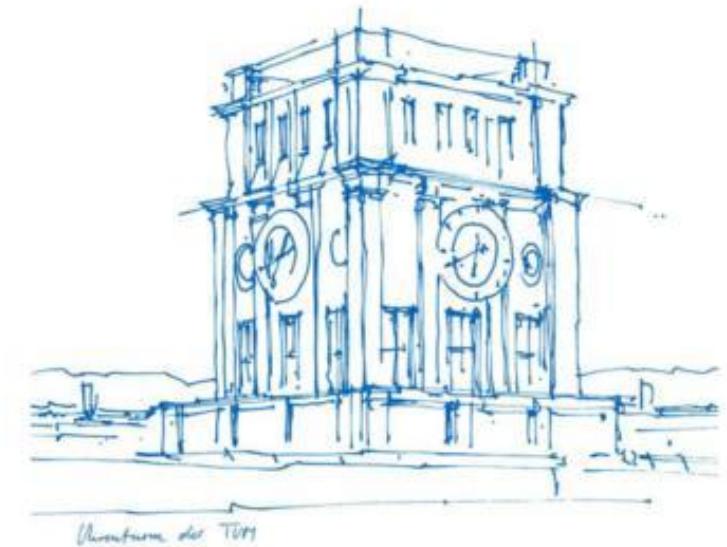


# Advancing Green Electricity Claims with Granular Matching: Motivations, Challenges and Pathways to Successful Implementation

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## Motivation

**Academic literature calls for a revision of the current ‘electricity accounting system’ to improve transparency, better reflect physical availability, and support real emissions reductions.**

NON-EXHAUSTIVE

Prior Work	Focus	Proposed Solutions	Peer-reviewed Journal Paper	Published Working Paper
Mulder & Zomer (2016)	GOs	Impose <b>restrictions on international trade</b> <i>or</i> <b>restrict issuance of new certificates</b>		
Hamburger (2019)	GOs	<b>Consider physical barriers of electricity transport</b>		
De Chalendar (2019)	RECs	<b>Revision in corporate carbon accounting</b> to leverage benefits of different RES at certain times of day		
Herbes et al. (2020)	GOs	<b>Establish environmental standards</b> and minimum criteria for performance via state-led labeling		
Bjorn et al (2022)	EACs	<b>Revision of current accounting guidelines</b> , fearing inflated estimate of the effectiveness of mitigation efforts due to EACs		
Bjorn & Brander (2023)	EACs	<b>Proposal for revision of accounting guidelines</b> on basis of principles that include <b>better reflection of physical availability</b>		
Xu & Jenkins (2024)	RECs	<b>Hourly matching</b> of green electricity production and -demand <b>within same grid region</b> by corporates		
Riepin & Brown (2024)	GOs	beneficial in terms of emission reductions, yet costly		
Langer et al. (2024)	EACs	<b>Hourly matching to reduce system emissions</b>		
Holzapfel et al. (2024)	GOs	Impose <b>restrictions on international GO trade</b> to ensure that each country meets own renewable generation targets <i>or</i> <b>prohibit international GO trade</b> to prevent market distortions <i>or</i> <b>limit GO trade to actual physical electricity transmission</b> to better align EAC accounting with real-world energy flows.		
Scholta & Blaschke (2024)	GOs	Implement <b>seasonal matching as short-term solution</b> and <b>hourly matching</b> as solution <b>in the long run</b>		

## Motivation

**There are already players in the market applying more granular matching practices. The shift towards this approach could further accelerate due to ongoing revisions of relevant regulatory frameworks.**

### 29 EnergyTag Case Studies in 5 continents

**Hourly Matching of Solar Energy with Svea Solar Retail Customers**  
Country: Sweden  
Svea Solar is one of Europe's leading solar companies, with local offices in Sweden, Spain, Germany, Belgium, Netherlands, and Italy. It serves over 33,000 customers. Svea Solar works with software provider Sprout to match solar generation with the selected retail customers and looking at the wider implementation for Svea Solar B2B customers.

**24/7 CFE by 2040 for Data Centers**  
Country: United States  
Cleartrace is providing digital infrastructure to enable 24/7 granular energy matching for data centers in the U.S. with clean energy generation on hourly basis, with a target of 24/7 CFE for all Iron Mountain data centers by 2040.

**24/7 Renewable Supply for Commercial Customers**  
Country: United States  
Cleartrace is matching Brookfield Properties and its tenants electricity consumption with renewable generation on hourly basis, through source-specific access to Brookfield Renewable's 2,800 GWh of hydropower plants in upstate New York.

