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SUSTAINABLE PLACES 2024

Hydrogen Synergy: Bridging the Entire Hydrogen Value Chain

Clean Hydrogen Partnership

Co-funded by the European Union

This project is supported by the Clean Hydrogen Partnership and its members.

Hydrogen

- Will play a critical role in decarbonising industry and transport
- May place a crucial role in energy networks, for long-term seasonal storage

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Industry

- Many industrial processes will decarbonise via direct electrification
- For example, some process heat can be supplied via industrial heat pumps

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Industry

- Some existing industries must *transition* to hydrogen, e.g. steelmaking
- Some new industries *require* hydrogen as a key input material, e.g. sustainable aviation fuel

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Transport

- Also direct electrification is suitable for most applications
- Some long-distance transport and air transport will require hydrogen

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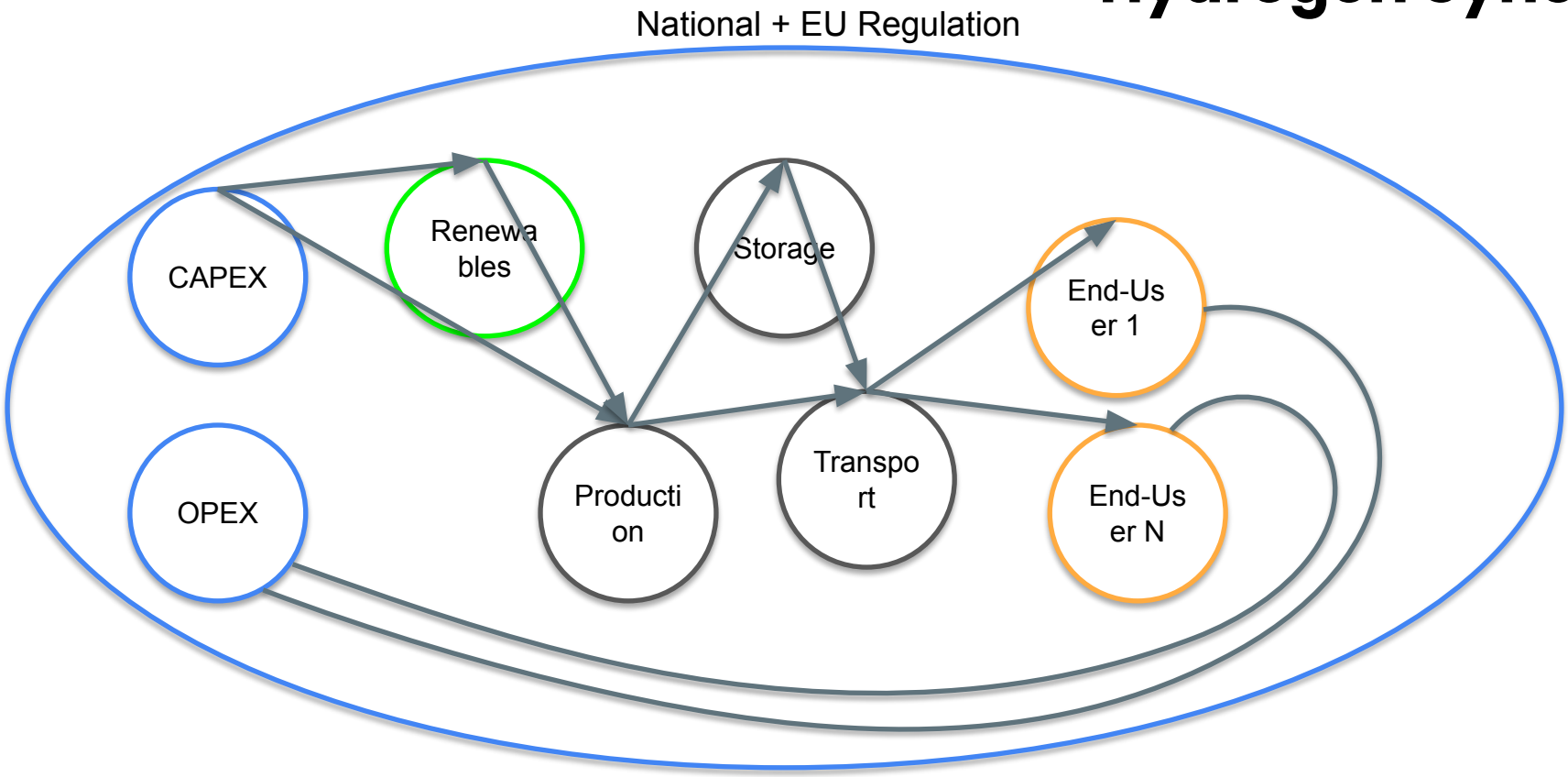
Hydrogen Synergy

- Chicken-and-egg situation means that the very significant investments for production and use of hydrogen, usually must proceed simultaneously

Hydrogen Synergy



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Hydrogen Synergy

- In the following presentations you will hear from different sections of the value chain
- Synergy in moving forward together is crucial

