ADVANCES IN »
HYDROTHERMAL CONVERSION OF INDUSTRIAL BIOGENIC RESIDUES INTO INTERMEDIATE BIOENERGY CARRIERS

RESULTS FROM THE **F-CUBED PROJECT**

F-CUBED

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 884226.

Connecting F-CUBED's bioenergy carriers: A novel supply chain model

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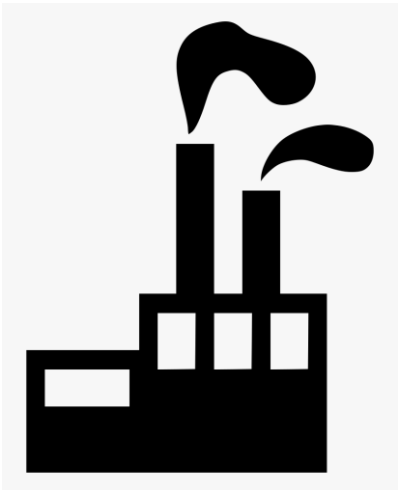
Objective of this work

To develop a ***novel*** supply chain model for intermediate bioenergy carriers produced from the F-CUBED process.

Wet Residue Source

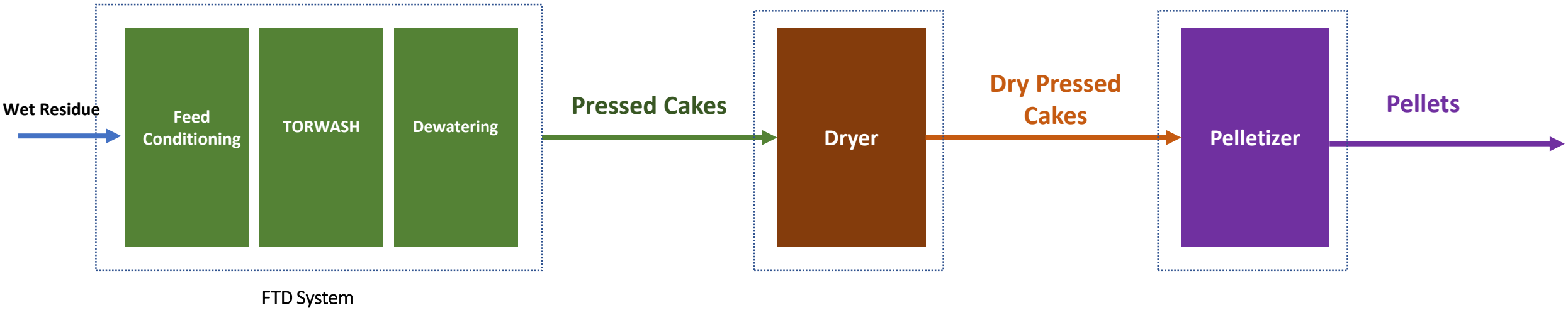
F-CUBED



End User

?

Simplified F-CUBED process



Methodology

Develop possible configurations for F-CUBED system components

Construct **case studies**.

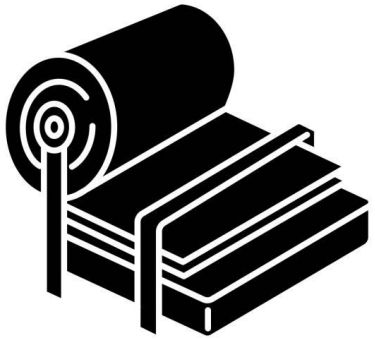
Within these case studies, **build scenarios using the developed configurations and other parameters**

