Adding value to dairy liquid waste streams

A new production process for the circular economy

Problem

- Treatment of liquid wastes from the dairy industry
- World milk production: 852’000’000 tonnes/year*
- World cheese production: 22’000’000 tonnes/year**
- Very large wastewater volumes from plant equipment washing and cheese making
- Liquid waste treatment costs to the dairy are high and in many cases the wastewater burden is placed on the environment or on the municipal wastewater treatment plant

Liquid wastes from the dairy industry

- From milk production : up to 2400 kg wastewater/ tonne of raw milk processed[+]
- From cheese production: 900 kg whey/ tonne of raw milk + 2000 kg wash water/ tonne of raw milk processed

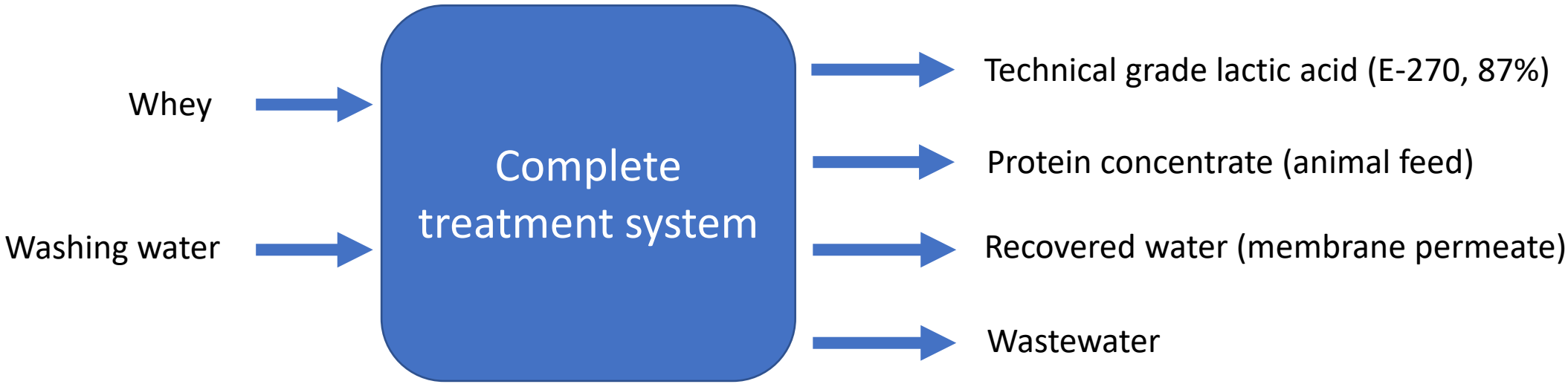
*OECD-FAO World Economic Outlook 2020-2029

** www.statsitca.com

[+] L.A.H.M. Verheijen et. al. (1996). Management of Waste from Animal Product Processing, Food and Agriculture Organization of the United Nations

Solution

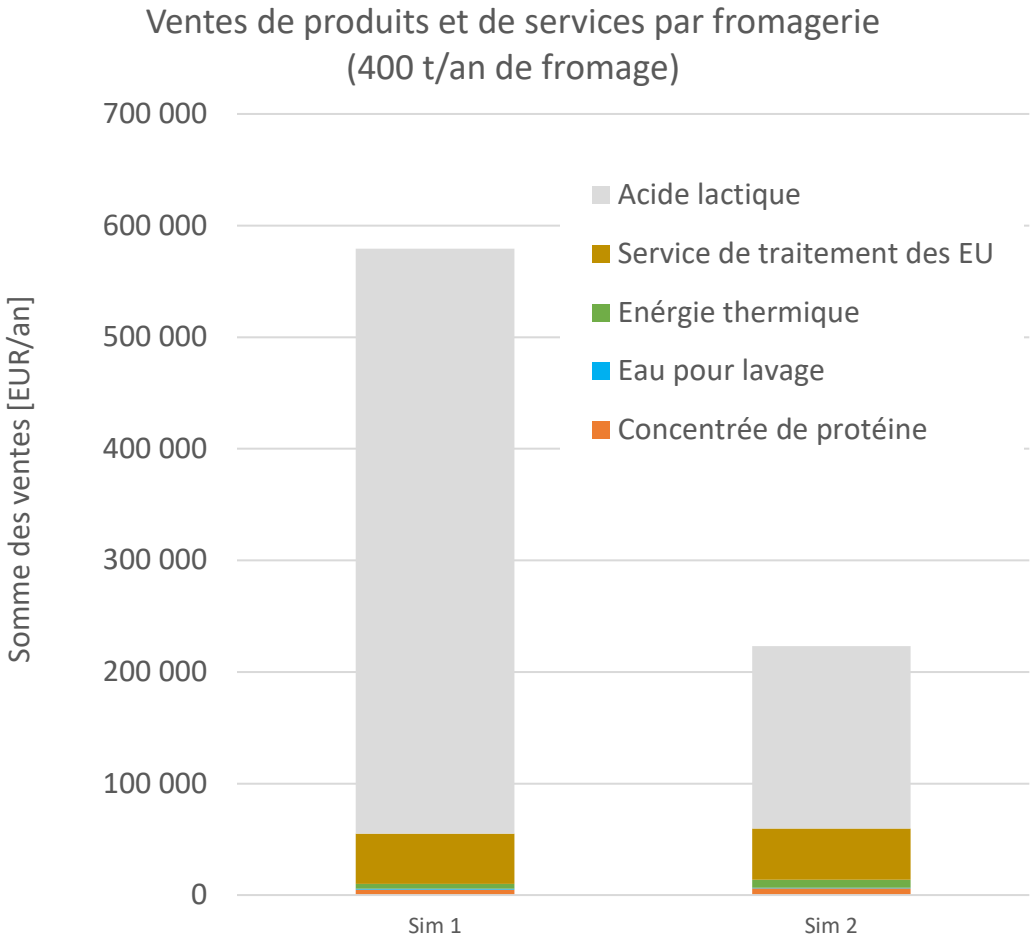
A complete dairy wastewater and whey treatment system



