

Solid Oxide Cell (SOC) Technology – Gamechanger Towards High Efficient Production of Hydrogen and Derivatives

18th A3PS Conference

Josef Macherhammer

H2 & Fuel Cell Technology in numbers



Commercial Share

~7%



Order Intake

> 100
Mio€



Patents &
Publications

> 200



Locations &
People

6 / 650

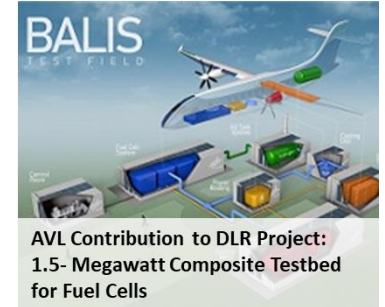


Share outside
automotive

~50%



TECO 2030 Produces First Fuel Cell Stack for Marine Applications



AVL Contribution to DLR Project: 1.5- Megawatt Composite Testbed for Fuel Cells



Graz Becomes Location for the Most Modern Power-To-Liquid Facility in Europe



AVL joins HZwo Innovation Cluster to Drive New Mobility Technologies



AVL Opens New Hydrogen and Fuel Cell Test Center in Graz



AVL Joins Collaborative Project to Develop Hydrogen-Powered Land Rover Defender Fuel Cell Prototype



AVL and Ceres Set to Combine Competencies for Solid Oxide Fuel Cell Systems Technology

AVL Fuel Cell and Electrolysis Solutions H₂ Ecosystem Implementation

PEM FC ... Polymer Electrolyte Membrane Fuel Cell
SOFC ... Solid Oxide Fuel Cell
PEM EL ... Polymer Electrolyte Membrane Electrolysis
SOEC ... Solid Oxide Electrolysis Cell

