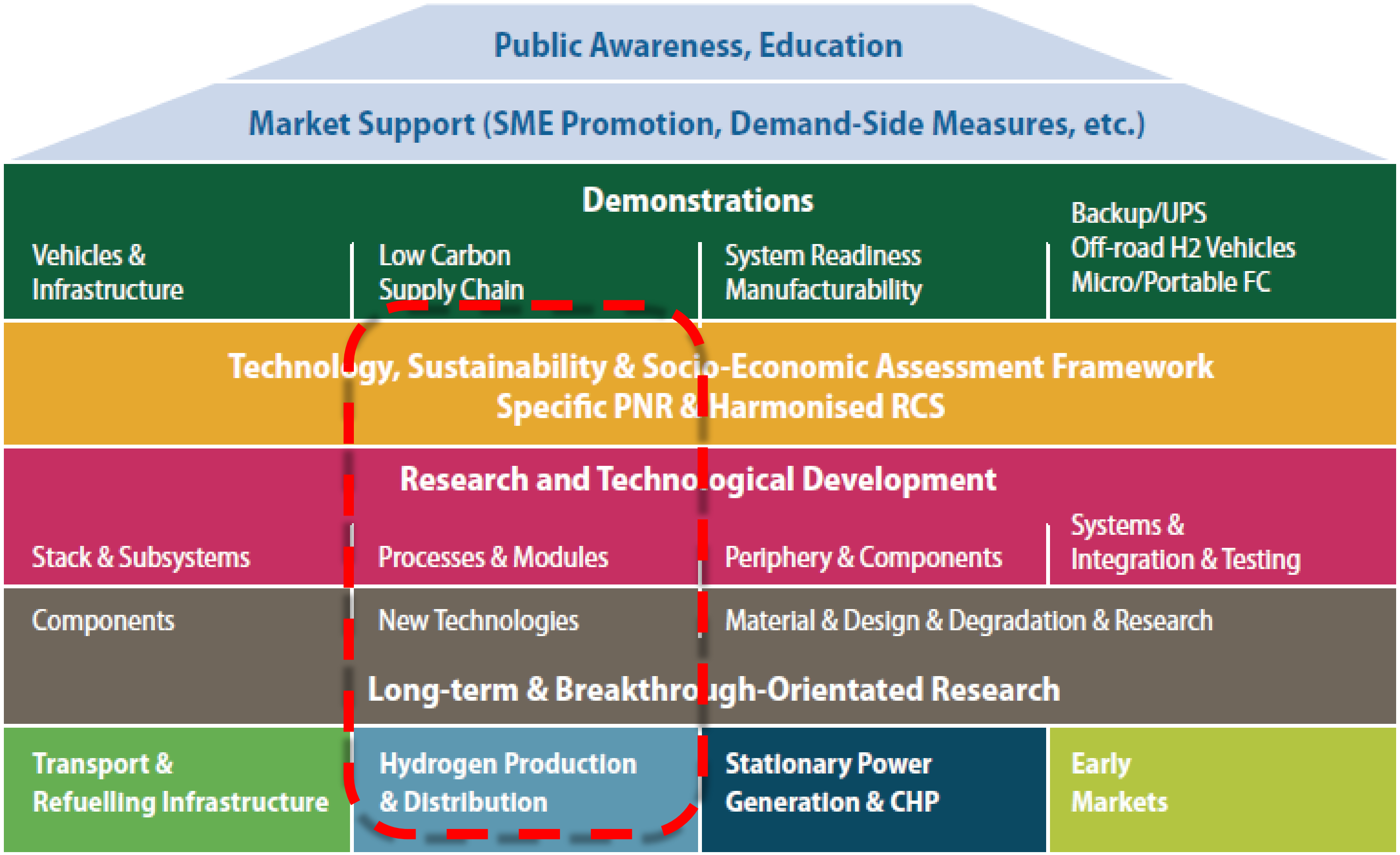
Introduction to Hydrogen production, distribution and storage portfolio

