



## **World Robot Olympiad 2017**

Regular Category

Senior

Game Description, Rules and Scoring

**Sustainabots [Robots for sustainability]**

# **Renewable and Clean Energy**

Version: Final Version January 15<sup>th</sup>



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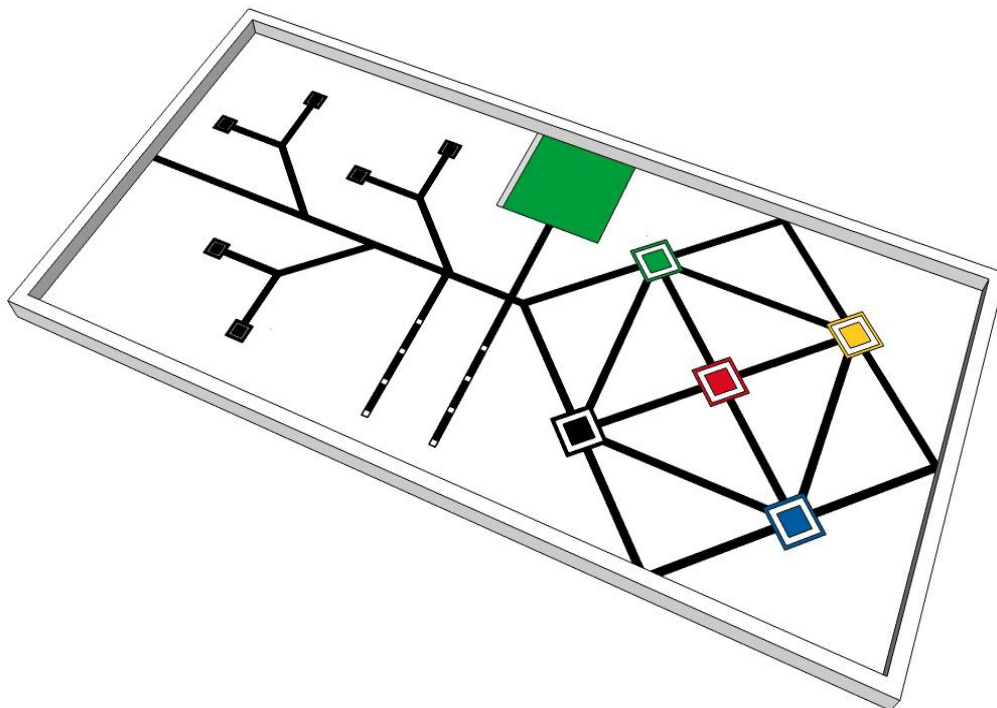
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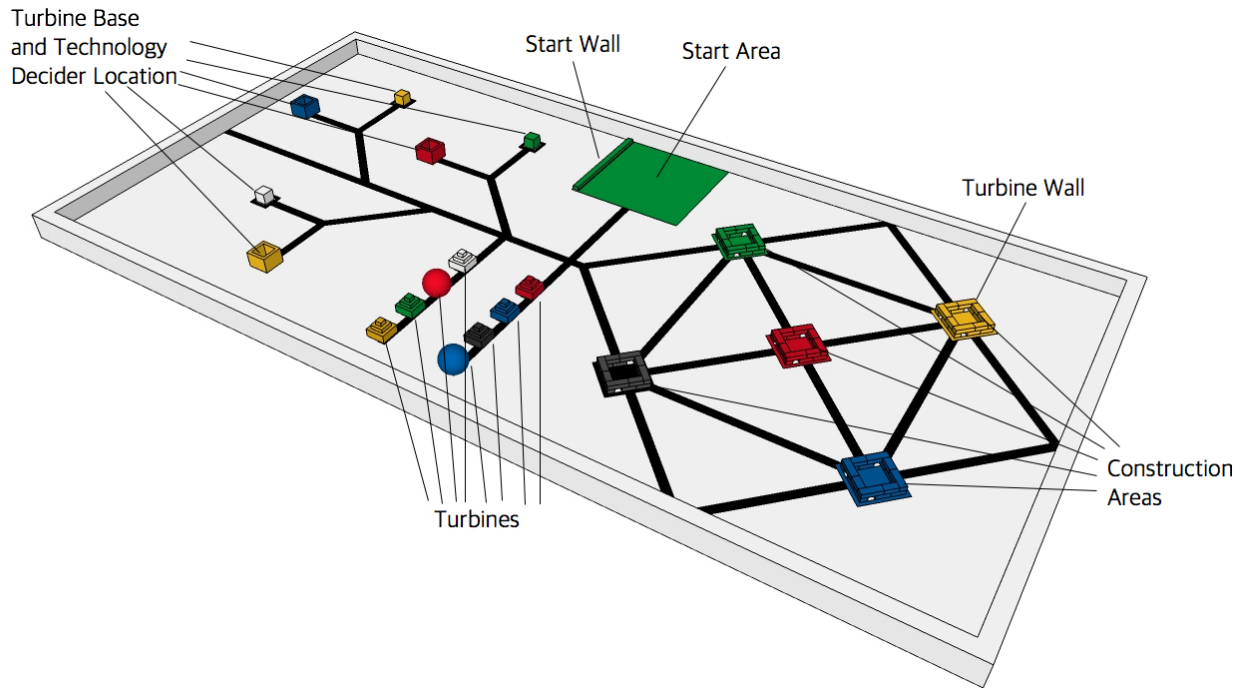
## Introduction

