The Journey
Idea to Implementation

St1 AB Etanolix 2.0
In Cooperation with
NEOT AB, St1 Biofuels OY and EU

LIFE12ENV/SE/000529

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Commencement of the Project

St1 has a clear vision to change our fossil sources of feedstock to environmentally friendly CO_2-neutral sources.

St1 Biofuels Oy, a part of the St1 company, has developed a concept where residues and rejects from bakeries, supermarkets and other suitable sources are transferred to be a valuable source for 2th generation biofuel.

Why Ethanol from Waste and Residues?

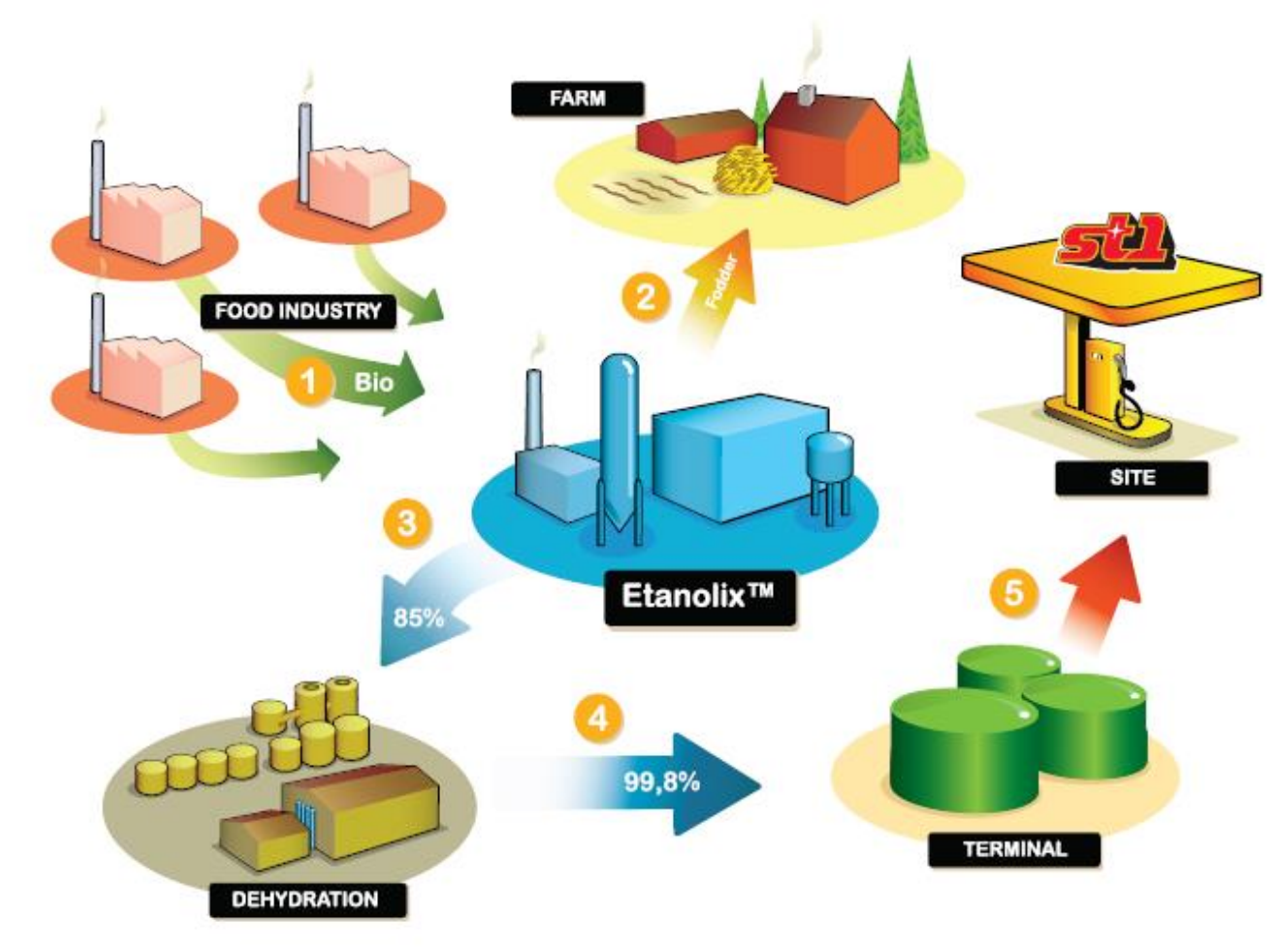
Why ethanol?