N. Lymperopoulos – Project Manager
Hydrogen production

AGENDA Day 2 Afternoon

	PLENARY SESSION ON HYDROGEN PRODUCTION, DISTRIBUTION AND STORAGE
16:00 – 16:15	**Introduction to hydrogen production, distribution and storage portfolio: Nikolaos Lymperopoulos (Alcide de Gasperi Room, 2nd floor)**
16:15 – 16:20	Q&A
	Panel 5 - Energy RTD and demonstration: Hydrogen production, distribution and storage
	Moderators: Nikolaos Lymperopoulos and Bernard Dam
	Panel - Low carbon hydrogen production - Electrolysis
16:20 – 16:35	RESELEYSER
16:35 – 16:50	ELECTROHYPEM
16:50 – 17:00	Q&A
	Panel - Low carbon hydrogen production - Other routes
17:00 – 17:15	ARTIPHYCTION
17:15 – 17:30	HYTIME
17:30 – 17:50	Green Hydrogen Study
17:50 – 18:00	Q&A
	Panel - Hydrogen storage, handling and distribution
18:00 – 18:15	HYTRANSFER
18:15 – 18:30	EDEN
18:30 – 18:40	Q&A
18:40 – 18:50	**Concluding Remarks**
	Eden Mamut, Chair of Scientific Committee (Alcide de Gasperi Room, 2nd floor)
18:50 – 19:00	**Event key message and closure**
	Bert de Colvenaer, FCH 2 JU Executive Director (Alcide de Gasperi Room, 2nd floor)
19:00 – 19:45	**Poster Session - Panels 5 and 6 Manned (2nd floor)**
19:45 – 21:00	**Cocktail Dinner and Networking**

- H_2 Production & Distribution Application Area



- H_2 Production & Distribution in Energy Pillar

HORIZON 2020

- Road vehicles
- Non-road vehicles and machinery
- Refuelling infrastructure
- Maritime, rail and aviation applications

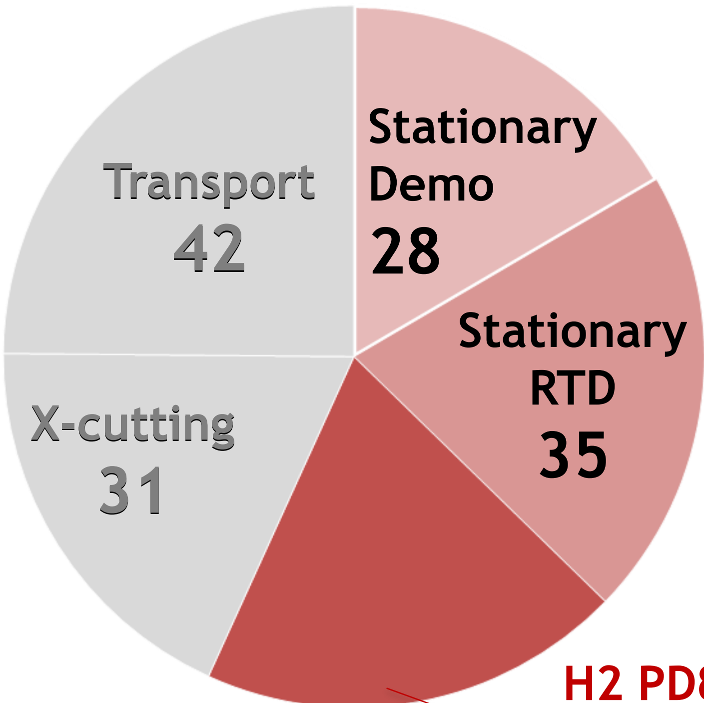
- Hydrogen production and distribution
- Hydrogen storage for renewable energy integration
- Fuel cells for power and combined heat & power generation

Cross-cutting Issues

(e.g. standards, consumer awareness, manufacturing methods, …)

