



European graphene alliance for sustainable multifunctional materials – a case study of a hydrogen storage tanks

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HYDROGEN TECHNOLOGY



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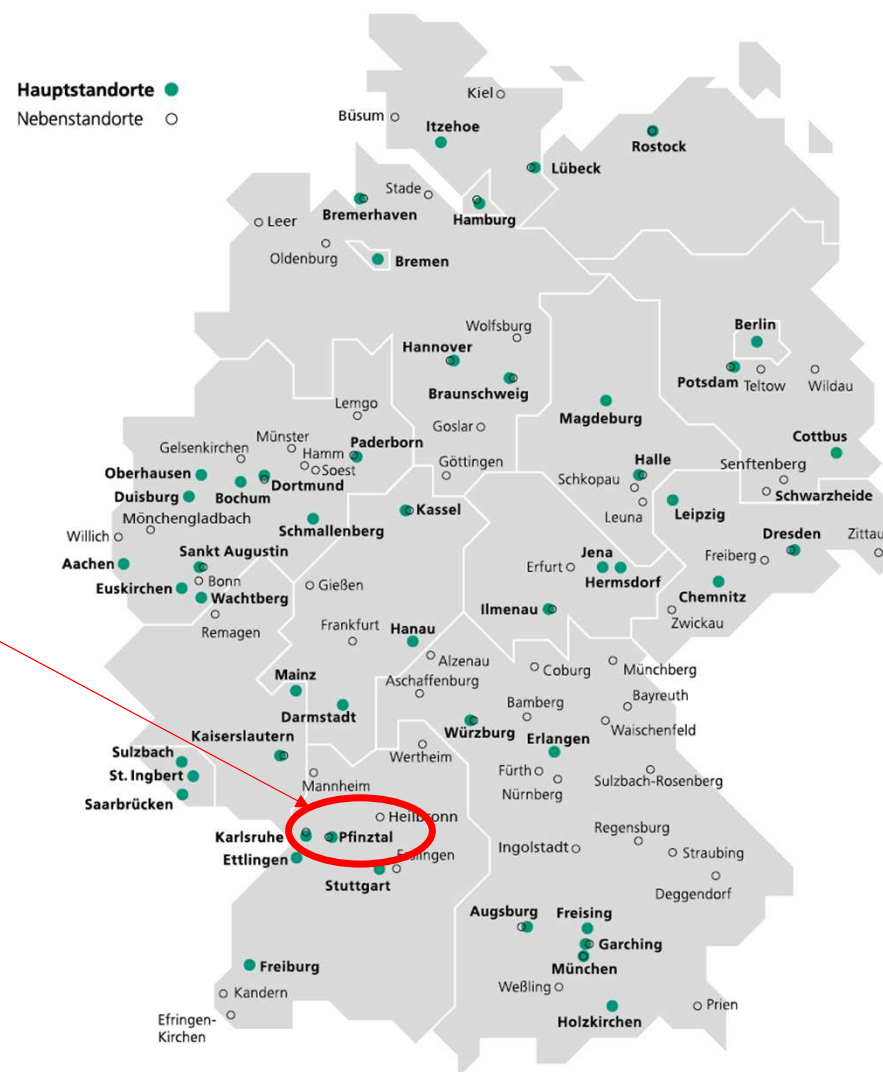


30,800 employees



76 institutes and research units

- ❖ Chemical processes
- ❖ Energy and drive systems
- ❖ Polymer engineering
- ❖ Explosives technology, safety and security





HYDROGEN TECHNOLOGY



— PATENTED RSH2 NANOPOLYMER · MADE IN AUSTRIA

The safest form of hydrogen storage.

HydroSolid stores hydrogen in solid form — at just 35 bar, without rare earths, reversible over 20,000 cycles. There is only one solution for a clean and sustainable future.

