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The Comparison of Estonian Oil Shale Thermal Treatment Processes by BAT criteria

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The Colorado School of Mines

Topics

- What are the BAT criteria by EU concept?
- Comparison of oil shale thermal treatment processes
- Development of oil shale processing technologies



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Integrated Pollution Prevention and Control (IPPC) Directive 96/61/EC

General principles and obligations for Member States

- (a) all the appropriate preventive measures are taken against pollution, **in particular through application of the best available techniques;**
- (b) no significant pollution is caused;
- (c) waste production is avoided); where waste is produced, it is recovered or, where that is technically and economically impossible, it is disposed of while avoiding or reducing any impact on the environment;
- (d) **energy is used efficiently;**
- (e) the necessary measures are taken to prevent accidents and limit their consequences;

Best Available Techniques (BAT)

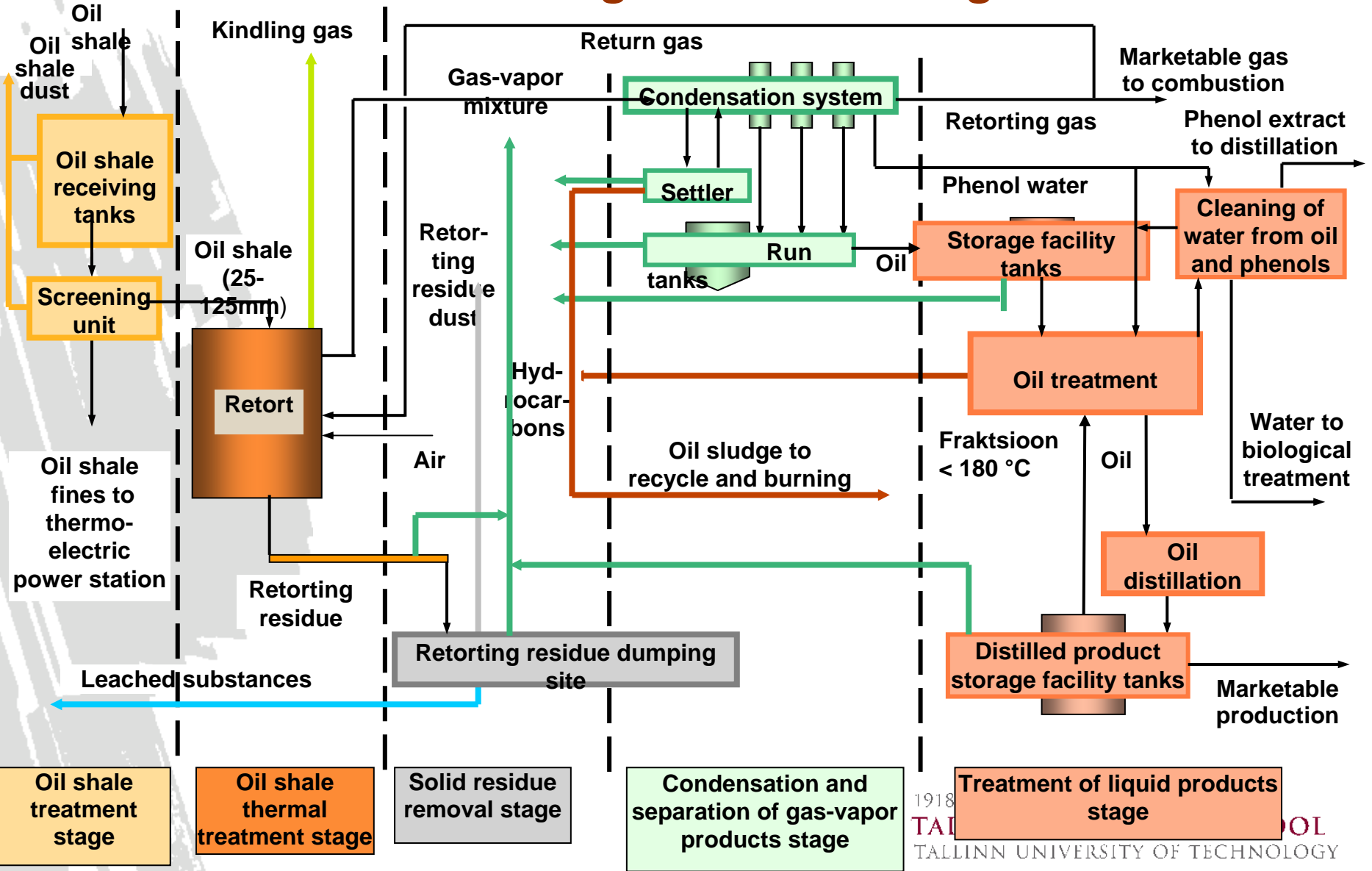
- The term "techniques" includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned
- Those "available" techniques should allow implementation in the relevant industrial sector, under **economically and technically** viable conditions
- The "best" mean most effective in achieving a high general level of protection of the environment as a whole.
- <http://eippcb.jrc.es/>



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Process Structural Diagram of Retorting Plant

