Transferring a technology incubator to address climate change – lessons from Taiwan for Vietnam

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Abstract

Acceleration of climate-friendly technology transfer is a key goal of international climate policy. Technology incubators are institutions that support companies in accessing technological knowledge and developing technologies that are appropriate in the context of their business activities. Taiwan is a showcase of technology incubator experience and thus can support other countries in repeating a rapid technology leapfrogging.
Vietnam is a country with a strong written commitment to climate change mitigation and adaptation; it is active in all current mechanisms that generate

revenues for mitigation outcomes. Particularly the agricultural and the textile sectors would be appropriate for technology incubation applying Taiwanese experience. This could harness international funding streams through multi- and bilateral climate finance. Such streams are available both for technical assistance as well as implementation of concrete projects.

Contents

List of acronyms

AF	Adaptation Fund
CDM	Clean Development Mechanism
CIC	Climate Innovation Center
CTCN	Climate Technology Centre & Network
GCF	Green Climate Fund
GDP	Gross domestic product
GEF	Global Environment Facility
GHG	Greenhouse gas
ITRI	Industrial Technology Research Institute
JCM	Joint Crediting Mechanism
MRV	Monitoring, reporting and verification
NAMA	Nationally Appropriate Mitigation Action
NCCS	National Climate Change Strategy
PMR	Partnership for Market Readiness
R&D	Research and development
REDD+	Reducing Emissions from Deforestation and Forest Degradation
SME	Small and medium enterprises
SOE	State-owned enterprises
TNA	Technology Needs Assessment
TPP	Trans Pacific-Partnership
UNFCCC	United Nations Framework Convention on Climate Change
VGGS	Vietnam Green Growth Strategy

1. Introduction

In order to reach the ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC), namely to limit the average global temperature increase to no more than 2°C from the preindustrial level (decision 1/CP.16, I, 4), efforts from all countries are required. This is acknowledged in the negotiation process that is culminating in the Paris Conference in December 2015.

Yet due to differing historic responsibilities and capacities, support for developing countries for low-carbon development, greenhouse gas mitigation and climate change adaptation measures is required – for instance in the form of capacity building, financial or technological support. There are ongoing efforts through various mechanisms under the UNFCCC, to assist developing countries to mitigate and adapt to climate change through the transfer of appropriate technologies. For example the Climate Technology Centre & Network (CTCN) aims at the exchange of technology and the build-up of regional capacities to diffuse technologies developed in the industrialized countries. For a period of almost a decade, the Clean Development Mechanism (CDM) contributed to technology transfer through several thousand projects in developing countries (Seres et al., 2009). However, the decline in prices for CDM credits slowed the flow of projects to a trickle.

One approach for the transfer of technologies would be to build upon the expertise of local firms, thereby strengthening their capacities and business opportunities in low carbon technologies. Climate change can therefore represent an opportunity to create business opportunities in low carbon technologies, which can drive sustainable economic growth and provide environmental benefits (see also UNEP et al., 2012a, p. 4).

Taiwan is a success story of rapid development. In less than two generations, the island mutated from a primarily agricultural economy to a high technology hub. A key role in this process was played by the Industrial Technology Research Institute (ITRI). ITRI developed an Incubation Mechanism for scaling-up of technologies in Taiwan. With this expertise ITRI is now envisaging supporting developing countries in replicating this success story and make low carbon technologies viable. This concept would rest on three pillars: the Incubation Mechanism would identify suitable technologies, transfer feasible technologies and assist the designated countries to seek international funding opportunities for achieving a Public-Private and Partnership (PPP) in the upscaling and rollout of the technologies (OECD, 2012).

In this paper we discuss options how the support through the Incubation Mechanism could work in practice and illustrate them through a case study. For Vietnam the following questions are to be answered:

- How could the Incubation Mechanism support a country in identifying promising technologies?
- Which financial resources could potentially be harnessed to support the scaling up of the respective low carbon technology?

First, the proposed functioning of the support through the Incubation Mechanism is described. This is followed by a sample application of the

Incubation Mechanism for Vietnam, including a description of the context of Vietnam as well as of the required steps for support through the Incubation Mechanism.

2. Incubation Mechanism

Small and medium enterprises (SME) can play an important role for economic growth due to their ability to adapt to policy changes, yet they often face disadvantages compared to large firms when it comes to access to technology. Challenges are even greater in developing countries, for instance due to lack of capacity, and volatility of economic conditions (Akçomak, 2009, p. 5). Jan and Chen (2006, p. 595ff) identify – in the case of Taiwan – lack of resources for research and development (R&D) as another critical challenge, leading to the need for governmental support for R&D. The potential of so-called incubators to overcome the technology access barrier of entrepreneurs is well reflected by the great number of incubators in developing countries – in 2009, about 40% of the worldwide 3,500 incubators were located in developing countries (Akçomak, 2009, p. 5).

2.1. ITRI Incubation Mechanism

The government of Taiwan supported R&D agencies in Taiwan as a mean to support SME which often did not have capacities to conduct research themselves (Jan and Chen, 2006, p. 560; Lui and Qiu 2001, p. 75). The government further provided support for training and education purposes as research and innovation support (Lui and Qiu 2001, p. 75). Further, it provided incentives for new university departments focusing on "industrial engineering, industrial design, automatic controls, and petro-chemistry" leading to the doubling of matriculation in such programmes from the mid-1960s to the late 1980s (Ranis, 1995, p. 528).

ITRI is a cornerstone of Taiwan's technology policy. It is a non-profit R&D organization engaging in applied research and technical services, aiming to innovate a better future. Founded in 1973, ITRI has been dedicated to helping industries stay a competitive and an economically sustainable cooperation. About half of ITRI's overall budget is sponsored by the Taiwanese government (Wang et al., 2007, p.1). ITRI conducts research on technologies and provides these technologies later on to businesses (Jan and Chen, 2006, p. 560ff), which has played a vital role in Taiwan's economic growth when it shifted from a labor-intensive industry into a value-added, technology-driven one. Further, ITRI provides premises to small enterprises for three years; with the enterprises ideally re-locating afterwards to the closely located Hsinchu Science Park which has favourable conditions for businesses regarding taxes and infrastructure (Hsu et al., 2003, p. 82; Lui and Qiu 2001, p. 79). A study by Hsu et al. (2003, p. 84) revealed that the business park and its "clustering effect" was perceived by many as a key success factor of ITRI since it allowed for maximum synergy.

