NC2I
Nuclear Cogeneration Industrial Initiative

Market opportunities, possible business models and system integration

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NC2I is one of SNETP's strategic technological pillars, mandated to coordinate the European nuclear cogeneration roadmap.

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Sustainable Nuclear Energy Technology Platform
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Summary

1- Scope and objectives

2- Market opportunities

3- Current business models of a chemical park

4- Ownerships models of a NPP

5- Business model of a HTR for industrial applications

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Scope

Qualitative analysis of the market and the opportunities

Quantitative economics analysis conducted in another presentation

Objectives

- Understand the industrial heat market
- Identify the possible applications for an HTR
- Have a clear representation of the current situation of chemical park's business models and ownership solutions for an NPP
- Determine the opportunities resulting from the coupling of an HTR coupled with a chemical park

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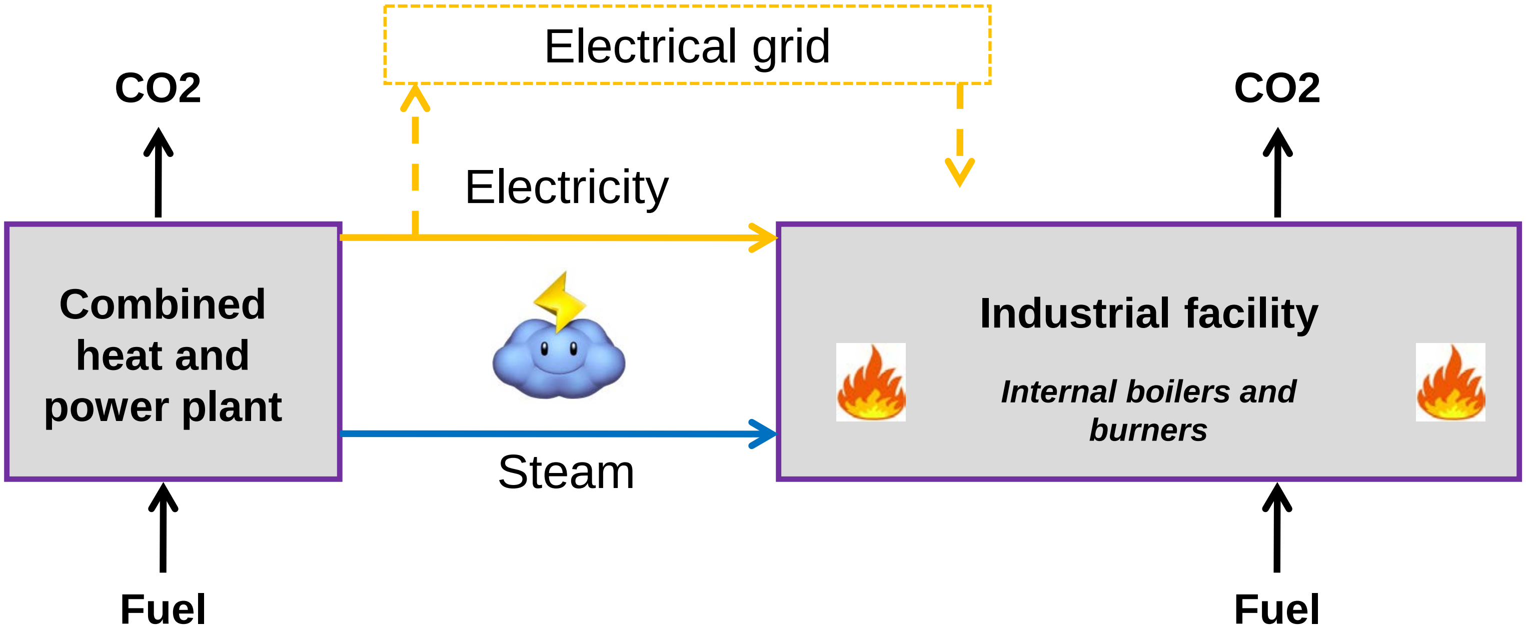
Segmentation of the industrial heat market



Plug-in

(784 TWh/y)

Extended

(1,830 TWh/y)

Source: LGI Consulting (EUROPAIRS, 2011)

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Opportunities in the heat market for nuclear cogeneration

Best opportunities in the current heat-intensive industries

- Chemical industry
- Oil refining sector
- Hydrogen production (Steam Methane Reforming)

Innovative technologies

- Hydrogen production (HT electrolysis, chemical cycles)
- Coal-To-Liquid

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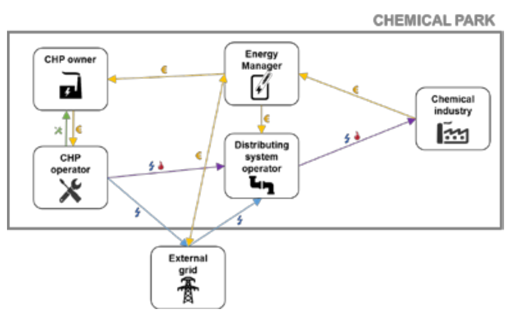
Definition of a Business Model

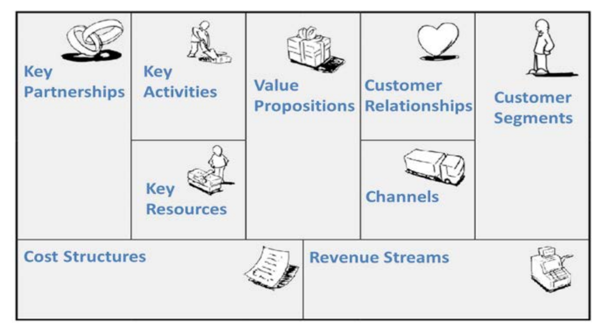
- **Osterwalder**[1] (2004) “So differently put the business model is an abstract representation of the business logic of a company. And under business logic I understand an abstract comprehension of the way a company makes money, in other words, what it offers, to whom it offers this and how it can accomplish this”.

Tools used

- Ecosystem map



- Business Model canvas



[1] Osterwalder, A., 2004. *“The Business Model Ontology L A Proposition in a Design Science Approach”*. PhD Thesis. Lausanne, Switzerland: Université De Lausanne.