The demand for electricity is increasing every day. More facilities like wind farms that generate electricity from renewable and clean energy sources are needed. The Challenge is to make a robot that helps to build a wind farm. The robot will select the best places to build the different wind generators of the wind farm in order to ensure maximum efficiency from the generators and no impact on the environment.

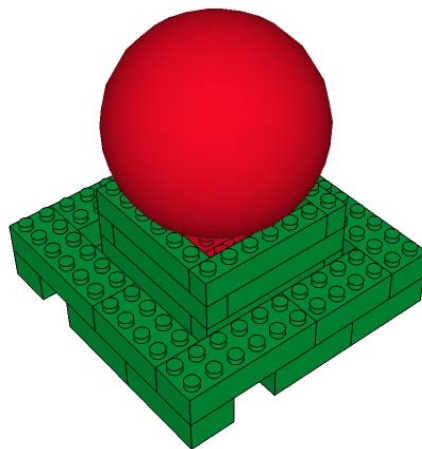


# 1. Game Description

The mission of the robot is to build 3 wind generators for a wind farm. The robot must build the generators inside the Turbine Walls in 3 of the 5 different Construction Areas. When the mission is completed the robot must return to the Start Area.



The robot must build each wind generator using a Turbine Base, a Technology Decider, and a Turbine. See the figure below for a finished Wind Generator:



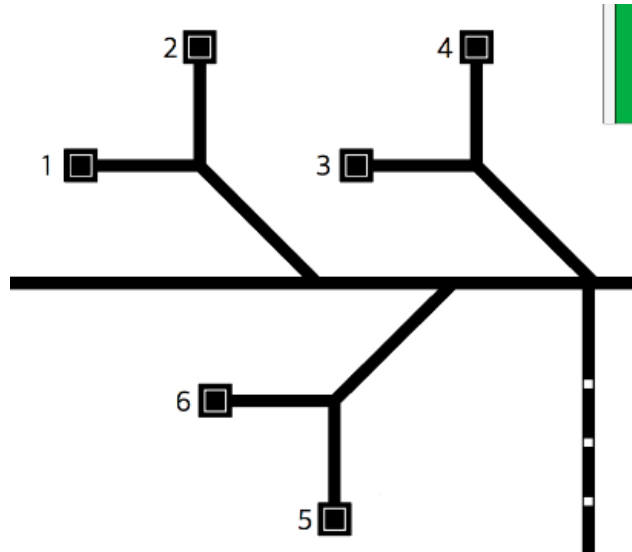
Shown above is one example of a wind generator that has been assembled inside a green LEGO Turbine Wall. This wind generator has a square green LEGO Turbine Base. The

Base holds a Technology Decider [a red LEGO cube that supports the Turbine], and the Turbine itself [a red LEGO ball].

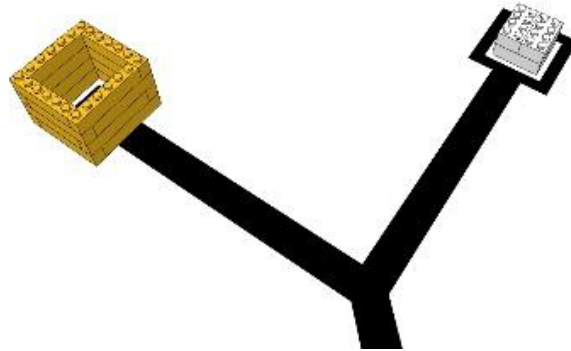
The robot will begin from within the Start Area (the green square). On the table there will be 3 groups of building elements required to construct each of the 3 wind generators:

1. **3 Turbine Bases** [chosen randomly from a red base, a blue base, a yellow base, a green base, and a black base] Each base is a 7x7 LEGO hollow square.
2. **8 Turbines** [a red ball, a blue ball, a red LEGO cuboid, a blue LEGO cuboid, a yellow LEGO cuboid, a green LEGO cuboid, a black LEGO cuboid, and a white LEGO cuboid]
3. **3 Technology Deciders** [chosen randomly from a red, a blue, a yellow, a green, a black and a white technology decider] Each Technology Decider is a 4x4 solid LEGO cube.

