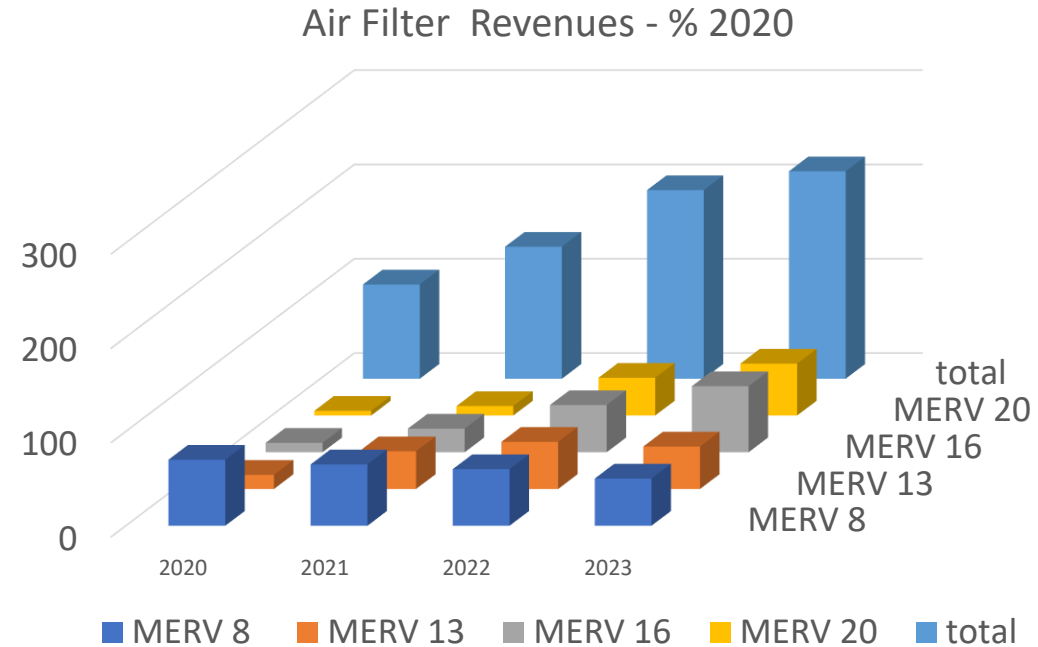


Air Filter Market and Proactive Program for Suppliers

A service offered by the
McIlvaine Company



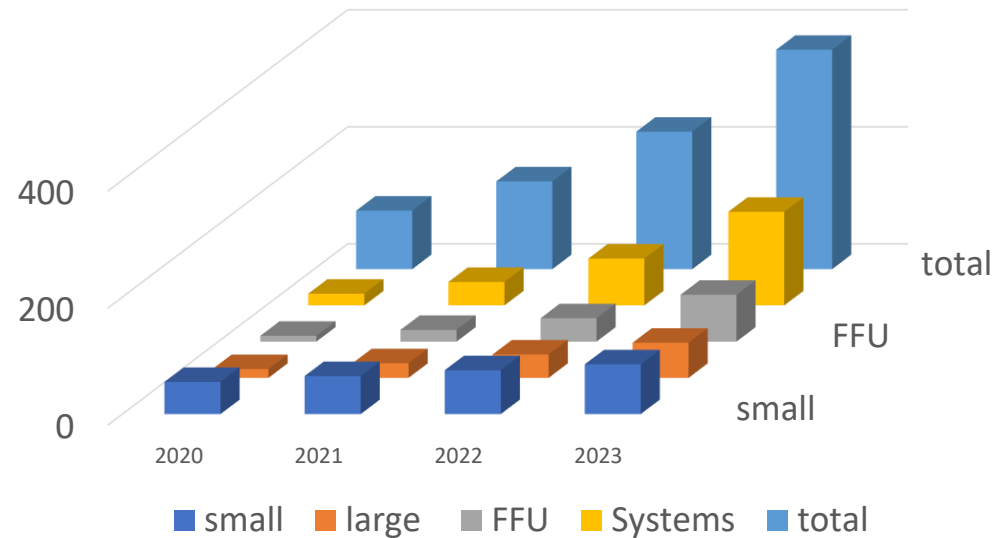
Evidence is growing that highly efficient air filters will be needed to vanquish COVID. A proactive program by filter and media suppliers would greatly reduce COVID and generate very large revenues for suppliers of media and filters.