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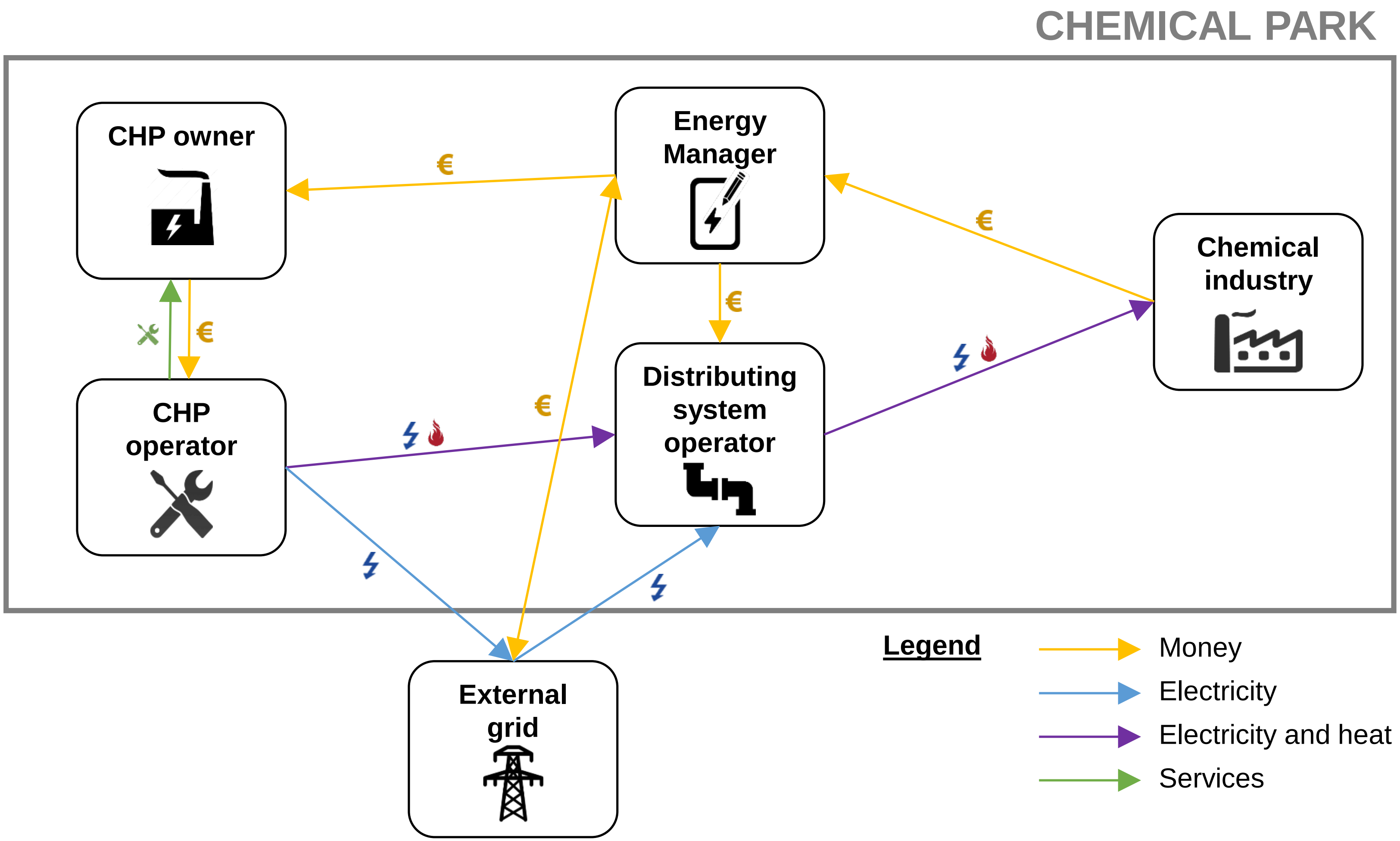
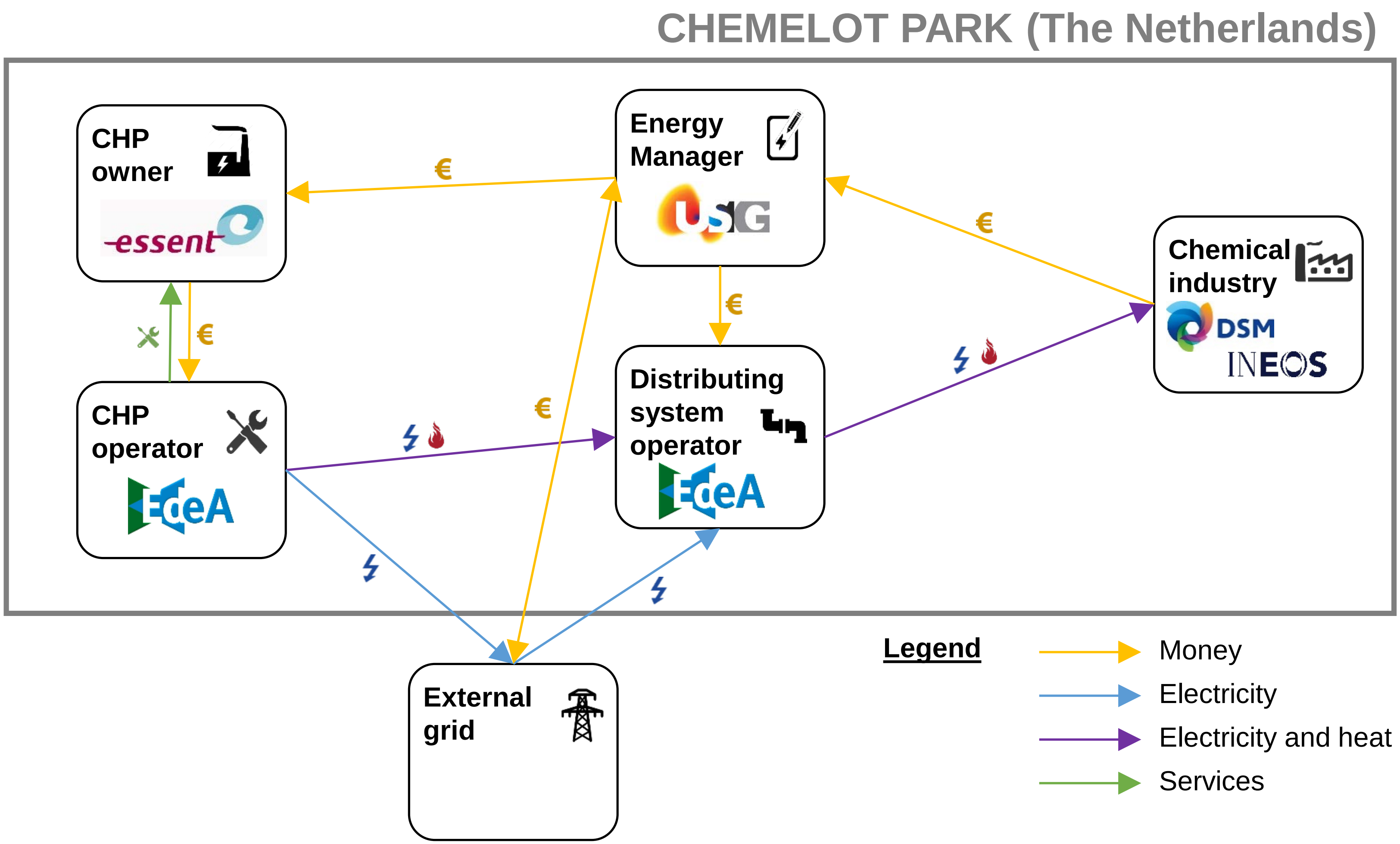
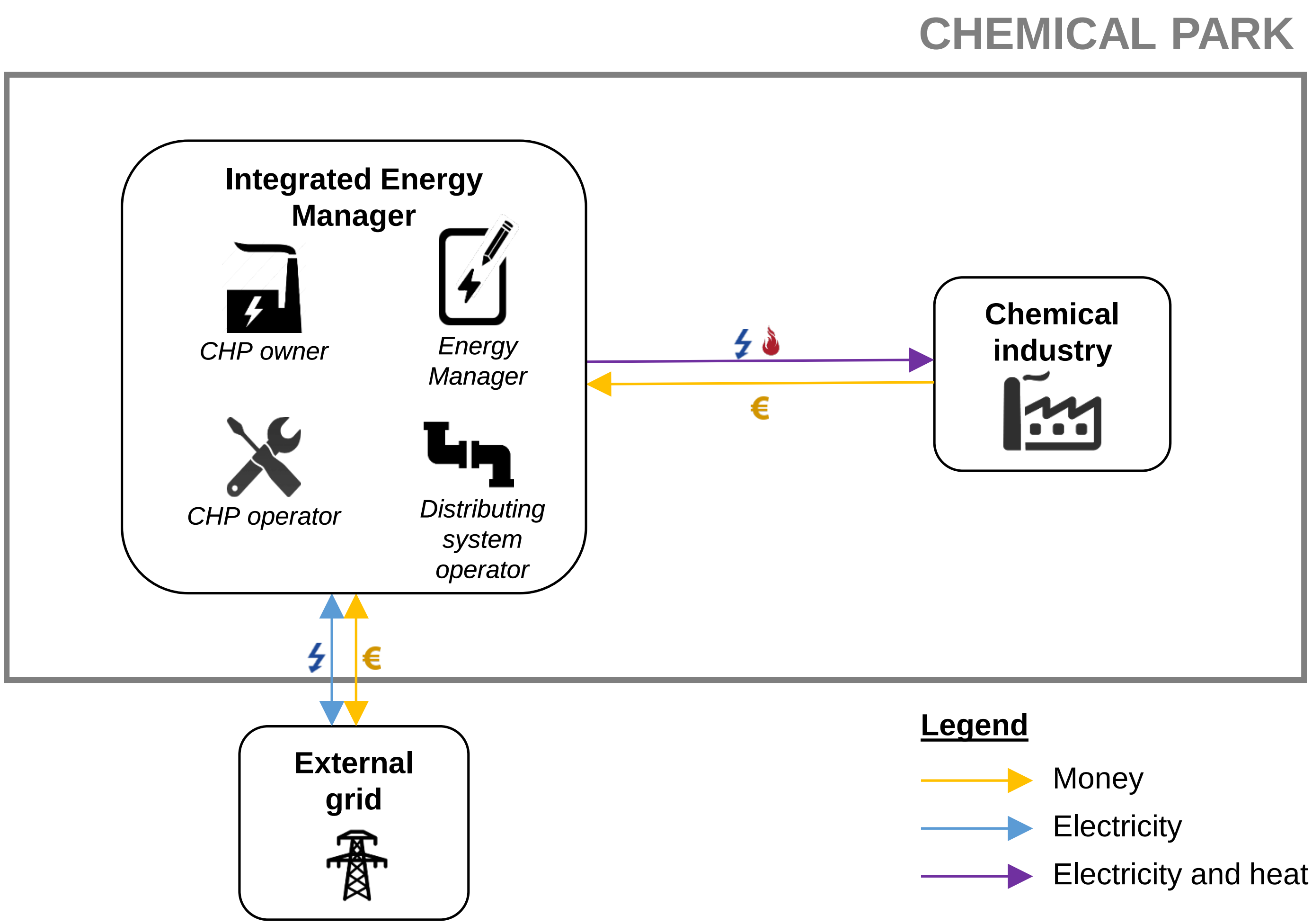
- **Case n°1: No integration**