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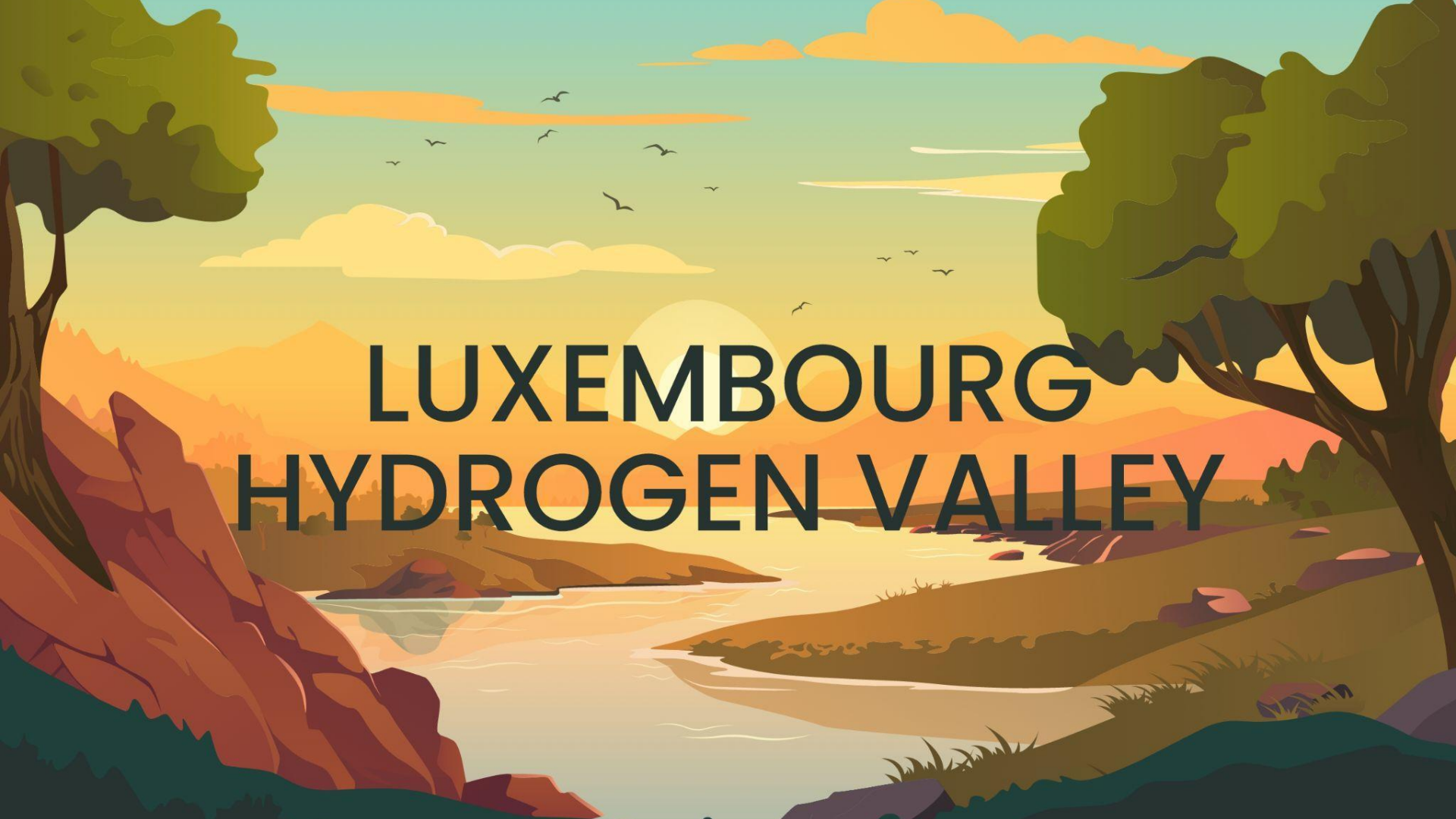
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The Energy Behind Green Hydrogen: Securing Sustainable Power for a Greener Future

enovos

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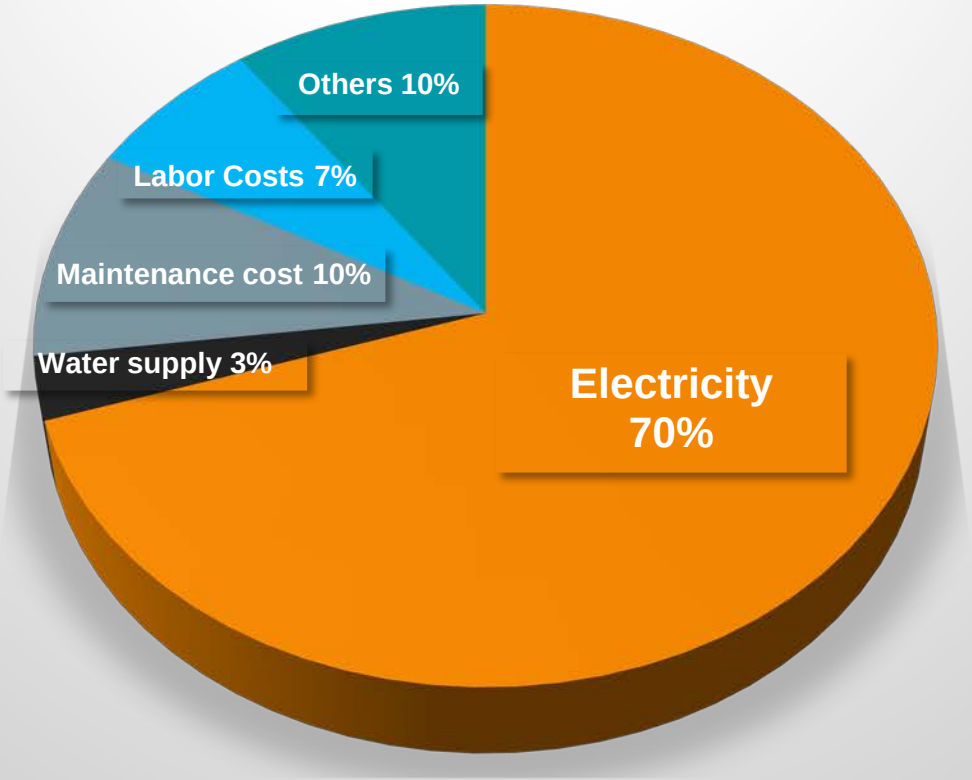
Operating costs of an electrolyser



