

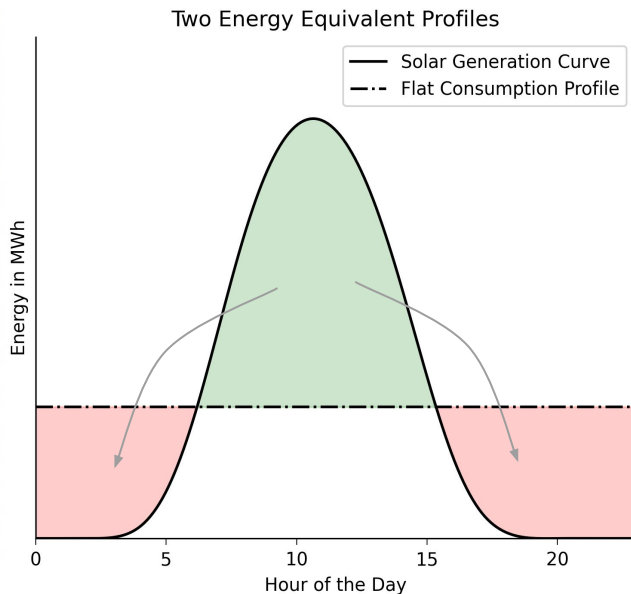
Moves Towards Greater Temporal and Geographical Granularity

Killian Daly,
Executive Director, *EnergyTag*

Today: Low Temporal and Spatial Granularity

(Disconnected from power flows)

Time: Annual Matching



Don't Capture **Variability**
"100% **Solar** at **Night**"

Space: Broad Matching



Don't Capture **Grid Constraints**
"100% Powered by **Norwegian** Hydro
in **Spain**"

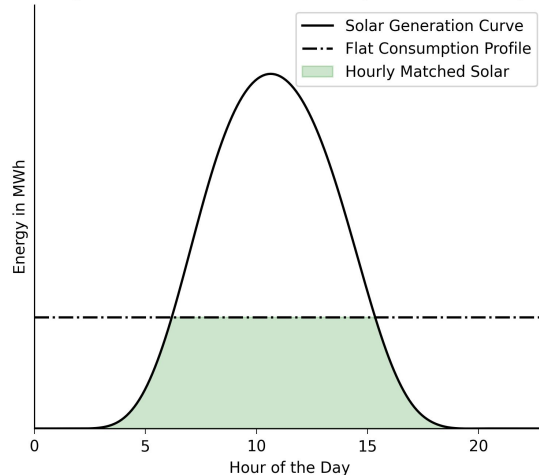
Tomorrow? More Temporal and Spatial Granularity

(Similar to how power markets work)

