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# Technological breakthrough and innovation in the production of whey powders, with 30-40% reduction in energy costs

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**Technological breakthrough and innovation  
in the production of whey powder with  
30-40% reduction in energy costs**

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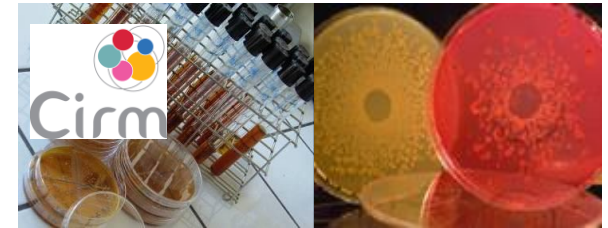
# STLO

## Science & Technology of Milk & Egg

# A multidisciplinary and multiscale approach, reinforced by two high-calibre facilities:

### Dairy Platform

### Biological Resource Centre



80 standing fellow workers  
25 PhD students



- ❑ **Structuration / destructuration mechanisms of food matrix:** *from structural characterisation to digestion*
- ❑ **Dairy processing and cheese making:** *toward sustainable dairy systems*
- ❑ **Microbial interaction:** *food matrix and host cell*

Please visit [http://www6.rennes.inra.fr/stlo\\_eng](http://www6.rennes.inra.fr/stlo_eng)

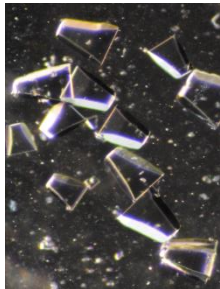
# Process to produce Whey/Permeate Powder

## Whey/Permeate



- Heat Treatment
- Separation (MF, UF, NF, RO, IE, ED)
- Concentration by Vacuum Evaporation up to 60%

## Whey/Permeate Concentrate



- Lactose Crystallization
- Spray Drying
- Post crystallization* (option)
- Fluid bed drying



## Whey/Permeate Powder

# Energetical Consumption

(kJ.kg<sup>-1</sup> water)

**Energy cost in France** 3 TWh to remove water to produce dairy powder on a total of 12 TWh for dairy companies.



**Vacuum  
Evaporation**



**Spray  
Drying**

**< 360 kJ.kg<sup>-1</sup>**

**> 3,600 kJ.kg<sup>-1</sup>**

**Min: X 10**

Energy cost for spray drying represents **31, 36 and 57%**, (on the total cost including vacuum evaporation) only to remove **3.3, 4.3 et 9.5%** of the total water to produce **permeate, whey and skim milk powder** respectively

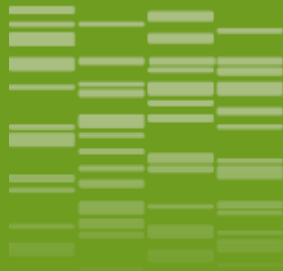


Schuck et al., *Drying Technology*, 33 (2015) 176–184

**2 options:**

- ✓ Increase the total solid content during [C°] by VE before SD
- ✓ Remove the spray dryer !

