Ocean Plastic Turned into an Opportunity in Circular Economy

Brochure April 2021

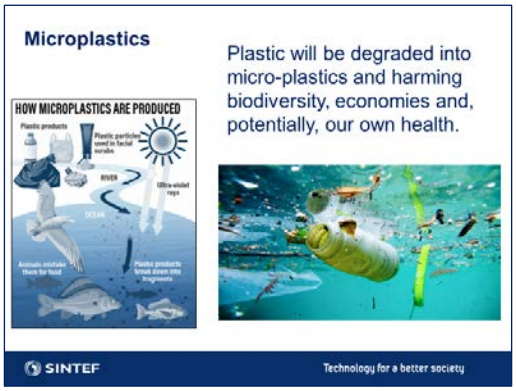
Norad SINTEF Norwegian Ministry of Foreign Affairs

1. Introduction

This project is part of the Norwegian Development Programme to Combat Marine Litter and Microplastics launched in 2018. The programme is intended to contribute to Sustainable Development Goal (SDG) 14.1 which states that by 2025, the world should prevent and significantly reduce marine pollution of all kinds (Regjeringen, 2020).

2. The problem

An estimated amount of 13 million tonnes of plastic leak into our oceans every year, harming biodiversity, economies and, potentially, our own health (The State of Plastics, 2018).



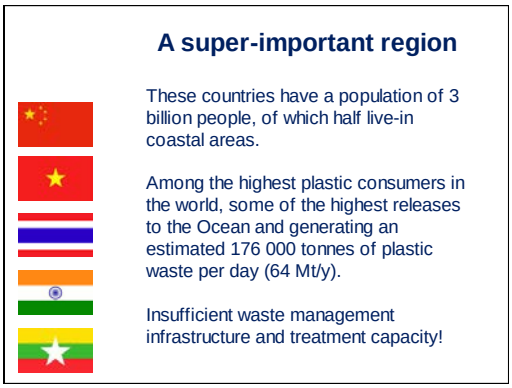
3. Reasons of the problems

International action is key to tackle the most significant sources of plastics litter in the oceans, i.e. insufficient waste management in developing countries and emerging economies, especially connected to major world river basins, dumpsites/landfills and industrial hotspots.

It is estimated that more than 80% of marine debris comes from land-based sources and Asian countries are among the top contributors to marine litter and microplastics (Jambeck et al., 2015).

4. Objective of OPTOCE

The regional project Ocean Plastic Turned into an Opportunity in Circular Economy – OPTOCE - will investigate how the involvement of Energy Intensive Industries, like cement manufacturing, can increase the treatment capacity for Non-Recyclable Plastic Wastes in China, India, Myanmar, Thailand and Vietnam and thereby contribute to reduce the release of plastics to the Sea.



They are producing an estimated 176 000 tonnes of plastic waste every day (64 million tonnes/year) and have some of the highest releases of Plastics to the Sea. Relatively small quantities are handled in an environmentally sound way.

But they also have the highest production of cement, steel and electric power, using huge amounts of coal and contributing with large amounts of the world's greenhouse gas emissions.

Replacing parts of this coal with Non-Recyclable Plastic Wastes may represent a win-win opportunity – preventing the plastic from ending up in the ocean, reducing the need for large amounts of fossil coal and indirectly reducing greenhouse gas emissions by avoiding building new incinerators or landfills.

What is considered waste in one sector becomes a resource in another. This concept represents circular economy in practice and incorporates waste treatment with existing industrial production, which is also preferred to Incineration and Landfilling in the internationally accepted Waste Management Hierarchy.

5. Additional Objectives

Additional objectives and synergies of the OPTOCE-project will be the following:

- Strengthen actions at the national level as well as through collaborative actions among countries in the region to prevent and significantly reduce marine debris, particularly from land-based activities, including environmentally sound management.
- Enhance the multi-stakeholder coordination and cooperation to combat marine debris, including implementing joint actions and partnerships.
- Promote private sector engagement in preventing and reducing marine debris, including partnerships between public and private sector through various mechanisms and incentives.
- Strengthen research capacity and application of scientific knowledge to combat marine debris, in particular, to support science-based policy and decision making.

