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A Planet for Life 2014 aims to answer these questions and explore innovation in all its aspects, through a series of texts written by international experts. The objective of this book is to analyse experiences from across the world and the role of innovation in a variety of areas of development such as urbanization, agriculture and food, the mobility of people and freight, education and the provision of water and energy to all.

The book includes:
• Papers by leading international experts and academics
• New perspectives through in-depth analyses
• Numerous maps, charts and tables
• A wealth of ideas for specialists and non-specialists alike: scholars, policymakers, administrators, concerned citizens, development professionals, entrepreneurs, journalists, students and others.
In pursuit of development through industrialization, latecomer countries and the firms within them are able to develop strategies that counteract their disadvantages, and instead enable them to utilize advantages such as drawing from the pool of available and emerging technologies, which can be applied with transient low costs. This latecomer approach to drawing advantages from leapfrogging can be found today as China industrializes, lifting hundreds of millions out of poverty, followed by India and Brazil – adapting the patterns laid down in the 20th century by Japan, Korea and Taiwan, and in the 19th century by Germany. Developing countries looking to green their industrialization efforts for added advantage face barriers in the form of patent walls that call for further innovative strategies, as well as cost and trade barriers. These are discussed in the cases of solar photovoltaic (PV) cells and light emitting diodes (LEDs), two of the most significant industries today promising tangible leapfrog benefits for developing countries themselves and lower carbon emissions for the world.

Laying down the foundation for a sustainable industrial system: the Chinese model

Developing countries today are caught between two apparently conflicting demands. On the one hand they are anxious to share in the wealth-generating potential of industrialization, to liberate themselves from conditions of poverty and move into the modern, globalized, industrialized and urbanized economy. The fastest and most obvious way for them to do so is to build up their carbon-intensive energy systems, based on coal, oil and gas – just as the now-industrialized countries did before them. On the other hand, they do not wish to be left behind with dirty, noxious industries while the rest of the world moves ahead to a new focus on clean and green industries, starting with renewable energy industries. How are they to resolve this dilemma?

As in so many other ways, China provides a model. China is ramping up its coal and oil-fired energy system as fast as it can, as it builds the world’s largest manufacturing economy that has achieved stellar growth of close on 10% per year for the past three decades. This is the ‘black’ Chinese economy – one which is making the air in Chinese cities unbreathable as well as emitting the world’s largest carbon emissions. However, China is simultaneously engaged in building renewable energy and energy efficiency industries faster than any other country – starting with solar photovoltaic (PV) and wind power industries, and moving to encompass concentrated thermal power (CSP) involving fields of mirrors and lenses, along with other industries such as light emitting diodes (LEDs) for lighting. China’s ramping up of these clean and green industries is taking place at an unprecedented speed; in the case of LEDs, China’s government expects the country to have replaced a third of its traditional incandescent lighting by 2015, thereby saving as much electricity as 1.5 times the annual output of the Three Gorges Dam.

So China is resolving the dilemma by building new clean
and green industries as fast as its black, fossil-fuelled power system expands, with the green system steadily overtaking the black system through logistic industrial dynamics and the rapidly falling costs of the clean and green sector. And of course as it does so, China is building major new industries that are becoming ‘pillar’ industries alongside steel and automotive, and providing the export platforms of tomorrow.

We discuss here how China’s strategy can be generalized and made a model for developing and industrializing countries around the world. When we abstract from the specifics of China’s experience, we see a latecomer industrialization strategy focused clearly on catch-up, using technological capability enhancement as its driving engine. China did not invent this model. It was perfected in the second half of the 20th century in East Asia – first by Japan, then Korea, Taiwan and Singapore, then diffusing into Southeast Asian countries. Now in the 21st century we see it being applied with enormous success by industrial giants like China, India and Brazil – which as they industrialize along ‘green and black’ lines are lifting hundreds of millions of people out of poverty and laying the foundations for a sustainable industrial system.

The foundations are being laid – but such a system has not yet been built. The carbon-emitting aspects of the black industrialization model may yet overwhelm the green shoots as they mature, and condemn the world to a nightmare future of global warming and consequential catastrophes associated with floods, droughts, fires, hurricanes – not to mention wars and terrorism. The future is open. Nothing has been determined.