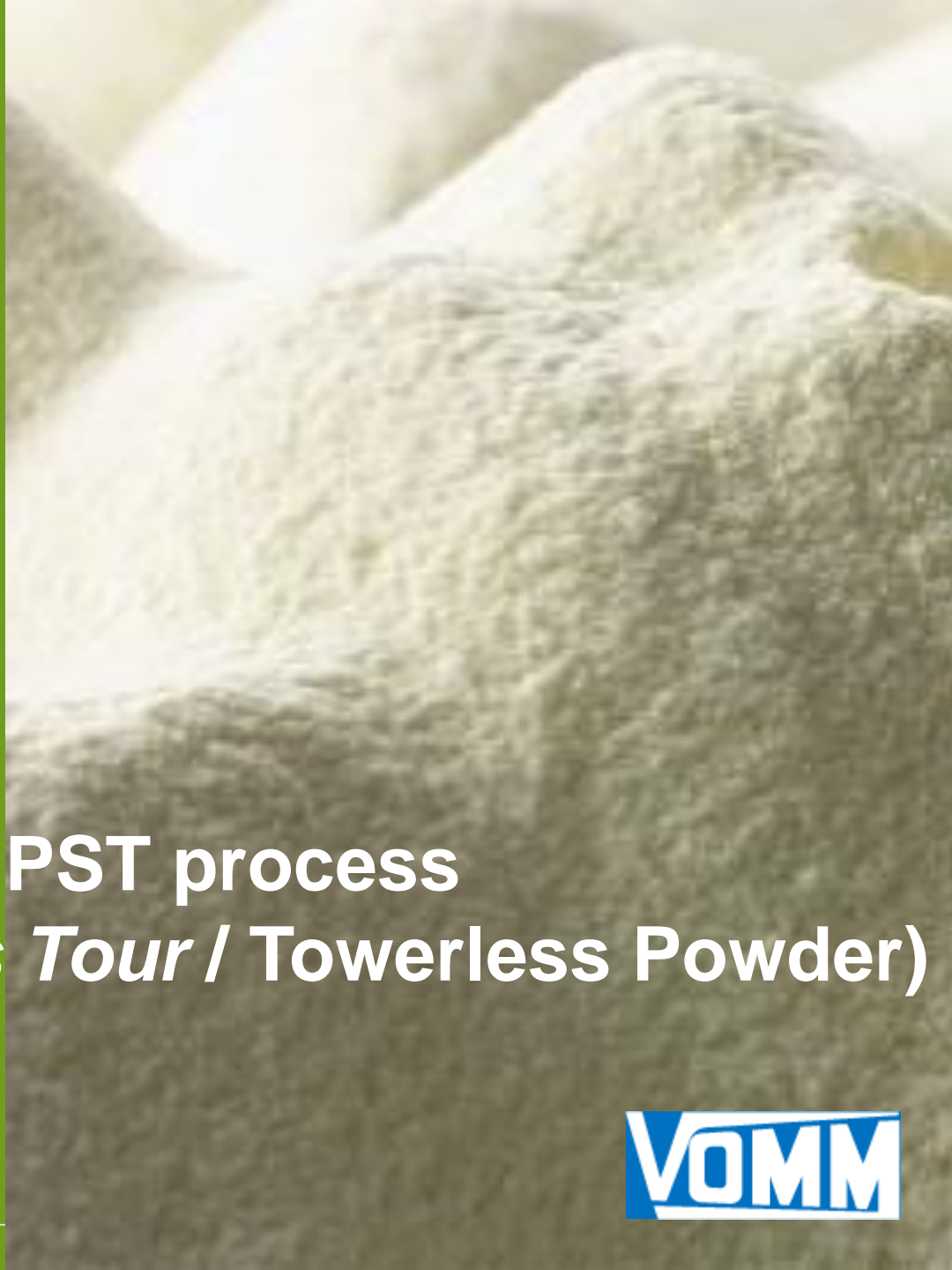




**Patent PST** (Poudre Sans Tour/Towerless Powder) : "Poudres laitières" n°1457413 submitted the 31/07/2015.

**Inventors:** Schuck P, Tanguy G, Dolivet A, Méjean S, Jeantet R, Garreau D, Vezzani C.

## The patented PST process (*Poudre Sans Tour* / Towerless Powder)



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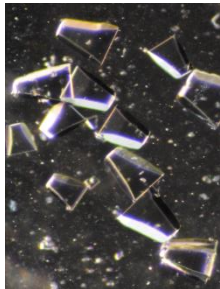
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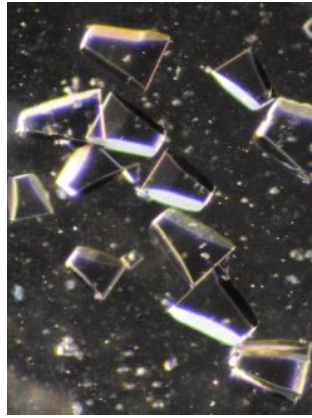
- Lactose Crystallization
- ~~Spray Drying~~
- Post crystallization* (option)
- Fluid bed drying



