

GREEN GROWTH AND ROLES OF TECHNOLOGICAL INNOVATIONS FOR DEVELOPING COUNTRIES

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Abstract:

In the declining context of environment, natural resources and impacts from climate changes, the green growth has become an avoidable trend in the world. It becomes a huge challenge for all the nations, particularly for developing countries including Vietnam. In the evolution process to a green economy with a sustainable green growth, research and development (R&D) activities and technological innovations play the core roles no one can deny. This paper is focused on (i) presentation of related notions, (ii) clear identification of the roles of science-technology (S&T) development to achieve green growth, (iii) indication of difficulties and challenges, and (iv) proposal of new approaches and solutions to push up the S&T application for green growth in developing countries such as Vietnam. This paper provides also policy makers, scientists and businessmen with a global and new visions to S&T development process to achieve green and sustainable growth.

Keywords: *Green growth; R&D; Science-technology innovation; Green economy.*

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1. General introduction

S&T development plays important roles in the development of mankind. But the traditional way of development has led to serious consequences, threatened the continued existence of mankind, caused so many negative problems such as exhausted natural resources, lost bio diversity, recession, environment pollution and climate changes. Practice shows that in developed countries the most concerned problem is related to environment. As evidence for that, the most recent report by World Bank (WB) shows that the dust content in urban areas of the countries with low and medium-low incomes is twice higher the one of the countries with medium and high incomes. As consequence, the countries with low and medium-low incomes lose 0.7% of GDP due to impacts from dusts. The same figure of the countries with high incomes is 0.3% (WB, 2009).

This problem turns to be more difficult for Asian nations, particularly the under-developed and developing countries due to their specific particularities. The later include: fast growth, high population, limited

ecological carrying capacity, high green-house emission (34% of global volume), high rate of poor population (2/3 of total population). Therefore, one of the crucial and immediate problems is to make a fast growth to settle the problem of poverty.

In this context, we need to identify new ways for development which have to secure the existence and development, from one side, and to retain the living environment, to adapt to and to mitigate impacts from climate changes. This concept is named “green growth”.

2. Green growth - solutions to overcome challenges in short term and long term visions

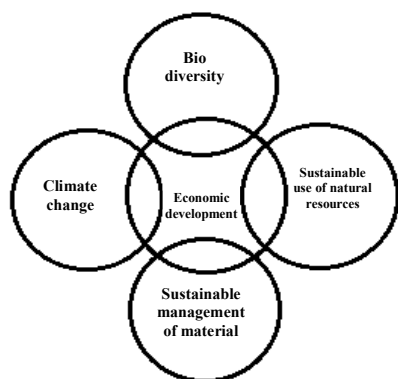
Since the 2008 financial crisis, the new notions such as low-carbon development, green economy and green growth have gradually got familiar and important, and they keep top positions in global policy debates (*United Nations Environment Programme [UNEP] 2011; Barbier 2010; World Bank, 2011*). The notion of “green growth” is permanently coupled with the notion of “low carbon”, and together they make the notion of “low-carbon green growth”. Actually, we do not have any definition to be absolutely exact and unified for the notion of low-carbon green growth. Some notions highly worth of attention are listed under here:

- "Green growth is the strong advance of economic growth and development while securing that the nature is still capable to supply resources and environmental conditions for the existence of mankind." (*Towards Green Growth, OECD Ministerial Council Meeting, 2011.5*);
- "Green growth is to achieve the economic growth while still securing the sustainability of climate and environment. In this process, efforts are focused on core causes of these challenges while still securing the establishment of necessary channels for distribution of resources. New ideas, innovations and advanced technologies will become main driving forces for development" (*Green Growth in motion, GGGI, 2011.5*);
- "Green growth is to enhance human interests and social interests while still mitigating considerably environment risks and ecological scarcity. This is low carbon production, effective use of natural resources which include also social elements." (*Green Economy Initiative, UNEP, 2011.8*);
- "Green growth is the actual economic growth to satisfy the increasing energy demands while mitigating maximally hazardous impacts to environment. This can be realized through the popularization of technologies and clean energy systems. The adaptation to climate

changes is also an important target.” (*The APEC Leaders' Growth Strategy, APEC, 2010.9*).

