

# Heat Pump Closed Loop Spray Drying

Energy Consumption Less than 1/3 of Conventional Spray Drying

## Environmental Benefits, United States

- Natural Gas Mitigation, Therms per Year: 7.7 Billion
- CO<sub>2</sub> Mitigation, Tons per Year: 46.7 Million

## End User Benefits, Food and Dairy Sector

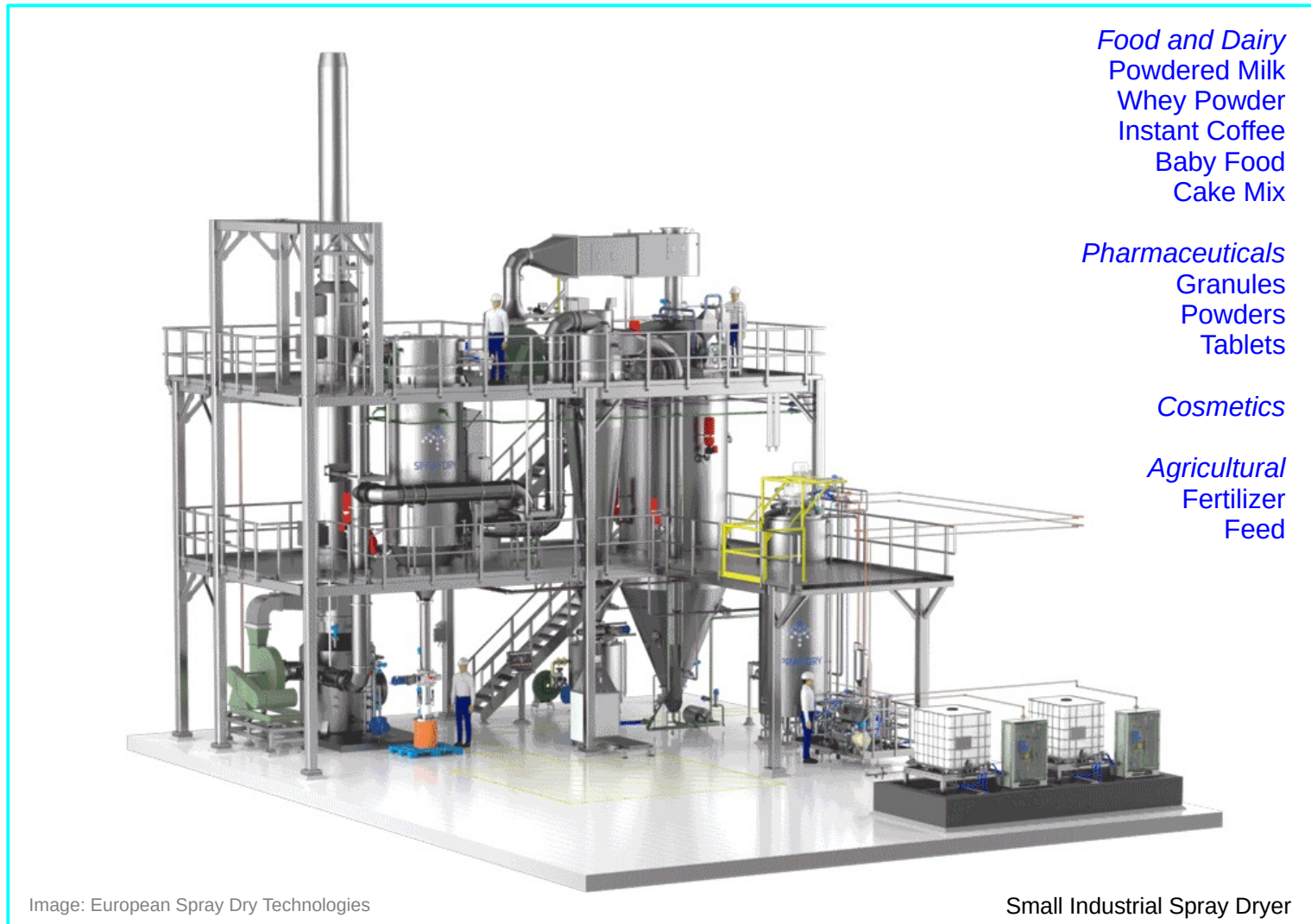
- Operating Cost Saved per Dryer Year: \$1.2 Million
- Typical ROI: < 3 Years

Spray Drying is the only practical method for converting liquid into powder at scale.

Industrial Spray Dryers are a ubiquitous critical link in supply chain infrastructure.