EXPLORE THE TECHNOLOGY —

35 bar	20,000 cycles	0 rare earths	500 kg H ₂
WORKING PRESSURE	REVERSIBLE LIFETIME	CRITICAL RAW MATERIALS	MAX. CAPACITY / UNIT



GRAPHENE
FLAGSHIP



- Project launched in 2013 by the European Commission
- Goal: to advance Europe's strategic autonomy in technologies that rely on graphene and other 2D materials
- 126 partners across 18 European countries
- 13 Research and Innovation Actions in 6 focus areas
- **EU-Brazil workshop at Graphene Week Sept 2026**



A GLIMPSE OF GIANCE

Graphene Alliance for Sustainable Multifunctional Materials to Tackle Environmental Challenges

11 Use Cases (UCs)

Duration: 3 years

Period: Oct 2023 – Dec 2026

23 partners / 10 countries

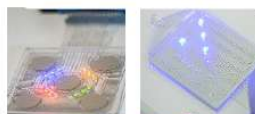
Total cost: 9.5 Mio Euro
(8 Mio Euro - EU Horizon contribution)



UC7 (H₂ storage)
Physical tank (Type 4)



UC8 (SHM)
Multiparametric Sensors



UC9 (Solid lubricant)



UC10 (H₂ generation)
MEA in PEM electrolysis Stacks

HYDROSOLID

UC11 (H₂ storage materials)
Adsorbent for physical Hive tank (Type 2)



UC1 (Aerodynamic shield)
Maserati Levante



UC2 (Spare wheel well)
Jeep Renegade



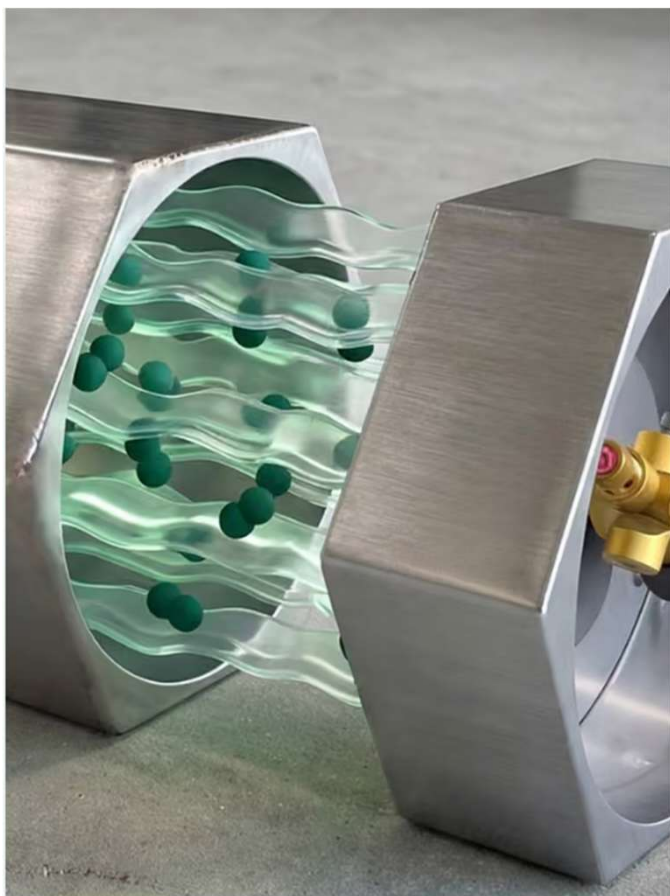
UC3 (Water desalination)
NF membrane/PDP system



UC4 (Oil/water separation)
UF membrane/PDP system

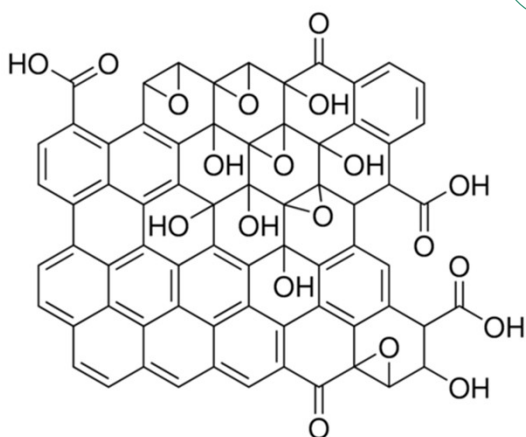


HYDROGEN STORAGE TANK



- ❖ Redesigned for physical and chemical storage with absorbent material foam inside of lower pressure tank.
 - expanded graphene oxide (GO) with metal alloys
- ❖ Stationary H₂ storage tank
- ❖ Higher volumetric H₂ density: ↑ storage volume (G: 110 g/L) vs (REF: 36 g/L) → Safer
- ❖ Less energy loss compared to Lower Heating Value (G: 5%) vs (REF: 20%) → Less additional electricity need for heat management

