[REPORT TASK I.5.2/3/4] LOW CARBON OPTIONS FOR THE CEMENT SECTOR OF VIETNAM

EXECUTIVE SUMMARY

This study on the cement industry in Vietnam envisages four scenarios calculating the CO_2 emission reduction versus a reference level of today's existing capacity and practice (reference years 2009-2013). The reference level includes a growth of cement capacity in the future under the different scenarios, e.g. up to 1'200 kg cement per inhabitant per year by 2030 for VN-BaU-1200 and BATP-1200 and 800 kg cement per inhabitant per year under the BATP-800. Under the BATP-650 scenario no additional installed capacity would be required to meet the estimated demand in 2030. We further assumed as reference a 80% sector average capacity utilisation factor (i.e. 960 kg cement production per inhabitant per year) and the current sector's energy and CO_2 intensity for the period of 2009-2013, i.e.: 3'700 MJ/ton clinker thermal consumption, 100% coal, 83% clinker in cement, 60 kWh/ton clinker electric energy and 740 kg CO_2/ton cement. While this is the reference level for calculating CO_2 emission reductions, this is not necessarily the baseline scenario for NAMA support mechanisms.

Identification of potential mitigation options

The first chapter of this report describes 40 mitigation options (for an overview and summary: see section 3.6). About 12 of those are classified as first priority, mainly because of their economically affordable and high energy and CO_2 mitigation potential. Another 13 are ranked second or third priority, because of a variety of reasons being mainly that the technology is already implemented in the relatively young Vietnamese cement industry; or first priority actions must be implemented before the secondary options can be utilized or the mitigation potential is uncertain or small. The remaining options are classified as "off radar", i.e. not important the coming 10-15 years because they either have already been largely implemented, they are uneconomic or the technology is immature.

It is necessary to mention that, even electric power saving options are not included in the list of potential mitigation options due to very low potentials of CO_2 emission reductions, those options (usually "low hanging fruit" measures) could be considered within the status-quo of a specific cement plant for domestic investment.

Marginal Abatement Cost assessment of 12 selected mitigation options

Absolute energy consumption and CO_2 emissions are defined by the multiplication of the production volume (ton product per year) with the energy and CO_2 intensity of production (energy and CO_2 per ton product).

The MAC curves are calculated per scenario and report CO_2 mitigation volumes and costs *for the production volume of that scenario*. The MAC curves consequently relate to *efficiency improvement only* and do not include the CO_2 mitigation that may be realized through the optimisation of the capacity and production volume.

Key findings and recommendations

Clinker and cement production capacity and production volume

Maintaining an economically and environmentally adequate balance between cement and, especially, clinker production capacity and domestic market demand is probably one of the most important aspects to contain and mitigate energy consumption and CO_2 emission.

There are four main mechanisms that make too ambitious cement and clinker capacity growth economically and environmentally unattractive:

- Over-capacity erodes the profitability of the cement companies. Over-capacity depresses cement market prices and capacity utilisation, increases production and financial costs. As a consequence less own financial resources are available for production optimisation and efficiency improvements.
- Over-capacity of clinker production seriously erodes the incentive to lower the clinker content in cement, which is the most effective lever to mitigate energy consumption and CO_2 emission per ton cement.
- Over-capacity increases the tendency to export clinker and/or cement. As explained in report I.3, a clinker export strategy is from a country perspective not an economical and environmental optimal value proposition, because clinker and cement are products with a relatively low financial added value, low employment but comparatively very high energy consumption and CO_2 emission, from production and transport.
- Over-capacity leads to low capacity utilisation factor, which in turn increases the thermal energy consumption and CO_2 emission per ton product.

Vietnam’s cement Master Plan would have as a result that cement capacity would double from roughly 600 kg cement per inhabitant per year in 2013 to 1’200 kg cement per inhabitant per year by 2025 – 2030. Vietnam’s current capacity is already significantly higher than domestic demand and export.

Building 1’200 kg cement production capacity per capita per year would make Vietnam the 4th largest global cement producer only after China, Saudi Arabia and Qatar; with 1’000 kg per capita at par with Singapore and the UAE and with 800 kg cement per capita close to South Korea. These are all countries with a significantly different economy and mega-construction culture. The cement industry in China, but also Saudi Arabia, faces already a systemic over-capacity and severe profitability problems.

