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Datasheet for the decision of 30 March 2023

Case Number: T 0639/20 - 3.5.03

Application Number: 15164911.8

Publication Number: 2940296

IPC: F03D7/04, F03D9/00, G05B13/04, F03D17/00

Language of the proceedings: EN

Title of invention:
Systems and methods for optimizing operation of a wind farm

Patent Proprietor:
General Electric Company

Opponent:
Siemens Gamesa Renewable Energy GmbH & Co. KG

Headword:
Wind-farm optimisation/GENERAL ELECTRIC

Relevant legal provisions:
EPC Art. 54, 111(1)
RPBA 2020 Art. 11, 12(3), 12(4)

Keyword:

Novelty - main request (no): incorrect claim interpretation by the opposition division

Admittance of claim requests filed but not examined during the opposition proceedings - auxiliary requests 1 to 5 (yes)

Remittal - "special reasons" (yes): auxiliary requests not examined yet by the opposition division

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Boards of Appeal

Chambres de recours

Boards of Appeal of the
European Patent Office
Richard-Reitzner-Allee 8
85540 Haar
GERMANY
Tel. +49 (0)89 2399-0
Fax +49 (0)89 2399-4465

Case Number: T 0639/20 - 3.5.03

D E C I S I O N
of Technical Board of Appeal 3.5.03
of 30 March 2023

Appellant: (Opponent)	Siemens Gamesa Renewable Energy GmbH & Co. KG Beim Strohhause 17-31 20097 Hamburg (DE)
Representative:	SGRE-Association Siemens Gamesa Renewable Energy GmbH & Co KG Schlierseestraße 28 81539 München (DE)
Respondent: (Patent Proprietor)	General Electric Company 1 River Road Schenectady, NY 12345 (US)
Representative:	Zimmermann & Partner Patentanwälte mbB Postfach 330 920 80069 München (DE)
Decision under appeal:	**Decision of the Opposition Division of the European Patent Office posted on 15 January 2020 rejecting the opposition filed against European patent No. 2940296 pursuant to Article 101(2) EPC.**

Composition of the Board:

Chair	K. Bengi-Akyürek
Members:	K. Peirs
	C. Almberg

Summary of Facts and Submissions

I. The appeal of the opponent (appellant) is against the decision of the opposition division to reject the opposition.

The opposition division deemed that neither the opposition ground under Article 100(a) EPC nor the one under Article 100(b) EPC prejudiced the maintenance of the opposed patent. Given the opposition division's positive assessment of the claims as granted, none of the proprietor's five auxiliary requests filed during the opposition proceedings required consideration by the opposition division.

II. A communication was issued under Article 15(1) RPBA 2020 including the board's preliminary opinion concerning, amongst others, novelty (Article 54 EPC) having regard to the following prior-art document:

D2: US 2009/0099702 A1.

III. Oral proceedings before the board were held on 30 March 2023. The parties' final requests were as follows:

- The appellant requests that the appealed decision be set aside and that the patent be revoked.

- The proprietor (respondent) requests, as the **main request**, that the appeal be dismissed, i.e. that the patent be maintained as granted. In the alternative, the respondent requests that the patent be maintained in amended form on the basis of one of five auxiliary requests re-filed with the

written reply to the appeal (**auxiliary requests 1 to 5**). These five auxiliary requests are identical to the five auxiliary requests mentioned in point I above.

At the end of the oral proceedings, the board's decision was announced.

IV. Claim 1 of the **main request**, i.e. claim 1 as granted, reads as follows (board's feature labelling):

A. "A method (200) for optimizing operation of a wind farm (100), comprising:
(a) receiving (210) new values corresponding to at least some wake parameters for wind turbines (102) in the wind farm (100);
(b) identifying (212) new sets of interacting wind turbines (102) from the wind turbines (102) based on the new values;
(c) developing (214) a farm-level predictive wake model for the new sets of interacting wind turbines (102) based on the new values and historical wake models determined using historical values of the wake parameters corresponding to reference sets of interacting wind turbines (102) in the wind farm (100); and
(d) adjusting (216) one or more control settings for at least the new sets of interacting wind turbines (102) based on the farm-level predictive wake model;
(e) wherein the method (200) further comprises: continually monitoring the wake parameters for the wind turbines (102); and
(f) repeating the receiving, the identifying, the developing, and the adjusting when a change in a monitored value of one or more of the wake

parameters is outside a corresponding threshold".