Conduct **cost evaluation and optimization**

Identify the **best scenario**

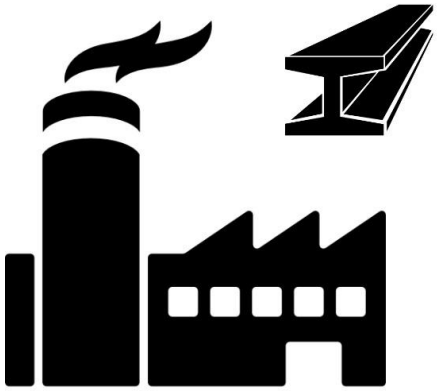
Parameters for the Case studies

For these case studies……



Source of wet residue: Paper mills

Truck Transportation of F-CUBED products



End use: Partial replacement of coal in Ore reduction Steel mills

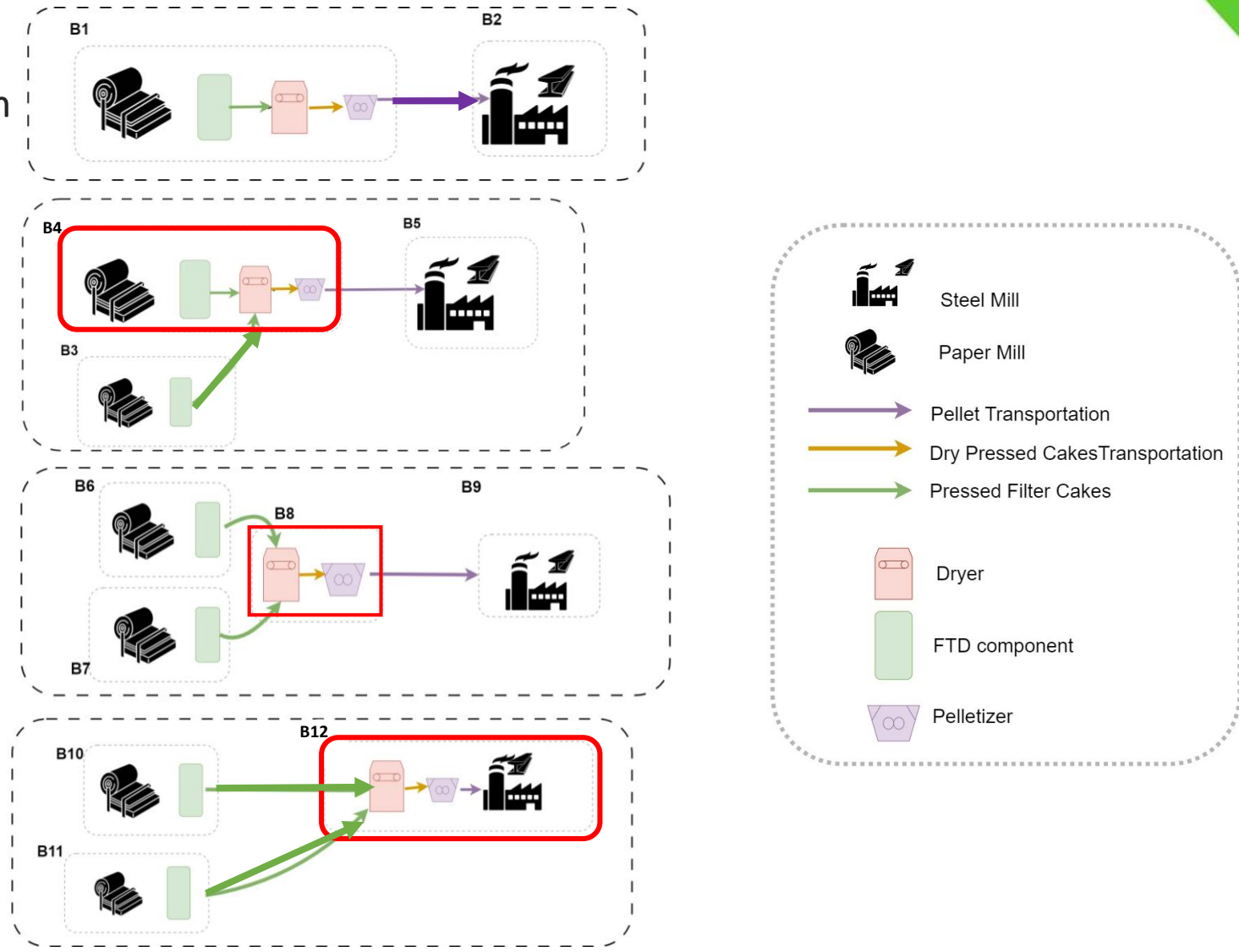
Configurations

Configuration 1 – Onsite F-CUBED system

Configuration 2 - Drying hub at B4

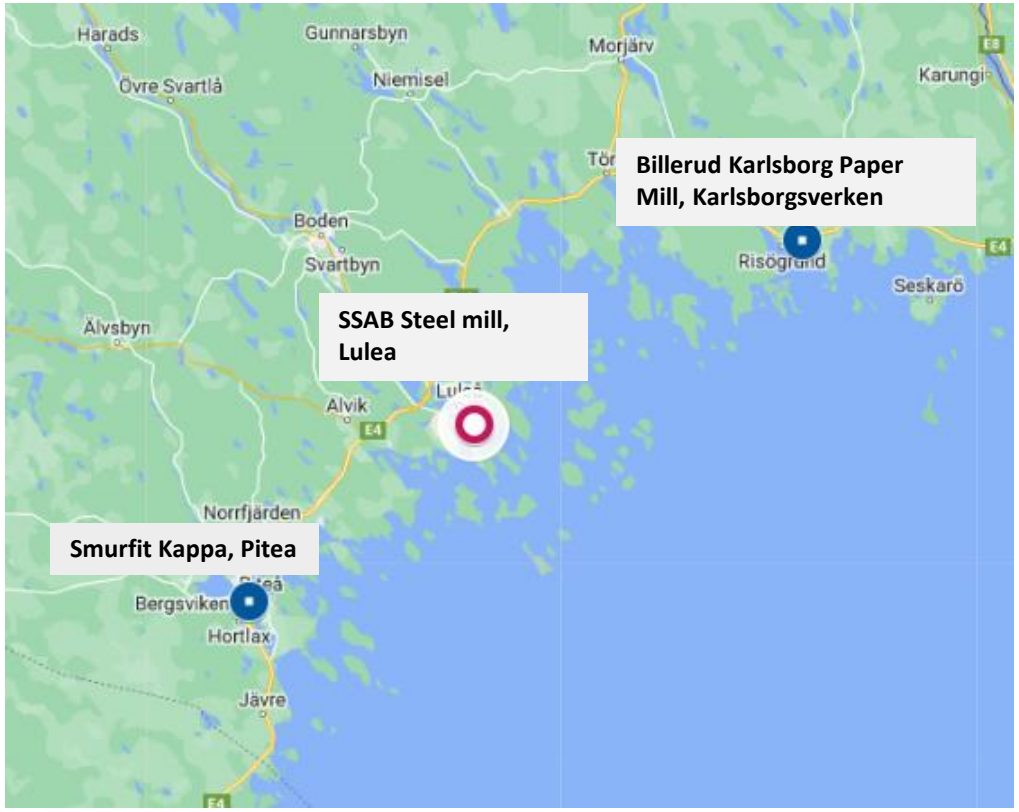
Configuration 3 – Centralized drying hub

