Optimising H_2-based Energy Models – using Decision Support Tools

Dr Rory Monaghan
School of Engineering, National University of Ireland Galway (NUI Galway)
Ryan Institute for Marine, Environment and Energy Research, NUI Galway
MaREI, the SFI Research Centre for Energy, Climate and Marine

Hydrogen: Getting the green light, Driving Europe's green recovery
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- Why hydrogen?
- Chickens and eggs
- A decision support tool for hydrogen investments
- Hydrogen value chain case studies
- Outlook

Why are we Talking about Renewable Hydrogen?

Hydrogen can close half of the gap between current EU 2050 plans and 2DS GHG emissions

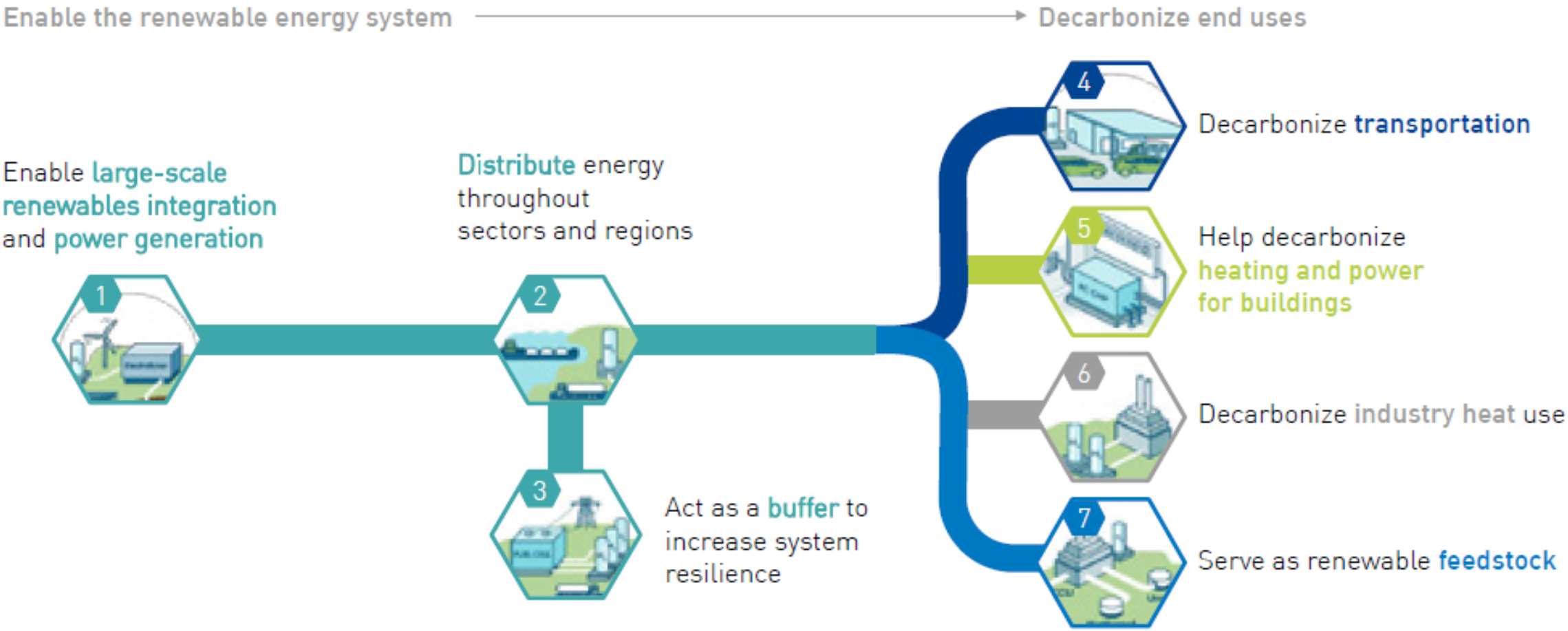
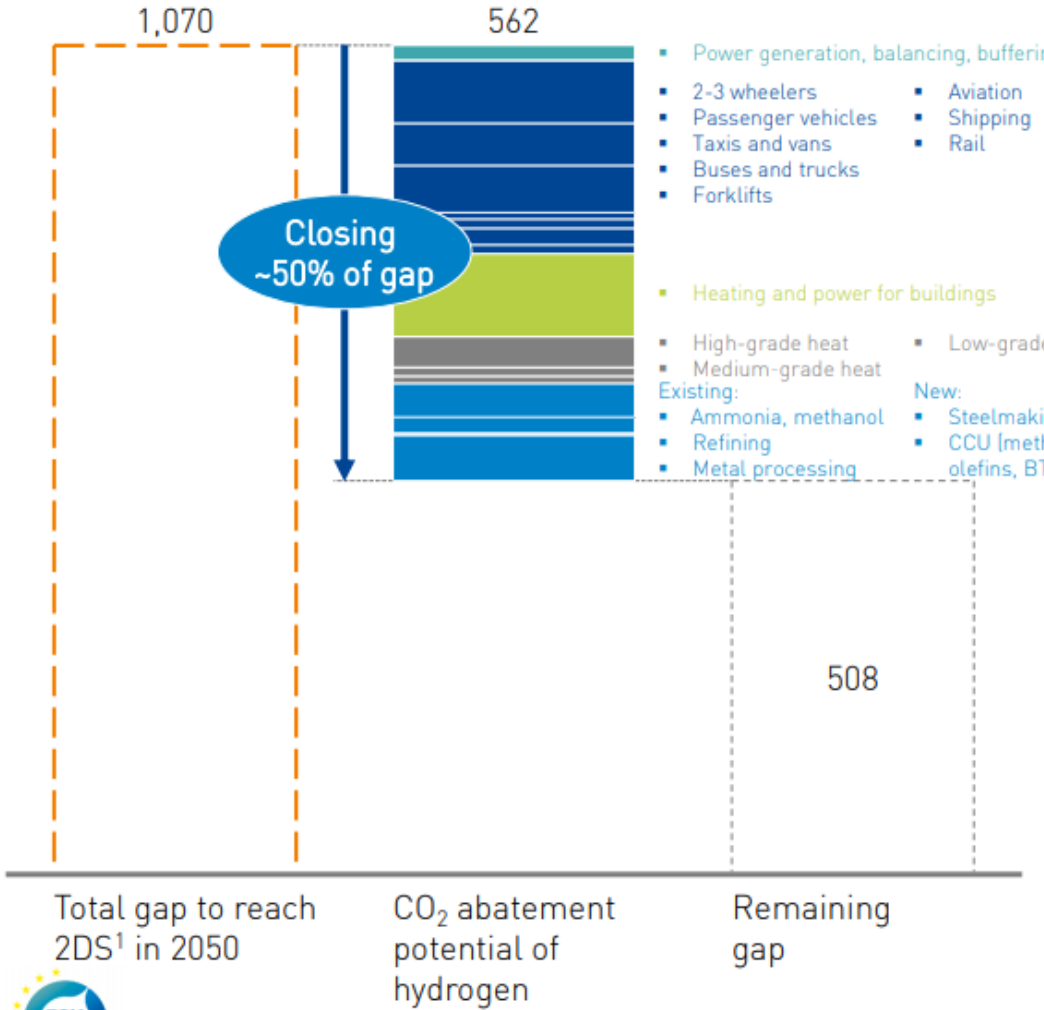


Image: *Hydrogen Roadmap Europe*, FCHJU, 2019

ACROSS APPLICATIONS HYDROGEN CAN CLOSE HALF OF THE GAP TOWARDS THE 2DS

Carbon emissions gap to reach 2DS[1] in 2050, Mt



Segments

- Power generation, balancing, buffering
- 2-3 wheelers
- Passenger vehicles
- Taxis and vans
- Buses and trucks
- Forklifts
- Aviation
- Shipping
- Rail
- Heating and power for buildings
- High-grade heat
- Medium-grade heat
- Low-grade heat

Existing:
- Ammonia, methanol
- Refining
- Metal processing

New:
- Steelmaking (DRI)
- CCU (methanol, olefins, BTX)

Hydrogen decarbonization levers

Power generation	Integration of renewables into the power sector[2] Power generation from renewable resources
Transportation	Replacement of combustion engines with FCEVs, in particular in buses and trucks, taxis and vans as well as larger passenger vehicles Decarbonization of aviation fuel through synthetic fuels based on hydrogen Replacement of diesel-powered trains and oil-powered ships with hydrogen fuel-cell-powered units
Heating and power for buildings	Decarbonization of natural gas grid through blending Upgrade of natural gas to pure hydrogen grid
Industry heat	Replacement of natural gas for process heat
Industry feedstock	Switch from blast furnace to DRI steel Replacement of natural gas as feedstock in combination with CCU

1 2-degree scenario 2 Please see the chapter on renewables and power for information on the role of hydrogen as enabler of a renewable power system. The "enabled" carbon abatement from renewables is not included here and is an additional benefit of hydrogen for decarbonization

SOURCE: IEA Energy Technology Perspectives 2017; Hydrogen Roadmap Europe team

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From: *Hydrogen Roadmap Europe*, FCHJU, 2019

Chickens, Eggs & Hydrogen

Awareness is growing of the benefits of hydrogen but how can investors and communities understand sector integration and the opportunities?

Who invests first?

"I want to produce renewable hydrogen but who would buy it?"

Community Hydrogen Forum

"I want to run fuel cell buses but who sells renewable hydrogen?"

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The Missing Links: Community Hydrogen Forum & Decision Support Tool

Community Hydrogen Forum

Where can I learn about hydrogen opportunities?

Decision Support Tool

Curtailed renewable energy sources

- Wind Energy
- Solar Energy
- AD Plant

Hydrogen could make sense for my community, organisation or company.

But how do I make it happen?

How do I find a hydrogen source or market?

Energy demands

- Industry
- Mobility
- Stationary Energy

How do I take the next steps?
How do I connect with others across Europe?