**24/7 Renewable Supply for Operations**  
Country: United Kingdom  
Cleartrace and EDF partner to provide 24/7 renewable energy to JPMorgan Chase's UK operations. As part of the deal, EDF, Britain's largest producer of zero-carbon electricity, will match JPMorgan Chase's electricity consumption with renewable generation on a 24/7 basis, through source-specific access to EDF's 8 TWh of Power Purchase Agreement portfolio.

**Pilot Project in Green Electricity**  
Country: Germany  
Based on its Energy Track & Trace registry, the transmission system operator 50Hertz has started a pilot project in Germany to enable hourly level transparency on green electricity sources.

**Hourly Clean Energy Matching for Business Customers in Japan**  
Country: Japan  
JERA Cross, a wholly-owned subsidiary of JERA, is launching a service in Japan to monitor and verify the carbon energy sources used by business customers on a monthly basis. The service, based on the EnergyTag standard and in collaboration with Flexidao and the University of Tokyo, aims to enhance the accuracy of CO2 emission reporting from energy use.

**Decarbonizing a Global Financial Institution**  
Country: United States  
The Brookfield Renewable + JPMorgan Chase partnership is launching a global corporate sustainability and decarbonization. The pioneering partnership leverages Brookfield's extensive hydropower resources and cutting-edge blockchain technology to meet JPMorgan Chase's goal of sourcing 100% renewable energy for its global operations.

**The Granular Certificate Trading Alliance**  
Country: United States  
The Granular Certificate (GC) Trading Alliance, spearheaded by LevelTen Energy in partnership with AES, Constellation, Google, and Microsoft, has joined forces to develop a pivotal solution in collaboration with ICE to reduce carbon emissions in the power grid.

**Half-Hourly Matching for EV Daytime Charging by Distributed Community Solar Energy**  
Country: United States  
As the Government of Japan funded project, D-Sharing Co., Ltd. and Cyber Source Co., Ltd. developed a distributed energy trading platform connected to nationwide Powergrid smart meter system and, using AI and behavioral insights (rudgel, machine learning) EV daytime charging of consumers with a large number of solar energy prosumers in each region with a smartphone P2P trading application.

**Constellation's Hourly Carbon-Free Energy Agreement with Microsoft**  
Country: United States  
Landmark agreement combines the environmental attributes of up to 35% nuclear power with hourly carbon-free energy matching to help a Virginia data center operate on nearly 100% clean power.