GRAPHINE OXIDE ADAPTATION



CRF

UC 1,2: GO water dispersion 8g/L

Composite

**LENN
IRIS**

UC3&4: Membrane: GO slurry (20mg/mL) & GO powder Catalyst: $\text{Fe}_3\text{O}_4/\text{GO}$, TiO_2/GO

Coating &
Composite

BOING

UC5: GO dispersion 4mg/mL

Composite

FAU

UC7: Functionalised GO

Composite

EUT

UC8: Dopped commercial ink + Reduced GO

Coating

HYD

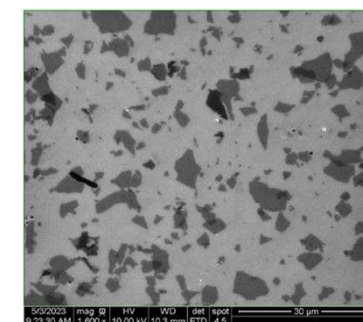
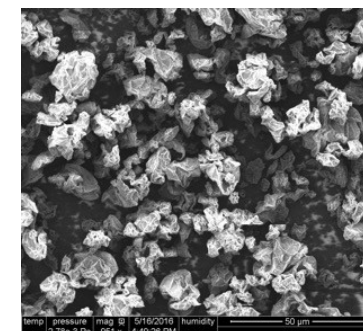
UC10: catalyst: Pt/GO. Support: Reduced GO

Foam

HYD

UC11: Additive. Expanded GO

Composite

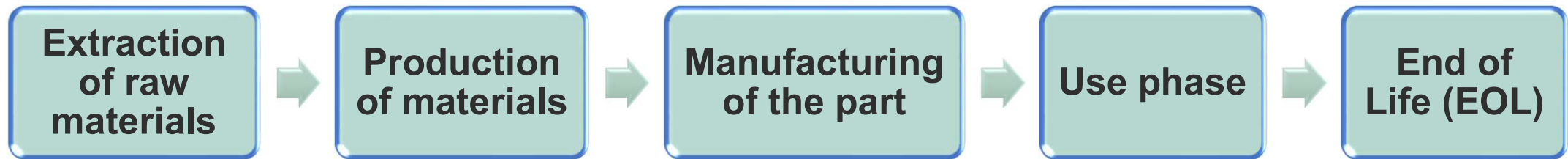


ENVIRONMENTAL ASSESSMENT

Life Cycle Assessment (LCA) of GIANCE energy storage tank in comparison with a reference tank

Main changes on material level	Functional unit (FU) & Amount of graphene	LCA values
Replacement of CFRP with HDPE-Liner by TiMn_2 with expanded GO	FU: 1 H_2 tank with 92 g/L storage capacity during 30 years 0.1145 g expanded GO with metal alloys / FU	• Higher volume of H_2 stored • Lower energy loss → Reduce raw material and electricity consumption (heat system) → Increase 5-years lifespan GIANCE's part; adjusted by lifetime factor: 1.2 (30 years G / 25 years REF)

