



# Enhancing Electrolyzer Durability Through a Multiscale Strategy: The ELECTROLIFE Approach

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**Webinar: Advancing Online Diagnostics and Building Durable Electrolysis Systems for Europe's Hydrogen Future**



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# Outline



- **About ELECTROLIFE**
- **Objectives and Concept**
- **Partners**
- **Approach**
- **Results**



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# ELECTROLIFE

- Electrolife: Enhance knowledge on comprehensive electrolyser technology degradation through modelling, testing, and lifetime prediction, toward industrial implementation.
- ELECTROLIFE aims to advance the understanding of electrolyzer degradation mechanisms and improve cell performance to boost efficiency, reduce critical material use, and extend system lifetime.
- How?
  - Through a combination of experimental testing, multiphysics modelling, and prototyping, the project supports the industrial implementation of durable, scalable, and recyclable green hydrogen technologies.
- Ultimately, ELECTROLIFE seeks to accelerate the decarbonization of European industry by overcoming current limitations in electrolysis technologies.



Objectives



Concept



Approach



Structure



Facts and figures



Results

Acronym: ELECTROLIFE

Duration: 60 months

Start date: 01 January 2024

End date: 31 December 2028



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# Approach

The ELECTROLIFE concept and architecture is unique because focus its research activities on all the 5 today classified electrolysis technologies, in order to approach with the same structured methodology all the paths to understanding and modeling the degradation mechanisms of different electrochemical systems, to develop and assess improved electrochemical cells and stacks (especially under dynamic use and operational stress) and to validate technologies and diagnostic tools (SoH).

## Keystones

The ELECTROLIFE concept consist of 8 keystones (KS):

- KS1: Identification and comprehension of degradation phenomena that affect the 5 (AEL, AEMEL, PEMEL, SOEL, and PCCEL) technologies involved
- KS2: Development of degradation and lifetime prediction models
- KS3: Development of testing procedures for degradation assessment
- KS4: Development of ad-hoc testing and diagnostic tools
- KS5: Technologies development and optimization
- KS6: Execution of test campaigns on the 5 electrolysis technologies
- KS7: Validation of the degradation models and diagnostic tools
- KS8: Guidelines for next generation robust stacks, diagnostic tools and optimized strategies of operation, for electrolyser lifetime extension

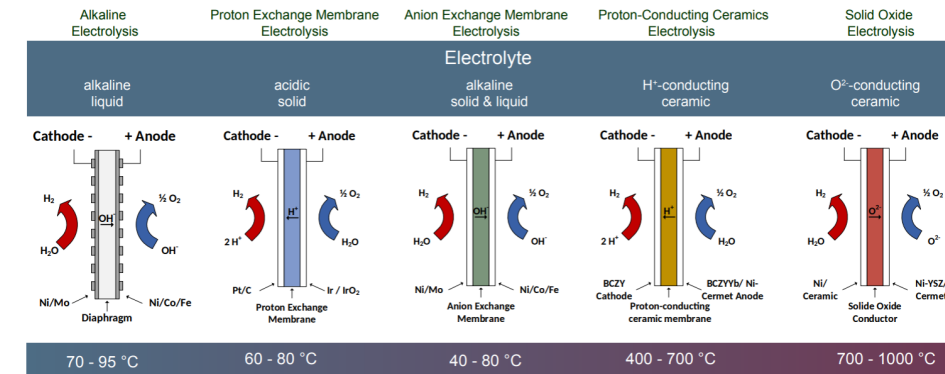


Figure. Overview of the five electrolysis technologies studied in ELECTROLIFE



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# ELECTROLIFE in figures



## ELECTROLIFE in figures

**40% progress**

of the total project.

ELECTROLIFE started at January 2024  
and will run for 60 months.

**9.995.705,00 €**

funding from the European Commission  
in Horizon Europe program.

**17 partners**

from 9 different countries.

<https://electrolife-project.eu/>  
<https://cordis.europa.eu/project/id/101137802>



Duration: 60 months

Start date: 01 January 2024

End date: 31 December 2028

Total budget: €9.995.705,00



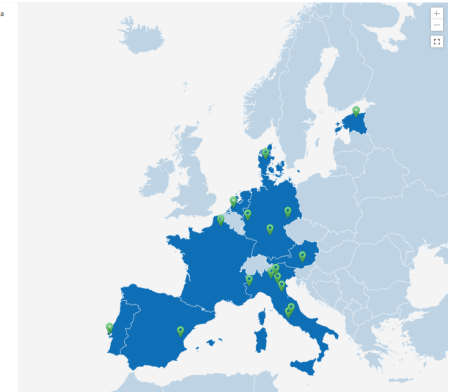
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# ELECTROLIFE Partners