6. Where does all the plastic go?

An estimated 9.3 billion tons of virgin plastics was produced globally up to 2019.

Out of this, 6.3 billion tonnes have already ended up being plastic waste; of this, only 9% was recycled, 12% incinerated and 79% dumped.

If current production and waste management trends continue, roughly 12 billion tonnes of plastic waste will be in landfills or in the natural environment by 2050 (Geyer et al. 2017).

Billions of tonnes?

>5 Billion tonnes of plastic wastes is today accumulated in dumpsites/landfills around the world.

Plastic in dumpsites and landfills will slowly break-down and be released to groundwater & rivers and constitute a continuous source of microplastics to our Oceans ☹

7. What about Recycling?

Recycling is the preferred option but not all plastic waste is suitable for recycling. From a technical aspect, it is challenging to recycle plastic that consists of several types of polymers, as you need to separate them.

From an economic perspective, the recycling sector suffers greatly from low oil prices. The main component of plastic is oil; hence the low oil prices leads to low prices of virgin plastic.

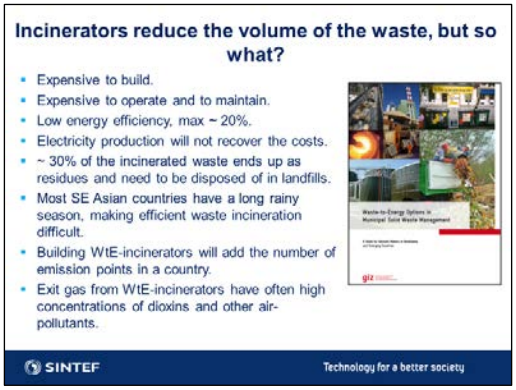
Studies from Asia post-Covid has shown that the recycling sector has seen a 50 percent drop in demand and a 20 percent drop in prices (Safeguarding the plastic value chain, 2020). Studies has also shown that most of the plastic that ends up in the oceans is low-quality plastic that is hard to recycle (Stemming the Tide, 2015).

8. Incineration is becoming increasingly popular

Energy recovery from wastes and plastics in Municipal Solid Waste Incinerators with Waste to Energy (WtE) normally involves generation of electricity in steam turbines, but the conversion efficiency to electricity is poor and will not recover the construction costs (Mutz et al., 2017).

WtE-plants are expensive to build and operate, they represent an additional emission source and produce large amounts of residues (fly ash, bottom ash etc.) that need to be treated/landfilled.

Incineration of wet wastes in the rainy season is another challenge, which causes difficult burning conditions and results in elevated emissions.



9. What about integrated options?

Countries with cement industry may to a certain degree forego building expensive WtE's/incinerators.

Cement kilns are already in operation and may increase the waste treatment capacity significantly if integrated into the waste management strategy. They are usually cost-efficient and do not produce any residues that needs disposal.

Co-processing of wastes in cement kilns versus incineration

	Cement kilns	Incinerators with generation of electricity/steam
Purpose	Industrial production of cement clinker	Reduce the volume by burning
Temperature ranges	1500-2000 °C.	800-1100 °C
Construction investment costs	Facilities are already in place and operates at all time. The industry bears the investment and operation costs	Expensive to build, operate and maintain
Cost	Usually cost-efficient	Varies widely; 10-200 USD/t of waste
Energy efficiency	Approaches 100%.	Low energy efficiency, range 15 – 25%. Electricity production will not recover the Construction costs
Waste types versatility	Certain limitations; pre-treatment of the wastes is usually needed	Wet wastes in rainy season makes operation difficult and will lead to elevated emissions
Production of residues	Usually no residues to dispose of	25-35% of the incinerated waste ends up as residues and need disposal
Emissions	Normally unaffected if properly operated	Exit gas have often high concentrations of dioxins and other air-pollutants
Green house gases	Reduces CO2 emissions compared to landfilling or incineration the same waste	Building WtE incinerators will add the number of emission points in a country