V. Claim 1 of **auxiliary request 1** includes all the features of claim 1 of the main request and further includes, at the end, the following features (board's feature labelling):

(g) "receiving (202) the historical values of the wake parameters corresponding to the wind turbines prior to receiving the new values;
(h) identifying (204) the reference sets of the interacting wind turbines from the wind turbines based on the historical values; and
(i) determining (206) the one or more historical wake models for the reference sets of interacting wind turbines based on the historical values corresponding to the reference sets of interacting wind turbines,
wherein determining (206) the historical wake models comprises fitting the historical values corresponding to each of the reference sets of interacting wind turbines (102) using a regression-based model".

VI. Claim 1 of **auxiliary request 2** includes all the features of claim 1 of auxiliary request 1 and further includes, at the end, the following feature (board's feature labelling):

(j) "wherein determining (206) the historical wake models comprises computing a ratio of downstream wind speed to upstream wind speed as a function of wind direction at an upstream wind turbine (102), relative locations of upstream and downstream wind turbines (102), and the one or more control

settings corresponding to the upstream wind turbine using the regression-based model".

VII. Claim 1 of **auxiliary request 3** includes all the features of claim 1 of the main request and further includes, at the end, the following feature (board's feature labelling):

(k) "wherein adjusting the control settings comprises sequentially determining the control settings for each of the new sets of interacting wind turbines (102) positioned in the wind farm (100) in a sparse tree structure such that, at each positional level in the sparse tree structure, a combined power output of the wind turbines at that positional level and preceding positional levels in the sparse tree structure is maximized".

VIII. Claim 1 of **auxiliary request 4** includes all the features of claim 1 of auxiliary request 3 and further includes, at the end, the following feature (board's feature labelling):

(l) "further comprising re-adjusting the control settings for a subset of the wind turbines (102) if the control settings determined for the subset of the wind turbines (102) results in a performance parameter that falls outside a permissible limit specified for a wind speed expected at the subset of wind turbines, wherein readjusting the control settings comprises sequentially determining the control settings for each of the subset of wind turbines (102) in a top-down manner".

IX. Claim 1 of **auxiliary request 5** includes features A, (a) to (i), (k) and (l) in this order.

Reasons for the Decision

1. *Technical background*

1.1 The opposed patent relates to a wind farm, such as wind farm 100 having wind turbines 102 and rotor blades 104 (see Figure 1 reproduced below).

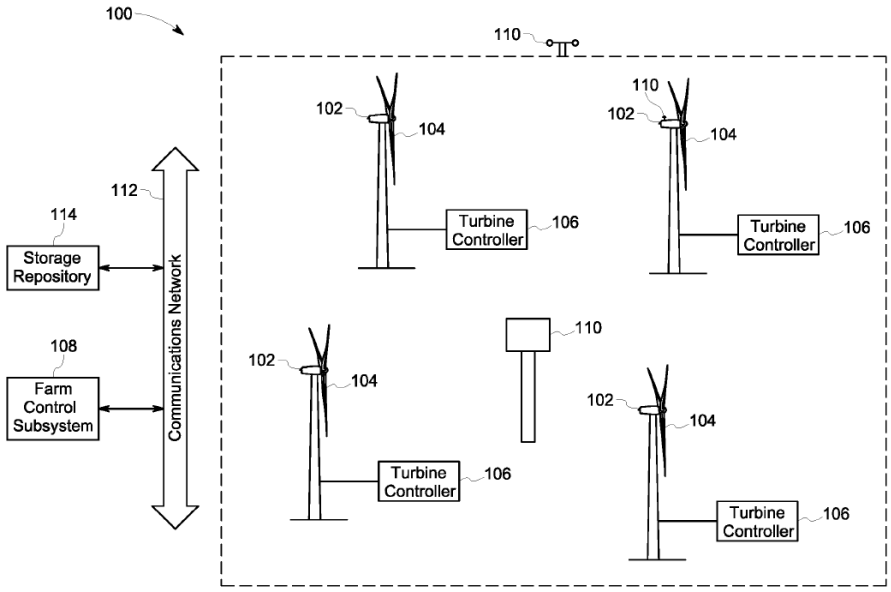

FIG. 1

1.2 The opposed patent particularly concerns wind-energy capture optimisation in such a wind farm. It aims to do so by maximising the wind farm's "annual energy production" while minimising negative effects such as the fatigue load on wind turbines 102. This (constrained) maximisation is supposed to output optimal control settings for wind turbines 102. Using these optimal control settings, rotor blades 104 may, for instance, be swivelled and aligned relative to the

prevailing wind direction.