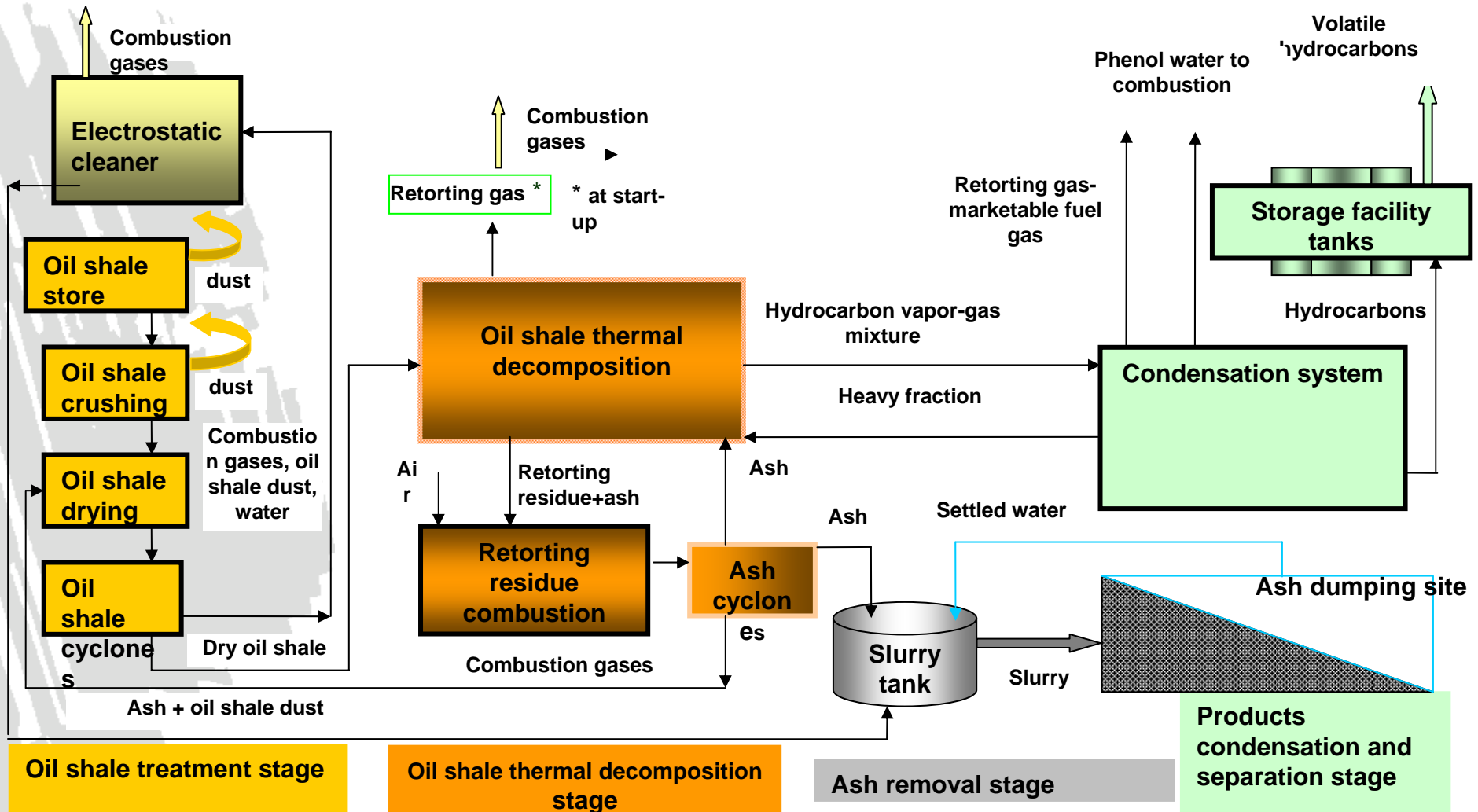


Waste from Lump Oil Shale Thermal Processing

Process stages	Waste	Waste place		
		Air	Ground	Water
1. Oil shale treatment	Oil shale dust	Oil shale dust		
2. Oil shale thermal processing	Kindling gas	Gas components		
3. Removal of solid retorting residue	Retorting residue	Hydrocarbons and residue dust	Retorting residue	Water-soluble components
4. Condensation and separation of gas-vapor products	1. Oil sludge Phenol water	- -	- -	- -
5. Treatment of liquid products	1. Oil sludge 2. Phenol water 3. Hydrocarbons	- Hydrocarbons	- -	- -
TOTAL	Oil sludge: 13,3 kg/t		Retorting residue: 580 kg/t	



Process Structural Diagram of UTT-3000 Shale Oil Plant



Waste from Oil Shale Fines Processing with Solid Heat Carrier

Process stages	Waste	Waste place		
		Air	Ground	Water
1. Oil shale treatment	Oil shale dust	-	-	-
2. Oil shale thermal processing	1. Kindling gas 2. Combustion gases	Gas components	-	-
3. Solid residue removal	Ash	-	-	-
4. Condensation and separation of gas-vapor products	1. Retorting gas 2. Phenol water 3. Hydrocarbons	- -	- -	- -
TOTAL		Combustion gases 530 nm³/t	Ash 640 kg/t	



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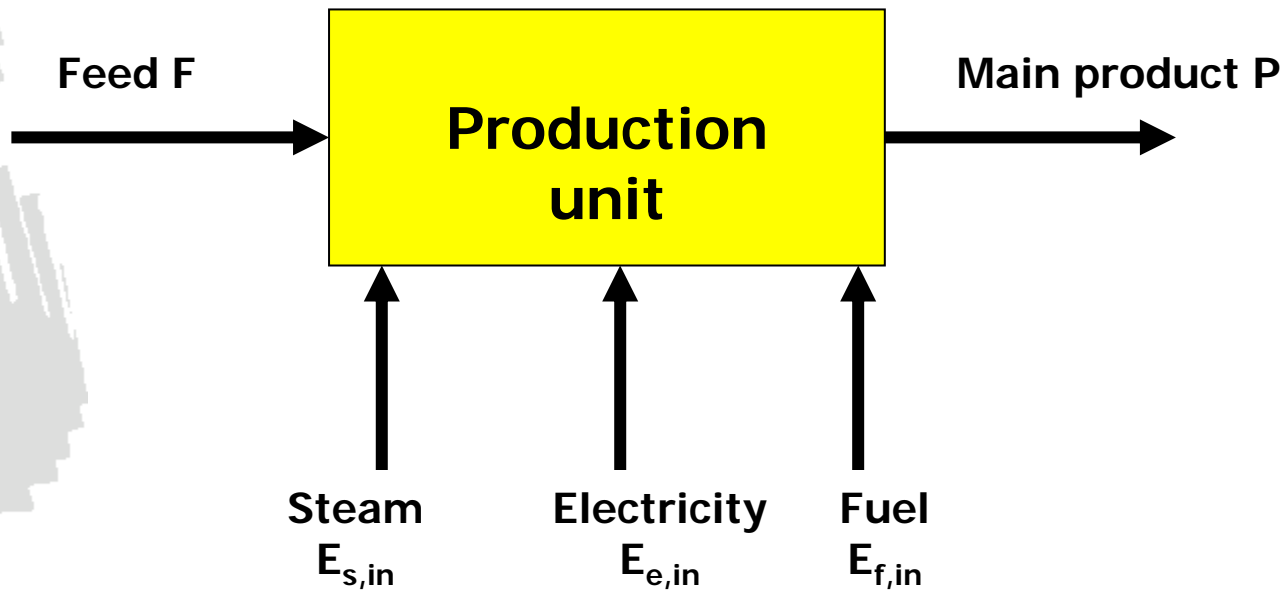
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Definitions of Energy Efficiency

Defining energy efficiency is a complex task. It is not possible to present a solution that fill fit in all cases and will satisfy all stakeholders. Some definitions of energy efficiency:

- A ratio between an output of performance, service, goods and energy (Directive 93/76/EEC)
- The amount of energy consumed per unit of product/output
- The amount of energy consumed per unit of feedstock

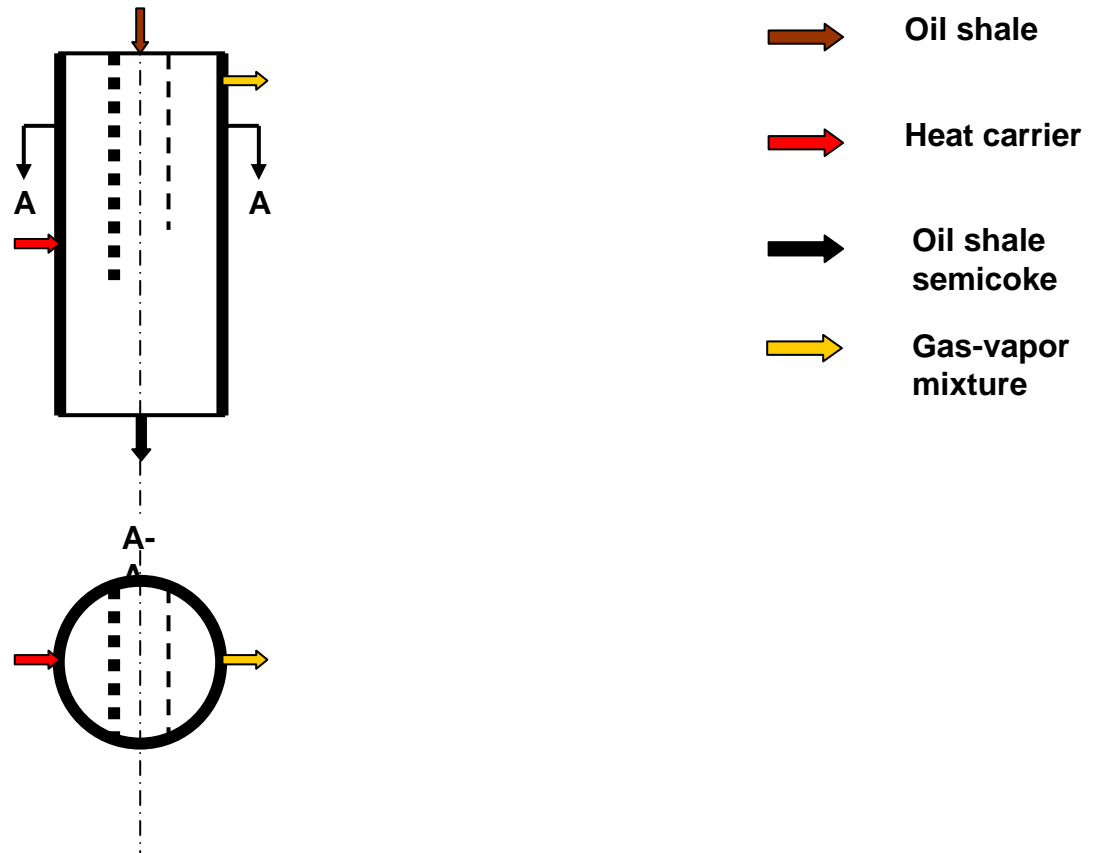
Energy vectors in a simple production unit



