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INDUSTRIALISATION AND SUSTAINABLE GROWTH

CHANGING MARKET AND POLICY DYNAMICS OF CLEAN ENERGY & ECONOMIC INNOVATION AND LOW CARBON DEVELOPMENT PATHWAYS IN SOUTH AFRICA:

DRIVERS, TRENDS, AND OUTLOOK

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Abstract

Based on a multi-year research project (including field visits to Kenya, Tanzania, Zimbabwe, Uganda, Mozambique, and other countries in Sub-Saharan Africa in 2012-2016) examining early-stage clean energy ventures and low carbon technology innovators (e.g. M-KOPA, d.light, Off Grid Electric, among others), this paper seeks to connect the theory and practice of how clean energy & economic innovation and low carbon development pathways can more effectively serve as a market-based solutions to address energy poverty and foster new models of inclusive commerce in South Africa.

This paper argues that clean energy & economic innovation and low carbon sustainable development pathways in South Africa and other emerging market economies need to be understood within its own socio-economic and institutional market context and not as a lesser developed version of OECD industrialized countries.

Divided into three parts, the first element of the paper will examine the key drivers that are shaping clean energy & economic innovation and low carbon development pathways in South Africa and other emerging market economies. The second element of the paper will discuss the key trends in terms of clean energy & economic innovation and low carbon development in South Africa and other emerging market economies, particularly in terms of clean energy/low carbon enterprise development. The third element of the paper will focus on the future outlook for clean energy & economic innovation and low carbon development pathways in South Africa and other emerging market economies.

About the Author

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1. Introduction [1]

One of the first things that many first-time visitors from North America, Europe, and Asia notice when they visit South Africa and other countries in sub-Saharan Africa (SSA) is the frequency in which one encounters street signs and billboards featuring mobile finance and e-money advertisements in large cities as well as in rural villages. Most notably, launched in 2003 by Vodafone with the support of a $1.5 million grant by the UK Department for International Development as a "speculative technology project", Safaricom's M-Pesa mobile money system is now recognized one of SSA's most well-known technological breakthroughs (Mworia 2016 and Barrett 2011) and is studied in business schools around the world as an African innovation case study.

Using inclusive market development (Mair et al 2012) theories drawn from the business management, international development, renewable energy technology and other related scholarly literature and based on an assessment of emerging early-stage solar energy business models in emerging market economies, this paper has two major goals. The first goal is to highlight the geo-economic importance of conceptualizing clean energy & economic innovation and low carbon development pathways in South Africa, as distinct from the market, policy, and institutional context of the industrialized OECD countries.

The second goal is to underscore the importance of accelerating market-led clean energy & economic innovation and achieving triple bottom line (social, economic, environmental) renewable energy development in South Africa without exacerbating social and environmental inequality (Gollwitzer et al 2016 and Tawney et al 2015) and intensifying climate change emissions (Andrews-Speed 2016).

Divided into three parts, the first element of the paper will examine the key drivers that are shaping clean energy & economic innovation and low carbon development pathways in South Africa and other emerging market economies. The second element of the paper will discuss the key trends in terms of clean energy & economic innovation and low carbon development in South Africa and other emerging market economies, particularly in terms of clean energy/low carbon enterprise development. The third element of the paper will focus on the future outlook for clean energy & economic innovation and low carbon development pathways in South Africa and other emerging market economies.

2. Clean energy & economic innovation and low carbon development pathway drivers

[1] Earlier draft versions of this paper were presented at the Climate Strategies' Global Climate Policy Conference in Dar es Salaam, Tanzania on 14-16 July, 2016 and at the Cornell University's Mobile Money. Financial Inclusion, and Development in Africa Conference in Ithaca, New York on 21-22 April, 2017. I am grateful for the comments and feedback received at these two conferences.

