



FUEL CELLS AND HYDROGEN
JOINT UNDERTAKING

Hydrogen and Fuel Cell Value Chain in Europe

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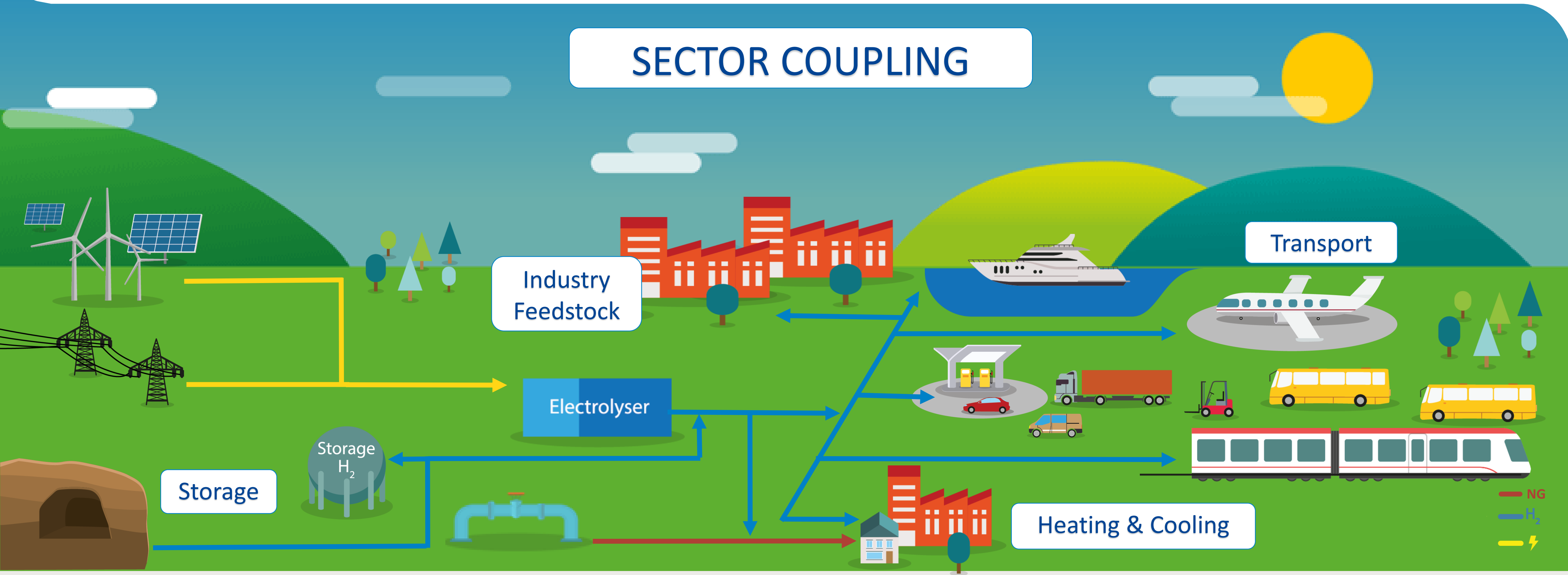
HyBalance Workshop

Brussels 8 October 2019



The hydrogen economy

Hydrogen allows more renewables in the energy system and enables sector-coupling



Why Hydrogen 2050 vision?

Besides CO₂ abatement, deployment of the hydrogen roadmap also cuts local emissions, creates new markets and secures sustainable employment in Europe



2050 hydrogen vision



~24%

of final energy demand¹



~560 Mt

annual CO₂ abatement²



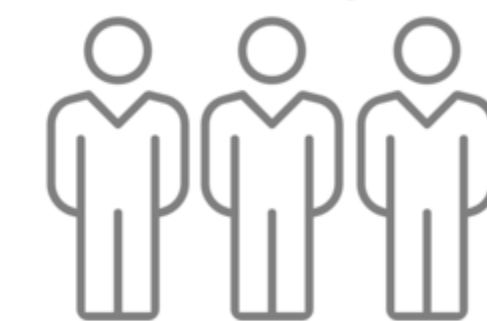
~EUR 820bn

annual revenue (hydrogen and equipment)



~15%

reduction of local emissions (NO_x) relative to road transport



~5.4m

jobs (hydrogen, equipment, supplier industries)³



¹ Including feedstock ² Compared to the reference technology scenario ³ Excluding indirect effects

SOURCE: Hydrogen Roadmap Europe team

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First analysis of benefits across the FCH Value Chain