- Liquid fuel that replaces gasoline directly in existing fleet, ensuring speed to market.
- Globally most widely used and well-known biofuel.
- Possibility for vast reduction of fossil GHG emissions.
- Market exists still for decades.
- Superior weight efficiency vs. batteries.

Why from waste and residues?

- Unused or underused source of energy.
- No direct or indirect land use issues.
- No negative impact on the availability of food.
- No negative impact on food price.
- Avoidance of methane leak to atmosphere from landfills.

The Concept


FARM
FOOD INDUSTRY
1
Bio
2
Fodder
SITE
3
85%
Etanolix™
5
4
99,8%
DEHYDRATION
TERMINAL

Start of the Project in Sweden

In 2012 the work with gathering information about available sources was started.

It was soon clear that there was a lot of suitable feedstock available.

Bread, cookies, candies etc of all kind is discarded in huge quantities. The potential feedstock was in best cases delivered to a local biogas-plant or to local farmers. But in most cases it was blended with garbage and sent for combustion.

Start of the Project in Sweden

This investigation resulted in a decision to build a plant capable of processing **20500 ton feedstock/year,** yielding up to **5000 m3 of 100% ethanol.**

The unit was decided to be located at the St1 Refinery in order to utilize the synergies with existing utilities, infrastructure and logistics in most valuable way.

Start of the Project in Sweden

The project group with representatives from St1 Biofuels and St1 Refinery, decided about the prerequisites for the project and the integration between the Etanolix unit and the refinery.

CO_2 emission reduction >90%

Energy:
Electricity: 1782 MWh
Heat: 6759MWh

Cooling water (Brackish): 9529 MWh/a**

Raw material 20500 tn

Transports

ETANOLIX Process

EtOH99,7%:* ca 5000 m3

Additives:
Water: 35000 tn
Enzymes: 19 tn
Yeast: 27 tn
Urea 38 tn
Nitric acid: 67 ton
NaOH (cleaning): 22 ton

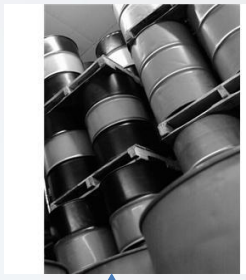
Fossil Emissions
Transports CO_2: 14 tonnes
Energy CO_2 : 73 tonnes
Chemicals CO_2 : 243 tonnes
VOC: 1 tonnes

Process sewer Water:
6000-12000 tn
(own biotreater)

Waste
(plastic and paper
350 tn**

Animal food
50000 tonnes
7-8%dry solids

Integration of the Etanolix Unit



Process sewer water treated in refinery water processing unit

Controlled from local control-room

Safety systems

Nitrogen for safety-inerting

Instrument Air

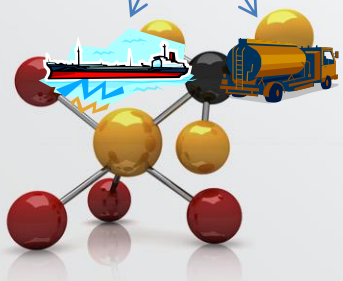
City-water

Ref Ethanol

Heat by connection to Refinery low pressure steam system

Cooling maintained by connection to refinery cooling-system. Brackish water

Ethanol direct to refinery blending tanks



Integration of the Etanolix Unit

Etanolix 2.0 – converting Industrial Waste to Ethanol in oil refinery

http://ec.europa.eu/environment/life/

BUDGET INFO:

Total amount: 4,552,001 Euro
EC Co-funding: 50 % of total eligible budget (1,682,920 Euro)

