

PolarDry® Electrostatic Spray Dryers

The Benefits of Low Temperature Spray Drying

Bogdan Zisu

23-26 July 2023

Melbourne Convention
and Exhibition Centre



A Division of *Spraying Systems Co.*®



PolarDry® Electrostatic Spray Dryers



Spraying Systems Co.

WORLD LEADER IN SPRAY TECHNOLOGY

RECOGNISED GLOBAL BRAND



12

manufacturing locations
worldwide

100+

sales offices

400+

active global patents

ISO

ISO 9001 since 1996
ISO 14001 since 2006
(US locations)

84

years in business



A Division of *Spraying Systems Co.*®

Polar Dry®
Electrostatic Spray Dryers



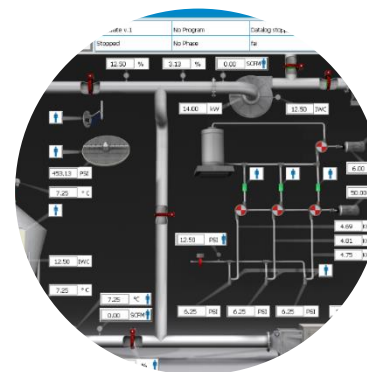
FLUID BED
PROCESSING



HIGH-SHEAR
GRANULATION



SIZE
REDUCTION



PROCESS
AUTOMATION



SPRAY
DRYING

Scalable Low-Temperature Drying Technology

Model 0.1 (0.1 kg/hr)



**Model 001
(1 kg/hr)**



**Model 004
(4 kg/hr)**



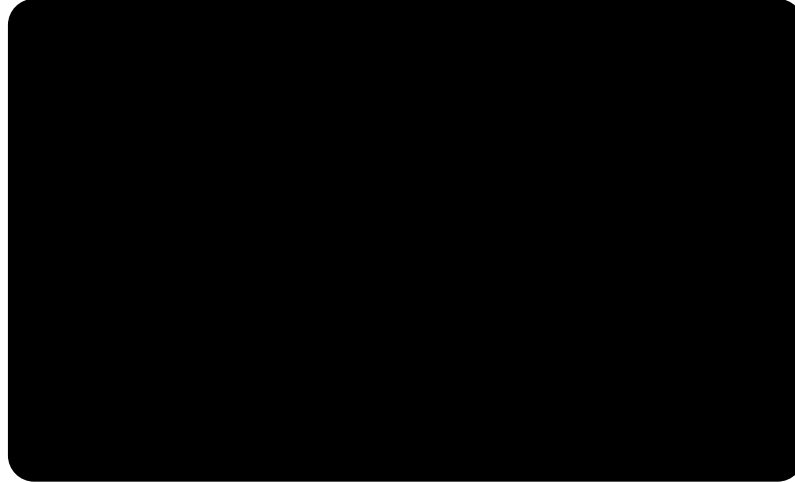
Model 032 (32 kg/hr)



**Model 050
(50 kg/hr)**

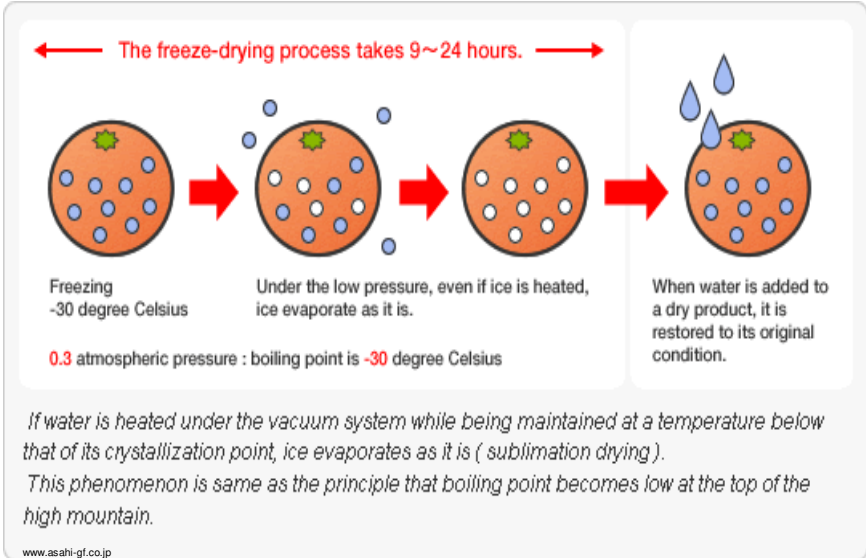


**Model 100
(100 kg/hr)**

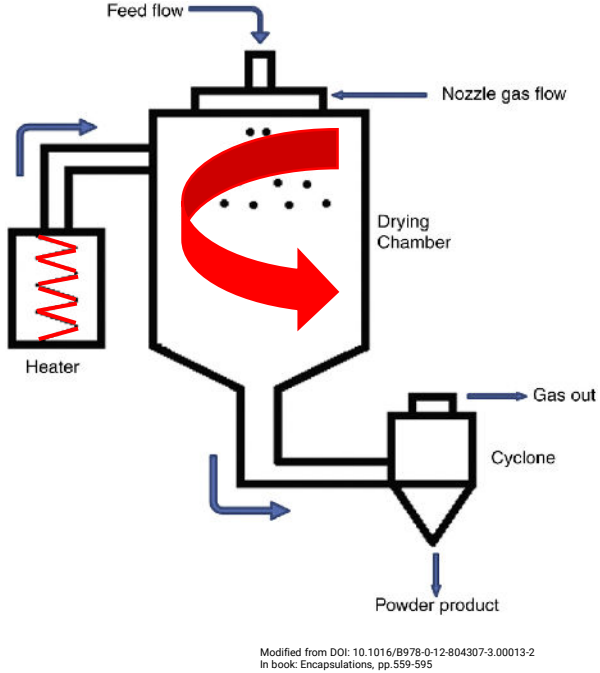


Nominal maximum water evaporation capacity of the unit in kilograms / hour at ***maximum temperature***.