Environmental, social and economic

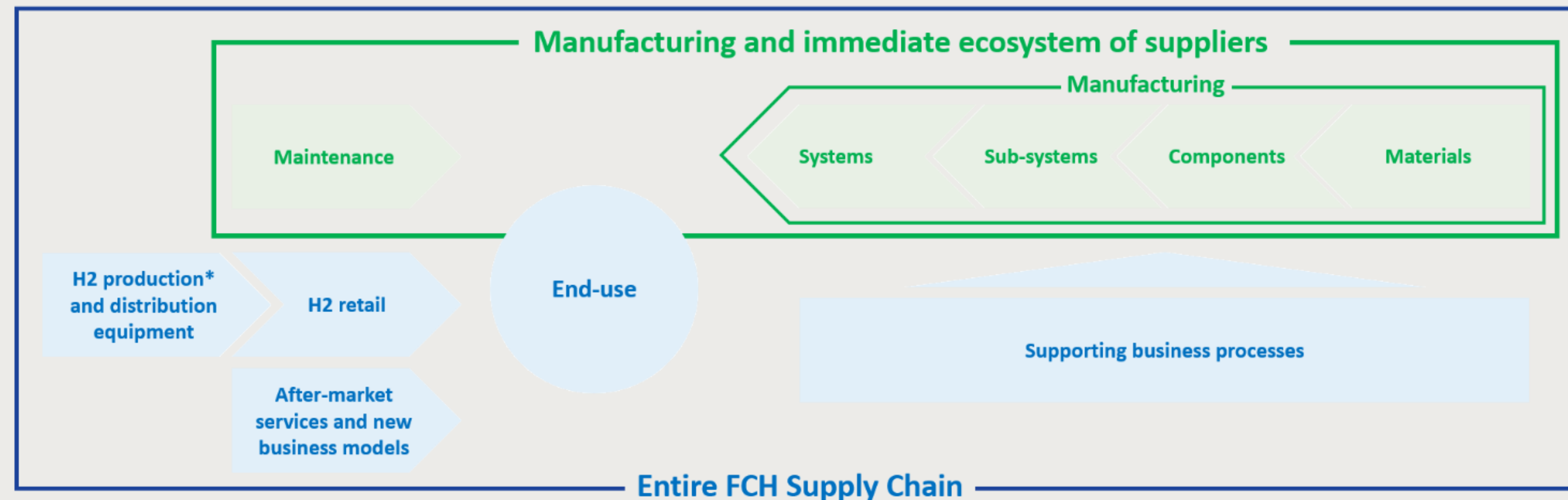


Top down - entire FCH value chain

- scale of FCH roll-out needed to meet the 2-degree scenario objectives
- across entire value chain

Bottom-up- manufacturing

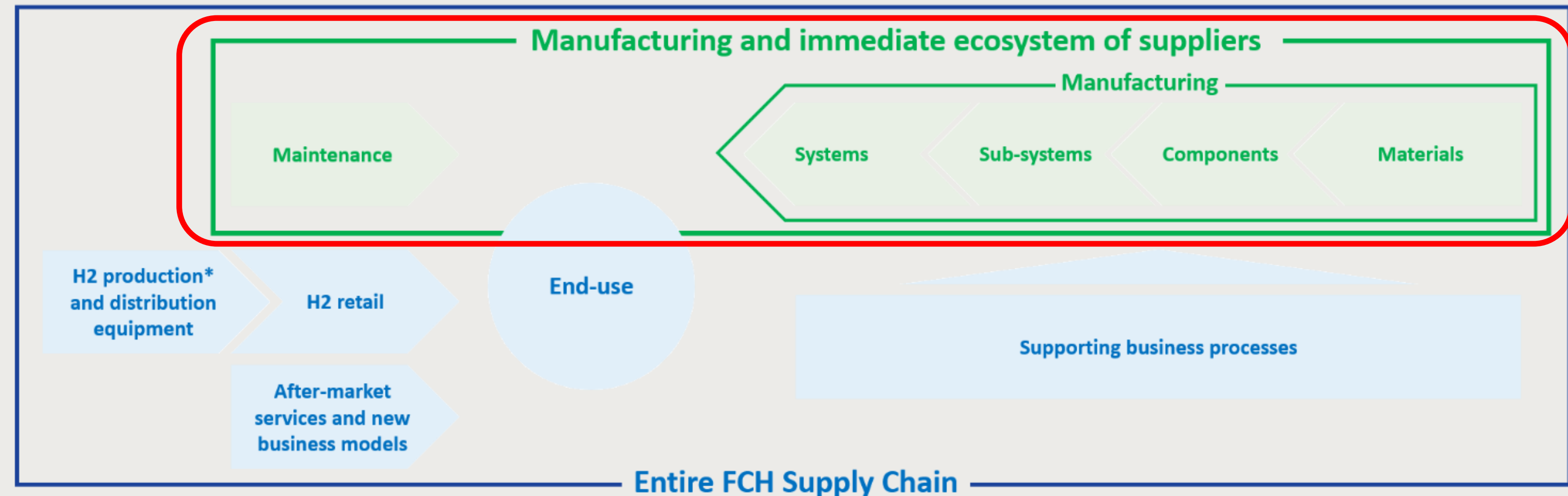
- value-added in manufacturing activities and the immediate ecosystem of suppliers
- employment in development, manufacturing, installation and service sectors, and through technology export



Manufacturing Competitiveness Analysis for Hydrogen and Fuel Cells Technologies



Simulation and assessment of potential development scenarios by 2024 and 2030 for the European FCH value chain and manufacturing competitiveness