There are three key drivers of clean energy & economic innovation and low carbon development pathways in South Africa and the wider SSA region (Ockwell and Byrne 2016, Newell and Phillips 2016, Hancock 2015, Ahlborg et al 2015),

2.1 Climate change and its socio-economic impacts

Climate change-related environmental stresses are already having a major impact on South Africa and other SSA countries, most notably the drought and related food insecurity crisis in the Southern African region. In a recent scientific survey of climate change and meteorological trends in 30 African countries, two-thirds of the countries surveyed were experiencing warming faster than the world as a whole. Critical economic disruptions, particularly in the agricultural sector, are expected, with as much as 20-30 percent decline in yield for major agricultural crops by 2050 (Bishop 2017). Such a disruption is likely to have a disproportionate economic, social, and environmental impact on the most vulnerable population in South Africa, most notably the rural and urban poor.

Beyond South Africa and the SSA region, because smallholder farmers provide up to 80 per cent of the food available in the developing world (Grainger-Jones 2011), agricultural/food system enterprises that are inclusive, environmentally-friendly, and commercially successful represent a key economic, institutional, and market factor in meeting the sustainable livelihood needs of the global population and in transforming farming and agricultural practices to become more climate resilient to disruptive events like floods and droughts (FAO 2010).

A critical question is how best to foster an enabling governance structure that can encourage smallholders to adopt clean energy-based agricultural practices resulting in a triple dividend of increasing food production, strengthening adaptive capacity and sourcing renewable energy (Parry and Boyle 2012).

2.2 Energy access and poverty

Access to energy is a critical factor in commercial activities in both industrialized and developing countries because energy and electricity access provide a wide range of economic, social, and environmental benefits for individual households and communities. Most notably, providing electricity access with renewable sources is becoming economically feasible compared to kerosene-based lighting systems (IRENA 2013).

SSA region consumes only 145 terawatt hours of electricity a year, which is equivalent of one incandescent light bulb per person for three hours a day (Lucas 2015). Although energy access is less of a problem in the case of South Africa, it should be noted that nearly 600 million people (or about 57% of the population) in the wider SSA region had no access to electricity, which would constitute one of the worst energy poverty stricken regions in the world (IRENA 2013). While there has been relative progress in terms of energy poverty issues in African cities and urban areas, one energy use survey of rural communities conclude that electrification rates remain very low in rural areas, averaging 5 percent for rural households and 22 percent for rural businesses (Lee et al 2016).

Even as energy poverty and renewable energy access for the poor have traditionally suffered from insufficient policy attention, even less attention has been given to addressing these issues for the rural poor in South Africa and the wider SSA region. This is why off grid electrification is not only the most market-friendly solution, but it represents the most realistic and sustainable energy policy strategy for rural communities in South Africa and other SSA countries.

2.3 Off grid solar technology innovation

What makes clean energy innovation and low carbon market development "unique" in the case of the wider SSA region is not that it focuses on market-led renewable energy development per say, but it is the "speed" in which the clean energy innovation and low carbon market development-related issues (particularly in terms of early-stage off grid solar technology companies using pay as you go business models) have taken off and impacted the market dynamics of the energy transition process most notably in East Africa (Park 2016).

The off-grid solar technology sector received $360m in investment capital in 2011-2016 (see **figure 1**), with more than half of that amount being allocated just in 2015 (Bloomberg New Energy Finance 2016). Moreover, off-grid solar companies received more than $200 million in debt and equity in 2016, which is almost ten-fold increase from the comparable figure in 2013, and the overwhelming bulk of this funding is targeting the East Africa region (Bloomberg New Energy Finance 2017).

Consequently, there is a critical need to assess whether these emerging clean energy innovation and low carbon business models have actually resulted in ventures with shared value (Porter and Kramer 2011) and that link commercial success and community development engagement in the deep poverty context (Mair et al 2012).

3. Clean energy & economic innovation and low carbon development pathway trends

Despite the growing scholarly research on emerging market innovation and entrepreneurship (e.g. Brem and Wolfram [2014] on new product development; Govindarajan and Trimble [2012] on reverse innovation; Seyfang and Smith [2007] on grassroots innovation;), there remains an important gap in terms of figuring out what type of clean energy & economic innovation and low carbon development practices are needed to accelerate the triple bottom line (social, environmental, and economic) impact of clean energy market development in South Africa and in the wider SSA region. Three important trends are starting to address this knowledge gap.