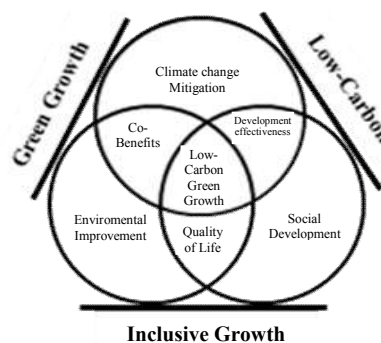
Therefore, with any definition to have, the green growth always covers the common concepts: economic growth, protection of bio diversity, environment, and protection of natural resources. By other words, this is the sustainable interaction between the two systems: environment and economy. This makes environment investments become a driving force for economic development and, at the same time, targets to maximize chances to exploit natural resources in a cleaner way. Then the environmental pressure gets out from economic growth (*OECD, 2010*).

The low-carbon green growth itself is the key to achieve green economy. It is a development model where not only human life gets improved, the inequality gets reduced but also environment risks and eco scarcity get mitigated. This is a model for low carbon growth, effective use of natural resources for global social aspects (*UNEP, 2011*). This model requires (i) lower use of energy, higher effective use of natural resources and shift to use low carbon energy sources, (ii) protection of natural resources, (iii) design and popularization of low carbon technologies for business models to recover local economy, and (iv) implementation of policies and incentive measures for use of low carbon technologies (*ADB - ADBI, 2013*).



Source: OECD, 2010.

Figure 1: Core environment problems targeted by green growth



Source: ADB - ADBI, 2013.

Figure 2: Approaches by low-carbon green growth

Briefly, the green growth is the shortest, most effective and unavoidable way to face challenges in short term and long term visions, and for both developed and developing countries. In this vision, the promotion of technological innovations and improvements is the key to the green growth for all the nations, particularly for the developing countries.

3. Technological innovations - key to green growth

Today, the challenges the human race, in general, and every nation, in particular, have to face come from climate changes, energy shortage, environment degradation, problems of fresh water and environment hygiene. At the same time, the nations have to achieve their own objectives of economic development. By other words, the nations need to break down the important links in the interaction matrix between climate changes, poverty and development (Fig. 3). In order to achieve all of these objectives, the nations need to have new solutions and creative approaches based on new and highly benefit producing business models. This includes also breakthrough moves for financial models and S&T innovations. The green technological innovation would provide these new solutions and approaches.

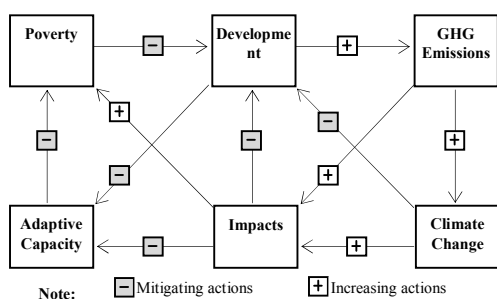
These changes need to be oriented to apply green, clean and low carbon growth and to bring in great socio-economic benefits. Therefore, it requires great efforts of the nations to intensify R&D activities and technological innovations. R&D is a process to explore new technologies which help to change and to improve the living ways, producing and consuming modalities or modifications to optimize ongoing works. A typical example of that is the appearance and development of Internet and related communication and information technologies. In the meantime, the innovations are applied for technological changes and are used usually to talk about the changing of products or services. The example of that is the improvement of models and/or processes of production and business activities. In this process, technological innovations get the best meanings and biggest potentials because of their great impacts to creation of favorable environment to set up ideas, R&D capacities and, then, numerous chances for commercialization and financial sustainability.

