36% of its available hydropower resources. This number is set to increase to 75% by 2020.

Figure 15: **Hydropower capacity**



Source: NDRC, Credit Suisse estimates

Figure 16: **Proportion of available hydropower resources exploited**

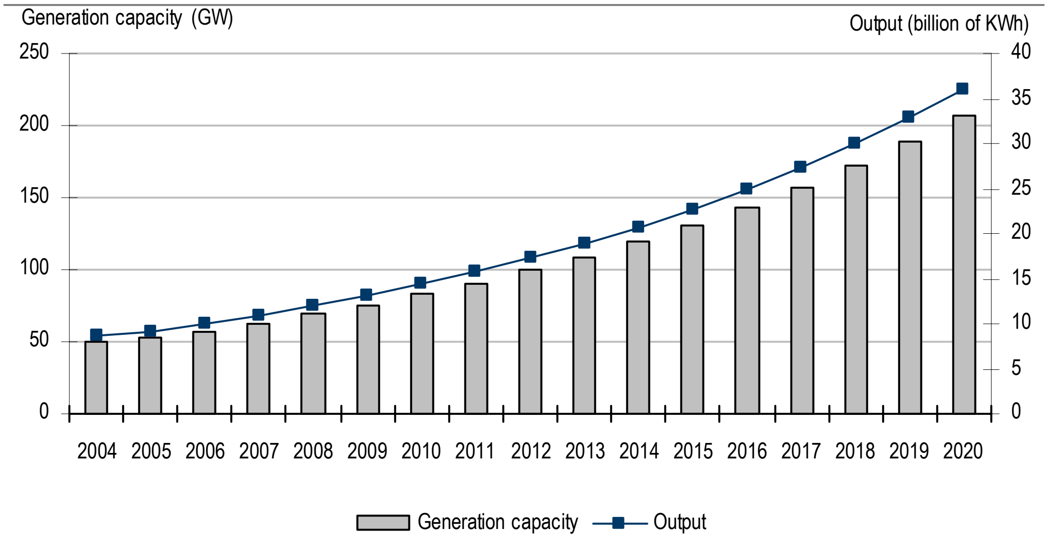


Source: NDRC, Credit Suisse estimates

Nuclear power

The NDRC has said that China plans to use nuclear power technology to help ease its current energy shortage. The NDRC reported that in 2004, nuclear power contributed 50.1 bn KWh of China's total generated electricity and that nuclear power currently represents only 2.3% of China's total electricity output, compared with a world average of 16%.

Figure 17: **China's nuclear power generation capacity and output**



Source: NDRC, Credit Suisse estimates

China's expansion into nuclear power has been driven by the power shortage China has experienced recently

As of 2004, China's nuclear power industry is entering a new round of fast development, featuring independent construction, plant imports and Chinese-foreign co-operation. The Uranium Information Centre (UIC) Nuclear Issue Briefing Paper #68 reported that, in July 2004, the construction of two nuclear power projects with an aggregated capacity of 1 GW was approved. The paper also stated that, to date, six nuclear power plants exist in China. China's aggressive expansion into the nuclear sector has been driven largely by the power shortage that the country experienced recently.

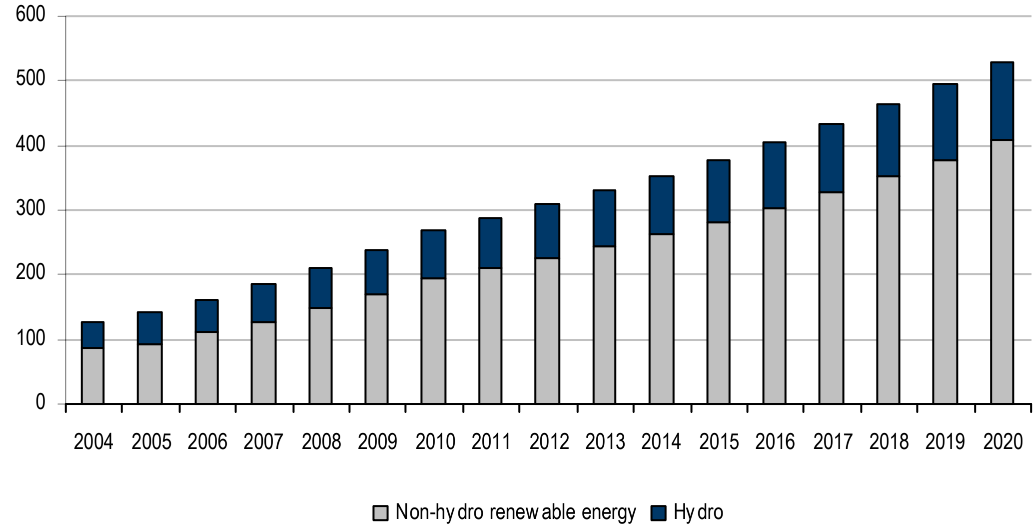
The NDRC reported that China increased its nuclear power generation capacity from 50.10 kWh in 2004 to 52.3 kWh in 2005. In order to mitigate the current dilemma of power shortages, the International Atomic Energy Agency (IAEA) reported that China plans to increase its nuclear power generation capacity to 36 GW by 2020, representing a 9% CAGR. This implies that by 2020, around 4% of the nation's total power output will be generated using nuclear power technology. In order to achieve this target, China will need to approve at least two 1 GW nuclear power units per year between 2004 and 2020. For further details, please refer to our report titled *China's Nuclear Shift*, dated 15 August 2005.

Non-hydro renewable energy

China is expected to boost its renewable energy sector

The 11th FYP outlined China's intention to expand its renewable energy industry aggressively in order to reduce its air pollution problems and the reliance on coal and oil. On 13 September 2005, Mr Zhang Guobao, vice-chairman of the NDRC, stated that the Standing Committee of the National People's Congress has passed the Renewable Energy Law, which increased the target for renewable energy consumption from 7% of the country's total energy consumption to 15% in 2020. The target implies that 300 mn tce of energy based on fossil fuels will be substituted with energy based on renewable sources by 2020. Mr Shi Li-Shan of the NDRC said on 13 November 2005 that the NDRC aims to increase the supply of renewable energy to 270 mn tce in 2010 and 530 mn tce in 2020, representing 10% and 20%, respectively, of China's total energy consumption in 2010 and 2020.

Figure 18: **China's renewable energy capacity**

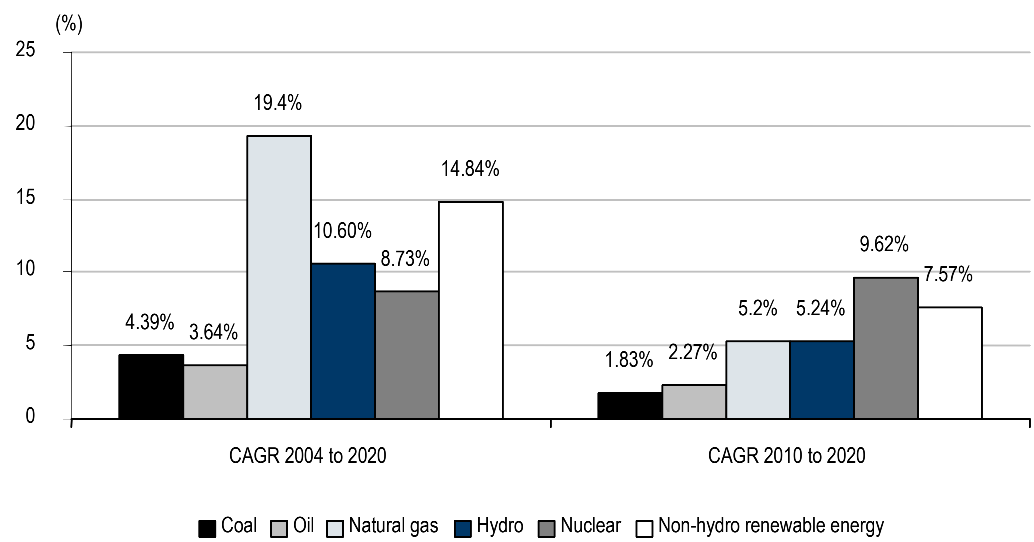


Source: NDRC, Credit Suisse estimates

China's renewable energy will reach 530 mn tce by 2020

In accordance with Mr Shi's forecast, we believe that the proportion of renewable energy to China's total energy consumption will reach 9.9% in 2010 (270 mn tce). By 2020, China's renewable energy consumption is expected to reach 530 mn tce, representing 14.8% of total energy consumption. Our forecast of 14.8% is slightly below Mr Shi's estimates of 15-20%. We believe this is due to our estimate of China's total energy consumption in 2020 (3.587 mn tce) being higher than the NDRC's (2,650 mn tce). We outline the grounds for our higher than the NDRC's estimate in a later section of this report.

Figure 19: **China's renewable energy is set for strong growth**



Source: NDRC, Credit Suisse estimates

We estimate the CAGR of China's non-hydro renewable energy production at 14.84% in 2004-10E and 7.57% in 2010-20E

We estimate the CAGR of China's renewable energy production to be 13.6% in 2004-10E and 3.6% in 2010-20E. Excluding hydropower, we expect the CAGR of China's renewable energy to be 14.8% in 2004-10 and 7.6% in 2020-10. Relative to the consumption growth of other energy sources, the CAGR of non-hydro renewable energy in 2004-10 is second only to that of natural gas. For the 2010-20 period, non-hydro renewable energy exhibits the highest CAGR among all energy resources.

Government consumption reduction targets too optimistic

The government's targets are overly ambitious

We believe the government's targets for a reduction of energy consumption are too optimistic. In the 11th FYP, the Chinese government declared that its target would reduce energy consumption per unit of GDP by 20% in 2005-10. By assuming the same 7.5% GDP growth as Mr Ma Kai, the head of the NDRC, we estimate that China's energy consumption per unit of GDP will decrease by 13.7% in 2005-10E. The 20% reduction target set by the NDRC requires the nation to achieve either a coal consumption CAGR of -2% or an oil consumption CAGR of -11% between 2005-10E. Given China's historical 17% and 26% CAGR for oil and coal consumption in 2001-04, as reported by the EIA, we are sceptical as to whether China can achieve such a reduction in coal and oil consumption in 2006-10. Shifting GDP growth to developing the commercial sector will take more time.

The NDRC's target for 2,650 mtce total energy consumption implies a GDP CAGR of 2.46% in 2010-20

Therefore, we believe the NDRC's target for China to consume only 2,650 mtce of total energy consumption in 2020 may be too optimistic. Assuming a 4% GDP CAGR over 2010-20, the NDRC target implies a CAGR for energy consumption per unit of GDP of -4.0% in 2010-20, which we believe is highly ambitious, as achieving the NDRC's target would require a -2.66% CAGR for energy consumption per unit of GDP in 2005-10. Accordingly, if we assume a decline of -2.66%, the NDRC's target of 2,650 mtce for total energy consumption in 2020 implies a 2.46% CAGR for China's GDP in 2010-20, which is remarkably low, especially on China's standards. This looks particularly aggressive, given the government's target to maintain annual GDP growth of around 7%.

China's renewable energy

Renewable energy is likely to become the next boom sector in China

China is currently confronted by an energy shortage, a rapid increase in its reliance on imported oil and worsening air pollution. The government is targeting an aggressive capacity expansion on renewable energy in order to mitigate these issues. The NDRC's targets imply a CAGR of 36.9%, 46.8% and 18.4% on the capacity growth of wind, solar and biomass power, respectively, between 2005-10 and a CAGR of 19.6%, 7.2% and 18.5%, respectively, between 2010 and 2020. The NDRC is aiming for a CAGR of 3.1% for hydropower capacity between 2005 and 2020, but this is expected to lag behind other renewable energy forms. Based on these targets, we believe that renewable energy is likely to become the next boom sector in China.

We expect wind power and biomass energy to see the highest growth rates in the near future, due to their lower costs compared to the other types of renewable energy (not including small hydro). The latest government policy of granting higher on-grid tariffs for renewable energy power applies only to biomass power. The on-grid tariff for wind power will be determined on the basis of a tendering process. We expect that the solar power development in China will be driven mainly by the rural electrification programme in the near future. On-grid solar power generation may take time to develop in China, given that the generation cost is higher than for traditional fossil fuel energy and other forms of renewable energy. However, we believe this could change if companies such as Suntech successfully produced thin film solar cells using crystalline silicon on glass technology, which is expected by 2008.

A need to promote the use of renewable energy in China

China's rapid increase in energy consumption

In recent years, China's energy consumption growth has been driven by its rapid economic growth. The head of the NDRC, Zhang Guobao, has said that China's per-capita annual energy consumption, at 1.08 tons of oil equivalent is only 66% of the world average of 1.63 tons and is significantly lower than the 8.02 tons, 4.03 tons and 3.82 tons per-capita annual consumption of the US, Japan and the UK, respectively. According to the NDRC, China's total energy consumption in 2004 was 1,970 mtce, or around 13% of global energy consumption. According to the NDRC, China's coal consumption in 2004 (68% of China's total energy consumption) represents 34% of global coal production, making it the largest coal consumer in the world.

In 2003, China's GDP grew by 9.4% while its energy consumption increased by 12.5%

China's large energy consumption is attributed to the country's rapid economic growth as well as its low energy efficiency. As China's economy grew at a rapid rate in the recent past, its demand for energy increased at even a faster rate. In 2003, China's GDP grew by 9.4%, while its energy consumption increased by 12.5%. The rapidly increasing energy demand exposes China to the volatility of global energy prices as well as heavy reliance on imported energy.

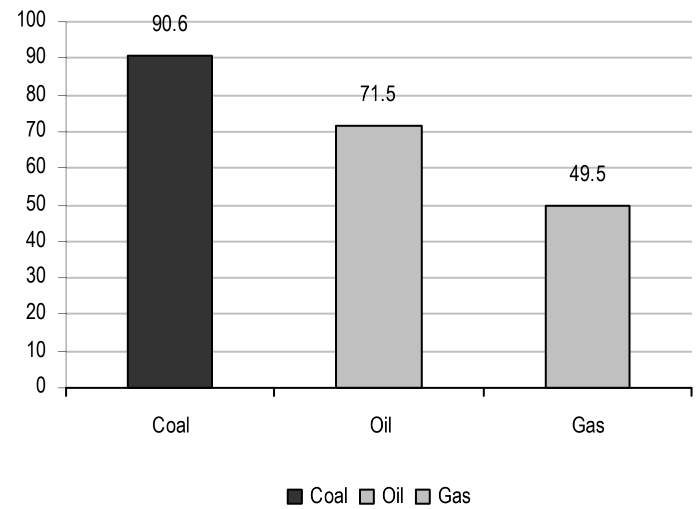
China's reliance on imported oil will reach 56% of the nation's oil consumption by 2020

China's heavy reliance on coal creates a number of concerns. First, due to the rapid increase in demand, safety concerns on coal mining have been relegated to second place. The State Administration of Work and Safety stated that in 2004, 40% of China's coal output came from mines that did not meet safety standards fully. Second, the high demand for coal has created a transportation bottleneck in coal distribution.

China's carbon-dioxide emissions are currently the second highest in the world

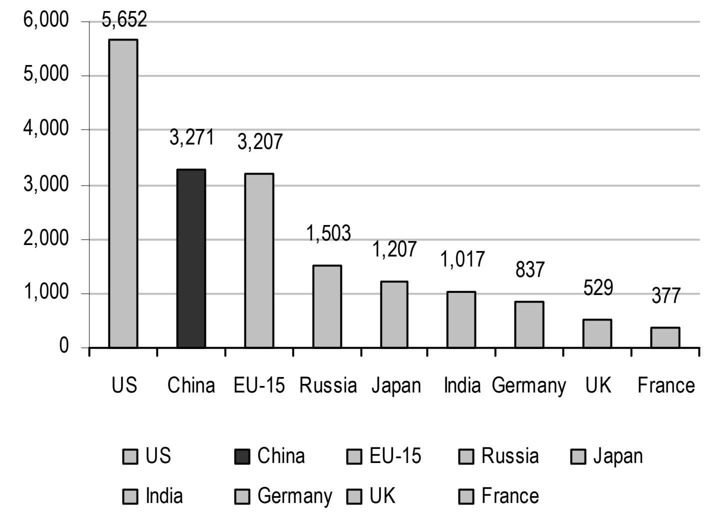
More importantly, with coal producing the highest level of emissions (higher than gas and oil), China's heavy reliance on coal contributes aggressively to the country's worsening air pollution problems. China's carbon-dioxide emissions are currently the second highest in the world. Professor Ni Weidou of Tsinghua University predicts that China's emissions are likely to peak in 2015. In addition, China has low emission standards, even relative to other Asian countries. In 2002, the IEA reported that China's carbon-dioxide emissions accounted for 14% of global CO_2 emissions, which was slightly higher than the total carbon-dioxide emissions by the EU-15 countries combined.

Figure 20: **Coal produces the most carbon-dioxide emissions among major fossil fuels**



Source: METI

Figure 21: **Carbon-dioxide emissions in 2002**



Source: IEA

Figure 22: **Emission standards for coal-fired power plants in 2000**

	Particulate matter (mg/m³)	SO_2 (mg/m³)	Nox as NO_2 (mg/m³)
China	200-600	1,200-2,100	650-1,000
Hong Kong	50	200	670
Indonesia	125	750	850
Japan	100	k-value method	410
Korea	50	770	720
Malaysia	400	Ambient only	Ambient only
Thailand	400	Ambient only	940
United States	40	1,480	560-620

Source: Study on Atmospheric Emissions Regulations in Asia-Pacific Economic Cooperation (APEC) economies and their compliance at coal-fired plants.

Up to RMB1.5 tn will be invested in China's renewable energy sector by 2020

The 11th FYP proposes two measures to address China's increasing energy consumption: 1) enhancing energy efficiency and 2) promoting the use of renewable energy. The first measure is likely to prove the more difficult to achieve, as it requires the country to undergo significant structural changes. The latter measure involves a commitment by the NDRC to invest up to RMB1.5 tn by 2020.

Renewable energy provides local governments with a fresh area for investment

As stated by Zhang Guobao, vice-minister of the NDRC, renewable energy would not only help to ease the energy shortage, but it would also help to cut China's contribution to climate change and reduce China's poverty by increasing demand for agricultural products (biomass energy). The renewable energy sector provides local governments with a fresh investment area that could stimulate economic growth and employment.

The business sector and international corporations will play an important role in the development of China's renewable energy sector

Mr Zhang recognised that the private sector and international corporations will play important roles in determining China's success to promote renewable energy sector development. Mr Zhang encouraged both domestic and overseas investors to share the large-scale investment required. The government has passed a law that allows for the implementation of a bidding system in order to attract both domestic and foreign investors, and is currently considering providing additional incentives such as further tax breaks to encourage the business sector to invest in renewable energy.

Wind power generation capacity

The NDRC aims to build large-scale wind power plants in the northern and eastern coastal areas and develop small and medium-sized wind power plants in other suitable areas. China is aiming to enhance the price competitiveness of wind power through technological advancement and economies of scale.

Government subsidies and initiatives play an important role in the success of wind power industry

A joint research study carried out by the NDRC and the Institute of Nuclear and New Energy Technology (NNET) stated that the capacity of wind power installed in Germany, Spain and the US is among the highest in the world, with China in the tenth position. More than 80% of wind power capacity is installed in Europe, with the US constituting 4.8% and Asia (mostly India) a 4.0% share. Government subsidies and initiatives play an important role in the success of the wind power industry, and the study recommended similar measures to be undertaken by the Chinese government.