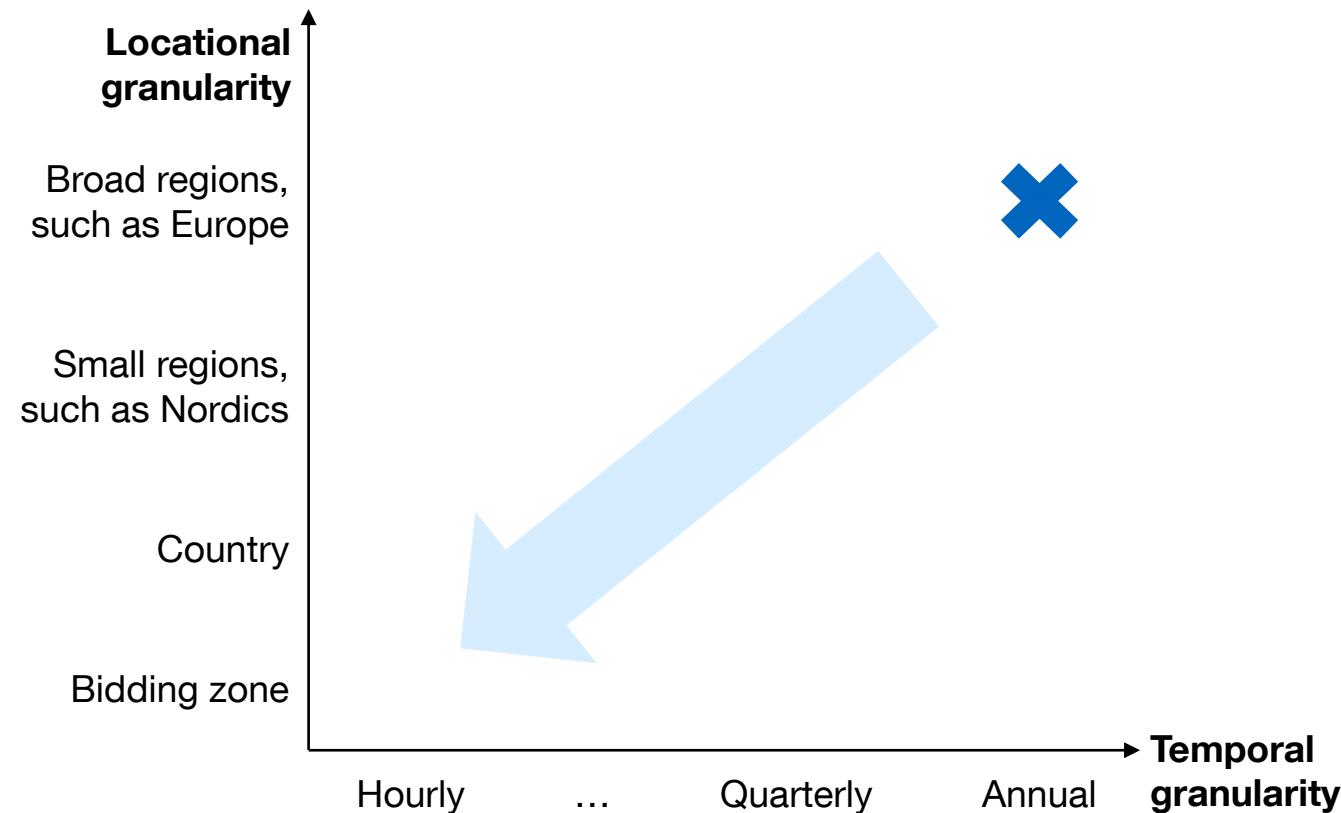
### Scope 2 Revisions GHG Protocol

- **As of now, GHG protocol supports annual matching without hardly any locational restrictions**
- On the agenda for the revision is amongst others the **future of this approach**
- **Strong lobbying efforts** by major tech companies in the U.S. are fueling **public discourse and education**, see exemplarily recent reporting of Financial Times (Bryan et al. 2024)

Source: EnergyTag (2024), WBCSD & WRI (2022), WRI (2015, 2024)

## Theoretical Background

**The term *granular matching* refers to both a temporal and a locational dimension. It is often used interchangeably with 24/7 matching, typically referring to hourly intervals within the same country.**



Source: Own Illustration

## Research Gap & Research Design

**Granular matching could emerge as the future of renewable energy accounting, but research on its implementation is lacking. Pilots in the field offer potential for qualitative case study research.**

### Research Gap:

Little prior literature on the implementation of granular matching

Several pilots on granular matching as of now unstudied in literature



### Research Design:

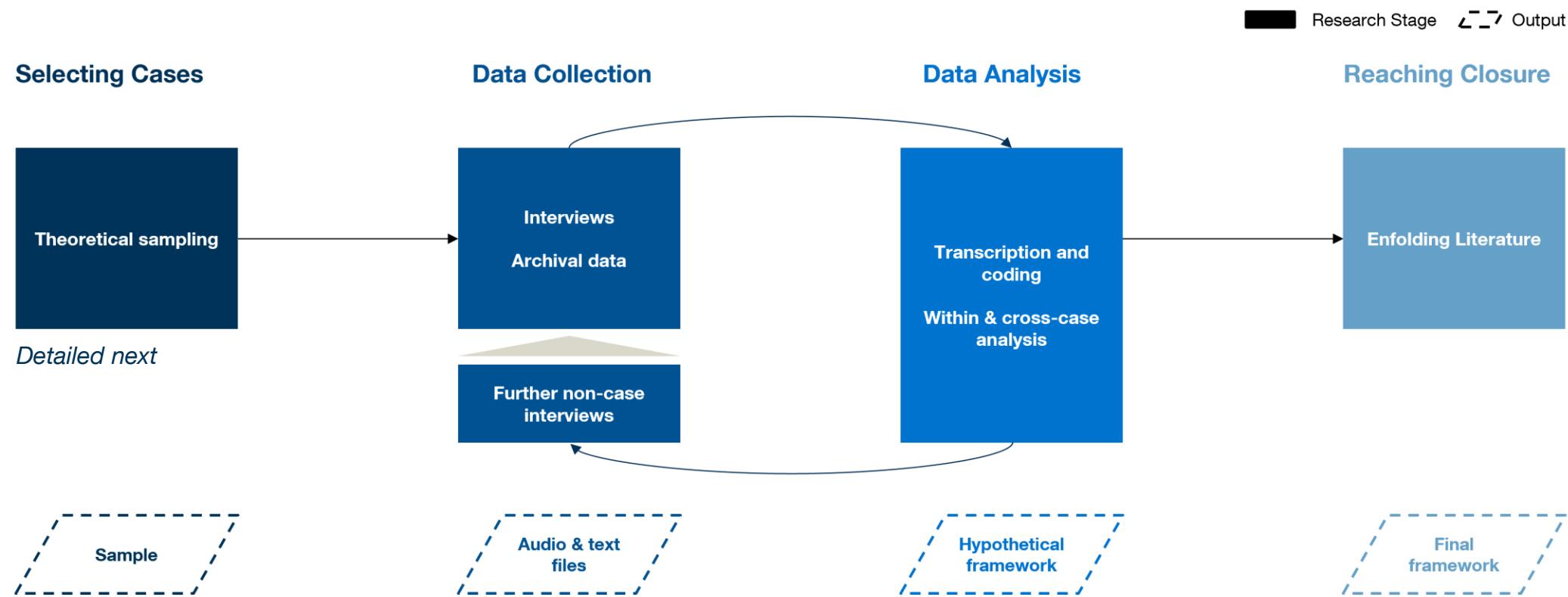
Qualitative multiple case study research on implementation of granular matching following Eisenhardt (1989, 2021) to build theory