The latecomer industrialization model and technological leapfrogging

Latecomer countries, and the latecomer firms within them, face enormous obstacles as they seek to industrialize (Lee and Mathews, 2013). They lack initial resources, including technologies, skilled workers and engineers. They are having difficulties entering into advanced country markets due to the competitive threats from well-established firms – usually from firms in countries that have most recently industrialized. But, latecomers also possess certain advantages – provided they can deploy smart strategies to capture these benefits. They can enjoy lower costs (particularly labour costs) for a time, and they can access the pool of technologies already developed. Using strategies of resource leverage (Hamel and Prahalad, 1992) they can access these technologies (e.g. through joint ventures or licensing) and then put them to work to build production systems enjoying lower costs than their established competitors. This is a process that has worked now for many decades. As described by Gerschenkron (1962), latecomers in Europe like Germany caught up with the leader Great Britain in the 19th century through capturing latent advantages and compensating for deficiencies such as commercial banking by creating a new industrial bank (the Deutsche Bank) to channel savings towards investment in new industries which included dyestuffs and chemicals. Latecomers in East Asia in the 20th century caught up by again deploying extraordinary institutional innovations, termed the developmental state (Johnson, 1982) and reciprocal control mechanisms (RCMs) (Amuzien, 2001) – such as the practice in Korea of providing rewards to firms prepared to invest in targeted catch-up industries but disciplined by world export market competition.

Now these strategies are being deployed in their specific institutional settings by China, India and Brazil as they industrialize in the 21st century. But the difference is that this time there is a green developmental strategy alongside a black, fossil-fuelled strategy. And firms in these countries can look to deploy the same latecomer strategies, involving technological leapfrogging, as the earlier industrializers were able to do (Mathews, 2013). Successful catch-up firms move on to become innovators in their own right, further adapting technologies as they build their competences in newly emerging industries (Lee, 2013). The firms in the presently industrializing countries face further barriers, including more pronounced restrictions on infant industry protection imposed by the WTO, and tighter enforcement of patents and intellectual property rights – under the trade-related aspects of intellectual property rights (TRIPS) and technical barriers to trade (TBT) provisions of the WTO.

It is instructive to examine how these opportunities and new barriers present themselves in the important cases of two of the new energy-related industries, namely solar
The general decline in costs of different solar technologies has made it possible to develop competitive solar industries in developing countries.

PV and LED industries. These industries utilize similar technologies, and promise enormous benefits to developing countries, both in terms of reducing energy poverty and providing new, clean industries that have great developmental and export potential.

The solar PV and LED industries: huge leapfrog gains for developing countries

Each of the two emerging industries is the complement of the other: solar PVs turn light into electric power, while LEDs turn electric power into light. They have similar core technologies, involving deposition of a semiconductor onto a wafer. Solar PVs use silicon as basic raw material (sourced ultimately from sand, the commonest raw material on the planet) while LEDs are on the cusp of an evolutionary leap that will enable them to use silicon as substrate as well. A critical feature of each is that they represent an enormous step towards a low-carbon future for developing countries. Solar PVs can be utilized to generate electric power for people far from existing grids, giving villages and rural communities access to power at minimal expense. Likewise LEDs can generate light for domestic and communal uses at reduced costs, bringing illumination (and with it greater opportunities for education) within reach of poor communities. Beyond these poverty alleviation features, each industry represents a potent source of development and exports, particularly for latecomer countries that are prepared to invest in innovation capabilities such as national R&D laboratories that can adopt the technologies utilized (Mathews, 2007). China has already targeted both solar PVs and LEDs as future ‘strategic industries’ — thereby making them eligible for low-cost loans and other forms of assistance designed to build comprehensive value chains covering components...
and final production of both solar cells and LEDs. The global expansion and rapid move along the innovation chain by these Chinese firms has astonished scholars and observers (LEMA et al., 2012; LEWIS, 2012). Apart from technology leverage, the critical institutional innovation that underpins these new firms’ success is credit lines from the China Development Bank (SANDERSON and FORSYTHE, 2013).