Import substitution is likely to reduce the price of wind turbines in China by around 20%

Li Junfeng, the director of the Chinese Renewable Energy Industries Association, pointed out that the cost of electricity generated using wind power is still higher than for coal-fired power generation. Wind turbines accounting for 70% of the total cost of a wind farm. Deng Yuangchang, deputy director of the Wind Resource Research Centre at the Sun Yat-sen University, predicts that the increase in local production content and import substitution will probably reduce the price of wind turbines in China by around 20%.

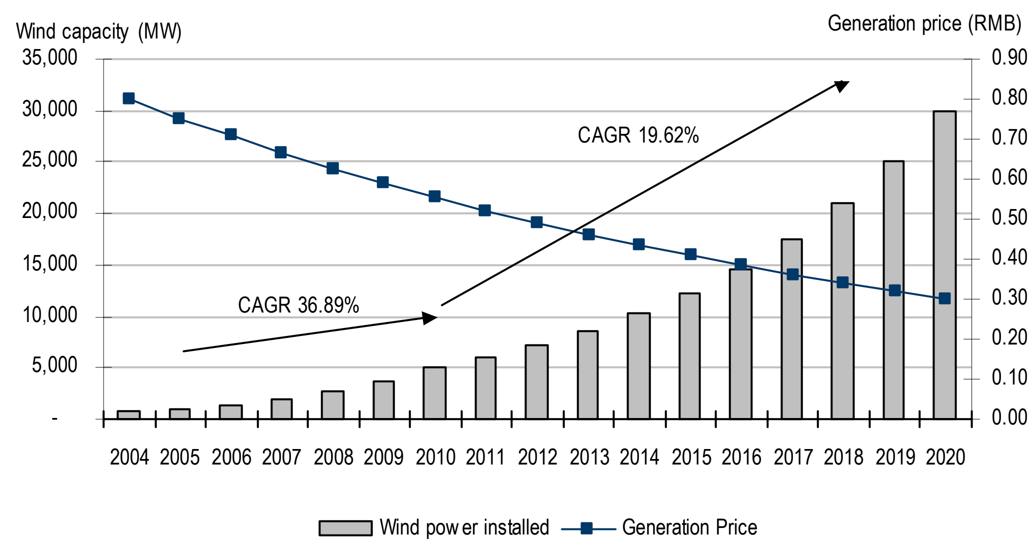
Robert Threshner, director of the National Wind Technology Centre in the US Department of Energy's National Renewable Energy Laboratory, stated that the cost of electricity generation using wind power has decreased substantially from US$0.80 per KWh in 1980 to around US$0.04-0.06 per KWh currently. Similar estimates have been provided by Li Junfeng, who stated that the average grid price had fallen from RMB0.80 (US$0.064) in the 1990s to RMB0.60 (US$0.048) per KWh in 2004.

The cost of generating electricity using wind power (RMB0.60-0.80) is still higher than that generated using coal (RMB0.35)

Mr Li's estimates are significantly below those of Mr Zhang, who stated that the cost of electricity generated using wind power in China is approximately RMB80 (US$0.10) per kWh. Mr Zhang attributed the higher cost to the requirement to import more expensive equipment from developed countries upon receiving assistance, loans, grants or technical aids from these nations. Nonetheless, the estimates of both Mr Li and Mr Zhang imply that the cost of generating electricity using wind power (RMB0.60-0.80) is still higher than that generated using coal (RMB0.35). Shanghai Electric has a partner/technology provider from Germany, Aerodyn (not listed), to produce wind turbine equipment in China.

With 70% of wind farm costs attributed to the cost of wind turbine, as projected by American Wind Energy Association (AWEA), the cost of electricity generated using wind power is highly sensitive to the volatility in the price of wind turbine. AWEA predicts that the price of wind energy will decrease from the current level of US$0.04-0.06 per kWh range to below US$0.03 by 2013 and to US$0.025 by 2020. Much of the forecasted decrease in wind energy price is ascribed to the price of wind turbines. The cost of wind turbines is expected to fall for the following reasons. First, technological advancement implies lower costs for the manufacture of wind turbines. Second, production capacity expansion will lead to economies of scale, which should help lower turbine prices. Third, price competition is likely to rise because of an increase in the number of manufacturers.

Figure 23: **Wind energy generation capacity and cost**



Source: NDRC, AWEA, Credit Suisse estimates

The cost of wind energy in China will decrease from the current RMB0.80 per kWh to RMB0.30 by 2020

Mr Zhang's estimate of RMB0.80 per kWh cost of wind power is marginally higher than the RMB0.60 per kWh cost estimated by Mr Li and the global average cost of US$0.04-0.06. We estimate the cost of wind energy in China to decrease to RMB0.30 (US$0.037) by 2020, marginally higher than the US$0.025 that the AWEA estimates is the average global wind energy cost. Our estimate implies a wind energy price CAGR of -5.95% in China to 2020, at a more rapid pace than the estimated global price CAGR of -4.12% over the same period. As the Chinese government continues to promote the use of wind power, we believe a rapid increase in manufacturing capacity is likely. As such, we forecast China to exhibit faster rate of cost reduction than the global market.

Via CRESP, the World Bank is providing financial assistant of around US$88.82 mn to China's large-scale wind power development

The NDRC reported that the total wind power capacity amounted to 760 MW as of 2004 and is expected to reach 1GW by the end of 2005. The NDRC is aiming for 5 GW and 30 GW of installed capacity by 2010 and 2020, implying CAGR of 36.89% and 19.62% in 2004-10 and 2010-20, respectively. The NDRC aims to establish 30 large-scale wind power projects with unit capacity of 100 MW. The NDRC also aims to establish three 1 GW wind power generators in Jiangsu province, Hebei province and Inner Mongolia by 2010.

The China Renewable Energy Scale-up Programme (CRESP) of the World Bank offers a US$40.2 mn grant to support the institutional development and capacity expansion during the first phase of large scale wind power projects in a number of provinces in China including Fujian, Jiangsu, Zhejiang and Inner Mongolia. Cost-sharing by participants is expected to contribute an additional US$48.6 mn for a total grant of around US$88.8 mn. CRESP projects that the discounted gain of the project is approximately US$100 mn from taxes paid by the new power plant to provincial and local governments. By 2020, China plans to have several provinces with wind power capacity of over 2 GW each, six large-scale wind power farms with individual capacity of 1 GW and to achieve marine power capacity of 500 MW.

According to estimates made by the NDRC, proven wind energy reserves in China are around 1,000 GW, where 250 GW is located in the remote and eastern coastal areas. Hence, the 760 MW capacity installed by 2004 only accounted for 0.08% of total resources available. The NDRC's target of 30 GW installed capacity by 2020 accounts for only 3% of the total wind power resources available in China. Through CRESP, the World Bank estimates that China's technical potential for wind power is around 160 GW.

The need for electricity storage adds to the cost of wind energy

A primary concern regarding wind-generated electricity is that wind power supply can be unreliable. Hence, there is a risk that wind generators could under-supply during periods of high demand. In order to ensure a more secure electricity supply, a method of storing electricity is required. The need for electricity storage translates into additional costs for the use of wind power.

Disputes on the bidding-price-based wind power pricing mechanism

China's Renewable Energy Law came into effect on 1 January 2006, and the NDRC announced the renewable energy pricing mechanism later that month. The regulation stipulated that the on-grid tariff of wind power projects in China would be decided by the State Council based on the competitive bid-winning price for wind power projects. This competitive bidding price-based pricing mechanism for wind power generation is not new. In 2003, China NDRC established the regulation regarding wind power franchise awards. In this regulation, the NDRC stated that the wind power franchises would be awarded to whichever entity submitted the lowest bidding price, which would in turn be the on-grid tariffs for the wind power projects. The Chinese regulator had planned to use this stipulation to increase the transparency of decision process for wind power projects awards, thus encouraging the participation of various types of investors in wind power projects in China.

However, since the launch of this regulation, wind power project operators have objected, because some operators deliberately submitted artificially low bids in order to secure the franchises. The best-known example was the 100 MW wind power project in Rudong county in Jiangsu province, which was opened for tender in 2003. The lowest bidding price, which was submitted by Chinese company Hua Rui Investment Group Corporation (Hua Rui), was only RMB0.39 per KWh, equivalent to US$0.047 per KWh. This price was widely considered by the wind power industry as insufficient even to cover the generation costs. The other bidders' prices ranged from RMB0.6 per KWh to RMB0.7 per KWh. Many wind power project operators publicly criticised Hua Rui's low bidding price, saying it could lead to low industry profitability.

They also pointed out that the only reason that Hua Rui had submitted such a loss-making bidding price was because it intended to secure the market first, and after the project had started operation, negotiate with the government to raise tariffs. Shi Peng Fei, a member of the evaluation panel for the Rudong wind power project, said that having reviewed Hua Rui's bid, it was the result of the company's having overestimated the wind resources, underestimated the equipment cost and financing costs and having omitted the necessary maintenance expenses. Even the regulator did not believe that the low bidding price would be achievable. As a compromise, the project was finally awarded to Hua Rui with an adjusted on-grid tariff of RMB0.436 per KWh.

The 2003 regulation was amended in 2005, following pressure by wind power operators. In the amended tendering documents for wind power projects in 2005, the weight of the bidding price was decreased to 40% from the 100% stipulated in the 2003 regulations. However, the bidding price remained the most important factor in choosing the tender winner.

Price-based mechanism is likely to intensify competition

We believe the bidding-price-based pricing mechanism of wind power will probably intensify the competition among wind power project operators, and will thus lower the profitability of wind power operations drastically. The competition, although we believe it would help to drive down wind power generation costs rapidly, may discourage investment in Chinese wind power projects. Acknowledging the negatives of this pricing mechanism, the Chinese regulator has to some extent taken a compromise between government-guided price and market-driven price in order to encourage the investment in wind power projects in China. In the bidding for the first batch of wind power projects opened to tender after the announcement of pricing mechanism this January, three companies were granted franchises to operate wind power projects in coastal areas in Jiangsu province. The on-grid tariffs for the three wind power projects were unanimously set at RMB0.487 per KWh.

We believe the bidding-price-based pricing mechanism of wind power will be positive for the domestic Chinese wind power equipment producers because the wind power operators are likely to be more inclined to use cheaper domestically manufactured equipment than imports. As reported by the China Electricity News Web site, Mr Zhang, the vice-minister of the China NDRC, pointed out in a speech given at a conference on 19 February 2006 that the launch of bidding-price-based pricing mechanism for wind power was also aimed at the localisation of wind power equipment. The Chinese government has introduced a regulation stipulating that 70% of wind power equipment should be procured from domestic companies, including joint ventures between domestic companies and foreign companies. China's wind power equipment manufacturing industry still lags behind the advanced companies in foreign countries in terms of manufacturing technologies. For example, the highest unit output of imported wind power units can be between 3.6 MW and 5 MW, while domestically manufactured units can only reach 0.75 MW.

Solar power generation capacity

The cost of solar energy is expected to come down

At an average generation cost of US$0.32/KWh, solar power based on current technology is much higher than the cost of electricity generation using other energy sources. Before taking into consideration the cost of grid investment (as solar power could be generated on site and on small incremental output capacity), solar power generation cost is five to seven times more expensive than the electricity generation using fossil fuel. The cost of solar-generated electricity is expected to decline due to technological advancement, primarily aimed on the reduction in silicon usage. Economies of scale due to production capacity expansion and synergies from vertical integration by PV manufacturers will further reduce the cost of PV systems.

We believe Suntech Power is well positioned to tap the growth potential in China PV demand with its low cost manufacturing base, proprietary technology and scale production base in China. The company's strength and track record in PV R&D and its strong balance sheet further lends strength to Suntech potentially integration upstream commercialise the next generation thin film solar cell design technology. In addition, third-generation solar cells could deliver energy conversion efficiencies ranging from 60% to 80% compared to the current 15%-17% (the highest conversion efficiency from commercially produced cells is around 23% but at a high cost as such cells require high purity, high cost silicon wafers). However, it may take a further 15 years to produce third-generation solar cells commercially.

Shanghai Electric's solar partner, ErSol Solar Energy AG (ES6 GR, €48.32, not rated), is proposing to introduce crystalline silicon solar cells with three-busbar (3BB) technology to the market before the end of the year. The solar cell provides up to 2% higher fill factor, which allows for a higher overall conversion efficiency. 3BB technology was developed to reduce the risk of breakage in the production of modules from even-thinner solar cells. The new contacting concept will initially be employed in the BlackPower Monocrystalline solar cell (156 mm x 156 mm). ErSol proposes to manufacture cells with a thickness of 200 µm. ErSol's 3BB technology is currently only at the prototype stage, but the company expects it to reach commercial production before the end of 2006. The first modules with these solar cells show 3% better performance relative to the conventional cell technology with two conductors.

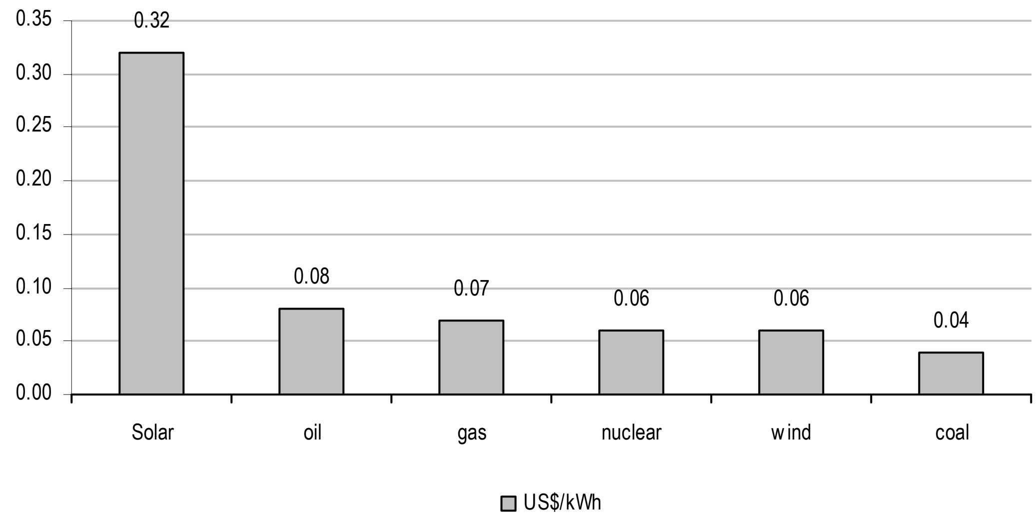
Long-term module prices have declines by 15%-24% in 1997-2004 while cell price dropped by 33%-55% during the same period

Cambridge Energy Research Association predicts that, for every doubling in production capacity, production costs will decrease by 20%. The expansion of the global market by a 30% CAGR over the past decade, translated to a CAGR of -5% for production costs. Solarbuzz reported that the long-term module prices declined by approximately 15% to 24% between 1997 and 2004 while cell price dropped by between 33% and 55% during the same period. In Japan, the cost of electricity generated using solar power decreased from ¥2.60 per kWh in 1993 to ¥42 per kWh in 2005 and is expected to continue its decline to ¥23 per kWh by 2010.

Solar energy cost will decline from the current RMB2.54 per kWh to RMB1.57 in 2010 and to RMB0.47 by 2020.

Assuming that the cost of solar power in China tracks the global market, the current generation cost of RMB2.54 per kWh will fall to RMB1.57 per kWh by 2010, implying a CAGR of -11.35% in 2005-10. If this trend continues, the cost of solar energy will decline to RMB0.47 per KWh by 2020. At RMB0.47 per kWh, solar power would still be marginally more expensive than the RMB0.35 per kWh cost of coal power generated electricity. In order to be competitive without any government subsidies, the cost of solar energy needs to see a CAGR of -13.2% between 2005-20, which is almost double the historical CAGR of -7.7% in 1996-2005. The crystalline silicon on glass (CSG) technology pioneered by Pacific Solar (which is currently partly owned by Q-Cells) is set for commercial production within the next 18 months. Suntech management who was engaged in the pioneering phase of this CSG technology is looking to develop a low-cost CSG platform and have it produced commercially in 2008. We believe the targets for cost reduction are achievable within the aforementioned time frame. This would make solar power cost-competitive relative to traditional fossil fuel generated power.

Figure 24: Average unit power generation cost comparisons



Source: NDRC, AWEA, Credit Suisse estimates

The increase in solar-grade silicon supply and reduction in silicon usage will drive the future price of PV systems down

Solar-grade silicon accounts for 70% of total production costs of PV modules (See Credit Suisse's Suntech Power Holdings initiation report, *A leading global versatile low-cost PV producer*, published on 23 January 2006, for more information). Solarbuzz reported that the current shortage of solar-grade silicon supply has pushed the price from US$35/kg to US$45/kg in 2005. The shortage of solar-grade silicon is not expected to ease before 2008, and we expect price of solar-grade silicon will rise to US$50/kg in 2006 and to US$60/kg in 2007. We expect the price of solar-grade silicon to ease in 2008 because of additional supply from production capacity expansion programmes that are currently being undertaken by silicon manufacturers. In addition, PV module manufacturers are striving to increase the efficiency of silicon usage, which may put further downward pressure on the price of PV modules.

Two thirds of China's landmass gets more than 2200 hours of sunlight a year

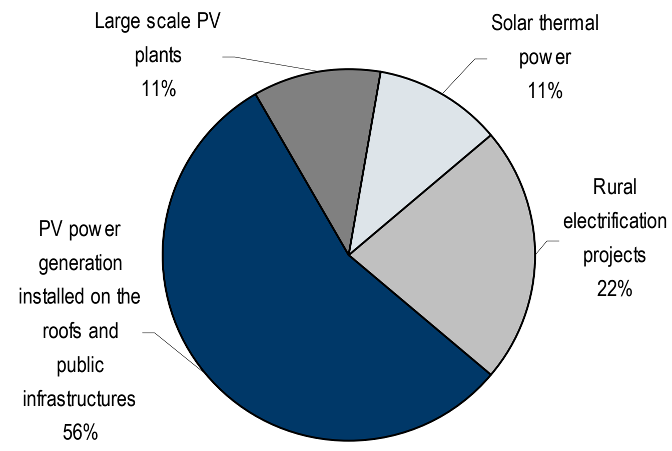
Given the high solar incidence, China represents a suitable market for solar power. The NDRC stated that two thirds of China's landmass gets more than 2,200 hours of sunshine a year. As of 2004, the total solar power capacity in China amounted to 65 MW, most of which is installed to satisfy power demand in remote areas and special industries.

The installed capacity of China's solar power will reach 2 GW by 2020

The NDRC stated that the Chinese government is currently aiming to increase the country's solar power capacity to 2 GW by 2020. This includes 300 MW of rural electrification projects, 1 GW of PV power generation projects installed on rooftops and public infrastructure, 200 MW of large-scale solar power plants and 200 MW of solar thermal power. The NDRC's target implies a CAGR of 46.8% and 7.2% for China's solar power capacity between 2004-10 and 2010-20, respectively. We believe the government could raise the 2020 target further in its next five-year plan, which will start in 2011.

