

Green Hydrogen Certification for Export to Europe

Compatibility Gap Analysis of European Sustainability Criteria for Renewable Hydrogen Production with the Indian Electricity System

Report by:



Initiated by:



On behalf of:



GOVERNMENT OF INDIA
MINISTRY OF NEW
AND RENEWABLE ENERGY



Federal Ministry
for Economic Affairs
and Climate Action

on the basis of a decision by
the German Bundestag

Imprint

Commissioned on behalf of

Ministry for Economic Affairs and Climate Action (BMWK), Govt. of Germany
Ministry of New and Renewable Energy (MNRE), Govt. of India

Commissioned by

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Version: May 2023

Design and Layout

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Key Findings

- The regulatory uncertainty whether India can be considered as one bidding zone is associated with high investment risks in renewable hydrogen production.
- India's nationwide transmission system can be considered as a "geographical area within which market participants are able to exchange energy without having to allocate capacity" as defined by the EU and can therefore be considered as one bidding zone.
- Electricity exchange between Indian bidding areas is possible nearly without capacity allocation and market splits. The most similar concept to European bidding zones could therefore be India as a country.
- The EU Commission allows renewable hydrogen producers to use national schemes or international voluntary schemes recognised by the Commission pursuant to Article 30(4) of Directive (EU) 2018/2001 to demonstrate compliance with the criteria set out in the Delegated Act. If such a recognised voluntary scheme is approved with the concept of India being considered as a bidding zone, further notification by the EU Commission would be redundant
- If a certification scheme using a methodology that certifies countries like India as a bidding zone is recognised by the EU Commission, the regulatory uncertainty and associated investment risks would be removed.

The motivation behind this report

With its European Green Deal and REPowerEU plan, the European Union has set out ambitious goals to combat climate change and to no longer depend on fossil fuel imports from Russia. Consequently, the EU plans to produce 10 Mio. t of renewable hydrogen within its member states and import 10 Mio. t from third countries in 2030.¹

To have a common understanding under which conditions hydrogen can be considered 'renewable', the Renewable Energy Directive (2018/2001) (RED II) is supplemented by a delegated act (DA) on article 27, which establishes a Union methodology, setting out detailed rules related to the source of renewable electricity used for production of renewable hydrogen.² A second DA on article 28 which is not part of this report, specifies the methodology for assessing GHG minimum required emissions savings from renewable hydrogen (min. 70%).

Although the rules defined in this DA apply for the transport sector only, it is assumed that these definitions will be adopted for other sectors as well. Moreover, these rules will apply to hydrogen produced outside and inside the territory of the European Union. Therefore, the rules are of importance for third countries that want to export renewable hydrogen into the EU, for example India.

Since third countries' electricity system and market design may vary from that of the European Union, the goal of this short study is to point out compatibility issues and uncertainties between the rules set in the DA and energy systems of countries outside the EU aiming to export renewable hydrogen to Europe. Especially the criterion for geographical correlation and more specifically the concept of bidding zones is subject to this study and will be elaborated in detail.

¹ European Commission (2022) p. 10

² European Commission (2023)

Overview of criteria for geographical correlation with a focus on the bidding zone concept

As described above, the DA specifies the conditions under which hydrogen can be considered as renewable. Though the European Union has set goals for importing renewable hydrogen from third countries, producing non-renewable hydrogen or so-called “low carbon hydrogen” is not restricted. Though the production of non-renewable hydrogen is not restricted, only renewable hydrogen will be accounted for emission reduction obligations of EU member states and its industries. The DA clarifies the principle of "additionality" for hydrogen set out in the EU's Renewable Energy Directive. Accordingly, electrolysers to produce hydrogen must be connected to new plants for the production of electricity from renewable sources. According to the DA, producers can demonstrate in different ways that the renewable electricity used for hydrogen production complies with additionality rules. Furthermore, the act introduces criteria to ensure that renewable hydrogen is produced only at times and places when sufficient renewable energy is available, so-called temporal (Article 6) and geographic correlation (Article 7). Suitable locations for electrolysers and electricity generation plants are intended to prevent additional grid expansion requirements. Therefore, electrolysers must in principle be either directly connected with the renewable energy plant or must be erected in the same electricity bidding zone as the generation plant for renewable energies in case of electricity being withdrawn from the public grid.