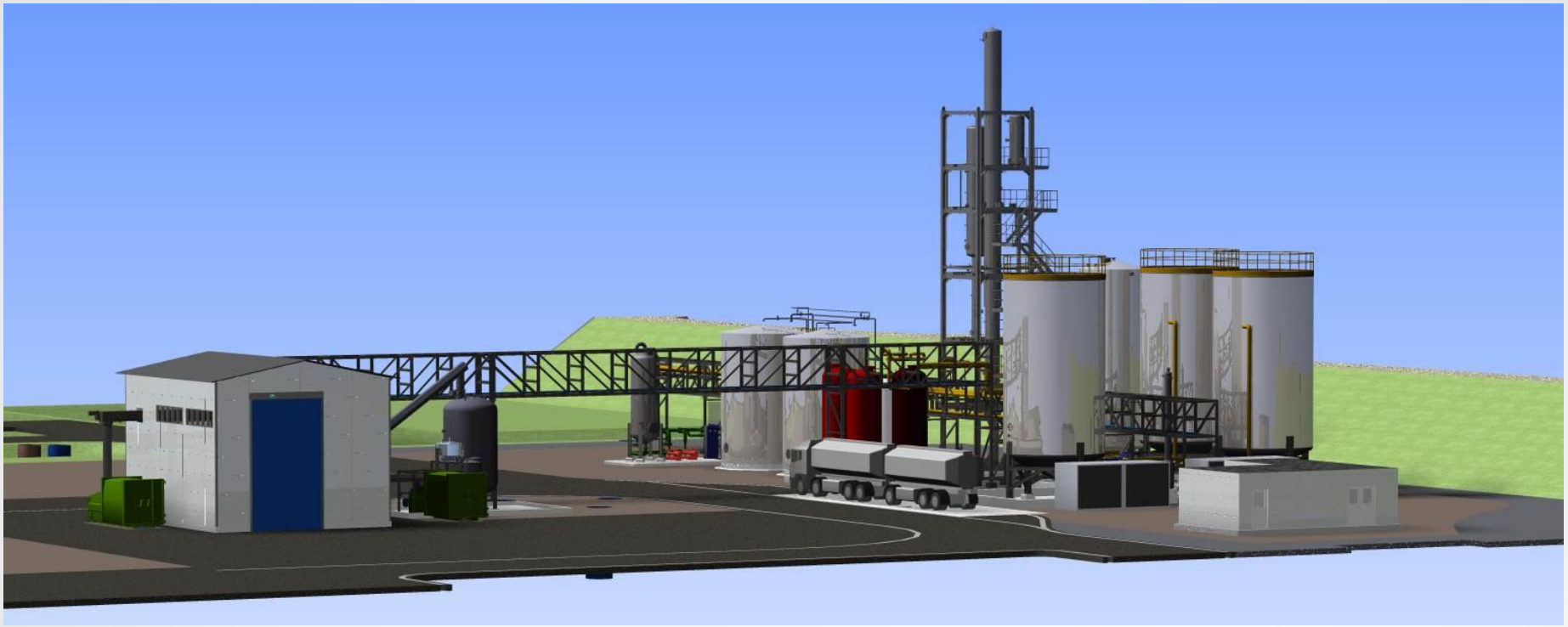
DURATION: Start: 01/09/2013 - End: 15/09/2017

MAIN EU POLICY(IES) TARGETED:

Directive 2009/28/EC: Renewable Energy Directive
Directive 2009/30/EC: Fuel Quality Directive
Directive 2008/98/EC: Waste Framework Directive
Energy Efficiency Directive
COM/2012/0271 final: Renewable energy: a major player in the European energy market
COM/2011/0112 final: A Roadmap for moving to a competitive low carbon economy in 2050
COM(2010)235 final: Future steps in bio-waste management in the European Union

Building Phase

The Unit



Food Industry Process Waste and Residue - Etanolix® Plant

Sources

- Food industry: bakeries, breweries, potato processing, alcohol production etc.
- Retail: shops, logistics and shop bakeries

Feedstock characteristics

- High ethanol yield from starch and sugars
- Variable in quality and quantity
- Often contains salt, inhibitors and impurities
- Packed in paper, plastic, bags etc.
- Cost connected to quality and local utilization

Collection systems

- Integrated site: industrial sources
- Direct transportation from bakery/source
- Dedicated collection from shops
- Return logistics to industry or logistic hub

Etanolix® Plant

Feedstock:	Food industry process waste and residues - Package removal included
Product:	Renewable Ethanol: - EU Double counted - US Advanced Ethanol
Capacity:	5 – 10 million liters/year/unit
CO_2 savings:	Up to 90 %
Co-product:	- Protein rich liquid animal feed or - High yielding biogas plant feed
Units:	4 units in Finland, 1 in Sweden

KPIs

• Production of Ethanol	417 m3/month 5000 m3/year
• Stillage production	2080 m3/month 25000 m3/year
• Feedstock intake	1750 ton/month 20500 ton/year
• Yield	30%
• CO_2 Reduction	>90%
• Ethanol production fulfilling quality to spec	95%