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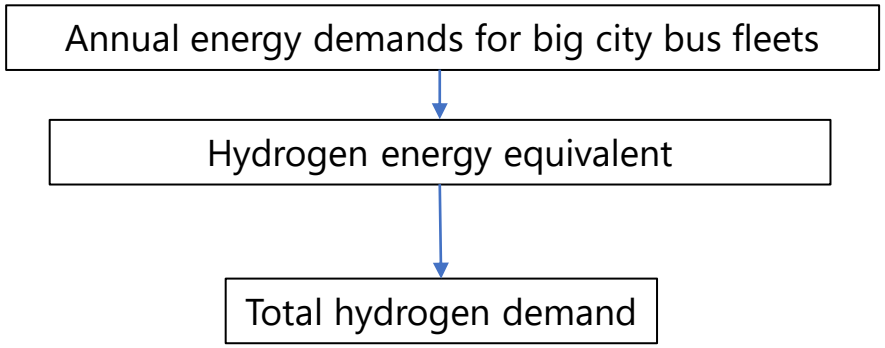
Decision Support Tool

- Supports NWE stakeholders to evaluate the potential of hydrogen in:
  - Sustainable community development
  - Decarbonisation
  - Energy security
- Achieves this by demonstrating the role of hydrogen produced at onshore wind farms in decarbonising public bus fleets in large cities across the region
  - Will later be expanded to include solar and bioenergy
- Visualised in an online interactive map of NWE



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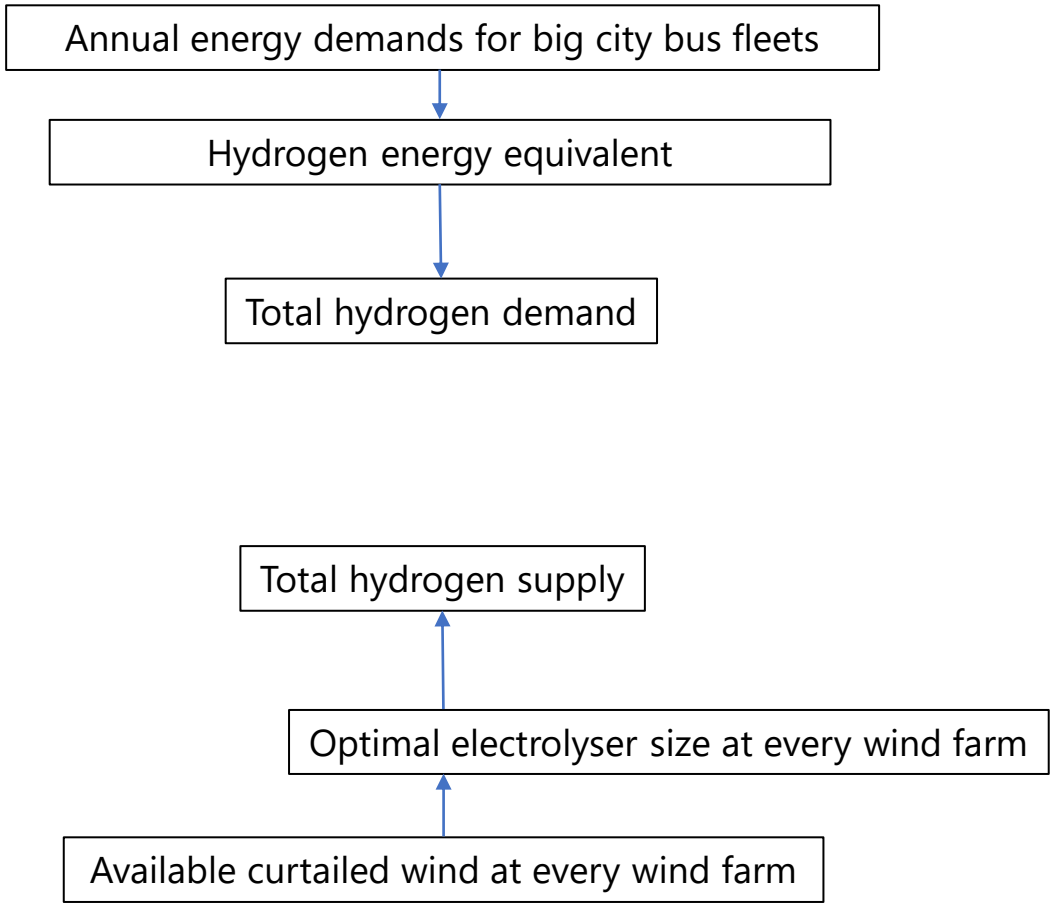

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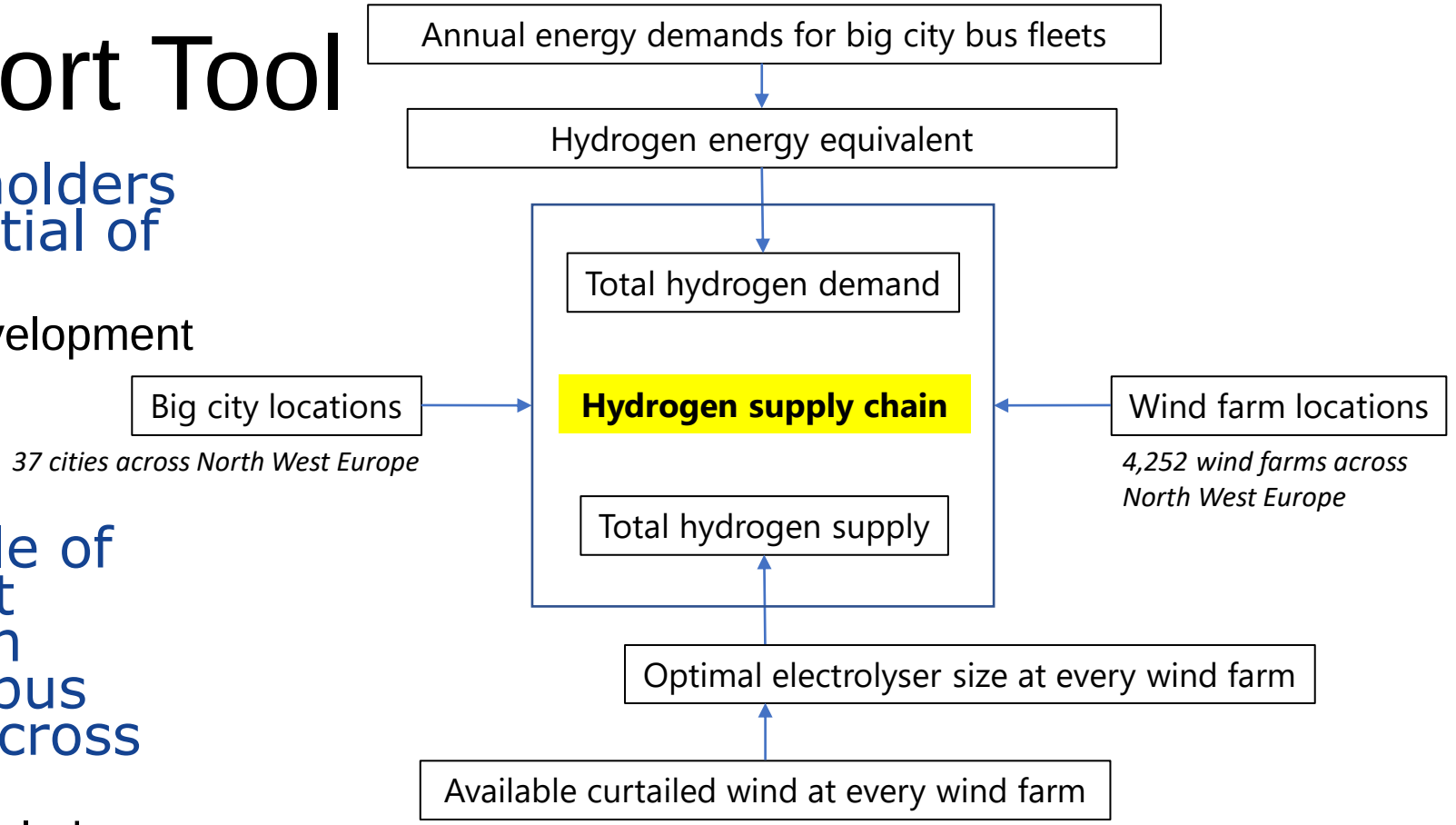