Thus, first and foremost recommendation is therefore to limit the growth of Vietnam’s cement production capacity to 650 to 800 kg cement/cap/year. Limiting capacity to 650 kg cement per capita per year would still keep Vietnam within the world’s top 10 cement producers. Increasing it to 800 kg cement per capita per year would make from Vietnam the emerging economy with the highest cement production, at par with very wealthy countries like South Korea, Singapore and the Emirates.

Clinker substitution

Using slag, fly ash, pozzolana and limestone as cement constituent partially replacing clinker is the most effective lever to reduce CO_2 emission per ton cement because it reduces at the same time process and fuel CO_2 and power related CO_2 emission from clinker production. In cases of growing cement market demand and shortage of clinker capacity, clinker substitution is economically a very attractive alternative to building new clinker capacity because it avoids investment in new clinker installations. The cost saving thus relates the *total* cost of clinker production, including depreciation, amortisation, financial, personnel and variable costs.

Blending with low cost limestone and pozzolana is economically attractive in all scenarios, but blending the technically valuable fly ash and slag becomes economically less unattractive compared to limestone and pozzolana. However, given the limit of limestone as the filler in the cement, and that fly ash and slag are "industrial waste", using more fly ash and slag in the cement production would give also co-benefit from waste management perspective, thus should be encouraged within the NAMA for the cement sector. It is though very important to highlight that this concerns *cement* demand, not necessarily *clinker* demand. With expanding capacity it is very important to adequately tune the additional clinker and cement capacity as a function of reduced clinker factor. Clinker capacity expansion should thus be lower than cement capacity expansion.

Effective policy measures include:

- Review the Vietnam cement Master Plan, especially the growth of future clinker and cement production capacity limiting the 2030 cement production capacity to 650 to 800 kg cement per inhabitant per year, exactly the same as recommended for the previous priority mitigation option;

- Include in the Master Plan a policy objective for lower clinker to cement ratio, aiming at reducing the current 83% clinker factor to about 69%;

- Adapt the capacity of clinker production and cement grinding in such a way as to enable this lower clinker factor. This means that clinker production capacity will have to grow at a slower pace than cement grinding capacity.

- Include in Vietnam's iron and steel Master Plans the obligatory construction of slag granulation equipment at existing and future blast furnaces in the Vietnam iron and steel companies, enabling the domestic production of granulated blast furnace slag (instead of air cooled slag).

- Include in Vietnam's electric power master plan technical measures to improve the quality of fly ash from domestic coal fired power stations, enabling sufficient quality (especially the content of non-burnt carbon) of the fly ash for use as cement constituent.

Alternative fuels

Besides saving roughly 25 - 28% or 2.1 Mton coal consumption, alternative fuels would result in 2.7 Mton CO_2 mitigation in the existing plants. The corresponding investment and CO_2 mitigation costs are uncertain and dependent on many aspects that remain to be developed in Vietnam. In a conservative approach, the CO_2 mitigation cost is very likely to be negative, around – US$ 10/ton CO_2 or lower, i.e. profitable, and sectoral investment could be in the order US$ 500 million spread over 5 to 10 years.

The use of waste derived alternative fuels is also the mitigation option with the most realistic and tangible co-benefits. These include: providing an environmentally sound solution to a part of the waste disposal problem of a country; the stimulus to develop adequate waste management legislation, regulation and law enforcement; indirect employment creation in the "upstream waste management value chain" and direct employment for the conversion of waste to alternative fuels.

The most important policy measure that would enable AFR business development concerns bridging the gap on waste and AFR insight, knowledge and expertise of the national governmental and industrial stakeholders. For individual AFR projects communication and engagement with local politicians, population and NGOs is indispensable. The necessary investments can only follow when this knowledge gap is – at least partially and gradually - bridged.

Investments and operations of AFR in the cement industry are economically profitable provided adequate waste and AFR policies and service pricing are in place. Consequently, the necessary investments can normally be financed by traditional domestic sources and revenues from the cement companies as well as by the international financial market.

The policy measures may also include carbon pricing for industry's CO_2 emission because this improves the competitive costs of low CO_2 alternative fuels compared to high CO_2 coal. Carbon pricing can be realized via a carbon tax, a domestic emission trading system, which can be a baseline and credit system. These systems could be linked with the international carbon market and New Market Mechanisms.