- **Case n°1: Example**



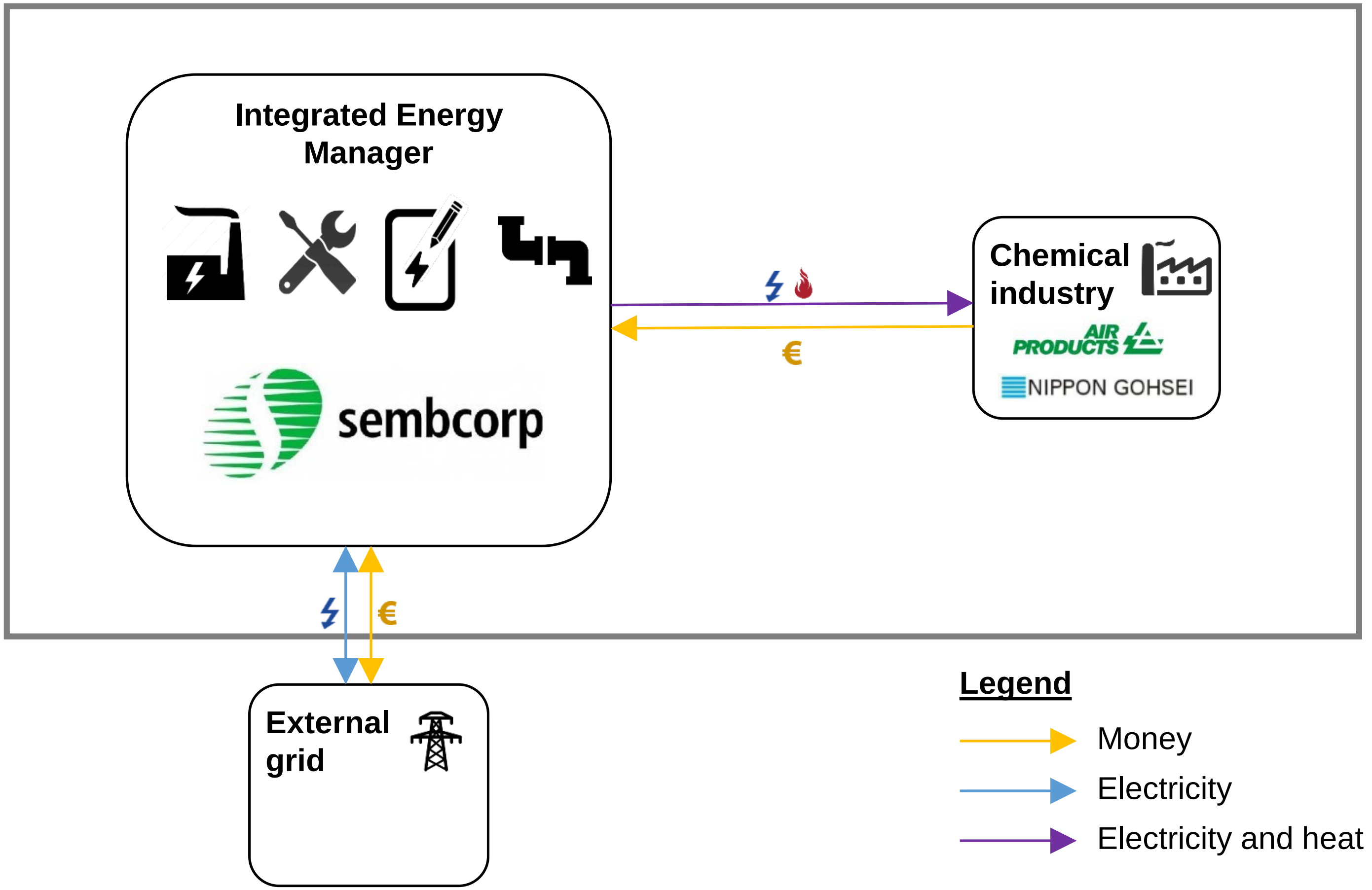
- **Case n°2: Energy Management integration**