The 3 Turbine Bases and the 3 Technology Deciders are placed on the 6 black squares of the Base and Technology Decider Locations. 1, 3 and 5 are considered left parts of a branch. 2, 4 and 6 are considered right parts of a branch:



The 6 black squares are grouped as 3 branches with 2 squares each. Each branch contains 1 Turbine Base and 1 Technology Decider [eg., a yellow Turbine Base and a white Technology Decider].



The color of the Turbine Base determines at which of the 5 Construction Areas the wind generators must be built. The color of the Technology Decider determines the type of Turbine that needs to be used for the wind generator.

Figure 1 shows an example of an initial configuration of Turbine Bases, Technology Deciders, and types of Turbines. Figure 2 shows how the elements could be positioned at the end of a run to earn maximum points.

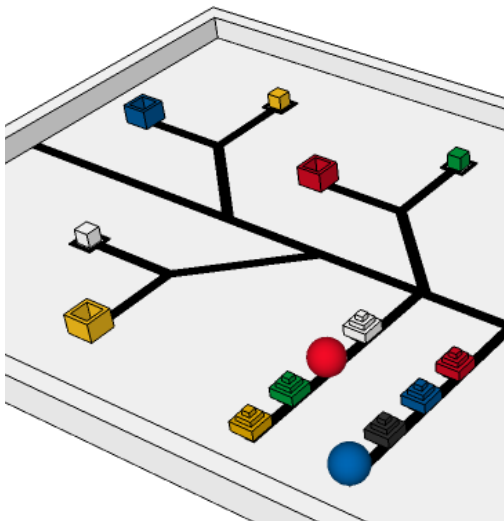


Figure 1

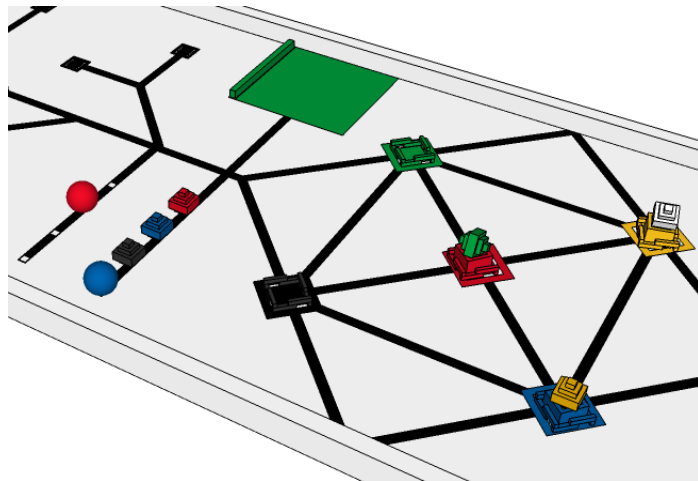
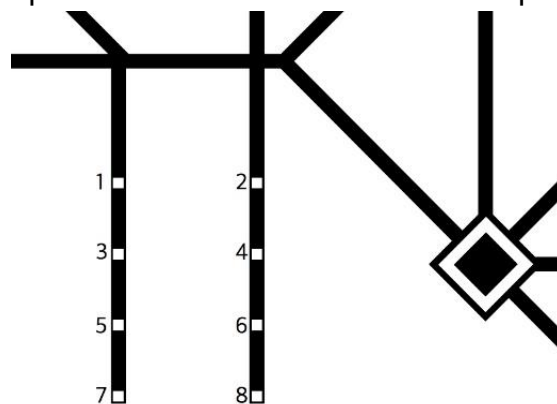


Figure 2

The time allowed for the Challenge is 2 minutes.