Time: Hourly

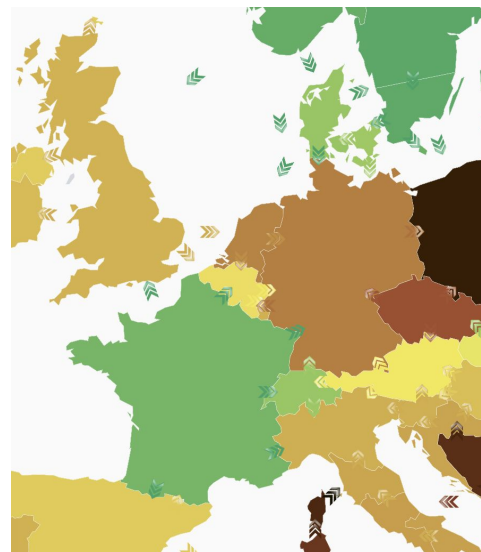


Matching Solar Generation and Consumption at an Hourly Level



*“Demand matched with clean power by the **hour**”*

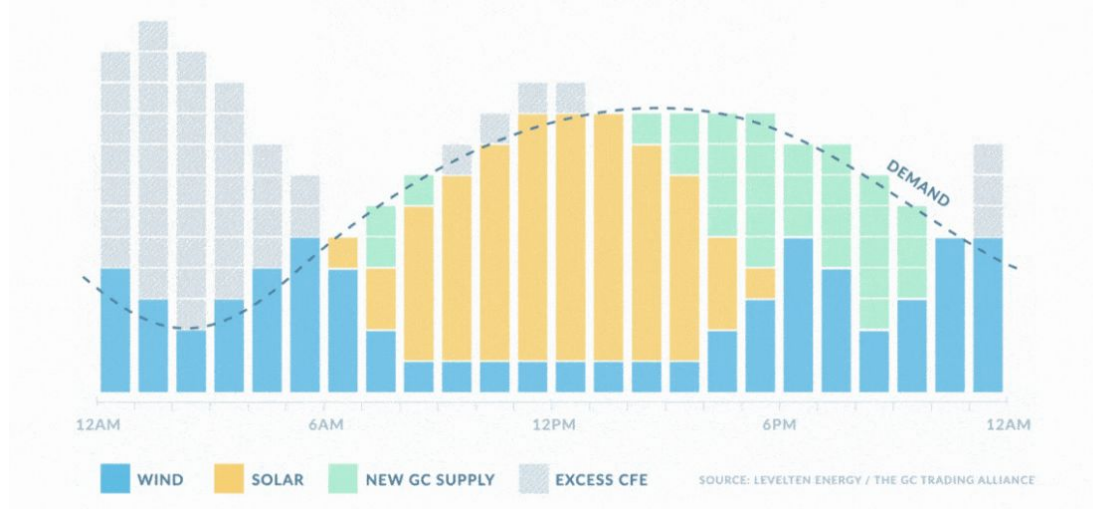
Space: Deliverable



*“Demand matched with clean power **in same grid***”*

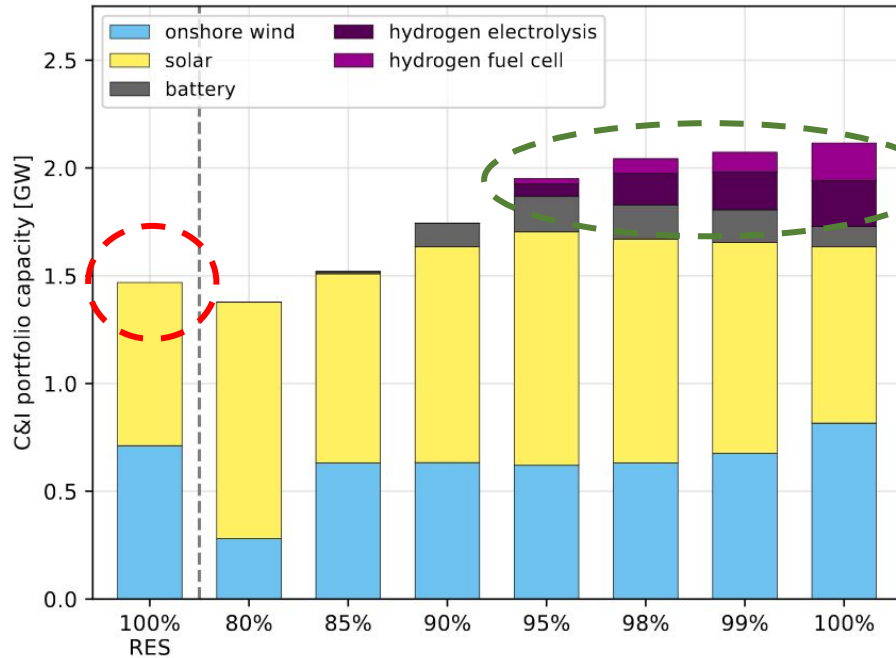
* In Europe, this is typically defined at bidding zone level. Interconnector flows should be possible if proven. 23

Granularity Helps Fill the Gaps



- Carbon-free energy (CFE) hasn't been able to meet demand at all hours
- Redirecting CFE supply to when & where it's needed ensures a cleaner, more reliable grid
- A market for granular certificates incentivizes carbon-free energy generators to fill the gap
- And makes it possible for organizations to buy CFE when they need it, and sell it when they don't