1.3 The constrained maximisation is based on "farm-level wake models" which involve "wake parameters". These parameters will typically include ambient conditions, geometrical layout of the wind farm and/or operational information of the wind turbines. According to the invention, some of these wake parameters, such as the ambient conditions, are continuously monitored, e.g. by monitoring devices 110. These monitored values are then used to identify aerodynamically interacting sets of wind turbines and to estimate corresponding (set-wise) wake interactions. The set-wise estimation of these wake interactions, in turn, would, according to the opposed patent, make it possible to generate the farm-level wake models in real-time.

2. *Main request: claim 1 - construction*

Throughout the appeal proceedings, the parties have put a particular emphasis on the construction of **features A, (b) to (d) and (f)**. The board construes these features as follows.

2.1 The board agrees with the respondent that the "optimizing" step according to **feature A** can relate to a plurality of goals. As the respondent correctly brought forward, the wind-farm operation optimisation according to the method of granted claim 1 could aim

- to increase the lifetime of wind turbines of the "wind farm" of feature A,
- to maximise the wind farm's energy output or
- to reduce the wind farm's maintenance.

Granted claim 1, however, does not specify any cost function, which the skilled reader would typically expect to be minimised and yield an optimised operation in the sense of feature A. As a result, granted claim 1 does not allow to identify *which* goal the "optimizing" step of this feature is directed to. Similar comments apply to the "farm-level predictive wake model" of **features (c) and (d)**, about which granted claim 1 also specifies no details. The farm-level predictive wake model of these features is a mere "black box" that does not allow to draw any conclusion as to *which* of the wind farm's operational aspects are supposed to be optimised in the claimed method.

2.2 For the reasons set out in points 2.2.1 and 2.2.2 below, the board does not share the respondent's view that the meaning of features (b) and (d) is to be confined to a grouping, resulting in "sets", of wind turbines that interact with each other. Likewise, the respondent could not convince the board that **feature (d)** would require to adjust the control settings for these interacting wind turbines in a set-wise way, rather than for each of the wind turbines individually. The board acknowledges that the first sentence of paragraph [0015] of the opposed patent mentions a "set-wise evaluation" in this respect, but no such evaluation is apparent from claim 1 as granted taken by itself.

2.2.1 In the board's view, feature (b) merely requires to identify, i.e. "to indicate", sets of interacting wind turbines, rather than to (actively) group these wind turbines with the purpose of adjusting their control settings "en masse" within a particular set. The board notes in this respect that the term "set" can refer to a "pair". The second sentence of paragraph [0045] of

the opposed patent is, moreover, in line with this interpretation. This means that feature (b) can, within the wind farm of **feature A**, boil down to a mere identification of those pairs of wind turbines that are interacting under currently prevailing weather conditions.

2.2.2 Moreover, feature (d) is silent about whether the control settings are adjusted for the new sets of interacting wind turbines on an "individual basis", i.e. wind turbine per wind turbine, or whether the control settings are adjusted for all of the interacting wind turbines of a particular new set in one go.

2.3 The board holds that the phrase "developing a farm-level predictive wake model" according to **feature (c)** can, in combination with **feature (f)**, be taken to mean that, for each repetition in accordance with the latter feature, a *new* farm-level predictive wake model is "developed" in the sense that it is "generated" by the claimed method. For each repetition, this "new farm-level predictive wake model" could either be the *same* as before or could be a *different* one. The board acknowledges that, by virtue of feature (c), such generating would have to be "based on the new values" of the wake parameters. However, this does not necessarily mean that the mathematical function underlying the newly generated farm-level predictive wake model must depend, taken by itself, on all of these new values. This can be illustrated by an example which the respondent brought forward during the oral proceedings before the board. In this example, two farm-level predictive wake models were used in the claimed method, one for a *dominant* wind direction (e.g. "North") and another one for a *secondary* wind direction

(e.g. "East"). If the wind changes from "North" to "East", feature (c) could result in a mere change of farm-level predictive wake model, without this model being explicitly dependent on the wind direction.