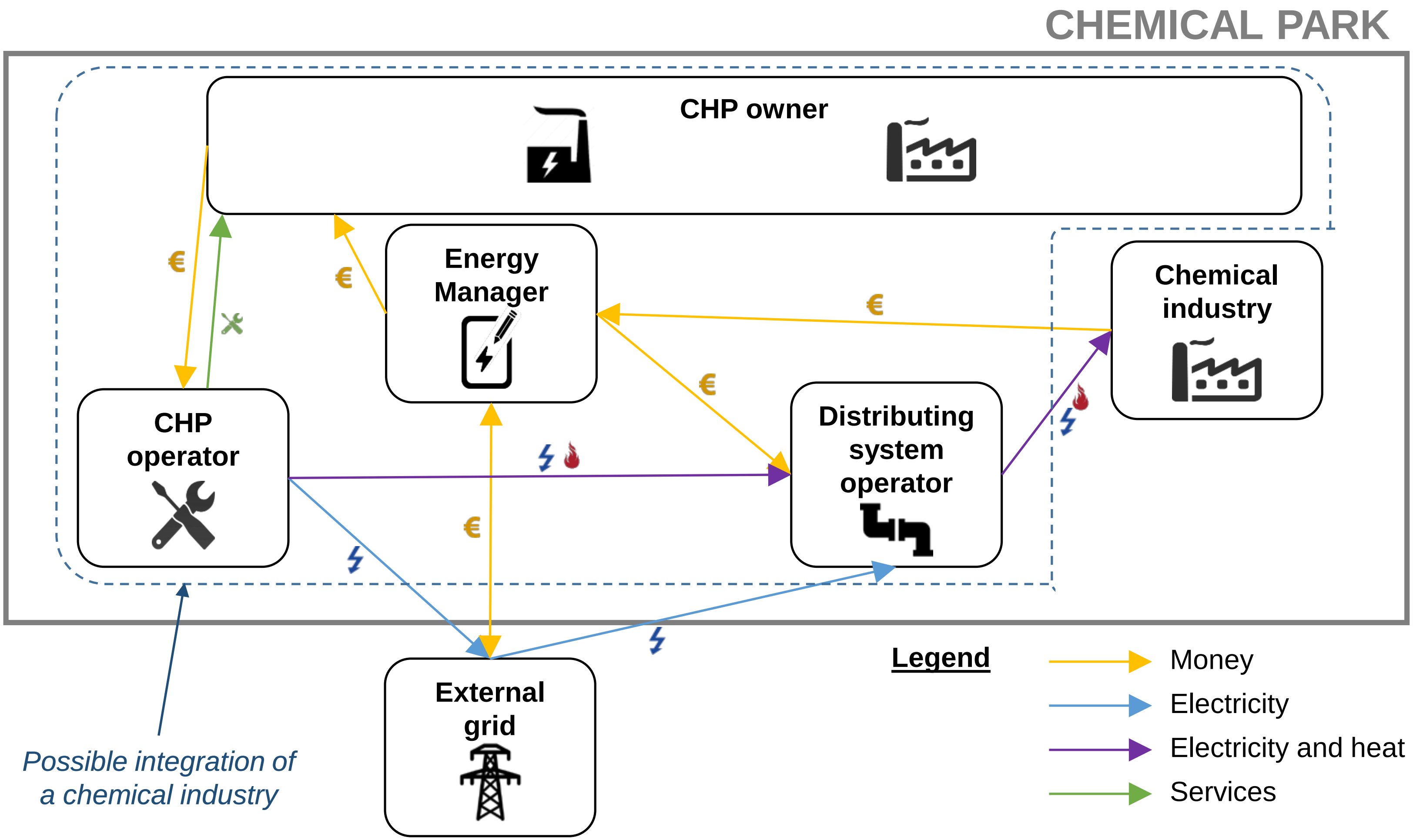
1-Scope & objectives
2- Market opportunities
3- BM chemical park
4- Ownership models NPP
5- BM coupled system

- Case n°2: Example

SALTEND CHEMICALS PARK (UK)

