Process Electrification

How can it accelerate decarbonization of Refining & Petrochemicals

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Key drivers for downstream industry decarbonization

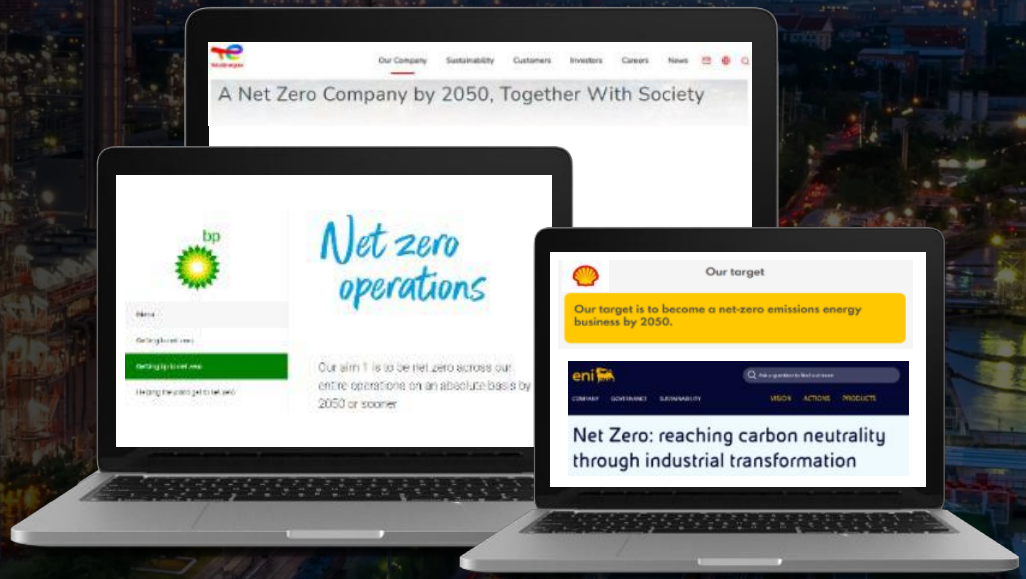
Internal & external stakeholders demand action to decarbonize

Financial incentives vs tax (e.g. Carbon tax)

ESG conscious stakeholders

New Global Regulations (e.g. Fit For 55 in Europe)

Oil Refining survival in a changing energy landscape



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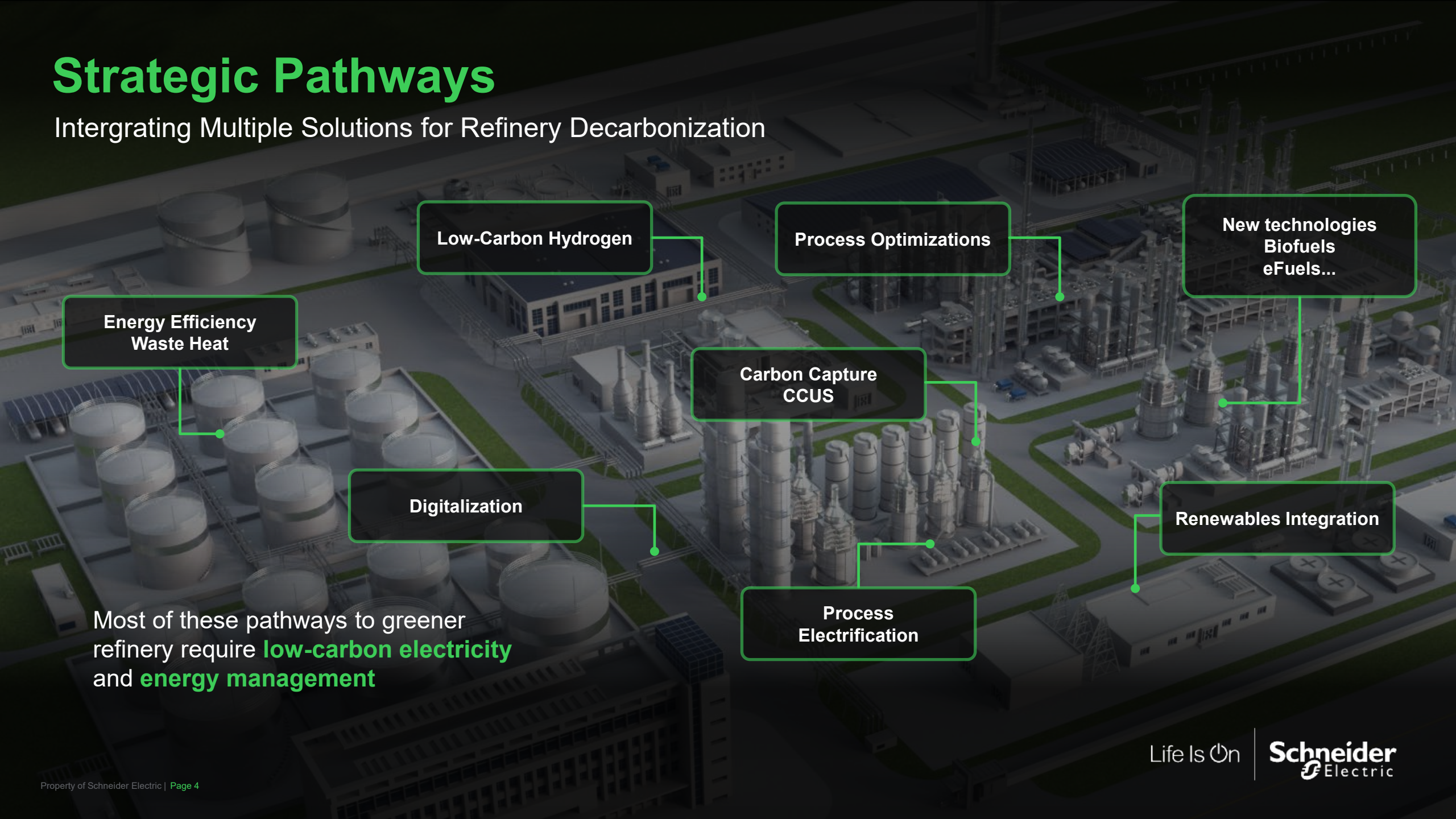
Strategic Pathways

Intergrating Multiple Solutions for Refinery Decarbonization



Most of these pathways to greener refinery require **low-carbon electricity** and **energy management**