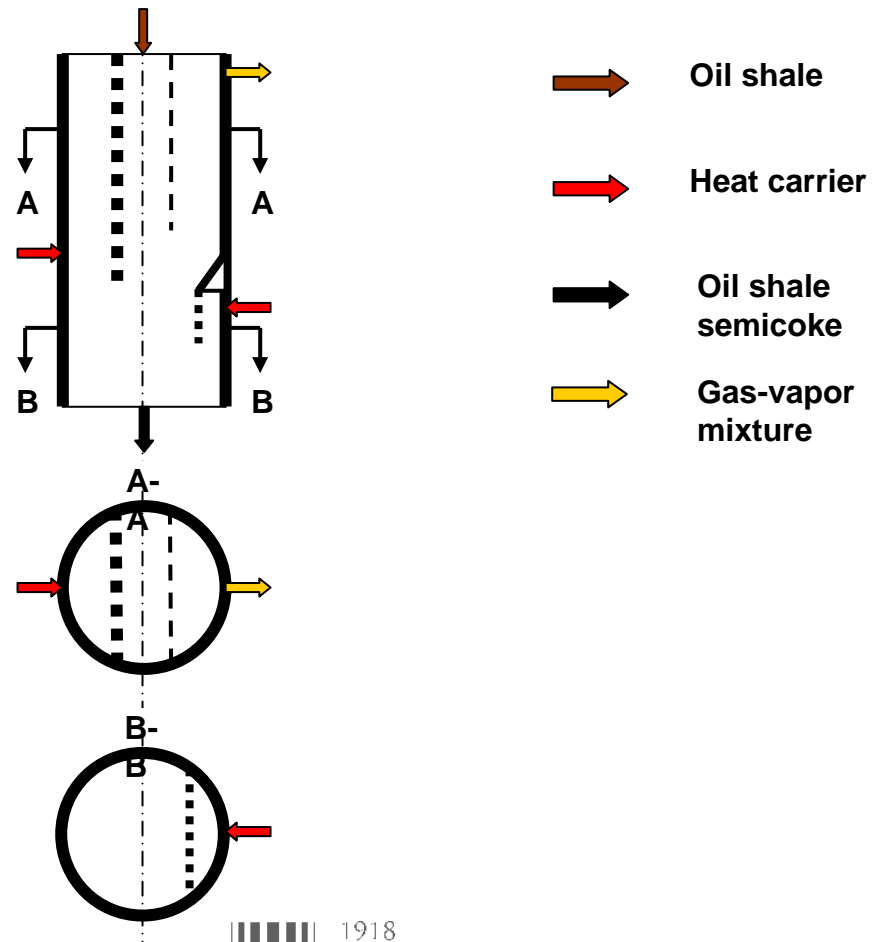
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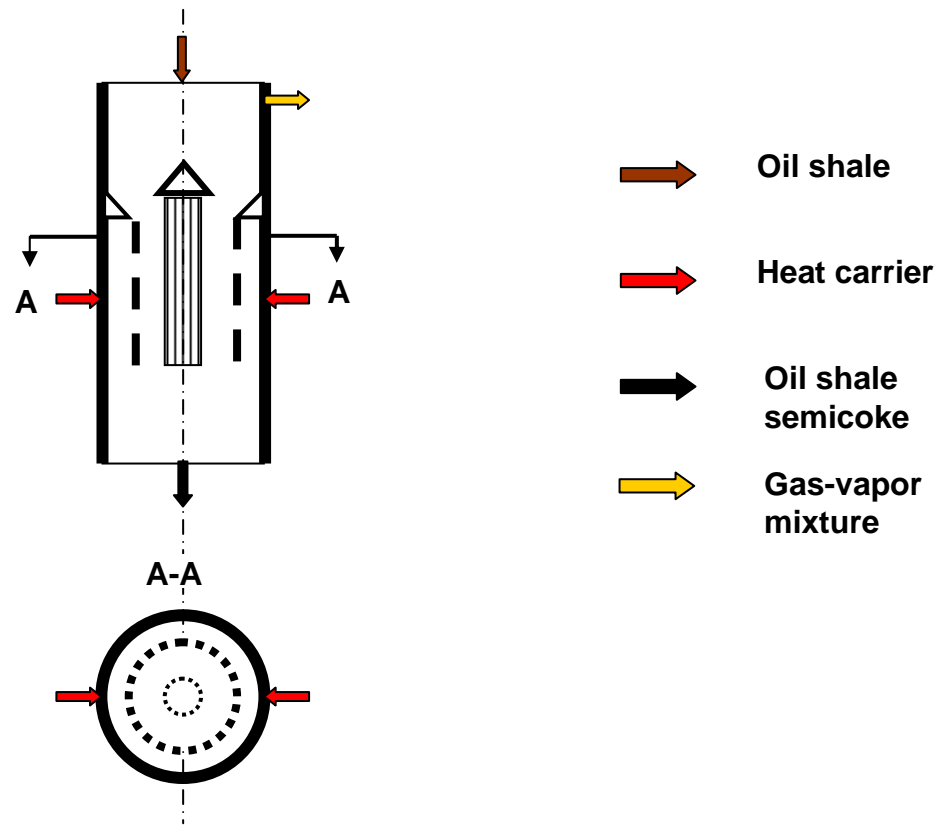
Principal flow sheet of the retort with cross-flow of heat