*Spray Dryers affect myriad aspects of industrial production. Modern life effectively depends on them.*

Spray Dryers are used for Food & Dairy, Pharmaceutical, Chemical, and many other products.



**Food and Dairy**  
 Powdered Milk  
 Whey Powder  
 Instant Coffee  
 Baby Food  
 Cake Mix

**Pharmaceuticals**  
 Granules  
 Powders  
 Tablets

**Cosmetics**

**Agricultural**  
 Fertilizer  
 Feed

Image: European Spray Dry Technologies

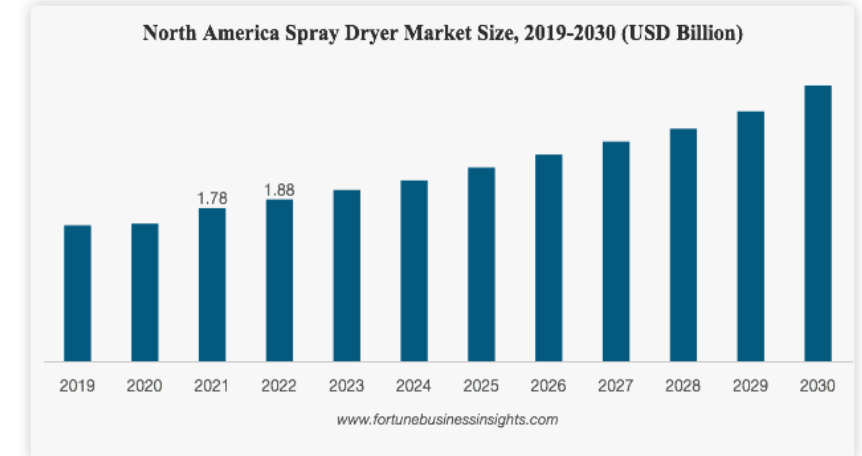
Small Industrial Spray Dryer

## Industrial Spray Dryer Market

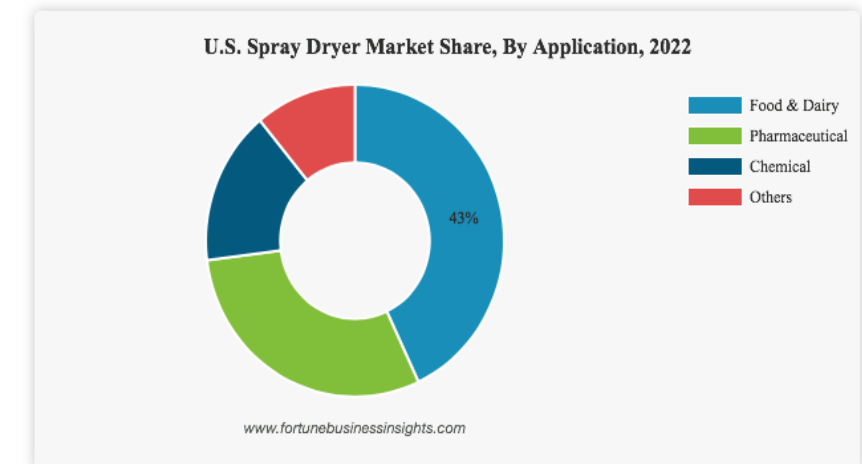
Spray Dryer Market Size (2023)	US\$ 4.98 Bn
Spray Dryer Market Size (2030)	US\$ 7.64 Bn
Spray Dryer Market CAGR	4.4%

US Market Trends

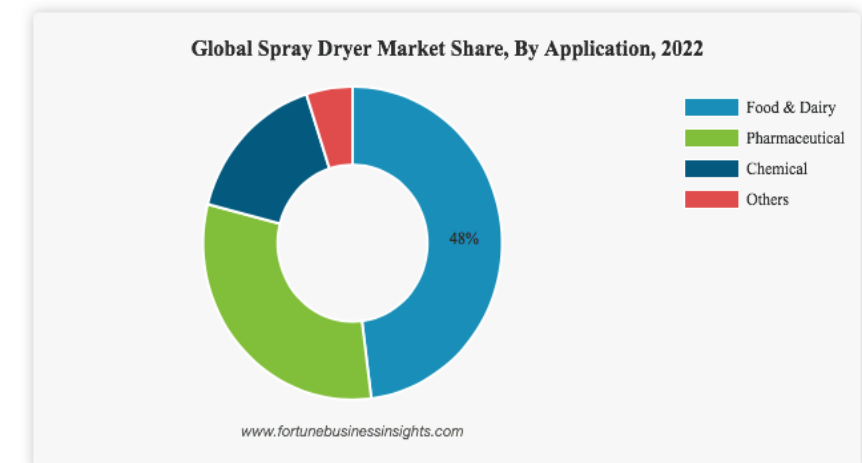
North America Projection



United States Market Share



Global Market Share



Sources:  
 Fortune Business Insights  
 Fortune Market Insights  
 Global Market Insights  
 Mordor Intelligence  
 Fact.MR

Annual market trends and projections shown are for new transactions. The HPCL Dryer market comprises the entire installed base, new dryers and retrofits.