According to Wang et al. (2007, p. 2), different technology transfer strategies have been applied in the past by ITRI, including "spin-offs, patent licensing, cooperative research, open laboratories, technology training, and other strategic

tools"[1]. ITRI helped several industries in Taiwan in their development – with some world market companies being ITRI spin-offs (Jan and Chen, 2006, p. 560).[2] The ITRI Incubator is thus only one part of a whole array of activities to promote technology development and diffusion (Wang et al., 2007, p. 3, Jan and Chen, 2006, p. 564). It assists enterprises for instance through support on R&D and personal training (Jan and Chen, 2006, p. 567). It provides a fully equipped laboratory as well as an on-site management team and consultants, such as lawyers and accountants. The incubator experts help companies to access subsidies (Wu, 2002). Between 1996 when the ITRI incubator was founded, and 2015 more than seventy incubators were set up with the help of the ITRI Open Lab Project under the ITRI incubation center in Taiwan, supported by the Taiwanese government (Hsu et al., 2003, p. 79ff) (ITRI, no date). In the environmental field, ITRI provides technological solutions to reduce greenhouse gas emissions, recycling resources in an environmentally friendly way, producing biofuels, and systematically establishing certification and testing services.

Potential success factors of the Taiwanese example for triggering technology development include:

- Governmental support for R&D and results being provided to SMEs to lower their risk,
- close link between research institutions and industrial parks, and
- availability of personnel trained for new technologies for local firms, i.e. by strengthening higher education programmes in engineering or by providing capacity building workshops for SME personnel.

2.2. Potential options for applying the Incubation Mechanism outside of Taiwan

In the context of climate change, the ITRI Incubation Mechanism plans to support developing countries in identifying domestic low carbon technologies to be scaled-up at national level. Under this mechanism, consultancy services would be provided to identify technology needs, potentials and cost analysis. Based upon the results, support would be provided for developing and submitting project proposals to national and international funding institutions. Finally, support would be provided in the implementation and evaluation period, i.e. through guidance on monitoring, reporting and verification (MRV). The proposed functioning of the Incubation Mechanism is displayed in Figure 1.

[1] For a more detailed description of different tools applied by ITRI, see Wang et al., 2007, p. 2ff.

[2] For instance ITRI established laboratories – Opto-Electronics and System Laboratories (OES) – to conduct joint research on CD-ROM development. This led several local firms to invest in CD-ROM production, leading in turn to an increase of required personnel, who were headhunted from OES (Jan and Chen, 2006, p. 568).

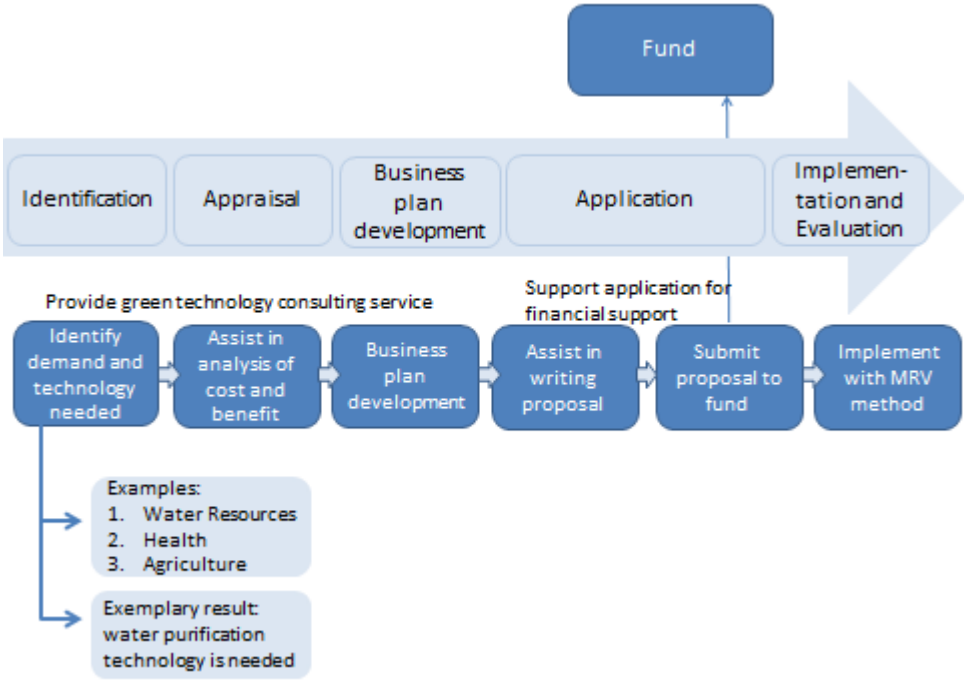

Figure 1: Support provided by the envisaged new function of the Incubator Mechanism (Source: adapted from Michaelowa, 2015)

The Incubation Mechanism includes hence the following steps:

- Identification
  - Set collaboration contact points.
  - Identify targeted country's consultancy service demand.
  - Identify targeted country's technology demand based amongst others on Nationally Appropriate Mitigation Actions (NAMAs), Technology Needs Assessments (TNA), and Climate Technology Centre and Network (CTCN), etc. (see also table 2).
- Appraisal
  - Analyse cost and benefits for selected technologies regarding standards of efficiency and performance, supporting policies, environmentally sound management and a management scheme of monitoring and verification of the technology performance.
  - Build bridges with all stakeholders under a memorandum of understanding (MOU) or letter of intent (LOI) regarding collaboration on technology development.
  - Develop a small scale pilot plant or facility installation for production of the technology.
- Business plan development
  - Development of a business plan for technology roll-out.
- Application
  - Assist in writing proposals for financial support.
  - Submit proposal to fund providers.
- Implementation and Evaluation
  - Implement the business plan.
  - Assist in project audit with MRV methods.

3. Incubator case study for Vietnam

3.1. Background on Vietnam

Climate change impacts and strategies

Vietnam is particularly vulnerable to the adverse effects of climate change given its long coastline, high share of low-lying land and rugged territory. The dependence of a high share of the population on agriculture exacerbates the impacts of floods and droughts, while extreme events such as typhoons impact on the infrastructure. The country is already experiencing increases in temperature, sea level, and severity/frequency of occurrence of natural disasters (Institute of Strategy and Policy on natural resources and environment Viet Nam, 2009, p. iv). At the same time, Vietnam's greenhouse gas (GHG) emissions are expected to increase significantly under current business as usual scenarios of economic growth. Projections show a threefold increase of Vietnam's total net emissions between 2010 and 2030 (Ministry of Natural Resources and Environment, 2010, p. 56).