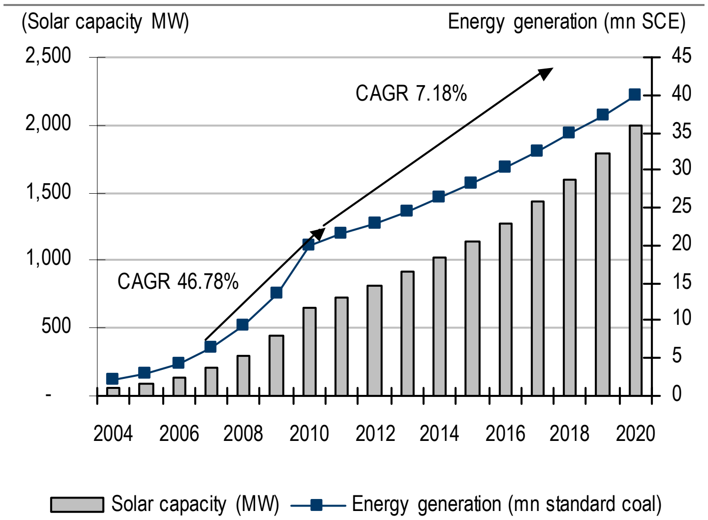
The Chinese government is also aiming to promote solar power for heating purposes. The NDRC aims to increase the cumulative installation of solar energy heaters from 15 mn sq m in 2004 to 150 mn sq m (equivalent to 20 mn tonnes of standard coal) in 2010 and to 300 mn sq m (equivalent to 40 mn tonnes of standard coal) in 2020.

Figure 25: Composition of China solar power market in 2020



Source: NDRC

Figure 26: Solar power capacity and generation



Source: NDRC, Credit Suisse estimates

China is building the entire value chain from raw materials supplies to PV cells to systems integration devices

An emerging PV industry value chain in China

We believe China's PV manufacturing industry is becoming a booming investment sector, due to strong demand from the solar power industry around the world, especially in Germany, the US, Japan, Spain and Italy. We believe additional countries or US states (following California) are likely to initiate environmental incentive programmes and raise global solar product demand. According to Photon International's 2005 survey of PV cell and module producers around the world, China more than doubled its market share in the global PV cell market from just 4.1% for 51.8 MW in 2004 to 8.3% for 150.7 MW, more than half of which was due to Suntech Power.

As a result of the entrance of new PV cell manufacturers in China, Suntech's market share in the total production of PV cells from China has declined to 54.4% in 2005 from 67.6% in 2004. However, we believe Suntech will maintain competitive advantages over its Chinese peers for several reasons.

Suntech's long-term relationships with its customers and suppliers should bring it sufficient silicon supply at good prices to feed its rapid capacity expansion in the next five years. Undoubtedly, the procurement of silicon supply has become the most important factor for PV cell manufacturers. According to Credit Suisse silicon analyst Masami Sawato, polysilicon for solar use will remain short of supply until 2007. More importantly, as a result of the boom-and-bust cycle of the polysilicon industry, we believe the polysilicon suppliers have become more oriented to build long-term partnerships with their customers, which play an important role in the capacity expansion plans of these polysilicon suppliers. Suntech said it has secured 100% of the silicon supply for its production of PV cells in 2006, and 40% of its silicon supply volume is covered under fixed-price contracts. Most of these fixed-price silicon contracts of Suntech are entered under exchange programme arrangements with the silicon wafer companies, including Solarworld (SWV GR, Eu52.60, not rated) and Tianwei Yingli (not listed). Under these exchange programmes, Suntech will provide PV modules to the same companies from which it secures its silicon wafers.

We believe Suntech's integrated large-scale production of high quality PV cells and modules gives the company a stronger bargaining position compared to its Chinese counterparts in the procurement of silicon. However, rising competition from its Chinese peers may lead to price competition as Suntech's competitors try to win market share in the PV market.

Several Chinese start-up PV cell manufacturers have quite aggressive production expansion plans in 2006

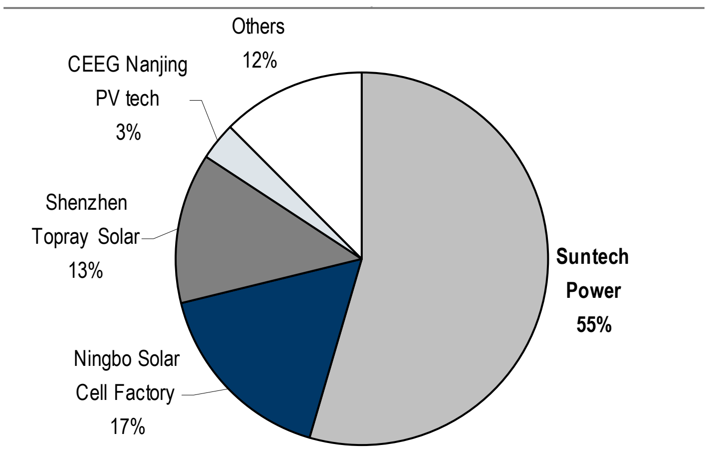
As seen in Figure 27, several Chinese start-up PV cell manufacturers have quite aggressive production expansion plans in 2006. For example, CEEG Nanjing PV tech (not listed), Ningbo Solar Cell Factory (not listed) and Shenzhen Topray Solar (not listed), have all planned to increase their production of PV cells to 50 MW in 2006. These are still smaller than Suntech's target capacity of 240-270 MW by the end of 2006.

Figure 27: China PV cell manufacturers (MW)

	2006 production	2005 production	End-05 capacity	Production 2004
Baoding Yingli	n.a.	3	12	3
CEEG Nanjing PV Tech	50	5	32	n.a.
Jing Ao Solar	50	n.a.	n.a.	n.a.
Jiangsu Linyang	30	n.a.	n.a.	n.a.
Jiang Ying Jetion	25	n.a.	n.a.	n.a.
Ningbo Solar Cell Factory	50	25	50	3
Shanghai Topsol Green Energy	15	5	10	3
Shenzhen Topray Solar	50	20	35	4
SMIC	3.5	0	0	n.a.
Suntech Power	140	82	150	35
Tianjin Jinneng Solar	2.5	2.2	2.5	1
Trina Solar	15	n.a.	n.a.	n.a.
Trony	n.a.	4.0-5.0	6	0.8
Yunnan Semiconductor	n.a.	3.0-5.0	10	2
Total	**431**	**150.7**		

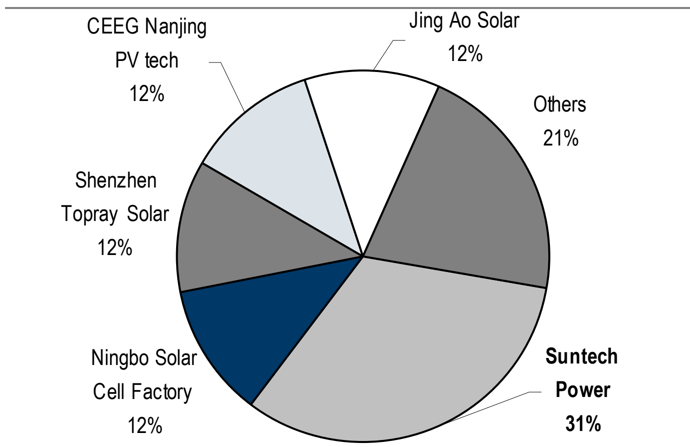
Source: Photon International March 2006 Issue, Credit Suisse estimates

Figure 28: China PV cell market shares in 2005



Source: Photon International

Figure 29: China PV cell market shares in 2006 (Photon International estimates)



Source: Photon International

China's current silicon capacity mainly comes from He'nan Luoyang Silicon (not listed) and Sichuan Emei Silicon (not listed) with total capacity of around 600 tonnes annually, equivalent to 55 MW of PV cells' silicon requirement assuming 11g of silicon per watt of PV cell production. That said, over 87% of silicon required by the Chinese PV cell manufacturers will be imported. We believe China's new silicon production capacity will most likely come on stream after 2007 given the investment cycle of a silicon production.

These Chinese silicon suppliers may face competitive pressure from imported silicon, given that most of the global large silicon companies' capacity expansion will come on stream in 2008 and the domestic Chinese silicon companies mostly have lower production efficiency and smaller scale than their global peers.

Polysilicon supply in China

China is rich in raw silicon reserves

According to the PV industry report in China co-authored by China's NDRC and the World Bank, only two companies can produce polysilicon (for use in semiconductors and PV cells) in China: Luoyang Silicon and Emei Silicon. These have a current annual production capacity of 450 tonnes and 150 tonnes, respectively. The bottleneck exists because until 2000, China did not have the silicon purification technology, which currently is controlled by eight polysilicon producers in Japan, Germany and the US. However, China acquired the production technology for polysilicon from Russia in 2000, which appears to have alleviated the bottleneck. China is rich in raw silicon reserves for producing polysilicon, but it has been exporting most of the raw or low-purity processed silicon to the countries that own the polysilicon production technologies.

In 2001, the Chinese government initiated the first polysilicon production project in Sichuan province using domestically owned technology, which was an improvement of existing Russian technology. However, the construction of this project was delayed due to a lack of financing until 2004, when the demand for polysilicon from semiconductor and PV manufacturers reached a record high. After a round of competition for ownership from various investors, the Sichuan state-owned investment company (38.99% stake) and Tianwei Yingli (35.66% stake) became the two biggest shareholders of this Sichuan-based polysilicon production base, which is now operated under the company named Xing Guang Silicon (not listed). Suntech was reported to have competed with other companies for control of Xing Guang, but lost to Tianwei Yingli. The other shareholders of Xing Guang are all state-owned Sichuan-based companies. With designed capacity of 1,260 tonnes, this project is now under construction and the targeted commission time is the end of February of 2007. The total investment for the project is RMB1.26 bn.

Luoyang Silicon is expected to increase its production capacity from the current 450 tonnes to 700 tonnes by the end of 2006. It has been reported that it is planning to increase its capacity to 3,000 tonnes by the end of 2010. Luoyang Silicon is reputed to use the same technology as Sichuan-based Xing Guang Silicon.

Two more polysilicon production projects are in the negotiation phase in Ningxia and Liaoning provinces

Two more polysilicon production projects are in the negotiation phase in Ningxia and Liaoning provinces. The designed capacity for these two projects is at least 1,000 tonnes. We expect these projects will commence production at the end of 2007, at the earliest, given the 18 to 24 months of production time for a polysilicon project with 500 tonnes of annual capacity, and the fact that production has not yet started at these two projects. The municipal governments want to introduce investment funding, production equipment and polysilicon production technology to these projects from foreign investors. As an exchange, the municipal governments will provide rich raw silicon reserves and cheap land for production. In addition, the projects are located in northern or north-eastern China, where labour and utility costs (including electricity and water supply) are much cheaper than in the developed costal areas in China.

We expect China's silicon production capacity to increase from 600 tonnes now to about 3,000 tonnes and 7,000 tonnes by 2008 and 2010 respectively, which is sufficient to produce 270 MW and 640 MW of solar cells, respectively, before assuming wafer thickness reduction.

PV cell manufacturers in China

As we pointed out in our initiation report on Suntech published on 23 January 2006, we believe the attributes of successful PV manufacturing companies include:

- Ability to secure silicon supply;
- Ability to control production cost on back of advanced production technologies;
- Access to a wide distribution channels especially in the countries or areas with highest demand growth in the solar power industry.

Since most of the PV companies are not publicly listed, we select three companies to discuss below, which are renowned for their production scale or technology abilities:

- CEEG Nanjing PV tech

This company was co-founded two years ago by Mr Zhao Jianhua and China Electricity Engineering Co. Mr Zhao Jianhua developed crystalline solar cells with a conversion efficiency of 24.7%.

According to Photon International's report of September of 2005, the company started with simple cell designs with energy conversion efficiency goals of 15% for multi-crystalline cells and around 16% for cells made of monocrystalline silicon. The total installed capacity up to the end of May 2005 was 100 MW and the near-term capacity target is 300 MW with timing for realising this target dependent on the supply of silicon.

- Baoding Tianwei Yingli New Energy Resources (known as Tianwei Yingli)

Baoding Tianwei Yingli New Energy Resources was founded in 1998. Tianwei Baobian Electric holds a 51% stake and Baoding Yingli holds the remaining 49% stake. Tianwei Yingli is a specialised manufacturer of PV products and also an integrated supply chain with wafers, cells and modules production line. In 1999, Tianwei Yingli contracted to develop the 'National High-Tech Demonstration Project' in polycrystalline silicon ingot manufacturing. Tianwei Yingli imported a set of advanced wafers, cell, module production lines from the US, Japan and Italy and it completed overall national inspection by December 2003.

With total production capacity of 6 MW, 10 MW and 30 MW for wafers, cells and modules, respectively, by the end of 2005, Tianwei Yingli aims to increase its capacity sufficiently to supply its own to silicon wafers to its cells and modules production lines.

The third phase 500 MW Solar Power Project of Tianwei Yingli is under construction, with an estimated total investment of RMB2.9 bn. The implementation schedule is shown in Figure 30. Total annual capacity under this plan is 500 MW in each production line of wafers, cells and modules with completion scheduled for December 2009.

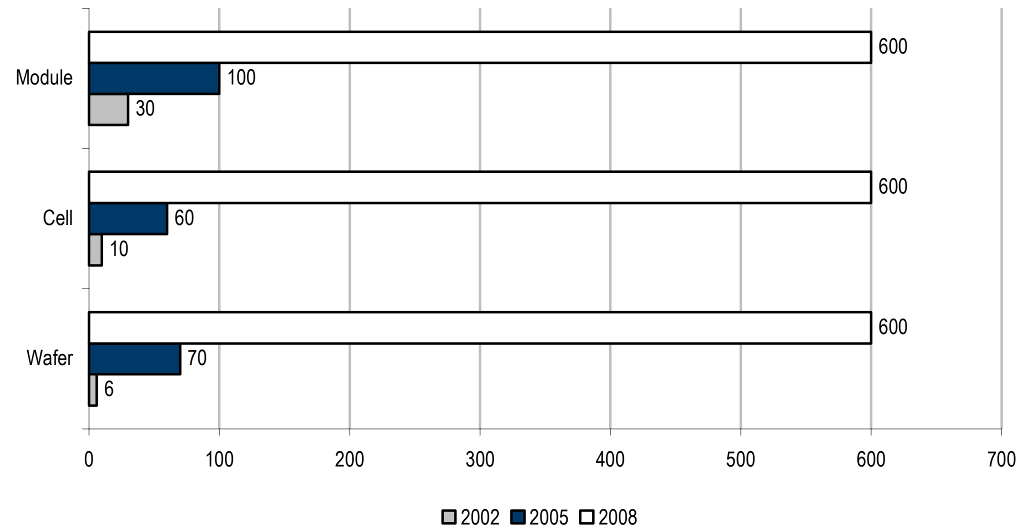
Baoding Tianwei Baobian Electric (600550 CH, RMB22.86, not rated), which has RMB-denominated A shares listed on the Shanghai Stock Exchange said on 21 March that it has received regulatory approval for its solar power equipment unit, Tianwei Yingli Energy Resources, to seek a listing on the New York Stock Exchange. In a statement, Tianwei Baobian said the preliminary plan is to list on the New York Stock Exchange within a year of receiving consent from its shareholders.

Figure 30: **Implementation schedule of third term solar power project of Yingli Solar**

	Schedule	Wafer (MW)	Cell (MW)	Remark	Schedule	Module (MW)
First stage	March 2006-July 2007	200	200	70% infrastructure	July-December 2007	100
Second stage	August 2007-July 2008	200	200	30% infrastructure	July-December 2008	300
Third stage	August 2008-July 2009	100	100		July-December 2009	100

Source: Company data, Credit Suisse estimates

Figure 31: **Yingli's capacity expansion plan**



Source: Company data, Credit Suisse estimates

PV module manufacturers in China

China is becoming one of the biggest PV module suppliers in the world

We believe that China is becoming one of the biggest PV module suppliers in the world on the back of its low labour cost production base and the labour-intensive nature of PV module manufacturing. Unlike European and Japanese PV manufacturers, China's PV module manufacturers, such as Suntech, deploy labour in place of expensive automated production lines, thus improving the efficiency of silicon utilisation and cutting production costs significantly, while at the same time allowing for a flexible design of production processes to implement technological improvements.

Shanghai AeroSpace Automobile Electromechanical's (SAAE [600151CH, RMB15.93, not rated] {52%-owned subsidiary of Shanghai Solar Power Science and Technology Corp., SSPST}), with registered capital of RMB100 mn, is engaged in the assembly of PV modules and installation of PV systems in China. SSPST, according to the September 2005 issue of *Photon International*, has become the PV module OEM supplier for Sharp (6753 JP, ¥1,809, NEUTRAL, TP ¥2,060, MW), the largest integrated PV equipment manufacturer globally. Some 60% of SSPST's production of PV modules is for Sharp. Sharp provides the raw materials and the formula for assembling the modules. Currently, SSPST still has capacity for new customers, as only half of the company's 120 MW total annual capacity is being exploited. SSPST is planning to expand into the PV cell manufacturing business on the back of the PV cell technology of SAAE, which develops high-efficiency solar cells for use in aerospace.

Other shareholders of SSPST include: Shanghai Shenergy (600642 CH, RMB6.09, not rated) with a 20% stake, Shanghai Airspace Energy Research Institution (No. 811

Research Institution) with a 18% stake and Shanghai Science and Technology Investment Corporation, with a 10% stake. Shanghai Shenergy acquired a 20% stake in July 2005 as a strategic investor to SSPST. Shanghai Shenergy's major business is power and water supply to Shanghai, and it has recently decided to move into the renewable energy business in order to seek high-growth investment opportunities.

SAAE announced on 17 January 2006 that its board had approved a plan to establish a new holding company engaging in the PV cell manufacturing business in Minghang District Industry Zone, near Shanghai. The new company will have registered capital of RMB100 mn, with its total investment amounting to RMB204 mn. SAAE plans to inject RMB20 mn into this new company, named Shanghai AirSpace New Energy Development Corporation, as SAAE's first-phase equity-funded investment.

According to a news article published on 24 January 2006 in *China Securities Journal*, this new company has been included as part of Shanghai's 2005-07 PV Industry Development Scheme, announced on 14 September 2005 by the Shanghai Municipal Government, Shanghai Communication University and the Ministry of Construction. According to this scheme, the PV manufacturing industry will become an important backbone industry for Shanghai's future economic growth, with the backing of government support and private investment. Designed capacity will be 150-200 MW for PV modules and 100-150 MW for PV cells with total revenue reaching RMB10 bn by 2007. The installed capacity of PV systems in Shanghai is expected to reach 5 MW by 2007.

Minghang district will be built into the new PV industry base under the Shanghai government's plan. Therefore, SAAE has to establish a new company in Minghang district in exchange for government support, including the acquisition of land use rights and renting production properties at low prices and enjoying preferential tax rates, etc.

Biomass energy

China's biomass sector is still at its infancy

Although biomass is well known, produced and specifically legislated for use in Europe and the US, it remains in the shadows in China. As previously discussed, China's reliance on imported oil is expected to exceed 250 mn tonnes by 2020, more than 50% of its total oil consumption in that year (see previous section). Undoubtedly, it signifies a pressing need for China to develop an alternative energy source in order to supplement and possibly reduce the nation's expected heavy reliance on imported oil. Biomass represents one of the options to supply (at least partially) China's insatiable demand for oil.