Value Chain study

Supporting European growth and competitiveness



Main findings

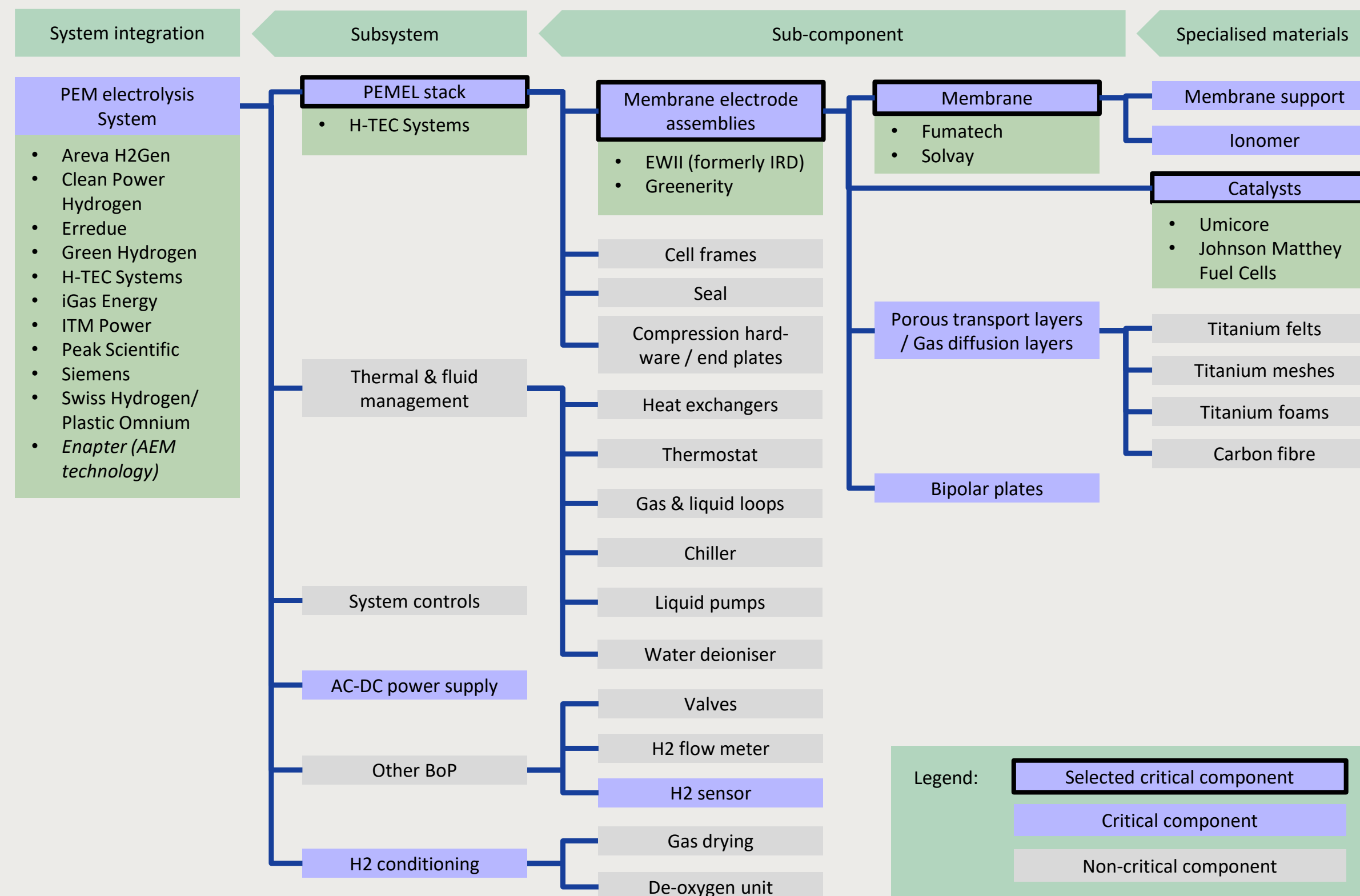
- The Value Chain study is an in-depth bottom-up analysis of the socio-economic benefits of FCH manufacturing and the supporting supplier ecosystem
- The European benefits could be significant: FCH sector manufacturing alone could create €12 bn in business turnover and 110,000 jobs by 2030
- Capturing these benefits requires early and coordinated action to support deployment and supply chain maturation
- First detailed evidence base to support decision-making by both policy makers and sector actors
- The results have already been used to inform on-going policy discussions



Approach

Detailed supply chain maps for FCH applications created
Data was gathered on 13 applications of which 8 were analysed in detail

PEM electrolysis supply chain



Transport applications

- Passenger cars and LCVs
- Buses
- HGVs
- Trains and light rail
- Forklifts
- Boats