Speaking in detail way, green technologies in general, and R&D and technological innovation in particular, would create strong and crucial forces to achieve green growth, namely:

- (1) *Overcoming the environment challenges*: They provide low cost and effective solutions to overcome environment challenges. At the same time, they help to achieve development objectives, to enhance the living conditions on basis of improvement of approaches to sources of clean energy and fresh water, even for poor rural areas;
- (2) *Orienting to economic growth*: New technologies create more new chances for business, investment and creation of labors. Particularly, in context of overloaded pressures to natural resources and fossil energy sources (causing great impact to energy security), the needs of low

carbon technologies and green commodities and services are increasing considerably and provide promising potentials;

- (3) *Enhancing national technological strengths and innovation capacities:* The Government needs to establish and to enhance innovation capacities and S&T backgrounds of the country including the institutionalization of the national innovation system (NIS) and human resources;
- (4) *Intensifying domestic innovation capacities for development of applicable technologies in the actual context of the country:* Technology transfer would increase technology absorbing and applying capacities, then increase domestic innovation capacities to meet actual needs and to fit actual conditions of the country.



Source: Kameyama et al. (2008).

Figure 3. Interaction matrix between climate changes, poverty and development

Briefly, the green low carbon technologies are the main driving force for the nations to reduce carbon emissions, to stabilize the green house gas content in atmosphere, to reduce the 2⁰C less temperature increase and to create the shift to low carbon growth. Without development, implementation and commercialization of innovative technologies, the nations cannot reduce green house gas emissions to achieve the agreed global objective of CO₂ emissions by 2050.

4. Green growth for developing countries

4.1. Why do developing countries need to achieve green growth?

The answer is that the target of low-carbon green growth is to get more benefits from emission reduction. This is not only the need and target of developing countries but also developed countries. Recently, governments of many Asian countries have accepted that the model of “end pipe treatment” gets outdated in the actual context when there are so many concerns and clear consequences of climate changes and environment degradation (ADB - ASBI, 2013). Sciences of climate changes note clearly: once carbon gas gets emitted into air its existence in air will last a century.

Therefore, the governments need to realize that it is impossible in future to clear fully the volume of carbon gas emitted today. The only way to cover this trend is to reduce its emission since today. Only by this way, the nations over the world can avoid the serious and dangerous consequences from climate changes. It is clear also that the early actions are the important and optimal options while actual technologies still could “detain” the nations in high carbon living styles and high carbon infrastructure. This will be particularly clearly seen in fields of energy, transport and heavy industries which will be built up by almost all the emerging economies within the coming decades.

Many big nations in Asia have noted the needs to get the high rate development and to eradicate poverty as well as the impossibility to avoid highly cost destructions and damages caused by climate changes and environment degradation. Therefore, it is possible to say the policies for low-carbon green growth can be seen as a kind of investment, particularly the benefits earned from expenditures for mitigation of impacts from climate changes can be seen in the long lasting future.

According to ADB - ADBI (2013), other factors which make the ideas of low-carbon green growth attract Asian economies in general and developing countries in particular are their capacities to rise GDP (measured by traditional tools) through 4 channels, namely:

- (1) *Input effect*: Increasing volumes of physical capitals, labor and financial capitals (making the production more effective);
- (2) *Efficiency effect*: Increasing productivity by reparation of failures of market and increasing the effective use of natural resources;
- (3) *Stimulus effect*: Occurring in the declining economy period when the effects from capital use are low and the low chances for labors. Green investments will increase demands then increase potentially chances for labors;
- (4) *Innovation effect*: Occurring when there will be interventions from promotional policies for green technologies, such as investments for R&D.