Much of the available biomass resources are still unutilised

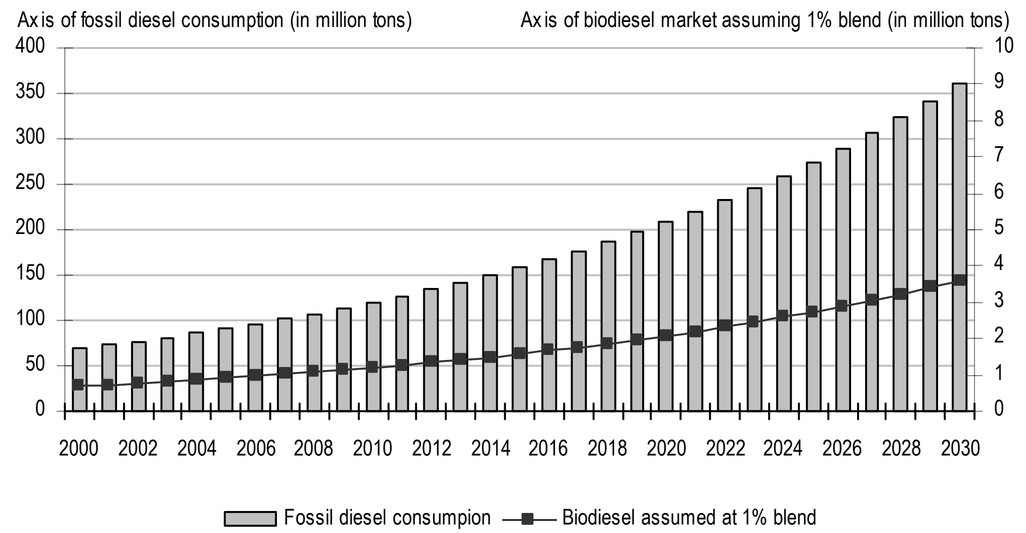
The NDRC stated that China's available biomass resources include 700 mn tons of crop straw, 900 mn tons of forest disposables, 80 bn cubic metres of methane from stock feeding and industrial waste and 120 mn tonnes of urban garbage. However, much of the available resources are still to be utilised. CRESP estimates that China's technical biomass capacity is approximately 125 GW, or around 300 mtce.

According to Shi Li Shan, the deputy director of renewable energy bureau of the NDRC, by the end of 2004，China had set up 15 mn methane pools for rural residential usage. These have an annual methane production of about 5.5 bn cubic metres, and have built up about 2 mn KW of installed capacity for power generated from biology energy. China has been developing the conversion of stale foodstuff into ethanol fuel with designed capacity of about 1 mn tonnes. China is also embarking on the trial for the production of ethanol fuel and biology diesel by converting agricultural crops.

China's biomass production capacity is to reach 30 GW by 2020

The NDRC reported that the Chinese government is currently aiming to install 5.5 GW of biomass power production capacity by 2010 and 30 GW by 2020. Of the 30 GW targeted for 2020, more than 70% of the power generation will come from agricultural forest products. The NDRC is currently aiming to produce 1 mn tonnes and 50 mn tonnes of solid fuel from biomass energy conversion by 2010 and 2020, respectively. In addition, utilisation of methane by rural residents is expected to reach 11 bn cubic metres by 2010 and 18 bn cubic metres by 2020. Production of liquid fuel converted from biomass energy is targeted to amount to 10 mn tonnes of oil equivalent by 2020 whereas ethanol fuel production is targeted to reach 10 mn tonnes by 2020. China also aims to produce 2 mn tonnes of biodiesel by 2020.

Figure 32: **Diesel fuel consumption, 2000-30**



Source: IEEJ, Credit Suisse estimates

Biodiesel is a viable alternative to fossil diesel fuel

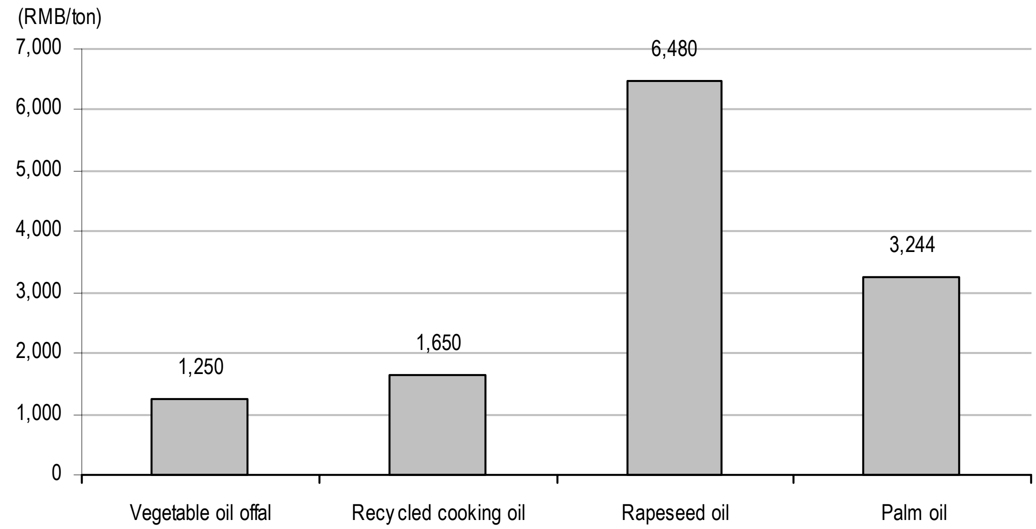
The NDRC target of 2 mn tonnes of biodiesel production by 2020 is low compared to our estimate of China's 90 mn tons of fossil diesel consumption in 2005. It is apparent that China's biodiesel market has been largely overlooked. Assuming a relatively low 1% blend, we calculate that China's biodiesel demand will reach 1.2 mn tonnes by 2010, 2 mn tonnes by 2020 and 4 mn tons by 2030. This means that at 1% biodiesel blend, China's market would represent almost 50% of Asia's biodiesel demand estimated by Bio-era for 2010. While the absolute demand level appears aggressive, we believe such growth is plausible, provided that Chinese biodiesel manufacturers maintain their ability to produce biodiesel at lower costs than the price of fossil diesel and sufficient supply of feedstock.

China's biodiesel market has been overlooked

Biodiesel is a viable alternative to fossil diesel fuel and may provide a measure for China to reduce its worsening air pollution, address China's increasing reliance on imported fuel. In addition, biodiesel raw materials are typically oil crops such as palm oil, jatropha, rapeseed oil and soy oil. As such, development of biodiesel enhances the growth of agricultural sector and thus, provides China with a measure to combat its poverty issues.

In addition, being one of the highest cooking and vegetable oil consumers, China is able to produce biodiesel using recycled cooking and vegetable oil. China's lack of agricultural land (and thus potentially insufficient agricultural products) will make the use of recycled cooking and vegetable oil very important of the large-scale production of biodiesel oil. The use of recycled cooking oil allows a highly cost-competitive biodiesel to be produced. However, it is important to recognise that the total supply of biodiesel feedstock in China would only allow for biodiesel production of equivalent to around 20% of China's annual fossil diesel consumption. As such, resorting to biodiesel as a complete substitute for fossil diesel is not feasible. However, it remains an attractive option for blending purposes.

Figure 33: **Cost of biodiesel feedstock**



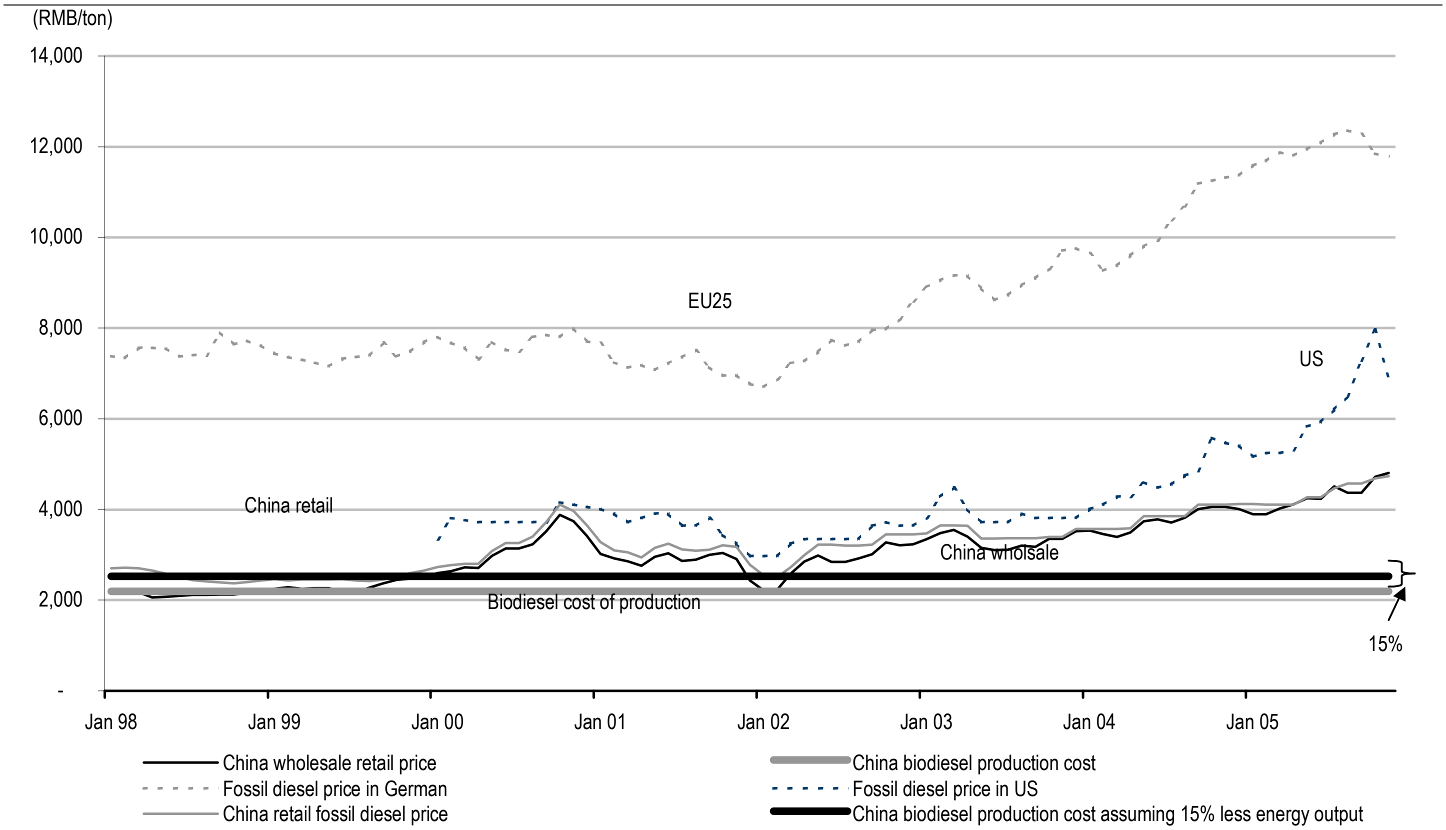
Source: Bio-era, Credit Suisse estimates

China has access to cheap biodiesel feedstock

Bio-era estimated that China's current recyclable used cooking and vegetable oil is around 5 mn tonnes per year. We estimate the current cost of vegetable oil in China to be around RMB1,200-1,300/tonne, whereas recycled cooking oil costs around RMB1,600-1,700/tonne. This implies that the cost of biodiesel feedstock in China is over 70% cheaper than rapeseed oil and over 50% than palm oil. Bio-era estimates that the cost of rapeseed oil in Germany is approximately €675/tonne or RMB6,480/tonne (at an exchange rate of €1 = RMB9.60). At the 2005 Palm Oil Conference (POC), market participants estimated that the cost of palm oil in 2006 would range from around RM1,450/tonne to RM1,540/tonne, or RMB3,141/tonne to RMB3,336/tonne (at exchange rate of RM1 = RMB2.1665).

Bio-era estimates that feedstock accounts for around 80% of total biodiesel production costs in most parts of the world. Given the significantly lower cost of feedstock in China, we estimate conservatively that feedstock cost accounts for 60% of total biodiesel production costs in China. This estimate implies that the total cost of producing biodiesel in China is about RMB2,200/tonne, significantly cheaper than in other countries. Bio-era estimates that the cost of biodiesel in Germany, where rapeseed oil is the dominant feedstock source, is around €805/tonne or RMB7,700/tonne. Based on the palm oil price provided at the POC and the biodiesel production costs provided by Bio-era, we estimate that the cost of biodiesel produced using palm oil is approximately RMB3,961/tonne.

Figure 34: Biodiesel versus fossil diesel price



Source: Bloomberg, OGP, Credit Suisse estimates

With the ability to produce biodiesel at such a competitive price, China's biodiesel manufacturers are well positioned to penetrate both the domestic diesel fuel market and the global biodiesel export market. Assuming that China's biodiesel cost from 1998 to 2004 were at the same level as in 2004 (the dotted line in Figure 34), China's biodiesel cost has been consistently the same or lower than China's heavily subsidised diesel price. The spread is even more pronounced when compared to fossil diesel price in the EU and US. Such conclusion remains consistent even if we impose a very conservative assumption that China's biodiesel produces 15% less energy than fossil diesel.

Absence of a national standard is a drawback

However, China must overcome some hurdles to penetrate the global biodiesel market, especially the EU and the US markets. China's biodiesel market is primarily confronted by the absence of a national standard. Currently, biodiesel specifications and standards in China are set at the provincial level, so the quality of biodiesel in China may vary between provinces. In addition, the absence of a stringent biodiesel standard may result in biodiesel manufacturers forgoing quality control in order to minimise production costs. Currently, the Chinese biodiesel manufacturers claim that their product complies with the old German standard DIN E 51606. If the Chinese quality level does genuinely meet the old German standard, the quality is not far behind the global standard. However, China may still be prevented from exporting to the US and the EU until further enhancements are made.

Compared to the old German standard DIN E 51606, new EU standard EN 14214 is more stringent and stipulates additional requirements that were not initially included in

DIN E 51606. Standard EN 14214 prohibits the use of recycled oils with a high polymer content. In addition, animal fats derived from knackery operations (which process the whole animal including hairy skins), contain higher levels of sulphur than permitted by standard EN 14214. Therefore, reduction of sulphur content via specific distillation process is required in order to comply with EN 14214. Hence, compliance with DIN E 51606 does not guarantee that China's biodiesel complies with the US standard set for biodiesel products, ASTM D 6751.

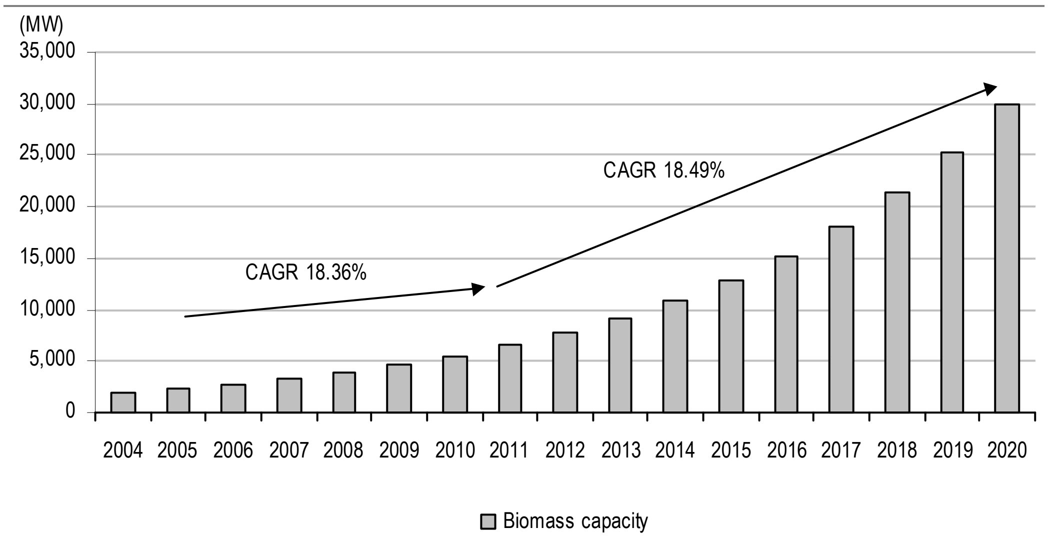
The Central Government is currently seeking to develop a national standard for biodiesel in China

The Central Government is currently developing a national standard for biodiesel. There are two possible implications that the introduction of a national standard could have on China's biodiesel market. First, implementation of a national standard that is less stringent than EN 14214 and ASTM D 6751 would allow local biodiesel manufacturers to maintain their cost-competitiveness. However, this would mean that China could not export its biodiesel to the EU and US, which the two largest biodiesel markets in the world. Second, the introduction of a stringent standard, such as one that complies with EN 14214 and ASTM D 6751, may result in higher production costs for PRC biodiesel manufacturers.

Given that biodiesel market currently does not seem to have substantial technological entry barriers, high profit margins may attract a large number of new entrants, which will result in increased competition. The increase in the number of manufacturers will also increase competition in securing feedstock, which may create upward pressure on feedstock costs and thus production costs. Existing biodiesel manufacturers in China are currently planning for aggressive production capacity expansion. In conjunction with the potential increase in the number of newly established manufacturers, aggressive production capacity expansion may result in potential overcapacity in China's biodiesel market in the future. In addition, it is important to note that the price of fossil diesel plays a major role in determining the outlook of biodiesel market. A significant decline in the price of fossil diesel would have a detrimental effect on the global biodiesel market.

The NDRC's targets imply that biomass production will see a CAGR of 18.36% in 2004-10 and 18.49% in 2010-20

Figure 35: China's biomass production capacity



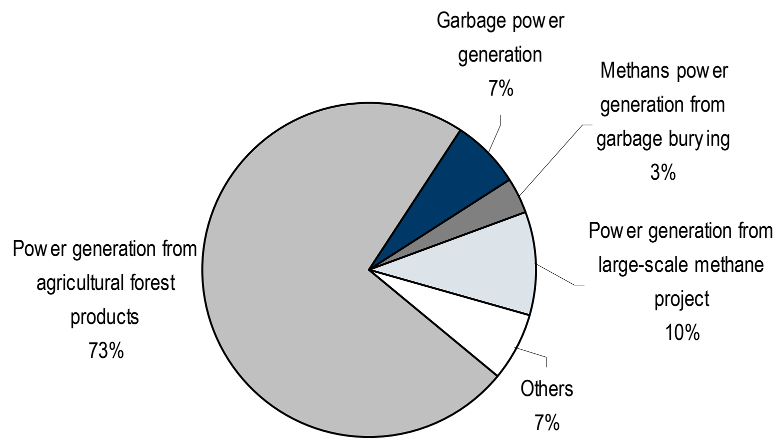
Source: NDRC, Credit Suisse estimates

The NDRC aims to expand China's biomass production capacity from 5.5 GW in 2004 to 30 GW by 2020. The NDRC's targets imply that biomass production will experience a CAGR of 18.4% in 2004-10 and 18.5% in 2010-20. Power generation capacity from agricultural and forest products, garbage power generation capacity, methane power generation capacity from garbage burying and power generation capacity from large-scale methane project will grow from 2 GW, 0.5 GW, 0.2 GW and 0.8 GW in 2004 to 22 GW, 2 GW, 1 GW and 3 GW in 2020, respectively.

The primary concern that surrounds the Chinese biomass sector is the absence of an official national standard

The absence of a regulatory standard could dampen consumer confidence and stunt the growth of China's biomass industry.

Figure 36: **Composition of biomass sources**



Source: NDRC, Credit Suisse estimates

The growth of hydropower

The growth of hydropower in China is likely to lag other renewable energy sources such as wind power, solar power and biomass

The utilisation rate of economically exploitable hydro resources in China was about 30% as of 2005. We believe there is room for growth. However, with production capacity predicted to see a CAGR of 3.4% in 2005-20, it is significantly lower than those for wind power, solar power and biomass. In addition, our estimate shows that around 70% of available hydro resources in China will be exploited by 2020, leaving little room for further growth beyond 2020. We believe that the growth potential of hydropower, while still positive, will be inferior to those of other renewable energy sources such as wind power, solar power and biomass.