Enovos Luxembourg

Leading & sustainable energy player

- 38 WTG in 10 windparks
- Installed Capacity : 152 MW
- Exp. Production: 321 GWh/y

- 29 Photovoltaic Installations
- Installed Capacity: 43 MW
- In Construction: 17 MW (2024/2025)
- Exp. Production: 44 GWh/y

- 7 Hydro Assets
- Installed Capacity : 32 MW
- Exp. Production: 60 GWh/y

Total Capacity : 227 MW
Exp. Production : 420 GWh/y

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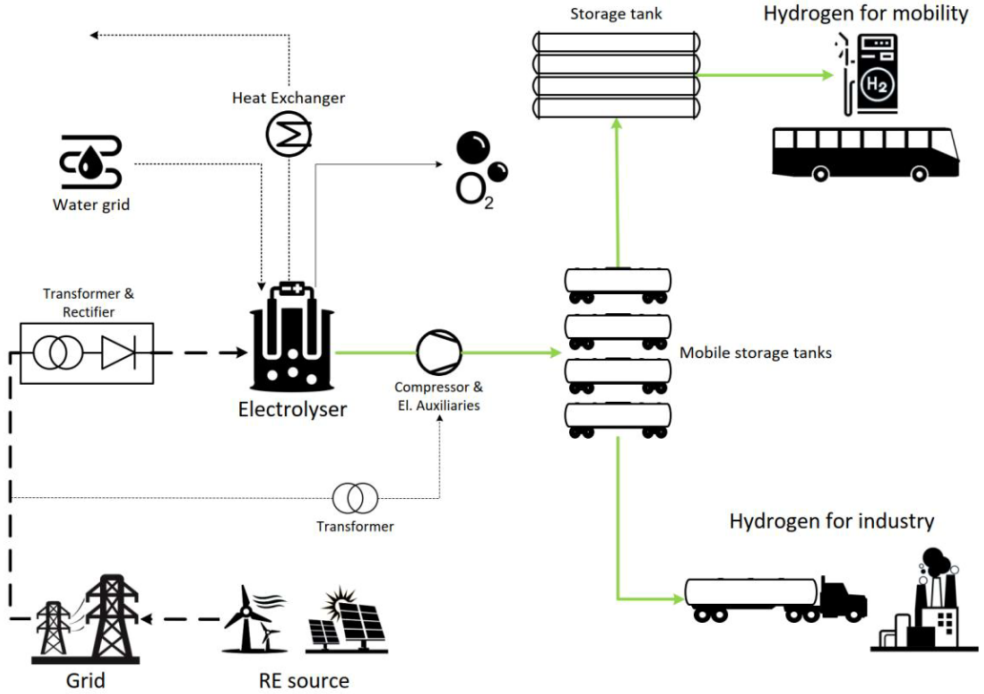


Renewable Energy Sources:

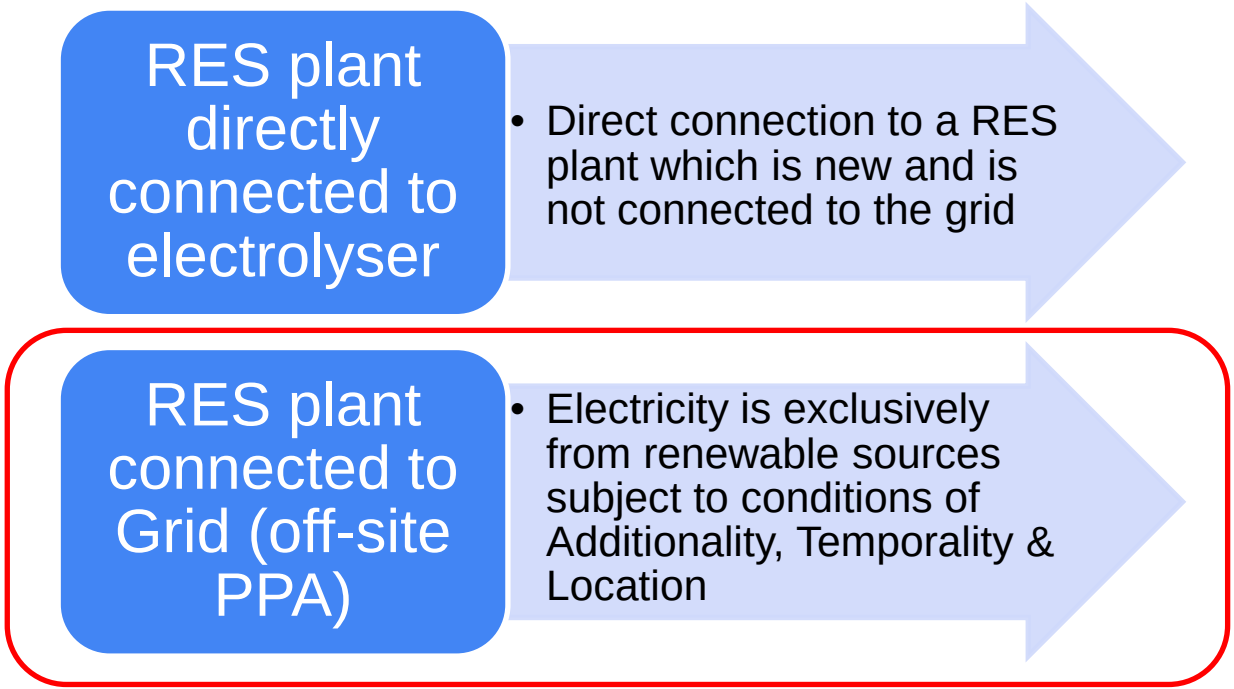
- Wind power
- Solar power
- Hydroelectric power