More Granularity = More Storage



→ **100% Annual matching** means just solar+wind get us to “0”
◆ **No Storage Incentive.**

→ **100% Hourly matching** means, renewable AND short/duration storage needed!
◆ **Strong Storage Incentive.**

Source : TU Berlin

System Operators Want Granularity

Valuing
consumer
action

MMR
2024



ENTSO-E Position Paper

Views on a Future-Proof Market Design for Guarantees of Origin

July 2022

1. “The introduction of **temporal matching**”.
2. “The **consideration of the available capacity** between countries.”



ENERGINET



ENTRANCE

*“Alliander’s own score for how well it matches the two is **59%... may seem disappointingly low.** But we already know that it is **not yet possible to match consumption with 100% green energy 24/7.** The only way organisations can make **real progress** with decarbonising their energy supply **is to acknowledge their true position.**”*

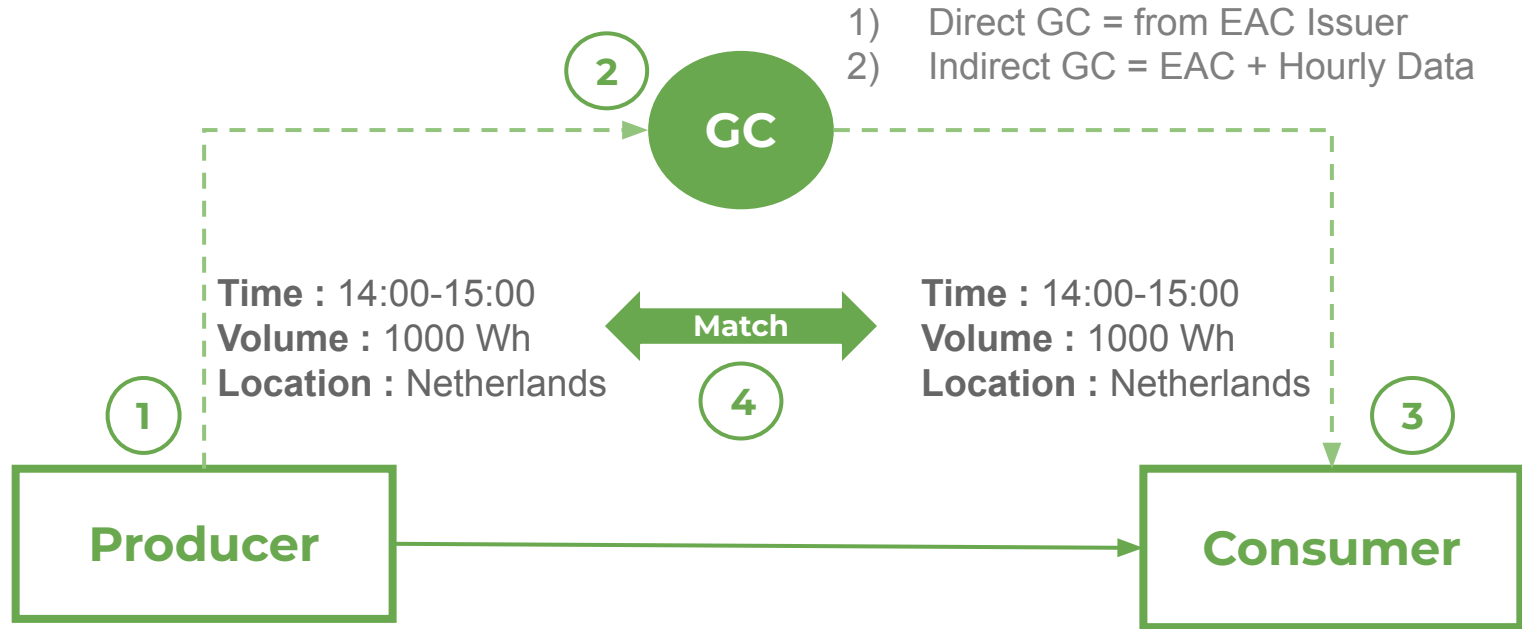
Granular Policies In Place

Law	Institution	Document	Doc Citation	Status	Region	Temporal	Deliverable
US Clean Hydrogen "45v" Tax Credit	US Treasury	Proposed rules 45v	Proposed §1.45V-4(d)(3)(ii)(A) "would provide the general rule that an EAC satisfies the temporal matching requirement if the electricity represented by the EAC is generated in the same hour that the taxpayer's hydrogen production facility uses electricity to produce hydrogen."	Proposed ▾	US	<= Hour	Same Grid (Doe Grid Regions)
EU 24/7 Hydrogen Standard	European Commission	Adopted Delegated Act	Article 4.2.(c) "The renewable liquid and gaseous transport fuel of non-biological origin is produced: (i) during the same one hour period as the renewable electricity produced under the renewables power purchase agreement."	Adopted ▾	EU	<= Hour	Bidding Zone (or interconnected)
US Government 24/7 Target	US Government	Presidential Executive Order 14057	Sec 203 "match use on an hourly basis to achieve 50 percent 24/7 carbon pollution-free electricity"	Adopted ▾	US	<= Hour	RTO (of BA if no RTO)