Configuration 4 – Drying hub at B12



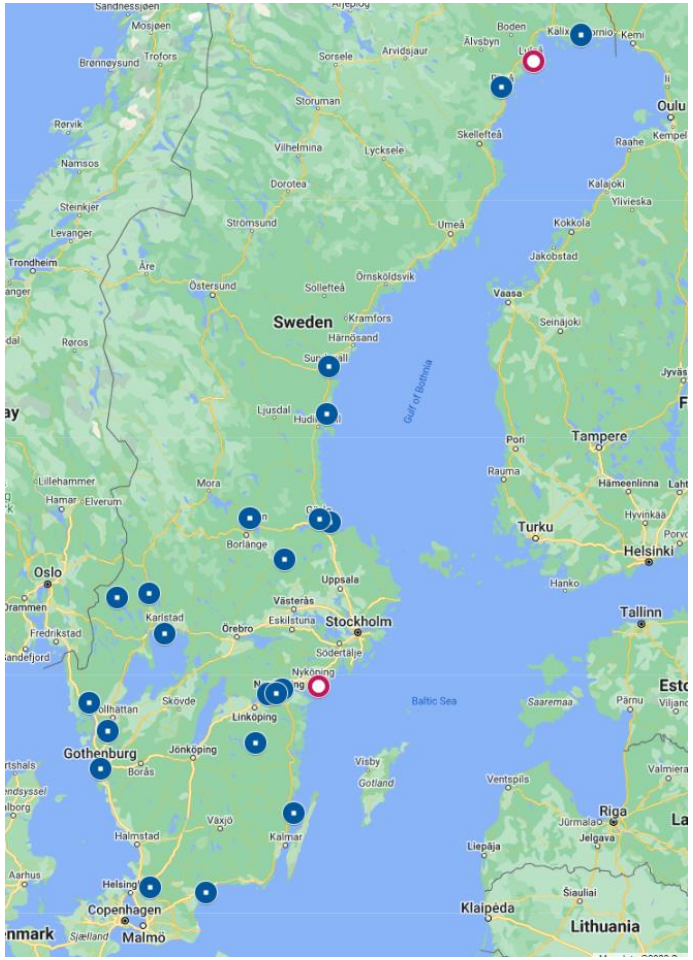
Case studies for Sweden

North East of Sweden



Paper mils Steel mils

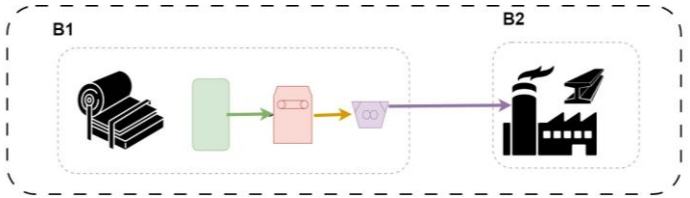
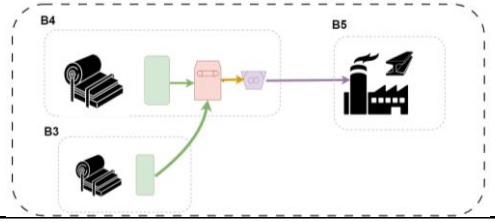
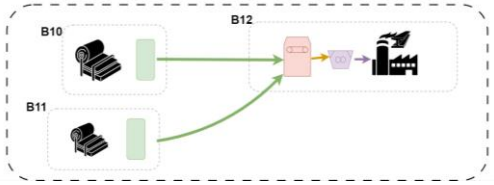
All of Sweden