As an aside, the board observes that the opposed patent is not specific regarding the precise form of this mathematical function. The appellant correctly pointed out that the opposed patent discloses, at most, one single equation that may underlie the "farm-level predictive wake model" of feature (c), namely equation (1) indicated in paragraph [0049] of the opposed patent. The board emphasises that the term "others" in this equation (1) does not necessarily encompass all of the other wake parameters considered in the opposed patent. Moreover, the opposed patent is silent about how the different parameters mentioned in the argument of function *f* of equation (1) are actually weighted. In sum, the skilled reader would understand the "developing" step of feature (c) to encompass more than a mere "updating" in view of currently prevailing weather conditions as suggested by paragraphs [0049] to [0051] of the opposed patent.

2.4 The board further agrees with the respondent's interpretation of the term "reference sets of interacting wind turbines" of **feature (c)** as meaning "certain groupings of upstream and downstream turbines" in the sense that the interacting wind turbines comprised in these reference sets will typically involve one or more *upstream* wind turbines that impact the operation of at least one *downstream* wind turbine. The skilled reader would also readily understand from the expression "historical values of the wake parameters corresponding to reference sets of interacting wind turbines" according to feature (c)

that these "reference sets" must relate to sets that have been determined previously, e.g. when calibrating the "wind farm" of feature A or as determined via the "identifying" step according to feature (b) in a previous iteration of the claimed method.

2.5 Regarding **feature (f)**, the board does not agree with Reasons 12 of the appealed decision that the clause "when a change in a monitored value of one or more of the wake parameters is outside a corresponding threshold" necessarily means that the repeating step of feature (f) would take place *only* if this change is outside the corresponding threshold or when this change would be "significant".

In this respect, the respondent, on the one hand, convincingly argued that the interpretation of the term "when" can have a *temporal* as well as a *causal* aspect. The board holds that the interpretation of the term "when" in the sense of "while" fits within this temporal aspect. On the other hand, the board does not share the respondent's view as to how this clause would limit feature (f): the mere presence of this clause in feature (f) does not necessarily convey to the skilled reader that the "threshold" could not be chosen arbitrarily. Granted claim 1 is, after all, silent about which value to attribute to this threshold. It does, in particular, not mandatorily require to set this threshold to 5% as suggested by the respondent based on paragraph [0054] of the opposed patent.

The skilled reader would, in the board's view, readily understand that this "threshold" according to feature (f) determines the sensitivity of the repetitive scheme underlying granted claim 1: a value close to zero means a *high* sensitivity to changes in

the monitored value according to feature (f), whereas a high value represents a *low* sensitivity, i.e. a more robust scheme.

The skilled reader could, in fact, even eliminate the repetition involved in feature (f) altogether. It would make technical sense for the skilled reader to do so, for instance, when performing a test run of the claimed optimisation method. The respondent correctly argued in this respect that any method for optimising the operation of a wind farm will typically consist of several stages. The time lapse between these stages is not necessarily stringently defined. In one scenario, it could be that, in a first "initial-test" stage, the wind turbines of a particular wind farm are operated with a first set of wake parameters underlying the "farm-level predictive wake model" of feature (c). The board concurs with the respondent that such an "initial-test" stage may last for several weeks and that it can be used

- to gather data on, for instance, blade fouling,
- to perform sensor calibration or
- to study corrosion.

To allow for technically meaningful test results within such a scenario, the skilled reader would, in the board's view, readily choose the "threshold" of feature (f) to be sufficiently high. In this way, the change in the monitored value of any of the wake parameters would always be below this threshold and the control settings would remain the same for a sufficiently long period. The board therefore does not agree with the respondent that a high threshold would be contrary to the purpose of the claimed method to

optimise a wind-farm operation.

3. *Main request: claim 1 - novelty*

3.1 The board holds that paragraphs [0004], [0006], [0008], [0028] and [0030] to [0036] as well as Figure 5 of document **D2** indeed disclose features A and (a) to (f) of present claim 1.

3.2 The respondent questioned the disclosure of **features (b) to (d) and (f)** by document D2. The board makes the following comments in that regard:

3.2.1 In particular, feature (b) is disclosed in paragraph [0033] of D2 in view of three clauses, namely (emphasis added in all three clauses):

- "[t]he second component of the algorithm determines which upstream turbine 12 causes a wake";
- "[a]ny upstream turbine 12 that does not cause a wake that impacts a downstream turbine 14 will not be adjusted";
- "[t]he sequence of turbines to be switched is also determined by the algorithm".