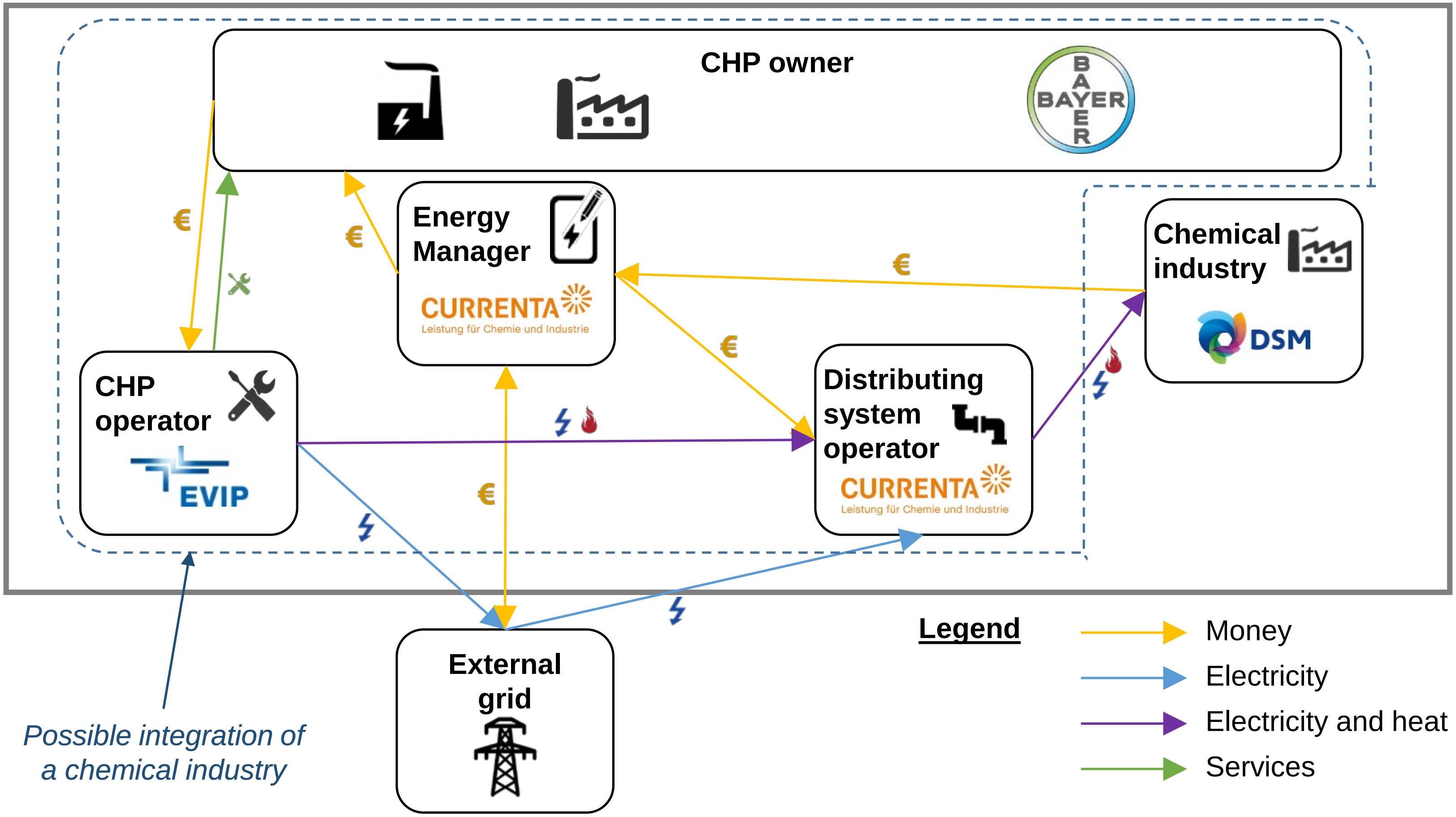


- **Case n°3: Integration with a chemical industry**



- **Case n°3: Integration with a chemical industry**

BAYER BITTERFELD PARK (GERMANY)



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End-user: chemical industry

END-USER: CHEMICAL INDUSTRY				
KEY PARTNERS	KEY ACTIVITIES	VALUE PROPOSITION	CUSTOMER RELATIONSHIPS	CUSTOMER SEGMENTS
	- Production of chemicals R&D - Waste management - Ensuring security - Transporting chemicals	- Sell chemical products - Reduce CO2 emissions - Develop Green chemistry		
	KEY RESOURCES		CHANNELS	
	- Energy (heat + electricity) - Raw materials - Processes and boilers			
COST STRUCTURE	- Energy costs (~50% of the production costs) - Raw materials - Investment for processes/land/boilers			REVENUE STREAMS

With an energy manager, chemical industries do not deal with energy issues and can **focus more on their core business.**

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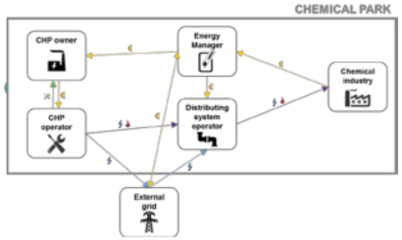
▪ Case n°1: non-integrated energy manager



CASE N°1: NON-INTEGRATED ENERGY MANAGER				
KEY PARTNERS	**KEY ACTIVITIES**	**VALUE PROPOSITION**	**CUSTOMER RELATIONSHIPS**	**CUSTOMER SEGMENTS**
- CHP owner - Distributing system operator - Utility (external grid)	- Negotiates contracts with industries - Buys electricity from the grid	- Ensures the supply of heat and electricity 24-7 with given characteristics (V, T°, P, etc.) - Supplies energy at best prices	- Enables the chemical industries to focus on their core business	- Industries located on the park
	KEY RESOURCES		**CHANNELS**	
	- Negotiation skills - Juridical workforce		- Direct relationships (onsite)	
COST STRUCTURE	- Energy bought from CHP operator		- Contracts from industries - Money from surplus electricity to the grid	**REVENUE STREAMS**

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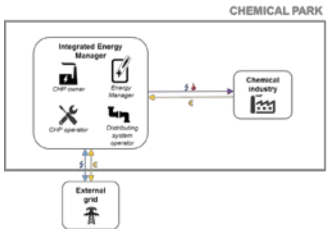
- **Case n°2: energy manager integration**