UK 24/7 Hydrogen Standard	UK Department for Transport	RTFO Guidance for Renewable Fuels of Non-Biological Origin	Para 2.18 "temporal correlation between electricity generation and electricity consumption must be demonstrated. This can be demonstrated over a settlement period of up to 30 minutes"	Adopted ▾	UK	<= 30 min	Bidding Zone
UK 24/7 Low Carbon Hydrogen Standard	UK Department for Business, Energy & Industrial Strategy	Low-carbon hydrogen standard	Sec 8.1.2 "Real time tracking of generation and consumption (temporal correlation) is required across all 30-minute consignments."	Adopted ▾	UK	<= 30 min	Bidding Zone
US Colorado	State of Colorado	MEASURES TO ADVANCE THE USE OF CLEAN HYDROGEN	SUBSECTION (3)(a)(II) "THE MATCHING OF ELECTROLYZER ENERGY CONSUMPTION WITH ELECTRICITY PRODUCTION ON AN HOURLY BASIS"	Adopted ▾	US	<= Hour	Same Load Balancing Area
Hourly Source Reporting Requirement	Government of California	California SB1158	"This bill would require, beginning January 1, 2028, every retail supplier to annually report specified information to the State Energy Resources Conservation and Development Commission (Energy Commission), including the retail supplier's sources of electricity used to serve loss-adjusted load for each hour during the previous calendar year"	Adopted ▾	California	<=Hour	CAISO
Irish Climate Action Plan (24/7 for Large Energy Users)	Irish Government	2023 Climate Action Plan	Pg 134 "More granular certification processes will be required, including 'time stamped' guarantees of origin, so that energy intensive users can demonstrate that they are using zero emissions electricity during the same hour and geographical location to match all of their consumption on a 24-hours a day, seven days a week basis."	Adopted ▾	Ireland	<= Hour	Bidding Zone
German Ammonia Import Tender, 24/7 (900 m€)	German Government	Government Tender	English Summary	Adopted ▾	Germany	<= Hour	Bidding Zone / <500km
Dublin Data Center Hourly Matching	Irish Government / Fingal County Council	Planning Permission Document	he amount of electricity generated by the new renewable energy projects shall be equal to or greater than the electricity requirements of the data centres in operation at any given time.	Adopted ▾	Ireland	<= Hour	Bidding Zone