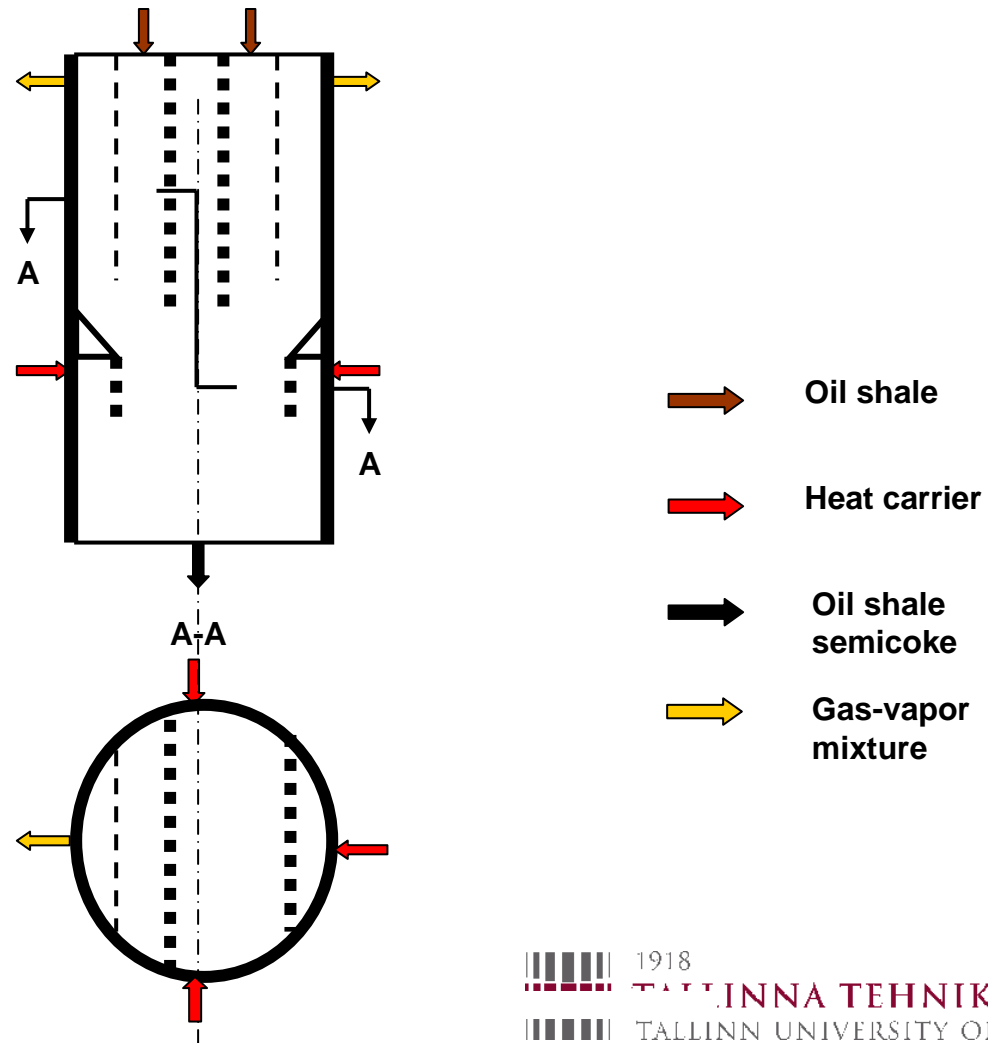
Principal flow sheet of the retort with cross-flow of heat



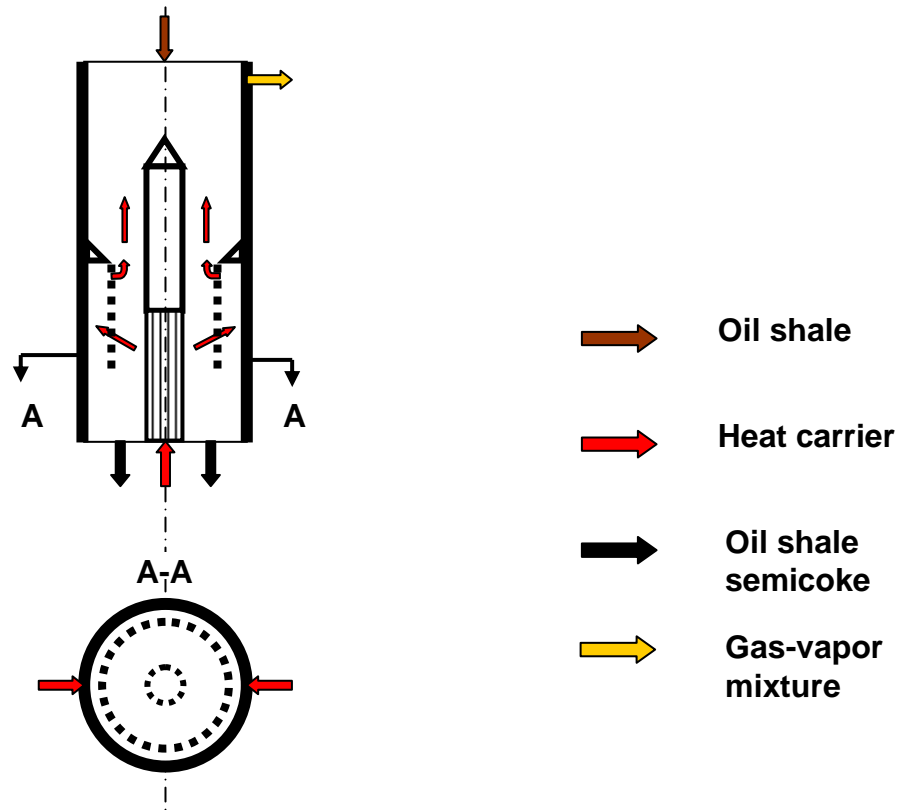
Principal flow sheet of the vertical retorts with circular retorting chamber



The Kiviter process for retorting lump oil shale



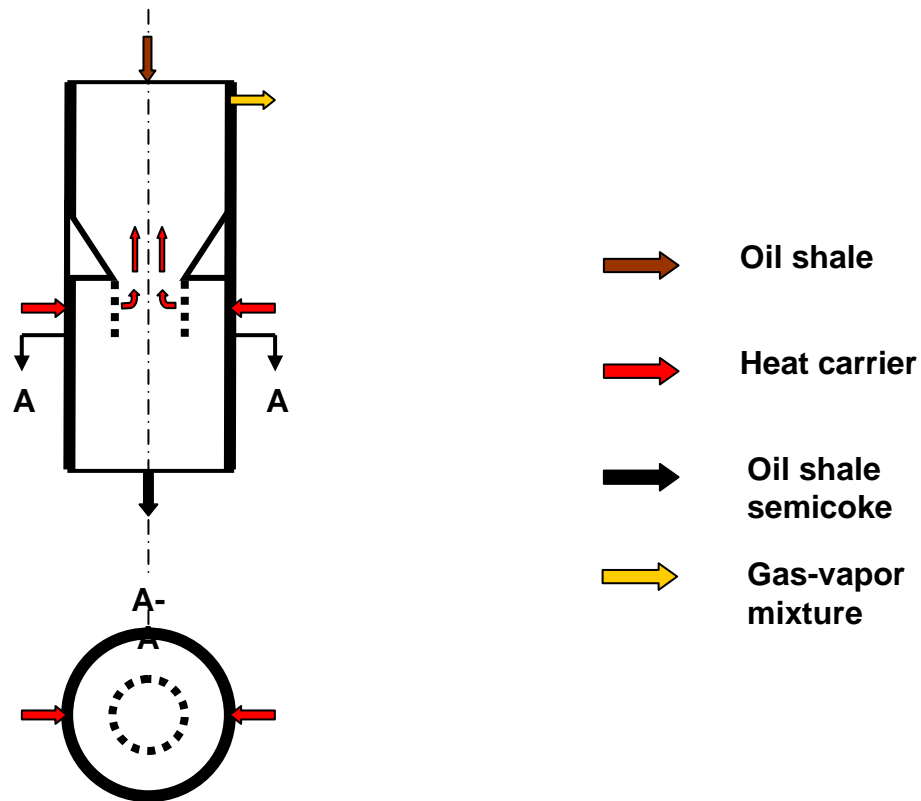
Oil shale retorting in a cross-flow and countercurrent flow of gaseous heat carrier