Solution

Sellable product or service	Price
Technical grade lactic acid solution (E-270)	CHF 3300/t
Protein concentrate for use in animal feed	CHF 140/t
Process water (membrane filtration permeate)	CHF 2/m^3
Wastewater treatment tax	CHF 4/m^3

- Lactic acid is the main product
- Sim 1 = simulation of the best case
- Sim 2 = simulation of the worst viable case



Product

- The Innosuisse project objectives are to design, build and operate a pilot plant at a medium sized cheese dairy
- A company will be created to build design, build own, and operate industrial plants



On-site production at the cheese dairy



Monthly lactic acid product delivery

Production of whey concentrate using membrane filtration processes:

- Product used in animal feed or in human dietary supplements (whey protein)
- Turn-key systems are available from many suppliers
- The systems typically extract valuable lactose and protein but do not treat wastewater
- The processes make it possible to reduce liquid waste treatment costs but are not profitable to the dairy

International research and development focus and situation:

- The need to recycle wastewater is widely recognized
- Potential high value addition of lactic acid production is widely recognized
- Many published results of lactic acid production by fermentation
- Bioprocesses to produce other products (e.g., ethanol)
- Anaerobic digestion to produce biogas
- Membrane processes to recover water
- No consensus best practice
- None of the above systems can be supplied as commercially viable, turn-key solutions known to me

Current practices

Advantages of the proposed solution

- Comprehensive system to manage wastewater and whey liquid waste streams from the dairy industry
- Unit processes developed using machine learning data analysis methods
- Improved capacity to build predictive models leads to optimized processes and equipment designs
- Optimized designs lead to robust and high performance processes
- High performance processes lead to higher economic return on investment
- Higher economic return on investment leads to increased deployment of the technical solution

Traction

- Completed 2 desktop technical and economic feasibility assessments financed by Innosuisse (Innovation cheque*)
- Agreement with a dairy to host a pilot plant in the canton of Vaud
- Practical experience in anaerobic wastewater treatment using immobilized supports
- Knowledge and experience building neural network models of bioprocesses for wastewater treatment

*https://www.innosuisse.ch

Market

Swiss cheese dairies (whey and wastewater):

450 (medium sized dairy equivalents*)

Swiss milk and dairy product producers (wastewater):

2 very large industrial sites

Large international milk and dairy product producers (wastewater):