The geographical correlation condition can be fulfilled if one of the following criteria relating to the location of the electrolyser is fulfilled, as stated in article 7 of the delegated act:

- a. the installation generating renewable electricity under the renewables power purchase agreement is located or was located at the time when it came into operation, in the same bidding zone as the electrolyser
- b. the installation generating renewable electricity is located in an interconnected bidding zone, including in another Member State, and electricity prices in the relevant time period on the day-ahead market referred to in Article 6 in the interconnected bidding zone is equal or higher than in the bidding zone where the renewable liquid and gaseous transport fuel of non-biological origin is produced
- c. the installation generating renewable electricity under the renewables power purchase agreement is located in an offshore bidding zone

If electricity is taken from the grid, it can be accounted as renewable if the electrolyser is located in a bidding zone where the emission intensity of electricity is lower than 18 gCO₂eq/MJ and the hydrogen producers have a renewable power purchase agreement for the used amount of electricity and the conditions of temporal and geographical correlation in accordance with articles 6 and 7 of the delegated act are met. Another case for electricity taken from the grid counting as renewable is if the conditions on additionality, temporal and geographic correlation are met.

Gap analysis

As shown in chapter 2, requirements for producing renewable hydrogen as in RED II are closely linked to the concept of bidding zones (mainly rules on geographical correlation) within the European electricity market. Since importing renewable hydrogen and its derivatives is an essential part of the EU's plan to reach its climate goals, the concept of European bidding zones must be applicable also to third countries without or with different bidding zone concepts.

The European Commission therefore allows hydrogen producers in third countries to rely on equivalent concepts, if the objective of the delegated act is maintained and the most similar concept existing in the third country is used for the implementation. “[...] such concept could be similar market regulations, the physical characteristics of the electricity grid, notably the level of interconnection or as a last resort the country.”²

To elaborate on what concept in India is “most similar” to the EU's concept of bidding zones (and should consequently be used to fulfil the requirements in the DA), this chapter first analyses the definition and reasoning behind bidding zones within the EU's energy system and subsequently the Indian electricity grid to identify compatibility issues.

Bidding zones in the European electricity market

Bidding zones are an integral part of the European electricity market. Within the European Regulation 2019/943 bidding zones are defined as

“[...] the largest geographical area within which market participants are able to exchange energy without capacity allocation.”³

Hence, bidding zones are defined as areas where electricity can be allocated without capacity restrictions. As a result, end consumers in one bidding zone pay the same price for the transmission of electricity.⁴ Furthermore, the allocation of electricity from one bidding zone to another is based on transfer capacities calculated by Transmission System Operators (TSO).⁵ These calculations are based on the physical capacity limitations of the used interconnectors, which serve as connectors for different bidding zones.⁶

³ European Commission (2019) Regulation 2019/942 (2019) Art. 2 point 65.

