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China's Five Year Plan, Indigenous Innovation and Technology Transfers, and Outsourcing

Commissioner Mulloy, Commissioner Slane, other panel members, commission staff, and distinguished guests, good morning, and thank you for the invitation to speak with you this morning.

China's 12th Five Year Plan focuses on the development of what it calls seven strategic emerging industries (SEIs). Within those seven industries, 35 projects have been identified. I have listed these industries and sub-industries in Exhibit 1 submitted in the written part of this testimony. To highlight a few of them: high-efficiency energy saving technologies like lighting, next-generation mobile communications, Internet core equipment, Internet of things, cloud computing, high end software and servers, bio-pharmaceuticals, high-end assembly and manufacturing including aerospace, rail and transport, and smart assembly, nuclear, solar, wind and biomass power and smart grids, advanced materials and composites, and electric and fuel cell cars.

I believe that this plan is strongly aligned with the other guiding policies from the central government, in particular the "Medium to Long Term Plan for the Development of Science and Technology" issued in 2006, which articulated the goal of making China an innovation-oriented society. I think these are in response to a perception that opening the country to foreign direct investment has not led to improvement of domestic innovation capabilities and that foreign technologies continue to dominate the high value parts of high-tech products, with China relegated to low value-added labor intensive roles in global production networks. A great deal of China's advanced production capabilities rely on imported tools that embody technology and know-how, or the licensing of foreign technologies that are often a generation or more behind. By calling out specific projects, the government can target areas for investment and capability development. This is implemented through the research agendas of universities and research institutes, the strategies of state-owned enterprises (SOEs), and through projects, policies and incentives that favor the areas mentioned. An example of such a policy is a grant for 50% of the purchase price of MOCVD tools that are used in the production of LEDs, which are the foundation of energy-efficient solid state lighting. A similar program several years ago addressed the dependence on overseas sources of supply for crystalline polysilicon used in solar cells. Such actions help to ensure that the global production center for these commodities

will be in China. Other actions favoring the production and ownership of hybrid electric and pure electric automobiles are designed to help the country become the leading global supplier of electric vehicles and components. In this regard, China recognizes that they are not saddled with legacy infrastructure associated with the manufacture of gasoline powered vehicles, and wants to use their large market to leapfrog to a position of global leadership in electric vehicles. They have already done it in electric bicycles and scooters, cars are next.

The most important driver for the roll-out of plans is through the annual goal setting cycles at all levels in the government. Meeting targets for a city, region, or province, for example, is the path to advancement for officials in the party. Those who do a superlative job get chosen for the prime leadership positions. Those who fail to meet targets get sidetracked, so the motivation is powerful.

I should add that I believe work is already well underway in all of these project areas, as they represent the leading edge of innovation in advanced economies like the U.S. and Europe as well. The 12th Five-Year Plan is a continuation of a long term strategy of capability building that had been in place for decades.

What are the implications for the United States of China's attempt to bolster its high technology industries? First I think we will see increasing market competition for American firms across the board from Chinese companies, with the circumstances in some industries more pressing than others. U.S. firms will not necessarily be global leaders in many fields where we take such leadership as a given. Chinese companies like Huawei will increasingly be world leaders in supplying advanced technology products to world markets. The seeds are already sown.

This means America, and all nations, will increasingly turn to Chinese companies for the purchase of products with high intellectual content, and not just products with high labor content. Huawei supplying the core telecom infrastructure in Iraq is one example, but we will likely see it in other technologies like wind energy, solar, and others. This will make our trade deficit problem even more challenging than it already is.

Second I think we will see increased purchases of Western companies as a path to acquire technology. This has already been taking place, not only in the U.S. but across Europe. I visited a German manufacturer last month that expressed serious concerns over the acquisition by Chinese companies of German companies that controlled key advanced machine tool technologies. These purchases are not limited to SOEs. Geely's acquisition of Volvo is an example of a distress sale in the West that provides key system level capability to a rising private automaker. As the Chinese currency gets stronger, these purchases become easier. That's another downside to our enormous trade deficit. An article on the front page of the Wall Street Journal of June 7, 2011 highlighted this trend. The article pointed out that Chinese companies found it easier to acquire in Europe because of the absence of any kind of strategic review.

FDI like this is not a behavior unique to China of course. European and Japanese companies have long done this, as have U.S. companies in establishing global leadership positions. Look at Roche with Genentech, or Takeda Pharmaceuticals with Millennium or Daiichi Sankyo's purchase of Ranbaxy Laboratories of India. Our trade deficit and the inevitable impact on the dollar have put America on sale.

