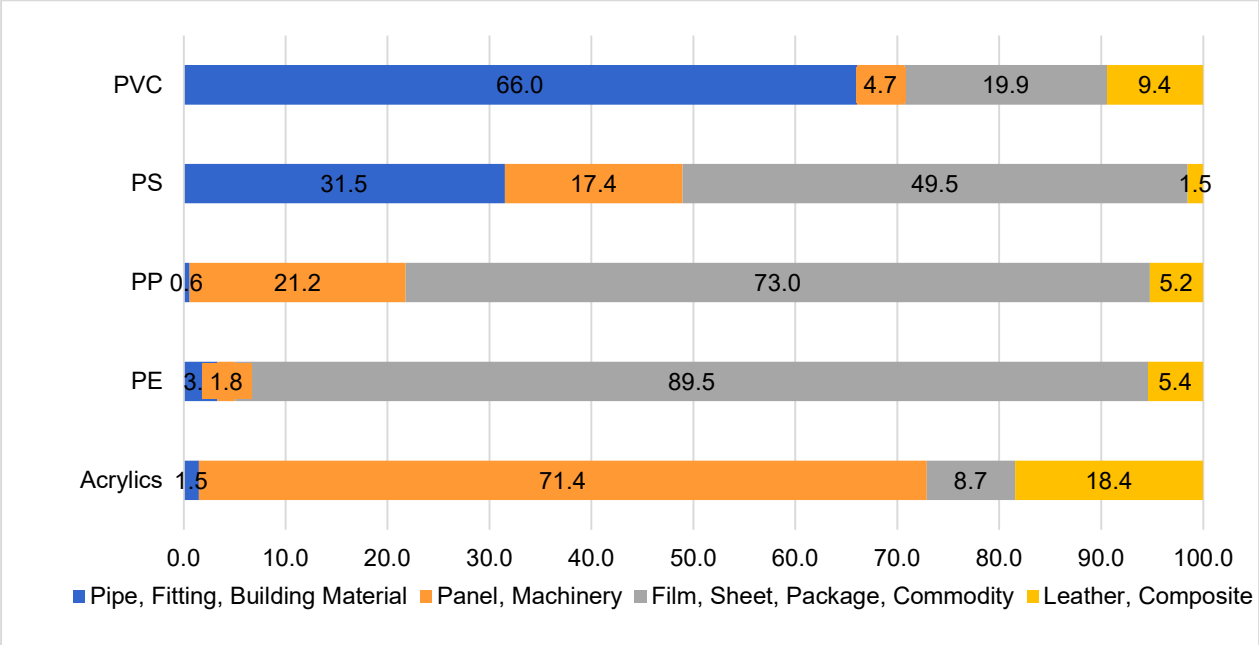
Global warming and PVC

1. Contribution to Global Warming Prevention through PVC Products

1.1 PVC products have a long life

Service Life	Over 15 years	5 to 15 years	Less than 5 years	others
Application	Pipe, Fitting, Building Material	Panel, Machinery	Film, Sheet, Package, Commodity	Leather, Composite



PVC is characterized by its long service life compared to other plastic products, as its use in pipes, fittings, and building materials accounts for 66% of the total.