Gaps In Drying Technology

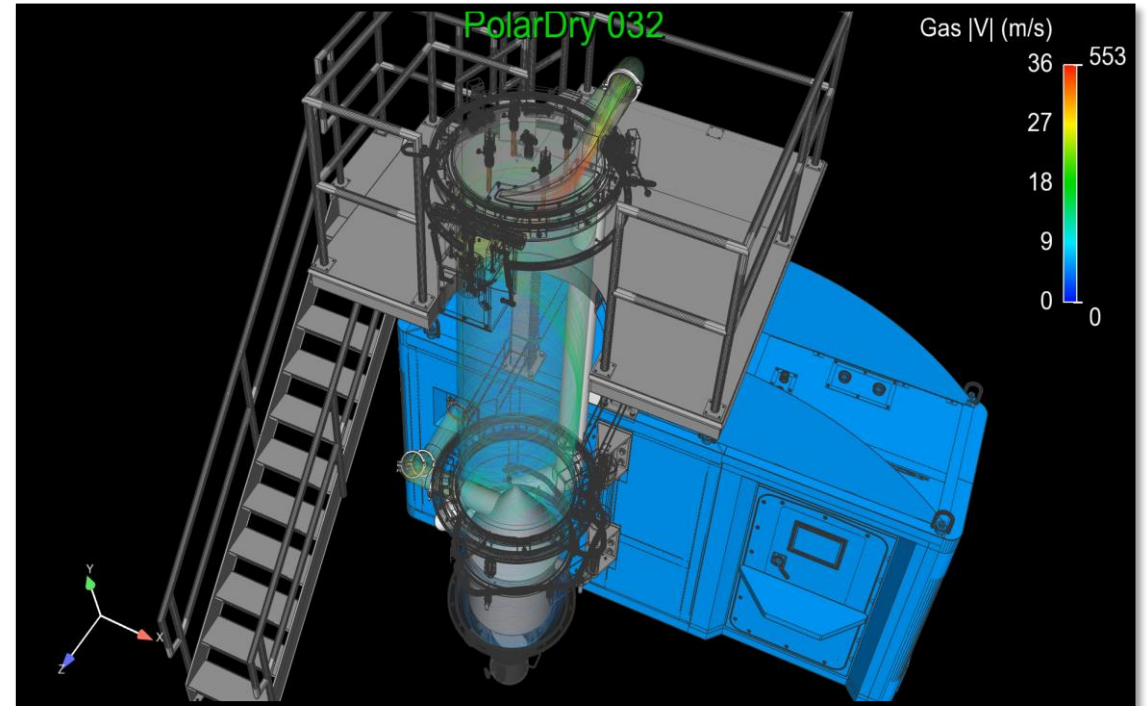


Missing Link in Continuous Manufacturing!