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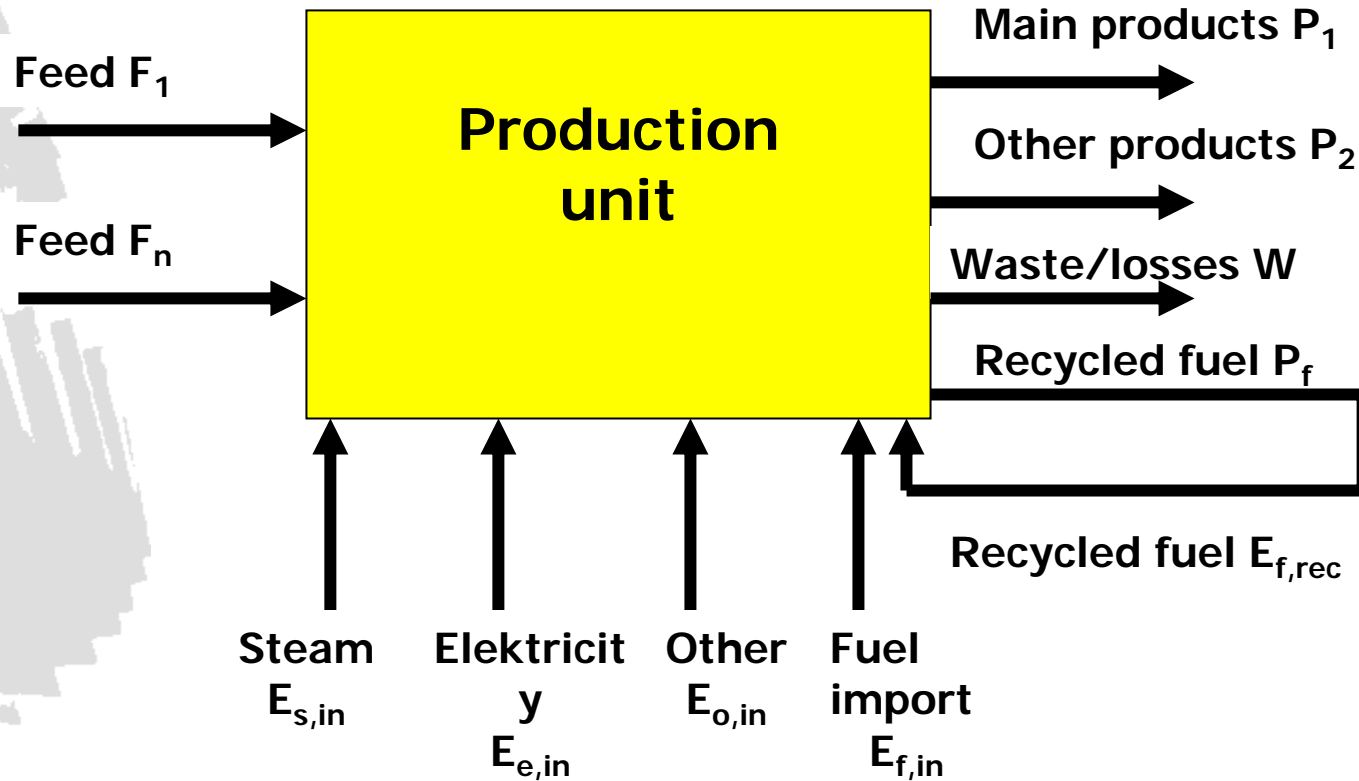
Oil shale retorting in a countercurrent flow of gaseous heat carrier



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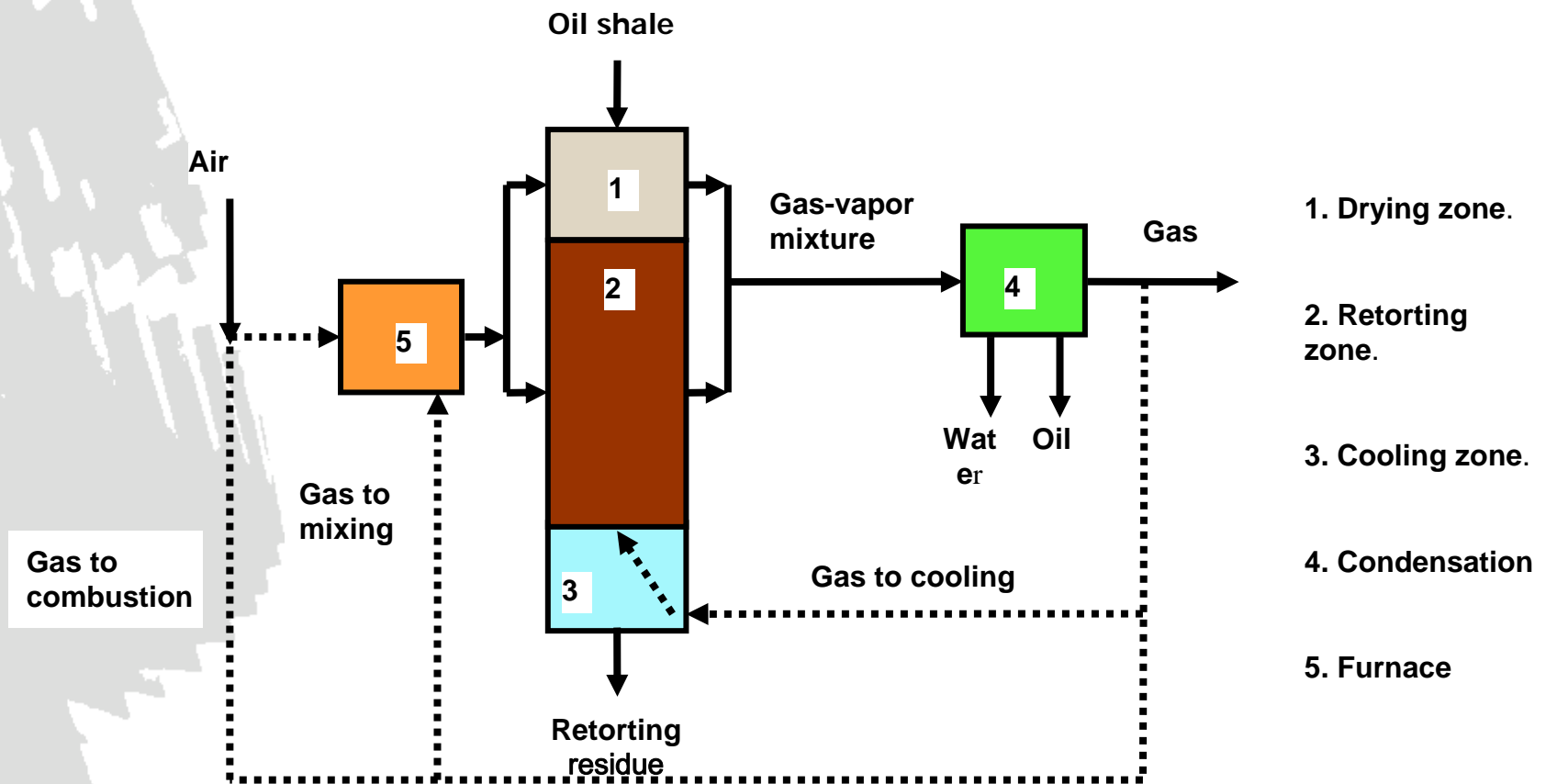
Energy vectors in a production unit