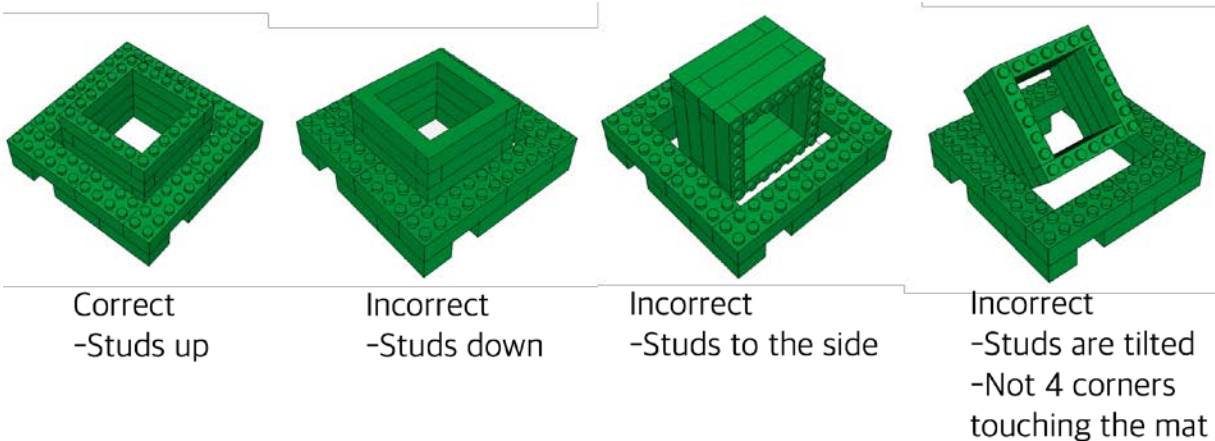
## 2. Game Rules

1. Before each round, a randomly selected Turbine Base and Technology Decider are placed on the black squares of each of the 3 branches of the Base and Technology Decider Locations. The random placement of the 3 pairs should be accomplished as follows:
  - Put the 5 Turbine Bases and the 6 Technology Deciders in two different non-transparent boxes.
  - Mix the elements in each box gently by hand.
  - Toss a coin for each branch to decide whether the base should be placed on the left or the right side.
  - Pick a Turbine Base and a Technology Decider from the two boxes and place them on the 2 black squares of the branch as decided by the coin flip.
  - The chosen placements of the 3 pairs are kept constant through a round.
  
2. Before each round the 8 Turbines [the 2 balls and the 6 colored cuboids] are placed randomly on the 8 positions for Turbines on the two black lines. The random placement of the 8 Turbines should be accomplished as follows:
  - Put the 8 Turbines in a non-transparent box.
  - Mix the Turbines in each box gently by hand.
  - The chosen placements of the 8 turbines are kept constant through a round.
  - The chosen placements of the 8 turbines are kept constant through a round.

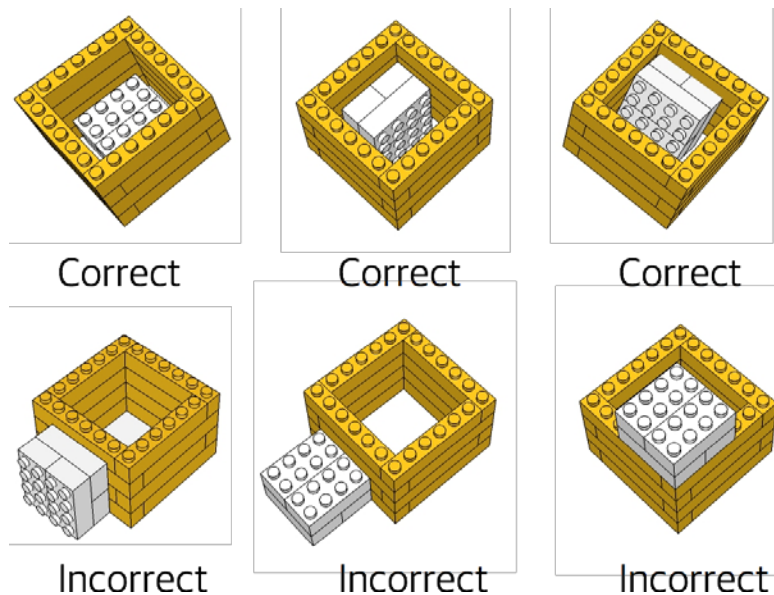


3. The robot must assemble 3 wind generators completely inside 3 of the Turbine Walls of the 5 Construction Areas. The robot must build the wind generators out of 3 elements as follows:

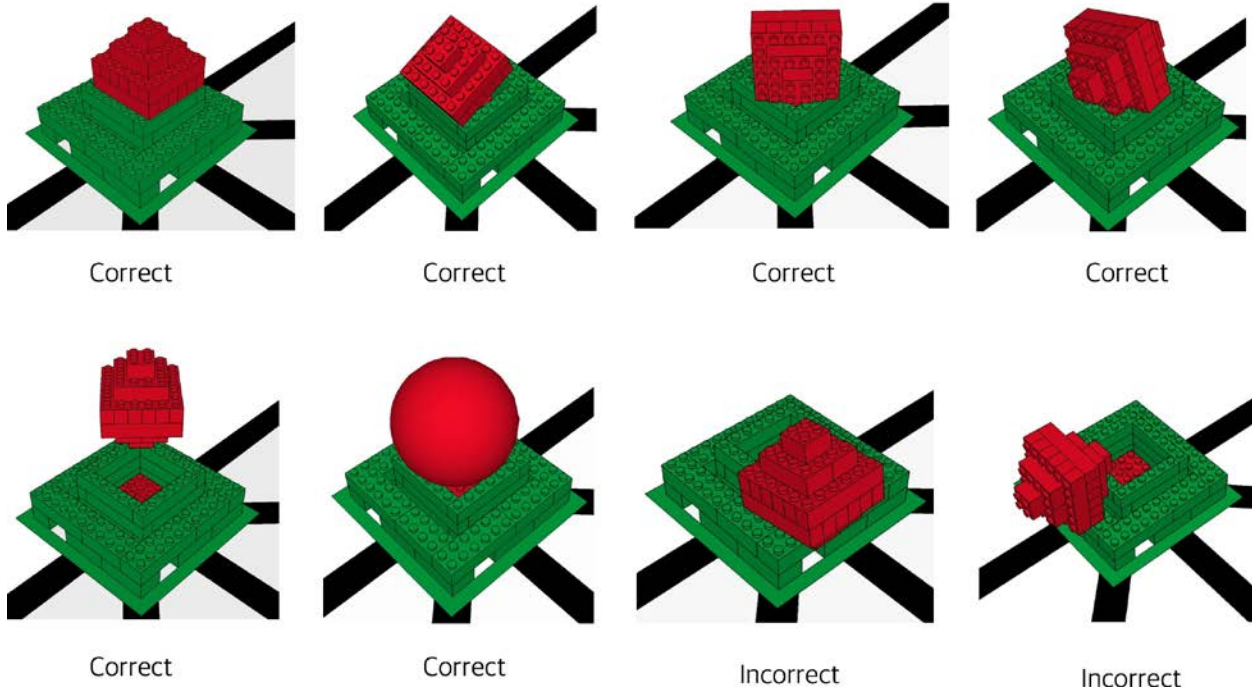
a. A Turbine Base must be placed completely inside a Turbine Wall of the same color. A base is inside the wall if the bottom side of the base is touching the mat and the studs are up.



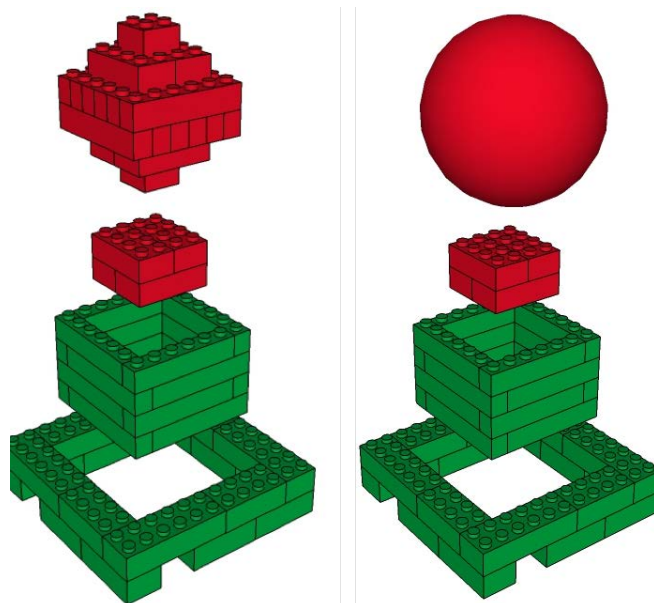
b. The Technology Decider from the same branch as the Turbine Base must be placed completely inside the Turbine Base. A tech decider is inside a base if any part of the tech decider is touching the mat (see the following graphic):



- c. A Turbine of the same color\* as the Technology Decider, must be placed on top of the Technology Decider and completely over the Turbine Base. A Turbine is over the Turbine Base if it is **not** touching the ground **nor** the wall and any part of the Turbine is touching the Turbine Base.