A key feature of these industries is their rapidly declining costs, making them more accessible to latecomer developing countries. Solar PV sector costs have been coming down in recent years at 45% per year (BAZILAN et al., 2013), while for LEDs, costs have been dropping at 12% per year (Figure 1). Both rates of cost decline are extremely significant in bringing these industries within the reach of developing countries and making them more competitive with respect to incumbents.

The falling costs of PVs. The global market for solar PVs is growing so fast, and its costs are coming down so dramatically, that it is making it more accessible to everyone – and particularly latecomer developing countries (MCKINSEY, 2012b). Costs are now achieving or approaching $1 per watt, which is close to ‘grid parity’, while the size of the solar PV sector is estimated to be 65 GW by 2011 and is on target to reach 1000 GW (1 TW) by 2020 – although various obstructions might reduce that target to 600 GW (still an enormous total). Chinese manufacturing capacity has grown at an unprecedented pace, and this has been the principal factor in driving down costs (FU and ZHANG, 2011).

LEDs: industrial leadership targeted by China. The LED lighting sector is in the process of taking over the global lighting market, estimated to be worth $100 billion by 2020 (MCKINSEY, 2012a). McKinsey & Co sees LEDs rising to account for 45% of this market by 2016 and 70% by 2020 – making it a huge market full of fresh opportunities for latecomer firms in industrializing countries. As McKinsey puts it: ‘The [lighting] market is on a clear transition path from traditional lighting technologies to LED’.

McKinsey expects that the concern to improve energy efficiency will be one of the drivers of this transition, which will open up a lighting market to millions (or even billions) who have been excluded so far. China has poured immense resources into developing a comprehensive LED industry, backed by legislation banning incandescent light bulbs. It is estimated that as many as 4,000 firms have crowded into the LED sector in China – many of which will go bankrupt. They have been tempted by tax breaks, subsidies and offers of low-cost land for factories, in line with China’s targeting of the sector in the 12th Five-Year Plan (FYP) on account of its energy efficiency and energy consumption cutting potential. The Chinese Ministry of Science and Technology plans for an industry worth 500 billion yuan (US$79 billion) by 2015, when LEDs should count for 30% of the lighting market.

Intellectual property rights, patent walls and hold-ups

Quite apart from difficulties involved in accessing technologies protected by patents (where at least a prima facie case for licensing exists) latecomer countries face further difficulties in confronting the ‘patent wall’ around advanced technologies (LEE et al., 2013). The barriers are particularly strong when leading firms engage in what is termed ‘strategic patenting’ – which is where firms extract rents from prior established (de facto) industry standards, where different firms hold patent rights to part of the technological system but not to all. The Stanford Law professor Mark Lemley graphically labels this practice as ‘patent hold-up’ and ‘royalty stacking’; other terms used are patent ambush, unilateral refusal to license and denial of fair, reasonable and non-discriminatory contracts (LEMLEY and SHAPIRO, 2007). The leading firms have the upper hand in these kinds of cases; under the current operation of the TRIPS and TBT there are few remedies available to contesting countries.

The LED and solar PV industries have abundant patent-related cases demonstrating these difficulties. While solar PVs have a lengthy history, and many of the patents relating to the dominant technology of crystalline silicon have now expired, making the technology freely available, this is certainly not the case for the second and third generation solar PV systems such as CIGS (thin film second generation) and organic PVs (third generation).1 Strong patent