1S1 Energy Portugal Unipessoal Lda  
Aalborg University  
Consiglio Nazionale Delle Ricerche  
Enel Green Power SpA  
Forschungszentrum Jülich gmbh  
Friedrich-Alexander-Universität  
Erlangen-Nürnberg  
Graz University of Technology  
Hyter s.r.l.  
Kerionics S.L.  
Loccioni  
Pietro Fiorentini SPA  
Polito Di Torino  
Solydera SpA  
Stargate Hydrogen Solutions OU  
Uniresearch  
University of Lille  
Volytica Diagnostics gmbh



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# General assemblies and partners



Third General Assembly (#GA03) of  
ELECTROLIFE in Erlangen, Germany



Second General Assembly (#GA02) of  
ELECTROLIFE in Ancona, Italy



Four General Assembly (#GA04) of  
ELECTROLIFE in Tallin, Estonia



Kick-off meeting (#GA01) of  
ELECTROLIFE in Torino, Italy

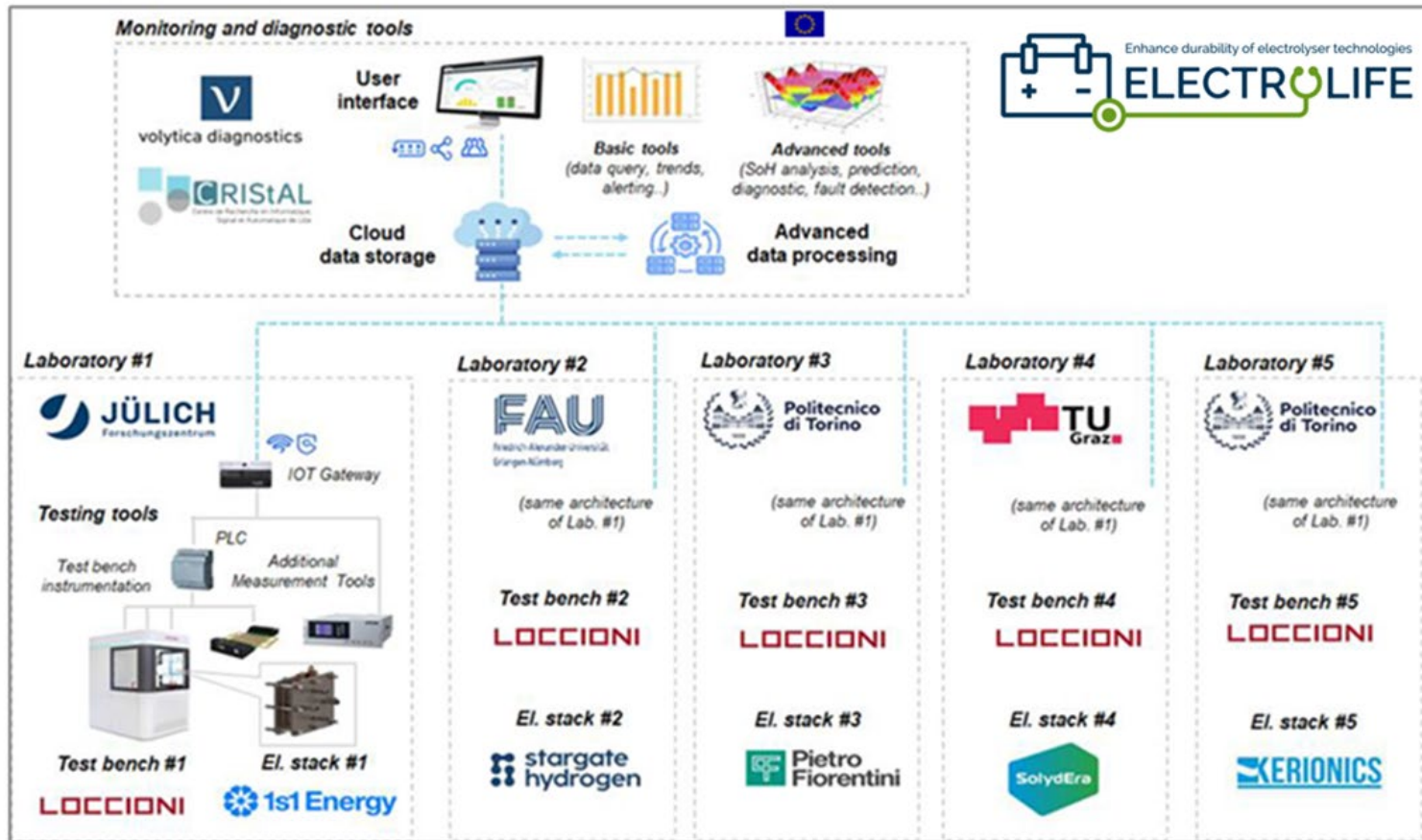
**Typical meetings: big crowd,  
bigger ideas**



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# Overall Approach and Key Activities



## Key Activities

### Testing of all Electrolyzer Types

- Testing of AEL, AEMEL, PEMEL, SOEL, and PCCEL at the stack level (**TRL 5**).