⁴ FINGRID

⁵ ENTSO-E (2018) p. 9

⁶ 50Hertz

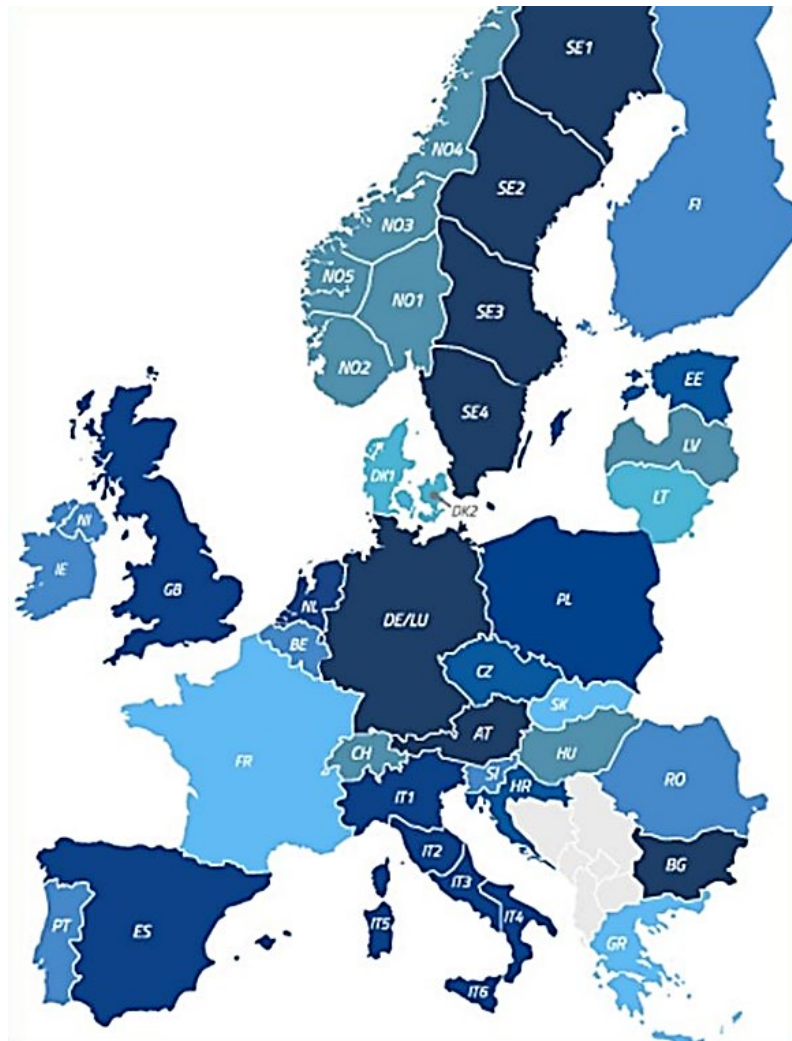


Figure 1 Bidding zones in Europe ⁷

Concept of bidding zones in the context of hydrogen production

Generally, bidding zones reflect structural congestion in the grid. In the case of hydrogen, the geographical correlation between electrolyser and renewables located in the same bidding zone is therefore reasonable. If the electrolyser and the installation generating renewable electricity are located in separate bidding zones with limited transmission capacity between them, electrolysis may depend on fossil-based generation and possibly result in the curtailment of renewable electricity production.

The reasoning behind the definition of bidding zones within the European electricity market sources from limited transmission capacities. Outside of this environment where bidding zone borders are not defined by possible network congestion, rules on geographic correlation (that are based on the European concept of bidding zones) between renewable electricity sources and the electrolyser could be unnecessarily restrictive.

⁷ ACER (2021) p. 6

Overview of the Indian electricity system and market design

India's electricity grid used to be characterized mainly by its unevenly distributed resources for coal, hydro, wind and PV power plants. To supply not only its centralized power demands but also small consumers spread throughout the country, a robust transmission system including the establishment of inter-regional corridors were needed.⁸

In 2013, India achieved their so-called goal of “one nation – one grid – one frequency” – an interconnected comprehensive energy system. However, there were still constraints in freely exchanging electricity due to congestion in the transmission network, leading to market splitting and different market prices in different regions. Following a strong governmental initiative in 2014, to realize a congestion free transmission network, India has become one of the largest synchronous interconnected electricity grids in the world today. Electricity markets are now able to (almost) freely exchange electricity resulting in a single price across different grid areas.⁹

Apart from the inter and intra connected electricity grid, India has established a variety of possibilities to exchange renewable energy within the country and its states. Examples are the Green Day/Term Ahead Markets which exclusively trade certified renewable electricity. Another example is the so called ‘Green Energy Open Access’, a transparent platform through which long term, medium term and short-term open access transactions will be managed and performed to the inter state transmission and intra state transmission system.¹⁰ The scheme also allows consumers to ‘bank’ their purchased renewable electricity monthly. Consumers who have purchased a certain amount of electricity are therefore able to draw electricity from the grid based on their preferred load profile and still account it as renewable.¹¹ The platform assures that renewable energy is not curtailed but fed into the grid.

Gaps between the concept of bidding zones in Europe and the Indian electricity system

As mentioned before, by 2014 congestions in the Indian transmission system were still relatively common resulting in market splits and different prices, which ultimately is still represented by today's so-called bid areas (see Figure 2). In the nowadays very unlikely event of congestions within the transmission grid (0.06 % of unconstrained cleared volumes¹²), affected regions are again split into separate bid areas resulting in different clearing prices of bid areas.