MERV 8 filters will not remove more than 15% of the viruses. MERV 13 filters will remove about 40% of the virus. The MERV 16 filter will remove close to 70%. The market for high efficiency MERV 17-20 filters with a proactive supplier program is forecast to grow 10-fold over the next 4 years. The MERV 14-16 market will grow 7-fold

Room air purifiers, fan filter units, and laminar flow systems will be critical to preventing the spread of COVID. There is already a market for small air purifiers but growth in larger units will be the trend in the future.

Stand Alone, FFU, Laminar Flow System Revenues -%
2020



There will be high growth for fan-filter units which will be a better solution than partitions. The best solution is controlled laminar air flow systems with HEPA filtered air. They will find increasing use in nursing homes, meat processors and other applications in addition to their present use in cleanrooms and hospital operating suites.

McIlvaine is providing enough information in the daily alerts and analysis to make it possible to justify the investment in a specific type of filter for a specific location in a specific process and determine the risk reduction. Many influencers and purchasers do not understand the differences in filter efficiency and are therefore not investing in the right products to reduce their risk to levels they believe acceptable.

As a result the market for efficient filters and systems is much smaller than it will be when buyers and influencers are presented with reliable cost/benefit information. There is the opportunity for the suppliers to greatly increase sales by joining in a program to

1. Ascertain reliable cost/benefit information for every application in every country for each type of process
2. Communicate that information to the influencers and decision makers with webinars, magazine articles, and white papers
3. Receive market forecasts for the thousands of individual opportunities with an understanding of competitive advantages and disadvantages



Air Filter Market and Proactive Program for Suppliers

Contents and Costs

Scope

- Coronavirus Technology Solutions
 - Daily Alerts and Analysis
 - Webinars and White Papers
 - Easy search capabilities
- home.mcilvainecompany.com/index.php/markets/air/82ai-coronavirus-market-intelligence
- Air Filter Market Program
 - True cost evaluations of all options
 - Continuously updated and comprehensive market forecasts
 - Five recorded interviews
 - Participation in general webinars
 - Participation in important decisions such as ways to define the market (but also the customer choices)
 - Ability to shape the market with input to Alerts and webinars

Deliverables and Costs

- Provision of the daily alert to any designated individual within the company
- Custom website to encourage intra company discussions
- Display of the forecasts for each country continually revised and displayed
- Intra company sales and technical discussions
- All services for 12 months for the price of \$8900