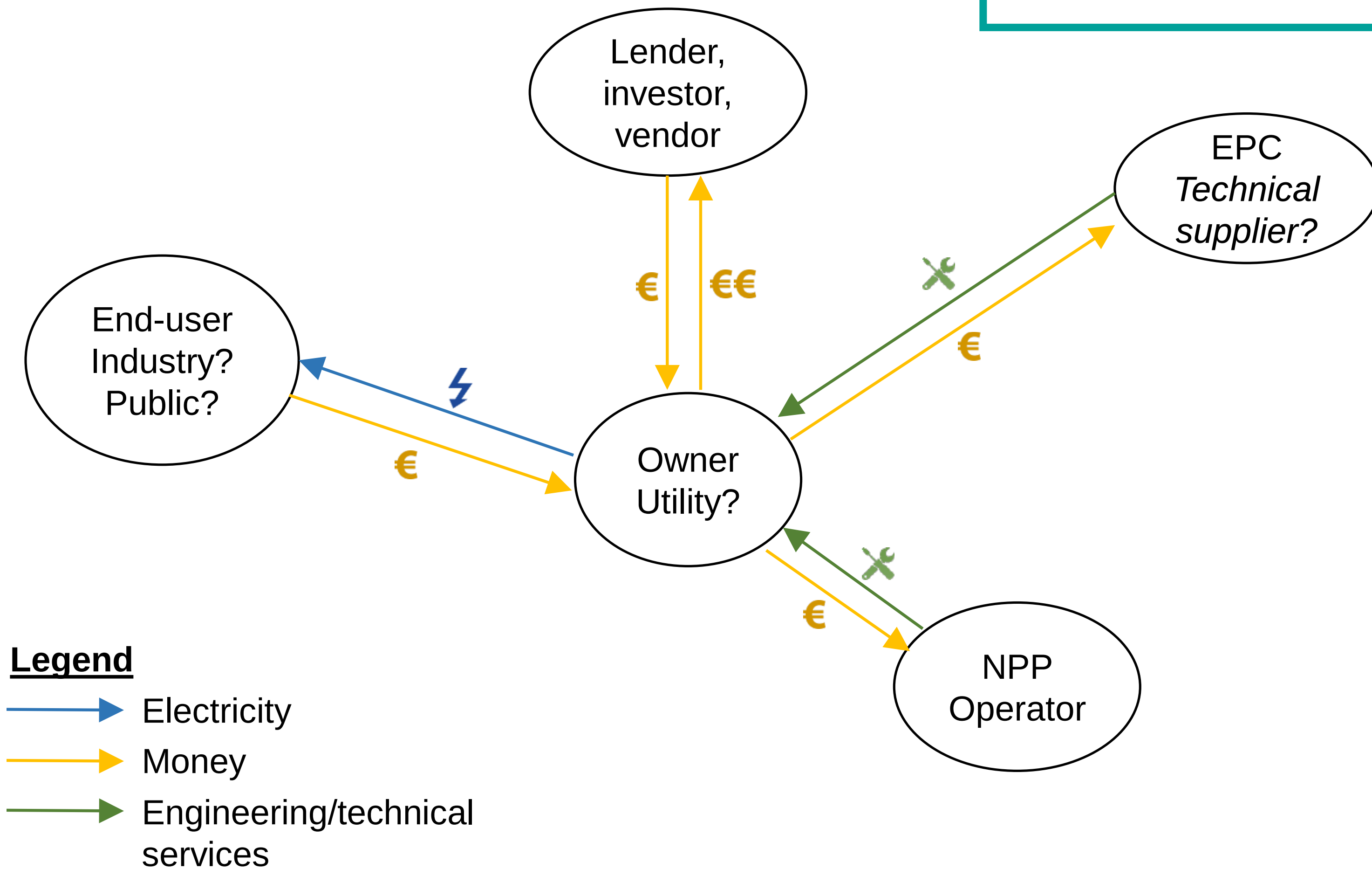


CASE N°2: ENERGY MANAGER INTEGRATION				
KEY PARTNERS	**KEY ACTIVITIES**	**VALUE PROPOSITION**	**CUSTOMER RELATIONSHIPS**	**CUSTOMER SEGMENTS**
- External grid	- Negotiates contracts with industries - Buys electricity from the grid - Operates CHP plant and distribution network	- Ensures the supply of heat and electricity 24-7 with given characteristics (V, T°, P, etc.) - Supplies energy at best prices	Enables the chemical industries to focus on their core business	Industries located on the park
	KEY RESOURCES		**CHANNELS**	
	- Negotiation skills - Juridical workforce - Distributing system - Technical workforce - CHP plant		Direct relationships (onsite)	

COST STRUCTURE			**REVENUE STREAMS**
	- Energy bought from CHP operator - Coupling system investment - CHP investment - O&M CHP costs	Contracts from industries Money from surplus electricity to the grid	

- **Case n°1: Standalone entity**

Example plants:
- Loviisa 1 & 2, Finland



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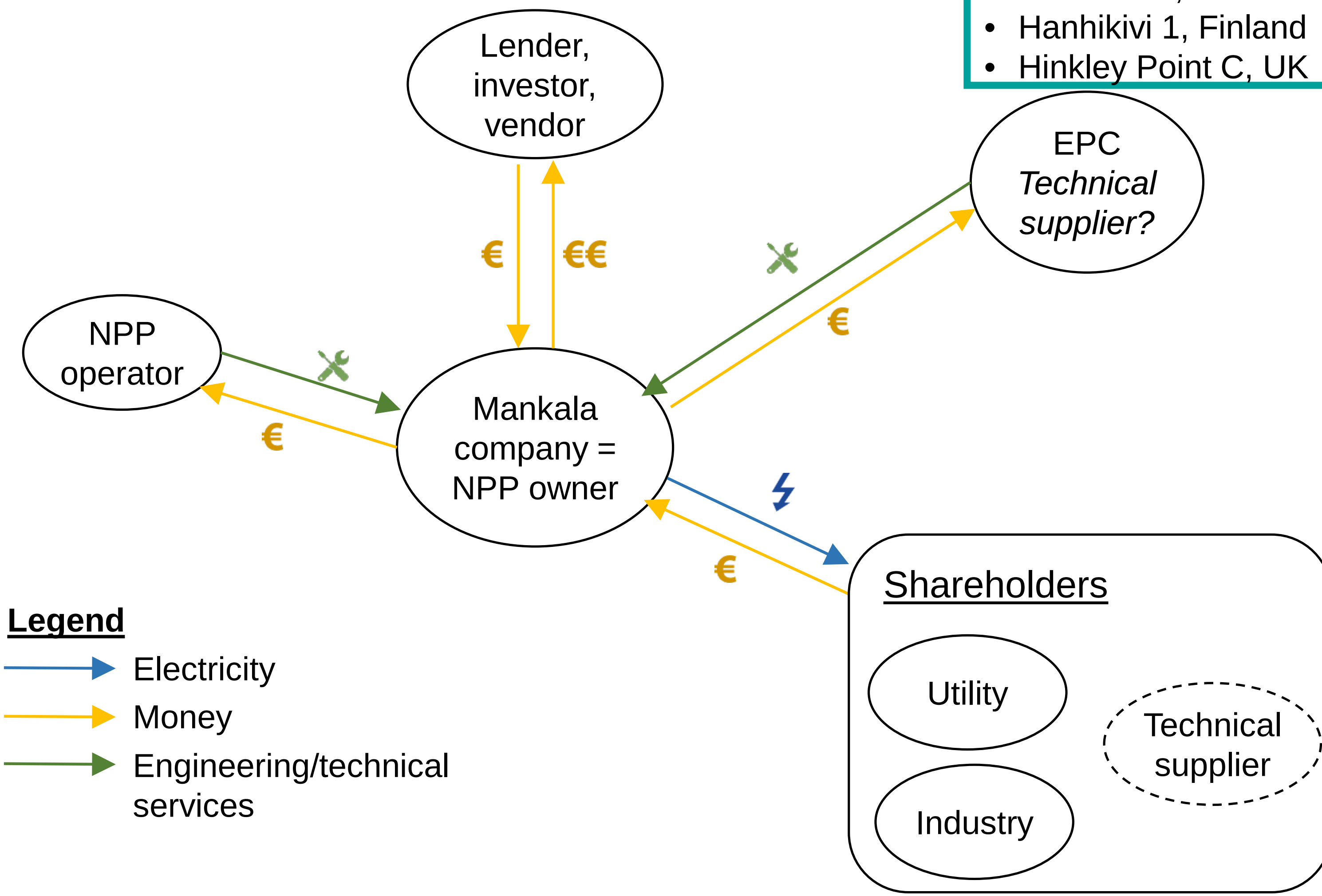
▪ Case n°2: Co-owned generation plant