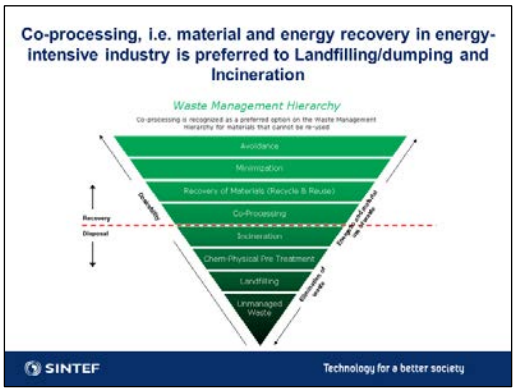
10. Possible to use Cement kilns?

Cement kilns have proven to be effective means of recovering value from waste materials and co-processing in cement kilns is now an integral component in the spectrum of viable options for treating several waste categories, practised in developed countries for the last four decades.

The two cement plants we have in Norway, replace today around 75% of its coal with waste, including plastic, and this has been the only treatment option for disposal of organic hazardous wastes in Norway for the last 30 years – a dedicated incinerator for hazardous wastes was never built.

This practice has been cost-effective, resource-efficient and environmentally sound compared to incineration. The energy utilization efficiency is much better than in an Incinerator with WtE – and no residues are produced, compared to around 30% in a WtE.

A preheater cement kiln possess many inherent features which makes it ideal for waste treatment; high temperatures, long residence time, surplus oxygen during and after combustion, good turbulence and mixing conditions, thermal inertia, counter currently dry scrubbing of the exit gas by alkaline raw material (neutralises all acid gases like hydrogen chloride), fixation of the traces of heavy metals in the clinker structure, no production of by-products and efficient recovery of energy and raw material components in the waste.



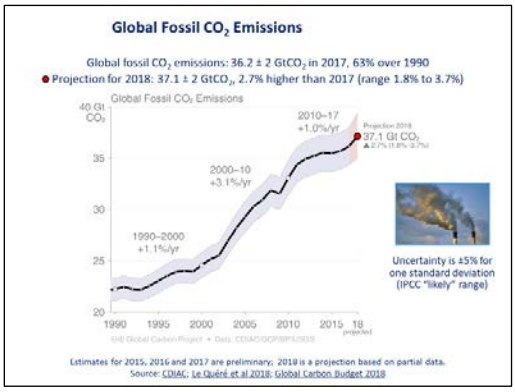
11. A win-win opportunity?

As not all plastic waste can be recycled, we need to find additional solutions to avoid that the plastic strangles us and our planet!

The project is expected to uncover a huge untapped potential to treat, remove and beneficially utilise non-recyclable plastic wastes by the private sector.

Cement production in five countries needs huge amounts of coal and emits more than 1 billion tonnes of CO_2.

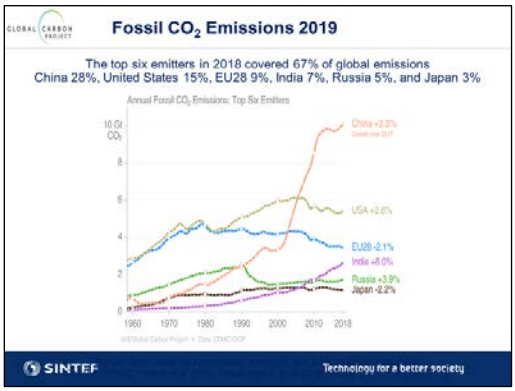
Our initial estimates show that the cement industry in the five countries can theoretically co-process all the plastic waste generated in the partner countries by replacing in average 10-20% of their coal usage, which would amount to millions of tonnes of coal/year – a solution worth considering?



The world likely needs to halve greenhouse-gas emissions within 2030 to prevent dangerous levels of global warming.

Global carbon dioxide emissions from fossil fuels will rise for the third straight year in 2019, ticking up an estimated 0.6% to a record 37 billion metric tons, according to the closely watched annual report from the Global Carbon Project.

Slight declines in the US and European Union were offset by projected increases in China, India, and other parts of the world, where economic growth is fuelling rising energy demands.



