NRC 2023 REGULAR CATEGORY

Tertiary

GAME RULES

Version: 16 June 2023

Organiser:

Sponsored by:

Ministry of Education
SINGAPORE

Supported by:

NRC 2023 Regular Category - Tertiary

CHALLENGE BOOKLET CHANGE LOG

Version	Release Date	Description
1.0	24 May 2023	Official Challenge Booklet release
1.1	26 May 2023	Updated Building Instructions
1.2	16 June 2023	- 4 Game Objects, Positioning, Randomisation - 5.3 Deliver Energy Tokens to the BatteryStorage - 8 Scoring
1.3	23 August 2023	- 4 Starting Positions - 5.2 Wind Turbine Direction - 9 Scoring Interpretations

Contents

PART ONE – GAME DESCRIPTION

1. Introduction

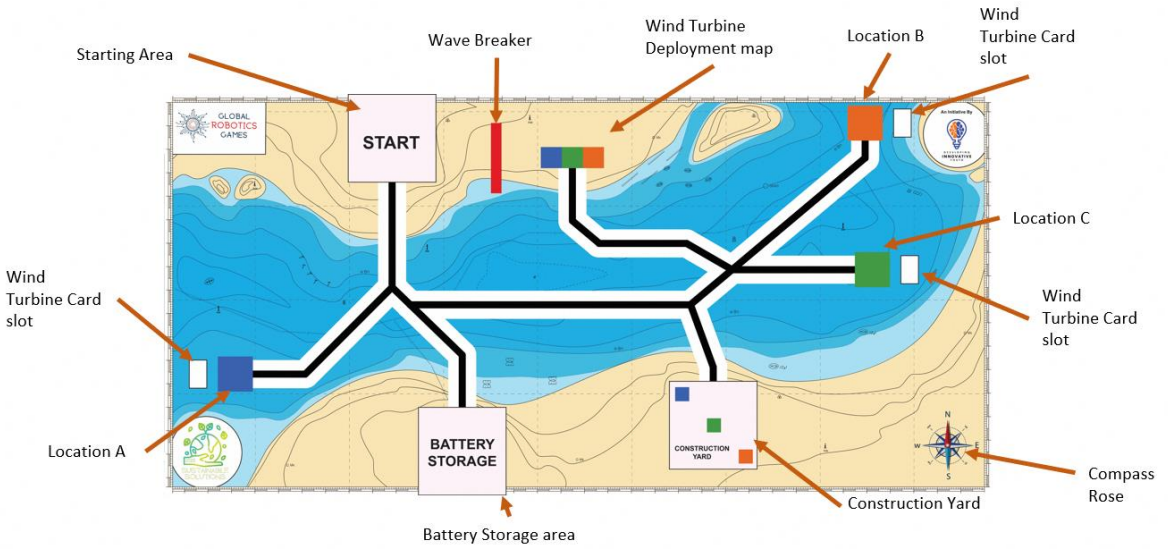
For this category, the theme is “Green World”.

A Green World considers how countries can develop and work towards maximising renewable energy. One source of sustainable energy is wind energy. Moving beyond Singapore’s landscape with low average wind speed, constrained land for wind turbine placement and high demand for energy use, this category will focus on offshore floating wind turbines globally.

Wind turbines installed on shore or close to shore only receive the tail end of the possible wind energy generated. Scientists and engineers have discovered that wind is stronger out at the oceans.

In this category, each team’s robot is tasked to deliver expired wind turbine to construction yard, deliver wind turbines to their designated location, deliver energy tokens to battery storage.

2. Game Field



The following graphic above shows the game field with the different areas.

For more information about the table and game mat specifications, please refer to NRC 2023 Regular Category General Rules.

For all information regarding rules of robot in this document will take precedence over the 2023 Regular Category General Rules.

3. Sub-Category Game Rules

If there is any uncertainty during the robot attempt, the judge will make the final decision. The judge should decide in favour of the team if no clear decision is possible.

3.1 Pre-Run

- Robot will be inspected by referees according to the requirements prior to quarantine.
- Robot must be placed in the respective starting area so the projection of the robot on the game mat is completely within the start area.
- Teams are allowed to make physical adjustments to the robot in the starting area only.
- Teams are not allowed to enter data to a program by changing positions or orientation of the robot parts or to make any sensor calibrations of the robot.
- Referees are to inspect the placement of the Robot.
- No wireless communication (Wifi, Bluetooth etc) is allowed unless declared to the Referee (only for AI purposes)

3.2 Start of Robot Run

- Time begins when the judge gives the signal to start.
- Each robot attempt is 2 minutes run (120 seconds)

3.3 During Robot Run

Teams are not allowed:

- To touch the robot when the robot is moving.
- To reprogram and enter data into the robot during robot run.
- To physically move any mission prop or their robot.

3.4 Ending of Robot Run

A robot attempt will end if:

- The 2 minutes mark is up (120 seconds).
- The robot has reached the Starting Area
- The robot has completely left the game table.
- The robot or team has violated the rules or regulations.
- A team member shouts “STOP”, and the robot does not move anymore. If the robot is still moving, the robot attempt will only end once the robot stops by itself or is stopped by the team or judge.

After the robot run, referees will score the attempt. Teams are required to sign off the scores noted on the scoring sheet (on paper or digital). Once the score is signed off no further changes are possible.

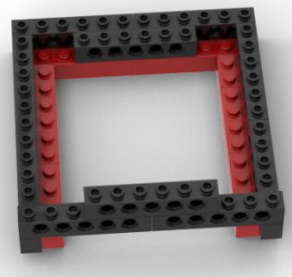
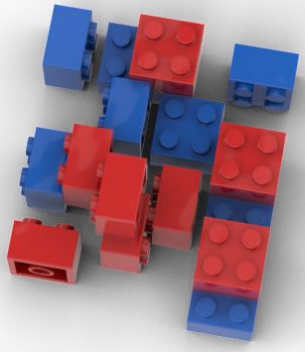
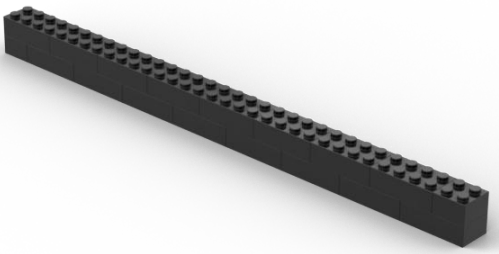
If a team does not want to sign off after a certain period of time, the judge can decide to disqualify the team for this round. It is not allowed for a team coach to join the discussion with judges on the scoring of the run. Video or photo proofs will not be accepted.

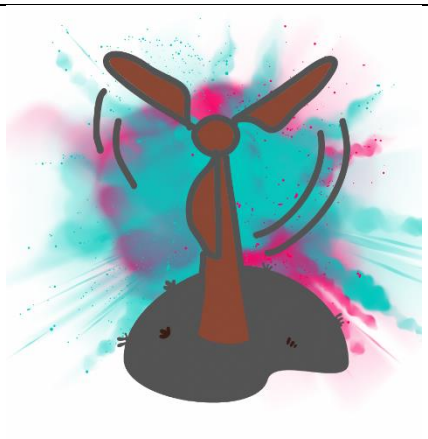
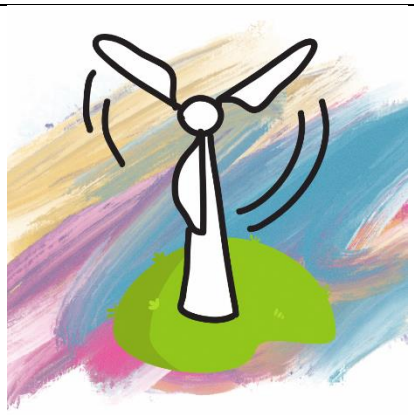
If a team finishes an attempt without having solved a (partial) task that yields positive points, the time of that run will be set at 120 seconds.

The ranking of teams depends on the overall tournament format. For example, the best attempt out of two rounds could be used and if competing teams have the same points, the ranking is decided by the record of time.

4. Game Objects, Positioning, Randomisation

1 X Expired Wind Turbine (placed facing south)	
1 X Wind Turbine White (placed facing south)	
1 X Wind Turbine Yellow (placed facing south)	

2 X Wind Turbine Bed (placed facing left of approach)	
2 X set of Energy Tokens ● 8 red LEGO bricks in each set ● 8 blue LEGO bricks in each set	
1 X Wave Breaker	

1 X Retired Wind Turbine Card	
1 X Yellow Wind Turbine Card	
1 X White Wind Turbine card	
1 X South Directional card	

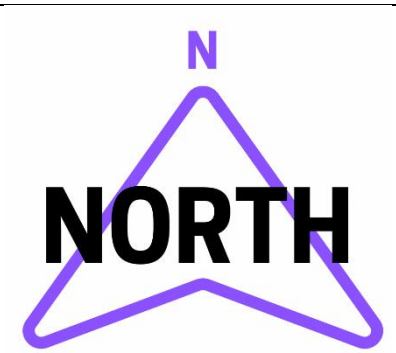
1 X North Directional card	

Image Card Dimension: 74mm by 105mm

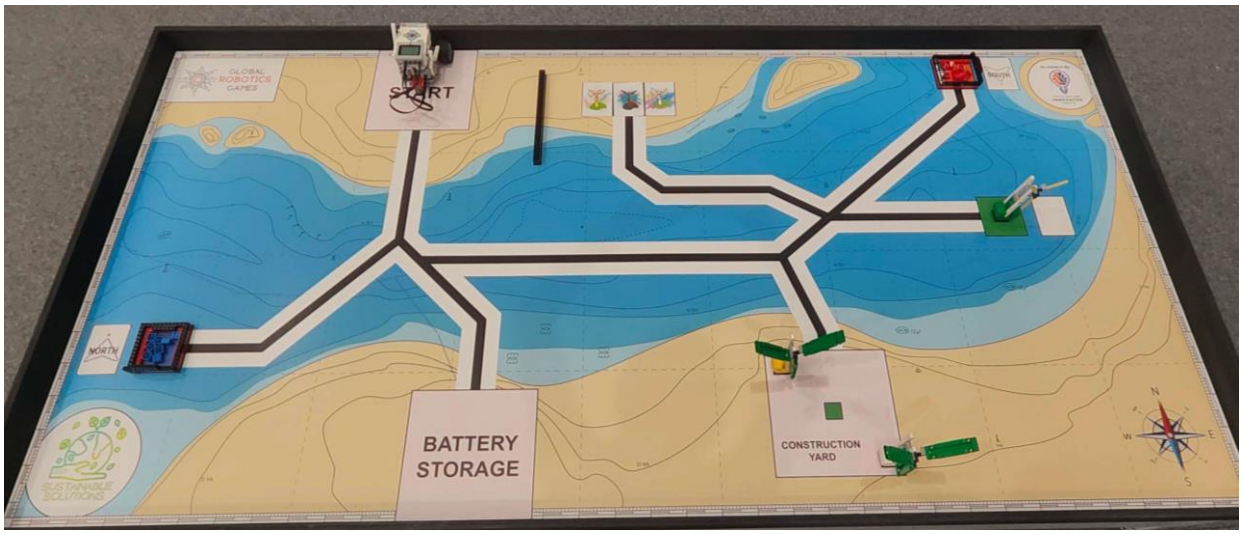
Image Download

One start area

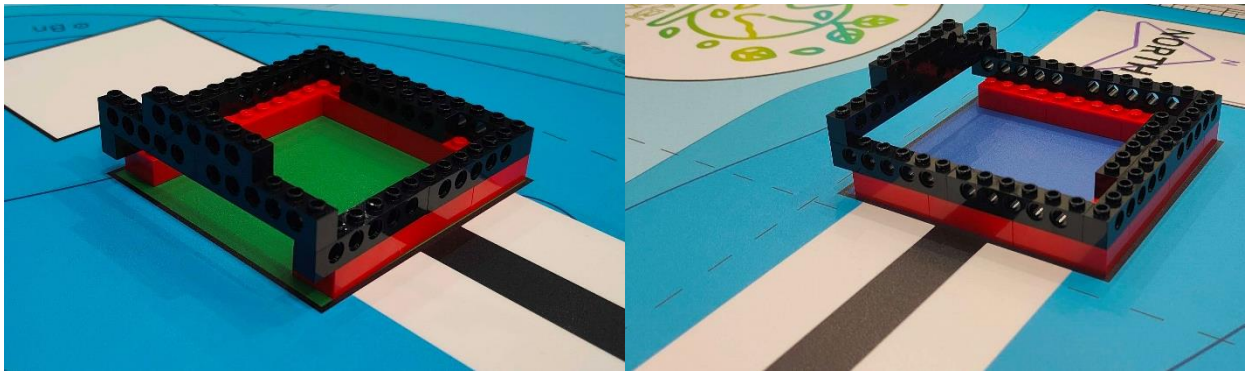
There is only one start area on the field which is the Start area. Before the start of the run, the robot must fit completely in this start area. The surrounding line is not included in the start area. Cables must be included in these dimensions. After the Robot has started, the dimensions of the robot are not restricted to the size of the Start area.