3.1 Meeting the financing & investment gap

In a well-functioning financial system, clean energy ventures and other forms of early-stage enterprises are more likely to have a range of financing options and support services as they grow. Even in the case of the U.S., where entrepreneurial financing is considered to be most advanced, CB Insights (2017), New York city-based venture data analytics firm, concluded that less than half or 46%, managed to raise a second round of funding in its 2008-2009 survey of 1,098 early-stage technology companies (which includes energy and other types of technology companies). Every round sees fewer companies receiving new venture capital, with only 14 percent of the companies that go onto raise a fourth round of venture funding (see **figure 2**)

Although early-stage African business ventures (as is the case in many other developing countries) typically operate in a much less supportive funding and investment capital ecosystem (Baker 2015), investor interest in clean energy ventures and low carbon projects across the SSA region has increased dramatically in the past five years. SSA clean energy investments nearly doubled to $5.2

billion in 2015, as compared to 2014 figures (Climatescope 2016), while as noted earlier, off-grid solar companies have received more than $200 million in debt and equity in 2016 or almost ten-fold increase from the comparable figure in 2013 (Bloomberg New Energy Finance 2017).

3.2 Designing a new "ecosystem" approach to clean energy & economic innovation and low carbon development pathways

According to Henderson and Newell (2011), an innovation ecosystem needs to have the following three components: a) clear market signals to private firms to invest in energy technology commercialization (b) adequate investments in and funding of basic energy scientific research; and (c) an institutional environment that includes active engagement with private sector firms and prioritizes technology diffusion.

Unfortunately, Henderson and Newell's innovation ecosystem elements are either weak or non-existent in virtually all SSA countries. Because there is not one model of clean energy innovation and entrepreneurship that cuts across the diverse socio-economic, technological, and geographical domains, clean energy innovation and in the South African market context needs to be understood in terms of the specific policy, market, and institutional context in which it occurs (Ockwell and Byrne 2016).

Because the institutional capacity that is necessary support market innovation and new venture development is weak in South Africa and across the wider SSA region (Gollwitzer et al 2016), a multi-sectoral, collaborative "ecosystem" approach to clean energy & economic innovation and low carbon market development (similar conceptually to what OECD [2015] refers to as system innovation in industrialized countries) is likely to succeed in scaling policy and market success in South Africa and other emerging market economies.

3.3 Understanding the "hierarchy" of sustainable energy needs

The emergence of microgrid and clean energy system design and development companies like PowerGen suggests that there is sort of a "hierarchy" of off-grid electrification market solutions, with consumer demand migrating from solar lanterns, to solar-home systems, and then to micro-grids in the SSA region.

This may explain why clean energy business models (for instance, Solar City in the case of the U.S.) in OECD countries do not "fit" the market, policy, and institutional environment of developing countries. A more effective South African market-friendly approach might be to use a form of a "pay-as-you-go" business model which has been used very successfully by East Africa-based solar technology ventures like M-KOPA, in which customers borrow a solar panel and then make small payments each month to gradually pay off the cost so they can own it.

Unlike leasing programs that are common in US and other OECD countries, "pay as you go" business model asks customers to pay in larger increments one or two times per year (instead of a monthly payment plan, for instance) when the customers are likely to have the necessary cash flow to make the payments. Many low to middle income South Africans as well as similar consumer groups in the base of the pyramid markets have fluid cash cycles, which means that the companies need to design their product financing to align with their customer's cash flow situations (for instance, link

payments to right after the harvest season when cash flow situation tends to be more positive and not to post-school payment time periods) (Ahearn 2016).

4. Clean energy & economic innovation and low carbon development pathway outlook

Similar to the way M-Pesa helped incubate and accelerate a mobile finance technology market ecosystem in Kenya since its 2003 launch, solar and other renewable energy technologies are starting to connect people without access to electricity and to light their homes and businesses in places where traditional grid power is non-existent and/or extremely expensive or unreliable.