SYSTEM BOUNDARY



LCA RESULTS – HOTSPOTS & SDG 13

TOTAL

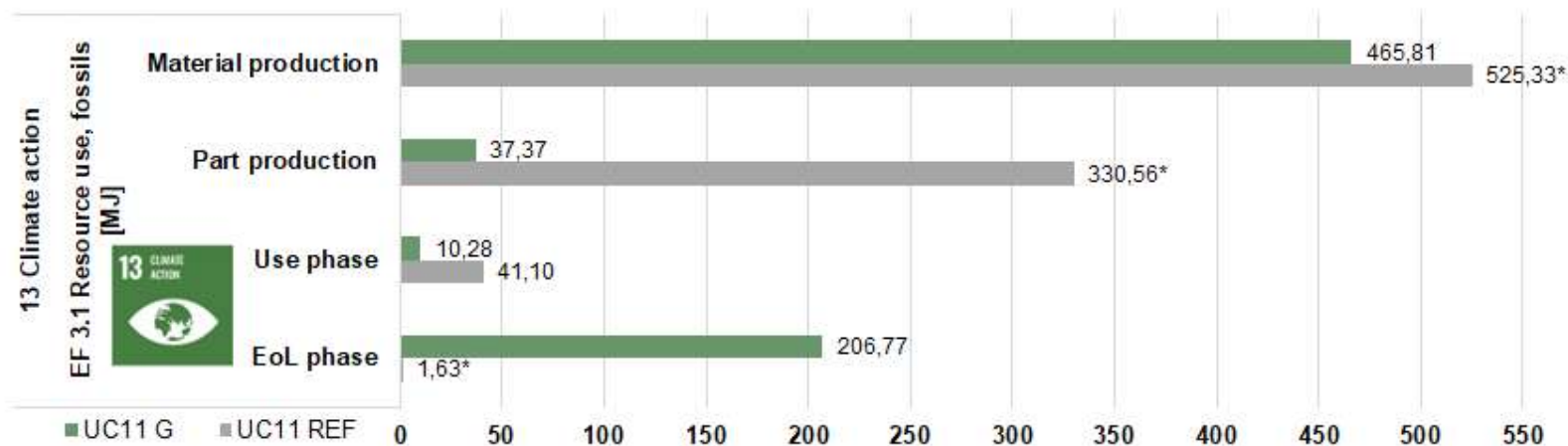
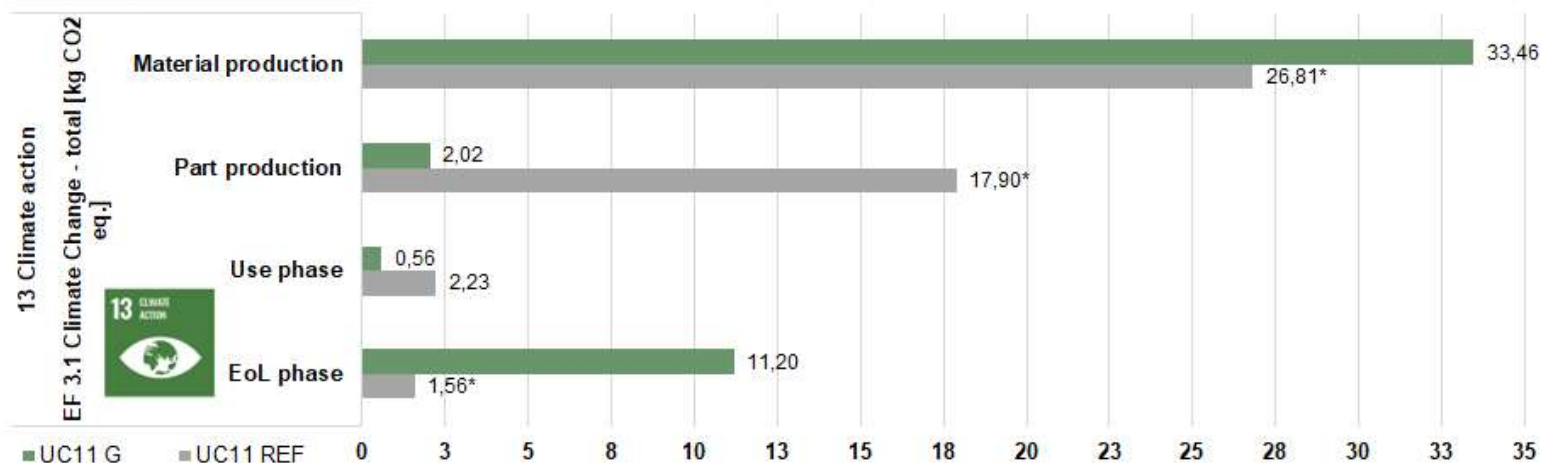
REF