Uniquely Electrostatic Spray Drying

1. Nitrogen Drying
2. Low Temperature Spray Drying
3. Electrostatic Charge



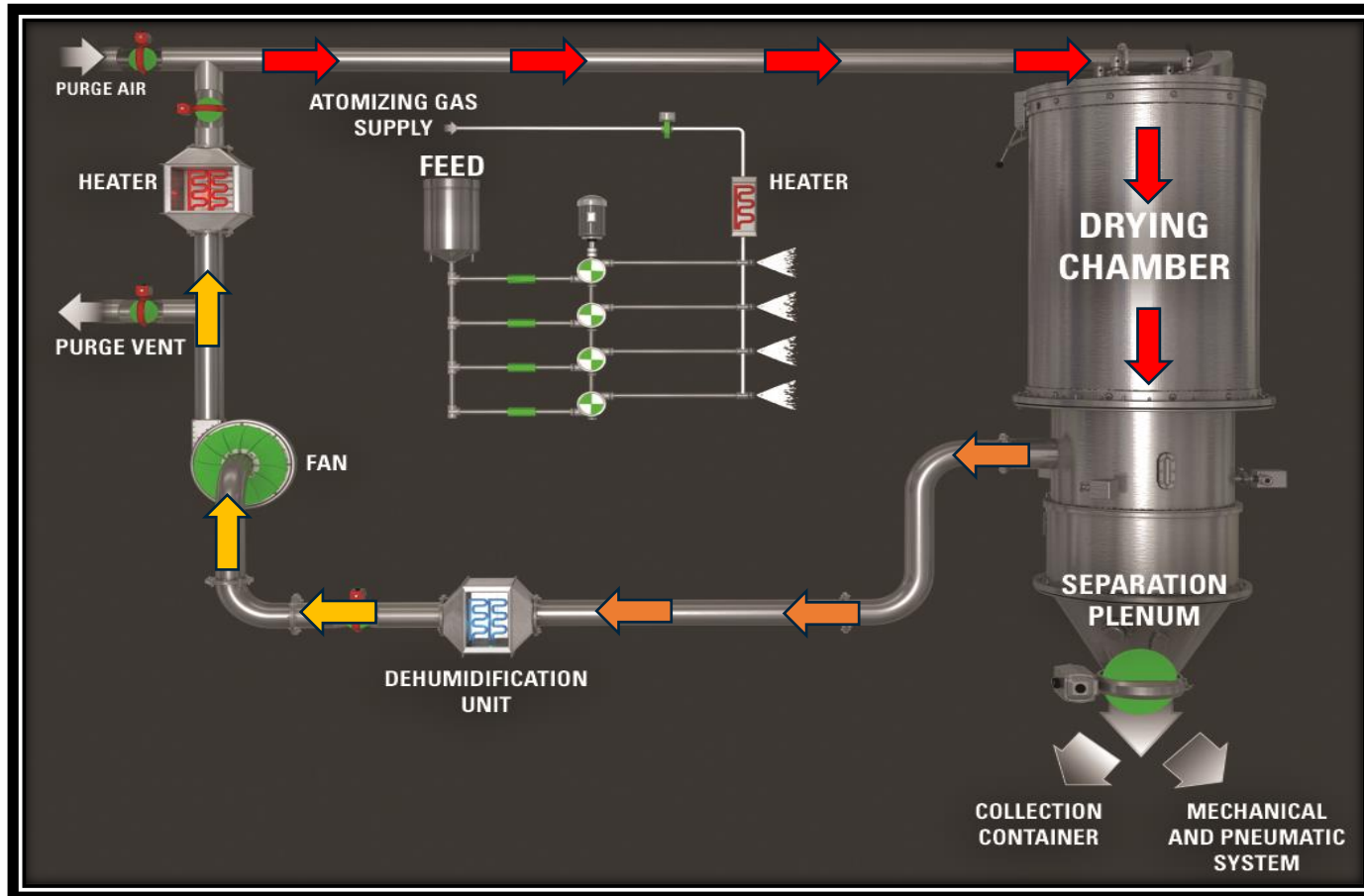
Uniquely Electrostatic Spray Drying

1. Nitrogen Drying

2. Low Temperature Spray Drying

3. Electrostatic Charge

Electrostatic Spray Drying in a Nitrogen Environment



- ESD operates at $< 5\% \text{ O}_2$
- Nitrogen closed loop for large dryers
- Advantages of drying in nitrogen
 - Oxidative stability
 - Viability of anaerobic microorganisms

Uniquely Electrostatic Spray Drying

1. Nitrogen Drying

2. Low Temperature Spray Drying

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Typical Spray Drying Temperatures

What temperatures are commonly used in spray drying?

Spray drying	Inlet temperature (°C)	Atomising temperature (°C)	Outlet temperature (°C)	Electrostatic charge (kV)
	150 – 250*	NA#	70 – 90*	NA#

#Not applicable

*C. Anandharamakrishnan (2017); Bloore & O'Callaghan 2009

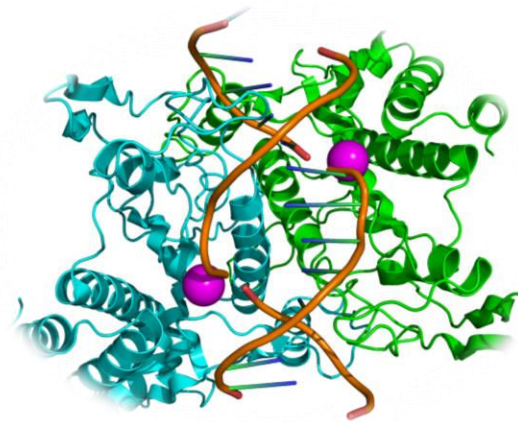
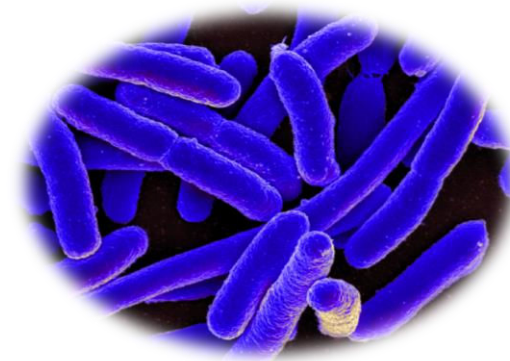
Typical Water Activity	0.05-0.20
Typical Residual Moisture	2-4%

Can electrostatic spray drying produce powder at lower temperatures?

Electrostatic spray drying	Inlet temperature (°C)	Atomising temperature (°C)	Outlet temperature (°C)	Electrostatic charge (kV)
	60-150	30-60	30-60	0.1-30

Applicable Products

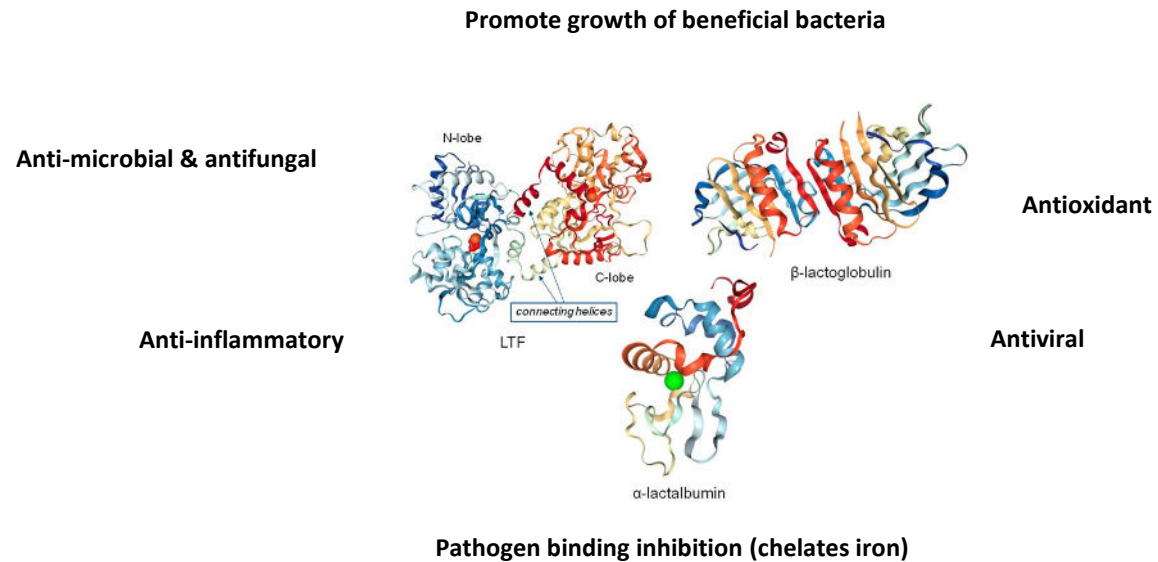
- Biological materials
 - Peptides
 - Proteins
 - Enzymes
 - Microorganisms
- Volatiles
 - Flavours and essences
- High lipid microencapsulation



