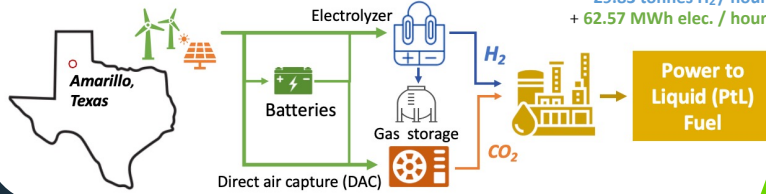


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## Introduction – Sustainable aviation fuel from 100% renewable energy

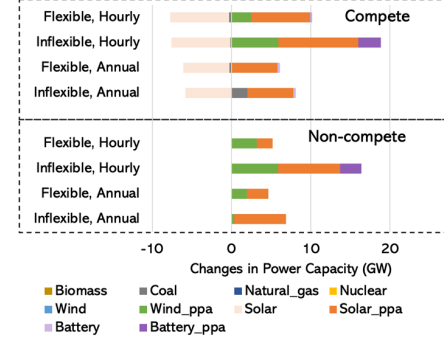
- Power-to-Liquid fuel (PtL) is a synthetic aviation fuel produced from **hydrogen** and **carbon dioxide**, aiming to achieve zero emissions using 100 % **renewable power**.
- We conduct a case study for a daily demand of 10,000 barrels PtL at Amarillo, Texas, in 2030 to evaluate its grid impacts.



## Results – How the grid will change with a daily demand of 10,000 barrels PtL ?

**Power Capacity:**

- In the compete scenario, the annual time-matching policy will prevent coal plant retirement.

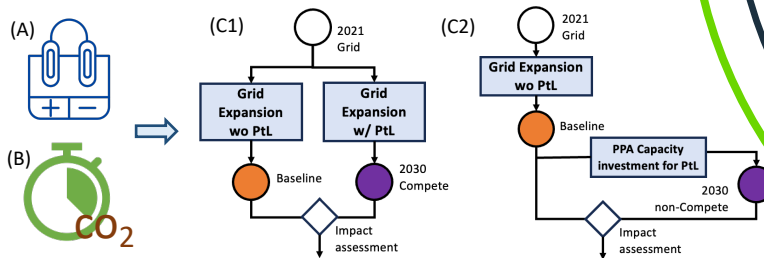


- Under the inflexible operation, the hourly time-matching policy requires significant investments in renewable generations and batteries.

## Methods – Grid expansion model for future scenarios

We simulate the grid expansion in 2030 using an open-source model [1] and consider different future scenarios:

- (A) **Hydrogen electrolyzer operations: flexible or inflexible operations** if the hydrogen electrolyzer is operated with or without hydrogen gas storage.



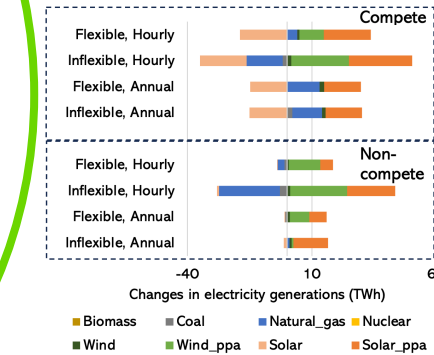
- (B) **Time-matching carbon policy: annual or hourly time-matching policy** enforces 100% renewable power generation to match the PtL demand annually or hourly.
- (C) **Capacity investment:** the **'compete' scenario** (C1) represents grid expansion including the PtL demand (C1), while the **'non-compete' scenario** (C2) considers capacity investment exclusive for the PtL demand (i.e., PPA contracted capacity) [2].

## Research Highlights

**Compared to ERCOT 2030 without the PtL demand (represented as ×100% baseline) - How significant is the change in carbon emissions and renewable curtailment?**

		Carbon Emission (%)	Renewable Curtailment (%)
<b>Compete</b>	Inflexible, Annual	9.24	-25.49
	Flexible, Annual	7.61	-37.48
	Inflexible, Hourly	-18.03	29.10
	Flexible, Hourly	-2.79	9.65
<b>Non-compete</b>	Inflexible, Annual	-1.35	42.28
	Flexible, Annual	-0.85	-2.86
	Inflexible, Hourly	-18.03	29.10
	Flexible, Hourly	-2.79	9.65

In the non-compete scenario, flexible and annual time-matching policy can reduce carbon emissions and mitigate curtailment.



## Electricity generation:

- In the compete scenario, natural gas electricity meets part of the PtL demand.
- In the non-compete scenario, renewable electricity can fully supply the PtL demand, except in the inflexible, annual time-matching case.

## Conclusions:

- Future development of PtL should consider its grid impacts systematically.
- Flexible hydrogen operations avoid over-investment in renewables and mitigate curtailment, especially under the stringent hourly time-matching policy.

**Reference:** [1] <https://github.com/macroenergy/DOLPHYN>, DOLPHYN  
 [2] Cybulsky, Anna, Michael Giovanniello, Tim Schittekatte, Dharik S. Mallapragada, and MIT Energy Initiative. "Producing Hydrogen from Electricity: How Modeling Additionality Drives the Emissions Impact of Time-Matching Requirements." (2023).