Advanced Data Analytics for Next Generation Product Development

by Philip Totaro, CEO of Totaro & Associates www.totaro-associates.com

Companies engaged in both turbine and component design will desire to have foreknowledge of unit sales per product in regional and global markets.

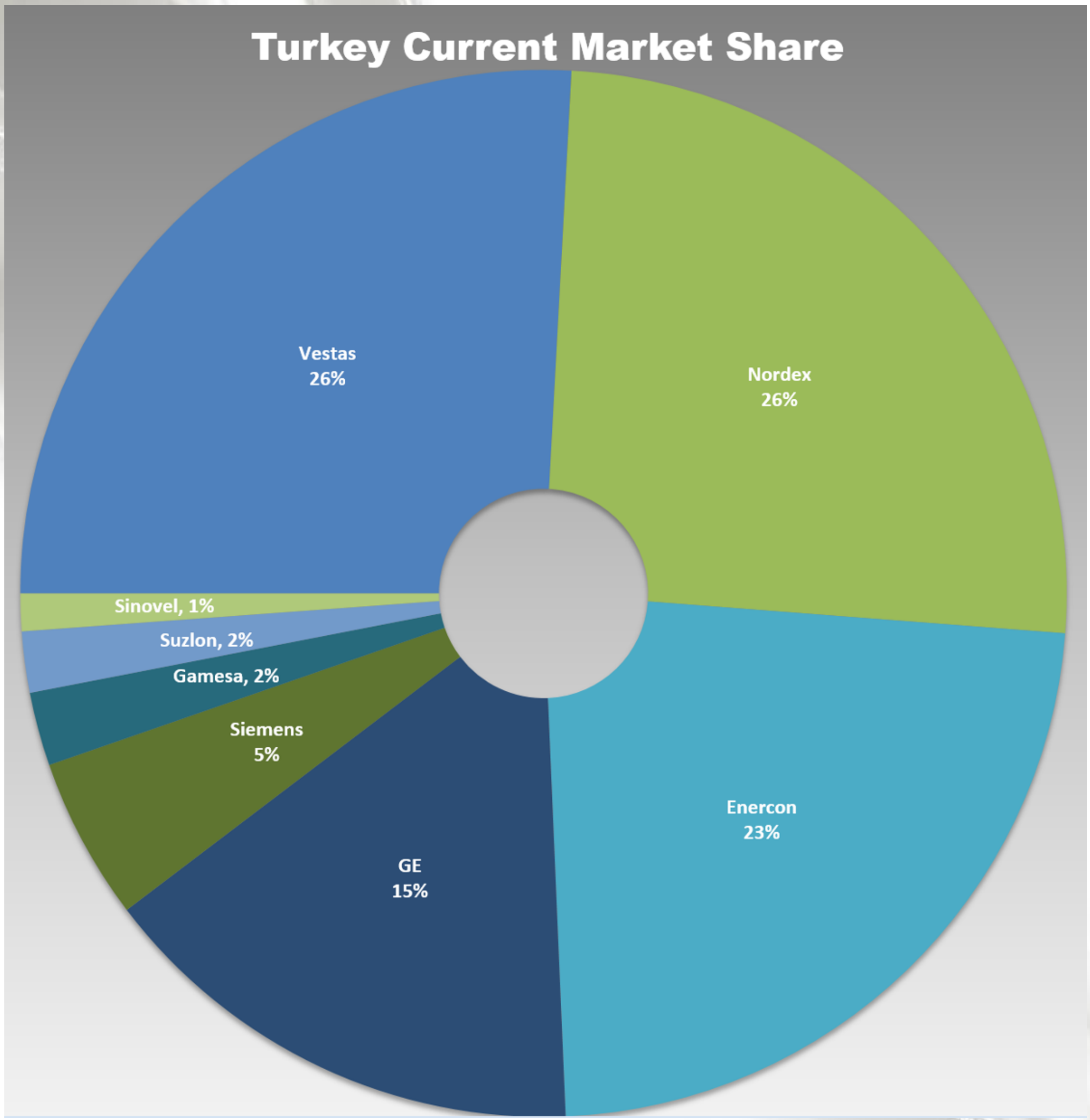
Conventional methods for market size based on economic forecast are outdated, often inaccurate, & fundamentally detached from taking into account critical factors such as available wind resource, known transmission infrastructure, as well as siting regulations for a given country or region.