International support will thus in the first place be for enabling activities. This could be very attractive for international donors because the beneficiary of such support will certainly include governmental organisations and the leverage effect will be large. On the other hand, domestic and commercial finance sources and the carbon market may support the investments for individual projects, because AFR projects will largely be profitable.

Thermal energy efficiency

The large majority of thermal energy efficiency improvement and related CO2 mitigation can be achieved by "practice" aspects requiring limited upfront investment in equipment. Up to 1.1 Mton coal and 1.5 Mton CO2 can be saved annually through the following five measures: (i) Management commitment, process know how and control; (ii) Diagnostic energy auditing by experienced experts and implementation of the resulting corrective measures; (iii) Modern automation and control systems; (iv) Clinker cooler modification; and (v) Retrofit to multichannel burner (which is also necessary for AFR).

The potential policy measures include:

- The merger of several smaller independent companies to a larger group of companies that has the necessary economy of scale to develop and sustainably afford a professional technical department, disposing off a high-quality staff and the necessary technical know how and equipment;
- Additionally the cement sector could envisage a technical competence centre at cement sector level. Undoubtedly competition aspects could make the governance and operations of such a sector competence centre more difficult. There are some examples of very successful and effective sector technical and policy competence centres in Europe.
- The pricing of coal to the international market price, as such abolishing the hidden coal price subsidy (even minor). The existing energy efficiency laws, decisions, audits and data reporting seem to have proven not to be quite effective on the ground. Appropriate energy pricing is likely to be more effective in focusing management's attention to energy efficiency.
- More or less similar to the international knowledge transfer for AFR, there could also be knowledge transfer in the area of energy efficiency. Whereas the knowledge transfer for AFR will in the first place be at policy and waste and cement sector level, the knowledge transfer for energy efficiency will rather be directly to the

cement companies. Hence the financing of such knowledge transfer is likely to be different, probably not through international donors but through commercial or shareholder partnership agreements.

Since the majority of the energy efficiency improvement can be realized with modest upfront investment in equipment and infrastructure, financing can largely be done by domestic or market sources.

Annexes

Figure ES-1: Projected cement production until 2030 in the 1200-, 800- and 650- kg cement per capita scenarios