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1. CIGS is an alternative semiconductor layer, made up from Copper, Indium, Gallium and Selenide.
barriers have been erected in the case of CIGS – but these have been breached in an unexpected way by the Chinese firm Hanergy which was quick to buy up advanced technology firms that developed CIGS and protected this knowledge base with IPRs, but then fell on hard times as crystalline silicon firms continued to lower their costs and prices below those that could be maintained by the CIGS firms. Hanergy took over Solibro (the CIGS subsidiary of the German company Q-Cells), MiaSole and most recently Global Solar Energy – and with these companies it acquired considerable patent rights as well. It is notable that Samsung is known to have accumulated a considerable ‘war chest’ of patents on CIGS technology as a prelude to entering the sector – but at the time of writing it has not yet entered production. In Taiwan, the Industrial Technology Research Institute (ITRI) has accumulated a set of patents covering CIGS technology which it has assigned as a ‘patent pool’ to latecomer Taiwan firms looking to break into second generation solar PVs (Mathews et al., 2011). Such patent pools represent an interesting institutional latecomer innovation, modelled on the successful patent pools created in the developed world – such as the MPEG-2 patent pool that was given exemption from anti-trust action in the US and now continues to charge royalties on video streaming, even after the original patents have expired.

In the LEDs sector a veritable cartel of seven firms – Nichia, Cree, Samsung, LG, Osram, Sharp and Phillips – have maintained a tight patent ring (involving cross-licensing deals), covering all aspects of LED lighting, such as chips, phosphors and substrates. For example a cross-licensing agreement between Sharp (Japan) and Osram (Germany) was announced in August 2013, covering LEDs and laser diodes. Everlight from Taiwan has broken into this tight patent ring, but only at the cost of severe patent infringement suits that have sapped the company. Such cases make the argument for fundamental reform of the patent system to make it of greater use in driving the diffusion of innovations, as much as their protection.

Cost and trade: promoting green industries

Latecomer countries looking to leapfrog to the lead in green technologies face a variety of other challenges, including cost and trade barriers. Many of the most favourable renewable energy systems, such as CSP (involving large arrays of lenses and mirrors to concentrate solar energy and storing it through such means as molten salt systems), still entail costs that are in excess of those of dirty and unreliable coal or oil supplies. The costs are coming down rapidly (as they are for solar PV) and will soon be driven down faster as China enters the field of CSP. But smart financial instruments such as green bonds/climate bonds can get around such barriers, by lowering the cost of finance through aggregating projects into packages that can be floated on bond markets. The example of a $500 million bond issued by the Korean Export-Import Bank (Kexim) in March 2013 demonstrates how countries can utilize such financial innovation that supports green development; the Kexim Bond was targeted at institutional investors and was oversubscribed, showing the appetite for such investments.

The ultimate barrier to green development through leapfrogging is the world’s trading system, with its bias against green exports from developing countries (such as sustainable bioethanol from Brazil produced efficiently from sugar cane) and continuing trade barriers against the export of green energy equipment from advanced countries. There are proposals to resolve such trade barriers through a ‘Green Goods Free Trade Agreement’ that could accelerate global trade in environmental and green goods in the same way that a similar agreement covering IT goods has (in an unobtrusive way) facilitated the rapid growth of the IT sector around the world over the past two decades. The APEC countries (Asia Pacific Economic Cooperation) including both China and the US agreed on such a lowering of tariffs on a long list of


4. See the report at Climate Bonds Initiative: http://www.climatebonds.net/2013/02/kexim-green-bond/
‘environmental’ (essentially green) goods at their Vladivostok Summit in 2012, and negotiations are underway to extend the agreement to the G20 – with a view to such an agreement being adopted by the WTO. This would have more impact on global concerns over climate change than all the efforts so far expended on the Kyoto process.5

Conclusion

The greening of development strategies represents a new frontier that could prove to be of decisive importance in maintaining and enhancing the living planet while raising hundreds of millions of people out of poverty through sustainable industrialization. On the former ‘business as usual’ model fuelled by coal, oil and gas, there is no way that these goals can be reconciled. But as China, and to some extent India and Brazil and other countries industrializing in their wake adopt a new green model, and turn it through industrial strategy into a source of employment, wealth generation and exports, the prospects for the planet are transformed. Lopsided trade arrangements as well as patents and intellectual property rights issues stand as potential barriers, calling for global institutional innovations. In this case such innovations could be a global free trade agreement for environmental goods that would encourage technology transfer and the opening up of markets which help to drive down costs, making green technologies more accessible. And patent initiatives such as patent pools created by national R&D institutions could help to get around potential patent walls. The countries that have full industrialization in their sights will demand nothing less.

REFERENCES


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