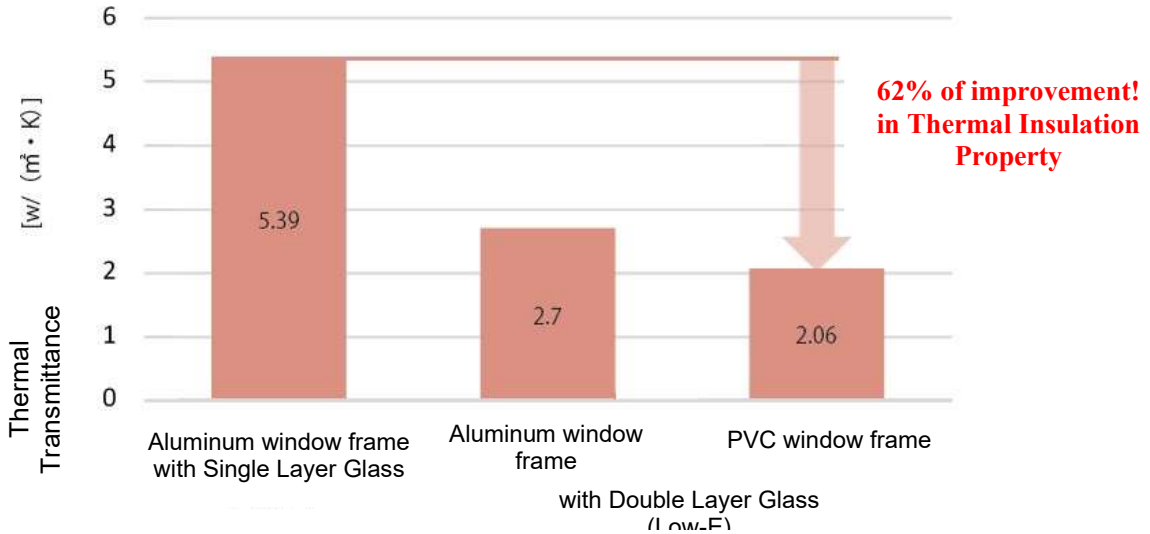
For example, Japan's Ministry of Land, Infrastructure, Transport and Tourism (MLIT) data indicate that pipes made of hard PVC pipe have an expected service life of 40 years, also the Japan PVC Pipe and Fittings Association evaluated that the estimated service life of 50 years or more. One of its advantages is that it is resistant to corrosion and is inexpensive to construct and repair. In Japan, the average life span of houses is only about 30 years, which is shorter than in Europe and the United States (data from the MLIT: Japan 32 years, the United States 67 years, and the United Kingdom 81 years)*[1]. It is expected that more efficient use of national wealth will be possible by using materials with longer service lives.

(*1) Source: MLIT FY2018 Housing Economy Data

https://www.mlit.go.jp/statistics/details/t-jutaku-2_tk_000002.html

(Changes in the average number of years after construction of lost houses)

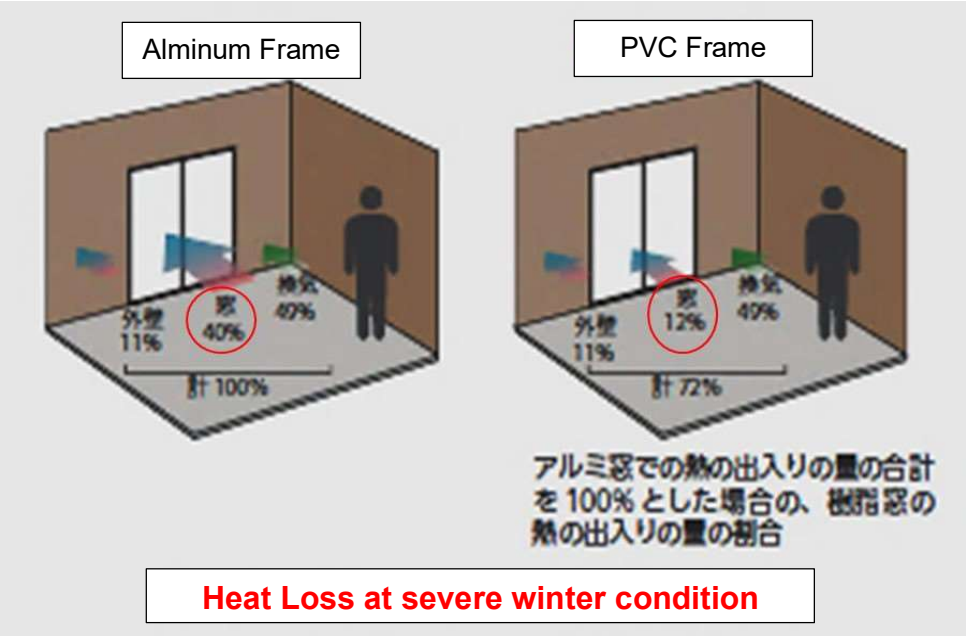
1.2 Energy-saving performance of PVC window frames and window openings products



Data from “Technical information on evaluation of energy consumption performance in accordance with 2016 energy conservation standards” by Building Research Institute

Comparison of Thermal Transmittance of window

PVC windows (windows with PVC frame) can greatly reduce the heat flow in and out of the room, saving heating cost. PVC windows offer excellent insulation, heat shielding, and airtightness, resulting in less heat escaping and entering from windows. For this reason, the insulation efficiency of PVC windows is improved by approximately 62% compared to aluminum single-layer glass windows.