Government initiatives

A 50% tax break is available for investors in renewable energy, and the government is considering more favourable incentives

The 11th FYP saw the increase in the Chinese government's commitment to promoting renewable energy. Zhang Guobao, vice-minister of the NDRC, stated that up to RMB1.5 tn (US$184 bn) would be invested by 2020, with some of the investment expected to come from international and private investors. In addition, a 50% tax break is currently available for those who invest in solar, wind and renewable energy. Currently, the government is considering more favourable incentives to encourage businesses to invest in renewable energy projects. The proposed RMB0.25/kWh (which should decline by 2% p.a. after 2010) subsidy for electricity generated using non-hydro renewable energy represents approximately 0.90%, 1.25% and 1% of China's GDP in 2004, 2010 and 2020, respectively, assuming a GDP CAGR of 7.5% in 2005-10 and 4% in 2010-20. According to the *China Daily*, the Ministry of Finance will launch a fund to help research and development on renewable energy. Although the size of the fund has not yet been established, the money will be allocated in the form of subsidies and interest repayments.

The energy authorities of local governments above the county level are responsible for the management of the development and utilisation of renewable energy within their own jurisdictions. Medium- and long-term targets on the total volume of renewable energy to be developed at the national level will be determined by the State Council.

The 11th FYP sets out a tender process for licences for the construction of renewable power generation projects. Grid enterprises are required to purchase renewable energy generated by licensed generators in their region.

Based on the 11th FYP, local governments above the county level are required to prepare a renewable energy development plan. They are also required to provide financial support for the renewable energy utilisation projects in rural areas.

The current government subsidy is at RMB0.25 per kWh

The law that came into effect at the beginning of 2006 stipulates two forms of renewable energy pricing: the government-set price and the government-'guided' price. For biopower, the government will set the price based on the provincial or local on-grid price of desulphurised coal-fired power, plus a government subsidy of RMB0.25 (US$0.03) per kWh. Biomass plant that produces output with more than 20% blend of fossil fuel will not be eligible for the RMB0.25 per kWh subsidy. The subsidy will cease when the project has been operating for 15 years. Subsidies are also set to decrease by 2% YoY for projects approved after 2010. For biomass projects, licensees that are determined through competitive bidding process will have the project power tariffs set based on the bid-winning price, as long as it does not exceed the local price of on-grid power.

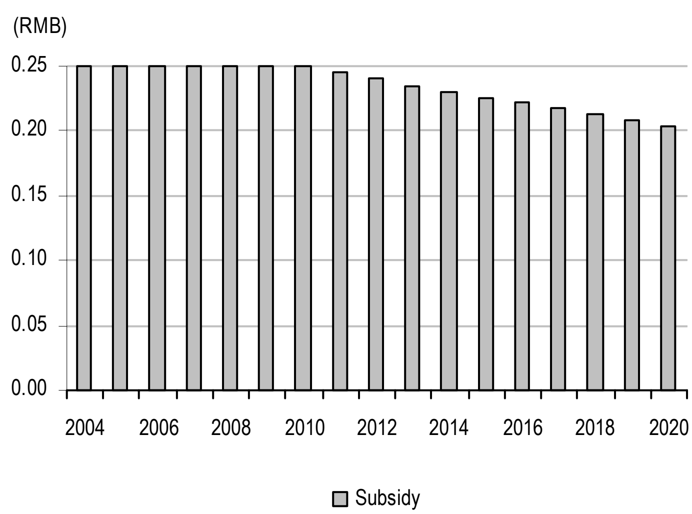
The NDRC stated that the additional tariff for renewable energy is computed as the proportion of total additional tariff of renewable energy to national electricity sales (with additional tariff included). The total additional tariff of renewable energy accounts for the higher running and maintenance cost of renewable energy plants, connection fees of renewable energy power projects and other fees.

The cost difference between on-grid renewable power and power from an on-grid desulphurised coal-fired plant will be shared in the selling price at the provincial and national level

The on-grid price of wind power will be established by the State Council based on the bid-winning price. The price of solar, marine and geothermal power projects will be determined on an 'economic and reasonable' basis. The pricing of hydropower is not affected by this new law. The cost differential between on-grid renewable power and power from an on-grid desulphurised coal-fired plant will be shared in the selling price at the provincial and national level.

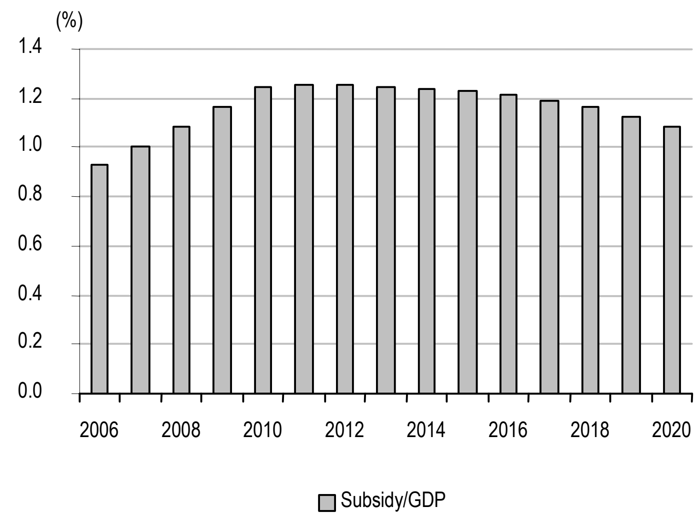
Assuming an average of RMB0.25 per kWh subsidy for all electricity generated using non-hydro renewable energy, it implies a total additional tariff of RMB182 bn in 2006, which represents around 0.9% of China's estimated GDP for 2006 and will amount to 1.25% and 1% of China's GDP in 2010 and 2020, respectively. Our estimates take into consideration the 2% p.a. decrease in subsidy after 2010, our 7.5% GDP CAGR assumption from 2005-10 and 4% CAGR assumption from 2010-20. Derived from the presentation of Li Shan Shi of the NDRC, between 2006 and 2020, around 23% of non-renewable energy capacity will be used for means other than electricity generation.

Figure 37: Government subsidy for biomass



Source: NDRC, Credit Suisse estimates

Figure 38: GDP subsidy 2006-20



Source: NDRC, Credit Suisse estimates

The 11th FYP states that power grid enterprises that fail to purchase renewable power in full and results in economic loss to the renewable power generation enterprises will be penalised. The magnitude of the penalty, however, shall be less than the size of the economic loss.

Power grid enterprises stand to lose

The current structure of the legislation implies that the State Council is responsible only to provide a broad picture guideline whereas detailed implementation will be carried out by local governments. The current structure of legislation may affect negatively power grid enterprises that are required to purchase power generated from renewable power generators. The power grid enterprises are allowed to pass on any additional costs from purchasing power generated from renewable power generator to end-customers. However, price increases must be approved by local governments in a public hearing process in much the same fashion as for gas distributors in the event of an upstream gas well-head price increase. If these hearings reject price increases, it would result in margin squeeze for power grid enterprises.

Absence of national standard for China's biodiesel products

Currently, an explicit nationwide standard regulating the specification of China's biodiesel is still absent. The 11th FYP mandates that all bioliquid fuels meet the standards prescribed by the state, and that failure to comply will result in the payment of penalty no worse than the economic loss suggested by the manufacturers. Nonetheless, the explicit definition of the specifications and the standards are not provided. China's regulatory framework for biodiesel is far less stringent than those of the EU and US. The absence of a stringent standard regulating the specifications and the quality of biodiesel may result in discrepancy on the quality of biodiesel produced by manufactures from different provinces. In addition, the under-regulated environment may encourage biodiesel manufacturers to forgo quality control in return for lower production costs.

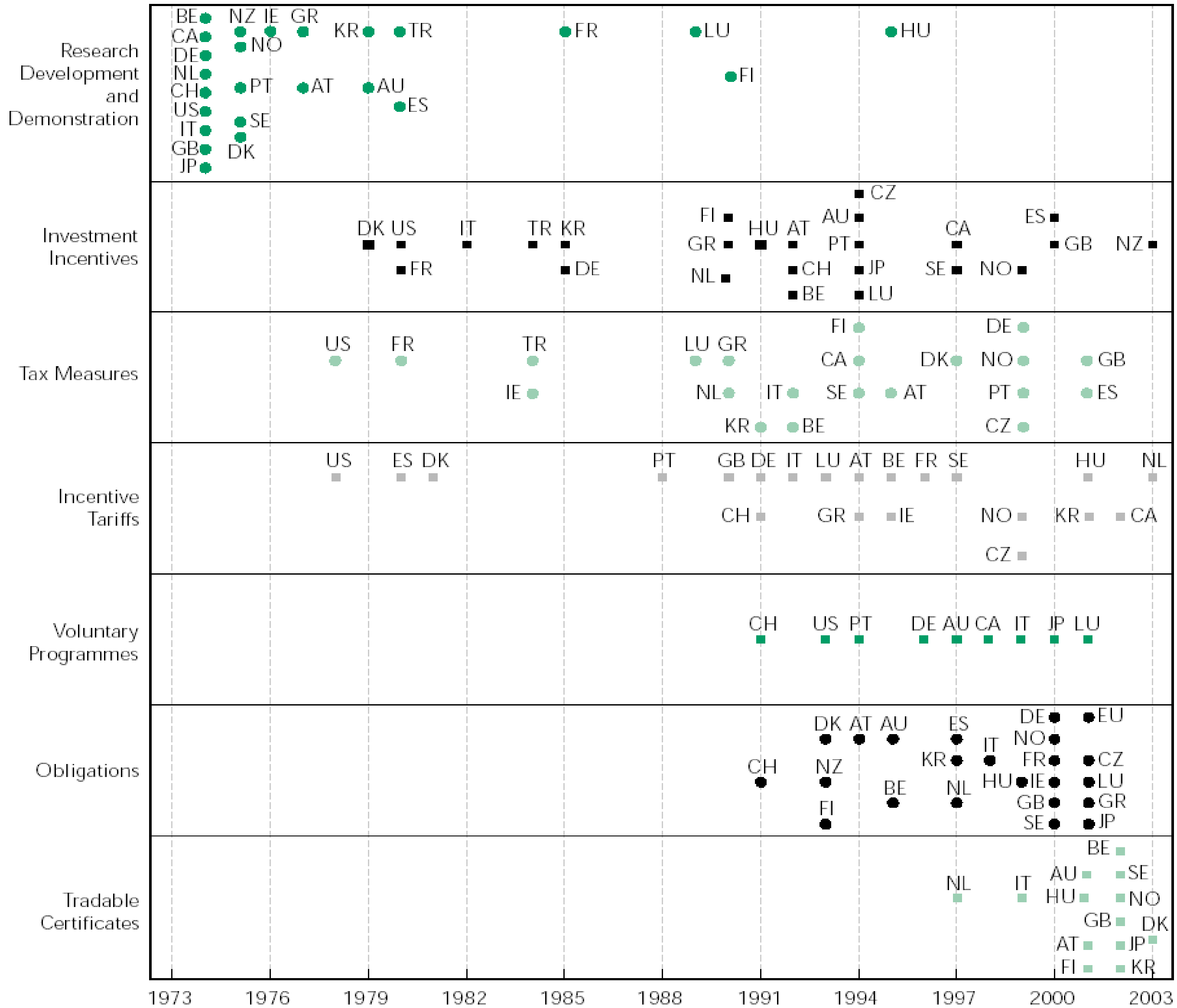
Global renewable energy policy framework

We believe government supportive policies have been critical to the development of renewable energy technologies.

Generally, we can categorise global renewable policies into two types:

- *Research, development and demonstration (RD&D) expenditure by the government.* Government investment is indispensable if renewable energy technologies are to be developed, as their lack of revenue visibility discourages the private sector.
- *Market deployment policies.* The implementation of these policies can offset the higher start-up costs of developing renewable energy technologies compared to fossil energy technologies, ultimately reducing the cost of producing renewable energy. Market deployment polices can be categorised as: investment incentives, tax measures, incentive tariffs, voluntary programmes, obligations and tradable certificates. We analyse these policies in detail in the following section.

Figure 39: The introduction of renewable policies by country



Note: AT=Austria, AU=Australia, BE=Belgium, CA=Canada, CH=Switzerland, CZ=Czech Republic DE Germany, DK=Denmark, ES= Spain, FI=Finland, FR=France, GB=United Kingdom, GR=Greece, HU=Hungary, IE=Ireland, IT=Italy, JP=Japan, KR=Korea, Republic of LU=Luxembourg, NL=Netherlands NO=Norway, NZ=New Zealand, PT=Portugal, SE=Sweden, TR=Turkey, US=United States
Source: Credit Suisse research

Figure 39 shows the evolution of government policies and measures in IEA countries over the past three decades. On the vertical axis are the renewable energy policies and measures, while the year each country first introduced a specific renewable energy policy is indicated by the country's initials on the horizontal axis.

The evolution of new energy policies for renewable energy sources shows a discernible pattern over the past three decades. Starting with RD&D in the early 1970s, government investments moved towards market deployment support with a variety of approaches.

Beginning in 1978, but before 1985, countries employed guaranteed prices, investment incentives, voluntary programmes and tax measures. By the mid-1980s, virtually all IEA countries had RD&D policies as a foundation for market aspirations. By the early 1990s, many more countries had adopted various market deployment policies, and first obligations were introduced. Almost all countries have established guaranteed prices at one time or another, with varying degrees of success. A few countries have moved to quotas, and a number of countries have established, or are in the process of establishing, certificate systems. At the same time, several recent commitments have been made for guaranteed price systems. While a clear evolution of overall policies and measures in IEA countries is evident from Figure 39, it does not necessarily denote a single trend. Each country has chosen policies and measures that best match their resource endowments, economic structure and objectives for market development.

Research development and demonstration

Global effort supporting renewable energy development

Solar and wind technologies, as well as new forms of bioenergy, were introduced into the market in the late 1970s. This development came after a period of research, development and demonstration that started around 1970, and intensified as the impacts of the oil price crises mounted. Denmark, Finland and Germany were the first countries to allocate RD&D funding for renewable technologies. The US, the UK and Japan also funded renewable energy RD&D programmes in the early 1970s. Except for a few countries, RD&D spending on renewable energy represented the first tier of support to the development of renewable energy markets.

Total government energy RD&D budgets increased sharply after the oil price shocks in the 1970s. Budgets declined to about half of their peak levels by 1987 and remained relatively stable to 2002. As a percentage of total RD&D funding, funding for renewables was higher from 1974 to 1986 than in the period since 1987.

Renewable energy technologies accounted for just 7.7% of total government energy RD&D funding from 1987 to 2002. Over this period, the shares of renewable energy technologies out of total energy RD&D funding are shown below.

Figure 40: **Shares of renewable energy technologies in total energy RD&D funding in OECD countries**

	(%)
Solar photovoltaic	2.70
Biomass	1.60
Wind energy	1.10
Geothermal	0.90
Solar heating and cooling	0.70
Solar thermal electric	0.50
Ocean energy	0.10
Large hydro	0.10
Small hydro	0.04

Source: Credit Suisse estimates

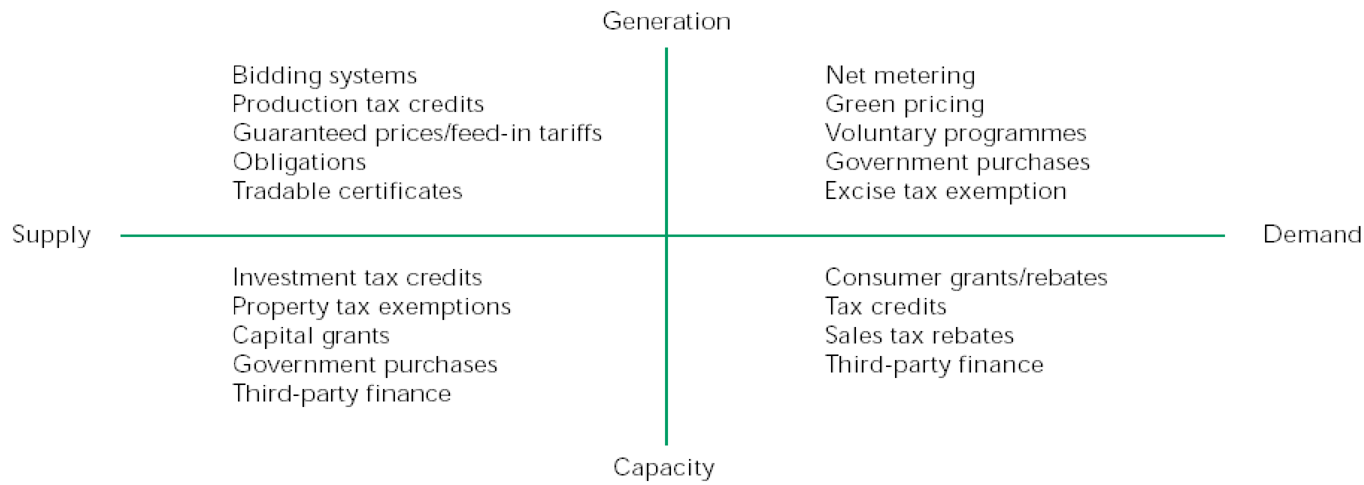
The US, Japan and Germany accounted for 70.4% of IEA government renewable energy RD&D funding from 1974-2002. The decreasing share of public funding for energy RD&D allocated to renewable energy appears to be inconsistent with presumed political intentions in many IEA countries to increase the share of renewables in total primary energy supply.

RD&D support for mature technology, such as large hydropower, has been provided by utilities, turbine and generator manufacturers and other industries related to the electricity system infrastructure. Municipal authorities are increasingly interested in extracting the energy component of waste 'resources', such as refuse and landfills, and they often benefit from both public and private sector RD&D. Renewable technologies, such as solar photovoltaic, solar heating and cooling and ocean energy, are heavily dependent on public RD&D budgets.

Market deployment policy

According to the renewable energy report published by the IEA in 2004, the renewable energy policies that have been implemented by governments around the globe can be categorised into four quadrants, based on the direction of their support as shown in Figure 41.

Figure 41: Renewable energy policies



Source: Credit Suisse research

The history of global renewable energy development

1973-1988

The policies in the 1970s and 1980s were predominately investment incentives, such as capital grants and low-interest loans for the uptake of renewable technologies, or tax measures, such as exemptions or credits to businesses and consumers.

In the late 1970s and early 1980s, the US, Denmark, Spain, France and Italy instituted the first market deployment policies in IEA countries. These began with the US Public Utility Regulatory Policies Act (PURPA) guaranteed price programme, coupled with an investment tax credit, both of which were established in 1978. In the following year, Denmark instituted a capital grant programme for wind turbines. In 1980, Spain established its energy conservation law, which guaranteed network interconnection, power purchase contracts and prices set by an administrative body. In 1980, France established a risk guarantee fund for low temperature geothermal energy, and the US established a loan guarantee programme for bioenergy and alcohol fuels. In 1981, Denmark announced its Act for the Support for Utilisation of Renewable Energy

Resources, which provided for RD&D, capital grants, and guaranteed prices. In 1982, Italy, established a capital grant programme. During the remainder of the 1980s, the pace at which policies were established remained relatively modest, at first due to a perception that the technologies were not yet ready for deployment, and later by the decline in fossil fuel prices.