Projects financed since 2008

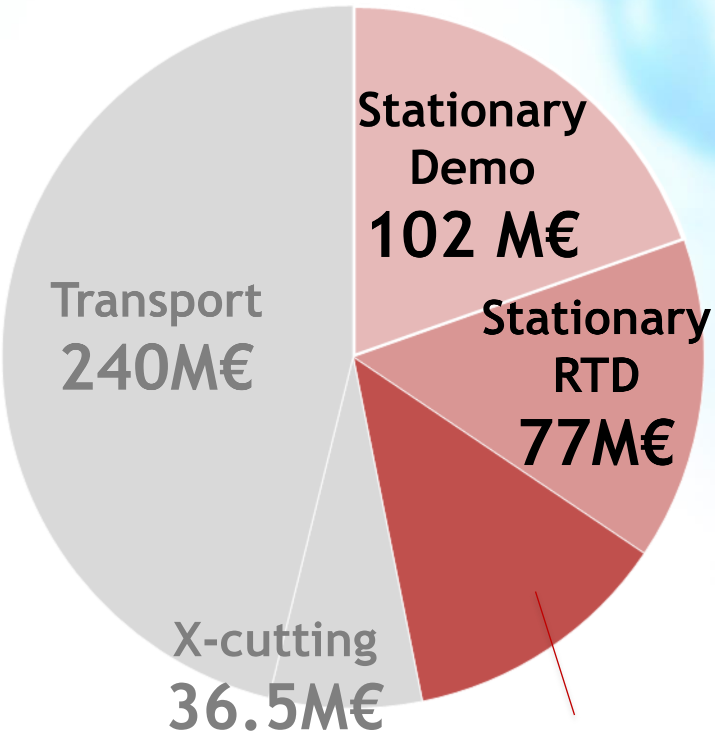
Number of projects
169 (of which FP7: 155)



H2 PD&S
33

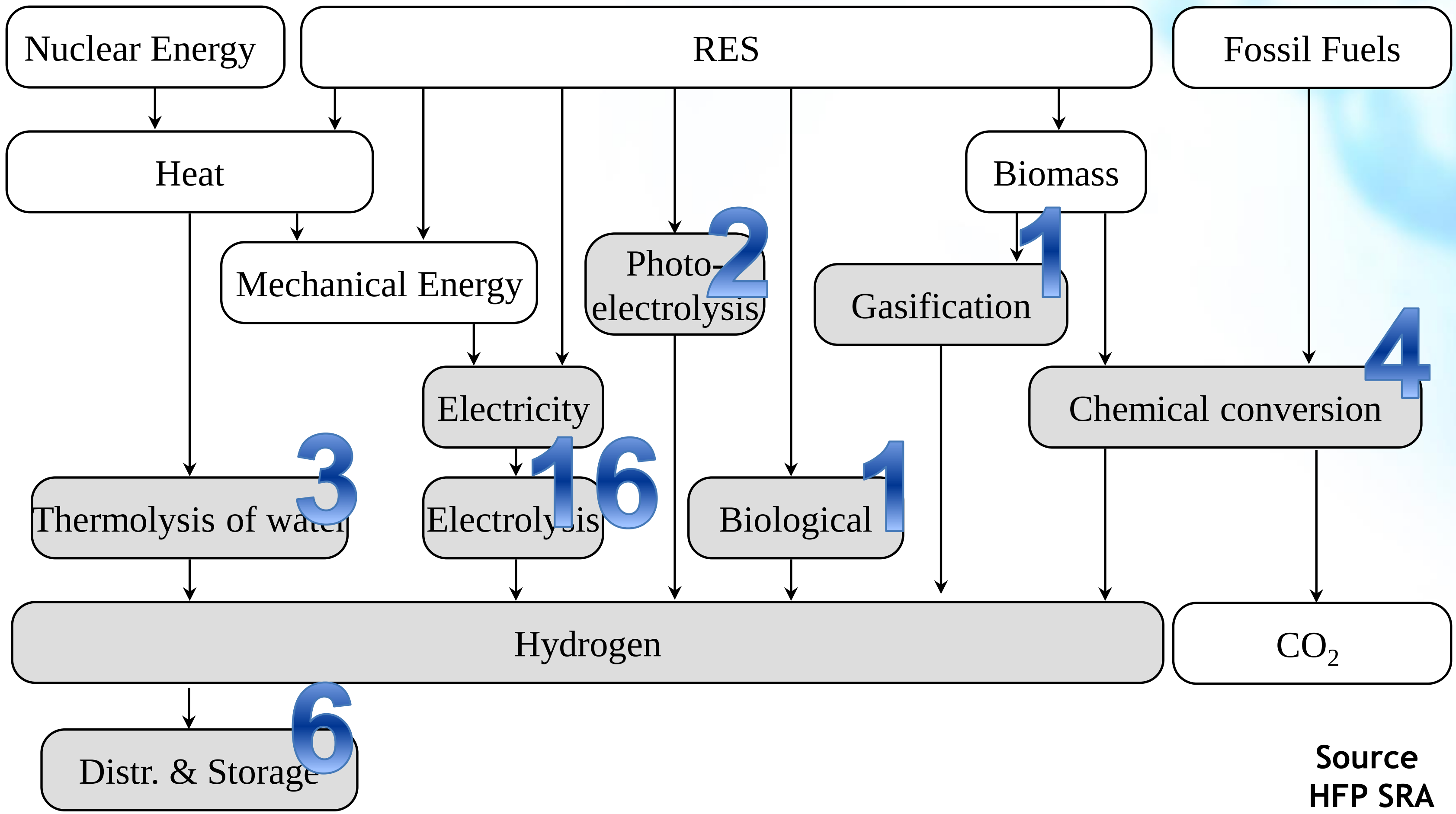
- 8 completed
- 21 active under FP7 = posters
- 4 under H2020