4.2. Challenges for developing countries

In order to achieve the low-carbon green growth, developing countries need to overcome many difficulties and challenges. These difficulties and challenges can be classified into the following 5 groups (ADB - ADBI, 2013):

- (1) *Absence of national program frames for R&D promotion and technological innovations*: Developing countries, as matter of rules, are

not clear in short term and long-term policies. They do not have also price signals to increase demands for green technologies and to stimulate investors to make reasonable decisions;

- (2) *Lack of linking bridges for low carbon technologies due to failures of market*: Failures of market come from impossibilities to link environmental externalities and they cannot create necessary encouragements for private sector and customers in order to shift their attentions to exploration, acceptance and purchase of green technologies, commodities and services;
- (3) *Lack of sources of financial supports for national level R&D efforts*: These moves require big investments, the actual investment level being not enough even in industrialized countries. According to International Energy Agency, we are experiencing a shortage of USD40-90 billions of expenditures for low carbon energy (actual investment is estimated to be USD10 billion) to achieve the objective to reduce 50% of CO₂ emissions by 2050 (*OECD, 2011*);
- (4) *Lack of capacities for innovations*: Developing countries are experiencing a shortage of human resources and public institutional capacity to carry out R&D for low carbon technologies. This is similarly observed also for private companies including small and medium enterprises (SMEs);
- (5) *Barriers from legal regulations and rules for transfer of technologies to under-developed countries*: Developing countries do not have reasonable trade and investment policies. Also, they do not have the system for IP protection, or have it but it does not operate fully or properly. This is a very big obstacle for green growth.

4.3. Actual status of implementation of green growth in Vietnam

For purpose to stabilize macro economy, to secure environment quality and social security in context of uncomfortable international situations, negative impacts from low growth, crisis of public debts in many countries and heavy impacts from climate changes, the Vietnamese Government, realizing clearly opportunities and challenges, has issued many strategical valued important documents, namely:

- Decision No. 432/QD-TTg dated 12th April 2012 for approval of Strategies for Sustainable Development of Vietnam, 2011 - 2020 period;
- Decision No. 1393/QD-TTg dated 25th September 2012 for approval of Strategies for Green Growth, 2011 - 2020 period and 2050 visions;

- Decision No. 339/QĐ-TTg dated 19th February 2013 for approval of Global Project for re-structuring of economy and binding it to shifting of growth models towards enhancement of quality, effectiveness and competitiveness, 2013 - 2020 period.

As a country to go behind, Vietnam has advantages to be positioned to select the world's suitable science achievements and technological procedures for green growth. However, in implementation stage, the realization of green development projects face many difficulties, namely: mechanisms and policies are not found suitable, Government capital supports are not made in-time, losses in investments for high techs turn to be too much higher than product costs and etc. Therefore, the realization of green growth remains big challenges for producing sectors, administration and management agencies in Vietnam.

5. Some new solutions and approaches for developing countries to achieve green growth

5.1. Requirements towards new approaches

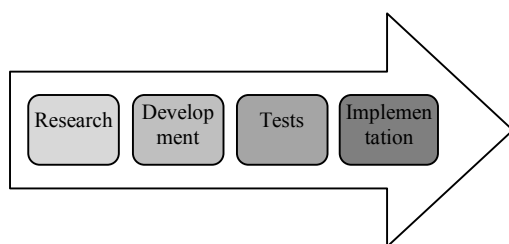
New approaches are focused mainly on capacity building for technological development, and, at the same time, to encourage private sectors to participate in research and innovations for green growth. These approaches need to gather fully the following factors:

- (1) *Conformity to challenges of green development*: Supports can be made in various scales (small, medium and large).
- (2) *Capacities to stimulate the advancing, adapting and absorbing*: Adaptive innovation may be the key to achieve green development for under-developed countries; absorptive innovation may encourage developing countries. Absorption capacity stimulating policies need to enhance education qualities and to retain talents. They need to stimulate "the technological exploration spirits" at all the levels (from families to laboratories) and to widen the openness of the economy to new technologies.
- (3) *Supports for innovations in technological value chains*: Technological implementations can be promoted through financial supports and related logistic supports to secure and to develop supply chains, and to introduce them to customers to enhance market entry capacities.
- (4) *Financial innovation to reduce risks for private investments*: Financial products are kicks-off for public investments because they reduce risks for private capitals.