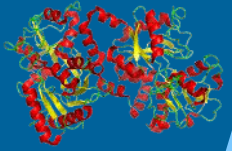
Biological Function and Thermal Degradation of Whey Proteins

Whey proteins are **heat sensitive!**

Does low temperature spray drying preserve biological function?



Preserving Biological Activity: Lactoferrin and IgG in Bovine Colostrum



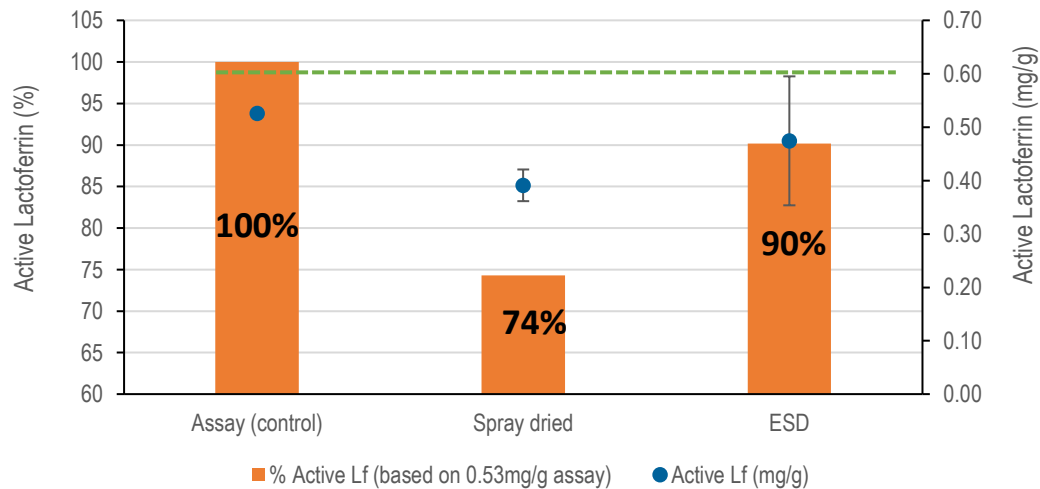
Source: <https://www.pdb.org/entry/1w1wz>