Max FCH JU contribution
520 M€ (of which FP7: 446 M)



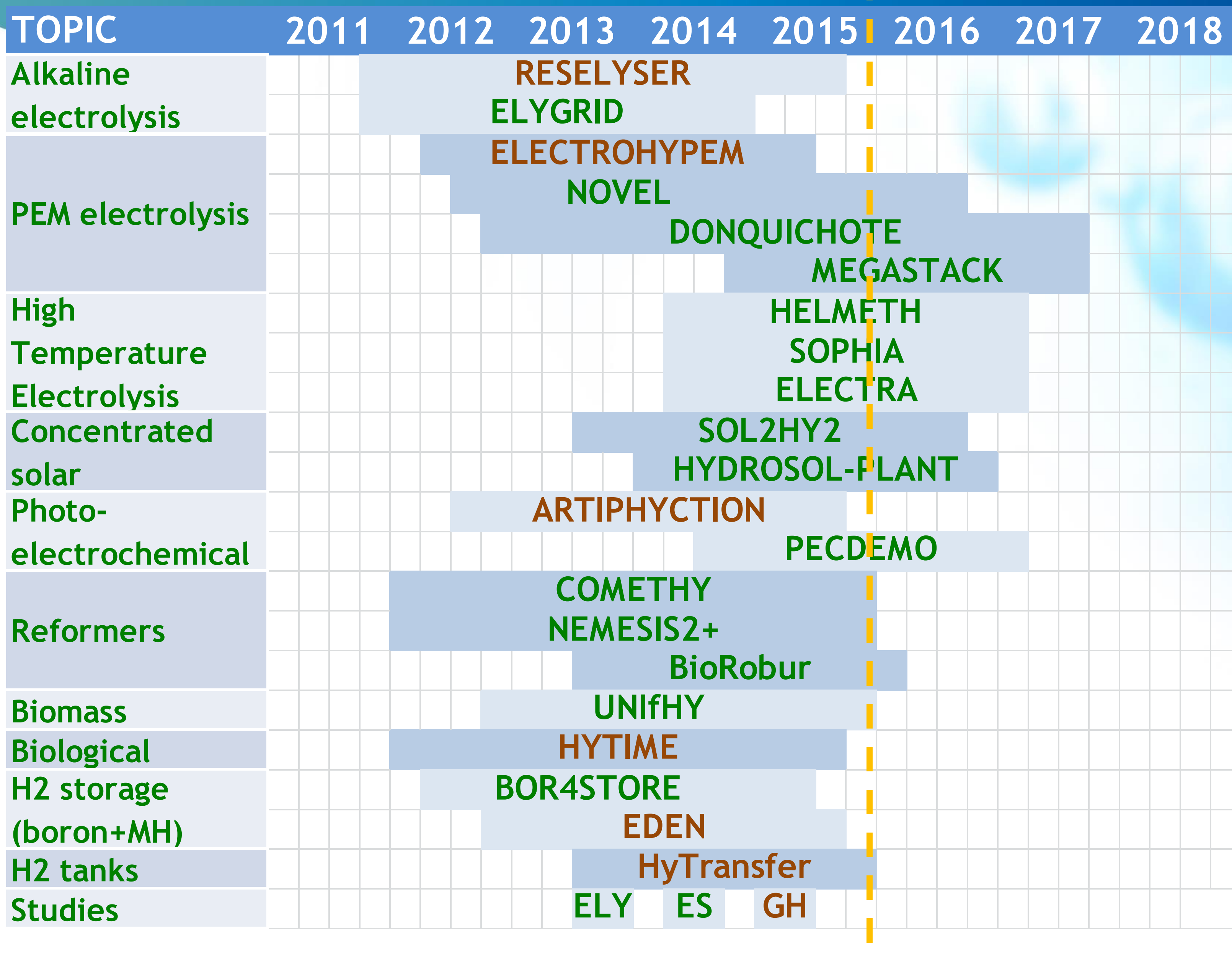
H2 PD&S
64.5M€
MAIP 10-12%

Hydrogen Prod., Stor. & Distr. Technical Coverage



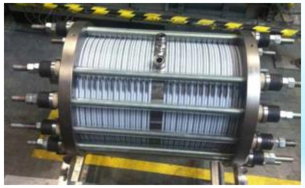
Source
HFP SRA

Panel 5 projects in a nutshell



Programme Targets and Achievements

- Electrolysers - 1



– Alkaline (RESELYSER, ELYGRID)

	Aim	Status
η	>80%,	76-82%
η retention	>90% over 1,000 on/off	>98% over 1,100
cost (k€/Nm^3.h)	3	7
capacity (tn/d)	1.5	3

– PEM (ELECTROHYPEM, NOVEL, DONQUICHOTE, MEGASTACK)

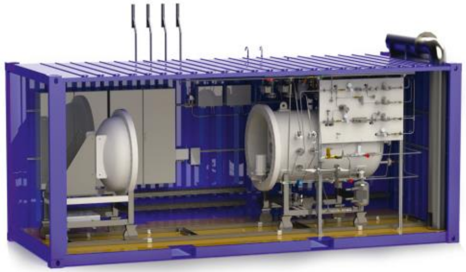
	Aim	Status
η (kWh/Nm^3)	< 4	3.53
V increase (μV/h)	< 15 @ 1 A cm^{-2}	8
H2 cost (€/kg)	< 15	13 (RES cost)
capacity single stack (Nm^3/h)	100	60

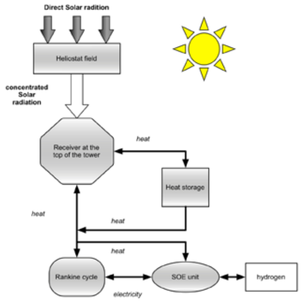
Programme Targets and Achievements

- Electrolysers - 2
  - High temperature (HELMETH, SOPHIA, ELECTRA)

Helmeth	Aim	Status
η (%)	85-95%,	86% ✓

- Achieved: 5kW, 10bar, 700ºC, total η 86%
- Scope:Design, fabrication, and operation on-sun of a 3 kW_e-size pressurized High Temperature Electrolysis (HTE) system, coupled to a concentrated solar energy source
- Scope: build and test a kW size multi-tubular proton ceramic high temperature electrolyser for production of hydrogen from steam and renewable energy



Programme Targets and Achievements

- **Concentrated solar** (SOL2HY2, HYDROSOL-PLANT)
  - Scope: Development of the key hybrid plant components: SO_2-depolarized electrolyzer (SDE), solar-powered H_2SO_4 cracker and heat storage
  - SDE stack constructed & tested for H_2 and H_2SO_4 co-production
  - Aim: 0.5-2.0 MW, Design for >0.5 MW