- (5) *Attractive mechanisms for investors, policy-makers and developed countries:* In financial field, the nations need necessarily to create an infrastructure suitable to kick-off public financial sources from developed countries and to create real values and benefits for private investors.

5.2. Requirements for global visions in new approaches and challenges to shift to green innovation

As illustrated in Fig. 4, on basis of cycles of technological development, the innovations for green growth can be described in 3 types (Brookings, 2012) as follows:

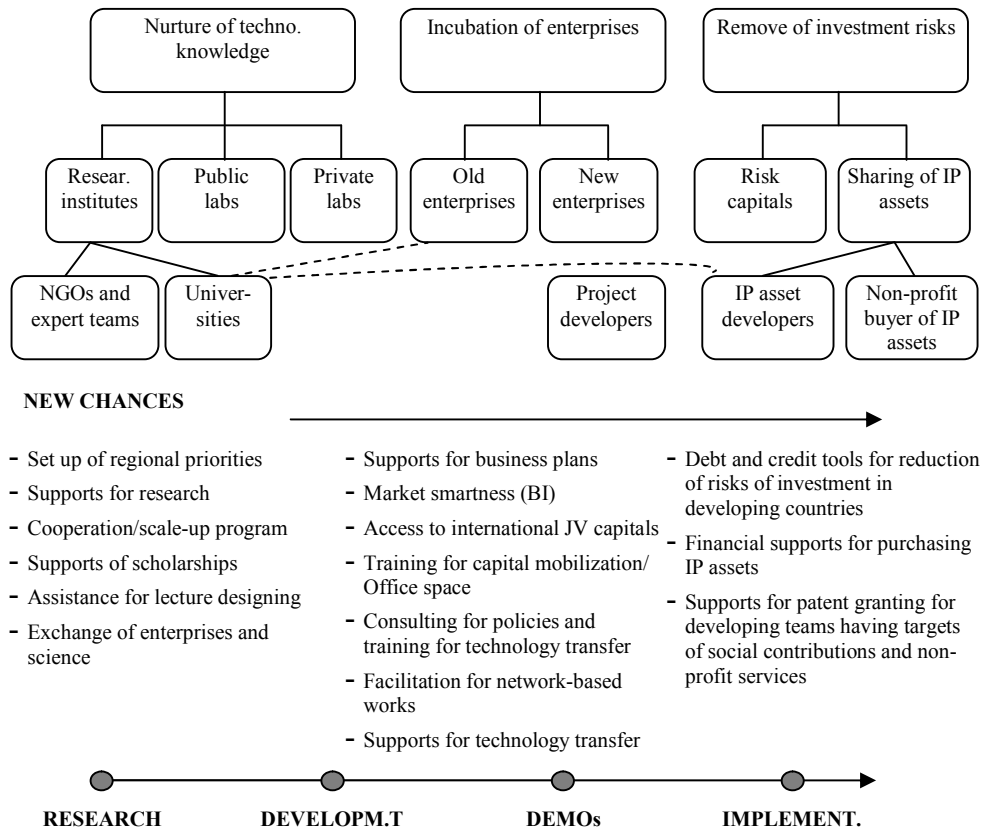


Source: Brookings (2012)

Figure 4. Types of innovation according to process of technological development

- (1) *Frontier innovations:* They are unique and deeply specialized solutions which have not been explored worldwide. This type of innovations is usually found in research stages of cycles.
- (2) *Adaptive innovations:* They are improvements or modifications of existing technologies to make more benefits for various situations. This type of innovations can be found in all the stages of cycles.
- (3) *Absorptive innovations:* They are related to changes of institutional environment for successful shift and realization of the two previous stages of innovations. This type of innovation is applied for the two last stages of cycles. For example, national infrastructure for dissemination of knowledge and inventions, regulations for IP protections and international agreements for technology transfer.