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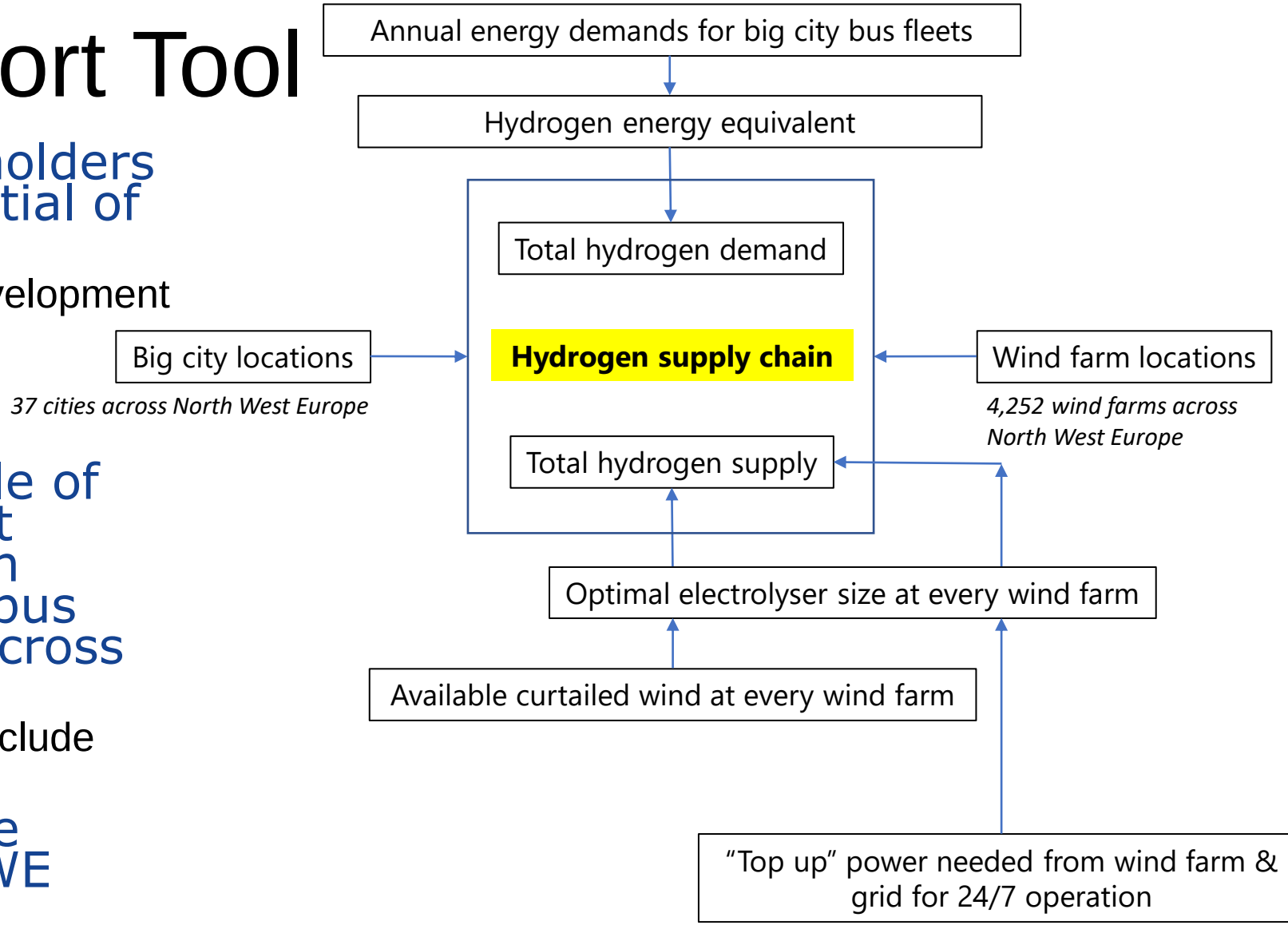
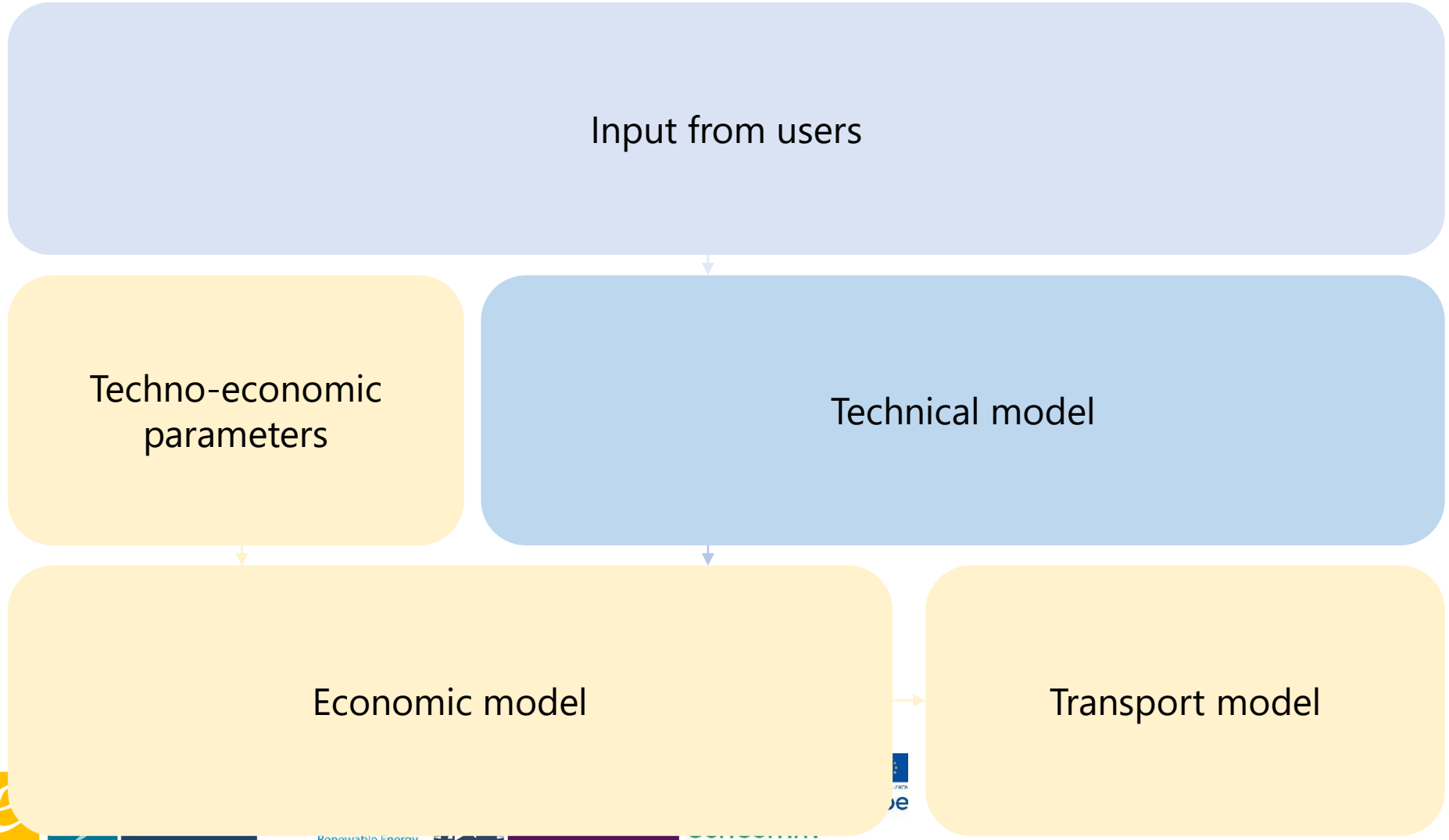


The Decision Support Tool
How it works



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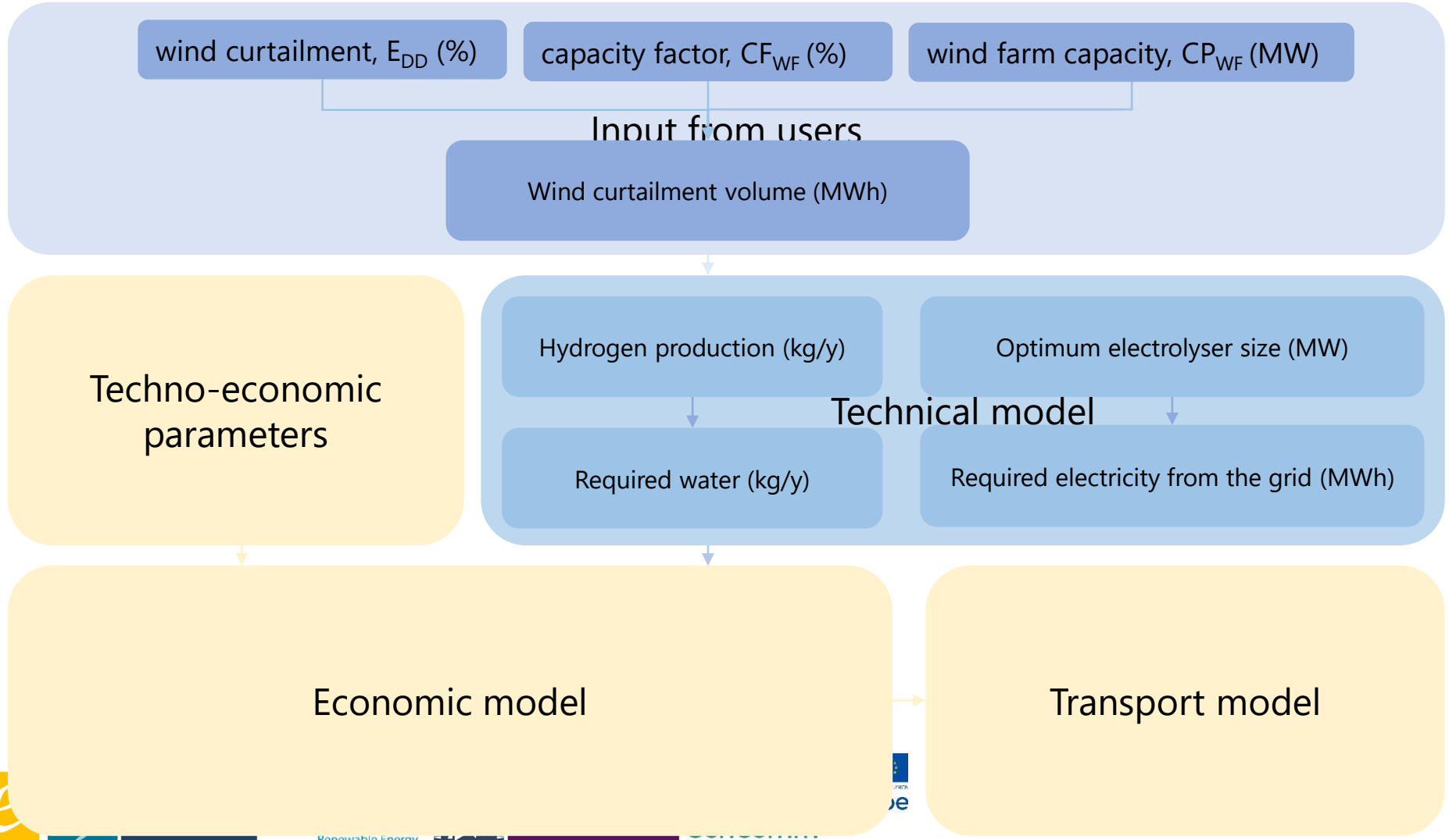