Not only does the development of solar power and other clean energy technologies have the potential for technological leapfrogging (Amankwah-Amoah 2015), harnessing clean energy & economic innovation and low carbon development pathways are starting to be perceived as one of the most effective integrated approach to poverty alleviation and economic development in South Africa and in other SSA countries. Whether clean energy & economic innovation and low carbon development pathway truly become this integrated energy poverty and market development solution is likely to be determined by three factors.

4.1 Responding strategically to the Industry 4.0 technological challenge

Technological advances have fueled economic growth since the early stages of the Industrial Revolution. The best recent example of this technological advance is the market development of mobile phone technologies in South Africa and the developing world. More households in developing countries own a mobile phone than have access to electricity or clean water, and nearly 70 percent of the bottom fifth of the population in developing countries own a mobile phone (World Bank 2016).

With more than three-quarters of the world's inhabitants with access to a mobile phones, mobile communication technologies represent less about a story about a particular technology ("what") and more about the changing social-institutional and economic norms that mediate the use of such technologies ("how") (Radelet 2010). For instance, citizens in Kenya are starting to use mobile phone technologies to create new models of sustainable livelihoods (Suri and Jack 2016).

According to Rüßmann et al (2015), our planet may be amidst the fourth wave of technological advancement known as Industry 4.0. Industry 4.0 represents a digital industry technology platform powered by nine sensors, machines, workpieces, and IT systems (see **figure 3**). Industry 4.0 has the potential to enable faster, more flexible, more efficient processes, and to produce higher-quality goods at reduced costs, which have very large but still unexplored implications in terms of manufacturing productivity, industrial growth, workforce development for South Africa and many other countries.

4.2 Co-innovating with "complementary" mobile finance technology platform

What is the likely market development of "complementary" mobile finance technology (particularly personal finance system) in South Africa? Globally, around 2 billion people have no credit scores that might make them eligible for bank loans and other financial resources common even for poor

people in the OECD countries (World Bank 2015). A key reasons why "pay as you go" business model is and will continue to be the preferred business model for many SSA companies and organizations is that more than 80 percent of the regional population lack access to formal financial services such as bank loans and other financial means to make big ticket purchases like solar panels and other consumer durables (Jackson 2017).

Since there are no current information business platforms that aggregate the credit history and payment records (compared to what is freely available online through a company like Credit Karma in the case of the U.S.), there is not yet an easy, cost-effective way for companies to evaluate the business risk of lending solar panels to an individual or a household. This is the reason why the future business success of M-KOPA and Off-Grid Electric is likely to depend on the business growth of companies like Tala, which use data from cell phones and social networks to gauge a person's ability and willingness to repay loans.

4.3 Financing the scaling of clean energy innovation and low carbon development market development

How sustainable is the financing of early-stage entrepreneurs and innovators in South Africa? Depending on how one defines "African" venture capital, South Africa (most notably, Johannesburg) is regarded as the most popular (or second after Nigeria) destination of entrepreneurial venture capital (Kuo 2017).

Despite the positive regional trends in clean energy venture financing and investments, these trends do not fundamentally alter the still critical SSA "missing middle" dilemma (Yago et al 2015), in which many business ventures are caught in the middle of the business funding cycle, too large to access microcredit financing mechanisms while being too small to have the necessary cash flow to attract longer-term growth financing from commercial banks.

E-commerce technology sector (see **figure 4**) represents a good illustration of the "missing middle" dilemma in Africa. According to one survey of the largest e-commerce companies in the world private e-commerce companies raised over $46.7B across 3,880 deals between 2012 and 2016. While the US is often the top hub for many technology categories (clean tech, biotech, among others), China now has the largest number of e-commerce companies with $100M+ in funding (25 in China compared to 20 in the U.S.). Most notably, no company from Africa region (nor Latin America) made it onto the global list (CB Insights 2017).