PEM FC



#Mobility and Power Generation

- Automotive
- Marine
- Rail
- Aviation

SOFC



#Combined Heat and Power

- Decentral Power
- BEV Charging stations
- Marine APUs

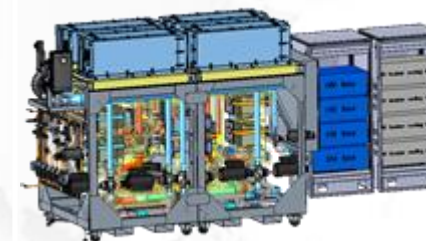
PEM EL



#Hydrogen Production

- Renewable Power Plants
- Decentral Hydrogen Production

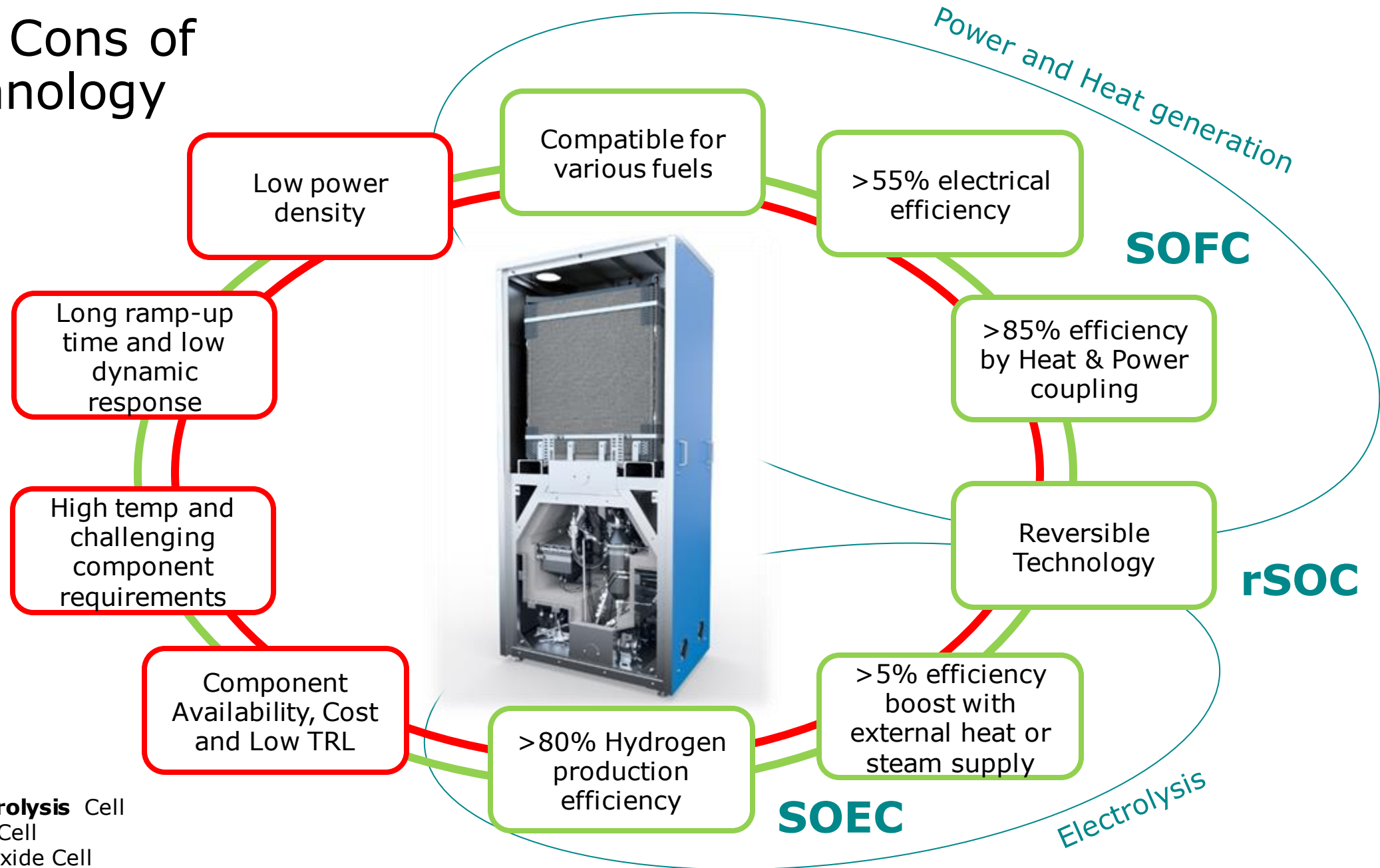
SOEC



#Hydrogen, Syngas and Power-to-X

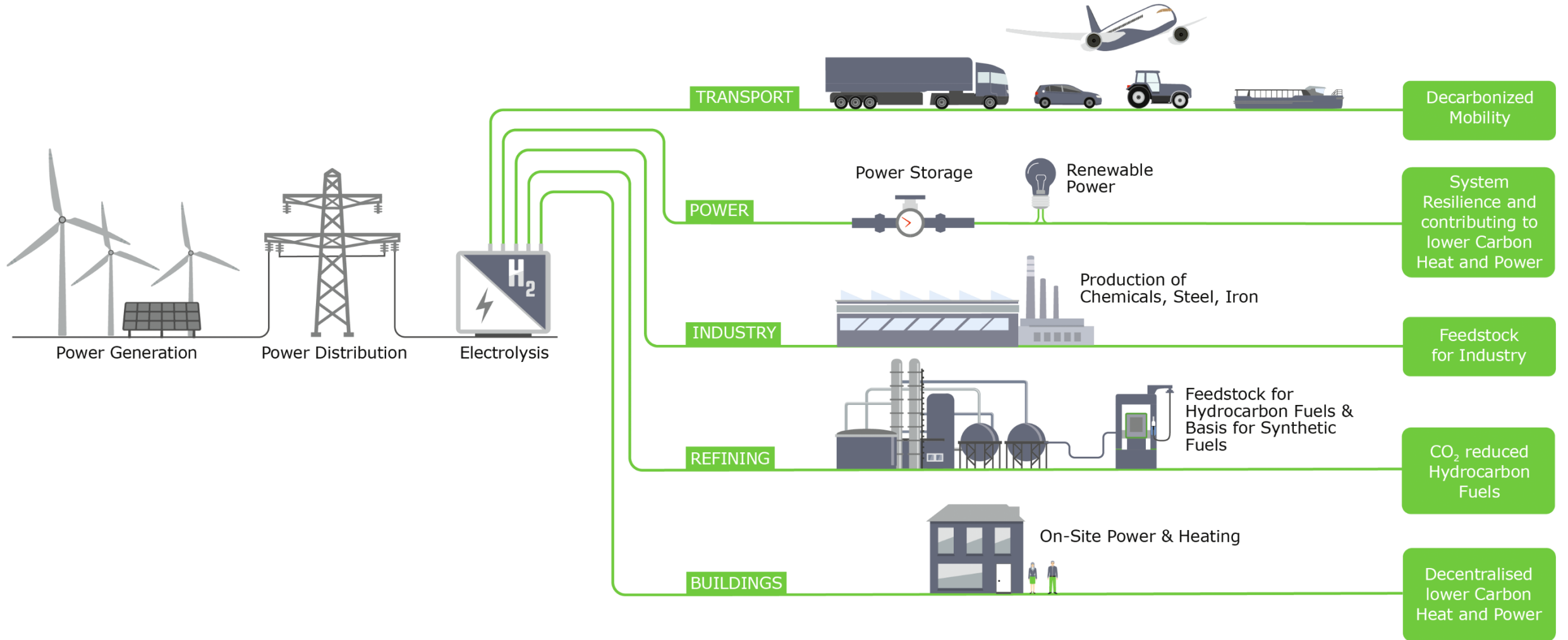
- Industry
- Refining
- Synthesis
- Waste Heat Usage