Convection drying is always driven by the *humidity* of the drying air.

This air must be very dry, on the order of 2% rH.

Conventional dryers heat incoming ambient air *to reduce its humidity*.

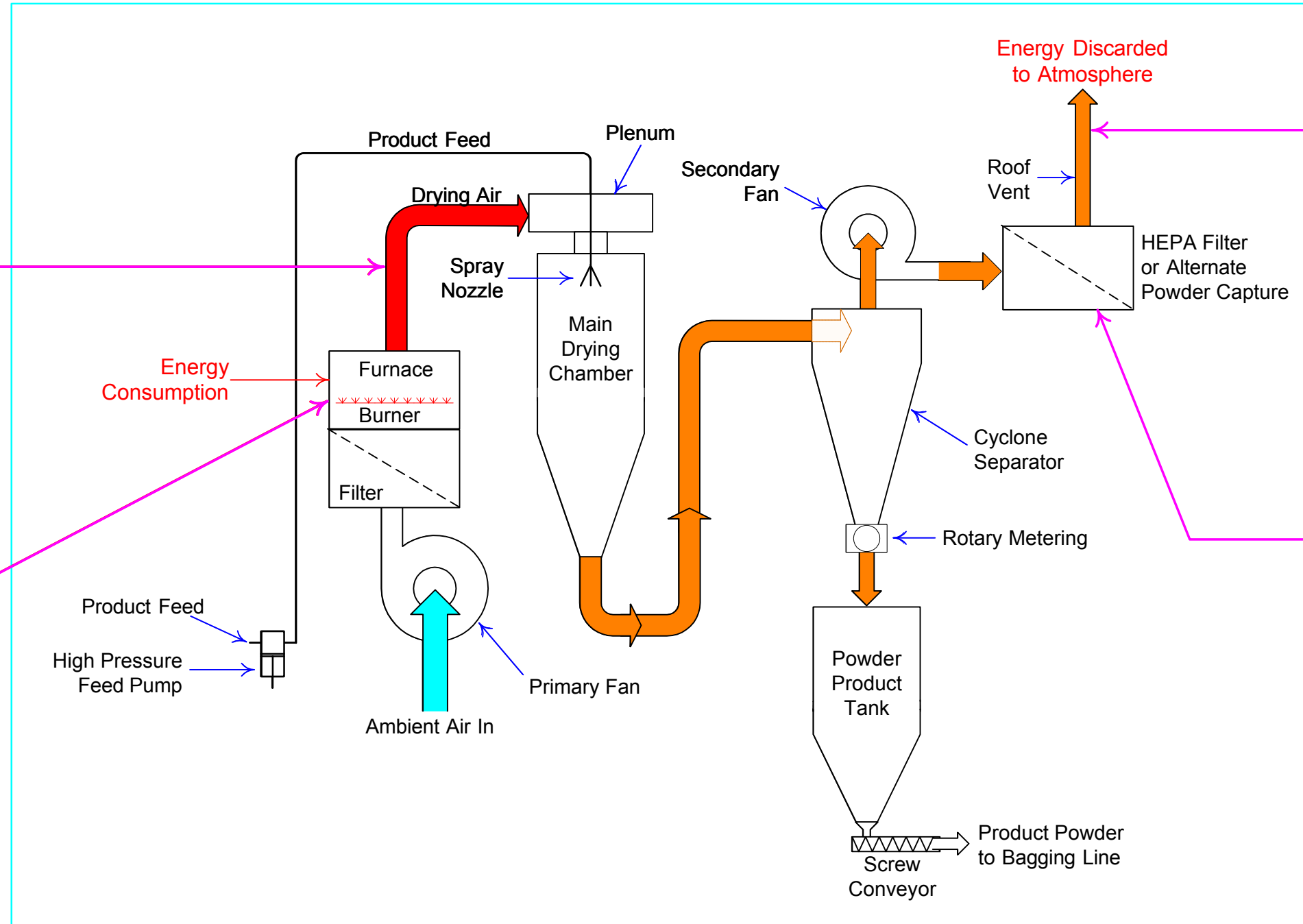
In order to achieve sufficiently low humidity, they run very hot, typically 400° to 500° F.