Third the U.S. must prepare for the eventuality that we will have to source critical military technology abroad as more of our domestic capabilities wither away. Earlier this month I was watching high speed laser drilling of through vias in complex circuit boards used for your favorite smartphones. In China of course, using Japanese tools. What we haven't focused on as a nation yet, with the exception of DOD and DARPA, is the importance of so called dual-use technologies. I remember talking to DARPA in the mid-1990s about this, how commercial off the shelf (COTS) civilian technologies were on a much faster improvement curve than mil-spec. That is even more true today, and this is well understood in China. It is not widely understood here.

With regard to point four, will China's indigenous innovation policies help them? The 1994 Automotive Industrial Policy, part of the ninth five-year plan, is a good role model. That plan sought to force increasingly complete transfers of automotive technology and know-how to China. The plan has had considerable success, with China now equipped with modern production plants and the management capability for running them. As most of us know, today the Chinese auto market is the largest in the world. It is also the most profitable in the world, and it is driven by domestic consumption, not export. But it has also laid the institutional foundation for another large export industry – vehicles and vehicle components. I should add that I feel the Chinese auto industry still has many issues, but it has made huge strides in a fraction of the time taken by Western, Japanese, and Korean counterparts, and it has learned and internalized many of the lessons of the Japanese and particularly the Koreans.

I visited a U.S. wind turbine manufacturer last month. Though they are a technological leader in direct drive permanent magnet designs, they will face increasing competitive pressure, especially as they increasingly have to source critical components in China. Even though transport costs favor local manufacture, I am pessimistic about the long term prospects for U.S. firms in this sector.

Some segments will take more time. I believe it will take years before Chinese companies will be able to design and manufacture the hot section of commercial air transport turbine engines, but they will invest a huge amount trying. Commercial engines require extreme reliability as well as fuel burn performance. The Chinese will make faster progress on the military side.

I believe that China's indigenous innovation policies will help them advance up the value chain to more sophisticated and valuable segments. Progress will not be uniform, but for the last 25 or more years, China's five year plans have targeted the development of capabilities and their goal setting, incentive systems, and long-range thinking have served them extraordinarily well.

What are the implications for the United States should China capture leadership of these seven SEIs? I think China will capture more of the higher value-add segments in many industries. Again, Huawei is a good model here. It has a significant number of essential patents covering LTE in 4G phone systems; we will likely see the pattern repeated in other industries. The value capture could accrue to Chinese companies as well as global multinationals operating in China. We will inevitably see increases in the share of global R&D in those fields pulled into China as well.

But let's not be too harsh on China. This is no different than what happened in Japan over the last 40 years. As I mentioned before, if you want to buy a high-speed two micron laser drill, your choice is among Japanese companies. The same is true for a laser annealing system for polycrystalline silicon. If you want to buy the most advanced optical lithography equipment, your choice is European or Japanese. And remember 70% of the world's semiconductor foundry capacity is in three science parks in Taiwan.

Will China transition from its current export and investment led growth model to a model that calls for increased domestic consumption? This question has been the focus of much that has been written lately. I think we can look again to the 1994 AIP as a role model. As I mentioned earlier, China is now both the largest and its most profitable auto market in the world.

I think it is helpful to take another perspective. In China today, nobody younger than age 35 to 40 years has ever experienced a recession. If you are an urban citizen in China, your standard of living has doubled every six or seven years. At some point in time when that stops, there is a giant problem. The likelihood of an overreaction from the Chinese consumer pulling back is very high. The central government is very worried about such an eventuality, which is why there is an imperative for incremental change, gradual not discontinuous. The economic crisis that started in the United States gave significant pause to Chinese leadership, forcing them to recognize that an overdependence on export to countries like the U.S. put their stability at grave risk. I traveled extensively across Asia at the depths of that crisis. I saw vast capacity underutilization and huge employment challenges. That's the motivation; they don't want to go through that again.

So back to the question: will we see a shift from export-led to domestic consumption led growth? I believe we will, and the proportion will vary across industrial sectors. But China will continue to be an export powerhouse, because so many global supply chains have relocated there. Those supply chains took decades to move, so for many industries there is no short term alternative. That die is cast.

Because of time limitations, I wanted to focus my time on answering the questions posed by the Commission. I will leave some of my recommendations to my written testimony.