Pros and Cons of SOC technology

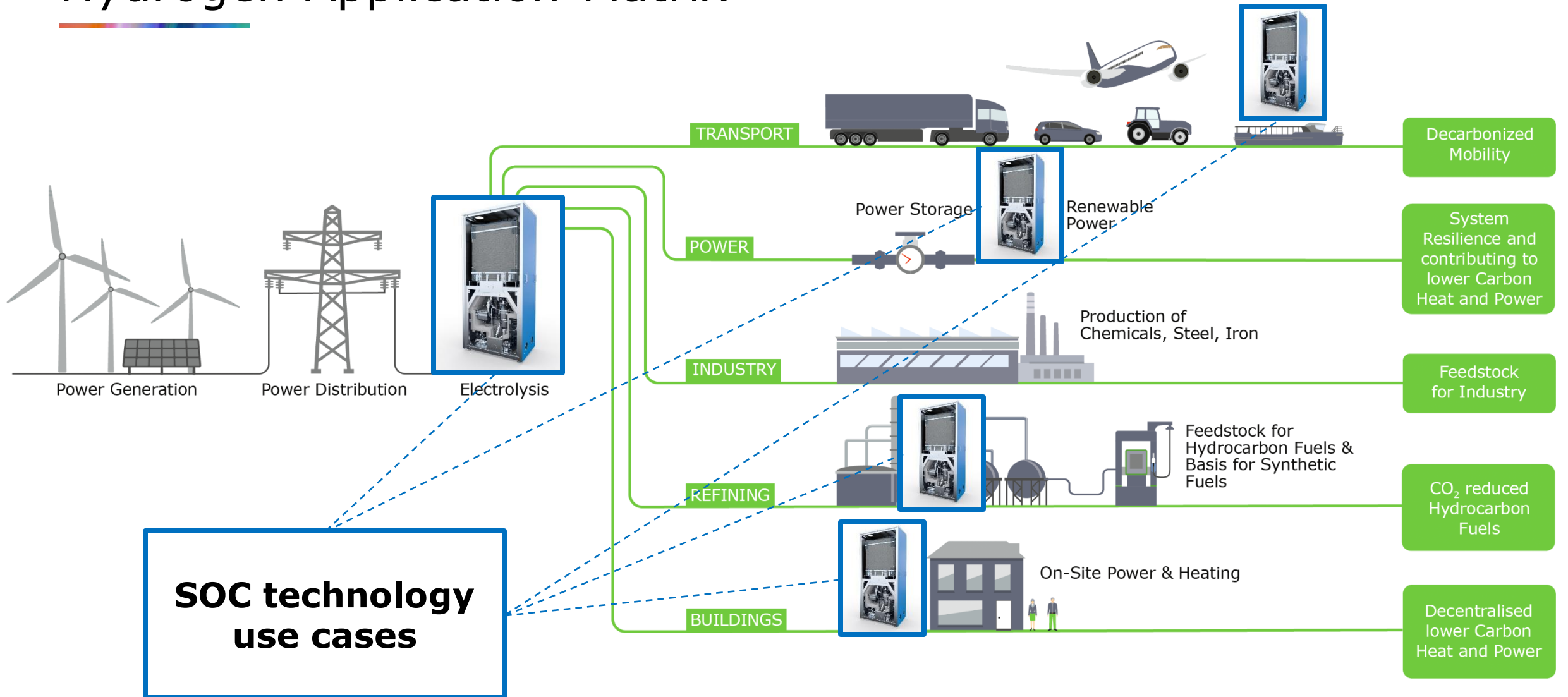


SOC ... Solid Oxide Cell
 SOEC ... Solid Oxide **Electrolysis** Cell
 SOFC ... Solid Oxide **Fuel** Cell
 rSOC ... Reversible Solid Oxide Cell

Hydrogen Application Matrix



Hydrogen Application Matrix



Next Generation Electrolyzer Technologies