### Durability Testing:

- Conducting durability tests for 10,000 hours.
- Applying RES profiles to assess durability.

### Degradation Modeling:

- Developing and validating degradation models at both single-cell and stack levels.

### Economic Evaluation:

- Evaluating the Levelized Cost of Hydrogen (LCOH) for specific scenarios.



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# Results: Degradation factors, degradation mechanisms and degradation effects

HORIZON EUROPE PROGRAMME  
TOPIC HORIZON-JTI-CLEANH2-2023-1  
GA No. 101137802


## ELECTROLIFE

Enhance knowledge on comprehensive electrolyser technologies  
degradation through modeling, testing and lifetime prevision,  
toward industrial implementation



### Deliverable report

#### D2.1 – Degradation phenomena compendium

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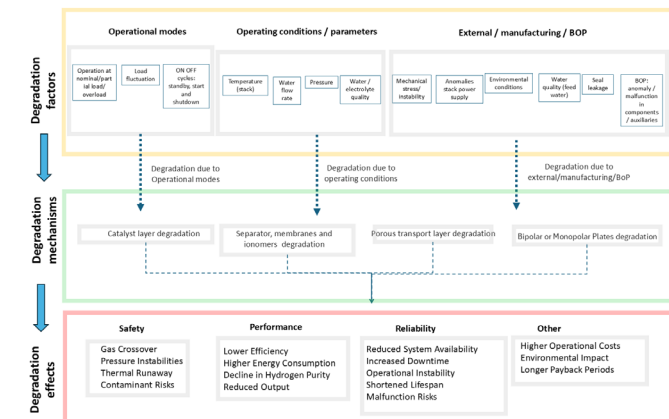
GA No. 101137802

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D2.1 – < Degradation phenomena compendium > (PU)

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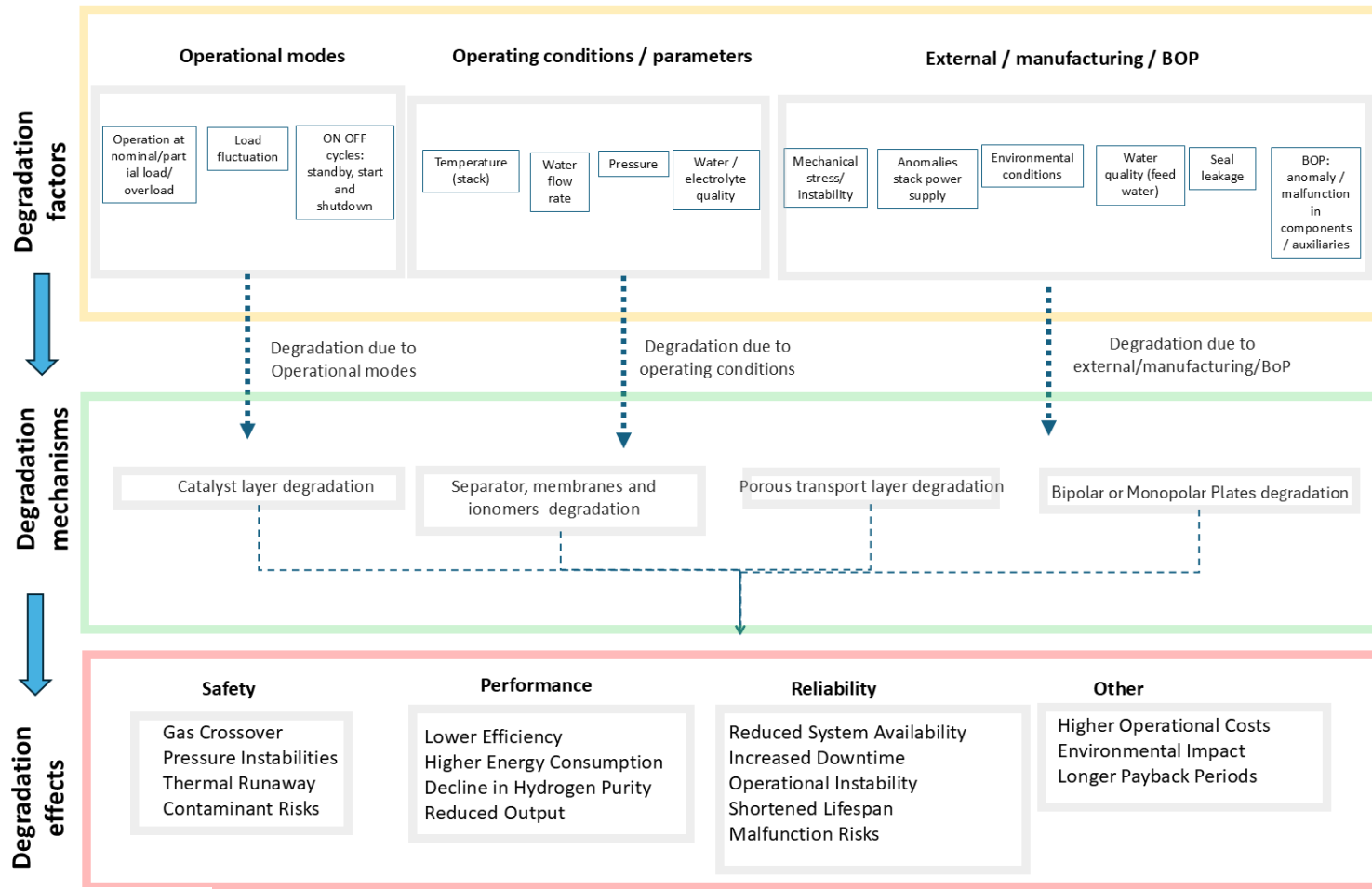
[https://electrolife-project.eu/wp-content/uploads/sites/24/2025/02/ELECTROLIFE\\_D2.1-Degradation-phenomena-compendium\\_PUB\\_final.pdf](https://electrolife-project.eu/wp-content/uploads/sites/24/2025/02/ELECTROLIFE_D2.1-Degradation-phenomena-compendium_PUB_final.pdf)