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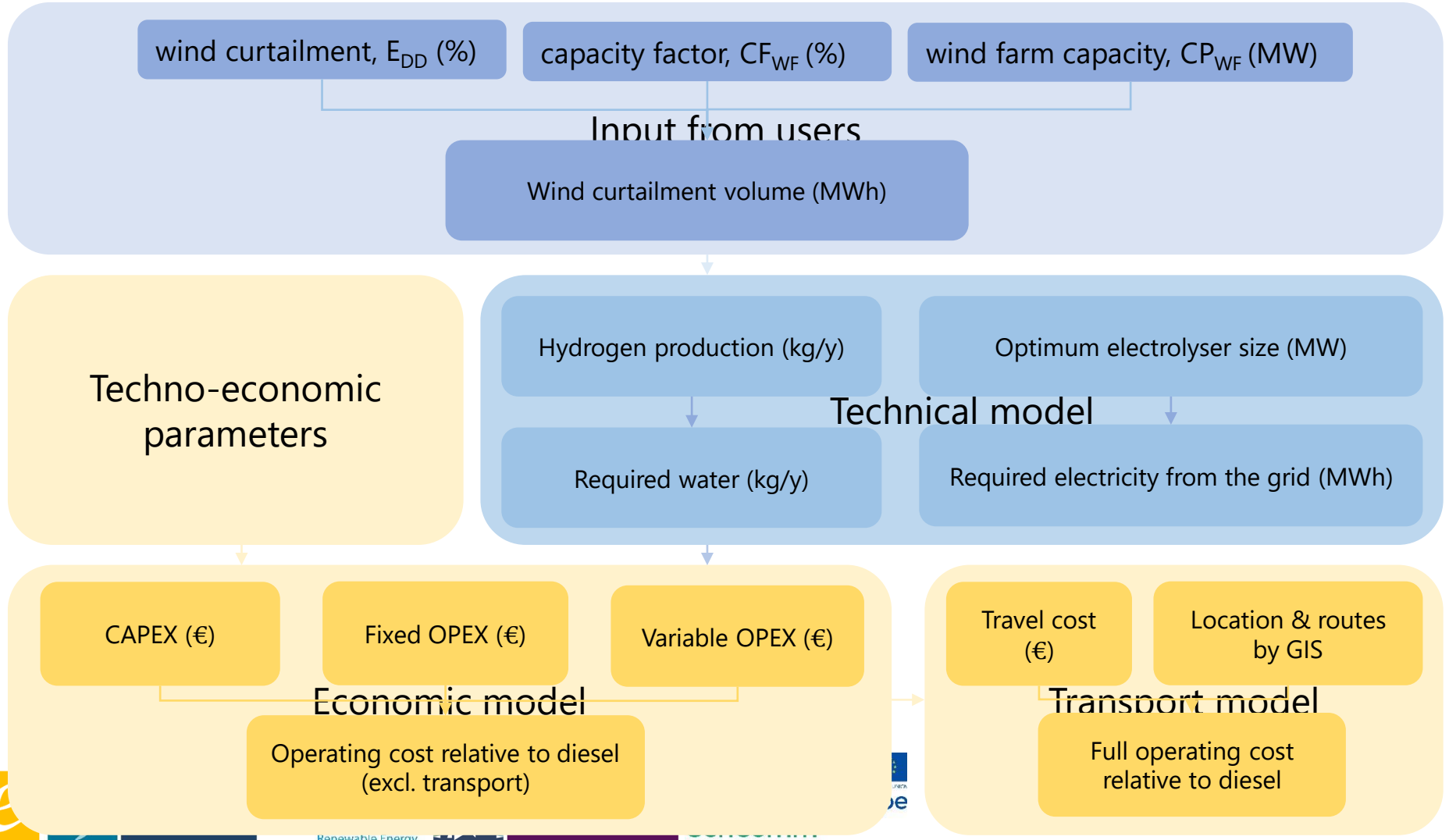


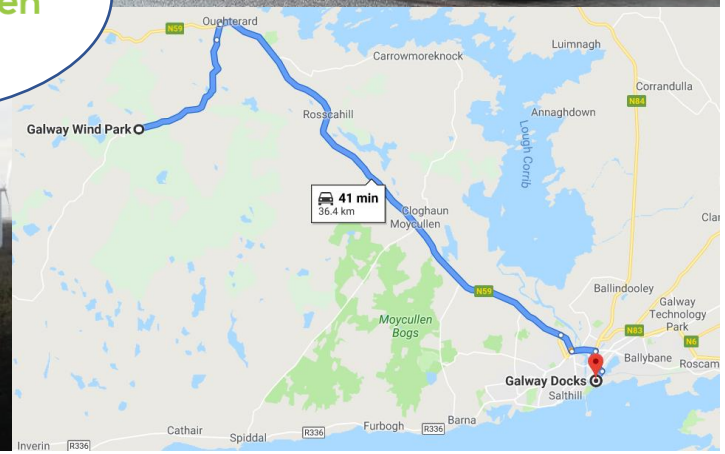
Hydrogen Value Chain Case Studies

1. Local – Galway bus pilot
2. Regional-National – Decarbonisation of Irish city bus fleets
3. Multinational – Decarbonisation of European city bus fleets
4. Gas grid injection – Decarbonisation of heat

Case Study – Galway, IE
Local Hydrogen Supply Chain

"Can we use wasted wind energy from Ireland's largest wind farm to produce hydrogen to fuel 5 buses in Galway?"

Community Hydrogen Forum



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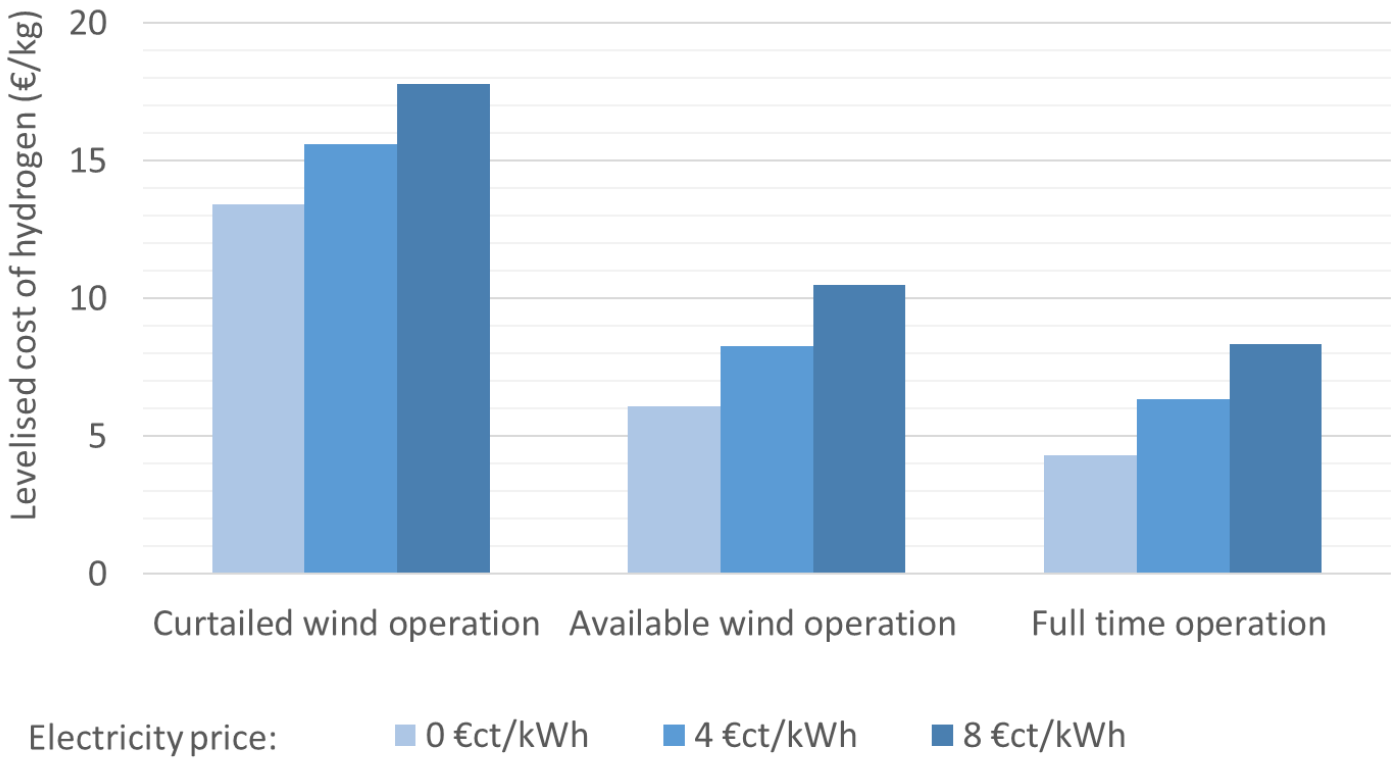

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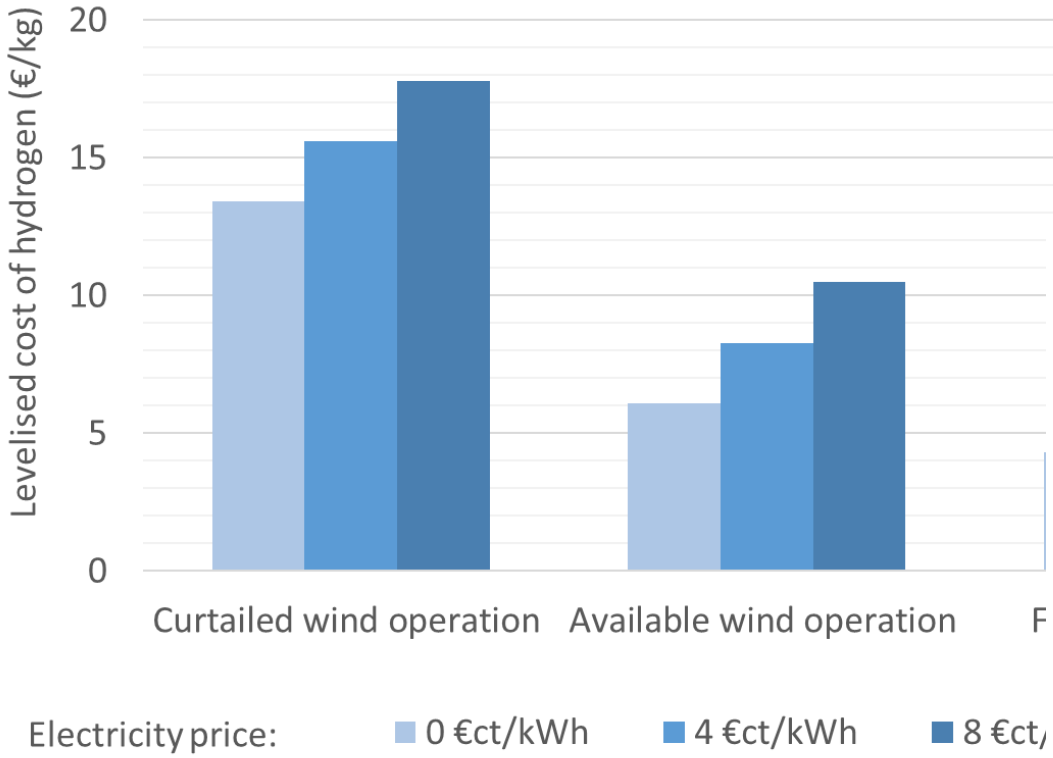