1MW 40ft Container Solid Oxide Electrolysis System

- 87% efficiency demonstrated - water steam electrolysis on SOEC module level
- Module Integration, Container Build Up, Testing, Commissioning by AVL

NEWS

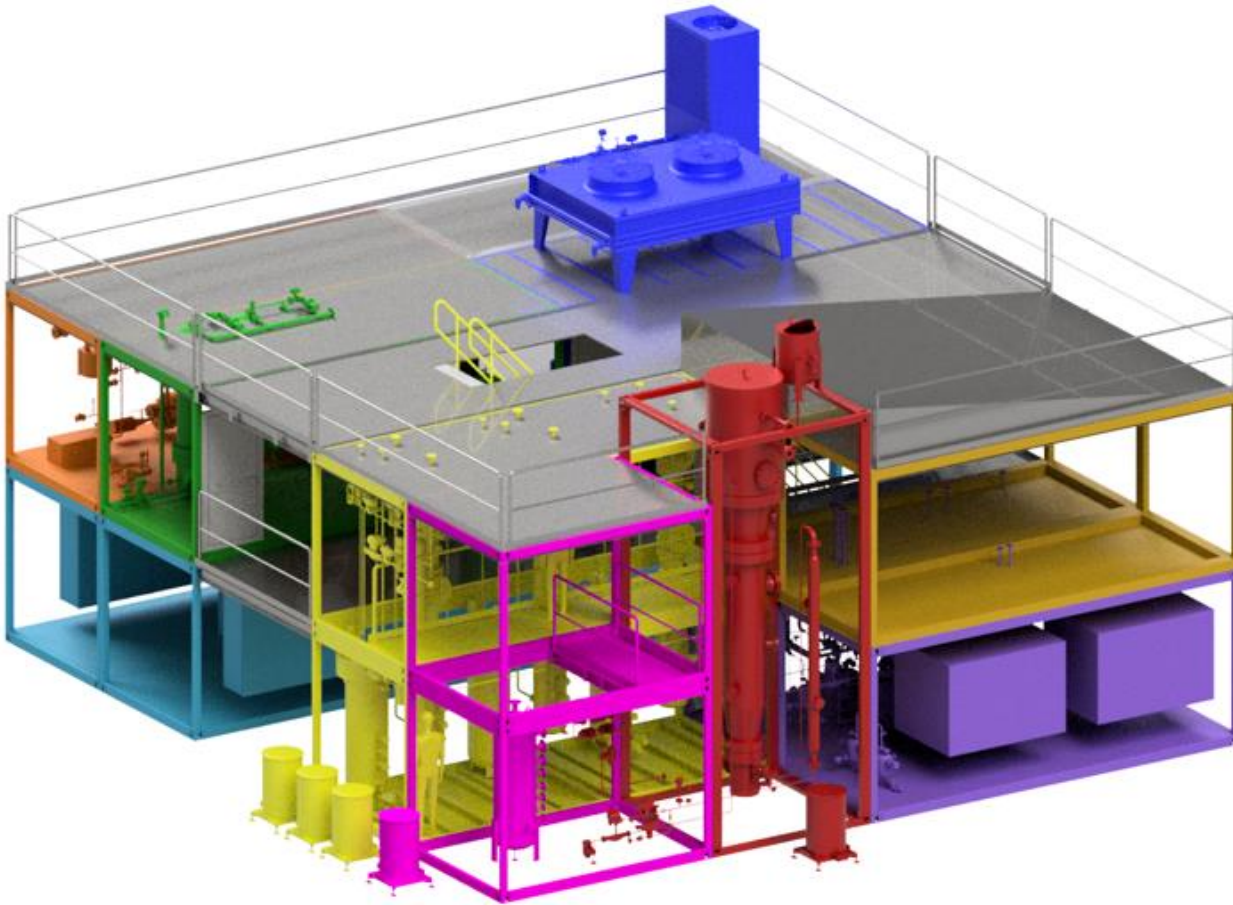
Ceres and Shell sign agreement for green hydrogen