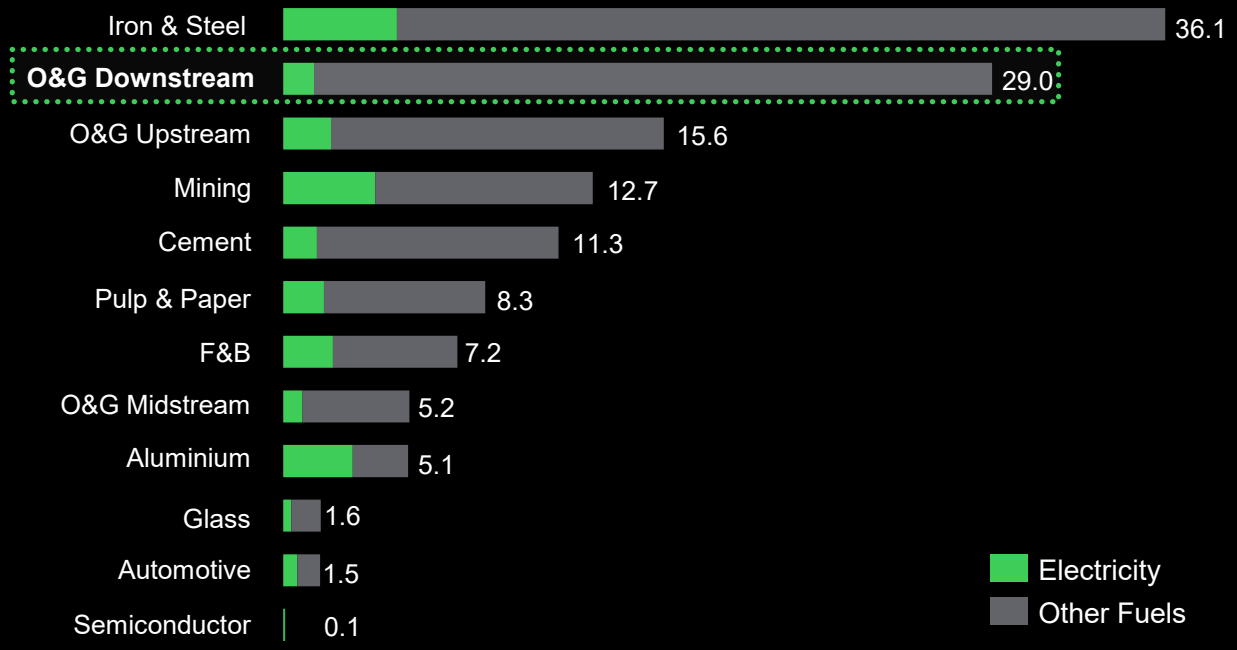
Electrification is a major opportunity to **change the game**

EU refineries average Energy Use*

91% Fuels (Gas, Liquid Fuel, Steam and Coke)

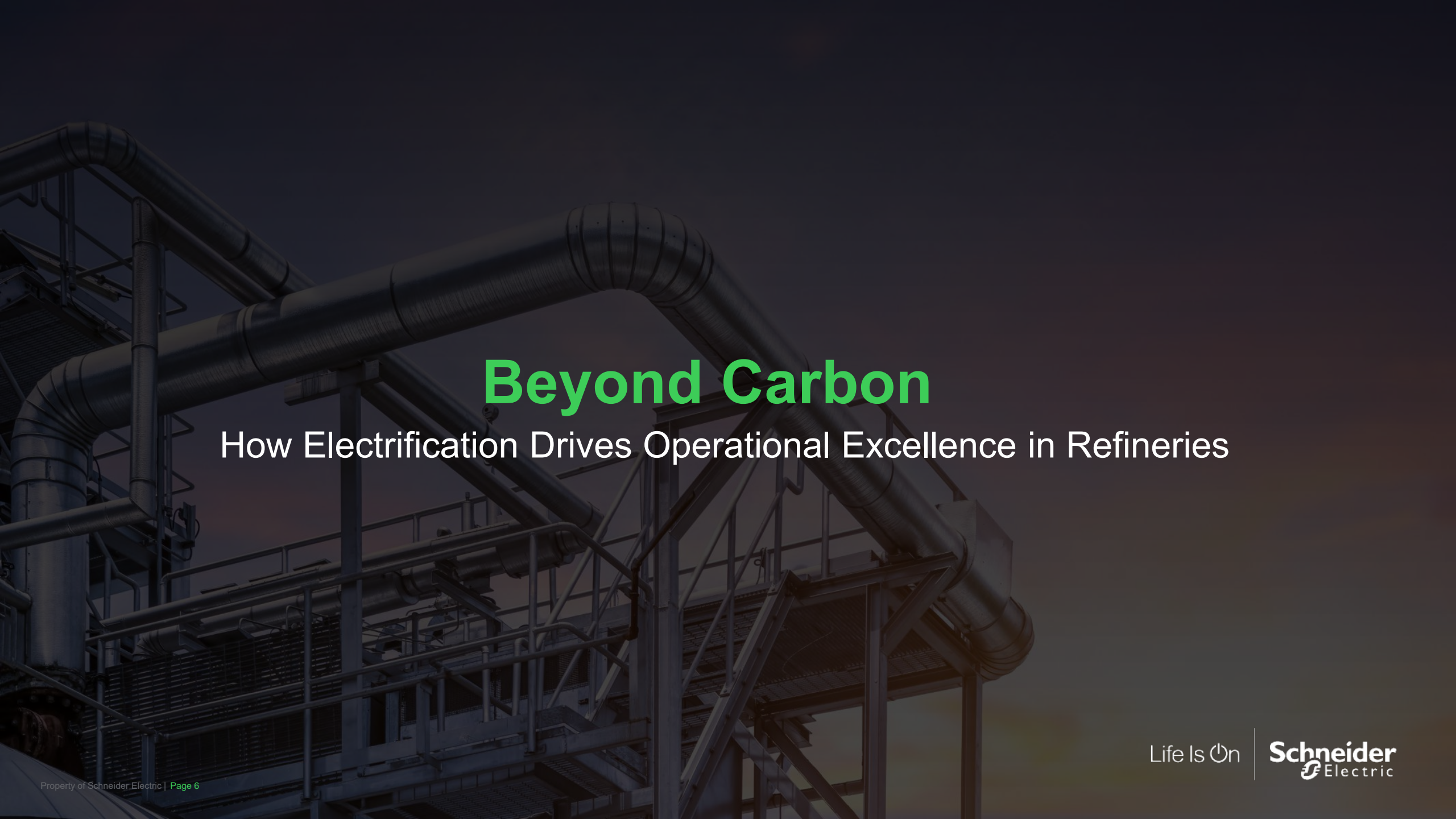
9% Electricity

Energy Use by Sector (EJ)*



(*) Source : Concawe – CO2 reduction technologies, 2019

(*) Source: IEA WEO 2021
Source: IEA, BNEF, Schneider Electric
O&G Downstream Includes Refineries and Chemicals



Beyond Carbon

How Electrification Drives Operational Excellence in Refineries

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Benefits can go **beyond decarbonization**

Improved **energy efficiency** of electrified process

Enhanced operational flexibility, driving higher **operational efficiency**

Better controls, reduced **safety risks & maintenance**

Lowered **environmental impacts**, integration with **renewables**

Leveraging **grid stability & flexibility** mechanisms

"Electrification is one of the **most important strategies** for reducing CO_2 emissions.

... As the industry landscape is very diverse, the many **benefits of electrification in industry** may not be well-known to all industrial producers."