GIANCE

49 kgCO₂e 48 kgCO₂e

899 MJ 720 MJ

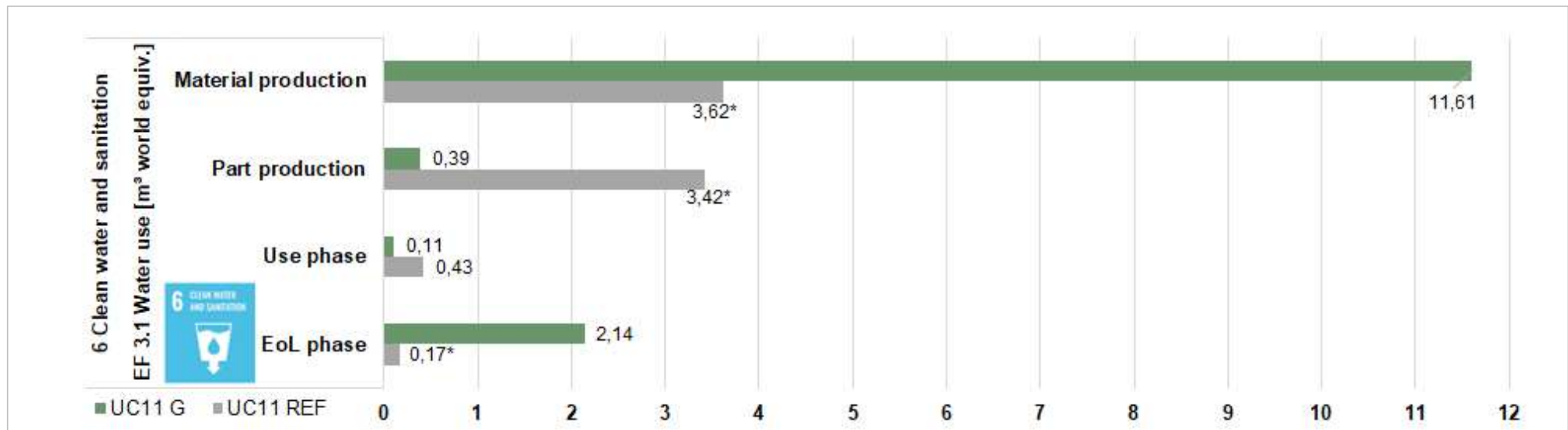
Graphene: 0,4% of total CO₂e emissions



Notes:

- i) Decimal separator is the comma
 - ii) Reference: TRL 9 / GIANCE: TRL 5
 - iii) SDG; Sustainable Development Goals
- * Adjusted using a lifetime factor

LCA RESULTS – HOTSPOTS & SDG 6



TOTAL	
REF	GIANCE
8 m³ world equiv.	14 m³ world equiv.

Notes:

- i) Decimal separator is the comma
 - ii) Reference: TRL 9 / GIANCE: TRL 5
 - iii) SDG; Sustainable Development Goals
- * Adjusted using a lifetime factor

CONCLUSIONS

- **Production & use:** Changes in material composition **show a positive trend**, reducing impacts during part production and use phases.
- **Material production: TiMn_2 + GO** has a **negligible contribution to overall environmental impact** while enhancing system functionality. However overall impact increases, mainly driven by the **Ti alloy**.
- **Extended lifetime and EOL:** Extended service life and restoration pathway reduce raw material extraction, material production and manufacturing impacts, but **does not fully offset higher EOL impacts** compared with the reference tank (no credits given for recycled metal materials). Further investigation on circularity of the materials could improve the results.
- **Future optimization:** Large-scale production offers opportunities to optimize the **TiMn_2 -based adsorbent/GO production route** and investigation of alternative metal materials.

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Sept 2026



PARTNER WITH US

The partnering mechanism within the Graphene Flagship allows the initiative to add new knowledge, competencies, ideas and resources throughout the project.

Benefits:

- Networking within the 2DM community
- Collaboration opportunities
- Increased visibility

Association opportunities for:

- Companies
- Academic institutions
- European research projects and associations



Learn more here!



Funded by
the European Union

Thanks for listening!



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Sustainability and Circularity Assessment

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