	Inlet temp	Outlet temp
ESD	90°C	35°C
Spray dried	150°C	60°C

Day 2 colostrum, untreated

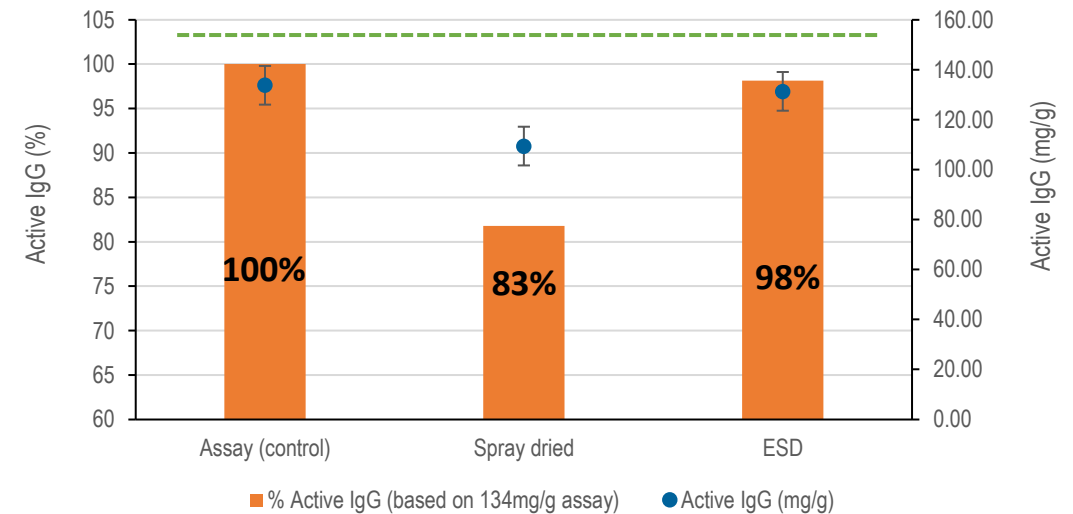
Based on 0.53 mg/g in liquid sample

Lactoferrin



Based on 133.78 mg/g in liquid sample

IgG

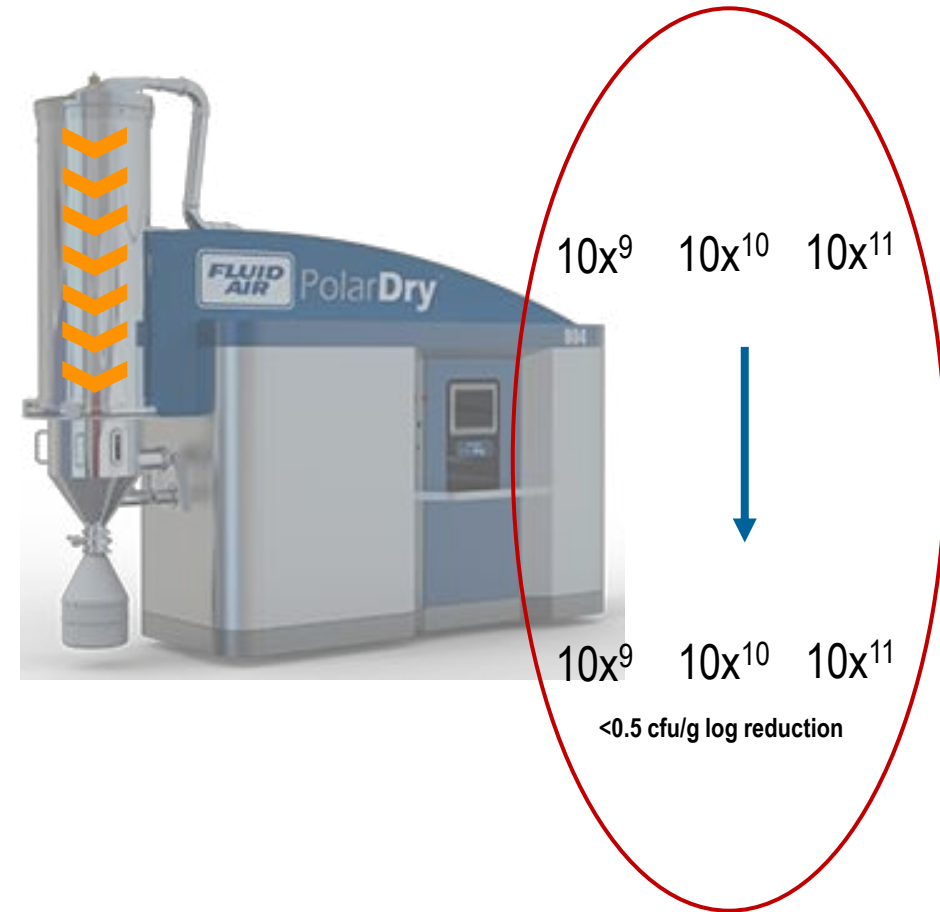
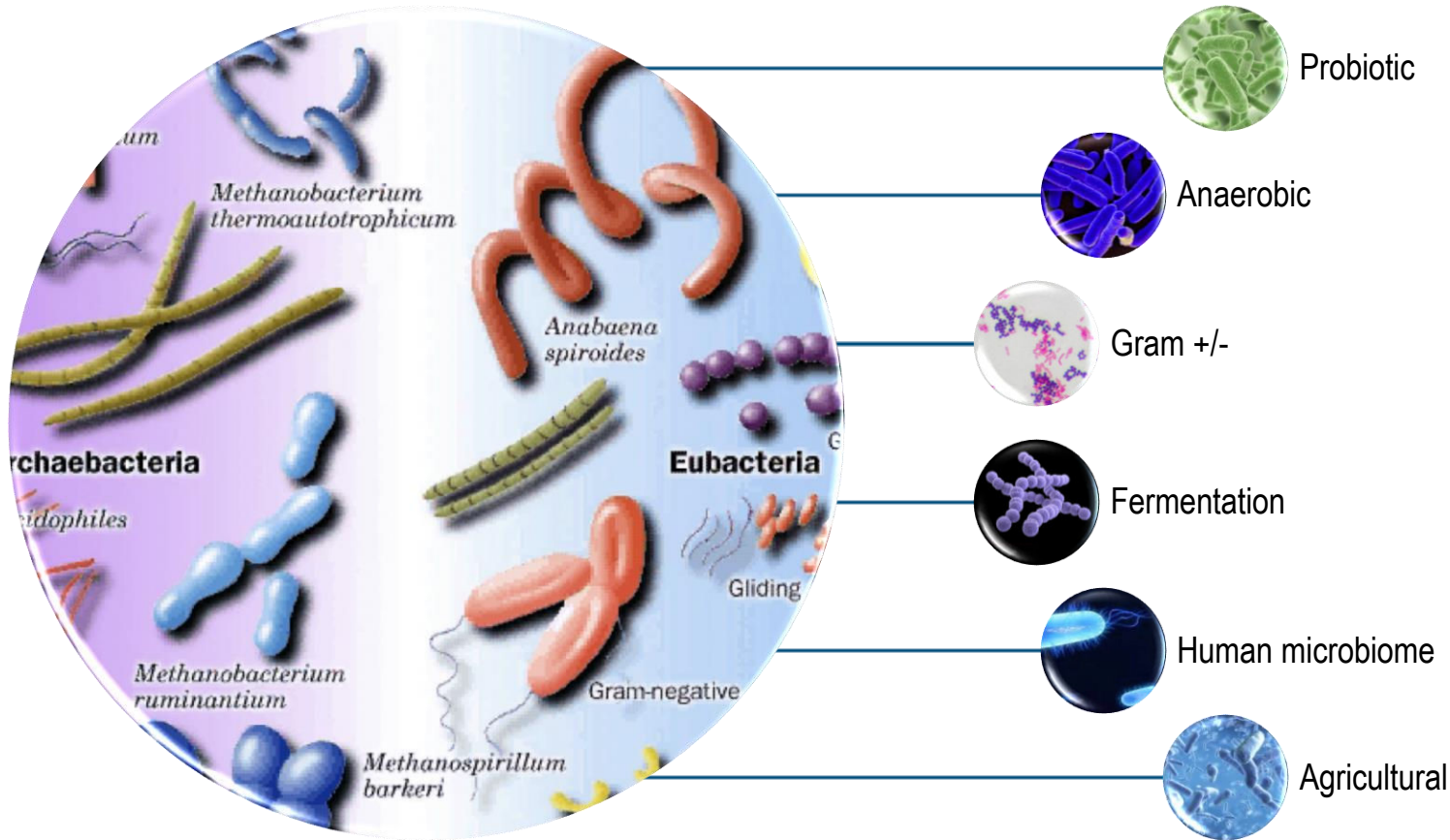


The advantage of ELISA over other techniques is the detection of only the active form of lactoferrin & IgG. If the lactoferrin / IgG molecules are damaged by heat, they will not be recognised by the antibodies of the ELISA.