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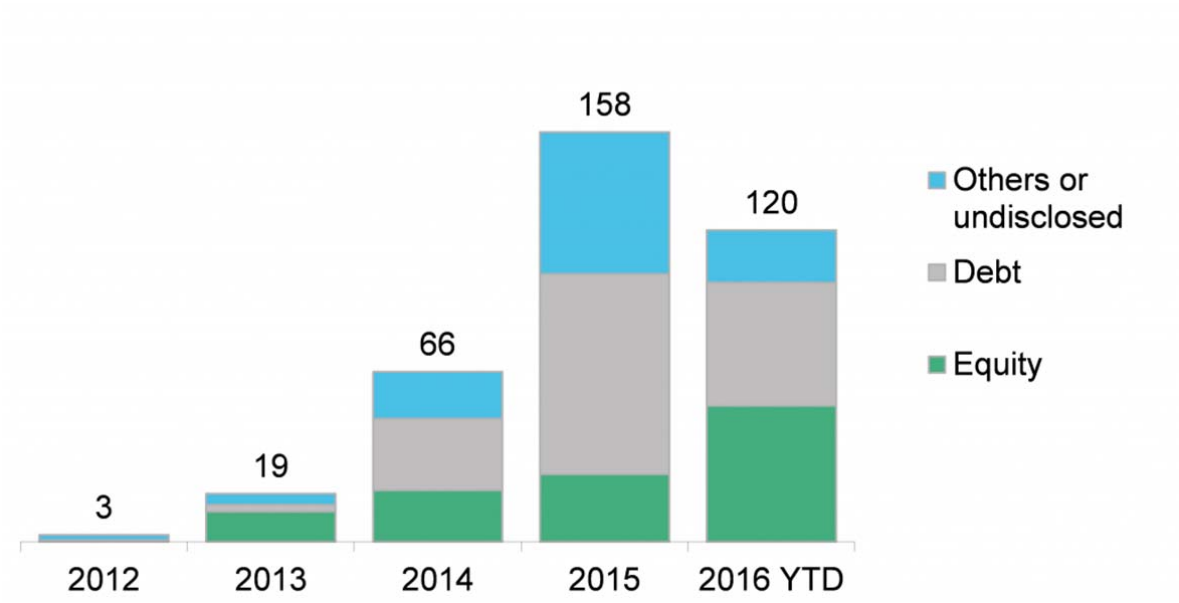
FIGURE 1