These clauses necessarily imply the identification of *new* sets of interacting wind turbines. Otherwise, the wake optimisation algorithm shown in paragraphs [0032] to [0035] of D2 could not recognise which turbines need to be adjusted and in which sequence this should occur. The board was not convinced by the respondent's argument that the "set-wise analysis" according to paragraph [0015] of the opposed patent differed from what the respondent referred to as the "classical analysis" of paragraph [0033] of D2. This is because the first two sentences of this latter paragraph

identify those downstream wind turbines 14 that are affected by the wake of a particular upstream wind turbine 12. In agreement with the board's construction of feature (b) as explained in point 2.2.1 above, this means that "new sets of interacting wind turbines" are likewise identified in the system of D2.

3.2.2 Feature (c) is shown by the wake optimisation algorithm described in paragraphs [0032] to [0035] and illustrated by Figure 5 of D2. The latter unequivocally teaches in combination with paragraph [0034] of D2 calculating new turbine settings based on a look-up table which is based on inputs such as "ambient wind conditions" and "turbine operating parameters". These inputs are in turn continuously measured and (at least partly) predicted as set out in paragraphs [0028] and [0031] of D2. The new turbine settings allow "*to increase overall windpark [i.e. farm-level] energy capture*", as is apparent from paragraph [0034] of D2. The board holds that this look-up table is the place where the "farm-level predictive wake model" underlying D2's wake optimisation algorithm is stored. This is similar to how "historical wake models" are stored according to paragraph [0052] of the opposed patent. Moreover, the "look-up table" according to paragraph [0034] of D2 is updated in an *iterative* fashion. By definition, an iterative approach calculates *new* values of a particular parameter (set) based on *previous* values of this parameter (set). The skilled reader would thus understand that the iterations in D2 must correspond to different cycles of executing the wake optimisation algorithm in which the meteorological and turbine operating conditions, i.e. the "wake parameters" of features (a) and (c), are continuously detected as explained in paragraph [0031] of D2. It would further be immediately apparent for the

skilled reader that, during normal operation, only a sub-set of the look-up table's inputs will have to be updated during a particular cycle. As a result, in each cycle, the look-up table will be based on "new values" and on "historical values of the wake parameters". The latter constitute, by virtue of being stored in the look-up table, "historical wake models" which were determined during the *previous* cycles of the iterative approach. These previous cycles must, again by definition of an *iterative* approach, have identified their own sets of interacting wind turbines as set out in paragraph [0033] of D2, which correspond to the "reference sets" of feature (c) as construed in point 2.4 above. It goes without saying that these reference sets will include "historical values of the wake parameters" associated with them. These historical values will, in turn, determine "historical wake models" according to feature (c).

The respondent contested that the term "iterative fashion" of the last sentence of paragraph [0034] of D2 would necessarily involve a calculation of *new* values based on *previous* values. Rather, in the respondent's view, this term was to be construed, on the basis of the Merriam-Webster dictionary and within the context of D2, as a mere "repetition" without any renewed identification of "sets of interacting wind turbines". The respondent concluded that D2 did not directly and unambiguously disclose the "reference sets" of feature (c).

The board is not convinced that the skilled reader would indeed consider the terms "iterative" and "repetitive" to be equivalent, even if the notorious "man in the street" would arguably do so. This is because the skilled reader from the field of

optimisation algorithms such as the algorithm disclosed in paragraphs [0032] to [0034] of D2 would have no doubt that the former term comprises the connotation of obtaining successively closer approximations to the solution of a particular problem, which the latter term does not have. Moreover, it would also not make any technical sense for the skilled reader to simply repeat the three components of the wake optimisation algorithm of paragraphs [0032] to [0034] of D2 for each and every change in the meteorological (i.e. ambient-wind) conditions and wind-turbine operating parameters that play a role in that wake optimisation algorithm. For instance, if a downstream wind turbine's operating status is changed from *not running* to *running*, the skilled reader would immediately understand that the second component of the wake optimisation algorithm need not be repeated for each and every wind turbine of the wind farm. Rather, it would be unequivocal for the skilled reader that only those *upstream* wind turbines 12 that could cause a wake impacting the now running *downstream* wind turbine will be identified to form part of the new sets of interacting wind turbines. All other sets of interacting wind turbines which are not affected by switching on the downstream wind turbine would remain the same as determined before this switching on. Therefore, the skilled reader would immediately dismiss the respondent's interpretation of the term "iterative" as an academic rather than a practical one. Therefore, D2 in fact discloses the "developing" step according to feature (c) in the same sense of "updating" as defined in paragraphs [0049] to [0051] of the opposed patent (cf. the last paragraph of point 2.3 above).