This presents significant powder product degradation issues.

Conventional spray dryers, typically gas or steam heated, are highly energy intensive.

A typical industrial dairy dryer, with water removal capacity of 8,000 - 10,000 Lb/Hr., consumes 15 - 20 Million BTU/Hr.

Typical energy consumption is then 100 - 130 Billion BTU/Year.



Present day dairy spray dryers are variations on the same shared theme:

*Large quantities of energy are consumed and discarded to the atmosphere.*

*Hot drying air passes through the drying chamber once.*

*Much of the drying air bypasses the product entirely, and exits without doing useful work.*

*Conventional spray drying produces powder fines, a significant air pollutant.*

*Powder fines must be removed from the dryer discharge airstream before it is vented, via HEPA filtration or equivalent means.*

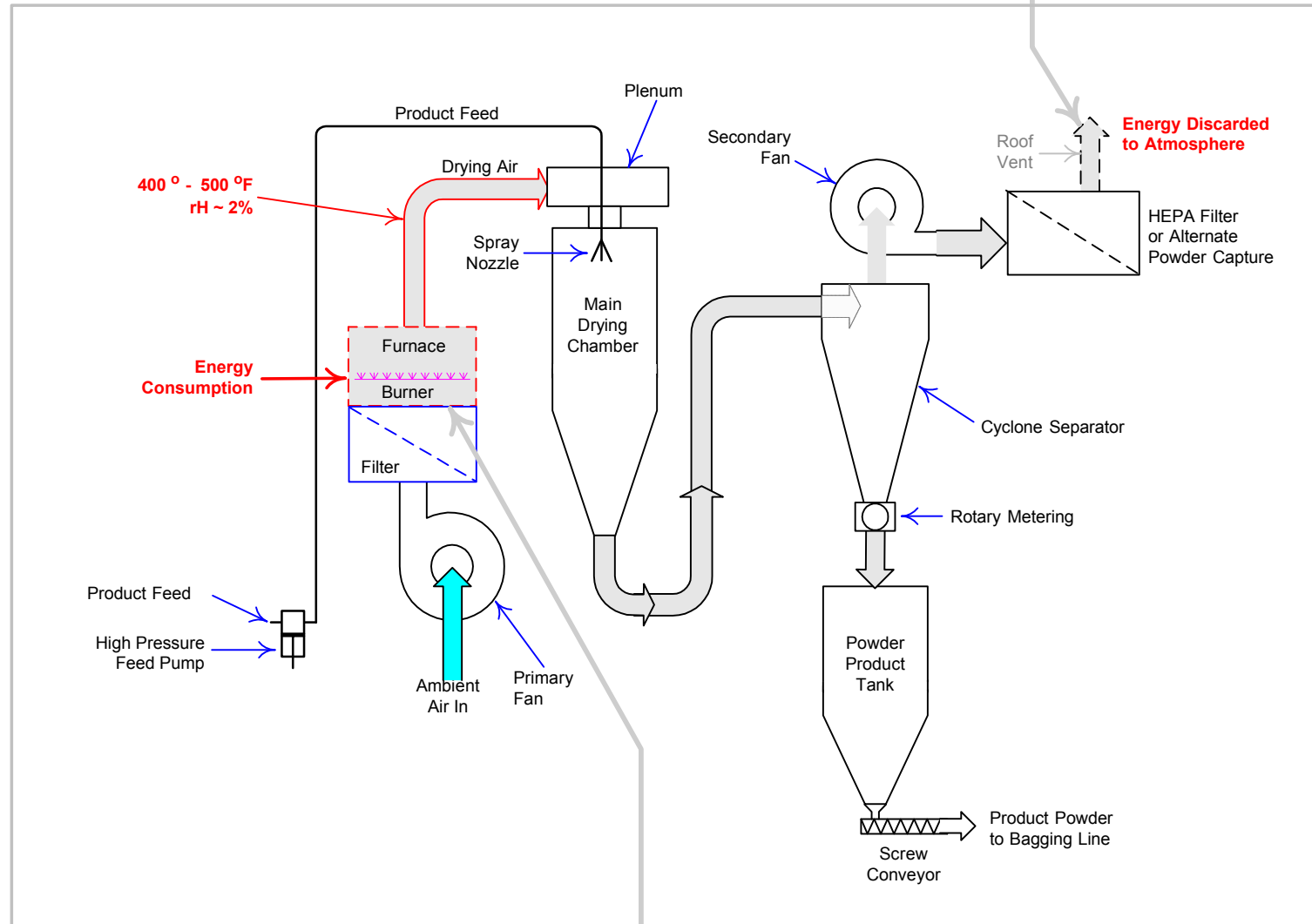
*These requirements impose operational and regulatory burden and expense.*