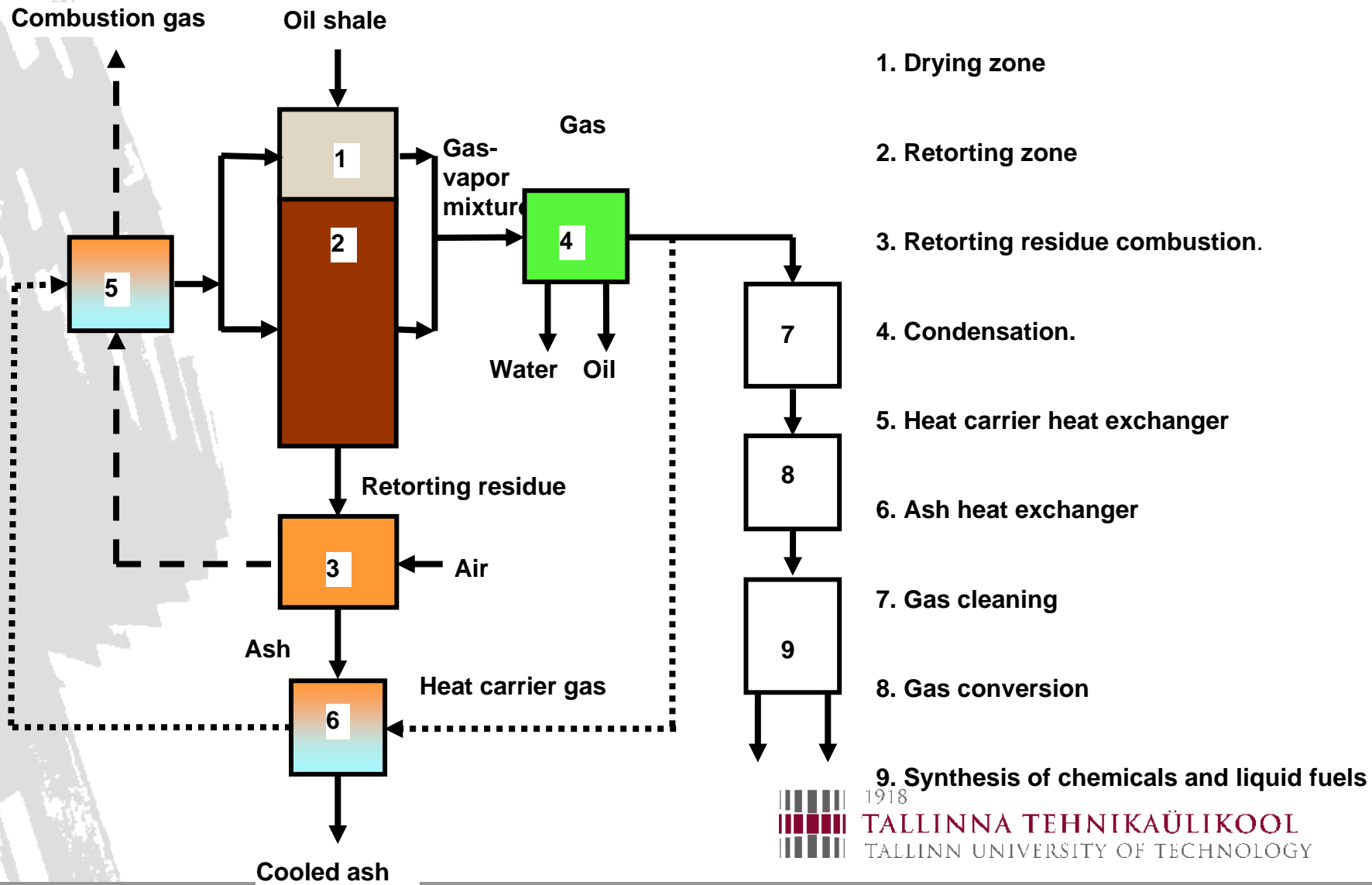
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Process with gaseous heat carrier



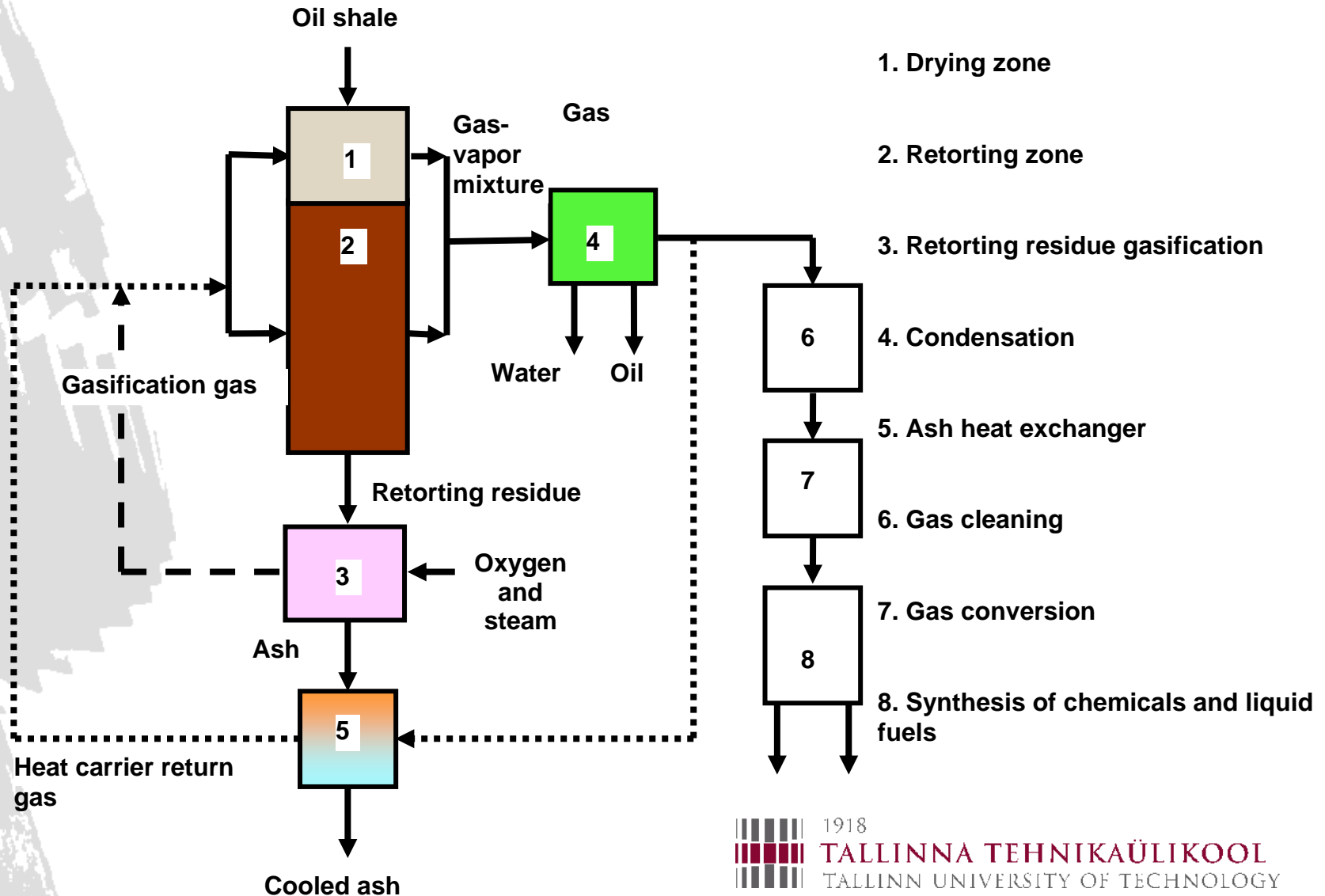
Process with circulating gaseous heat carrier