In addition, research results by the "Society of Thinking the Realization of ZEB/ZEH " (2016-19) held by VEC revealed the following energy-saving and condensation-prevention benefits of PVC windows.

・Chairman: Professor Akimoto, Faculty of Architecture, Shibaura Institute of Technology

・Purpose: Research activities aimed at spreading PVC windows to buildings through industry-academia-government collaboration
・Activities: Thermal environment measurement by differences in window type in hotels and nursing homes, and thermal environment measurement with PVC windows in apartment houses
・Results: Improvement of indoor thermal environment in hotels, nursing houses, and apartment houses with PVC windows compared to the case of aluminum single-layer glass windows, prevention of condensation (95% improvement) and energy saving (approximately 30% reduction) were found.

VEC is currently evaluating the energy-saving and dew-prevention performance of PVC windows in hospitals and nursing houses that eliminate the risk of mold outbreak and secondary infections and are expected to have effects on the health of residents (research results by the Study Group for Considering the Indoor Environment of Hospitals and Nursing Houses from Windows, Chairman: Prof. Akimoto, 2019-ongoing).

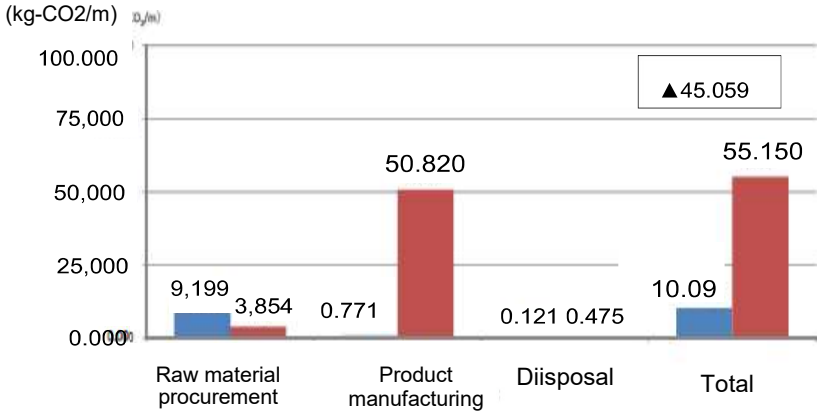
Furthermore, the "Study Group on Thermal Shielding and Insulation of Window Openings" (Chairman: Prof. Akimoto, 2019-ongoing), currently conducted by VEC, measures the performance of various types of building materials for window openings to further reduce heating and cooling energy. Until now, one of the results is the summer energy-saving benefits of adding shutters and shades to PVC windows, approximately 16% and 14%, respectively.

1.3 Less environmental impact than other materials in pipes and agricultural vinyl films

Plastic products consume much less energy during the manufacturing and processing stages of their raw materials and consume much less total energy than other materials.

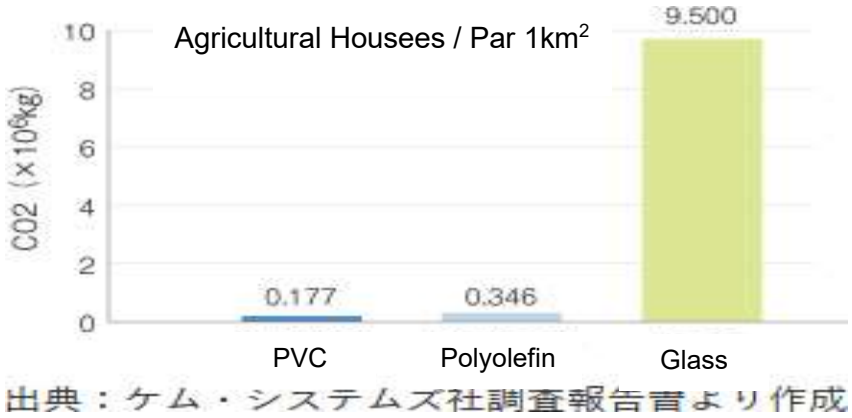
When you consider the global warming issue, the extent of CO_2 emissions in the lifecycle of materials from manufacturing to consumption/disposal is a key indicator. In comparison with iron and glass, PVC pipes and agricultural house have less CO_2 emission than steel pipes and agricultural house glass respectively.