21 paper mills | 2 Steel mills

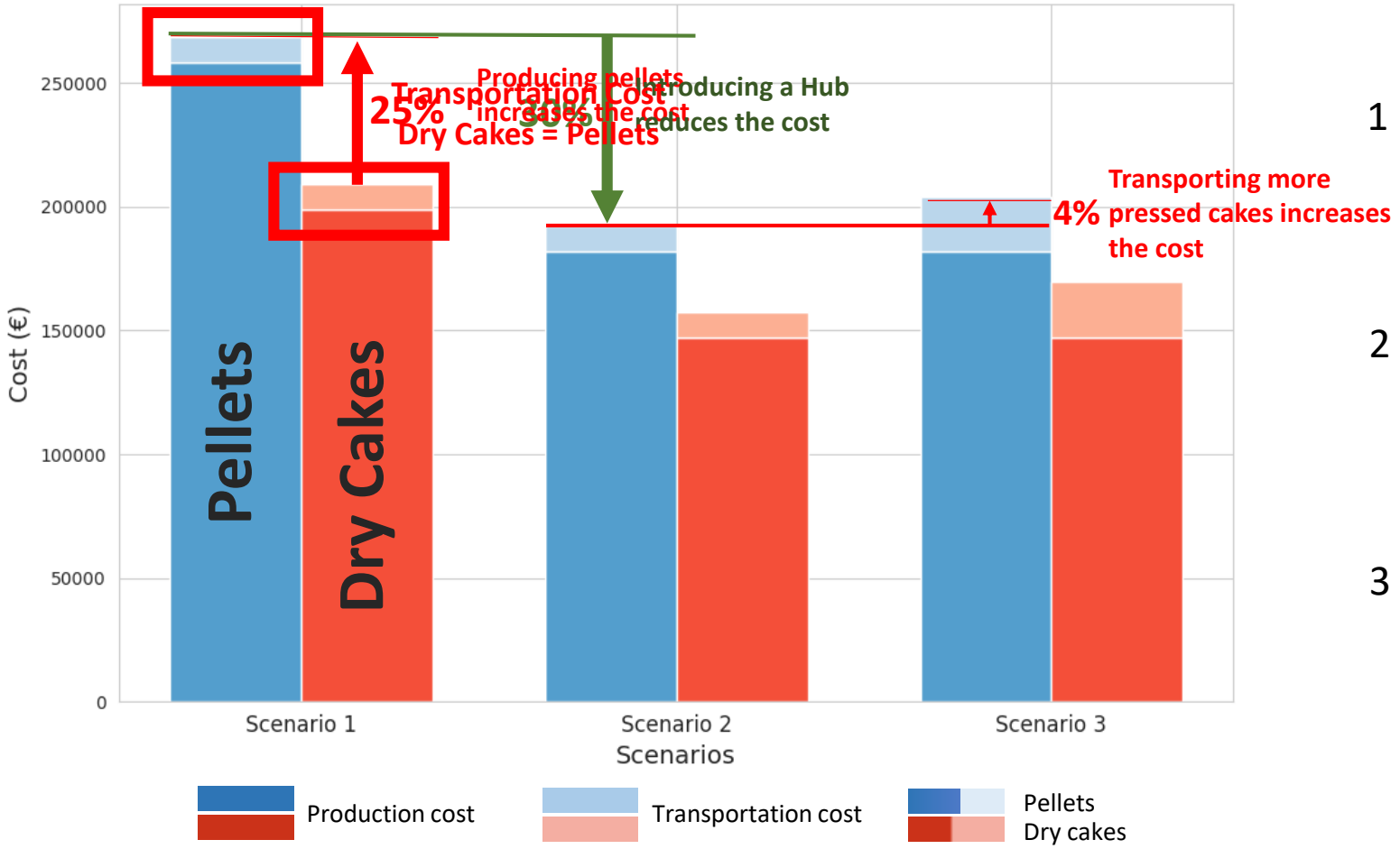
Scenarios for the North East of Sweden

With respect to Smurfit Kappa, Pitea

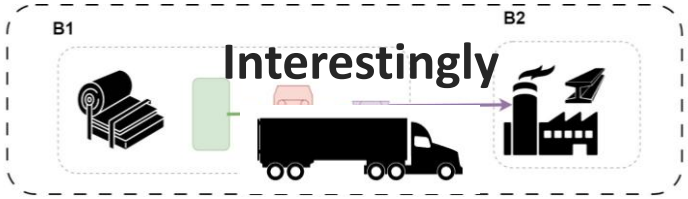
Scenario No.	Region	Wet residue source	End-use	Configurations
1	North east of Sweden	Paper sludge (Smurfit Kappa)	SSAB Steel mill	
2		Paper sludge (**Smurfit Kappa** + Billerud)		 Hub at Smurfit Kappa
3		Paper sludge **(Smurfit Kappa + Billerud)**		 Hub at SSAB Steel mill

Results for the North East of Sweden Region

With respect to Smurfit Kappa, Pitea



1



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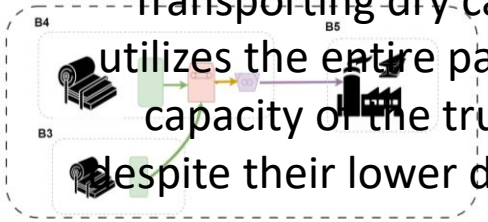


Transporting dry cakes utilizes the entire payload capacity of the truck, despite their lower density