Example plants:

- Olkiluoto 3, Finland
- Hanhikivi 1, Finland
- Hinkley Point C, UK



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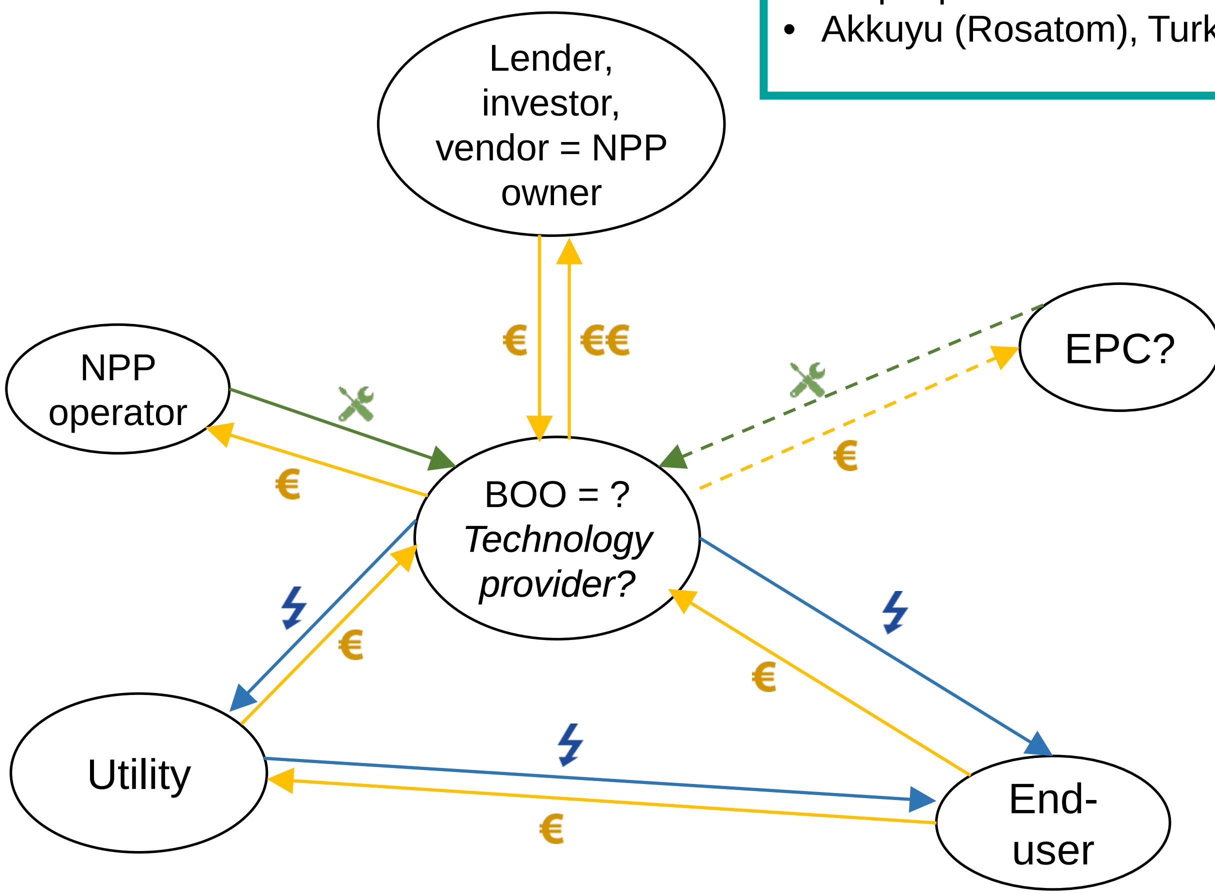
- **Case n°3: Build-Own-Operate**