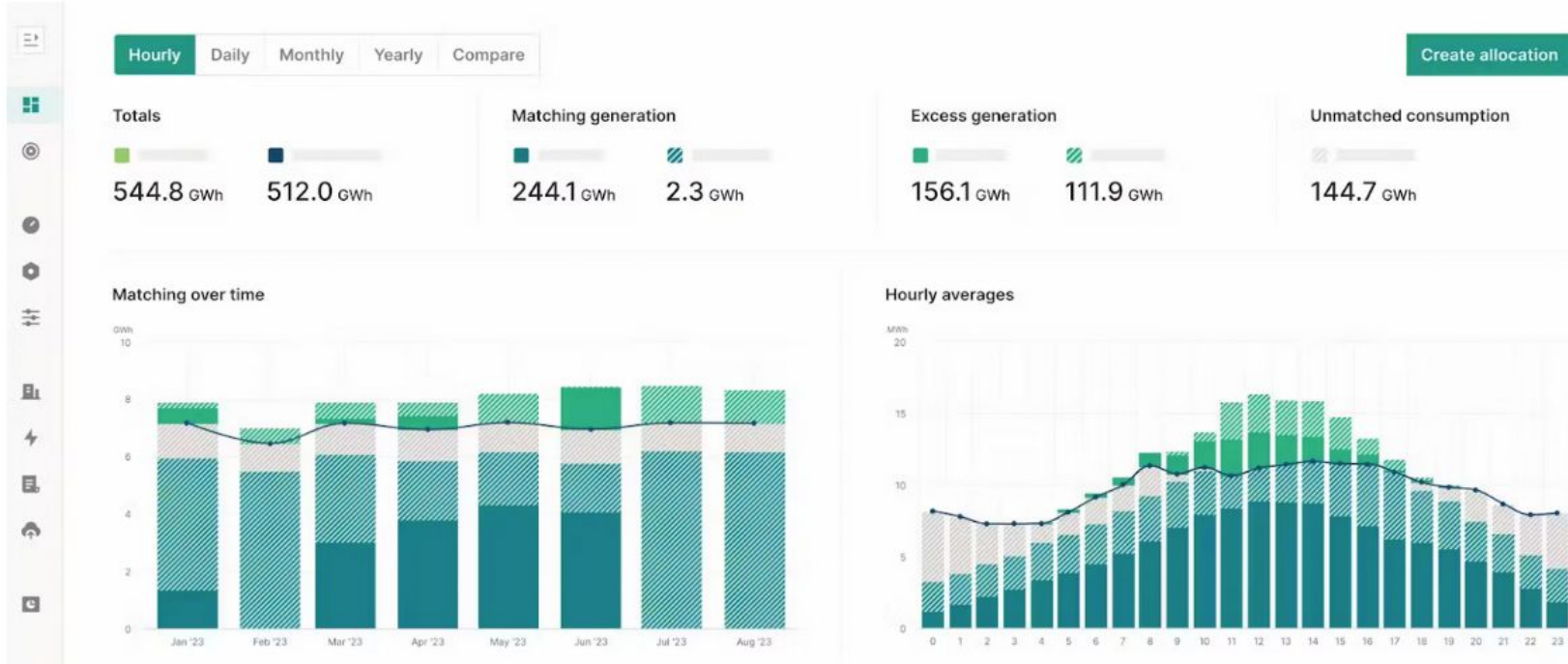
GWs of Granular PPAs Are Signed

Deal	Buyer	Supplier	Volume	Hourly	Region	Deliverable	Additional	Signed In	Techno
Google Virginia 24/7	Google	AES	500 MW	90%	US - PJM	Same Grid	YES	2021	Solar PV, Wind, Li-Ion Battery
Google 24/7 Germany	Google	Engie	152 MW	~80% (by 2022)	Germany	Same Grid	YES	2021	Wind, Solar
Microsoft 24/7 Virginia	Microsoft	AES	576 MW	90%	Global	Bidding Zone	Old/New Assets	2021	Solar PV, Wind, Storage
AES/Microsoft California	Microsoft	AES	165 MW	100%	California, US	Same Grid	-	2022	Solar PV, Storage
US Gov Arkansas	US Gov.	Xcel	278 GWh	100%	Entergy Arkansas	Same Grid	Old/New Assets	2023	Solar PV, Wind, Nuclear, Hydro
Google 24/7 California	Google	SVCE	-	92% (by 2027)	US - California	Same Grid	YES	2022	Solar PV, Wind, Storage, Geothermal
Iron Mountain 24/7	Iron Mountain	NRG	-	100%	PJM, ISONE, NYISO	Same Grid	Existing Assets	2023	Wind, Hydro

What is an Hourly Match?