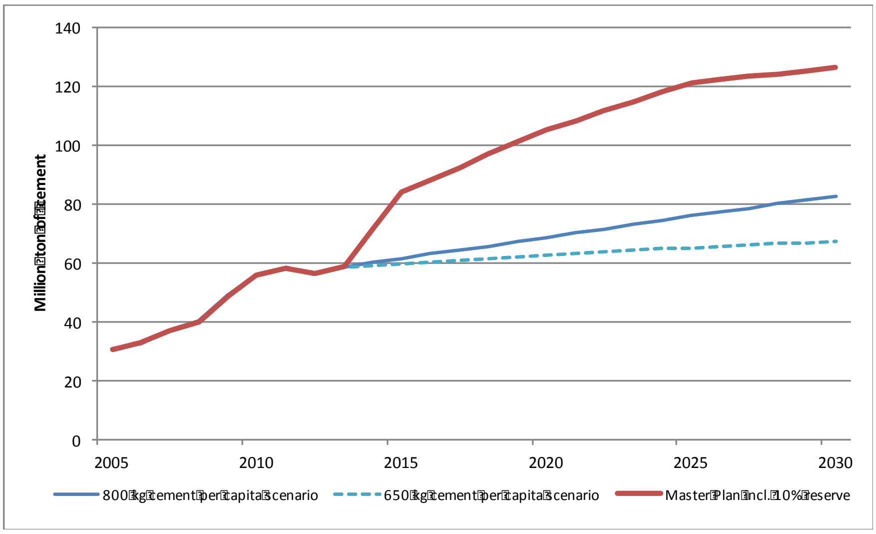

Figure ES-2: Development of CO2 emissions under four scenarios

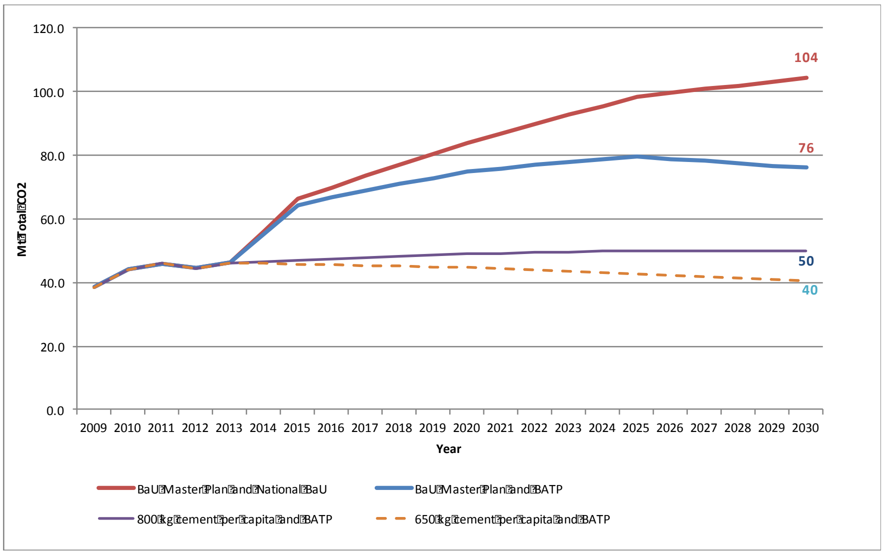

Table ES-1: Mitigation options considered under MAC analysis for Vietnamese cement sector

1. Thermal energy efficiency of clinker production (SAP 1)	1a) Process knowhow, control and management	1b) Diagnostic energy audits	2) Modern automation and control systems (TP 8)	3) Clinker cooler modification (TP4)	4) WHR (TP5)	5) Adding a pre-calciner to existing pre-heater kiln	6) Additional Pre-heater cyclone (TP6)
2. Alternative fuels (SAP 3)	7a) Best Available Technology (BAT) for Alternative fuels - replacing fossil fuels (TP10)		7b) Best Available Practice (BAP) for Alternative fuels - replacing fossil fuels		8) Retrofit to modern multi-channel burner (TP13)		
3. Lowering the clinker content in cement (SAP 4)	9) Blending: GBFS as cement constituent (TP21)	10) Blending: Fly ash as cement constituent (TP24)		11) Blending: Pozzolana (TP25)		12) Blending: Limestone	

Table ES-2: Results of MAC analysis for selected mitigation options

Category	Sub-category	VN-BaU-1200		BATP-1200		BATP-800		BATP-650	
		USD/ tCO_2	$MtCO_2$/ year	USD/ tCO_2	$MtCO_2$/ year	USD/ tCO_2	$MtCO_2$/ year	USD/ tCO_2	$MtCO_2$/ Year
Improving thermal energy efficiency of clinker production	1a) Process knowhow, control and management & 1b) Diagnostic energy audits	-16.1	0.44	-16.4	0.81	-16.5	1.02	-16.5	1.02
	2) Modern automation and control systems	-11.0	0.12	-11.0	0.12	-11.0	0.12	-11.0	0.12
	3) Clinker cooler modification	-9.8	0.29	-9.8	0.29	-9.8	0.29	-9.8	0.29
	4) Waste heat recovery (WHR)	-21.5	0.05	-21.5	0.19	-21.5	0.19	-21.5	0.19
	5) Adding a pre-calciner to existing pre-heater kiln	65.3	0.04	65.3	0.04	65.3	0.04	65.3	0.04
	6) Additional Pre-heater cyclone	66.6	0.04	66.6	0.04	66.6	0.04	66.6	0.04
Use of alternative fuels	7) BAT for Alternative fuels - replacing fossil fuels	0.0	-	-4.0	2.81	-4.0	2.81	-4.0	2.81
	8) Retrofit to modern multi-channel burner	-19.2	0.08	-19.2	0.08	-19.2	0.08	-19.2	0.08
Reducing clinker content in cement	9) Blending: GBFS as cement constituent	-46.3	0.16	-38.5	0.66	-9.3	0.46	-6.6	0.45
	10) Blending: Fly ash as cement constituent	-46.5	0.40	-38.7	1.64	-9.5	1.16	-6.8	1.12
	11) Blending: Pozzolana	-56.9	0.40	-48.7	1.64	-19.5	1.16	-16.7	1.12
	12) Blending: Limestone	-61.3	0.64	-53.2	2.63	-23.9	1.85	-21.1	1.80
Sub-total			2.65		10.95		9.21		9.08
Avoided CO_2 emissions from avoided clinker capacity (650/800 kg/cap vs. 1,200 kg/cap)			0		0		Up to 32.6		Up to 43.7
Total			**2.65**		**10.95**		**41.77**		**52.74**

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