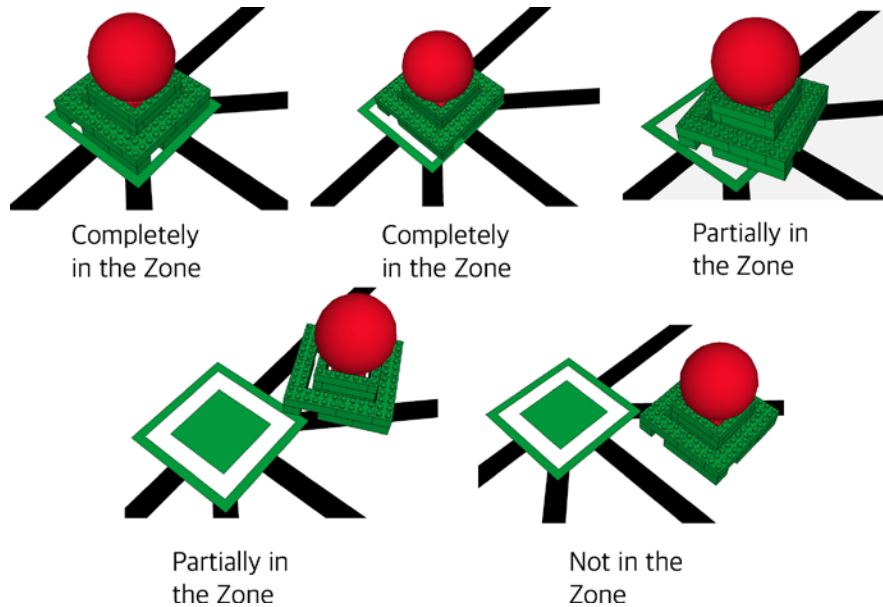


[\*Notice that in the case of a red or a blue Technology Decider, 2 types of Turbines are available and can be used...a ball or a cuboid, as shown below:]



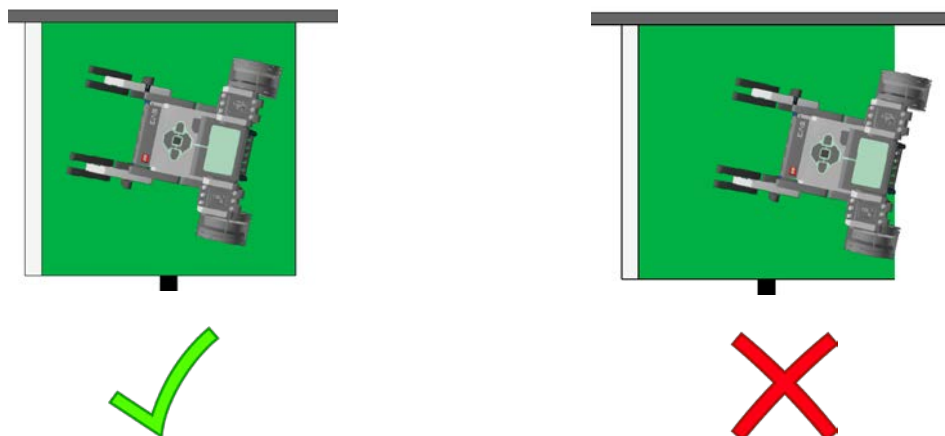


4. Points will be granted for a completely or partly built wind generator only if the surrounding Turbine Wall is not damaged\* and the Turbine Wall is either touching or is completely inside the colored square of the same color as the Turbine Wall.



*(\*) Definition of damaged for this document: A game object is damaged if at least one brick is completely detached from the position it was attached in the initial buildup*

5. The Start Wall must not be damaged or moved from its initial placement. In case this happens a penalty is given if this does not result in a negative score.
6. The mission is completed when the robot returns to the Start Area, stops, and the projection of the robot is completely within the Start Area (cables are allowed to be outside of the finish area).



### 3. Scoring

1. Score will when the Challenge is completed or when time elapses.
2. Maximum score = 195 points.
3. Penalties are subtracted only if it results in a non-negative score.
4. If teams have the same score, ranking is decided by the shortest time recorded.

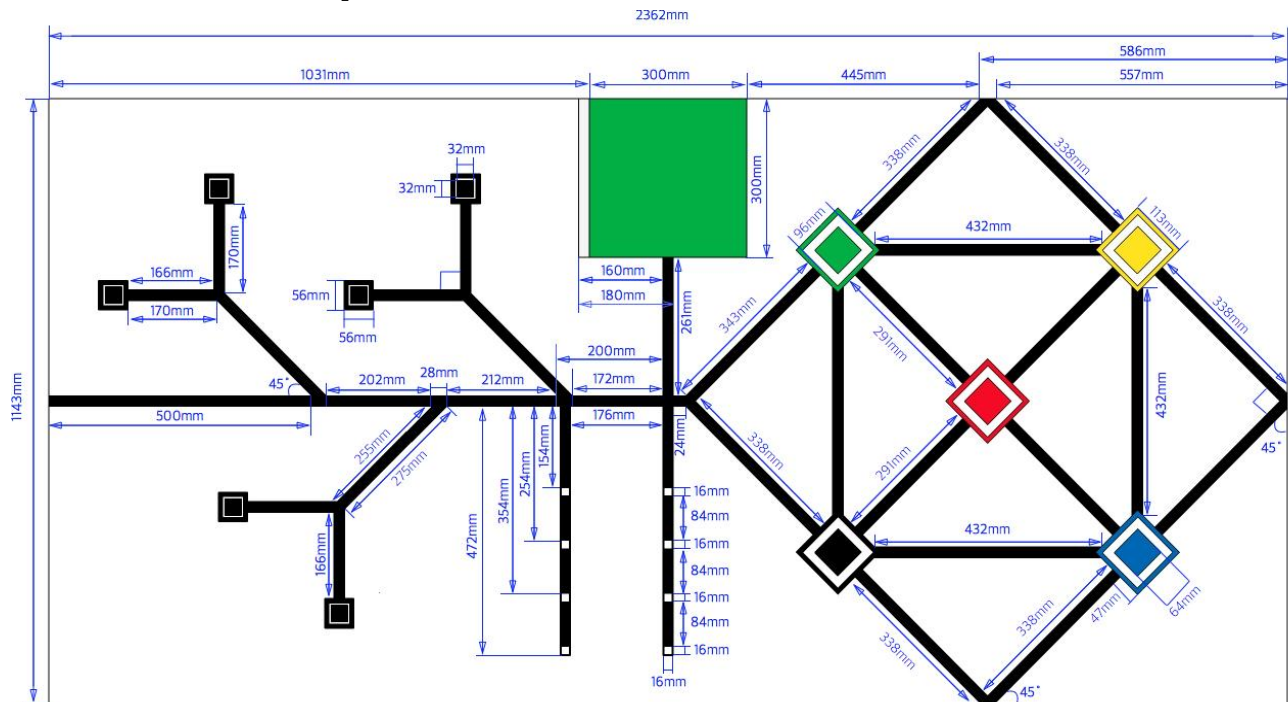
#### Scoring Table:

Tasks	Each	Total
Turbine Base correctly placed inside the corresponding turbine wall (turbine wall completely inside the corresponding colored square)	10	<b>30</b>
Turbine Base correctly placed inside the corresponding turbine wall (turbine wall partly inside the corresponding colored square)	5	15
Technology Decider correctly placed inside the Turbine Base of the same branch with the Turbine Base inside the corresponding Turbine Wall (Turbine Wall completely inside the corresponding colored square)	20	<b>60</b>
Technology Decider correctly placed inside the Turbine Base of the same branch with the Turbine Base inside the corresponding Turbine Wall (Turbine Wall partly inside the corresponding colored square)	10	30
Turbine correctly placed over the Turbine Base with a Technology Decider inside the same color as the Turbine (Turbine Wall completely inside the corresponding colored square)	20	<b>60</b>
Turbine correctly placed over the Turbine Base with a Technology Decider inside the same color as the Turbine (Turbine Wall partly inside the corresponding colored square)	10	30
If <b>all three</b> wind generators are partially or completely built with all three parts (Base, Technology Decider, Turbine) each: <ul style="list-style-type: none"> <li>• 5 points for each <b>Turbine</b> that is <b>not</b> to be used in the construction of the wind generators and touching the black line or, in case of a ball, touching the base of the ball and the base of the ball touching the black line.</li> <li>• 5 points for each <b>Turbine Wall</b> that is <b>not</b> to be used in the construction of the generators touches the colored square of the corresponding color where the wall was initially placed.</li> </ul>	5 (max. 5)  5 (max. 2)	<b>35</b>
The Start Wall is damaged or moved away from its original placement.		-10
The robot stops completely within the Start Area (only gets these points if other points are assigned).		<b>10</b>
<b>Maximum Total Points</b>		<b>195</b>

## 4. Table Specifications





1. The internal dimensions of a game table are 2363 mm x 1143 mm.
2. The external dimensions of the table are 2438 mm x 1219 mm.
3. Primary color of the table surface is white.
4. Height of the borders:  $70 \pm 20$  mm.

## 5. Game Mat Specifications



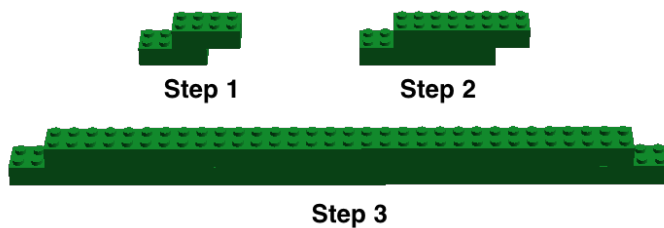
1. All black line are  $20 \pm 1$  mm.
2. All dimensions may vary within  $\pm 5$  mm.
3. If the table is larger than the game mat the top edge and the right edge of the game mat should align with two walls on the table.