1988-1997

From 1988 to 1994, eight IEA countries introduced feed-in tariffs, starting a new wave of intervention. Portugal established an independent power law that allowed private generators of renewable systems to sell to the grid with interconnection and price guarantees. In 1990, the UK launched its Non-Fossil Fuel Obligation (NFFO), a guaranteed price scheme with the added dimension of competitive bidding for the rate. Germany and Switzerland introduced feed-in tariffs in 1991. Altogether, twenty IEA countries have had feed-in tariffs at one time or another, although not for every renewable energy technology.

The first voluntary programmes started in the early 1990s. Switzerland launched its Energy 2000 programme in 1991. The US Climate Change Action Plan started in 1993 with the goal of co-operative programmes between utilities and the US Department of Energy. Portugal initiated its Energia Programme in 1994, which reinforced voluntary actions with capital grants.

The 1980s to the mid-1990s represented a period of experimentation with market deployment strategies among IEA countries. Some countries employed a wide range of policies, including new variations of guaranteed prices, such as feed-in tariffs combined with investment incentives and tax measures. Renewable energy policy in South Korea is based on a combination of corporate loans, tax incentives and feed-in tariffs. The UK, Portugal, the US and Austria combined voluntary purchase agreements between public and private companies with other market deployment incentives. This period was followed by a period of rapid expansion in new renewable energy markets in IEA countries, particularly wind, bioenergy, solar energy and small hydropower. While a wave of IEA countries introduced investment incentives in the mid-1990s, tax measures have been employed more sparingly. Except for the US, IEA countries did not generally introduce incentive tariffs until the early to mid-1990s.

Switzerland established a target for hydroelectric and heat from renewable sources in 1991. Denmark followed in 1993 with a Biomass Agreement to increase biomass use from about 50 PJ to 75 PJ by 2000. Finland established a 100 MW wind target in the same year. The Netherlands introduced renewable energy obligations in 1997 with a target of 3.2% renewable energy in the electricity supply by 2000. The late 1990s saw a number of additional countries institute obligations and quota-based renewable energy policies as they strived to open and widen renewable energy markets. In 2001, the EU Directive for Electricity Produced from Renewable Energy Sources set indicative targets requiring member countries to implement relevant national policies. The targets are for the percentage of renewable energy in electricity consumption of each EU member state by 2011. Thirteen states in the US have similar strategies to expand the share of renewables through obligations, with a binding portfolio standard in many states and a non-binding quota in others.

Latest developments

Latest global incentives supporting renewable energy development

The latest development of renewable energy deployment policies is the introduction of tradable certificates. The Netherlands was the first to employ these certificates in 1997 as a mechanism to efficiently achieve a target that was also set in 1997. Italy established its certificate system in 1999. Australia launched its Mandatory Renewable Energy Target (MRET) in 2000, which uses tradable certificates as a compliance instrument. MRET is the first target/certificate system with substantial penalties to enforce the obligation. By early 2004, ten other IEA countries had also introduced them.

Below, we analyse the various market-deployment policies.

Investment incentives

Investment incentives are used to reduce the capital cost of deploying renewable energy technologies both to the renewable energy suppliers and consumers. They can also reduce investment risk in renewable energy.

Capital grants

Government can provide capital grants to renewable energy producers or end-users. For distributed, modular technologies, such as solar hot water and photovoltaic (PV), incentives are directed towards customers, not the suppliers.

For example, to stimulate PV power system development, Japan instituted a capital grant programme in 1994, which has been the driving force behind the country's rapid PV development. The grant programme also supported hydropower, geothermal and other new energy technologies.

Effective from 1994, the policy was the first solar power policy initiated by the government, which provided subsidies for installation of PV systems. It was managed by the New Energy Foundation (NEF) on behalf of the Japanese Ministry for International Trade and Industry. The programme was renewed in 1997 and renamed the Residential PV System Dissemination Programme. The goal of both programs was to reduce the cost of installing PV systems by subsidising the installation costs of residential systems. The subsidies were available for homeowners installing their own PV systems, for suppliers of ready-built houses, and for public organisations to introduce systems in public buildings. Finally, there was also a subsidy for connecting PV systems to low-voltage lines on the power grid. Over the course of the programme, the subsidies decreased as the economics of PV systems became more favourable. Benefiting from this policy, PV systems were installed in more than 50,000 houses.

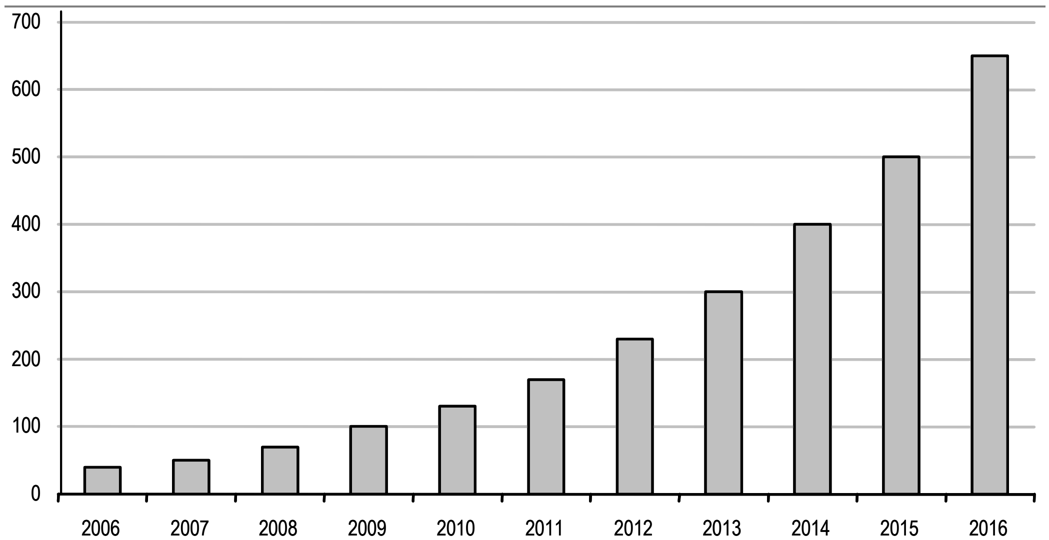
The national subsidy decreased from US$2,613/kW (1997) to US$840/kW (2003) and US$433/kW in 2004. The average system price decreased from approximately US$9,630/kW to US$6,740/kW in this corresponding period. Price targets set for the future range between US$2888/kW and US$4815/kW, and should be realised with the help of improved production scale-economy (learning curve) and PV integration into buildings. The Japanese government has established the target of solar power becoming self-sustainable for householders in 2010 and for businesses in 2020.

Another good example of capital grants is the Californian Solar Initiative. On 12 January 2006, the California Public Utilities Commission (PUC) created the largest solar programme of its kind in any state in the country – the California Solar Initiative, a ten-year, US$2.9 bn programme designed to help California move towards a cleaner energy future and help bring the costs of solar electricity down for California consumers. The goal of the programme is to increase the amount of installed solar capacity on rooftops in the state by 3,000 MW by 2017.

Under the new programme, the funding for 2006 through 2009 is proposed at US$350 mn per year, declining to US$275 mn per year from 2010 through 2013, then dropping to US$175 mn per year until 2015 before being phased out in 2017, as shown in Figure 42. The gradual decline in the annual funding plan for each year reflected the 10% cut each year in rebate rates as proposed in the CSI.

Although the objective of the CSI programme is to bring on line or displace 3,000 MW of power capacity, CPUC also stated in its staff report that CPUC do not adopt an absolute goal based on installed capacity. Figure 42 shows the PV installations plan of the PUC. As shown in the chart, most of the PV capacity under the CSI programme will be added after 2008, which is in line with our view that the PV productions will be capped by the total silicon supply in 2006 and 2007 in spite of the strong demand. According to the CSI plan, the cut in rebate rate will be triggered each year once the planed capacity that year is reached. The 10% cut in rebates can be adjusted according to the market conditions that year, according to the CSI plan.

Figure 42:PV capacity installations envisioned by the CSI programme



Source: CPUC

The CSI plan is the biggest government-funding programme to date to encourage the installation of PV systems in the US. We believe it will trigger new demand for the global PV equipment producers, including Suntech Power.

Third-party finance to renewable energy suppliers and consumers

Other types of incentives include third-party finance arrangements where the government assumes risk or provides low-interest loans. Favourable lending schemes, in which banks guarantee the cash flow of a project thus reducing investor risk, have been very effective, as exemplified by the rapid growth of wind capacity in Spain.

The German Development Bank (KfM) offers preferential loans in the context of the KfW CO_2 Reduction Programme for financing photovoltaic installation. On 1 January 2005, KfW introduced a new loan finance initiative in the areas of construction, housing and energy conservation. KfW will offer a discrete programme to finance small photovoltaic investments.

Government purchases

Various forms of government incentives

Government purchases of systems at above-market rates are a type of investment incentive to industry. In a number of cases, governments have purchased large, on-site renewable systems, such as solar thermal hot water systems or photovoltaic systems for schools or other public buildings.

Investment incentives are generally funded out of national and/or state budgets and thus compete with other public funding needs. As such, incentives are often subject to legislative review and changes, including revision. Incentives must be of adequate size and must be predictable and consistent over time to be effective. Governments must balance the budgetary burden against other public policy priorities.

The success of financial incentives to impact investment decisions also depends on whether the level of the incentive is adequate to bridge the gap between the market price of energy and the cost of renewable energy. Incentives should be gradually lowered and even phased out over time to ensure that manufacturers and developers continue to improve the technology and reduce costs. Governments need to monitor capital costs and incentive structures over time. This is challenging because capital cost reductions tend to be driven by global market growth, as markets within a specific country generally are not large enough to drive market learning.

Tax measures

Investment tax credits and property tax exemptions

On the production side, investment tax credits and property tax exemptions are used to reduce tax payments for project owners.

Production tax credit

In 1992, the US established a production tax credit for wind energy. This has, in combination with other policies, spurred substantial new installations of wind power, but its piecemeal extension since 1999 has led to a 'boom-and-bust' cycle of development in the US wind power industry. The success of tax policy in impacting investment decisions depends on whether the level of incentive covers the additional costs of the renewable energy system compared to market alternatives. For example, the US federal production tax credit has aided the domestic wind industry, but has not been sufficient to spur the development of 'closed-loop' biomass systems, which also qualify for the credit.

Excise tax exemption

Tax policy can also be used to capture the externalities associated with energy production and consumption, such as environmental degradation and energy import dependence. For example, the Netherlands and Germany introduced a regulatory energy tax or 'ecotax' on final energy consumption in the 1990s. Renewable electricity consumption is exempt from the tax in the Netherlands. Moreover, in the Netherlands, producers of renewable electricity also receive a production incentive from the ecotax funds collected from consumers of non-renewable electricity.

A gasoline excise tax exemption allows liquid fuel refiners to offset the higher cost of including biofuels in gasoline blends. The biodiesel tax exemption has been the driving force behind the evolution of the biofuels market in Italy. Carbon taxes and taxes on other pollutants, such sulphur oxides and nitrogen oxides, are not renewable support mechanisms, but are part of the overall competitive energy policy framework. To the extent that they cause conventional energy prices to rise, and renewables are exempt from the tax, they do have the effect of increasing the competitiveness of renewables.

Tax credits and sales tax rebates

For customer-owned systems, a tax credit or system rebate allows the owner to recover a portion of the up-front capital costs more quickly after the investment is made. Provisions are sometimes made for sales tax rebates.

Incentive tariffs

Guaranteed price systems and feed-in tariffs

Global incentive tariff systems in support of renewable energy sector

Guaranteed price systems, feed-in tariffs and preferential rates are all terms for tariffs at above-market rates. Generally, the government sets a premium price to be paid for power generated from renewable energy sources. The price is usually differentiated by technology and is paid by either consumers or taxpayers through the utility.

Guaranteed price systems have been adopted in a number of IEA countries. The US initiated the first system with passage of the PURPA in 1978. PURPA required utilities to purchase power from renewable energy developers and to pay the utility's avoided cost, i.e., the cost that the utility would have incurred by generating or otherwise supplying the power itself. These prices were not established by the federal government, but rather by utilities or state regulatory commissions. At the time, avoided costs were high, due to high fossil fuel prices. As a result of PURPA legislation, more than 12,000 MW of renewable energy projects were developed during the 1980s and 1990s, including geothermal, wind and concentrating solar power plants. Although the law remains in effect, the prices offered by utilities now are generally too low to support new project development.

Germany, Italy and Spain have introduced feed-in tariff schemes based on avoided costs. A guaranteed price system is often supported by complementary rules. For example, electric utilities may be required to provide interconnection and non-discriminatory backup power to qualifying facilities. Feed-in tariffs, combined with other policy support, are considered to be the main impetus behind the development of 12,000 MW of wind energy capacity in Germany and of 4,830 MW in Spain.

The German parliament approved new preferential tariff rates for solar electricity in December 2003. The new tariffs came into force on 1 January 2004. The removal of the very attractive soft loan financing available under the 100,000 PV Roofs Programme was compensated by an increase in the tariff rates for solar electricity under the Renewable Energy Act.

The base tariff for solar power was 45.7 euro cents per KWh in 2004, applicable to ground-mounted systems in designated development areas. Compensation for roof-mounted systems was increased by 8.3 to 11.7 euro cents per KWh depending on the system size. Facade installations receive an additional 5 cents per KWh. The feed-in tariffs are summarised in the table below.

Figure 43: **German feed-in tariff summary**

Application type	Euro cents per KWh (1 Jan-31 Dec 05)	Annual decline thereafter (%)
Ground-mounted systems in undeveloped areas	45.7	6.50
Rooftop (<30KW)	57.4	5
Rooftop (for that part >30KW, but <100KW)	54.6	5
Rooftop (for that part >100KW)	54	5
Facades (<30KW)	62.4	5
Facades (for that part>30KW, but <100KW)	59.6	5
Facades (for that part >100KW)	59	5

Source: Solarbuzz, Credit Suisse research

On 1 January 2005, regulations came into force that mean the minimum feed-in tariff for newly commissioned systems will be cut annually by 5% of the rate applicable to systems newly commissioned in the previous year. Ongoing reduction of the compensation for newly commissioned systems is to reflect the German government's expectation of production cost reduction of PV systems as a result of mass production promoted by the feed-in tariffs to purchase solar power. For ground-mounted systems in underdeveloped areas, the feed-in tariff will decrease by 6.5% each year, starting from 1 January 2006.

This preferential tariff for solar power generation has resulted in a significant increase in the installation of PV systems ever since the launch of this new policy in 2004. The most important reason behind it is that the solar power tariff has become more than enough to make up for the high generation cost of solar power. According to Solarbuzz's 2005 PV market report, the investment return for PV market investors can reach 6-12%, thus providing a low-risk return that is very competitive against current interest rates and other energy investment options.

The PV installations in Germany increased from 145 MW to 366 MW in 2004, thus registering more than a 150% increase in PV installations in 2004. Installations of PV in an agricultural environment underpinned much of the market growth in 2004. Large PV systems have been installed on the ground and on buildings in and around farming communities. The 100 kW ceiling that restricted feed-in payments depending on the size of the installations has been removed as of 1 January 2004. Farmers have benefited from additional support through the Agricultural Investment Promotion Programme (AFP). This programme provides subsidies of up to 35% for the implementation of solar systems for small investments (€10,000 up to €50,000) through most of the German states. This has been seen as attractive route to supplement farm income with a stable, 20-year income stream. However, there are concerns that farmers may become ineligible for these financial incentives if the PV systems generating non-farming income installed by farmers constitute classifications of industrial concern.

Feed-in tariff schemes have several potential shortcomings. First, the tariffs are administratively determined. While the rate is sometimes set as a function of avoided cost, it is the government, rather than the market, that determines the tariff level.

Second, guaranteed prices may be a disincentive for technology innovation or cost reductions unless the tariffs decrease over time. The time period over which a producer receives a guaranteed price should be sufficient to recover costs. Anticipating and scheduling reductions in guaranteed prices is challenging, as costs are determined by factors external to national markets. For example, market experience within a country can lead to reductions in installation costs, but equipment cost reductions are largely driven by the global market.

Shortcomings and controversy over feed-in tariffs and different mechanisms to encourage competition among various forms of renewable energy

Furthermore, there is some controversy over whether feed-in tariffs can or should promote competition between renewables. Most feed-in tariff schemes differentiate tariffs to reflect different levels of maturity of renewable energy technologies. But some administrations employ a single tariff for all renewables, a 'one-size-fits-all' policy framework, in order to stimulate competition. This can lock the relatively less mature technologies out of the market at the RD&D stage.

Bidding systems

Bidding systems such as the UK's Non-Fossil Fuel Obligation (NFFO) and Ireland's Alternative Energy Requirement (AER) scheme are based on competition for contracts to build projects with the lowest generation costs. The principal mechanism is a guaranteed price, with the rate set by competition for the lowest bid. This is based on a function of the power pool wholesale price plus a technology-specific premium that is paid by electricity consumers. Renewable technologies are separated into different technology categories and competitive bidding rounds are organised for each category separately.

Voluntary programmes

Several IEA countries have employed voluntary programmes. One of the first voluntary programmes for renewables was in Denmark in 1984 when utilities agreed to purchase 100 MW of wind power. In 1992, Japan established a similar programme when power companies developed agreements with renewable energy generators. The primary method of implementation was through government 'request' to energy suppliers to buy electricity generated by renewables. Suppliers had to pay the retail price of electricity to the facility that generated the power. These voluntary purchase agreements in Japan made a large contribution to the penetration of solar and wind technologies.

Green pricing

Green pricing is an optional utility service that gives customers an opportunity to support an increased level of utility company investment in renewable energy technologies. Participating customers generally pay an additional amount on their electric bill to cover the incremental cost of the renewable energy. Many utilities are offering green pricing to build customer loyalty and expand the business lines and expertise in advance of electric market competition. Green pricing programmes are prominent in the US and Europe.

Net metering

Net metering arrangements, for example in Denmark, Italy, the US and Japan, also provide a form of guaranteed pricing as customer-generators are credited for their electricity generation at the prevailing retail rate. For consumer-owned systems, net metering is a practice that allows customers to 'bank' at the utility any excess electricity generated from qualifying systems for later use. The customer pays only for the electricity used 'net' of the electricity generated over the entire billing cycle. Net metering allows customer-generators to maximise the value of their production because the generation is valued at retail prices. Usually the size of the system is capped to keep the policy focused on small-scale systems.

Obligations

Most obligations are based on the final product (kWh of electricity or litres of liquid fuel) although some are based on capacity. Renewable energy portfolio standards, also known as quota systems, place an obligation on suppliers to provide a set quantity or percentage of their supply from renewable energy sources. Generally, quota systems do not distinguish between different renewable energy sources, i.e., a quota level is established and the market determines which resources are chosen. These systems encourage the development of renewables at lowest cost. Renewable energy certificates may be used to facilitate compliance with quota systems and can also reduce the cost of compliance.

Targets are a form of obligation being used in the EU countries and Australia. Target systems determine different levels of obligation for each renewable technology, sometimes with a penalty for non-compliance. Figure 44 shows the renewable energy targets set up in various countries.