Factors Shaping the Market

The following factors are shaping the market and are being continually assessed



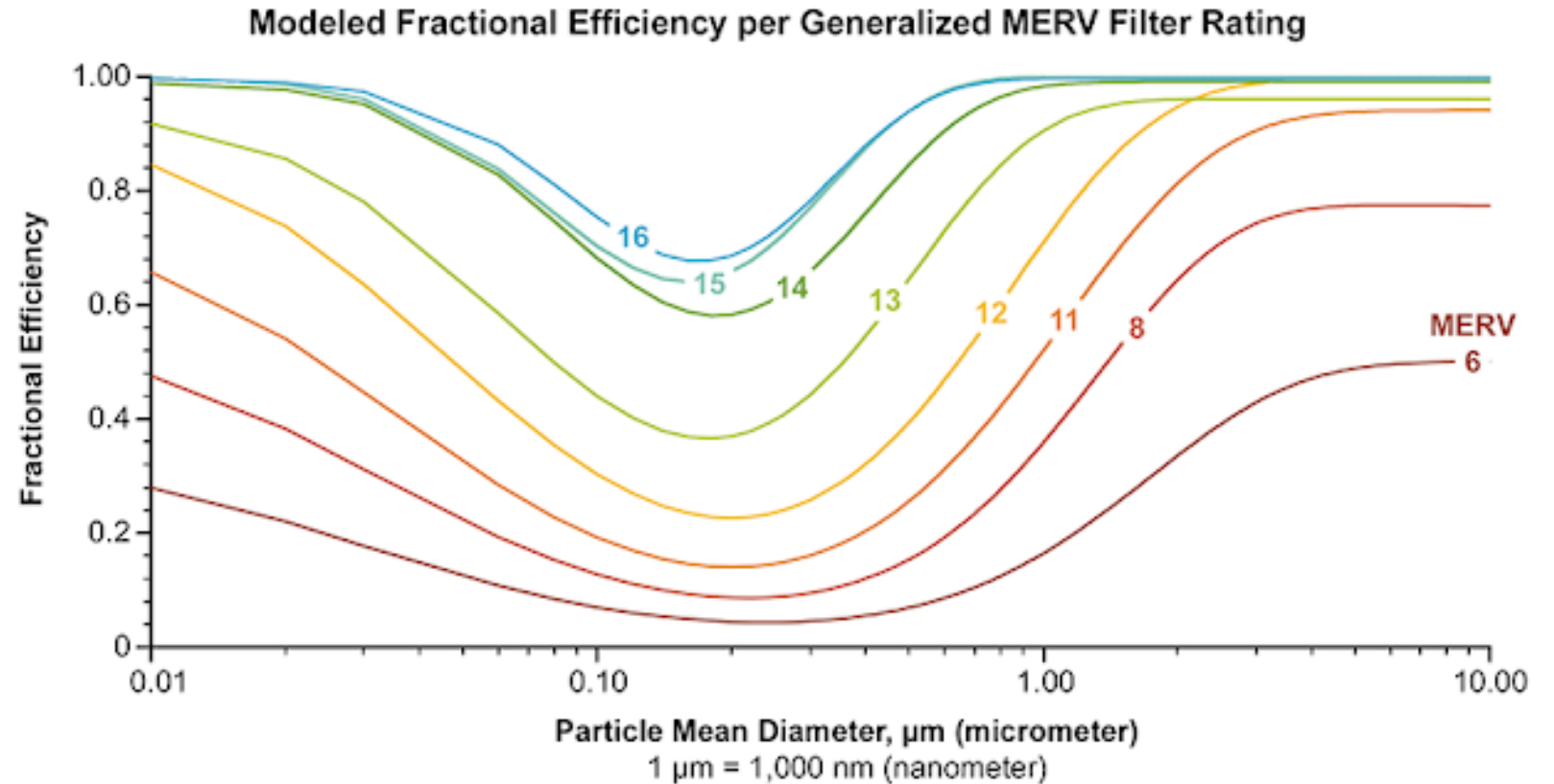
Issue	Aspects
Virus Parameters	Size, quantity, minimum infectious load, life, destruction methods, deposition on duct internal surface, distance traveled
Treatment Types	Filtration, ionization, UV disinfection, precipitators, carbon beds. What is the performance and how widely is each used? Are combinations used and is this a benefit?
Filter Design	Pleated, panel, box, pocket
Filter Media	Membranes vs micro fiberglass for high efficiency, shapes, pleats, and other parameters
Particulate Efficiency	Viral removal performance of the range of MERV and HEPA filters including the efficiency after any electrostatic charge dissipates
Placement	Pre filter or final filter,
Pressure Loss	Filter depth vs filter efficiency and pressure drop
Filter Inventory	How efficient are filters now installed in schools, nursing homes, meat processors, etc. What about buildings without HVAC?

Expense	How costly will it be to install more efficient filters?
Air Quantity	How many air changes per hour are needed? How much outside air should be introduced? How is this limited cost wise by outdoor temperature and humidity?
Air Direction	How is air directed so that the maximum amount flows from transmitter to the HVAC system and then is diluted prior to reaching the recipient? Where are partitions and diffusers beneficial?
Room Air Purifiers	When and where should they be used and what volume and efficiency is needed?
Fan Filter Units	Where should they be used rather than partitions or in conjunction with partitions?
Isolators, Modules	Where are isolators and modular cleanrooms the best choice?
Pollution Combination	Use of filters to eliminate air pollutants and viruses in outdoor spaces such as traffic intersections?
Indoor Air	Benefits of purifying indoor air to remove pollutants as well as viruses; a common metric to measure all harm and good
Processes	Rooms, elevators, reception, cashier counters, industrial processing, machinery rooms, individual AC units
Facilities	Residential, commercial, hotel, nursing homes, hospitals, dental, meat processing, schools, gyms, transportation