Source: IEA International Energy Agency, Tracking Electrification

Understand your **Electrification Potential**

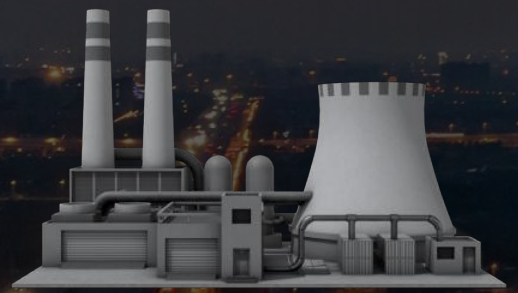
Above 70% of Oil Refining emissions come from process heat*

Power supply

Capacity Availability
Reliability
Carbon intensity

Technologies

Readiness level
Commercial availability
Capabilities



Energy mix

Fuel gas and
Steam balance
Energy management

Economics

Energy Costs & CO2 Tax
Incentives vs Regulations

OIL AND GAS CLIMATE INITIATIVE

"As per an **OGCI's study**, primary roadmap shows that it would be possible to **reduce over 65%** of a refinery's CO_2 emissions by 2040 if there was sufficient **availability of low carbon power**" *

(*) Source : Concawe – CO2 reduction technologies, 2019
(*) Source : OGCI – Pathways to decarbonize, 2023

Electrification Technologies

Refining & Petrochemicals

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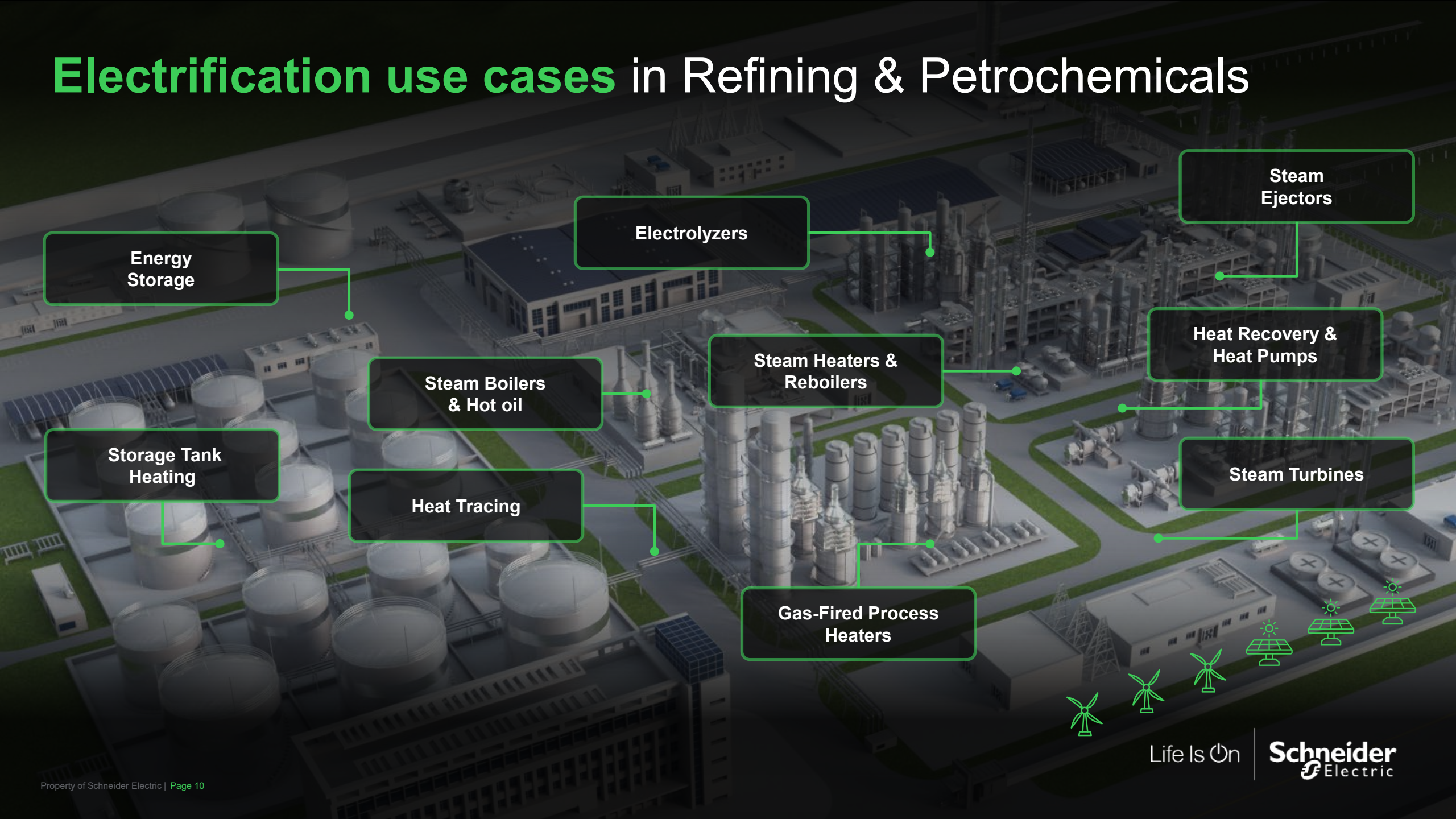
Electrification use cases in Refining & Petrochemicals



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Electrify your **process heat**

Main concepts of electrical heaters

- Electrical heaters involves sending an electric current through a resistor to produce heat
- Large achievable temperatures depending on technologies

Main benefits:

High energy efficiency

Precise temperature control

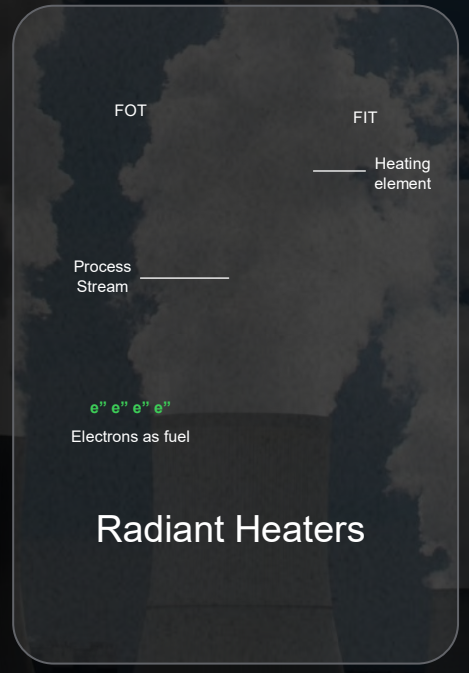
Low maintenance

Wide operating range

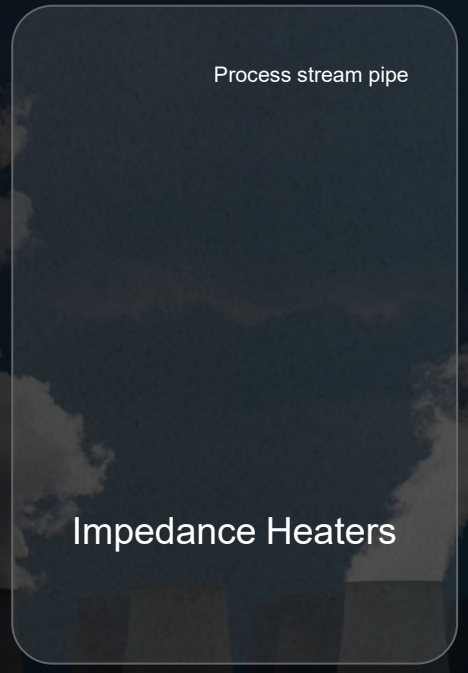
Rapid ramp up/downs

Zero emission

Circulation / Immersion Heaters



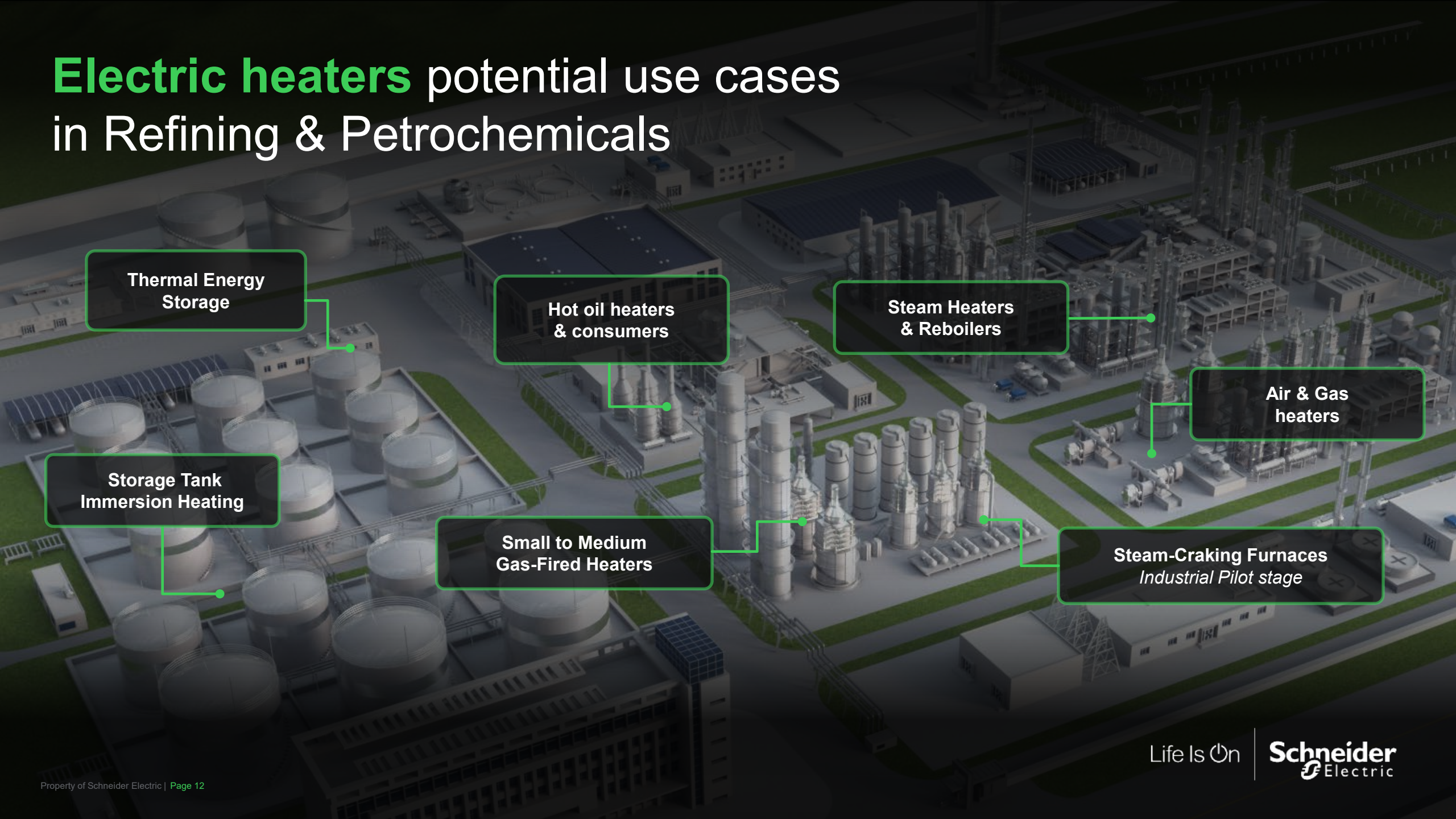
Radiant Heaters



Impedance Heaters

(*) Source : Thermon – Industrial Process Heating

Electric heaters potential use cases in Refining & Petrochemicals



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Electrify your **steam production**

Main concepts of electrical steam generators

- Steam can be generated by circulating a current trough a resistor elements or the water itself to produce heat. Heat pumps solutions can also generate steam
- Large achievable temperatures depending on technologies

Main benefits:

High energy efficiency

Precise temperature control

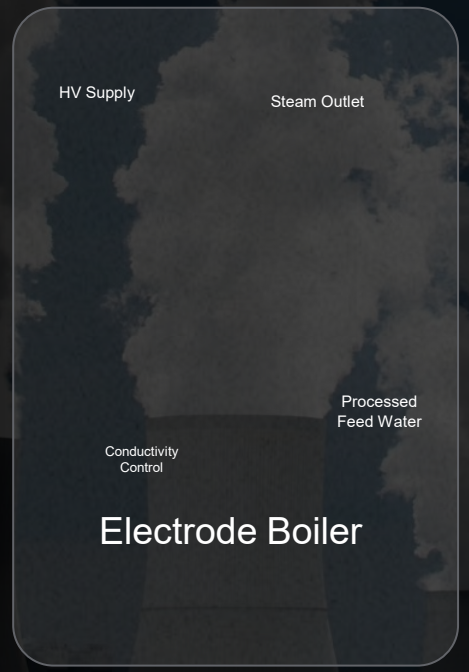
Low maintenance

Wide operating range

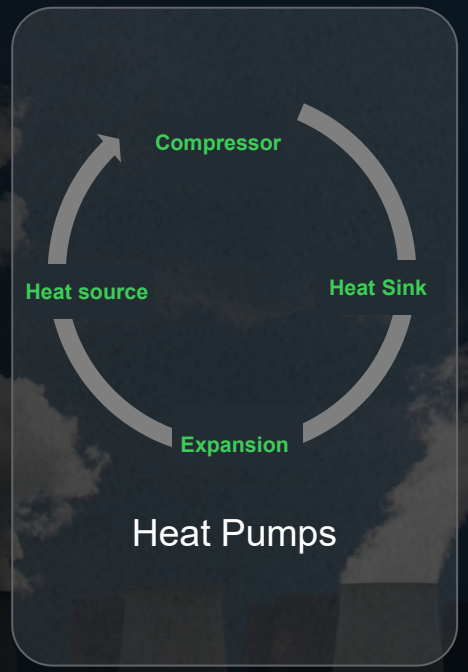
Rapid ramp up/downs

Zero emission

Resistive Boiler



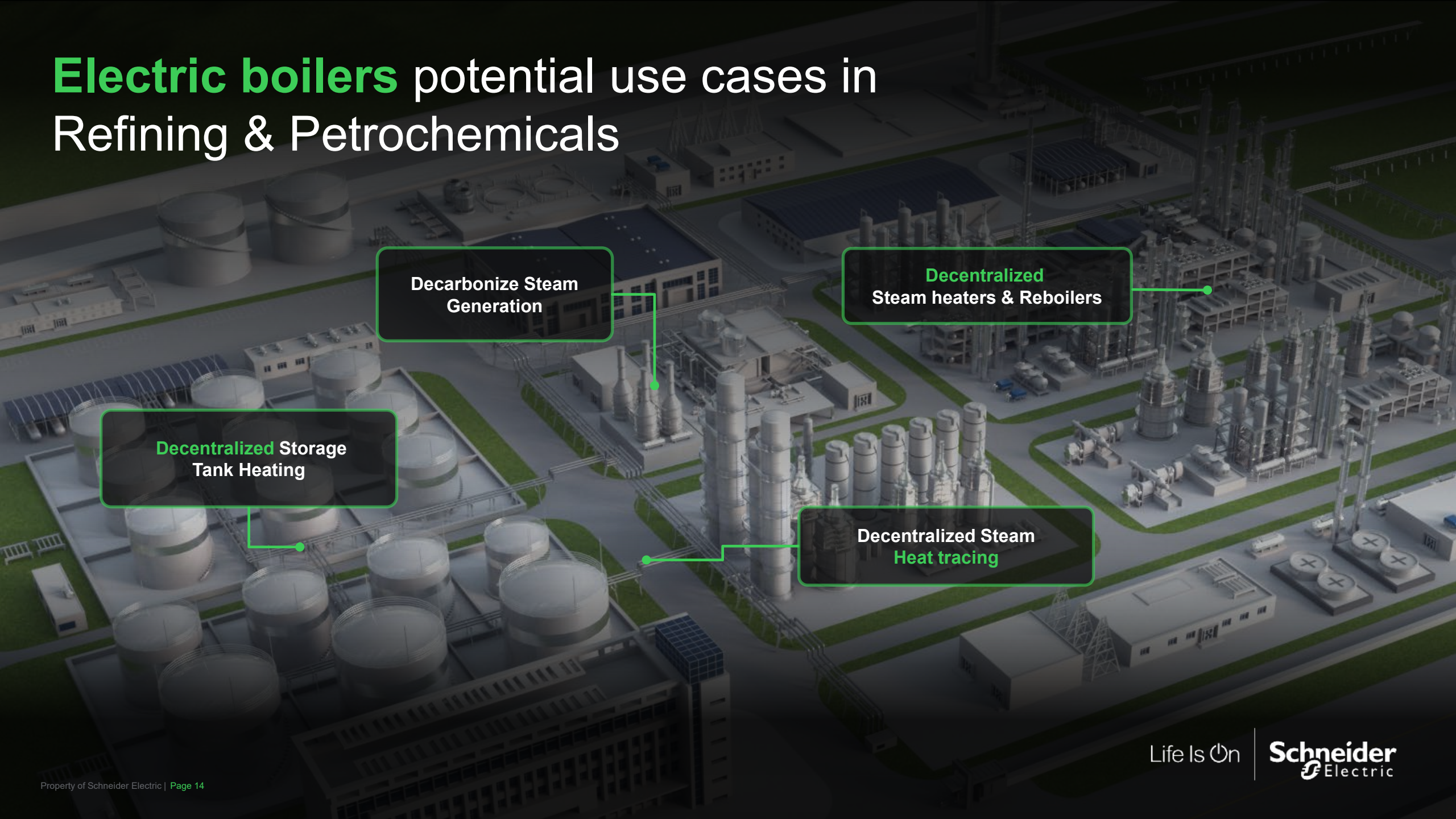
Electrode Boiler



Heat Pumps

(*) Source : Chromalox – High capacity steam generator brochure
(*) Source : Parat – High Voltage Electrode boiler

Electric boilers potential use cases in Refining & Petrochemicals



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Electrification challenges & opportunities

Refining & Petrochemicals

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Electrification specific challenges & opportunities