Yearly Hydrogen Production:

650 t require **36 GWh** of electricity

→ Equivalent of **9 000** households

Sourcing of Green electricity for Hydrogen production

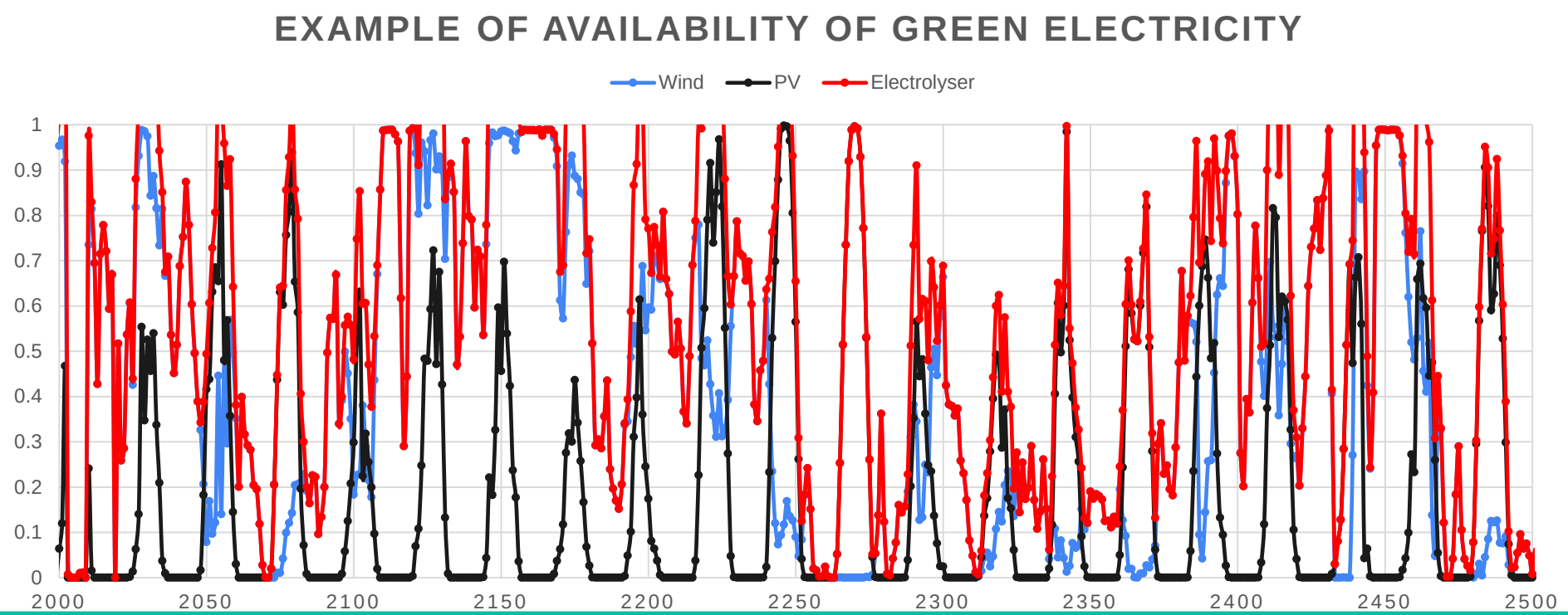


Key principles to produce green hydrogen

- **Additionality**:
  - Renewable energy used must come from **newly added** capacity, not existing sources. (applicable for electrolysers that come into operation after 2028)
  - Ensures that hydrogen production does not cannibalize the renewable grid.
- **Time Correlation**:
  - Renewable electricity must be generated at the **same time** as hydrogen production. (hourly correlation after transition period until 2030)
- **Geographical Proximity**:
  - The renewable energy must be sourced **near** the hydrogen production site. (Same bidding zone)
  - This reduces transmission losses and maintains the sustainability of the process

According to RFNBO (Renewable Fuels of Non-Biological Origin) and RED II (Renewable Energy Directive II)

Challenges and Impact on Electrolyser Operation



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Challenges and Impact on Electrolyser Operation

- **Intermittency of Renewable Energy:** Wind and solar energy are variable, which can disrupt constant hydrogen production.
  - → Requirement for good forecasting to optimize production
  - → Requirement for hydrogen storage to compensate fluctuations

- **Technical Complexity:** Electrolysers must adapt to the variable production profile of renewable energies, requiring advanced control systems to manage fluctuations in power supply while maintaining efficiency
  - → PEM Electrolysers: Suited for intermittent renewable energy (solar, wind) due to fast response times and flexibility, efficiently scaling with fluctuating supply for optimal hydrogen production.

Conclusion

- **Sustainable Electricity Procurement is Essential:** Green hydrogen production hinges on sourcing renewable electricity that meets strict criteria, such as additionality, time correlation, and geographical proximity.
- **Technology and Operations Must Align with Renewables:** Efficient hydrogen production requires adaptable technologies, like PEM electrolysers, which can handle the variability of renewable energy sources.Green
- **Hydrogen is Critical for Decarbonization:** The successful integration of renewable electricity with hydrogen production is essential to meeting Europe's climate goals and advancing the global energy transition.