- 1) What are the **main motivations** to adopt more granular matching for green electricity claims?
- 2) What are the **key challenges** when adopting more granular matching for green electricity claims?
- 3) **How could more granular matching** for green electricity claims be navigated and implemented successfully?



## Outline of Research Project

**Following the process of case study research, my research endeavor on granular matching passes the following research stages: case selection, data collection, data analysis & reaching closure**

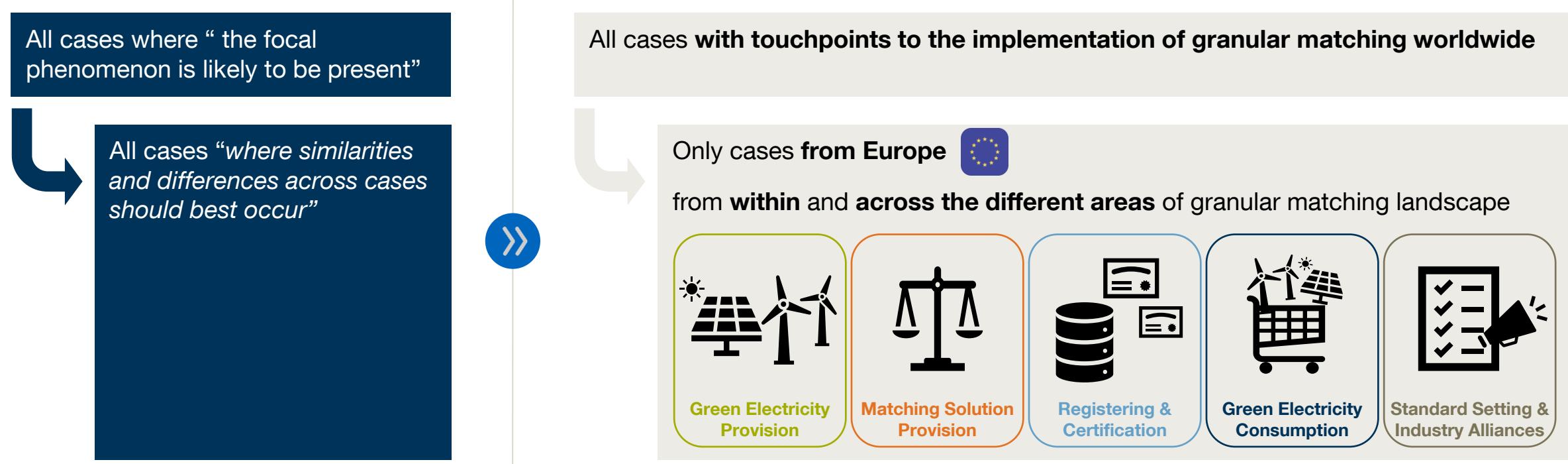


Source: Own illustration based on „Process of Case Study Reserach“ by Eisenhardt (1989)

## Theoretical Sampling

**Building on key sampling principles within the field of qualitative case study research, I theoretically sample my cases via a two-stage process.**

*“There is **no specific formula for case selection**, but rather an appreciation of the need to consider whether the **focal phenomenon is likely to be present** and where **similarities and differences across cases** should best occur” (Eisenhardt, 2021)*



Source: Eisenhardt (1989, 2021); Goia et al. (2022)

## Current Sample and State of Data Collection

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**So far, I have conducted 13 expert interviews. My sample currently covers 11 cases from all areas except that of “Green Electricity Consumption” with the onboarding of further cases ongoing.**