Data analytics can predict the probability of sales for an existing product portfolio in a given market, or otherwise identify how a specific product platform should evolve in order to maximize market share given regional wind characteristics. These results are obtained from an analysis of the power density evolution and the knowledge about maximum torque capacity of each of the existing platforms available commercially.

The approach begins with a thorough and accurate catalogue of projects in a given market including year of commissioning, capacity, wind class, turbine vendor, rating, and rotor size. From these, we can calculate AEP, Capacity Factor, # of units, power density, and other variables.

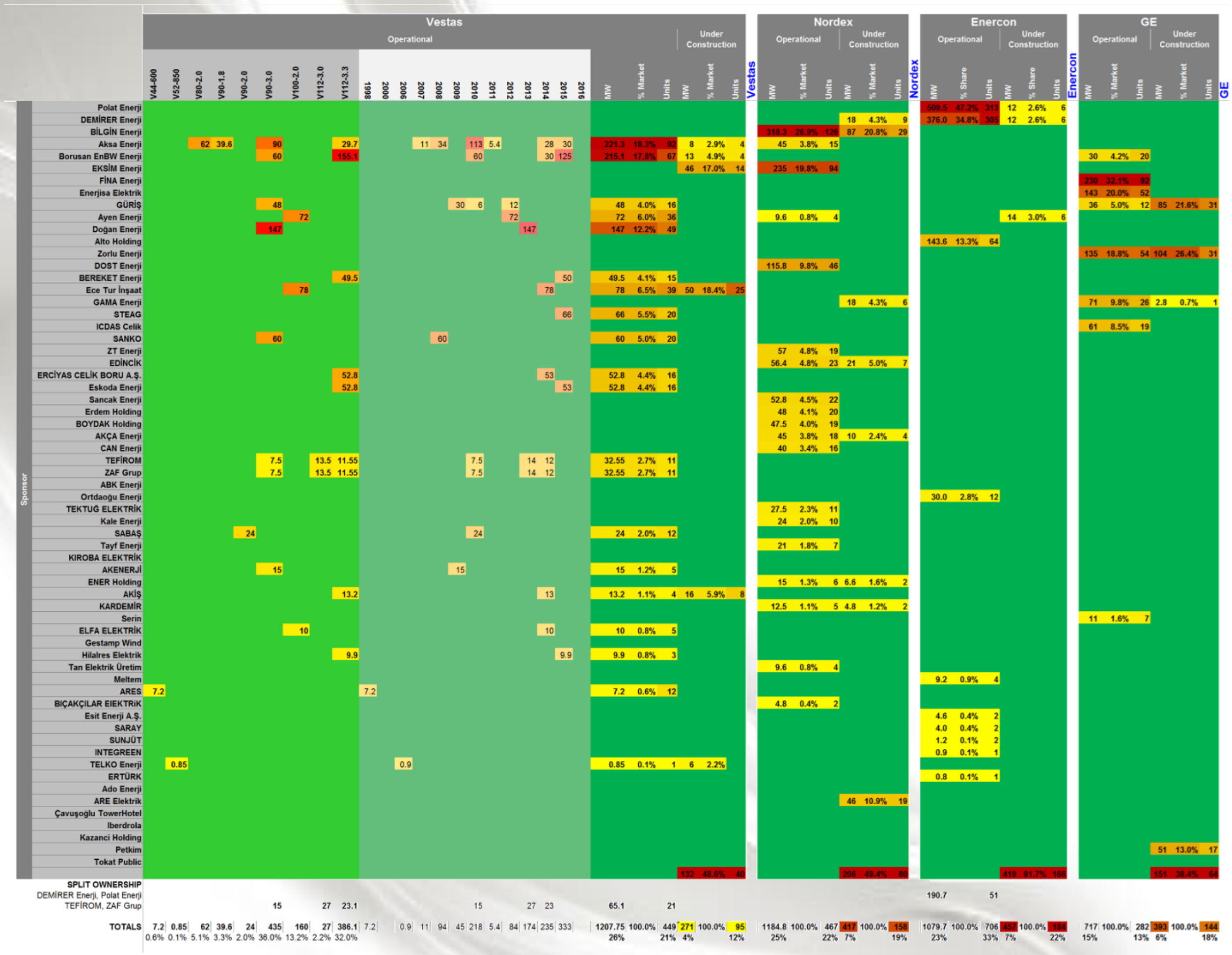
Neuer Wall 80, Floor 4
20354 Hamburg, DE
www.totaro-associates.com