In thinking about recommendations, I want to note the circumstances of America's post World War II global leadership. It was built on institutional foundations of global domination of mass

production industries, easy access to the world's largest market, and enormous investments made over the prior three quarters of a century in scientific and technical education. Wartime production extended the capabilities of American firms and a faith in science and huge post-war investments in publicly funded scientific research as well as private investments in industrial research fell on fertile ground as American companies used their mass production capabilities to translate inventions into mass market products. We saw it in synthetic fibers and pharmaceuticals, petrochemicals and a host of consumer goods. In fields like electronics and aeronautics, large scale DOD and NASA investments drove crucial demand for the purchase of advanced technology. America produced products that could not be made anywhere else in the world.

Today we live in a different world, where knowledge, know-how, and people flow more freely across borders, and the globalization of production systems expose arbitrage opportunities that are quickly exploited. As many have suggested, we need to continue to innovate, we need to invest in our education systems to produce people who are capable of supporting the advanced capabilities future industries require, and many other obvious things I won't repeat here.

Let me offer a few ideas. We have many leaders in science and technology in this country who want to contribute to the discussion and work on the solution. The National Academies of Sciences, National Academies of Engineering, and the Institute of Medicine produced a highly relevant report, "Rising Above the Gathering Storm," that offered a well thought through set of recommendations. In a follow-up two years later they pointed to how other governments appeared to be taking the initiative to implement the recommendations of the first report, not the United States. As I do my research across Asia, I am struck by the strong technological grounding of leadership in government: in Taiwan, in Korea, in Singapore, and In China. Asian governments rely on technocrats to help them understand policy implications, and to identify the types of capabilities they need to build to support the future paths of their economies. Many leaders in those countries have an engineering or scientific training. We could use our technical leaders in this country more, we certainly have people who want to help.

I also feel that partisan debate is crowding out intelligent discussion of long term planning. We need to identify capabilities that we want to foster and preserve in this country for the century ahead. That is what the Chinese, and other Asian nations have done for many decades. It's a "tragedy of the commons" problem: we know long term investments are vital to the future of the nation, but our focus is short term. Just as the government has to provide infrastructural investments for the common good because private interests cannot, the same applies to the funding of basic research. Basic research makes significant contributions to the productivity growth of the economy, yet the social returns from basic research are higher than private returns, which is the argument for financing by the taxpayer. Cutting investments now because of an inability to address other structural aspects of our budget only exacerbates the problems for later.

I want to add a cautionary note on military spending. I am certainly not an expert on the military budget, but I do observe that a lot of military spending has funded key market demand

pull for the advancement of new technologies. Integrated circuits, composite aerostructures, energy efficient turbine engines, the Internet, code-division multiple access, the global positioning system, and countless other technologies where the U.S. has the lead are examples. We need to take a holistic view, especially with regard to dual-use technologies.

I want to close on a personal note about five year plans. When I was a child, I used to laugh at China's five year plans. The "Great Leap Forward" and others were a big joke to me because of the frequency of perverse outcomes amidst poor central planning choices. But over the last two decades I have come to change my view. Starting with the "863" plan of March 1986, I started to pay more attention. A lot more. Because the Chinese have been diligent in learning from their mistakes and improving their goal setting and measurement systems. Are they perfect? Not by any means. They still often have perverse outcomes. But they work on it every day, and they try to learn from their mistakes.

In this regard, I don't fault them for what they are doing. They are focusing intently on the capabilities required to be competitive in a modern global economy. It would serve us well to do the same thing in this country.

Exhibit 1 China's Seven Strategic Emerging Industries and 35 Projects for Sub-industries included in the 12th Five-year Plan

Energy Saving and Environmental Protection	• High-efficiency and energy saving • Advanced environmental protection • Recycling usage • Reusing waste products
Next-generation IT	• Next-generation mobile communications • Next-generation core Internet equipment • Smart devices • Internet of Things • Convergence of telecom / cable TV / Internet networks • Cloud computing • New Displays • Integrated circuits • High-end software • High-end Servers • Digitization of culture and creative industries
Bio Industries	• Bio-pharmaceuticals • Innovative pharmaceuticals • Biomedicine • Bio-agriculture • Bio-manufacturing • Marine biology
High-end Assembly and Manufacturing Industries	• Aerospace and space industries • Rail and transport • Ocean engineering • Smart assembly
New Energy Sources	• Nuclear power • Solar power • Wind power • Biomass power • Smart power grids
New Materials	• New function materials • Advanced structural materials • High performance composites • Generic base materials
New Energy-Powered Cars	• Electric hybrid cars • Pure electric cars • Fuel cell cars