

Current status of plastic packaging recycling in the Nordics and the impact of packaging made from Trifilon biocomposites

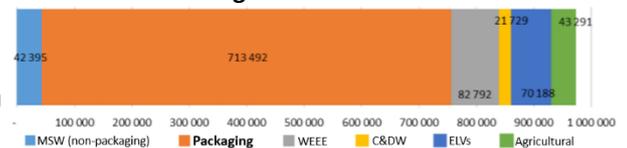
Plastics & Waste Management in the Nordics

The Nordic region includes some of the most developed and mature waste management and recycling systems in Europe, with various aspects of the industries rightly being seen as world-leading. While the Nordic countries have progressed along the same path as the rest of Europe (92% improvement since 2006ⁱ) with regards to improved recovery and recycling rates of plastic, the bulk of the waste plastic resources are still targeted towards Waste-to-Energy (WtE). Since the adoption of landfill bans and increased taxes on combustible waste (1997 Denmark, 1999 Norway, 2002 Sweden, 2003 Finland), WtE plants have played an important role throughout the Nordicsⁱⁱ. While energy recovery has offered a short-term solution to the landfilling of plastics (see Figure 1 belowⁱⁱⁱ), and securing a low cost feedstock for district heating, there is a clear mismatch between the national recycling targets and the existing recycling infrastructure in the Nordics today. Similarly to the rest of Europe, most of the plastic waste stream is generated from packaging (see Figure 2 below^{iv}).

Figure 1. Plastic post-consumer waste rates of recycling + energy recovery and landfill per country in 2018ⁱⁱⁱ



Figure 2. Plastic waste generated by waste stream in Nordic region – Eurostat 2016^{iv}



Sweden

Current Plastic Recycling Rate: 7,7% (domestic) and 4,8% (exported)^v

National Plastic Packaging Recycling Target: 55% by 2025^{vi}

Current Plastic Recovery System: The majority of Swedish plastic producers are part of the Extended Producer Responsibility Organisation (EPRO) Förpacknings- och Tidningsinsamlingen (FTI), which is responsible for the operation and collection of plastic packaging^{vii}. FTI has approximately 6000 unmanned bin sites across Sweden where households can dispose of their plastic packaging waste. The bin sites consist of separate containers that are emptied on a regular basis and then transported to sorting facilities contracted by FTI.

Current Plastic Recycling System: The vast majority of plastics, especially those coming from residential sources, are incinerated in one of Sweden's 34 WtE facilities (see Figure S2^{viii}). According to the 2019 report commissioned by the Swedish Environmental Protection Agency, of the 1.747.000 tonnes of plastic waste in Swedish circulation, only 134.000 tonnes were recycled^{ix}. Most troubling, of the 278.000 tonnes of residual waste recovered, whereof plastic packaging represented 249.000 tonnes or 89,5%, a total of 0 (zero) tonnes were recycled. All 278.000 tonnes went to energy recovery^x.

Recycling Systems Developments: In late 2019, FTI commissioned a new plastic recycling plant in Motala, Sweden. This plant has a nameplate sorting capacity of 120.000 tonnes/yr (~50% of the total residential plastic packaging waste in Sweden)^{xi}.

Impact of Trifilon based packaging on recycling: *Minimal.* Given that the density of Trifilon's specially designed packaging biocomposites are >1.00 g/cm³, they will likely sink to the bottom of a float/sink screening tank and be