Figure 44: Renewable energy targets comparison by country

Country	Renewable energy targets
Australia	78.1% of electricity output by 2010
Belgium	6% of electricity output by 2010
Brazil	Additional 3300 MW from wind, small hydro, biomass by 2016
China	15% of total energy consumption by 2020
Cyprus	6% of electricity output by 2010
Czech Republic	5-6 % of TPES by 2010 8-10% of TPES by 2020 8% of electricity output by 2010
Denmark	29% of electricity output by 2010
Estonia	5.1% of electricity output by 2010
Finland	35% of electricity output by 2010
France	21% of electricity output by 2010
Germany	12.5% of electricity output by 2010
Greece	20.1% of electricity output by 2010
Hungary	3.6% of electricity output by 2010
Ireland	13.2% of electricity output by 2010
Israel	2% of electricity from renewable energy resources by 2007 5% of electricity from renewable energy sources by 2016
Italy	25% of electricity output by 2010
Korea, Republic of	- 2% of total energy consumption from new and renewable energy, including solar, wind and biomass energy by 2006
Latvia	6% of TPES (excluding large hydro) by 2010 49.3% of electricity output by 2010
Lithuania	12% of TPES by 2010 7% of electricity output by 2010
Luxembourg	5.7% of electricity output by 2010
Mali	15% of TPES by 2020
Malta	5% of electricity output by 2010
Netherlands	12% of electricity output by 2010
New Zealand	30 PJ of new capacity (including heat and transport fuels) by 2012
Norway	7 TWh from heat and wind by 2010
Poland	7.5 % of TPES by 2010 (Development Strategy of Renewable Energy Sector) 14 % of TPES by 2020 (Development Strategy of Renewable Energy Sector) 7.5% of electricity output by 2010 (As per Directive 2001/77/EC)
Portugal	45.6% of electricity output by 2010
Singapore	Installation of 50,000 m2 of solar thermal systems by 2012 Complete recovery of energy from municipal waste
Slovak Republic	31% of electricity output by 2010
Slovenia	33.6% of electricity output by 2010
Spain	29.4% of electricity output by 2010
Sweden	60% of electricity output by 2010
Switzerland	3.5 TWh from electricity and heat by 2010
Turkey	2% of electricity from wind by 2010
UK	10% of electricity output by 2010

Source: IEA, Credit Suisse estimates

A penalty for non-compliance that is set at least as high as the estimated cost of meeting the obligation is crucial for the success of obligation systems because utilities and producers will be more inclined to comply. For example, in the UK, suppliers unable to meet their requirements must buy renewable obligation certificates at £30 per megawatt-hour (MWh). The revenue is distributed back to electricity suppliers according to their success in meeting the targets. This provides an additional incentive for companies to meet their requirements. In Texas, where suppliers must pay a non-compliance penalty of up to US$50/MWh, far more capacity has been built than required to meet the state's renewable portfolio standard. The policy is considered a success, as the cost of wind power declined to the point that wind is the lowest-cost option in certain areas of the state.

An effective obligation system takes into account renewable resource availability, the ability of the renewable energy industries to respond with technology and systems and the lead times required to bring new projects into operation. Obligations should also be in place long enough to ensure that investors recover their investments, in our view.

Tradable certificates

We expect mechanisms promoting renewable energy as well as production technology to continue to evolve

Renewable energy certificates (REC) provide a mechanism to track and register renewable electricity production. Certificates can be used to document compliance with quota systems or can be sold to endure customers in a voluntary green power market. The creation of a certificate allows the renewable energy attribute to be sold or traded separately from the physical electricity product. The establishment of a REC system does not by itself constitute a supply requirement, but rather certificates provide greater market flexibility in achieving the goals of other policy instruments.

REC systems can be consistent with energy labelling. This type of system may be advanced by the European Commission's directive on guarantee of origin of electricity produced by renewable energy sources, which requires member states to establish appropriate mechanisms 'to enable producers of electricity from renewable energy sources to demonstrate that the electricity they sell is produced from renewable energy sources'.

REC systems also have potential drawbacks. In some instances, for example, the administrative procedures can be substantial and may prove to be costly. Furthermore, there is considerable confusion about the distinction between 'renewable energy attributes' and environmental benefits. For some, renewable energy attributes are greater than carbon value or environmental performance, but relate also to energy security and economic benefits. For others, the REC is a substitute for, and perhaps equal to, a carbon certificate, although such determinations have not yet been set by law. Clarifying these issues will be important to the future use of REC on a larger scale.

Feedstock and raw material suppliers are likely to benefit

We prefer raw material and feedstock suppliers as well as upstream manufacturers

We prefer raw material and feedstock suppliers and midstream manufacturers to downstream systems integrators, as the former can deploy proprietary technology and pass on cost increases to their customers. We believe that there is a risk that aggressive capacity expansion will lead to oversupply. In addition, rapid technological advancements dictate the need for generators to maintain large capital expenditure in order to remain competitive. Hence, the potential for oversupply and rapid technological advancements hinder the prospect of downstream system integrators. However, they imply larger demand for midstream products and raw material and feedstock supplies. Therefore, we believe midstream manufacturers and feedstock and raw material suppliers will benefit most from the rapid expansion in China's renewable energy.

We believe Suntech Power Holdings' (STP US, $28.85, NEUTRAL [V], TP $32.00) (Suntech) integrated large-scale production of high quality PV cells and modules gives the company a stronger bargaining position compared to its Chinese counterparts in the procurement of silicon.

Shanghai Electric Group Co., Ltd. (2727 HK, HK$2.775, OUTPERFORM, TP HK$4.50) (SEG) has partnered with a technology provider from Germany, Aerodyn, to produce wind turbine equipment in China. Joint ventures with Aerodyn, Ersol Solar and Jiaotong University position SEG well to capture Shanghai and other PRC renewable orders to further increase its power and environmental equipment income. In July 2005, SEG paid RMB100 mn to acquire a 61% stake in a solar cell and module factory called Shanghai Topsola Green Energy Ltd (STGE) (not listed). The technology of comes from Shanghai Jiaotong University. STGE had two production lines, a 20MW and a 25MW line, which use imported equipment. According to SEG, the chief engineer of STGE, Cui Rongqiang (who is equivalent to CTO), has over 40 years of solar research experience and is the key designer behind the government-funded programme to put solar panels on 100,000 rooftops in Shanghai (please see our report dated 23 January 2006). The RMB10 bn project is expected to be completed by 2015, and although the contract has not been officially awarded, we believe three Shanghai-based companies are likely to share the mandate, STGE, Semiconductor Manufacturing International Corp. (SMIC) (981 HK, HK$1.06, NEUTRAL, TP HK$1.20) and Shanghai Aerospace Automobile Electromechanical Co (600151.CH, RMB15.93, not rated).

STGE's production lines can deploy both mono- and multi-crystalline silicon wafers. The CEO of ErSol, Dr Claus Beneking, together with other representatives from Shanghai Environment Protection Complete Engineering Co. Ltd, a subsidiary of Shanghai Electric Group Co. Ltd., and Shanghai Silverstone Terry Investment Co. Ltd and Chinese authorities, recently opened the module production of Shanghai Electric Solar Energy Co. Ltd (SESE). The venture involves the processing of silicon solar cells in high performance modules. Each company holds 35%, 55% and 10% of interest in the venture respectively. The operating plant is located on the Shanghai industrial estate, 'Songjiang Export Processing Zone' with a total production capacity of 6 MW for 2006. Since the beginning of 2006, ErSol has been shipping a part of its solar cell production to SESE. The certification of the modules and the production plant in accordance with IEC61215 has largely been prepared. The solar modules will shortly be granted the TÜV

(Technical Control Association) certification mark and thus meet the requirements of the IEC61215 standard in the future.

SEG acquired a 55% stake in SEG Solar Company, which is 35% held by Ersol Solar in Germany, a company that supplies wafers and procures modules made from these wafers from the JV. SEG aims to lift total solar cell/module production capacity to 200 MW by 2010. The solar business derived 80% of its 2005 revenue from Germany and the rest from Italy, Spain, Austria, and China. Gross margin in 2005 was 13-15%, while the energy conversion efficiency of solar cells produced from these 2 lines is close to the current industry average of around 17%, the scale and production yield lags behind most of the global and PRC leaders. Due to higher deployment ratio of labour, STGE can also make use of warped and scratched wafers and thus save on silicon consumption costs, but output-per-head may be 15% lower than industry leaders'. STGE plans to reduce wafer thickness from 240 microns in 2005 to 200 microns within 2006. We believe STGE generates 5-6% net profit margin versus low to mid-teens for the industry leaders. In addition, we are uncertain whether this venture will be able to secure sufficient silicon wafers to allow scale expansion match the growth pace of or catch up with the industry leaders. In addition to considering possible Sino-foreign joint venture opportunities, we believe STGE is also well positioned to benefit from the Shanghai government's plan to produce 10,000 tonnes of polysilicon.

MEMC Electronic Materials (WFR US, US$37.94, OUTPERFORM, TP US$45.00), Inc. has signed a non-binding letter of intent (LOI) with Suntech, one of the top producers of solar cells in the world today, for the supply of solar wafers. Under the terms outlined in the LOI, MEMC will supply solar wafers to Suntech over a ten-year period, with pre-determined pricing, on a take-or-pay basis. Sales of the wafers over the period should generate at least US$5-6 bn in revenue for MEMC. The LOI also provides that Suntech would provide an interest-free loan to MEMC (we estimate US$50-100 mn), which would be used for the expansion of MEMC's manufacturing capacities. As part of the agreement, MEMC will also receive a warrant to purchase a 4.99% equity stake in Suntech. The effective date of a definitive agreement, if executed, is expected to be some time in August.

Phoenix SonnenStrom AG (PS4 GR, €23.15, not rated) signed contracts with two new suppliers for the delivery of solar modules with a potential power output totalling 6 MW in 2006. Phoenix SonnenStrom AG has a supply contract for 2006 with Changzhou Trina Solar Energy Co. Ltd (not listed), to supply 2 MW of monocrystalline solar modules. Tianwei Yingli New Energy Resources Co. Ltd (not listed) is to deliver 4 MW of polycrystalline modules during the current financial year. In addition, an LOI was signed with Yingli on the supply of 143 MW in total between 2006 and 2010. Phoenix SonnenStrom currently takes deliveries from seven module manufacturers.

On 29 April 2006, Trina Solar Energy Co. Ltd, a solar cell producer in Changzhou in Jiangsu province, signed a strategic cooperation agreement with Merrill Lynch (MER US, US$70.90, restricted) and Milestone Capital Management (not listed). After three months of talks, both Merrill Lynch and Milestone Capital Management agreed to provide funds of $30 mn to Trina for the expansion in its production capacity. It is estimated that Trina will increase output from 50 MW in 2006. The company aims to lift this to 200 MW in 2008 and 360 MW in 2010, with the supports of international funds. Established in 1998, Changzhou Trina Solar Energy Co. Ltd was the first company to industrialise photovoltaic production in Jiangsu province. Trina developed China's first solar energy house, which is included in the environmental protection activities for the 2008 Beijing Olympics. The company earned RMB330 mn in revenue and RMB30 mn in profit in 2005. It expects to increase total revenues to RMB1.5 bn this year.

Wind power

Wind turbine manufacturers will face increasing demand, but consumers' price sensitivity is likely to remain high

We estimate the CAGR of China's wind power capacity at 38.89% in 2004-10 and 19.62% in 2010-20. This represents a remarkable growth potential for manufacturers of wind turbines. However, with wind turbines accounting for 70% of the cost for wind energy, we believe that consumers are likely to exhibit high price sensitivity. In addition, as the government moves to promote wind power energy, we may see local and international manufacturers crowd into the sector, putting downward pressure on the price of wind turbines and thus on manufacturers' profit margins. Moreover, with rising oil prices, global demand for wind power has increased dramatically, and a number of wind turbine and system manufacturers are struggling to find supply of raw materials to meet this increasing demand.

The outlook for wind power generators is less enticing

With wind turbines accounting for 70% of wind-generated electricity costs, and with turbine prices falling rapidly, due to technological advancements, today's wind electricity generators are likely to lose their competitiveness to future generators quickly. In addition, wind power generators are typically established in remote areas and are thus exposed to high transmission costs. The inability of wind power to ensure supply security during periods of high demand induces the need for electricity storage, which adds to the cost of electricity generation. Therefore, we do not believe that wind power generators represent an attractive investment opportunity.

Raw material suppliers for wind turbines should benefit from rising demand

It is apparent that, as the Chinese government increases its wind power capacity, raw material suppliers are likely to benefit the most. Unlike generators, they are not exposed to technological advancements and other additional costs of electricity generation, while they do benefit from the rising demand for wind turbines. Wind turbine manufacturers, while representing an attractive investment in our view, are exposed to a shortage of raw materials, high price sensitivity of consumers and increasing competition due to crowding of the market by local and international manufacturers.

Wind power generators represent a less attractive investment option, in our view, as their ability to supply electricity is highly exposed to weather risks. That is, wind might simply not blowing during the peak demand period. Thus, the use of wind power as a supplementary power generator is a more attractive option. Current fossil fuel power generators may consider adding wind power as an additional means of generating electricity.

Solar power

The Chinese government is aiming to increase installed capacity for solar power by a CAGR of 46.78% in 2004-10 and 7.18% in 2010-20. The growth of solar power capacity in 2004-10 is significantly higher than that of wind power capacity. However, at a 7.18% CAGR for 2010-20, the growth of solar power capacity lags the growth capacity of wind power.

We prefer upstream manufacturers to downstream

Despite attempts to reduce production costs, the cost of solar power remains significantly higher than that of other energy sources, especially coal. Consequently, the growth of solar market relies heavily on government subsidies. This implies that, unlike upstream manufacturers, ascribed to political aspects, the ability of downstream manufacturers to channel any increase in production costs to end-consumer via price increase is low.

Solar-grade silicon suppliers may prove to be an attractive investment option

Currently, the primary concern confronting PV modules and cells manufacturers are the shortage of solar-grade silicon supply, coupled with the increasing price of solar-grade silicon. Thus, we prefer upstream manufacturers, which have secured their solar-grade silicon supply. In addition, with increasing demand from solar power industry, silicon manufacturers may prove to be an attractive investment option.

Biomass

The production costs of biomass producers used for power generation must fall below RMB0.60 per kWh

Power generation from agricultural and forest products represent around 70% of China's total biomass production in 2020. Currently, the government is offering a standard subsidy tariff of RMB0.25 per kWh on top of the regional local desulphurised coal-fired power tariff for biomass plants with an output of less than a 20% fossil-fuel blend. This implies that biomass's production costs must fall below RMB0.60 (assuming it costs RMB0.35 to generate electricity using coal power). Henceforth, the investment spectrum for the biomass sector must be limited to producers with proven ability to achieve production costs of less than RMB0.60 per kWh.

China's future reliance on coal will remain high, and its reliance on imported oil will increase. The Chinese government is promoting the use of biomass in order to ease the country's heavy reliance on coal and imported oil, which should mean excellent growth potential for the biomass fuel sector.

Biodiesel is an attractive market

Currently, the China has demonstrated high cost-competitiveness in the production of biodiesel. The biodiesel market, which we believe has largely been overlooked by the government, may prove to be the next boom market in China, given the high cost-competitiveness exhibited by the country's manufacturers. China's biodiesel manufacturers have demonstrated the ability to produce biodiesel below the price of China's heavily subsidised fossil fuels. The ability of the local manufacturers to penetrate the country's domestic diesel fuel market is apparent. The potential export markets are also attractive. However, this is conditional on China's biodiesel manufacturers' exhibiting the ability to comply with global biodiesel standards, while simultaneously maintaining their cost-competitiveness. However, the absence of a national standard may result in biomass fuel producers forgoing quality in order to achieve lower production costs. The anticipated implementation of a national standard may push the currently low production costs upward if it proves to be stringent.

The attractive profit margin exhibited by China's biodiesel manufacturers may result in newcomers crowding into the market, which would increase the level of competition. More importantly, given the limited availability of low-cost feedstock supply, newcomers would naturally result in higher competition to secure raw materials. In turn, this would put an upward pressure on the price of feedstock, and thus, increase the production costs of China's biodiesel manufacturers.

Feedstock suppliers may represent an attractive investment option

We believe that the Chinese biomass sector exhibits an excellent growth potential and thus, investment opportunity. However, for power generation from the agricultural and forest products sector, we recommend only producers that have exhibited the ability to achieve production costs below RMB0.60 per kWh. For biomass fuel sector, we recommend companies with production costs (accounting for government subsidies) that fall below fossil fuel price. Given the rapid increase anticipated for China's biomass production capacity, we believe that feedstock suppliers may represent an attractive investment option.

Stock screening

This section outlines companies that may benefit from initiatives by the Chinese government to boost the country's renewable energy sector. Consequently, China's wind power sector is likely to experience rapid growth. Below, we list companies that are involved in the wind power sector.

- *Vestas (VWS DC, DKr165.00, not rated)*. Based in Randers, Denmark, Vestas is the world's largest windmill maker by sales. The company develops, manufactures and market wind turbines that generate electricity. Vestas also provide installations and maintenance services. In November 2005, Vestas announced that it expected to post an operating loss for 2005, due to component shortages and cost overruns. The stock rose significantly at the end of January 2006, due to expectations that it might be bought by ABB *(ABBN VX, SFr16.00, OUTPERFORM, TP SFr19.00, MW)* or Caterpillar Inc. *(CAT US, $74.77, OUTPERFORM, TP $75.00, OW)*
- *Japan Wind Development Co. Ltd 2766 JP (2766 JP, ¥200,000, not rated)*. Established in July 1999, Japan Wind Development is an international wind project developer. In March 2003, the company was listed on the Tokyo Stock Exchange as the first wind business venture in company Japan, and it is currently expanding its market reach. Japan Wind Development provides integrated services for windmill power. The company imports and distributes windmill machinery as its main business line, develops land for windmill power stations and generates and distributes electricity.
- *Suzlon Energy Ltd (SUEL IN, Rs1,060.65, not rated)*. Based in India, Suzlon Energy designs, manufactures, operates and maintains wind power generating equipment. The company constructs large wind parks. The company claims to have the largest market share in Asia and claims to be among the top ten globally. Suzlon has developed some of the largest wind parks in Asia, including the world's largest wind park of its kind of over 200 MW capacity. It was listed on 5 October 2005.
- *Nordex AG (NDX1 GR, Eu11.24, not rated).* Nordex AG develops, produces, installs and maintains electricity-generating wind turbines. The company also designs and produces blades and control systems. The company claim to be the world's leading supplier of wind turbines and has a principal focus on units with a high capacity. The company stated that the company has produced more than 2,500 wind turbines with combined output of more than 2,400 MW that are currently located in 25 countries. Based in Germany, Nordex has office and subsidiaries in 18 countries.

- *Repower Systems AG (RPW GR,Eu46.00, not rated).* Repower Systems AG develops, produces, installs, sells and maintains wind power plants. The company reported that, as of 31 December 2003, it had captured 3.5% of the global market and was ranked among the worldwide top ten wind energy turbine manufacturers. Based in Germany, Nordex was formed in 2001 by a merger of five companies involved in wind turbine manufacturing, project development and engineering.