In response to these challenges, Vietnam has developed national, sub-national and sectoral policies and programmes which aim to address climate vulnerability and promote a low carbon, green growth development path. Core climate change policies in Vietnam include the National Climate Change Strategy (NCCS) and Vietnam Green Growth Strategy (VGGS) in conjunction with a number of related action plans. The NCCS states various targets, including to

- "research and apply new technologies of low greenhouse gas emission in industrial production; to speed up the replacement of fossil fuels with low-carbon ones; to popularize cleaner production, so that by 2020, 90% of industrial production facilities must use cleaner technologies and save energies, fuels, and materials" as well as to
- "enhance research and development of high technologies in key industries; by 2020, the added value of hi-tech industries must be raised to 42-45% of the total industrial production; to boost technological renovation through adopting high technologies and renewing 20% of machinery and equipment by 2020. The production value of hi-tech industries must be raised to 80% by 2050" (Government of Vietnam, 2011, IV, no. 5 b)).

The VGGS for the period 2011-2020 (with a vision to 2050) highlights that greening of existing sectors and more efficient use of natural resources contributes to restructuring and improving economic conditions in the country (Government of Vietnam, 2012, section I, para 2 b)). The VGGS contains the following targets:

- Reduction of greenhouse gas emission intensity (GHG/GDP) by 8-10% between 2011 and 2020, which corresponds to an annual reduction of energy consumption per GDP of 1-1.5% (section II, no. 1).
- Greening of industrial production: By 2020, 50% of applied technologies shall become green technologies and 42-45% of GDP shall be formed by production of advanced and green technologies. Moreover, industrial investments in environmental protection and enriching natural capital shall reach 3-4% of GDP (section II, no. 2).
- Greening of lifestyle: By 2020, 60% of the Vietnamese grade III cities and

40% of the grade IV-V cities and villages shall comply with regulatory standards for waste water collection and treatment systems. In large and medium cities the share of public transport shall reach 35-45%. Half of these cities shall comply with green urban standards (section II, no. 3).

Solutions identified in the VGGS (section III, no. 8 a)) include developing policies for incentives towards R&D for green products as well as issuing "special policies on economic-technical assistance that encourage enterprises and individuals to apply appropriate high technology and techniques to expand markets and develop green traditional products where Viet Nam has competitive advantage, including herbal medicines; eco-agriculture, forestry and fisheries; foods; as well as commodities goods and garments made from local materials."

Thus both, VGGS and NCCS, put great emphasis on low carbon technologies. They are supported by programmes that focus on climate change and green growth[3] and related strategies focused on renewable energy, energy efficiency, disaster risk reduction and management, Reducing Emissions from Deforestation and Forest Degradation (REDD+), and science and technological development. These policy measures provide a good basis for Vietnam's climate change strategy. Specific national climate action triggered by international support and climate policy mechanisms is listed in table 1.

Table 1 Vietnam's participation in international mitigation approaches

International approach	Description
Nationally Appropriate Mitigation Actions	Several sectoral NAMAs are currently under development in Vietnam (covering cement, waste, steel, transport) or preparatory work in the form of feasibility studies is being conducted (studies on wind power, biogas, hybrid and electric cars) (Huong, 2014).
Clean Development Mechanism	By mid-2015, 254 projects in Vietnam had been registered under the CDM, with the majority of them being in the hydro sector (UNEP DTU, 2015).
Partnership for Market Readiness	In late 2014, Vietnam has submitted a proposal under the Partnership for Market Readiness (PMR) which aims at the establishment of a carbon market pilot in the steel sector and no-regret measures in the waste sector (Ministry of Natural Resources and Environment, 2014).
Joint Crediting Mechanism	Vietnam has signed an agreement with Japan regarding the participation in the Joint Crediting Mechanism (JCM). A project on eco-driving was approved in 2015 (JCM, 2015).

Since the foreign investment had deregulated in 1989, the economic growth and living standard of Vietnam have increased, which was accompanied by a rapidly increasing amount of waste generated. Nowadays, Vietnam is facing problems on reducing the volume of waste and converting it to useful material. Therefore, effective waste management schemes and treatment technologies are imperatively needed. In order to promote industry development on waste

[3] For example National Target Program to Respond to Climate Change and the Support Program to Respond to Climate Change.

treatment and recycling, the government of Vietnam established various policies regarding waste management and has announced several investment incentives (APO, 2014).

Public and private sector in Vietnam

In the late 1980s, the Vietnamese government implemented several policies under the "Doi Moi" reform aiming to shift from a centrally planned economy towards a market-oriented economy (Glewwe, 2004, p. 2ff). Policies included decollectivizing the agricultural sector and opening up of the country towards international trade. Unprofitable state-owned enterprises (SOE) were sold or closed, halving the number of SOE within only three years (1989-1992) while at the same time, employment in the private sector grew steadily[4] (Glewwe, 2004, p. 3). Since 2000, nearly 400,000 new enterprises have been registered in Vietnam with around half of the start-ups being registered in Ha Noi and Ho Chi Minh City. However, only about 50% are still operating. 85%-90% of these enterprises are of small and medium size. The domestic private sector accounts for 90% of total employment with most being employed in the manufacturing sector (51%)[5], which is however not reflected in the number of enterprises registered (20%). (Country partnership strategy, no date) In late 2010 a regulation was issued which fosters pilot projects for public private partnerships in various infrastructure sectors, including waste treatment and power plants (Hogan Lovells, 2010).

Comparative advantages in key sectors of Vietnam's economy

Vietnam has a large workforce (2010: 49.1 million) and a young population (average age: 27.4 years) (Breu et al., 2012, 21); its labour market is still characterized by low wages. 70% of the Vietnamese population lives in rural areas, hence the **agricultural sector** is of great importance. Over the last decades, agricultural exports in Vietnam have increased continuously and Vietnam is now among the top world exporters for certain tropical products (e.g. pepper, rice, rubber, coffee, pepper, cashew nuts, wood products and fisheries) (VieTrade, 2014) [6]. Due to this leading role, Vietnam is the only agricultural tropical country which is currently considered and actively negotiating in the Trans Pacific-Partnership (TPP) (Arita and Dyck, 2014).