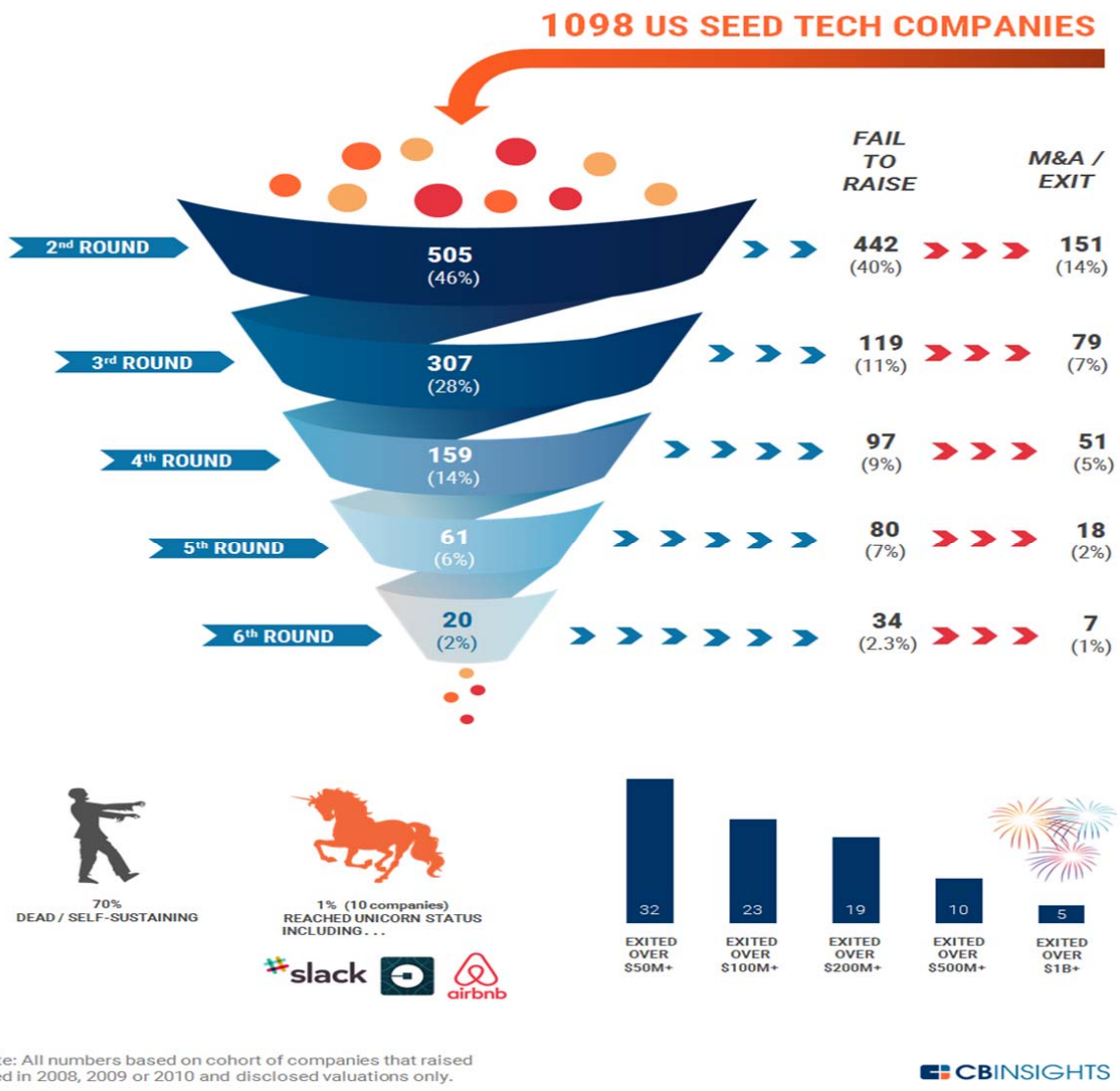
Investments in pay-as-you-go solar companies ($m)



Source: Bloomberg New Energy Finance. Note: 2016 figures as of 30 September 2016.

FIGURE 2

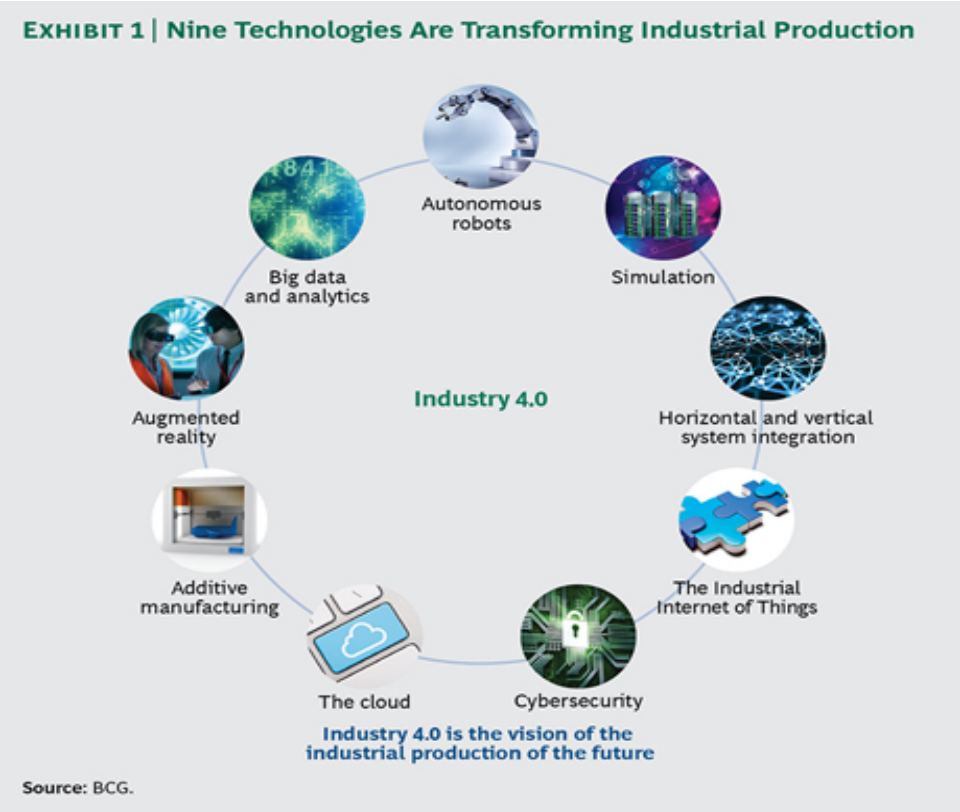
Venture capital "funnel"