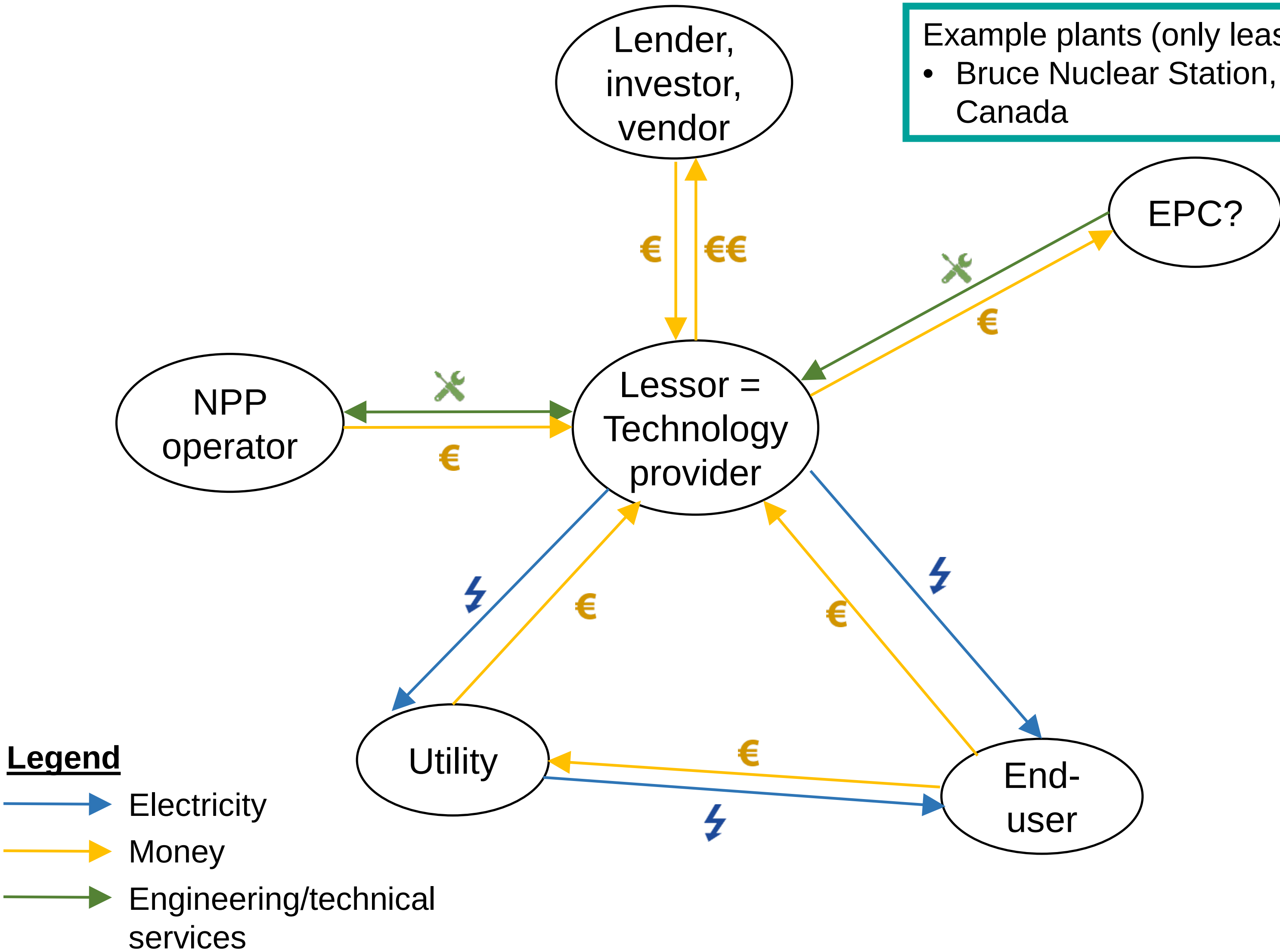


Example plants:
- Akkuyu (Rosatom), Turkey

Legend
- Electricity
- Money
- Engineering/technical services

- **Case n°4: Lease-to-own**

Example plants (only lease):
- Bruce Nuclear Station, Canada



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- **Roles and risks in the ownerships models**

Roles	Standalone entity	Co-owned generation plant	Build-Own-Operate	Lease-to-Own
Utility	Full ownership	Partial ownership	Purchasing energy	Purchasing energy
Industry	Purchasing energy	Purchasing energy / Partial ownership	Purchasing energy	Purchasing energy
Vendor	Sell equipment and services	Sell equipment and services / Partial ownership	Full ownership	Fixed-term ownership

Risks	Standalone entity	Co-owned generation plant	Build-Own-Operate	Lease-to-Own
Utility	Depends on a market, may be high	Moderate	Low	Low
Industry	Low	Moderate	Low	Low
Vendor	May be high (turnkey delivery)	May be high (turnkey delivery) / Moderate (ownership)	Depends on a market, may be high	Depends on a market, may be high

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Ownerships models for a NPP

Business models of a chemical park

- Several possibilities of business models
- New actors: EPC, lenders
- Only possible involving of a chemical industry through a Mankala company (co-owned generation plant)
- Energy Manager: decision-making actor, must include him in the Business Group

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Opportunities resulting from HTR powering a chemical park

- **Integration of nuclear actors** downstream in the value chain as Energy Manager
- **Energy storage**: store extra energy under another form through innovative technologies: production of hydrogen, coal-to-liquid, etc.
- Supplying **district heating** to a town located close to the chemical park
- Development of **new industrial parks**

Conclusion

- HTR can serve process industry with continuous heat and electricity delivery to its processes.
- The chemical industry presents the best opportunities for the implementation of high temperature nuclear cogeneration in a short-term view.
- Several business models exist depending on the integration of the different stakeholders and the ownership models of the NPP.
- Risks of a new technology such as HTR and markets can be shared through long-term contracts or by sharing the ownership with relevant parties

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Thank you for your attention!

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CASE N°2: ENERGY MANAGER INTEGRATION

KEY PARTNERS

Distribution system operator

Utility (external grid)

Heat & electricity consumers

KEY ACTIVITIES

Heat and electricity production

Heat delivery to nearby industrial sites

KEY RESOURCES

HTR plant

Negotiation skills

Juridical workforce

Distribution system

Technical workforce

VALUE PROPOSITION

The supply of heat and electricity 24-7 with given characteristics (V, T°, P, etc.)

Long-term delivery of energy at nearly stable price

CO_2 free energy

CUSTOMER RELATIONSHIPS

Long-term contracts

Enables the chemical industries to focus on their core business

CHANNELS

Direct relationships (onsite)

Heat delivery system

Electricity grid

CUSTOMER SEGMENTS

Industrial heat and electricity customers on the park

Electricity markets/Electricity consumers

(District heating customers)

COST STRUCTURE

HTR investment
O&M costs
Personnel costs
Fuel costs

REVENUE STREAMS

Long-term contracts
Electricity sales to the market
Electricity/heat sales to end-consumers

Conclusion

- HTR can serve process industry with continuous heat and electricity delivery to its processes
  - The chemical industry presents the best opportunities for the implementation of high temperature nuclear cogeneration
    - *The sector uses cogeneration*
    - *The required temperatures correspond to the output of an HTR*
    - *The power capacity of several parks is large enough to be compatible with the size of an HTR*
    - *Strong willingness to decrease the CO_2 emissions*
  - In the steel industry many processes require high temperature steam (above 700°C)
  - The hydrogen production mainly uses the SMR process, which is a possible application for HT nuclear cogeneration
  - The CTL (Coal To Liquid) and the CCS (Carbon Capture and Storage) technologies are also potential applications for HT nuclear cogeneration
    - *CTL requires temperatures between 450°C and 800°C which are compatible with HTR's output temperature*
    - *The CCS technologies could be applied to highly-emissive industries such as the chemical, steel, cement and refining industries*
- Risks of new technology and markets can be shared through long-term contracts or by sharing the ownership with relevant parties
  - Utility needs the electricity to be delivered to its customers
  - Utility may need district heat to its customers
  - Industry needs CO_2 free electricity and heat to its process with competitive price level
  - Vendor needs a demonstrator for its technology