Challenges

- **Project start**
  - Location of unit
  - Permits
  - Building on a refinery site with ongoing production
  - New type of operation (solid feed, hygienic issues)
- **During build-up**
  - Safety
  - Delivery time on materials
- **Startup**
  - Feedstock quality
  - Unwanted items in feedstock
  - Process stability
- **During operation**
  - Feedstock quality
  - Throughput speed
  - Fulfilling product specification

CO_2 Reduction

1. Ethanol (Etanolix/St1)

0,01 kg CO2/kgoe

2. Ethanol (Sugarcane/Brazil)

0,5 kg CO2/kgoe

3. Ethanol (Corn/U.S)

1,4 kg CO2/kgoe

4. Biodiesel NExBTL

1,6 kg CO2/kgoe

5. Biodiesel RME

1,6 kg CO2/kgoe

6. Fossil gasoline

2,7 kg CO2/kgoe

7. Fossil diesel

3,8 kg CO2/kgoe

kgoe = kilogram oil equivalent
41,868 MJ/kg (EtOH 26,9 MJ/kg)

Referenssit:
1) WSP Report 2006. 2) BioScience 55/7 2005. 3) BioScience 55/7 2005. 4) Neste Oil.
5) Concave, Shell, WTW 2004. 6) BioScience 55/7 2005. 7) Concawe/ Eucar WTW 2004

Conclusion

100 tonnes with bread-waste

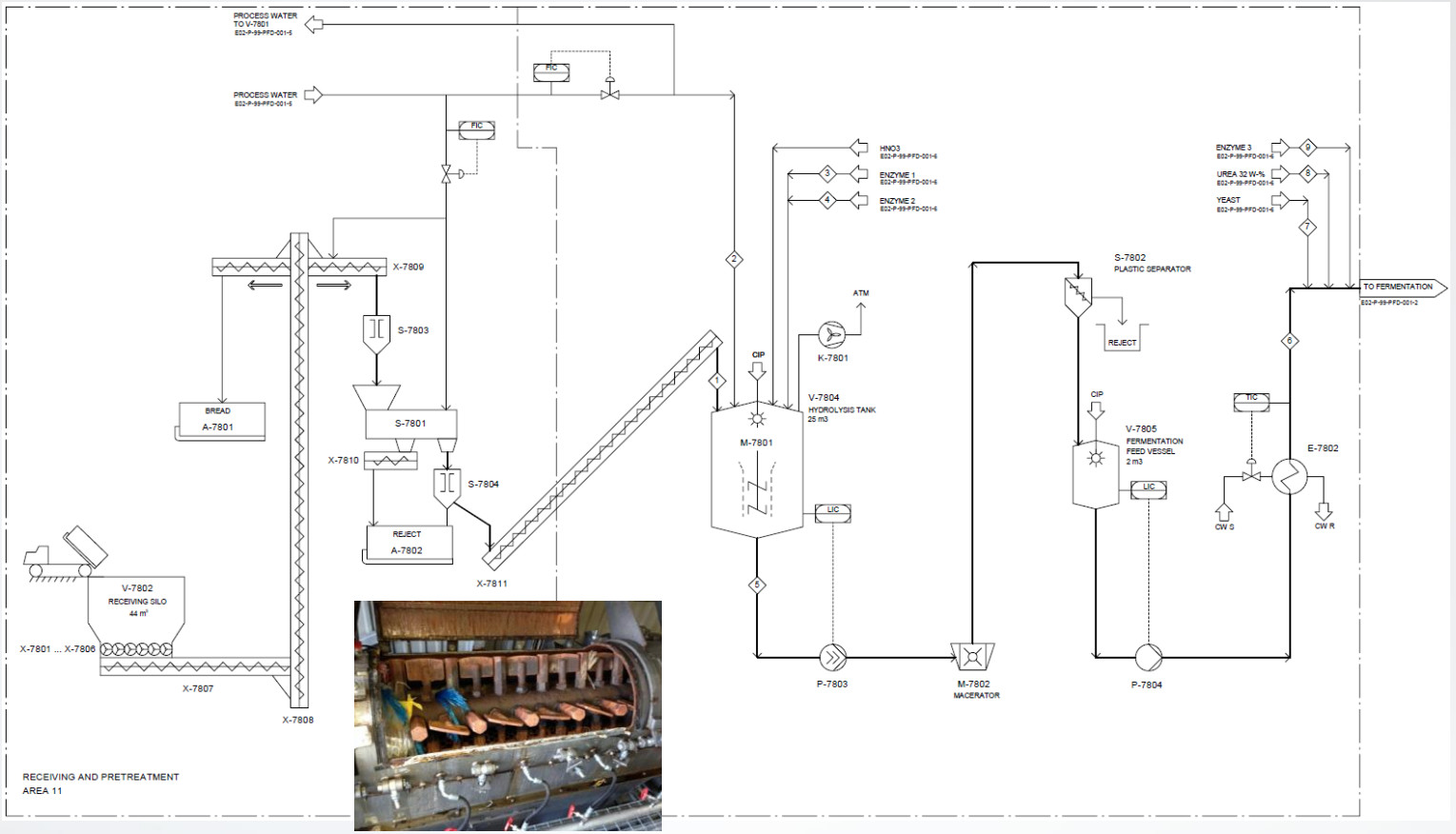
Production of 25 000 liters of 100% ethanol