Source: CB Insights (March 29, 2017) https://www.cbinsights.com/blog/venture-capital-funnel-2/

FIGURE 3

Industry 4.0: The Future of Productivity and Growth in Manufacturing Industries

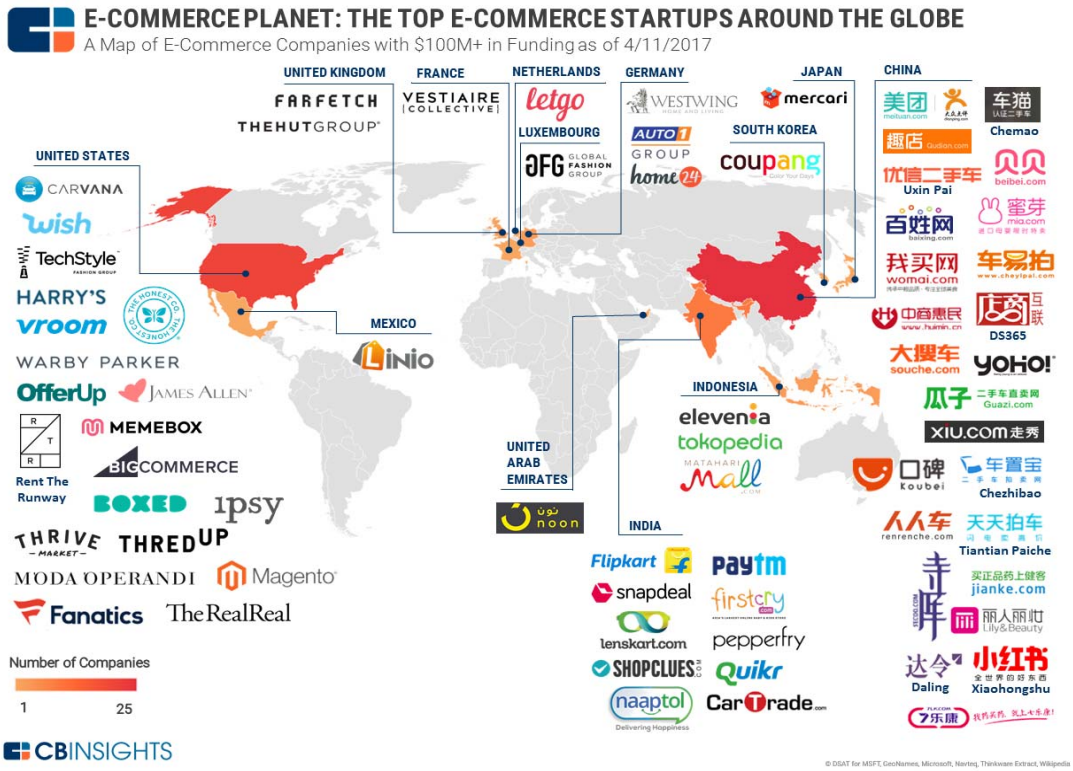


Source: Boston Consulting Group (April 9, 2015)

https://www.bcgperspectives.com/content/articles/engineered_products_project_business_industry_40_future_productivity_growth_manufacturing_industries/

FIGURE 4

70 Largest E-Commerce Startups Around the Globe



Source: CB Insights (April 18, 2017) https://www.cbinsights.com/blog/top-ecommerce-startups-global-map/

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