TEL: +49 (0)40 822 138 324
info@totaro-associates.com



These calculated variables are then assembled and sorted in order to identify the time-dependent trend of capacity additions per product, OEM, developer / owner, wind class, region, and country. The heatmap below shows a representative example from analysis of the installed base in the country of Turkey. Annual megawatts, units and market share are all known or calculated from the project database.

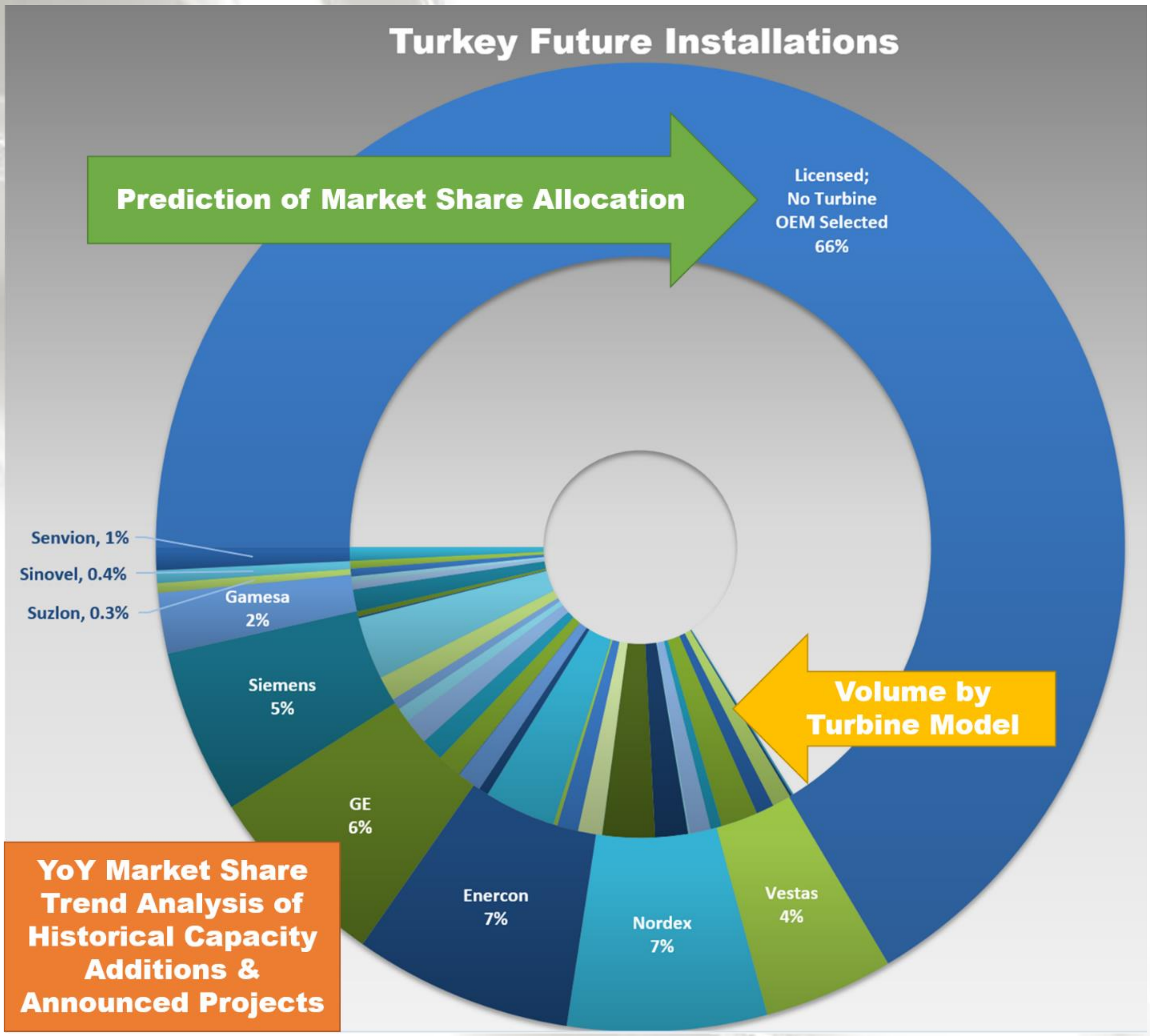
Advisory Note



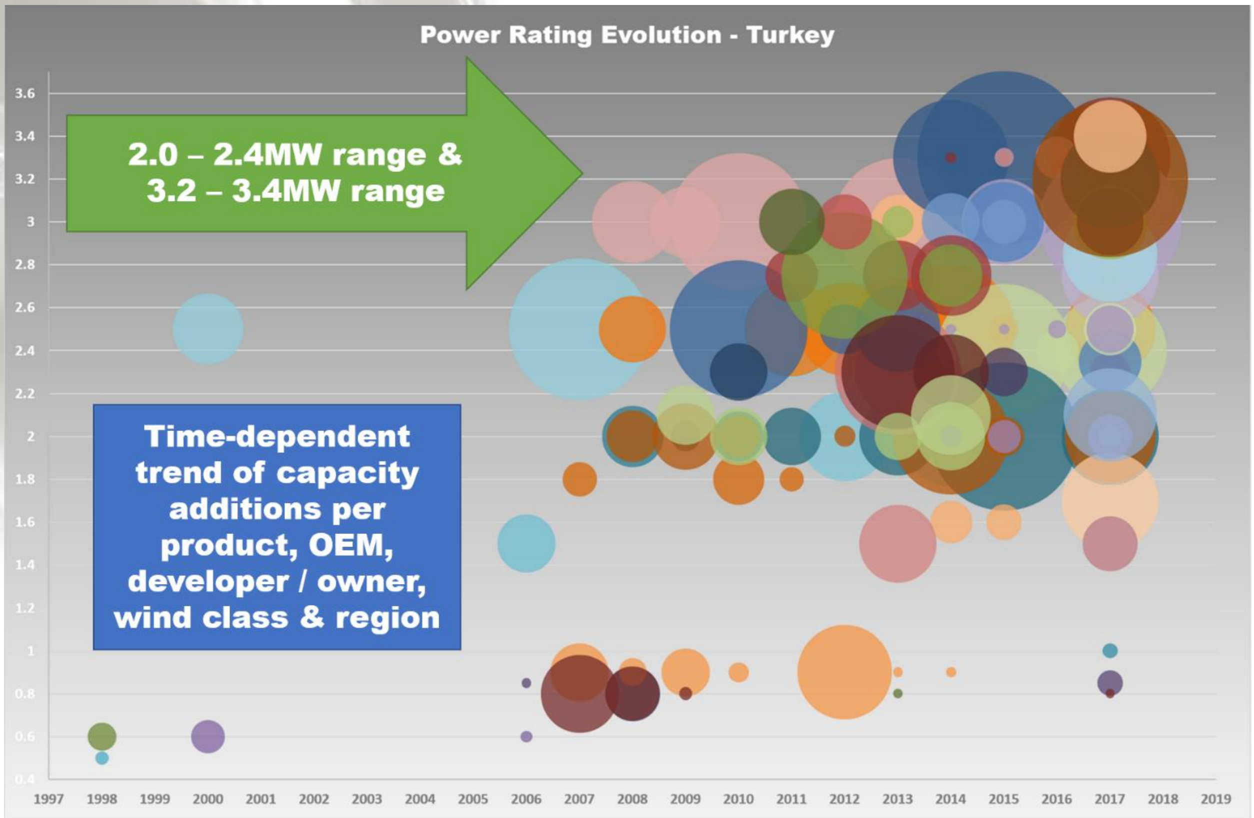
Once the existing installed base is considered, future projects are also catalogued and analyzed. In some cases a turbine vendor has been announced, while in others the license / permit has not yet been made public, so the developer is unknown. Nevertheless, if wind class for a specific project is known, or it can be estimated, the data can be segmented and analyzed for each wind regime.