Enough for a normal car running 240 000 km

Reducing fossil CO_2 with approx 36 000 kg.

Producing approx 100 000 kg of stillage suitable for animal feed or biogas production enough for running a normal car 10 000 km

How it Works –Flow Scheme



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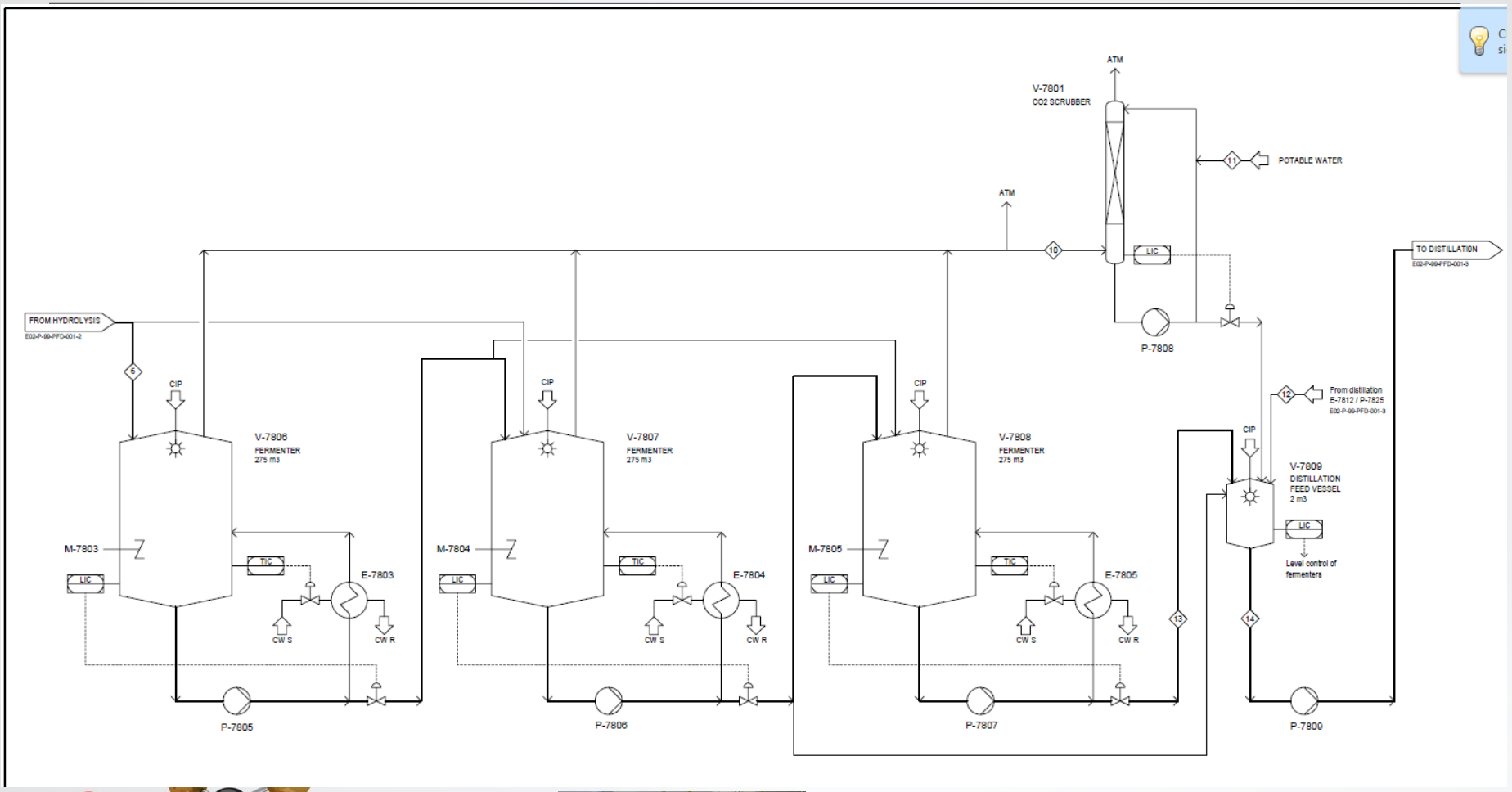