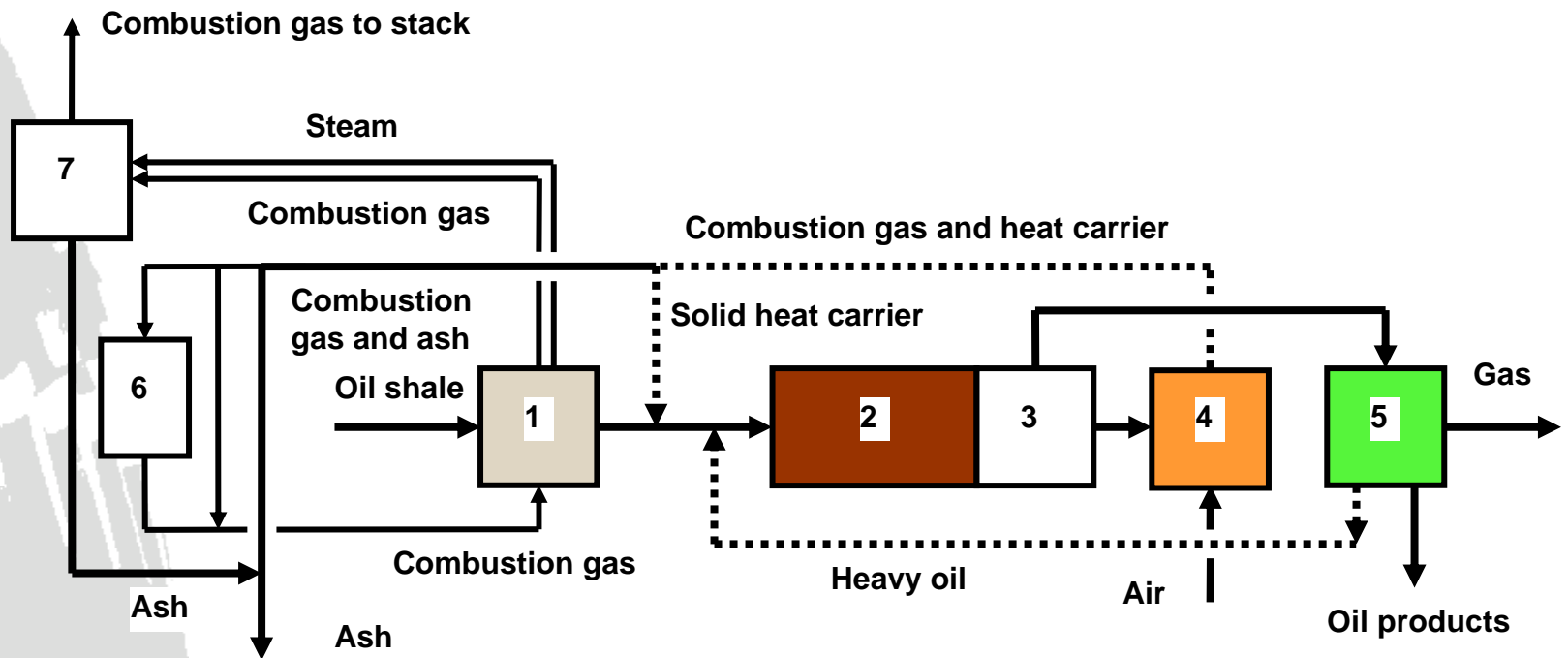
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Process with circulating gaseous heat carrier and gasification of retorting residue



Process with solid heat carrier



1. Drying zone

5. Condensation

2. Retorting zone

6. Boiler

3. Retorting residue separation

7. Electrostatic cleaner

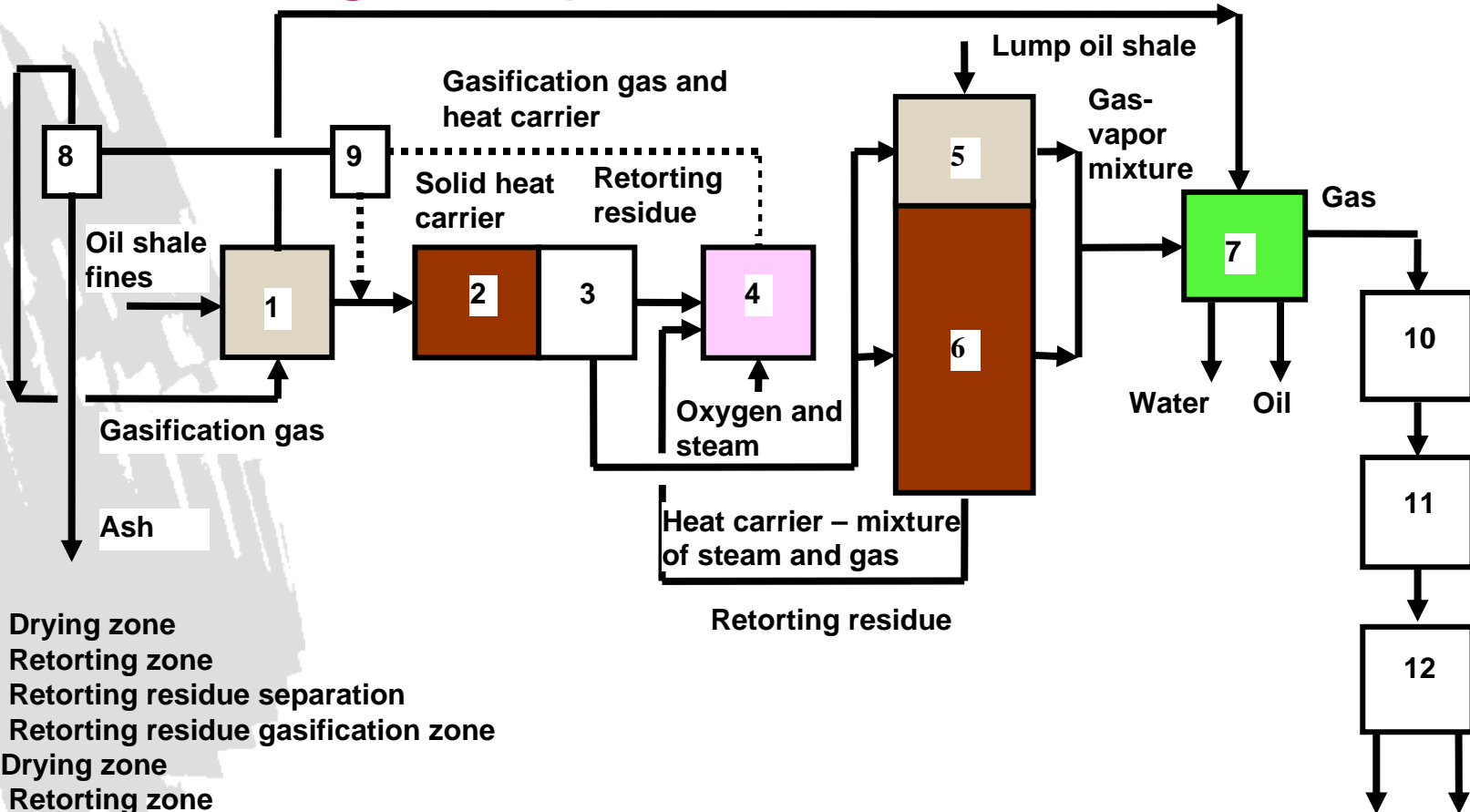
4. Retorting residue combustion zone



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Co-retorting of lump oil shale and oil shale fines