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Sustainable Communities with Local Energy Production and Storage

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GPSS S.A.

Founded in 2021

Challenge:

Generating green energy locally and making it usable

Innovative solutions:

Agri-PV – Generate green electricity locally

Green Hydrogen – storing green energy and making it usable

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What is Agri-PV?

This is **not** Agri-PV!

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What is Agri-PV?

This is Agri-PV!

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Agri-PV is creating a sustainable and local Energy Source

How to reach sustainability with Agri-PV?

- Integration in local communities
  - Farmers: Concepts suitable for existing and useful farming
  - Residents: Information and participation
- Integration of measures to promote biodiversity

1. Agri-PV plant in Luxembourg, build by GPSS

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The two main Challanges for sustainable green Hydrogen Production

1. **Get it really green!**

- Make sure that 100 % of the used energy is renewable. Transforming fossils to energy to hydrogen is not sustaibale

2. **Get it really affordable!**

- If green hydrogen is to expensive there is no incentive to use it or produce it. Heavy subsidization is needed on both sites which is not sustainable

One Solution for two challanges

Local and directly to RES coupled hydrogen production and usage

- Direct connection ensures that hydrogen is only produced when green electricity is available -> 100% green hydrogen guaranteed
- The two main cost drivers are avoided, which are

- Grid charges due to the usage of the public electricity grid
- Energy and infrastructure for compression and transportation

GPSS S.A.

Green Power Storage Solutions S.A.

1, Haaptstrooss
L-6869 Wecker
Luxembourg

www.gpss.lu

Thank you for your attention.

If you have any further questions, please do not hesitate to contact us:

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Designing Luxhyval Digital Twin

Jean-Sébastien Sottet
Pierre Brimont

Clean Hydrogen Partnership

Co-funded by the European Union

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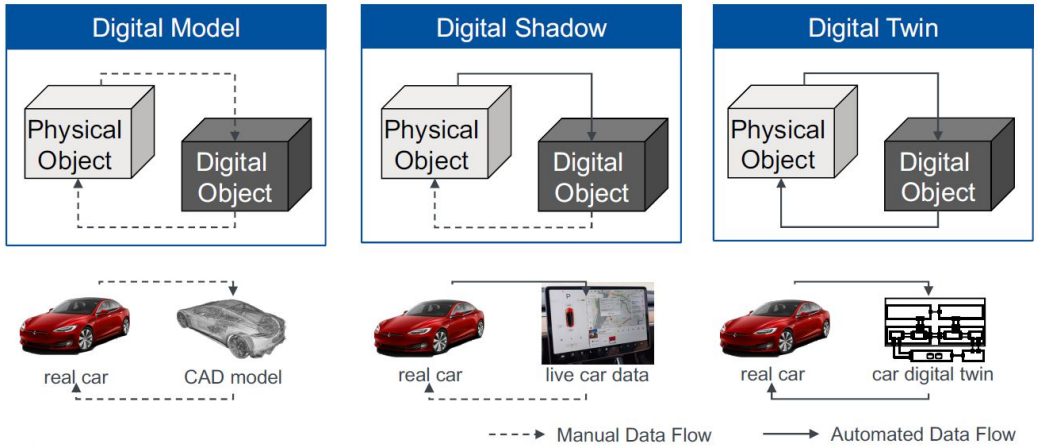
What is a Digital Twin ?

A Characterization based on Data Flows[2]

Data flows between physical and digital object(s) define what kind of system it is



[2] Kritzinger, W., Karner, M., Traar, G., Henjes, J., & Sihn, W: Digital Twin in manufacturing: A categorical literature review and classification. IFAC-PapersOnLine, 2018.

Usual features

- Real time monitoring
- Simulation, prediction
- Resilience, improvement

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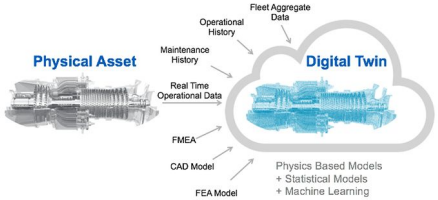
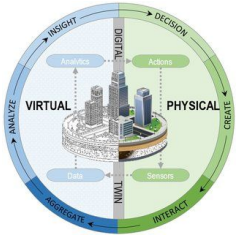
Closed or Open world ?



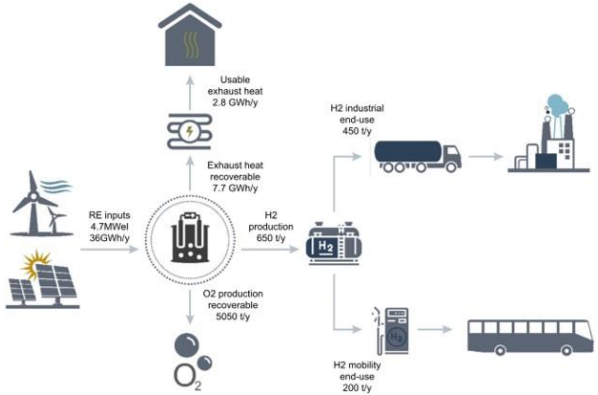
- Business expertise identified
- Design models available
- System clearly defined
- Human intervention managed



- Multiple domains : energy, climate, transports,…
- Incomplete design : models discovered during operation
- Evolutive scope : physical system not exhaustively defined
- Human in the loop : operators, policy makers, citizens,…