Vietnam has attracted major **high technology** multinational companies like Microsoft, Intel, LG Electronics, Samsung etc. that have set up bases in Vietnam or have announced plans to do so (Vietnam Briefing, 2014b). The high-tech sector has increased in recent years, even if not as fast as in other Asian countries (Breu et al., 2012, p. 16). One reason for this increase can be seen in the government policy support with preferential tax and investment policies (Relander, 2015). In 2012 a plan for developing science and technology was enacted which announced to increase the share of high-tech products value up to 45% of Vietnam's GDP by 2020 (Ministry of Science and Technology, 2012), which is also reflected in the VGGS. Also in this sector, low labour costs play an important role. Finally Vietnam has a geographically strategic location, close to

[4] Since 2000, the number of SOEs in Vietnam has halved to 3,135 SOE in 2013, partly due to privatization (Vietnam Briefing, 2014a).
[5] Construction: 14%, trading 11% and transportation 7% (Country Partnership Strategy, no date)
[6] For challenges in the agriculture sector, see Vie Trade 2014a.

large cities such as Singapore, Kuala Lumpur, Bangkok, Manila, Hongkong and Taiwan.

Vietnam's **textile industry** has increased significantly in the last 20 years and now serves as the second largest export sector, counting 6,000 enterprises (van Tot, 2014, p. 11), and accounting for 15% of GDP (Nguyen, 2014). Vietnam's advantages in this sector include modern equipment (Zakir, 2010), product acceptance on competitive markets (e.g. US, EU) (van Tot, 2014, p. 25), low labour costs as well as its coverage under the potential free trade agreement under the TPP (Nguyen, 2014).

Challenges for technology scale up in Vietnam

Barriers to technology development in Vietnam are manifold. On the one hand there are general challenges such as a weak financial sector as well as macroeconomic instability, with the former causing difficulties in accessing finance especially for SMEs (Swiss Department for Economic Affairs, 2013). Furthermore, in the Corruption Index 2014 (Transparency International, 2014) Vietnam ranks 119 out of 175 countries, which shows that corruption is still critical in Vietnam. On the other hand, challenges regarding the further deployment of technologies exist. Skilled personnel, especially with regard to applied engineering remains scarce. Machinery and equipment constituted in 2010 – despite their growth – a much smaller share of export (13%) than for instance in China (43%) or other emerging countries in Asia (Breu et al., 2012, p. 16). Another challenge lies in the lack of cooperation between different actors, i) between industry and research institutions in Vietnam (infoDev/ World Bank, 2012, p. 49) and ii) between foreign investors and local industry. According to the Swiss Department for Economic Affairs (2013), the latter leads – combined with the fact that foreign invested firms mainly operate in labour-intensive sectors – to limited capacity and technology transfer to the local industry.

3.2. Potential for support from the Incubation Mechanism for Vietnam

Support for low-carbon technology development in Vietnam is of particular importance, since according to UNEP et al. (2012a, p. 5), technologies applied in Vietnam are often outdated, leading to an underdeveloped industrial sector. The experience from ITRI could be valuable to remove several of the barriers identified for technology scale-up in Vietnam. Due to the large percentage of SMEs in Vietnam's private sector and their challenges for accessing finance, the experience from Taiwan in supporting SMEs through governmental support and through the provision of technical consulting services can be of great relevance. ITRI's experience in cooperation with different actors for instance by linking research institutions and industry provides another valuable experience for technology incubation. Further, Taiwan's experience in increasing export of high technologies[7] can be valuable to Vietnam.

Support could be provided to the public as well as private sector. For the public sector lessons on technology incubation learned from the ITRI Incubation Mechanism could be relevant and for instance be provided through consultancy on supporting policy legislation and management schemes. For the private sector experiences regarding the scaling up of technology as well as regarding

[7] In 2014, around 50% of Taiwan's exports were electronic equipment or machinery (World's top exports, 2015).

cooperation between research institutions and industry could be relevant and for instance be provided through technical services and training courses to build up capacities.

Identifying demand and technology needed in Vietnam

As indicated in Figure 1, the three first steps could contain consultancy services for expanding low-carbon technologies in the host country. In order to do so, it is suggested to consider the following steps.

1. **Alignment with national policies** is crucial. Thus as a first step Vietnam's climate change related policies would need to be assessed and objectives for technology development identified (see section 3.1).
2. The **technology demand and needs** of Vietnam would need to be identified. Any assessment of relevant technologies should **involve stakeholders** in order to ensure **country ownership** of the suggested program and to ensure government and private sector are truly interested in scaling up the identified technology. Vietnam has conducted its first Technology Needs Assessment (TNA) under the UNFCCC in 2005 and has submitted mitigation resp. adaptation specific TNAs in 2012 (UNFCCC, no date, UNEP et al., 2012a, UNEP et al., 2012b). Since many stakeholders have been involved in the TNA process (see UNEP et al., 2012a, p. 156ff), the proposed criteria for identifying technologies should be included in the process for identifying demand and technology needed. Further, the TNA could serve as the basis for identification of technologies to be beneficially scaled up in Vietnam; yet updates are needed for the assessment of the technologies' relevance since the TNA data is based on the Greenhouse Gas Inventory of the year 2000 (UNEP et al., 2012a, p. 19). Further, more criteria could be included in the assessment, e.g. those shown in Table 2 below:

Table 2 Potential criteria to be used for technology identification[8]

Criterion	Applied in (source)
Sector identification	
Sector identified as priority in national strategies	
"Contribution (…) into national economy, via ratio of sector over GDP, energy saving"	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 19), similar in Adaptation TNA for Vietnam (UNEP et al., 2012b, p.21)
Share of GHG emissions	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 19)
Mitigation potential	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 19)
Capacity for low-carbon technologies	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 19)
Significance "to development of land, air, water, ecology environments"	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 19), similar in Adaptation TNA for Vietnam (UNEP et al., 2012b, p.22)
Comparative advantage to other countries (see section 3.1)	

[8] For further criteria applied in the assessment of promising technologies for CiC, see infoDev/World Bank, 2012, p. 23.