Fig. 5 describes the main 3 challenges to start the system of green innovations. A system oriented to these three aspects can be operated smoothly from universities, research organizations (profit based or non-profit), academic institutions up to independent researchers, financial experts, new and full potential businessmen. The whole system can be added with funds to reduce risks for technology transfer and propagation activities which were proven through demonstration stage.

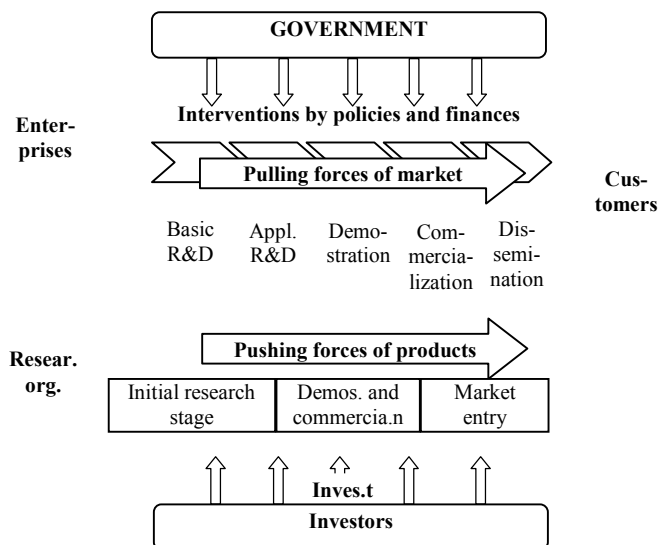


Source: Brookings (2012)

Figure 5. Three challenges for successful start of green innovations

On basis of research by Shane Tomlinson (2009) and Grubb (2004), the process of innovations can be phased out to 3 stages (ref. Fig. 6):

- (1) *Early research*: This stage includes researches which make contributions to sciences and basic knowledge. They are usually conducted in lab scale in research institutes. This stage includes two sub-stages: basic R&D and applied R&D;
- (2) *Demonstration and commercialization*: New knowledge is applied in real worlds through pilot researches and initial commercial scale;
- (3) *Market uptake*: Once the new knowledge gets realized in a proven product or service, it gets sold to open market.



Source: Shane Tomlinson (2009) and Grubb (2004)

Figure 6. Stages of green technology innovations and stakeholders

There are so many low carbon technologies positioned in various development stages of innovation chains. Accordingly, necessary supports provided by the Government would be different subject to stages and control level of expected technologies, namely:

In early stages, the Government would have large roles in offering priorities and implementation of policies as well as financial supports for technologies to fill up gaps between costs and time.

In late stages, technologies get better controlled and closer to commercialization which involves more the private sector.

In addition, in order to achieve stages of implementation and commercialization the pulling forces are required from market (pulling forces from market demands). Some emerging technologies require pushing forces of technologies (pushing forces from supply) under intervention and orientation of State policies and financial supports, such as technology of carbon capture and storage (CCS), smart grids and hydrogen fuel cells.

From innovation vision, there is no single technology which can become an effective remedy for reduction of CO₂ emission and achievement of low-

carbon green growth. It is necessary to combine various technologies applied in different fields. Efforts are oriented directly not only to develop breakthrough moves of technologies but also to improvement of existing technologies, such as energy saving or innovations in their application and use. Some big advantages of low carbon technologies reside in field of renewable energies. Some of these types of energy have become well controlled such as wind plants, solar PV, while bio-fuels actually are in stage of demonstration and implementation

According to ADB - ADBI (2013), the following technologies will be commercialized before 2030:

- (1) Technologies for carbon capture and storage;
- (2) Advanced nuclear power;
- (3) Renewable energy;
- (4) Second-generation biofuels;
- (5) Advanced electric and hybrid vehicles;
- (6) Integrated design of commercial vehicles;
- (7) Land-use strategies;
- (8) Non-CO₂ GHG emission reductions.