Hydrosol-Plant	Aim	Status
Lifetime (h)	> 1,000	450
Capacity (MW)	0.5-2	0.75

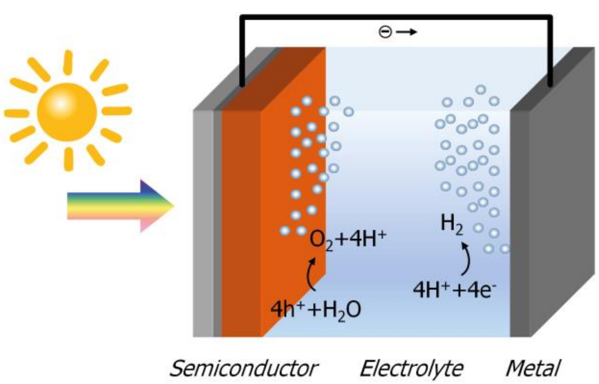



Programme Targets and Achievements

- Photo-electrochemical (ARTIPHYCTION, PECDEMO)

ARTIPHYCTION	Aim	Status
η (%)	5	2 (for high durability) ✗
Durability (h)	> 1,000	+ 450 ✓

PECDEMO	Aim	Status
η (%)	8-10	2.1, trend for improvement ✗
Durability (h)	> 1,000	

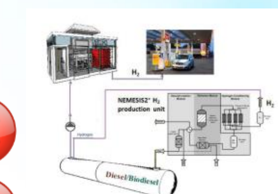


Programme Targets and Achievements

- Reformers (COMETHY, NEMESIS2+, BIOROBUR)

COMETHY	Aim	Status
η of SMR (%)	>70%	> 70% for >5,000 Nm^3/h ✔
Catalyst replacement (h)	< 4	< 2 ✔
Scalability (Nm3/h)	2-750	2 ✔

NEMESIS2+	Aim	Status
η of SMR (%)	>70%	< 70% ✘
H_2 production cost (€/kg)	< 4	5.8 ✘
Material Cost (€/Nm^3)	< 5,000	4,500 ✔

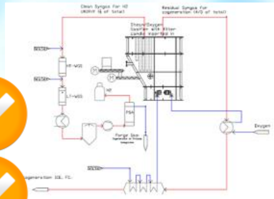


BIOROBUR	Aim	Status
Capacity (kg/day)	50-250	
Catalyst η (CO vol%)	< 10	
Biogas to H_2 (%)	> 65	

Programme Targets and Achievements

- ## Biomass gasification (UNIFHY)

	Aim	Status
Cost of H_2 (€/kg)	< 5	< 5 conditionally on Capex
η (%)	67	seems achievable
Scalability (kg/day)	> 500	50-500

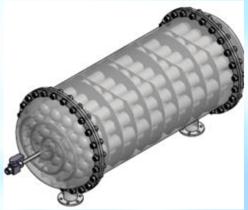

UNIfHY 1000 flowsheet

- ## Biological routes (HYTIME)

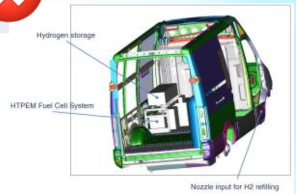
	Aim	Status
Mobilisation of sugars (%)	>75%	71 straw, 36 grass, 10 waste
Stable prod (kg/day)	1-10	225 L 0.1
Productivity (gH_2/L.h)	0.08	0.04

Programme Targets and Achievements

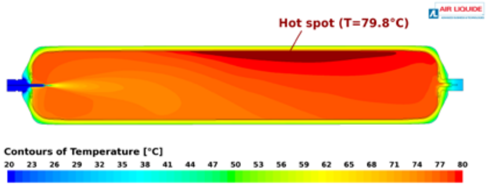
- H2 Storage (BOR4STORE, EDEN)