*Independent ELISA testing at AgResearch, New Zealand



Probiotics and Other Viable Microorganisms



Large-Scale Advantages of Electrostatic Spray Drying

- **Continuous operation**
 - Greater throughput
 - Reduced manufacturing cost (per kg of powder produced)
- **O₂ free drying**
- **Free-flowing powder characteristics and distinct morphology**
 - No milling or post production handling



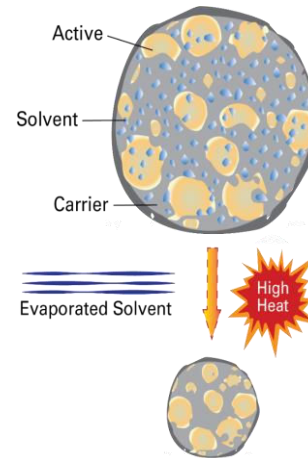
Uniquely Electrostatic Spray Drying

1. Nitrogen Drying

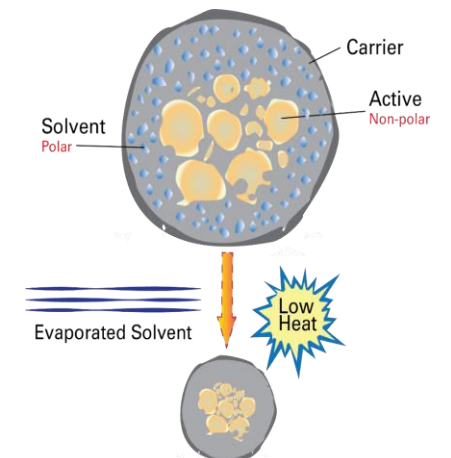
2. Low Temperature Spray Drying

3. Electrostatic Charge

TRADITIONAL SPRAY DRYING

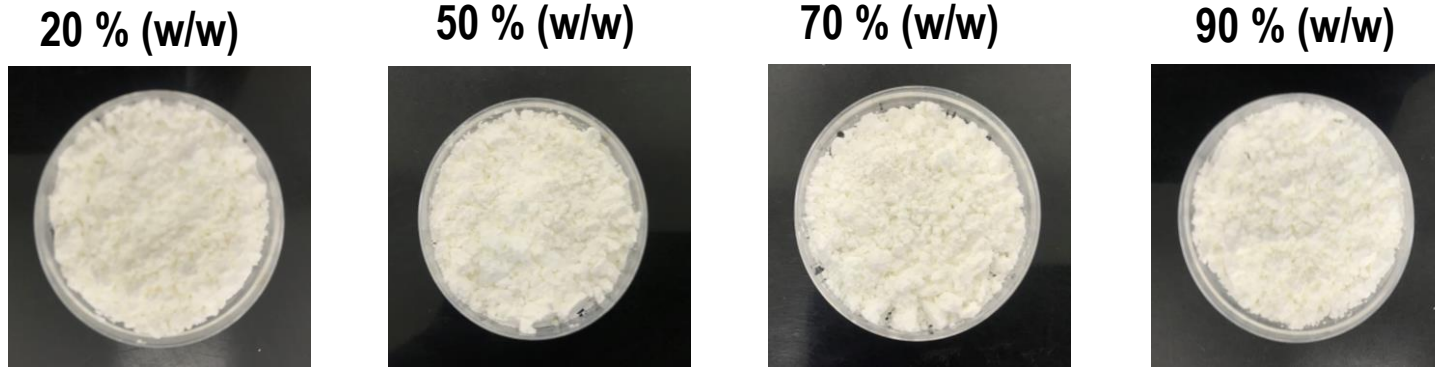


ELECTROSTATIC SPRAY DRYING



Oil Encapsulation: High Oil Load and Oxidative Stability