At first sight

- Hydrogen production is central
- Technical schemas are available
- Scope is under control
- No citizen uncontrolled behavior



Looking closer

- Green energy, climate, transports
- Innovative = incomplete knowledge
- Plant is not the only asset
- Business staff is still human

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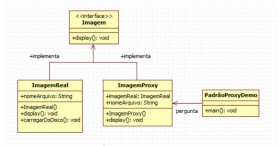
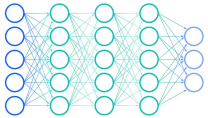
Model Driven : an inclusive approach

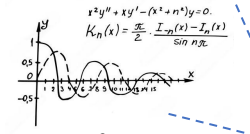


Blueprint



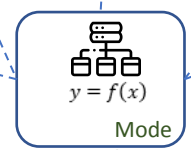
Machine Learning

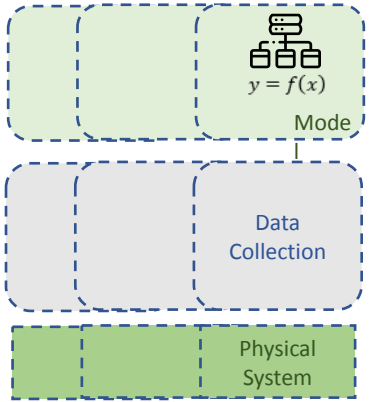
Human

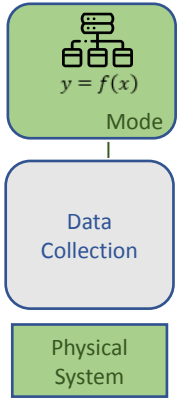


Scientific

Rules







Tests ✓
Simulation ✓
Prediction ✓

time

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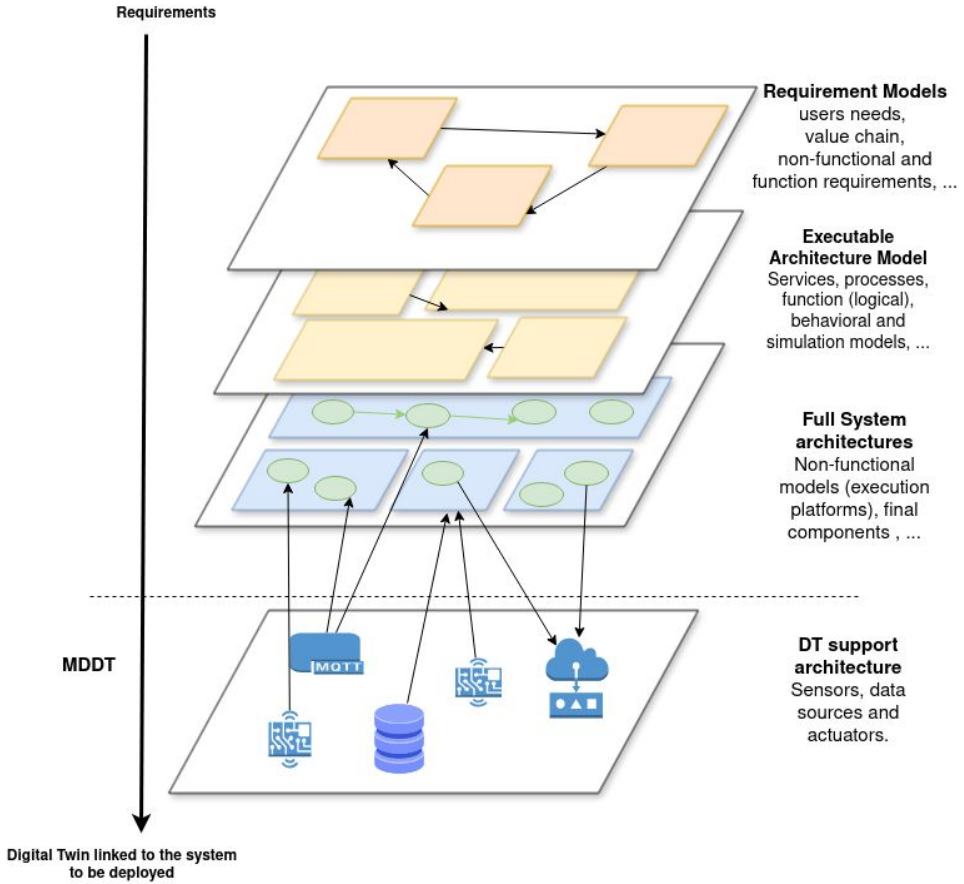
Model Driven Architecture