This Start area is also where the robot should end to gain bonus points.

An example of the starting positions is shown below.



Example of starting position. All wind turbines are facing south.



Examples of Wind Turbine bed, with opening facing left of approach

5. Robot Missions

For a better understanding, the missions will be explained in multiple sections.

The team can decide in which order they will do the missions.

Scoring for each mission will be:

Final State (scoring is done when the robot attempt ends)

5.1 Deliver Expired Wind Turbine to Construction Yard

Floating Wind Turbines are often subjected to structural stresses due to the immense water and wind pressures faced out in the open sea. As such, their lifespans are usually accounted to be 25 years long. After which, they are either decommissioned or re-fitted with new parts. Therefore, these Wind Turbines have to be brought back to their original manufacturing facilities.

BRING THE DESIGNATED EXPIRED WIND TURBINE BACK TO THE CONTRUCTION YARD

- The Expired Wind Turbine must not be damaged.
- No parts of the Expired Wind Turbine may be put back together if the robot has broken the model while it was transported.
- To score, the Expired Wind Turbine must be standing up in the Construction Yard at the end of the match.
- Use of Robot or any element left behind by the robot that belongs to the team, to assist the Expired Wind Turbine in standing up is allowed.

Expired Wind Turbine

5.2 Deliver Wind Turbines to their Designated Location

Wind Turbines and their accompanying structures are all made on shore and then transported out to sea. Depending on the Wind Turbine floating structure design, the wind turbine is floated and dragged out to its desired location. Finally mooring lines are used to anchor these structures to the seabed.

DELIVER THE CORRECT WIND TURBINE TO ITS FINAL LOCATION.

- There will always be two Wind Turbines to transport. Wind Turbine White and Wind Turbine Yellow.
- The Wind Turbines must be left standing fully within the space of their Location A, Location B or Location C.
- The Wind Turbines cannot be broken or damaged when they reach their Location.
- **The Wind Turbines must be placed such that the blades are facing the direction indicated by the arrow.**
- The Wind Turbines must be left standing up on its own without the help of the robot or with any equipment left behind by the team's robot.
    - Any robot or equipment touching any part of the Wind Turbines during the end of robot run will be considered as helping the Wind Turbines.

Wind Turbine White

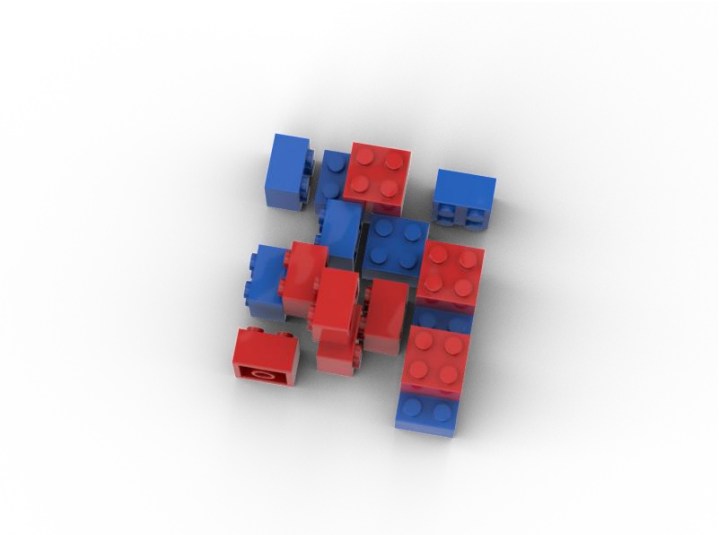
Wind Turbine Yellow

5.3 Deliver Energy Tokens to Battery Storage

Setting up the Wind Turbines is a difficult and arduous process, but we must not forget the end goal. Which is to harness the energy of the wind and convert it into energy for our grid. For the energy to be successfully brought back to shore, long underwater cables do the job. Of course, we must also find ways to store the energy in cases of oversupply or under supply.

DELIVER THE ENERGY TOKENS TO THE BATTERY STORAGE

- The Energy Tokens must be fully in the projection of the Battery Storage area and in the Wind Turbine Bed
- The Energy Tokens may be placed in any orientation.
    - E.g. LEGO Brick is sitting studs-up
    - E.g. LEGO Brick is standing on its side
- The Energy Tokens may be stacking on top of each other within the Battery Storage area.



Energy Tokens

5.4 Bonus points

Bonus points will be awarded to teams that can end their robot run back in the Start area. Robot can be partially in the Start area to score. This bonus points will only be given if there are scores given for any of the three preceding missions.

6. Technical Report

While creating the robot and AI or ML models, we must also be mindful of documenting our work. A good engineer is one who is meticulous in his report and can communicate his/her work efficiently.

All teams will have to submit a digital copy of their Technical Report by 15th Aug '23. Here are the details of what should be reported.

6.1 Robot Design:

Each team is required to submit 1 picture of each side of their robot. Namely:

- Picture of the top of the robot;
- Picture of the bottom of the robot;
- Picture of the left of the robot;
- Picture of the right of the robot;
- Picture of the front of the robot;
- Picture of the back of the robot.

6.2 List of Sensors and Cameras:

Teams should clearly identify and list all the sensors and cameras used in the robot. Students should also remark on how the sensors/cameras were used and show samples of codes to explain how the input from these sensors/cameras are used.

6.3 Artificial Intelligence model

Teams should also describe the AI or ML model created that that allows the robot to detect the Wind Turbine cards and the North/South cards

Teams should describe the following:

- The process used in training the AI model to achieve these missions.
- The software employed to create the AI model.
- The programming language used in creating the AI model.
- How was the robot programmed to react to the AI model?

An online drive/folder will be shared with each team to allow them to share their Technical Report to receive scores for Mission 2: Deliver Wind Turbines to their designated Location.

7. Robot Material and Regulations

Artificial Intelligence systems

- Teams are allowed to use any Artificial Intelligence systems.
- Teams may use more than 1 cameras for object detection.
- Teams may use any software or coding language to program their robot's movement or Artificial Intelligence systems.

8. Scoring

Definitions for the scoring

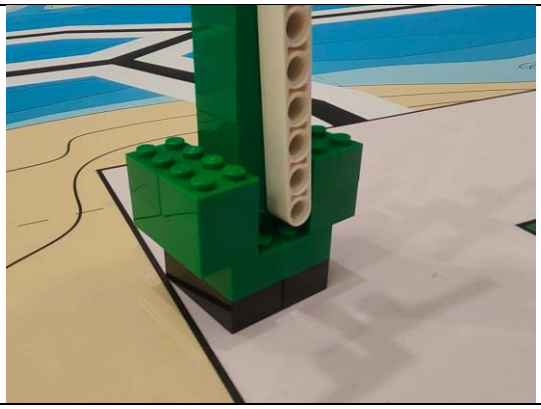
"Completely" means that the game object is only touching the corresponding area (not including the black lines). Scores for Mission 2 will only be assigned if the teams can show evidence of the use of Artificial Intelligence to solve the mission.

Tasks	**Each**	**Total**
1. Deliver Expired Wind Turbine to Construction Yard		
Expired Wind Turbine is completely in Construction Yard and standing up without assistance of any equipment	**20**	**20**
Expired Wind Turbine is completely in Construction Yard and standing up with assistance of some equipment	**10**	**10**
Expired Wind Turbine is partly in Construction Yard and standing up with or without assistance of any equipment.	**8**	**8**
2. Deliver Wind Turbines to their designated Location		
Wind Turbine White/Yellow is completely standing in its designated Location and is facing the correct direction.	**40**	**80**
Wind Turbine White/Yellow is completely standing in its designated Location but is not facing the correct direction	**20**	**40**
3. Deliver Energy Tokens to Battery Storage		
Energy Token is completely in the Battery Storage area and in the Wind Turbine Bed	**1**	**32**
Energy Token is completely in the Battery Storage area	**0.5**	**16**
4. Bonus (Only scored if there are points given in the preceding missions)		
Robot returns fully/partially into Starting Area at the end of the match	**10**	**10**
Maximum Score		**200**

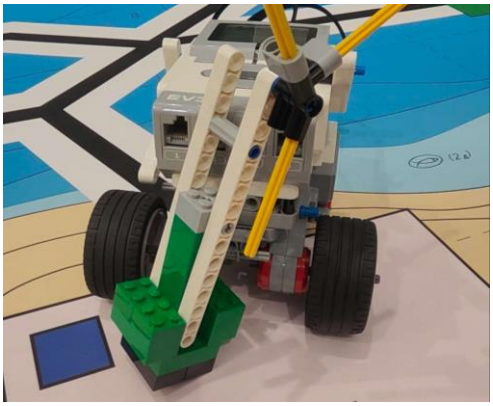
9. Scoring Interpretation

1. Deliver Expired Wind Turbine to Construction Yard

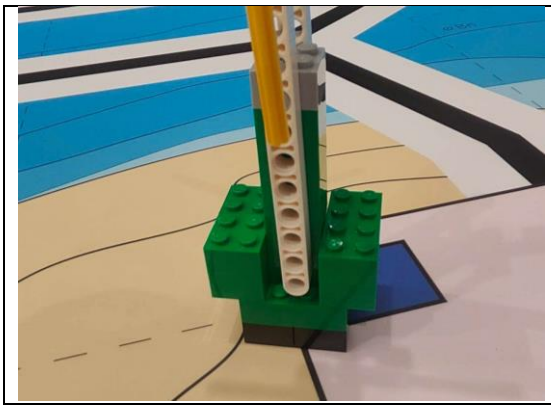
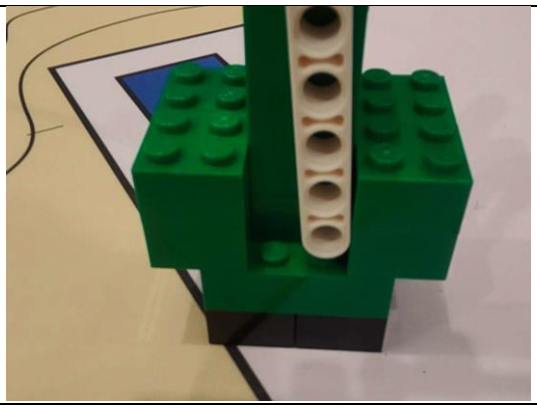
Expired Wind Turbine is completely in Construction Yard and standing up without assistance of any equipment. (score of 20)