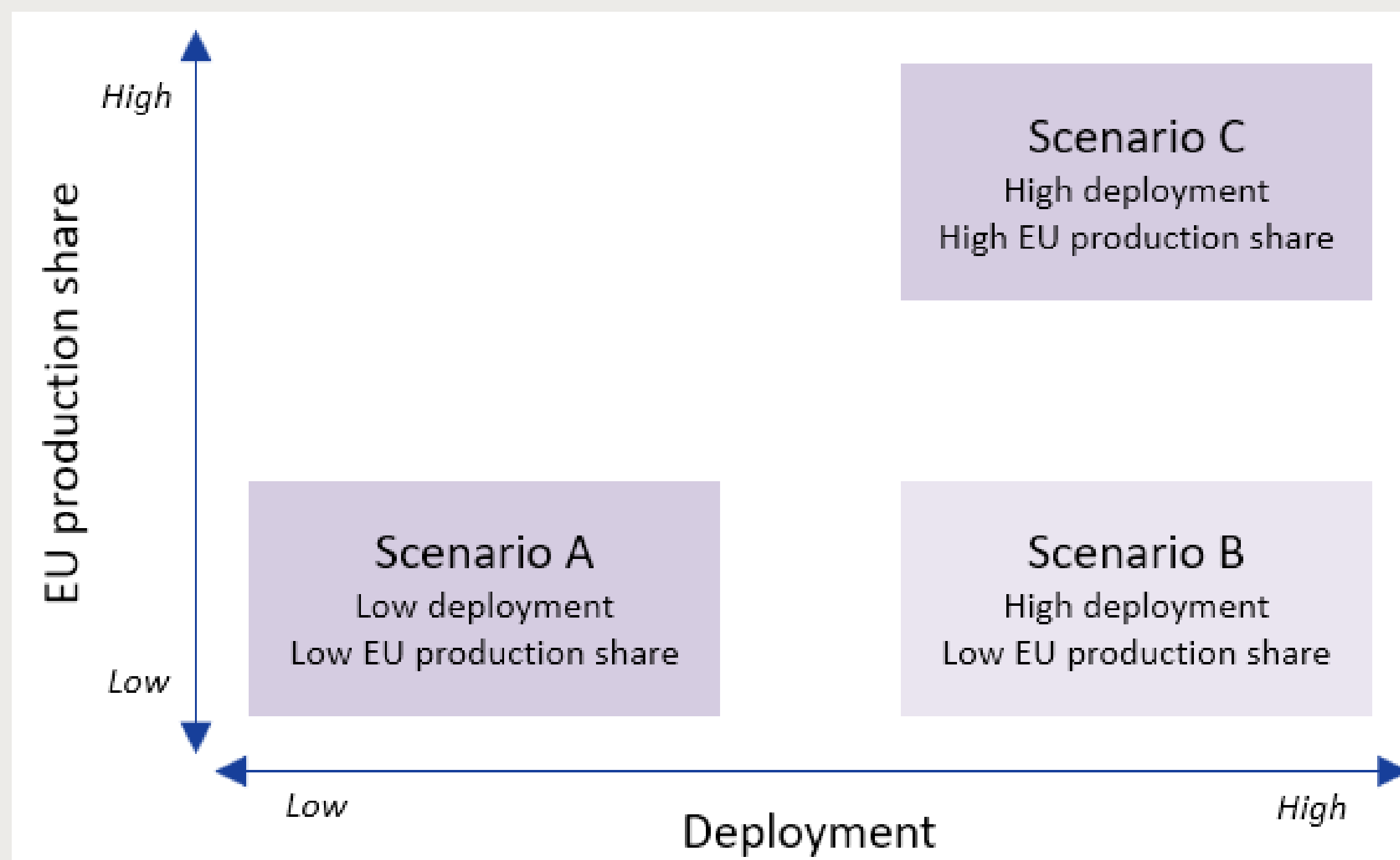


Stationary applications

- HRS
- Electrolysers
- Micro-CHP
- Commercial CHP / prime power
- Large scale CHP / prime power
- Back-up power / gensets
- Fuel processors / reformers

- 40 individual supply chain maps are included in the report
- Outputs include supply chain maps by application and by chemistry

Industry scenario definitions



- Three scenarios were considered in the value-added analysis. FCH deployment and EU production share were varied.
 - Scenario A: Low deployment / Low EU share
 - Scenario B: High deployment / Low EU share
 - Scenario C: High deployment / High EU share
- These allow the impact of different levels of European participation to be assessed and relevant recommendations provided

Approach

Global and European deployment scenarios have been developed



Global and EU deployment scenarios were developed to 2024 and 2030

Global deployment in units

Application	Comments	Units	2024			2030		
			L	M	H	L	M	H
FCEV	Passenger cars and light commercial vehicles (LCV)	millions	0.33	0.90	1.8	1.6	5.5	10
FC Buses		thousands	16	24	35	61	120	190
HGV		thousands	3.0	3.8	10	20	37	80
FC Forklifts		thousands	48	67	93	85	140	230
Trains and light rail		units	87	190	490	420	1,200	2,400
Maritime and inland boats		units	16	38	110	75	240	520
HRS		thousands	0.76	1.9	3.9	3.5	11	20
Micro CHP	1-5 kW _e	millions	0.75	1.4	1.7	2.3	4.8	7.0
Commercial CHP	5-100 kW _e	thousands	4.7	7.3	26	31	72	200
Large CHP	> 100 kW _e	thousands	7.3	14	27	17	45	97
Back-up power and gensets		thousands	42	60	75	85	150	230
Electrolysers	Not applicable as stack sizes vary significantly							