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# Results: Degradation factors, degradation mechanisms and degradation effects



Electrolyser operational modes and various degradation factors (e.g., operating conditions, manufacturing, BoP) trigger specific degradation mechanisms—chemical or physical—based on their frequency and intensity. These mechanisms lead to performance loss, safety issues, and reduced reliability.

Figure illustrates the degradation process in three layers:

**Top (yellow):** Main degradation factors, including operational, environmental, and manufacturing-related stressors.

**Middle (green):** Resulting degradation mechanisms affecting key components (e.g., membranes, catalysts, BPPs).

**Bottom (red):** Effects on system-level performance, safety, and economic viability.

The figure highlights how factors lead to mechanisms, which in turn cause measurable degradation effects.

[https://electrolife-project.eu/wp-content/uploads/sites/24/2025/02/ELECTROLIFE\\_D2.1-Degradation-phenomena-compendium\\_PUB\\_final.pdf](https://electrolife-project.eu/wp-content/uploads/sites/24/2025/02/ELECTROLIFE_D2.1-Degradation-phenomena-compendium_PUB_final.pdf)

## Results: Harmonised protocols for LTEL



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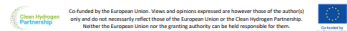
## ELECTROLIFE

Enhance knowledge on comprehensive electrolyzers technologies degradation through modeling, testing and lifetime prevision, toward industrial implementation



- Deliverable report

#### D4.1 – Specification, terminology and Harmonised protocols for LTEL



**Reviewed by JRC** 

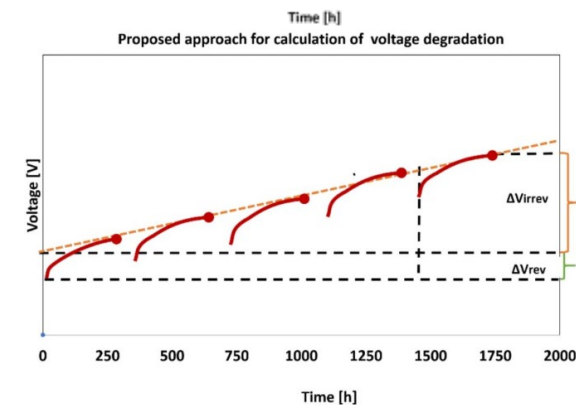
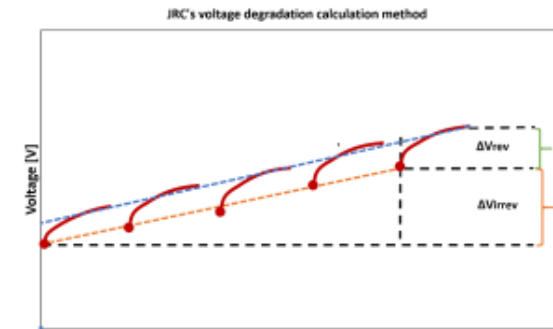
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D<4.1> – < Specification, terminology and Harmonised protocols for LTEL > (PU)