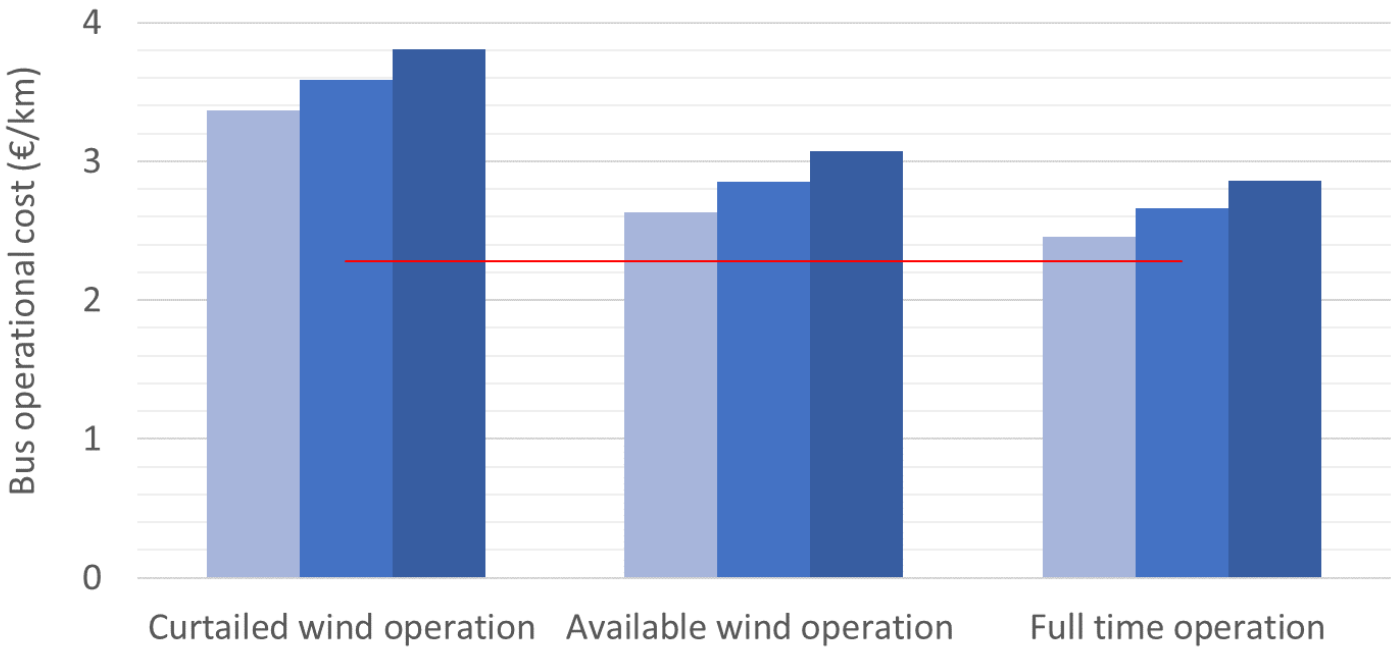

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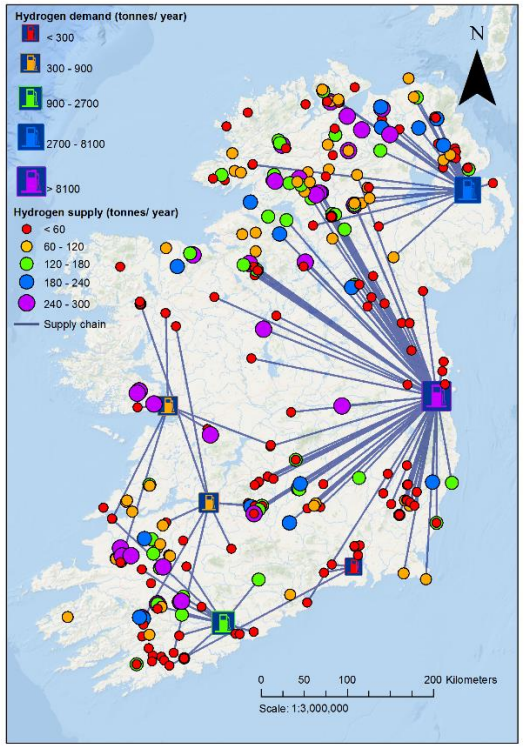
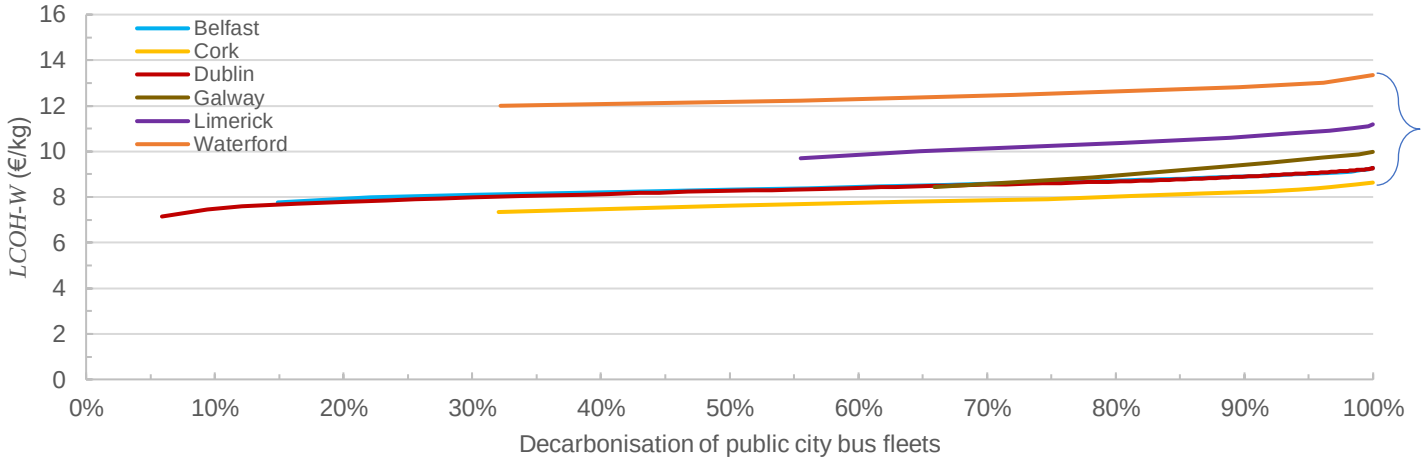
Case Study - Ireland
Regional-National Hydrogen Supply Chain



Wind-solar H_2 supply chain to city bus networks
100% demand coverage



Levelised cost of delivered hydrogen

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Case Study - Ireland
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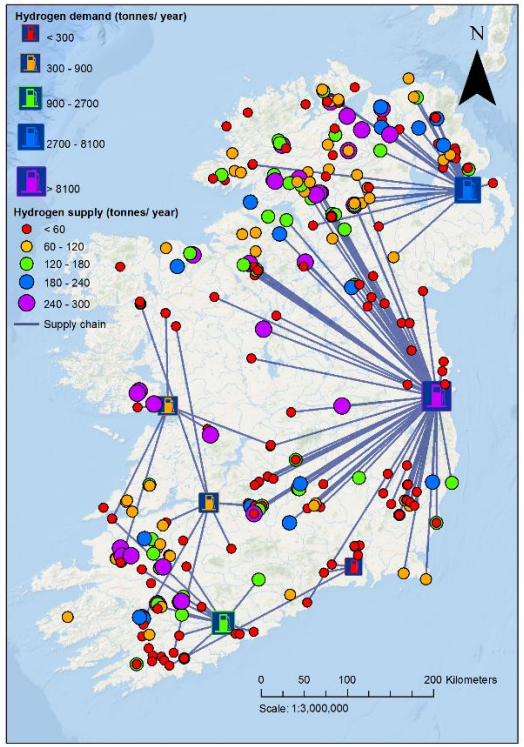

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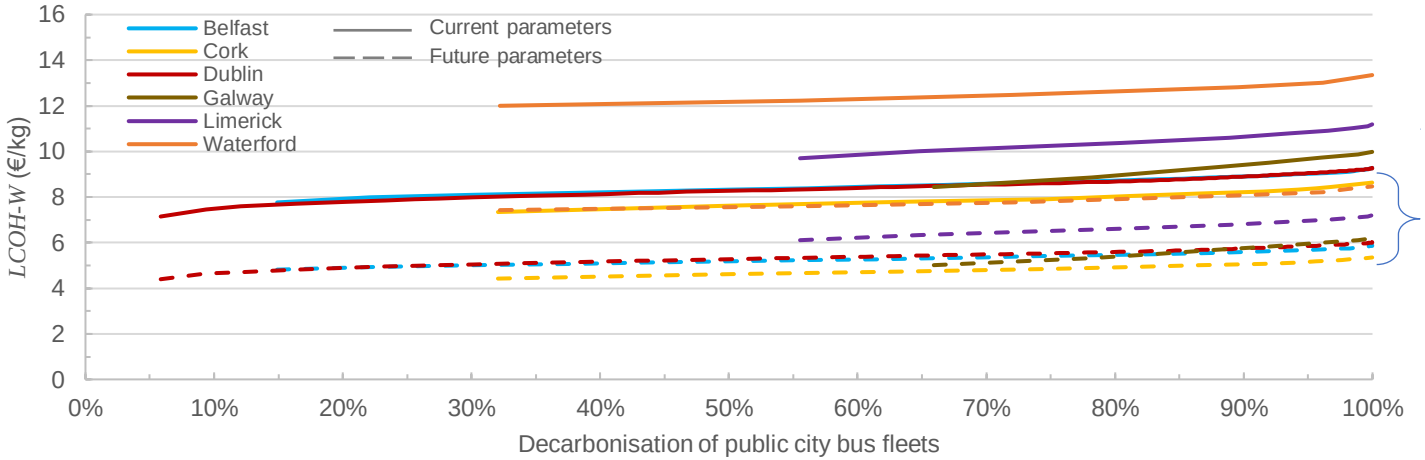