EU deployment in units

Application	Comments	Units	2024			2030		
			L	M	H	L	M	H
FCEV	Passenger cars and light commercial vehicles (LCV)	millions	0.060	0.20	0.48	0.3	1.2	2.6
FC Buses		thousands	1.0	1.7	3.0	3.6	8.4	16
HGV		thousands	0.44	0.66	2.20	2.90	6.5	17
FC Forklifts		thousands	0.96	2.0	4.7	1.7	4.3	11
Trains and light rail		units	23	61	180	110	390	870
Maritime and inland boats		units	2	4	11	8	24	52
HRS		units	130	400	990	600	2,300	5,000
Micro CHP	1-5 kW _e	millions	0.05	0.12	0.18	0.16	0.43	0.77
Commercial CHP	5-100 kW _e	thousands	0.27	0.75	3.5	1.8	7.5	27
Large CHP	> 100 kW _e	thousands	0.07	0.65	2.2	0.29	4.0	10
Back-up power and gensets		thousands	1.3	3.0	5.2	2.5	7.6	16
Electrolysers	Not applicable as stack sizes vary significantly							

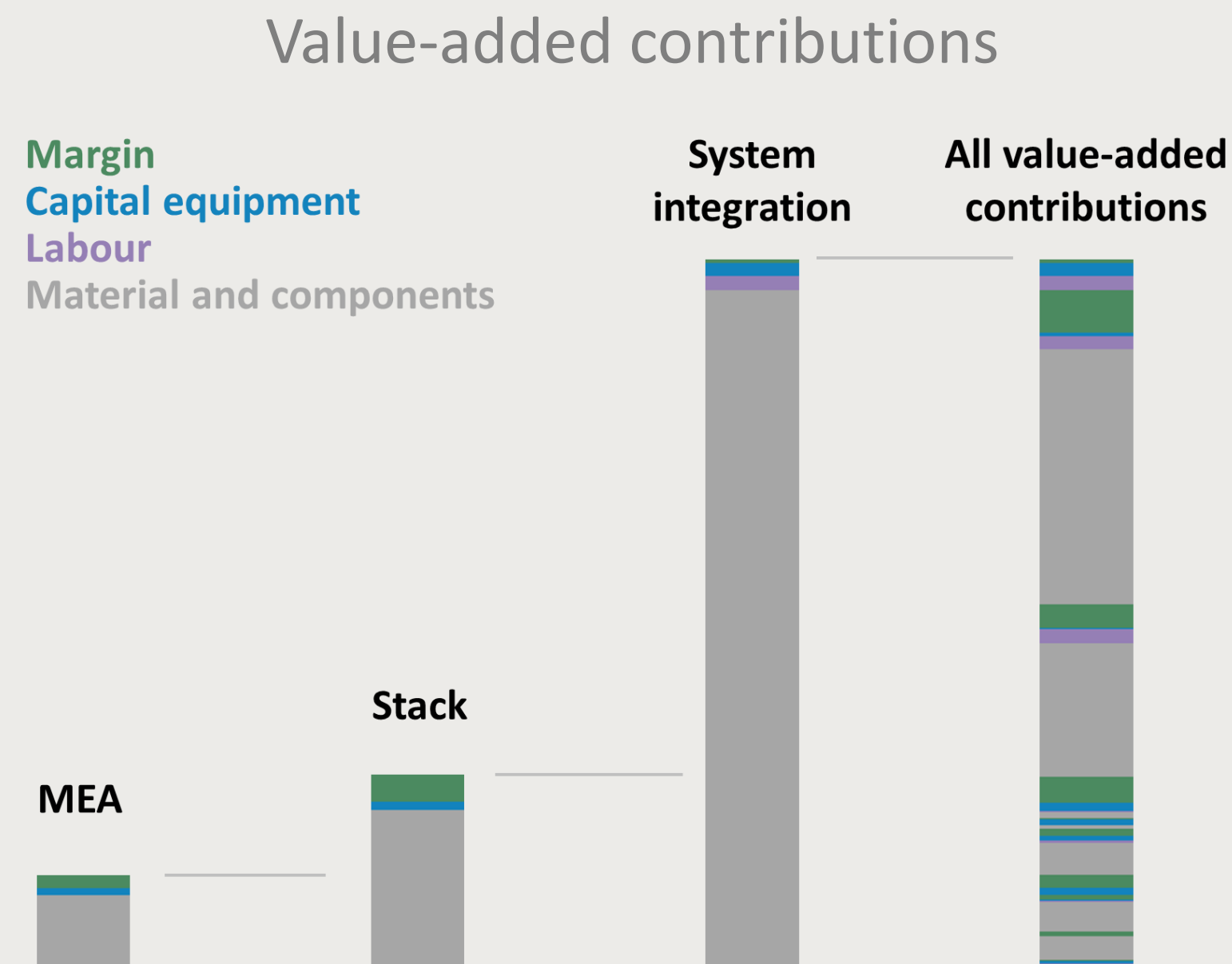


Approach

Value-added analysis was conducted to track value creation throughout the supply chain