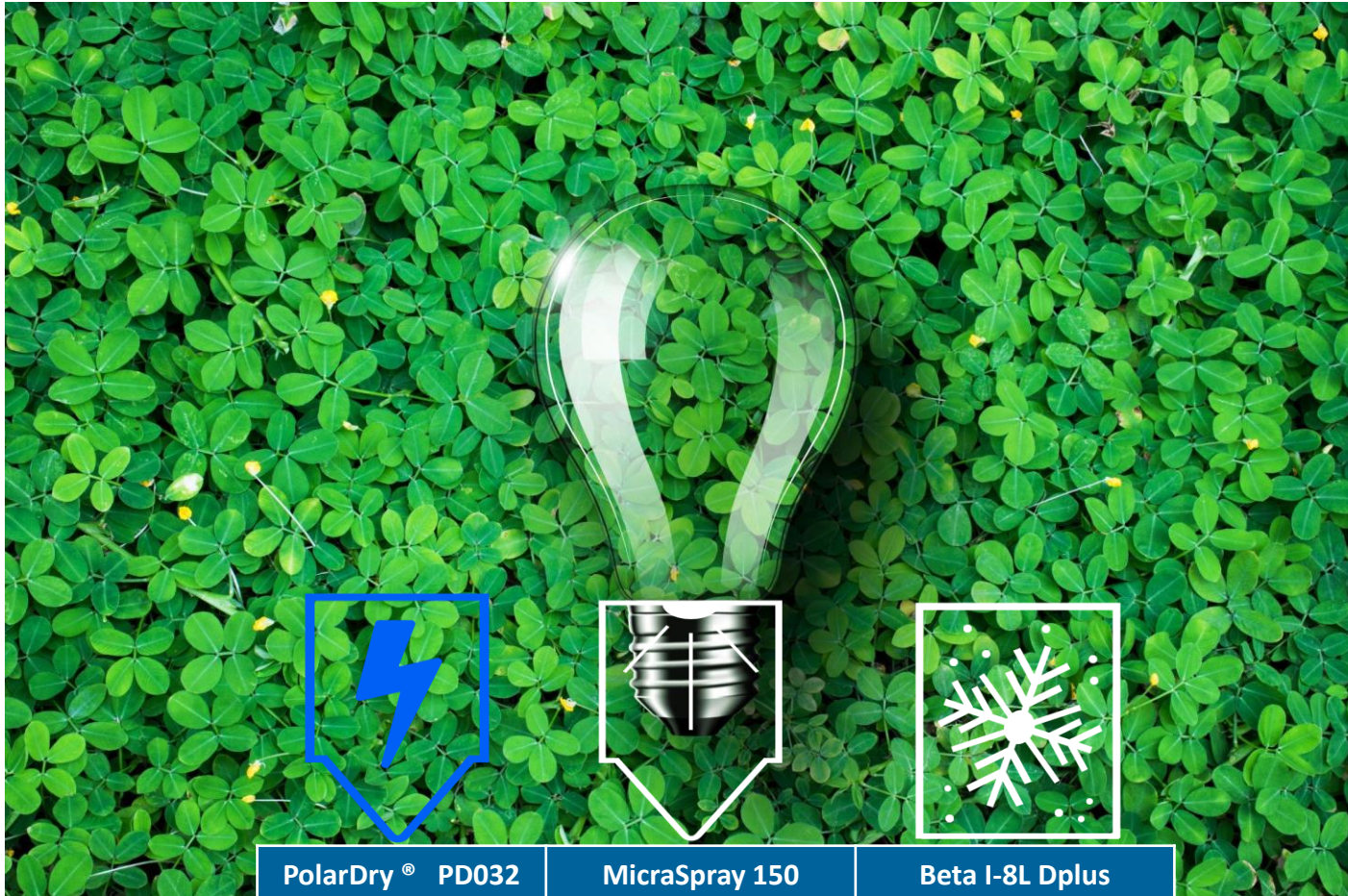
50% (w/w) oil load	Surface free fat (%)	Encapsulation efficiency (%)
Electrostatic spray dried	1.49 ± 0.01	99.46
Spray dried	5.08 ± 0.45	89.83



Carbohydrate carrier
+
Protein stabiliser

Oxidation (meq O ₂ / kg oil)	
Electrostatic spray dried	0.96 ± 0.09
Spray dried	1.74 ± 0.18

Energy Usage and Carbon Footprint Comparison



PolarDry® PD032 (Fluid Air)	MicraSpray 150 (Anhydro)	Beta I-8L Dplus (Christ)
32 kg/h	14 kg/h	8 kg/h
140 C°	170 C°	N/A
26.8 kg powder	5.6 kg powder	0.5 kg powder



EVEA (France) specialist in product life cycle analysis



UNIVERSITÉ DE LORRAINE

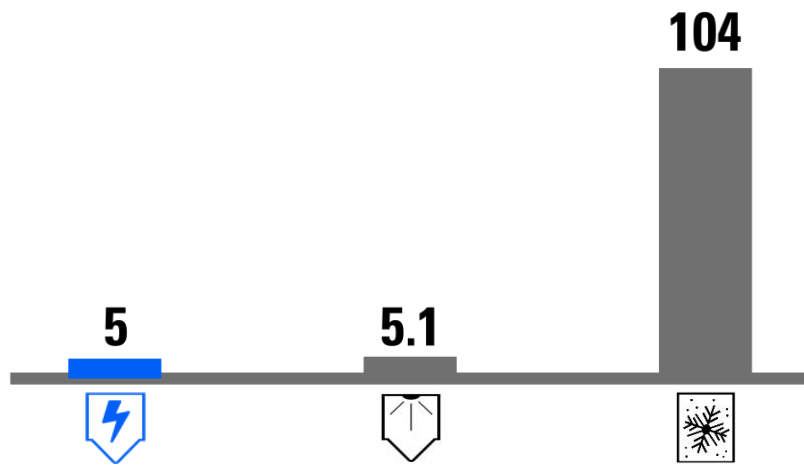


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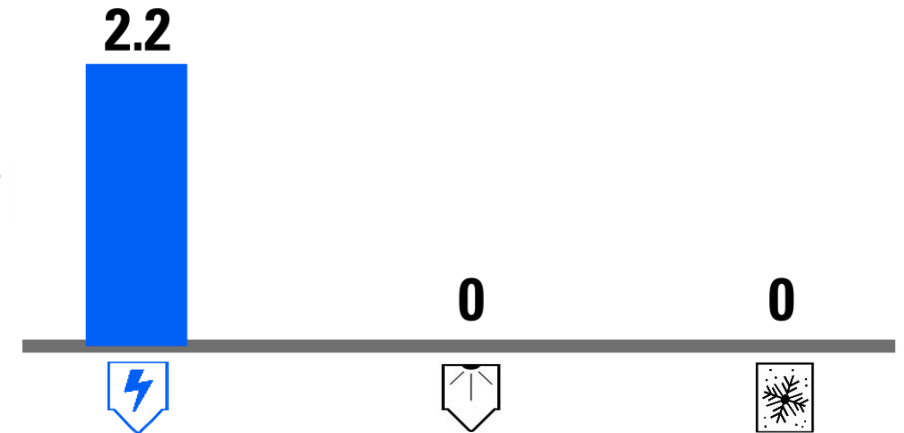