3.2.3 Furthermore, feature (d) is palpably disclosed in paragraphs [0030], [0031] and [0034] of D2.

3.2.4 Lastly, feature (f) is also disclosed by virtue of the "iterative fashion" according to paragraph [0034] of D2. As apparent from the term "turbine operating parameters" in the penultimate sentence of this paragraph, this iterative update is triggered, for instance, if there is a discrete change in the wind-turbine operating status, e.g. from *running* to *not running* or *vice versa*. Such a discrete change will evidently be outside of some non-zero value. The board also notes, for the sake of completeness, that the "repeating" step according to feature (f) is not necessarily performed and therefore does not necessarily limit the claimed method under all circumstances that would occur to the skilled reader (cf. the last two paragraphs of point 2.5 above).

3.3 Hence, the board agrees with the appellant that claim 1 as granted lacks novelty (Article 54 EPC), contrary to the opposition division's conclusions.

4. *Auxiliary requests 1 to 5: admittance*

4.1 The appealed decision was not based on auxiliary requests 1 to 5 within the meaning of Article 12(2) RPBA 2020 ("on which the decision under appeal was based") for the simple reason that the opposition division rejected the opposition, i.e. allowed the respondent's higher-ranking main request (cf. appealed decision, point 7). Therefore, the respondent was supposed to *demonstrate* that these requests were admissibly filed and maintained in the proceedings before the opposition division (Article 12(4), first sentence, RPBA 2020). If this is done, these auxiliary

requests form part of the appeal proceedings and cannot be regarded as an "amendment". Moreover, Article 12(3) RPBA 2020 requires that the written reply to the appeal contains the respondent's "complete appeal case" and specifies "expressly all the requests relied on".

4.2 In the case in hand, however, the respondent did not make any submissions to that effect in its written reply to the appeal. Only in its response to the board's preliminary opinion under Article 15(1) RPBA 2020 did the respondent address that matter by contesting the board's discretion not to admit auxiliary requests 1 to 5 (letter of 3 March 2023, pages 4 to 6). Therefore, the five auxiliary requests on file are to be regarded as "amendments", and may be admitted only at the discretion of the board (Article 12(4) RPBA 2020).

4.3 Given that, in the present case, the board is convinced without any burden that the respondent indeed admissibly filed and maintained the present auxiliary requests during the opposition proceedings (albeit not *demonstrated* with the written reply to the statement of grounds of appeal), and since the fact that the opposition division did not need to examine and decide upon those requests cannot be imputed to the respondent (cf. point I above), it seems to be just and fair to admit them into the proceedings.

4.4 Hence, the board decided to admit auxiliary requests 1 to 5 into the appeal proceedings (Article 12(4), second sentence, RPBA 2020).

5. *Remittal of the case to the opposition division*

5.1 Given the extensive claim construction conducted during the appeal proceedings (which deviated substantially from that of the appealed decision), the respondent favoured a remittal of the case to the opposition division. The opposition division could then, in the respondent's view, decide upon the case using the claim construction as adopted by the board (see points 2.1 to 2.5 above). Also, further prior-art documents on file may potentially become relevant for the assessment of novelty and/or inventive step as regards auxiliary requests 1 to 5.

5.2 The appellant had no objections against a remittal to the opposition division.

5.3 In view of the above, it is justified to remit the case to the opposition division, so that the latter may assess the allowability of auxiliary requests 1 to 5 first. In that context, the board only adds that, where Article 56 EPC is considered in that assessment, it could in particular be relevant, for establishing which technical effect e.g. feature (k) credibly achieves over the whole claimed scope, to determine how the skilled reader would construe the term "sparse tree structure" used therein and to which extent this term is indeed reflected in Figure 3 of the opposed patent.

5.4 Hence, "special reasons" present themselves for remitting the case to the opposition division for further prosecution (Article 11 RPBA 2020 and Article 111(1) EPC).

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the opposition division for further prosecution.

The Registrar: The Chair:

B. Brückner K. Bengi-Akyürek

Decision electronically authenticated