As Figure 2 shows there are 13 bidding zones in India, divided into five regional grids. Considering the EU's reasoning of setting bidding zone borders based on market participants ability to exchange energy without capacity allocation, the country of India can be regarded as one comprehensive bidding zone. Of course, congestions still happen today as roughly 0.06% of electricity cannot be cleared in Power Exchanges, but in comparison to European member states like Germany who has curtailed around 1 % of its renewable electricity

⁸ Ministry of Power (2023)

⁹ Ministry of Power (2023); According to the Ministry of Power volume of electricity that cannot be cleared in Power Exchanges as percentage of Unconstrained Clear Volume has reduced to only 0.06% in 2020-21 as compared to 16% in 2013-14

¹⁰ GRID-INDIA

¹¹ Ministry of Power (2022)

¹² Ministry of Power (2023)

production alone in 2020 and yet is still referred to as one bidding zone (together with Luxemburg), this seems insignificant.¹³

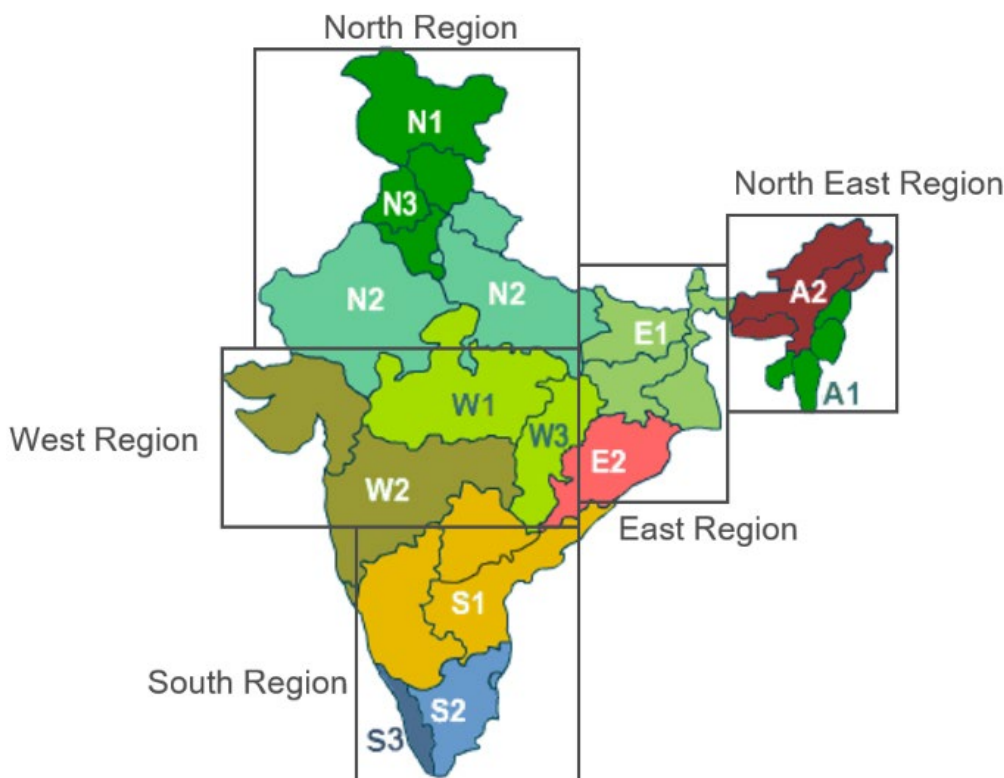


Figure 2. Regional grids and bid areas in the Indian Day-Ahead market ¹⁴

A resulting gap between the EU and the Indian electricity market is therefore a common understanding at what ‘congestion threshold’ interconnected market participants in third countries are still regarded as “exchanging energy without capacity allocation” as per EU definition and can therefore be considered as one bidding zone.

Furthermore, it remains unclear if the concept of India being one bidding zone by EU definition is the ‘most similar’ (as described in the DA) to the concept of bidding zones within the EU. Since some of India’s electricity markets are still organised in so called ‘bid areas’ this could be interpreted as most similar judging by the semantics of the terminology itself. However, the difference to EU bidding zones is, that electricity exchange between Indian bidding areas is possible nearly without capacity allocation and market splits. The most similar concept could therefore be India as a country.

At this point it is worth mentioning that the EU commission allows renewable hydrogen producers to make use of national schemes or international voluntary schemes recognised by the Commission pursuant to Article 30(4) of Directive (EU) 2018/2001 to demonstrate compliance with the criteria set out in the DA. If such recognised voluntary scheme approves the concept of India being considered as one bidding zone, further communication by the EU commission would be redundant.

