Power-to-Gas
Biogas upgrading for a freight transport fuel

Shane McDonagh
IEA Bioenergy symposium
August, 2018
Power-to-Gas systems
What is their potential role?

Context...

- 14% renewable energy in transport by 2030....
- Cap on traditional biofuels such a biodiesel....
- P2G contributes to targets similar to EVs....
- Renewable electricity means renewable fuel....
- Can turn on/off to facilitate wind/solar energy....

In terms of Anaerobic Digestion...

- Can be used in place of traditional upgrading....
- Combine carbon in biogas with hydrogen to create more methane (CO$_2$ + 4H$_2$ = CH$_4$ + 2H$_2$O)....
- Ideal early adopter to produce HGV fuels....

Audi E-Gas project in Wertle, Germany
Research aims
P2G modelling

Simplified methodology

1. Develop figures for costs and system specifications....

2. Build a whole life cash flow model of a Power-to-Methane (P2G) system ....

3. Model P2G as a large flexible electricity consumer using figures from EirGrid and PLEXOS models of the 2030 electricity system....

4. Employ operational strategies (controls) aiming increase the sustainability of P2G....
Published papers
Levelised costs, sensitivity analysis, optimisation

Key findings...

- LCOEs of €124/MWh in 2020, €105/MWh in 2030, and €93/MWh in 2040....
- Electricity by far the largest contributor to the LCOE....
- Integration, secondary incomes, and/or incentives are essential for competitive P2G....
- P2G depends on the electricity market in which it operates, not technology or carbon source.....
- Solely consuming cheap or otherwise curtailed energy is not economically viable....
- Be willing to pay more for your electricity to produce a cheaper product gas....
Levelised costs
Insights from published papers

What contributes to the levelised costs?
• Electrolysis makes up majority of fixed costs
• Lack of traditional upgrading can offset methanation costs
• Focus should be reducing electricity cost

What effect do incentives/secondary incomes have?
• Oxygen sold at 10c/Nm³ profit...
• €15/MWₑ (8500hrs x 10MW plant)...
• €50/MWh incentive...
Operational strategies
Are there environmental and economic synergies?

*If otherwise curtailed energy alone is insufficient, can we increase the sustainability of consuming grid electricity?*

Results from a recently completed work (to be submitted soon)...

<table>
<thead>
<tr>
<th>Economically optimised P2G compared to the grid average for 40-60% RES-E</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbon intensity of hydrogen</strong></td>
</tr>
<tr>
<td><strong>Bid Price</strong></td>
</tr>
<tr>
<td><strong>Wind Forecast</strong></td>
</tr>
</tbody>
</table>

Bid Price control akin to engaging in the market and purchasing guarantees of origin.

Wind Forecast control akin to engaging in the market in order to relieve grid congestion.

The RED promotes both concepts.
Summary

- **Policy/Target implications**
  Contributes to RES-T similar to EVs, can decarbonise HGVs and facilitate RES-E.

- **Levelised costs**
  LCOEs of €124 to €93/MWh (2020-2040), comparable to diesel, far below competing synthetic biofuels. Dominated by electricity costs.

- **Market interactions**
  Otherwise curtailed electricity alone is insufficient, pay more to minimise LCOE.

- **Operational strategy**
  Controlled electricity use reduces carbon intensity, cost, and curtailment.

*Thank you!*