Hourly Matched Portfolio

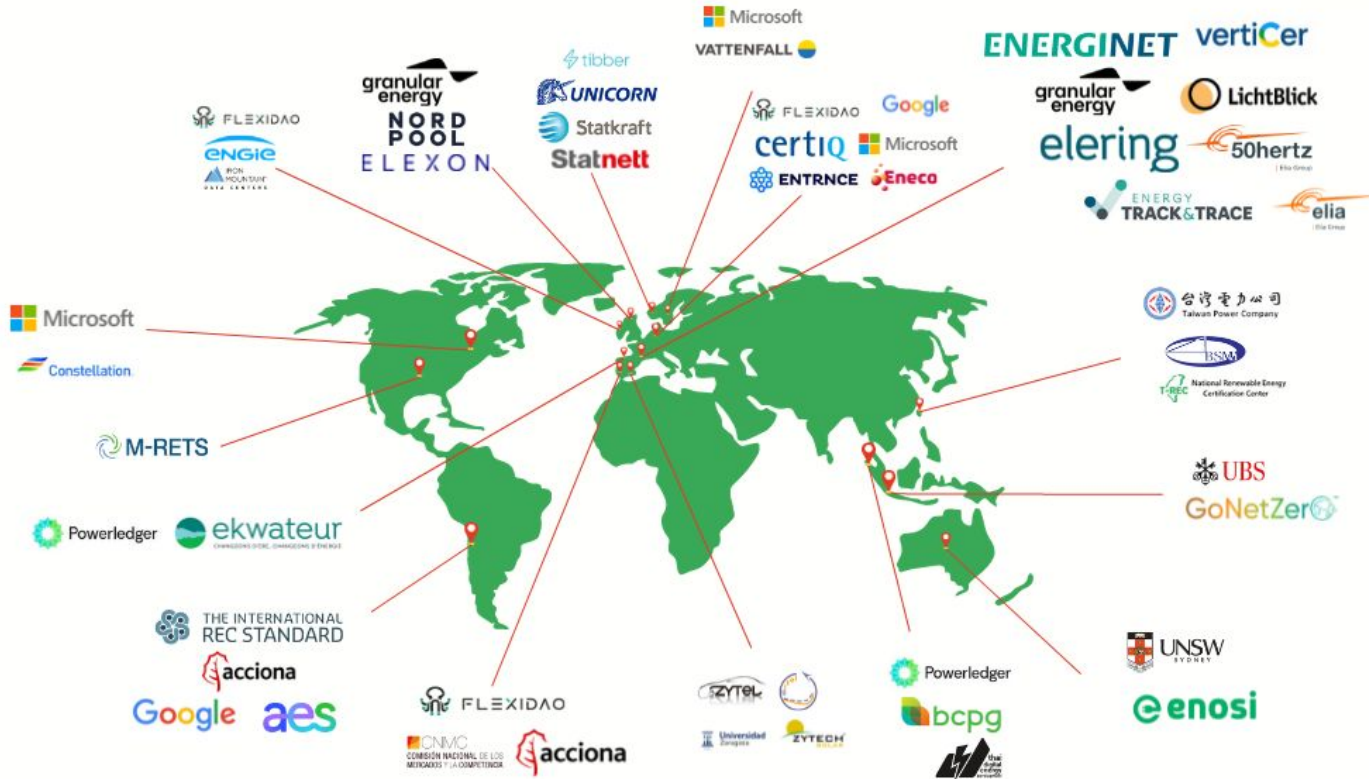


Source : Granular Energy

Millions of MWhs Hourly Matched Already

Valuing
consumer
action

MMR
2024



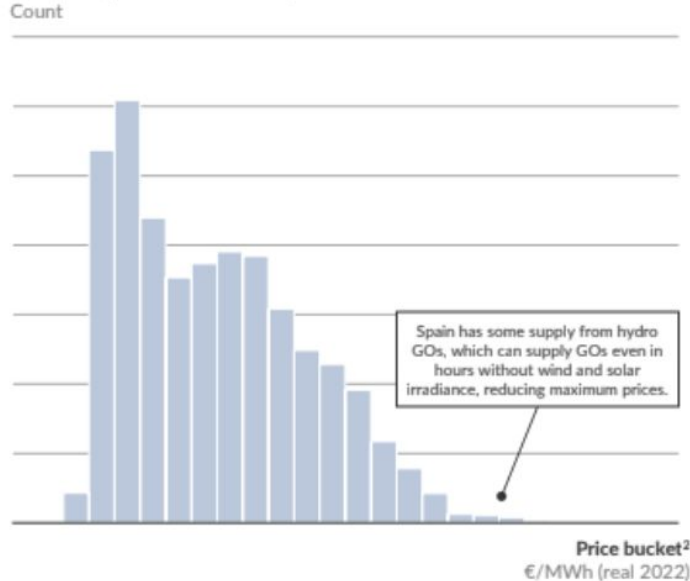
*See "Case Studies" on energytag.org. All doing **hourly** matching on the **same grid**.

Potential Impact of Granularity on Prices

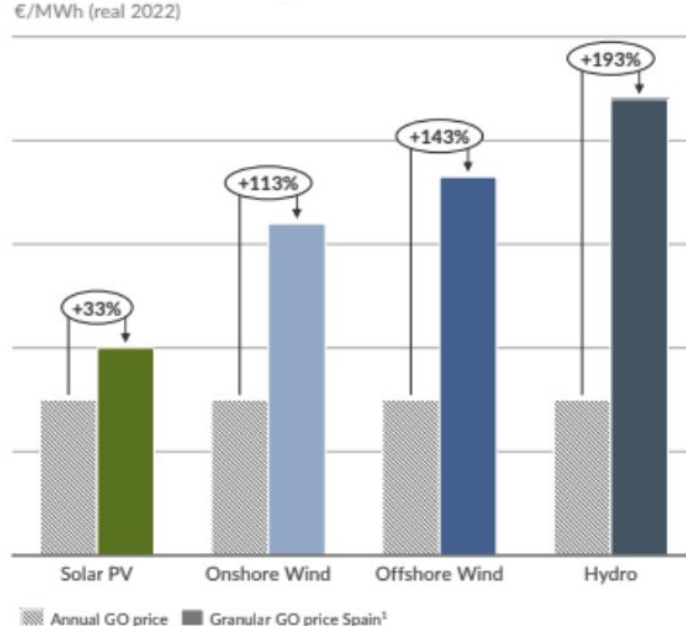
Modelling granular GOs in Spain shows higher granular GO prices and a shift in captured GO prices

AURORA

Hourly GO price distribution in Spain in 2030¹



Hourly GO prices per technology in 2030



Spain

Annual GO price Granular GO price Spain¹

¹ Assuming 100% of electricity demand would ask for GOs; ² The respective price bucket includes all prices up to the number of the previous bucket (i.e. the price bucket for 2 would include all prices above 1 but below, and including, 2 €/MWh).

But, early days. Lot's to do.



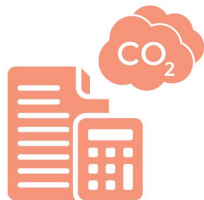
Accelerated EAC Issuer Adoption

Global movement for GC Availability



Continued Regulatory Adoption

Electrification, Corporate Disclosure, Carbon Border



Evolve Global Standards

GHG Protocol, ISO Net Zero, SBTi etc...



Continued Market Uptake

24/7 PPAs GW, GC Trading GWh, Market Design