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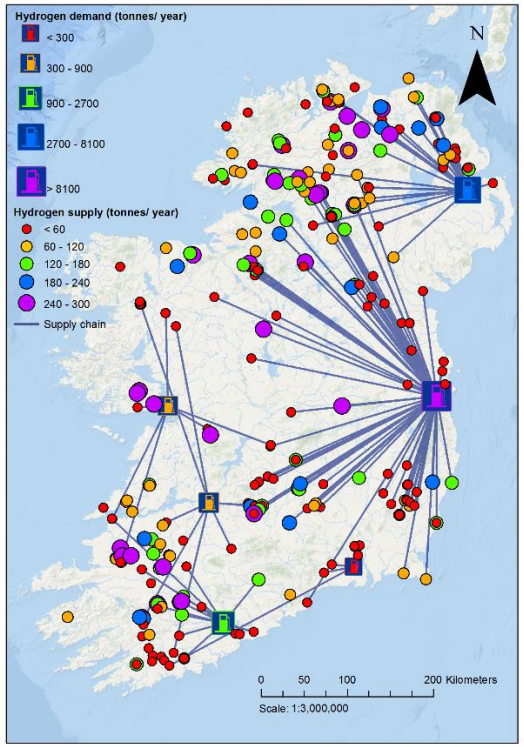

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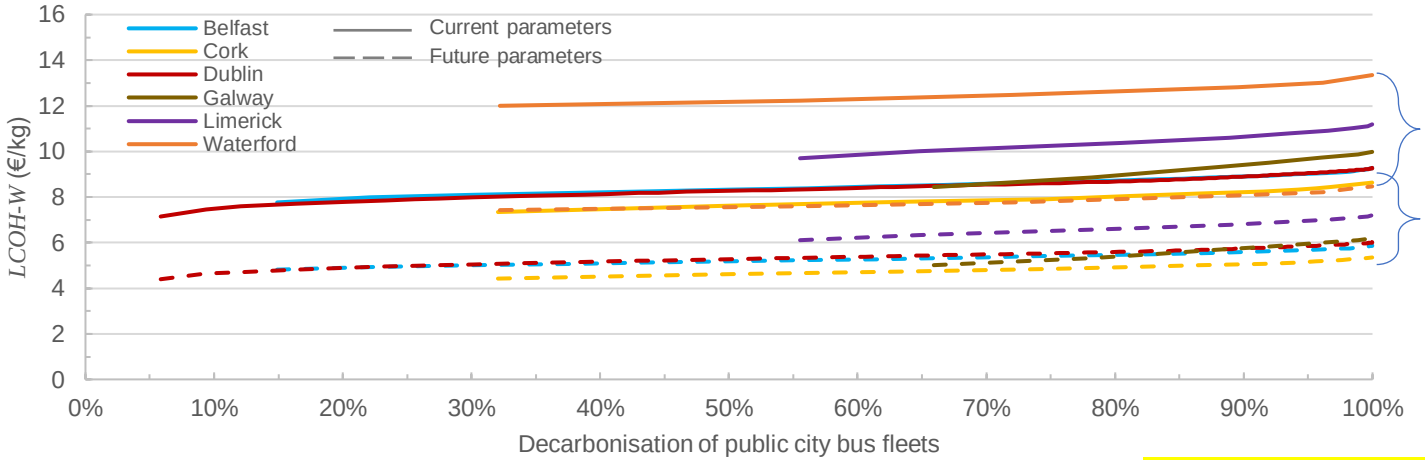

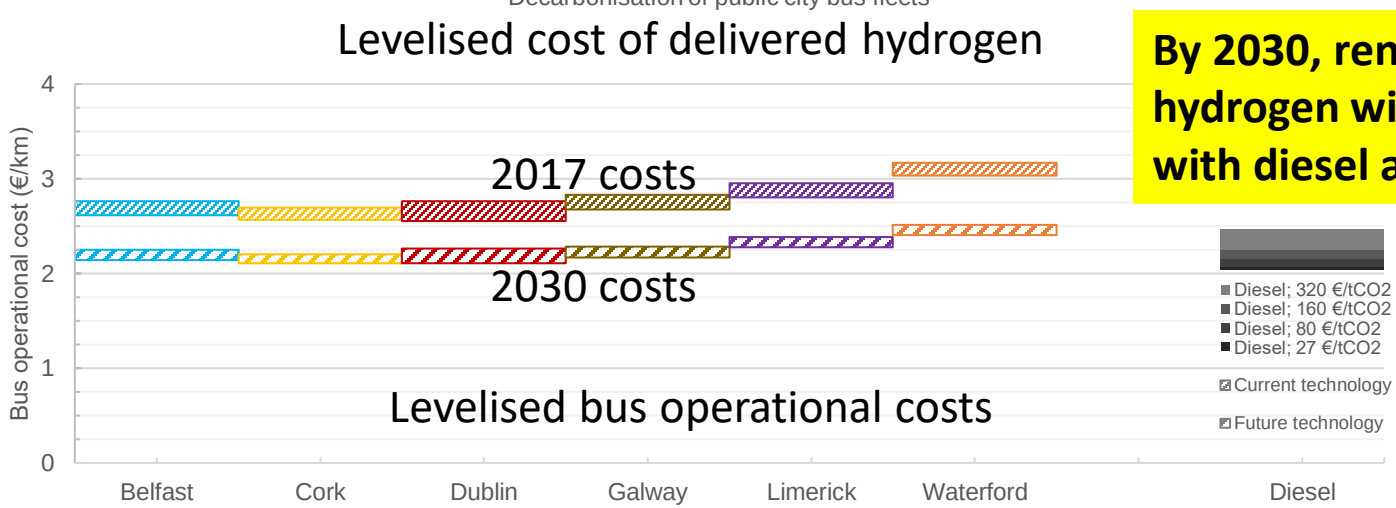

By 2030, renewable hydrogen will be competitive with diesel at any CO_2 price

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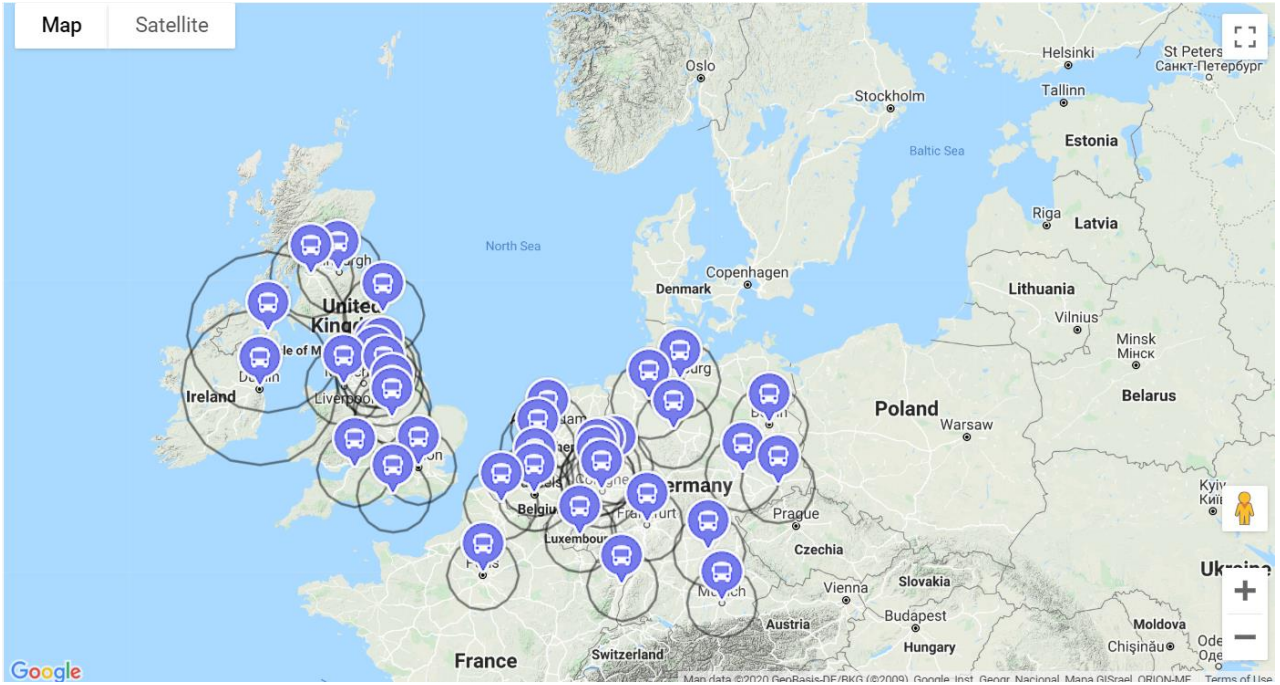
Online DST – Northwest Europe Multinational Hydrogen Supply Chain