Value-added analysis shows socio-economic benefit creation along the chain



Labour

- Local employment created where plants are located



Capital

- Value flows to capital equipment suppliers



Margin

- Value flows to home country of business entity

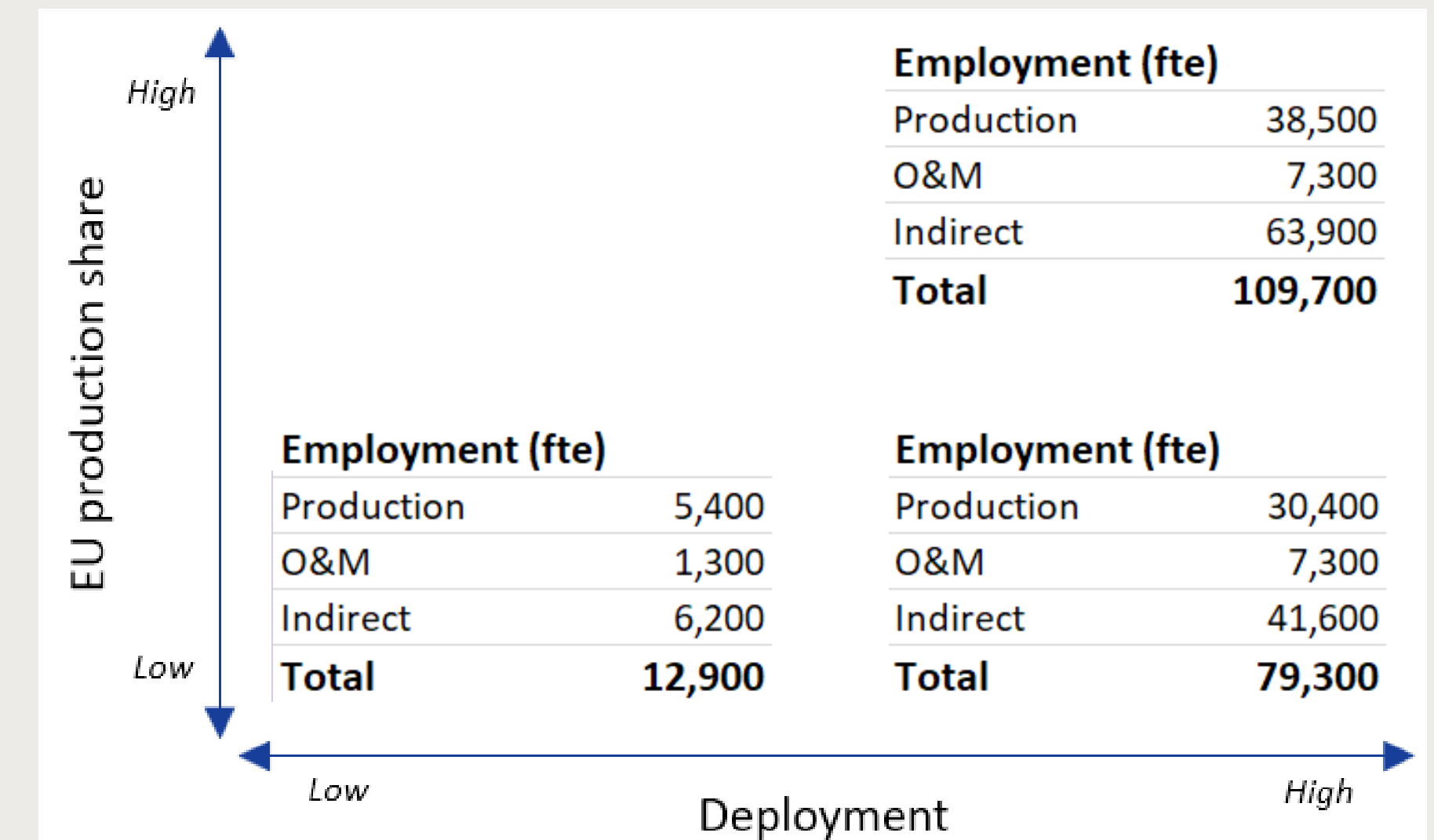
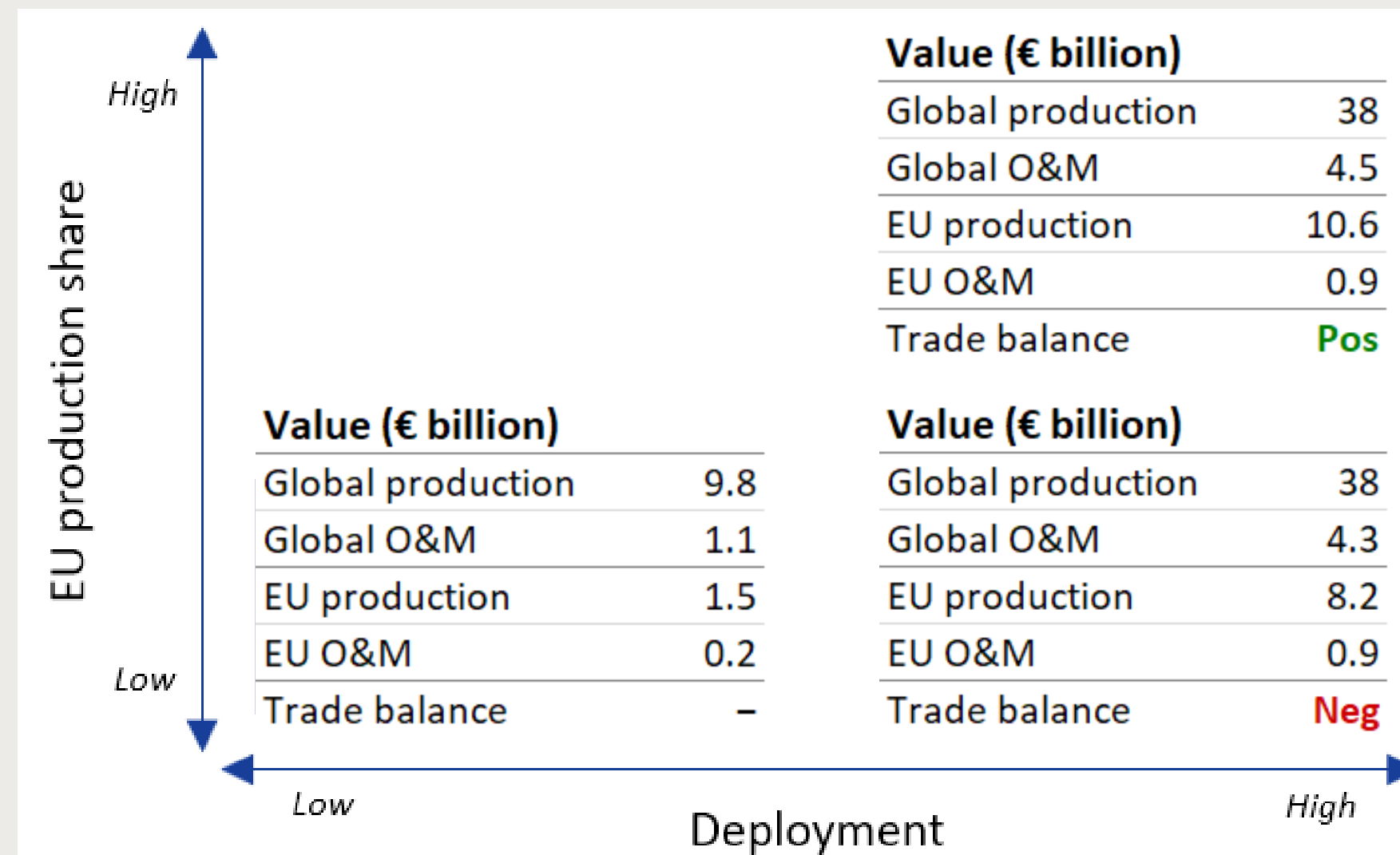
- Value-added analysis tracks contributions of capital, labour and margin in production processes throughout the chain
- This can be used to assess the socio-economic benefits and provides insight into how to capture them