Neuer Wall 80, Floor 4
20354 Hamburg, DE
www.totaro-associates.com

TEL: +49 (0)40 822 138 324
info@totaro-associates.com



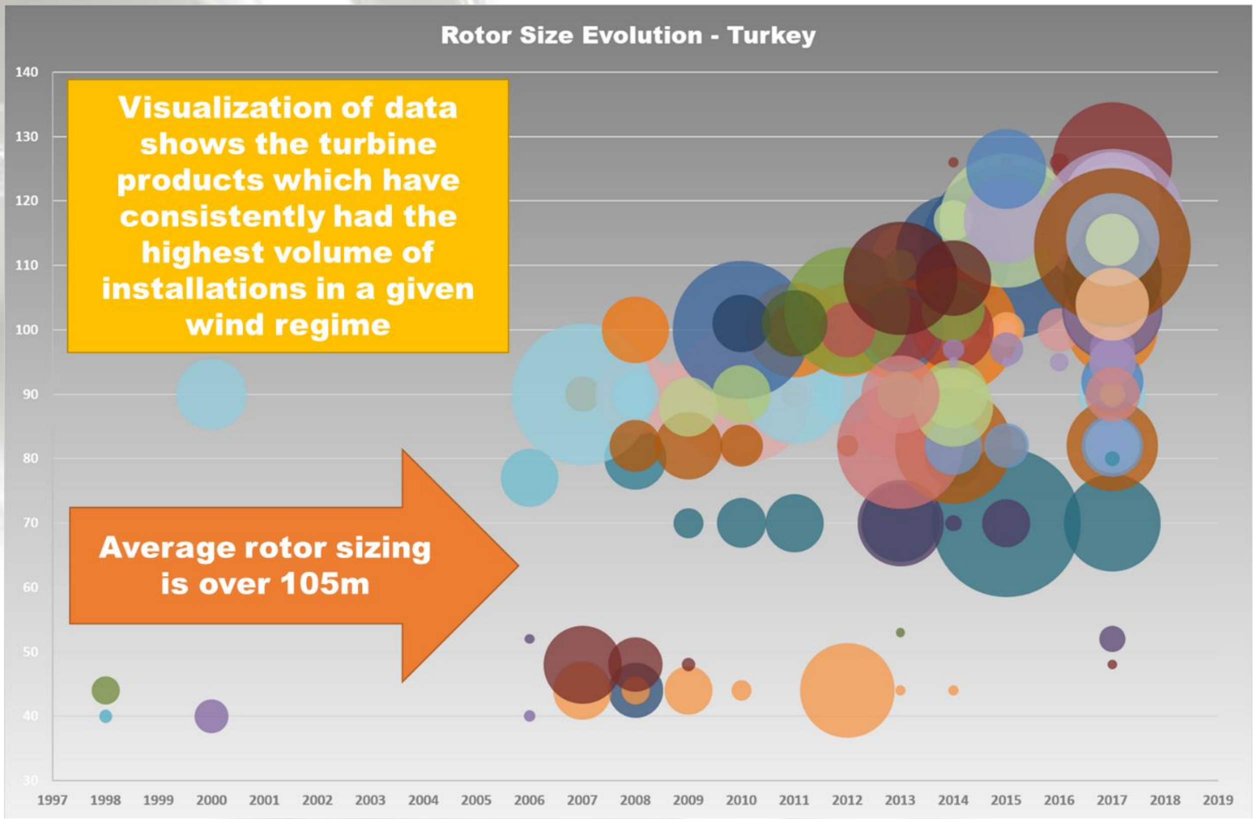
We start the trend analysis and prediction by considering the evolution of power rating. The chart below visualizes this trend, with the bubble centered on the year of installation (x-axis) and the rating of the turbines installed (y-axis). The bubble size corresponds to the MW installed that year.