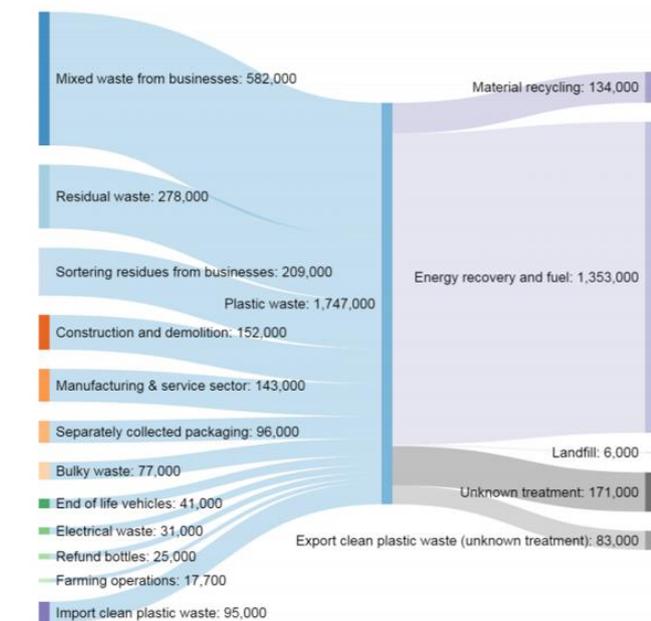


Figure S2: Overview of plastic waste flows and their treatment 2016/2017 (tonnes)^x

recycled via energy recovery for electricity and local district heating. Near infrared scanning will also detect a relatively high bio-content (+30%) and sort them for energy recovery.

Norway

Current Plastic Packaging Recycling Rate: 30,6% (exported)^{xii}

National Plastic Packaging Recycling Target: 50% by 2025^{xiii}

Current Plastic Recovery System: Norwegian municipalities are responsible for collecting and separating plastic from other waste streams. Collection is done through curbside collection and centralized bins. In 2019, 129.394 tonnes of plastic packaging were collected, of which 84.733 tonnes came from residential households^{xiv}.

Current Plastic Packaging Recycling System: *Limited*. Once separated from other waste streams, plastic is handled by the Norwegian plastic packaging EPRO Grønt Punkt Norge (similar to FTI in Sweden), which sends 99,9% of the plastic to northern Germany for further screening, recycling and energy-recovery via WtE^{xv}.

Future Recycling Systems: Finnish energy company Fortum recently signed a letter of intent with Grønt Punkt Norge to build a 30.000 tonne/yr recycling+WtE plant in Indre Østfold municipality^{xvi}. No timeline is yet given.

Impact of Trifilon based packaging on recycling: *Minimal*. Packaging made with Trifilon's biocomposites would be separated together with other residential plastic packaging and sent to northern Germany for recycling. There, due to its density being >1.00 g/cm³, it would be screened out during the float/sink and sent to energy recovery.

Denmark

Current Plastic Packaging Recycling Rate: 13% (domestic) and 28% (exported)^{xvii}

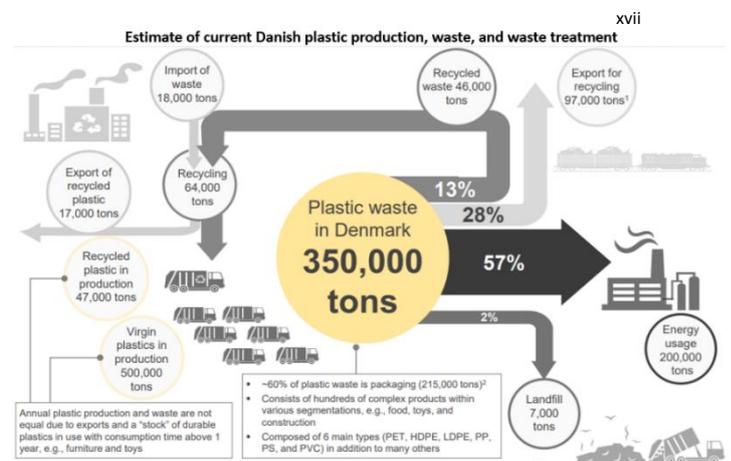
National Plastic Packaging Recycling Target: 50% by 2025^{xviii}

Current Plastic Recovery System: Today, of the total 350.000 tonnes of plastic waste generated in Denmark each year, 125.000 tonnes of residential plastic waste is collected by local Danish municipalities via curbside or central bins^{xix}.

Current Plastic Packaging Recycling System: The large waste incineration overcapacity in Denmark has limited the incentive to switch waste volumes to recycling. Today, industry is the main contributor to plastics packaging recycling and collects ~64% for recycling, compared to households that recycle ~15%^{xx}. There are little economic incentives to recycle the highly variable household plastic waste stream, as Danish WtE plants incinerate 57% of Denmark's plastic waste for energy and district heating^{xxi}.