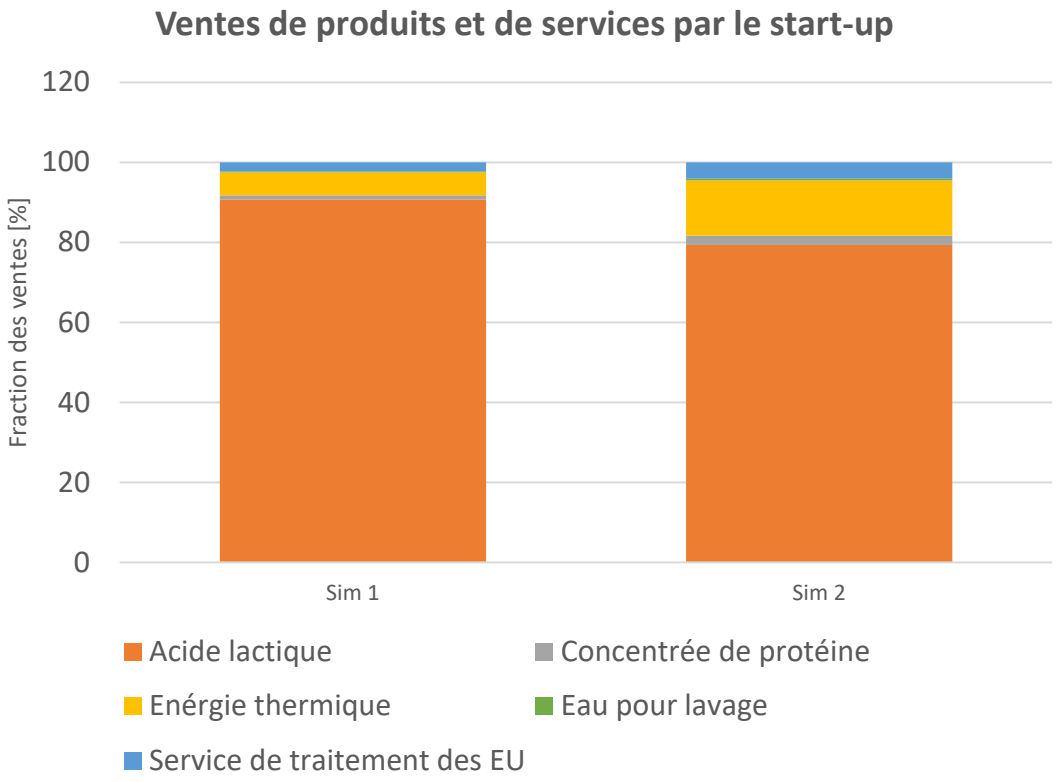
A major problem at large dairies

International cheese dairies (whey and wastewater):

7000 (medium sized dairy equivalents*)

* Cheese production, medium sized dairy = 400 t/year

Market



- Lactic acid is the major product
- Currently used in the food production, cleaning and personal care product industries
- Switzerland is a net importer of 4’100 tonnes/year of lactic acid (2019)*
- Potentially very high demand for use in the production of biodegradable poly lactic acid polymers

Simulations (medium sized cheese dairy)

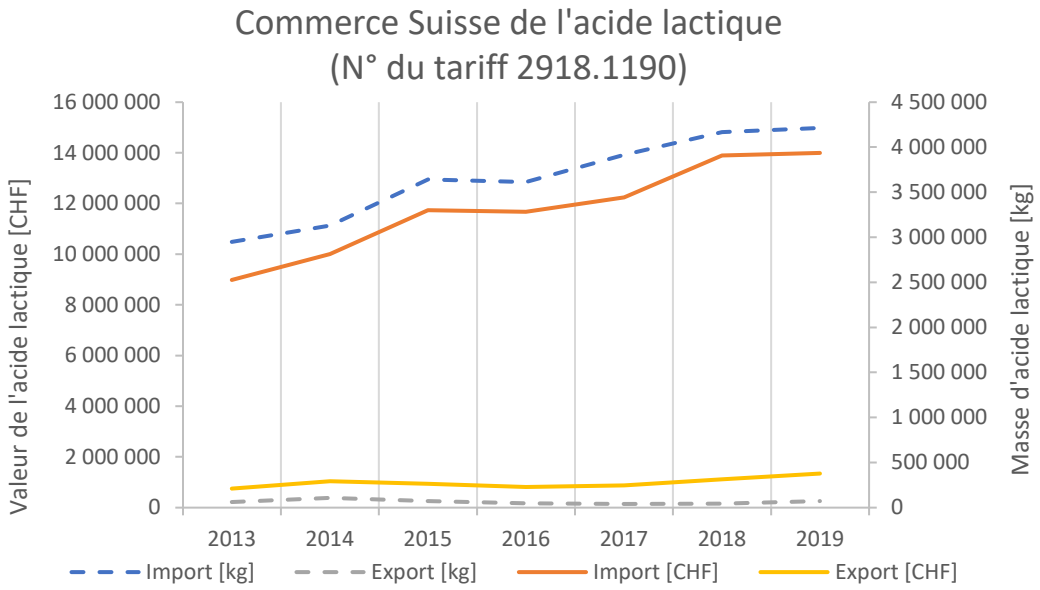
Sim 1 (overall lactic acid yield = 64%): Expect to payback the investment in less than 2 years.