The results of this indicate the turbine product which has consistently had the highest volume of installations in a given wind regime, or one which is trending by visualizing the growth in bubble size over time. This analysis can be sub-segmented by turbine OEM and competitive product benchmarking is even possible based on the data set.

From the data above it is clear that in this example, there are two distinct competitive product family ranges in the 2.0 – 2.4MW range as well as the 3.2 – 3.4MW range.

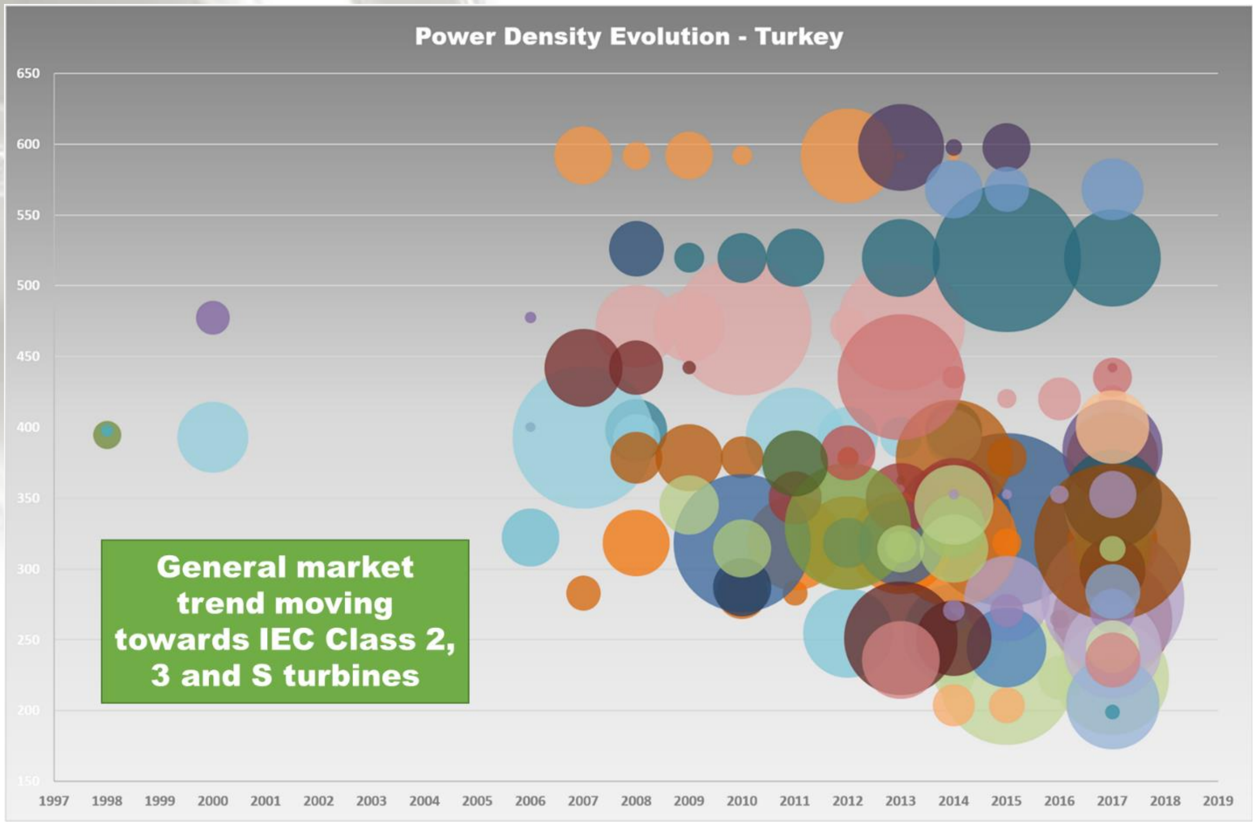
Next, in order to understand more about the key product attributes which have led to sales growth of a specific product regionally, we look at the rotor size evolution. As before, this is visually represented with a bubble chart. The bubble is once again centered on the year of installation (x-axis) but now it corresponds to the rotor size of the turbines installed (y-axis), with the bubble size still equivalent to the MW installed that year.



As before, a general trend in rotor sizing over time can be understood from data analysis. The chart indicates that average rotor sizing for the most competitive turbines in the market is over 105m.