28 June 2022

- Megawatt scale demonstrator to be located in Bangalore, India
- Aim to deliver low-cost green hydrogen for industrial decarbonisation

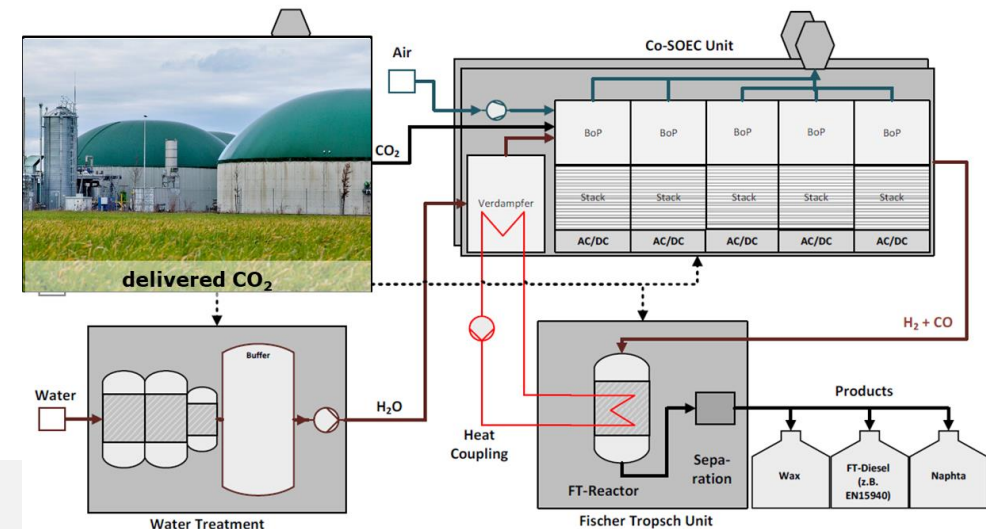


Power-to-Liquid Demonstration Plant

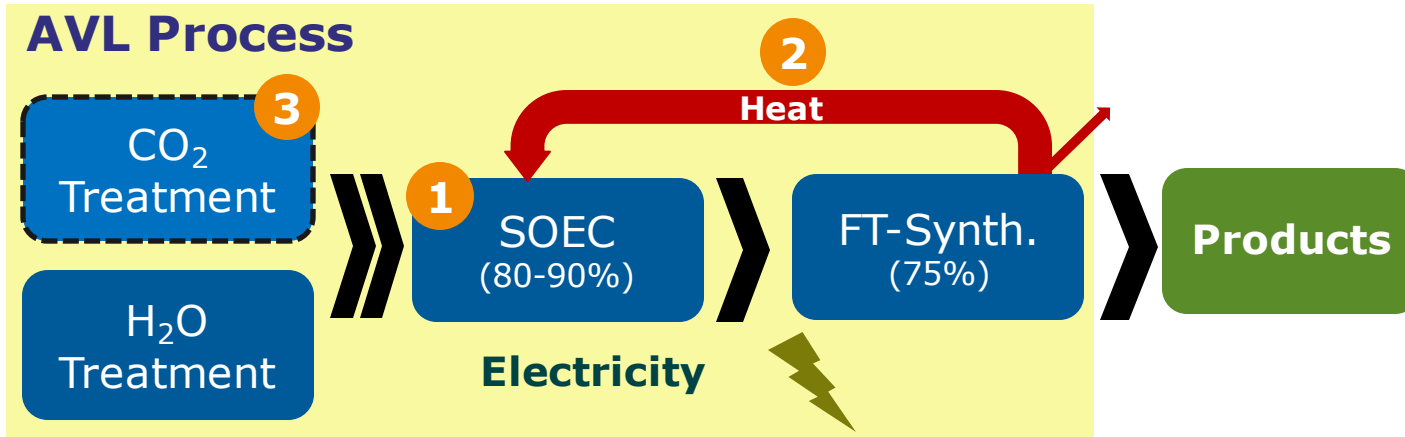


- 200kWel SOEC capacity
- ~100.000l production capacity of e-fuels per year
- Focus: Diesel and SAF (sustainable aviation fuels)
- Commissioning in Q4/2024
- >30% Efficiency Improvement in e-fuel production

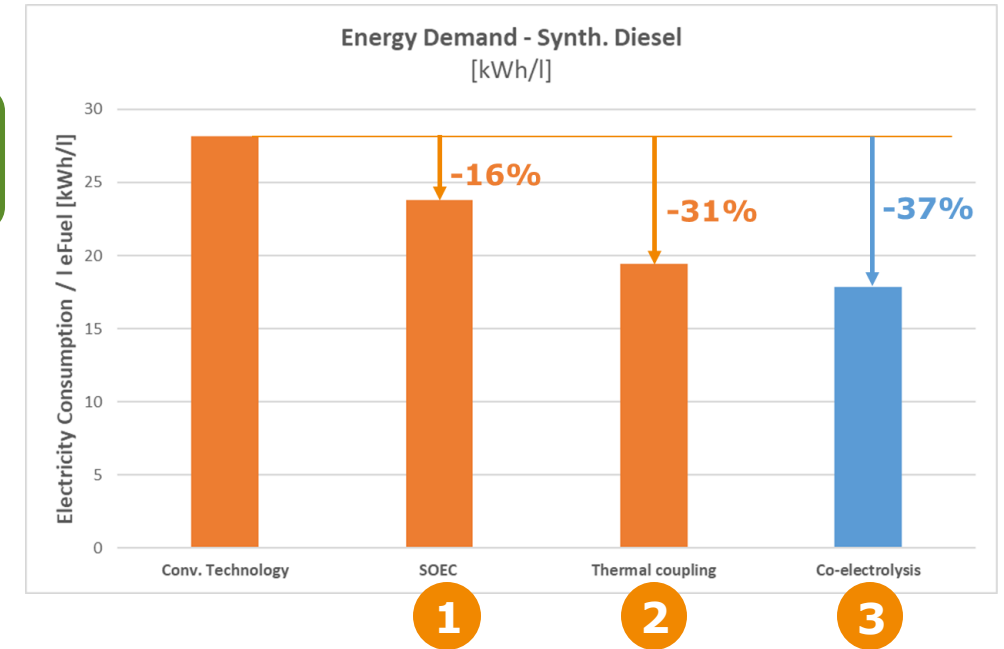
Process applicable to ammonia, methanol & SNG as well



Efficiency Improvement Potential of e-Fuel Production with SOEC



- 1 High-temperature electrolysis
- 2 Thermal Coupling
- 3 Co-electrolysis



Combined SOEC-FT process allows 30-40% higher efficiency compared to PEM and AL EL