### Color Specification

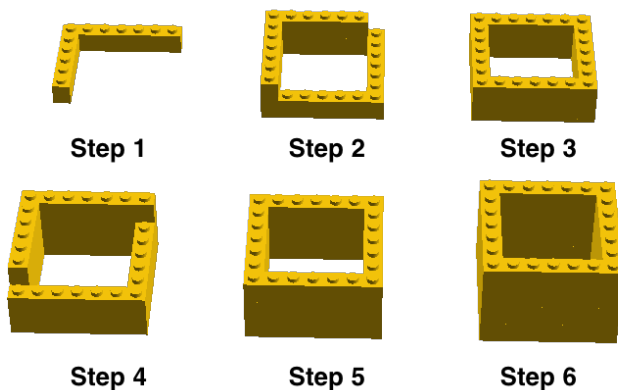
Color Name	Lego Color ID	Pantone	CMYK				RGB			RGB Sample
			C	M	Y	K	R	G	B	
Bright Red	21	032C	0	100	100	0	237	28	36	
Bright Blue	23	293C	100	47	0	0	0	117	191	
Bright Yellow	24	116C	0	19	100	0	255	205	3	
Bright Green	37	355C	88	0	100	0	0	172	70	

## 6. Game Object Specifications

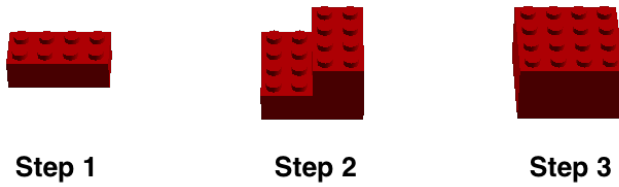
There is 1 **Start Wall** containing 17 green 2x4 LEGO bricks:



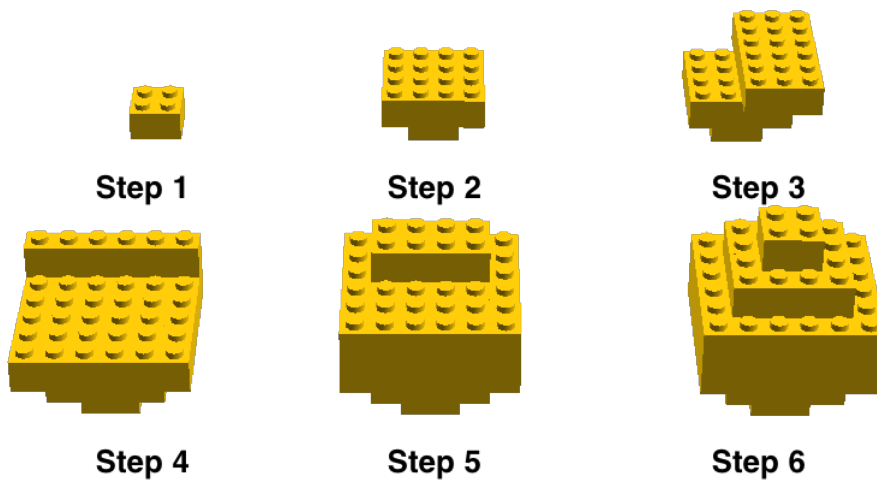
There are 5 **Turbine Bases**: 1 red, 1 yellow, 1 blue, 1 green and 1 black. Each Base is a 7x7 LEGO hollow square containing 16 1x6 LEGO block:



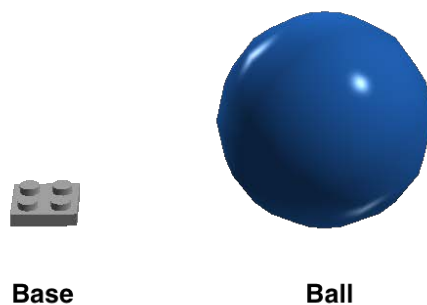
**There are 6 Technology Deciders:** 1 red, 1 yellow, 1 blue, 1 green, 1 black and 1 white. Each technology decider is a 4x4 LEGO cube containing 4 2x4 LEGO block:



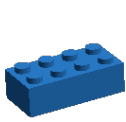
**There are 6 LEGO cuboid Turbines:** 1 red, 1 yellow, 1 blue, 1 green, 1 black and 1 white each containing 2 2x2 LEGO block, 4 2x4 LEGO block, 12 1x6 LEGO block:



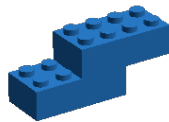
There are **2 LEGO ball Turbines** [a red ball and a blue ball]. The two balls are initially placed on a LEGO base:



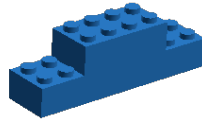
There are **5 Turbine Walls**: 1 red, 1 yellow, 1 blue, 1 green and 1 black each containing 8 1x6 LEGO block, 12 2x4 LEGO block:



**Step 1**



**Step 2**



**Step 3**



**Step 4**



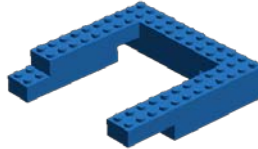
**Step 5**



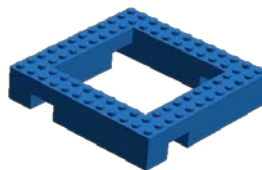
**Step 6**



**Step 7**



**Step 8**



**Step 9**