¹³ assuming 508 TWh net electricity consumption in Germany in 2020 and 6 TWh of curtailed renewable electricity (Agentur für Erneuerbare Energien (2021))

¹⁴ Indian Energy Exchange (2022)

Effect on production costs of renewable hydrogen in India

Making use of India's well interconnected transmission system, vast renewable energy resources and advanced electricity market designs is a crucial factor to further reduce renewable hydrogen production costs. Being able to maximise peak load operating hours of the electrolyser by sourcing electricity from a widespread country with vast renewable energy potentials and without cost-intensive electricity storage means a great location advantage.

Applying current European rules on geographical correlation, this advantage however would not be useable to full extend. To fulfil the geographical correlation, installations generating renewable electricity and the electrolyser must be either located in the same bidding zone or in interconnected bidding zones where the electricity price in the interconnected bidding zone is equal to or higher than in the bidding zone where renewable hydrogen is produced or the installation generating renewable electricity must be located in an offshore bidding zone.¹⁵ This means the location of the installation generating renewable electricity and the electrolyser is not free to choose within India. The electrolyser must be built in a bidding zone close enough to that bidding zone of installations generating renewable electricity to fulfil the geographical correlation.

The levelized cost of renewable hydrogen from a well-balanced electricity procurement portfolio of wind power and solar is around 25% (1.3 €/kg) cheaper than a portfolio of only solar power.¹⁶ The European concept of bidding zones would therefore limit attractive electrolyser locations to those with high wind, solar and hydro potentials. Moreover, to save hydrogen transport costs, installations generating renewable electricity might be built in regions with less favourable wind and solar conditions e.g., in order to make use of a well-located harbour facility.

The regulatory uncertainty whether the country of India as can be considered as one bidding zone, is associated with high investment risks for renewable hydrogen. Being able to use the vast renewable potentials in India to enter PPAs with producers of renewable hydrogen located in other bid areas to build production facilities close to a harbour with sufficient terminal capacities to carry out the export to Europe, would lower production costs of renewable hydrogen and thereby import costs of renewable hydrogen to the EU.

Nevertheless, the EU rules permit the production of hydrogen compliant with Art 27 RED II as well as hydrogen not compliant with Art 27 RED II in the same electrolyser. This gives developers the opportunity to increase the full load hours of the electrolyser and produce more hydrogen at a lower LCOH, which could then be sold to off takers with sustainability criteria different from those in RED II.

It should be also noted that in absence of legally binding versions of the delegated acts, the ongoing German green PTX-tenders under Hint.Co/H₂ Global had defined criteria which match the criteria of the Delegated Acts 27(3) and 28(5) published by the EU Commission on 20 May 2022. In case legally binding versions of the delegated acts are published before the

¹⁵ European Commission (2019)

¹⁶ Frontier economics (2021) p. 34

end of the tender procedure under Hint.Co/H2 Global, the sustainability criteria set in the tender will be overruled by the criteria of the delegated acts.

Conclusion and recommendation for action

The rules of the delegated act complementing Art 27 RED II on counting electricity taken from the grid as fully renewable to produce hydrogen were developed focussing on the European electricity system and market. To ensure that electrolyzers are well integrated into the existing and future energy system without causing additional CO₂-emissions or increasing risks of grid congestions, criteria like geographical correlation were established.

Within the European context, the concept that incorporates this provision best is to require the installation generating renewable electricity and the electrolyser to be located within the same bidding zone. Since bidding zones are defined as “the largest geographical area within which market participants are able to exchange energy without capacity allocation” it is coherent to incorporate this terminology into the rules on renewable hydrogen production.

However, while bidding zones generally reflect structural congestion in the European grid, this is not the case for India. As it turns out, India has a well-connected electricity network with sufficient interconnection between bidding zones. Renewable electricity only markets have been implemented with a functioning certification scheme to guarantee renewable origin. Renewable PPAs between market participants located in different Indian bidding areas are possible without causing congestions.

Considering, that third countries may rely on similar concepts to those of bidding zones in the EU¹⁷, India could rely simply on the provision that electricity from renewable PPAs would have to be proven to be delivered to an electrolyser without causing grid congestion. Since this is the case for market participants throughout the nation, India as a country would qualify as one coherent bidding zone by European definition. Hydrogen producers in India could then make use of the vast renewable energy sources and the well-interconnected transmission grid, lowering production and import costs of renewable hydrogen for the European Union.

¹⁷ Delegated Regulation supplementing Directive (EU) 2018/2001 paragraph 3 (European Commission 2023)

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