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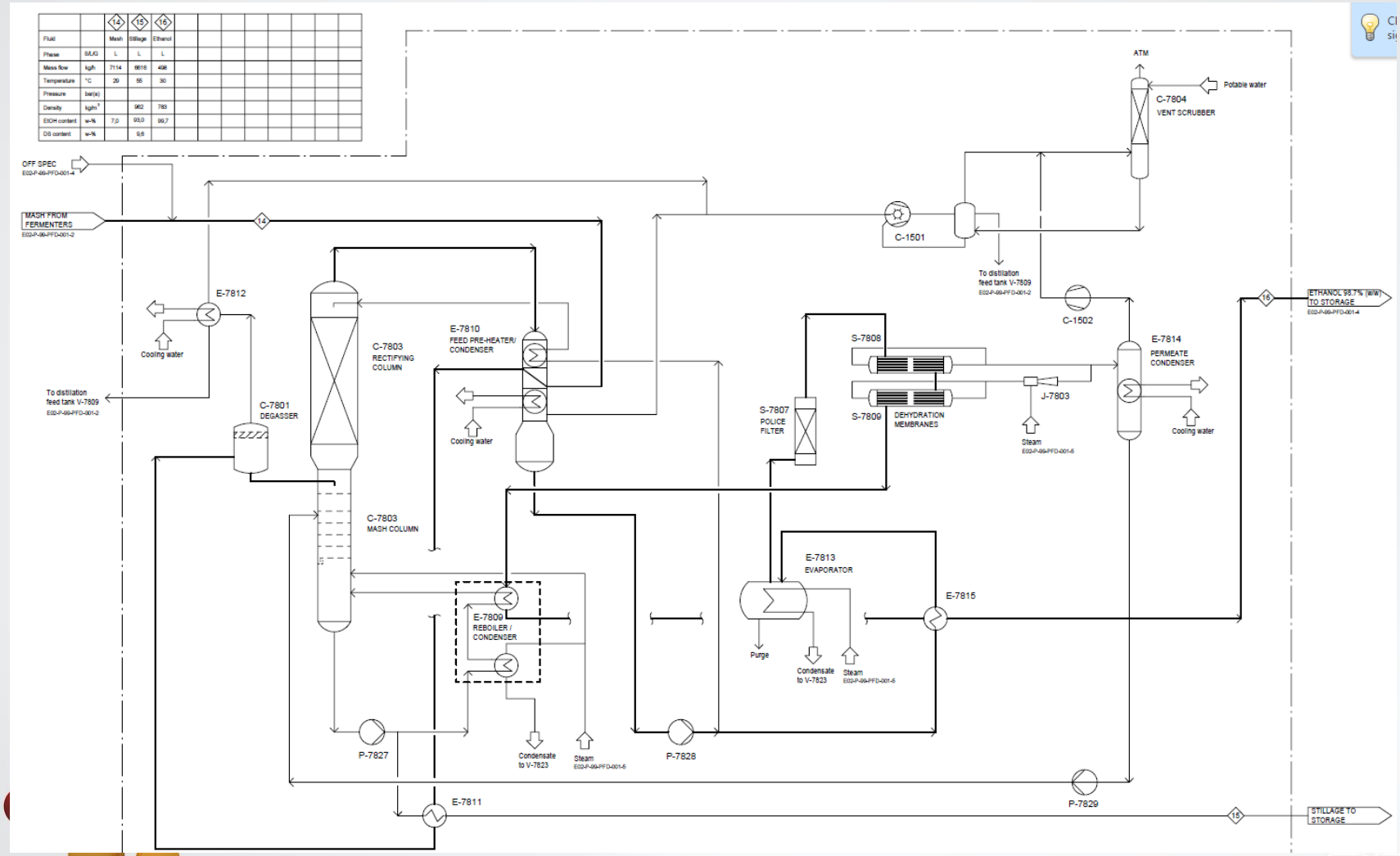

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