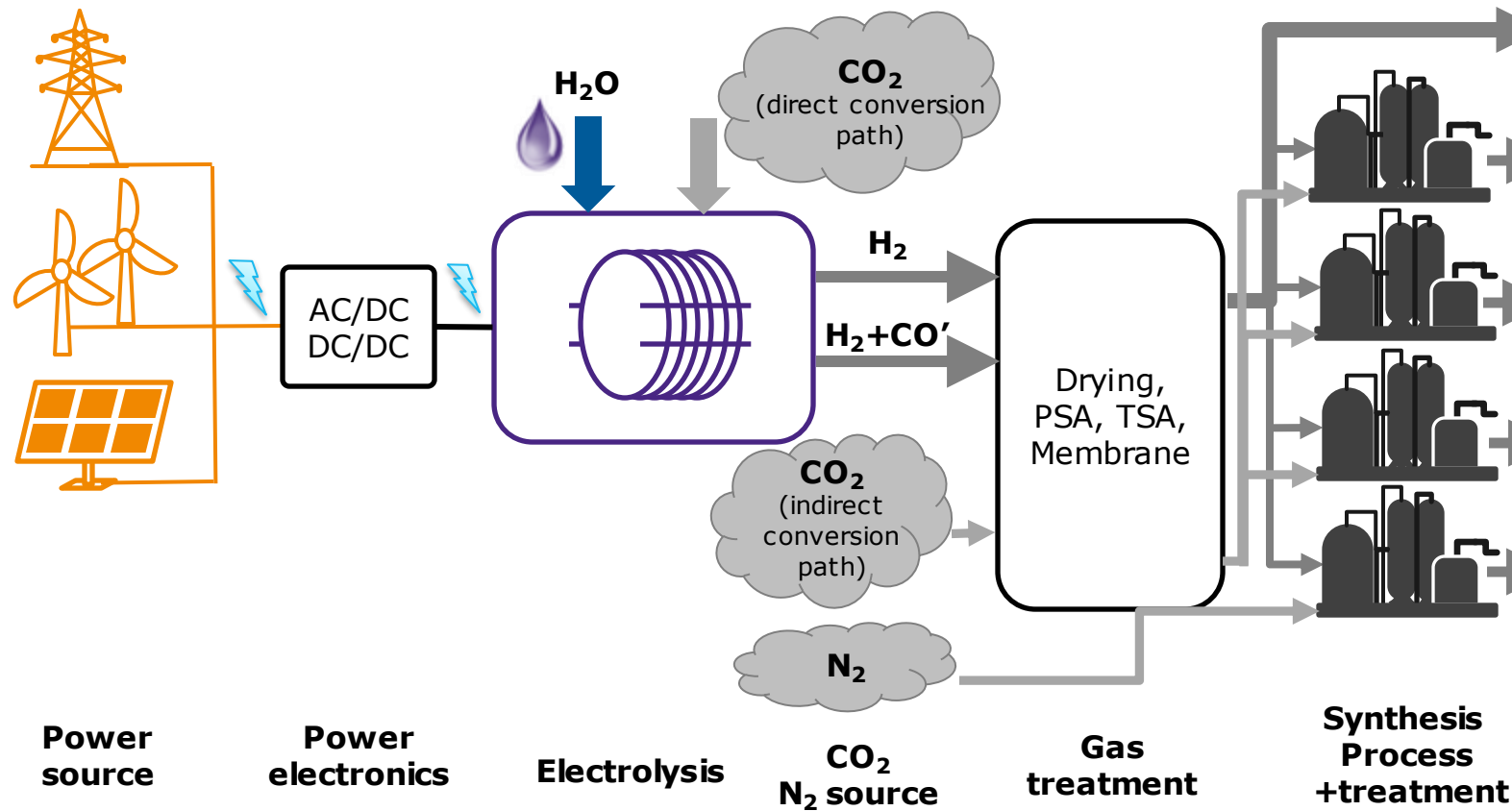
FT...Fischer Tropsch, PEM EL...Polymer Electrolyte Membrane Electrolysis, AL EL...Alkaline Electrolysis

Power-to-Liquid Demonstration Plant

Process Design

Scenarios	Demo Plant			
	# 1	# 2	# 3	# 4
Product tailgas recirculation to FT	✓	✓	✓	✓
CO ₂ separation <u>before</u> Co-SOEC	✗ (CO ₂ tank)	✓ (AmineWasher)	✓ (AmineWasher)	✓ (AmineWasher)
CO ₂ separation <u>after</u> Co-SOEC	✗	✗	✓ (PSA)	✗
rWGS for recirc. tailgas	✗	✗	✗	✓
FT heat integration	✓ to steam generation (150°C)	✓ to amine washing	✓ to amine washing	✓ to amine washing
PtL efficiency	>55%	~47%	~55%	~57%
Carbon efficiency	~66%	~60%	>95%	>95%

SOEC Power-to-X Routes



Product	Process Efficiency	
	SOEC	SoA
Hydrogen	~85%	~70%
Methane	~80%	~50%
FT Fuels	~55%	~40%
Methanol	~70%	~45%
Ammonia	~70%	~50%

SOEC improves the efficiency of all major eFuel production routes significantly

Thank you



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