## Whey/Permeate Powder



# New Process to produce Whey/P<sup>te</sup> powder



## Whey/Permeate

- ❑ Concentration by vacuum evaporation up to 60% DM
- ❑ Lactose crystallization

## Whey/Permeate Concentrate

- ❑ Surconcentration up to 80% DM
- ❑ Granulation up to 90% DM

## Whey/Permeate Powder $a_w$ 0.4 - 0.6

- ❑ *Post crystallization (option)*
- ❑ Fluid bed / Turbo drying up to 97% DM

Whey Powder  $a_w$  0.2

50%



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# Powder properties (Permeate)

	H <sub>2</sub> O (%)	a <sub>w</sub> (25°C)	Crystallization ratio (%)
<b>STD</b>	<b>2.2</b>	<b>0.23</b>	<b>86</b>
<b>PST</b>	<b>2.1</b>	<b>0.20</b>	<b>62</b>

	d(0.5) (µm)	Span (-)	True ρ (kg.m <sup>-3</sup> )	Bulk ρ (kg.m <sup>-3</sup> )	Tapped ρ (kg.m <sup>-3</sup> )	Flow- ability (-)	Flood- ability (-)
<b>STD</b>	<b>125</b>	<b>1.5</b>	<b>1513</b>	<b>528</b>	<b>637</b>	<b>70</b>	<b>53</b>
<b>PST</b>	<b>200</b>	<b>1.5</b>	<b>1554</b>	<b>527</b>	<b>616</b>	<b>78</b>	<b>50</b>

# Powder properties (Permeate)

	Hygroscopicity (%)		Solubility (%)	Dispersibility (%)	Wettability (s)
	43% RH	86% RH			
<b>STD</b>	<b>1.0</b>	<b>13</b>	<b>&gt; 99.5</b>	<b>97</b>	<b>14</b>
<b>PST</b>	<b>0.9</b>	<b>16</b>	<b>&gt; 99.5</b>	<b>96</b>	<b>2</b>

*On whey powder by PST process, no more modified proteins (HPLC profile) than by STD process*