Efficiency Comparisons

If one assumes that the capture of COVID on a % basis is equivalent to the MERV efficiency at 0.3 microns, the MERV 8 filters installed in most schools are removing only 10%. They may be capturing 75% of the 10-micron cough droplets but if these droplets evaporate then 90% of the virus in these droplets will pass through the filter.



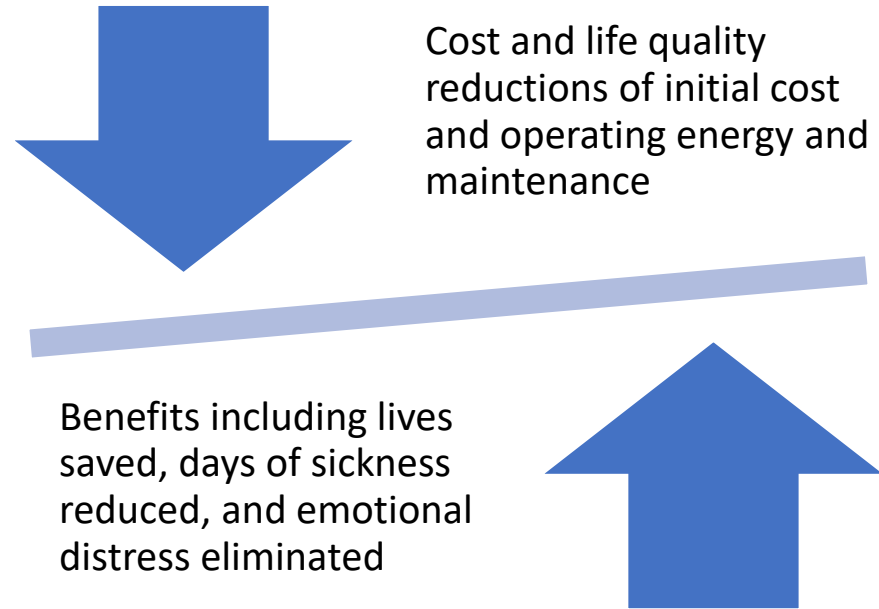
Source: W.J. Kowalski and W.P. Bahnfleth, "MERV Filter Models for Aerobiological Applications" (2002)

Children wearing masks will be generating small aerosols. A MERV 16 filter will remove only 70% of the virus. A vaccine vial in a pharmaceutical cleanroom is protected by a 99.999 % removal of any potential virus in the air. It would therefore be a priority to do better than 70% to protect children and teachers.



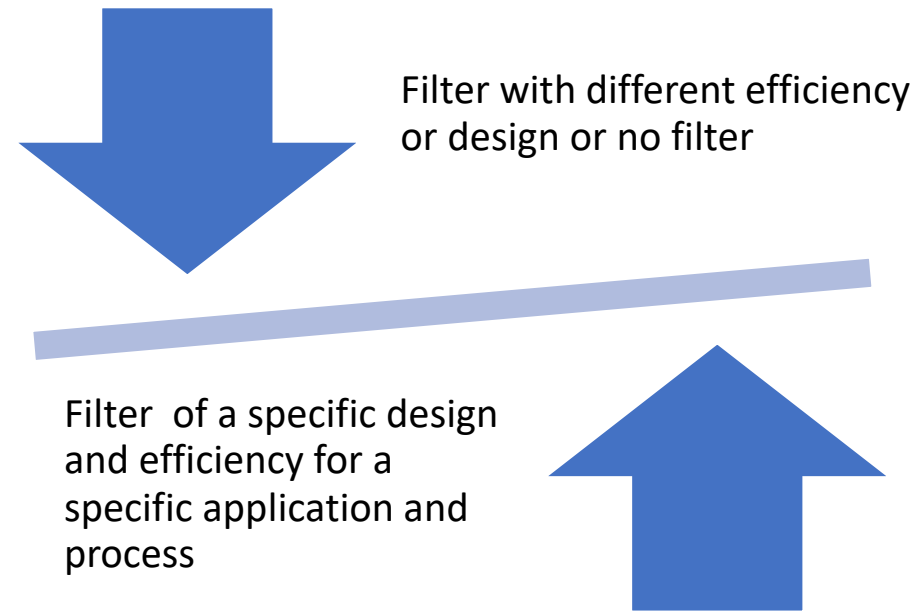
Shaping the Market through Analysis and Collaboration