3

All of Sweden case study

Goal

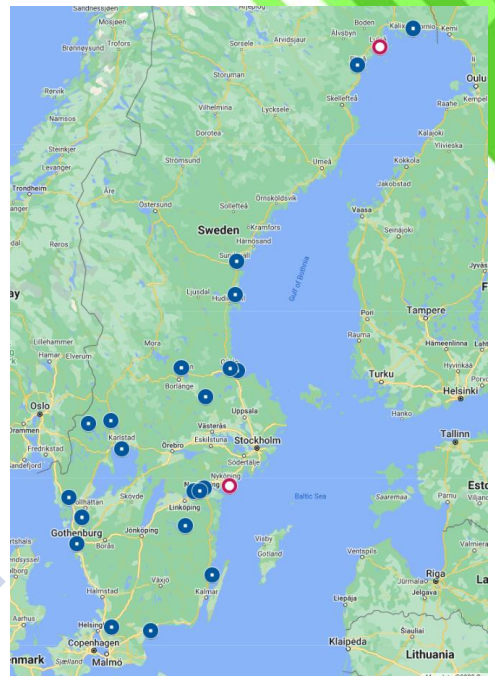
- To identify optimal number of hubs and their locations

Challenge

- Handling **non-linear cost functions** (drying and palletization costs depend on the economies of scale)
- **Traditional supply chain algorithms** such as **p-median** requires **the size and locations of the hubs** to be pre-defined

Methodology

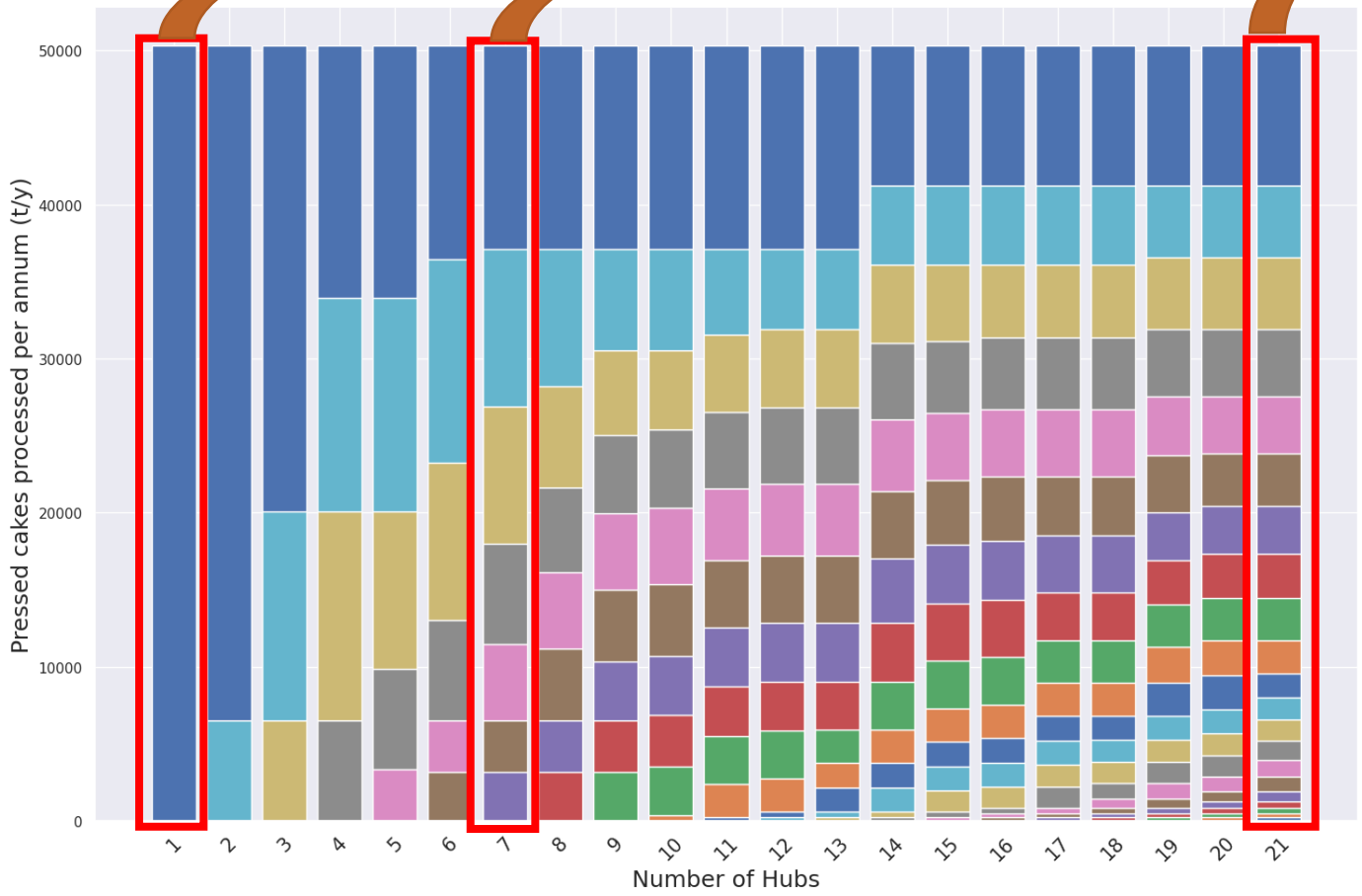
- Developed a optimization model using **Stimulated Annealing algorithm**
- The objective functions were built to handle the transportation cost and the **drying and palletization costs (non linear) which depends on the size of the hub**