FCH manufacturing supply chains can generate significant socio-economic benefits

EU employment

2030
socio-economic
indicators



- The following socio-economic indicators are evaluated by application. Only the FCH-specific elements are assessed
 - Turnover
 - Value-added
 - Employment
 - Maintenance (O&M)
 - Indirect employment

Electrolysers value analysis

Key socio-economic figures for electrolyser industry scenario (2024 and 2030)



- By 2030, for European production:
 - Value: €520m
 - Corresponding value-added: €180m
 - Overall European number of employees: 1,600
 - Overall positive trade balance: €120m

Year	2024			2030		
	Scenario A	Scenario B	Scenario C	Scenario A	Scenario B	Scenario C
Global Market						
Global system production value (million)	€ 230	€ 730	€ 730	€ 500	€ 2,000	€ 2,000
Global system O&M value (million)	€ 20	€ 140	€ 140	€ 120	€ 450	€ 450
European market and production						
European production value (million)	€ 91	€ 180	€ 190	€ 190	€ 480	€ 520
European O&M value (million)	€ 6.4	€ 10	€ 10	€ 20	€ 42	€ 42
Macro-economic impact						
Value added - Total (million)	€ 29	€ 58	€ 66	€ 64	€ 160	€ 180
Value added - Labour (million)	€ 10	€ 19	€ 21	€ 21	€ 52	€ 59
Value added - Capital (million)	€ 13	€ 26	€ 30	€ 29	€ 73	€ 84
Value added - Margin (million)	€ 6.6	€ 13	€ 14	€ 14	€ 36	€ 40
European annual trade balance impact (million)	€ 15	€ 29	€ 44	€ 32	€ 81	€ 120
Employment impact						
Direct employment system production (fte)	260	500	560	550	1,400	1,600
Direct employment O&M (fte)	54	85	85	170	360	360
Indirect employment (fte)	180	350	370	390	960	1,000
Sum (fte)	490	940	1,000	1,100	2,700	2,900