The investment in filters is a function of perceived life quality net impacts. A true cost analysis will be performed for each filter type in each application. A common metric to measure all harm and good was originally developed through a contract with a major surgical gown supplier but it is uniquely applicable to all COVID related choices. Since this metric incorporates the life quality risk choices as well as tribal and discounted future values, it is a true reflection of the will of the people rather than imposed morality.



Many of the factors such energy consumption and upgrade cost are those within the control of suppliers. Collaboration among suppliers can result in shaping the basis for true cost. For example, a major filter media company has volunteered to test the aerosol generation from cloth masks and filters. With this program and collaboration of the participants the market can be shaped to the benefit of everyone.

True costs need to be determined for each circumstance. Everyone agrees that there are high virus load situations where M 20 filters are unquestionably the choice. In a crowded subway FFFUS with HEPA filters may be the best choice. An M16 filter may be the best choice in some residential settings..



The filter comparison includes the common metric of Quality Enhanced Life Days (QELD). Every minute we drive in a zone with a 65-mph limit reduces life expectancy by 30 seconds . If we went back to the 55-mph limit, we would statistically lose 25 seconds of life for each minute spent traveling. The difference is a few days over a lifetime. But we make many decisions such as eating ice cream that shorten life but enhance life quality. We can probably justify a lower filter efficiency equal to the risk of a 65-mph speed limit, but few people will want to take the risk of raising the limits to 100 mph or being in a space with inefficient filtration which adds that much extra risk.

Fan Filter Units are Better than Partitions

Fan Filter Units (FFUs) are widely used in the cleanroom industry. They clean and move 500 cfm economically.

Many establishments from restaurants to meat processors are using partitions which cause air turbulence when they would be much better off with FFUs.

HEPA filtered air moves downward sweeping any virus away from the breathing zone toward the floor. It then rises and is re-filtered.



Big Box Store with laminar flow from ceiling to floor.

HEPA filtered air flows from ceiling units such as FFUs in a downward path thereby removing viruses from the breathing zone. If you think of the virus as traveling like second-hand smoke, you quickly realize the advantages of this approach rather than social distancing.



Forecasts

Filter Market by Media Type - \$ Millions								
Subject	2018	2019	2020	2021	2022	2023	2024	2025
Total	X	X	X	X	X	X	X	X
MERV 1-7	X	X	X	X	X	X	X	X
MERV 8-12	X	X	X	X	X	X	X	X
MERV 9-13	X	X	X	X	X	X	X	X
MERV14-16	X	X	X	X	X	X	X	X
MERV 17-20	X	X	X	X	X	X	X	X

This segmentation differentiates based on the efficiency of the media. In general the higher the efficiency the greater the projected growth rate. COVID is the big driver but the growing awareness of contaminants from indoor activities plus the ambient air being introduced into the space will be a factor.