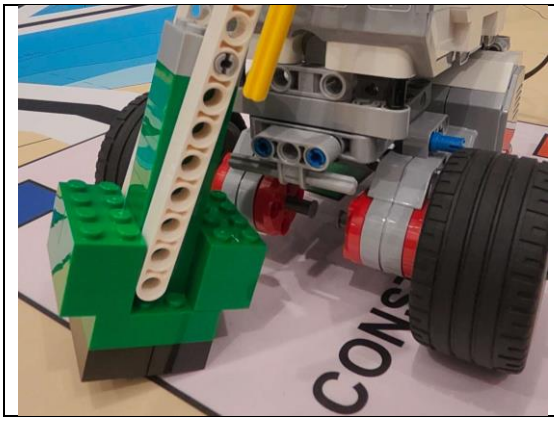



Expired Wind Turbine is completely in Construction Yard and standing up with assistance of some equipment. (Score of 10)



Expired Wind Turbine is partly in Construction Yard and standing up with or without assistance of any equipment. (Score of 8)

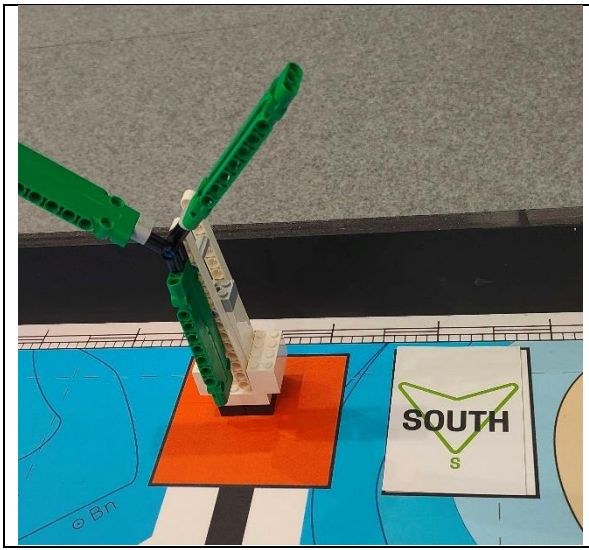
	<- Still partly in the Construction Yard, but with assistance of another equipment. (Score 8)

2. Deliver Wind Turbines to their designated Location.

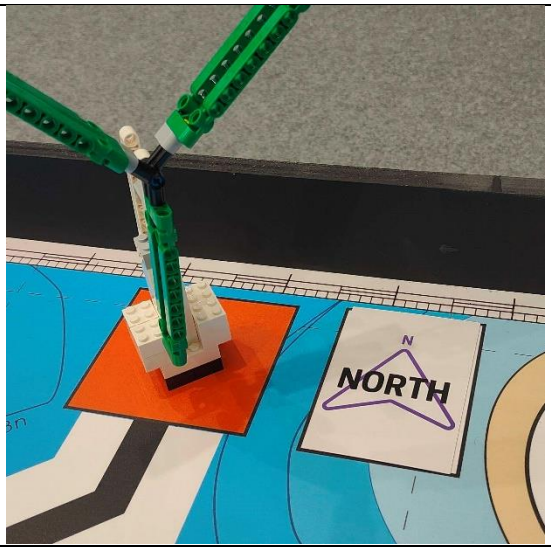
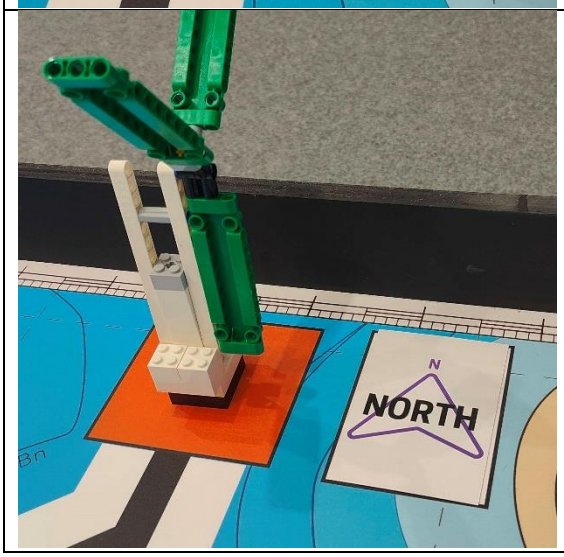
(Only scored if technical report is received by Organisers.)

Referees will look at the closest cardinal direction (NSEW and diagonals) to determine if the wind turbine is facing the correct direction. Should there be any disputes with the direction, the more favourable outcome for the team will be used, eg, if the turbine is facing about 30 degs off N/S, and isn't quite at the diagonals, the referee will award the full points.

Wind Turbine White/Yellow is completely standing in its designated Location and is facing the correct direction. (Score of 40 each)

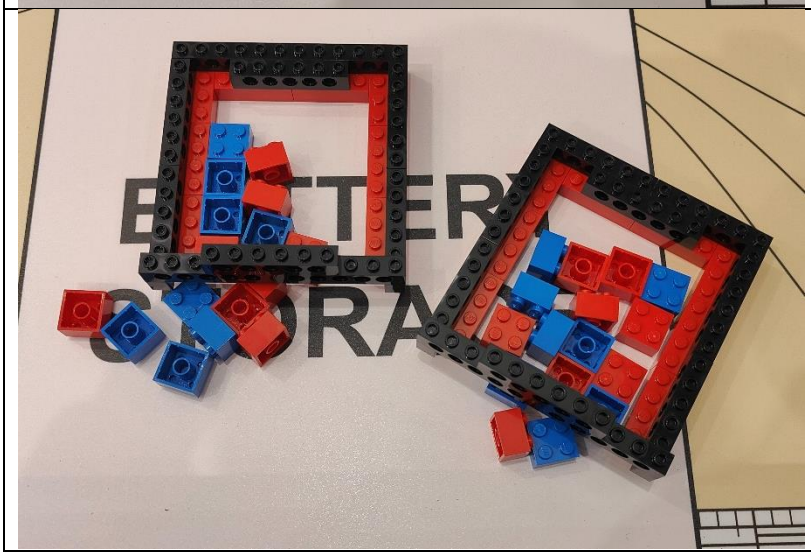
	

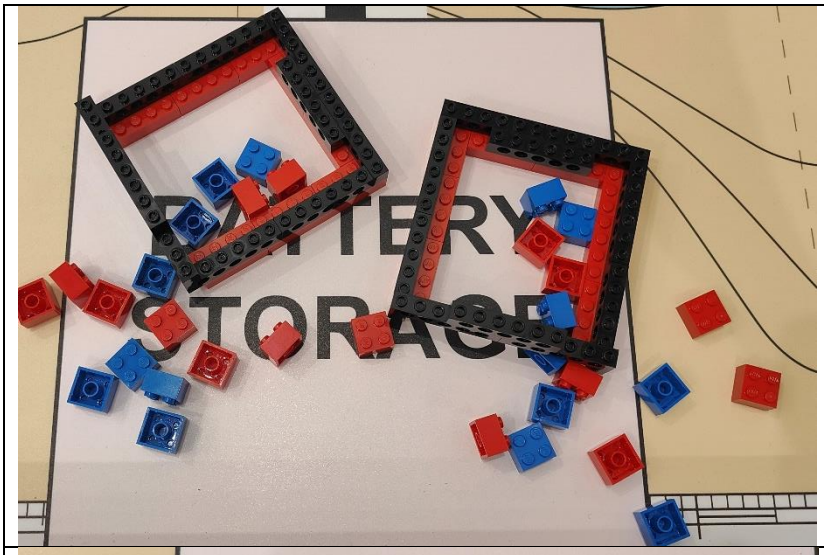
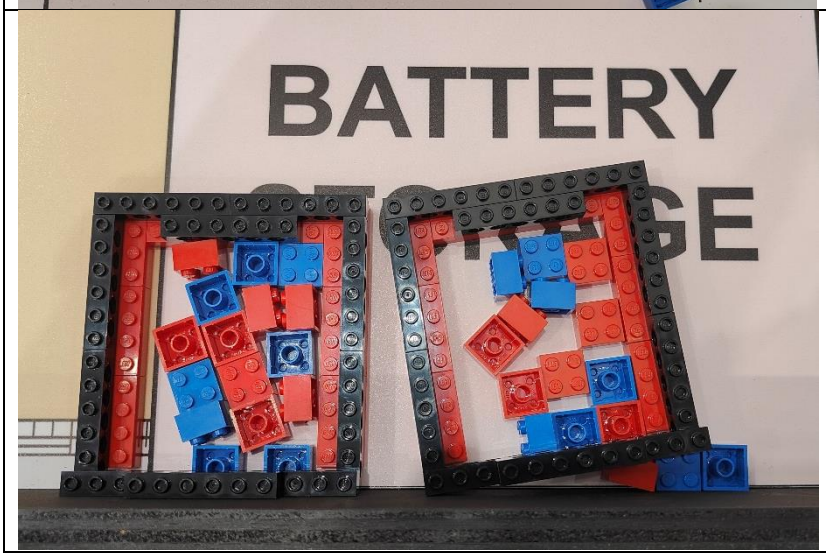
Wind Turbine White/Yellow is completely standing in its designated Location but is not facing the correct direction. (Score of 20 each)

<table>
<tr>
<td> 
</td>
<td> 
</td>
</tr>
<tr>
<td> 
</td>
<td></td>
</tr>
</table>

3. Deliver Energy Tokens to Battery Storage

Refer to the following 5 scenarios for scoring. Referees will use the more favourable outcome to the team for determining if the energy tokens are within the wind turbine bed if the energy token is at the mouth of the opening.