	Aim	Status
Capacity (kg/m³) / (wt%)	> 80 / > 8	100 / 9-10 (material basis)
Capacity with tank (wt%)	> 4	2
FC compatible (temp)	< 450	350-450
Cost (€/kg)	< 500	5,000

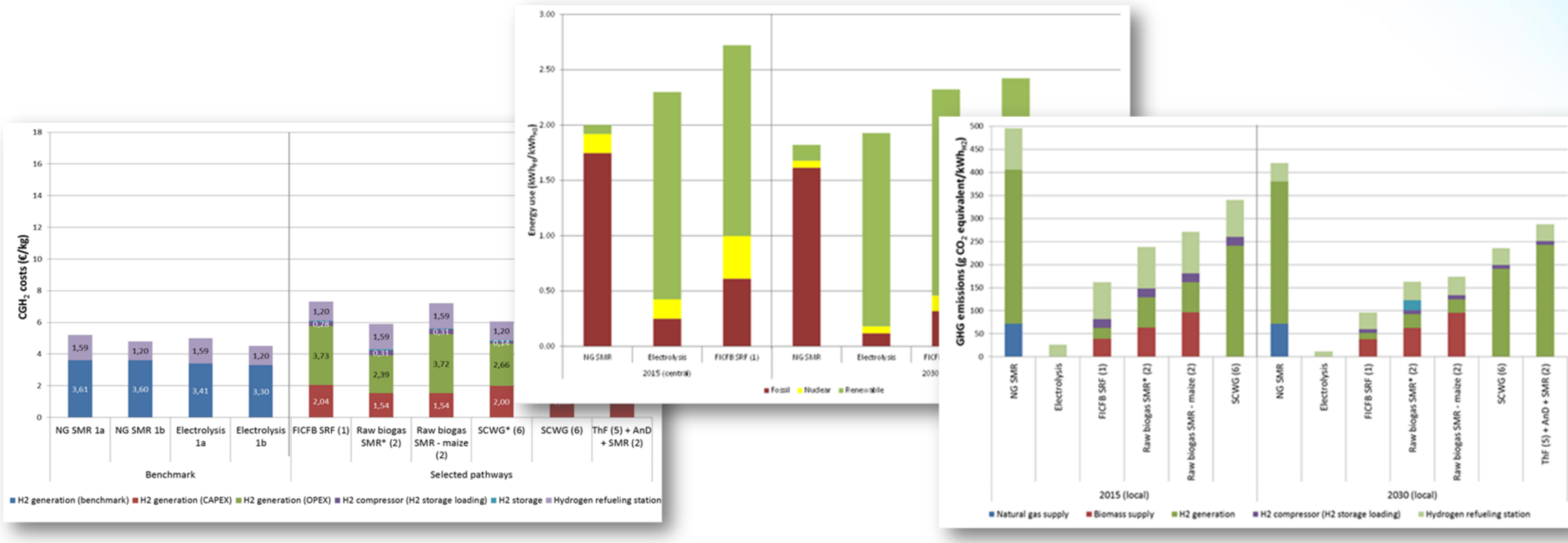


- H2 tanks refilling (HYTRANSFER)
    - Scope: optimise fast filling of CH tanks meeting material temperature limits, providing recommendations to RCS
    - CFD model developed, 3°C error
    - 65 filling/emptying on two types of tanks



Programme Targets and Achievements

- Green Hydrogen Pathways Study
  - Performed by LBST and Hinicio
  - Aim: to identify most promising green H_2 production pathways based on a number of key parameters
  - 11 pathways assessed, 6 selected
  - Soon available at http://www.fch.europa.eu/studies



Conclusions

- ✓ Comprehensive coverage of MAIP/MAWP objectives
- ✓ FCH JU supports a broad variety of pathways for H2 production, storage and distribution
- ✓ Electrolysers successfully diversifying to dynamic operation, high Pressures and Temperatures
- ✓ Potential of concentrated solar to be assessed in the field
- ✓ PEC reaching prototype level
- ✓ Reformers mature, aiming for increased versatility
- ✓ Bio-mass/logical routes in need of breakthroughs
- ✓ MH-based H_2 storage in need of identifying market niches

Thank you for your attention!