Criterion	Applied in (source)
Existence of (international) initiatives addressing the sector leading to technology needs	
Contribution to development goals	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 19)
"Contribution (…) to employment, hunger eradication and poverty reduction, enhancing health and cultural living"	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 19), similar in Adaptation TNA for Vietnam (UNEP et al., 2012b, p.22)
Potential to reduce vulnerability (economic and ecological) to climate change through the technology	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.22)
Technology identification	
Overall	
Alignment with ongoing/planned NAMAs or NAPAs	
GHG reduction potential	Mitigation TNA for Vietnam (UNEP et al., 2012a, pp. 25, 27, 35, 40), CIC (infoDev/World Bank, 2012, p. 23)
"Cost: capital, operation and maintenance costs, and cost-benefit of the GHG mitigation" resp. of the climate change adaptation	Mitigation TNA for Vietnam (UNEP et al., 2012a, pp. 25, 27, 35, 40), Adaptation TNA for Vietnam (UNEP et al., 2012b, p.28, 32, 37, 42)
Type of barriers to overcome	
Readiness of technology for deployment	CIC (infoDev/World Bank, 2012, p. 23)
Demand for technology	CIC (infoDev/World Bank, 2012, p. 23)
Economic impact, i.e. job creation	CIC (infoDev/World Bank, 2012, p. 23)
Social impact	CIC (infoDev/World Bank, 2012, p. 23)
Potential for reducing vulnerability	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.28, 32, 37, 42)
Energy sector	
"Contribution to economic development, saving energy and balance of payments"	Mitigation TNA for Vietnam (UNEP et al., 2012a, pp. 25, 27)
Reduction of pollution (air, land, water (transport: noise))	Mitigation TNA for Vietnam (UNEP et al., 2012a, pp. 25, 27)
Energy excl. transport: Job creation, "improved healthcare services and enhanced awareness and understanding" Transport: "decrease in the number of traffic accidents, more work created, improved services and enhanced awareness"	Mitigation TNA for Vietnam (UNEP et al., 2012a, pp. 25, 27)
Agriculture sector	
Air and other environmental pollution reduction	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 35), Adaptation TNA for Vietnam (UNEP et al., 2012b, p.28)
Increase of biodiversity	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 35)
Increase of resilience and of "carbon assimilation in photosynthesis"	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.28)
Job creation, poverty and hunger reduction, food security	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 35), Adaptation TNA for Vietnam (UNEP et al., 2012b, p.28)
"Contribution to economic development and balance of payments", income increase	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 35) similar in Adaptation TNA for Vietnam (UNEP et al., 2012b, p.28)

Criterion	Applied in (source)
Land use land, use change and forestry sector	
"Improving and preventing soil degradation, conserving water resources and reducing runoff decrease, improving air quality and biodiversity"	Mitigation TNA for Vietnam (UNEP et al., 2012a, p.40) similar in Adaptation TNA for Vietnam (UNEP et al., 2012b, p.32)
Job creation and improving rural living standards	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 40), Adaptation TNA for Vietnam (UNEP et al., 2012b, p.32)
"Improving livelihood, protecting infrastructure and helping to develop other industries"	Mitigation TNA for Vietnam (UNEP et al., 2012a, p. 40), similar in Adaptation TNA for Vietnam (UNEP et al., 2012b, p.32)
Water	
Reducing air and other environmental pollution and preventing soil erosion	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.42)
Biodiversity and natural habitat protection	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.42)
Job creation, improved living conditions, prevention of epidemics	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.42)
Reducing import needs and costs for equipment and energy	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.42)
Coastal zone	
Prevention of coast erosion	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.38)
Improving water utilization and "preventing salinity intrusion"	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.38)
Reducing air and other environmental pollution	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.38)
Protecting biodiversity	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.38)
Job creation, prevention of "epidemic by sanitation"	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.38)
Reducing import needs and costs for equipment and energy	Adaptation TNA for Vietnam (UNEP et al., 2012b, p.38)

3. **Consideration of other climate change initiatives in Vietnam** is important for coherence and coordination. These include besides the national policies, CDM projects, NAMA implementation and development, assessments under the PMR[9], etc. For the Incubation Mechanism, the work of the World Bank and DFID on a Climate Innovation Center (CIC), which intends to focus on energy efficiency and sustainable agribusiness technologies is especially relevant (infoDev/World Bank, 2012, p. 20). However, as the slow start of the CIC shows, a realistic assessment of the willingness of local SMEs to engage in technology development is key for the planning of a technology incubator.
4. Identify means for **cooperation with other initiatives and local actors**. For instance, potential cooperation with a CIC could include targeting complementary technologies or different sectors or by providing – as

[9] Under the PMR the waste and steel sector were identified – after consultations with various stakeholders – for proposing market based instruments (PMR, 2014).

cooperation between Vietnamese and Taiwanese universities as well as research institutes– research for the respective technologies[10].

5. Assessment according to the criteria in Table 2 requires a **cost and benefit analysis**, with the former being relevant for the criterion "Cost: capital, operation and maintenance costs, and cost-benefit of the GHG mitigation" resp. of the climate change adaptation and the latter for instance for "GHG reduction potential" resp. potential for reducing vulnerability or criteria referring to job creation. The benefit analysis should also consider benefits identified in national policies. The VGGS aims for instance at increasing employment in green industries as well as developing green infrastructures (section I, para 2 b)).

Identifying climate finance options to mobilize low carbon technology incubators in Vietnam

Rather than providing funding to entrepreneurs via an own fund (as is done in the CIC (infoDev/World Bank, 2012, p. 73)), ITRI would provide guidance for applications for international support. This would be more attractive to Vietnamese stakeholders as they would not have to use scarce local resources. Different options could be considered for financing the scaling-up of low carbon technologies in Vietnam. There are different mechanisms which support the deployment of low carbon technologies. In Table 3 these different funding options are shortly described.

[10] University partnerships are identified as one proposed activity in the CIC business plan (infoDev/World Bank, 2012, p. 58).