Area	Company	First Touchpoint with Granular Matching	Interviewee Position at Company	Interview Date	Additional Data
Green Electricity Provision	Alpha	2015-2020	Energy Strategy Specialist	25.09.2024	Further documentation of granular matching efforts (where available), such as company press releases, press releases of project partners, EnergyTag case descriptions, company presentations
	Epsilon	2020-2025	Portfolio Specialist	19.11.2024	
	Eta	2010-2015	Business Development Expert	16.12.2024	
Matching Solution Provision	Theta	2015-2020	Partnerships & Policy Lead	17.01.2025	
	Iota	2020-2025	Commercial Operations Manager	31.01.2025	
	Kappa	2020-2025	Senior Executive	18.03.2025	
	Lambda	2020-2025	Commercial Operations Lead	19.03.2025	
Registering & Certification	Gamma	2020-2025	Energy Policy Analyst	15.10.2024	
	Delta	2020-2025	Business Analyst	31.10.2024	
	Zeta	2025-2020	Energy Certification Specialist <sup>1</sup>	10.12.2024	
Standard Setting & Industry Alliances	Beta	2020-2025	Board Representative	26.09.2024	
			Executive Director	25.11.2024	
			Advisory Board Member	12.12.2024	

Note: 1 Interviewee is former employee of case company

## Drivers of Granular Matching

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## Systemic, technological, and regulatory pressures challenge the function and impact of the current GO system.

### Developments Driving the Adoption of Granular Matching



**Pressures on the GO- & Energy System:** Criticism of the current GO system, worsening grid **congestion**, and growing pressure to **align renewable expansion with grid needs**



**Technological & Demand Shifts:** Digitalization & greater **data availability**, and expected substantial **increases in energy demand** in specific sectors



**Regulatory & Societal-Driven Pressure:** Increasing **environmental consciousness** among consumers, and stronger **sustainability regulations** and reporting requirements

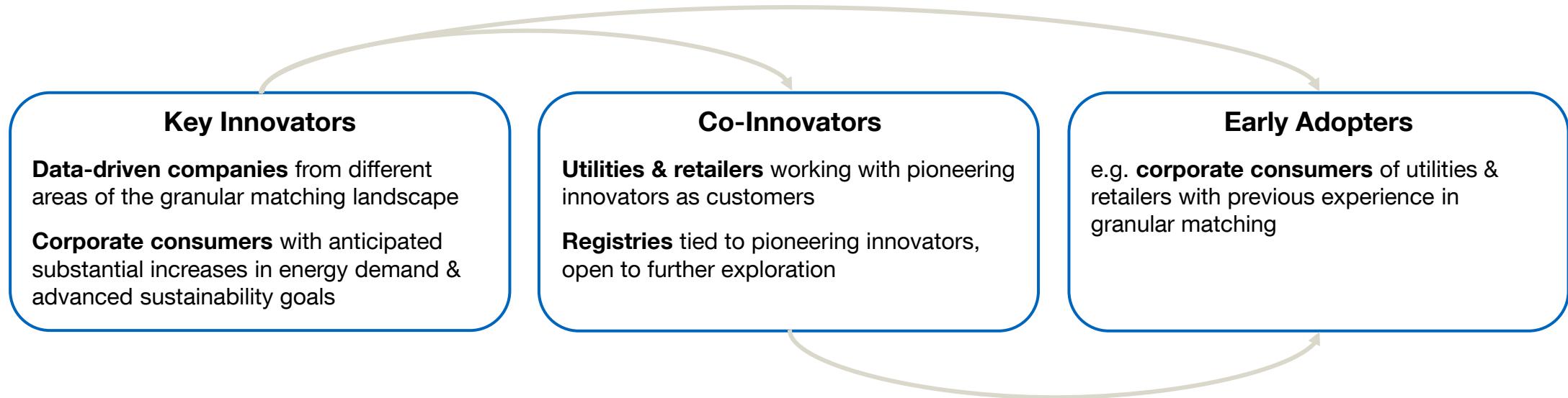
Source: Own Analysis

## Adopters of Granular Matching

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**Key innovators, co-innovators, and early adopters are shaping the emerging landscape, with innovators playing a leading role in initiating the shift toward granular matching.**

## Typology of Adopters in Granular Matching



Source: Own Analysis

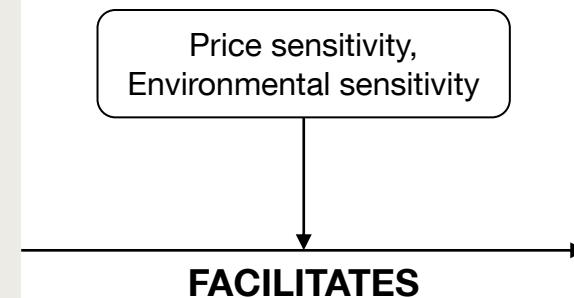
## Opportunities of Granular Matching

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**Granular matching can raise awareness among green consumers and create price signals to drive RES expansion during times of scarcity, support storage adoption, and leverage demand flexibilities.**

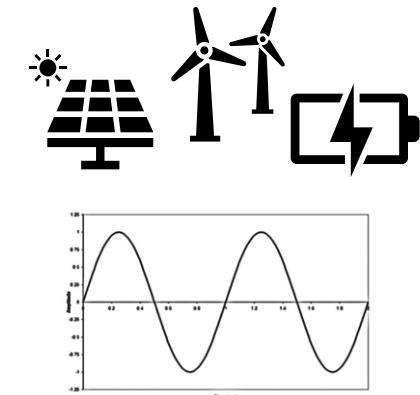
## OPPORTUNITIES

- **Raise awareness among green consumers** for dynamics of renewable supply and demand
- **Create price signals** that reflect real-time imbalances in renewable generation and green demand.