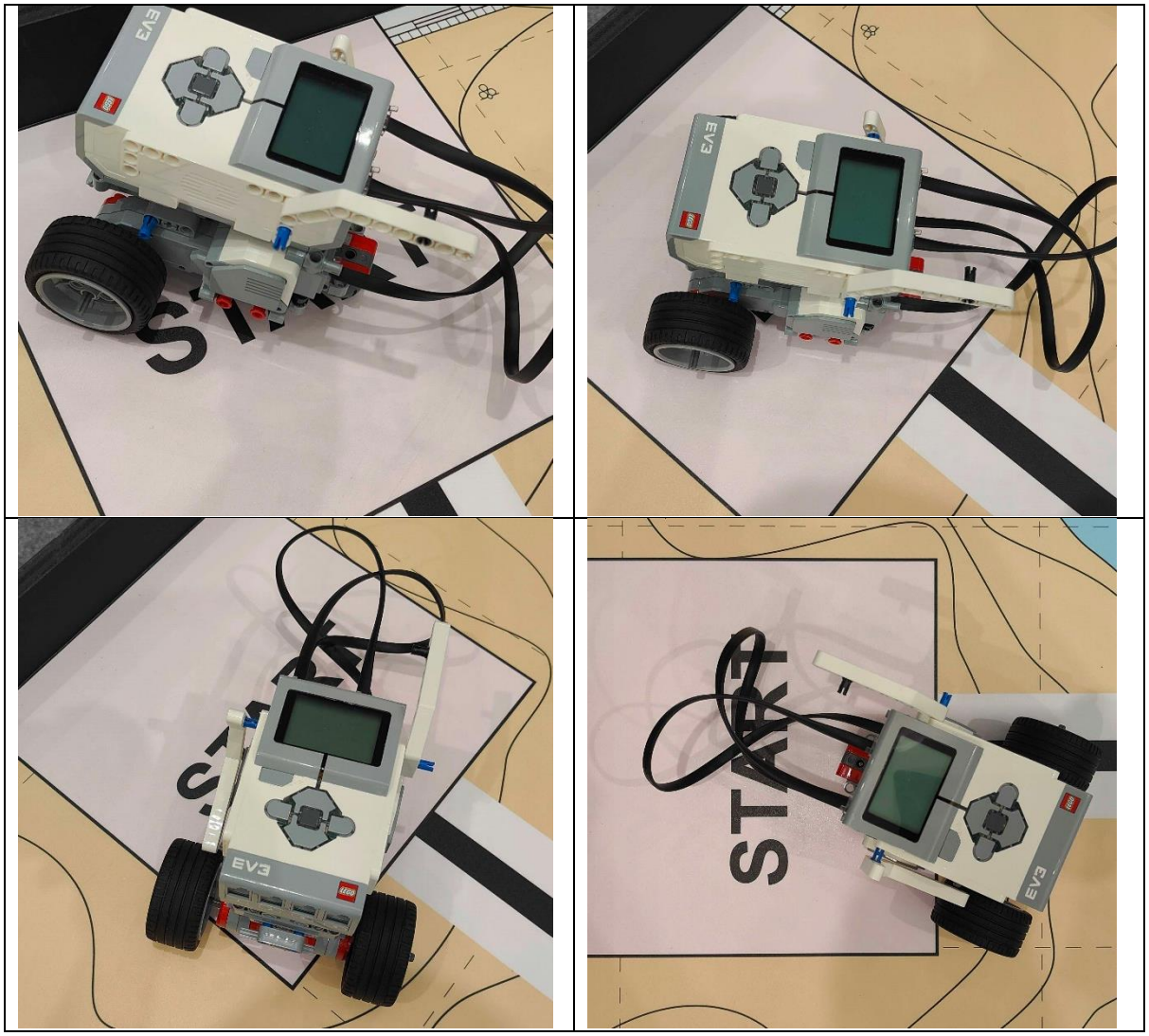
	Energy tokens completely inside battery storage and wind turbine bed (score 1) – 32 pieces Energy tokens completely inside battery storage but not inside wind turbine bed (score 0.5) – 0 piece Energy Token not completely inside Battery Storage – 0 piece **Total: 32**
	Energy tokens completely inside battery storage and wind turbine bed (score 1) – 25 pieces Energy tokens completely inside battery storage but not inside wind turbine bed (score 0.5) – 5 pieces Energy Token not completely inside Battery Storage – 2 pieces **Total: 27.5**
	Energy tokens completely inside battery storage and wind turbine bed (score 1) – 21 pieces Energy tokens completely inside battery storage but not inside wind turbine bed (score 0.5) – 10 pieces Energy Token not completely inside Battery Storage – 1 piece **Total: 26**

	Energy tokens completely inside battery storage and wind turbine bed (score 1) – 10 pieces Energy tokens completely inside battery storage but not inside wind turbine bed (score 0.5) – 17 pieces Energy Token not completely inside Battery Storage – 5 pieces **Total: 18.5**
	Energy tokens completely inside battery storage and wind turbine bed (score 1) – 29 pieces Energy tokens completely inside battery storage but not inside wind turbine bed (score 0.5) – 3 pieces Energy Token not completely inside Battery Storage – 0 piece **Total: 30.5**

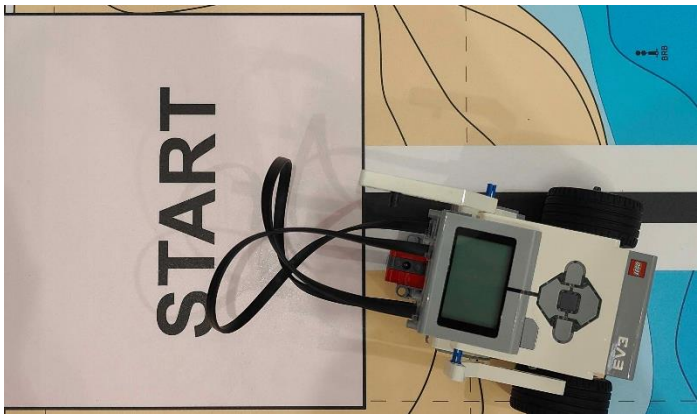
4. Bonus (Only scored if there are points given in the preceding missions)

Robot returns fully/partially into Starting Area at the end of the match. (Score of 10)

For partially inside, the base of the robot (area between the contact points with the playfield) must be within the start area. If only the projection of the robot is inside, it will not be counted.