Future Recycling Systems: *Limited*. The newly commissioned Copenhill / Amager Bakke WtE plant near Copenhagen was commissioned in 2017 and has an annual capacity of 400.000 – 560.000 tonnes/yr and will require a significant portion of Denmark's plastic waste to run efficiently^{xxii}.

Impact of Trifilon based packaging on recycling: *Minimal*. Given the current state of recycling and incentives for WtE in Denmark, it is likely that packaging made from Trifilon's biocomposites will be burned for electricity and district heating.



Finland

Current Plastic Packaging Recycling Rate: 25% (includes WtE)^{xxiii}



National Plastic Packaging Recycling Target: 50% by 2025^{xxiv}

Current Plastic Recovery System: Suomen Uusiomuovi Oy (SU), the Finnish plastic packaging EPRO, operates 500 bring stations and 30 curb-side sorting facilities throughout Finland^{xxv}. SU delivers sorted plastic waste to Fortum's Riihimäki WtE / recycling centre^{xxvi}.

Current Plastic Packaging Recycling System: *Limited*. Fortum's Riihimäki plant is the only domestic recycling plant in Finland focused on post-consumer packaging and has a capacity of 20.000 tonnes / yr^{xxvii}. L&T's Muoviportti 20.000 tonnes/ year facility also recycles plastic waste but is focused on industrial scrap^{xxviii}. According to VTT,

the Technical Research Centre of Finland, 40 to 60% of separately collected plastic waste ends up being incinerated^{xxix}.

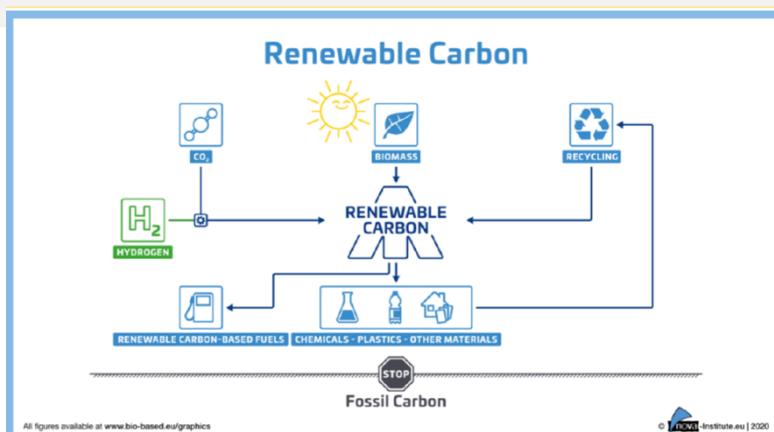
Future Recycling Systems: VTT has successfully demonstrated a chemical recycling technology that promises to provide an environmentally friendly alternative to incineration^{xxx}. No commercialization timeline has been provided.

Impact of Trifilon based packaging on recycling: *Minimal*. Given the current state of recycling Finland, it is likely that packaging made from Trifilon's biocomposites will be burned for electricity and district heating.

Conclusion

While the Nordics have some of the most advanced recycling and waste management systems in the world, the use of municipal waste as a fuel for district heat production has become established. Its role in balancing the electricity, district heating and waste management needs of the Nordic countries mean that there is little economic incentive currently to increase the rate of plastic packaging recycling. Without this fuel source, WtE plants throughout the Nordics would need to find alternative sources of fuel, such as imported plastic waste or forest residues.

Given the current recycling and waste management infrastructure of the Nordics, the impact of Trifilon's biocomposites will be minimal. Being partially bio-based, packaging made from Trifilon biocomposites will offer a lower CO₂ footprint versus conventional plastics when incinerated, while contributing toward the EU 2030 goal of using bio-based feedstocks for plastic packaging. Trifilon's sustainable plastics align with the EU wide push toward "renewable carbon" based plastic packaging (Figure 5 below^{xviii}).