# Energy cost (Permeate)

**Global Process:**  
**PST/STD: -11%**

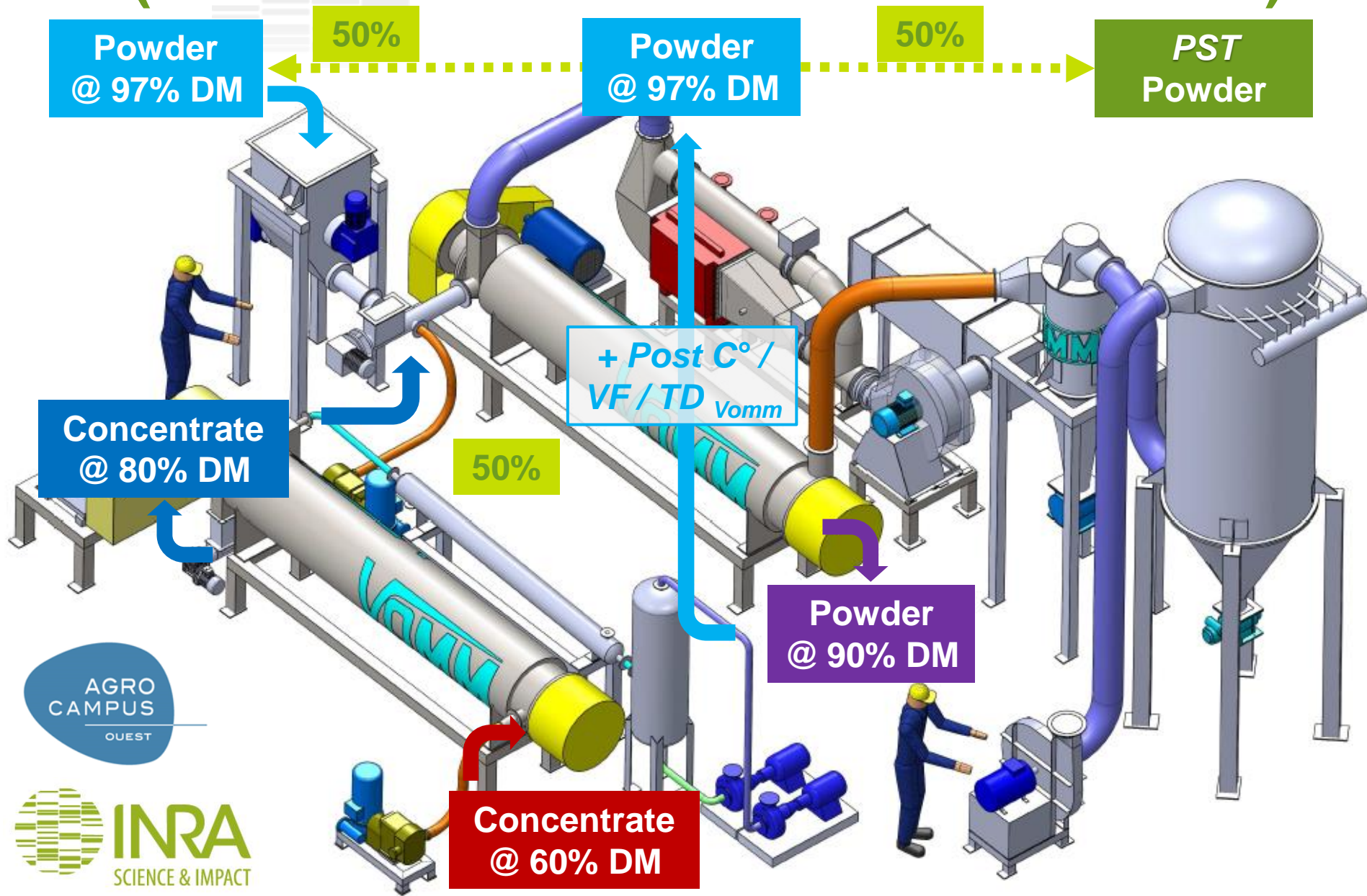
**Process 60-97%DM:**  
**PST/STD: -32%**

		Inlet		Outlet		Energy	
		Dry Matter	Flow rate	Dry Matter	Flow rate	Steam	Cost
		% w/w	kg.h <sup>-1</sup>	% w/w	kg.h <sup>-1</sup>	kg.h <sup>-1</sup>	kJ.kg <sup>-1</sup> of powder
<b>STD</b>	Vacuum [C°]	5.5	30,000	60	2,750	4,542	<b>10,067</b>
	Spray-drying	60	2,750	97	1,701	2,308	
<b>PST</b>	Vacuum [C°]	5.5	30,000	60	2750	4,542	<b>8,987</b>
	Over [C°]	60	2,750	80	2,063	791	
	Turbo drying	88.5	4,126	97	3,764	782	