12. We want to showcase the plastic removal potential through local proof of concept

OPTOCE will carry out Pilot Demonstrations in local cement plants to investigate and document the feasibility, to prove the concept under various local conditions and to uncover potential limitations of the practice.

We have entered into agreements with central and local authorities, and with leading Waste management companies and Cement industry in all the OPTOCE-countries; we have agreements with universities and NGOs and will cooperate with international organisations like the Asian Development Bank, UNDP, UNEP, UNIDO etc.

The Pilot Demonstrations will document the performance, i.e. describe the co-processing capacity for Non-Recyclable Plastic Wastes, the environmental performance, cost- and energy efficiency, and the need for pre-treatment and preparation of the Non-Recyclable Plastic Wastes prior to co-processing, limitations in types and volumes of Plastic Wastes that can be co-processed etc.

The overall aim is to provide a quantitative and qualitative assessment of how the involvement of private industry can improve plastic waste management and prevent marine litter reaching the ocean in each country.

13. Planned Pilots in Thailand

Some Waste landfills and dumpsites in Thailand contain up to 42% plastic. There are about 2500 of these scattered around the country, which together will contain up to 190 million tonnes of accumulated plastic waste if representative (Sharma et al., 2020).

We have entered into an agreement with the second largest cement producer in the country, which extract plastic waste from dumpsites and use it as a coal substitute.

There is a great interest in utilizing resources and cleaning up landfills and dumpsites in Asia - they occupy large areas of valuable land and contributes with local and global pollution. We also intend to investigate and document the environmental implications and benefits of landfill mining together with the Asian Institute of Technology.

14. Planned Pilots in China

The Yangtze River in China is draining waste materials from hundreds of millions of people which leads to turbine problems in the world's largest dam plant located in Hubei Province (Three Gorges Dam).

We have entered into an agreement with Huaxin cement in the town of Zigui, located upstream of the dam, to document the possibility of collecting and co-processing floating materials from the river, including large quantities of plastic.

We have also entered into an agreement with BBMG cement in Jilin City, on the bank of the Songhua river. The aim of the pilot demonstration is to investigate the benefits of using Non-Recyclable Plastic Wastes from the paper recycling industry and a dumpsite as fuel in the local cement plant.

15. Planned Pilots in Vietnam

Asian paper mills use mostly used paper and cardboard imported from Europe and the Middle East in their production of new paper. Used paper with laminated plastic is a major waste problem throughout Asia.

We have entered into an agreement with Vietnam's largest Paper producer, which is located at the Mekong River and produces large quantities of Non-Recyclable Plastic Waste.

We will conduct a performance verification in the INSEE cement plant located in Hon Chong, Kien Giang province, to assess the suitability and feasibility to co-process such wastes.

In Vietnam we will also cooperate with UNDP in their project "Scaling Up a Socialised Model of Domestic Waste and Plastics Management in Five Cities". The OPTOCE project will collect the non-recyclable fraction of plastic waste and use it as fuel in the INSEE cement plant in Hon Chong.

16. Planned Pilots in Myanmar

Myanmar has currently no treatment options for non-recyclable plastic wastes. Together with environmental authorities MONREC-ECD and Myanmar's largest waste management company, we will initiate demonstration experiments in cement factories outside Mandalay and Yangon and assess whether plastic waste can be handled in an environmentally sound manner by involving the industry.

17. Planned Pilots in India

We have agreements with central and local environmental authorities in India, as well as the country's largest waste management companies, to demonstrate the feasibility of handling Non-Recyclable Plastic Wastes from major cities such as Agra and Goa.

18. International cooperation is crucial

The OPTOCE project, a part of the Norwegian Development Programme to Combat Marine Litter and Microplastics, has launched an Academic Collaboration in our partner countries.

The objective of the "Academic Collaboration" is to build competence on treatment options for Non-Recyclable Plastic Wastes (NRPW) and provide better knowledge about the NRPW situation in the country and the possibility to involve local energy intensive industry to solve waste problems.

The OPTOCE-project will generally contribute to support all the objectives of the Bangkok Declaration, while this Academic collaboration aims to build capacity, to strengthen research capacity and to support science-based policy and decision making.