User-friendly wind-H_2 supply chain costings for northwest Europe's 40 largest cities



http://communityh2.eu/dst/

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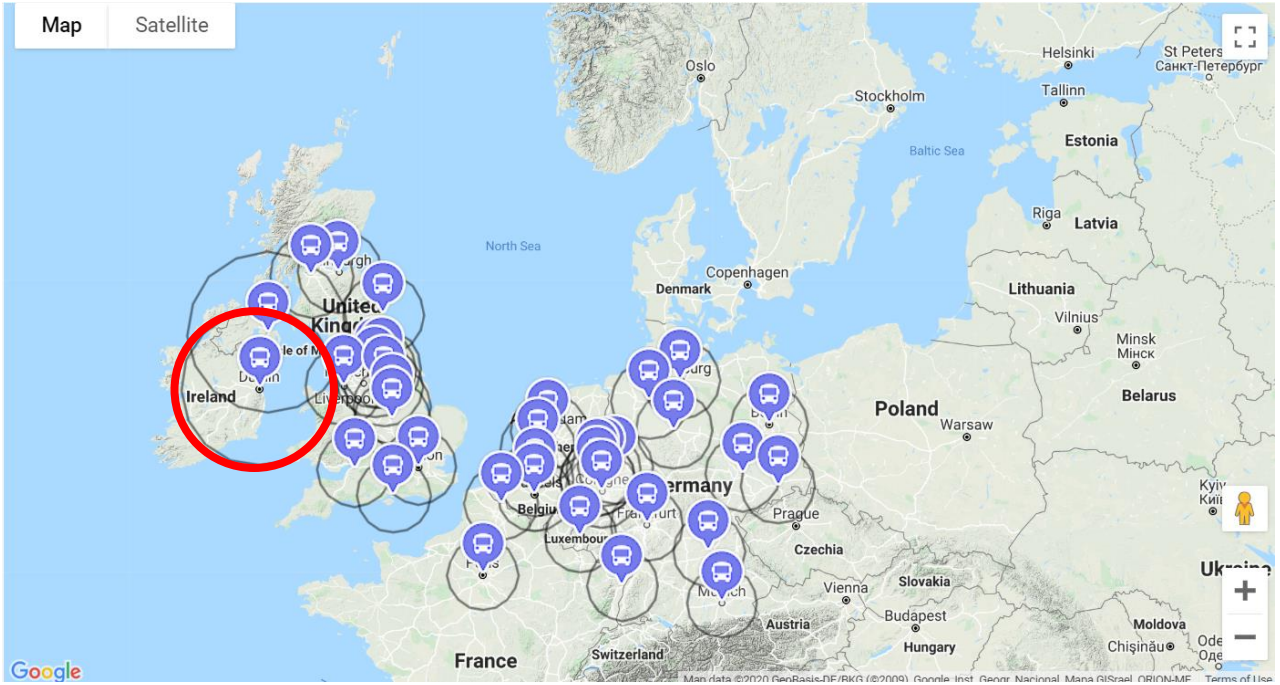

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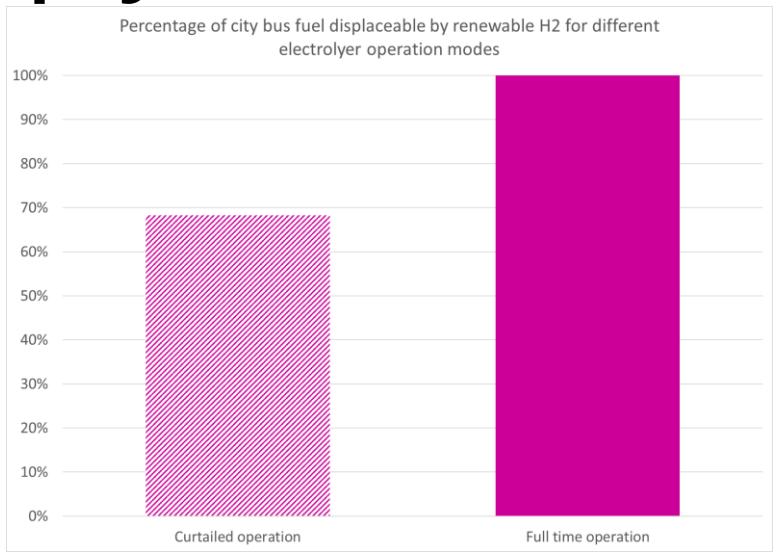

Hydrogen would displace 70% of Dublin bus fleet fuel use with curtailed operation of the electrolyser, or 100% with full time operation

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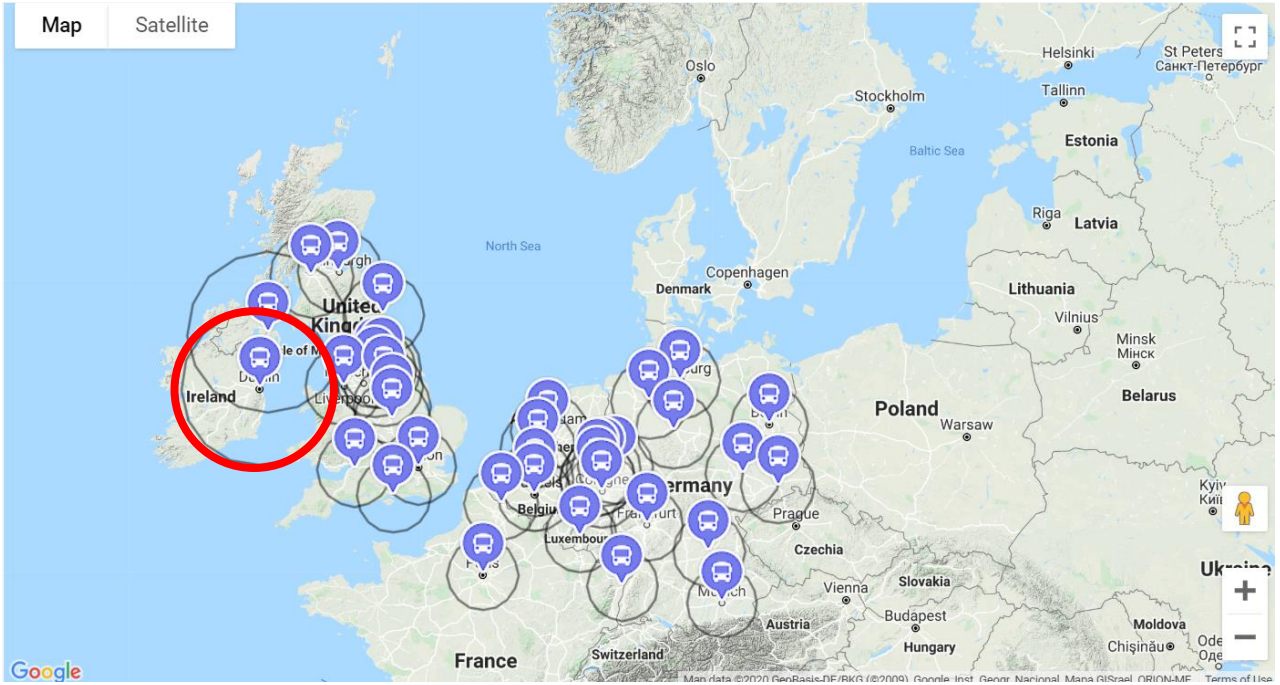

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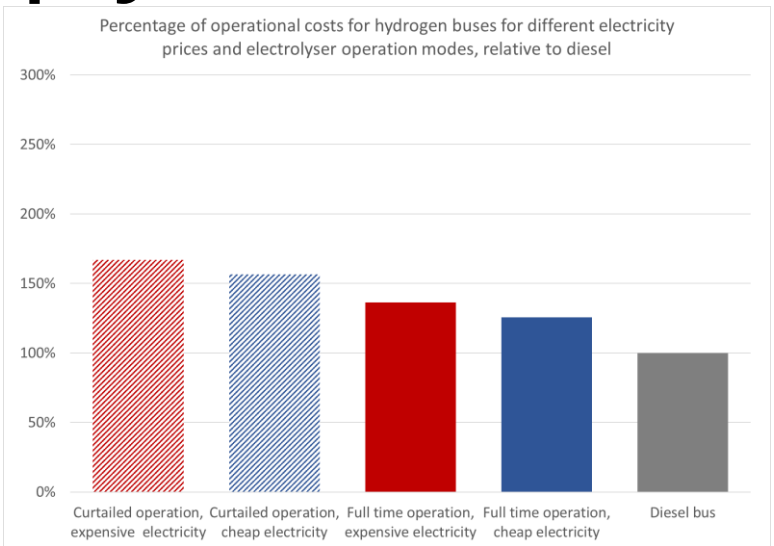

A Dublin fuel cell bus could operate with costs from 26% higher than diesel (full time electrolyser operation, cheap electricity) to 67% higher (curtailed operation, expensive electricity)

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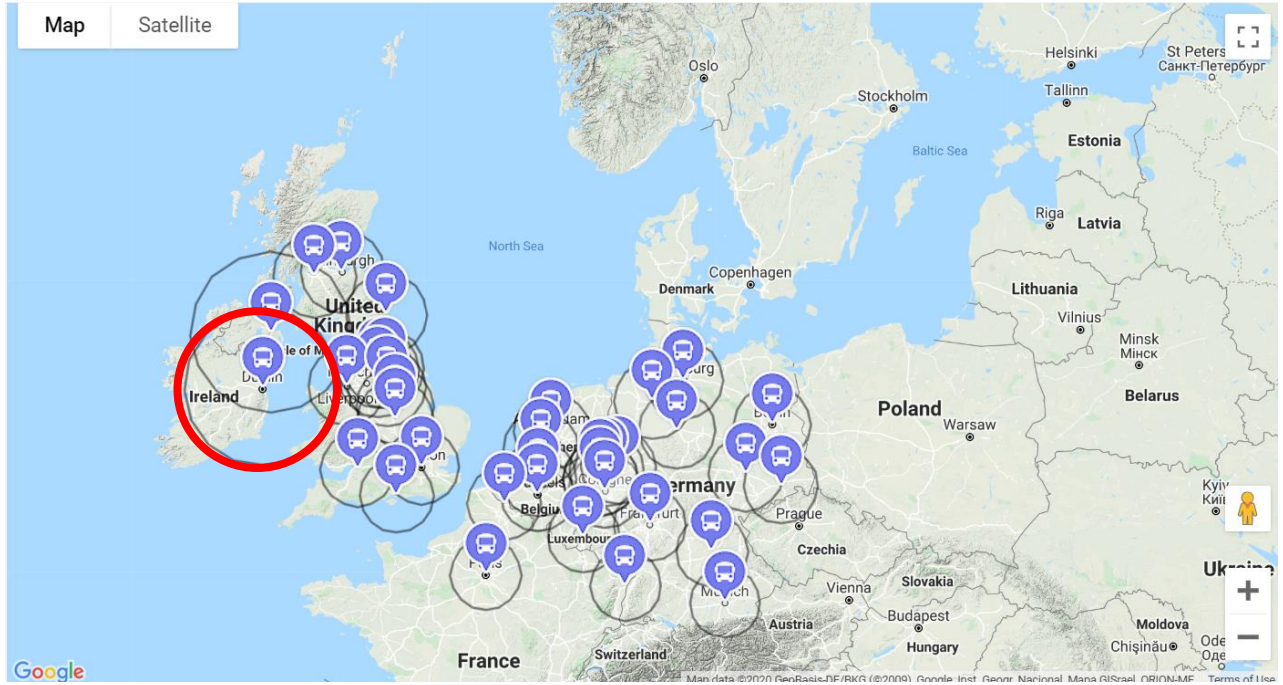