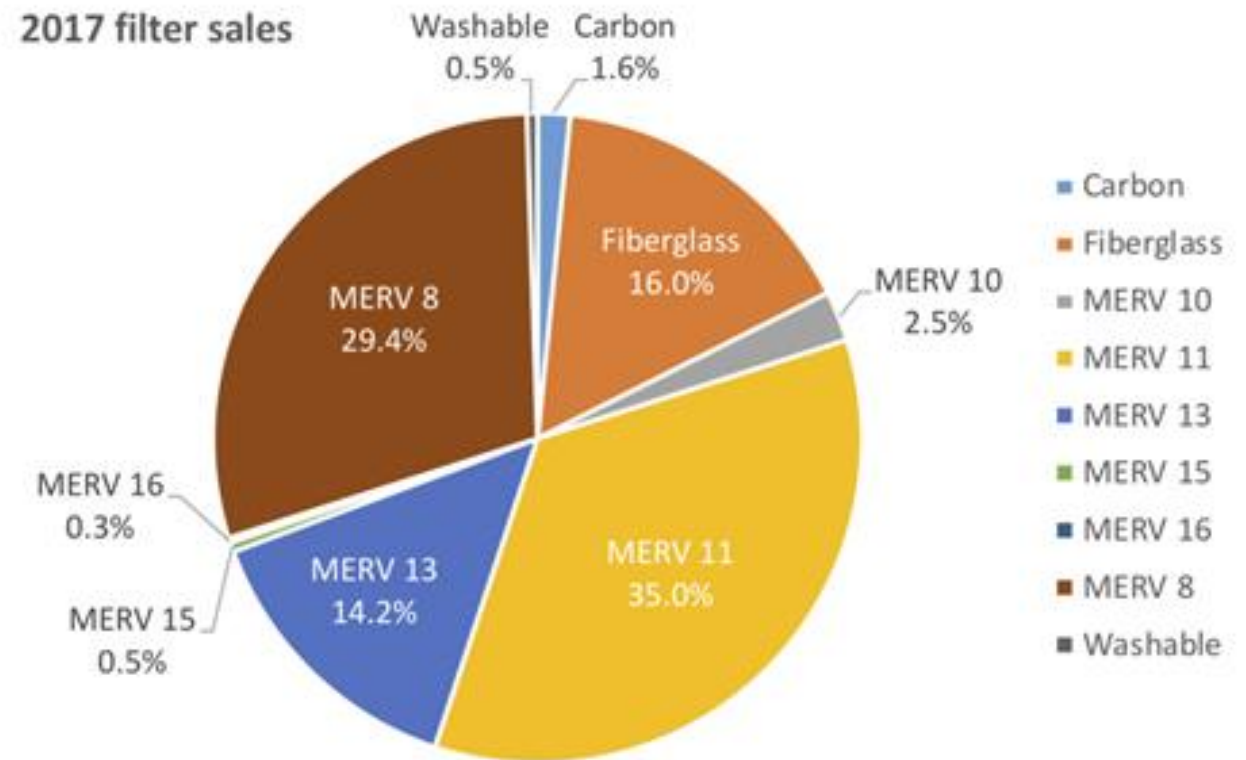


Historical Filter Sales Based on Efficiency

As of 2017 in the U.S. the MERV 8 filters were outselling less efficient fiberglass filters by nearly 2-1. MERV 11 held the biggest market share.

As of Mid 2020 there is a huge demand for MERV 13 filters. With the proactive program the future growth will be in MERV 16 and higher.

The U.S. distribution is not representative for all countries. In China more efficient filters have been utilized due to air pollution concerns.



Filter Market by Scope - \$ millions								
Subject	2018	2019	2020	2021	2022	2023	2024	2025
Filter	x	x	x	x	x	x	x	x
Media	x	x	x	x	x	x	x	x

Media are forecasted in M2 per year and \$ for major media types. Filter revenues are forecasted in \$/yr based on the price obtained by the filter manufacturer. There is analysis of the distribution chain and mark ups through the supply chain. The forecasts take into account artificial price pressures exerted by governments.

Forecasts are constantly revised. The longer-range forecasts are shaped by the availability of vaccines and therapies. Since McIlvaine also publishes *Coronavirus Pharmaceutical Solutions* it has the perspective to evaluate this impact.



Market by Country - \$ millions								
Subject	2018	2019	2020	2021	2022	2023	2024	2025
Argentina	x	x	x	x	x	x	x	x
Bolivia	x	x	x	x	x	x	x	x
Brazil	x	x	x	x	x	x	x	x
Chile	x	x	x	x	x	x	x	x
Columbia	x	x	x	x	x	x	x	x

Forecasts are provided for each filter type in each application in each of 80 countries and sub regions. The forecasts are then aggregated by region. The forecasts take into account the air pollution as well as COVID mitigation in China and other Asian cities. For underdeveloped countries, the U.N. assistance programs are evaluated.