Table 3 Potential financing options

	Type of funded projects or programs	Resource availability
Green Climate Fund (GCF)	The GCF "will promote the paradigm shift towards low-emission and climate-resilient development pathways by providing support to developing countries to limit or reduce their greenhouse gas emissions and to adapt to the impacts of climate change" (para 2 Governing Instrument) . Thus technologies whose deployment shall be funded through the GCF need to be adequate to promote such paradigm shift. One indicator for assessing the paradigm shift potential is "Opportunities for targeting innovative solutions, new market segments, developing or adopting new technologies, business models, modal shifts and/or processes" (GCF/B.09/23, Annex III). Thus there is a close link to the scaling up of low-carbon or adaptation technologies.	In 2014 about 9.3 billion USD have been pledged to the GCF.
Adaptation Fund (AF)	Finances "concrete" adaptation projects and programs (decision 10/CP.7 para 1).	Funding cap per country: 10 million USD; currently no projects are being funded in Vietnam. Access either through multilateral development bank or direct access (Vietnam has no national implementing entity under the AF yet).
Global Environ-ment Facility (GEF)	The GEF has different funding categories • full-size projects: must be aligned with national priorities and fulfil requirements of relevant Convention (here: UNFCCC) • medium-size projects: smaller than full-size projects • enabling activities: i.e. to identify country priorities • programmatic approach: partnership between country (or countries), GEF and other stakeholders (e.g. from science or private sector), includes several projects and the inclusion of global environmental objectives into national strategies	Funding differs per project category: • full-size projects: > 2 million USD, about 1.6 years for preparation, approval by GEF Council required • medium-size projects: < 2 million USD, expedited approval procedure, approval by GEF CEO required • enabling activities: < 1 million USD, approval by GEF CEO required

	Type of funded projects or programs	Resource availability
	• small-scale projects: for community based projects (likely not relevant in this context) (GEF, 2013a). In the area of climate change, 19 national projects and 8 regional or global projects have as of now been funded by the GEF (GEF, 2013c). The so called GEF-6 "Climate Change Mitigation Focal Area Strategic Framework" which runs until 2018 has three objectives, one of them closely related to technology, namely: "CC1: Promote innovation, technology transfer, and supportive policies and strategies" (GEF, 2013b). One of its two programs is also technology relevant: "Promote timely development, demonstration and financing of low-carbon technologies and mitigation options" (GEF, 2013b).	• programmatic approach: funding undefined, approval by GEF Council required • small-scale projects: < 50,000 USD (GEF, 2013a).
Climate Investment Funds (CIF)	The Clean Technology Fund under the CIF finances "demonstration, deployment and transfer of low carbon technologies with a significant potential for long-term greenhouse gas emissions savings" (CIF, 2014). Four programmes are currently being funded (focus: energy, transport) (CIF, no date).	Nearly 200 million USD are provided by the CTF for activities in Vietnam with expected co-financing of about 900 million USD. They mostly relate to urban rail systems (CIF, no date).
Climate Innovation Centers	As indicated in section 3.2., support is being provided for a CIC in Vietnam which in turn can directly support innovative start-up companies in Vietnam (infoDev, 2013, p. 30).	Grants up to VND 1 billion (= 45,000 USD) are being provided for proofs of concept for developing or scaling up technologies (infoDev, 2014).
Climate Technology Centre & Network (CTCN)	CTCN provides support for technology transfer (including technical support and capacity building) and provides access to a broad network. Vietnam currently has one project being supported by CTCN (rice sector). The Department of Meteorology, Hydrology and Climate Change, Ministry of Natural Resources and Environment of Viet Nam is the National Designated Entity, which needs to submit project proposals (CTCN, no date a; CTCN, no date b).	No direct funding is provided. But technical assistance (incl. assessments, strategies, trainings) is provided which can equal a value up to 250,000 USD (CTCN, no date c).

	Type of funded projects or programs	Resource availability
Clean Development Mechanism (CDM)	The majority of the currently registered 254 CDM projects in Vietnam are in the hydro sector (UNEP DTU, 2015). Thus there is broad experience to build upon. The future role of market mechanisms in the new climate agreement is still undefined, since no agreement could be found yet on new market mechanisms. The Department of Meteorology, Hydrology and Climate Change of the Ministry of Natural Resources and Environment of Viet Nam is the Designated National Authority under the CDM for Vietnam.	Funding is set by the carbon price. While the carbon price under the CDM had initially been high (i.e. in 2007: > 20 EUR/certified emission reduction (CER)) it has dropped significantly and is currently only at about 0.45 EUR/CER. The future development of carbon prices under the CDM or in future new market mechanisms is still unclear and strongly dependent on the design of these mechanisms.
Partnership for Market Readiness (PMR)	In late 2014, Vietnam has submitted a market readiness proposal under the PMR, which aims at the establishment of a carbon market pilot in the steel sector and no-regret measures in the waste sector (MNRE, 2014). Considering the overall funding cap of the PMR (currently: 85 million USD (Climate Finance Options, 2013)) and the fact that so far countries have only submitted one proposal it seems likely that only one proposal is allowed.	Funding (up to 350,000 USD) is provided for developing a market readiness proposal. In order to implement the proposal's components funding in the range from 3 to 8 million USD is available (Climate Finance Options, 2013). The estimated required support in the market readiness proposal submitted by Vietnam is 3 million USD (Ministry of Natural Resources and Environment, 2014).
Co-financed NAMAs	As indicated above, several NAMAs are currently under development in Vietnam. Many NAMAs are being funded through bilateral partnerships.	No general indication on the amount of resources provided under NAMAs can be provided. This is strongly dependent on the technology, scope and scale of the NAMA.
Bilateral Partnerships	Switzerland provides financial support to the Vietnam Green Credit Trust Fund, where local small and medium companies can apply for credits for low-carbon technologies (MPI et al., 2012). As indicated above, Vietnam has signed an agreement with Japan regarding the participation in the Joint Crediting Mechanism (JCM) aiming at spreading and enhancing low carbon technologies in Vietnam. Emission reductions achieved in Vietnam are transformed	Resources available under bilateral partnerships depend on the partnership or individual bilateral arrangements. Hence they cannot be specified here. Funding under the Vietnam Green Credit Trust Fund could be an interesting option for SME. The price for JCM credits has not yet been defined.

	Type of funded projects or programs	Resource availability
	into credits and transferred under the JCM to Japan which uses them to reach its emission reduction targets.	

As can be seen in Table 3, funding opportunities differ strongly depending on the financing option. CIC provides funding for project concept preparations while others provide also financial support for the implementation of the project (e.g. GCF, GEF). Others, such as the CTCN do not provide any direct funding but rather technology feasibility assistance. The CTCN might however be a potential cooperation partner for supporting the scaling-up of low carbon technology with project risk assessment. Similarly, cooperation could be sought with CIC. A detailed analysis of financing opportunities would only be possible for a specific project idea.