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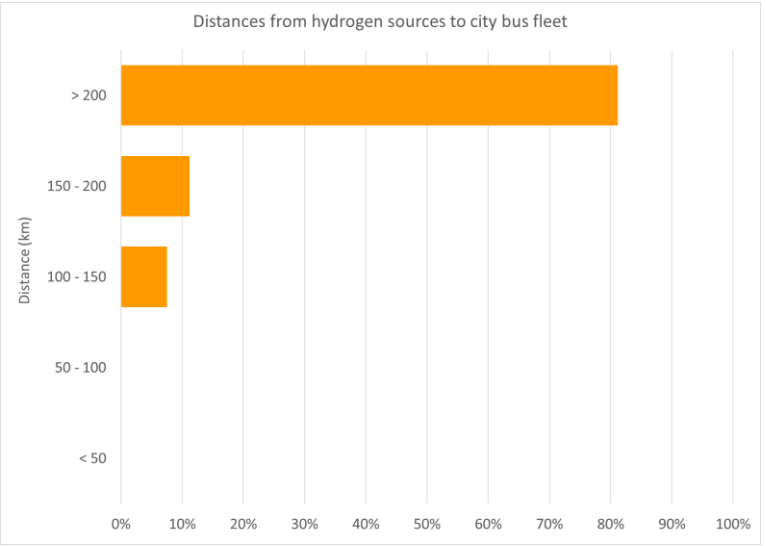

Over 80% of the hydrogen available to fuel the Dublin bus fleet must be transported over 200 km (from the west coast) but the wind resource makes it worthwhile

The DST can inform potential hydrogen suppliers and users where they can make the greatest impact and how much it could cost

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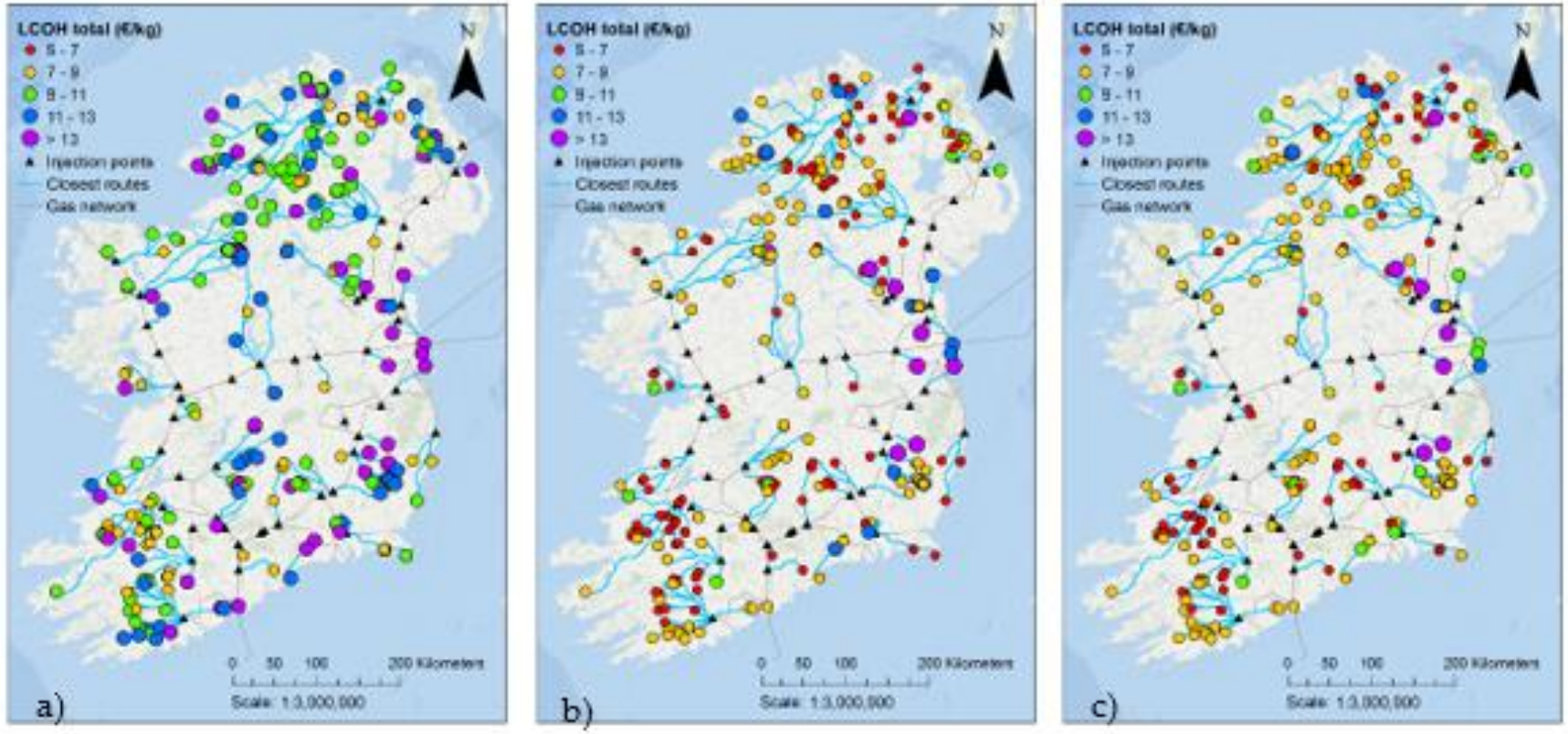
Gunawan, T.A.; Singlitico, A.; Blount, P.; Burchill, J.; Carton, J.G.; Monaghan, R.F.D. At What Cost Can Renewable Hydrogen Offset Fossil Fuel Use in Ireland's Gas Network? *Energies* **2020**, *13*, 1798. Full paper: https://www.mdpi.com/1996-1073/13/7/1798

Gas grid injection supply chain



Curtailed wind, high price | Available wind, high price | Full capacity, high price

Levelised cost (2030) of hydrogen delivered to gas grid

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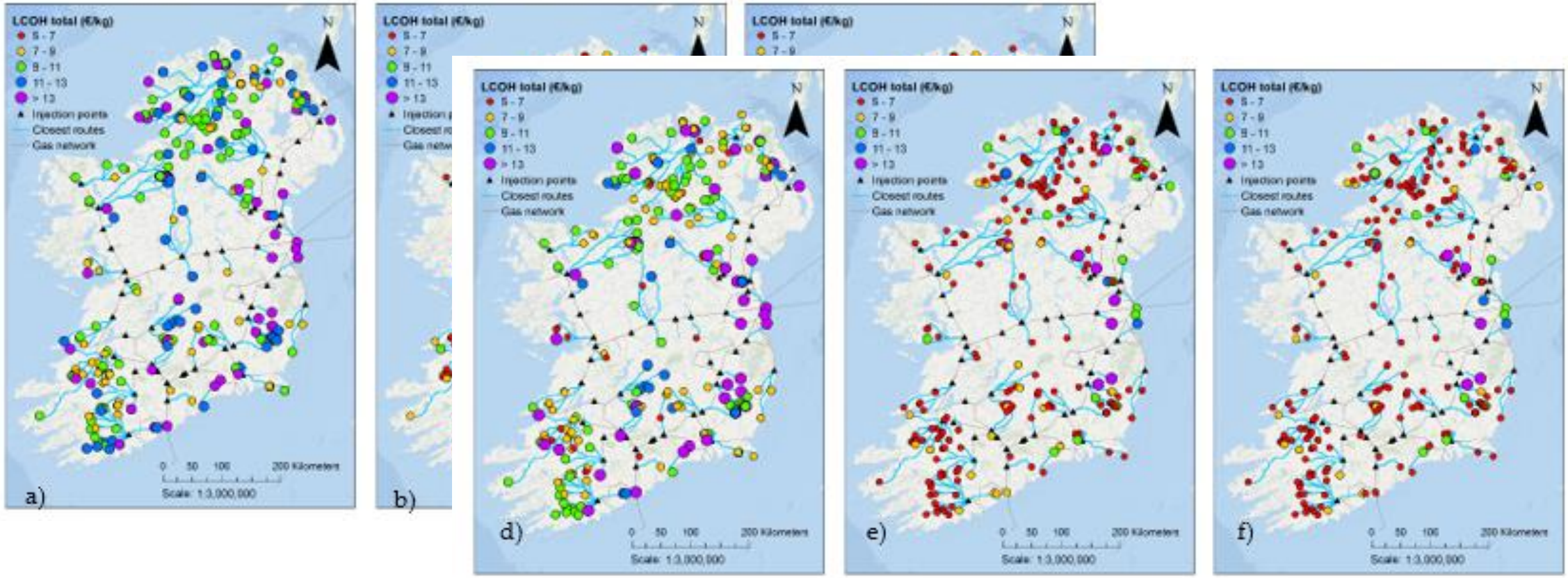

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Key messages

- Renewable hydrogen suppliers and consumers need to understand each other before investing.
- The Community Hydrogen Forum aims to facilitate this.
- The Hydrogen Decision Support Tool guides northwest Europe stakeholders through the first steps of appreciating their opportunities.
- Current DST focus is wind-hydrogen-bus but new features will include solar, gas grid injection and industrial heat.
- Join us at http://communityh2.eu/

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