## CONSEQUENCES

- **More renewable** energy generation during times of scarcity
- **Higher battery** & other storage adoption
- Usage of **demand flexibilities**



**Resilient and 100% renewable energy system**

Source: Own Analysis

## Challenges of Granular Matching

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**Granular matching encounters eight challenges across a wide range of areas that must be navigated successfully to allow for a broader adoption.**

### 1 Market Resistance & Institutional Inertia

*“there's a lot of stakeholders and organizations who have been set up to function in today's way of buying green electricity. And [...] then you'll always have [...] push back against change” – Beta 2*

### 2 Regulatory & Policy Challenges

*“customer demand is not yet as high” – Iota; “I think we need a more systemic change there.” – Beta 2*  
**vs.** *“We must make sure that we don't cater this system for the most flexible and most energy-intensive consumers” – Zeta*

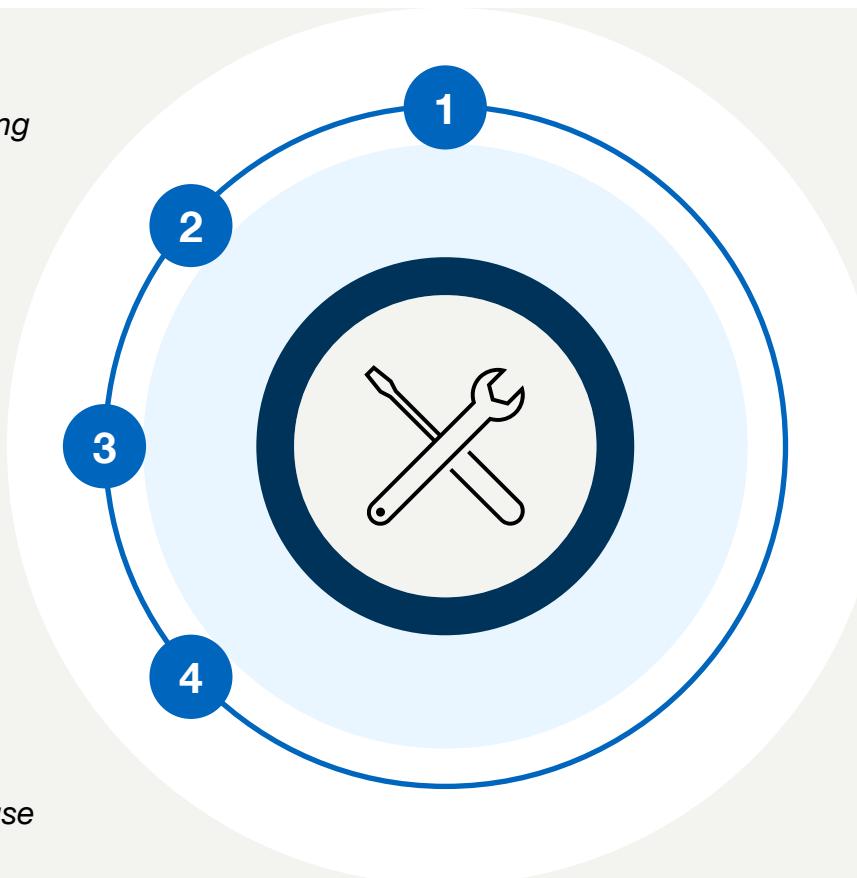
### 3 Awareness & Knowledge Gaps

*“Many companies also don't know what 100% green electricity means, or rather, doesn't mean, and would possibly do more to promote it if they knew.” – Iota; “It's complicated and it requires more of the consumers. So, it's more challenging to explain.” – Alpha*

### 4 Data Governance & Privacy Challenges

*“We need production and consumption data. Unlike the GOs at the moment, [...], we now need data broken down to quarter-hourly or hourly resolution. So, the data needs are exploding in particular because consumers are also coming on board.” – Delta*