Comparison of CO_2 Emissions from Manufacturing by Material: Pipes



Blue = PVC pipe, red = cast iron pipe (source) JCIA cLCA (2014)

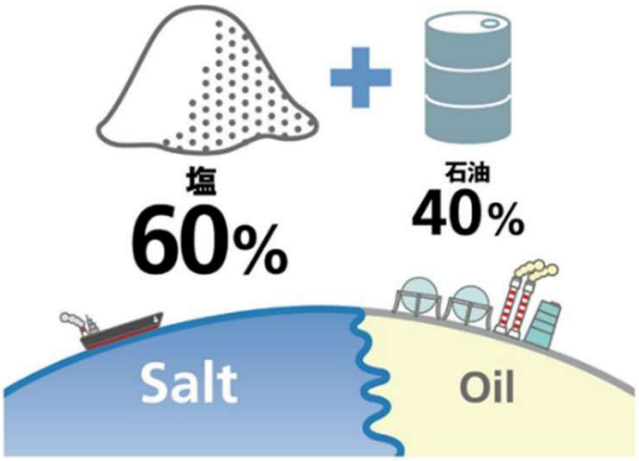
Comparisons of CO_2 Emissions from Manufacturing with Materials: Agricultural Houses



2. Reduction of greenhouse gas emissions in the production of PVC resins and products

2.1 60% of PVC raw materials are industrial salt

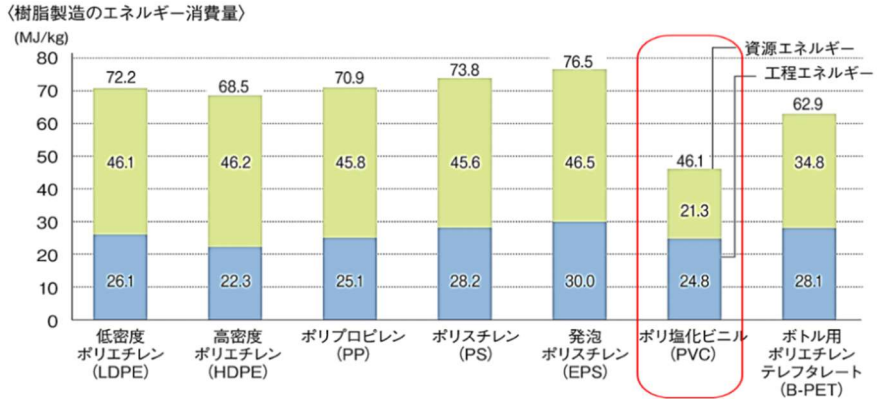
About 60% of PVC is chlorine (Cl) derived from natural industrial salts (NaCl), which are abundant in the planet. Unlike many other plastics made from 100% petroleum, PVC is greatly contributing to the conservation of limited petroleum resources.



2.2 Less resource energy consumption than other plastic materials

Comparison of the required energy in the resin manufacturing stage is shown below. You can see that the resource energy (energy required from resources) is less than other hydrocarbons because the contribution of "industrial salt" 60% of the raw material.

Comparison of Required Energy in Resin Manufacturing Phase



Data from “LCI Data of Petrochemical Resins” by Plastic Waste Management Institute

There are no significant differences between the various types of resins in the process energy (energy required for processing) from oil mining to the resin manufacturing stage. However, in terms of resource energy, chloride accounts for 60% of the composition of PVC and is therefore less than resin mainly composed of hydrocarbons, and the total energy load of resources and processes is also less than that of resin mainly composed of hydrocarbons. In this way, PVC saves energy at the manufacturing stage and contributes to the reduction of CO_2 emissions.