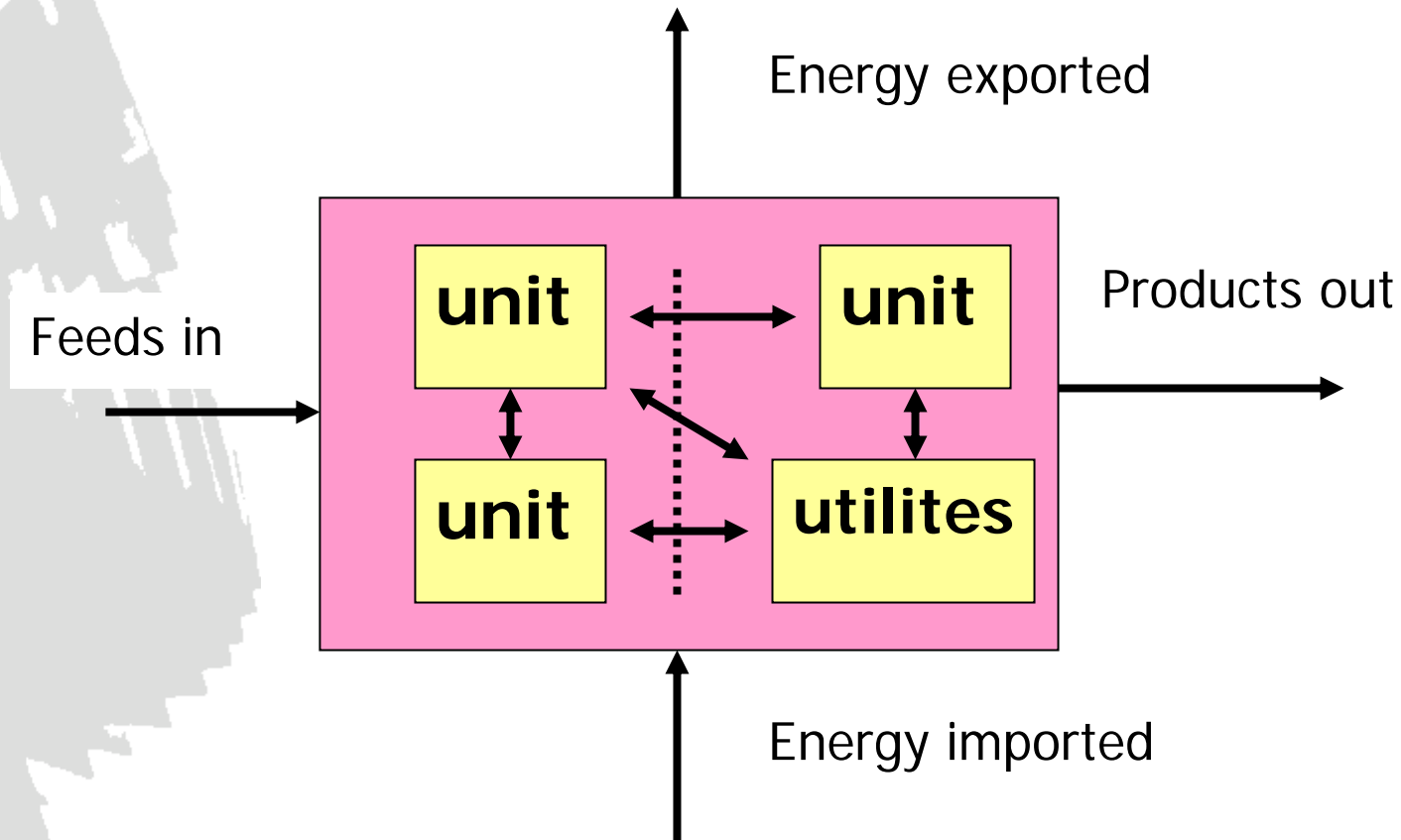
1. Drying zone
2. Retorting zone
3. Retorting residue separation
4. Retorting residue gasification zone
5. Drying zone
6. Retorting zone
7. Condensation
8. Ash cyclone
9. Doser
10. Gas cleaning
11. Gas conversion
12. Synthesis of liquid fuels



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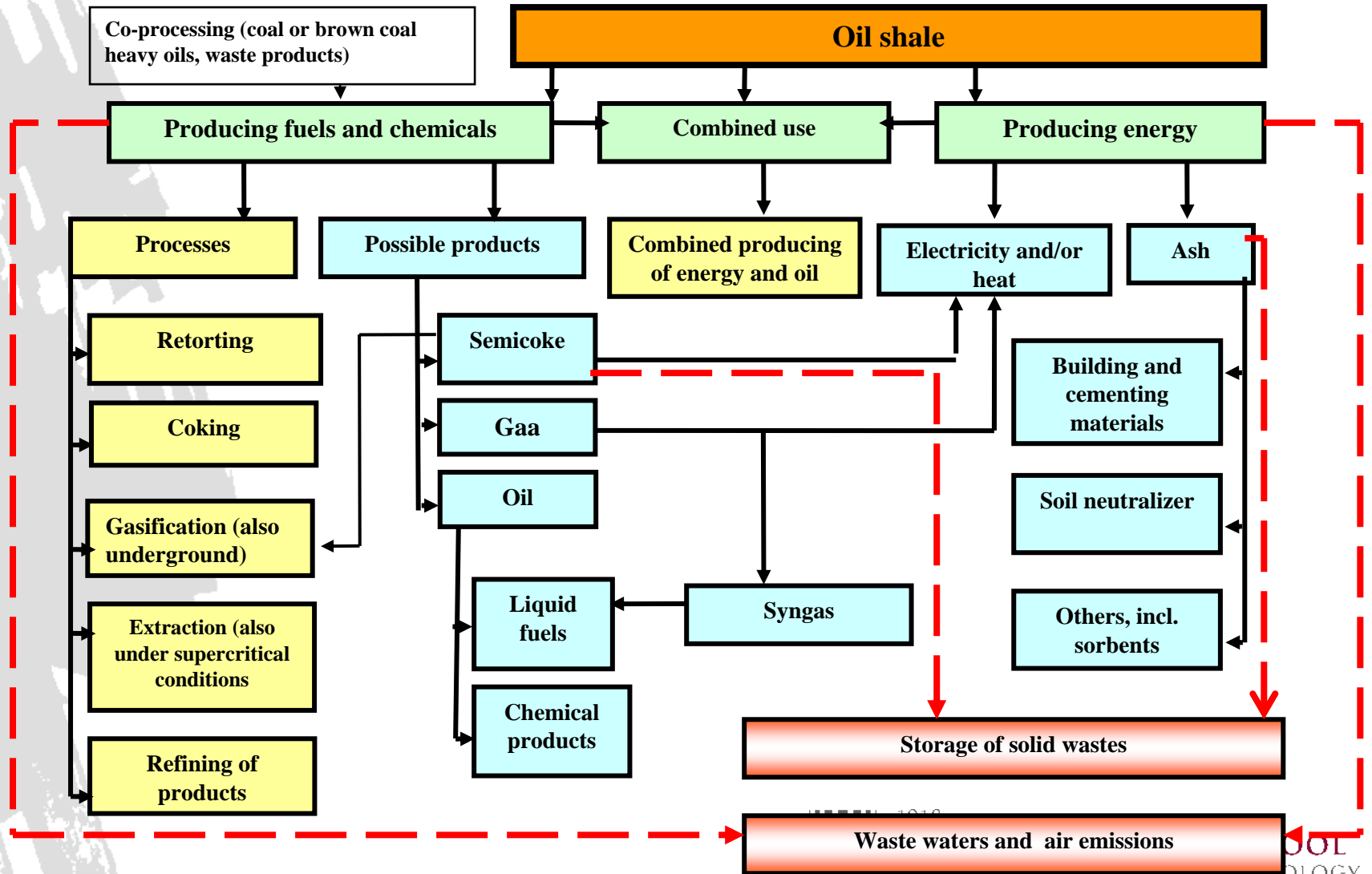
Inputs and outputs in a site



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Possibilities of combined use of oil shale for energy and chemical products as Best Available Techniques (BAT)





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Thank you!