Figure 45: Wind power sector stocks

Name	Ticker	Price	Currency	Market cap (local currency mn)	Market cap (US$ mn)	P/E (x) 2005A	P/E (x) 2006E	P/E (x) 2007E	2006 P/E to 2006/08 EPS CAGR
Vestas Wind System A/S	VWS DC	165.00	DKr	30,558.7	5,138.1	n.m.	32.6	20.5	0.76
Japan Wind Development	2766 JP	200000	¥	19,600.0	168.4	39.3	38.5	26.9	1.04
Suzlon Energy	SUEL IN	1060.65	Rs	304,969.8	6,590.4	43.1	24.6	18.9	1.92
Nordex AG	NDX1 GR	11.24	€	723.2	907.0	n.m.	84.5	25.1	0.56
Repower Systems AG	RPW GR	46.00	€	372.7	467.4	n.m.	47.9	23.1	0.69

Note: Companies are priced as at 04 July 2006; EPS for 2006-08 are earnings consensus
Source: Bloomberg, Datastream, company data, Credit Suisse estimates

As outlined in the 11th FYP, the Chinese government aims to boost the nation's solar energy sector. Upstream manufacturers and silicon producers are likely to benefit from this government initiative. Some companies in the sector are:

- *Suntech Power Holdings.* Established in 2001 in Jiangsu Province, China, Suntech Power Holdings Co. Ltd specialises in the design, development, manufacturing and sale of solar cells, modules and systems. Currently, Suntech is ranked as one of the top eight global solar cell manufacturers by production output. The company aims to become the 'lowest cost per watt' provider of PV solutions to customers worldwide. Suntech Power Holdings Co., Ltd., has recently announced an exclusive contract to supply 130 kW solar energy systems to Beijing's Bird's Nest Stadium for the 2008 Beijing Olympics, which will be installed at 12 entrances around the stadium.
- *Sunpower Corp. (SPWR US, $28.49, OUTPERFORM, TP $40.00, OW).* SunPower is headquartered in Sunnyvale, California, and its solar cells are manufactured in a facility in the Philippines. Dr Richard Swanson, who founded the company in 1985, was responsible for developing SunPower's technology while working at Stanford University. SunPower's first notable 'customer' was NASA, which built the company's solar cells directly into the curved surfaces of the Helios solar powered aeroplane in 2001. In 2004, full-scale commercial production of solar cells began at SunPower's Philippines facility. SunPower went public on 17 November 2005, offering 7.7 mn shares at US$18 a share. SunPower plans to use the proceeds of the offering to expand manufacturing operations, to make any potentially appealing acquisitions, and possibly to purchase its Philippines facility, which it now leases from Cypress (not listed) with the option to buy.
- *Motech Industries Inc. (6244 TT, NT$784.00, not rated).* Based in Taiwan, Motech Industries entered solar cell production in 1999, almost one and a half decades after it was founded in 1981. Around half of Motech's revenue originated from its solar cell sales. The company is expanding its production capacity from 50 MW in 2005 to 85 MW in 2006.

- *Sino-American Silicon Products (5483 TT, NT$73.10, not rated).* Sino-American Silicon Products is the first publicly listed companies specialising in the manufacturing of small-diameter silicon wafers in Taiwan. The company possesses all the required technology for silicon ingot growth, slicing, etching, diffusing, dicing and polishing. Sino-American is currently increasing its solar ingot production capacity due to strong demand.
- *Tokuyama (4043 JP, ¥1,675, NEUTRAL, TP ¥2,120, MW)* is one of the largest poly-silicon producers in the world. Based in Japan, Tokuyama produces around 4,800 tonnes of poly-silicon annually. Tokuyama also produces industrial chemicals, cement and construction materials.
- *Solarworld (SWV GR, Eu52.60, not rated).* Solarworld has a fully integrated solar value chain process from solar silicon as the raw material to high-quality solar power generating systems. Around 13.5% of Solarworld's revenue originated from the Asian region. The company is currently expanding its solar-wafer, solar cells, solar modules and solar-grade silicon production capacities.
- *Q-Cells (QCE GR, Eu70.07, NEUTRAL, TP Eu90.62, OW).* Q-Cells is one of the ten largest solar cell manufacturers with production capacity of 75 MW p.a. in 2004 (*Marketbuzz, 2005*). Its core business is the development, production and sale of mono- and polycrystalline, silicon-based solar cells. The company is the largest independent manufacturer of crystalline silicon cells in the world. Q-Cells' crystalline solar cells are among the highest efficiency polycrystalline solar cells commercially available. In 2004, more than 10% of the company's revenues are generated from outside the European region.
- *ErSol Solar Energy (ES6 GR, Eu48.32, not rated).* Established in 1997, ErSol is one of the largest German manufacturers of solar cells. The company also produce and distribute ingots and wafers through its subsidiary, ASI Industry GmbH. It was listed on the Frankfurt Stock Exchange on 30 September 2005. Around 20% of ErSol's revenues are generated from outside the European region. ErSol has signed an LOI with UNACIX S.A. to purchase equipment to produce thin-film modules. In the period up to 2008, ErSol plans to develop production capacity to 40 MW per annum. Around 100 new permanent jobs will be created. The medium-term annual capacity target is 100MW. ErSol Group will manufacture thin-film solar modules using PECVD (plasma enhanced chemical vapour deposition) process to produce amorphous silicon. ErSol has also announced to increasing production of crystalline silicon cells production to 180 MW by the end of 2007.
- Ever-Green Solar Inc. *(ESLR US, US$12.97, not rated)*. Established in 1999, Evergreen Solar develops, manufactures and markets solar power products using the company's proprietary low-cost string-ribbon manufacturing technology, which cuts silicon costs by 35% compared with crystalline silicon solar cell manufacturing technology. The company established a strategic partnership with Q-Cells by taking 25% stakes in the joint venture with Q-Cells in 2005. The company plans to build up its capacity to 45 MW by 2006 from currently 15 MW.

Figure 46: Solar power sector stocks

Name	Ticker	Price	Currency	Market cap (local currency mn)	Market cap (US$ mn)	P/E (x) 2005A	2006E	2007E	2008E	2006 P/E to 2006/08 EPS CAGR
Suntech Power Holdings	STP US	28.85	US$	4,174	4,174	144.9	54.4	30.5	20.8	0.88
Motech Industries INC	6244 TT	784.00	NT$	66,206	2,030	29.9	15.4	26.6	n.m.	n.m.
Sino-American Silicon Products	5483 TT	73.10	NT$	11,133	341	43.3	26.9	17.0	n.m.	n.m.
Tokuyama	4043 JP	1675.0	¥	460,003	3,951	34.1	24.3	19.6	17.0	1.25
Solarworld	SWV GR	52.60	€	2,938	3,685	13.6	9.8	29.2	6.1	1.65
Q-Cells AG	QCE GR	70.07	€	2,587	3,244	55.9	35.5	27.8	21.3	1.22
ErSol Solar Energy	ES6 GR	48.32	€	474	594	69.0	30.2	22.3	12.3	0.54

Note: Companies are priced as at 04 July 2006; EPS for 2006-2008 are earnings consensus except for Suntech, Tokuyama, Sunpower and Q-cells, for which we use Credit Suisse estimates
Source: Bloomberg, Datastream, company data, Credit Suisse estimates

The 11th FYP outlines the Chinese government's target to boost China's biomass sector in order to reduce the country's reliance on imported oils and coals. We list a number of palm oil producers and biomass manufacturers.

- *IOI Corporation (IOI MK, RM15.00, UNDERPERFORM, TP RM14.70).* IOI Corp. cultivates and processes oil palm rubber, manufactures industrial and chemical gasses and provides building, engineering and construction services. The company's main profit is derived from cultivating oil palms. IOI Corp. has 58% ownership of Palmco (the largest oleochemical company in Malaysia) and 100% ownership on Loders Croklaan (leading speciality fats supplier in Europe and the US).
- *Kuala Lumpur Kepong (KLK MK, RM10.30, OUTPERFORM, TP RM11.70).* Kuala Lumpur Kepong produces and processes palm products, natural rubber and cocoa. Through its subsidiaries, the company also mills and refines oil palm products and manufactures oleochemicals. KLK's main profit contributor is its oil palm plantation. Around 19% of its plantations are planted with rubber and cocoa.
- *Golden Hope Plantation (GHP MK, RM4.12, NEUTRAL, TP RM4.70).* Golden Hope Plantations is an investment holding company, which, through its subsidiaries, produces and processes rubber, palm oil, palm kernel, cocoa and copra. The company's primary profit contributor is its oil palm plantation.
- *Biofuels Corp. plc (BFC LN, GBp130.50, not rated).* Biofuels Corp. is involved in the large-scale production and exploitation of biodiesel and glycerine. The company produces biodiesel from vegetable oils and aim to become Europe's leading biodiesel producer. Biofuels is in the process of building its first 250 bn tonne biodiesel processing plant at Seal Sands, Middlesbrough, on the north-east coast of England, equivalent to around 284 mn litres of biodiesel.
- *Australian Biodiesel Group (ABJ AU, A$1.20, not rated).* One of the most advanced commercial-scale participants in the emerging Australian biodiesel industry, ABG has been producing biodiesel since 2002, when it evolved its internally developed technology from 'pilot plant' scale to its current complete-scale activities. Founded in 2001, ABG's facility is now complete and currently operating at 75% of nameplate capacity. Its plant is expected to operate at full capacity by July 2006.

Figure 47: Biofuel energy sector stocks

Name	Ticker	Price	Currency	Market cap (local currency mn)	Market cap (US$ mn)	P/E (x) 2005A	P/E (x) 2006E	P/E (x) 2007E	2006 P/E to 2006/08 EPS CAGR
IOI Corporation BHD	IOI MK	15.00	RM	18,185.8	4,933.8	17.8	20.6	16.7	1.68
Kuala Lumpur Kepong BHD	KLK MK	10.30	RM	7,338.9	1,991.0	17.9	16.0	13.1	1.05
Golden Hope Plantations	GHP MK	4.12	RM	9,364.3	2,540.5	9.8	17.3	11.4	0.62
Biofuels Corp Plc	BFC LN	130.50	GBp	6,462.4	11,727.9	n.m.	n.m.	n.m.	n.m.
Australian Biodiesel Group	ABJ AU	1.20	A$	139.1	101.4	n.m.	18.8	4.2	0.14

Note: Companies are priced as at 04 July 2006; EPS of Biofuels and Australian Biodiesel Group for 2006-2008 are earnings consensus
Source: Bloomberg, Datastream, company data, Credit Suisse estimates

Companies Mentioned *(Price as of 04 Jul 06)*
Australian Biodiesel Group (ABJ AU, A$1.20, NOT RATED)
Baodian Tianwei Electric (600550.CH, RMB22.86, NOT RATED)
Biofuels Corp Plc (BFC LN, 130.50 p, NOT RATED)
Conergy (CGY GR, Eu49.48, NOT RATED)
Ersol Solar Energy (ES6 GR, Eu48.32, NOT RATED)
Evergreen Solar Inc. (ESLR, $12.97, NOT RATED)
Golden Hope Plantation (GHOP.KL, RM4.12, NEUTRAL, TP RM4.70)
IOI Corporation (IOIB.KL, RM15.00, UNDERPERFORM, TP RM14.70)
Japan Wind Development Co. Ltd (2766 JP, ¥200000, NOT RATED)
Kuala Lumpur Kepong (KLKK.KL, RM10.30, OUTPERFORM, TP RM11.70)
MEMC Electronics Materials (WFR, $37.94, OUTPERFORM [V], TP $45.00, MARKET WEIGHT)
Merrill Lynch (MER, $70.90, RESTRICTED, MARKET WEIGHT)
Motech Industrials (6244 TT, NT$784, NOT RATED)
Nordex AG (NDX1 GR, Eu11.24, NOT RATED)
Phoenix Sonnenstrom (PS4 GR, Eu23.15, NOT RATED)
Q-Cells (QCEG.DE, Eu70.07, OUTPERFORM [V], TP Eu93.94, OVERWEIGHT)
Renewable Energy Corp. (R3Q GR, Eu11.10, NOT RATED)
Repower Systems AG (RPW GR, Eu46.00, NOT RATED)
SAG Solarstrom (SAG GR, Eu4.44, NOT RATED)
Semiconductor Manufacturing International Corp. (0981.HK, HK$1.06, NEUTRAL, TP HK$1.2)
Shanghai Aerospace Automobile Electromechanicals (600151 CH, RMB15.93, NOT RATED)
Shanghai Electric Group Co., Ltd. (2727.HK, HK$2.775, OUTPERFORM, TP HK$4.50)
Shenergy Company Limited (600642.SS, RMB6.09, NOT RATED)
Sino-American Silicon Products (5483 TT, NT$73.10, NOT RATED)
Solar-Fabrik (SFX GR, Eu11.50, NOT RATED)
SolarWorld AG (SolarWorld, Eu52.60, NOT RATED)
Solon (SOO1 GR, Eu36.06, NOT RATED)
Sunpower Corp. (SPWR, $28.59, OUTPERFORM, TP $40.00, OVERWEIGHT)
Suntech Power Holdings (STP.N, $28.85, NEUTRAL [V], TP $32.00)
Sunways (SWW GR, Eu11.68, NOT RATED)
Suzlon Energy Ltd (SUEL IN, Rs1060.65, NOT RATED)
Tokuyama (4043, ¥1675, NEUTRAL, TP ¥2,120, MARKET WEIGHT)
Vestas Wind Systems A/S (VWS.CO, DKr165.00, NOT RATED)
Wafer Works (6182 TT, NT$42.70, NOT RATED)

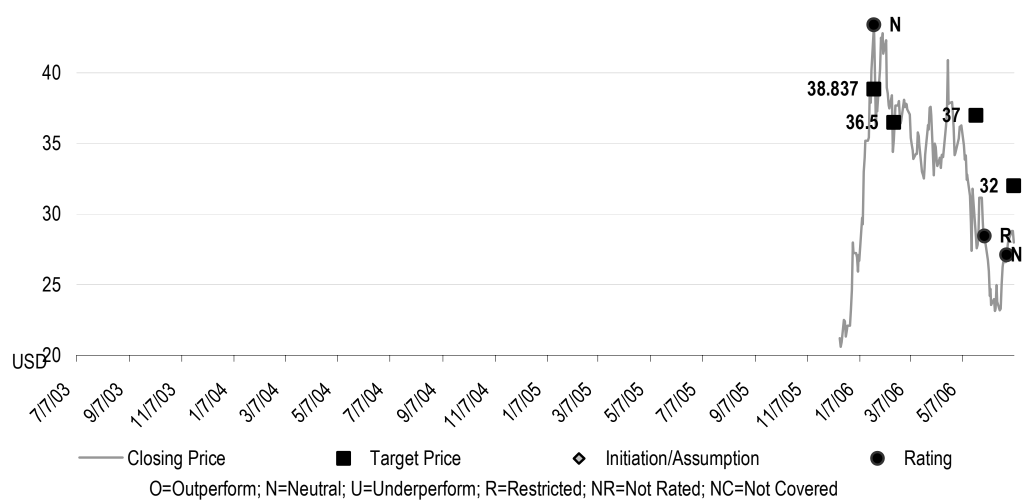
Disclosure Appendix

Important Global Disclosures

Angello Chan & Edwin Chen each certify, with respect to the companies or securities that he or she analyzes, that (1) the views expressed in this report accurately reflect his or her personal views about all of the subject companies and securities and (2) no part of his or her compensation was, is or will be directly or indirectly related to the specific recommendations or views expressed in this report.

See the Companies Mentioned section for full company names.

3-Year Price, Target Price and Rating Change History Chart for STP.N



STP.N Date	Closing Price Price (US$)	Target Price Price (US$)	Rating	Initiation/ Assumption
1/22/06				X
1/23/06	43.4	38.837	NEUTRAL	
2/15/06	35.24	36.5		
5/22/06	28.29	37		
6/1/06	28.45		RESTRICTED	
6/27/06	27.1		NEUTRAL	
7/5/06	27.97	32		

The analyst(s) responsible for preparing this research report received compensation that is based upon various factors including Credit Suisse's total revenues, a portion of which are generated by Credit Suisse's investment banking activities.

Analysts' stock ratings are defined as follows***:

Outperform: The stock's total return is expected to exceed the industry average* by at least 10-15% (or more, depending on perceived risk) over the next 12 months.

Neutral: The stock's total return is expected to be in line with the industry average* (range of ±10%) over the next 12 months.

Underperform:** The stock's total return is expected to underperform the industry average* by 10-15% or more over the next 12 months.

**The industry average refers to the average total return of the analyst's industry coverage universe (except with respect to Asia/Pacific, Latin America and Emerging Markets, where stock ratings are relative to the relevant country index, and Credit Suisse Small and Mid-Cap Advisor stocks, where stock ratings are relative to the regional Credit Suisse Small and Mid-Cap Advisor investment universe.*

***In an effort to achieve a more balanced distribution of stock ratings, the Firm has requested that analysts maintain at least 15% of their rated coverage universe as Underperform. This guideline is subject to change depending on several factors, including general market conditions.*

****For Australian and New Zealand stocks a 7.5% threshold replaces the 10% level in all three rating definitions.*

Restricted: In certain circumstances, Credit Suisse policy and/or applicable law and regulations preclude certain types of communications, including an investment recommendation, during the course of Credit Suisse's engagement in an investment banking transaction and in certain other circumstances.

Volatility Indicator [V]: A stock is defined as volatile if the stock price has moved up or down by 20% or more in a month in at least 8 of the past 24 months or the analyst expects significant volatility going forward. All Credit Suisse Small and Mid-Cap Advisor stocks are automatically rated volatile. All IPO stocks are automatically rated volatile within the first 12 months of trading.

Analysts' coverage universe weightings* are distinct from analysts' stock ratings and are based on the expected performance of an analyst's coverage universe versus the relevant broad market benchmark***:**

Overweight: Industry expected to outperform the relevant broad market benchmark over the next 12 months.

Market Weight: Industry expected to perform in-line with the relevant broad market benchmark over the next 12 months.

Underweight: Industry expected to underperform the relevant broad market benchmark over the next 12 months.

***Credit Suisse Small and Mid-Cap Advisor stocks do not have coverage universe weightings.*

***An analyst's coverage universe consists of all companies covered by the analyst within the relevant sector.*

****The broad market benchmark is based on the expected return of the local market index (e.g., the S&P 500 in the U.S.) over the next 12 months.*

Credit Suisse's distribution of stock ratings (and banking clients) is:

Global Ratings Distribution

Outperform/Buy*	40%	(61% banking clients)
Neutral/Hold*	42%	(56% banking clients)
Underperform/Sell*	15%	(48% banking clients)
Restricted	3%	

**For purposes of the NYSE and NASD ratings distribution disclosure requirements, our stock ratings of Outperform, Neutral, and Underperform most closely correspond to Buy, Hold, and Sell, respectively; however, the meanings are not the same, as our stock ratings are determined on a relative basis. (Please refer to definitions above.) An investor's decision to buy or sell a security should be based on investment objectives, current holdings, and other individual factors.*

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See the Companies Mentioned section for full company names.

Price Target: (12 months) for (STP.N)

Method: In arriving at our target price of US$32 for Suntech Power Holdings (STP.US), we explicitly discount cash flow out to 2016 using a weighted average cost of capital of 14.4% WACC and a 8% terminal growth rate.

Risks: Potential risks to our target price for Suntech Power Holdings of US$32 include: 1) a higher-than-expected silicon price increase, 2) a silicon supply shortage, resulting in a lower production of PV cells/modules, 3) a potential margin squeeze, because of competition beyond 2008.

See the Companies Mentioned section for full company names.

The subject company (STP.N) currently is, or was during the 12-month period preceding the date of distribution of this report, a client of Credit Suisse.

Credit Suisse provided investment banking services to the subject company (STP.N) within the past 12 months.

Credit Suisse has managed or co-managed a public offering of securities for the subject company (STP.N) within the past 12 months.

Credit Suisse has received investment banking related compensation from the subject company (STP.N) within the past 12 months.

Credit Suisse expects to receive or intends to seek investment banking related compensation from the subject company (STP.N) within the next 3 months.

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The analyst(s) involved in the preparation of this report have not visited the material operations of the subject company (STP.N) within the past 12 months.

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