Market by Product - \$ millions								
Subject	2018	2019	2020	2021	2022	2023	2024	2025
Small AP	x	x	x	x	x	x	x	x
Large AP	x	x	x	x	x	x	x	x
FFUs	x	x	x	x	x	x	x	x
Laminar Systems	x	x	x	x	x	x	x	x
Total	x	x	x	x	x	x	x	x

Forecasts are provided for each equipment product type in each application in each of 80 countries and sub regions. The forecasts are then aggregated by region. The forecasts take into account the air pollution as well as COVID mitigation in China and other Asian cities. For underdeveloped countries, the U.N. assistance programs are evaluated. This group is segmented into small air purifiers (AP) covering less than 100 ft2, large air purifiers, fan filter units (FFUs) and laminar flow systems with HEPA ceiling filters.



Market by Application

- Efficient filters will be a primary weapon to vanquish COVID. The individual will wake to clean air in his residence, ride a subway with clean HEPA filtered air emanating from the roof and then enter a building with clean filtered air in the elevator and in the working space. He will enjoy lunch in a restaurant with HEPA filters and laminar downward air flow.
- The new evidence that much of the transmission is by small aerosols which can travel long distances means that filters become the first line of defense.
- Selection of filter efficiency will be influenced by the viral load.
- The most accurate way to forecast filter use in any country is to analyze each of application rather than just use total population figures. Each application will also be impacted by pollutants generated internally and pollutants in the ambient air.
- The next display segments these applications



Filter Market by Application - \$ Millions

Subject	2018	2019	2020	2021	2022	2023	2024	2025
Commercial	X	X	X	X	X	X	X	X
Education	X	X	X	X	X	X	X	X
Government	X	X	X	X	X	X	X	X
Hospitals	X	X	X	X	X	X	X	X
Nursing homes	X	X	X	X	X	X	X	X
Food processing	X	X	X	X	X	X	X	X
Pharmaceutical	X	X	X	X	X	X	X	X
Semiconductor	X	X	X	X	X	X	X	X
Other healthcare	X	X	X	X	X	X	X	X
Other industrial	X	X	X	X	X	X	X	X
Residential	X	X	X	X	X	X	X	X
Transportation	X	X	X	X	X	X	X	X
Entertainment, dining, sports	X	X	X	X	X	X	X	X



Analysis of the Technology

- The market is shaped by developing knowledge and technology. The Daily Alerts, interviews and webinars are providing insights which change the outlook. The amount of new information and resultant potential progress is unprecedented. Many suppliers have made the COVID problem their # 1 priority.
- The following listing shows some of the newer media technologies which are being evaluated in the daily alerts.
- They are listed chronologically with the latest reports first.
- New designs are being introduced on an almost daily basis.
- The Daily Alert is 10 pages in length. This extensive coverage is necessary to keep up with the developments
- The following lists cover the period of July 1 to August 7.

RECENT FILTER MEDIA ANALYSES IN THE *CORONAVIRUS TECHNOLOGY SOLUTIONS*

<u>Date</u>	<u>Company</u>	<u>Type</u>	<u>Details</u>
8-7	Verder	Nanofiber	Surface and depth
8-7	HiFyber	Nanofiber	High efficiency
8-7	Fibertex	Nanofiber	High and medium efficiency
7-27	AAF	fiberglass	MERV 16
7-24	H&V	Nanoweb	MERV 15
7-24	Camfil	Microfiber glass	Single stage (no prefilter)
7-24	Filtration Group	Rigid cell	Upgrade to M15 at same pressure
7-22	Koch	V Bank	High virus capture with MERV 15
7-20	ITT	2 inch M 13	Good performance on virus
7-9	U. Houston	Nickel foam	Heated filter has 99.9% virus kill
7-8	M+H	Cabin air	polyphenol anti-microbial coating
7-1	AAF	membrane	Better for ULPA and HEPA