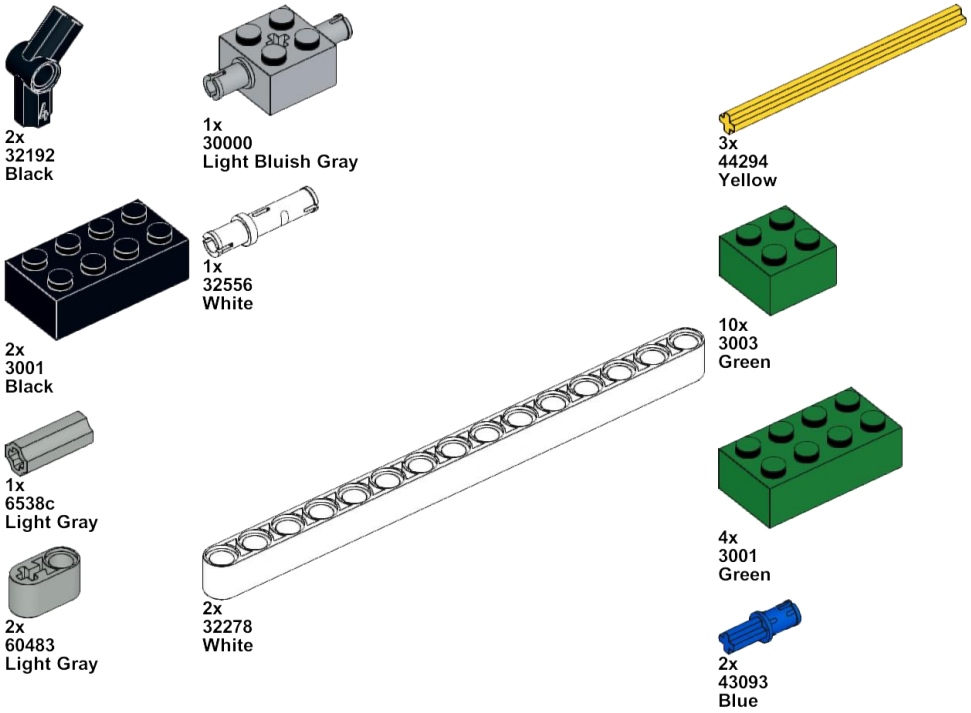


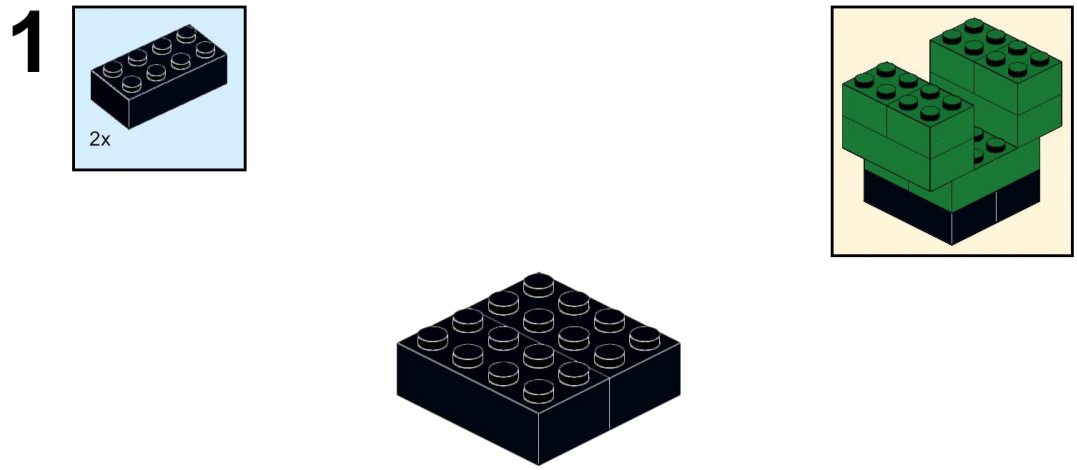
No bonus score given –



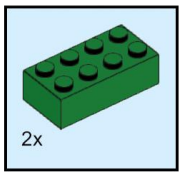
10. Assembly of Game Objects

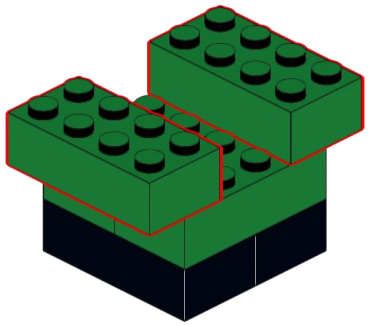
10.1 Expired Wind Turbine



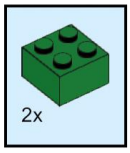

1
2x
2
2x

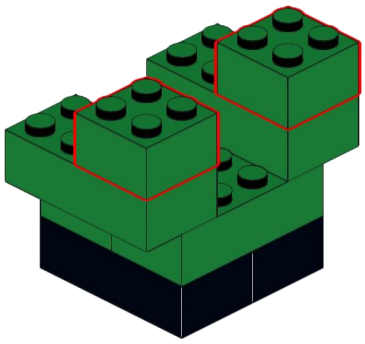
3



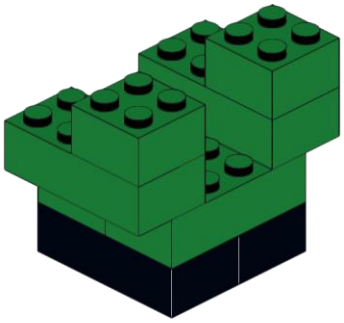


4

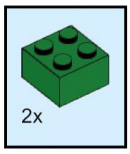


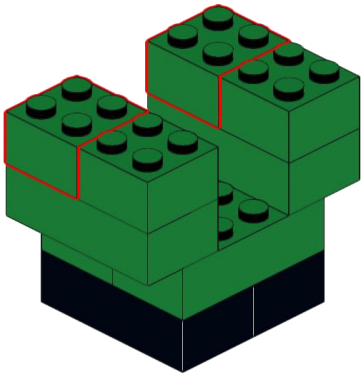


5

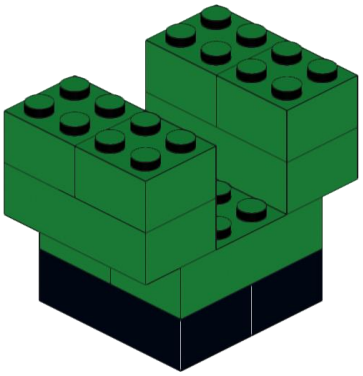


6

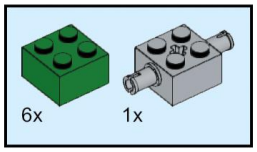


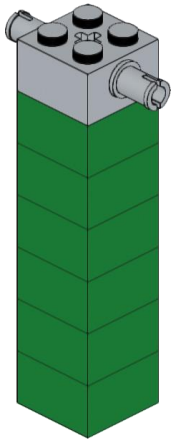


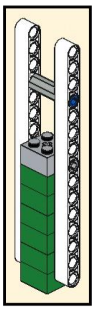
7



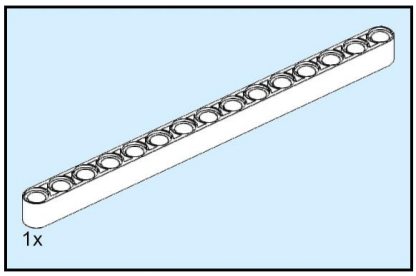
8

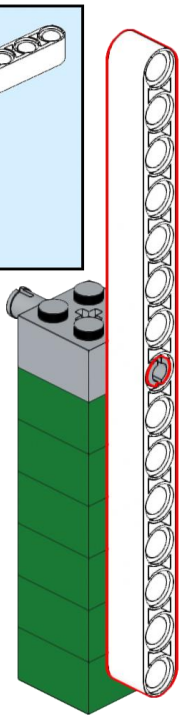




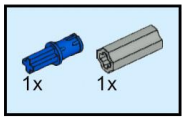


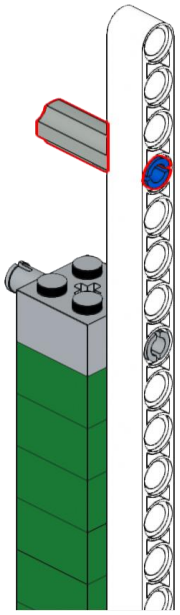
9



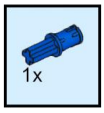


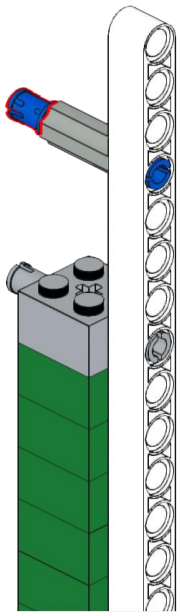
10



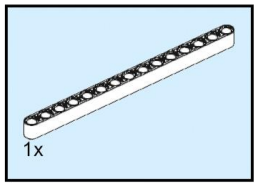


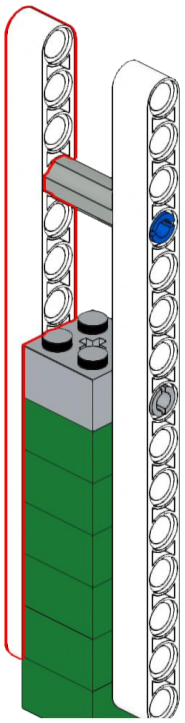
11



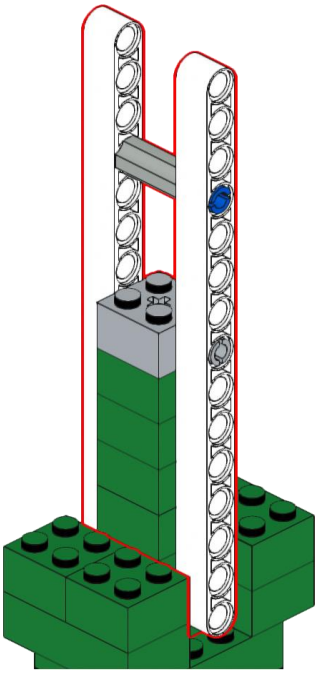


12

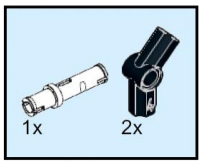


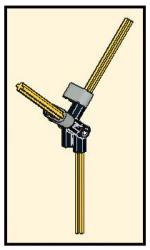


13

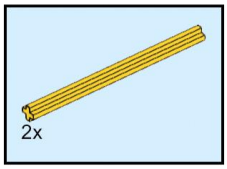


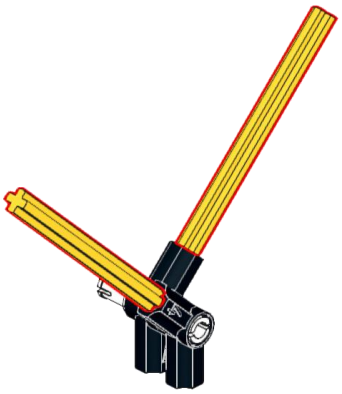
14



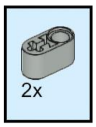


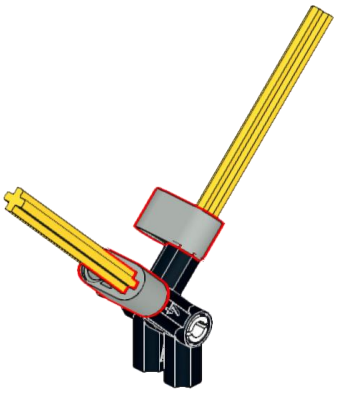
15



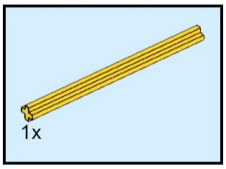