We also desire to investigate the evolution of power density, or the watts per swept area of the rotor. This calculated metric is widely used within the industry as a proxy for the relative efficiency of a given product. For this analysis, the bubble is once again centered on the year of installation (x-axis) but now it corresponds to the power density of the turbines installed (y-axis), with the bubble size still equivalent to the MW installed that year.

While this example of power density is utilized, it is well understood from this approach that the analysis will not cease with these three examples, but can be performed on the AEP, Capacity Factor and so on.



Capacity additions based upon announced projects or quantified wind potential which is co-located with existing or planned transmission is important to accurately calculate. An analysis of the likelihood of capacity additions for wind turbines with a specified power density vs. wind speed range are shown in a probability distribution.

The probability distribution can be used to determine the allocation of new capacity for the 66% of announced capacity in Turkey. These results are obtained from an analysis of the power density evolution and the knowledge about maximum torque capacity of each of the existing platforms available commercially.

Turkey Market Share

Calculate Probability Distribution Based on Regional Wind Conditions

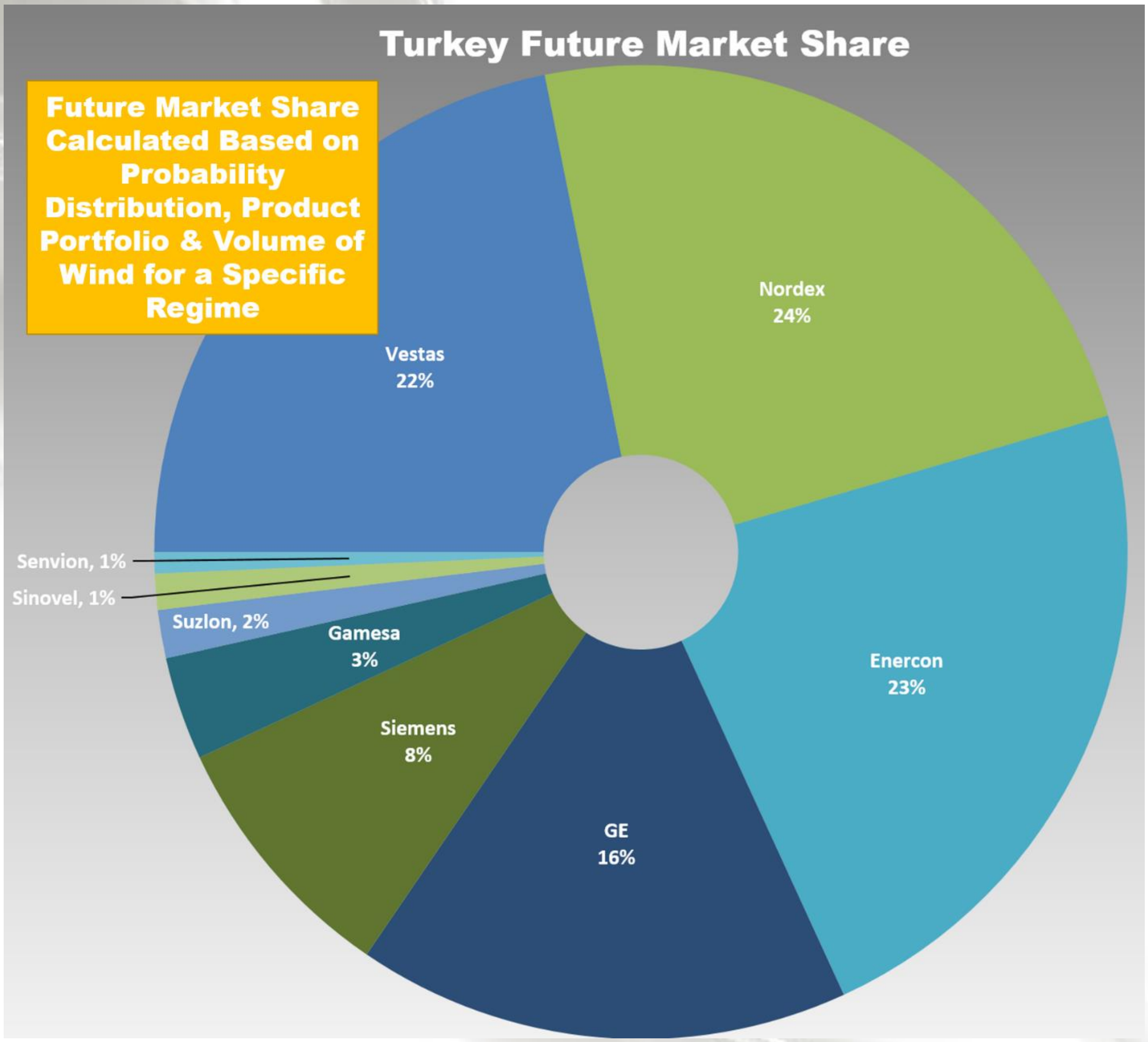
Power Density (W / m²)	Average Wind Speed (m / s) @ Rated Power: 10.0+	9.9 - 9.5	9.4 - 9.0	8.9 - 8.5	8.4 - 8.0	7.9 - 7.5	7.4 - 7.0	6.9 - 6.5	6.4 - 6.0	5.9 - 5.5	5.4 - 5.0
650+	3										
649 - 625	5	7									
624 - 600	12	8									
599 - 575	15	10	8								
574 - 550	18	21	17	6							
549 - 525	21	26	23	4							
524 - 500	26	33	24	13	4						
499 - 475	28	30	24	14	4						
474 - 450	25	27	26	17	5						
449 - 425	22	24	30	18	6						
424 - 400	14	22	30	21	9	4					
399 - 375	8	17	27	28	16	4					
374 - 350	3	15	23	30	24	5					
349 - 325		7	20	32	25	11	5				
324 - 300			12	22	35	16	12	3			
299 - 275				10	16	32	24	16	2		
274 - 250					11	24	38	21	6		
249 - 225						12	18	45	17	8	
224 - 200						1	7	24	36	17	15
199 - 175							3	16	30	32	19