- ⁱ [Plastics-the Facts 2019, An analysis of European plastics production, demand and waste data, Plastics Europe.](#)
- ⁱⁱ [Analysis of Nordic regulatory framework on waste prevention and recycling, Nordic Council of Ministers 2019](#)
- ⁱⁱⁱ [Plastics-the Facts 2019, An analysis of European plastics production, demand and waste data, Plastics Europe](#)
- ^{iv} [Plastic Waste Markets Overcoming barriers to better resource utilisation, Nordic Council of Ministers, 2018](#)
- ^v [Kartläggning av plastflöden i Sverige, Sveriges Meteorologiska och Hydrologiska Institut, 2019](#)
- ^{vi} [Plastsprånget 2025, Svensk Plaståtervinning, 2019](#)
- ^{vii} [Avfall Sverige. Svensk Avfallshantering 2017; Avfall Sverige: Malmö, Sweden, 2017](#)
- ^{viii} [Kartläggning av plastflöden i Sverige, Sveriges Meteorologiska och Hydrologiska Institut, 2019](#)
- ^{ix} [Kartläggning av plastflöden i Sverige, Sveriges Meteorologiska och Hydrologiska Institut, 2019](#)
- ^x [Kartläggning av plastflöden i Sverige, Sveriges Meteorologiska och Hydrologiska Institut, 2019](#)
- ^{xi} [Sverige blir självförsörjande på plaståtervinning – ny anläggning invigs i dag, Dagens Nyheter, 2019](#)
- ^{xii} [Veikart for sirkulær plastemballasje i Norge, Emballasje Foreningen, 2019](#)
- ^{xiii} [Veikart for sirkulær plastemballasje i Norge, Emballasje Foreningen, 2019](#)
- ^{xiv} [Grønt Punkt Norge, Fakta og tall, 2020](#)
- ^{xv} [Grønt Punkt Norge, Fakta og tall, 2020](#)
- ^{xvi} [Fortum og Grønt Punkt Norge går sammen, Fortum Press, 2020](#)
- ^{xvii} [New Plastics Economy, A Research, Innovation and Business Opportunity for Denmark, McKinsey&Company, 2019](#)
- ^{xviii} [Plastik uden spild – Regeringens plastikhandlingsplan, Dansk Miljø- og Fødevareministeriet, 2018](#)
- ^{xix} [New Plastics Economy, A Research, Innovation and Business Opportunity for Denmark, McKinsey&Company, 2019](#)
- ^{xx} [New Plastics Economy, A Research, Innovation and Business Opportunity for Denmark, McKinsey&Company, 2019](#)
- ^{xxi} [New Plastics Economy, A Research, Innovation and Business Opportunity for Denmark, McKinsey&Company, 2019](#)
- ^{xxii} [A Danish fiasco: the Copenhagen incineration plant, Zero Waste Europe, 2019](#)
- ^{xxiii} [Reduce and refuse recycle and replace – A Plastics Roadmap for Finland, Ministry of the Environment, Finland, 2018](#)
- ^{xxiv} [Reduce and refuse recycle and replace – A Plastics Roadmap for Finland, Ministry of the Environment, Finland, 2018](#)
- ^{xxv} [Plastics recycling guarantor in Finland, Suomen Uusiomuovi Oy, 2020](#)
- ^{xxvi} [Plastics recycling guarantor in Finland, Suomen Uusiomuovi Oy, 2020](#)
- ^{xxvii} [Finland exports plastic waste, Yle, Finnish National Broadcaster, 2020](#)
- ^{xxviii} [Muovin, kartongin ja paperin kierrätyskäytänteet Suomessa, Milla Leikas, 2020](#)
- ^{xxix} [VTT to add new methods to the plastics recycling chain, VTT Press, 2019](#)
- ^{xxx} [VTT to add new methods to the plastics recycling chain, VTT Press, 2019](#)
- ^{xxviii} [Renewable Carbon is the Key to a Sustainable and Future-Oriented Chemical and Plastic Industry, Nova-Institute, 2020](#)