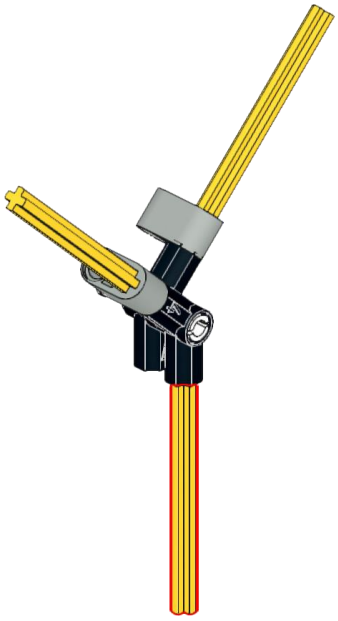
16



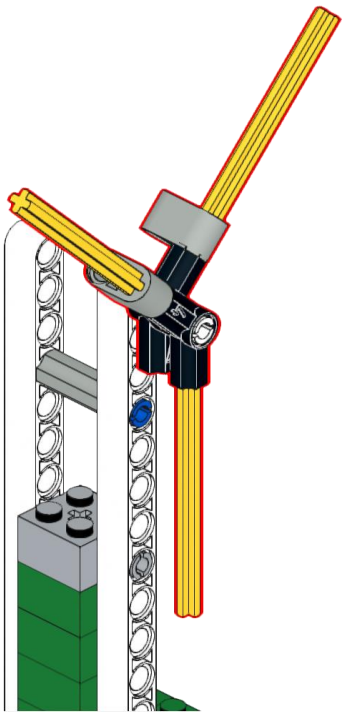


17

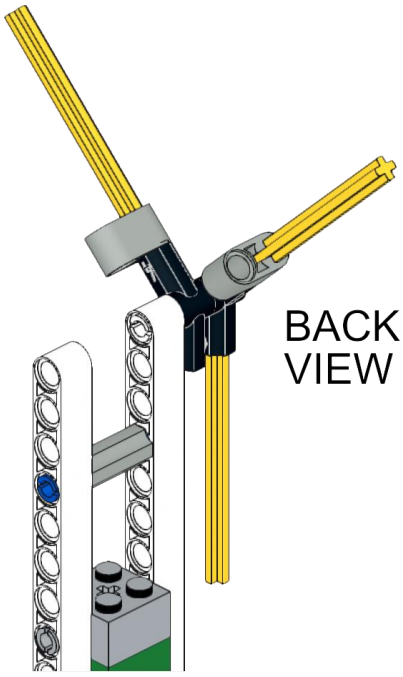




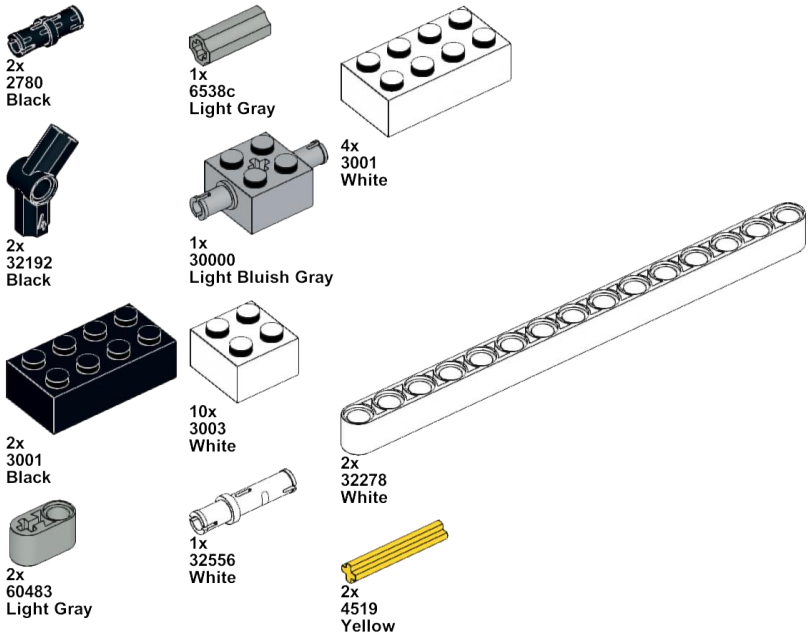
18

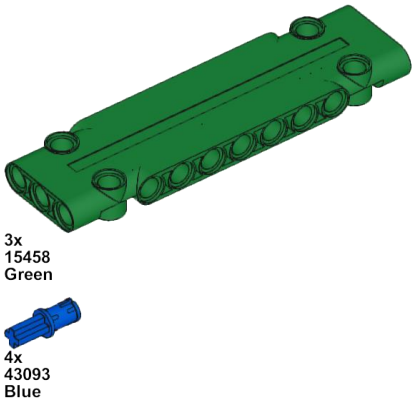


19

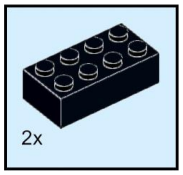


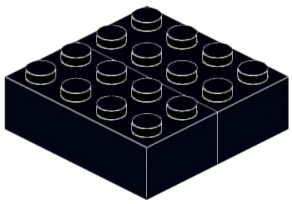
10.2 Wind Turbine White



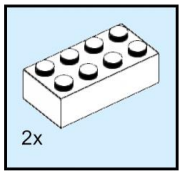


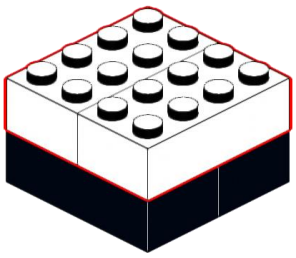
1

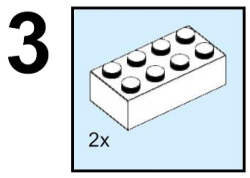


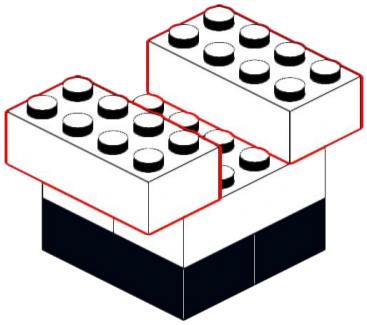


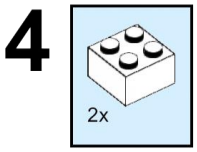
2

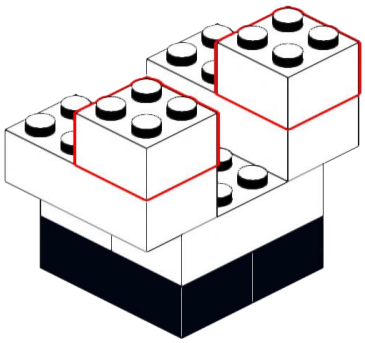




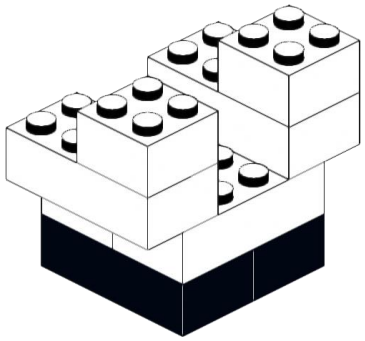

3
2x



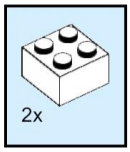

4
2x

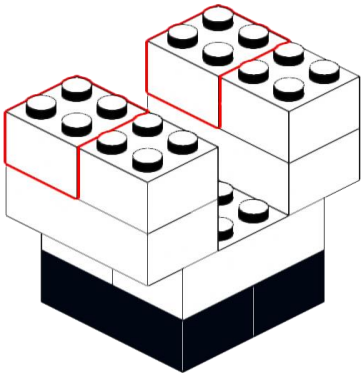


5

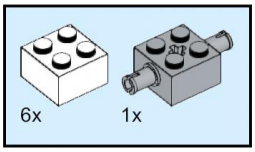


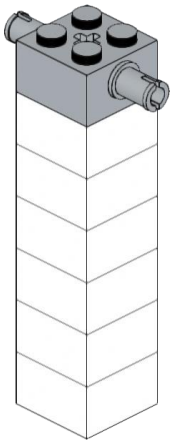
6

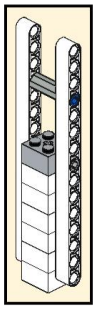




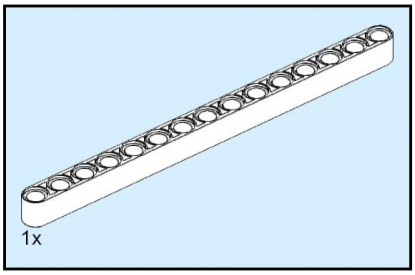
7

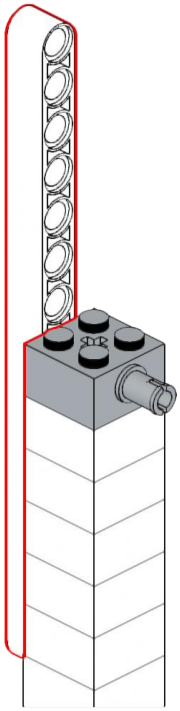




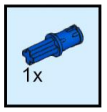


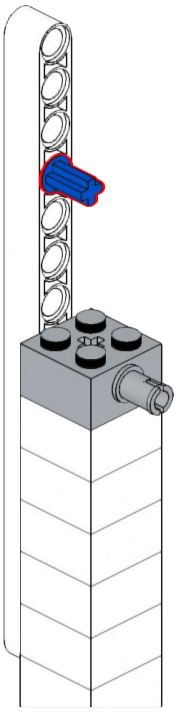
8



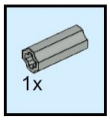


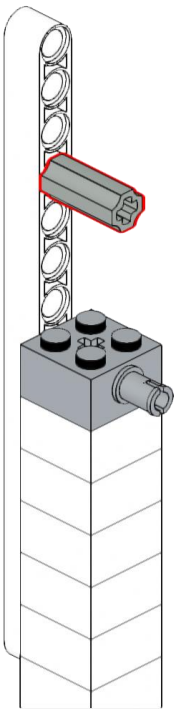
9



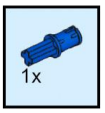


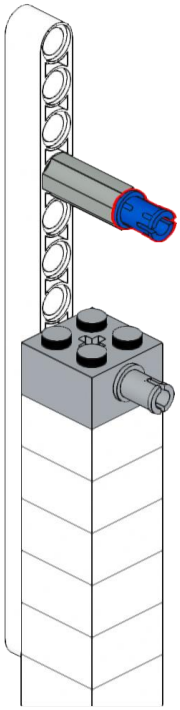
10



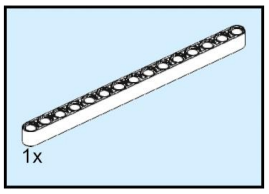


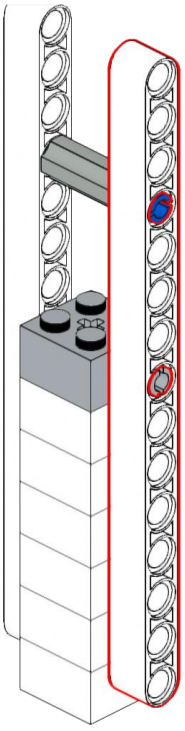
11



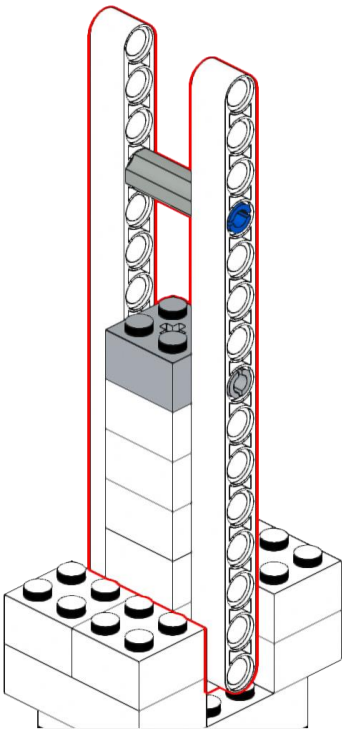


12

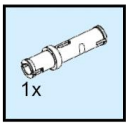