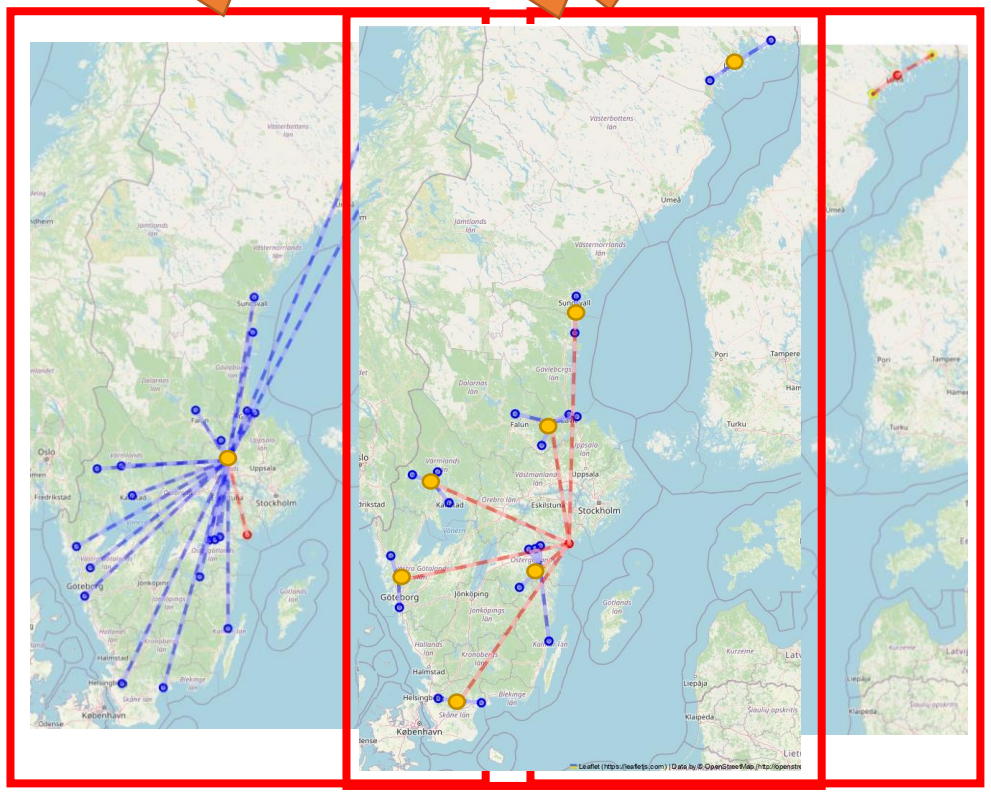


21 paper mills | 2 Steel mills

Quantity of pressed cakes processed at hubs

An analysis based on the number of processing hubs





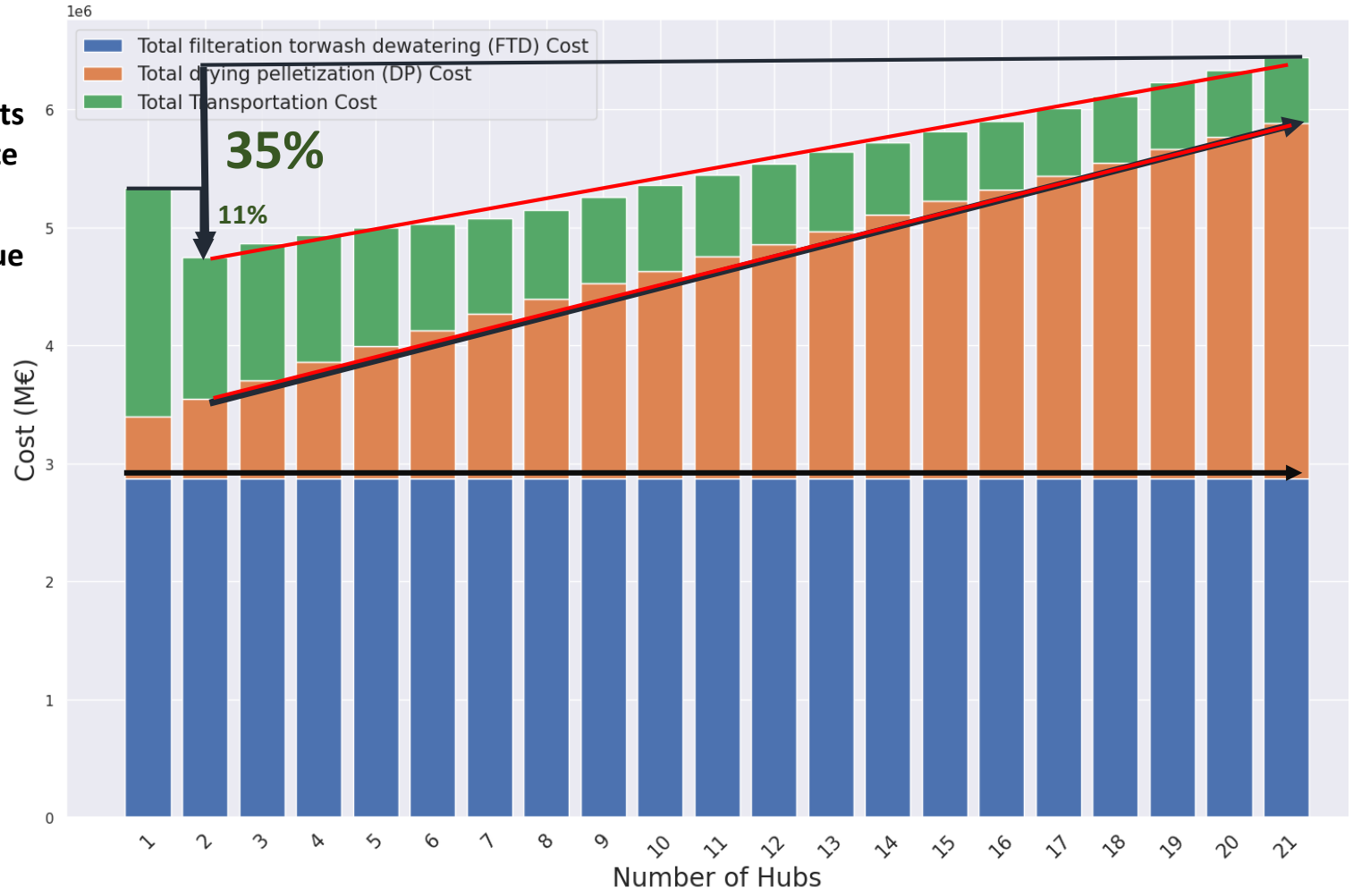
Paper mills
Steel mills
Hubs

Pressed cakes transportation
Pellets/Dry cakes transportation

Variation of total system cost (FTD, drying and palletization and transportation) based on the number of hubs

2 Hub scenario costs less than the onsite case

2 Hub scenario is cheaper than 1 hub due to the decrease in transportation cost



Transportation cost keeps decreasing as the quantity of pressed cakes transported decreases

Total cost increases as the drying and pelletization cost increases

No Variation in cost of producing pressed cakes

Conclusions for paper bio-sludge case

Primary Findings:

- Dry cakes are around 25% cheaper to produce than pellets
- Integration of hub infrastructure results in up to 35% overall cost reductions for the all of Sweden case

End-product choices, optimized hub infrastructure **for some of the components of the system** lead to reduction in costs.

Scenarios for olive pomace and orange peels

Scenarios for olive pomace

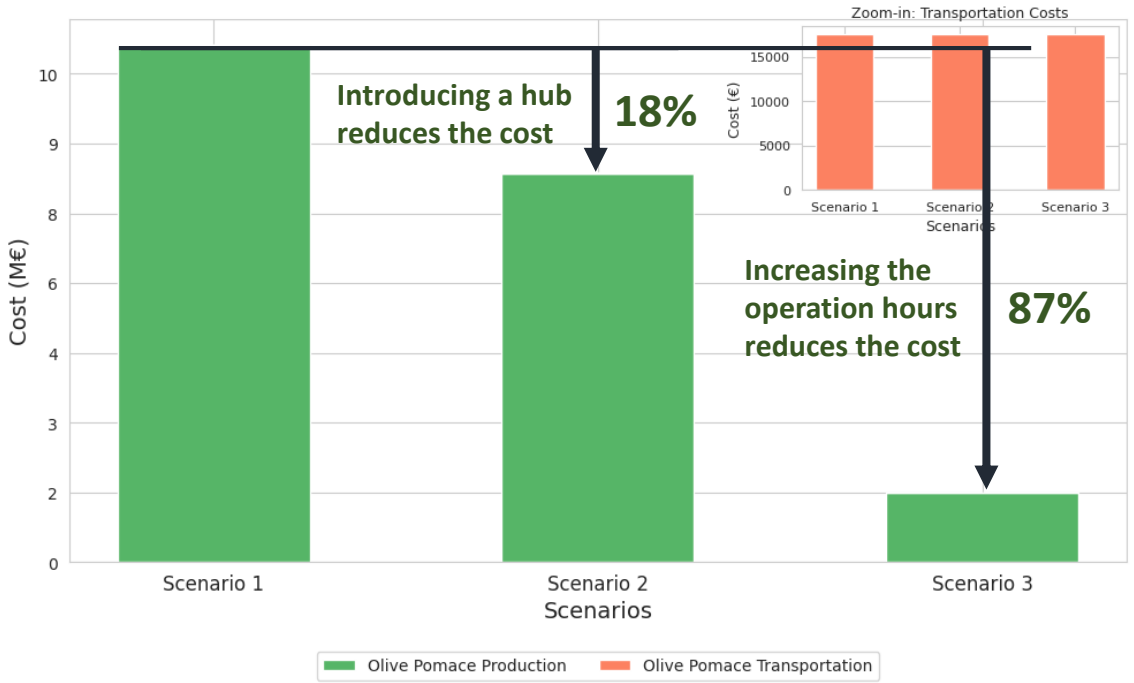
No.	Wet residue source	Configurations	End use	Operation hours (h)	Transport method	Material transportation Form (wet residue site to End user)
1	appo(1884t DM/y)	Point to Point (Configuration 1)	ENDU01 – 100 km away from OP01	960	Truck	Dried Cakes
2	appo(1884t DM/y)	Hub (Configuration 2) 10000t (DM)	ENDU01 – 100 km away from OP01	960	Truck	Dried Cakes
3	appo (1884t DM/y)	Hub (Configuration 2) 10000t (DM)	ENDU01 – 100 km away from OP01	7500	Truck	Dried Cakes