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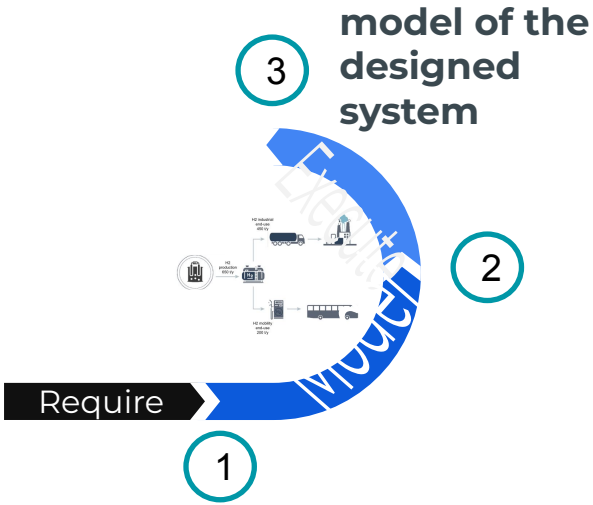
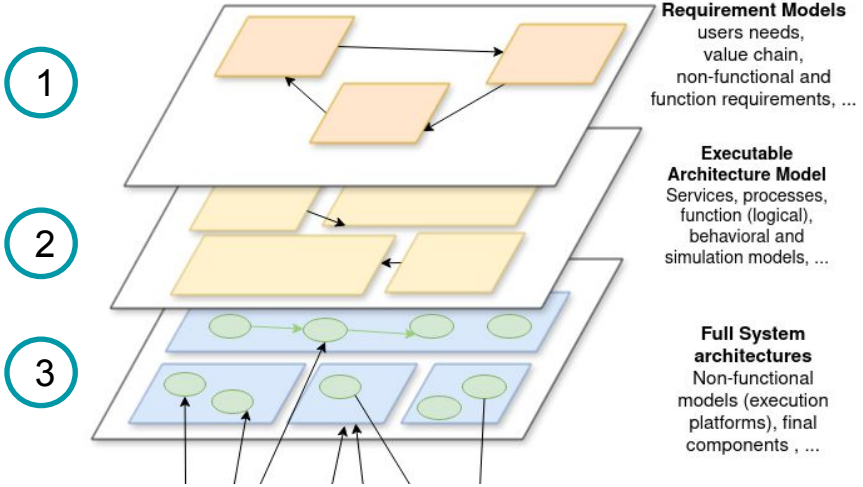
Model Driven solution in practice





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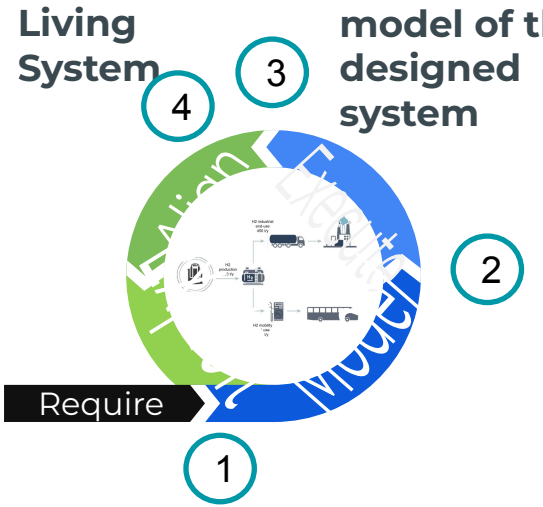
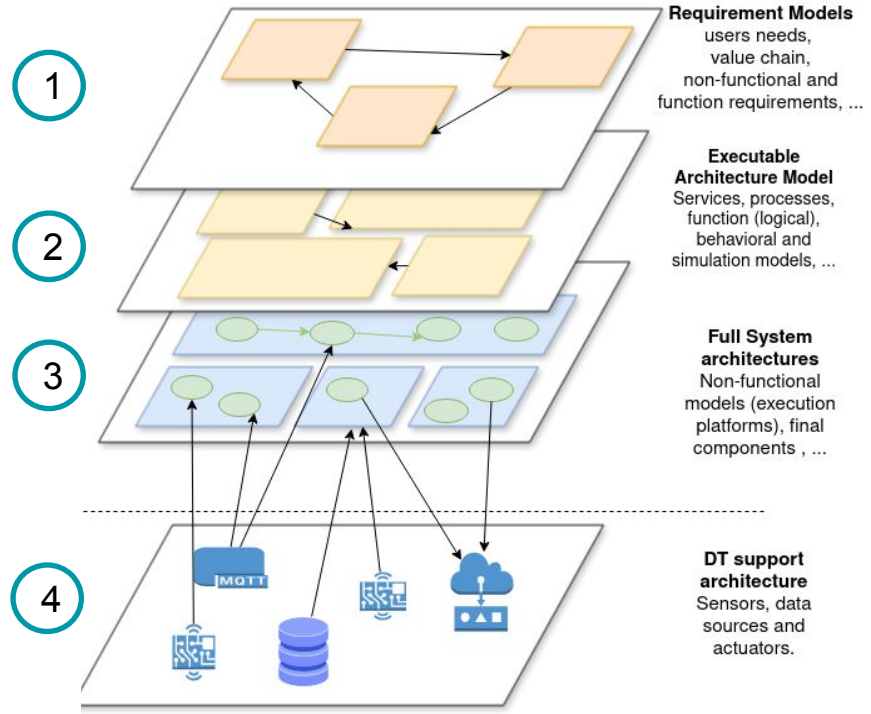
Model Driven solution in practice