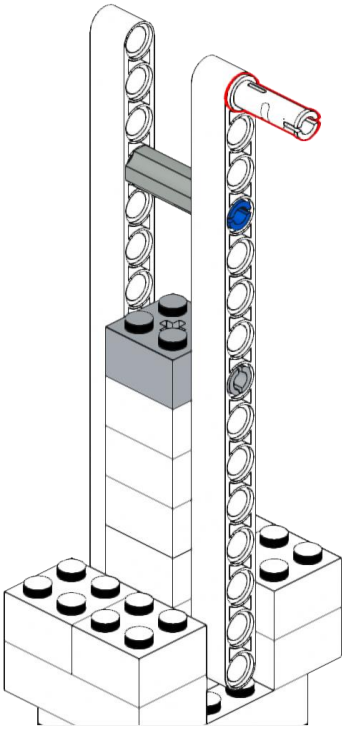


13

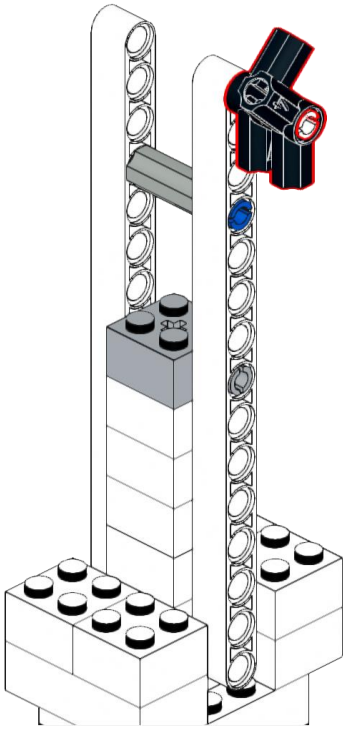


14

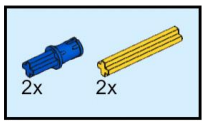


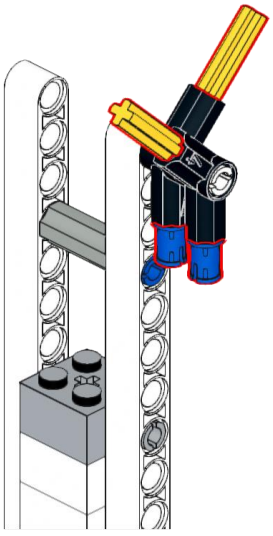


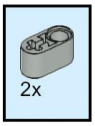
15

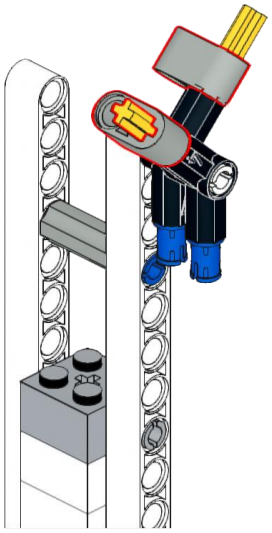


16

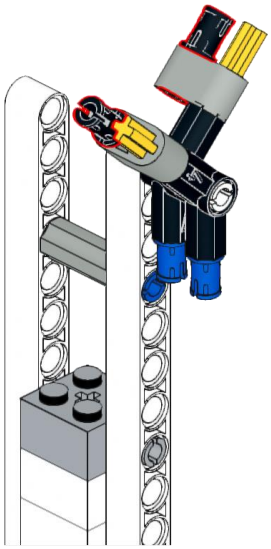




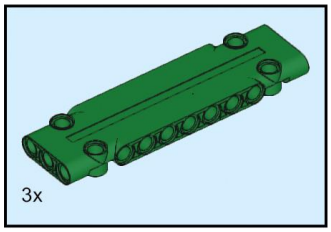
17 

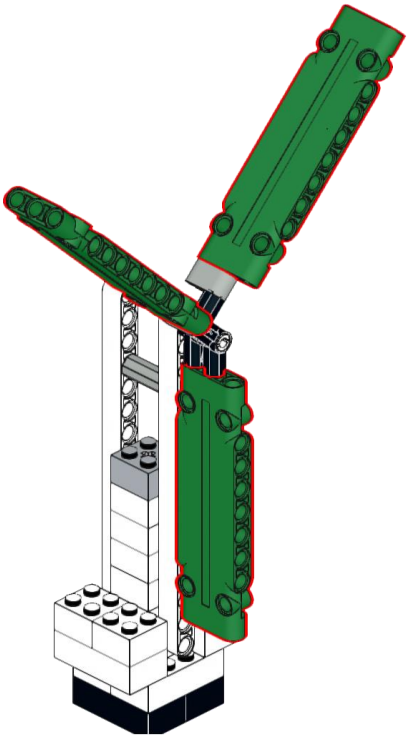


18 

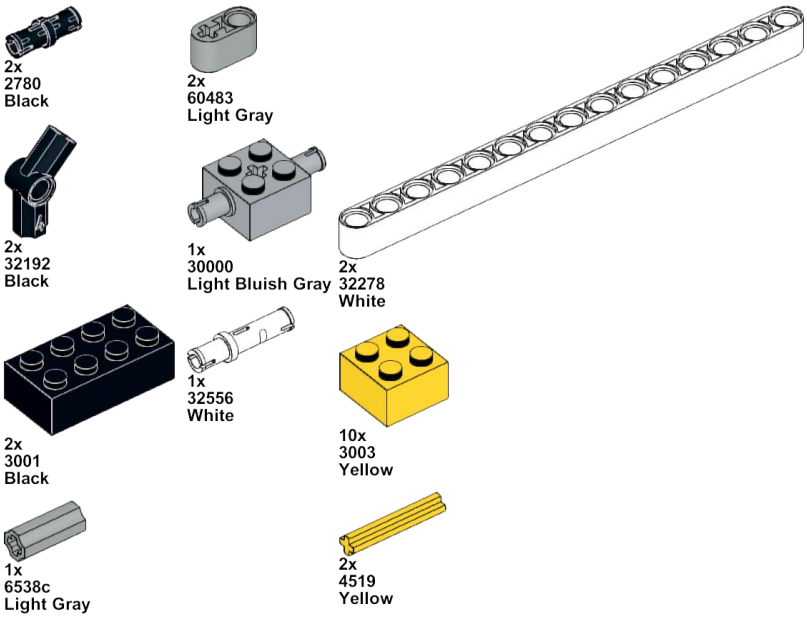


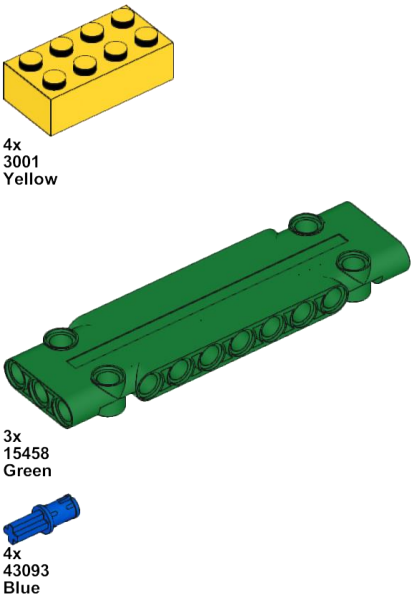
19



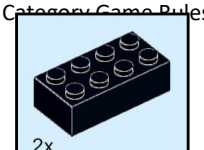


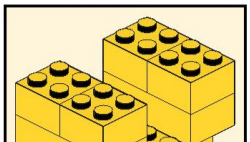
10.3 **Wind Turbine** Yellow

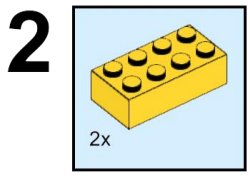


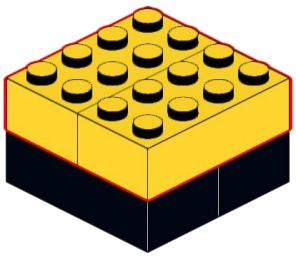


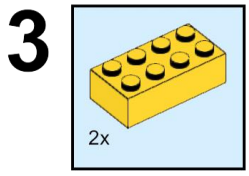
1

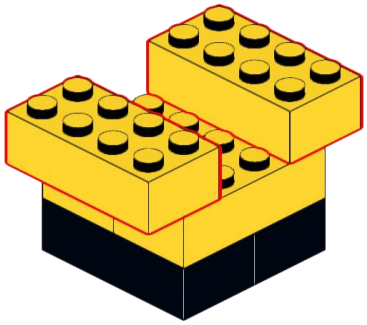


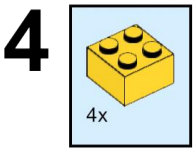


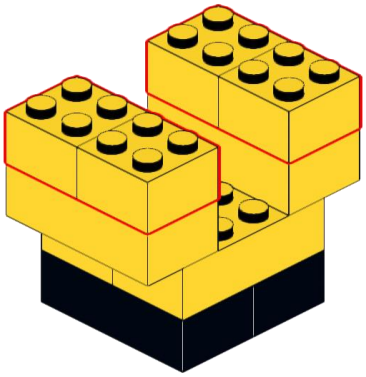

2
2x



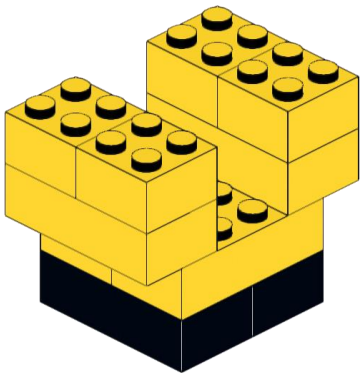

3
2x



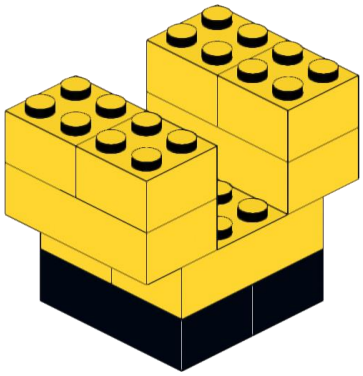

4
4x



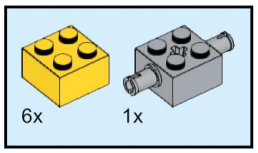
5

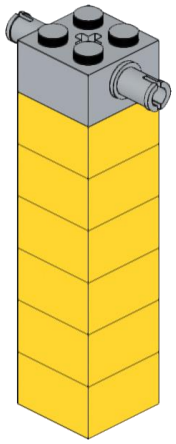


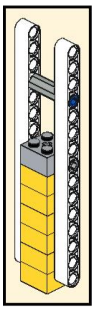
6



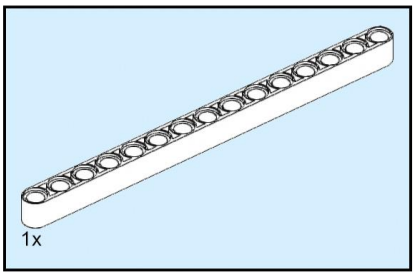
7

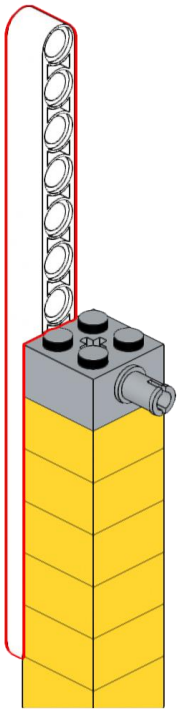




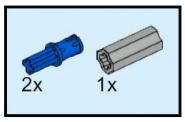


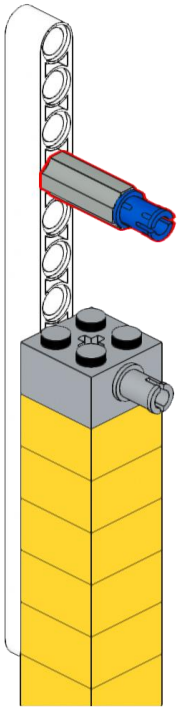
8



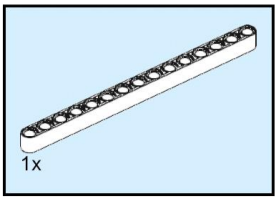


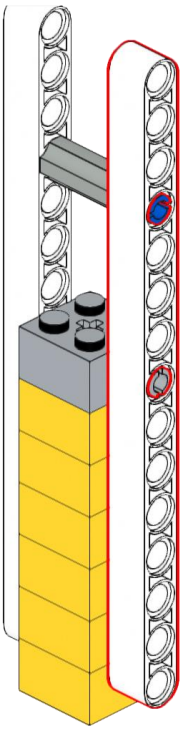
9



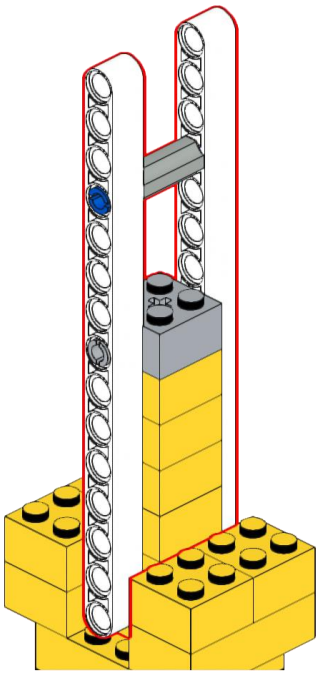