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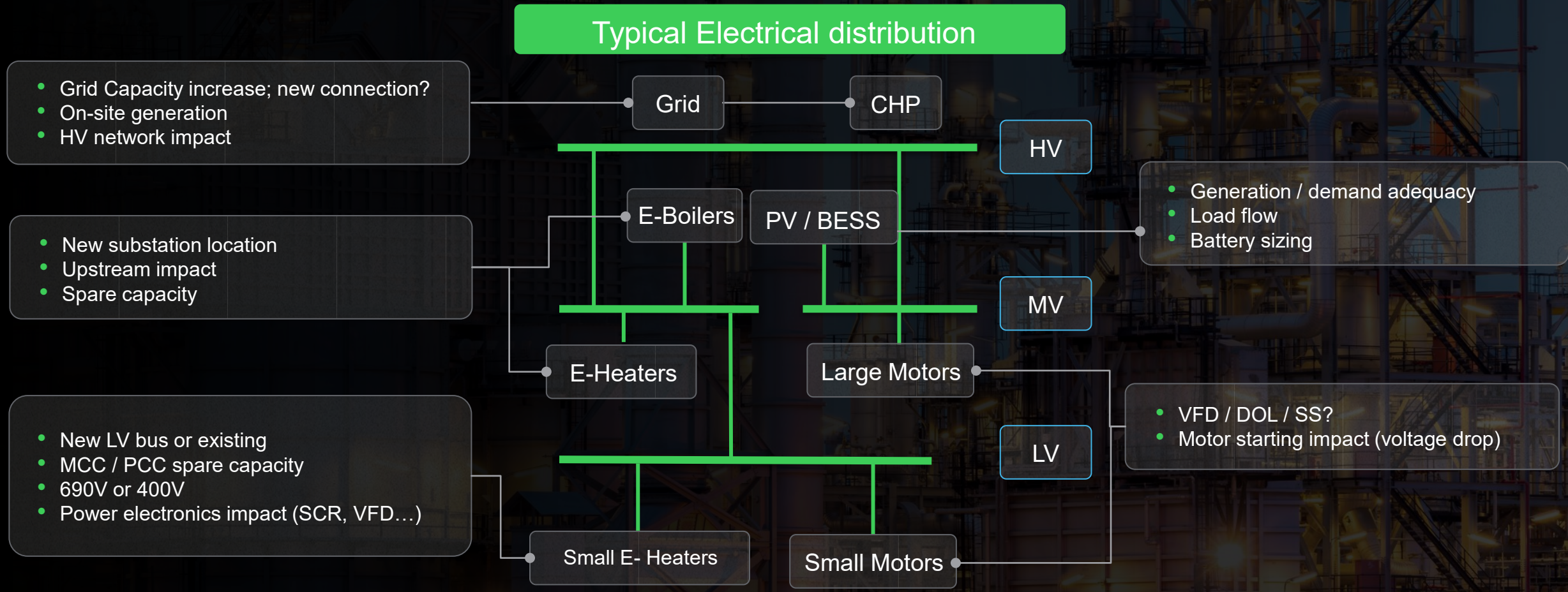
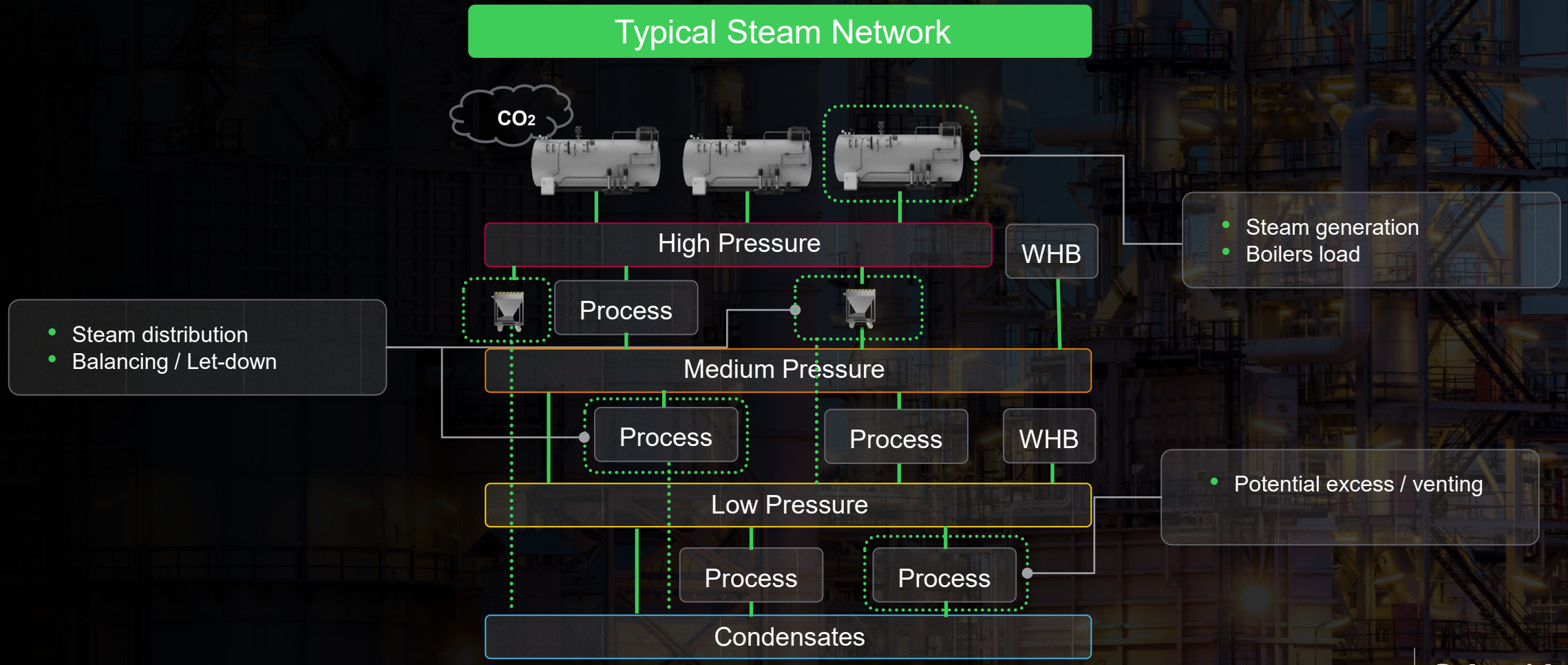
Process Electrification

What impacts on a plant's power system?



Process Electrification

What impacts on a Plant's Steam system ?



Energy Management System opportunity

Optimise fuel cost: **10-15%** on heat production (*)

- Electricity / Gas price forecast
- Whether forecast
- Refinery energy demand forecast (steam, heat, electricity)
- Storage (BESS / thermal) State of charge
- Assets status

Site EMS

Multi-objectives:

- Minimize CO_2
- Minimize fuel cost
- Minimize peak consumption

Optimal control for :

- Grid import (electricity purchase schedule from electricity markets)
- Boilers (NG/Electric) setpoints
- Heat pumps setpoints
- Heaters setpoints
- Flexible loads setpoints (shedding schedule)

(*) Savings for a small petro-chemical pilot site based on conventional gas-based heat generation (steam & hot water) where heat electrification and energy storage where added.

Process Electrification Case Study

European Refinery

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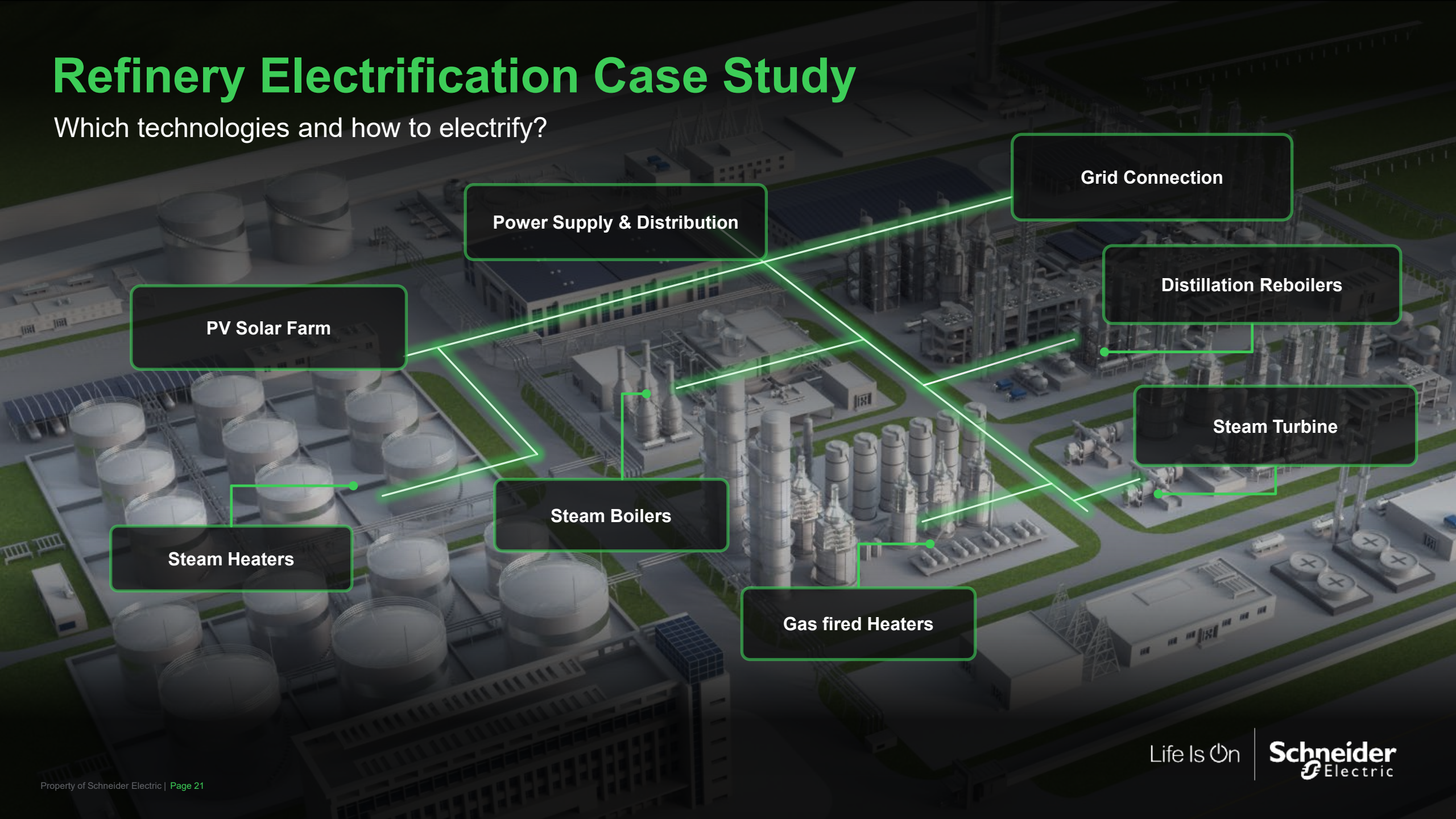
Refinery Electrification Case Study