6. Some conclusions and proposals

The green growth puts down urgent needs to establish a new way for sustainable development through combination of innovations in private sector and commitment of national and international supports. The nations have, at the same time, to overcome three big challenges, namely:

- (1) Pushing up development and reducing poverty;
- (2) Developing strongly economy on basis of green and clean technologies;
- (3) Securing a greener and cleaner world.

The process to achieve green growth requires the application of many approaches, the involvement of various social stakeholders and the cooperation between sectors, areas, nations and regions.

At the Copenhagen Conference, Vietnam has given commitments of the national action program to reduce the energy consumption by 5-8% by 2015 and to increase the share of renewable energy by more than 5% by 2020 and 11% by 2050 (*UNFCCC, 2011*). This objective is not easy to achieve, particularly in the actual situation of economic recession.

Therefore, Vietnam needs to integrate numerous measures including the involvement of social communities and international supports and cooperation.

Some measures can be listed under here for attention:

- (1) Establishing national objectives for science, technology and innovation to keep pace with the objectives of socio-economic development;
- (2) Establishing the national development program frame on rational, scientific and well targeted basis;
- (3) Establishing short, medium and long term innovation policies within the national development program frame;
- (4) Establishing investment plans and investment road maps clearly targeted and well integrated into the national policy frame;
- (5) Identifying priorities in policies for socio-economic development, environment protection, responses to climate changes as well as priorities for technological innovations;
- (6) Improving gradually institutional frames, policies and regulations to support and to promote science and technologies in direction towards green growth and low carbon practice;
- (7) Improving and upgrading gradually bank systems and financial institutions for financial supports and provisions for technological innovations;
- (8) Improving and innovating education systems for nurture and development of knowledge, to enhance the world's knowledge absorbing capacities, to train human resources, enough in quantity and qualified in quality, to be capable to meet practical demands of the nation's future;
- (9) Maximizing the use of advances in field of information technologies and Internet for communication, education and training purposes in order to enhance awareness and to develop scientific knowledge of population, enterprises and other related stakeholders to facilitate the practical implementation of science-technological advances, promotion of green and low carbon living styles;
- (10) Calling for investment and domestic/international cooperation; establishing and promoting incubator programs, cultural exchanges, academic and scientific exchanges and etc.;
- (11) Pushing up gradually scientific research and R&D activities which are considered as key driving forces for the nation's green growth;

- (12) Providing priorities, in early stages, to adaptive and absorptive innovations which means the priorities for application of researches conducted successfully home and abroad; and, at the same time, conducting frontier innovations (basic R&D and applied R&D) to avoid the full dependence from technologies of other countries;
- (13) Providing reasonable policies to stimulate and to support R&D activities, particularly to get the involvement of private enterprises and large population;
- (14) Enhancing the proper enforcement of IP Law and the sharing of intellectual assets;
- (15) Providing supports for scientific exploration programs at community level and high level challenging programs to encourage social communities to participate in innovation research;
- (16) Issuing financial policies and providing reasonable financial products to reduce investment risks in technological development (such as first-loss fund), risk assurances by the Government and transferable loans;
- (17) Promoting and encouraging practices of green production, consumption of green commodities and services in order to create pulling and pushing forces for technological innovations.

The above proposed solutions would target: (i) Introduction and promotion of new forms of business and new financial structures, (ii) Enhancing the knowledge and overcoming challenges in sharing of intellectual assets, (iii) Creating structures to support enterprises in their extension of professional interests and approaches to systems. These solutions need to be unified and integrated scientifically, particularly they do not need to hinder market fair competition, to cause impacts to economic growth and poor people./.

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