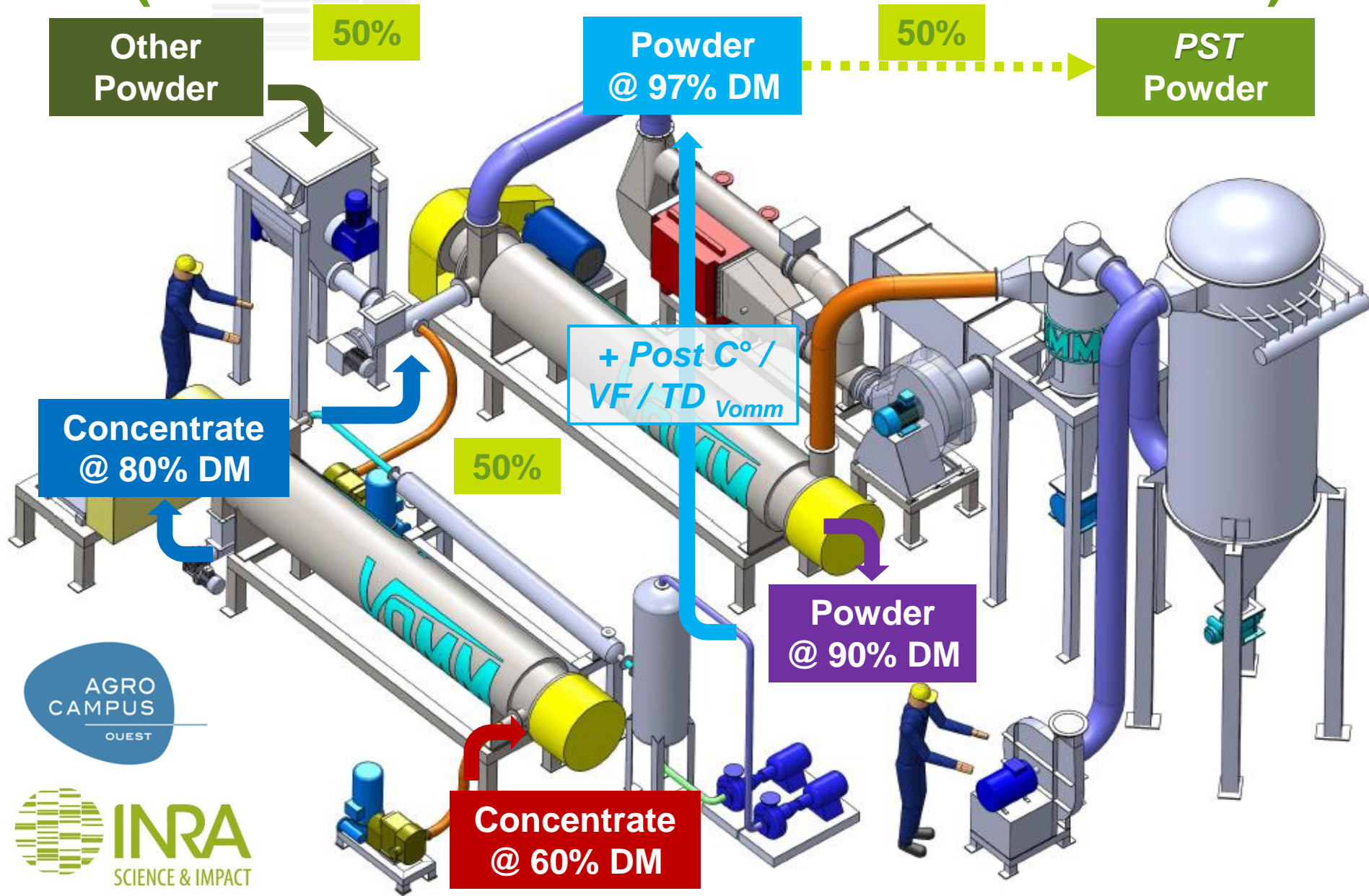
*Comparison of the energy costs between PST and Standard processes for the production of 1,701 kg.h<sup>-1</sup> of permeate powder at 97% DM from 30,000 kg.h<sup>-1</sup> of liquid at 5.5% DM.*



# The patented PST process (*Poudre Sans Tour / Towerless Powder*)



# The patented PST process (*Poudre Sans Tour* / Towerless Powder)



AGRO  
CAMPUS  
QUEST

**INRA**  
SCIENCE & IMPACT



# The patented PST process (*Poudre Sans Tour / Towerless Powder*)



# Conclusions on the patented PST process (*Poudre Sans Tour / Towerless Powder*)

- Pilot plant
- 50 kg powder.h<sup>-1</sup>

**VALIDATION**

**REDUCTION**

- Energy 10 to 30%
- Building 40%

- Sustainability
- Technological breakthrough

**INNOVATION**

Economic gain between PST and Standard for the production of 20,000 t.year<sup>-1</sup> of permeate powder would be more than

**> 360 000 € per year**





**THANK YOU FOR  
YOUR ATTENTION**



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