*Heat Pump Closed Loop Drying mitigates or eliminates all of these issues.*

# Heat Pump Closed Loop Spray Dryer *Difference*

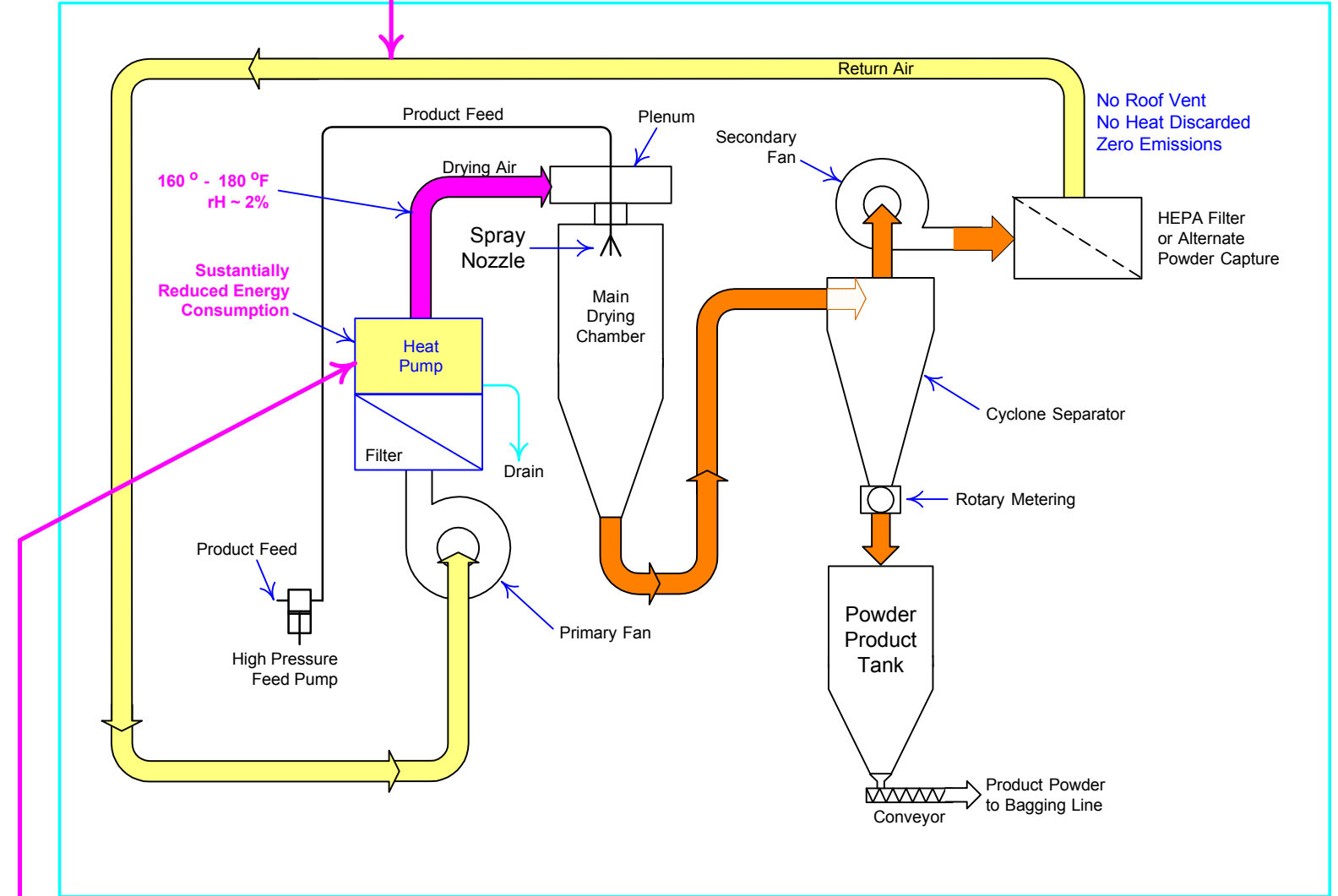
Conventional open loop; drying air, heat, and emissions are vented to the atmosphere.

Conventional Open Loop Fuel Fired Spray Drying



Closed loop replaces roof vent; drying air is not vented, no heat loss, zero emissions.

Heat Pump Closed Loop Spray Drying



Heat pump replaces furnace, equals or exceeds conventional dryer performance, at low temperature, using one third of the energy.