2.3 Less energy in manufacturing the same product compared to other materials

As described in 1.3, PVC products consume much less energy in the manufacturing and processing stages of raw materials than other materials.

PVC is also a material that emits less CO_2 over its lifecycle, from manufacturing to consuming and disposing of materials, because it has a smaller amount of natural resource energy.

2.4 PVC manufacturers are actively working to save energy and reduce GHG emissions.

Major manufacturers of PVC are also actively contributing to the "Low Carbon Society Action Plan" in the chemical industry, which is compiled through the Japan Chemical Industry Association.

The chemical industry as a whole aims to reduce CO_2 by 6.5 million tons from BAU level *2 and to reduce the absolute volume by 6.79 million tons (based on FY2013 standards) as a target for FY2030. Japan's chemical industry is already at the world's highest level of energy efficiency, but it will work to further improve energy efficiency by spreading best practices and technologies.

Major PVC manufacturers have set voluntary standards and are actively working to reduce greenhouse gas emissions *3.

(*2) BAU Ratio: Compared to emissions projected for sustained activity

(*3) Refer to the following websites for the results of activities in the environmental reports, etc. of major companies.

・Shin-Etsu Chemical: "Climate Change Response" Activities Introduction Site

https://www.shinetsu.co.jp/jp/sustainability/esg_environment/global_warming/

・Tosoh Corporation: Tosoh Report 2020

https://www.tosoh.co.jp/csr/environment/climate.html

・Kaneka: ESG Activity Introduction Website (Environmental _Climate Change)

https://www.kaneka.co.jp/esg/environment/env/climate-change.html

・Tokuyama: Tokuyama Group CSRs "Efforts to Prevent Global Warming"

https://www.tokuyama.co.jp/csr/global_warming.html

3. Reducing greenhouse gas emissions during the disposal and regeneration of PVC products

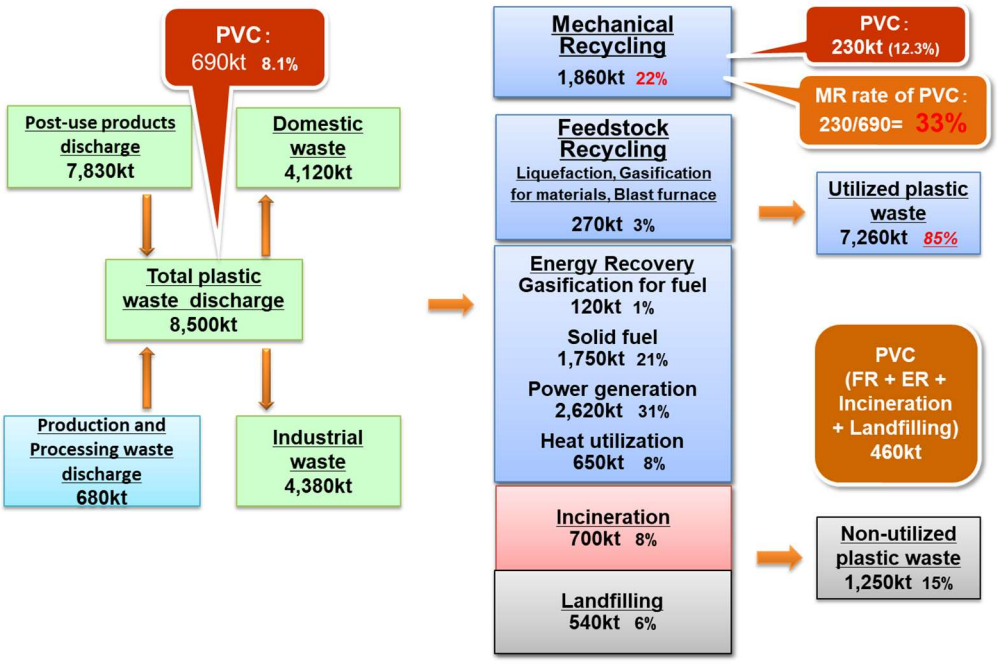
In the disposal and recycling stages, PVC products have a relatively high material recycling (MR) ratio of around 33% compared to other plastics.