Which technologies and how to electrify?



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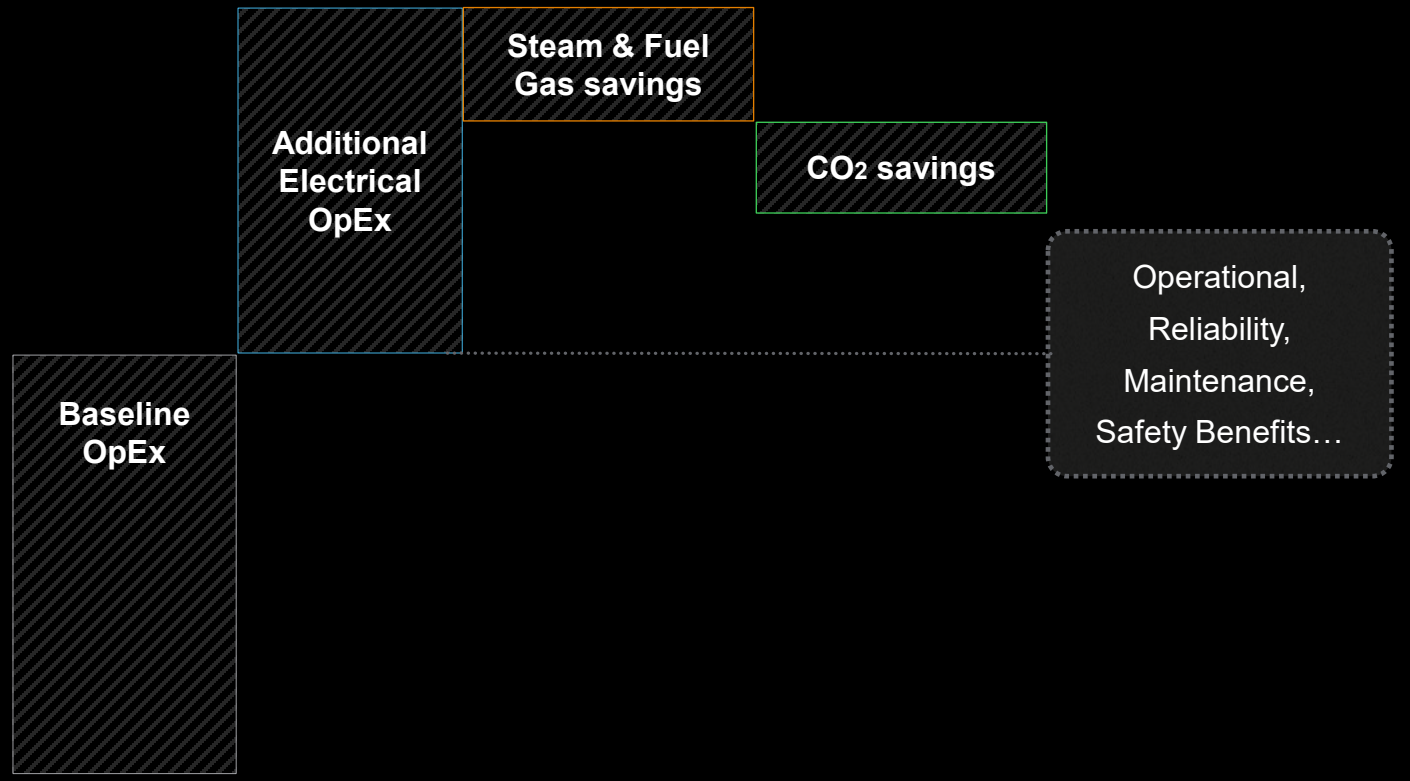
Process Electrification Case Study

Illustrative OpEx Business case

Business Case highly impacted by high **low-carbon electricity price**

Other **drivers** to support the business case (Operational & Maintenance, Reliability & Safety aspects)

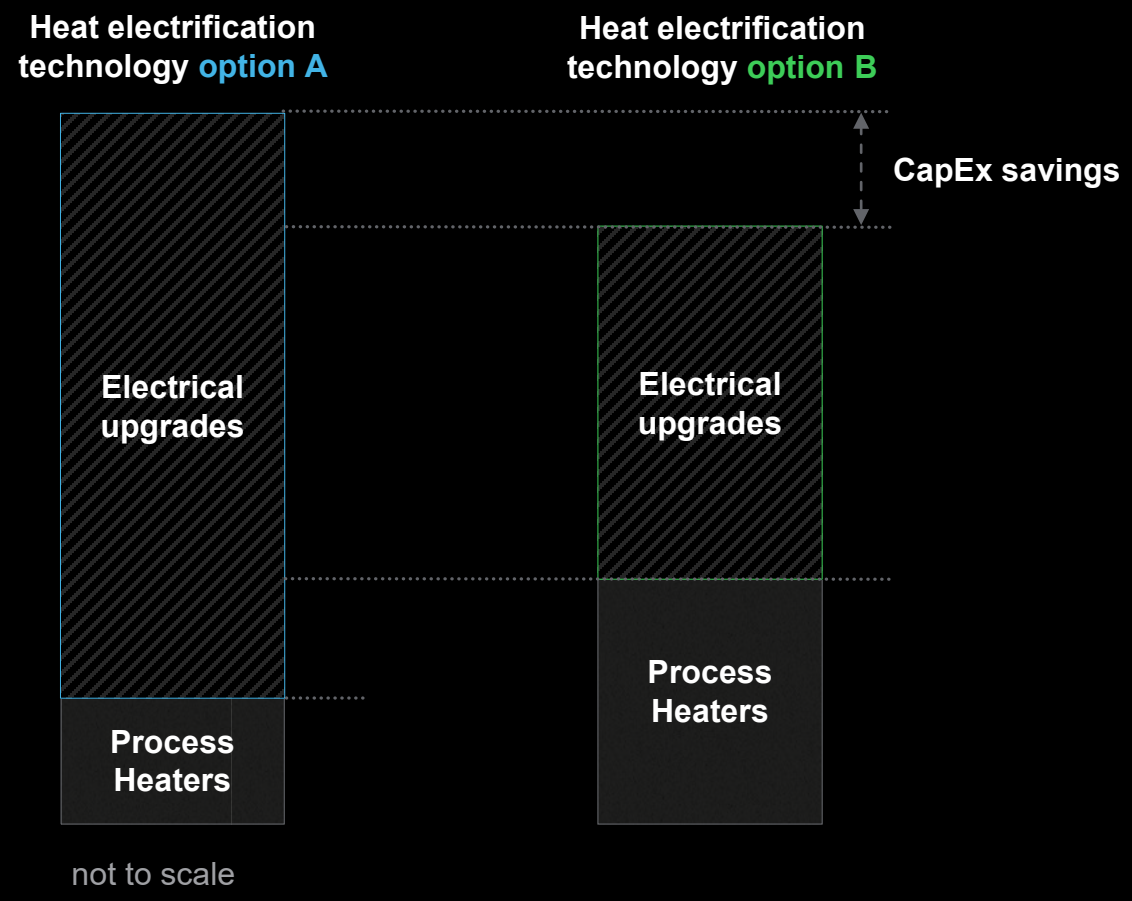
- End-of-life replacement planned
- Performance or reliability bad actors
- Potentially avoided trips and incidents