Electrolysers value analysis

Estimated value creation potential for PEM electrolyser systems



Supply chain

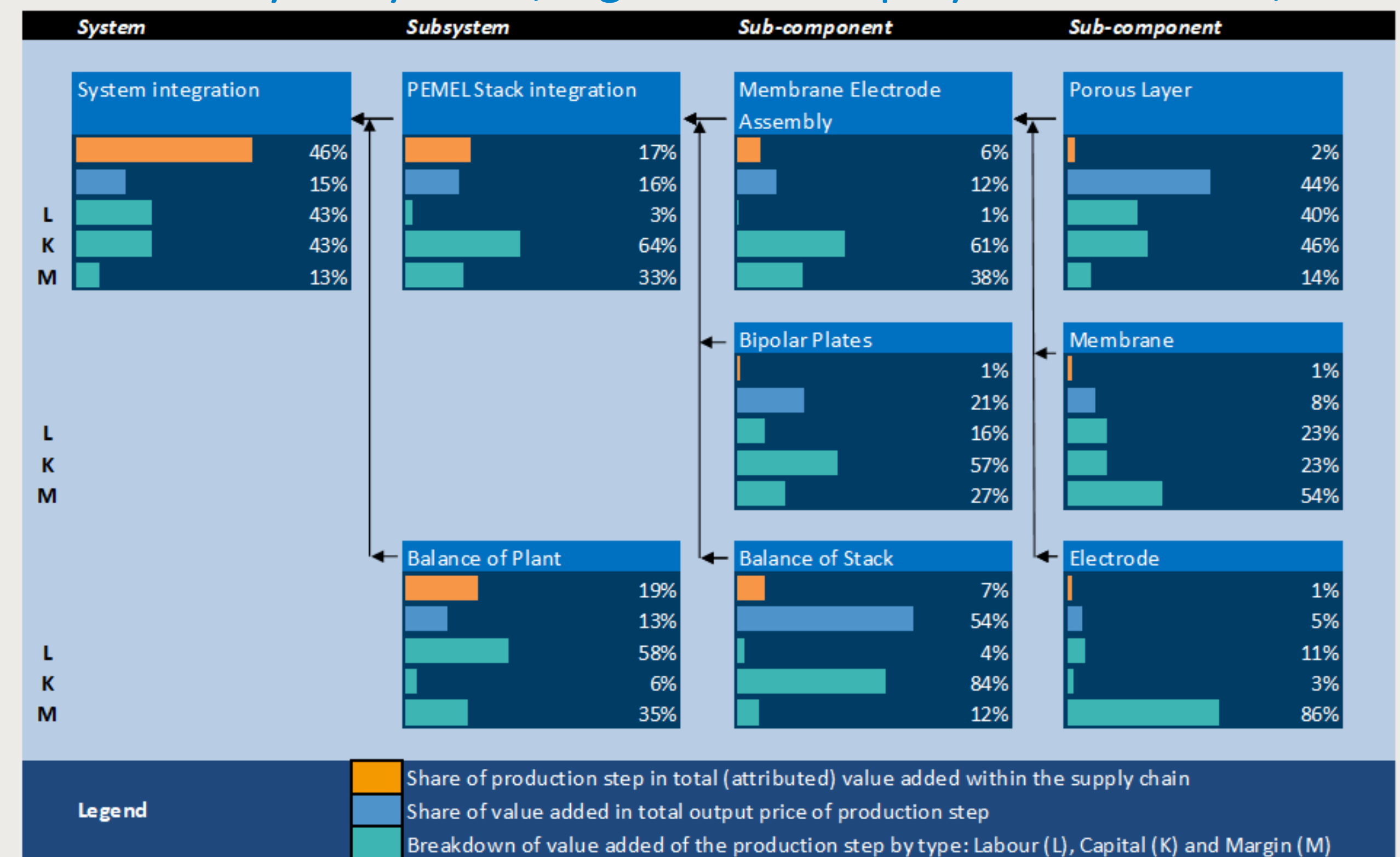
- Main cost contributors: stack (40%-60%), power electronics (15%-21%)
 - MEA is main cost driver in stack
- Europe leads in PEM electrolysers
- Supply chain is in general less developed compared with PEM FCs

Biggest contributors to PEMEL value-added

- System integration: Labour and capex
- BOP: Labour
- Stack: capex

Value-added map

PEM electrolyser systems, high market deployment scenario, 2030



L: labour; K: capital equipment; M: margin



Electrolysers value analysis

Where would the most significant EU benefits come from

- System integration located in the EU
- EU PEM stack and system manufacturing equipment suppliers
- EU SOFC cell manufacturing equipment suppliers



Capitalising on Europe's FCH manufacturing opportunities requires action now

- Increasing the value to Europe depends on both support and deployment in Europe
- Deployment will activate the market and promote the development of localised EU supply chains
- Support to the supply chains will allow European actors to build or strengthen their positions

EU deployment is important to capturing the potential economic value

- For the majority of applications, system integration labour is a significant source of value-added
- For this value-added to generate benefits in the EU, this activity needs to be located in the EU
- Applications serving mainly regional markets (buses,...) imply EU deployment is necessary to take advantage of system integration added value



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