Quantification of likely OEM selection based on this methodology can predict future market share. In this example, the 66% of projects which have been announced but no OEM has been selected can be accurately calculated based upon this probability distribution in conjunction with the wind site characteristics.

The analysis reveals market share drops for some and gains for others based on their product portfolio.

Neuer Wall 80, Floor 4
20354 Hamburg, DE
www.totaro-associates.com

TEL: +49 (0)40 822 138 324
info@totaro-associates.com



Through this analysis, it is also possible to suggest new products which would capture more market share by increasing their contribution according to the probability distribution (i.e. increase rotor diameter & / or rated power). The results indicate that for a specified wind shear and the standard definition of average wind speed in each class, the following are idealized rotor sizing for 2.XMW and 3.XMW families of products.

Wind Class	Power Density	Rating	Rotor Size	Rating	Rotor Size
I	317	2.5	110	3.4	117
II	270	2.3	104	3.2	123
III	228	2.1	108.3	3.0	129.5
S	200	2.1	115	3.0	138

The results of this analysis for one region can be cross-referenced to the results from other regions or countries where wind shear, turbulence intensity and average wind speed are comparable. Given the accuracy of wind site data as well as known transmission infrastructure and siting regulations for a given jurisdiction, it is possible to visualize and calculate total possible installed capacity for a current turbine model with specific product attributes, or alternatively a new product developed with competitive attributes specified by the analytics engine.

Neuer Wall 80, Floor 4
20354 Hamburg, DE
www.totaro-associates.com

TEL: +49 (0)40 822 138 324
info@totaro-associates.com

Correlation with comparable wind site characteristics globally reveals total market projection and volume of anticipated orders. This helps enable funding justification for new product development expenditure.

Power Density	NorthAm	LatAm	EU	MENA	APAC
501 - 600	0.84	0.30	1.26	1.08	2.52
401 – 500	0.78	0.54	0.84	0.96	2.88
301 – 400	0.90	0.60	0.78	0.60	3.12
201 – 300	1.32	0.48	1.14	0.36	2.70
Total	3.84	1.92	4.02	3.00	11.22

Global Sales Volume Projection (in GW) for [OEM Removed for Confidentiality] (2016 – 2020)