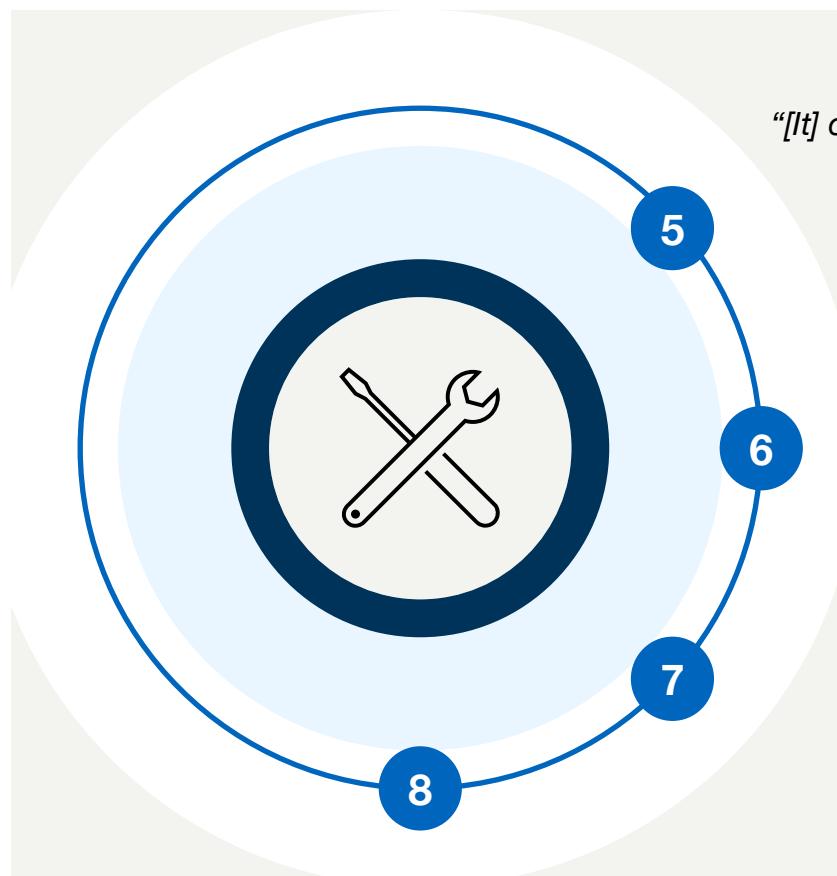
Source: Own Analysis



## Challenges of Granular Matching

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### Infrastructural & Technology Barriers 5

*“[It] comes really to changing the landscape of software architecture of an energy company. [...] we but also all our colleagues are (...) sitting on energy IT- infrastructure from back to two decades in the past”* – Eta

### Operational & Procedural Barriers 6

*“You promised that you would be 100% renewable and you would use only wind. And now you have to back down on that.”* – Alpha

*“New structures are needed, also in coordination with suppliers and plant operators.”* – Delta

### Financial & Economic Constraints 7

*“then they say, ‘oh, but this is extremely expensive. How can I achieve 100% 24/7 with my operation?’”*

*– Theta; “The challenge is actually [...] ensuring that the necessary resources are available to implement it.”* – Delta

### Perceived Risks & Complexity Issues 8

*“So, on one hand, there is a strong fear of technical complexity, which is very present. But once you understand that this is a solved problem and that there is software that can handle it, the effort required is actually not that great.”* – Iota

Source: Own Analysis

## Enablers of Granular Matching

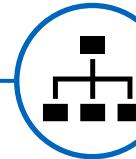
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**While a phased approach creates a practical pathway toward implementing granular matching, internal transformation and strategic partnerships are essential to overcoming increases in complexity.**



### Phased Approach

- Derive **hourly matching score to better understand current position**, instead of aiming to publicly claim 100% match on hourly level
- Use score internally to **strategically improve position**



### Transformation

- Shift from manual to more **automated processes** to avoid exponential increase in effort
- **Rethink IT infrastructure** to facilitate more data-driven way of working