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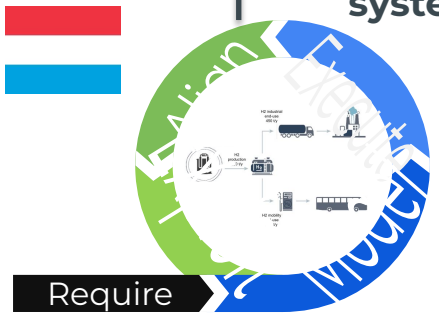
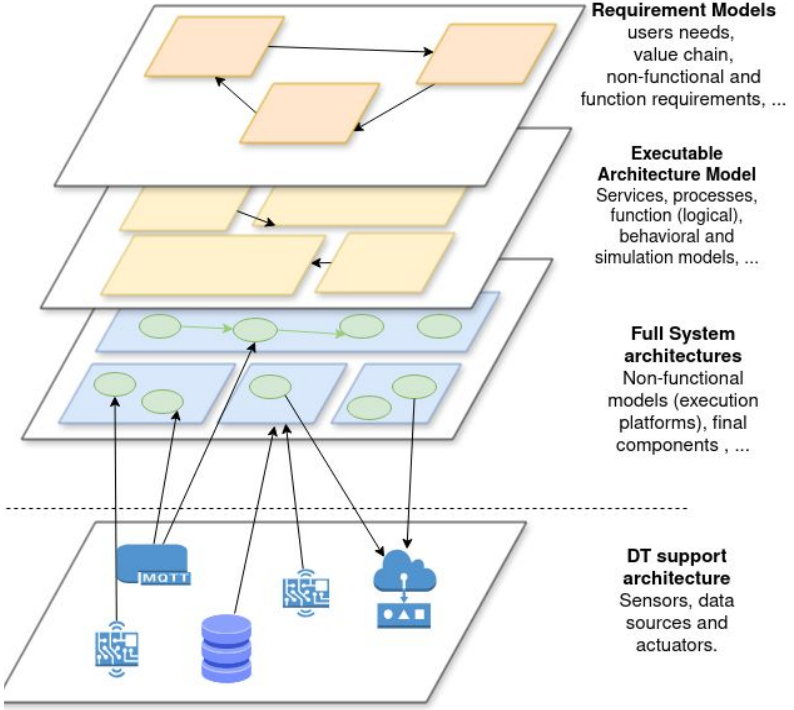
Model Driven solution in practice

Living System | **model of the designed system**



Reuse and adapt the solution
to different contexts



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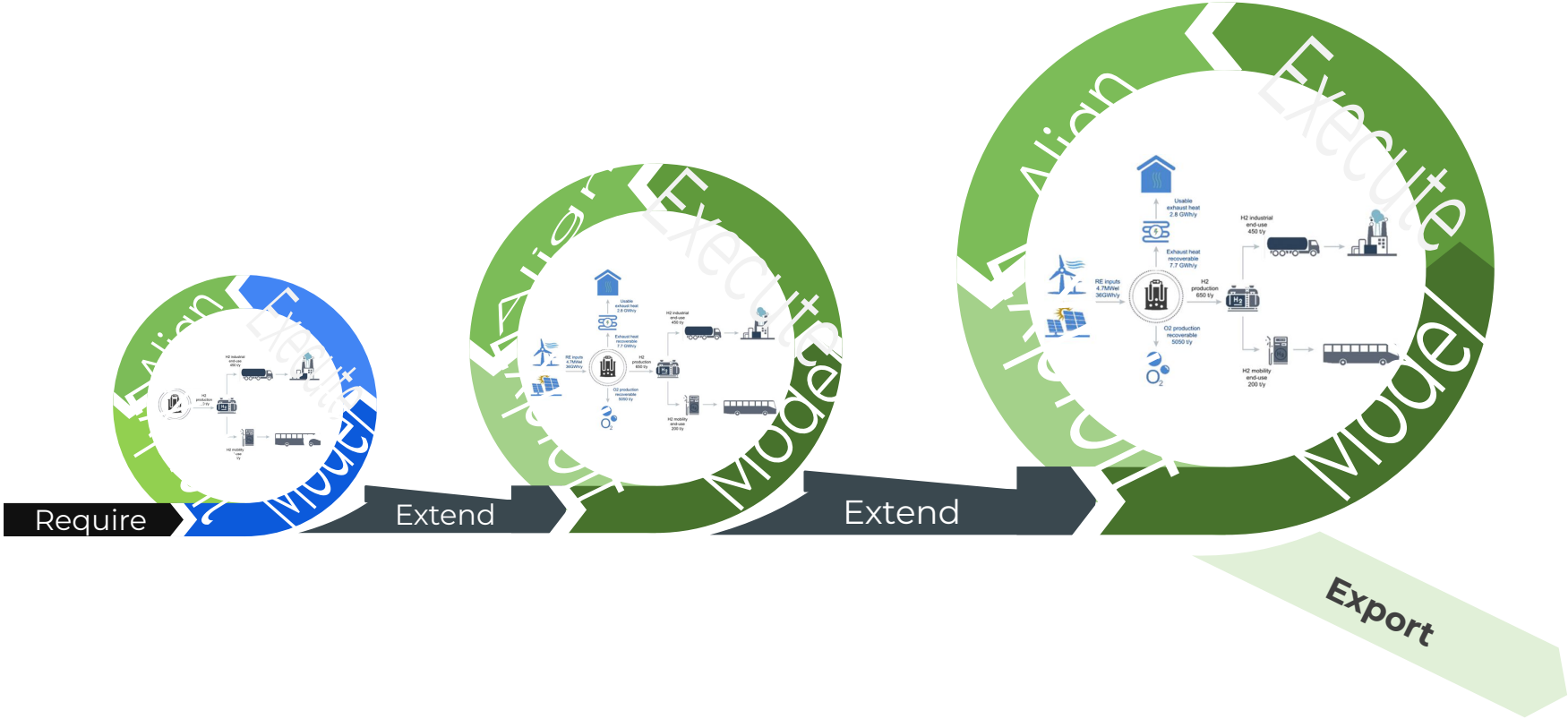
Overall development lifecycles



Software Solution Sustainability ?

Our approach of Model-Driven Digital Twining enables:

- Reusability of digital twin components/models amongst different cases
- Focus on analytical model vs AI re-training
- Deploy only IoT sensors that we really need

Thanks to Luxhyval to welcome us !

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