Utility Results

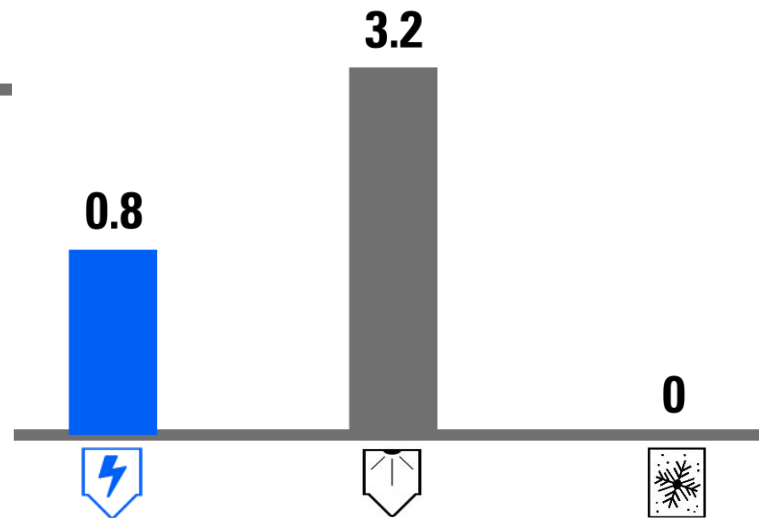
Energy - kwh/kg of powder



Nitrogen - NM3/kg of powder

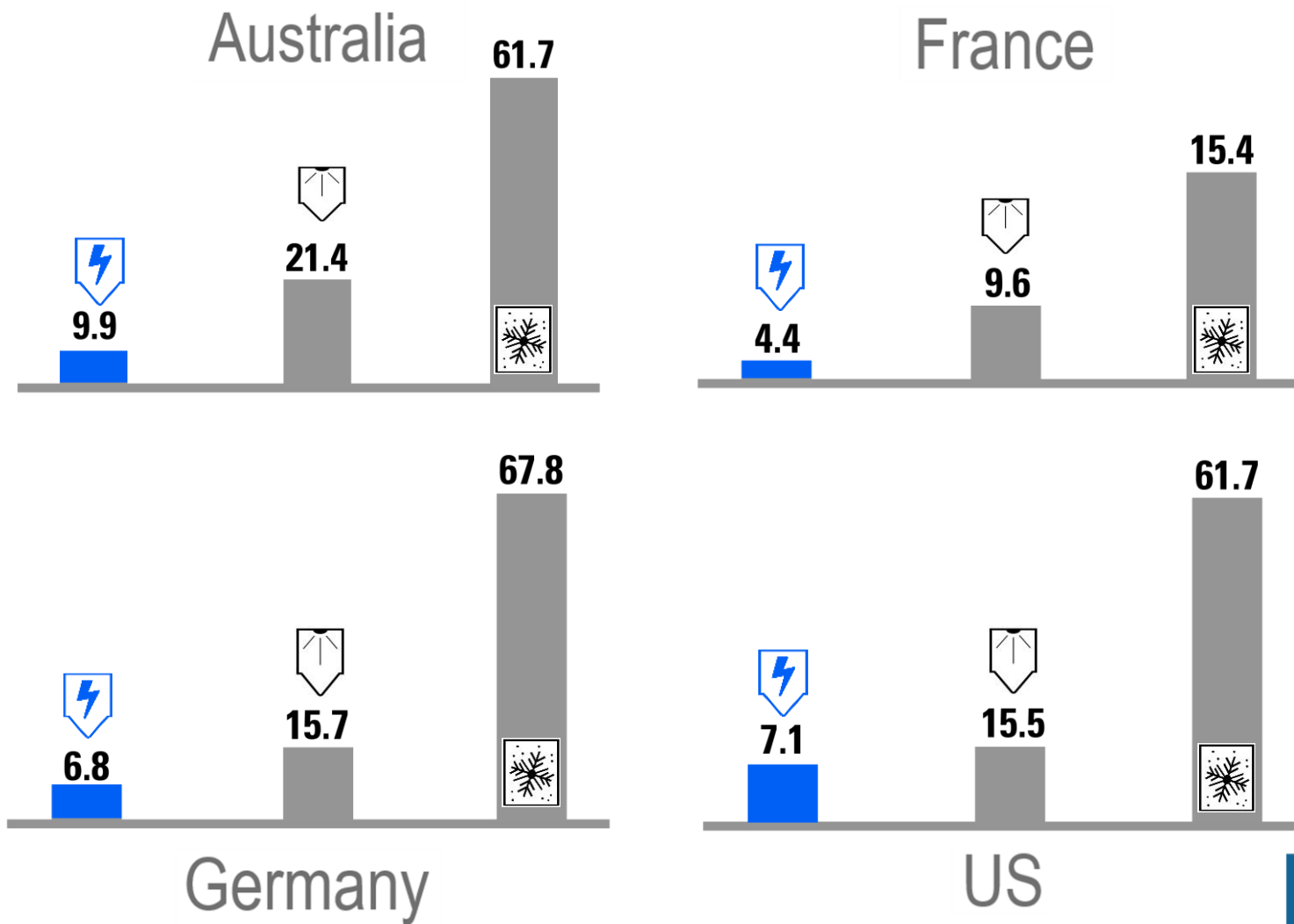


Compressed Air - NM3/kg of powder



THIS IS FOR REFERENCE ONLY and INCLUDES ESTIMATES.
It is the responsibility of the customer to fully assess their process.

CO₂ Emissions Comparison (Carbon Footprint - kgCO₂/kg of powder)



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Customer Testing Facilities

- R&D and full production scale
 - Melbourne, Australia
 - USA, France, China, Japan, S. Korea
- Detailed customer training
- Optimisation studies





**Experts in Solid
Dosage Technology**
A Division of *Spraying Systems Co.*®

Booth A24



Booth A24

INTERESTED IN LEARNING MORE?

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