4. Conclusions and recommendations

The ITRI Incubation Mechanism has operated for almost twenty years. Hence a great amount of experience on collaboration between research and industry for the scaling-up of technologies exist. Other countries could benefit from this experience. Support could therefore be provided to interested public or private actors in other developing countries for identifying technology demand and needs and for preparing project proposals which outline how such low-carbon technology demand could be met. Under the proposed mechanism, Taiwanese well-developed technologies and consultancy services could hence be linked with guidance for accessing financial support and be provided to interested developing countries. Various financing instruments for the development and scaling-up of low-carbon technologies exist already. Which of the funding instruments would be the most fitting one is however strongly dependent on the specific project proposal. Country ownership and local partners for such approaches are of crucial importance in order to ensure that the identified technologies are aligned with the country's development strategy and that they are really taken up in the country. This requires entrepreneurial acumen, as the best incubation mechanism will not work without innovative entrepreneurs.

As further steps it is recommended to get in contact with potential partners to identify their potential interest in such support. This could then be followed by a more detailed assessment of the technology needs and demands as well as potential financing options. Another option could be to conduct research on how similar incubation mechanisms could be established together with local partners in other interested developing countries.

References

Akçomak, S. (2009): Incubators as tools for entrepreneurship promotion in developing countries, UNU-Merit, Working paper series, #2009-054

Arita, S.; Dyck, J. (2014): Vietnam's Agri-Food Sector and the Trans-Pacific Partnership, United States Department of Agriculture Economic Research Service Economic Information Bulletin 130, Washington

APO COE GP (2014): Technical Service Team Report- Resource Recycling – Vietnam

Breu, M.; Dobbs, R.; Remes, J.; Skilling, D.; Kim, J. (2012): Sustaining Vietnam's growth: the productivity challenge, McKinsey Global Institute

CIF (2014): Clean Technology Fund, http://www.climateinvestmentfunds.org/cif/Clean_Technology_Fund, (download: 26.07.2015)

CIF (no date): Project, http://www-cif.climateinvestmentfunds.org/projects?title=&field_related_country_target_id=45&field_mdb_tid=All&field_sector_tid=All&field_pp_sector_tid=All&field_related_fund_target_id=1, (download: 26.07.2015)

Climate Finance Options (2013): Partnership for Market Readiness, http://climatefinanceoptions.org/cfo/node/3308 (download: 31.07.2015)

Country partnership strategy (no date): Country Partnership Strategy: Viet Nam 2012-2015, Private sector assessment (summary), http://www.adb.org/sites/default/files/linked-documents/cps-vie-2012-2015-psa.pdf, (download: 23.07.2015)

CTCN (no date a): About the Climate Technology Center and Network, http://ctc-n.org/about-ctcn (download: 31.07.2015)

CTCN (no date b): Viet Nam, http://ctc-n.org/country/VN (download: 31.07.2015)

CTCN (no date c): Technical assistance, http://ctc-n.org/technical-assistance (download: 31.07.2015)

GEF (2013a): Project type and programmatic approach, https://www.thegef.org/gef/project_types (download: 31.07.2015)

GEF (2013b): GEF Climate Change mitigation strategy, https://www.thegef.org/gef/CC_mitigation_strategy (download: 31.07.2015)

GEF (2013c): GEF projects, https://www.thegef.org/gef/project_list (download: 31.07.2015)

Glewwe, P. (2004): An overview of economic growth and household welfare in Vietnam in the 1990s, in: Glewwe, P.; Agrawal, A.; Dollar, D. (eds.): Economic growth, poverty, and household welfare in Vietnam, World Bank, Washington D.C., p. 1-26

Government of Vietnam (2011): National Climate Change Strategy, http://chinhphu.vn/portal/page/portal/English/strategies/strategiesdetails%3FcategoryId%3D30%26articleId%3D10051283, (download: 31.07.2015)

Government of Vietnam (2012): Decision, Approval of the national green growth strategy, http://www.greengrowth-elearning.org/pdf/VietNam-GreenGrowth-Strategy.pdf (download: 31.07.2015)

Hogan Lovells (2010): Vietnam approves its much anticipated public-private partnership framework legislation, http://www.lexology.com/library/detail.aspx?g=770af3f1-ff7c-4b95-8751-933918ea2031 (download: 23.07.2015)

Hsu, P.-H.; Shyu, J.; Yu, H.-C.; You, C.-C.; Lo, T.-H. (2003): Exploring the interaction between incubators and industrial clusters: the case of the ITRI Incubator in Taiwan, in: R&D Management 33, , p. 79-90

Huong, H., (2014): Mitigation Option and NAMA Development in Vietnam, presentation 1-3 October 2014, http://www.lowcarbondev-support.org/-/media/Sites/FIRM_Facilitating_Implementation_and_Readiness_for_Mitigation/Workshop%20Presentations/Regional%20Workshop%20on%20NAMAs%20Vietnam%20Oct%202014/Day%201%20Session%201/4-Chu%20Thi%20Thanh%20Huong-Vietnam%20Mitigation%20Option%20and%20NAMA%20Development.ashx?la=da (download: 23.07.2015)

Institute of Strategy and Policy on natural resources and environment Viet Nam (2009): Viet Nam assessment report on climate change, Hanoi

infoDev/World Bank (2012): Vietnam Climate Innovation Center: CIC, A business plan for the financing and implementation of a CIC in Vietnam, http://infodev.org/infodev-files/resource/InfodevDocuments_1181.pdf (download: 31.07.2015)

infoDev (2013): infoDev's work programme 2013-2015, http://www.infodev.org/infodev-files/resource/InfodevDocuments_1200.pdf, (download: 26.07.2015)

infoDev (2014): Climate Innovation Center Vietnam, Services, http://www.vietnamcic.org/vietnam-CIC/services/, (download: 26.07.2015)

ITRI (no date): Open Lab & Incubator, https://www.itri.org.tw/eng/Content/Messagess/contents.aspx?SiteID=1&MmmID=617755772433266023 (download: 26.08.2015)

Jan, T.-S.; Chen, Y. (2006): The R&D system for industrial development in Taiwan, in: Technological Forecasting & Social Change 73, p. 559–574