The PVC industry has been actively engaged in MRs such as pipes and agricultural PVC. In order to contribute to chemical recycling (CR) of waste plastics as well as to build an MR system for PVC window frames and other materials, VEC Recycling Promotion System provides new support for research project candidates of chlorine-separation technologies and other technologies.

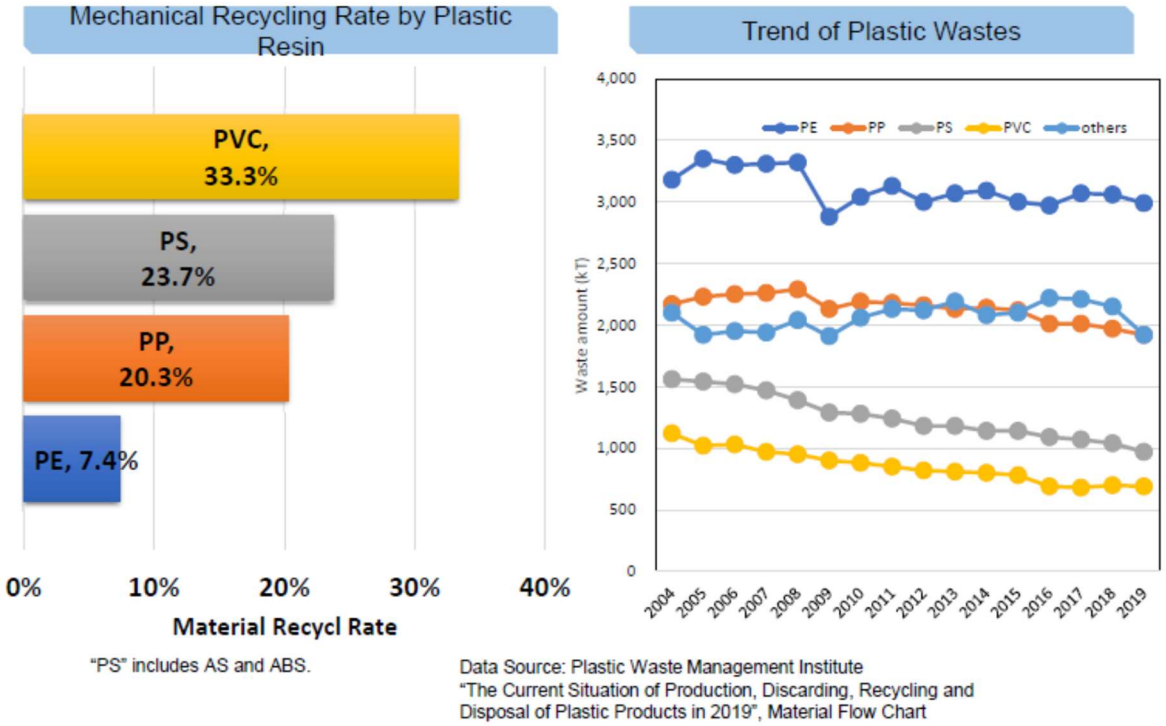
3.1 The MR ratio of PVC is around 33%, which is relatively high among plastics.

The following is a flow chart of the production, disposal, and recycling of plastics. The total amount of waste plastics discharged was 8.5 million tons, the amount of material recycled was 1.86 million tons, and the material recycling rate was 186/850 = 22%. In contrast, the total amount of PVC produced was 690,000 tons and the amount of waste PVC material recycled was 230,000 tons, so the material recycling rate was 23/69 = 33%, which is considerably higher than the overall average (2019 data).