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<https://electrolife-project.eu/deliverable-4-1/>



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# Results: Specifications of the testing tools



Test bench Provider	LOCCIONI	LOCCIONI	LOCCIONI	LOCCIONI	LOCCIONI
Laboratory	JÜLICH Forschungszentrum	FAU	Politecnico di Torino	TU Graz	Politecnico di Torino
Stack manufacturer	1s1 Energy	stargate hydrogen	Pietro Fiorentini	SolydEra	KERIONICS
	PEM	AEL	AEMEL	SOEL	PCCEL

Figure 1. ELECTROLIFE partners directly involved in stack testing



## Detail engineering of stacks and test bench:

Specifications and requirements of the stacks to be tested were discussed between three actors (Test bench Provider, Laboratories and stack manufacturer):

- Test Bench provider (Loccioni)
- Stack manufacturers (1s1, Stargate, PF/Hyter, Solydera, Kerionics)
- RTOs owners of labs (Polito, FAU, GRAZ, Julich)
  - PEMEL, AEL, AEMEL, SOEL and PCCEL
  - Stack specifications, requirements for stack manufacturers; Requirements For Laboratories and Rtos; Specifications of Testing Tools.

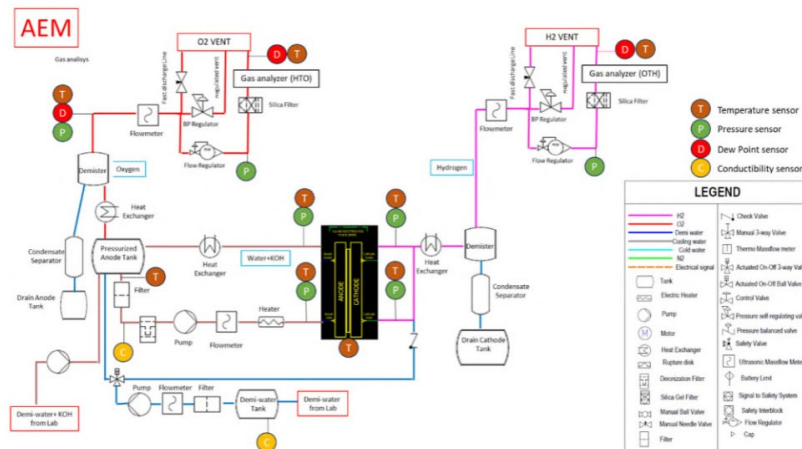


Figure 10: Process Flow Diagram of AEMEL test bench



## Test bench design & construction (\*indicative):

- Example of PI&D for AEMEL

[a] EU harmonised protocols for testing of low temperature water electrolysis. <https://op.europa.eu/en/publication-detail/-/publication/bbbeba00-ee82-11eb-a71c-01aa75ed71a1>



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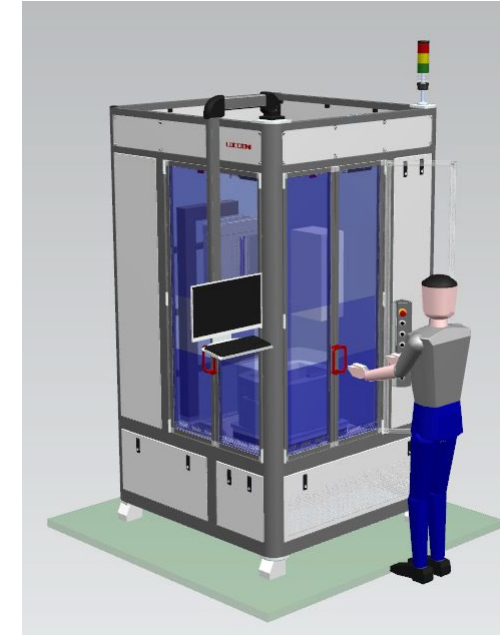




# Results: Test benches manufacturing



*Frame of first two test benches (AEM, AEL) assembled*



**LOCCIONI**

\*Courtesy image: Loccioni



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# Thanks for the Attention




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