The objective is to carry out parallel MSc-thesis research in India, China, Myanmar, Thailand and Vietnam during the academic year 2020/2021.

19. Marine Plastic Abatement

The Asian Institute of Technology in Thailand is launching the first postgraduate program on marine plastic litter in the Asia, called Marine Plastic Abatement (MPA).
https://www.ait.ac.th/2020/04/ait-launches-marine-plastic-litter-msc-with-us-3-mil-japanese-grant/
This programme is supported by the Japanese Government and aims to fund one-year MSc-scholarships for many students.

OPTOCE is involved in the development of the course curriculum, in teaching and in relevant research and student follow-up.

20. Capacity Building

Lessons learned from OPTOCE pilot demonstrations and from the academic collaboration will be shared through a regional multi-stakeholder forum, enabling awareness raising, capacity building and replication across the continent. The first forum will be hosted in Bangkok on 11 November 2021.

In conjunction with the Forum, SINTEF will organise the **1st International Conference on Treatment Options for Non-Recyclable Plastic Wastes** in Bangkok, Thailand, on 11-12 November 2021.

The aim is to share and discuss experiences, practical applications, research and recent findings and information about current treatment practice for non-recyclable plastic wastes. Please send an Abstract by 1 June 2021. For more details, participation, and presentations, please consult:

http://www.int-nrpw-conference.com
https://optoce.no/

21. Contact/information

Dr. Kåre Helge Karstensen
Chief scientist and Programme Manger
khk@sintef.no

References

Geyer, R., Jambeck, J.R., and Law, K.L., 2017. Production, use, and fate of all plastics ever made. Science Advances, 2017;3: e1700782. 19 July 2017.

Jambeck, J.R., Geyer, R., Wilcox, C., Siegler, T.R., Perryman, M., Andrady, A., Narayan, R., Law, K.L., 2015. Plastic waste inputs from land into the ocean. Science, 13 February 2015 Vol 347 Issue 6223.

Kåre Helge Karstensen, Palash Kumar Saha, Eirik Vigerust, Anneli Alatalo Paulsen, Christian John Engelsen and Mehdi Ahmadi, 2019. Ocean plastic: an opportunity in the circular economy? International Cement Review. October 2019. ISSN 0959-6038.

Kåre Helge Karstensen, Palash Kumar Saha, Eirik Vigerust, Anneli Alatalo Paulsen, Christian John Engelsen and Mehdi Ahmadi, 2019. Asia's plastic potential. International Cement Review. March 2020. ISSN 0959-6038.

Mutz, D., Hengevoss, D., Hugi, C. and Gross, T., 2017. Waste-to-Energy Options in Municipal Solid Waste Management. A Guide for Decision Makers in Developing and Emerging Countries. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany.

Regjeringen, 2020 (https://www.regjeringen.no/en/dokumenter/marine_litter/id2642037/

Sharma, A., Aloysius, V, Visvanathan, C., 2019. Recovery of plastics from dumpsites and landfills to prevent marine plastic pollution in Thailand. Waste Dispos. Sustain. Energy DOI 10.1007/ s42768-019-00027-7.

The state of plastics, 2018. World Environment Day Outlook, www.unenvironment.org

A few articles about the use of Cement Kilns:

Karstensen, K.H. et al., 2006. Environmentally Sound Destruction of Obsolete Pesticides in Developing Countries Using Cement Kilns. Environmental Science & Policy, 9, 577-586.

Karstensen, K.H., 2008. Formation, release and control of dioxins in cement kilns – A review. Chemosphere, 70 (2008) 543–560.

Karstensen, K.H., 2010. Test burn with PCB in a local cement kiln in Sri Lanka. Chemosphere, 78, 717-723. ISSN: 0045-6535

Karstensen, K.H. et al., 2014. Destruction of concentrated Chlorofluorocarbons in India demonstrates an effective option to simultaneously curb climate change and ozone depletion. Environmental Science and Policy, 38 (2014) 237-244. ISSN No. 1462-9011.