Status of Plastic Manufacturing, Disposal, and Recycling 2019



PVC Mechanical Recycling in Japan

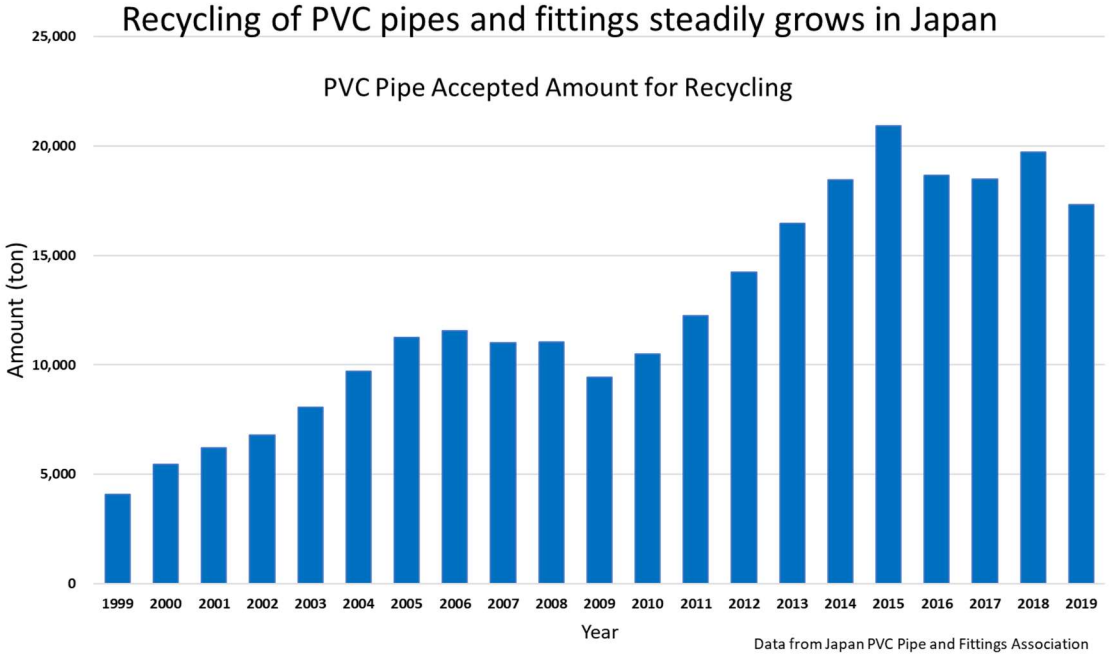


"PS" includes AS and ABS.

Data Source: Plastic Waste Management Institute
"The Current Situation of Production, Discarding, Recycling and Disposal of Plastic Products in 2019", Material Flow Chart

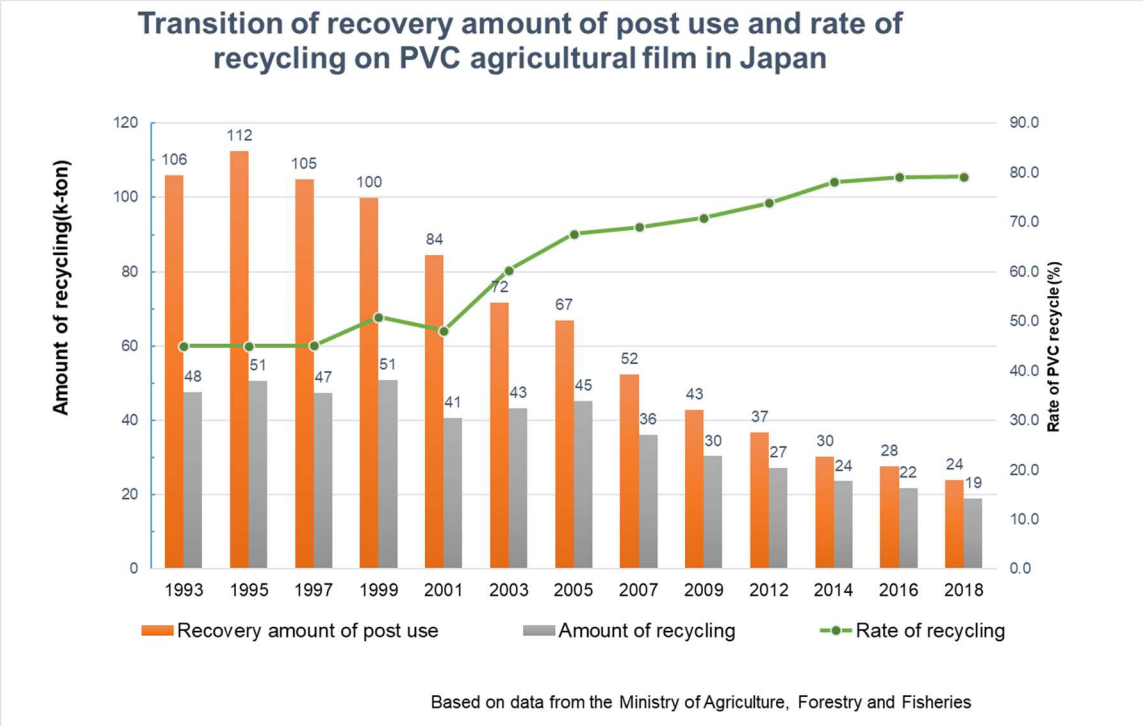
3.2 In addition to pipes, agricultural PVC films and other products, VEC will continue to work on MRs such as plastic windows.