Scenarios for orange peels

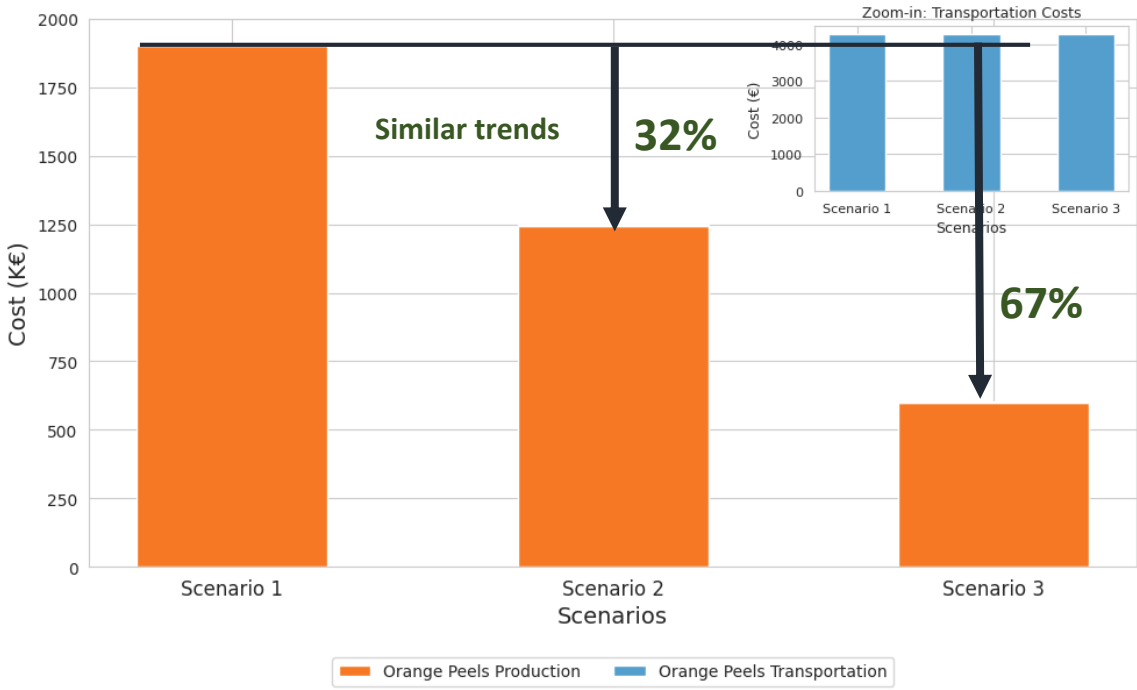
No.	Wet residue source	Configurations	End use	Operation hours (h)	Transport method	Material transportation Form (wet residue site to End user)
1	Delafruit(460t DM/y)	Point to Point (Configuration 1)	ENDU01 – 100 km away from ORP01	3200	Truck	Dried Cakes
2	Delafruit(460t DM/y)	Hub processing 10000t (Configuration 2)	ENDU01 – 100 km away from ORP01	3200	Truck	Dried Cakes
3	Delafruit(460t DM/y)	Hub (Configuration 2) 10000t (DM)	ENDU01 – 100 km away from ORP01	7500	Truck	Dried Cakes

Cost results for the olive pomace and orange peels

Olive Pomace



Orange peels



Conclusions for olive pomace and orange peels case

- Olive pomace and orange peels can achieve **significant cost savings for producing F-CUBED products** (up to 87% and 69%, respectively) using **large hubs with extended operational hours**.

- **Centralized hubs** with extended hours offer clear cost advantages.

- **Seasonality of olive pomace and the limited supply of orange peels** present challenges, and therefore a potential solution is **diversifying feedstock by processing multiple feedstocks** throughout the year.

THANK YOU!

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