Process Electrification Case Study

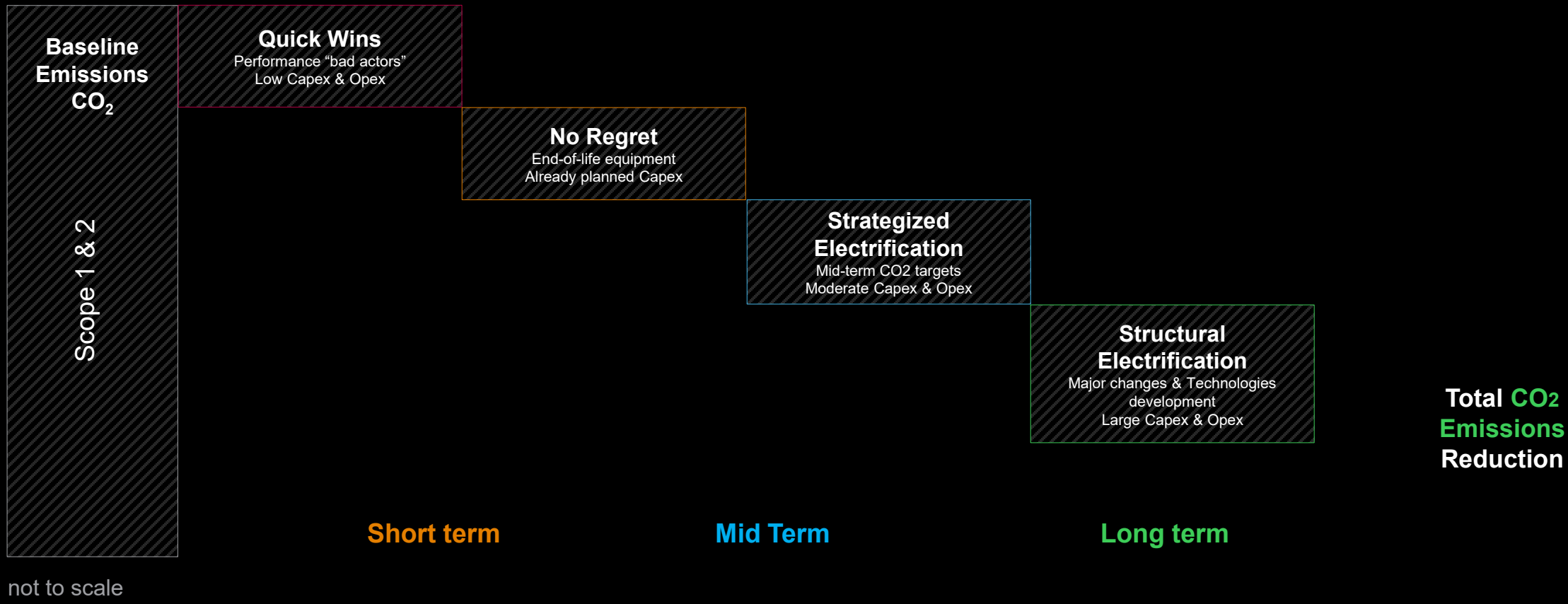
Illustrative CapEx Breakdown

- Main CapEx impact comes from the required **electrical upgrades**
- Selection of the right process heaters and **electrification technologies** is made considering the electrical impacts
- A global view on all electrification initiatives enhances **potential synergies and optimizations**



Accelerating Your Refinery's Evolution

Strategic Electrification Roadmap



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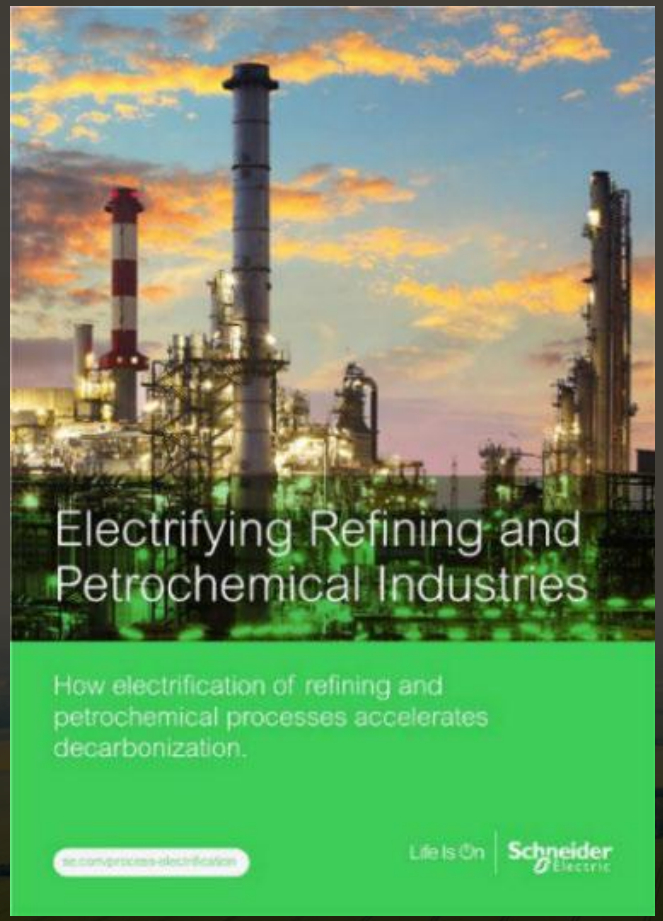

Explore the **Electrification potential** for your industry

Scan the QR Code to find out more

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