JCM (Joint Crediting Mechanism) (2015): Project VN001 Eco-Driving by Utilizing Digital Tachograph System, https://www.jcm.go.jp/vn-jp/projects/7 (download: 13.08.2015)

Lui, F.; Qiu, L. (2001): Taiwan: thriving high-technology industries and SMEs, in: Kwong, K. (2011) Industrial development in Singapore, Taiwan, and South Korea, World Scientific, Singapore, p. 56-117

Michaelowa, A. (2015): Barriers and opportunities for the incubator mechanism in Vietnam, Presentation on 9 June 2015

Ministry of Natural Resources and Environment (2010): Viet Nam's second national communication to the United Nations Framework Convention on Climate Change, Hanoi

Ministry of Natural Resources and Environment (2014): Final market Readiness Proposals, https://www.thepmr.org/system/files/documents/20141030_MRP_Final%20for%20PA10_Santiago%20Presentation%20Ver%203.pdf (download: 16.07.2015)

Ministry of Science and Technology (2012): The strategy for Science and Technology Development for the 2011-2020 period. http://www.most.gov.vn/Desktop.aspx/Details-Article/ST-stratergy/The_translation_is_for_reference/ (download: 29.07.2015)

Ministry of Planning and Investment, UNDP, World Bank (2012): Vietnam Green Credit Trust Fund, http://cfovn.mpi.gov.vn/Home/funding/post.aspx?id=48 (download: 17.07.2015)

Nguyen, V. (2014): TPP and Opportunities for Vietnam's Textile and Garment Industry. Vietnam Pictorial,

http://vietnam.vnanet.vn/english/tpp-and-opportunities-for-vietnams-textile-and-garment-industry/59275.html (download: 29.07.2015)

OECD (2012): Recommendation of the Council on Principles for Public Governance of Public-Private Partnerships

Partnership for Market Readiness (2015): Final market readiness proposals, https://www.thepmr.org/system/files/documents/20141030_MRP_Final%20for%20PA10_Santiago%20Presentation%20Ver%203.pdf, (download: 23.07.2015)

Ranis, G. (1995): Another look at the East Asian Miracle, in: The World Bank Economic Review, 9, p. 509-534

Relander, B. (2014): Expanding Vietnam Tech Market Attracts Investors. Investopedia, http://www.investopedia.com/articles/investing/032615/expanding-vietnam-tech-market-attracts-investors.asp (download: 29.07.2015)

Seres S.; Haites, E.; Murphy, K. (2009). Analysis of technology transfer in CDM projects: An update. Energy Policy, 37, p. 4919–4926

Swiss Department for Economic Affairs (2013): Vietnam country strategy 2013-2016, http://www.seco-cooperation.admin.ch/laender/05148/05150/index.html?lang=en&download=NHzLpZeg7t,lnp6I0NTU042l2Z6ln1ad1IZn4Z2qZpnO2Yuq2Z6gpJCDeH59g2ym162epYbg2c_JjKbNoKSn6A--, (download: 24.07.2015)

Thuc, T. (2012): Green Growth Strategy and NAMA-readiness in Vietnam, www.lowcarbondev-support.org%2F~%2Fmedia%2FSites%2FFIRM_Facilitating_Implementation_and_Readiness_for_Mitigation%2FWorkshop%2520Presentations%2Fworkshop%2520presentations%2520-%2520vietnam%2Fgreen_growth_strategy_and_nama_readiness_in_vietnam.ashx (download: 24.07.2015)

Tot van, B. (2014): Textile and apparel industry report, Opportunities for breakthrough, http://fpts.com.vn/FileStore2/File/2014/07/01/Textile%20and%20Apparel%20Industry%20Report%20%28latest%29.pdf (download: 31.07.2015)

Transparency International (2014): Corruption Perceptions Index 2014: results, http://www.transparency.org/cpi2014/results (download: 24.07.2015)

UNEP, GEF, UNEP Risoe, AIT (2012a): Technology needs assessment for climate change mitigation, Vietnam, Synthesis report, Nairobi

UNEP, GEF, UNEP Risoe, AIT (2012b): Technology needs assessment for climate change adaptation, Vietnam, Synthesis report, Nairobi

UNEP DTU (2015): CDM Pipeline sheet, as of July 1, 2015, http://www.cdmpipeline.org/cdm-projects-region.htm (download: 23.07.2015)

UNFCCC (no date): Technology Needs Assessments, source: http://unfccc.int/ttclear/templates/render_cms_page?TNA_home (download: 16.07.2015)

Vietnam Briefing (2014a): The decline of state-owned enterprises in Vietnam, http://www.vietnam-briefing.com/news/decline-state-owned-enterprises-vietnam.html/, (download: 23.07.2015)

Vietnam Briefing (2014b): Vietnam's High-tech Boom,http://www.vietnam-briefing.com/news/vietnams-high-tech-boom.html (download: 29.07.2015)

VieTrade (2014): Challenges and new opportunities for Vietnam's agriculture in the international integration process. Vietnam Trade Promotion Agency, http://www.vietrade.gov.vn/en/index.php?option=com_content&view=article&id=2246:challenges-and-new-opportunities-for-vietnams-agriculture-in-the-international-integration-process&catid=270:vietnam-industry-news&Itemid=363 (download: 31.07.2015)

Wang, B.; Shyu, J.; Cheng, C.-C. (2007): Changing Technology Transfer Strategies in a Non-profit Organization – An Examination of ITRI, http://www.f.waseda.jp/watada/Conference/ISME2007/ISME2007paper/ISME2007BenjaminWang.pdf (download: 17.07.2015)

World's top exports (2015): Taiwan's top 10 exports, http://www.worldstopexports.com/taiwans-top-exports/2644 (download: 26.07.2015)

Wu, W. (2002): Innovative Approaches for Incubators to Reach Financial Self-sufficiency, http://www.aspa.or.kr/files/webzinevol.3_050602/webzinevol3_paper1_eg.htm?ckattempt=1 (download: 15.08.2015)

Zakir, M. (2010): Report on Vietnam textile & garment industry. ACTIF, http://www.actifafrica.com/documents/ACTIF%20Report%20on%20Vietnam%20Textile%20and%20Garment%20Industry_Zakir%20Hossain_2010.pdf (download: 31.07.2015)