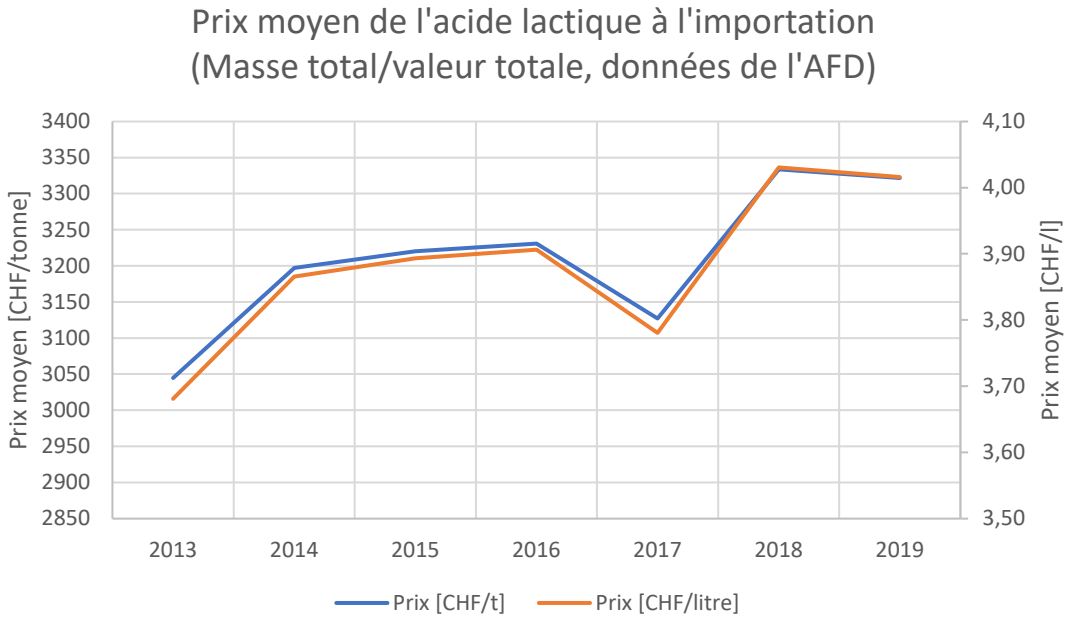
Sim 2 (overall lactic acid yield = 30%): Expect to payback the investment in less than 5 years.

*Data from the Federal Customs Administration (https://www.ezv.admin.ch)

Market

Swiss market trends





Competition

- I am not aware of any commercial competitor offering a comprehensive lactic acid production and wastewater treatment solution for the dairy industry.
- Potential competitors include major players such as Veolia and hundreds of smaller companies that propose variants of conventional technologies.
- During the past 50 years, many scientific publications report the transformation of whey into valuable products such as lactic acid and biogas. None are commercially viable

Business model

- Owner of the system: Design, Build, Own, Operate (DBOO) model where the start-up company pays all investment costs and owns the complete system
- Operation: start-up company pays all maintenance costs and pays fees to the client dairy for supply of utilities and operational services
- Revenue sources: Revenues from sales of products (lactic acid, protein, water) and wastewater treatment services go entirely to the start-up

The waste treatment burden is transferred from the client dairy to the start-up company

Planned cash flows (CHF, best case, medium sized Swiss cheese dairy)

Year	0	1	2	3	4	5	6
Cash inflow	287 228	287 228	287 228	287 228	287 228	287 228	287 228
Cash outflow	543 161	77 161	77 161	77 161	77 161	77 161	77 161
Cashflow (cash inflow - cash outflow)	-255 934	210 066	210 066	210 066	210 066	210 066	210 066

Investing

Seeking investors and implementation partners

Total initial investment in the pilot plant project:

< CHF 150’000 to cover some of the salaries and some of the operating expenses

The initial investment will be matched by Innosuisse

A swiss based start-up will be created during the Innosuisse project

Contact

Mark McCormick

Praz-Palud 9

CH-1040 Echallens

T: +41 78 604 52 42

mark.mccormick@unil.ch

http://www.markmccormick.ch



- Environmental engineer, data scientist (Ph.D., Information systems, University of Lausanne)
- More than 20 years' experience mostly in applied R&D
- DOB: May 4th, 1965
- US and Swiss nationalities