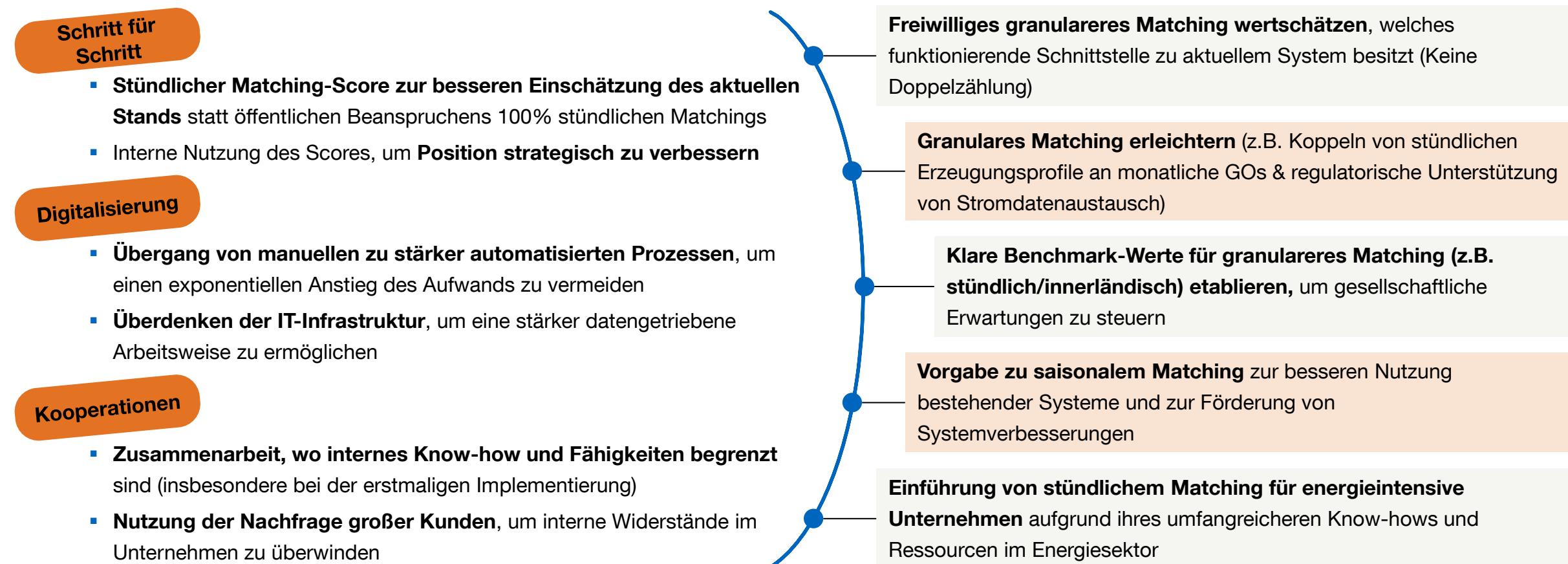
### Smart Collaboration

- Collaborate where internal **knowhow/capabilities are scarce** (especially for first time implementation)
- **Leverage demand from large customers** to overcome firm internal resistance

Source: Own Analysis

## Zusammenfassung und Thesen für die Panel Diskussion

**Eine schrittweise Implementierung, Digitalisierung und sinnvolle Kooperationen können Granularität ermöglichen. Es braucht regulatorische Unterstützung, klare Benchmarks und zielführende Vorgaben.**



Ausblick

GET INVOLVED

## Erfahrungen mit granularerer Bilanzierung von Grünstrom in Europa (zeitlich und/oder lokal)? Nehmen Sie an unserer Studie teil!

**Wir bieten:**

- ✓ **Flexible Termingestaltung:** 60-minütiges Interview via Teams/Zoom zu einem Termin nach Ihren Wünschen im April/Mai 2025
- ✓ **Anonymität garantiert:** Ihre Erkenntnisse werden anonymisiert, um Ihre Identität zu schützen
- ✓ **Früher Zugang zu Ergebnissen:** Erhalten Sie exklusiven, frühen Zugang zu umfangreichen Ergebnissen vor deren Veröffentlichung



**Bei Interesse kontaktieren Sie uns gerne über die unten angegebenen Kontaktdaten!**

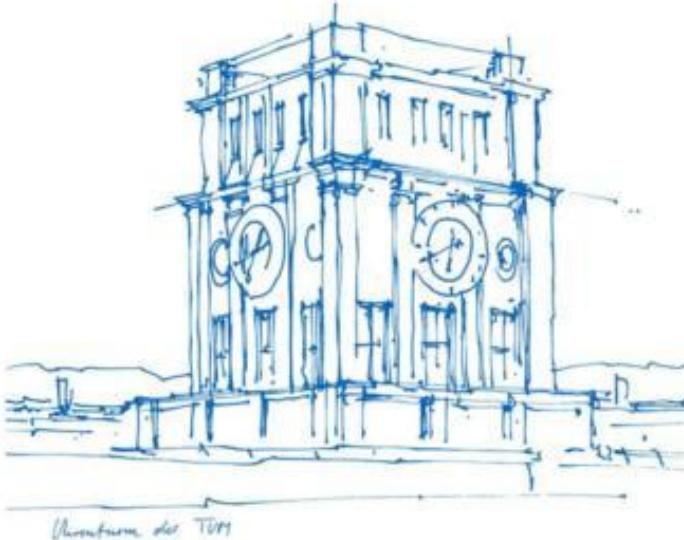


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