PVC Pipes and Fittings



Data from Japan PVC Pipe and Fittings Association

PVC Agricultural Fiims



PVC Window Frame

30th August 2019, VEC launched the "PVC Window Recycling Review Committee" (Chair: Professor Tsuyoshi Seike of the University of Tokyo) in cooperation with the Japan Sash Manufacturers Association and the PVC Windows Industries Association.

The three groups will work together to build and realize a framework for promoting the recycling of waste PVC windows. Starting with the examination of the collection processing route plan, we will organize and examine the issues related to the construction of the medium to long term recycling system, such as the search for applications of recycled products, product design, and verification tests.

3.3 Recognizing the importance of material recycling in the early 2000s, VEC established a recycling support system in 2007, and has been promoting recycling support activities since early on. Recently, in order to contribute to the chemical recycling (CR) of waste plastics as a whole, the industry is searching for chlorine separation technologies.

Outline of Recycling Support System

- Purpose of system establishment at 2007
  VEC will further promote PVC recycling by supporting advanced efforts by related companies and organizations, such as the development of technologies related to PVC recycling and the construction of recycling systems.
- Framework at the time of system establishment
  Projects to be sponsored by the Support System

- Development of technology related to PVC recycling
- Development of a system related to PVC recycling
- Demonstration experiment related to PVC recycling

  Projects will be adopted based on the opinions of the "Evaluation Committee" consisting of outside experts.

- How to sponsor the qualified projects
  Period: Within 2 years
  Sponsored to cover: Development costs (material costs, utility costs, outsourcing costs, etc.) Equipment / equipment costs
  Sponsorship amount: 50% of the sponsorship cost and up to JPN 20 million.
- Achievements: 9 cases were supported, among which 2 cases put into practical use

Improvement of Recycling Support System (2020)

To expand coverage to support budding technology, the following condition was added to qualifying requirements.

- Development of important basic technologies related to PVC recycling
  The following technology will be qualified;
  - Technology that has the potential for chemical recycling using PVC as a raw material for other useful substances
  - De-chlorination technology that facilitates use as a reducing agent or fuel
  - Separation technology of PVC resin from a mixture of various types of resin for the purpose of recycling

    Among the technologies to be used, those with a certain evaluation

4. Conclusion

PVC is a material that contributes to curbing global warming in a comprehensive way.

VEC will continue to strive to gain a correct understanding of these features of PVC. In addition, we are actively working to bring together VEC's efforts to achieve our targets, such as "zero-greenhouse gas emissions of newly built houses by 2030."

<Column> Role of caustic soda in PVC

This paper focuses on the properties of PVC that can directly contribute to global warming, but PVC also has the aspect of serving as a stable compound of chlorine, which is a co-product in the electrolysis of caustic soda (sodium hydroxide). Considering that caustic soda plays an important role in various aspects related to the global environment, such as water neutralizers and raw materials for lithium-ion batteries, it can be said that PVC also contributes indirectly to global environmental issues.