10

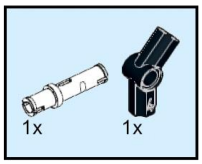


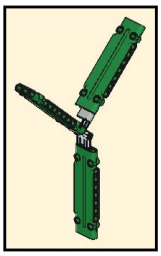


11

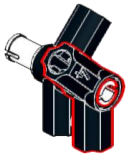


12

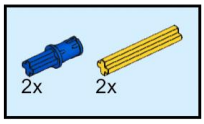


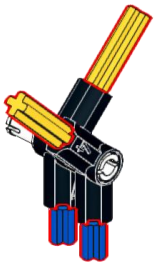


13

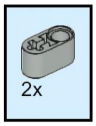


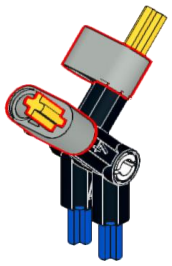
14



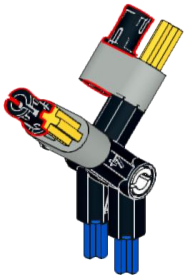


15

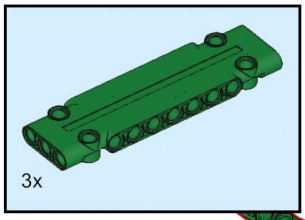


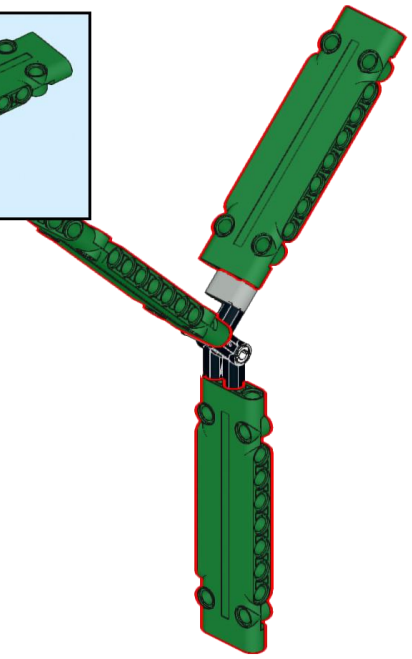


16

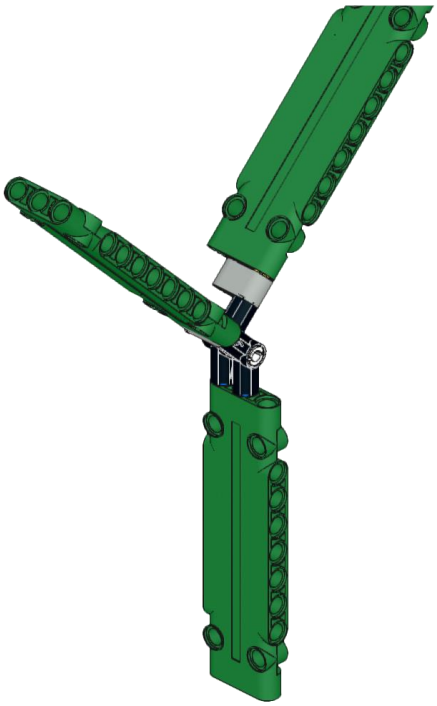


17

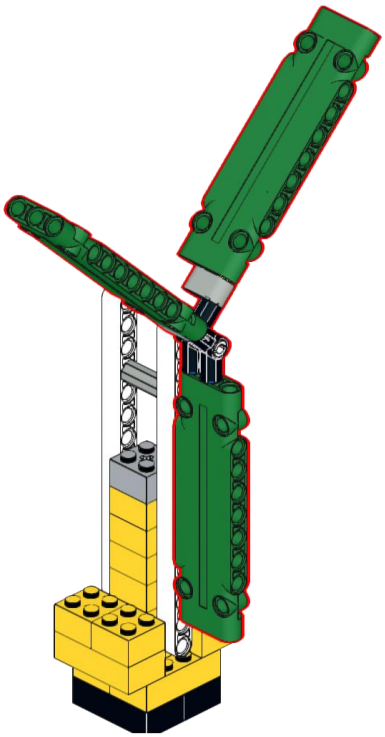




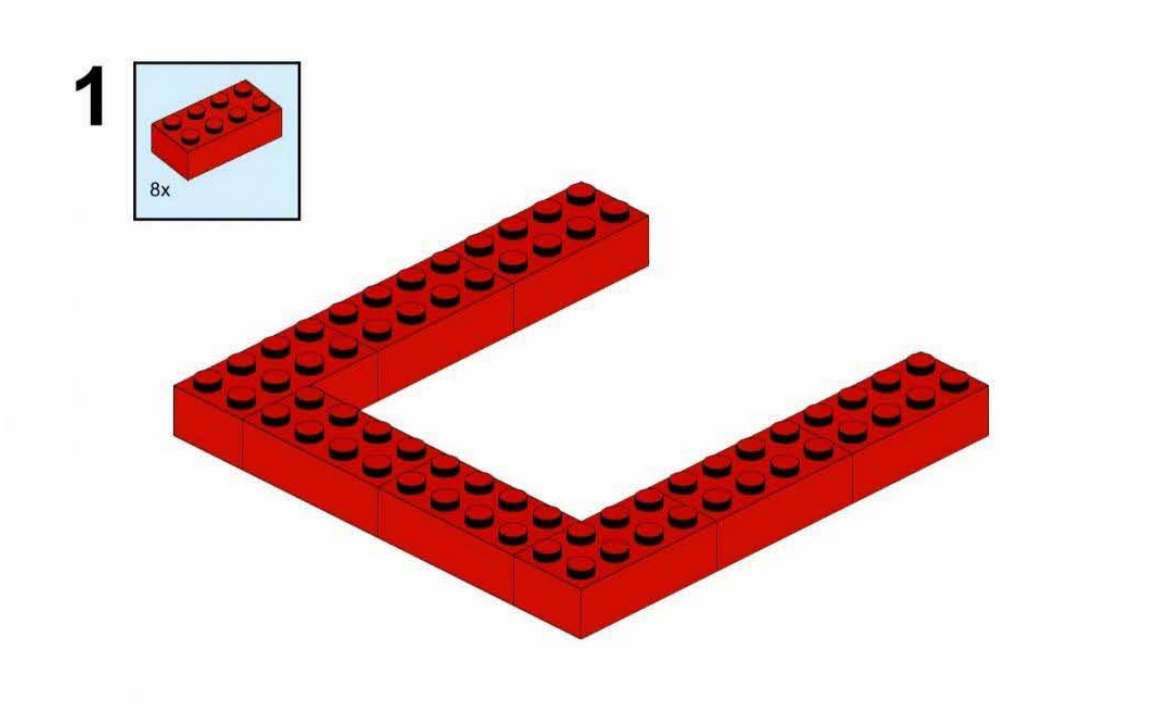
18

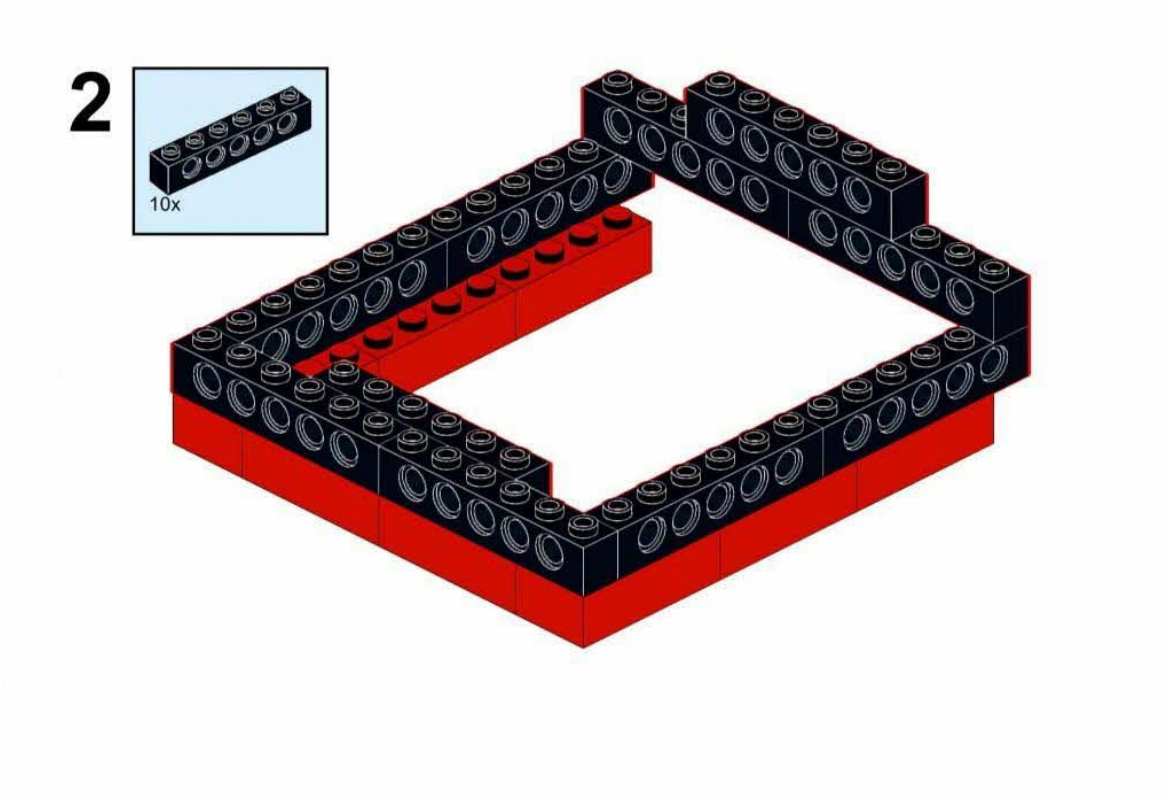


19

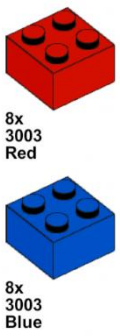


10.4 Wind Turbine Bed



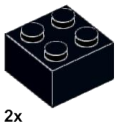


10.5 Energy Units

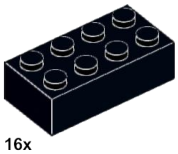


The Energy Units will be randomly dropped within the Energy Bed.

10.6 Wave Breaker

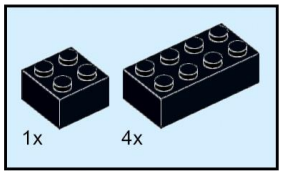


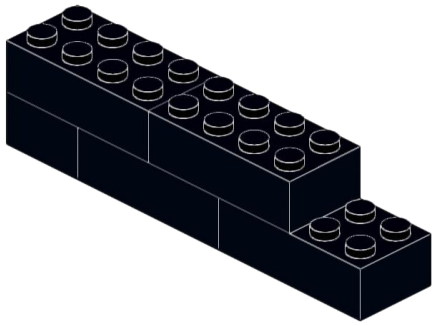
2x
3003
Black



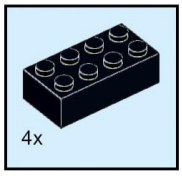
16x
3001
Black

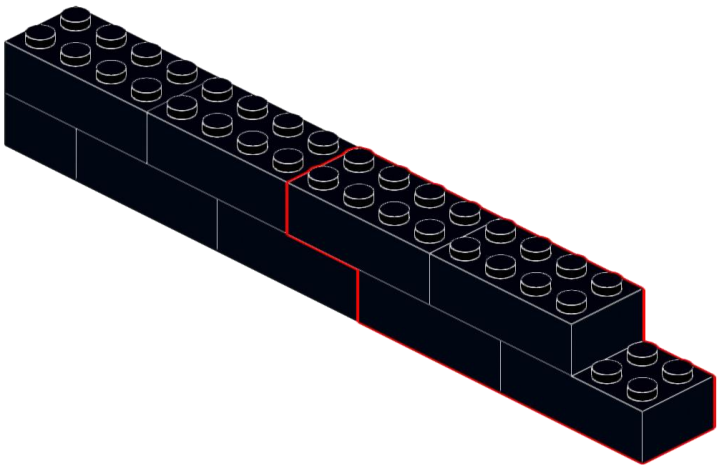
1



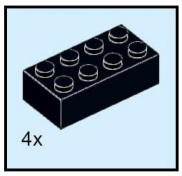


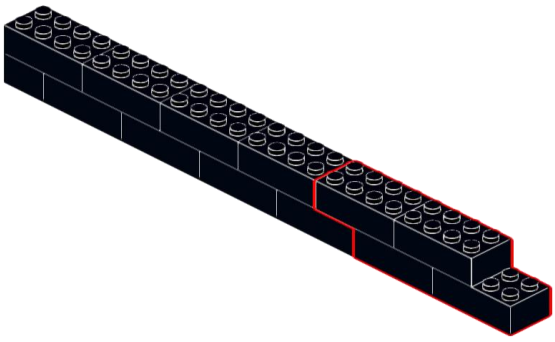
2



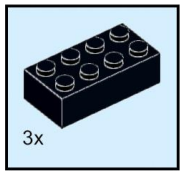


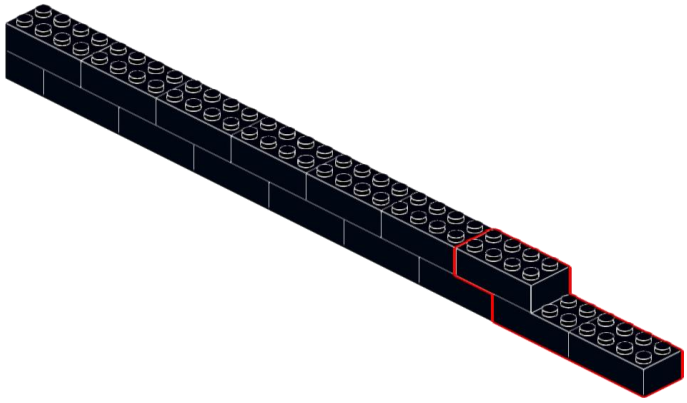
3



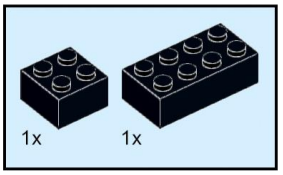


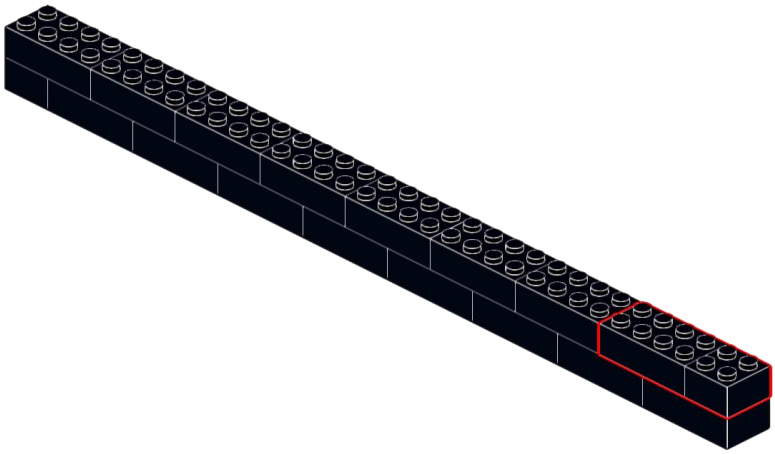
4





5





END